Ergonomic hazards among rag pickers in India: an analytical study
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Abstract: The aim of the study was to identify the work-related ergonomic hazards experienced by the rag pickers. Multi-stage random sampling technique was used for selecting the sample. Tools used to conduct the study comprised of general information, rating scale for assessing intensity of discomfort, and Nordic Musculoskeletal Questionnaire. The statistical analysis of the quantitative variables was performed using SPSS software program, v20.0. Research revealed that rag pickers experienced severe pain in lower back (65%), followed by upper back (52.5%), feet (47%), and hands (43%). Older rag pickers, between 55 and 65 age groups, reported more discomfort or pain in backache and knee (μ = 2.00), as compared to other age groups. This may be due to the reason that with age, bones become weak and the strength of the muscles also reduces, and since they are involved in the work. Rag pickers experience many work-related ergonomic problems, and these problems are associated with various risk factors such as working experiences and age. Frequent bending, standing, and carrying heavy loads on the back increased these problems. To lighten the load of ergonomic problems, preventive and curative approaches are strongly suggested. Ergonomics and safe practices must also be established to reduce work-related vulnerabilities.

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1. Introduction

The question of occupational health and safety, as a global issue, is now taking a new turn. Rag pickers in developing countries perform arduous and painful waste collection work in the informal sector. Rag pickers are also known as informal recyclers, rag man, bone man, who is an unlicensed individual collecting recyclables and second hand goods for reuse or recycling (Waste collection and transportation management, 2021). In many developing countries, waste is collected, transported, and disposed of using a labor-intensive system with insufficient preventive measures (Cointreau, 2006). Due to their daily exposure to municipal solid waste (MSW), rag pickers are at risk of developing a wide range of occupational illnesses. Evidence suggests that waste collection workers are in danger for a number of occupational health issues, including respiratory problems, gastrointestinal illnesses, skin problems, eye problems, headaches, and musculoskeletal disorders (MSDs; Abou-elwafa et al., 2012; Mehrdad et al., 2008; Nagaraj et al., 2004). MSDs among rag pickers are mostly non-fatal injuries such as anatomical injuries, pain, or discomfort in muscles, joints, bones, ligaments, cartilage, blood vessels, and limbs (Dorevitch & Marder, 2001). Because of the nature of their work, studies with rag pickers have revealed that they have a higher risk of developing MSDs than the general population (Abou-elwafa et al., 2012; Mehrdad et al., 2008). Workers who are repeatedly exposed to lifting, bending, and standing for longer periods of time have been identified as being at risk for MSDs (Fejer et al., 2006; Palmer, 2003). Municipal waste loading entails similar tasks such as lifting, pulling, pushing, bending, and loading waste materials into waste containers during the collection of waste materials. Continuous waste loading work entails strenuous physical activities such as lifting heavy loads to a higher loading position and unloading them on landfills, which increases pain episodes in structural body regions (Poulensen et al., 1995; Schibye et al., 2001).

Rapid urbanization has resulted in the production of huge amounts of recyclable waste material in towns and cities (Singh & Chokhandre, 2015). The working environment has a strong and significant relationship with MSDs. Heavy lifting, manual handling, prolonged bending, and repetitive tasks are all linked to an increased risk of MSDs in the workplace (Hoozemans et al., 2004; IJzelenberg et al., 2004; Keyserling, 2000; Schibye et al., 2001). The most vulnerable are those whose regular jobs require prolonged time of intense physical movement, which include pulling, pushing, lifting, carrying, picking, or bending (Dorevitch & Marder, 2001; Fejer et al., 2006). MSDs are a leading cause of occupational injury and illness in many countries, and they have become a major cause of morbidity (Cole et al., 2001; Gerr et al., 2002; Guo et al., 2004; Morken et al., 2000). According to the literature, solid waste workers have a higher rate of MSDs than the general population (Abou-elwafa et al., 2012; Mehrdad et al., 2008). The burden of MSDs is global and in light of the gravity of the situation, WHO declared 2000–2010 as the Bone and Joint Decade (The World Health Organization, 2003).

In the working population, musculoskeletal issues constitute a leading cause of morbidity (Bernard, 1997; Habib et al., 2019). “Musculoskeletal disorders (MSDs) are injuries and disorders that affect the human body’s movement or musculoskeletal system (i.e. muscles, joints, ligaments, blood vessels, bones, etc.).” Work-related MSDs are the MSDs that arise from activities and postures such as bending, straightening, gripping, holding, twisting, and reaching. We do these activities every day but what makes them more harmful at the workplace is the constant repetition and the long time spent in those postures (CCOHS, n.d.; Murarka & Chauhan, 2021). Musculoskeletal problems cause long-term impairment and significant economic losses in society. These musculoskeletal problems are frequently linked to job issues. Low back pain is one of these work-related musculoskeletal illnesses, and it is the major cause of activity restriction, absenteeism from work, inability to work, and disability (Verma et al., 2022). Improper manual load carrying is regarded as
a significant risk factor for the development of low back pain (Abdul Majid et al., 2016). Various risk factors have been associated with musculoskeletal discomfort in different parts of the body. Risk factors for various kinds of musculoskeletal discomfort differ in accordance with the body part. Risk factors associated with neck pain may be different from the risk factors associated with back pain or pain in upper limbs. Furthermore, because risk factors for wrist pain may differ from those for shoulder pain, risk factors for musculoskeletal pain should be described separately for each portion of the body (Aytutuldu et al., 2022).

