Screening for respiratory morbidities and obstructive lung function among municipal waste handlers in Puducherry: A community-based cross-sectional study

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Introduction

Municipal solid waste is generated because of economic production and consumption by individuals, commercial enterprises, institutions, markets, and businesses.¹ Solid waste management includes trash collection, separating recyclables, and processing commercial and industrial waste. Population and economic expansion have increased solid waste in both urban and rural regions.² Waste management poses hazards at every stage: collection, transportation, recycling, and disposal, posing a growing environmental and public health problem.³ In developing nations like India, the collected waste is seldom kept in covered containers and is instead deposited directly on the ground, where it must be either shoveled or cleaned up by hand. Workers, therefore, have significant direct contact with management includes trash collection, separating recyclables, and processing commercial and industrial waste. Population and economic expansion have increased solid waste in both urban and rural regions.³ Waste management poses hazards at every stage: collection, transportation, recycling, and disposal, posing a growing environmental and public health problem.³

Background: Waste management is a societal problem because of its environmental impact and public health implications. Solid waste handlers have a high incidence of occupational health issues, with respiratory morbidities being the most common. Aim: To assess the prevalence of respiratory morbidities, obstructive lung pattern and its associated factors among municipal solid waste management workers in Puducherry. Materials and Methods: This community-based cross-sectional study was carried out in May and June 2018 among 264 solid waste management workers selected by simple random sampling. They underwent a semi-structured interview schedule capturing their sociodemographic characteristics, work profile, presence of respiratory symptoms, and morbidities followed by lung function tests using a portable spirometer. The data was entered using Epidata entry client and analyzed using SPSS (v16). Results: The mean age of the workers was 47.1 (±8.87) years. The majority were females (85.6%), working as waste collectors (86%) on day duty (73.5%). More than two in five workers had either respiratory morbidity (42.8%) or obstructive lung pattern (44%). Higher age, occupation as waste collector, night shift duty, not using face mask on duty, and not receiving training on waste handling were the factors significantly associated with the respiratory morbidities and obstructive lung function. Conclusion: The prevalence of respiratory morbidities and obstructive lung disease were high among municipal solid waste handlers. Measures are needed to improve the work environment of waste handlers by ensuring the availability of protective gears and adequate training on work handling based on ergonomic principles.

Keywords: Lung function, occupational exposure, respiratory morbidities, solid waste, waste workers

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solid waste than their counterparts in high-income countries, who predominantly handle sealed plastic bags and covered dustbins. Due to numerous risk factors, municipal solid waste employees have reported terrible working conditions, with no access to drinking water or sanitation. All of these variables enhance worker exposure to infections, hazardous substances, and chemicals. Due to numerous risk factors, municipal solid waste employees have high rates of occupational health issues, especially respiratory morbidities such chronic bronchitis and bronchial asthma. Additionally, bioaerosols from decomposing garbage cause irritation in the airways, causing respiratory issues.

Studies on the short- and long-term impacts of garbage exposure on public health have concentrated on finding any links between living near a landfill and unfavorable health effects. The danger presented to those directly engaged in garbage handling, particularly the impact on the respiratory system, has received less attention. Moreover, the screening for respiratory illness in these high-risk populations has not been part of any routine health services in primary care. Hence, the current study was an attempt to screen the municipal solid waste management workers in Puducherry for respiratory morbidities and obstructive lung function.

**Objectives**

1. To estimate the prevalence of respiratory morbidities among municipal solid waste management workers in Puducherry.
2. To determine the sociodemographic and work-related factors influencing respiratory morbidities and
3. To assess their obstructive lung function using spirometry.

