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Assessment of Respiratory Symptoms and Lung Functional Impairments among a Group of Garbage Collectors

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ABSTRACT

Garbage collectors are occupationally exposed to a variety of airborne contaminants. The main objective of this study was to evaluate the respiratory health of garbage collectors. This study was carried out in Fars Province, south of Iran. A group of 105 garbage collectors and 93 referent subjects were investigated. A standard questionnaire was administered to both groups. Furthermore, subjects underwent Pulmonary Function Tests. The data revealed that a few symptoms of respiratory disease were significantly more prevalent among garbage collectors. Likewise, significant decrements were observed in some parameters of pulmonary function such as FEV1and FEV1/FVC ratio among garbage collectors. The ventilatory disorder found in spirometry of garbage collectors was consistent with that of obstructive pulmonary disease. Our findings indicate that the prevalence of respiratory symptoms as well as impaired lung functional capacities were more common among garbage collectors than in their control counterparts. This is likely to be attributed to the occupational exposure of this group to workplace contaminants, particularly, bioaerosols.

Keywords: *Garbage Collectors, Pulmonary Function Tests, Obstructive Pulmonary Disease, Respiratory Symptoms*

INTRODUCTION

A large group of workers is involved in municipal waste collection and utilization. Generally, the process of waste management starts already in the place of its origin, namely in households. From there, waste is directly transported to a dumping ground or it is treated by sorting, composting, burning and storing [1].

Municipal solid waste workers (MSWWs) (Persons employed in public or private organizations or companies, involved or play a role in collecting waste from the residential areas, hospitals, commercial and industrial centers, etc., or in the process of transporting waste and the process of waste disposal) play an important role in maintaining the health and hygiene in the cities. This job exposes municipal solid waste workers to a variety of risk factors such as dust, bioaerosols, chemicals caused by burning solid waste,

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smoke and fume arising from automobile exhaust and noise, unfavorable climatic conditions, ultraviolet rays, infrared and visible light and mechanical stress, which make them susceptible to certain occupational diseases. Handling and disposal of waste is associated with inevitable exposure to a large number of pathogenic and non pathogenic microorganisms and germs [2]. Therefore, exposure to Bioaerosols is the major occupational risk factor of garbage collectors.

In many countries municipal solid waste is collected manually by traditional methods [3] .There is increasing evidence that exposure to bioaerosols is associated with health effects such as respiratory diseases [4].

In a study on the pattern of lung disease among street sweepers of Nagpur, India, chronic bronchitis was significantly more prevalent among garbage collectors than in a control group [1]. Similarly, the prevalence of chronic bronchitis and asthma was significantly higher in Copenhagen trash sweepers than in a group of graveyard workers. The risk of chronic bronchitis was calculated as 3.2 and the amount of air pollutants from traffic, were below the standard limits [5].Conversely, TschoppA, Bernard A, et al. in a study of 52 MSWWs, in Switzerland did not find any significant difference between the parameters of pulmonary function in garbage collectors and the reference group [6]. There was not any positive case of tuberculosis (TB), or radiographic evidence of pulmonary diseases in chest x-ray of a group of garbage collectors in Sari, north of Iran [7].

Therefore, due to the above controversies, further research in this field is clearly needed. Moreover, on a national scale, extensive research on respiratory disorders among different occupational groups has been strongly recommended. Given the above and owing to the fact that previously conducted studies on respiratory health of garbage collectors suffer from methodological limitations, selection bias, lack of control for confounding variables (such as age, sex, addiction smoking, socioeconomic conditions and diseases), the current study was undertaken with the following objectives:

1. To determine the prevalence of respiratory disease symptoms among a group of garbage collectors.
2. To find out if there exist any abnormalities in the parameters of pulmonary function of garbage collectors.
3. To determine the nature of possible ventilators disorders, if any, among garbage collectors.
4. To determine the relationship between age, length of exposure, smoking habit, etc, with the prevalence of respiratory symptoms and lung functional impairments.

