Occupational Health Hazard Exposure to the Municipal Solid Waste Workers in Himachal Pradesh

A Thesis

Submitted in partial fulfillment of the requirements for the award of the degree of

MASTER OF TECHNOLOGY
In

CIVIL ENGINEERING

With Specialization in

Environmental Engineering

Under the supervision of

Dr. Rajiv Ganguly
(Associate Professor)
By

Prannoy Thakur
(162756)
To

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY
WAKNAGHAT, SOLAN – 173234
HIMACHAL PRADESH, INDIA
May-2018

CERTIFICATE

This is to certify that the work which is being presented in the project title **"Occupational Health Hazard Exposure to the Municipal Solid Waste Workers in Himachal Pradesh"** in partial fulfillment of the requirements for the award of the degree of Master of technology with specialization in Environmental Engineering and submitted in Department Of Civil Engineering, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out By **Prannoy Thakur** during a period from July 2016 to May 2018 under the supervision of **Dr. Rajiv Ganguly**, Professor, Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of my knowledge.

Date:

Dr. Rajiv Ganguly	**Dr. Ashok Kumar Gupta**	**External Exminar**
Associate Professor Department of Civil JUIT Waknaghat Engineering	Professor and Head of Department Department of Civil Engineering JUIT Waknaghat	

DECLARATION

I hereby declare that the work reported in the M-Tech project entitled **"Occupational Health Hazards to the Municipal Solid Waste Workers in Himachal Pradesh"** submitted at **Jaypee University of Information Technology, Waknaghat, India** is an authentic record of my work carried out under the supervision of **Dr. Rajiv Ganguly**. I have not submitted this work elsewhere for any other degree or diploma.

Prannoy Thakur
Department of Civil Engineering
Jaypee University of Information Technology,
Waknaghat, India
Date: -

ABSTRACT

The total volume of MSW generated in Himachal Pradesh is predicted to be 350 tons per day along with annual growth rate varying between 1 to 1.33%. This leads to serious considerations of workforce associated with MSW. The study presents the prepatent occupational health hazards of such workers associated with MSW generated from non-engineered landfill sites carried out at three study locations (Shimla, Solan, Mandi) in Himachal Pradesh, India . The leading objective of the work was to determine existing occupational hazards related to MSW management at these locations, to coordinate with the different municipalities and suggest advisable sanative measures for our study locations. In particular, the exposure assessment to the work force comprising of street sweeping of streets, waste collection from different collection points, waste processing at the treatment plants, and rag picking from the dumping site as well as from open dumps were assessed using an interview scheduling technique. A questionnaire survey was carried out on these workers with the questions asked related to their work culture, socio-economic conditions, general awareness of occupational health risks and related occupational health hazards associated with the work being performed by them. The results showed that the workforce mainly comprised of males with a low percentage literacy rate. The age assortment showed majority of waste collectors and street sweepers were above 30 years of age (67%) and that the rag pickers of Mandi town were under 20 years of matured age. Income variation between casual and regular workers were highly significant with regular workers (INR 600 to 1200; USD 9 to 18) getting almost six times the payment of the casual workers (INR 100 to 200; USD 3 to 7.5). From the interview studies conducted the study reported that about 64% of waste collectors, 80% of the street sweepers and 10% of the rag pickers in Solan were not provided with any personal protective equipment whereas the figures reported in Mandi were 6.67% street sweepers, 57.47% waste collectors and 100% of rag pickers. Interestingly, in the city of Shimla a small fraction of the street sweepers (28%) and waste collector (6%) reported that they were given protective

equipments on every six months. The lack of provisions of protective equipment along with the ignorance of the workers results in occupational health hazards due to different description of external injuries. The extensive health problems during job tenure reported by different classes of workers indulged in waste handling activities were like muscle & ligament sprain, cuts and lacerations and different allergies varying between 1.97 to 66.67% [for e.g. in Solan it varies from 32.47 to 66.67%; Shimla 1.97 to 10.16% and in Mandi 9.52 to 16.67%], 6.36 to 67.95% and 5.77 to 42.86%, respectively.. From our study, it was observed that such workers are ill-protected against such kind of occupational health hazards that is why there is a great need to form new laws and policies in benignity of the MSW workers.

Keywords: occupational health exposure, street sweepers, waste collectors, Himachal Pradesh.

TABLE OF CONTENTS

Contents

LIST OF TABLES & FIGURES

LIST OF BAR CHARTS

CHAPTER 1

INTRODUCTION

1.1 General

Increased industrialization along with urbanization has led to increased growth of waste, and hence proper management of MSW generated in progressing countries e.g. India is of serious concern [1, 19]. In emerging countries like India, due to cheap availability of laborers due to high illiteracy rates [9] they are associated with different aspects of waste handling including waste collection processes, sorting techniques, transportation mediums, processing and disposal of waste [2,3,8]. The total production of MSW computed in India is 350 TPD with an expected growth rate of 1 to 1.33% [24]. In such scenario, MSWW are subjected to many types of occupational risks like exposure to noxious materials comes out as left outs from the chemicals, elixirs, ailment induced flies, other pollutants and diffusion done by the deterioration of the biological entity[13, 14] along with musculoskeletal problems due heavy load handling of MSW generated[3,6,8,12]. Some of the studies have also reported being exposed to emissions from transportation vehicles of MSW [4, 13]. In particular, laborers working as waste collectors, such exposures can be classified as primarily destructive and non destructive exposures with musculoskeletal problems being the most common amongst non fatal injuries [17, 18, 20, 21, 22] .A convinced percentage of the workers reported that they are not suffering from any external injuries but suffered from allergies, nausea and headaches frequently. From the questionnaire survey carried out, the proportion of respondents varied between 5.77 to 42.86%. The lowest values and highest values were reported by street sweepers in Shimla and drivers in Mandi. Musculoskeletal problems (MSP) are of significant importance as they affect the gratification including increased economic grievance due to productivity and job losses [11, 25].

Further, such problems account for majority of related treatment costs and the susceptibility of such groups are of significant concern. It has been observed that even though this is widespread issue in every country, recently some studies associated with these exposed MSW workers have been reported [13, 23]. A similar such study was executed in Chandigarh [12] which is very nearby to the selected state (Himachal Pradesh) wherein the present study locations are situated. It is expected that this study will serve as a comparison to the reported study of Chandigarh (a Tier-II city) with the other selected study areas of Solan (Tier-III/IV city), Shimla (Tier-II city) and Mandi (Tier-III/IV city) in Himachal Pradesh (HP). The present study reports the occupational health risks experienced by municipal solid waste laborers for three different study locations in Himachal Pradesh and suggests advisable sanative measures for better management of the workers to prevent such health related problems.

1.2 Study area profile

As for the occupational health exposure of MSW workers study in Himachal Pradesh. We have chosen three major cities of state Himachal Pradesh, Solan city, Shimla City and Mandi City.The population of Shimla is 1.7lakhs[5] significantly higher than Solan and Mandi. Shimla city is branched into 35 numbers of blocks and workers are deployed according to the area of each block and the population it covers. The total numbers of waste collectors deployed within the Shimla city are 456 in number. Since it is an tourist place, we have focused on the busiest of areas of Shimla city i.e. The Mall, Upper bazaar, Lower Bazar, Lakkar Bazaar amd Jakhu. These area and the different blocks associated with these collectively have 121 Street Sweepers and around 100 waste Collectors. Further, The population of Solan city is 39,256[5] approximately one fourth of Shimla city. Solan city is branched into 15 numbers of wards. The total numbers of waste collectors deployed within the Solan city are 77 in number and street sweepers are 78 in number. Whereas, the

living population of Mandi city is 26,422 [5]. Mandi city is branched into 12 wards. The number of waste collectors deployed in Mandi city i.e. 87 is higher in number than street sweepers deployed i.e. 30.

Figure 1.2 (A) - Map of Study Area

1.3 Objective of Study

1. To evaluate the prevalence of adverse health effects among MSW workers and describes their socio economic situation and work characteristics.

2. To study both components internal and external injuries caused to msw worker during various handling practices of solid waste.

3. To valuate the prevalence of diseases caused during the operational work done by MSW workers.

4. To prescribe relevant waste management and disposal standards/ appropriations in accord with the current administrative requirements.

1.4 Need of Study

Municipal solid waste collectors are from the most extreamly exposed occupational category contingent to musculoskeletal disorders. The greater percentage of musculoskeletal indications among municipal solid waste workers could hold responsible due to the longer period of employment, lesser job control, and the type of their job, which is physically exhausting and includes lifting of stacks, pulling of waste loaded carts, pushing heavy loads, and constant bending and wriggling activities. Also the unschooled collectors were less informed of the possible hazards and health impacts co-related to the collection techniques. The ominous working conditions of municipal solid waste collectors could be alleviated by way of engineering techniques, medical facilities, and legislative amendments along with a legitimate workplace

CHAPTER 2

LITERATURE REVIEW

2.1(A) Institutional Research work for waste management practices.

2.1.1 A. Afon, (2012) [1]

The purpose of the study is to present the socio-economic, environmental and health implications of scavenging activity for solid waste in Olusosun, it is one out of the government authorized open waste disposal scrap heaps in Lagos, Nigeria. Scavaging is a process of Recovering the items from a sheaf of waste which involves physical energy as they use manually-driven machinery. Despite the fact the scavengers realize that scavenging introduces them to both environmental and health hazards, they keep on scavenging for their social and economic reasons. Without reconstituting, the scavengers will develop a socio-economic and security menace to the community. Scavenging must, therefore, be interspersed all the way into the waste-management practices and governed.

2.1.2 L. Giusti, (2009) [9]

This study reviews the existing waste management systems on an international scale. Due to the increased urbanization in the growing countries, oodles of tons of produced waste are engendered every year. The developing health issues linked with the disposal of waste are mounting in dominating countries like China and other Asian country India. Substantial investment in waste management systems, exercises and education are prescribed in order to mow down the health hazards of erroneous waste disposal techniques.

2.1.3 S. Jerie, (2016) [11]

The purpose of this research was to describes and evaluates the risks factors our workers go through during job tenure and to correlate them with SWM proceedings in the casual workers of Gweru. In profuse categories of research, interest have been shown in the budding harms that are coming out due to waste generation in the environment and to the living community, The research proclaims that systems which are handling solid waste are handled manually exercises which report greater event of musculoskeletal affliction.

2.1.4 R. Khaiwal et al, (2016)[12]

This study focuses on the waste management practices. Seeing this, health risks of MSWW engaged in different categories like street sweeping of streets, door to door waste collection in cities, waste processing in the dumping sites, and rag picking from the open humps were computed in Chandigarh, India. The study demonstrates that the general purpose for any form relating to conservative gear is very less in the cleaning workers. Above, 90% of all waste, workers categories experience different types of injuries.

2.1.5 R. Rana et al, (2017) [19]

This study gives an scrunity of generation of waste, collection methods, transportation practices, treatment and disposal techniques of the pre-existing solid waste management (SWM) systems in Mohali and other study area Panchkula, obscure towns of Chandigarh.