Work-related musculoskeletal problems, such as low back pain, upper and lower limb discomfort, are becoming a major ergonomic concern in both developed and developing countries. The high prevalence of work-related musculoskeletal problems is a significant issue that must be addressed not just to enhance worker’s health and quality of life, but also to increase productivity (Ergonomic guidelines for the optimization of musculoskeletal workload, 2014). Garbage sorting is a step in the recycling process that has been linked to a number of health risks, including a significant risk of musculoskeletal problems owing to repetitive movements and awkward working postures (Kruta de Araújo et al., 2019). Despite the fact that MSDs are a significant occupational issue for rag pickers around the world, the literature review revealed a paucity of evidence. There has been little research on the health and incidence of MSDs among rag pickers in developing countries like India. Majority of the reviewed studies have flaws such as poor exposure assessment and a lack of information on relevant confounders (Porta et al., 2009). This study was designed to determine the prevalence of ergonomic hazards among rag pickers in Lucknow, India.

2. Literature review

A pilot study was conducted on sixty rag pickers at Lucknow city to determine the prevalence of musculoskeletal problems among rag pickers. According to the study responders with more than 15 years of work experience were found to have maximum pain in different body parts. Pain in the spinal cord and backache during working was higher among rag pickers whose age group was 58–69 years with work experience of more than 15 years. This study showed that rag pickers experienced the most discomfort in their spinal cord, backache, and shoulder. Additionally, knee pain and hand pain were also found among rag pickers (Kumari & Kiran, 2020).

A study conducted at Chandrapur City, Central India with an objective to assess the occupational health of rag pickers revealed that rag pickers encounter a variety of occupational health issues during rag picking. Among these workers, musculoskeletal problems were emerged to be a prominent issue. Musculoskeletal system–related problems are general body soreness, joint pain, and backache (93.3%, n = 28). The reasons for these occupational health hazards, as indicated by all identified rag pickers for this study, include frequent carrying of solid garbage sacks weighing roughly 16–20 kg and keeping static posture while travelling >20 km per day (Dongre & Kamble, 2019).

A study performed in Tshwane city, South Africa reported that rag pickers have ergonomic issues due to the physically demanding nature of their work. In this study, 55% of the rag pickers said that they did not have musculoskeletal problems. About 37% of the subject experienced joints and back pain, while 10% experienced only back problems and 2% experienced joint problems. The above-mentioned reasons included bending over for long periods while working and walking long distances. Also it was reported that older people who believed their problems was due to their age rather than their work (Mothiba et al., 2017).

A study on municipal waste loaders of Mumbai, India, examined the impact of the waste loading occupation on the development of MSDs and disabilities. The researchers calculated the difference in outcomes between the exposed group (waste loaders) and the matched control group over the previous 12 months. A cross-sectional case–control design survey was conducted in 24 municipal wards from March to September 2015. The study sample consisted of 180 municipal garbage loaders and 180 control subjects. MSDs were significantly higher in the garbage loaders than in the
matched control group in the hips/thighs (22%), low back (19%), shoulders (18%), and upper back (15%). Workplace duration, substance usage, and mental health have all been recognized as possible psychosocial drivers to MSD and disability development. The garbage loaders showed a higher prevalence of MSDs than the control group, which had 29%, 20%, 27%, and 11%, respectively, in the low back (39%), hips/thighs (34%), upper back (32%), shoulders (26%), and neck (13%). MSD-related disability was observed to be significantly higher among garbage loaders when compared to the control group, particularly in the low back (31%), upper back (25%), hips/thighs (23%), shoulders (16%), and wrists/hands (14%; Salve et al., 2017).

A cross-sectional study on MSW workers in India focused to identify the prevalence of musculoskeletal problems among workers who work in MSW corporation. For this study, 220 MSW workers from the Chennai Municipal Corporation in India were selected through a cross-sectional study using probability proportionate to size sampling. Data on demographic and occupational history, as well as information on musculoskeletal pain, were collected using a pretested validated questionnaire. In their study, 70% of the participants said they had experienced musculoskeletal problems in one or more of the nine specified body parts in the previous 12 months, and 91.8% said they had pain in the previous 7 days. Knees, shoulders, and lower back problems were shown to be more common in 84.5%, 74.5%, and 50.9% among waste workers, respectively. MSDs were observed to be more common among female illiterate workers with lower socioeconomic position (Reddy & Yashobant, 2015).