**Materials and Methods**

The current research was a cross-sectional community-based analytical study conducted in the Puducherry district from May to June 2018. The district is one of four in the union territory of Puducherry in southern India, and it is made up of two administrative municipalities and five commune panchayats. Solid waste management workers who have been employed by Puducherry municipalities and communes for at least one year were included, while those who were absent on the day of the evaluation were excluded. A minimum sample size of 255 solid waste management workers were required considering the prevalence of respiratory morbidities among solid waste management workers as 21%, absolute precision of 5%, and 95% confidence interval. The required number of individuals were selected from the total list of eligible solid waste management workers working under Puducherry district by simple random sampling. Computer-generated random numbers were used.

Among the selected eligible solid waste workers, a semi-structured interview schedule was done capturing their sociodemographic characteristics and work-related information. The respiratory symptoms and morbidities were assessed using an adapted version of the validated Medical Research Council Respiratory Questionnaire developed by Centre for Disease Control and Prevention (CDC), which screened for eight respiratory/cardiovascular illnesses and four respiratory symptoms in the last 3 months.

The interview was followed by respiratory assessment by trained physicians. Lung function tests were performed using a portable electronic spirometer following the American Thoracic Society (ATS) guidelines. All tests were performed by the same trained health care professional. The most important aspects of spirometry are the forced vital capacity (FVC) and the forced expiratory volume (FEV1) in one second. Spirometric airflow limitations are defined according to the Tiffenau Index as (FEV1/FVC) <70% or an FEV1 <80% of predicted values.

Permissions from Puducherry Municipality and informed consent of the workers were obtained. The workers were surveyed and tested at their agreed convenient time before the start of their shift. The information of the workers was kept anonymous from the stage of data collection. Institutional Human Ethical committee approval was obtained before starting the study. The data collected was entered twice in Epidata Entry client (v4.2) to check for data entry errors and analyzed using SPSS (v16). The baseline sociodemographic characteristics and lung function of the participants were summarized. Pearson Chi-square or Fisher's exact tests were used to identify the various sociodemographic and work characteristics associated with the presence of respiratory illness and obstructive lung function among the solid waste management workers. The output was expressed as an odds ratio. To identify the predictors of respiratory illness and obstructive lung function, binomial logistic regression was used and expressed as an adjusted odds ratio.

**Results**

**Sociodemographic and working condition characteristics**

A total of 264 workers participated in this study. The mean age of the workers was 47.1 (±8.87) years. The majority were females (85.6%), illiterate (65.9%), and belonging to lower middle class (45.8%) when classified according to modified BG Prasad's classification. Most of them were street sweepers or waste collectors (86%), working in day shifts (73.5%) and had more than 5 years’ work experience [Table 1].

**Occupational safety and behavioral factors**

More than half of the workers used face mask (54.5%) and hand gloves (58.3%) regularly during their work shift. The majority did not receive any training on either waste handling (81.8%) or occupational safety (82.2%). Around one-tenth (10.6%) consumed alcohol, while nearly one-fourth (23.1%) consumed either one form of tobacco [Table 2].
Past respiratory symptoms and respiratory illness

Table 1: Sociodemographic and working condition characteristics of solid waste management workers in Puducherry (n=264)

| Variables                              | Summary Statistics |
|----------------------------------------|--------------------|
| Age of Respondents, mean (±SD)         | 47.1 (±8.87) years |
| Gender, n (%)                          |                    |
| Male                                   | 38 (14.4%)         |
| Female                                 | 226 (85.6%)        |
| Educational Qualification, n (%)       |                    |
| Illiterate                             | 174 (65.9%)        |
| Primary School                         | 55 (20.8%)         |
| Secondary School                       | 22 (8.3%)          |
| High School and above                  | 13 (4.9%)          |
| Socioeconomic status, n (%)            |                    |
| Upper class                            | 1 (0.4%)           |
| Upper middle class                     | 26 (9.8%)          |
| Middle class                           | 109 (41.3%)        |
| Lower middle class                     | 121 (45.8%)        |
| Lower class                            | 7 (2.7%)           |
| Type of work, n (%)                    |                    |
| Street sweepers/waste collector         | 227 (86%)          |
| Lorry Drivers/Office staffs            | 37 (14%)           |
| Nature of work shift, n (%)            |                    |
| Day                                    | 194 (73.5%)        |
| Night                                  | 70 (26.5%)         |
| Work experience, n (%)                 |                    |
| ≤5 years                               | 170 (64.4%)        |
| >5 years                               | 94 (35.6%)         |

