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# Assessing impact of waste picking on musculoskeletal disorder among waste pickers of Mumbai, India: a cross-sectional study

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## Title:

Assessing impact of waste picking on musculoskeletal disorder among waste pickers of Mumbai, India: a cross-sectional study.

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## Abstract

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**Objective:** To assess the prevalence of musculoskeletal disorders as well as the impact of waste picking occupation and complaints of MSDs among waste pickers. Further, the study attempt to understand the factors affecting MSDs for selected body parts.

**Design:** A cross-sectional household survey was conducted using a case control design. The survey instrument for measurement of musculoskeletal symptoms was adopted from the Standardized Nordic Questionnaire.

**Participants:** Study population consisted of the waste pickers (n=200) who had been working for at least a year and a control group (n=213) was selected with same socio-economic and living condition in and around the community.

**Results:** The twelve month prevalence of MSDs has been found higher among waste pickers (79%) as compare to control group (55%) particularly at lower back (40-21%), knee (48-35%), upper back (40-21%) and shoulder (32-12%) respectively. Similar patterns have been observed while analyzing 12 month prevalence of MSDs led inability in working at home or workplace particularly for lower back (36-21%), shoulder (21-7%) and upper back (25-12%) respectively for waste pickers and control group. While assessing impact of waste picking occupation on complaints of MSDs, analysis suggest that occupation of waste picking poses greater risk of MSDs particularly in shoulder, lower and upper back. Occupation of waste picking, Increase in age and longer duration of work have emerged as significant predictors for MSDs.

**Conclusion:** The study suggests that a higher prevalence of musculoskeletal disorder is found among waste pickers particularly in lower and upper back and shoulder when compared with the control group. It is evident from the study that exposure to occupation of waste picking leads to a high prevalence of MSDs. Results from the study strongly recommends both curative and preventive measures to minimize the burden of musculoskeletal disorders among waste pickers.

## **ARTICLE SUMMARY**

## **Article focus**

- Prevalence of musculoskeletal disorders (MSDs) among waste pickers.
- Impact of waste picking occupation on MSDs in various body part region.
- Factors affecting MSDs for selected body parts.

## Key messages

- MSDs are highly prevalent among waste pickers when compared with control group.
- Current age of respondents and weekly working hours have come out to be the major determinants which lead to high prevalence of MSDs.
- Preventive as well as curative interventions are needed to abate the episodes of MSDs
- There is a need to promote existing State sponsored health insurance scheme among waste pickers.

## Strengths and limitations of this study

- First study to be carried out on MSDs among waste pickers
- Attempts have been made to assess the MSDs which occur due to waste picking.
- Due to one year reference period biasness may occur in responses related to MSDs.
- Data has been collected from waste pickers who were collecting waste from dumping ground and not from road side or community dumping bins and hence cannot be generalized to all type of waste pickers.

## **INTRODUCTION**

Waste pickers play a noteworthy but unrecognized role in the solid waste management system. They salvage recyclable items and collect garbage that can be sold to scrap merchant (paper, plastic, tin etc.). This kind of work requires no skill and is a source of income for a growing number of urban poor. It has been estimated that up to 2 percent of the population in third world countries earns a living through waste picking and recycling.[1] International Labour Organisation (ILO) estimates that there are between 15 and 25 million waste pickers in the world.[2] An estimated two million of these are in India.[3]

A strong and significant relationship between working environment and complaints of musculoskeletal disorders (here after MSDs) has been widely reported. Workplace activities such as heavy lifting, manual handling, prolonged bending and repetitive tasks are known as risk factors for musculoskeletal disorders.[4-7] Person whose routine work involve strenuous physical activities such as pulling, pushing, lifting, carrying, picking, sweeping, or bending for long hours are the most vulnerable.[8-10] These kinds of activities are predominant among waste pickers. Musculoskeletal disorders are one of the major causes of morbidity. The burden of musculoskeletal disorders is global and looking at the gravity of the situation WHO declared 2000-2010 as the Bone and Joint decade.[11] In many countries, MSDs emerged as one of the leading causes of occupational injury, illness and disability and varies with occupations.[12-16] Literature suggests that the solid waste workers have more musculoskeletal disorders than general population.[17-18]

In this backdrop, the present study analyses the prevalence of MSD as well as MSD led inability to work at home or workplace during last 12 months prior to the survey. Adding to this, it also

examines the impact of waste picking occupation on MSD. Further, the study tries to understand the determinants of MSD for selected body parts.
 MATERIALS AND METHODS
 The study design was cross sectional and study population consisted of the waste pickers (n=200) residing near *Deonar* dumping ground, which is the oldest and biggest dumping ground

(n=200) residing near *Deonar* dumping ground, which is the oldest and biggest dumping ground in Asia. Similarly data also collected from non-waste pickers (n=213) residing in the same community as well as from nearby communities having almost similar socio-economic and living condition. The non-waste pickers are considered as a control group for the study. The participation in the study was voluntary and due care was taken to highlight the voluntary nature of participation. The data was collected during March-July 2014. Our survey instrument for measurement of musculoskeletal symptoms was adapted from the Standardized Nordic Questionnaire[19] and translated into Hindi language. An anatomical diagram with labels and arrows clearly indicating different body parts was used for the assessment of musculoskeletal symptoms. Presence of musculoskeletal symptoms defined as ach, pain or discomfort in one of the nine body parts (neck, shoulders, elbows, wrists or hands, upper back, low back, hips or thigh, knees and ankles or feet) during past 12 months. In addition, information was also collected on socio-demographic and occupational characteristics included questions on age, level of education household assets, duration of employment and weekly days and daily working hours. The results summarized in descriptive statistics. One year prevalence of musculoskeletal symptoms was calculated for the waste-pickers and for the control groups. Differentials in prevalence of symptoms among subgroups were tested by Chi square test.

In order to examine the impact of waste picking occupation on musculoskeletal disorder, the study adopted nearest neighborhood method of propensity score matching PSM.[20-21] This approach gives an opportunity to assess the impact of exposure on outcomes through cross-sectional survey data.[22-24] Propensity score is estimated by logistic regression, with the dichotomous exposure/treatment variable, for instant, 1 = exposed to waste-picking occupation; 0 = unexposed to waste-picking occupation using associated observed demographic and occupational characteristics of the waste pickers used as a predictor variables. The principal assumption in this method is that conditional of propensity score, the observable selected characteristics of the exposed and control groups have similar distributions.[22] This assumption test is applied by using 'pscore' command. Even if this 'balancing' property is satisfied, the

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study still assume that selection to the exposed group is not based on unobservable characteristics that also affect outcome variables. Propensity score has been calculated using probability of treatment assignment given pre-treatment characteristics.

## $\mathbf{p}(\mathbf{x}) \equiv \mathbf{prob} \ (\mathbf{D} = 1 | \mathbf{Xi}) = \mathbf{E}(\mathbf{D} | \mathbf{xi})$

where,  $D = \{0, 1\}$  is the indicator of exposure and x is the multidimensional vector of pretreatment characteristics.

The average treatment effect for the treated (ATET) is defined as the conditional expectation of the difference in treatment effects for treated units only.

## ATET = E ( $\Delta$ | p(x), D=1) = E (y<sub>1</sub>|p(x), D=1) - E (y<sub>0</sub>|p(x), D=0)

After matching propensity scores, we have compared the outcomes of treated and counterfactual scores of control observations.

## ATE = E ( $\Delta$ ) = E ( $y_1|x, D=1$ ) – E ( $y_0|x, D=0$ )

The average treatment effect ATE is defined as the expected (mean value) of the difference in potential outcomes across all units in our target population which is identical to the difference in expected potential outcomes of control group i.e.  $E(Y_1)$  and  $E(Y_0)$ . In this case, difference in musculoskeletal complaints between exposed (engaged in waste picking occupation) and control groups (engage in other than waste picking occupation) can be directly compared to show the impact of exposure on the exposed group, known as average treatment effect on treated (ATET). In order to calculate the impact of waste-picking occupation on MSD in the last 12 months as well as MSD led inability to work in last 12 months, the average effect in both the groups were weighted by the proportion of respondents in treatment and control groups which measured the increase/ decrease in MSD due to waste-picking occupation. In order to understand the covariates affecting musculoskeletal disorder for some selected body regions, multiple logistic regression analysis is used. The study has used STATA 13 package for the entire analysis.

