



Investigation of the Pulmonary Function Level in Municipal Solid Waste Collectors: A Case of Bandar Abbas City During 2015 - 2017

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Abstract

Background: In Iran, most of the cleaning processes are performed manually in urban areas. Sweepers are exposed to respiratory pollutants, infectious substances, and other hazardous substances such as chemicals, animal feces, and sharp objects during improper disposal of waste. Respiratory pollutants in these occupations can cause inflammation and damage to the respiratory system. Moreover, prolonged exposure to respiratory pollutants in the workplace can reduce lung function and cause numerous health problems.

Objectives: This study aimed to examine the effect of workplace exposures of municipal solid waste collectors on the reduction of the pulmonary function level.

Methods: This retrospective cohort study was performed on 198 municipal solid waste collectors aged 18 to 55 years who were employed in this profession for at least two years. The sampling method was census, and demographic data were extracted from occupational examination records.

Results: Examining the relationship between pulmonary function decline and the studied variables showed a significant relationship between smoking and reduction of FVC, FEV1, and FEF25-75. However, no significant relationship was observed between dust exposure and pulmonary function decline.

Conclusions: No significant relationship was observed between pulmonary function loss and occupational dust exposure in municipal solid waste collectors. This means that the occupational exposure of these individuals was not severe enough to cause pulmonary function loss.

Keywords: Spirometry, Municipal Solid Waste Collectors, Pulmonary Function

1. Background

Municipal solid waste collectors or street-sweeping workers form the structure of every community's urban cleaning system. They are responsible for keeping the community clean. In developed countries, the street cleaning process is mostly mechanized. However, in developing countries with limited resources, this process is mostly performed manually. A broom is the main cleaning tool, and probably the only used equipment. Street-sweeping workers are exposed to soil contamination, infectious substances, and other hazardous substances such as chemicals, animal feces, and sharp objects by improper disposal of waste at the source and all types of waste on streets. These substances, in turn, cause skin, gastrointestinal, respiratory, and orthopedic diseases in these workers (1).

Spirometry appears to be a simple and inexpensive method to measure disorders of the respiratory tract. Pul-

monary function tests are the most critical and most commonly used diagnostic tool for occupational diseases (2). Respiratory pollutants found in various occupations can cause inflammation and damage to the respiratory system, and prolonged exposure to respiratory pollutants in the workplace can reduce lung function and cause numerous health problems. Some studies have shown that cigarette smoking can also reduce pulmonary function indicators, which has a synergistic effect on dust exposure (3), although some other studies have refuted this relationship (4). It sometimes takes about a year to reduce lung function in some cases (3). Chronic exposure to dust can cause lung dysfunction and various respiratory symptoms. Consequently, according to the chronic status of most lung diseases, pulmonary function tests are highly useful in preventive medicine (5).

Municipal solid waste collectors are exposed to a heterogeneous mixture of bio-aerosols, gases, and vapors, in-

cluding microbial and non-microbial volatile organic compounds (6). Moulds may cause allergic reactions, and reports of cases of hypersensitivity pneumonitis and allergic bronchopulmonary aspergillosis have been published (6). However, allergic diseases are rarely reported in studies and are unlikely to explain most respiratory symptoms. Instead, non-allergic inflammatory reactions may be essential, especially because of the dust containing endotoxins and β (1, 3)-glucan, which are two components of the inflammatory protein in the wall of gram-negative bacterial cells and most fungi. Inflammatory protein production of cytokines such as interleukin- 1β (IL 1β), interleukin-6 (IL6), interleukin-8 (IL8), and tumor necrosis factor α (TNF α) plays a major role in these inflammatory processes. Garbage collectors show more airway inflammation and respiratory symptoms than the control group (6). Exposure to organic dust is probably the inflammatory factor caused by neutrophils, which, in turn, causes respiratory symptoms (6).

Increasing evidence suggests that diseases caused by exposure to bioaerosols are predominantly non-allergic. Exposure to bioaerosol is also associated with health effects such as respiratory symptoms, flu symptoms, and an increased risk of chronic obstructive pulmonary disease (7).

2. Methods

Subjects in this retrospective cohort study were selected using the census sampling method. The participants included all the staff working in the third regional municipality of Bandar Abbas city in the year 2019. Eligible individuals were selected according to the inclusion criteria (at least two years of municipal solid waste experience, age of 18 to 55 years, no history of respiratory disease, and no history of musculoskeletal disease and central nervous disease). The sample size was estimated to be 148 individuals with a relative risk of problems in the cohort group of 1.2, with a 95% confidence interval.

