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Original article

Chronic Respiratory Symptoms and Associated Factors among Fruit and Vegetable Workers in Addis Ababa, Ethiopia: A Comparative Cross sectional Study

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ABSTRACT

Background: Fruit and vegetable market is an abundant source of bioaerosols. Exposure to organic and inorganic waste and long-term inhalation of bioaerosols during working hours leads to chronic respiratory symptoms. Hence, this study aimed to determine the prevalence of chronic respiratory symptoms and related factors among fruit and vegetable workers compared with the control group in Addis Ababa, Ethiopia.

Methods and materials: A comparative cross-sectional study was conducted from 2020 to 2021. Data were entered in EpiData 3.1 and exported to Statistical Package for the Social Sciences (SPSS) version 25. Logistic regressions were computed to depict the data and related factors. The culture method was done to count and compare bacterial and fungal concentrations between fruit and vegetable workers and office workers.

Results: In this study, the prevalence of chronic respiratory symptoms (PR = 2.87, 95% confidence interval [CI]: 1.772–4.66) was significantly higher among fruit and vegetable workers (46.7%) than controls (23.4%). Sex (adjusted odds ratio [AOR] = 2.11, 95% CI = 1.12–3.98), educational status (AOR = 1.34, 95% CI = 0.78–2.32), working hours per day (AOR = 3.91, 95% CI = 1.586–9.65), and working department (AOR = 3.20, 95% CI = 0.90–11.40) were associated with chronic respiratory symptoms. Bacterial and fungal concentrations were significantly higher in the air of the vegetable market (276 colony-forming unit) than the air in the workplace of controls (7 colony-forming unit).

Conclusion: The fruit and vegetable market workers (greengrocers) had a higher prevalence of chronic respiratory symptoms relative to office workers. Respiratory protective devices should be given to deliver preventive measures.

1. Background

Respiratory disorders from occupational sources are the major public health problems, accounting for 30% of all reported work-related diseases and 10–20% of deaths worldwide [1]. The study, which was released from the U.S.A., stated that globally, owing to exposure to occupational airborne particulate matter, an estimated 386,000 deaths, and nearly 6.6 million disability-adjusted life years occurred among workers [2]. A study conducted in England showed that chronic respiratory symptoms accounted

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Abbreviations: AAU, Addis Ababa University; AOR, Adjusted Odds Ratio; COPD, Chronic Obstructive Pulmonary Disease; COR, Crude Odds Ratio; CFU, Colony Forming Unit; DW, Distilled Water; PEFR, Peak Expiratory Flow Rate; FVC, Forced Vital Capacity; FEV1, Forced Expiratory Volume in one second forced vital capacity; URTI, Upper Respiratory Tract Infection; PPE, Personal Protective Equipment; TNTC, Too Numerous To Count.

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for 10% and around 12,000 deaths annually from all occupational diseases [3].

Bioaerosols with high bacterial content are responsible for high endotoxin levels in the working environment, which is a major risk factor for respiratory problems among workers in the vegetable market [4]. In addition, vegetable market workers can be exposed to a non-specific irritant, various dust, fumes, and vegetable matters that can increase bronchial reactivity, which in turn can cause bronchospasm [5].

The fruit and vegetable workers are actively engaged in the handling of different vegetables and fruits originating from different localities and exposed to large quantities of bioaerosols, which constitute not only vegetable debris but also a variety of aerosolized microorganisms [6]. Bioaerosols are ubiquitous, highly variable, complex, and natural or man-made in origin. They contain various bacteria, fungi, spores, organic fiber, endotoxin, and peptidoglycan, and many of them may act as allergens, inflammatory mediators, or in some other ways act on the respiratory system. The symptom may appear in the form of various allergic, obstructive, or restrictive lung disorders [7]. The fruit and vegetable market is a rich source of bioaerosols, as loads of fruits and vegetables are loaded and unloaded daily. It is generally known that bioaerosols present in the air can affect human health, mainly transmitted respiratory diseases [8]. Fruit and vegetable market workers face different respiratory symptoms due to improper sanitary conditions in the workplace and the decay of fruit and vegetables. The majority of employers do not provide personal protective equipment (PPE) such as face masks, shoe covers, and rubber boots. In addition, they are not allowed to assure their safety [8].