Table 2: Utilization of personal protective equipment and behavioral status of solid waste management workers in Puducherry (n=264)

| Variables                                | Summary Statistics |
|------------------------------------------|--------------------|
| Use of face mask on duty, n (%)          |                    |
| All the time                             | 144 (54.5%)        |
| Some time                                | 61 (23.1%)         |
| No                                       | 59 (22.3%)         |
| Use of hand gloves on duty, n (%)        |                    |
| All the time                             | 154 (58.3%)        |
| Some time                                | 52 (19.7%)         |
| No                                       | 58 (22%)           |
| Occupational safety training done, n (%) |                    |
| Yes                                      | 47 (17.8%)         |
| No                                       | 217 (82.2%)        |
| Waste handling training done, n (%)      |                    |
| Yes                                      | 48 (18.2%)         |
| No                                       | 216 (81.8%)        |
| Alcohol consumption, n (%)               |                    |
| Yes                                      | 28 (10.6%)         |
| No                                       | 236 (89.4%)        |
| Tobacco consumption, n (%)               |                    |
| Smoke form                               | 18 (6.8%)          |
| Smokeless form                           | 43 (16.3%)         |
| No                                       | 203 (76.9%)        |

The prevalence of phlegm, cough, breathlessness, and wheeze among the workers were 31.4%, 29.5%, 29.2%, and 17.1%, respectively. The overall prevalence of any one respiratory illness is 42.8% among the workers. Around 7.7% and 6.3% of the workers were known cases of bronchial asthma and chronic bronchitis, respectively. About 1.5% and 2.7% had history of tuberculosis and pneumonia [Figure 1].

Predictors of respiratory symptoms

Bivariate analysis revealed that higher age, occupation as street sweeper or waste collector, night shift duty, not using face mask on duty, and not receiving training on waste handling were the factors significantly associated with the presence of respiratory symptoms among the workers. Multivariate analysis revealed similar results as bivariate analysis except for waste handling training [Table 3].

Lung function and its predictors

The predicted lung function measured by spirometry among solid waste management workers is summarized in Table 4. The FEV1/FVC ratio when categorized according to the American Thoracic Society (ATS) guidelines revealed that around 44% of the workers had obstructive lung pattern. Among the variables measured, higher age, female gender, occupation as street sweeper or waste collector, night shift duty, more than 5 years’ work experience, not using face mask on duty, and not receiving training on waste handling were the factors significantly associated with obstructive lung pattern among solid waste management workers in Puducherry. Multivariate analysis revealed similar results as bivariate analysis except for waste handling training [Table 5].

Discussion

Most of the workers were in the age group of 35–50 years, illiterate, and belonging to lower middle class (45.8%) and were occupied as street sweepers or waste collectors. The baseline characteristics were similar compared to the study by Salve among waste workers in Mumbai where a majority of workers working as waste collectors and street sweepers were illiterate, and two-third of them belonged to the scheduled caste category.[12]
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A study conducted by Nagaraj et al.[13] in Bangalore on street sweepers found maximum sweepers to be illiterate.

Traditionally, waste collection or cleaning public areas is considered a poor person’s line of employment in India. Scheduled caste people were socially and economically disadvantaged, and they were constantly forced to engage in the cruel practice of manual scavenging.[14] Manual scavenging has been banned by law; however, individuals involved in cleaning duties have not been disengaged at this time. Their health is severely impacted by a lack of education, bad housing, and an inadequate nutrition.

