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 FEV1 and 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,
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 graveyard workers. The risk of chronic bronchitis and asthma was significantly higher than in a control group [1]. Similarly, the prevalence of respiratory illness was significantly more prevalent among 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.

**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
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.

\[
\text{% predicted lung value} = \left( \frac{\text{observed capacities}}{\text{expected capacities}} \right) \times 100
\]

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 variables 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 (\( p < 0.05 \)).
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 collector, 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 relationship 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 FEV1 and FEV1/FVC ratio and increased prevalence of respiratory symptoms.

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

<table>
<thead>
<tr>
<th>Parameters†††</th>
<th>Garbage collectors</th>
<th>Referent subjects</th>
<th>p value</th>
<th>p value</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 105)</td>
<td>(N= 93)</td>
<td>Preshift vs.</td>
<td>Postshift</td>
<td>Preshift vs.</td>
</tr>
<tr>
<td>VC (mean ± SD)</td>
<td>84.46 ± 13.73</td>
<td>83.48 ± 12.27</td>
<td>0.427</td>
<td>0.614</td>
<td>0.261</td>
</tr>
<tr>
<td>FVC(mean ± SD)</td>
<td>78.86 ± 13.52</td>
<td>76.82 ± 15.82</td>
<td>0.204</td>
<td>0.871</td>
<td>0.563</td>
</tr>
<tr>
<td>FEV1(mean ±SD)</td>
<td>84.62 ± 16.49</td>
<td>83.89 ± 16.29</td>
<td>0.398</td>
<td>0.041*</td>
<td>0.018*</td>
</tr>
<tr>
<td>FEV1/FVC(mean)</td>
<td>111.02±12.38</td>
<td>110.19±12.22</td>
<td>0.503</td>
<td>0.019*</td>
<td>0.002*</td>
</tr>
</tbody>
</table>

†paired sample t-test comparison of PFTs in exposed subjects. †††Independent sample t-test (p<0.05). ††% Predicted lung function = %observed/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)

<table>
<thead>
<tr>
<th>symptoms</th>
<th>B</th>
<th>Odds ratio</th>
<th>p-value *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cough</td>
<td>0.81</td>
<td>2.26</td>
<td>0.25</td>
</tr>
<tr>
<td>Phlegm</td>
<td>2.22</td>
<td>9.22</td>
<td>0.02</td>
</tr>
<tr>
<td>Productive cough</td>
<td>2.22</td>
<td>9.22</td>
<td>0.03</td>
</tr>
<tr>
<td>Wheezing</td>
<td>1.04</td>
<td>2.84</td>
<td>0.04</td>
</tr>
<tr>
<td>Breathlessness</td>
<td>0.72</td>
<td>2.06</td>
<td>0.02</td>
</tr>
</tbody>
</table>

†Binary logistic regression. β: In (Odds Ratio)
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 instance, 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 Burger 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 referent 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 3 days 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 spirometric 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 FEV1 values 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

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

<table>
<thead>
<tr>
<th>Parameters</th>
<th>( \beta )</th>
<th>SE</th>
<th>( p )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VC</td>
<td>-1.49</td>
<td>1.70</td>
<td>0.383</td>
</tr>
<tr>
<td>FVC</td>
<td>-0.694</td>
<td>2.08</td>
<td>0.739</td>
</tr>
<tr>
<td>FEV1</td>
<td>-4.79</td>
<td>2.16</td>
<td>0.028</td>
</tr>
<tr>
<td>FEV1/FVC</td>
<td>-5.04</td>
<td>1.44</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Multiple linear regression model. \( \beta \): 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 1 are assigned to the reference group and garbage collectors respectively.
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 Isser 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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