MATERIALS AND METHODS

Subjects and study design

This historical cohort study was carried out among a group of municipal solid waste workers who were working in Fars Province, South of Iran in 2012. A total of 105 garbage collectors were studied. Similarly, 93 healthy unexposed subjects were randomly selected and served as the referent group. The sample size based on an α of 0.05 and a power of study equal to 80% and P1 and P2 equal to 27 and 10 percents, respectively, was calculated as 90 .

Subjects with preexisting medical conditions such as family history of asthma or other respiratory diseases as well as those with history of thoracic surgery were excluded from the study. Additionally, individuals with history of exposure to airborne contaminants were excluded from the referent group.

Both garbage collectors and referent subjects were volunteer individuals. No subject refused to participate in the study. Additionally, all participants signed an informed consent form before commencement of the study. Furthermore, the protocol of the study was approved by the university ethic committee. None of the exposed subjects had past medical or family history of respiratory illness or any other chest operations or injuries. Likewise, none of the referent subjects had been exposed to different waste collecting airborne contaminants.

Measurement of study variables

Respiratory Illness

Subjects were interviewed and respiratory symptom questionnaire, as suggested by the American Thoracic Society (ATS 1978), was administrated to them [8]. This standardized questionnaire included questions on respiratory (presence or absence of regular dry and/or productive cough, phlegm, wheezing, shortness of breath, etc), nasal and eye symptoms, smoking habits, medical and family history of each subject. Additionally, it contained detailed occupational history and specific questions concerning all jobs held before employment at the municipal contractors under study, particularly those associated with the risk of respiratory morbidity. These, were then used to obtain symptom prevalence data among garbage collectors and referent groups.

Pulmonary function tests

Pulmonary function tests (PFTs), including mean percentage predicted Vital Capacity (VC), Forced Vital Capacity (FVC), Forced Expiratory Volume (FEV1), followed guidelines given by the ATS (1979) and measured with a portable calibrated Fukuda spirometer (Model ST-150, Fukuda Sangyo CO, LTD), on site, twice for the exposed individuals (at beginning of the first working day of the week , and 3 days later) and once at the beginning of their workshift for the referent subjects [9]. The spirometer was calibrated twice a day with a 1-liter syringe in accordance to the standard protocol for the instrument used. The mean percentage predicted value was based on a subject age, weight, standing height, sex and ethnic background as calculated and adjusted by spirometer device. Subjects were requested not to take shower or smoke for at least two hours prior to the test. Additionally, they were trained to become familiar with the maneuvers. The standing height and weight of each subject were

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Table 1. Comparison of demographic variables, smoking habits, education level of garbage collectors and referent subjects

Variable	Garbage collectors (n=105)	Referent (n=93)	*p* value †
Age (yr) (mean ± SD)	44.01 ± 7.34	42.38 ± 7.92	0.137
Weight (kg) (mean ± SD)	74.40 ± 11.53	75.07 ± 8.14	0.603
Height (cm) (mean ± SD)	172.25 ± 7.10	172.62 ± 6.01	0.697
Length of employment (yr) (mean ± SD)	15.07 ± 6.76	13.16 ± 8.64	0.087
Smokers No. (%)	64(60)	47(50.53)	0.119
Length of smoking (yr) (mean ± SD)	10.36 ± 10.62	7.98 ± 10.63	0.177
Severity of smoking			
Light (4 cigarettes or less per day	23(36.50)	16(38.10)	
Heavy (More Than 4 cigarettes per day)	40(63.50)	26(61.90)	0.375
Education level			
Primary	35(33.33)	20(21.50)	
Secondary	70(66.66)	73(78.49)	0.080

† Chi-square or Fisher's exact test or independent sample *t*-test, $p<0.05$

Table 2. Frequency of respiratory symptoms among garbage collectors and referent subjects

Symptoms	Referent group (n = 93)	Garbage collectors (n = 105)	*p* value†	Odds ratio
Cough	3	7	0.340	2.14
Phlegm	1	11	0.006*	10.77
Productive cough	1	10	0.010*	9.68
Wheezing	6	19	0.014*	3.20
Breathlessness	21	41	0.013*	2.19

†Chi-square or Fisher's exact test. * Statistically significant.

measured in his normal working clothes. Before the test, they rested in a sitting position for about 5 minutes. They were then asked to stand in front of the spirometer, as comfortable as possible, and a nose clip was put on. At least, three acceptable maneuvers were performed. If subject showed great variability among the various FVC volumes, up to five maneuvers were obtained.

