Assessment of Musculoskeletal Disorder Among Garage Workers

Thesis

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By

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Pantnagar
December, 2020

(Alka Chandrakanta)
Authoress

CERTIFICATE

This is to certify that the thesis entitled **"Assessment of Musculoskeletal Disorder Among Garage Workers"** submitted in partial fulfillment of the requirements for the degree of **Master of Science in Home Science** with major in **Family Resource Management**, of the College of Post-Graduate Studies, G. B. Pant University of Agriculture and Technology Pantnagar, is a record of *bona fide* research carried out by **Ms. Alka Chandrakanta, Id. No. 46172** under my supervision and no part of the thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation have been acknowledged.

Pantnagar
December, 2020

(Deepa Vinay)
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CERTIFICATE

We, the undersigned, members of the Advisory Committee of **Ms. Alka Chandrakanta, Id. No. 46172,** a candidate for the degree of **Master of Science in Home Science** with major in **Family Resource Management**, agree that the thesis entitled **"Assessment of Musculoskeletal Disorder Among Garage Workers"** may be submitted in partial fulfillment of the requirements for the degree.

(Deepa Vinay)
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CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

Introduction

INTRODUCTION

The Indian auto industry is the 4th largest in the world. This sector contributes 7.1 % of GDP in the country. The global market for repair and maintenance services for the automobile is forecast at USD 810.3 billion by 2026. The factors expected to fuel demand for automotive repair and maintenance service over the forecast period are the growing number of vehicles, the increasing disposable income of people, the need for enhanced passenger safety in vehicles, and the increasing average age of the vehicle.

Any job or work that involves heavy labor or manual material handling may be in a high-risk category. Manual handling operations include lifting, carrying, pushing, pulling, and holding objects. Although it has been established that manual handling is any operation involving the use of a person's power to raise, push, lower, carry, drag, shift, maintain or restrain an individual, animal, or item. There is also a risk for injuries such as strains, sprains, breaks, cuts and bruise, lower back pain due to uncomfortable postures, muscle tiredness, and musculoskeletal issues involving the back, spine, head, elbows, and hands while carrying and lifting objects performed manually **(Genaidy *et al*., 2003).**

The car repairing garage or automobile car care center is among one of them which is prone to injuries. An automobile car care center is the place where cars (diesel or petrol) are repaired by auto mechanics and technicians. Automobile car care centers are also known as garages, automobile workshops, automobile service centers, etc. In India, the car servicing business is growing faster to meet the increasing demand from this large car population in the country **(Singh, L, and Singh, G. 2018).** The car servicing market is classified into three categories: 1.Authorized car dealership network catering to a particular brand of cars, 2. Organized multi-brand workshops that deal with multiple brands, 3.Unorganized brands (local garages). Garage workers repair car damaged body, cleaning, washing, and painting. The hydraulic lift is very rare in the unauthorized car care center so they use a hydraulic jack to lift the cars on the other hand authorized car care center uses hydraulic or mechanical lifts.

The workers of the car care center usually involve heavy manual material handling jobs. Their work may involve the replacement of one or more parts as

assemblies or the repair of a specific part. An awkward posture like repeated or prolonged reaching, working overhead, squatting, bending, kneeling, and holding fixed positions or pinch grips causes MSDs. They face many physical problems like injuries, low back pain, neck stiffness, shoulder pain, arm pain, leg pain, knee pain, elbow pain, etc **(Singh L. and Singh G.., 2018)**. Garage workers mostly work in standing posture on a floor made of cement or similar hard materials. A study of garage workers working postures found that many car repairs were done under the bonnet and underneath the car **(Kant *et al,* 1990).** This work requires that mechanics have to work for prolonged periods with their spine flexed forward and/or with their arms flexed at or above shoulder level. Many research studies found that psychological and environmental factors such as lack of social support, and high workload and pacing contribute to the development of musculoskeletal symptoms (MSS).

Musculoskeletal disorders (MSDs) is one of the main cause of disability and work-related injuries in developed and industrial developing countries. Occupational ergonomic risk factors to consider are high task repetition, forceful exertions, and repetitive or sustained awkward postures, while individual risk factors are poor work practices, poor fitness, poor health habits **(Middlesworth, 2016).** MSDs are the single largest category of workplace injuries and are responsible for almost 30% of all worker's compensation costs according to the Bureau of Labor Statistics**.** The poor health and safety conditions are still a challenge for all the working sites in India. Based on the Labor and Employment Department's work accident/illness report for 2009, ergonomic hazards that result in MSD were most prevalent. MSD reports involved low back pain, upper back pain, leg cramps, carpal tunnel syndrome, bursitis, and tendentiousness. In many studies, it is reported that there is a link associated with the working environment and musculoskeletal symptoms (MSS).

Workplace safety vulnerability poses a huge danger to a large percentage of the world's population. Approximately 75 percent of the world's labor force lives in developing countries but only 5-10 percent had access to occupational health services. A workplace health program is a multidisciplinary operation aimed at maintaining and improving workers' welfare through the prevention and management of workplace causes and circumstances that are detrimental to health and safety at work. The work

environment is adversely impacting the exposed human species.The garage owner may first make attempts to eliminate or mitigate unfavorable working environments. A worker's gear is worn to limit exposure to specific workplace hazards. The use of PPE is just one factor of a wide variety of techniques for ensuring a clean and stable working climate. It does not reduce the dangers of the household itself, nor does it offer lasting or absolute security. Personal protective equipment (PPEs) is intended to shield workers against severe injury or diseases arising from adverse occupational interaction with environmental, radiological, electrical, mechanical, or other dangers at work. PPE is an object used to shield the hair, ears, hands, chest, arms, and feet while utilizing sunglasses, caps, headgear, gloves, overall clothing, coats, waterproof shield, respirators, and earplugs. The danger can not be minimized by the PPE, but the possibility of injuries can be. A wearing system, for example, decreases the risk of hearing loss if the earplugs or muffs are safe for noise penetration or correctly used. Adequate body security is important to ensure the health of human life at work because the design of manufacturing differs from industry and depends not only on the method of the process but also on the form of danger associated with it.

In India, unauthorized garages are high in number. Due to a lack of supervision, regulation, and application of standards by the government, there is a high risk of occupational accidents and hazards. Most of the garage workers are illiterate or less educated and they work without using any safety measures.

In many studies, work environment and psychosocial factors such as high workload and pace and lack of social support have also been identified as possible risk factors for the development of musculoskeletal symptoms.

Justification of the study

The research was intended to study the actual prevailing conditions as well as to assess the MSDs among garage workers. Repetitive activity is popular in the workshop and has been established as a possible contributor to the production of musculoskeletal discomforts (WMSDs). Most of the garage workers are involved in work like welding, servicing, cutting, painting, spraying, grinding, fixing car engines, etc where they get prone to various occupational hazards like vibration, chemical, sharp metal, light, noise, electrical current, and the working environment.

Thus, considering the above scenario, the automobile center or garages is selected as a workplace of the study because it involves several types of manual handling work. Moreover, it is a factor that leads to occupational hazards in the workplace. Therefore, to access the working conditions of the garage workers and the influence of the work environment on the worker's health.

Further, to the best of the investigators' knowledge, the study on garage workers as a result of their occupational exposure has not been investigated in Uttarakhand. The purpose of this work was to gain awareness of the risk factors in the automotive sector as well as to illustrate guidelines for practice. From this analysis, the researcher will be able to establish the prevalence & related physical risk factors of musculoskeletal symptoms among the mechanics of the automobile repairing garages.

Researchable questions:

The following questions have been addressed in the light of the above problems:

- What are the occupational health hazards of the garage worker?
- What are the reasons for various worker-reported MSDs?
- Can the PPE boost working standards in terms of protection, health, and productivity?

Considering the above points in mind**, "Assessment of Musculoskeletal Disorder Among Garage Workers"** is planned with the following objectives:

1. To study the demographic profile and socio-economic status of garage workers.
2. To observe the existing conditions of garage workers in terms of activity profile, duration, an instrument used, and the working environment.
3. To identify the prevalence of ergonomic risk factors among garage workers with an assessment of MSD.
4. To assess the different work postures while mending vehicles and appraise the cause of MSD.
5. To conduct sensitization training for garage workers.

Hypothesis

The hypothesis is formulated in
light of the presumed relationship and based on the objectives of the study:

$H_0$1: There is no significant difference between years of employment and muscle pain.

$H_0$2: There is no significant difference between working hours and muscle pain.

$H_0$3: There is no significant difference between age and muscle pain.

Limitation

The study was limited to the garage workers having more than 5 years of experience.

The study was limited to 3 districts of Uttrakhand i.e Udham Singh Nagar and Nainital and Almora.

Review of Literature

REVIEW OF LITERATURE

Review of literature is an integral aspect of both science and social investigation. It offers systemic multi-actuarial knowledge relevant to the issues deals in past and now in various areas. The literature review would involve research on ideas and hypotheses, as well as observational research composed of earlier experiments applicable to one particular thesis.

According to **Young (1996),** a review of pertinent work and thinking by others help to enlarge, enrich, and clarify one's work and thinking. An exhaustive review of literature has several advantages. It shall help the researcher to:

- Develop a better understanding of the problem to be investigated.
- Delineate a new research area to prevent needless duplication.
- Decide on the tools and techniques to be adopted, including developing some new ones.
- Relates the present study with the previous ones, by finding out the areas of agreement or disagreement.

The functions of review of literature are to:

- Determine the prior work carried out and stating the problem areas
- Developing a basis for a theoretical framework
- Providing a basis for an interpretation of the results.
- Providing avenues for the comparison of results.

The literature review available on the subject under investigation is divided into the following subheadings:

2.1 Demographic characteristics

2.2 Socioeconomic status

2.3 Musculoskeletal disorders

2.4 Different Working Posture

2.5 Workstation design

2.6 Environmental Parameters

2.7 Personal Protective Equipment

2.8 Occupational Hazards

2.1 Demographic characteristics

Ataro *et al.* (2018) carried out a study on "Occupational health risk of working in garages, Harar, eastern Ethiopia". In Harar town, eastern Ethiopia a comparative cross-sectional study was conducted. Demographic and occupational data were collected by a professional data collector using a formal questionnaire. The garage workers were all males. The worker's age was 18–53 years, with 30.4±8.2 mean ± SD. Most of the workers (20 [66.67%]) were found to have worked for about 7 years in their garage. Eleven (36.67%), 19 (63.33%), 13 (43.33%), 22 (73.33%) and 14 (46.67%) workers used to smoke, drink, eat, chew and shower at work, respectively.

Motilewa and O. E (2016) carried a study among 151 auto technicians, majority, 148 (98.0%) were males. The average age of respondents was 30.95±4.8 years. Seventy-seven (44.4%) had primary education, while 72 (47.7%) had already completed secondary school. Auto mechanics outnumbered the other professions, accounting for 61.6 per cent of auto technicians. The commonest daily income earned by about half of them was 1000 – 3000 naira ($5-15).