Their immune system is further compromised by contextual vulnerabilities such as tobacco chewing, smoking, and frequent alcohol use, all of which contribute to additional health deterioration. The proportion of workers consuming tobacco and alcohol were 23% and 11%, respectively, in the present study. The proportion was low when compared to a similar population in Mumbai where more than 45% consumed either alcohol or tobacco.[15] The decrease in substance abuse proportion may be attributed to the maximum participation of females in the

### Table 3: Factors associated with respiratory symptoms among solid waste management workers in Puducherry (n=26)

| Variables                      | Total, n | Respiratory Illness present, n (%) | Odds ratio (95% CI)† | Adjusted odds ratio (95% CI)‡ |
|--------------------------------|----------|-----------------------------------|----------------------|-------------------------------|
| Age category                   |          |                                    |                      |                               |
| 21-35 years                    | 75       | 23 (30.6%)                         | Ref                  | Ref                           |
| 35-50 years                    | 105      | 53 (50.4%)                         | 2.31 (1.24-4.29)*    | 2.22 (1.15-4.09)*             |
| >50 years                      | 84       | 51 (60.7%)                         | 3.49 (1.81-6.75)*    | 3.11 (1.69-6.44)*             |
| Gender                         |          |                                    |                      |                               |
| Male                           | 38       | 15 (39.5%)                         | Ref                  | Ref                           |
| Female                         | 226      | 98 (43.4%)                         | 1.17 (0.58-2.37)     | 1.09 (0.55-2.31)              |
| Educational Qualification      |          |                                    |                      |                               |
| Illiterate                     | 174      | 74 (42.5%)                         | 1.18 (0.37-3.77)     | 1.09 (0.33-3.67)              |
| Primary School                 | 55       | 26 (47.3%)                         | 2.33 (0.73-7.43)     | 2.31 (0.71-7.35)              |
| Secondary School               | 22       | 8 (36.4%)                          | 1.49 (0.39-5.72)     | 1.41 (0.36-5.68)              |
| High School & above            | 13       | 5 (38.5%)                          | Ref                  | Ref                           |
| Socioeconomic status           |          |                                    |                      |                               |
| Upper and Upper middle         | 26       | 9 (34.6%)                          | Ref                  | Ref                           |
| Middle                         | 109      | 45 (41.3%)                         | 1.41 (0.58-3.41)     | 1.29 (0.55-3.30)              |
| Lower middle                   | 121      | 55 (45.5%)                         | 1.67 (0.69-4.01)     | 1.56 (0.65-3.93)              |
| Lower class                    | 7        | 4 (57.1%)                          | 2.67 (0.49-14.56)    | 2.57 (0.45-14.46)             |
| Type of work                   |          |                                    |                      |                               |
| Waste collector/sweepers       | 227      | 107 (47.1%)                        | 4.61 (1.85-11.47)*   | 4.38 (1.72-11.2)*             |
| Drivers/Office staffs          | 37       | 6 (16.2%)                          | Ref                  | Ref                           |
| Nature of work shift           |          |                                    |                      |                               |
| Day                            | 194      | 68 (35.1%)                         | Ref                  | Ref                           |
| Night                          | 70       | 45 (64.3%)                         | 3.34 (1.88-5.90)*    | 3.20 (1.75-5.74)*             |
| Work experience                |          |                                    |                      |                               |
| ≤5 years                       | 170      | 78 (45.9%)                         | Ref                  | Ref                           |
| >5 years                       | 94       | 35 (37.2%)                         | 0.70 (0.42-1.17)     | 0.69 (0.41-1.15)              |
| Use of face mask on duty       |          |                                    |                      |                               |
| Yes                            | 205      | 71 (34.6%)                         | Ref                  | Ref                           |
| No                             | 59       | 42 (71.2%)                         | 4.66 (2.48-8.78)*    | 4.50 (2.45-8.72)*             |
| Occupational safety training   |          |                                    |                      |                               |
| Yes                            | 47       | 24 (51.1%)                         | Ref                  | Ref                           |
| No                             | 217      | 89 (41%)                           | 0.67 (0.35-1.25)     | 0.62 (0.33-1.23)              |
| Waste handling training done   |          |                                    |                      |                               |
| Yes                            | 48       | 13 (39.8%)                         | Ref                  | Ref                           |
| No                             | 216      | 100 (56.3%)                        | 2.32 (1.16-4.63)*    | 2.20 (0.98-4.33)              |
| Smoking                        |          |                                    |                      |                               |
| Yes                            | 47       | 34 (71.1%)                         | 4.57 (2.28-9.17)*    | 4.29 (2.21-9.03)*             |
| No                             | 217      | 79 (36%)                           | Ref                  | Ref                           |