The largest volumes (as percentage predicted lung function) were selected for analysis. The percentage predicted lung values were observed capacities as measured by spirometer device divided by predicted or expected capacities (based on gender, age, weight, height, ethnic background, etc, as calculated and adjusted by spirometer device) multiple by 100.

% predicted lung value = (observed capacities/expected capacities) * 100.

Data analysis and statistical procedures

For bivariate analysis, the data were analyzed using the Student's *t*-test, Chi-square or Fisher's exact test, where applicable. Multivariable analysis performed by using logistic regression for binary outcomes and multiple linear regressions for quantitative outcomes. In all the statistical comparisons, a *p* value of less than 0.05 was considered significant. Experimental results are presented as arithmetic means ± SD. To conduct the logistic and multiple linear regression analysis, the main variable was considered to be a garbage collector. Other variables such as age, weight, height, smoking habits, and education were considered as potential confounders, and their simultaneous effects on the prevalence of respiratory symptoms and changes in the parameters of pulmonary function were controlled. Statistical tests were conducted using SPSS V11.5 on a personal computer.

RESULTS

The average (mean ± SD) age (yr), weight (kg), height (cm), duration of exposure (length of employment for referent subjects), length (yr) and severity of smoking are presented in Table 1.

As shown, garbage collectors and their referent group counterparts were similar, as far as these variable were concerned. Although garbage collectors were, on average, slightly older than referent group neither this difference nor the differences noted between other parameters, reached statistical significance.

Table 2 illustrates the frequency of abnormal clinical findings among garbage collectors and referent subjects. As shown, the prevalence of phlegm, productive cough, wheezing and breathlessness were significantly higher in garbage collectors than in the referent subjects ($p < 0.05$).

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Table 3. Comparison of Percentage predicted lung function between garbage collectors and referent subjects.

Parameters†††	Garbage collectors (n = 105)		Referent subjects (N= 93)	*p* value Preshift vs. postshift†	*p* value Preshift vs. referent group††	*p* value postshift vs. referent group††
	Preshift	Postshift				
VC (mean ± SD)	84.46 ± 13.73	83.48 ± 12.27	85.36 ± 11.22	0.427	0.614	0.261
FVC(mean ± SD)	78.86 ± 13.52	76.82 ± 15.82	78.03 ± 13.56	0.204	0.871	0.563
FEV1(mean ±SD)	84.62 ± 16.49	83.89 ± 16.29	89.02 ± 14.02	0.398	0.041*	0.018*
FEV1/FVC(mean±SD)	111.02±12.38	110.19±12.22	114.62 ± 6.69	0.503	0.019*	0.002*

†paired sample *t*-test comparison of PFTs in exposed subjects. ††Independent sample *t*-test ($p<0.05$). ††† % Predicted lung function = %observe/predicted.* Significantly different from referent group values($p<0.05$).

Table 4. Association between garbage collector occupation and the prevalence of respiratory symptoms (198 = n)

symptoms	*B*	Odds ratio	*p*-value †
Cough	0.81	2.26	0.25
Phlegm	2.22	9.22	0.02
Productive cough	2.22	9.22	0.03
Wheezing	1.04	2.84	0.04
Breathlessness	0.72	2.06	0.02

†Binary logistic regression. β: ln (Odds Ratio)

The results of spirometry for garbage collectors and referent subjects are displayed in Table 3. As seen, no cross shift changes were evident between the parameters of pulmonary function of garbage collectors. However, significant differences were noted between some parameters of pulmonary function such as FEV1, FEV1/FVC ratio between garbage collectors and referent subjects. Interestingly, this difference was present for both preshift and postshift values when compared with referent subjects.

The relationship between being a garbage collectors, and the prevalence of respiratory symptoms, is presented in Table 4 Logistic regression analysis, where variables such as age, weight, height, education level and smoking, were entered in the model showed that, after adjusting for these confounders, significant rela tionship exist between occupation and the prevalence of respiratory symptoms.