Apreko *et al.* (2015) carried a study that showed that the majority of the respondents (56%) were of a younger age (26-5 years). About 39 per cent of the respondents had 6-10 working experiences. Much of the respondents (57.5 per cent) had up to basic education, while 8.5 per cent had no formal schooling. About 86 per cent of respondents were professionals at their jobs and from diverse career specializations, most of them being car mechanics.

According to **Bernard(1997),** the level of risk from specific exposures may also be influenced by individual factors. There was evidence that certain specific risk factors affected job-related musculoskeletal dysfunction (i.e., elevated body mass index & carpel tunnel syndrome, or post-back pain history, & current low back pain).

Hales and Bernard (1996) stated that gender was also a modulating factor of these disorders' prevalence. Female sedentary workers who have done routine labor have reported an elevated level of dissatisfaction relative to their male peers. Furthermore,

female employees were more likely to take on dual shifts of work than their male colleagues, which significantly increased their exposure to repetitive computer tasks **(Demure *et al*, 2002).** Whereas the gender differences found by **Nordander *et al.* (1999)** are that females are often employed in more hand-intensive tasks and that anthropometric disparity (body size, strength) may disadvantage the female worker in work systems where these differences have not been taken into account.

2.2 Socio economic status

The research was carried out to examine the relationship between motor vehicle driver injuries and socioeconomic status, it was found that professional status and educational level tend to be significant determinants of the likelihood of driver injuries. Countermeasures for driver injuries should be aimed at people in low-status professions as well as those with very little formal knowledge. (**G Whitlock *et al*.,2003)**

Compared to higher SES people, those with lower SES reported greater occupational satisfaction, less self-reporting stress, and less perceived stress; SES was unrelated to cortisol, a biological marker for stress. SES expected the worker's momentary impressions of the workplace, with higher SES individuals showing more often feeling unable to fulfill job expectations, less work time, and less optimistic work appraisals. (**Damaske *et al.*,2016)**

Mishra and Kaul (2000) have introduced a standardized scale for measuring the socio-economic status of rural families in the village near Bareilly in the UP, which is helpful in the field of applied social research and demographic studies in rural areas. The scale provides convenience in the areas of expansion targeting, human resource development, community resource development programs, and evaluation.

According to **Rytina *et al.* (1992),** a long-standing and well-developed technique exists to quantify one dimension of socioeconomic status using occupational or incumbent characteristics. This has realistic implications as both past and current profession can be accurate, even by proxy, socio-economic status at work can not match alone, and certain common occupations do not match traditional relationships between socio-economic characteristics and career prestige.

2.3 Musculoskeletal disorder

OSHA **(US Department of Labor, Occupational Safety and Health Administration, 2000)** has defined the term work-related musculoskeletal disorder as a

disorder of the muscles, nerves, tendons, ligament joints, cartilage, blood vessels, or spinal disks in the neck, shoulder, elbow, forearm, wrist, hand, abdomen (hernia only), back, knee, ankle, and foot associated with risk factor exposure and it may contain tears and muscle strains, ligament sprains. Inflammation of the joints and tendons, pinched nerve, degeneration of the spinal discs, and chronic problems such as low back pain, tension neck syndrome, carpal tunnel syndrome, rotator cuff syndrome. DeQuervain syndrome, trigger finger. Tarsal tunnel syndrome, sciatica, epicondylitis, tendinitis, Raynaud disease, hand-arm shaking syndrome, carpet coating of the spine, and herniated spinal disc. Similarly, the **National Institute for Occupational Safety and Health (NIOSH, 1997)** defines MSDs as a group of conditions that involve the nerves, tendons, muscles, and supporting structures such as intervertebral discs. They display a wide range of disorders and can vary in severity from minor periodical effects to extreme chronic and painful problems, examples include carpal tunnel syndrome, tension neck syndrome, and low back pain. Some writers regard musculoskeletal disorders as a common term for multiple diseases subdivided into (a) scientifically well-defined disorders ((e.g. tendinitis, vibration-induced white fingers): (b) less clinically well-defined conditions (eg. tendon neck syndrome and (c) non-specific disorders (eg. cumulative trauma disorders or repetitive strain injuries (RSI**) (Griefahn, 1998).**

According to the **World Health Organization (2003),** a work-related disorder is one the result of several factors, and where the work environment and the performance of the work contribute greatly, though in differing degrees, to the origin of the disease. **Buckle and David (2000)** stated that the word musculoskeletal disease applies to health conditions of the locomotive structure, i.e. muscles, tendons, skin, cartilage, vascular system, ligaments, and nerves. Thus, work-related musculoskeletal disorders (MSDS) involve all musculoskeletal disorders exacerbated or worsened by function and the circumstances of their performance (WHO, 2003) or, according to the **Swedish Work Environment Authority (SWEA, 2005),** any current physical or non-physical condition affecting workers in their jobs is known as a work-related disorder. Whereas **Piliglan *et al.* (2000)** recorded that WMSD-associated musculoskeletal injuries involved tendinitis, tenosynovitis. Ganglion cysts, lateral dystonia, fibromyalgia, myositis bursitis, osteoarthritis, and synovitis Vascular and neurovascular disorders such as Raynaud's disease or reflex sympathetic dystrophy (RSD) have also been associated with WMSDs.

Research by **Ghasemkhani *et al*., (2006)** on musculoskeletal symptoms among automobile assembly line workers, showed that the commonest musculoskeletal symptoms were from the feet (50.0%), low back (47.4% and wrist/hand (30.1%), A cross-sectional study of 346 automobile assembly workers and office workers were carried out using a modified version of the Nordic questionnaire.

According to **Menzel Nancy (2007**), work-related musculoskeletal disorders have multifactorial signs and symptoms that involve both physical stressors and psychosocial risk factors like the burden of work, social assistance work, and depression. They also identify and gave intervention to eliminate MSD and to resolve the psychosocial risk factors for recovery delays.

Nasaruddin(2014) conducted a study among auto repair mechanics in Klang Valley, Malaysia. This cross-sectional study included 191 auto repair mechanics from eight outlet centers in Klang Valley, Malaysia. The standard Nordic questionnaire (SNQ) was used and posture analysis was carried out using the Rapid Upper Limb Assessment RULA developed by Lynn McAtamney and E Nigel Corlett. The purpose of this assessment is to analyze the exposure of individual workers to risk factors associated with posture inefficiency likely to result in upper limb disorder. . Work-related factors such as posture, force exertion, and vibration were contributing factors in increasing the risk of MSD for auto repair mechanics, compared to other physical risk factors.

Shing *et al.* (2018) reported that Occupational health and safety systems are still in the developing stage in India. The purpose of the study is to assess the work-related "musculoskeletal disorders (WMSD) among car repair mechanics in the Indo-Pak border region (Gurdaspur) of Punjab, India." This cross-sectional analysis involved 125 car mechanics, who were conveniently picked from several authorized and unauthorized workshops. To assess the risk level of musculoskeletal symptoms the rapid entire body assessment (REBA) technique was used The findings revealed that about 58 per cent of workers had at least one area of the body with musculoskeletal disease. The most frequently recorded MSD symptoms are lower back pain (52 per cent), neck stiffness, and shoulder pain (49 per cent). The socio-demographic and physical risk factor (at 'P' <0.05) is substantially correlated with the occurrence of musculoskeletal symptoms.

Hagberg and Wegman (1997) stated that musculoskeletal trauma or repeated activity can create painful as well as non-painful stimuli that cause androgenic chemicals to be released from sympathetic nerve fibers. These chemicals affect joints, spindles of the muscles, main C- fibers, and the muscles themselves.

Paoli, P. (1997) reported that evidence from the 2nd European Working Conditions Survey established sectors (in all European Member States) where, for at least 25 per cent of the time, 40 per cent or more of the employees were subject to three or more of the following risk factors, i.e. working in uncomfortable positions, carrying heavy loads, brief routine hours, frequency and length of activities and complex workloads.

Krause *et al.* (2005) examined the frequency of back and neck pain as well as its correlation with physical stress, ergonomic difficulties, and intensified demands for jobs. 941 unionized cleaners in hotel rooms conducted a report on safety and working conditions. Logistic regression models caretaking responsibility for hours and psychological job variables established the relationship between work demands and discomfort. The findings showed that the incidence of severe body pain was observed in general by 47 per cent, 59 per cent of the upper back, and 63 per cent of low back pain. Employees in the highest risk quartiles for physical workload and ergonomic issues are 3.24-5.42 times more likely than employees in the lowest quartile to experience significant discomfort. Adjusted odds ratios varied from 1.74 (upper back) to 2.33 (neck) for job intensification.

A large number of room cleaners experience extreme back or neck discomfort. There was a strong association between severe pain and physical stress, job intensification, and ergonomic issues.

Varmazayar *et al*. (2009) found that a high occurrence (36.8 per cent) of back spinal disorders among pharmacy staff in packaging. The objectives of this research are to test the workstation using RULA methodology and to analyze upper limb conditions by body map chart. The workforce is composed of 38 staff participating in pharmaceutical packing. Results show that none of the specific case studies was a score of one and two 45.7 per cent score acquired equivalent to 3 and 4, which indicated that further work would need improvements. Also, 36.9 per cent of them obtained scores equivalent to 5 and 6, so we may infer that the workplace should be redesigned in the future and the results revealed that 18.4 per cent of workers with a score of 7 with the

unsafe attitude that workplace should be redesigned immediately. The findings of the questionnaire revealed that knee pain 36.8 per cent, back pain 31.6 per cent, and neck pain 34.7 per cent were recorded. Findings showed a non-significant correlation in all topics between body part ratings and self-reported pains in the areas. The final RULA score (mean 4.87) stresses inappropriate workstation design for staff engaged in pharmacy packaging.

Ayoub and Karwowski (1997) and Garg (1997) pointed to more significant occupational risk factors and potential causes for their connection with accident danger connected with manual load handling, 1. The horizontal and vertical position of the load relative to the worker: the external joint loads will rise with a change in horizontal distance and the workers must use a significant proportion of their strength power, the distance load to be moved: increased travel distance results in decreased strength and higher energy expenditure. 2. Job frequency and duration: As the lifting frequency increases, there are higher metabolic demands and the onset of physical exhaustion becomes faster. 3. Load weight and size: The load weight can affect the necessary strength, postural stress, and metabolic demands.

Latko *et al.* (1999) stated that previous findings have found that repeated work is substantially associated with upper limb pain, tendonitis, and carpal tunnel syndrome. Workers in extremely repetitive jobs had chances of body pain increased (2 to 3 times) relative to workers in less repetitive jobs. This could lead to quicker muscle exhaustion after a long period **(Carter and Banister, 1994). (Gangopadhyay *et al.* 2003, 2007)** stated that high repetitiveness, prolonged work activity, and a prolonged duration of static posture can be considered to be the causative factors in the incidence of CTD as MSD.