*P<0.05; †Crude odds ratio by Chi-square test; ‡Adjusted odds ratio by Binomial logistic regression.

| Lung function parameters*       | Summary Statistics, mean (±SD) |
|--------------------------------|--------------------------------|
| Vital capacity (VC)            | 74.5 (±15.9)                   |
| Forced vital capacity (FVC)    | 58.9 (±12.7)                   |
| Forced Expiratory Volume1 (FEV1)| 67.6 (±15.5)                   |
| FEV1/FVC ratio                 | 69.9 (±14)                     |

*Measured using portable spirometer

Table 5: Factors associated with obstructive lung pattern among solid waste management workers in Puducherry (n=264)

| Variables                      | Total, n | Obstructive lung function, n (%) | Odds ratio (95% CI)† | Adjusted odds ratio (95% CI)‡ |
|--------------------------------|----------|----------------------------------|----------------------|-------------------------------|
| **Age category**               |          |                                  |                      |                               |
| 21-35 years                    | 75       | 27 (36%)                         | Ref                  | Ref                           |
| 35-50 years                    | 105      | 40 (38.1%)                       | 1.09 (0.59-2.02)     | 1.01 (0.55-1.99)              |
| >50 years                      | 84       | 49 (58.3%)                       | 2.49 (1.31-4.72)*    | 2.38 (1.25-4.62)*             |
| **Gender**                     |          |                                  |                      |                               |
| Male                           | 38       | 8 (21.1%)                        | Ref                  | Ref                           |
| Female                         | 226      | 108 (47.8%)                      | 3.43 (1.51-7.81)*    | 3.33 (1.43-7.7)*              |
| **Educational Qualification**  |          |                                  |                      |                               |
| Illiterate                     | 174      | 70 (40.2%)                       | 0.58 (0.19-1.79)     | 0.61 (0.2-1.8)                |
| Primary School                 | 55       | 29 (52.7%)                       | 0.96 (0.29-3.21)     | 1.03 (0.33-3.35)              |
| Secondary School               | 22       | 10 (45.5%)                       | 0.71 (0.18-2.83)     | 0.78 (0.22-2.91)              |
| High School & above            | 13       | 7 (53.8%)                        | Ref                  | Ref                           |
| **Socioeconomic status**       |          |                                  |                      |                               |
| Upper and Upper middle         | 26       | 0 (0%)                           | Ref                  | Ref                           |
| Middle                         | 109      | 10 (38.5%)                       | 1.41 (0.58-3.41)     | 1.29 (0.55-3.30)              |
| Lower middle                   | 121      | 41 (34.6%)                       | 1.67 (0.69-4.01)     | 1.56 (0.65-3.93)              |
| Lower class                    | 7        | 61 (50.4%)                       | 2.67 (0.49-14.56)    | 2.57 (0.45-14.6)              |
| **Type of work**               |          |                                  |                      |                               |
| Waste collector/sweepers       | 227      |                                  |                      |                               |
| Drivers/Office staffs          | 37       | 108 (47.1%)                      | 3.29 (1.44-7.51)*    | 3.36 (1.48-7.55)*             |
| **Nature of work shift**       |          |                                  |                      |                               |
| Day                            | 194      |                                  | Ref                  | Ref                           |
| Night                          | 70       | 77 (39.7%)                       | 1.91 (1.11-3.21)*    | 1.86 (1.01-3.12)*             |
| **Work experience**            |          |                                  |                      |                               |
| ≤5 years                       | 170      | 65 (38.2%)                       | 1.92 (1.15-3.19)*    | 1.82 (0.98-3.09)*             |
| >5 years                       | 94       | 51 (54.3%)                       | 2.45 (1.35-4.43)*    | 2.30 (1.21-4.19)*             |
| **Use of face mask on duty**   |          |                                  |                      |                               |
| Yes                            | 205      |                                  | Ref                  | Ref                           |
| No                             | 59       | 80 (39.1%)                       | 2.45 (1.35-4.43)*    | 2.30 (1.21-4.19)*             |
| **Occupational safety training done** | 36 (61.1%) |                             |                      |                               |
| Yes                            | 47       |                                  | Ref                  | Ref                           |
| No                             | 217      | 27 (57.4%)                       | 0.52 (0.27-1.18)     | 0.55 (0.29-1.23)              |
| **Waste handling training done** | 89 (41%) |                             |                      |                               |
| Yes                            | 48       |                                  | Ref                  | Ref                           |
| No                             | 216      | 28 (58.3%)                       | 0.51 (0.27-0.96)*    | 0.56 (0.29-1.08)              |
| **Smoking**                    |          |                                  |                      |                               |
| Yes                            | 47       | 27 (36%)                         | 6.46 (3.05-13.7)*    | 6.19 (2.95-13.36)*            |
| No                             | 217      | 40 (38.1%)                       | Ref                  | Ref                           |