## RESULTS

## Socio-demographic and occupational characteristics of study groups

Table 1 provides socio-economic and occupational characteristics of the waste pickers as well as the control group. Waste pickers are comparable with the respective control group in all aspects except education. The higher proportion of waste pickers as well as those in the control group falls in the age group 18-30 years (48% and 41%, respectively). The mean age of both the groups

is found to be around 35 years with standard deviation of little over 10 years. Similarly while looking at family size, bigger household size have been found among waste pickers household i.e. there are 24 percent of households belongs to waste pickers has seven or more number of persons whereas the corresponding figure for control group is 17 percent. Almost, equal proportion of respondent found among waste pickers and control group across the years of working. While considering education, the proportion of non-literate is found to be higher among waste pickers (70%) whereas it is 45 percent among the control group.

Background characteristics	Waste pickers	Control group
	n=200	n=213
Age		
18-30	48.0	33.3
31-40	30.5	40.4
Above 40 years	21.5	26.3
Mean ± SD	34.0 ± 10.2	36.5 ± 9.8
Education		
Not literate	69.5	40.9
Up to 5 yrs. of education	19.5	17.8
Above 5 yrs. of education	11.0	41.3
Mean ± SD	1.6 ± 2.8	4.2 ± 4.1
Family size		
Up to 4 members	38.5	42.3
5-6 members	37.5	40.9
7 or more members	24	16.9
Mean ± SD	5.3 ± 2.1	4.8 ± 1.8
Sex		
Female	42.5	15.9
Male	57.5	84.0
Years of working		
1-4 years	16.5	17.4
5-10 years	37.0	36.6
Above 10	46.5	46.0
Mean ± SD	11.1 ± 6.7	11.5 ± 7.7
Weekly working hours		
Up to 40 hrs.	62.0	41.3
Above 40 hrs.	38.0	58.7
Mean ± SD	36.5 ± 19.7	47.8 ± 19.4

#### Prevalence of musculoskeletal disorders (MSDs)

Table 2 shows the prevalence of musculoskeletal disorder (MSD) in various body parts and inability to work due to MSD at home or away from home in last 12 months among waste pickers and control group. Out of the total survey population more than half (66%) of the respondents reported that they had been troubled with musculoskeletal symptoms in one or more of the nine defined body regions during the last 12 months. Overall the prevalence of MSD has been found to be significantly higher among the waste pickers than among the control group. For instance, among the waste pickers MSD in shoulder (32%), upper back (40%), lower back (54%) and knee (48%), whereas the respective figures for control group are (12, 21, 36 and 35%). In case of those who find it difficult to work (in home or away from home) due to MSD, substantial difference is found between waste pickers and control group particularly in shoulder (21 and 7%), upper back (25 and 12%) and lower back (36 and 21%).

## MSDs caused due to waste picking occupation

The study tried to examine the impact of waste-picking occupation on MSDs by the estimated difference in the outcomes between exposed (waste pickers) and the matched control group (nonwaste pickers). A propensity score matching has been done to assess the impact of waste picking on MSDs. The PSM attempts to reduce the bias that could be found in an estimate of the treatment effect obtained from simply comparing outcomes among units that received the treatment versus those that did not by controlling the demographic and occupational variable. Results from **Table 3.1** show the average treatment effect (ATE) for discomfort/pain in various body parts during the last 12 months. Findings suggest that, overall MSDs found higher among waste pickers 34% (p<0.01) than non-waste pickers, whereas in specific body regions, shoulder, upper back, lower back and knee (28, 22, 24, 21% respectively) found higher among waste pickers than non-waste pickers. By and large similar pattern found while looking at the results of average treatment effect on treated (ATET). Similarly, while looking at the inability to work at home or work place due to MSDs for the past 12 months, it is evident that in overall the MSD found higher among waste pickers (29%) than non-waste pickers. Specifically, it is considerably higher at lower back, shoulder, knee and upper back (21, 18, 18 and 12% respectively). The overall message which could be brought out from this analysis is that the occupation of waste significantly disorder. picking increases the musculoskeletal

Table 2: Preva	lence of mus	culoskeletal di	sorder (MS	SD) among waste pickers	s (n=200) and	control group	(n=213).	
		MSD during	2 months	Work	Work problem due to MSD in past 12 months			
Body regions	Waste pickers	Control group	Total	chi2-test	Waste pickers	Control group	Total	chi2-test
Any	78.5	54.9	66.3	(x2=25.6; p<0.000)	58.5	39.4	48.7	(χ2=15.0; p≤0.000)
Neck	8.5	2.4	5.3	(χ2=7.7; p≤0.005)	8.0	1.9	4.8	(χ2=8.4; p≤0.004)
Hand	16.0	8.5	12.1	( $\chi 2=5.5$ ; p=0.019)	6.5	3.8	5.1	( $\chi$ 2=1.6; p=0.205)
Shoulder	32.0	12.2	21.8	(x2=23.7; p<0.000)	21.0	6.6	13.6	(χ2=18.3; p≤0.000)
Upper back	40.0	20.7	30.0	(x2=18.4; p<0.000)	24.5	12.2	18.2	( $\chi$ 2=10.4; p=0.001)
Lower back	54.0	36.2	44.8	(x2=13.3; p<0.000)	36.0	20.7	28.1	(χ2=12.0; p≤0.001)
Thigh	8.5	10.3	9.4	( $\chi 2=0.4$ ; p=0.525)	5.0	6.6	5.8	( $\chi$ 2=0.5; p=0.495)
Knee	47.5	34.7	40.9	(χ2=6.9; p≤0.008)	31.0	21.6	26.2	(χ2=4.7; p≤0.05)
Ankle	18.5	8.0	13.1	$(\gamma 2=10.0; p \le 0.002)$	10.0	3.8	6.8	$(\chi 2=6.4; p=0.012)$

Table 3: Averag disorders as we	e treatment e ell as unable to	ffect (ATE) and ave work due to MSD	erage treatment s in last 12 mon	t effect on treate ths.	d (ATET) of w	aste picking occup	ation on muscu	loskeletal
	M	usculoskeletal diso	order in last 12 n	nonths	Unal	ole to work in last :	12 months due	to MSDs
	ATE		ATET			ATE	ATET	
Body regions	Coef.	CI at 95%	Coef.	CI at 95%	Coef.	Cl at 95%	Coef.	Cl at 95%
Any	0.34***	(0.25-0.43)	0.32***	(0.2-0.44)	0.29***	(0.19-0.39)	0.27***	(0.16-0.37)
Neck	0.06***	(0.02-0.1)	0.08***	(0.03-0.12)	0.06***	(0.02-0.1)	0.07***	(0.03-0.11)
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Neck	0.06***	(0.02-0.1)	0.08***	(0.03-0.12)	0.06***	(0.02-0.1)	0.07***	(0.03-0.11)
Hand	0.12***	(0.05-0.19)	0.13***	(0.07-0.18)	0.04*	(-0.01-0.1)	0.04*	(0-0.08)
Shoulder	0.28***	(0.19-0.37)	0.27***	(0.19-0.34)	0.18***	(0.1-0.26)	0.19***	(0.12-0.25)
Upper back	0.22***	(0.11-0.32)	0.24***	(0.14-0.34)	0.12***	(0.04-0.21)	0.15***	(0.06-0.23)
Lower back	0.24***	(0.14-0.35)	0.19***	(0.06-0.32)	0.21***	(0.11-0.32)	0.18***	(0.08-0.28)
Knee	0.21***	(0.1-0.32)	0.18***	(0.07-0.29)	0.18***	(0.09-0.29)	0.13***	(0.04-0.22)
Ankle	0.16***	(0.08-0.25)	0.14***	(0.07-0.2)	0.10***	(0.03-0.16)	0.08***	(0.02-0.13)
Level of significance	***p<0.01, * p<	<0.1						

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## Factors associated with MSDs

Table 4.1 depicts the adjusted effect of covariates by complaint of MSD in various body parts during the last 12 months. The complaint of MSD in various body parts has been significantly higher among waste pickers i.e. shoulder (OR=2.86; p<0.01), for upper back (OR=2.08;p<0.01), for lower back (OR=1.90; p<0.05), for ankle (OR=2.92; p<0.01) and hand (OR=2.1; p<0.1) as compare to wage laborers. Similarly, while considering age group, it is found that increase in age directly correlated with the increase in complaints of MSD for various body parts. For instance, those are above 40 years of age have reported that they more likely to suffer with MSD i.e. for upper back (OR=2.75; p<0.01), for lower back (OR=2.64; p<0.01), for knee (OR=5.41; p<0.01), for ankle (OR=2.91; p<0.01) and for hand (OR=1.94; p<0.05) as compare to those in the age group 18-30 years. Working years and sex of respondent have not been found significant.