A study on rag pickers in Mumbai, India, assessed the prevalence of MSDs as well as the impact of the occupation of rag picking among rag pickers. The study aims to investigate the risk factors related to musculoskeletal discomforts in different body parts. The study included rag pickers (n = 200) who had been working for at least a year and a control group (n = 213) drawn from the same communities or residing nearby. MSDs were shown to be more common among rag pickers (79%) than in controls groups (55%) over a 12-month period, particularly in the lower back (54–36%), knee (48–35%), upper back (40–21%), and shoulder (32–12%). For waste pickers and control groups, similar patterns were seen in the 12-month prevalence of MSDs that impeded normal activity within and outside the home, particularly in the lower back (36–21%), shoulder (21–7%), and upper back (25–12%). Analysis indicated that MSDs are more likely to be happening among people who get older and work for extended periods of time (Singh & Chokhandre, 2015).

A cross-sectional study on MSW collectors in Mansoura, Egypt, determined the prevalence of musculoskeletal problems and their serious health consequences among MSW collectors. Permanent or temporary solid waste collectors employed for one year or more were selected as sample. MSW collectors had a higher percentage of musculoskeletal problems (60.8%) than the comparison group in the past 12 months (43.6%). Among MSW collectors, the low back was the most commonly affected body region (Abou-elwafa et al., 2012).

3. Materials and methods

3.1. Sample
The present study was carried out in Lucknow, which is capital city of Uttar Pradesh, India. For finalizing the sample pilot study was conducted with the collaboration of an Non-Government Organization (NGO) who works for rag pickers in Lucknow city. Information was sought regarding the areas where rag pickers live. Based on the observations obtained from pilot study, sample was identified using multistage random sampling technique. Using random sampling technique, 80 rag pickers were selected randomly from each area comprising to a total of 400 rag pickers. A sample of 400 rag pickers between 15 and 65 years of age and work experience of 1 year to more than 15 was chosen from five slums for the study. The respondents were properly informed about the study, and the study was carried out after obtaining consent from them. The procedures used to carry out the current study were presented to the committee, and they were approved. The survey was conducted during January to June 2020.
3.2. Tools and techniques used
A well-structured questionnaire covering the primary information about demographic and occupational characteristics of the respondents was used and each rag picker was requested to answer all the questions with full sincerity. As most of the rag pickers were illiterate, interviews were carried out verbally and responses were noted. It took 30 minutes to collect information from each rag picker. The questionnaire consisted of a series of objectives questions with yes or no response. To investigate discomfort, items on activities performed, work-related MSD problems, frequency of pain/discomfort, severity of pain and history of pain were enclosed. A standardized and validated Nordic Musculoskeletal questionnaire developed by Kuorinka et al. (Kuorinka et al., 1987) was employed to enquire about the MSD symptoms experienced. A 3-point rating scale indicating 0 as no pain and 3 as severe painful condition was used to assess the intensity of body pain.

3.3. Statistical analysis
Statistical analysis was done using Statistical Package for the Social Sciences (SPSS) software program, v20.0. Impact of MSDs on rag pickers according to their age and work duration was determined using ANOVA. Significant value was assessed at \( p < 0.01 \). The prevalence of MSDs in different body segments and intensity of pain were evaluated through frequency and percentage. Cross phi test was used to find out the association between pain lasting for 7 days and 1 month.

4. Results

4.1. Demographic profile of the rag pickers
It is evident from the data that majority (72%) of the rag pickers were females in comparison with males (28%). The reason behind this, as reported by the respondents may be that the women pick up the garbage and bring it to the house, and then men segregate the waste on the basis of price and then proceed for sale. The sample comprised of 37% of rag pickers in the age group of 25–35 years, followed by the rag pickers in the age group of 15–25 years and 35–45 years. Very few percentage (12%) of respondents were in the age group of more than 45 years.

Data is illustrious to the standard of education among rag pickers, where in majority (69.5%) were completely illiterate, followed by 23% of the respondents who completed their primary schooling and 7.5 percent of the respondents completed their middle schooling. The sample of the research comprised almost equal percentage of respondents with work experience of more than 15 years (28.5%), 10–15 years (25.5%), 5–10 years (23.5) and 0–5 years (22.5%). Majority (43.5%) of the respondents put in 5–7 hours in work, followed by 37% of the respondents putting in 7–9 hours of work and 16.5% working for 0–5 hours. Very few (3%) respondents were found to be working for more than 9 hours (Table 1).

4.2. Musculoskeletal disorders according to age
Responses of work related discomfort or pain in different body parts according to age have been presented in Table 2. Workers in the age group of 55–65 reported maximum pain. Equal proportion of respondents reported backache and knee pain (\( \mu = 2.00 \)), followed by pain in legs and hands (\( \mu = 1.60 \)), further followed by pain in thighs and strained shoulder.