Abdul Aziz *et al.(*2017) conducted a study on production team members of the automotive component manufacturer in Malaysia. He stated that MSD data were obtained by administering a structured interview with all participants by referring to the Cornell Musculoskeletal Disorder Questionnaire (CMDQ). Physical exposure risk factors for work-related musculoskeletal disorders (WMSD) were analyzed using Quick Exposure Check (QEC) techniques. Study findings established the extreme MSD that was associated with members of the production assembly team. The prevalence of MSD is estimated to be lower back (75.4 per cent), upper back (63.2 per cent), right

shoulder (61.4 per cent), and right wrist (60 per cent). The QEC study showed that about 70 per cent of work activities had very high neck posture risks and 60 per cent had high back (in moving condition) and shoulder/arm postures risks. There was 80 per cent of respondents received a high score for the chance of vibration damage.

2.4 Different working posture

Madhan Mohan and Pushparaj *et.al.* (2015) conducted a study to analyze the working posture of workers engaged in vehicle assembly applying different postural analysis tools and to identify the various risk factors associate with a work-related musculoskeletal disorder. Discomfort encountered during the process by the operators has been examined. The Jack software-Task Analysis Toolkit (TAT) was used with anthropometric scaling data from the 95th per centile Indian for postural analysis. Study RULA (Rapid Upper Limb Assessment) indicates that the operating position of the rear wheel assembly and rearview mirror assembly is wrong and the score is 5.

A cross-sectional analysis was undertaken to determine the prevalence of musculoskeletal disorders (MSD) and the association of automobile assembly line workers with an uncomfortable posture. A basic form of random sampling was introduced and data was gathered based on the Standardized Nordic Questionnaire (SNQ) and the Rapid Upper Limb Assessment (RULA) method to evaluate inappropriate posture. The findings showed that 78.4 per cent of employees registered MSD while the largest number of complaints referred to the lower back (50.9 per cent). However, the staff at the extremely high and high level of RULA behavior that was 69 times (OR = 69.38, 95 per cent CI 14.51-331.73) and 12 times (OR = 12.42, 95 per cent CI 5.21-29.58), have had higher chances of MSD complaints, respectively. This research indicates that the incidence of MSD is growing as the degree of RULA behavior and work duration rises. Thus, this issue may be minimized by reducing the degree of RULA behavior by adequate ergonomic workstation design and worker ergonomic training. **(Rahman Abd Anita *et al.*, 2014).**

Charm & Redfern(2004) reported that muscle tiredness was also a matter of concern due to standing positions in the automotive industry. To reduce fatigue by standing on hard surfaces for long periods, soft flooring options, and interventions such as anti-fatigue mats are some of the interventions proposed by him.

According to **Magnusson & Pope (1998**), approximately 70 per cent of patients with shoulder pain were found to work overhead with the hand-arm system at or above the shoulder level.

According to **Gallagher (2005),** the postural balance may be an issue in standing if the surface is uneven or has a low friction coefficient. This would not only be a concern for slip and fall accidents but may require a reduction in the application of force to minimize the effects of instability while performing tasks with high precision requirements.

Pope *et al*. (1990) suggested that the most common risk factors in various areas of the body:

- The most work-related injuries and pains in the neck tend to be associated with prolonged bent or twisted positions of more than 20 degrees.
- The conditions of the shoulders are related to the frequent raising of the arms to more than 30 degrees from the body.
- With elbows and hands, the recorded symptoms of disabilities included unaccustomed motions, repeated movements of high speed, extreme positions of the wrist and fingers.

Epidemiological findings specifically show a close correlation between cervical spine MSD and manual material handling (MMH) practices including heavy equipment and heavy lifting tasks. Epidemiological trials undertaken in 1998-2001 were analyzed by **Walker and Cooper (2005)** to clarify the soft tissue MSD of the neck and upper extremities in a wide spectrum of occupations. Results of the studies examined showed that neck pain was associated with susceptibility to prolonged irregular behavior, intense and/or stressful activities, insufficient job support from supervisors/colleagues, and elevated work demands. Data shows that chronic irregular posture and recurrence lead to these disorders. Non-fatal workplace accidents, such as sprains, strains, and breaks, have been mainly associated with work practices such as raising items that are too heavy, operating in uncomfortable postures for a prolonged period, bending, twisting, falling, and sliding **(Wates, 2004).** The body sections that are most likely to be injured include the neck, upper extremities, and lower back.

2.5 Workstation design

In the catering sector, **Gleeson (2001)** studied health and safety. He observed that the catering industry has high levels of injuries and illnesses linked to the job. This research investigated the prevalence, origin, and cause of work-related accidents and illness within the academic year of 315 months. Cutting and lacerations, arising from collisions with knives, were confirmed to be the most common injuries observed, accompanied by burns and scalds from hot liquids handling. It has also reported a significant level of work-related dermatitis. Trainee chefs have been described as an accident and illness to jobs. This community will profit from the tetanus vaccine. Work-related injuries and illness have resulted in a significant burden for the student health program, which is a good reason for catering companies to use occupational health facilities in itself.

Tongergen *et al.* (1995) developed a protocol that was focused on the findings of a systematic study of the working environment in the Dutch rubber industry. Protocol based on the results and knowledge of an industry-wide hygiene report. It has made it easier to analyze and monitor unsafe working practices in rubber production plants. The focus was put on the measurement of sensitivity to particulate solvents and disturbance, dermal sensitivity to pollutants, but also exposure to vibration, harsh climatic conditions, deleterious working environments, risks to injuries, and unsanitary working practices.

2.6 Environmental parameters

Stansfeld and Matheson (2003) reported that noise is a prominent aspect of the climate, like travel, manufacturing, and neighborhood noise. Sleep in the laboratory is disrupted by sensitivity to transporting disturbance, but not necessarily to field experiments where adaptation takes place. Noise interferes with the success of the complicated task, modifies social activity, and induces irritation. Studies of the sensitivity to the workplace and environmental noise indicate a connection between noise and cardiovascular disease. Exposure to aircraft and road traffic noise is correlated with psychological problems but not with mental illness and is scientifically described. Noise sensitivity in both industrial and population research is linked to the perception of catecholamine secretion. Chronic airplane noise sensitivity in children impairs comprehension awareness and long-term memory, which can be correlated

with elevated blood pressure. Further work is required to explore the coping mechanisms and the associated health effects of noise tolerance.

Maiti (2008) performed research to highlight the risk factors of occupation among female employees connected with building construction practices in India. The determined WBGT was measured as 30.26±1.52 °C from field environmental parameters, suggesting that these workers operated in a favorable heat charge scenario. A full-day job study was conducted on 11 adult female employees conducting practical operations. They were 28-32 years old and had 5-7 years of job experience.

Smith and Miles (1987) researched the influence of noise, night work, and meals and showed that these influences have an impact on various facets of performance. The speed of executing a low memory load version of a visual search task was influenced by operating at night but was not impaired either by noise or meals. Upon eating a meal, a high memory load variant of the search process was done more slowly, both in the daytime and at night, but was not affected by night work. Subjects working in the noise created more errors on the function of high memory load than those employed in a silent environment, but neither night work nor meals had any major impact on the number of errors. The only proof of an association between variables was obtained in the search task for high memory load, where noise decreased the size of the decrease in speed after a meal. These findings indicate that the impact on post-lunch efficiency of noise, night work, and meals are largely independent, with the difference being the beneficial influence of noise. They further show that the results of both of these variables depend on the complexity of the task being done and whether the component under consideration is speed or accuracy.

Noise is one part of the workplace that can have a detrimental effect on both staff and patients. Medical noise levels are created by staff, guests, patients, and medical devices such as telephones, equipment alarms, and patient monitoring systems beeping **(Bayo *et al*., 1995).**

According to recommendations from the World Health Organization, appropriate levels of constant background noise in rooms of patients are 35 dB. Noise levels peak at night should not exceed 40 dB **(Berglund *et al*., 1999)**. However, noise levels are steadily outperforming the prescribed standards. **Blomkvist *et al.* (2005)** claim that noise created by medical equipment and personnel approaches 70 dB to 75

dB when measured at the head of the patient. In the same way, devices such as X-ray machines generated noise levels over 90 dB. **Hodge and Thompson (1990)** observed that peak sound levels reported during surgery can interfere with staff members' attention, as well as impede effective contact between staff.

Begemann *et al.* (1997) stated that people's long-term behavior/response was observed during daytime work hours in regular window zone offices. Standard cell offices were fitted with experimental lighting systems that provide lighting conditions believed to affect physiology in humans. The findings reveal that most people tend to follow a period of daylight rather than a continuous amount. Preferred light rates are considerably higher than existing indoor lighting requirements and lead to conditions where biological stimulus can occur. The findings suggest that fulfilling the needs for biological illumination is very different from serving visual needs. The findings of two permanent residents reveal remarkable variations in lighting settings that lead to human circadian cycles and efficiency. This highlights the reality that existing indoor lighting rates (and standards) are too low for biological stimuli. Health evidence has found that chronic lack of light vitamins can cause health issues varying from mild sleep and efficiency disturbances to severe depressions. It undoubtedly means that 'bad' indoor illumination is the root cause of certain safety and efficiency issues. By calling this ill-lighting syndrome, we could have established an underlying cause that may result in several various adverse health/performance consequences. Creating safe indoor lighting can be a basic type of preventive medicine and a new task for the lighting group.

An analysis in Andhra Pradesh (India) showed that among 7154 employees (41.4 per cent drivers, 30.4 per cent passengers, 15.9 per cent of garage workers, 7.9 per cent office workers) the prevalence of respiratory symptoms was slightly higher in office workers (34.9 per cent) compared to passengers (24.2 per cent). Road transport workers have a high incidence of respiratory problems and slightly higher values for office staff and garage employees relative to drivers and conductors. **(Barne M and Komalkriti, 2011**)

2.7 Personal Protective Equipment

Personal protection equipment plays a very important role in reducing exposure to industrial hazards among car technicians. Analysis performed by **Motilewa *et al.* (2016)** to assess the awareness and usage of PPE by auto technicians in Uyo, Nigeria,

found that the most widely recognized PPE by respondents were overalls, 119 (78.8 per cent), boots were most frequently used by mechanics, 57 (61.3 per cent), while gloves were most used by panel beaters, 17 (60.7 per cent and 55 (59.1 per cent) ($p<0.05$). A total of 122 (80.8 per cent) respondents had a clear knowledge of the PPE.