Background characteristic	Any	Shoulder	Hand	Upper back	Lower back	Knee	Ankle
Occupation							
Wage labor®							
Waste picker	2.98***	2.94***	2.38**	2.12***	2.00***	1.44	3.03***
	(1.62-5.46)	(1.46-5.93)	(0.97-5.84)	(1.16-3.87)	(1.15-3.50)	(0.82-2.53)	(1.27-7.25)
Other	0.77	0.59	1.02	0.62	0.89	0.63	0.90
	(0.42-1.39)	(0.25-1.38)	(0.37-2.82)	(0.31-1.24)	(0.49-1.61)	(0.34-1.16)	(0.32-2.53)
Age							
18-30 yrs.®							
31-40 yrs.	1.01	1.34	1.25	1.32	0.93	1.20	0.80
	(0.60-1.69)	(0.74-2.42)	(0.60-2.59)	(0.77-2.27)	(0.57-1.52)	(0.73-1.98)	(0.37-1.73)
Above 40 yrs.	2.39***	1.27	1.35	1.54	1.53	2.75***	2.26**
	(1.23-4.61)	(0.65-2.49)	(0.59-3.08)	(0.85-2.81)	(0.87-2.67)	(1.56-4.87)	(1.06-4.83)

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<b>Duration of work</b> Up to 4 vrs.®							
5-10 yrs.	1.76	1.70	1.84	0.93	1.52	1.19	2.36
	(0.95-3.25)	(0.74-3.92)	(0.65-5.23)	(0.47-1.82)	(0.82-2.79)	(0.63-2.23)	(0.75-7.39)
Above 10 yrs.	2.21***	2.07	1.68	1.26	1.86**	1.56	2.45
	(1.16-4.21)	(0.90-4.77)	(0.59-4.83)	(0.64-2.47)	(1.00-3.48)	(0.83-2.95)	(0.78-7.69)
Weekly working days							
Up to 40 hrs.®							
Above 40 hrs.	1.41	1.54*	1.52	1.13	1.05	1.06	1.82*
	(0.89-2.23)	(0.92-2.58)	(0.81-2.84)	(0.71-1.78)	(0.69-1.59)	(0.69-1.63)	(0.97-3.42)
Reference category; **	*p<0.01, **p<0.05	, * p<0.1; 95% con	fidence interval in	parenthesis			

While looking at adjusted effect of covariates on MSD that prevented from doing normal work (at home or away from home) because of trouble (ache, pain or discomfort) at any time during the last 12 months in selected body parts are shown in Table 4.2. Findings suggest that waste pickers are more likely to suffer with MSD and could not work due to pain in shoulder (OR=3.17; p<0.01), upper back (OR=3.08; p<0.01), lower back (OR=2.52; p<0.01) and ankle (OR=8.76; p<0.01). Similarly age of respondent has been found to be the significant predictor while considering the MSD. The increase in age leads to increase in MSD complaints specifically in the age group above 40 years for upper back (OR=4.09; p<0.01), lower back (OR=5.05; p<0.01), knee (OR=7.65; p<0.01) and for ankle (OR=6.20; p<0.01).

Background								
characteristic	Any	Shoulder	Hand	Upper back	Lower back	Thigh	Knee	Ankle
Occupation								
Wage labor®								
Waste picker	2.51***	5.22***	4.34*	2.46**	2.27***	0.49	1.73*	6.91***
	(1.35-4.65)	(1.99-13.73)	(0.9-21.02)	(1.16-5.26)	(1.2-4.32)	(0.17-1.42)	(0.9-3.33)	(1.48-32.23)
Other	0.69	0.87	2.30	0.75	0.70	0.57	0.62	2.35
	(0.36-1.32)	(0.28-2.7)	(0.43-12.24)	(0.31-1.78)	(0.34-1.44)	(0.18-1.75)	(0.3-1.28)	(0.44-12.45)
Age								
18-30 yrs.®								
31-40 yrs.	1.88***	3.73***	1.59	1.97*	1.87**	0.84	2.62***	4.76**
	(1.12-3.18)	(1.65-8.45)	(0.49-5.19)	(0.99-3.94)	(1.05-3.36)	(0.31-2.27)	(1.39-4.94)	(1.25-18.19)
Above 40 yrs.	4.93***	4.48***	2.27	2.78***	3.98***	0.54	6.65***	10.99***
	(2.64-9.25)	(1.85-10.84)	(0.64-8.07)	(1.34-5.78)	(2.13-7.47)	(0.16-1.81)	(3.4-13)	(2.86-42.22)
Duration of work								
0 -4 yrs.®								
5-10 yrs.	2.76***	2.11	2.06	1.08	2.12*	5.20	1.79	1.37
	(1.34-5.67)	(0.57-7.84)	(0.23-18.37)	(0.4-2.96)	(0.91-4.98)	(0.65-41.85)	(0.72-4.46)	(0.27-6.92)
Above 10 yrs.	5.40***	3.10*	4.29	2.74**	2.83**	6.24*	2.66**	1.47
	(2.62-11.14)	(0.86-11.09)	(0.52-35.02)	(1.06-7.06)	(1.22-6.58)	(0.76-51.49)	(1.09-6.49)	(0.3-7.1)
Weekly working da	ays							
Up to 40 hrs.®								
Above 40 hrs.	1.35	1.80*	2.72**	1.15	1.23	0.85	1.33	1.36
	(0.85-2.13)	(0.94-3.42)	(1.01-7.34)	(0.66-2.01)	(0.76-1.99)	(0.35-2.04)	(0.8-2.2)	(0.58-3.17)

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## DISCUSSION

In the context of growing market of waste recycling in India, dumping ground becomes a gold mine for waste pickers. These waste pickers do a strenuous work all day long through collecting sellable waste out of the refuse items. The work they do is often called 3-D work i.e. dirty, dangerous and demanding, which may impose severe physical and mental costs on workers. Though there is an opportunity of livelihood through waste picking, yet dumping grounds indirectly impose ill health through emission of toxic gases or through water modes. The problem is acute because waste pickers are not protected by occupational health and safety measures. Moreover, waste pickers do not come within the purview of any labour legislation and hence they are not entitled to any benefits or security of livelihood. All the reported health issues among solid waste workers are directly applicable to waste pickers, but the vulnerability increases manifold for the latter. Previous studies indicates that relationship exists between solid waste handling and increased health risk.[25-31] Moreover the workplace activities such as heavy lifting, manual handling, prolonged standing, bending leads to musculoskeletal disorder. While it is generally accepted that morbidity is on higher side among waste pickers, but the other factors such as their lower socio-economic status, poor housing conditions and household hygiene practices may enhance their health vulnerabilities. Moreover, analysis from the present paper suggest that waste pickers are among the most highly exposed occupational groups with respect to MSDs. Study suggest higher prevalence of musculoskeletal disorder found among waste pickers particularly in lower and upper back and shoulder while comparing with control group. Similar pattern found in case of 12 month prevalence of inability to work due to MSD. The results of adjusted effect suggest that the likelihood of MSD complaints found significantly higher among waste pickers as compared to the wage laborers. Similarly, while looking at 12 month prevalence of inability to work due to MSD, increased age group and longer duration of work are found as significant predictors for increase in complaints of MSD.

## SPECIFIC STRATEGIES TO MINIMIZE THE BURDEN OF MSD

Results from the study strongly recommend not only curative but preventive measures to minimize the burden of musculoskeletal disorder among waste pickers. First, health providers can play a crucial role in lessening the incidences of MSDs by imparting health education and enhancing awareness to the early signs of MSDs. Second, in addition to the higher prevalence of

MSDs which is evident from the present study, several other studies also suggest morbidities are on higher side due to occupation of waste picking.[25-31] Further, their lower socio-economic status, poor housing conditions and household hygiene practices ultimately enhance their health vulnerabilities. Findings from the several studies suggest that impoverishment due to health care expenditure is very high in India.[32-34] Whereas treatment of regular non-hospitalised morbidity leads to impoverishment of urban households.[35] So, it seems imperative to to promote the State sponsor *Rajiv Gandhi Jeevandayee Arogya Yojana* (RGJAY)[36] or *Rashtriya Swasthya Bima Yojna*,[37] a cashless health insurance scheme among the waste pickers. Third, although the work of waste pickers is invisible to society, it is an accepted fact that work of waste pickers contribute positively towards society[38-39] in terms of it reduces the cost of collection, transportation and disposal.[40] Several studies tried to estimate the economic contributions of informal waste sector to the economy.[41-43] So, the local government need to extend its concern by improving the occupational as well as living conditions for overall health and well-being of waste pickers.