The subjects had at least two occupational examinations (initial and periodic) during 2015 - 2017, and also, had an acceptable spirometry annually. Spirometry tests were based on the ATS/ERS criteria (8), and FEV $_1$, FVC, and FEF $_{25-75}$ were recorded with respective percentages.

Individuals who did not have acceptable and repeatable spirometry based on the ATS/ERS criteria were excluded. Anthropometric data such as height, weight, age, and cigarette smoking as pack-year, history of pulmonary disease, and years of employment were extracted from occupational examination files. Moreover, according to the decisions of an occupational health expert, dust exposure

data was extracted from the occupational files based on the number of hazards.

Spirometric data was reviewed based on the American Thoracic Society's acceptability and repeatability criteria. Presently, it is common practice to determine airway obstruction with the use of a fixed cut-off point when FEV $_1$ /FVC is less than 70%, according to the guidelines from the Global Initiative for Chronic Obstructive Lung Disease (GOLD) (9). A subject was believed to have a restrictive spirometric pattern if there was a reduced FVC in the presence of a normal FEV $_1$ /FVC. To this end, a fixed cut-off of 80% of the predicted value for FVC was used (9). The recorded FEV $_1$, FVC, and FEV $_1$ /FVC was analyzed for each person using SPSS software, version 16, with the use of t-test and chi-square for quantitative and qualitative data, respectively.

3. Results

For this study, 927 occupational files of 523 municipal solid waste collectors in Bandar Abbas city, Iran, were examined, and ultimately, 198 of them were eligible to enter the study. All the subjects were male, with the mean age of 32.36 years, an average height of 169.45 cm, and an average weight of 60 kg. The participants were employed in the current occupation for an average of 3.18 years, and were previously employed with an average of 1.28 years. Systolic and diastolic blood pressure was normal in all the subjects (Table 1).

Results of the initial spirometry study showed that of the participants, 56% had normal spirometry, and 41% had a pattern of restrictive pulmonary disease (Table 2).

At the beginning of the study, we used the first spirometric data analysis to evaluate the pulmonary function of the subjects. Global Lung Function Initiative reference values and Z-scores were calculated for each healthy non-smoking subject, and the distributions and mean values were examined for FEV $_1$, FVC, and the FEV $_1$ /FVC ratio (10). The mean FEV $_1$ was 15.66 compared to FEV $_1$ percentile; the mean FVC was 13.72 compared to the FVC percentile, the mean FEV $_1$ /FVC was 53.82 compared to FEV $_1$ /FVC percentile, and the mean FEF $_{25-75}$ was 34.51 compared to FEF $_{25-75}$ percentile (Table 3).

A linear regression model was used to investigate the relationship between pulmonary function decline and the other variables, including smoking, work experience, and duration of study. For this purpose, the mean delta values of the first and last spirometry data were compared with each other in relation to the other variables. The results revealed that a decrease in FVC Per (P value = 0.01), FEV $_1$ _Per (P value = 0.04), and FEF $_{25-75}$ -PER (P value = 0.03) was significantly associated with smoking. However, there was no sig-

Table 1. The Average Height, Weight, Age, and Other Characteristics of the Municipal Solid Waste Collectors in Bandar Abbas City, Iran

	Units	Mean	Median	Standard Deviation	Min	Max
Height	Centimeter	169.45	169	7.161	149	190
Weight	Kilogram	60	57	11.46	41	101
Age	Year	32.36	30	8.56	21	60
Current employment	Year	3.18	2	3.26	2	15
Previous employment	Year	1.68	0	3.19	0	22
Smoking P/Y	Pack/year	0.67	0	2.61	0	18
Systolic blood pressure	Millimeter Hg	112.17	115	9.95	90	140
Diastolic blood pressure	Millimeter Hg	71.62	70	7.312	50	85
Number of children	Person	2.35	2	1.57	0	8

Table 2. Results of the Interpretation of the First Recorded Spirometry According to the GOLD Criteria

	Number (Percent)
Normal	111 (56.1)
Restrictive	83 (41.9)
Obstructive	2 (1)
Mix	2 (1)
Tot	198 (100)

nificant relationship between the other variables and pulmonary function decline (Table 4).