Apreko *et al.* (2015) stated in a survey that most of the respondents accepted that the use of PPE, such as wearing the prescribed garments for the workplace, wearing sturdy workplace clothes and shoes, was adequate to give them a degree of protection, but only 45.8% accepted that they were the prescribed garments in the workshop. Most respondents acknowledged that PPE is used to avoid the vulnerability of individual body parts to hazards. However, the finding shows that certain areas of the body were not covered by the use of PPE. For example, a large proportion of the respondents showed that they did not agree with the daily use of goggles to shield their eyes while operating. They also disagreed with the use of breathing aids for treating hazardous products. This may be attributed to the versatility of the work of the respondents. For eg, auto electricians and auto mechanics believe they don't need to wear goggles to cover their eyes. However, they operate in industrial environments and often have close contact with petrol and gasoline, exhaust gases, welding chemicals, oils, solvents, etc. These toxic compounds are ingested by immediate inhalation, absorption, and close touch with the skin, resulting in health conditions such as pulmonary disorders, dermatitis, eczema, and respiratory and cardiac disorders. The research further showed that the majority (64.9 per cent) of the respondents either disagreed or were neutral that they felt comfortable either unhappy or neutral that they feel comfortable using the PPE, 68 per cent disagreed or were neutral on the normal replacement of worn-out PPEs, but most of the respondents were sure that they should use the PPE properly.

Hanson (2003) revealed that employees are expected to wear PPE in certain industrial conditions to shield them from hazards. Though offering protection without knowledge, wearing any type of PPE in hot weather can increase the risk of heat strain as most types of PPE have a higher insulating value.

Anonymous (2007) said the experience of personal protection equipment would be the last preventive step that can be taken to minimize harm. This suggests that PPE consumers would be those housewives\workers who are vulnerable to high-risk

household hazards\technologically unavoidable (extreme circumstances, high-risk expert job, short-term temporary danger, etc.) where the usage of PPE may be counteracted. It further emerged in the report that housewives\employees and family members of their workers have failed to make the correct choice of uniform PPE. For a variety of factors that are inadequate workplace risk evaluation by the employee\housewives, the inability of advising employees on job results, solely economic concern disregarding the need for safety, or lack of knowledge from the PPE manufacture, it does not adequately defend housewives\workers from household hazards if a wrong PPE is selected.

Joshi (2009) studied the usage of the PPE among construction staff, the PPE design, and the redesign of selected PPE. Workers were observed to be vulnerable to impact from dropping items (85 per cent) and dropping pieces (70 per cent), intrusion by nails (76 per cent) and scrap metal \ sharp objects (65 per cent) on location, biological, electrical, mechanical, heat and cold, and more for non-PPE wearers. Hence, most staff reported experiencing discomfort due to inadequate clothing, constant sweating, skin irritation, decreased vision, agility, grip intensity, and inability to use PPE spontaneously.

In research undertaken by **Okwabi R *et al***., it was found that the majority of apprentices obtained practical instruction from their master craftsmen on the utility of personal protective equipment (PPE) only a few use them. Lack of law enforcement of security procedures in garages has also contributed to a poor degree of usage and awareness of personal protective equipment, as 90 per cent of staff have replied that there is no strict oversight of the use of PPE.

2.8 Occupational Hazards

A workplace hazard is a danger that has been encountered at work. Occupational hazards can include multiple types of hazards including environmental hazards, biological hazards, psychosocial hazards, and physical hazards.

An occupational hazard is a term that represents both long-term and short-term workplace-related hazards and is an area of research on occupational safety and health and public health. Short-term risks can include physical injuries, while the risk of contracting cancer or heart disease can rise over the long term. The occupational hazards are working activities that can cause/increase the risk of injuries or ill health **(Occupational Health and Safety Regulation, 2010**

An analysis performed at two Nigerian automotive assembly plants found that 304(95.6%) were aware of the hazards in their workplace, while 14(4.4%) were unaware of the hazards in their workplace. Most respondents (81.6%) reported machine accidents as a hazard, 60.5% reported metal particles, while 55.6 per cent identified excessive noise, 54.6 per cent identified chemicals and smoke, unsafe working conditions, electrocution, and excessive fire, 48.7 per cent, 48.7 per cent, 48.0 per cent, and 38.2 per cent respectively. External bodies in the eye, corrosives, sliding objects, hot liquid, and slick surfaces were 28.6 per cent, 21.4 per cent, 18.1 per cent, 10.5 per cent, and 9.5 per cent. Waist pain (76.7 per cent, followed by cut/laceration (63.8 per cent), eye problems (63.2 per cent), hearing difficulties (46.9 per cent) was the most prevalent occupational disease/injury found by respondents. 44.7 5, 38.7 per cent, 28.3 per cent, 23.9 per cent, and 6.6 per cent respectively reported lung disorders including sprain, electrocution, burns, and skin disease. **(Azuika *et al*.2016)** the respondents' knowledge of hazards in their workplace. Among the respondents, 304 (95.6%) were aware of hazards in their workplace, while 14 (4.4%) were not aware of hazards in their workplace. The table also shows the proportions of the respondents who identified the different hazards in their workplace. Among the 304 respondents that were aware of hazards in their workplace, the majority (81.6%) identified machine accidents as a hazard in their workplace. Metal dust was identified by 60.5%, while excessive noise was identified by 55.6%. Gases and Fumes, bad working positions, electrocution, and excessive heat were identified by 54.6%, 48.7%, 48.0%, and 38.2% respectively. Foreign body in the eye, corrosives, falling objects, hot liquid, and slippery floor were identified by 28.6%, 21.4%, 18.1%, 10.5% and 9.5% respectively. Table 3 shows the respondents' knowledge of occupational illnesses/injuries that can occur in their workplace. The commonest occupational illness/injury identified by the respondents was waist pain (76.7%), followed by cut/laceration (63.8%), eye problems (63.2%), hearing problems (46.9%). Respiratory problems, sprain, electrocution, burns and skin disease were identified by 44.7%, 38.7%, 28.3%, 23.9% and 6.6% respectively. While fracture, lead poisoning, cancers, traumatic amputation of a digit, were identified by 3.5%, 3.5%, 3.1%, and 2.2% respectively. Table 2 shows the respondents' knowledge of hazards in their workplace. Among the respondents, 304 (95.6%) were aware of hazards in their workplace, while 14 (4.4%) were not aware of hazards in their workplace. The table also shows the proportions of the respondents who identified the

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Table 1.1: Hazards related to automobile mechanics job according to Israel Institute for Occupational Safety and Hygiene jointly with the BIA (Germany).

Accident hazards	• Falls from ladders, stairs, elevated platforms, etc., and falls into inspection pits
	• Falls on the level, esp. on wet, slippery, or greasy garage floors
	• Injuries due to collapse of jacking, lifting or hoisting equipment, and vehicles falling from lifting equipment them
	• Crushed toes resulting from falls of heavy objects
	• Eye injury from splinters and flying objects from grinding, and machining operations, while operating compressed-air equipment and during cleaning and similar operations
	• Injuries as a result of being caught in or between moving and stationary objects
	• Injuries caused by rotating parts of machine tools
	• Acute musculoskeletal injuries (intervertebral disk rupture, hernia, etc.) due to overexertion while lifting or otherwise handling heavy vehicle parts, etc., and due to awkward work postures (underneath the vehicle, etc.)

	• Burns due to contact with hot surfaces, exhaust pipes, or hot-melt chemicals; sudden release of hot water and steam lines, radiator and cooling system pipes; soldering, brazing and welding operations, etc.
	• Electrocution as a result of defects, short circuits or improper use of electromechanical equipment, or contact with live wires, e.g., • electric shocks from portable power tools
	• Carbon monoxide poisoning
	• Fires and explosions of spilled or leaked flammable/explosive substances, or by the ignition of hydrogen released from batteries, or during flame cutting and welding operations, etc.
	• Increased rate of road accidents during test driving
	• Punctures and cuts caused by sharp edges of hand tools, vehicle parts, and sheet materials
	• Bursting of compressed-air lines or containers
	• Bursting of tires
	• Accidents due to improperly installed and maintained steam/water pressure cleaners
Physical hazards	• Exposure to direct and reflected ultraviolet and infrared radiation (esp. from welding operations)
	• Exposure to microwave and radiofrequency radiation (esp. in heat-sealing of panels and upholstery, drying of trim base panels, etc.)
	• Exposure to hand-arm vibration from power-driven hand tools, resulting in the development of White Finger Syndrome, etc.
	• Exposure to excessive noise (> 90 dBA), esp. in car bodywork, during engine testing, etc.
	• Exposure to excessive heat or cold, esp. in open garages or during roadwork (the use of improvised heating may cause fire and CO poisoning)
Chemical hazards	Exposure to a wide range of industrial chemicals including heavy metals, contained in brake fluids, degreasers, detergents, lubricants, metal cleaners, paints, fuel, solvents, etc., resulting in various forms of chronic poisoning: • Skin diseases and conditions (various types of dermatitis, skin sensitization, eczema, oil acne, etc.) caused by various chemicals, e.g.: adhesives, asbestos, antifreeze and brake fluids, epoxy resins, gasoline, oils, nickel, colophon, etc.

	• Eye irritation, dizziness, nausea, breathing problems, headaches, etc., caused by contact with irritating chemicals and their dust and fumes, e.g.: antiknock agents (such as methylpentadienyl manganese tricarbonyl [MMT]), ketone solvents (such as methyl isobutyl ketone [MIK]), etc.
	• Asbestosis and mesothelioma caused by asbestos dust from brake drum cleaning and processing operation
	• Chronic poisoning resulting from exposure to lead and its dust and fumes (esp. while repairing radiators, handling storage batteries, welding, using paints and lubricants, etc.)
	• Hematological changes as a result of exposure to solvents, such as benzene and its homologs, toluene, xylene, etc
	• Increased risk of cancer due to inhalation of diesel exhaust fumes or contact with certain heavy metals and their compounds, asbestos, benzene, etc
	• Increased risk of organic brain damage due to inhalation of diesel exhaust fumes
	• Acute eye and mucous membrane irritation, headaches, breathing difficulties, chest tightness, etc., caused by inhalation of NOx and respirable particulates
	• Gastrointestinal disturbances as a result of accidental or chronic ingestion of adhesives
	• Nuisance due to bad smells when working with certain solvent-based adhesives
	• Splashes of corrosive and reactive chemicals that may cause eye and skin injuries, etc
Biological hazards	• Infections as a result of microorganism contamination and growth in certain adhesives
Ergonomic, psychosocial, and organizational factors	• Acute musculoskeletal injuries (intervertebral disk rupture, tendon rupture, hernia, etc.) caused by physical overexertion and incorrect combination of weight and posture during lifting and moving of heavy loads
	• Cumulative trauma disorders, including carpal tunnel syndrome, caused by long-time repetitive work
	• The danger of being attacked by individuals (including dissatisfied customers) in workplaces open to the public
	• Psychological stress when working under time pressure

The findings of the analysis conducted by **Ahmad *et al.* (2017)** revealed that the data were gathered from local workshops (LWs, N=62) and workshops of multinational companies (CWs, N=11). The mean positive response among surveyed LWs and CWs for OHS components was as follows: personal protective equipment (ppes) (28% and 61%), fire protection and emergency services (52% and 91%), equipment supply (69% and 94%), electrical safety (44% and 82%), general workplace safety (43% and 82%), Housekeeping (18% and 84%), chemical exposure (16% and 69%), maintenance and servicing (54% and 86%), manual handling (84% and 100%), and equipment care (58% and 91%), respectively. Overall, the OHS means positive response, consistent with standard practices and legislation, was 47 per cent of all OHS components in LWs, which for CWs was much smaller than 84 per cent positive response.