Similarly, the association between being a garbage collector and changes in the parameters of pulmonary function is shown in Table 5. Multiple linear regression analysis, including variables of age, weight, height, smoking habit, and education level in the model showed that after adjusting for these important confounders, there was a statistically significant association between garbage collector occupation and FEV1 and FEV1/FVC ratio, in that, garbage collector occupation resulted in an average decrement of 4.79 and 5.04 units in these parameters, respectively.

DISCUSSION

The aim of this study was to evaluate the respiratory health of garbage collectors. Because of the nature of their occupation, garbage collectors are exposed to large amounts of household and commercial wastes, which are comprised of decomposable organic materials. Additionally, as garbage collectors are standing on the platform, behind the truck and near the garbage and handle, manually, trash bags and garbage bins, they are expected to have heavy exposure to Bioaerosols [4].

There is evidence that exposure to Bioaerosols such as fungi, 1-3 beta-glucan, endotoxin can cause inflammation in the respiratory airways. Similarly, exposure to bioaerosols may increase respiratory symptoms and often causes flu-like symptoms and chronic obstructive pulmonary disease (COPD) [10].

Although, no established OEL exists for bioaerosols [11,12], in some studies high atmospheric concentration of bioaerosols has been found in the breathing air of workers engaged in disposal of waste, or employed in waste recycling sites, collection and transferring stations of solid wastes, poultry industry, slaughterhouses, hospitals and food processing units [13].

Given the data provided, there were no significant differences in the major confounding variables of age, weight, height, length of employment, number of smokers, length of smoking and severity of smoking between the garbage collectors and referent subjects. Additionally, none of the subjects had past medical or family history of respiratory illnesses or any other chest operations or injuries. Since there were no significant differences in the major confounding variables of cigarette smoking, past history of medical illnesses and family history, the decrements in the parameters of pulmonary function such as FEV1and FEV1 / FVC ratio and increased prevalence of respiratory symptoms

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Table 5. Association between garbage collector occupation and the lung function parameters.

Parameters	β	SE	*p*- value
VC	-1.49	1.70	0.383
FVC	-0.694	2.08	0.739
FEV1	-4.79	2.16	0.028
FEV1/FVC	-5.04	1.44	0.001

Multiple linear regression model. β: Average units of decrement in each parameter of pulmonary function of garbage collectors compared to their referent counterparts. SE: Standard error.Code of zero and cod of 1are assigned to the reference group and garbage collectors respectively.

among garbage collectors are likely to be the direct results of occupational exposure to air contaminants.

Prevalence of symptoms of respiratory diseases such as phlegm, productive cough, wheezing and dyspnea were significantly higher in garbage collectors than in the referent subjects. Given the data provided, being a garbage collector increases the relative risk of productive cough, phlegm, wheezing, and shortness of breath by 9.22, 9.22, 2.84 and 2.06 fold, respectively. Similar findings have been reported by other investigators. For instances, Jani Hanssen et al. showed that the prevalence of respiratory symptoms was significantly higher among garbage collectors of Copenhagen City than in a control group. Similarly, the prevalence of chronic bronchitis in waste collectors of Nagpur and Karnataka in India was high [2,14].

Conversely, Jurgen Bunger et al. studied 53 garbage collectors and did not find any significant difference in the prevalence of symptoms of respiratory diseases between garbage collectors and reference group [14]. Likewise, Egon Mart et al. in Australia, conducted a study on 117 male and female workers in the workshops of composting, recycling and waste separation and compared the prevalence of respiratory symptoms with the administrative staff of the food industry (in a farm poultry) [15]. The authors did not find any significant difference between both groups. Although the exact reasons for these discrepancies are not known, insufficient sample size, inappropriate choice of control group, selection bias, failure to adjust the effects for important confounders, and inappropriate statistical analyses, may explain, at least in part, the reasons behind these controversial results. Interestingly, as shown in table 4, logistic regression analysis in which the role of important confounders were controlled for showed that a significant correlation exists between the prevalence of respiratory symptoms and waste collection career.