A comparative cross-sectional study in India showed that the prevalence of acute and chronic respiratory symptoms was higher in vegetable market workers than controls, as were lung function reductions, such as Forced Vital Capacity and Forced Expiratory volume in one second of forced vital capacity relative to controls [9]. Another study among vegetable workers in Rishikesh showed that the prevalence of cough, phlegm, wheezing, and breathlessness was (46.6%), (26.6%), (16.6%), and (23.3%), respectively [4].

The studies in India showed that the results of the microbial count of bacteria and fungi and the measurement of the reduction of lung function parameters among vegetable market workers were different [4,9]. However, the study in Poland did not show any relation to lung function reduction. Thus, there is a controversial result in the published literature, and no study has been conducted to assess the respiratory problem among vegetable market workers in Ethiopia. Therefore, the purpose of this study was to assess the prevalence of chronic respiratory symptoms and associated factors among fruit and vegetable (greengrocer) market workers in Addis Ababa, Ethiopia.

2. Methods and materials

2.1. Study area, period, and design

A comparative cross-sectional study was conducted from September 2020 to June 2021 in fruit and vegetable markets in Addis Ababa, Ethiopia. Addis Ababa is the capital city of Ethiopia and the place of the federal government. The city has 10 large-scale vegetable markets and 119 Woredas (the third levels of the administrative divisions of Ethiopia—after zones and the regional states), which are located in all of the 10 sub-cities.

2.2. Study participants

All fruit and vegetable markets and all office workers in Addis Ababa, Ethiopia were the source populations. The selected respondent workers from three fruit and vegetable markets in Addis Ababa, Ethiopia were the study population. The source population for office workers (the unexposed group) was external workers in the public administration (civil servants).

All workers who had direct involvement in the work of the market had a minimum of one year of work experience, and who were >18 years old were included in the study.

The sample size was determined by using the double population proportion formula, considering the occurrence of wheezing in India among the primary vegetable market workers was 16.6% and 3.3% in controls (4). A 95% power level was used at a significance level of 0.05.

$$n = \frac{(Z\alpha/2 + Z_{\beta})^2 * (P1(1-P1) + P2(1-p2))}{(P1-p2)^2}$$

There are ten large-scale vegetable markets in Addis Ababa; among those, three fruit and vegetable markets were selected by using the lottery method. The sample size was proportionally allocated to these sections. For office workers, three Woredas were selected randomly, and based on the sample size, the sample was proportionally allocated. Finally, using a simple random sampling technique, the study participants were selected for both groups (exposed and control).

2.3. Variables

Dependent variable: Chronic respiratory symptoms.

Respiratory symptoms: those respondents who had at least one respiratory illness symptom for example cough, cough with sputum, breathlessness, and wheezing in the last 12 months before study time (10).

Chronic respiratory symptoms: The development of one or more of the chronic symptoms of a cough, cough with sputum, breathlessness, wheezing, and chest illness that lasts for at least three months in one year [10].

Independent variables: Duration of exposure, length of working hours, past dust exposure, socio-demographic status (age, sex, income, educational status), smoking habit, availability and usage of PPE, training, and ventilation.