2.1.6 A. Sharma, et al, (2018) [24]

The study proclaims that low collection ability of the waste in the study regions because of an inadequate number of collection cartons, improper machinery and equipment, manpower is outnumbered, shortage of transportation vehicles for waste disposal processes. The study also highlights the ‘wastewater’ standard indicators

and matrix method for quantification analysis of the system for each study area of Himachal Pradesh. The study clearly showed the suffering of implementation of environmental control methods including collection of waste and treatment of waste generated, disposal techniques of waste, 3R's facilities in waste handling, etc., in Himachal Pradesh.

2.1.7 S. Pattnik, et al, (2010) [15]

The main aim of this study is to focus on MSW practices in Pondicherry, India. According to this study waste has been differentiated into different types and sections on the basis of generation points of the waste e.g. organic inorganic, biodegradable non biodegradable, house hold, industrial waste. Fields like composting of organic waste. Recycling of materials has also been focused in this study.

2.1.8 S. Gupta et al, (1998) [10]

In this research main focus is on the various process implemented starting from collecting to disposing of waste. This study has been done on Indian scenario and how these practices are executed in the country. Certain remedies have been also provided like composting for accurate and healthy disposal of waste.

2.1(B) Summary of the Research Work.

Summarizing the researches we can conclude that the primary focus is on the different waste management practices and different disposable standards utilized within India and outside India. Waste collection practices as well as disposable techniques needs to be improved for the betterment of the workers indulged in such jobs, As well as for the environment or we can say surroundings. Making compost, doing recycling, starting segregation straight from the household structures are the better option for the future fulfillment of the goals. With the evaluation of the disposing techniques we can equally find out the adverse health effects on the workers. Injuries associated with easch type of work can be sited and equal

remedies can be planned.

2.2 (A) Risks for Occupational Health Hazards among Solid Waste Workers

2.2.1 M. Athanasiou, et al, (2010) [2]

The motive of this course is to valuate the respiratory health conditions of MSWW. The research was operated around the area of municipal corperation of Keratsini, outskirts of the wharf city of Piraeus, Greece. The results of this study suggested that professional specialist should deal in all seriousness with the occupational health of municipal solid waste workers. Dynamism is required to revitalize the practices of safer waste handling procedures and the rightful avail of individual safety appurtenances.

2.2.2 D. Bogale, et al, (2014) [4]

The study was done to determine amplification of injuries occurs during job tenure and correlated components within MSW workers in Addis Ababa City. Individual safety equipment usage plays decisive factor for the injuries during job. That is why, exercise of primary health regarding & safety defining practices including the arrangement of individual safety accompaniments also ensuring implementations are highly recommended.

2.2.3 A. Chandramohan. et al, (2010) [6]

A survey was organised on a questionnaire which includes details regarding their age variations, sex ratios, educational qualification, socio-economic stature, other health related effects. 65 randomly chosen rag-pickers were taken as sample size for survey from different regions of Tiruchirappalli city. Some of the reported conclusions were that the workers should be rightly educated as well as disciplined so that they can keep themselves safe from unhealthy habits or obsession. Waste

generation is increasing equally with the increase of the population, which is why the area for dumping of waste and vehicles and workers are outnumbered.

2.2.4 E. W. A. El-Wahab , (2014) [7]

SWM systems have developed as an influential human and substantial health concern. MSW workers are likely vulnerable to many kind of risks and safety hazards during their job tenure. Purpose of this research meant to constitute healthy processes and regarding safety precautions adapted by the workers working in the municipal company in Alexandria (Egypt) and also the arrangements done for the experienced job associated ailing health.

2.2.5 AA. Ewis, (2013) [8]

Street sweepers act as an imperative role in sustaining the health and sanitation in the society, Waste collectors and street sweepers play an influential role. In spite of, their job opens them to different hazards although, very less focus is given on their sufferings and job related problems. Motive of this work was to evaluate the potential job featuring desolations within street sweepers and waste collectors focusing on the risks they posseses during their job tenure and the precautionary measures they follow to stay safe and for their job-associated precarious problems.

2.2.6 EM. Reddy, (2015) [20]

Municipal solid waste collectors are from the most extremely exposed occupational category contingent to musculoskeletal disorders. The greater percentage of musculoskeletal indications among municipal solid waste workers could hold responsible due to the longer period of employment, There job is obnoxious and physically exhausting which includes picking up the stacks, drawing of waste loaded carts, pushing heavy loads, and constant bending and wriggling activities. Also the unschooled collectors were less informed of the possible threats and health related impacts are co-related to the techniques how they collect them. The ominous working culture of MSW workers can be alleviated by way of engineering

techniques, medical facilities, and legislative amendments along with a legitimate workplace.

2.2.7 DE. Ross (2011) [21]

A contingent analysis of the analyzed literature and the other researches done in relation to the solid waste management from 21st century recommends that institutes and community at large often generally taken lightly. The utter goal our scientific research field must have to do the rectification of hygienic practises as a protection of the public health and community.

2.2.8 M.R . Ray, et al (2004) [16]

The main of this research was to find out adverse respiratory and health effects on one of the category of the waste workers i.e. rag pickers. Focus was given through different aspects like questionnaire surveys, medical checkups has been done to justify the results, which shows the rag pickers suffers with great extent having internal as well as external injuries at a time.

2.2 (B) Summary of the Research Work.

Summarizing the researches we discussed above will draw our focus on the adverse health effects on the waste working during their job tenure. Staying in direct contact with the waste led them to the direct exposure to the various deseases and they are very much vulnerable to the injuries during their job. injuries can be enternal as well as internal. these studies motive us to study and find out the remedies required to solve the allergies and injuries through any mean like providing personal protective equipments to the working , making sure they are working in healthy environment, focusing on the musculoskeletal disorders among the waste workers. The tasks can be accomplished by doing regular medical checkups, laboratory experiments. and more importantly we are in great need of healthy legislative policies so that the workers can claim for their rights on their own. these study have focused on joint pains, internal sufferings of the workers, regarding the existing blood count of the

worker, these are some of the internal injuries workers suffer through out there job time as well as after job life. This study draws our attention towards the prime health effects our workers suffer during their job tenure.

CHAPTER 3

MATERIALS AND METHODS

3.1 Classification of Waste Handling Processes and workers associated

The (MSW) handling workers in progressing countries are entangled in different types of waste management activities.

3.1.1 The waste collection:

Operative element of collection comprises not only the congregation of solid waste and recyclable goods, but also the transportation of these collected materials to the locale where the transportation vehicle is disgorged. This locale may be materials preparing facility, a relocation station or a disposal site. Street sweepers are the workers who are engaged in the activities like road sweeping and also in the compilation of littered waste from the streets and transfer it to the collection points. A study shows that among total 1225 MSW workers in Solan, Shimla and Mandi city. 383 are street sweepers which give us 31.26%. Waste collectors do activities like politicking waste collection. Informal segregation and the transport of waste are also done by the waste collection. A study shows that among total 1225 MSW workers in Solan, Shimla and Mandi city. 641 are waste collectors which give us 52.32%.

3.1.2 Transportation:

In This process two main steps are followed. First one is to transmit the waste from a minor collection carrier to larger transportation equipments. The waste is then carriage, usually over long stretches, to a disposal site. Informal segregation and the transport of waste are also done by the waste collectors. A study shows that among

total 1225 MSW workers in Solan, Shimla and Mandi city. 641 are waste collectors which give us 52.32%.

3.1.3 Sorting:

It is the technique in which waste is extracted into distinctive elements. Waste sorting can be done by hand at the domestics' level and poised through related organized collection techniques, or accordingly differentiated in materials recovery techniques. Manual sorting was the basic procedure adopted in the past for waste sorting. Waste segregation means portioning waste into dry waste and wet waste. Dry waste incorporates wood and related materials, waste metals, basically means to domestic waste usually grown by eating and weight more due to moisture. Waste can be discerned on the criteria of biodegradable waste or another form of it non-biodegradable waste. They search for the reusable items from the mixed chunk of the waste. Ragpicker used to sell them and make money from it. The study shows that, among total 1225 MSW workers in Solan, Shimla and Mandi city. 16 are waste processors which give us 1.30%.

3.1.4 Processing:

The desperation and transformation of wastes is mostly done at the generation point and the debarment of integrated wastes mostly happens at a materials restoration facility, disposal sites, Flaming conveniences for incineration processes and dumping sites. These workers segregate the large-sized fraction of waste from the garbage yard. Also helps in regulating the smooth flow of waste in a conveyor belt. A study shows that, among total 1225 MSW workers in Solan, Shimla and Mandi city. 26 are waste processors which give us 2.12%.

3.1.5 Disposal of waste:

In today's scenario, the dumping of wastes is done by directly dumping at landfill sites or waste spreading at disposal sites is the only method obliged for disposing of wastes. Albeit they are household wastes corporate and transported straightly into a landfill site.

3.2 Simplified Representation of Solid Waste Management in the study areas.

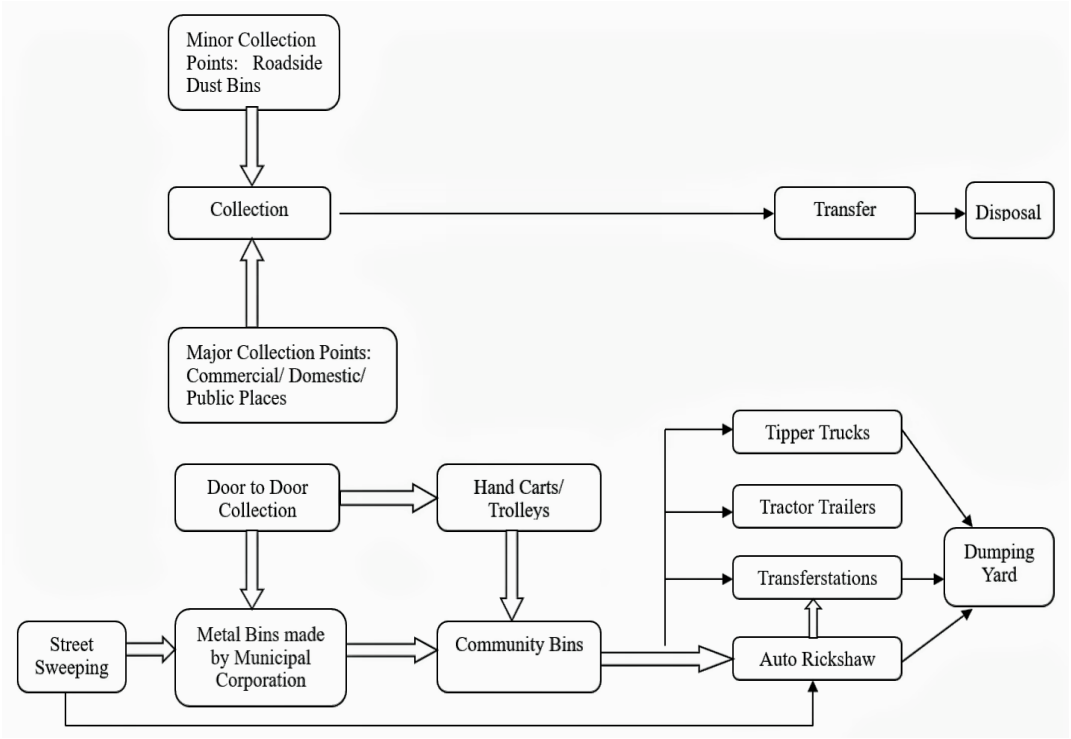


Figure 3.2 (A): Diagrammatic Representation of solid waste management in the study areas.