Possible differences between acute and chronic effects of exposure to workplace contaminants have not been investigated among garbage collectors. In order to differentiate these effect, PFTs were measured for garbage collectors twice, once after being absent from work for 48 hours, at the beginning of the shift on the first working day of the week (preshift) and 3days later at the end of the shift (postshift).The results showed that no significant differences exist between preshift and postshift values. Lack of cross shift changes in PFTs rules out the presence of an acute component in the nature of ventilatory disorders observed in garbage collectors. In contrast, some preshift and postshift values of PFTs such as FEV1, FEV1/FVC were significantly lower than those of control subjects. These finding imply that garbage collectors are likely to develop chronic irreversible lung functional disorders. Similar findings have been reported by other investigators which are in full agreement with the results of the present study. For example, a study in Turkish showed that exposure to bioaerosols can result in ventilatory disorders, and spirpmetric findings between MSWWs and control group showed statistically significant decrement in FEV1 parameter [16]. Similarly, Manas Ranjan et al. in their study conducted on landfill site workers, showed a significant increase in lung functional impairments in MSWWs [17]. Moreover, zuskin et al. reported significant decrements in FEV1 and FVC values as compared with a referent group (63 subjects) [18]. In Greece, it is noticed that mean FVC and FEV1values have significantly decreased when compared with control group (80 subjects) [4].

Egon Marth 1997 et al. in Australia did not observe any significant differences in lung functional parameters between MSWWs and a control group [16]. Those who had worked in the open air had normal spirogram [19]. Researchers did not observe any difference between MSWWs and control group [20]. Differences in study design, length of exposure and many other factors may explain these contradictory results. For example, 50% of workers worked less than 3.6 years [15]. The role of gender in this study was not determined. In the Wheeler et al. study, the sample size was too small to allow a valid conclusion to be drawn from the study. Additionally, in some studies appropriate statistical tests have not been employed for data analysis [2] and simplistic statistics has been utilized or confounding variables have not been controlled for [16]. Similarly, significant differences exist in the type of waste collected by MSWWs, responsibilities of MSWWs, in the capacity of the trucks used in the collection of solid waste and in the level of exposure [21]. Moreover, the difference in the level of mechanization systems for gathering and transportation, disposal and recycling, may also play a part in this scenario.

As there were no significant differences between the number of smokers, severity of smoking and length of

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smoking in both groups, it is unlikely that cigarette smoking accounts for a significantly higher prevalence rate of respiratory symptoms and ventilatory disorders among garbage collectors. This conclusion is further supported by the results presented in Tables 4 and 5, which show that after adjusting for important confounders, in logistic regression analysis and multiple linear regression analysis significant associations were present between the prevalence of respiratory symptoms and decrements in FEV1 and FEV1/FVC ratio with the profession of garbage collectors. Similarly, while these findings are in line with those of Halim Issever et al. [18], they correspond well with the spirometric pattern of obstructive ventilatory disorders where lung capacity (TLC) total and FVC are either normal or increased, but the hallmark is a decreased expiratory flow rate, usually measured by FEV1. Thus, the ratio of FEV1/FVC is characteristically decreased [22].

CONCLUSION

The prevalence of respiratory symptoms as well as impaired lung functional capacities was more common among garbage collectors than in their control counterparts. This is likely to be attributed to the occupational exposure of this group to workplace contaminants, particularly, and bioaerosols.