Least amount of pain was reported in hips by the workers in the age group of 15–25, whereas comparatively more pain in hips was reported by the workers in the age group of 45–55 and 55–65. Highly significant differences across various age groups in the MSDs found in various body parts reveals that with increase in age the efficiency of workers reduces due to physical and physiological changes in the body. It is also evident from the data that pain increased with age wherein lowest pain was reported by the rag pickers in the age group of 15–25 years and maximum pain in the age group of 55–65 years (Table 2).
Table 1. Demographic profile of the rag pickers

| Rag pickers (N = 400) | Frequency (%) |
|-----------------------|--------------|
| **Gender**            |              |
| Male                  | 112 (28)     |
| Female                | 288 (72)     |
| **Age (in years)**    |              |
| 15–25                 | 108 (27)     |
| 25–35                 | 146 (37)     |
| 35–45                 | 96 (24)      |
| 45–55                 | 38 (9.5)     |
| 55–65                 | 10 (2.5)     |
| **Education**         |              |
| Illiterate            | 278 (69.5)   |
| Primary               | 92 (23)      |
| Middle                | 30 (7.5)     |
| **Work Experience**   |              |
| Below 5 years         | 90 (22.5)    |
| 5–10 years            | 94 (23.5)    |
| 10–15 years           | 102 (25.5)   |
| More than 15 years    | 104 (28.5)   |
| **Work Duration (/day)** |          |
| Below 5 hrs.          | 66 (16.5)    |
| 5–7 hrs.              | 174 (43.5)   |
| 7–9 hrs.              | 148 (37)     |
| More than 9 hrs.      | 12 (3)       |

(Figures in parenthesis indicate percentages)

4.3. Musculoskeletal disorders according to work experience

The data depicted in Table 3 clearly indicate that maximum body discomfort was felt by the respondents whose work experience was more than 15 years. Majority ($\mu = 1.49$) of the respondents whose work experience was below 5 years reported severe backache.

It was found that equal pain ($\mu = 1.39$) in leg was experienced by the rag pickers whose working experience was 10–15 and more than 15 years. Maximum pain in knee ($\mu = 1.02$), followed by pain in hands ($\mu = 1.23$) and pain in hips ($\mu = 0.32$), further followed by pain in thighs ($\mu = 0.58$) and ankle ($\mu = 0.51$) was reported by the workers who have been picking up rags for more than 15 years. Least amount of pain was reported in elbows by the workers whose work experience was more than 15 years. Pain in wrist ($\mu = 0.86$) and neck ($\mu = 0.79$), further followed by workers who feel uncomfortable while sleeping due to body pain was also found maximum ($\mu = 1.14$) who have been working for more than 15 years. Highly significant differences across various work experiences in the MSDs was expressed in various body parts clearly reveals that with increase in work duration, the efficiency of workers reduces due to physical and physiological changes in the body. It is also evident from the data that pain increased with working duration wherein lowest pain was expressed by the rag pickers whose work experience was below 5 years and maximum pain was reported by the workers with more than 15 years’ experience. The findings clearly show that rag pickers with more years of experience suffer musculoskeletal discomfort. It is also clearly evident that with increase of work experience, the workers had more discomfort and this may be due to the reason that, persistent pain without any treatment may have led to chronic pain and discomfort in almost all the areas (Table 3).
Table 2. Musculoskeletal discomfort reported by rag pickers—analysis across age

| Musculoskeletal Discomfort | 15–25 M ± S.D. | 25–35 M ± S.D. | 35–45 M ± S.D. | 45–55 M ± S.D. | 55–65 M ± S.D. | F     | P     |
|---------------------------|----------------|----------------|----------------|----------------|----------------|-------|-------|
| Backache                  | 1.11 ± 0.53    | 1.38 ± 0.54    | 1.46 ± 0.57    | 1.89 ± 0.31    | 2.00 ± 0.00    | 20.19**| 0.00  |
| Pain in legs              | 1.06 ± 0.56    | 1.28 ± 0.60    | 1.33 ± 0.62    | 1.74 ± 0.44    | 1.60 ± 0.51    | 10.73**| 0.00  |
| Pain in the knees         | 0.30 ± 0.63    | 0.46 ± 0.74    | 0.83 ± 0.74    | 1.58 ± 0.50    | 2.00 ± 0.00    | 38.85**| 0.00  |
| Pain in hands             | 0.94 ± 0.49    | 1.00 ± 0.57    | 1.17 ± 0.51    | 1.42 ± 0.59    | 1.60 ± 0.51    | 9.28** | 0.00  |
| Pain in thighs            | 0.31 ± 0.46    | 0.45 ± 0.49    | 0.46 ± 0.54    | 0.89 ± 0.55    | 1.40 ± 0.51    | 17.64**| 0.00  |
| Pain in ankle             | 0.22 ± 0.41    | 0.23 ± 0.42    | 0.35 ± 0.52    | 0.74 ± 0.55    | 1.00 ± 0.94    | 14.85**| 0.00  |
| Pain in elbow             | 0.09 ± 0.29    | 0.11 ± 0.31    | 0.25 ± 0.43    | 0.47 ± 0.50    | 1.00 ± 0.66    | 21.56**| 0.00  |
| Pain in wrist             | 0.44 ± 0.49    | 0.68 ± 0.52    | 0.73 ± 0.49    | 0.89 ± 0.45    | 1.20 ± 0.42    | 10.47**| 0.00  |
| Pain in neck              | 0.54 ± 0.60    | 0.53 ± 0.57    | 0.85 ± 0.68    | 1.00 ± 0.46    | 1.00 ± 0.66    | 9.21** | 0.00  |
| Strained shoulders while working | 0.61 ± 0.62 | 0.68 ± 0.74    | 0.83 ± 0.74    | 1.05 ± 0.61    | 1.40 ± 0.84    | 5.68** | 0.00  |
| Uncomfortable while sleeping due to body pains. | 0.74 ± 0.61 | 0.96 ± 0.53    | 1.08 ± 0.61    | 1.32 ± 0.57    | 2.00 ± 0.00    | 16.64**| 0.00  |