3.3 Questionnaires followed for interview schedule

3.3.1 Questionnaire for occupational health hazards of the workers.

The study was over sighted in Himachal Pradesh, India, comprising waste workers engrossed in the collection of waste, transportation of waste to the disposal sites, segregation on the primary and secondary level and processing of MSW in the disposal sites. The all working unit is categorized within street sweepers who do road sweeping, the waste collector does politicking waste collection, waste processors works at dumping sites and rag pickers do informal waste reusables. The

information regarding count of street sweepers engaged and the waste processors were given by the employer. A questioning criterion was adopted as a evaluation method to cluster some valuable facts on socio-economic acquirements of workers, work practises they follow, Occupational risks they posses and the other health-related problems among MSW workers. (Details of computed frequencies have been provided in ANNEXURE-1 (A))

3.3.2 NORDIC Musculoskeletal Questionnaire for interviewing MSD'S among MSW workers.

The purpose was to evolve and test a regulated questionnaire methodology allowing contrasting of low back other parts like neck and shoulder and general complaints about use in epidemiological studies. The NMQ can be valued as a standard questionnaire or as a structured interview. (Details of computed frequencies have been provided in ANNEXURE-1 (B)).

3.3.3 Hematocrit Blood testing to evaluate musculoskeletal disorders among MSW workers.

After discussion with the concerned doctor for the musculoskeletal disorders among MSW workers, the reporting of the blood test of the workers have been found primarily important to evaluate the certain deflections in their blood components workers account during their waste handling activities and the purpose is to find out the deficiencies in their hemoglobin count white blood cell counts. For this purpose Hematology studies has been done according to parameters and certain defined parameters have been accounted. Details of computed frequencies have been provided in ANNEXURE-4 (C)).

CHAPTER 4

RESULTS AND DISCUSSIONS

For analyzing the certain factors like what kind of occupational health hazards our workers go through and what is their own ground conditions we have taken questionnaire survey as a medium. The questions have been answered out directly the workers itself. The motive of this survey is to find out in what type working environment they work. With what kind of facilities they have been provided. Now facilities like do they get any individual protective equipment, what is their income from this profession. Focus is also given on whether they get any medical allowances or not. How much ratio of the workers has been literated? Musculoskeletal disorders evaluation has also been done. The prime focus is how we can improve these evaluated percentages in favor of our working labor, So that SWM practices can be handled and executed in good manner. As we know it is a serious concern.

4.1 Classification of MSW Workers in Solan city:-

The working labor has been categorized in different types according to the nature of work. As we get different type of waste from different locations like street sweeping, collecting waste from home to home, and segregating waste on the first point at different location, during processing of waste, for the picking of recyclables. Now out of the total number of waste handling workers some percentage of workers have been interviewed as they are discussed in the following Table 4.1.

Waste workers Category	Nature Of Work	Workers (n)	Worker Interviewed (n)
Street Sweepers	1) Road Sweeping. 2) Collection of lumped waste from the city streets and deporting it to accumulation points.	78	62 (79.48%)
Waste Collectors	1) Door to Door Collection. 2) Informal Segregation. 3)Transportation of Waste	77	49 (63.63%)
Waste Processors	1) Discriminating the plus sized chunks of waste from garbage yard. 2) Regular Smooth flow of waste into conveyor belt.	6	6 (100%)
Rag Pickers	Search for the recyclable waste materials from the mixed fractioned humps of the waste from the accumulation points and disposal sites.	10	4 (40%)

Table 4.1: Enumerating the waste workers immersed in waste associated activities in Solan city.

4.1.1 SOCIO-ECONOMIC STATUS

- **Gender & age distribution:**

Within Himachal Pradesh, the percentage of male population is higher among all the waste workers categories. The stats were ascertained that maximum ratio of sweepers was falling within the age limit of 30-40yrs (45.45%) and >40yrs (38.46 as non government organizations favor to employ a tender workers. Out of total rag pickers, 20% found to be endowed in age extent of >40 yrs, pursued by age limit of

30–40yrs (20%). Larger part of the waste processors was falling in age limit of 20–30yrs (83.33%). The other fact ascertained that 12.99% of waste collectors were below the age limit of 20. (Details of computed frequencies have been provided in ANNEXURE-2(A))

- **Educational qualification:**

  Illiteracy rate with the higher proportion (58.97%) was found in the street sweepers, ensued by the waste collectors (32.47%), Rag pickers (30%) and waste processors (33.33%), having been literated only up to a elementary level. (Details of computed frequencies have been provided in ANNEXURE-2(A))

- **Source of Income:**

  Source of Income of the workers fluctuates considerably banking upon their executive and in the context of the scrap pickers they bank on the extent of salvaged items poised by the workers on the disposal site. Most of the waste accumulators (66.7%) make about Rs200/day in two ways, i.e. via commercing the salvaged items and reprehended fees from the community residents every month. Street cleaning workers and waste workers on disposal sites apprehend consistent payments by their executives moreover 76.5% of the workers acquire beyond Rs500/day. Grossly (91.5%) of the scrap pickers make below Rs100/day. (Details of computed frequencies have been provided in ANNEXURE-2(A))

4.1.2 Occupational risks

- **Hazardous waste regulating and use of protective gears:**

  Toxic debris is generally constituted within the MSW, also incorporates abandoned medications, carcass bodies, apical items etc. Rag pickers with the allocated waste collectors stays in straight contiguity of the MSW but still do not use any protective gear. In Solan, only 79.49% from street sweeper and 63.64% from waste collector and 10% from rag pickers says they have been provided with personal protective equipment but on every half yearly basis. The truancy of protective equipment

impels waste workers which leads him susceptible to afflictions from broken pieces of glass, worn medical injections, salient metals. If we see the other workers like waste processors plighted in nongovernmental arranging seen forging account of using the important protective equipment. (Details of computed frequencies have been provided in ANNEXURE-2(A)).

Figure 4.1(A)
(Negligence in using protection gears by Street Sweeper in Solan City)

Figure 4.1(B)
(Negligence in using protection gears by Waste collector in Solan City)

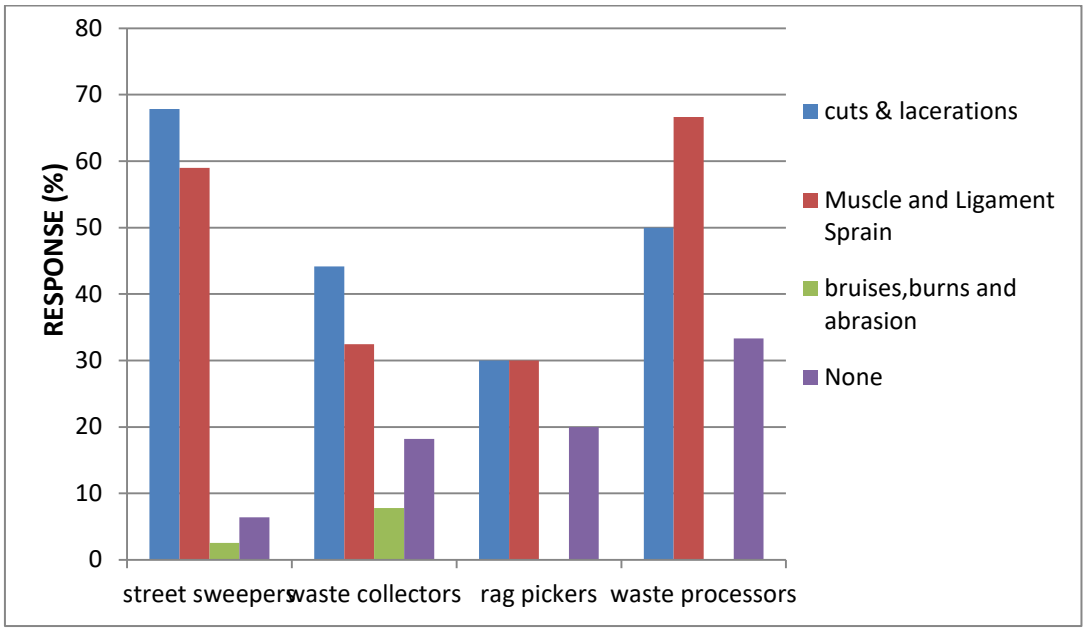
**Source- Onsite Images

4.1.3 Occupational health issues

- **Injuries & allergies:**

Furthermore, upto 90% workers of every classification were deteriorated by number of impairments, along with muscle & ligament sprain. We received numerous returns close to the description of reported injuries where 44.16% from waste collectors, 30% from rag pickers and 67.95% from street sweepers proclaimed that they endured from different injuries e.g. cuts and Lacerations. Furthermore, 58.97% from street sweepers, 30% from rag pickers, 32.47% from city waste collectors and

66.67% from processors recorded muscle & ligament sprains. The certain response percentages have been discussed out in following Bar chart 4.1(A). (Details of computed frequencies have been presented in ANNEXURE-2(A))

