

ASSESSING MUSCULOSKELETAL DISORDERS AMONG MUNICIPAL WASTE LOADERS OF MUMBAI, INDIA

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Abstract

Objective: The study aims to assess the impact of municipal waste loading occupation upon developing musculoskeletal disorders (MSDs) and thereby disabilities among waste loaders. Additionally, the study has identified the potential risk factors raising MSDs and disabilities. **Material and Methods:** A cross-sectional case-control design survey was conducted in 6 out of 24 municipal wards of Mumbai during March–September 2015. The study population consisted of municipal waste loaders (N = 180) and a control group (N = 180). The Standardized Modified Nordic questionnaire was adopted to measure the MSDs and thereby disabilities in the past 12 months. A Propensity Score Matching (PSM) method was applied to assess the impact of waste loading occupation on developing MSDs and disabilities. **Results:** Waste loaders had a significantly higher risk of developing MSDs as well as disabilities than the control group particularly for low back, hip/thigh upper back and shoulder. Propensity Score Matching results revealed that the MSDs were significantly higher among waste loaders for hip/thigh (22%), low back (19%), shoulder (18%), and upper back (15%) than matched control group. Likewise, MSDs-related disabilities were found to be significantly higher among waste loaders for low back (20%), hip/thigh (18%) upper back (13%) and shoulder (8%) than the control group. Duration of work, substance use and mental health were found to be the potential psychosocial factors for developing the risk of MSDs and disabilities. **Conclusions:** The municipal waste loading occupation raised the risk of MSDs and related disabilities among waste loaders compared to the control group. The preventive and curative measures are strongly recommended to minimize the burden of MSDs and disabilities. *Int J Occup Med Environ Health* 2017;30(6)

Key words:

Musculoskeletal disorder, Disability, Low back, Upper back, Shoulder, Waste loaders

INTRODUCTION

Collection of municipal solid waste in the unorganized and bursting cities is a vigorous and grievous work performed by waste collectors in the developing countries. In many developing countries, collection, transportation and landfilling of solid waste is done by a labour intensive

system performed manually with inadequate protective measures [1]. A metropolitan city like Mumbai generates an average of 8500 metric tons of municipal solid waste per day, with 13 691 municipal employees being associated with the collection, transportation and landfilling of this huge amount of solid waste in the city [2]. Municipal

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employees are at a risk of developing a variety of occupational diseases due to the daily exposure to municipal solid waste. Evidence suggests that workers engaged in the solid waste collection are vulnerable to various occupational health hazards such as respiratory disorders, gastrointestinal diseases, skin diseases, eye infections, headache and musculoskeletal disorders (MSDs) [3–5].

The musculoskeletal disorders among solid waste collectors are mostly non-fatal injuries such as injuries, pain or discomfort in the anatomical area, muscles, joints, tendons, ligaments, nerves, and in bones [6]. Studies conducted with waste collectors reveal that they have a higher probability of developing MSDs as compared to the general population due to the nature of their work [4,5]. Workers with repeated exposure to lifting, bending, pushing and pulling for a longer duration have been identified as being at risk and more likely to develop MSDs [7,8]. The municipal waste loading occupation involves a similar nature of work including lifting, pulling, pushing, bending during the collection of waste materials and loading it into garbage compactors. The continuous work of waste loading involving strenuous physical activities, like lifting heavy loads to a higher loading position and unloading it on landfills, increases the episodes of pain in the anatomical areas [9,10].

In many developing countries including India, municipal solid waste collection is usually carried out manually [11]. Although, the garbage compactors are used in metropolitan cities like Mumbai, many of the allied works are accomplished manually, such as collection of over-flowing waste around community dustbins and loading it into compactors due to inadequate mechanization. Though the increased prevalence of MSDs among solid waste workers is evident from much of the past literature, there is hardly any study assessing MSDs among municipal waste loaders in India. In this backdrop, this study aims to assess the relative risk of developing MSDs and related disabilities among waste loaders. Additionally, the study tries to

identify psychosocial risk factors that increase the risk of developing MSDs and disabilities.