2.4. Data collection tool and procedures

Data were collected by using face-to-face interviews, observational and bacterial and fungal culture methods. The questionnaire was adopted by the British Medical Research Council [11]. The questionnaire consisted of five parts: socio-demographic characteristics, work history, common chronic respiratory symptoms, behavioral factors of workers, and clinical factors. An observational checklist was used to describe the importance of PPE and working environment neatness. The culture methods were used to assess the microbial load in the vegetable markets. Two types of cultures were used: fungal counts and bacterial counts. We produced solutions with 23.5 gm of aerobic plate court agar per 1000 mL of distilled water for bacterial and 40 gm of yeast and mold agar per 1000 mL of distilled water for fungal, then autoclaved at 120°C for 15 minutes and cooled at 550°C. Then we sterilized Petri dishes and poured the media into each set of Petri dishes. The culture was kept at three distinct sites of the vegetable market, about 50–80 m apart at the same level from the ground and 5 m away from the stores so that it was not specialized to a particular type of vegetable shop. They were exposed to air for 18 minutes, closed, and incubated at 300°C for 72 hours before counting the microbes.

2.5. Data quality assurance

Standardized questionnaires and skilled professionals (environmental health and microbiologists) were involved in data collection. Before data collection training was given to data collectors and supervisors on data collection procedures, the information collected, and the aim of the study. A pre-tested was done on 5% of workers outside the selected fruit and vegetable markets and offices. The apparatus was calibrated, and refrigeration was prepared before starting procedure on a daily and weekly basis. Cold boxes were used for transporting samples from the laboratory to the places where they were taken for the sake of their safety.

2.6. Data processing and data analysis

The data were collected, cleaned, and entered in EpiData version 3.1 and exported to SPSS version 25 for analysis. Descriptive statistics were used to summarize the data. The Chi-square test was applied to detect the difference between fruit and vegetable workers and office workers. A 95% confidence interval (CI) was used to show the relationship between the exposure variable and chronic respiratory symptoms. Binary logistic regression and independent t-tests were used to compare the prevalence of chronic respiratory symptoms among greengrocers and office workers. Bacterial and fungal concentrations in samples of air were also compared in two groups with respect to their types and number of colony-forming units (CFU).

3. Results

3.1. Socio-demographic and behavioral characteristics of respondents

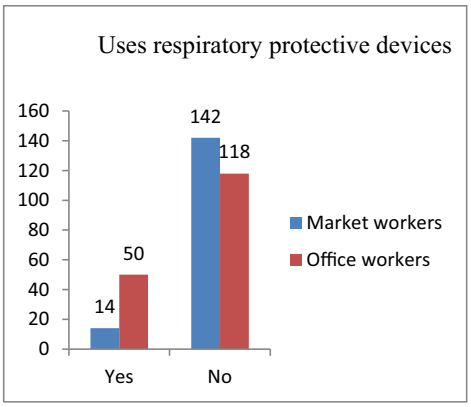
Of the total of 316 workers invited to participate, 314 workers participated in our study, with a response rate of 99.4%. Of these, 221 (70.4%) were males. The mean age of office and fruit and vegetable market workers were 36.36 ± 9.049 and 36.24 ± 12.015 SD, respectively. Fifty-nine (37.8%) fruit and vegetable market workers had completed the primary level of education, and 132 (83.5%) office workers had attained a diploma and above level of education (Table 1).

Table 1
Socio-demographic and behavioral characteristics of fruit and vegetable market and office workers, Addis Ababa city, Ethiopia, 2020

Variables	Categories	Fruit and vegetable workers ($n = 156$) frequency	Office worker ($n = 158$) frequency	X^2-test
Sex	Male Female	111 (71.2%) 45 (28.8%)	111 (69.6%) 47 (30.4%)	0.861
Age in year	≤29 30–39 ≥40	63 (40.5%) 36 (23.7%) 57 (35.8%)	46 (29.2%) 57 (35.4%) 55 (35.4%)	0.025
Educational status	Primary education (1–8) Illiterate Secondary education 9–12 Certificate and above	60 (38.5%) 17 (10.9%) 42 (26.9%) 37 (23.7%)	14 (8.9%) 0 (0.0%) 12 (7.6%) 132 (83.5%)	0.00
Monthly income	≤2000 2000–4000 >4000	7 (4.5%) 92 (60.3%) 57 (35.3%)	7 (4.4%) 32 (19.0% 119 (76.6%)	0.00
Uses of RPE	Yes No	14 (8.9%) 142 (91.1%)	50 (31.6%) 108 (68.3%)	0.001
Ever smokers	Yes No	20 (12.8%) 136 (87.2%)	24 (15.2%) 134 (84.8%)	0.545
Current smoker	Yes No	15 (9.6%) 141 (90.4%)	5 (3.2%) 153 (96.8%)	0.019