Materials and Methods

MATERIALS AND METHODS

After reviewing the available literature related to the present study, a scientific and systematic procedure was developed and adopted for conducting the present investigation. A systematic methodology is an important step in any study because it directly affects the validity of research results. Appropriate research methodology and skillful management of the same are imperative in the successful execution of the research project. This chapter provides a detailed description of the procedure adopted for conducting the study entitled, **"Assessment of Musculoskeletal Disorder Among Garage Workers"** under the following subheadings:

3.1 Research design

3.2 Conceptual framework of the study

3.3 Selection of variable

3.4 Operational definition

3.5 Selection, construction, and description of the tool

3.6 Selection of sample

3.7 Method of data collection

3.8 Statistical analysis and interpretation of data

3.1 Research Design

A research design is a conceptual structure within which the research was carried out and is necessary because it systematically facilitates smooth research operations. Generally, a good research design is one that minimizes bias and maximizes the reliability of the collected and analyzed information. A descriptive cum experimental research design was designed to achieve the study's objectives.

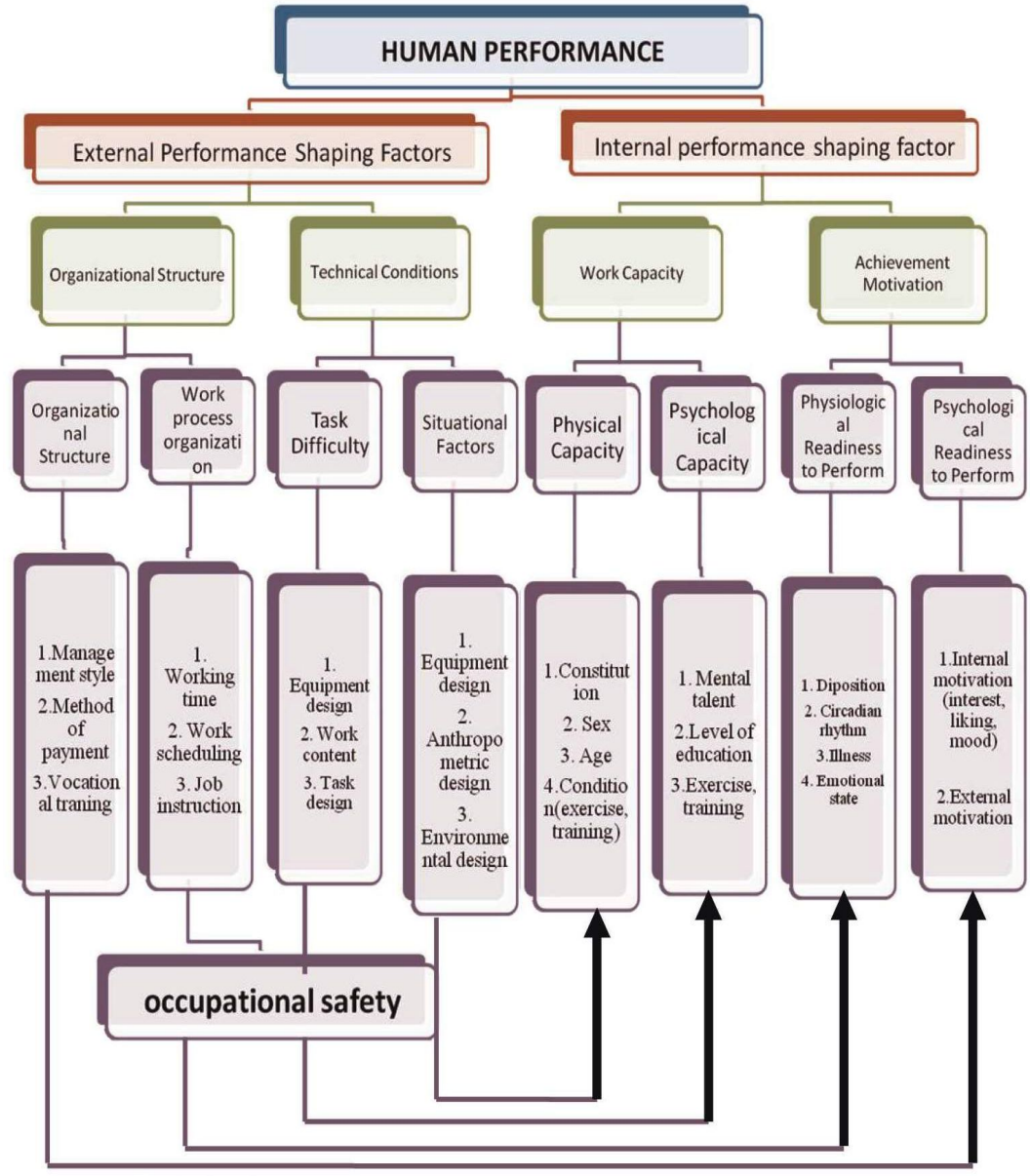
Descriptive design was chosen to find out the socioeconomic status and working profile of the garage workers, working environment, risk-prone activities, and personal protective equipment used by the workers. Whereas, an experimental design is selected to measure various awkward positions adopted by garage workers while performing various activities and to measure different environmental parameters.

3.2 Conceptual Framework of The Study

The conceptual framework of the study represents the relationship of variables concerning the objectives of the study and it also presents the variables at the workplace that affect the worker's working capacity which leads to musculoskeletal disorders. The following conceptual framework helps us to critically analyze the research gap and situation of the garage workers.

The following conceptual framework depicts that human performance in the garage depends on the external and internal performance shaping factors. The performance shaping factors are the aspects of human behavior and the context (or environment) that can impact human performance. The external performance shaping factors- influence the situation or environment that affect the individuals and have a direct impact on occupational health and the internal performance shaping factors- influences that the individual brings to the situation and have an indirect impact by management on occupational health.

External performance shaping factors depend on organizational structure and technical conditions. The organizational structure includes management style- that are the methods a person uses to manage an individual, meeting project, group of people or organization, method of payment- that is a payment made to an employee for the work they have done, vocational training- that is instructional programs or courses that focus on the skill required for a particular job function or trade and it also includes work process organization- that involve working time of workers, working schedule of workers and job instructions. Technical condition including task difficulty -that is due to equipment design, work content, and task design and it also includes situational factors- that involves equipment design, anthropometric design, and environmental design whereas, internal performance shaping factors depend on the work capacity and achievement motivation. Work capacity including physical capacity- that evaluates the capacity of an individual to perform physically demanding works tasks. Factors that influence the physical capacity of an individual are constitution, sex, age, condition (exercise, training), and psychical capacity persons' ability to perform a variety of mental tasks. Factors that influence the psychical capacity of an individual are- mental talent, level of education & exercise, training.



Direct impact

Indirect impact by the management

Figure 3.1: Schematic representation of the conceptual framework of the study

Achievement motivation- affect in connection with evaluated performance in which competition with a standard of excellence was paramount **(McClelland, *et al.*, 1953).** Achievement motivation includes physiological readiness to perform and psychological readiness to perform which means that individuals learn well when they are physically, mentally, and emotionally motivated to learn and do not learn well if they do not see any need to learn. Some factors influencing the physiological readiness to perform are: temperament, circadian pattern, disorder, mental state, and some factors affecting psychological readiness to perform are: internal motivation: desire, liking, mood, and external motivation.

3.3 Interaction of Variables

It is a concept in which qualitative and quantitative data varies. Variables are the characteristics or conditions that are manipulated, controlled, or observed by the researcher. The variables are selected according to the objectives of the study. The selected variables were categorized into the following categories: independent variables, intervening variables, and dependent variables.

3.3.1 Dependent Variable

Dependent variables are those variables affected by the independent variables. The following dependent variables are selected for the experiments:

1. Postural discomfort
2. Physical illness
3. Musculoskeletal discomfort

3.3.2 Independent Variable

Independent variables are that variable that is changed or controlled in a scientific experiment to test the effects on the dependent variable. The following independent variables are selected for the experiments: age, education, socioeconomic status, family size, family type, temperature, humidity, light, noise, dust.

3.3.3 Intervening Variables

Intervening variables are the variable that occurs between the independent and dependent variables and may change how and even if, the independent variable affects a dependent variable. The following intervening variables are selected for the experiment: Type of task/activity performed, duration of work, tools used, PPE used, etc.

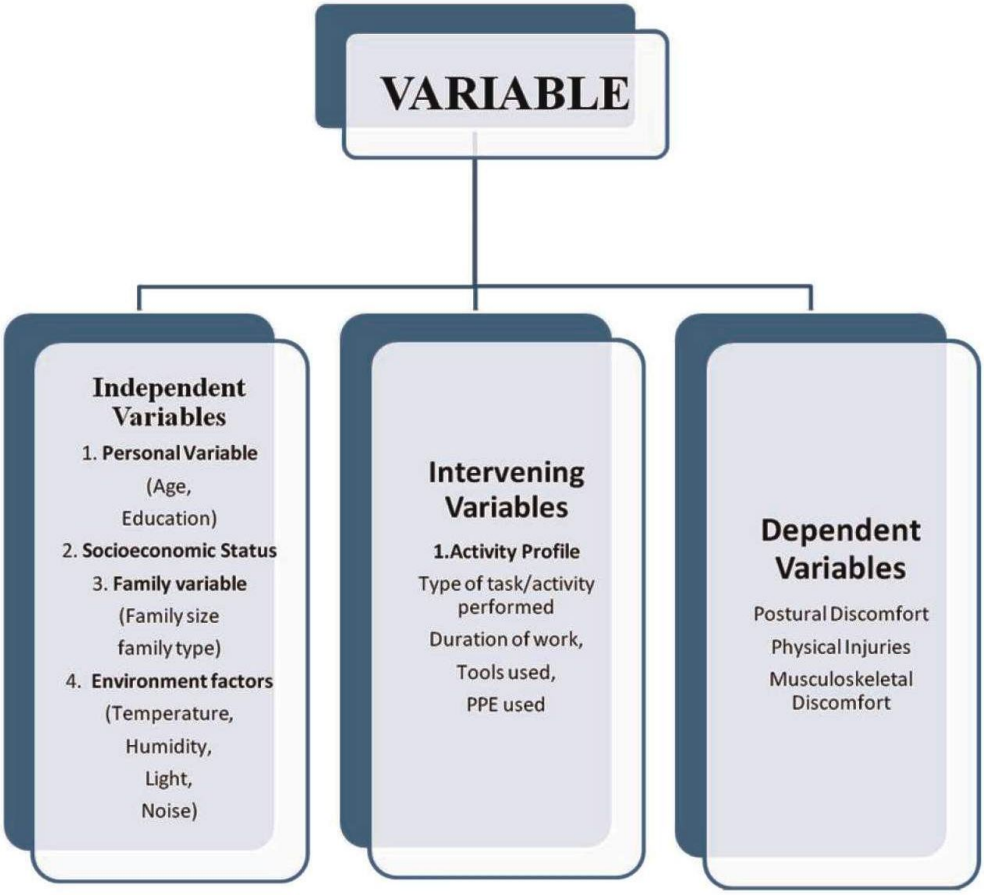


Fig.3.2: Schematic Presentation of Interaction of Variables

3.4 Occupational Definition

Coping strategies refer to the particular efforts that individuals employ to master, accommodate, eliminate, or mitigate traumatic situations, both behavioral and psychological.