(M = Mean, S.D. = Standard Deviation), **Highly significant p < 0.01
### Table 3. Assessment of musculoskeletal discomfort among rag pickers with varied work experience

| Musculoskeletal Discomfort | Work Experience |  |  |  |  | F | P |
|----------------------------|-----------------|---|---|---|---|---|---|
|                            | 0–5 years       | 5–10 years | 10–15 years | More than 15 years |
|                            | M±S.D.          | M±S.D.    | M±S.D.      | M±S.D.           |
| Backache                   | 1.49 ± 0.62     | 1.23 ± 0.47 | 1.35 ± 0.52 | 1.47 ± 0.62     | 4.26** | 0.00 |
| Pain in legs               | 1.04 ± 0.66     | 1.28 ± 0.57 | 1.39 ± 0.52 | 1.39 ± 0.61     | 7.01** | 0.00 |
| Pain in the knees          | 0.40 ± 0.68     | 0.53 ± 0.79 | 0.57 ± 0.80 | 1.02 ± 0.78     | 12.87** | 0.00 |
| Pain in hands              | 0.82 ± 0.57     | 1.15 ± 0.54 | 1.08 ± 0.48 | 1.23 ± 0.56     | 10.11** | 0.00 |
| Pain in thighs             | 0.40 ± 0.53     | 0.45 ± 0.54 | 0.47 ± 0.49 | 0.58 ± 0.59     | 2.01** | 0.11 |
| Pain in ankle              | 0.22 ± 0.41     | 0.30 ± 0.50 | 0.24 ± 0.42 | 0.51 ± 0.59     | 7.66** | 0.00 |
| Pain in elbow              | 0.11 ± 0.31     | 0.17 ± 0.37 | 0.08 ± 0.27 | 0.39 ± 0.52     | 13.59** | 0.00 |
| Pain in wrist              | 0.44 ± 0.50     | 0.66 ± 0.52 | 0.63 ± 0.52 | 0.86 ± 0.47     | 11.55** | 0.00 |
| Pain in neck               | 0.69 ± 0.69     | 0.60 ± 0.61 | 0.57 ± 0.60 | 0.79 ± 0.58     | 2.75*  | 0.48 |
| Strained shoulders while working | 0.76 ± 0.73 | 0.81 ± 0.70 | 0.67 ± 0.73 | 0.77 ± 0.70     | 0.69*  | 0.55 |
| Uncomfortable while sleeping due to body pains. | 0.93 ± 0.68 | 0.94 ± 0.60 | 0.92 ± 0.52 | 1.14 ± 0.63     | 3.21*  | 0.02 |

(M = Mean, S.D. = Standard Deviation), **Highly significant p < 0.01
4.4. Intensity of pain experienced by the rag pickers in upper and lower limbs

From the analysis, it was revealed that MSDs were the major problem among rag pickers. The activities of the rag pickers were also highly repetitive. The data in Table 4 portrays the intensity of pain in various body segments, classified in to upper limbs and lower limbs. The pain is categorized in to no pain, mild pain, moderate pain and severe pain in ascending order (0- no pain to 3- severe pain).

The results revealed that the subject experienced severe pain in lower back (65%), upper back (52.5%), right feet (47%), left feet (46.5%) followed by right hand (43%). Further, majority of the subjects reported moderate pain in neck (42%), left hand (36.5%), right shoulder (29%), and left shoulder (23.5%). Mild pain was found among rag pickers in left wrist (25%), right wrist (23%) left thigh (23%), and right thigh (25.5%; Table 4).

4.5. Pain experienced by the rag pickers in last seven days and one month

The data portrayed in the Table 5 regarding pain experienced by the rag pickers in the last seven days and one month. It can be seen from the data that maximum body pain was experienced by the rag pickers in neck (59.5%), shoulder (left: 80.5%, right- 87.5%), followed by wrists (left- 58.5%, right- 63.5%) and hands (left- 55%, right- 57.5%) in last one month. The anatomical distribution showed that 94.5% suffered maximum pain in lower back, 93.5% in upper back, followed by feet (left- 92%, right- 91.5%). The study clearly reveals that the percentage of musculoskeletal complaints during the past 1 month was significantly higher among the rag pickers compared to the last 7 days.