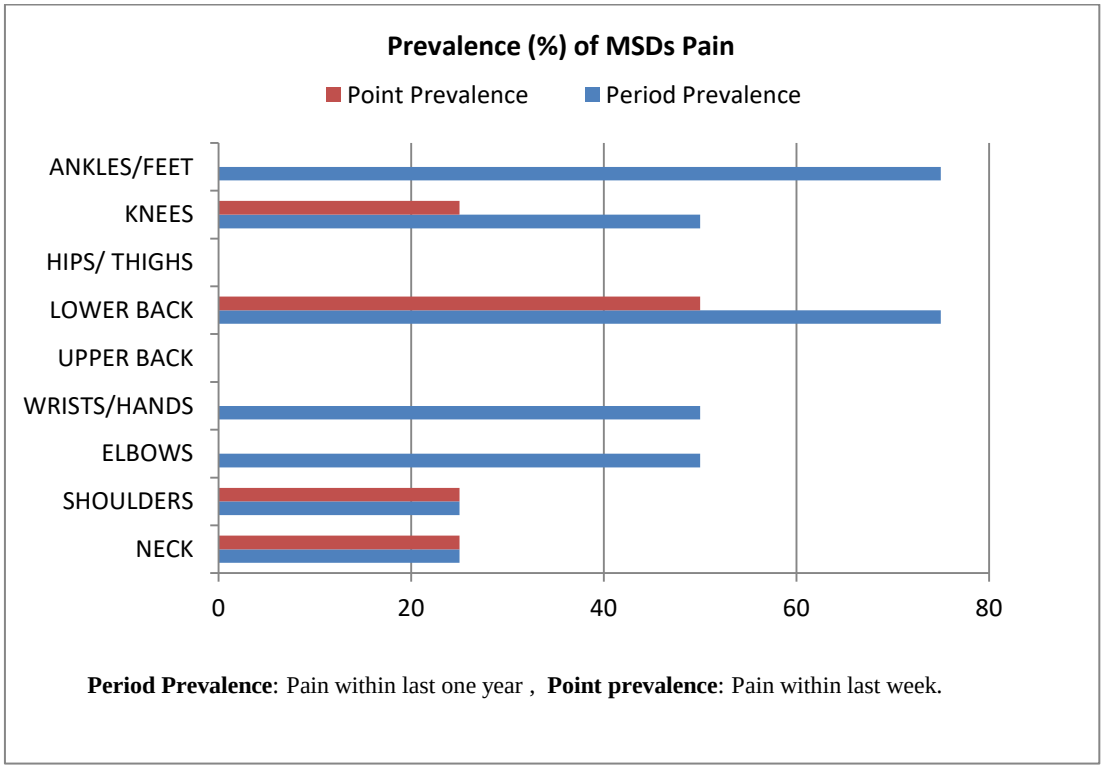


Bar Chart 4.1(A): Types of injuries to the Solid Waste Workers

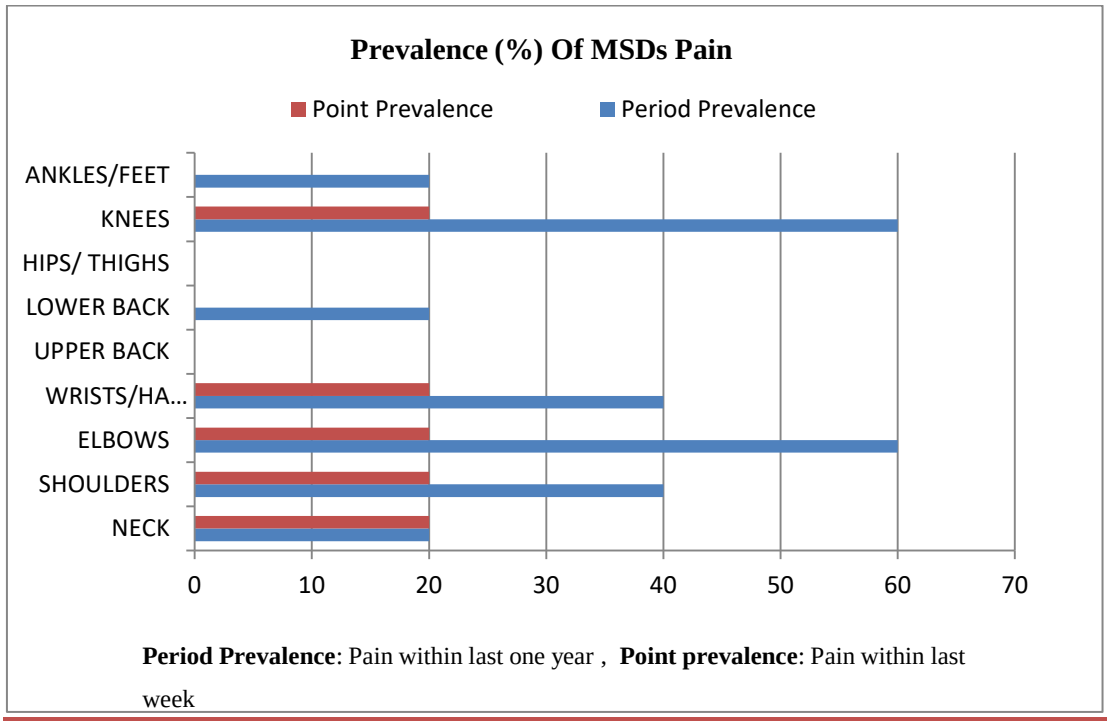
4.1.4 Musculoskeletal Predominance among MSW workers:-

In this course we are demonstrating the predominance of musculoskeletal pain with all the MSW workers. Sample of 9 workers were taken for the evaluation of MSDs their period prevalence was asked in last one year, and the point prevalence was asked for the last one week concerning pain in any body part, which was self-exclaimed by the interviewed workers. The highest period predominance, that is, last one year, anybody region pain was reported as 75%, whereas the highest point predominance, that is, last one week anybody expanse was found to be 50%. From all the body parts, lower back was erected to be the highest frequency percentages (point = 25%, period = 75%) persued by Elbows joint (point = 20%, period = 60%) and Knees (point = 20%, period= 60%). Shoulders pain and wrist

joint were adjoining atop as the manual dealing with waste involves these two dominantly. Other tangential joints such as elbow, hip, and ankle were in minute amplitude. The certain response percentages have been discussed out in following Bar chart 4.1(B) and Bar Chart 4.1(C). (Details of computed frequencies have been provided in ANNEXURE-2(B))



Bar Chart 4.1(B): Predominance of musculoskeletal disorders among Street Sweepers



Period Prevalence: Pain within last one year , **Point prevalence**: Pain within last week

Bar Chart 4.1(C): Predominance of musculoskeletal disorders among Waste Collectors

4.2 Classification of MSW Workers in Shimla city:-

The working labor has been categorized in different types according to the nature of work. As we get different type of waste from different locations like street sweeping, collecting waste from home to home, and segregating waste on the first point at different location, during processing of waste, for the picking of recyclables. No Rag Pickers have been found during the onsite surveying. Now out of the total number of waste handling workers some percentage of workers have been interviewed as they are discussed in the following Table 4.2.

Waste Workers Category	Nature Of Work	Workers (n)	Worker Interviewed (n)
Street Sweepers	1) Road Sweeping. 2) Compilation of lumped waste from the streets and relocating it to collection points.	422	121 (28.67%)
Waste Collectors	1) The door to Door Acquiring. 2) Informal Segregation. 3) Transportation of Waste.	456	40 (8.77%)
Waste Processors	1) Discriminating the plus-sized chunks of waste from garbage yard. 2) The regular Smooth flow of waste into a conveyor belt.	20	10 (50%)
Rag Pickers	Search for the reusable from the mixed fractioned humps of the waste from the accumulation points and disposal sites.	-	-

Table 4.2: Enumerating the waste workers immersed in waste associated activities in Shimla City.

4.2.1 SOCIO-ECONOMIC STATUS

- **Gender & age distribution:**

Within Himachal Pradesh, the percentage of the male population is higher among the waste workers in every classification. Study resulted that maximum number of sweepers were falling in age limit of 30-40yrs (13.86%) and >40yrs (13.39%) as

non government organizations favor to employ a tender workers. It was also ascertained that 7.24% of waste collectors were falling under the age group of 30-40yrs. (Details of computed frequencies have been presented in ANNEXURE-3)

- **Educational qualification:**

  llliteracy rate with the highest percentage of (10.38%) found in street sweepers, proceeded by the second category waste collectors (4.71%), and liberated upto the primary level. (Details of computed frequencies have been provided in ANNEXURE-3)

- **Source of Income:**

  In Shimla, the waste collectors earn the same rate of INR 200/day and a small proportion of workers (6.47%) earn INR 500/day as they are regular workers. (Details of computed frequencies have been presented in ANNEXURE-3)

4.2.2 Occupational risks

- **Hazardous waste regulating and use of protective gears:**

  Toxic debris is generally constituted within the MSW, also incorporates abandoned medications, carcass bodies, apical items etc. Rag pickers with the allocated waste collectors stays in straight contiguity of the MSW but still do not use any protective gear. In Shimla, only 27.94% of a street sweeper and 5.92% of waste collector says they have been provided with personal protective equipment but on every half yearly basis. The truancy of protective equipment impels waste workers which leads him susceptible to afflictions from broken pieces of glass, worn medical injections, salient metals. If we see the other workers like waste processors plighted in non governmental arranging seen forging account of using the importent protective equipment. (Details of computed frequencies have been provided in ANNEXURE-3)

Figure 4.2(A)
Unsafe Waste collection in streets of Shimla city

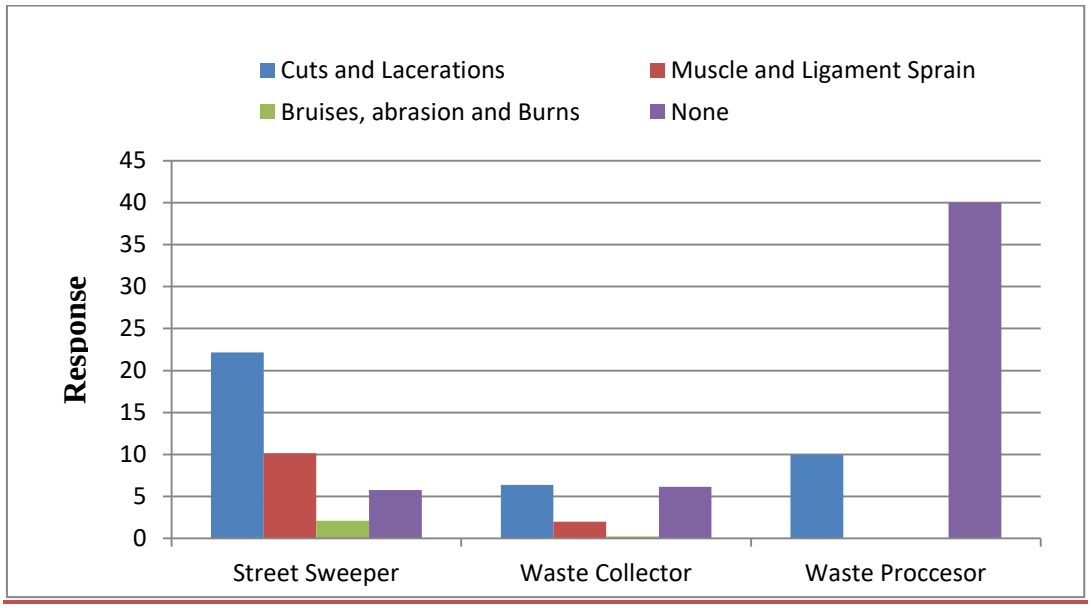
Figure 4.2(B)
Unsafe Waste Handling by waste collectors in Shimla city

**Source- Onsite Images

4.2.3 Occupational health issues

- **Injuries & allergies:**

Beyond 90% of entirely classifications of the immersed waste workers endured by different form of the observed injuries, containing muscle & ligament sprain. We observed numerous replies in relation to the categories of injuries where 6.36% of waste collectors and 22.17% of street sweepers proclaimed that they grieved from injuries like cuts and Lacerations. Furthermore, 10.16% of street sweepers, 32.47% of waste collectors and 1.97% of processors recorded muscle and ligament sprains. The certain response percentages have been discussed out in following Bar chart 4.2(A). (Details of computed frequencies have been provided in ANNEXURE-3)



Bar Chart 4.2(A): Types of Injuries to the MSW workers in Shimla City.

4.3 Classification of MSW Workers in Mandi city:-

The working labor has been categorized in different types according to the nature of work. As we get different type of waste from different locations like street sweeping, collecting waste from home to home, and segregating waste on the first point at different location, during processing of waste, for the picking of recyclables. Now out of the total number of waste handling workers some percentage of workers have been interviewed as they are discussed in the following Table 4.3.

Waste workers Category	Nature Of Work	Workers (n)	Worker Interviewed (n)
Street Sweepers	1) Road Sweeping. 2)Compilation of lumped waste from the streets and relocating it to collection points	30	13 (43.33%)
Waste Collectors	1) Door to Door acquiring. 2) Informal Segregation. 3) Transportation of Waste.	108	62 (57.40%)
Waste Processors	1) Discriminating the plus-sized chunks of waste from garbage yard. 2) The regular Smooth flow of waste into a conveyor belt.	-	-
Rag Pickers	Search for the reusable from the mixed fractioned humps of the waste from the accumulation points and disposal sites.	6	6 (100%)

Table 4.3: Enumerating the waste workers immersed in waste associated activities in Mandi City.