## Contributors

SK Singh contributed to the conceptualisation, design and development of statistical analysis. PC led the conceptualization, data analysis and write up. Both the authors have read and approved the final manuscript.

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Competing interests None.

**Ethics approval** It is worth mentioning that at the time of data collection, due care of research ethics and human subject protection was taken through informed consent of respondents. The informed consent adequately highlighted the issues of confidentiality and privacy. The voluntary nature of participation was also highlighted and respondents were allowed to choose not to answer any question or all of the questions if they wish so.

In fact, the International Institute for Population Sciences, Mumbai, where I have been registered for my doctoral work, there has not been any provision to get approval of PhD proposals from IRB till Dec-2014. For the same reason, we do not have ethical clearance certificate from any IRB.

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# Assessing impact of waste picking on musculoskeletal disorder among waste pickers of Mumbai, India: a cross-sectional study

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**SCHOLARONE**<sup>™</sup> Manuscripts

## Title

Assessing the Impact of Waste Picking on Musculoskeletal Disorder among Waste Pickers of Mumbai, India: A Cross-Sectional Study

## Abstract

**Objective:** To assess the prevalence of musculoskeletal disorders (MSDs) as well as the impact of waste picking occupation on complaints of MSDs among waste pickers. The study attempts to understand the risk factors for MSDs in selected body parts.

**Design:** A cross-sectional household survey was conducted using a case-control design. The survey instrument for measurement of musculoskeletal symptoms was adopted from the Standardized Nordic Questionnaire. The impact of waste picking occupation on MSDs has been analyzed using the PSM method.

**Participants:** The study population consisted of waste pickers (n=200) who had been working for at least a year and the control group (n=213) was selected from in and around the communities.

**Results:** The twelve-month prevalence of MSDs was found higher among waste pickers (79%) compared to the control group (55%) particularly at lower back (40%-21%), knee (48%-35%), upper back (40%-21%) and shoulder (32%-12%) respectively. Similar patterns were observed while analyzing twelve-month prevalence of MSDs which prevented normal activity at home or away from home particularly for lower back (36%-21%), shoulder (21%-7%) and upper back (25%-12%) respectively for waste pickers and the control group. While assessing the impact of waste picking on complaints of MSDs, the analysis suggests that the occupation of waste picking poses greater risk of MSDs particularly in the shoulder, lower and upper back. Increase in age and longer duration of work have emerged as significant risk factors for MSDs.

**Conclusion:** Findings suggest a relatively higher prevalence of MSDs among waste pickers particularly in the lower and upper back and shoulder as compared to the control group. It is evident from the study that exposure to the occupation of waste picking leads to a higher prevalence of MSDs. Results strongly recommend both preventive and curative measures to minimize the burden of MSDs among waste pickers.

## Article Summary

## **Article Focus**

- Prevalence of musculoskeletal disorders (MSDs) among waste pickers.
- Impact of waste picking occupation on MSDs in various body parts.
- Identifying potential risk factors to MSDs for selected body parts.

## Key Messages

- MSDs are highly prevalent among waste pickers compared to the control group.
- Increasing age of respondents and duration of work emerged as major risk factors to MSDs.

- Preventive as well as curative interventions are needed to lower the number of episodes of MSDs.
- There is need to strengthen the coverage and effectiveness of State sponsored health insurance scheme among waste pickers.

## Strengths and Limitations of this Study

- Perhaps this is the first study on MSDs among waste pickers.
- Attempts have been made to assess MSDs which occur due to waste picking.
- . Recall bias in reporting MSDs could have occurred due to the one-year reference period.
- Subjective responses on MSDs could be implicit bias as degree of MSDs was not quantified and might have underestimated or overestimated the prevalence.
- Although the study respondents were waste pickers collecting waste from dumping grounds and not from the road side or community bins, the results might be generalized with some caution.

## **INTRODUCTION**

Rapid urbanization has resulted in massive production of recyclable garbage material in towns and cities. Waste pickers play a noteworthy but unrecognized role in the solid waste management system. They salvage recyclable items and collect garbage (paper, plastic, tin and so on) that can be sold to scrap merchants. This kind of work requires no skill and is a source of income for a growing number of urban poor. It has been estimated that up to 2 percent of the population in third world countries earn a living through waste picking and recycling.[1] According to International Labour Organization (ILO) estimates, there are between 15 and 25 million waste pickers in the world.<sup>[2]</sup> Nearly two million of them are in India.<sup>[3]</sup>

A strong and significant relationship between working environment and complaints of musculoskeletal disorders (hereafter MSDs) has been widely reported. Workplace activities such as heavy lifting, manual handling, prolonged bending and repetitive tasks increase MSDs significantly.[4-7] Persons whose routine work involves strenuous physical activities such as pulling, pushing, lifting, carrying, picking, or bending for long hours are the most vulnerable.[8-10] These kinds of activities are predominant among waste pickers. MSDs are one of the major causes of morbidity. In many countries, MSDs emerged as the leading cause of occupational injury, illness and disability.[11-15] Literature suggests that the solid waste workers have more

MSDs than the general population do.[16-17] The burden of MSDs is global and looking at the gravity of the situation, the World Health Organization (WHO) declared 2000-2010 as the Bone and Joint decade.[18]

There are many studies on waste pickers and their occupational health risks such as respiratory illness, skin diseases, stomach problems, and eye irritation. However, studies on MSDs among waste pickers have not been published in India. The present study focuses on the relative health risk of MSDs among waste pickers as compared to individuals engaged in other manual work<sup>1</sup>. An attempt has been made to identify the potential working condition that increases the risk of MSDs among waste pickers. This study establishes empirical evidence to strengthen the preventive and curative health measures for waste pickers.

#### **Materials and Methods**

This study is based on cross-sectional case control sampling design, implemented in one of the oldest and biggest dumping grounds in Asia, located near Deonar, Mumbai. *Cases of exposed population* include waste pickers engaged in waste picking for at least a year. A group of respondents engaged in occupations other than waste picking for at least one year were considered as a control group; they were drawn from in and around the communities where waste pickers reside and in similar socio-economic conditions. Many of these respondents were engaged as daily wage labourers, in *'zari'* work (embroidery) and other manual occupations<sup>#</sup>. A community based organisation working for the health and well-being of waste pickers reported that 30 percent of the households in the study area have at least one waste picker. The estimated sample size was 441 households with p value 0.30, response rate of 0.90 and design effect of 1.25. In order to perform case control study, the total required sample was divided into two equal parts, cases (waste pickers) and control (non-waste pickers). Finally, a total of 200 waste pickers participated in the study (response rate of 90%) and 213 respondents were interviewed from the control group (response rate of 95%). The data was collected from March to July 2014.

## **Ethical Considerations**

<sup>&</sup>lt;sup>#</sup> Other manual work includes: vendor, *zari* (embroidery) work

Following the process of primary study, the research proposal went through the two-tier-review process of the institute research committee. At the first stage of the review, the concept was accepted by the institute's research committee consisting of concerned faculty and experts. The final proposal of the research implementation was presented and clarified before the Chair, experts and student members of the institute, and it was approved.

Before the data collection process, informed consent of the participants was obtained in the respondent's own language, and for illiterate respondents, the interviewer read the consent statement. The consent statement included the researcher's identification and purpose of study. Respondents were informed that participation was voluntary, and that they need not answer any of the questions that they did not want to, and leave the study if they wished to do so. The confidentiality and privacy of the information provided by the respondent was assured.

## **Study Tools and Methods**

Our survey instrument for measurement of musculoskeletal symptoms was adapted from the Standardized Nordic Questionnaire[19] and translated into Hindi language. An anatomical diagram with labels and arrows clearly indicating different body parts was used for the assessment of musculoskeletal symptoms. Along with information on musculoskeletal symptoms, data on occupational and demographic characteristics were collected from the respondents. The results were summarized in descriptive statistics. Prevalence of musculoskeletal symptoms that prevented normal work at home or away from home due to MSDs was calculated for the waste pickers and for the control groups. Differentials in prevalence of MSDs among the subgroups were tested by Chi square test.