Table 2
Work-related factors and past respiratory illnesses of workers, Addis Ababa city, Ethiopia 2020

Variables	Categories	Fruit and vegetable workers ($n = 156$) frequency	Office worker ($n = 158$) frequency	X^2-test
Working departments	Loading and unloading Cleaning Packaging/sales Office work	64 (39.8%) 18 (11.9%) 76 (48.3%) NA	NA NA NA 158 (100%)	0.001
Working hours per day	≥8 hours <8 hours	106 (67.9%) 62 (39.7%)	151 (95.6%) 7 (4.4%)	0.002
Work experience	1–5 years 6–9 years ≥10 years	89 (57.1%) 30 (19.2%) 37 (23.7%)	56 (35.4%) 55 (34.8%) 47 (29.7%)	0.001
Past dust exposure	Yes No	47 (30.1%) 109 (69.9%)	11 (7.0%) 147 (93.0%)	0.001
Energy used at	home Charcoal Electricity	32 (20.5%) 124 (79.5%)	2 (2.2%) 89 (97.8%)	0.003
Previous respiratory illness	Yes No	37 (23.7%) 119 (76.3%)	17 (10.8%) 141 (89.2%)	0.002



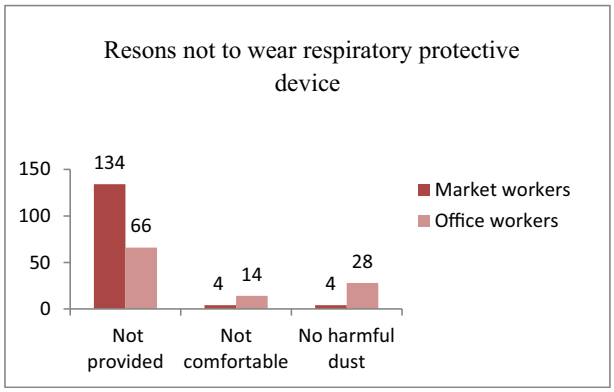


Fig. 1. Uses of respiratory protective devices and the reason not used by the workers, Addis Ababa Ethiopia, 2021.

3.2. Work-related factors among fruit and vegetable market workers and office workers

Of 314 study participants, 47 (30.1%) were fruit and vegetable market workers, and 11 (7.0%) office workers were experienced in dusty working environments before they started this job. Out of the fruit and vegetable market workers, 30 (19.2%) had worked in the market for more than ten years. Five (3.2%) office workers and 62 (39.7%) market workers were working more than 8 hours per day. Of the total fruit and vegetable market workers, 48 (30.8%) of them were engaged in the loading and unloading department. Majority of fruit and vegetable workers 111 (71.2 %%) and office workers 115 (72.8%) used electricity for energy sources at home (Table 2).

3.3. Respiratory protective devices

Of the total participants, 14 (8.9%) of fruit and vegetable workers, and 50 (31.6 %) office workers used respiratory masks. PPE was not used by any of the 134 (85.9%) fruit and vegetable workers and 79 (50%) office workers since it was not provided (Fig. 1).