The environment is a collection of complex situations or future stressors which can be used as opportunities, limitations, or demands

Ergonomics is the study of people's efficiency in their working environment.

Health is a condition of physical, mental, and social well-being in which there is no sickness and infirmity

Musculoskeletal disorders or MSDs are injuries and disorders that affect the human body's movement or musculoskeletal system(i.e. muscles, tendons, ligaments, nerves, discs, blood vessels, etc).

An occupational health hazard is defined as a condition that results from exposure in a workplace to a physical, chemical, or biological agent to extent that the normal physiological mechanisms are affected and the health of the worker is impaired.

Occupational risk factors associated with chronic neck and low back pain include physical stresses involved in manual labor, mental stress in both manual and office workers, and job-related stress due to lack of autonomy, lack of variation in workload, and lack of cooperation among workers.

Personal protective equipment means any device or appliance designed to be worn or held by an individual for protection against one or more health and safety hazards.

Posture adapted refers to the maintenance of the right posture is very important during work. Due to the wrong posture adopted during work, fatigue appears without substantial contributions to work.

Posture refers to the carriage of the body as a whole, the attitude of the body pr the position of the limbs (the arms and legs).

Safety is the condition of being safe from undergoing or causing hurt, injury, or loss.

The work environment describes as the surrounding conditions in which an employee operates. The work environment can be composed of physical conditions, such as office temperature, or equipment, such as personal computers.

Work experience is any experience that a person gains while working in a specific field or occupation, but the expression is widely used to mean a type of volunteer work that is commonly intended for young people- often students- to get a feel for professional working environments.

Work is a physiological or intellectual activity aimed at ending/completing the mission

Repetitive work is described as the work done quite a few times one after the other.

Static posture is defined as holding the same position or using the same muscles for extended periods

3.5 Selection, Construction, and Description of Tool

3.5.1 Selection of the Tool

An interview schedule was considered to be a suitable method. Therefore, for the present analysis, a close-ended interview schedule was established to gather data and other information from garage employees.

3.5.2 Construction and description of the tool

A preliminary survey was carried out at various garage parts to test the validity of the tool. A good relationship was formed with the respondents to gain proper insight into the workstation-related problems, working hours, and worker-related physical issues. It established a questionnaire consisting of the following sections:

Section 1

I. Demographic profile of the workers

A questionnaire was created and included questions concerning the worker's demographic profile (age, employment, type of family, family size, etc.).

II. Socioeconomic status of the workers

Updated Modified Kuppuswamy's Socioeconomic Scale (2020) was used to elicit information on the socio-economic characteristics of the respondents. This scale was initially developed by Kuppuswamy in the year 1976 which was later updated and modified in 2020.

III. Health status checklist

Health status checklist is an example of a "to-do list" which include questions related to the health status of the garage worker mainly sign and symptoms.

IV. Stress coping strategies questionnaire

Coping strategies refer to the specific efforts, both behavioral and psychological, that people employ to master, tolerate, reduce, or minimize stressful events. Stress coping questionnaire was used to know the strategies that the workers used to reduce the stress faced in their daily work.

V. Work environment questionnaire

Includes questions about the selected garage workers' work environment.

VI. Awareness of occupational hazard checklist

An occupational hazard is a hazard experienced in the workplace. Occupational hazards can encompass many types of hazards, including chemical hazards, biological hazards (biohazards), psychosocial hazards, and physical hazards. to know the awareness of occupational hazards among garage workers the occupational hazard checklist was used.

VII. Use of personal protective equipment checklist

PPE is equipment that will protect the user against health or safety risks at work. A personal protective equipment checklist was used to get information about how many workers use PPE at the workplace while handling equipment or tools.

VIII. Standardized Nordic Questionnaire

Standardized Nordic questionnaires were used for the analysis of musculoskeletal symptoms among garage workers.

IX. Risk assessment checklist

Risk assessment is the process of evaluating risks to workers' safety and health from workplace hazards therefore for assessing the garage workers' health and safety the risk assessment checklist was used.

X. Workplace checklist

Workplace checklist was used to assess the garage workplace and it includes 3 sections material handling, workstation, and teamwork environment

Section 2

It dealt with various observational methods to assess the ergonomic problems or MSDS and divided into three parts:

Part 1. It included the RULA (Rapid Entire Body Assessment) scale to measure MSDs prevalent in the upper limb.

Part 2. It dealt with REBA (Rapid Entire Body Assessment) scale to identify the ergonomics problems.

Part 3. It dealt with ART (Assessment of Repetitive Tasks) tool to assess the risk factors in repetitive work that contribute to the development of Upper Limb Disorders (ULDs).

Here, all 3 scales were used, so that comparison can also be made among these scales.

Section 3

It dealt with the measurement of environmental parameters: temperature, humidity, light, and noise.

3.6 Selection of Sample

Selection of the locale, sample design, and sample size

The present study was carried out in Uttarakhand at Udham Singh Nagar district, block-Rudrapur, Nainital district, block- Haldwani and Almora district, block- Dwarahat.

Earlier it was decided that the study will be carried out in only two districts- Udham Singh Nagar and Nainital but due to pandemic covid-19, all the garages were lockdown then have a significant sample from Almora district. Purposive and random sampling technique was done based on convenience and availability. For descriptive data 75 and experimental data 23(30 % of the total sample) samples were selected i.e, 9 samples from Udham Singh Nagar, 6 samples from Nainital, and 8 samples from Almora.

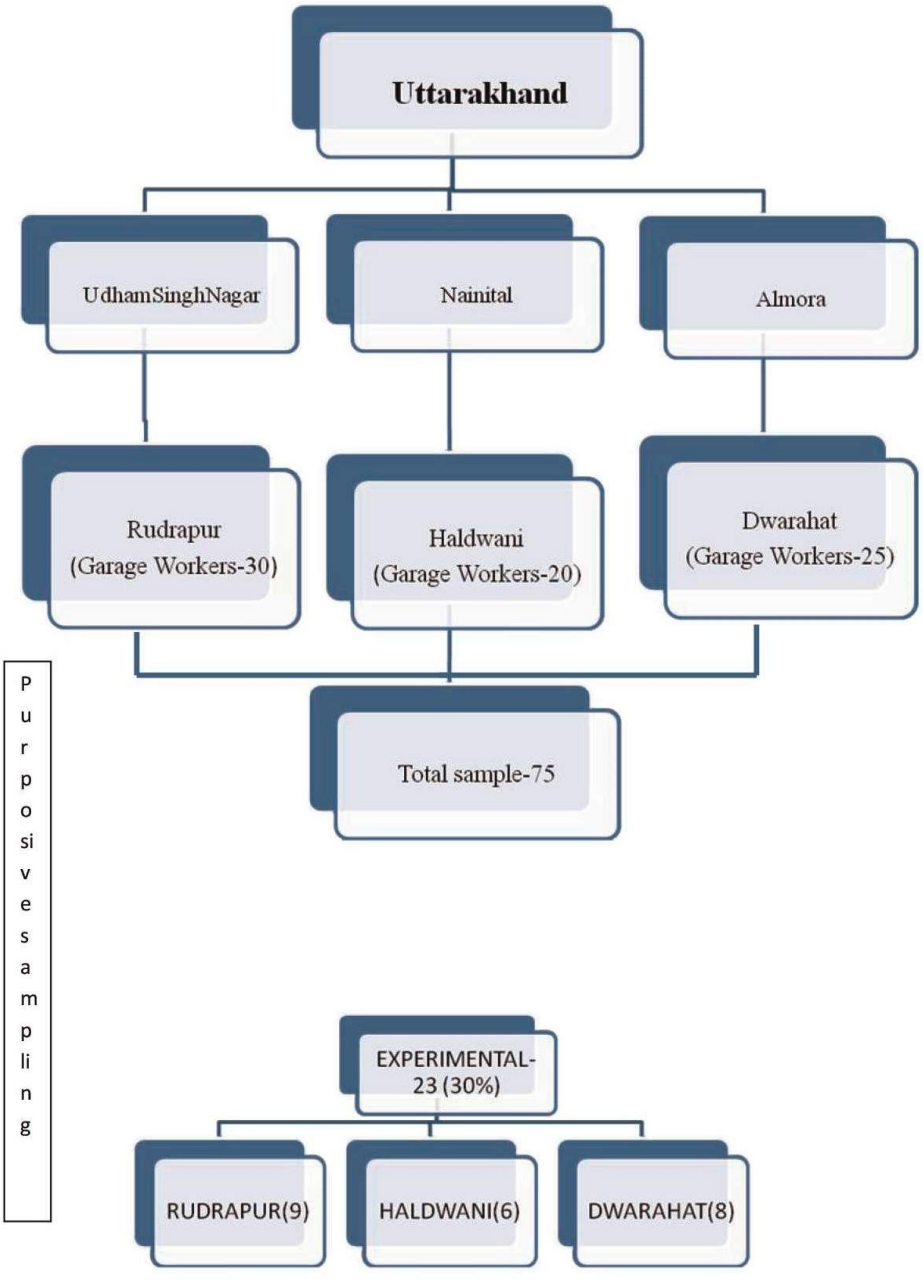


Fig-3.3: Schematic presentation of a selection of sample and locale selection

3.7 Method of Data Collection

Data collection lasted five months, due to lockdown, it stretched from one season to another, consisting of individual interviews or naturalistic observation. The semi-structured and informal interview methods were used to obtain a detailed understanding of primary knowledge and people's background of technology creation and its use. The interviews allowed concentrated yet conversational communication to explore more information with the respondents. Respondents' observations provided a deeper understanding of the context in which the events occurred, which the respondents were either unaware of or unwilling to discuss during the interview.

3.7.1 Ergonomic Assessment and Evaluation Methods

Several ergonomic methods/techniques were applied to measure the objective of the present study.

3.7.1.1 Descriptive method

The descriptive data were collected from all the 75 respondents personally using an interview schedule. A visit was made to all the selected respondents, before data collection to establish a rapport with the respondents as well as with the owner to ensure full cooperation from them. The respondents were interviewed personally and helped to understand clearly the term used to avoid misinterpretation of words and elicit reliable data.