## **Variables Information**

## Risk Factor

Earlier studies had found that individuals engaged in occupations that involved pulling, pushing, carrying loads, manual handling, long hours of continuous bending and repetitive tasks were at higher risk of MSDs.[16-17,20-21] Waste pickers do strenuous activities such as carrying loads, manual handling, long hours of bending forward, which may compress tendons and nerves and lead to complaints of MSDs. Injuries to the neck and upper extremities may occur because of carrying loads. There are other

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occupations like daily wage labour, *zari* (embroidery) work, vending and painting, which require the same type of physical activity as that of a waste picker, and those who undergo similar exposure in these occupations form the control group for the present study.

#### **Response Variables**

Respondents who reported pain in the neck, hands, upper and lower back, thigh, knees and ankle in the past twelve months were considered and classified as morbid with MSDs. In addition, those who were prevented from doing normal work (at home or away from home) in the past twelve months due to MSDs comprised the response variable.

#### Confounding Risk Factors of the MSDs

The physical strength of the body dwindles with advancing years, hence given risks have different effects on the young and the old. Studies have shown that the younger population has lower risk of MSDs than older adults engaged in physical activities. [17, 20-21]. Similarly, reviewed studies suggest that with the increase in duration of work, complaints of MSDs increase significantly. [16,17]. 'Sex' and 'household size' of the respondents were considered other confounding variables, whereas 'weekly working hours' was considered an effect modifier, as it may have increased or decreased the complaints of MSDs.

In order to examine the impact of waste picking on musculoskeletal disorders, the study had adopted the nearest neighbourhood method of propensity score matching PSM.[22-23] This approach gave an opportunity to assess the impact of exposure on outcomes through cross-sectional survey data.[24-26] Propensity score was estimated by logistic regression, with the dichotomous exposure variable, for instant, 1 = exposed to waste-picking occupation; 0 =non-exposed to waste picking occupation using associated observed demographic and occupational characteristics of the waste pickers as predictor variables. The principal assumption of PSM is that conditional of propensity score, the observable selected characteristics of the exposed and control groups have similar distributions.[24] This assumption test is applied by using 'pscore' command. Even if this 'balancing' property is satisfied, the study still assumes that selection to the exposed group is not based on unobservable characteristics that also affect outcome variables. Propensity score was calculated using probability of exposure assignment given pre-exposure characteristics.

 $p(x) \equiv prob (D = 1|Xi) = E(D|xi)$ 

where,  $D = \{0, 1\}$  is the indicator of exposure and x is the multidimensional vector of preexposure characteristics.

The average exposure effect for the exposed (AEEE) was defined as the conditional expectation of the difference in exposure effect for exposed units only.

## AEEE = E ( $\Delta$ | p(x), D=1) = E (y<sub>1</sub>|p(x), D=1) - E (y<sub>0</sub>|p(x), D=0)

After matching propensity scores, the outcomes of exposed and counterfactual scores of control observations were compared.

## AEE = E ( $\Delta$ ) = E ( $y_1$ |x, D=1) – E ( $y_0$ |x, D=0)

The average exposure effect, AEE has been defined as the expected (mean value) difference in potential outcomes across all units in target population, which was identical to the difference in expected potential outcomes of the control group, that is,  $E(Y_1)$  and  $E(Y_0)$ . In this case, difference in MSDs between exposed (exposed to waste picking occupation) and control groups (non-exposed to waste picking occupation) could have been directly compared to show the impact of exposure on the exposed group, known as average exposure effect on exposed (AEEE). While calculating the impact of waste picking on MSDs, as well as MSDs that prevented normal work at home or away from home, the average effect in both the groups was weighted by the proportion of respondents in exposed and control groups, which measured the increase/decrease in MSDs due to waste picking as an occupation.

For given occupation, the effect of risk factors, duration of occupation and age on the incidence on MSDs among the workers, had been established by applying multivariate logistic regression. Here, occupation was considered the exposure variable, the confounding factor was duration of work and age and socio-economic and demographic characteristics were controlled for. The whole analysis was performed using STATA 13.1 software.

## Socio-demographic and Occupational Characteristics of Study Groups

Table 1 provides the socio-economic and occupational characteristics of both the waste pickers and the control group. Waste pickers are comparable with the respective control group in all aspects except education. A higher proportion (48%) of waste pickers was in the age group, 18-30 years, whereas the corresponding proportion in the control group (41%) was in the age group

31-40 years. The mean age for both the groups emerged as 35 years with standard deviation of a little over ten years. Nearly 24 percent of the waste pickers had bigger households with seven or more persons, whereas the corresponding figure for the control group was 17 percent. There was an equal proportion of respondents among the waste pickers and the control group across the categories of duration of work. While considering education, the proportion of non-literates was higher among waste pickers (70%), whereas it was 45 percent among the control group.

Background characteristics	Waste pickers	Control group
	n=200	n=213
Age		
18-30	48.0	33.3
31-40	30.5	40.4
Above 40 years	21.5	26.3
Mean ± SD	34.0 ± 10.2	36.5 ± 9.8
Education		
Not literate	69.5	40.9
Up to 5 yrs. of education	19.5	17.8
Above 5 yrs. of education	11.0	41.3
Mean ± SD	1.6 ± 2.8	$4.2 \pm 4.1$
Family size		
Up to 4 members	38.5	42.3
5-6 members	37.5	40.9
7 or more members	24	16.9
Mean ± SD	5.3 ± 2.1	4.8 ± 1.8
Sex		
Female	42.5	15.9
Male	57.5	84.0
Years of working		
1-4 years	16.5	17.4
5-10 years	37.0	36.6
Above 10	46.5	46.0
Mean ± SD	11.1 ± 6.7	11.5 ± 7.7 👗
Weekly working hours		
Up to 40 hrs.	62.0	41.3
Above 40 hrs.	38.0	58.7
Mean ± SD	36.5 ± 19.7	47.8 ± 19.4

## Results

## Prevalence of Musculoskeletal Disorders (MSDs)

Table 2 shows the prevalence of musculoskeletal disorders (MSDs) in different parts of the body and the extent to which MSDs prevented normal work at home or away from home in the last twelve months among waste pickers and the control group. Out of the total survey population more than two-thirds (66%) of the respondents reported musculoskeletal symptoms in one or more of the nine defined body regions. Overall, the prevalence of MSDs had been found to be significantly higher among the waste pickers than among those in the control group. For instance, prevalence of MSDs among waste pickers was 32 percent for shoulder, 40 percent for upper back, 54 percent for lower back and 48 percent for knee, whereas the respective figures for the control group were 12 percent, 21 percent, 36 percent and 35 percent respectively. Substantial difference was found in the reporting of MSDs that prevented work (in home or away from home) among waste pickers and those in the control group, particularly in shoulder (21 and 7%), upper back (25 and 12%) and lower back (36 and 21%).

#### **MSDs Caused by Waste Picking**

The study tried to examine the impact of waste picking on MSDs by the estimated difference in the outcomes between exposed (waste pickers) and the matched control group (non-waste pickers) by using PSM. The PSM reduces the bias found in an estimate of the exposure effect obtained by comparing outcomes among units of exposed group versus control group by controlling the demographic and occupational variables. Results from Table 3 show the average exposure effect (AEE) for MSDs in various body parts during the last twelve months. Findings suggested that, overall, MSDs were found to be higher among waste pickers 34% (p<0.01) than among non-waste pickers, and in specific body regions, shoulder, upper back, lower back and knee it was 28%, 22%, 24%, 21% respectively. By and large, a similar pattern was found while looking at the results of average exposure effect on those exposed (AEEE). Similarly, while looking at the MSDs that prevented normal work (at home or away from home), it was evident that the MSDs were higher among waste pickers (29%) than among non-waste pickers. Specifically, it was considerably higher for lower back, shoulder, knee and upper back (21%, 18%, 18% and 12% respectively). The overall message from this analysis is that the occupation of waste picking significantly increases the MSDs, particularly of the shoulder, upper and lower back and knee.

