Original Article

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

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ABSTRACT

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

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.[1,3]

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

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solid waste than their counterparts in high-income countries, who predominantly handle sealed plastic bags and covered dustbins.[4] Furthermore, employees in solid waste management have reported terrible working conditions, with no access to drinking water or sanitation.[5] All of these variables enhance worker exposure to infections, hazardous substances, and chemicals.[6] 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.[7] Additionally, bioaerosols from decomposing garbage cause irritation in the airways, causing respiratory issues.[8]

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.[9] The danger presented to those directly engaged in garbage handling, particularly the impact on the respiratory system, has received less attention.[4] 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%,[5] 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[10] 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.[11]

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. Statistical significance was set at *P* value less than 0.05.

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 FEV_1/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 nonliterate, and two-third of them belonged to the scheduled caste category.[12]
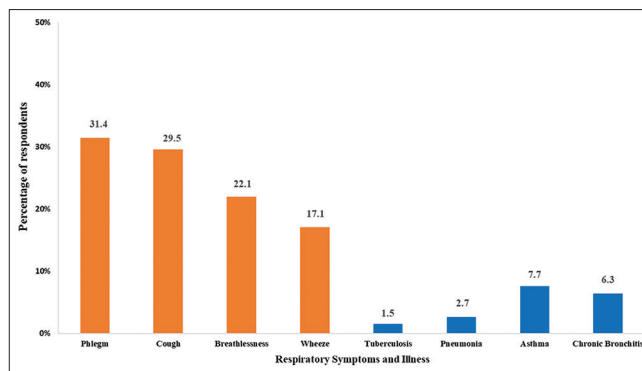

Figure 1: Distribution of past respiratory symptoms and respiratory illness among solid waste management workers in Puducherry (N = 264)

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

Table 4: Percentage of predicted lung function measured by spirometry among solid waste management workers in Puducherry (*n*=264)	
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)
FEV_1/FVC ratio	69.9 (±14)

*Measured using portable spirometer

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

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	Ref	Ref
Middle	109	10 (38.5%)	1.41 (0.58-3.41)	1.29 (0.55-3.30)
Lower middle	121	41 (37.6%)	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 (0.45-14.46)
Type of work		4 (57.1%)		
Waste collector/sweepers	227		3.29 (1.44-7.51)*	3.36 (1.48-7.55)*
Drivers/Office staffs	37	108 (47.1%)	Ref	Ref
Nature of work shift		8 (16.2%)		
Day	194		Ref	Ref
Night	70	77 (39.7%)	1.91 (1.11-3.21)*	1.86 (1.01-3.12)*
Work experience		39 (55.7%)		
≤5 years	170		Ref	Ref
>5 years	94	65 (38.2%)	1.92 (1.15-3.19)*	1.82 (0.98-3.09)*
Use of face mask on duty		51 (54.3%)		
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		90 (41.6%)		
Yes	47	27 (36%)	6.46 (3.05-13.7)*	6.19 (2.95-13.36)*
No	217	40 (38.1%)	Ref	Ref

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

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

current study.

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.[16] The main reasons for not using any protective clothing were their ignorance and poverty.[17] 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.[16] Jayakrishnan *et al*.[4] found that 21% of waste management workers in Kerala had respiratory symptoms and illness.[4] Chokhandre *et al*.[18] 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*.[16] 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.[19] In the current study, around 7.7% and 6.3% of the workers were known cases of bronchial asthma and chronic bronchitis, respectively. Sabde

and Zodpey in their study on street sweepers found upper respiratory tract infections (URTI) in 7.3%, followed by chronic bronchitis (5.9%) and bronchial asthma (1.8%).[20]

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.*[21] 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.*[22] evaluated the respiratory health of elementary workers and found that 46% of solid trash pickers had spirometry limitations. Van Kampen *et al.*[23] 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.[24,25]

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.

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.

Conflicts of interest

There are no conflicts of interest.

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