- A questionnaire was created and included questions concerning the worker's demographic profile (age, employment, type of family, family size, etc.).
- Updated Modified Kuppuswamy's Socioeconomic Scale (2020) was used to elicit information on the socio-economic characteristics of the respondents. This scale was initially developed by Kuppuswamy in the year 1976.
- To obtain data about health-related problems the health status checklist was developed.
- Stress coping strategies questionnaire was developed to elicit information
- To obtain data about working conditions like the type of job, work experience, etc, the work environment questionnaire was developed and used.

- **Standardized Nordic Questionnaire**

The assessment of musculoskeletal disorders was made using the revised Nordic musculoskeletal questionnaire validated by **Kuroinka *et al.* (1987)**. Such checklists also help in identifying risks to health. Categorical yes / no questions have been given to answer the occurrence of body parts disorder including (ache, pain, discomfort) over the entire life span, over the past 12 months, one month, and over the last 7 days. The workers have responded accordingly to these questions by standardizing the Nordic questionnaire. Both the categorical questionnaire encoded was then inserted into the datasheet and evaluated with correct statistics. Nevertheless, when the questionnaire was administered as part of a concentrated analysis on MSD issues and work causes, substantially higher levels of musculoskeletal problems were identified than when administered as part of a routine general health review **(Anderson, D. S, 1987).**

- To obtain data about the awareness of an occupational hazard and use of PPE the checklist was developed.

- **Workplace Checklist**

Workplace assessment was done by implementing a workplace checklist which was practical and easy to implement solutions for improving safety, health, and working conditions. The workplace checklist was introduced by Kazutaka Kogi. Kazutaka Kogi was established by the IEA to prepare the basis for a joint review by the IEA & ILO, which was conducted at a workshop in Bali, Indonesia, in 2005.

3.7.1.2 Observational methods

Observation methods are strategies focused on posture, with the use of intensity and length of activities in some approaches. Observational techniques are standard techniques that have been commonly used in science since posture is one of the key factors affecting muscle strength **(Cutlip, H.H . 2000).**

The most common observational methods are RULA (Rapid upper limb assessment), REBA (Rapid entire body assessment), ART(Assessment of Repetitive Tasks)

- **Rapid upper limb assessment (RULA)**

RULA is a survey tool developed for use in ergonomic studies for study related to upper limb disabilities (**McAtamney and Corlett, 1993).** RULA is a screening tool that assesses biomechanical and postural loads on the whole body with careful attention

to the neck, trunk, and upper limbs. The RULA assessment takes little time to complete and the score produces an action list showing the extent of intervention needed to minimize the risk of injuries related to physical loading on the operator **(McAtamney and Corlett;1993).** RULA is meant to be seen as part of a larger ergonomic analysis. The coding scheme is used to create a list of actions showing the extent of activity needed to minimize the risk of injuries due to physical loading on the operator.

RULA method.

- The postures were measured by numbers-the greater the number, the worse the posture.
- Group A tests the effect on the upper, lower arm, wrist, and wrist twist.
- Group B tests the impact on the neck, trunk, and leg.
- The average values of Group A and Group B were measured and the external force and frequency were modified to produce the total score.
- The degree of the intervention was calculated based on the total score

Table 3.1 RULA action levels

Final RULA scores	Action level
1 or 2	Indicates that posture is acceptable if it is not maintained or repeated for long periods.
3 or 4	Indicates that further investigation is needed and changes may be required.
5 or 6	Indicates investigation and changes are required soon.
7 or 8	indicates investigation and changes are required immediately

- **Rapid entire body assessment (REBA)**

REBA **(Hignett and McAtamney, 2000)** was proposed as a way of assessing posture for work-related musculoskeletal disorders (WRMSDs). Essential activities of work have been considered. The posture was measured for each assignment by assigning a score to each area.

REBA Method

- Posture was evaluated by numbers-greater the number, worse the posture.

- Group A evaluates the effect on the trunk, neck, and legs.
- Group B evaluates the effect on upper arms lower arms and wrist postures for left and right
- Average values were determined for group A and group B and frequency changes were made and coupling scores were applied to the overall score

The degree of risk was found in the REBA decision table based on the overall ranking.

Table 3.2: REBA action level

Action level	REBA score	Risk level	Action (including further assessment)
0	1	Negligible risk	Not necessary
1	2-3	Low risk	Change may be needed
2	4-7	Medium risk	Further investigation, change soon
3	8-10	High risk	Investigate and implement change
4	11+	Very high risk	Implement change immediately

- **Assessment of Repetitive Tasks (ART)**

The Assessment of Repetitive Tasks (ART) method is designed to analyze tasks that involve repetitive movement of the upper limbs (arms and hands). It allows you to determine some of the popular risk factors leading to the development of Upper Limb Disorders (ULDs) in repetitive work**. (HSE, 2010)**

The ART tool is a method that helps to:

- Identify repetitive tasks with major risks and where risk mitigation strategies can be aimed.
- Prioritizing routine enhancement processes
- Consider possible risk-reduction strategies
- Satisfy the regulatory standards to ensure the health and welfare of workers doing routine work

The ART tool uses a numerical score and a traffic light methodology to show the level of risk for 12 factors. These variables are classified into four stages:

- A: Frequency and repetition of movements
- B: Force
- C: Awkward postures of the neck, back, arm, wrist, and hand
- D: Additional factors, including breaks and duration

A system for the analysis of the exposure score is suggested in the table below:

Table 3.3: ART action level

Exposure score	Proposed exposure level	
0-11	Low	Consider individual circumstances
12-21	Medium	Further investigation required
22 or more	High	Further investigation required urgently

3.7.1.3 Measurement and classification of data

Environment parameter: Environment parameters i.e, temperature, relative humidity, noise, and light were measured thrice. Relative humidity and temperature were measured using a thermohygrometer. The noise was calculated using a noise level meter. The light was being measured using a lux meter.

3.8 Statistical Analysis and Interpretation of Data

In the present study frequency, percentage, mean, were computed. The following methods and formula were used to calculate the above information:

Frequency: the sum of responses (in numbers)

Percentage: for making simple comparisons for preparing value is calculated as:

$$\boldsymbol{P = \frac{h}{n} \times 100}$$

Where,

P= percentage

h = frequency of particular cell

n= total number of respondents

Mean= total sum of the responses / total number of the respondents

Hypothesis testing

The hypothesis of the study was tested through Pearson correlation using SPSS software.

Results and Discussion

RESULTS AND DISCUSSION

This chapter deals with the results of the ongoing inquiry and addresses the priorities set out in the present work.

The results of the analysis are summarized in a composite overview table, accompanied by a statistical application to test the hypothesis. The research findings were summarized as follows:

Section A: It covers the descriptive variables and was subdivided into ten parts:

4.1 Demographic profile of the garage workers

4.2 Socio-economic status of the garage workers

4.3 Assessment of health status of garage workers

4.4 Stress coping strategies

4.5 Work environment

4.6 Awareness of occupational hazard

4.7 Use of PPE

4.8 Assessment of musculoskeletal discomfort (MSD)

4.9 Risk assessment

4.10 Workplace assessment

Section B: It dealt with the various observational methods to assess the ergonomic problems or MSDs and divided into 3 parts:

4.11 Rapid Upper Limb Assessment (RULA)

4.12 Rapid Entire Body Assessment (REBA)

4. 13 Assessment of Repetitive Task (ART)

Section C: This section covers the experimental part and direct measurement

4.14 Work Environment (Environmental Parameters)

4.15 Testing of hypothesis

Section A: Descriptive Variable

4.1 Demographic Profile of the Garage Workers

Important findings of the selected garage workers' profile concerning the various personal and family variables are defined in this section.

4.1.1 Age

The age of selected garage workers was divided into five categories i.e, 19-28 years, 29-38 years, 39-48 years, 49-58 years, and 59-68 years. Based on arbitrary class intervals, a perusal of the analyzed data revealed that the majority of the garage workers i.e. 46.66 per cent fell under the category of 19-28 years, whereas 25.33 per cent were representing 29-38 years of age group, 17.33 per cent were representing 39-48 years of age group, 6.66 per cent were representing 49-58 years of age group and 4 per cent were representing 59-68 years of age group. Therefore it can be said that the majority of the garage workers were young. The result of the study was found to coincide with the study of **Pandey and Vinay (2014)** in which workers in the rice mill industry were found to be from all age groups. But the majority of them are in the age group of 19-28 (63.33%).

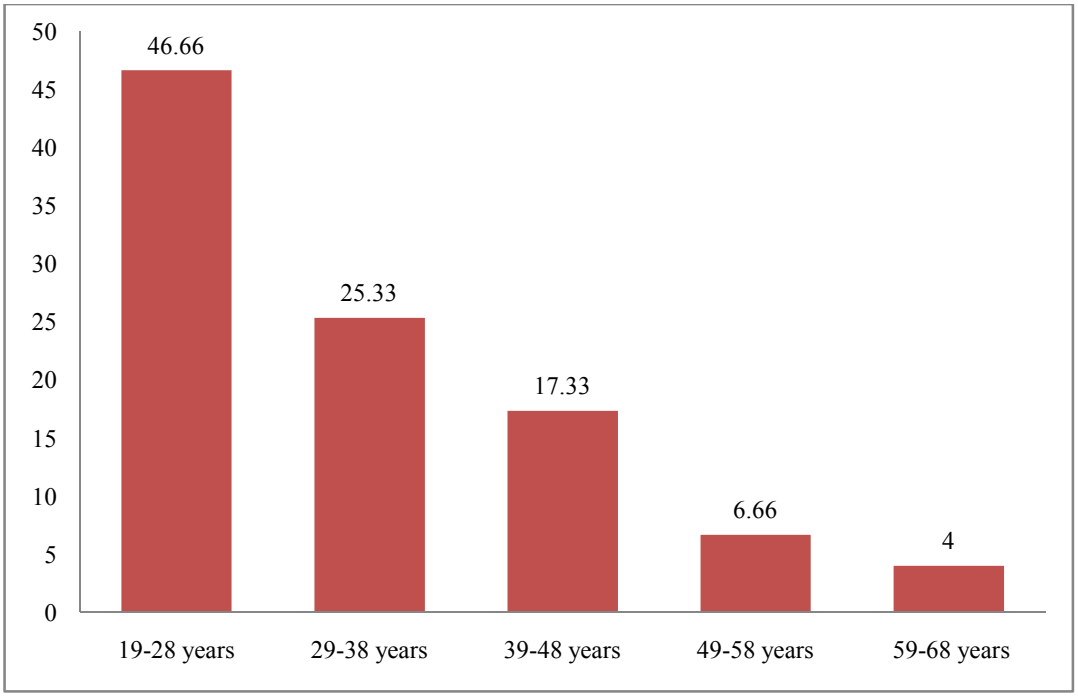


Figure 4.1: Percentage distribution of workers by age

4.1.2 Type of family

The type of family to which the garage workers belonged was grouped under four categories i.e. single, nuclear, joint, and extended. It was found that most of the workers were from the nuclear family (61.34%) while 28 per cent of workers were having joint families and only 1.34 per cent of workers were having extended families.