MATERIAL AND METHODS

The study adopted a cross-sectional case-control design to compare the prevalence of MSDs and disabilities among the exposed and non-exposed populations to the waste loading occupation in the financial capital of India, Mumbai. The exposed populations are regular employees of the Municipal Corporation of Greater Mumbai (MCGM) and engaged in the collection and loading of municipal solid waste into garbage compactors from assigned locations such as residential areas, markets, public parks, civil hospitals, and open settlements.

The garbage compactors then transport the collected solid waste to the landfill site. Male employees were only assigned to waste loading occupation by the MCGM, they worked in crews of 6 persons including a supervisor and a driver of garbage compactor. The non-exposed group (the control group) consisted of employees of the MCGM engaged in other occupations such as anti-hawkers squad, fogging/spraying workers and peons in offices of the MCGM. Anti-hawker workers demolish illegal shops and properties on public land; on the other hand, fogging workers practice heavy physical activities by carrying the fogging machine on their shoulders for malaria prevention and walk throughout the assigned area.

Office peons are class IV employees working as back office helpers in the department of solid waste management. These employees work for 8 h/day but their nature of work and workload is different from the waste loaders. This study was conducted in order to examine major morbidities including MSDs among municipal waste loaders in Mumbai. The estimated sample size was $N = 180$ with $p\text{-value} = 0.30$ and the design effect 1.25 [12].

The data was collected randomly from 360 municipal employees (180 waste loaders and 180 control group) in 6 out

of 24 municipal wards by applying stratified systematic random sampling design. At the first stage, municipal wards were stratified according to the proportion of slum population in these wards and further these municipal wards were arranged in the ascending order and divided into 3 strata, i.e., low, middle and high slum concentrated areas. At the second stage, 2 wards were randomly selected from each strata.

Further, a representative sample of 60 employees from each ward (i.e., 30 waste loaders and 30 non-exposed) were selected through systematic random sampling based on the list of employees provided by the Municipal Corporation. The data was collected during the period from March till September 2015.

Study tools

A Standardized Nordic Questionnaire was employed to capture the musculoskeletal symptoms as well as disabilities [13]. Along with capturing the information on musculoskeletal symptoms, the interview schedule covered the primary information about socioeconomic, demographic and occupational characteristics of the respondents. Further, information was collected on psychosocial factors such as mental health, job satisfaction, anthropometric measures, and substance use.

The primary data was entered in the CPro.06 package and analyzed by using STATA13 software. Descriptive statistics were used for understanding socioeconomic and occupational characteristics. The difference in the prevalence of MSDs between the exposed and the unexposed groups was tested using the Chi² test (significance level was at $p < 0.05$).

Response variables

Respondents reported pain in the neck, shoulders, wrist/hand, elbow, upper back, low back, thighs/hips, knees, and ankles were considered and classified as morbid with the MSDs. Similarly, workers, who were prevented from

performing day-to-day normal activities due to MSDs in the preceding 12 months were considered as disabled.

Individual risk factors

Prolonged physical activities result in the development of anatomical troubles for workers associated with waste collection and loading. Apart from occupational and environmental factors, several studies have highlighted that psychosocial factors also affect the prevalence of MSDs among solid waste workers [14,15]. Previous studies suggest that with an increase in age and the duration of work, complaints of MSDs increase continuously [16]. Likewise, overweight and obesity among working population may lead to musculoskeletal pain because of the increased physical pressure on the weight-bearing joints [17]. Available literature shows that overweight and obesity are positively associated with the anatomical pain [18–20].

Further, the meta-analysis of past studies reveals that the use of substances such as alcohol, smoking and chewing tobacco affects the physical capacity of a worker and causes musculoskeletal pain [21,22]. Symptoms such as worry, tension, anxiety, work-stress, and low mood have association with musculoskeletal disorders [23]. The state of job satisfaction among employees influences the prevalence of MSDs, too [24]. These all psychosocial factors may increase or decrease the prevalence of MSDs among solid waste loaders [25]. Hence, mental health and job satisfaction of workers are considered as confounding variables.

To analyze the mental health status of workers the General Health Questionnaire of 12 items (GHQ-12) [26] was applied. Workers were asked whether they had experienced positive and or negative emotions in the previous month. Each negative state was coded as 1, and 0 otherwise. The items were summed up to a score for each individual. As the score increases, mental health problem increases, ranging from 0 to 12. The scores were divided into 3 categories, that is, good, intermediate and poor. The scale is acceptable with internal consistency ($\alpha = 0.94$) [27].