4. Discussion

In a cross-sectional study conducted by Eshaghi Sani et al. (2016) to investigate spirometry patterns and respiratory symptoms of sweepers in Bandar Abbas city, Iran, 100 sweepers working in one of the municipalities of the city and 100 administrative workers from the same area were surveyed. According to the results, the prevalence of respiratory symptoms was not significantly different between the two groups. On examination, higher levels of haziness and wheezing were observed only in the sweepers. The mean values of spirometric indices including FEV₁, FVC, FEF₂₅₋₇₅, and PEF were statistically significantly lower in the sweepers compared to the other group ($P < 0.05$). Moreover, the expected mean percentages of FEF₂₅₋₇₅, FVC, FEV₁/FVC, PEF, and FEV₁ were lower in the sweepers than in the administrative workers, and this decrease was statistically significant with regard to FEF₂₅₋₇₅ and PEF. Further, spirometric abnormalities were higher in the sweepers than in the administrative workers, but were not statistically significant (11).

Analyzing the pulmonary function of a group of municipal sweepers in 2012, Neghab and his colleagues eval-

uated the prevalence of respiratory symptoms to be 39% for dyspnea, 9.52% for productive cough, and 18.09% for wheezing. They reported that the sputum of 10.47% was significantly higher in the sweepers compared to the control group. Moreover, there was a significant decrease in the FEV₁ and FVC/FEV₁ ratio in the sweepers compared to the control group. The spirometric pattern of disorders was consistent with obstructive lesions (12).

A retrospective cohort was analyzed by Habybabady et al. to investigate the effect of dust exposure on the respiratory health symptoms and pulmonary function of 80 sweepers. The results showed that the frequency of respiratory symptoms was significantly higher in the exposed group than in the control group ($P < 0.05$). In particular, cough was the most common complaint of the sweepers (81%) compared to the controls (16.3%). In addition, the mean FVC and PEF₂₅₋₇₅ were significantly lower in the exposed group compared to the control group (13).

In our study, it was found that the FVC and FEV₁ indices of the subjects under study were lower than the predicted values for people of similar height, age, and ethnicity. Similarly, in interpreting the spirometry data, more of the workers showed restrictive patterns of pulmonary function. The results of the longitudinal review of pulmonary function changes of the workers showed that their pulmonary function loss was not significantly related to dust exposure, but was significantly correlated with smoking. Previous studies have shown that pulmonary function indices are lower in municipal solid waste collectors compared to other people. Since previous studies have been mostly cross-sectional, the low pulmonary function of these workers cannot be attributed to their exposure to dust and may have been due to biases.

4.1. Conclusion

Due to variations in the work environment of municipal solid waste collectors, it is actually impossible to mea-

Table 3. Results of the Interpretation of the Employees' Baseline Spirometry

	Mean	Median	Standard Deviation	Min	Max
FEV1-Z-score	-1.33	-1.37	0.9	-4.14	2.31
FEV1-percentile	15.66	8.41	18.52	0	98.95
FVC-Z-score	-1.42	-1.47	0.918	-4.18	3.61
FVC-percentile	13.72	7.02	17.37	0	99.99
FEV1\FVC	0.83	0.83	0.06	0.62	0.99
FEV1\FVC-Z-score	0.13	0.15	0.95	-2.94	2.66
FEV1\FVC-percentile	53.82	56.02	27.69	0.16	99.61
FEF2575-Z-score	-0.52	-0.53	1.019	-6.39	2.75
FEF2575-Percentile	34.51	29.52	25.48	0	99.71

Table 4. Results of Linear Regression Analysis of Pulmonary Function Reduction in Municipal Solid Waste Collectors of Bandar Abbas City, Iran, in Terms of Cigarette Smoking, Study Duration, and Years of Dust Exposure

	FVC Decline	FEV1\FVC Decline	FEV1 Decline	FEF2575 Decline
Smoking P/Y	0.01	0.095	0.048	0.033
Duration of study	0.28	0.148	0.095	0.646
Years of dust exposure	0.81	0.979	0.701	0.711

sure the amounts of respiratory pollutants in them. Thus, investigating the trend of pulmonary function decline in employees can be considered as an estimate of occupational respiratory exposures. In this study, the relationship between pulmonary function loss and smoking was significant, but the relationship between pulmonary function decline and dust exposure was insignificant. Thus, we can conclude that dust exposure in this profession is not sufficiently severe to cause permanent respiratory problems in this group of people.

Further research is recommended to be conducted for longer periods and on more subjects. Due to the difficulty of working as municipal solid waste collectors, most of these workers do not stay in the job for a long time (a probable healthy worker effect), which can affect the results of the investigation.

Supplementary Material

Supplementary material(s) is available [here](#) [To read supplementary materials, please refer to the journal website and open PDF/HTML].

Footnotes

Conflict of Interests: The authors declare that there is no conflict of interest regarding the publication of the article.

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