Table 5 shows the results of cross phi test to find out the association between pain in last 7 days and pain in last 1 month in different body parts. The significant results were found in all the body parts (Table 5).

5. Discussion

The findings of this study revealed that musculoskeletal symptoms were common among rag pickers. They were most common in the lower back, upper back, feet, hands, neck, shoulder, and knee areas. Long periods of time spent lifting or carrying loads weighing 30–80 kg with a flexed back may have contributed to low back aches. In most cases, these loads were also lifted away from the body or the ground. It is possible that the high compressive forces exerted on the low back during this activity would have led to aches and pains.

In the present study majority (72%) of the rag pickers were females. In contrary, studies conducted in Mumbai (Mote et al., 2016), Delhi (Agarwalla et al., 2017), and Brazil (Cozzensa da Silva et al., 2006), revealed that 50% of the rag pickers are males. Also in the current study, majority (37%) of the study population belonged to middle aged (25–35 years). Similar findings were found by a report submitted on rag pickers of Kathmandu (Shrestha et al., 2020). A study from Paletos in Brazil reported that majority of the rag pickers (58%) belonged to the age group of 18–39 years (Cozzensa da Silva et al., 2006). Another study conducted in Lucknow reported that 50% of the rag pickers belonged to the age group of 22–34 years (Kumari & Kiran, 2020).

The present study revealed that majority of the rag pickers (69.5%) was completely illiterate. Similar findings were reported in studies conducted in Mumbai (Mote et al., 2016) and Delhi (Agarwalla et al., 2017). Studies in Mumbai (70.8%) and Delhi (53%) have shown that more than 50% of the rag pickers are completely illiterate.

Time spent on rag picking depends on the quantity of garbage produced. In this study it was found that majority of the rag pickers (43.5%) put in 5–7 hours in work per day. Studies in Thiruvananthapuram (73%; Menon et al., 1994) and Hyderabad (65%; Devi et al., 2014) reported that rag pickers work for 5–8 hours in a day. In Delhi’s (Mote et al., 2016) study 56% of the rag pickers works for 5–8 hours in a day and in Kathmandu (Shrestha et al., 2020) majority of the rag pickers were found to be working for 7 hours daily. However another study from Mumbai (Kuorinka et al., 1987) also found that majority (45.8%) of the rag pickers worked for 9 hours in a day.
Table 4. Intensity of pain experienced by the rag pickers in upper and lower limbs

| Body Parts | No Pain | Mild | Moderate | Severe |
|------------|---------|------|----------|--------|
| **Upper limbs** | | | | |
| Neck | 160 (40.0) | 32 (8.0) | 168 (42.0) | 40 (10.0) |
| Shoulder | | | | |
| Left | 160 (40.0) | 74 (18.5) | 116 (29.0) | 50 (12.5) |
| Right | 158 (39.5) | 57 (14.3) | 94 (23.5) | 91 (22.8) |
| Elbow | | | | |
| Left | 306 (76.5) | 18 (4.5) | 36 (9.0) | 40 (10.0) |
| Right | 306 (76.5) | 18 (4.5) | 36 (9.0) | 40 (10.0) |
| Wrist | | | | |
| Left | 166 (41.5) | 100 (25.5) | 86 (21.5) | 48 (12.0) |
| Right | 146 (36.5) | 92 (23.0) | 80 (20.0) | 82 (20.5) |
| Hand | | | | |
| Left | 76 (19.0) | 82 (20.5) | 146 (36.5) | 96 (24.0) |
| Right | 48 (12.0) | 52 (13.0) | 128 (32.0) | 172 (43.0) |
| **Upper Back** | 20 (5.0) | 62 (15.5) | 108 (27.0) | 210 (52.5) |
| **Lower Limbs** | | | | |
| Lower Back | 18 (4.5) | 18 (4.5) | 104 (26.0) | 260 (65.0) |
| Hips | 292 (73.0) | 6 (1.5) | 72 (18.0) | 30 (7.5) |
| Thighs | | | | |
| Left | 210 (52.5) | 92 (23.0) | 50 (12.5) | 48 (12.0) |
| Right | 198 (49.5) | 102 (25.5) | 54 (13.5) | 46 (11.5) |
| Knees | | | | |
| Left | 224 (56.0) | 30 (7.5) | 60 (15.0) | 86 (21.5) |
| Right | 224 (56.0) | 28 (7.0) | 60 (15.0) | 88 (22.0) |
| Ankle | | | | |
| Left | 280 (70.0) | 60 (15.0) | 60 (15.0) | 0 |
| Right | 278 (69.5) | 62 (15.5) | 60 (15.5) | 0 |
| Feet | | | | |
| Left | 32 (8.0) | 64 (16.0) | 118 (29.5) | 186 (46.5) |
| Right | 34 (8.5) | 62 (15.5) | 116 (29.0) | 188 (47.0) |