In order to examine the exposure of the waste loading occupation to the development of MSDs, the study adopted the nearest neighborhood method of propensity score matching (PSM). This approach gives an opportunity to assess the impact of exposure on outcomes through cross-sectional survey data [28]. The propensity score is estimated by logistic regression with dichotomous exposure variable, for instance 1 = exposed to the waste loading occupation and 0 = otherwise, using associated observed demographic and occupational characteristics of the waste loaders as predictor variables. For identifying the covariates affecting MSDs and related disabilities among waste loaders, the multiple logistic regression analysis was employed.

Ethical consideration

As the respondents were government employees, the permission to conduct the primary survey was approved by the MCGM. In addition, ethical clearance prior to

the data collection was approved by the Student Research Ethics Committee of International Institute for Population Sciences, Mumbai. The informed consent of participants was obtained in the local language, with the interviewer reading the consent statement for all the respondents. The consent statement identified the researcher and purpose of the study. The respondents were informed that participation was voluntary and if they chose not to answer, they could withdraw at any time. They were assured that the information would be confidential and used for research purposes only.

RESULTS

The socioeconomic and occupational characteristics of the waste loaders and the control group are exhibited in the Table 1. A marginal difference was observed while looking at the mean age of the participants as it was 36 years old and 38 years old for the exposed and

Table 1. Socioeconomic and occupational characteristics of waste loaders and the control group in the study assessing musculoskeletal disorders

Variable	Respondents (N = 360)	
	waste loaders (N = 180)	control group (N = 180)
Age [years] (M±SD)	35.79±8.69	38.11±7.39
19–34 years [%]	53.30	34.40
≥ 35 years [%]	46.70	65.60
Working time [years] (M±SD)	10.35±8.16	11.43±6.35
< 10 years [%]	67.80	51.10
≥ 10 years [%]	32.20	48.80
Addiction (smoking, tobacco, alcohol) [%]		
no	31.10	53.30
any	34.40	27.20
≥ 2	34.40	19.40
Mental health (tested by GHQ-12) [%]		
good	21.10	50.60
intermediate	37.20	24.40
poor	41.70	25.00

Table 1. Socioeconomic and occupational characteristics of waste loaders and the control group in the study assessing musculoskeletal disorders – cont.

Variable	Respondents (N = 360)	
	waste loaders (N = 180)	control group (N = 180)
Job satisfaction [%]		
good	17.20	30.60
average	58.90	61.10
bad	23.90	8.30
Body mass index (BMI) (M±SD)	23.52±3.41	25.14±3.35
≤ 25 [%]	67.20	51.70
> 25 [%]	32.80	48.30
Caste [%]		
scheduled castes	78.30	51.70
others	21.70	48.30

M – mean; SD – standard deviation.

GHQ-12 – General Health Questionnaire of 12 items [26].

the control groups, respectively. The substance use was very common among the waste loaders; for instance, more than one-third of the waste loaders (34%) were using 2 or more types of substances. The mental health status of the workers was analyzed and it was found that poor mental health reported by the waste loaders was higher (42%) compared to the control group (25%). The prevalence of MSDs and disabilities among the waste loaders and the control group in the previous 12 months are presented in the Table 2.

The Chi² analysis showed that the prevalence of MSDs and disabilities was significantly different among the waste loaders as compared to the control group. Findings from the table suggest that the waste loaders were at a higher risk of developing MSDs for the low back (39%), hips/thighs (34%), shoulders (26%), and wrists/hands (19%) as compared to the control group (27%, 20%, 11%, 10% and 9%, respectively). A similar pattern was observed in MSDs leading to disabili-

ties. For instance, disabilities among the waste loaders were significantly higher for the low back (31%), shoulders (16%) and hips/thighs (23%) as compared to the control group (18%, 9% and 8%, respectively).

Waste loading occupation enhances MSDs

The study examined the impact of the waste loading occupation on the development of MSDs as well as disabilities in the preceding 12 months by estimating the difference in the outcomes between the exposed group (waste loaders) and the matched control group. Results of the average exposure effect among the exposed (AEEE) from the Table 3 highlighted that MSDs were significantly higher among the waste loaders for hips/thighs (22%), low back (19%), shoulders (18%) and upper back (15%) than in the matched control group.