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REFERENCES

1. Krajewski JA, Tarkowski S, Cyprowski M, Szarapińska-Kwaszewska J, Dudkiewicz B, Occupational exposure to organic dust associated with municipal waste collection and management. *Int J Occup Med Environ Health* 2002; 15(3):289-301.
2. Sabde YD, Zodpey SP. A Study of morbidity pattern in street sweepers: A Cross-Sectional study. *Indian Journal of Community Medicine* 2008; 33(4): 224–228.
3. Mehrdad R, Majlessi NM, Aminian O, Sharifian SA, Malekahmadi F. Muscluskeletal disorders among municipal solid waste workers. *Acta Medica Iranica* 2008; 46:3.
4. Athanasiou M, Dounias G. Respiratory health of municipal solid waste workers. *Oxford Journals Medicine Occupational* 60; 8: 618-623.
5. Raaschou-Nielsen O, Nielsen ML, Gehl J. Traffic-related air pollution: Exposure and health effects in Copenhagen street cleaners and cemetery workers. *Archives of Environmental Health* 1995; 50 (3): 207-13.
6. Bernard D, Steiner A, Jeggli S, Tschopp A, Bernard A,Oppliger A, Hilfiker S, Hotz P. Clara cell protein and surfactant protein B in garbage collectors and in wastewater workers exposed to bioaerosols. *Int Arch Occup Environ Health* 2005; 78: 189–197.
7. Ahanjan MNM. The reaction of the tuberculin test (PPD) in Sari municipal street cleaners. *Journal - Mazandaran University of Medical Sciences* 2000; 10:27.
8. Ferris BG.Epidemiology Standardization Project (American Thoracic Society). *Am Rev Respir Dis* 1978; 118: 1–120.
9. American Thoracic Society. ATS Statement-snowbird workshop on standardization of spirometry. *Am Rev Respir Dis* 1997; 119: 831-8.
10. Matheson MC, Benke G, Raven J et al. Biological dust exposure in the workplace is a risk factor for chronic obstructive pulmonary disease. *Thorax* 2005; 60:645–651.
11. Tanusha SS,Onnicah DM, Mohamed FJ. Endotoxin exposures and workrelated asthma. *A Review Current Allergy & Clinical Immunology* 2010; 23:2.
12. Swan Akelsey J R M. Occupational and environmental exposure to bioaerosols from composts and potential health effects -A critical review of published data. *Sudbury: HSE, Printed and published by the Health and Safety Executive* 2003.
13. Kalahasthi R, Narendrana P, Hirehal R, Raoa R. Evaluation of the relationship between pro-inflammatory cytokines and health in workers invovlved in hazardous waste sites at Karnataka India. *Journal of Research in Health Science* 2010; 10(1):7-14.
14. Bunger J, Antlauf Lammers M, et al. Health compliants and immunological markers of exposure to bioaerosols among biowaste collectors and compost workers. *Occup Environ Med* 2000; 57:458-464.
15. Marth E, Reinthaler FF, Schaffler K, Jelovcan S, Haselbacher S, Eibel U, Kleinhappl B. *Occupational Health Risks To Employees Of Waste Treatment Facilities. Ann Agric Environ Med* 1997; 4:143–147.
16. Issever H, Hulya G, Erelel M. Health problem of garbage collectors in Istanbul. *Indoor Built Environment* 2002; 11: 293-301.
17. Ranjan Ray M, Roychouhury S, Gopeshwar Mukherjee, Senjuti Roy TL. Respiratory and general health impairments of workers employed in a municipal solid waste disposal at an open landfill site in Delhi. International *Journal of Hygiene and Environmental Health* 2005; 208: 255–262.
18. Zuskin E, Mustajbegovic J, Schachter, E Neil, J Kern, D Pavicic, A Budak. Airway function and respiratory symptoms in sanitation workers. *Journal of Occupational & Environmental Medicine* 1996; 38(5):522-527.
19. Wheeler PA, Stewart I, Dumitrean P, Donovan B. Health effects of composting: A Study of three compost sites and review of past data. *Environment Agency R&D Technical Report, Bristol* 2001; 1-315.
20. Steiner A, Jeggli S, Tschopp A, Bernard D, Oppliger A, Hilfiker S, Hotz P . Hepatitis E Helicobacter pylori, and gastrointestinal symptoms in workers exposed to waste water. *Occupational& Environmental Medicine* 2004; 61:622-627.
21. Hansen J, Ivens UI, Breum NO et al. Respiratory symptoms among Danish waste collectors. *Ann Agric Environ Med* 1997; 4:69–74.
22. Kumar V, Cotran R, Robbins S. *Basic Pathology,WB Saunders Company, Philadelphia, 5th Ed* 1997; 393–425.

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