4.3.1 Socio-economic stature of workers.

- **Gender & Age distribution:**

Within Himachal Pradesh, the percentage of the male population is higher among

the waste workers in every classification. The stats were ascertained that maximum ratio of sweepers was falling within the age limit of >40 yrs (43.33%) whereas waste collectors in 30-40yrs (40.23%) as private managements prefer to procure for the young age workers. In the rag pickers, 66.67% of them endowed in the range of <20 yrs, pursued by the certain age limit of 20–30yrs (33.33%). Larger part of waste processors found to be falling inside age limit of 20–30yrs (83.33%). (Details of computed frequencies have been provided in ANNEXURE-4(A))

- **Educational qualification:**

  Illiteracy proportion was found (100%) among the Scrap Pickers, ensued by waste collectors (26.44%), Street Sweepers (30%), having been literate only up to an elementary level. (Details of computed frequencies have been provided in ANNEXURE-4(A))

- **Source of Income:**

  Source of Income of the workers fluctuates considerably banking upon their executive and in the context of the scrap pickers they bank on the extent of salvaged items poised by the workers on the disposal site. Most of the waste accumulators (57.47%) make about Rs200/day in two ways, i.e. via commercing the salvaged items and reprehended fees from the community residents every month. Street cleaning workers and waste workers on disposal sites apprehend consistent payments by their executives moreover 23.33% of the workers acquire beyond Rs500/day. Grossly (100%) of the scrap pickers make below Rs100/day. (Details of computed frequencies have been presented in ANNEXURE-4(A))

4.3.2 Occupational risks workers posses

- **Hazardous waste & use of protective gears:**

  Hazardous perceptible was generally constituted with the percent of MSW and also incorporates deserted medicines, Cadaverous animals bodies, sharp-edged items,

paints and dead batteries, in conjunction with sharp items. Rag pickers and the allocated waste collectors hover in straight association with the MSW but do not use any protective gear. In the survey determination results borne out in Mandi, it was reported that 36.67% of regular street sweepers reported positively in getting protective gears from their employers, whereas, 6.67% of them denied getting any type of protective gears. Further, about 57.47% from waste collectors and the collective group of fellow co-workers reported of not receiving any protective equipment. The truancy of protective equipment conceives waste workers susceptible to the afflictions outside of glass pieces, worn syringes etc. The engaged community of workers on disposing site is found to be allied to the protective equipment. (Details of computed frequencies have been presented in ANNEXURE-4(A)).

Figure 4.3(A)
Waste transporting techniques in Mandi city

Figure 4.3(B)
Rag picker Picking up waste from disposal site of Mandi City

Figure 4.3(C)
Unsafe Waste transportation in Mandi City

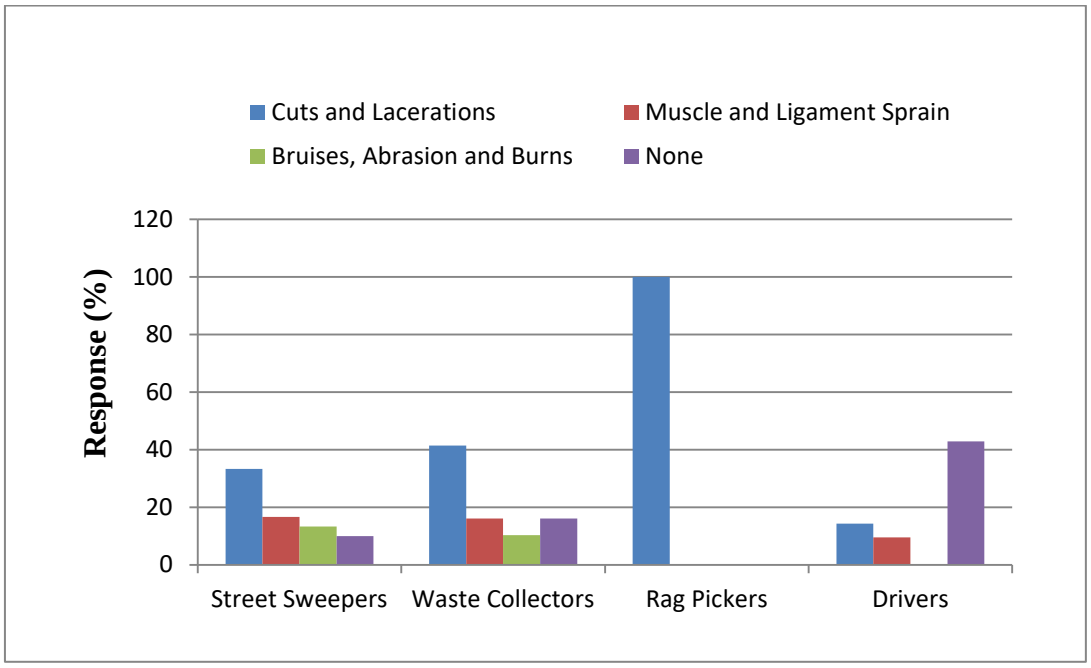
Figure 4.3(D)
Waste transportation by cycle carts in Mandi City

**Source- Onsite Images

4.3.3 Occupational health issues

- **Injuries & allergies:**

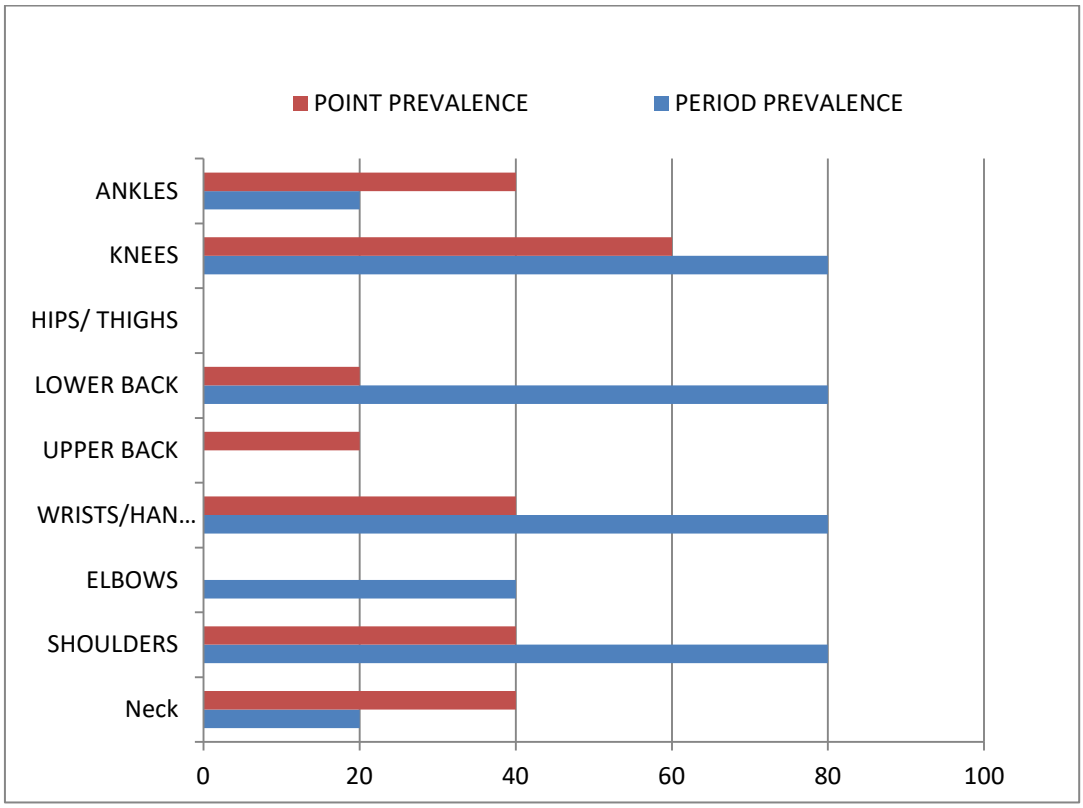
  Beyond 90% laborers of all classification of waste operatives deteriorated from different descriptions of impairments, along with muscle & ligament sprain. In the field, numerous returns close the description of injuries where 41.38% from waste collectors, 100% from rag pickers and 33.33% from street sweepers proclaimed endured from injuries e.g. cuts & Lacerations. Furthermore, 16.67% of street sweepers, 16.09% of waste collectors recorded muscle and ligament sprains. The certain response percentages have been discussed out in following Bar chart 4.3(A) (Details of computed frequencies have been provided in ANNEXURE-4(A))



Bar Chart 4.3(A): Types of Injuries to municipal solid waste workers in Mandi City.

4.3.4 Musculoskeletal Predominance among MSW workers:-

In this course we are demonstrating the predominance of musculoskeletal pain with all the MSW workers. Sample of 5 workers were taken for the evaluation of MSDs their period prevalence was asked out for the last one year, and the point prevalence was asked for the last week concerning pain in any body part, which was self-explained by the interviewed workers. The highest period prevalence, that is, last one year, anybody region pain was reported as 80%, whereas the highest point prevalence, that is, last 7 days anybody expanse was found to be 60%. From all the body parts, knees was erected to be the highest frequency percentages (point = 60%, period = 80%) pursued by shoulder joint (point = 40%, period = 80%) and wrists (point = 40%, period= 80%). Lower Back were adjoining atop as the manual dealing with waste involves these two dominantly. Other tangential joints such as elbow, hip, and ankle were in minute amplitude. The certain response percentages have been discussed out in following Bar chart 4.3(B). (Details of computed frequencies have been provided in ANNEXURE-4(B))



Bar Chart 4.3(B): Prevalence of musculoskeletal disorders among Waste Collectors

4.3.5 Hematology Study of MSW workers in Mandi City.

Further, Blood tests of the workers have been organized to find out the internal suffering of workers in the job tenure. Sample of 5 workers have been taken. Hemoglobin Cyanmeth of three out five have been found below the permissible limits i.e (14-16) gm%. All the Differential Leucocytes Count like (Neutrophils, Lymphocytes, Monocytes, Eosinophil, and Basophile) was found under the permissible limits. Only one worker has been reported with the lesser red blood cell count. Platelet count of 3 out of 5 workers was falling below the permissible limits i.e. (150000-450000) cu/Cumm. Taking sample into account, 60% of workers reported lesser hemoglobin and platelet count. (Details of computed frequencies have been provided in ANNEXURE-4(C))

CHAPTER 5

CONCLUSIONS & RECCOMENDATIONS

1) This study is carried out for MSW workers in three non-engineered disposal sites located within the vicinity of three important towns of Solan, Shimla and Mandi in Himachal Pradesh. The questionnaire survey exposed that greater number of the workers in the study locations was male and belonged in age groups of 30 to 40 years and greater than 40 years. Most of the labor forces are illiterate with only a certain proportion being educated till primary levels.
2) Workers are primarily categorized in two types of regular and contractual workers with regular workers were having more working experience and better wages and benefits than casual workers who were limited up to 10years of work experience. Regular workers were also observed receive a daily wage of six times more than the casual workers.
3) Regular workers were provided with medical allowance, casual worker who were under contract or with private contractor is not beneficiary of medical allowance. Only waste collectors in SEHB society in Shimla were found to be provided with Health-Card facility.
4) It was observed from the questionnaire survey that besides 90% peasants of all classification of waste operatives endured different types of musculoskeletal abuses like cuts & lacerations, and muscle & ligament sprain. Majority of workers also proclaimed that they undergoes from puking and body miseries.
5) The study commenced that issues related to occupational health are allied with uncontrolled recycling of waste. The truancy of protective equipments makes waste workers susceptible to injuries. Protective equipment to a certain extent is provided in Shimla but that is only twice in a year or during special visits or occasions. A casual approach of these workers is also one of the reasons behind low standards of protective gears. This study also urges government and private organization to provide protective equipment to MSW workers and should also provide regular

medical checkup of all workers particularly those working as contractual laborers.