*P<0.05; †Crude odds ratio by Chi-square test; ‡Adjusted odds ratio by Binomial logistic regression

More than one-fifth of the workers did not use any personal protective equipment during their work shift contrary to the study in Ethiopia where 87.8% workers did not use any PPEs on duty. The majority of waste collectors were less adherent to health and safety measures. The main reasons for not using any protective clothing were their ignorance and poverty. The overall prevalence of acute respiratory symptoms among solid waste collectors in Puducherry was 42.8% with proportion of cough and wheeze being the highest. Similarly, the overall prevalence of respiratory symptoms among solid waste collectors in Ethiopia was 40.7% with a major proportion of cough and breathlessness. Jayakrishnan et al. found that 21% of waste management workers in Kerala had respiratory symptoms and illness. Chokhandre et al. reported that the prevalence of respiratory symptoms was significantly higher among the waste-pickers (28%) compared to the control work group (15%). Particularly, the prevalence of dyspnea and chronic cough were found to be higher among the waste-pickers.

The occupation as solid waste handler, improper training, and inadequate use of personal protective equipment were significantly associated with respiratory morbidities and obstructive lung function. Similarly, Emiru et al. revealed that the absence of facemask on duty, sleeping disorder, and past illnesses were major contributing factors for respiratory symptoms to occur in Ethiopia. In Gambia, solid waste collectors who never used respiratory protective device had significantly higher prevalence of respiratory symptoms. In the current study, around 7.7% and 6.3% of the workers were known cases of bronchial asthma and chronic bronchitis, respectively.
and Zodpey in their study on street sweeper found upper respiratory tract infections (URT) in 7.3%, followed by chronic bronchitis (5.9%) and bronchial asthma (1.8%).

Around 44% of the workers had obstructive lung pattern when assessed by spirometry in the study. Studies have reported higher respiratory morbidity among conservancy workers. Roopa et al. reported a higher prevalence of respiratory impairments (as established through pulmonary function tests) in conservancy workers working in solid waste management sector of Chennai, India. Hamid et al. evaluated the respiratory health of elementary workers and found that 46% of solid trash pickers had spirometry limitations. Van Kampen et al. found that, although compost workers’ spirometry readings were within normal limits, their FVC percent predicted values were substantially lower than controls. All the previous studies had linked the obstructive pattern and high prevalence of respiratory symptoms to an inflammatory response of the airway caused by bioaerosol exposure and subsequent interaction with bacterial endotoxins and beta-glucans. On the contrary, few studies had found no significant reduction in the lung function parameters of the waste management workers on comparison with different control groups.