3.4. Prevalence of chronic respiratory symptoms among fruit and vegetable market workers and office workers

The overall prevalence of chronic respiratory symptoms among fruit and vegetable workers and office workers were 73(46.7%) and 37(23.4%), respectively. The prevalence ratio of all of the chronic respiratory symptoms was significantly higher for the fruit and vegetable workers than controls after adjusting for education, previous and family history of the disease, the use of respiratory protective devices, and years worked in other dusty work places, safety training, and work places supervision. The likelihood of a fruit and vegetable market worker developing at least one respiratory symptom was 2.73 times higher than office workers (Fig. 2).

3.5. Workplace observation

Observational findings of the study showed that fruit and vegetable wastes, as well as dust accumulated on the walls of different working sections of the market shops, presence of stray animals in the area, decomposition and decay of agricultural products, and lack of appropriate waste disposal materials, lack of artificial and natural ventilation. Fruit and vegetable market managers did not provide sufficient respiratory protective devices for the workers, as shown in the (Figure).

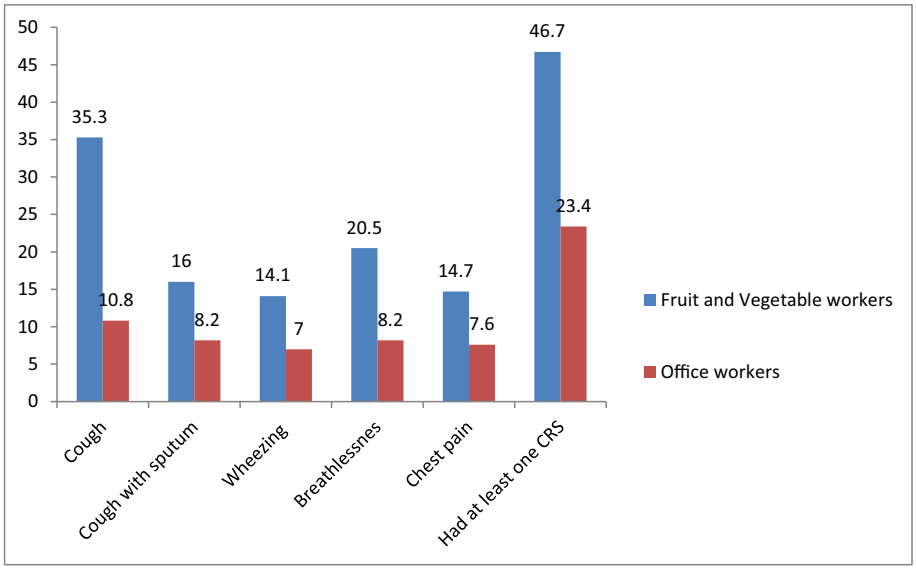


Fig. 2. Prevalence of respiratory symptoms among fruit and vegetable and office workers, Addis Ababa, Ethiopia, 2021.




3.6. Factors associated with chronic respiratory symptoms among fruit and vegetable market workers and office workers

On multivariate logistic regression analysis, sex, age, monthly income, service year, and educational status of respondents were significantly associated with chronic respiratory symptoms. Workers who had primary (Grade 1–8) and below education level were 1.34 (95% CI: 0.78–2.32) times more likely to develop chronic respiratory symptoms than those who had secondary (Grade 9-12) and above education level. Male respondents were 2.11 times (adjusted odds ratio [AOR] = 2.11, 95% CI: 1.12–3.98) more likely to develop chronic respiratory symptoms than female respondents.

Working departments were significantly associated with chronic respiratory symptoms among fruit and vegetable market workers. Workers who had engaged in loading and unloading were 3.2 times (AOR = 3.20, 95% CI = 0.90–11.40) more likely to develop chronic respiratory symptoms than those who had engaged in cleaning and packaging/sales sections.