_		Ν	MSDs		Prevented normal work due to MSDs			
Body regions	Waste pickers	Control group	Total	chi2-test	Waste pickers	Control group	Total	chi2-test
Any <sup>#</sup>	78.5	54.9	66.3	( $\chi 2=25.6; p<0.000$ )	58.5	39.4	48.7	(χ2=15.0; p≤0.000)
Neck	8.5	2.4	5.3	(χ2=7.7; p≤0.005)	8.0	1.9	4.8	(χ2=8.4; p≤0.004)
Hand	16.0	8.5	12.1	( $\chi 2=5.5$ ; p=0.019)	6.5	3.8	5.1	( $\chi$ 2=1.6; p=0.205)
Shoulder	32.0	12.2	21.8	( $\chi 2=23.7; p<0.000$ )	21.0	6.6	13.6	(χ2=18.3; p≤0.000)
Upper back	40.0	20.7	30.0	( $\chi 2=18.4$ ; p<0.000)	24.5	12.2	18.2	( $\chi 2=10.4$ ; p=0.001)
Lower back	54.0	36.2	44.8	( $\chi 2=13.3$ ; p<0.000)	36.0	20.7	28.1	(χ2=12.0; p≤0.001)
Thigh	8.5	10.3	9.4	(χ2=0.4; p=0.525)	5.0	6.6	5.8	( $\chi 2=0.5$ ; p=0.495)
Knee	47.5	34.7	40.9	(χ2=6.9; p≤0.008)	31.0	21.6	26.2	(χ2=4.7; p≤0.05)
Ankle	18.5	8.0	13.1	$(\chi 2=10.0; p \le 0.002)$	10.0	3.8	6.8	$(\chi 2=6.4; p=0.012)$

Table 3: Average exposure effect (AEE) and average exposure effect on exposed (AEEE) of waste picking occupation on musculoskeletal
disorders and for MSDs prevented normal work in the past 12 months.

		Musculoskeletal	disorders(MSD	s)		Prevented normal w	vork due to M	SDs
		AEE	AEEE		AEE		AEEE	
Body regions	Coef.	CI at 95%	Coef.	CI at 95%	Coef.	CI at 95%	Coef.	CI at 95%
Any <sup>#</sup>	0.34***	(0.25-0.43)	0.32***	(0.2-0.44)	0.29***	(0.19-0.39)	0.27***	(0.16-0.37)
Neck	0.06***	(0.02-0.1)	0.08***	(0.03-0.12)	0.06***	(0.02-0.1)	0.07***	(0.03-0.11)
Hand	0.12***	(0.05-0.19)	0.13***	(0.07-0.18)	0.04*	(-0.01-0.1)	0.04*	(0-0.08)
Shoulder	0.28***	(0.19-0.37)	0.27***	(0.19-0.34)	0.18***	(0.1-0.26)	0.19***	(0.12-0.25)
Upper back	0.22***	(0.11-0.32)	0.24***	(0.14-0.34)	0.12***	(0.04-0.21)	0.15***	(0.06-0.23)
Lower back	0.24***	(0.14-0.35)	0.19***	(0.06-0.32)	0.21***	(0.11-0.32)	0.18***	(0.08-0.28)
Knee	0.21***	(0.1-0.32)	0.18***	(0.07-0.29)	0.18***	(0.09-0.29)	0.13***	(0.04-0.22)
Ankle	0.16***	(0.08-0.25)	0.14***	(0.07-0.2)	0.10***	(0.03-0.16)	0.08***	(0.02-0.13)

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 A8

## Factors Associated with MSDs

Table 4.1 depicts the relationship between risk factors with increase in MSDs for various body part regions with adjustment for sex and household size and weekly working hours of the respondents. The complaint of MSDs of various body parts were significantly higher among waste pickers, shoulder (OR=3.52; p<0.01), upper back (OR=1.95;p<0.05), lower back (OR=1.92; p<0.05), ankle (OR=2.99; p<0.05) and hand (OR=2.1; p<0.1) as compared to wage labourers. Similarly, it was found that increase in duration of work was directly correlated with the increase in complaints of MSDs in different parts of the body. For instance, respondents working for more than ten years were more likely to report MSDs for shoulder (OR=2.01; P<0.1) and lower back (OR=2.15; p<0.05) as compared to those who were working for four years. Respondents above the age of forty were more likely to suffer with MSDs of the lower back (OR=1.56; p<0.1), knee (OR=5.41; p<0.01) and ankle (OR=2.91; p<0.1) compared to those in the age group, 18-30 years.

Table 4.1 Results of logistic regression analysis examining the effect of demographic and occupational characteristics on MSDs in last 12 months for various body part regions. Occupational and demographic Anv<sup>#</sup> characteristics Shoulder Hand Upper back Lower back Knee Ankle Occupation Wage laborer<sup>®</sup> Waste picker 2.74\*\*\* 3.52\*\*\* 2.10\* 1.95\*\* 1.92\*\* 1.41 2.99\*\* (1.22-7.38)(1.47-5.13)(1.69-7.36)(0.83-5.33)(1.05 - 3.66)(1.08 - 3.44)(0.79 - 2.53)Other 0.78 0.62 1.00 0.63 0.92 0.64 0.92 (0.43 - 1.42)(0.26 - 1.45)(0.36 - 2.78)(0.32 - 1.27)(0.50 - 1.68)(0.35 - 1.17)(0.33 - 2.59)**Duration of work** Upto 4 yrs.<sup>®</sup> 1.93\* 1.66 1.03 1.22 5-10 yrs. 1.97 1.66 2.41 (1.03 - 3.63)(0.71 - 3.87)(0.69-5.65)(0.52 - 2.04)(0.89 - 3.11)(0.65 - 2.32)(0.76 - 7.61)2.55\*\*\* 2.01\* 1.90 1.48 2.15\*\* 1.61 2.51 Above 10 yrs. (1.30-4.99)(0.86 - 4.73)(0.65 - 5.56)(0.74 - 2.97)(1.12-4.14)(0.84 - 3.11)(0.79 - 8.03)Age of respondents Protected by copyrights independent of the section Enseignement Superieur (ABES)

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18-30 yrs. <sup>®</sup>							
31-40 yrs.	0.96	1.51	1.23	1.28	0.92	1.16	0.76
	(0.56-1.64)	(0.82-2.79)	(0.58-2.59)	(0.74-2.21)	(0.56-1.53)	(0.69-1.93)	(0.35-1.68)
Above 40 yrs.	2.31**	1.52	1.30	1.51	1.56*	2.69***	2.20*
	(1.18-4.52)	(0.76-3.03)	(0.56-3.00)	(0.82-2.78)	(0.88-2.77)	(1.51-4.80)	(1.01-4.77)
® Reference category; ***p	<0.01, **p<0.05, *p<0.	1; 95% confidence	e interval in parent	thesis.			
# Either shoulder, hand, upp	per back, lower back, kne	e or ankle.					
Adjusted for sex, household s	size of the respondents. V	Veekly working hot	urs considered as a	effect modifier.			

MSDs that prevented waste pickers from doing normal work (at home or away from home) because of trouble (ache, pain or discomfort) in selected body parts at any time during the study period of twelve months are shown in Table 4.2. Findings suggested that waste pickers were more likely to suffer with MSDs, of the shoulder (OR=3.17; p<0.01), upper back (OR=3.08; p<0.01), lower back (OR= 2.52; p<0.01) and ankle (OR=8.76; p<0.01). Similarly, the age of the respondent was found to be significantly correlated with increase in MSDs. With increase in age, it was more likely that MSD complaints increased, specifically in the age group forty years+, for upper back (OR=2.71; p<0.01), lower back (OR=4.38; p<0.01), knee (OR=6.47; p<0.01) and ankle (OR=10.20; p<0.01). Data regarding duration of work suggested, that MSDs, particularly of the upper back (OR=3.28; p<0.05), lower back (OR=2.98; p < 0.01) and knee (OR=2.72; p < 0.05) were more likely among those working for more than ten years.