5.1 Suggested solutions for the better management of the MSW workers in the investigated locations.

1. Along with the appointment of the sanitary inspectors and sanitary supervisors, Safety engineer's appointment can also help in improving the work culture of MSW workers. It will ensure that every activity is done under the all safety measures.

2. Within the region of these three cities we have esteemed medical colleges like IGMC in Shimla, ESIC in Mandi etc. we can motivate them to study the health hazards of workers involved in municipal solid waste management. Can even promote their studies for the better management of municipal solid waste workers.

3. Safety and Health teaching practices camps can be arranged on a regular basis for MSW workers which will aware them about the importance of using of protective equipments during work.

4. Regular employees are employed directly, they work for an employer and are directly paid their employer. They get benefits like subsidized health care allowances, numbered vacations for which they get no salary deduction, and also get contributions to a retirement plan in a form of EPF. Whereas Casual employees get salary on daily basis. No health care allowances are provided. And there is no EPF facility. Polices should be made for the betterment of workers as well as workers family.

5. Among the total 1202 Municipal Solid waste workers in these three cities, 813 are casual workers with percentage of 67.64% and 389 are regular workers with percentage of 32.36%. Only Regular workers which are appointed by government are provided with medical allowance, casual worker who is under contract or with Private Contractor is not beneficiary of medical allowance. Only waste collectors in

SEHB society which is a semi government Scheme run under the support of municipal corporation Shimla. Workers work under this scheme are are casual workers but get Health Card facility.The point behind this discussion is the same provision of health card facility can be provided though out the working Casual workers.

REFRENCES

[1] Afon, A. (2012). A survey of operational characteristics, socioeconomic and health effects of scavenging activity in Lagos, Nigeria. *Waste Management & Research, 30(7), 664-671*.

[2] Athanasiou, M., Makrynos, G., Dounias, G. (2010). Respiratory Health of Municipal Solid Waste Workers. *Occupational Medicine, 60, 618-623.*

[3] Bastani, M., Celik, N., Coogan, D. (2016). *Risks for Occupational Health Hazards among Solid Waste Workers. Available online at http://environmentalscience.oxfordre.com/view/10.1093/acrefore/9780199389414.001.0001/acrefore-9780199389414-e-87*

[4] Bogale, D., Kumie, A., Tefera, W. (2014). Assessment of occupational injuries among Addis Ababa city municipal solid waste collectors: a cross-sectional study. *BMC Public Health*, 14, 169. https://doi.org/10.1186/1471-2458-14-169

[5] Census 2011 of India, https://en.wikipedia.org/wiki/2011_Census_of_India.

[6] Chandramohan, A., Ravichandran, C., Sivasankar, V. (2010). Solid waste, its health impairments and role of rag pickers in Tiruchirappalli city, Tamil Nadu, Southern India. *Waste Management & Research, 28, 951–958*.

[7] El-Wahab, E. W. A., Eassa, S. M., Lotfi, S. E., Masry, S. A. E., Shatat, H. Z., & Kotkat, A. M. (2014). Adverse health problems among municipality workers in Alexandria (egypt). *International Journal of Preventive Medicine, 5(5), 545-556*

[8] Ewis, AA., Rahma, AA, Mohamed, ES., Hifnawy, TM., Arafa, AE. (2013). Occupational Health-Related Morbidities among Street Sweepers and Waste Collectors at Beni-Suef, Egypt. *Egyptian journal of occupational medicine, 37(1), 79-94*.

[9] Giusti, L. (2009) A review of waste management practices and their impact on human health. *Waste Management, 29(8), 2227–2239*.

[10] Gupta, S., Mohan, K., Prasad, R., Gupta, S. & Kansal, A. (1998) Solid waste management in India: options and opportunities. *Resources, Conservation and Recycling*, **24**, 115–137.

[11] Jerie, S., (2016) Occupational risks associated with solid waste management in the informal sector of Gweru, Zimbabwe. Journal of Environmental and Public Health, *vol. 2016, Article ID 9024160, 14 pages, 2016. doi:10.1155/2016/9024160*

[12] Khaiwal, R., Kaur, K., Mor, S. (2016) Occupational Exposures to the municipal solid waste workers in Chandigarh, India. *Waste Management & Research, 34(11), 1192-1195.*

[13] Majumdar, D., Ray, S., Chakraborty, S., Rao, P.S., Akolkar, A.B., Chowdhury, M., Srivastava, A. (2014) Emission, speciation, and evaluation of impacts of non-methane volatile organic compounds from open dump site. *Journal of the Air and Waste Management Association, 64(7), 834-845.*

[14] Majumdar, D., Srivastava, A., (2012) Volatile organic compound emissions from municipal solid waste disposal sites: A case study of mumbai, india. Journal of the Air and Waste Management Association, 62(4), 398-407.

[15] Pattnik, S., Reddy, M.V., 2010. Assessment of municipal solid waste management Puducherry (Pondicherry), India. Resource, Conservation and Recycling. 54 (8), 512-520.

[16] Ray, M.R., Mukherjee, G., Roychowdhury, S. & Lahiri, T. (2004) Respiratory and general health impairments of rag pickers in India: a study in Delhi. *International Archives of Occupational and Environmental Health*, **77**, 595–598.

[17] Patil, P.V., Kamble, R.K. (2017). Occupational health hazards in street sweepers of Chandrapur city, central India. *International Journal of Environment, 6(2), 9-18*

[18] Poulsen OM, Breum NO, Ebbehoj N, et al. (1995) Sorting and recycling of domestic waste. Review of occupational health problems and their possible causes. *Science of Total Environment, 168, 33–56.*

[19] Rana, R., Ganguly, R., Gupta, A.K. (2017). Parametric Analysis of solid waste management in satellite towns of Mohali and Panchkula-India. *Journal of Solid Waste Technology and Management, 43(4), 280-294.*

[20] Reddy, EM., Yasobant, S. (2015). Musculoskeletal disorders among municipal solid waste workers in India: A cross-sectional risk assessment. *Journal of Family Medicine and Primary Care, 4, 519-24.*

[21] Ross, DE. (2011). Safeguarding public health, the core reason for solid waste management. *Waste Management & Research, 29(8), 779-780.*

[22] Scanlon, K. A., Lloyd, S.M., Gray, G.M., Francis, R.A., LaPuma, P. (2015) An approach to integrating occupational safety and health into life cycle assessment: Development and application of work environment characterization factors. *Journal of Industrial Ecology, 19(1), 27-37.*

[23] Sharif, K.I.B.M. (2014), The analysis safety and health risks of workers in the municipal solid waste landfill in Malaysia. Proceedings of The 4th International Conference on Technology and Operations Management (ICTOM 04), Pg 47 -53. Available online at http://repo.uum.edu.my/15934/1/P5.pdf

[24] Sharma, A., Ganguly, R., Gupta, A.K., (2018). Matrix method for evaluation of existing solid waste management system in Himachal Pradesh, India. *Journal of Material Cycles and Waste Management, Available online at https://link.springer.com/article/10.1007/s10163-018-0703-z*

[25] Yasobant, S., Rajkumar, P. (2014). Work related musculoskeletal disorders among health care professionals: A cross-sectional assessment of risk factors in a tertiary hospital, India. *Indian Journal of Occupational Environmental Medicine, 18, 75 -81*

ANNEXURE – 1 (A)

1.1 Questionnaire for occupational health hazards of the workers.

S.no	Worker Name-	SS	WC	RP	WP	
1	SEX	MALE		FEMALE		
2	AGE GROUP	UNDER 20		20-40yrs		ABOVE 40yrs
3	Duration of employment	< 1yr		1-5yrs		> 5yrs
4	Shift of Work	DAY		NIGHT		
5	Level Of Education	NIL		PRIMARY		SECONDARY
6	Respiratory Problem	YES		NO		
7	Injuries and Allergies	Cuts & Lacerations		Muscle & Ligament Sprain		Bruises, Abrasion Burns
8	My Employer Supplies PPE	YES		NO		
9	I use hearing protection if needed	YES		NO		
10	I use Communication Device-Radio or Phone In Case OF Emergency	YES		NO		
11	My Employer gives me training regarding PPE	YES		NO		
12	I use the Long Pants, Sleeves or Coverall	YES		NO		
13	I use the Heavy Leather work Gloves	YES		NO		
14	I use safety boots During Work	YES		NO		
15	I use Eye Protection & Splash sheilds during work	YES		NO		
16	I use the safety West during work					

ANNEXURE – 1 (B)

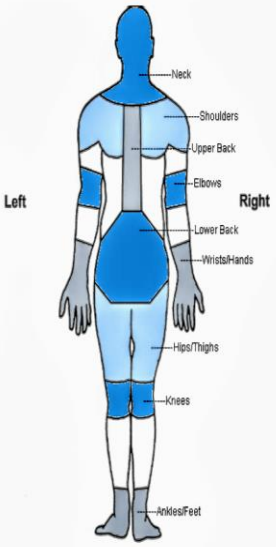
1.2 NORDIC Musculoskeletal Questionnaire for interviewing MSD'S among MSW workers.

Musculoskeletal Discomfort Form (Based on the Nordic Questionnaire (Kourinka et al. 1987)) **Employee ID:**_____

Job/Position: _____ Gender: M F Age: _____ Height: ___ ft.___ in. Weight: _____
How long have you been doing this job? ___years ___ months How many hours do you work each week? _____

How to answer the questionnaire:

***Picture*:** In this picture you can see the approximate position of the parts of the body referred to in the table. Limits are not sharply defined, and certain parts overlap. You should decide for yourself in which part you have or have had your trouble (if any).



Back View

***Table*:** Please answer by putting an "X" in the appropriate box - one "X" for each question. You may be in doubt as to how to answer, but please do your best anyway. Note that column 1 of the questionnaire is to be answered even if you have never had trouble in any part of your body; columns 2 and 3 are to be answered if you answered yes in column 1.