Service years in the market were significantly associated with chronic respiratory symptoms. Workers who had work experience of 6–9 years (AOR = 1.73, 95 % CI = 0.71–4.19) and ≥10 years (AOR = 7.16, 95 % CI = 2.52–20.30) were 1.73 and 7.16 times more likely to develop chronic respiratory symptoms than those who had work experiences between 1 and 5 years, respectively. Participants who had a monthly income ≤2000 ETB were 3.01 (1.34–6.76) times more likely to develop chronic respiratory symptoms than those who had a monthly income of ≥4000 Ethiopian birr. Workers who stayed longer than 8 hours per day were 3.91 times (AOR = 3.91, 95% CI, 1.586–9.65) more likely to develop chronic respiratory symptoms than those who stayed ≤8 hours per day (Table 3).

3.7. Microbial load

On doing the microbial sampling of the air, bacterial and fungal concentrations were found to be significantly higher in the air of the vegetable market (276 CFU/m^3) than that of the air in the workplace of controls (7 CFU/$m^{3)}$. The results of air culture in terms of the growth of bacteria and fungi were found in various culture media at their incubation temperatures, as shown in (Table 4).

4. Discussion

This study compared the prevalence of current respiratory symptoms between fruit and vegetable market workers and office workers. The result of this study found that fruit and vegetable market workers had a higher prevalence of chronic respiratory symptoms than office workers, such as cough (35.3%) vs. (10.8%), phlegm (16.0%) vs. (8.2%), wheezing (14.1%) vs. (7.0%), breathlessness (20.5%) vs. (8.2%), and chest pain (14.7%) vs. (7.6%), respectively. This study is supported by the studies done in India and the Republic of Iran, which report a higher prevalence of chronic respiratory symptoms [9,12]. Various factors, such as the collection of agricultural items from diverse sources, the spraying of fruits and vegetables with water leading to suspension of microorganisms in the air, the decomposition and decay of agricultural products, poor sanitation, and improper waste disposal, may be responsible for the generation of organic dust and thus the compromised respiratory status of fruit and vegetable workers was exposed to them.

PPE utilization practice of the fruit and vegetable workers suggested a lower frequency. However, some workers harmonized in opinion on the relevance of wearing PPE to keep themselves from bioaerosols, but the market owners do not provide PPE for workers, which is in line with a study in India [13] and had discrepancies in studies done in India and Iran [4,12]. It may be their differences in using PPE, the ventilation system they used, and how to collect the wastes they generate.

In this study, sex is associated with the development of chronic respiratory symptoms. Male respondents had 2.11 times (AOR = 2.11, 95% CI (1.12–3.98)) higher chance of developing chronic respiratory symptoms than female respondents. This is

Table 3
Multivariable models of factors associated with chronic respiratory symptoms among fruit and vegetable market workers and controls in Addis Ababa, Ethiopia, May, 2020