Likewise, results of the AEEE for MSDs leading to disabilities among the waste loaders was found to be significantly

Table 2. Prevalence of musculoskeletal disorders (MSDs) and disabilities among waste loaders and in the control group in the past 12 months

Anatomical region	Respondents (N = 360) [%]		Chi ² test	p
	waste loaders (N = 180)	control group (N = 180)		
Neck				
MSD	13.3	10.6	0.66	0.416
disability	5.6	9.4	1.96	0.161
Shoulder				
MSD	26.1	11.1	13.36	0.000
disability	15.6	9.4	3.07	0.080
Elbow				
MSD	10.6	8.9	0.28	0.594
disability	5.0	5.6	0.05	0.814
Wrist/Hand				
MSD	18.9	18.9	0.00	1.000
disability	13.9	13.3	0.02	0.878
Upper back				
MSD	31.7	27.2	0.85	0.355
disability	25.0	18.9	1.96	0.161
Low back				
MSD	38.9	29.4	3.56	0.059
disability	30.6	17.8	8.01	0.005
Hip and thigh				
MSD	34.4	20.0	9.47	0.002
disability	22.8	7.8	15.64	0.000
Knee				
MSD	3.3	3.9	0.07	0.778
disability	2.2	3.3	0.41	0.521
Ankles/Feet				
MSD	3.3	2.2	0.41	0.521
disability	1.7	2.2	0.14	0.703

higher than the control group. Specifically, it was considerably higher for the low back (20%), hips/thighs (18%) upper back (13%) and shoulders (8%). The PSM analysis suggested that the occupation of waste loading increases the prevalence of MSDs and related disabilities.

Individual risk factors for developing MSDs and disabilities

The multivariate logistic regression analysis helped to identify psychosocial risk factors enhancing MSDs among waste loaders in the previous 12 months, with adjustment

Table 3. Exposure effect of waste loading occupation (AEEE) on developing MSDs and disabilities for various body regions of waste loaders in the past 12 months

Anatomical region	MSDs		Disability ^a due to MSDs	
	coefficient	95% CI	coefficient	95% CI
Shoulder	0.18***	0.09–0.26	0.08**	0.01–0.16
Wrist/Hand	0.06	–0.03–0.14	0.03	–0.05–0.11
Upper back	0.15***	0.06–0.24	0.13***	0.05–0.21
Low back	0.19***	0.10–0.29	0.20***	0.12–0.27
Hip/Thigh	0.22***	0.13–0.31	0.18***	0.10–0.25
Knee	0.01	–0.03–0.05	0.01	–0.03–0.05

AEEE – average exposure effect on exposed; MSDs – musculoskeletal disorders.

CI – confidence interval.

*** $p < 0.01$; ** $p < 0.05$.

^a Prevented normal activity at home or away from home due to MSDs.

Table 4. Odds ratio showing correlation in symptoms of musculoskeletal disorders (MSDs) and associated risk factors among waste loaders (past 12 months)

Variable	OR (95% CI) ^b				
	shoulder	wrist/hand	low back	hip/thigh	upper back
Age					
19–34 years ^a					
≥ 35 years	1.04 (0.41–2.65)	0.80 (0.26–2.44)	2.01 (0.88–4.63)	3.04*** (1.28–7.23)	2.26** (0.98–5.18)
Working time					
< 10 years ^a					
≥ 10 years	4.57*** (1.75–11.92)	4.40*** (1.40–13.83)	3.14*** (1.30–7.59)	2.25** (0.92–5.50)	2.94** (1.24–6.95)
Substance use					
no ^a					
1	1.25 (0.45–3.47)	0.63 (0.20–1.98)	2.23 (0.88–5.63)	1.46 (0.57–3.74)	1.10 (0.44–2.70)
≥ 2	3.03** (1.10–8.39)	1.68 (0.57–4.93)	2.92** (1.13–7.56)	3.07** (1.17–8.02)	1.17 (0.46–2.99)
Mental health					
good ^a					
intermediate	3.47** (1.03–11.68)	5.78** (1.03–32.30)	2.65 (0.87–8.08)	6.02*** (1.72–21.04)	2.23 (0.75–6.64)
poor	2.84** (0.93–8.77)	8.72 (1.73–43.90)	7.56 (2.66–21.45)	7.10 (2.21–22.77)	2.95** (1.07–8.12)

^a Reference category.