(Figures in parenthesis indicate percentages)
Table 5. Comparison in pain experienced by the rag pickers during last seven days and one month

| Body Parts   | Pain in last 7 days | Pain in last 1 month | Phi Value* |
|--------------|---------------------|----------------------|------------|
|              | Frequency | Percentage | Frequency | Percentage |          |
| Upper limbs  |          |           |           |           |          |
| Neck         |          |           |           |           |          |
| Shoulder     |          |           |           |           |          |
| Left         | 104      | 26.0      | 220       | 55.0      | 0.536**  |
| Right        | 112      | 28.0      | 230       | 57.5      | 0.536**  |
| Elbow        |          |           |           |           |          |
| Left         | 8        | 2.0       | 68        | 17.0      | 0.316**  |
| Right        | 14       | 3.5       | 76        | 19.0      | 0.393**  |
| Wrist        |          |           |           |           |          |
| Left         | 60       | 15.0      | 234       | 58.5      | 0.354**  |
| Right        | 66       | 16.5      | 254       | 63.5      | 0.337**  |
| Hand         |          |           |           |           |          |
| Left         | 162      | 40.5      | 322       | 80.5      | 0.406**  |
| Right        | 232      | 58.0      | 350       | 87.5      | 0.444**  |
| Upper Back   | 176      | 44        | 374       | 93.5      | 0.234**  |
| Lower Limbs  |          |           |           |           |          |
| Lower Back   |          |           |           |           |          |
| Hips         | 36       | 9.0       | 110       | 27.5      | 0.511**  |
| Thighs       |          |           |           |           |          |
| Left         | 56       | 14.0      | 188       | 47.0      | 0.428**  |
| Right        | 64       | 16.0      | 198       | 49.5      | 0.414**  |
| Knees        |          |           |           |           |          |
| Left         | 114      | 28.5      | 176       | 44.0      | 0.712**  |
| Right        | 118      | 29.5      | 176       | 44.0      | 0.730**  |
| Ankle        |          |           |           |           |          |
| Left         | 34       | 8.5       | 112       | 28.0      | 0.489**  |
| Right        | 34       | 8.5       | 116       | 29.0      | 0.477**  |
| Feet         |          |           |           |           |          |
| Left         | 312      | 78.0      | 368       | 92.0      | 0.555**  |
| Right        | 312      | 78.0      | 366       | 91.5      | 0.531**  |

**Significant values (P ≤ 0.05), *P= significance tested by Cross Phi test at 0.05

According to Kumari and Kiran’s study, older rag pickers experience more pain and the reason behind this may be that their bones are weaker and moving their bodies frequently causes more body pain. It is also evident that with increase of work experience, the workers had more pain and this may be due to the reason that, prolonged pain without any treatment may have led to chronic pain and discomfort in almost all the body parts (Kumari & Kiran, 2020). Similar result was found by a study conducted by Salve et al. In their study, musculoskeletal discomfort was significantly higher among the waste loader aged 35 years 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 (Salve et al., 2017).

The study also revealed that the prevalence and intensity of pain was highest in lower back, upper back, feet, and hands. It was because the nature of their work which requires the rag pickers to constant bent and walk, which increased the discomfort in these body regions. Rag pickers have to climb all the way up a pile of rags to collect garbage and climb down with the pile of rags usually while carrying heavy loads rested either on their back and shoulders. Thus, carrying heavy loads may also contribute to the increased prevalence of ergonomic hazards among the rag pickers (Singh & Chokhandre, 2015). The joints affected in order of propensity are the knee, back, shoulder, elbow, ankle, and neck (range 39–17%). Higher levels of joint pain have also been reported in the Indian cities of Bombay, Calcutta, and Bangalore (Chokhandre et al., 2017; Waste collection and transportation management, 2021). A review of the global literature found strong evidence that work-related lifting is connected to low back disorders (Poulsen & Midtgard, 1996).
Another study reported that all the workers working with solid waste management suffer from various types of musculoskeletal injuries, muscles and ligament sprain, and cuts and laceration (Barrera et al., 1995). Abou-El Wafa et al. reported that low back, shoulder, neck, knee, hips and thighs, and elbow are the frequently affected body regions among solid waste workers (Abou-elwafa et al., 2012). According to a study conducted in Mumbai, waste loaders have a higher prevalence of musculoskeletal discomforts in the back (37%), hips/thighs (34%), upper back (32%), shoulders (26%), and neck (13%). Previous studies of solid waste workers in developing countries such as Iran (Mehrdad et al., 2008), Nigeria (Thakur et al., 2018), and Taiwan (Iinyang, 2007) have found a higher prevalence of MSDs, especially in the low back, shoulders, wrist/hand, upper back, and knee. The findings of these studies support the current study’s hypothesis that rag pickers who work in garbage collection have more musculoskeletal problems.