To be answered by everyone	**To be answered by those who have had trouble**	
Have you at any time during **the last 12 months** had trouble (ache, pain, discomfort, numbness) in:	Have you at any time during the **last 12 months been prevented from doing your normal work** (at home or away from home) because of the trouble?	Have you had trouble at any time during **the last 7 days?**
Neck ☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes
Shoulders ☐ No ☐ Yes, right shoulder ☐ Yes, left shoulder ☐ Yes, both shoulders	☐ No ☐ Yes	☐ No ☐ Yes
Elbows ☐ No ☐ Yes, right elbow ☐ Yes, left elbow ☐ Yes, both elbows	☐ No ☐ Yes	☐ No ☐ Yes
Wrists/Hands ☐ No ☐ Yes, right wrist/hand ☐ Yes, left wrist/hand ☐ Yes, both wrists/hands	☐ No ☐ Yes	☐ No ☐ Yes
Upper Back ☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes
Lower Back (small of back) ☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes
One or Both Hips/Thighs ☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes
One or Both Knees ☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes
One or Both Ankles/Feet ☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes

ANNEXURE- 2 (A)

2.1 Details of computed frequencies for street sweepers and waste collectors in Solan city.

	Total SS= 78			Total WC= 77	
	STREET SWEEPERS			WASTE COLLECTORS	
	Frequency	percentage		Frequency	percentage
Worker job Status					
Regular	78	100		0	0
Casual	0	0		77	100
SEX					
Male	53	67.95		44	57.14
Female	25	32.05		5	6.49
AGE GROUP					
under 20	0	0.00		10	12.99
20-40yrs	32	41.03		35	45.45
above 40yrs	30	38.46		4	5.19
shift of work					
day	78	100.00		49	63.64
night	0	0.00		0	0.00
level of education					
nil	46	58.97		25	32.47
primary	14	17.95		19	24.68
secondary	2	2.56		5	6.49
Awarness regarding OHR					
yes	59	75.64		47	61.04
No	3	3.85		2	2.60
Respiratory					
yes	12	15.38		10	12.99
no	50	64.10		39	50.65
injuries and allergies					
cuts & Laceration	53	67.95		34	44.16

muscle & Ligament sprain	46	58.97		25	32.47
Bruises, Abrasion Burns	2	2.56		6	7.79
none	9	11.54		15	19.48
Work Experience					
0-10yrs	0	0.00		28	36.36
10-20yrs	14	17.95		21	27.27
>20yrs	48	61.54		0	0.00
Salary Status					
5000-10000 (CASUAL WORKERS)	0	0.00		49	63.64
10000-20000 (REGULAR WORKERS)	14	17.95		0	0.00
20000-30000 (REGULAR WORKERS)	32	41.03		0	0.00
30000-40000 (REGULAR WORKERS)	16	20.51		0	0.00
my employer supplies ppe					
yes	0	0.00		0	0.00
no	62	79.49		49	63.64
I use hearing protection					
yes	0	0.00		0	0.00
no	62	79.49		49	63.64
use of communcation device					
yes	62	79.49		49	63.64
no	0	0.00		0	0.00
employer gives training regarding ppe					
yes	0	0.00		0	0.00
no	62	79.49		49	63.64
use long pants,sleeves or coverall					
yes	62	79.49		49	63.64
no	0	0.00		0	0.00
use of heavy leather work gloves					
yes	0	0.00		0	0.00
no	62	79.49		49	63.64
use of safety boots					

yes	2	2.56		0	0.00
no	60	76.92		49	63.64
eye protection & splash Sheilds					
yes	0	0.00		0	0.00
no	62	79.49		49	63.64
safety west during work					
yes	0	0.00		0	0.00
no	62	79.49		49	63.64

2.1 Details of computed frequencies for rag pickers and waste processors in Solan city.

	Total RP= 10			Total WP= 6	
	RAG PICKERS			WASTE PROCESSORS	
	Frequency	percentage		Frequency	percentage
Worker job Status					
Regular	0	0		0	0
Casual	10	100		6	100
SEX					
Male	4	40		3	50
Female	0	0		3	50
AGE GROUP					
under 20	0	0		0	0
20-40yrs	2	20		5	83.33
above 40yrs	2	20		1	16.67
shift of work					
day	10	100		6	100
night	0	0		0	0
level of education					
nil	3	30		2	33.33
primary	1	10		4	66.67
secondary	0	0		0	0
Awarness regarding OHR					
yes	6	60		6	100
No	0	0		0	0.00
Respiratory					
yes	2	20		1	16.67
no	4	40		5	83.33
injuries and allergies					
cuts & Laceration	3	30		3	50
muscle & Ligament sprain	3	30		4	66.67
Bruises, Abrasion Burns	0	0		0	0

none	3	30		2	33.33
Work Experience					
0-10yrs	4	40		6	100.00
10-20yrs	0	0		0	0.00
>20yrs	0	0		0	0.00
Salary Status					
5000-10000 (CASUAL WORKERS)	4	40		6	100.00
10000-20000 (REGULAR WORKERS)	0	0		0	0.00
20000-30000 (REGULAR WORKERS)	0	0		0	0.00
30000-40000 (REGULAR WORKERS)	0	0		0	0.00
my employer supplies ppe					
yes	1	10		6	100
no	1	10		0	0
I use hearing protection					
yes	0	0		0	0
no	2	20		6	100
use of communcation device					
yes	0	0		6	100
no	2	20		0	0
employer gives training regarding ppe					
yes	0	0		6	100
no	2	20		0	0
use long pants,sleeves or coverall					
yes	2	20		6	100
no	0	0		0	0
use of heavy leather work gloves					
yes	1	10		6	100
no	1	10		0	0
use of safety boots					
yes	0	0		6	100
no	2	20		0	0

eye protection & splash Sheilds					
yes	0	0		0	0
no	2	20		6	100
safety west during work					
yes	0	0		6	100
no	2	20		0	0

ANNEXURE – 2 (B)

2.1 Musculoskeletal disorders among MSW workers in Solan City.

	MSDs among MSW workers in Solan						
Variables	**Category**	**Total(n)**	**Street sweepers(%)**		**Total(n)**		**Waste Collectors(%)**
Age	**<25yrs**	0	0.00		2		2.60
	25-35yrs	0	0.00		0		0.00
	35-45yrs	0	0.00		3		3.90
	>45yrs	4	5.13		0		0.00
Sex	**Male**	4	5.13		5		6.49
	Female	0	0.00		0		0.00
Education	**nil**	4	5.13		3		3.90
	Primary	0	0.00		2		2.60
	Secondary	0	0.00		0		0.00
Smoking	**No**	0	0.00		2		2.60
	Yes	4	5.13		3		3.90
Alcoholism	**No**	1	1.28		1		1.30
	Yes	3	3.85		4		5.19
BMI	**normal**	2	2.56		3		3.90
	Under weight	1	1.28		1		1.30
	Over weight	1	1.28		1		1.30
Working period	**0-10yrs**	0	0.00		2		2.60
	10-20yrs	0	0.00		3		3.90
	20-30yrs	4	5.13		0		0.00
MSD	**No MSDs**	0	0.00		5		6.49
	MSDs	4	5.13		0		0.00

2.2 (A) MSD's among Street Sweepers in Solan City.

		Prevalence (%) of MSDs Pain						
		STREET SWEEPERS						
Body Part	**Response**	**Total(n)**		**Response(%) in last 12 months**		**Total(n)**		**Response(%) in last 7 days**
Neck	**yes**	1		25		1		25
	no	3		75		3		75
Shoulders	**yes**	1		25		1		25
	no	3		75		3		75
Elbows	**yes**	2		50		0		0
	no	2		50		4		100
Wrists/Hands	**yes**	2		50		0		0
	no	2		50		4		100
Upper Back	**yes**	0		0		0		0
	no	4		100		4		100
Lower Back	**yes**	3		75		2		50
	no	1		25		2		50
Hips/ Thighs	**yes**	0		0		0		0
	no	4		100		4		100
knees	**yes**	2		50		1		25
	no	2		50		3		75
ankles/feet	**yes**	3		75		0		0
	no	1		25		4		100

2.2 (B) MSD's among waste collectors in Solan city.

	Prevalence (%) of MSDs Pain			
	WASTE COLLECTORS			
Body Part	**Response**	**Total(n)**	**Response(%) in last 12 months**	**Total(n)**	**Response(%) in last 7 days**
Neck	**yes**	1	20	1	20
	no	4	80	4	80
Shoulders	**yes**	2	40	1	20
	no	3	60	4	80
Elbows	**yes**	3	60	1	20
	no	2	40	4	80
Wrists/Hands	**yes**	2	40	1	20
	no	3	60	4	80
Upper Back	**yes**	0	0	0	0
	no	5	100	5	100
Lower Back	**yes**	1	20	0	0
	no	4	80	5	100
Hips/ Thighs	**yes**	0	0	0	0
	no	5	100	5	100
knees	**yes**	3	60	1	20
	no	2	40	4	80
ankles/feet	**yes**	1	20	0	0
	no	4	80	5	100

ANNEXURE- 3

3.1 Details of computed frequencies for street sweepers and waste collectors in Shimla city.

	WORKERS DONE			WORKERS DONE	
	REGULAR	CASUAL		CASUAL	
	74	47		40	
	Total SS= 433			**Total WC= 456**	
	STREET SWEEPERS			**WASTE COLLECTORS**	
	Frequency	**percentage**		**Frequency**	**percentage**
Workers job Satatus					
Regular	**275**	**63.51**		**0**	**0.00**
Casual	**147**	**33.95**		**456**	**100.00**
SEX					
Male	276	**63.74**		351	**76.97**
Female	146	**33.72**		105	**23.03**
AGE GROUP					
under 20	3	**0.69**		0	**0.00**
20-40yrs	60	**13.86**		33	**7.24**
above 40yrs	58	**13.39**		7	**1.54**
shift of work					
day	422	**97.46**		456	**100.00**
night	0	**0.00**		0	**0.00**
level of education					
nil	45	**10.39**		11	**2.41**
primary	36	**8.31**		19	**4.17**
secondary	40	**9.24**		10	**2.19**
Medical Allowance				Health Card	
yes	275	**63.51**		456	**100.00**
no	147	**33.95**		0	**0.00**

Work Experience					
0-10yrs	47	**10.85**		40	**8.77**
10-20yrs	34	**7.85**		0	**0.00**
>20yrs	40	**9.24**		0	**0.00**
Salary Status					
5000-10000 (CASUAL WORKERS)	147	**33.95**		456	**100.00**
10000-20000 (REGULAR WORKERS)	19	**4.39**		0	**0.00**
20000-30000 (REGULAR WORKERS)	28	**6.47**		0	**0.00**
30000-40000 (REGULAR WORKERS)	27	**6.24**		0	**0.00**
Awarness regarding OHR					
yes	116	**26.79**		38	**8.33**
no	5	**1.15**		2	**0.44**
Respiratory Problem					
yes	12	**2.77**		10	**2.19**
no	111	**25.64**		30	**6.58**
injuries and allergies					
cuts & Laceration	96	**22.17**		29	**6.36**
muscle & Ligament sprain	44	**10.16**		9	**1.97**
Bruises, Abrasion Burns	9	**2.08**		1	**0.22**
none	25	**5.77**		28	**6.14**
my employer supplies ppe					
yes	121	**27.94**		27	**5.92**
no	0	**0.00**		13	**2.85**
I use hearing protection					
yes	0	**0.00**		0	**0.00**
no	121	**27.94**		40	**8.77**
use of communcation device					
yes	121	**27.94**		40	**8.77**
no	0	**0.00**		0	**0.00**
employer gives training regarding ppe					
yes	121	**27.94**		27	**5.92**
no	0	**0.00**		13	**2.85**

use long pants,sleeves or coverall					
yes	121	**27.94**		40	**8.77**
no	0	**0.00**		0	**0.00**
use of heavy leather work gloves					
yes	121	**27.94**		27	**5.92**
no	0	**0.00**		13	**2.85**
use of safety boots					
yes	121	**27.94**		27	**5.92**
no	0	**0.00**		13	**2.85**
eye protection & splash Sheilds					
yes	0	**0.00**		0	**0.00**
no	121	**27.94**		40	**8.77**
safety west during work					
yes	121	**27.94**		27	**5.92**
no	0	**0.00**		13	**2.85**