^b The full model is additionally adjusted for job satisfaction and body mass index (BMI).

OR – odds ratio; CI – confidence interval.

*** $p < 0.01$; ** $p < 0.05$.

for job satisfaction and body mass index. Results from the Table 4 highlighted that the complaints of MSDs were significantly higher among the waste loader aged 35 years

old and above, particularly for hips/thighs (odds ratio (OR) = 3.04, $p < 0.01$) and upper back (OR = 2.26, $p < 0.05$) as compared to the workers aged 19–34 years

old. Duration of work emerged as a significant predictor as waste loaders with higher years of working were significantly more likely to report symptoms of MSDs. For instance, those who were working for 10 or more years were more likely to suffer from MSDs for shoulders (OR = 4.57, $p < 0.01$), wrists/hands (OR = 4.40, $p < 0.01$), upper back (OR = 2.94, $p < 0.05$) and low back (OR = 3.14, $p < 0.05$) compared to those working for less than 10 years.

Similarly, substance use significantly enhanced the occurrence of MSDs among waste loaders having 2 or more types of addiction, particularly for shoulders (OR = 3.03, $p < 0.05$), hips/thighs (OR = 3.07, $p < 0.05$) and low back (OR = 2.92, $p < 0.05$) as compared to those who were not consuming any substances. The analysis of the effect of mental health on MSDs revealed that workers with poor mental health status were significantly more likely to

report MSDs for upper back (OR = 2.95, $p < 0.05$) and shoulders (OR = 3.26, $p < 0.05$) as compared to workers having good mental health status.

Further, the study shows the association between psychosocial factors and disabilities among waste loaders in the Table 5. As expected, duration of work comes out to be a highly significant predictor of developing disabilities. Waste loaders with 10 or more years of engagement in waste loading were significantly more likely to report disabilities for wrists/hands (OR = 5.78, $p < 0.01$), shoulders (OR = 4.81, $p < 0.01$), hips/thighs (OR = 3.96, $p < 0.01$), upper back (OR = 3.94, $p < 0.01$) and low back (OR = 3.59, $p < 0.01$) as compared to those working for less than 10 years.

In the case of substance use, workers with 2 or more types of addiction were significantly more likely to report

Table 5. Odds ratio showing correlation of disability due to musculoskeletal disorders (MSDs) and associated risk factors among waste loaders (past 12 months)

Variable	OR (95% CI) ^b				
	shoulder	wrist/hand	low back	hip/thigh	upper back
Age					
19–34 years ^a					
≥ 35 years	0.58 (0.17–1.92)	1.52 (0.41–5.61)	2.17 (0.86–5.48)	2.12 (0.73–6.13)	1.19 (0.47–3.02)
Working time					
< 10 years ^a					
≥ 10 years	4.81*** (1.42–16.27)	5.78*** (1.57–21.30)	3.59*** (1.43–9.06)	3.96*** (1.39–11.30)	3.94*** (1.55–10.05)
Substance use					
no ^a					
1	0.63 (0.16–2.42)	0.41 (0.11–1.50)	1.46 (0.52–4.05)	1.10 (0.36–3.41)	0.92 (0.34–2.48)
≥ 2	3.30** (1.02–10.71)	0.73 (0.21–2.56)	3.87*** (1.39–10.76)	2.78** (0.92–8.41)	1.41 (0.53–3.73)
Mental health					
good ^a					
intermediate	2.34 (0.63–8.73)	4.11 (0.70–24.15)	6.35*** (1.63–24.68)	1.53 (2.43–13.73)	1.69 (0.52–5.47)
poor	1.47 (0.43–5.06)	4.33 (0.83–22.60)	9.60 (2.72–33.83)	2.66 (3.47–18.42)	2.75** (0.95–7.95)

^a Reference category.

^b The full model is additionally adjusted for job satisfaction and body mass index (BMI).

OR – odds ratio; CI – confidence interval.