A limitation of this study is that a temporal relationship cannot be determined due to the cross-sectional design of our study. A further limitation is that data pertaining to specific bioaerosol, or chemical exposures were not available in this study. The lung function measurements were made on-site using a portable spirometer; hence, an objective assessment of static lung volumes was not possible. The diagnosis of obstruction was based on low FVC values, as total lung capacity could not be calculated. Because a specific exposure assessment and air pollution measurements were not part of this study, there is some uncertainty over the generalizability of our results.

It is critical that these waste management employees be covered by an occupational health-monitoring programmer that keeps them under frequent observation. Primary care physicians could be sensitized to these kinds of occupational hazards and could be trained to screen for respiratory morbidities routinely as part of the health profile. Additionally, the use of the hand-held spirometer could be a feasible option to detect obstructive lung function early at the primary care level. Longitudinal studies may be designed using this study’s findings to evaluate chronic or permanent functional decline. Because epidemiological data from this sector is scarce, medical and occupation health institutes should be encouraged to research the health of conservancy employees. Aside from this, an environmentally sound garbage management system is needed.

**Summary**

The study found that two in five workers had either respiratory morbidity or obstructive lung pattern. Specific demographic factors such as occupation as solid waste handler, improper training, and inadequate use of personal protective equipment were significantly associated with respiratory morbidities and obstructive lung function. Those identified with obstructive lung pattern were referred to higher centers for further management. An emphasis is placed on screening solid waste management employees for respiratory illness. Baseline health evaluations of solid waste management employees can help develop monitoring systems. A periodic pulmonary function test is also required to evaluate fitness to use respirators.

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**Ethical Committee approval**

Approved by the Institutional Human Ethics Committee of Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth, Puducherry.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form, the participants have given their consent for their images and other clinical information to be reported in the journal. The participants understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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**Conflicts of interest**

There are no conflicts of interest.

**References**

1. Cointreau-Levine S, Listorti J, Furedy C. Solid waste. In: Herzstein JA, Bunn WB, Fleming LE, Harrington JM, Jeyaratnam J, Gardner IR, editors. International Occupational and Environmental Medicine. 1st ed. St. Louis: Mosby; 1998. p. 620-32.
2. Porta D, Milani S, Lazzarino Al, Perucci CA, Forastiere F. Systematic review of epidemiological studies on health effects associated with management of solid waste. Environ Health 2009;8:60. doi: 10.1186/1476-069X-8-60.
3. Cointreau-Levine S. Occupational and Environmental Health Issues of Solid Waste Management. Special Emphasis on Middle-And Lower-Income Countries. Urban papers.
Washington D.C: World Bank Group, Urban Sector Board; 2006.

4. Jayakrishnan T, Jeeja MC, Bhaskar R. Occupational health problems of municipal waste management workers in India. Int J Env Health Eng 2013;2:42.

5. Agarwal A, Singhmar A, Kulshrestha M, Mittal AK. Municipal solid waste recycling and associated markets in Delhi, India. Resour Conserv Recycl 2005;44:73-90.

6. Lavoie J, Dunkerley CJ, Kosatsky T, Dufresne A. Exposure to aerosolized bacteria and fungi among collectors of commercial, mixed residential, recyclable and compostable waste. Sci Total Environ 2006;370:23-8.

7. Vimercati L, Baldassarre A, Gatti MF, De Maria L, Caputi A, Dirodi AA, et al. Respiratory health in waste collection and disposal workers. Int J Environ Res Public Health 2016;13:631. doi: 10.3390/ijerph 13070631.