3.2 Details of computed frequencies for waste processors in Shimla city.

	Total WP= 20	
	WASTE PROCESSORS	
	Frequency	percentage
Workers job Satatus		
Regular	**0**	**0**
Casual	**20**	**100**
SEX		
Male	10	**50**
Female	0	**0**
AGE GROUP		
under 20	7	**35**
20-40yrs	3	**15**
above 40yrs	0	**0**
shift of work		
day	10	**50**
night	0	**0**
level of education		
nil	6	**30**
primary	3	**15**
secondary	1	**5**
Medical Allowance		
yes	0	**0**
no	10	**50**
Work Experience		
0-10yrs	10	**50**
10-20yrs	0	**0**
>20yrs	0	**0**
Salary Status		
5000-10000 (CASUAL WORKERS)	10	**50**
10000-20000 (REGULAR WORKERS)	0	**0**
20000-30000 (REGULAR WORKERS)	0	**0**
30000-40000 (REGULAR WORKERS)	0	**0**

Awarness regarding OHR		
yes	10	**50**
no	0	**0**
Respiratory Problem		
yes	0	**0**
no	10	**50**
injuries and allergies		
cuts & Laceration	2	**10**
muscle & Ligament sprain	0	**0**
Bruises, Abrasion Burns	0	**0**
none	8	**40**
my employer supplies ppe		
yes	10	**50**
no	0	**0**
I use hearing protection		
yes	0	**0**
no	10	**50**
use of communcation device		
yes	10	**50**
no	0	**0**
employer gives training regarding ppe		
yes	10	**50**
no	0	**0**
use long pants,sleeves or coverall		
yes	10	**50**
no	0	**0**
use of heavy leather work gloves		
yes	10	**50**
no	0	**0**
use of safety boots		

yes	10	**50**
no	0	**0**
eye protection & splash Sheilds		
yes	10	**50**
no	0	**0**
safety west during work		
yes	10	**50**
no	0	**0**

ANNEXURE- 4 (A)

4.1 Details of computed frequencies for street sweepers and waste collectors in Mandi city.

	Total SS= 30			Total WC= 87	
	interviewed	13		interviewed	50
	STREET SWEEPERS			WASTE COLLECTORS	
	Frequency	percentage		Frequency	percentage
Workers job Satatus					
Regular	30	100.00		0	0.00
Casual	0	0.00		87	100.00
SEX					
Male	24	80.00		23	26.44
Female	6	20.00		27	31.03
AGE GROUP					
under 20	0	0.00		2	2.30
20-40yrs	0	0.00		35	40.23
above 40yrs	13	43.33		13	14.94
shift of work					
day	30	100.00		87	100.00
night	0	0.00		0	0.00
level of education					
nil	9	30.00		23	26.44
primary	3	10.00		25	28.74
secondary	1	3.33		2	2.30
Medical Allowance					
yes	30	100.00		0	0.00
no	0	0.00		87	100.00
Work Experience					
0-10yrs	0	0.00		35	40.23
10-20yrs	0	0.00		15	17.24
>20yrs	13	43.33		0	0.00
Salary Status					

5000-10000 (CASUAL WORKERS)	0	0.00		50	57.47
10000-20000 (REGULAR WORKERS)	1	3.33		0	0.00
20000-30000 (REGULAR WORKERS)	7	23.33		0	0.00
30000-40000 (REGULAR WORKERS)	5	16.67		0	0.00
Awarness regarding OHR					
yes	13	43.33		48	55.17
no	0	0.00		2	2.30
Respiratory problems					
yes	5	16.67		12	13.79
no	8	26.67		38	43.68
injuries and allergies					
cuts & Laceration	10	33.33		36	41.38
muscle & Ligament sprain	5	16.67		14	16.09
Bruises, Abrasion Burns	4	13.33		9	10.34
none	3	10.00		14	16.09
my employer supplies ppe					
yes	11	36.67		0	0.00
no	2	6.67		50	57.47
I use hearing protection					
yes	0	0.00		0	0.00
no	13	43.33		50	57.47
use of communcation device					
yes	13	43.33		50	57.47
no	0	0.00		0	0.00
employer gives training regarding ppe					
yes	11	36.67		0	0.00
no	2	6.67		50	57.47

use long pants,sleeves or coverall					
yes	13	43.33		50	57.47
no	0	0.00		0	0.00
use of heavy leather work gloves					
yes	11	36.67		0	0.00
no	2	6.67		50	57.47
use of safety boots					
yes	11	36.67		0	0.00
no	2	6.67		50	57.47
eye protection & splash Sheilds					
yes	0	0.00		0	0.00
no	13	43.33		50	57.47
safety west during work					
yes	11	36.67		0	0.00
no	2	6.67		50	57.47

4.2 Details of computed frequencies for rag pickers and drivers in Mandi city.

	Total RP= 6			Total Driver= 21	
	interviewed	**6**		**interviewed**	12
	RAG PICKERS			Driver	
	Frequency	**percentage**		**Frequency**	**Percentage**
Workers job Satatus					
Regular	0	0		6	28.57
Casual	6	100		15	71.43
SEX					
Male	6	100		21	100.00
Female	0	0		0	0.00
AGE GROUP					
under 20	4	66.67		0	0.00
20-40yrs	2	33.33		10	47.62
above 40yrs	0	0		2	9.52
shift of work					
day	6	100		21	100.00
night	0	0		0	0.00
level of education					
nil	6	100		4	19.05
primary	0	0		6	28.57
secondary	0	0		2	9.52
Medical Allowance					
yes	0	0		0	0.00
no	6	100		12	57.14
Work Experience					
0-10yrs	6	100		6	28.57
10-20yrs	0	0		6	28.57
>20yrs	0	0		0	0.00
Salary Status					
5000-10000 (CASUAL WORKERS)	6	100		6	28.57
10000-20000 (REGULAR WORKERS)	0	0		2	9.52

20000-30000 (REGULAR WORKERS)	0	0		4	19.05
30000-40000 (REGULAR WORKERS)	0	0		0	0.00
Awarness regarding OHR					
yes	6	100		12	57.14
no	0	0		0	0.00
Respiratory problems					
yes	0	0		2	9.52
no	6	100		10	47.62
injuries and allergies					
cuts & Laceration	6	100		3	14.29
muscle & Ligament sprain	0	0		2	9.52
Bruises, Abrasion Burns	0	0		0	0.00
none	0	0		9	42.86
my employer supplies ppe					
yes	0	0		0	0.00
no	6	100		12	57.14
I use hearing protection					
yes	0	0		0	0.00
no	6	100		12	57.14
use of communcation device					
yes	0	0		12	57.14
no	6	100		0	0.00
employer gives training regarding ppe					
yes	0	0		0	0.00
no	6	100		12	57.14
use long pants,sleeves or coverall					
yes	6	100		12	57.14
no	0	0		0	0.00
use of heavy leather work gloves					
yes	0	0		0	0.00
no	6	100		12	57.14

use of safety boots					
yes	0	0		0	0.00
no	6	100		12	57.14
eye protection & splash Sheilds					
yes	0	0		0	0.00
no	6	100		12	57.14
safety west during work					
yes	0	0		0	0.00
no	6	100		12	57.14

ANNEXURE – 4 (B)

4.1 Musculoskeletal disorders among MSW workers in Mandi City.

MSDs among MSW workers in Mandi				
Variables	**Category**	**Total(n)**		**Waste Collectors(%)**
Age	**<25yrs**	0		0.00
	25-35yrs	0		0.00
	35-45yrs	4		4.60
	>45yrs	1		1.15
Sex	**Male**	5		5.75
	Female	0		0.00
Education	**nil**	3		3.45
	Primary	2		2.30
	Secondary	0		0.00
Smoking	**No**	3		3.45
	Yes	2		2.30
Alcoholism	**No**	2		2.30
	Yes	3		3.45
				0.00
BMI	**normal**	4		4.60
	Under weight	1		1.15
	Over weight	0		0.00
Working period	**0-10yrs**	2		2.30
	10-20yrs	3		3.45
	20-30yrs	0		0.00
MSD	**No MSDs**	5		5.75
	MSDs	0		0.00

4.2 MSD's prevalence among MSW workers in Mandi City

Prevalence (%) of MSDs Pain								
Waste Collectors								
Body Part	**Response**	**Total(n)**		**Response(%) in last 12 months**		**Total(n)**		**Response(%) in last 7 days**
Neck	**yes**	1		20		2		40
	no	4		80		3		60
Shoulders	**yes**	4		80		2		40
	no	1		20		3		60
Elbows	**yes**	2		40		0		0
	no	3		60		5		100
Wrists/Hands	**yes**	4		80		2		40
	no	1		20		3		60
Upper Back	**yes**	0		0		1		20
	no	5		100		4		80
Lower Back	**yes**	4		80		1		20
	no	1		20		4		80
Hips/ Thighs	**yes**	0		0		0		0
	no	5		100		5		100
knees	**yes**	4		80		3		60
	no	1		20		2		40
ankles/feet	**yes**	1		20		2		40
	no	4		80		3		60

ANNEXURE – 4 (C)

4.1 Blood test report of MSW workers in Mandi City.

	Blood Test Report of MSW workers of Mandi					
S.No		**Worker 1**	**Worker 2**	**Worker 3**	**Worker 4**	**Worker 5**
1	**Age**	**40yrs**	**35yrs**	**37yrs**	**45yrs**	**49yrs**
2	**Hemoglobin Cyanmeth**					
a)	**Female (12-14) gm%**	NA	NA	NA	NA	NA
b)	**Male (14-16) gm%**	12.6	13.2	14.8	12.4	14.8
3	**Total Leucocyte Count (4000-11000) Cum**	6200	4000	5100	5600	5100
4	**Differential Leucocyte Count**					
a)	**Neutrophils (40-75) %**	59	62	60	58	58
b)	**Lymphocytes(20-4) %**	36	33	35	35	36
c)	**Monocytes (2-10) %**	3	3	3	4	4
d)	**Eosinophil (1-5) %**	2	2	2	3	2
e)	**Basophil (0-10) %**	nil	nil	nil	nil	mil
5	**E.S.R (Westergren) (0-20) mm% 1 hrs**	10	0.5	0.5	16	16
6	**Packed cell volume (3.5-5.4) %**	3.8	4.6	4.2	3.9	5.2
7	**Red Blood Cell Count (3.5-6.5) Cell/Cumm**	3.4	4.2	4.8	3.8	4.8
8	**Platelet Count (1,50000-4,50000) cu/Cumm**	125,000	310,000	124,800	136,000	310,000