Variables	Categories	At least one chronic respiratory symptoms		COR (95% CI)	AOR (95% CI)
		Yes	No		
Sex	Male	89 (80.9%)	133 (65.2%)	2.26 (1.29–3.94)	2.11 (1.12–3.98) *
	Female	21 (19.1%)	71 (34.8%)	1	1
Age (in years)	≤29	32 (29.1%)	77 (37.7%)	1	1
	30–39	23 (20.9%)	70 (34.3%)	0.80 (0.481.43)	1.92 (0.87–4.24)
	≥40	55 (50.0%)	57 (27.9%	2.32 (1.33–4.04)	2.25 (1.05–4.85)
Educational status	Primary school and below	60 (54.5%)	31 (15.2%)	6.69 (3.919–11.44)	1.34 (0.78–2.32)**
	Secondary school and above	50 (45.5%)	173 (84.8%)	1	1
Monthly income	≤2000	7 (6.4%)	7 (3.4%)	1.72 (1.07–2.74)	3.01 (1.34–6.76) *
	2000–4000	39 (31.5%)	85 (41.7%)	0.83 (0.48–1.43)	1.39 (0.35–5.48)
	>4000	64 (58.2%)	112 (54.9%)	1	1
Service year	1–5	24 (21.8%)	121 (59%)	1	1
	6–9	38 (34.5%)	47 (23.0%)	1.64 (0.898–3.02)	1.73 (0.71–4.19)
	≥10	48 (43.6%)	36 (17.6%)	6.72 (3.63–12.43)	7.16 (2.52–20.30)**
Working hours per day	<8 hours	46 (41.8%)	11 (5.4%)	12.61 (6.16–25.80)	3.91 (1.586–9.65) **
	≥8 hours	64(58.2%)	193(94.6%)	1	1
Working departments	Loading and unloading	38 (31.7%)	13 (6.7%)	9.9 (3.47–14.5)	3.20 (0.90–11.40)**
	Cleaning	15 (12.5%)	5 (2.6%)	10.01 (3.67–14.70)	1.41 (0.28–7.14)
	Packaging/sales	21 (17.5%)	64 (33.0%)	1.1 (0.29–3.20)	1.05 (0.098–11.3)
	Office work	36 (38.3%)	122 (57.7%)	1	1
Previous dust exposure	Yes	68 (61.9%)	78 (38.3%)	2.61 (1.75–3.79)	0.05 (0.02–0.18)
	No	42 (39.1%)	126 (61.7%)	1	1
Safety training	Yes	6 (5.5%)	68 (33.3%)	1	1
	No	104 (94.5%)	136 (66.7%)	8.66 (3.62–20.75)	2.118 (0.32–13.66)
Uses of RPE	Yes	4 (3.6%)	60 (29.4%)	1	1
	No	106 (96.4%)	144 (70.6%)	11.04 (3.89–31.32)	2.09 (0.44–9.75)

AOR, adjusted odds ratio; CI, confidence interval; COR, crude odds ratio; ** = p-value at (0.001), * = P < 0.05.

Table 4
Results of air culture in terms of growth of bacteria and fungi from vegetable workers at AA (2022)

Sites	Parameters					
	Aerobic plate count				Yeast and mold	
	Vegetable market			Work place control	Vegetable market area	Work place (control)
	Market 1	Market 2	Market 3			
Site 1	230 CFU	400 CFU	240 CFU	10 CFU	Too numerous to count	Nil
Site 2	180 CFU	270 CFU	210 CFU	NIL	Too numerous to count	Nil
Site 3	290 CFU	330 CFU	325 CFU	10 CFU	Too numerous to count	Nil
control	Nil	Nil	Nil	Nil	Nil	Nil
Average	234 CFU	334 CFU	258 CFU	7 CFU	Too numerous to count	Nil
Overall average	276 CFU			7 CFU	Too numerous to count	Nil

"CFU", colony forming unit, "TNTC", Too numerous to count.

supported by a study done in Ethiopia's Dejn town [14] and contradicted by a study in Thailand [15]. Evidence showed that the available data suggest that males are more susceptible than females to most types of respiratory tract infections in all age groups. The role of sex hormones in the regulation of the immune system may also contribute to the reported sex differences in the incidence and severity of the various types of respiratory tract infections, especially in adolescents and adults [16].

This study indicated that educational level was one of the sociodemographic factors associated for chronic respiratory symptoms. Those who attend primary school were more likely to develop chronic respiratory symptoms. This result was in line with a study conducted in Ethiopia [14]. This might be because higher education raises awareness about how to protect themselves from health effects associated with their work.

In this study, workers who were engaged in loading and unloading were 2.74 times more likely to develop chronic respiratory symptoms than those in packaging or sales departments. This result is in agreement with the studies conducted in comparative cross-sectional studies in Ethiopia [17,18]. However, this is inconsistent with the study in Dejen town [17]. This might be a result of how frequently they use respiratory protective devices, safety training, and workplace supervision differences.

Employees who had work experience of 6–9 years and ≥10 years were significantly associated with chronic respiratory symptoms. This result was consistent with the studies conducted in Iraq and Egypt [19,20]. This might be due to the increased amount of dust retention in respiratory system associated with extended exposure at work places.