8. Athanasiou M, Makrynos G, Dounias G. Respiratory health of municipal solid waste workers. Occup Med 2010;60:618-23.

9. Ravindra K, Kaur K, Mor S. Occupational exposure to the municipal solid waste workers in Chandigarh, India. Waste Manag Res 2016;34:1192-5.

10. Cotes JE. Medical Research Council Questionnaire on Respiratory Symptoms (1986). Lancet. 1987 Oct 31;2(8566):1028. doi: 10.1016/s0140-6736(87)92593-1.

11. American Thoracic Society. Standardization of Spirometry. Available from: https://www.thoracic.org/statements/resources/pft/PFT2.pdf.

12. Salve PS. A comparative study of prevalence of morbidities among municipal solid waste workers in Mumbai. SN Compr Clin Med 2020;2:1534-42.

13. Nagaraj C, Sivaram C, Jayanth K, Murthy NS. A study and mortality profile of Sweepers working under Bangalore City Corporation. IJOEM 2004;8:11-8.

14. Sarkar J. Caste Occupation and Change. Delhi: B. R. Publication Corporation; 1984.

15. Gore HD, Shelke AD, Kembhavi RS, Singru SA, Gore VH, Pandve HT. Working environment and occupational hazards in class IV employees in tertiary care hospital, Mumbai. Glob Res Anal 2013;2:146-8.

16. Emiru Z, Gezu M, Chichiabellu TY, Dessalegn L, Anjulo AA. Assessment of respiratory symptoms and associated factors among solid waste collectors in Yeka Sub City, Addis Ababa, Ethiopia. J Public Health Epidemiol 2017;9:189-97.

17. Abou El-Wafa HS, El-Bestar SF, El-Gilany AH, Awad El-Toraby EE. Respiratory disorders among municipal solid waste collectors in Mansoura, Egypt: A comparative study. Arch Environ Occup Health 2014;69:100-6.

18. Chokhandre P, Singh S, Kashyap GC. Prevalence, predictors and economic burden of morbidities among waste-pickers of Mumbai, India: A cross-sectional study. J Occup Med Toxicol 2017;12:30.

19. Darboe B, Kao MY, Tsai D. Respiratory symptoms among municipal waste workers in the Gambia: Types of solid waste and working conditions. Int J Health Promot Educ 2015;53:17-27.

20. Sabde YD, Zodpey SP. A study of morbidity pattern in street sweepers: A cross-sectional study. Indian J Community Med 2008;33:224.

21. Roopa S, Pavavarath R, Akolkar A, Sankar S, Ravishankar P, Vijayakalakshmi T, et al. Respiratory functions of conservancy workers working in solid waste management sector of Chennai, India. F1000Research 2013;1. doi: 10.12688/ f1000research.1-67.v1.

22. Hamid A, Saleem W, Yaqub G, Ghauri MU. Comparative assessment of respiratory and other occupational health effects among elementary workers. Int J Occup Saf Ergon 2019;25:394-401.

23. van Kampen V, Deckert A, Hoffmeyer F, Taeger D, Brinkmann E, Brünning T, et al. Symptoms, spirometry, and serum antibody concentrations among compost workers exposed to organic dust. J Toxicol Environ Health Part A 2012;75:492-500.

24. Coppeta L, Pietroiusti A, Policardo S, Mormone F, Balbi O, Tursi E, et al. Pulmonary functionality among workers of a Central Italy waste-to-energy plant: A retrospective study. J Occup Med Toxicol 2019;14:1-5. doi: 10.1186/ s12995-019-0241-1.

25. Papageorgiou CV, Savourdos P, Douma E, Georgakopoulou VE, Makrodimitri S, Dounias G. Respiratory symptoms and pulmonary function of workers in the waste management industry. Cureus 2021;13:e17027. doi: 10.7759/cureus.17027.