The study of Chennai has different findings from the findings of the present study. In this study, the most commonly affected body region (84.5 percent) was the knee (Yang et al., 2001). Studies in Brazil (Robazzi et al., 1997), Denmark (Ivens et al., 1998), Taiwan (Iinyang, 2007), the United States (An et al., 1999), and the Netherlands (Kuijjer & Frings-Dresen, 2004) reported a high prevalence of MSDs among waste collectors. Waste collectors in Egypt suffer from MSDs as a result of the large volume of waste they must manually pack. Musculoskeletal complaints were found in a high percentage of MSW collectors (60.8%), with the low back being the most commonly affected body region. Working duration, pushing, pulling, carrying heavy loads and long distance walking were all found to be significant hazardous factors for MSDs among MSW collectors. Low back (22.5%), shoulders (15.8%), neck (7.5%), knee (6.7%), and hips/thighs and elbows (5.8% each) were the most commonly affected body regions among MSW collectors (Abou-elwafa et al., 2012).

In Palestine, 45.7% of surveyed waste collectors reported backache, 34.1% reported twisted ankle, 22.1% reported muscle tear, and 8.7% reported joint pain (Milhem, 2004). In Nigeria, 171 workers suffered musculoskeletal injuries on the job, accounting for 61.3% of the solid waste collectors sampled. Because of the large volume of wastes they must manually pack instead of using hydraulic lifts, solid waste collectors in the Port Harcourt municipality suffered musculoskeletal injuries (Thakur et al., 2018). In Iran, the prevalence of musculoskeletal symptoms in the low back, knees, shoulders, upper back, and neck was 45%, 29%, 24%, 23%, and 22%, respectively, among MSW workers in Tehran. The risk of disease increased with the number of years spent working as a solid waste worker (Mehrdad et al., 2008). Singh et al revealed a high prevalence of MSDs among waste pickers, particularly in the lower back (54%), knee (48%), upper back (40%), and shoulder (32%) in their study (Singh & Chokhandre, 2015).

6. Conclusion

The work of rag pickers is characterized by heavy loads carrying as well as pulling the garbage carts. Furthermore, rag pickers’ work may include work above the shoulder level, frequent exertion of force, and extreme joint position, all of which are occupational hazardous factors leading to MSDs of the neck, shoulder, and hands. The impact of the waste loading occupation on the development of MSDs was investigated in this study. The occupation of rag picking, according to statistics, significantly increases the risk of MSDs development. Based on the observations and analysis of the results, it was concluded that the health of the rag pickers was greatly influenced by awkward body posture and workload. Twisting and bending are symptoms of poorly designed workstations. These actions put them into a non-neutral position, increasing pain and discomfort in the lower back, hand, feet, knees, and upper back.

Rag pickers are one of the most vulnerable occupational groups when it comes to MSDs. The higher rate of musculoskeletal symptoms among rag pickers could be attributed to the long duration of work and the physically demanding nature of their work, which includes carrying and pulling heavy loads and walking long duration on a daily basis. Rag pickers’ unfavorable working conditions could be improved.
6.1 Recommendations
To improve the overall well-being of rag pickers, ergonomics and safe practices must be established to reduce work-related vulnerabilities. Although the concepts of safety/health and good ergonomic practices are introduced in all industries, in the unorganized sector, these practices are always pushed to the back of the workers’ minds. MSDs are also likely to be high due to the unorganized structure, as workers must work in a stressful environment in order to maintain job security. To reduce the burden of MSDs, the study strongly recommends both preventive and curative measures. A training program to detect the early signs and symptoms of MSDs is needed so that rag pickers can demand curative measures. Since rag pickers are informal workers and receive low wages, developing low-cost, easy-to-use solutions to reduce the prevalence of MSDs would be beneficial. Bags and bins are being replaced with wheeled containers. A long litter smart grabber can be used for picking up the rags. The tool helps the rag pickers avoid bending, stretching, or squatting again and again to pick up the garbage. Also they could pick up the rags without directly touching the waste.

6.2 Implications
The present study evaluated work-related ergonomic problems faced by the rag pickers. This research revealed new information on the topic of rag pickers and MSDs. These data highlighted the body region where maximum pain or discomfort found among rag pickers, which could prioritize region to mitigate. The most significant region was upper (52.5%) and lower back (65%), feet (47%), and hands (43%). Based on these data, healthcare practitioners can play a vital role in preventing the prevalence of musculoskeletal illnesses by providing health education and spreading awareness of early signs of MSDs.

6.3 Limitations
In this study, only male and female rag pickers in the age group of 20–60 years were selected. Child rag pickers were excluded from the study. Data were collected from only one state, so it is difficult to generalize the results for a larger population.

6.4 Further scope for researchers
According to this study, rag pickers have a significant prevalence of musculoskeletal diseases, which could lead to higher inpatient and outpatient healthcare costs. Treatment seeking habits, coping methods, and the economic burden of musculoskeletal problems among rag pickers should all be investigated. A cohort study is further recommended.

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Manuscript writing, data collection, and interpretation have been done by Santoshi, and part of statistical analysis and editing of the script and final proof was done by U. V. Kiran. Both writers read and approved the final manuscript.

Ethical statement
This is a descriptive study so there is no ethical approval is required.

Consent to participate
Informed consent was obtained from all the respondents included in this research.

Data Availability Statement
The data of this research are available on request from the authors and not publicly provided due.

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