Occupational and demographic							
characteristics	Any <sup>#</sup>	Shoulder	Hand	Upper back	Lower back	Knee	Ankle
Occupation							
Wage laborer <sup>®</sup>							
Waste picker	2.56***	4.47***	4.50*	2.23**	2.41***	1.63	7.19***
	(1.35-4.86)	(2.18-16.29)	(0.90-22.45)	(1.01-4.92)	(1.23-4.72)	(0.82-3.21)	(1.48-34.9

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Other	0.70 (0.37-1.34)	0.90 (0.29-2.83)	2.26 (0.42-12.02)	0.76 (0.32-1.82)	0.73 (0.35-1.50)	0.61 (0.29-1.25)	2.36 (0.44-12.59)
Duration of work	× •	``` <b>`</b>	× •	× •	```·	```·	```·
Up to 4 years <sup>®</sup>							
5-10 years	2.76***	2.10	1.99	1.21	2.18*	1.81	1.33
	(1.34-5.74)	(0.56-7.90)	(0.22-17.89)	(0.44-3.35)	(0.92-5.19)	(0.72-4.56)	(0.26-6.80)
Above 10 years	5.44***	3.1*	4.11	3.28**	2.98***	2.72**	1.38
	(2.59-11.46)	(0.85-11.31)	(0.50-34.07	(1.24-8.73)	(1.25-7.08)	(1.10-6.79)	(0.28-6.90)
Age of respondents							
18-30 years <sup>®</sup>							
31-40 years	1.91**	4.16***	1.71	1.91*	1.98**	2.63***	4.66**
	(1.12-3.27)	(1.81-9.57)	(0.51-5.70)	(0.95-3.86)	(1.10-3.60)	(1.39-5.01)	(1.21-18.01)
Above 40 years	5.07***	5.17***	2.38	2.71***	4.38***	6.47***	10.94***
	(2.68-9.62)	(2.10-12.77)	(0.65-8.67)	(1.29-5.70)	(2.30-8.34)	(3.28-12.78)	(2.79-43.04)
<ul> <li>® Reference category; ***/</li> <li># Either shoulder, hand, up</li> <li>Adjusted for sex, household</li> </ul>	<ul> <li>Reference category; ***p&lt;0.01, **p&lt;0.05, *p&lt;0.1; 95% confidence interval in parenthesis</li> <li># Either shoulder, hand, upper back, lower back, knee or ankle</li> <li>Adjusted for sex, household size of the respondents. Weekly working hours considered as effect modifier</li> </ul>						
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## Discussion

The study aimed to investigate the prevalence of MSDs among those exposed (waste pickers), especially among those who were prevented from doing normal work for the duration of twelve months by comparing them with a control group (non-waste pickers). Bivariate analysis suggested the high prevalence of MSDs among waste pickers, particularly in the lower back (54%), knee (48%), upper back (40%) and shoulder (32%) compared to the control group (36%, 35%, 21%, and 12% respectively). The prevalence of MSDs that prevented the waste pickers from normal work was found to be higher for lower back (36%), upper back (25%) and shoulder (21%) as compared to those in the control group (21%, 12% and 7% respectively).

Analysis of the impact of exposure (waste picking occupation) on the exposed group (waste pickers) by matching with the control group (non-waste pickers) through PSM method, revealed that exposure of waste picking occupation increased MSDs of the shoulder (28%), upper back (22%) and lower back (24%). A similar pattern was found in the case of those who were unable to perform normal activity work due to MSDs. While adjusting for demographic and occupational variables in the multivariate logistic regression model, the findings suggested that waste pickers were more likely to have MSDs compared to other occupational groups. For instance, when compared with wage labourers, waste pickers were more likely to have complaints for shoulder (OR=3.5; p<0.01), ankle (OR=2.9; p<0.05), hand (OR=2.1; p<0.05) and upper and lower back (each OR=1.9; p<0.05). Similarly, MSDs that prevented normal activity were found to be significantly higher among waste pickers for shoulder (OR=3.17; p<0.01), lower back (OR=2.52; p<0.01) and upper back (OR=3.08; p<0.01) compared to wage labourers. This may be because waste pickers do strenuous work throughout the day for collection of saleable waste. The work they do is often called '3-D work', that is, dirty, dangerous and demanding.

All the reported health issues among solid waste workers are directly applicable to waste pickers, but the vulnerability increases manifold for the latter. Previous studies indicated that a relationship existed between solid waste handling and increased health risk.[27-33] Workplace activities such as heavy lifting, manual handling, prolonged standing and bending lead to

musculoskeletal disorders. After adjusting for sex and household size, greater number of working years and increased age of the respondents were found significantly correlated with complaints of MSDs as well for MSDs that prevented normal activity at home or away from home. The correlation between strenuous work and MSDs has been studied in many different countries, but in the absence of studies based on waste picking as an occupation and the ensuing complaints of MSDs, it is difficult to generalize the results. Thus, there is need for further studies to validate the results of this paper.

Studies based on similar nature of work suggested that the prevalence of MSDs was slightly lower among workers whose jobs were of a similar nature. [16-17, 34-35]. This may be because waste pickers are not protected by occupational health and safety measures. Moreover, waste pickers do not come within the purview of any labour legislation and hence, they are not entitled to any benefits or security of livelihood. Their lower socio-economic status, poor housing conditions seem to enhance their health vulnerabilities.

## Limitations of the Study

The use of cross-sectional survey to collect data might have underestimated the true prevalence of MSDs. Self-reported MSDs could be biased due to subjectivity in response, as the degree of MSDs was not quantified. Recall bias may also affect the estimated prevalence of MSDs. Data was collected from waste pickers who collect waste from dumping grounds and not from the road side or community dumping bins, and hence, the results may be generalized with a caveat due to similar nature of occupation.

## Strategies to Minimize the Burden of MSDs

This study recommends not only preventive but also curative measures to minimize the burden of musculoskeletal disorders among waste pickers.

- Health providers can play a crucial role in reducing the incidence of MSDs by imparting health education and enhancing awareness about the early signs of MSDs.
- Measures should be taken to promote physical exercise as well as the use of protective equipment to reduce work related disorders.

- Waste pickers are working as unorganized workers and earning meager amounts. It would be helpful to develop low cost and easy to use tools to minimize the occurrence of MSDs.
- The work of waste pickers is not always appreciated or acknowledged. Yet, it is an accepted fact that their work contributes positively[36-37] in terms of reduction of cost of collection, transportation and disposal.[38] Several studies tried to estimate the economic contributions of the informal waste sector to the economy.[39-41] The local government needs to extend its concern by improving the occupational as well as living conditions of waste pickers.
- The low socio-economic status, poor housing conditions and household hygiene practices of waste pickers contribute to their health vulnerabilities. Many studies suggest that health care expenditure often leads to impoverishment [42-44], especially in urban households.[45] Therefore, it is imperative to promote the State sponsored *Rajiv Gandhi Jeevandayee Arogya Yojana* (RGJAY)[46] or *Rashtriya Swasthya Bima Yojana*,[47] a cashless health insurance scheme among the waste pickers.

## **Further Scope for Researchers**

This study indicates the high prevalence of MSDs among waste pickers, which may increase inpatient and outpatient expenditure on treatment. It will be worth exploring their treatment seeking behaviour, coping mechanisms and the economic burden of MSDs.

## Contributors

SK Singh contributed to the conceptualisation, design and development of statistical analysis. PC led the conceptualization, data analysis and write up. Both the authors have read and approved the final manuscript.

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## Competing interests None.

**Ethics approval** It is worth mentioning that at the time of data collection, due care of research ethics and human subject protection was taken through informed consent of respondents. The informed consent adequately highlighted the issues of confidentiality and privacy. The voluntary

nature of participation was also highlighted and respondents were allowed to choose not to answer any question or all of the questions if they wish so.

In fact, the International Institute for Population Sciences, Mumbai, where I have been registered for my doctoral work, there has not been any provision to get approval of PhD proposals from IRB till Dec-2014. For the same reason, we do not have ethical clearance certificate from any IRB.

**Provenance and peer review** Not commissioned; externally peer reviewed.

Data sharing statement There is no additional data available.