*** $p < 0.01$; ** $p < 0.05$.

disabilities for low back (OR = 3.87, $p < 0.01$), shoulders (OR = 3.30, $p < 0.05$) and hips/thighs (OR = 2.78, $p < 0.05$). Similarly, waste loaders with poor mental health status were significantly more likely to report disabilities for low back (OR = 6.35, $p < 0.01$) and upper back (OR = 2.75, $p < 0.05$) as compared to workers with good mental health status.

DISCUSSION

This study depicted the higher prevalence of musculoskeletal disorders and thereby disabilities among the waste loaders as compared to the control group. The bivariate analysis exhibited a higher prevalence of MSDs – low back (39%), hips/thighs (34%), upper back (32%), shoulders (26%), and neck (13%) – among the waste loaders as compared to 29%, 20%, 27% and 11%, respectively, in the control group. The disabilities due to MSDs were found to be significantly higher among the waste loaders particularly in the low back (31%), upper back (25%), hips/thighs (23%), shoulders (16%) and wrists/hands (14%) as compared to the control group.

The results of the multivariate logistic regression analysis match with the previous study which revealed that the age of workers, duration of work, substance use and mental health come out to be significant psychosocial risk factors enhancing MSDs and disabilities among waste loaders [29]. The propensity score matching analysis suggested that exposure to the waste loading occupation enhanced the prevalence of MSDs and disabilities compared to the matched control group. The field observation suggested that this may be due to repetitively collecting litter from the community dustbins with a bending posture, which causes musculoskeletal pain for the low back, the upper back and the neck.

Similarly, lifting and loading heavy garbage dustbins, irrespective of the weight they bore, induced pain in the hips/thighs, shoulders, wrists/hands, elbows and knees. The result of this study is found to be similar to the previous

studies conducted among solid waste collectors [4,12,16]. Further, the study has shown higher prevalence of MSDs in hips/thighs compared to the other studies. This may be because waste loaders were repetitively engaged in lifting heavy community dustbins throughout the working period.

Past studies conducted with solid waste workers in developing countries like Egypt [5], Iran [4], Nigeria [30], Taiwan [31] and Brazil [32] have reported higher prevalence of MSDs particularly for low back, shoulders, wrist/hand, upper back and knee. Findings from these studies offers the evidence for present study that workers associated with municipal solid waste collection have higher musculoskeletal disorders as compared to the general population. Caste is a reality of the social structure in India, and it is merely a division of laborers [33].

This was reflected from the analysis that the majority of the employees working in solid waste management belonged to the low social category or the scheduled castes. They were previously untouchables, economically the weakest, and historically discriminated against because of caste identity. In this study, more than 3/4 (78%) of the waste loaders belonged to the scheduled castes.

The study has several methodological strengths such as the sampling design, selection of control group and application of the Standardized Modified Nordic questionnaire to assess the MSDs and related disabilities among waste loaders. Additionally, due to the voluntary nature of the study and the guarantee of confidentiality to the participants, the chances of false reporting may have been reduced.

This study not only assesses MSDs but also measures functional limitations/disabilities. Previous cross-sectional case-control studies used the Chi² test to examine the relationship between musculoskeletal disorders and occupational exposure whereas this study adopted the propensity score matching method, providing an opportunity to as-

sess the impact on the outcome through cross-sectional survey data.

The study has some limitations, such as the data collected on MSDs were mainly self-reported and hence there is a possibility of bias due to subjectivity of the responses. Further, seasonal variations may change working conditions and in turn lead to changes in the prevalence of MSDs, which has not been depicted through this study. Data was collected from municipal waste loaders and hence the results may not be generalized to all types of workers associated with waste handling.

CONCLUSIONS

Statistical methods of the Chi², multivariate logistic regression, and propensity score matching highlighted that the municipal waste loading occupation significantly increases the risk of development of MSDs and related disabilities among waste loaders as compared to the control group. Likewise, psychosocial factors, such as substance use and mental health status, are potential confounders to developing the risk for MSDs and disabilities among waste loaders.

The study strongly recommends preventive and curative measures to minimize the burden of MSDs and disabilities. Job rotation among municipal solid waste workers may reduce the burden of MSDs. Similarly, a training program needs to be organized to detect the early signs and symptoms of MSDs so that waste loaders may demand the curative measures.

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