On doing the microbial sampling of the air, bacterial and fungal concentrations were found to be significantly higher in the air of vegetable market (276 CFU/m^3) than the air in the workplace of controls (7 CFU/$m^{3)}$. The finding was partly consistent with the study in India that fungal and bacterial concentrations in market air (0.36 × 105 to 2.45 × 105 CFU/m3 and 1.13 × 105 to 1.042 × 106 CFU/m3), respectively, were much higher ($p < 0.001$) than that in control residential air (0.28 × 103 to 0.40 × 103 1.042 × 106 CFU/m3), respectively. The current study (276 CFU/m3 vs. 7 CFU/m3) partly consistent with the study in India, which found coagulase-negative staphylococci >25 CFU at incubation

temperature of vegetable market versus 10–12 CFU of the control at incubation temperature [4,9]. The reason that bacterial and fungal concentrations were found to be significantly higher in the air of the vegetable market than the air in the workplace of controls is due to the decay of agricultural commodities [21]. In addition, spraying of fruits and vegetables with water leads to the suspension of microorganisms in the air, the presence of stray animals in the area, decomposition and decay of agricultural products, and poor sanitation and improper waste disposal may be responsible for the generation of organic dust and thus cause respiratory symptoms among participants exposed to them.

4.1. Limitations of the study

Recall bias in answering questions relating to reported age, past dust exposure, and past respiratory disease. Since the study was cross-sectional, it is difficult to investigate the temporal relationship between outcomes and associated factors.

In this study, respiratory symptoms were raised in vegetable market workers. So, we can say that exposure to bioaerosols in a working vegetable market is associated with chronic respiratory symptoms. So, there is a requirement for the formulation of safety guidelines in the area.

Education level, duration of exposure (service years), work departments, and length of working hours are the associated factors for the development of chronic respiratory symptoms. The majority of participant in fruit and vegetable industry did not have respiratory protective devices. In general, the results of this study concluded that working in fruit and vegetable markets without proper respiratory protective devices hurt the workers respiratory health.

Recommendation

The Ministry of Labor and Social Affair jointly with the Ministry of Health and Ministry of industry should have scheduled and continuous workplace supervision and awareness creation to guarantee the health and well-being of workers in large-scale fruit and vegetable market. And also, the dust control methods such as improved ventilation/filtration and/or dust control at the source should be implemented. The fruit and vegetable market shop owners should provide all the necessary respiratory protective devices. The fruit and vegetable market owners should implement urgent measures to reduce environmental bio-aerosol exposure in the market, like concrete walls and roads, frequent waste collection in modern bins and mechanized disposal of vegetable waste in the long run. The fruit and vegetable market workers should have habituated respiratory protective devices, particularly face masks if provided by the owners while on work to minimize the harmful health effects of the bioaerosols (organic dust). It is advisable to conduct a prospective cohort study and a larger sample size to characterize the association between bioaerosol exposure and chronic respiratory symptoms among large-scale fruit and vegetable markets.

Funding

No external funding was obtained for this study. The administrators of Addis Ababa University indirectly supported this project and had no role in study design, data collection, data analysis, data interpretation, or writing the report. The corresponding author had full access to all data in the study and had responsibility for the decision to send it for publication.

Informed consent and patient details

This study was conducted after approval of the proposal by Addis Ababa University College of Medicine and Health Sciences institutional review board committee. Before the actual data collection, ethical approval and clearance were obtained from this board. Permission and a supportive letter were obtained from the Addis Abeba Trade Institute. Participation was voluntary, and information was also collected anonymously after obtaining written consent from each respondent by assuring confidentiality. The participants were also told the objective of the study and their rights to refuse, stop, or withdraw at any time during data collection. Finally, participants were informed that there was no incentive or harm to their participation in this study.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Consent for publication

Not applicable.

Conflicts of interest

The authors declare that we have no competing interests.

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