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## **BMJ Open**

STROBE Statement-checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(a) Assessing the Impact of Waste Picking on Musculoskeletal Disorder among Waste
		Pickers of Mumbai, India: A Cross-Sectional Study
		(b) The twelve-month prevalence of MSDs was found higher among waste pickers
		(79%) compared to the control group (55%) particularly at lower back (40%-21%)
		knee (48%-35%), upper back (40%-21%) and shoulder (32%-12%) respectively
		Similar patterns were observed while analyzing twelve-month prevalence of MSDs
		which prevented normal activity at home or away from home particularly for lower
		back (36%-21%), shoulder (21%-7%) and upper back (25%-12%) respectively for
		waste pickers and the control group. While assessing the impact of waste picking or
		complaints of MSDs, the analysis suggests that the occupation of waste picking poses
		greater risk of MSDs particularly in the shoulder, lower and upper back. Increase in
		age and longer duration of work have emerged as significant risk factors for MSDs.
		Findings suggest a relatively higher prevalence of MSDs among waste pickers
		particularly in the lower and upper back and shoulder as compared to the control
		group. It is evident from the study that exposure to the occupation of waste picking
		leads to a higher prevalence of MSDs. Results strongly recommend both preventive
		and curative measures to minimize the burden of MSDs among waste pickers.
Introduction		
Background/rationale	2	There are many studies on waste pickers and their occupational health risks such as
		respiratory illness, skin diseases, stomach problems, and eye irritation. However,
		studies on MSDs among waste pickers have not been published in India.
Objectives	3	An attempt has been made to identify the potential working condition that increases
		the risk of MSDs among waste pickers. This study establishes empirical evidence to
		strengthen the preventive and curative health measures for waste pickers.
Methods		
Study design	4	This study is based on cross-sectional case control sampling design, implemented in
		one of the oldest and biggest dumping grounds in Asia, located near Deonar, Mumbai.
		Cases of exposed population include waste pickers engaged in waste picking for at
		least a year. A group of respondents engaged in occupations other than waste picking
		for at least one year were considered as a control group; they were drawn from in and
		around the communities where waste pickers reside and in similar socio-economic
a		conditions.
Setting	5	Household based survey conducted during March to July 2014 in and round the
<b>—</b> • • •		communities near to dumping ground.
Participants	6	(a) Case-control study—Cases of exposed population include waste pickers engaged
		In waste picking for at least a year. A group of respondents engaged in occupations
		One man waste picking for at least one year were considered as a control group.
		control group
Variables	7	Risk Factor
		Earlier studies had found that individuals engaged in occupations that involved

and repetitive tasks were at higher risk of MSDs.[16-17,20-21] Waste pickers do strenuous activities such as carrying loads, manual handling, long hours of bending forward, which may compress tendons and nerves and lead to complaints of MSDs. Injuries to the neck and upper extremities may occur because of carrying loads. There are other occupations like daily wage labour, zari (embroidery) work, vending and painting, which require the same type of physical activity as that of a waste picker, and those who undergo similar exposure in these occupations form the control group for the present study.

**Response Variables** 

Respondents who reported pain in the neck, hands, upper and lower back, thigh, knees and ankle in the past twelve months were considered and classified as morbid with MSDs. In addition, those who were prevented from doing normal work (at home or away from home) in the past twelve months due to MSDs comprised the response variable.

Confounding Risk Factors of the MSDs

The physical strength of the body dwindles with advancing years, hence given risks have different effects on the young and the old. Studies have shown that the younger population has lower risk of MSDs than older adults engaged in physical activities. Similarly, reviewed studies suggest that with the increase in duration of work, complaints of MSDs increase significantly. 'Sex' and 'household size' of the respondents were considered other confounding variables, whereas 'weekly working hours' was considered an effect modifier, as it may have increased or decreased the complaints of MSDs.

Data sources/	8*	Primary data was collected. PSM method was used to match the exposed and non-
measurement		exposed group
Bias	9	Household size and sex of the respondents were adjusted in the table due to their
		variation in exposed and unexposed group.
Study size	10	A community based organisation working for the health and well-being of waste
		pickers reported that 30 percent of the households in the study area have at least one
		waste picker. The estimated sample size was 441 households with p value 0.30,
		response rate of 0.90 and design effect of 1.25. In order to perform case control study,
		the total required sample was divided into two equal parts, cases (waste pickers) and
		control (non-waste pickers). Finally, a total of 200 waste pickers participated in the
		study (response rate of 90%) and 213 respondents were interviewed from the control
		group (response rate of 95%).
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable,
		describe which groupings were chosen and why
Statistical methods	12	(a) Logistic regression analysis was employed to understand the risk factors
		associated with MSDs by adjusting confounding variables such as "Household size"
		and "Sex of the Respondent. The variable "weekly working hours" considered as
		effect modifier.
		(c) No missing data
		(d) Case-control study—The exposed and non-exposed group were matched through
		occupational and demographic characteristics
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Results		
Participants	13*	<ul> <li>(a) Cases of exposed (200) population include waste pickers engaged in waste picking for at least a year. A group of respondents engaged in occupations other than waste picking for at least one year were considered as a control group (213)</li> </ul>
		(b) Unavailability of respondents leads to non-response.
Descriptive data	14*	Waste pickers are comparable with the respective control group in all aspects except education. A higher proportion (48%) of waste pickers was in the age group, 18-30 years, whereas the corresponding proportion in the control group (41%) was in the age group 31-40 years. The mean age for both the groups emerged as 35 years with standard deviation of a little over ten years. Nearly 24 percent of the waste pickers had bigger households with seven or
		more persons, whereas the corresponding figure for the control group was 17 percent. There was an equal proportion of respondents among the waste pickers and the control group across the categories of duration of work. While considering education, the proportion of non-literates was higher among waste pickers (70%), whereas it was 45 percent among the control group. Due to differentials in household size and sex of respondents in exposed and control group, they are considered as potential confounders for the study.
Outcome data	15*	<i>Case-control study</i> —Outcome variable considered as MSDs and those who were prevented their normal activity at home or away from home due to MSDs
Main results	16	( <i>a</i> ) MSDs were found to be higher among waste pickers 34% (p<0.01) than among non-waste pickers, and in specific body regions, shoulder, upper back, lower back and knee it was 28%, 22%, 24%, 21% respectively. By and large, a similar pattern was found while looking at the results of average exposure effect on those exposed (AEEE). Similarly, while looking at the MSDs that prevented normal work (at home or away from home), it was evident that the MSDs were higher among waste pickers (29%) than among non-waste pickers. Specifically, it was considerably higher for lower back, shoulder, knee and upper back (21%, 18%, 18% and 12% respectively).
Other analyses	17	No other analyses done
Discussion		
Key results	18	Bivariate analysis suggested the high prevalence of MSDs among waste pickers, particularly in the lower back (54%), knee (48%), upper back (40%) and shoulder (32%) compared to the control group (36%, 35%, 21%, and 12% respectively). The prevalence of MSDs that prevented the waste pickers from normal work was found to be higher for lower back (36%), upper back (25%) and shoulder (21%) as compared to those in the control group (21%, 12% and 7% respectively). Analysis of the impact of exposure (waste picking occupation) on the exposed group (waste pickers) by matching with the control group (non-waste pickers) through PSM method, revealed that exposure of waste picking occupation increased MSDs of the shoulder (28%), upper back (22%) and lower back (24%). A similar pattern was found in the case of those who were unable to perform normal activity work due to MSDs. While adjusting for demographic and occupational variables in the multivariate logistic regression model, the findings suggested that waste pickers were more likely to have Complaints for shoulder (OR=3.5; p<0.01), ankle (OR=2.9; p<0.05), hand (OR=2.1; p<0.05) and upper and lower back (OR=2.52; p<0.01) and upper back (OR=3.08; p<0.01) compared to wage labourers.

Limitations	19	The use of cross-sectional survey to collect data might have underestimated the true prevalence of MSDs. Self-reported MSDs could be biased due to subjectivity in response, as the degree of MSDs was not quantified. Recall bias may also affect the estimated prevalence of MSDs. Data was collected from waste pickers who collect waste from dumping grounds and not from the road side or community dumping bins, and hence, the results may be generalized with a caveat due to similar nature of occupation.
Interpretation	20	Findings suggest a relatively higher prevalence of MSDs among waste pickers particularly in the lower and upper back and shoulder as compared to the control group. It is evident from the study that exposure to the occupation of waste picking leads to a higher prevalence of MSDs. Results strongly recommend both preventive and curative measures to minimize the burden of MSDs among waste pickers.
Generalisability	21	Studies based on similar nature of work suggested that the prevalence of MSDs was slightly lower among workers whose jobs were of a similar nature. [16-17, 34-35]. The correlation between strenuous work and MSDs has been studied in many different countries, but in the absence of studies based on waste picking as an occupation and the ensuing complaints of MSDs, it is difficult to generalize the results. Thus, there is need for further studies to validate the results of this paper.
Other informatio	n	
Funding	22	This research work received no specific grant from any funding agency in the public, commercial or not for profit sector.

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.