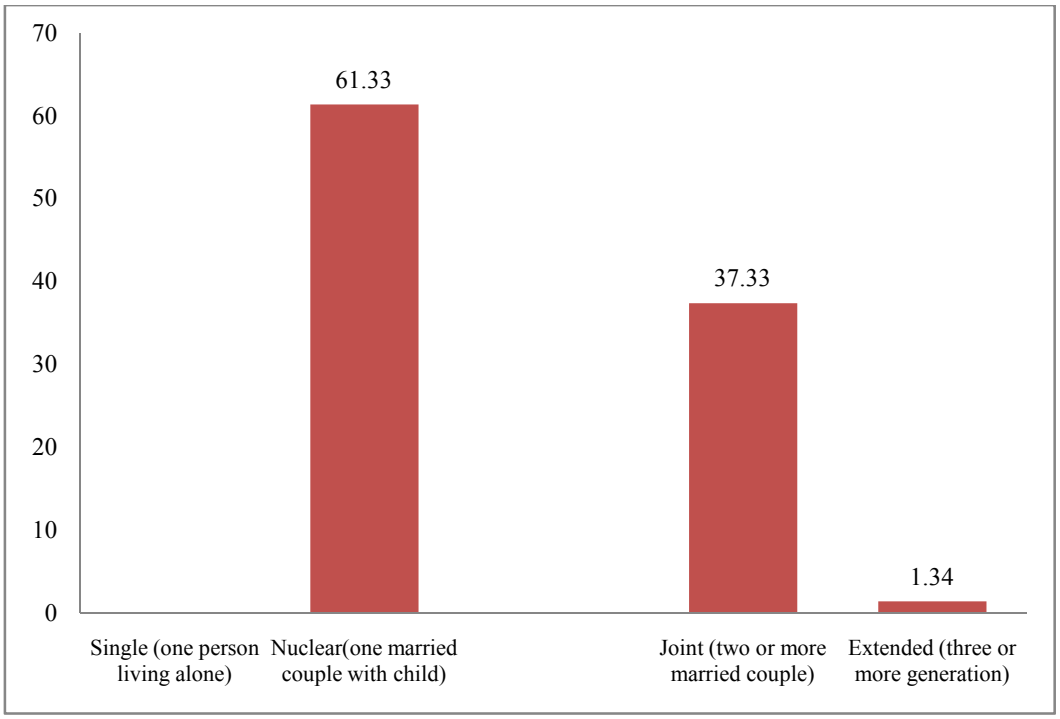


Figure 4.2: Percentage distribution of workers based on the type of family

4.1.3 Size of Family

The size of the family to which the garage workers belonged was grouped under three categories i.e, small, medium, and large. It was found that most of the workers were from a medium-size family (69.34%) while 24 per cent of workers were having large families and only 6.67 per cent of workers were having small families

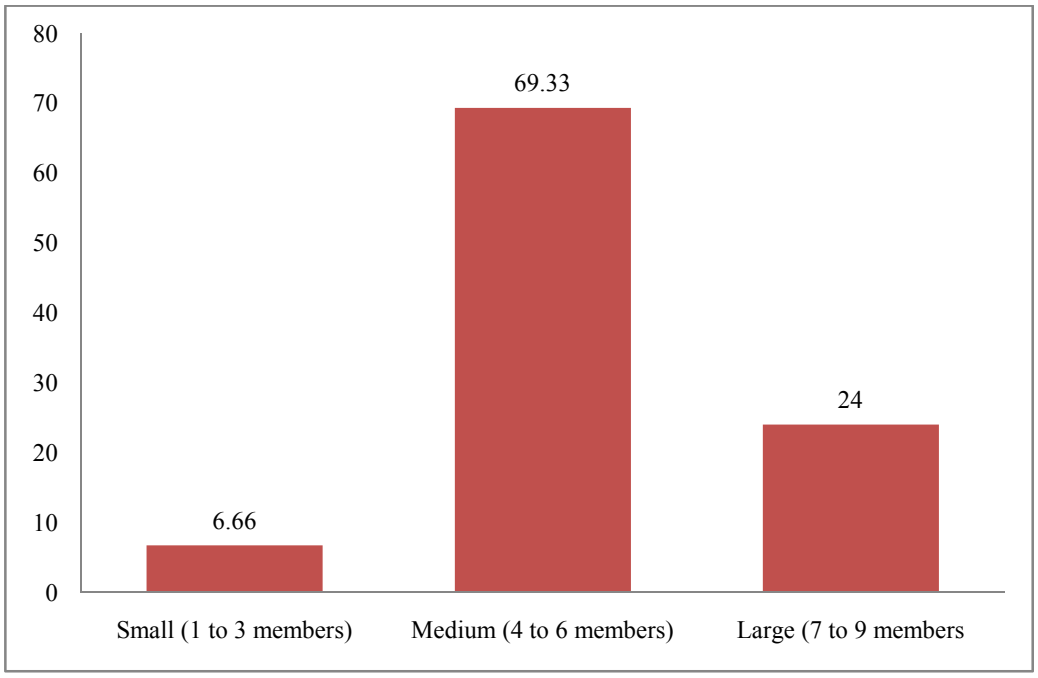


Figure 4.3 Percentage distribution based on the size of the family

4.1.4 Marital Status

Out of 75 workers, 69.33 per cent of workers were married and only 30.66 per cent were unmarried. The result of the study found almost similar where about 83 per cent of workers were married and 17 per cent unmarried in the construction industry of Varanasi City. **(Raj and Singh, 2018)**

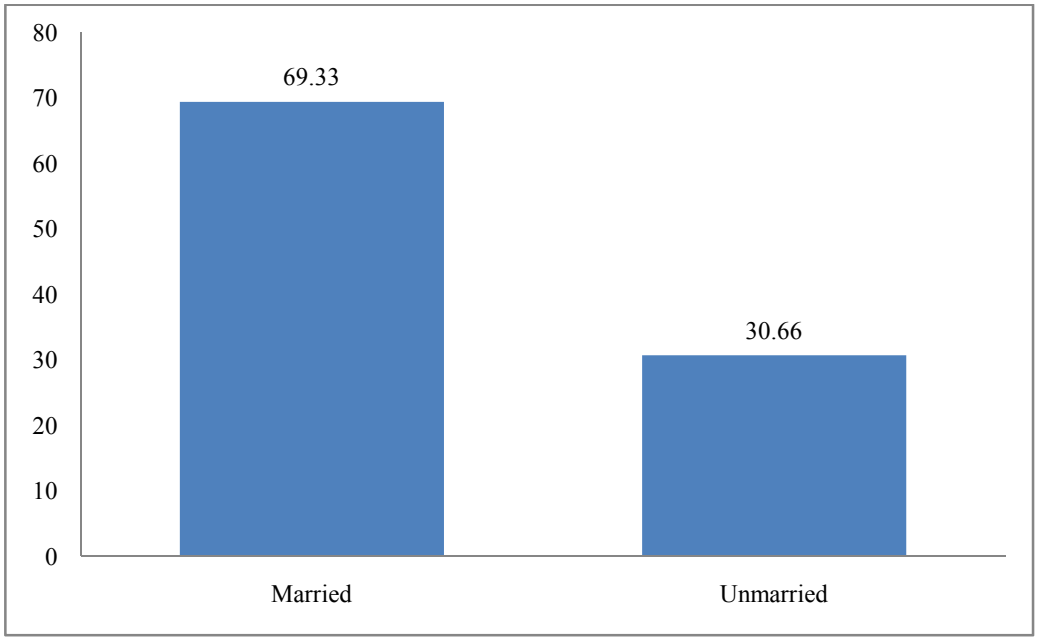


Figure 4.4: Percentage distribution of workers based on marital status

4.1.5 Caste

The caste of the family to which the garage workers belonged was grouped under general, other backward class, schedule caste, and schedule tribe. The workers belonged to the general category were 30.66 per cent and other backward classes were 36 per cent respectively. Workers who belonged to scheduled caste were 30.66 per cent and only 2.66 per cent belonged to the scheduled tribe category. In the construction industry, the majority of workers were from the local community of SC and OBC of Varanasi city **(Raj and Singh, 2018)**.

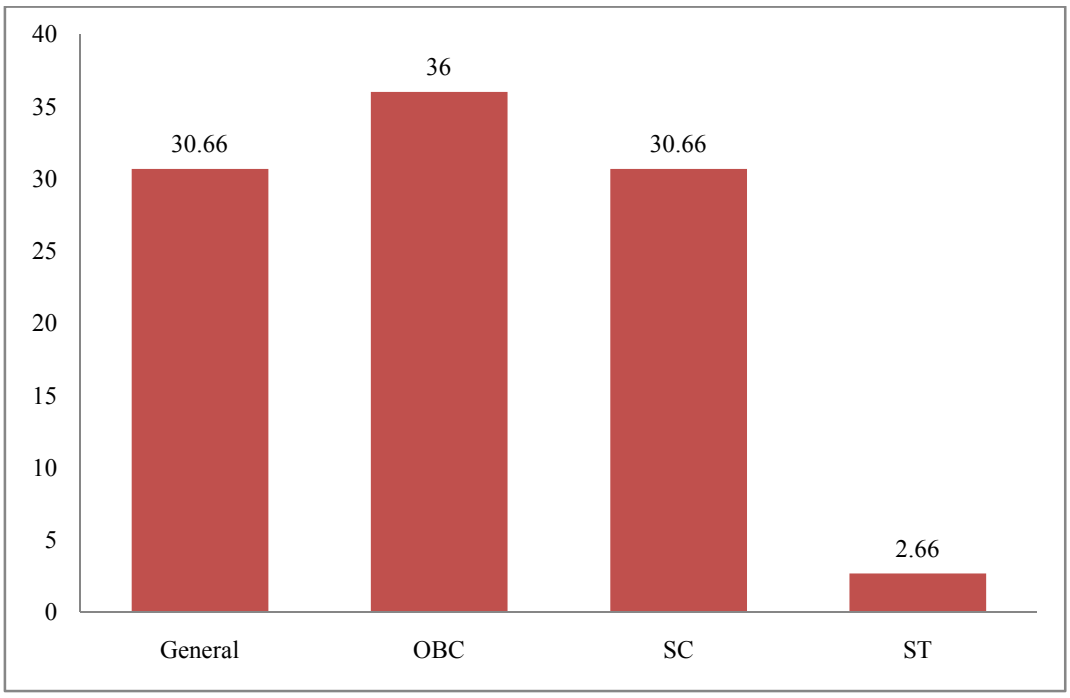


Figure 4.5: Percentage distribution of workers based on caste

4.1.6 The religion of the Family

The religion of the family to which the garage workers belonged was grouped under five categories i.e, Hinduism, Islam, Christianity, Sikhism, Buddhism, and Jainism. The majority of workers (54.66%) belonged to Hinduism whereas 41.34 per cent belonged to Islam and at least 4 per cent belonged to Sikhism. In the rice mill industry, the majority of workers were Hindu (96.66%) **(Pandey and Vinay, 2014)**.

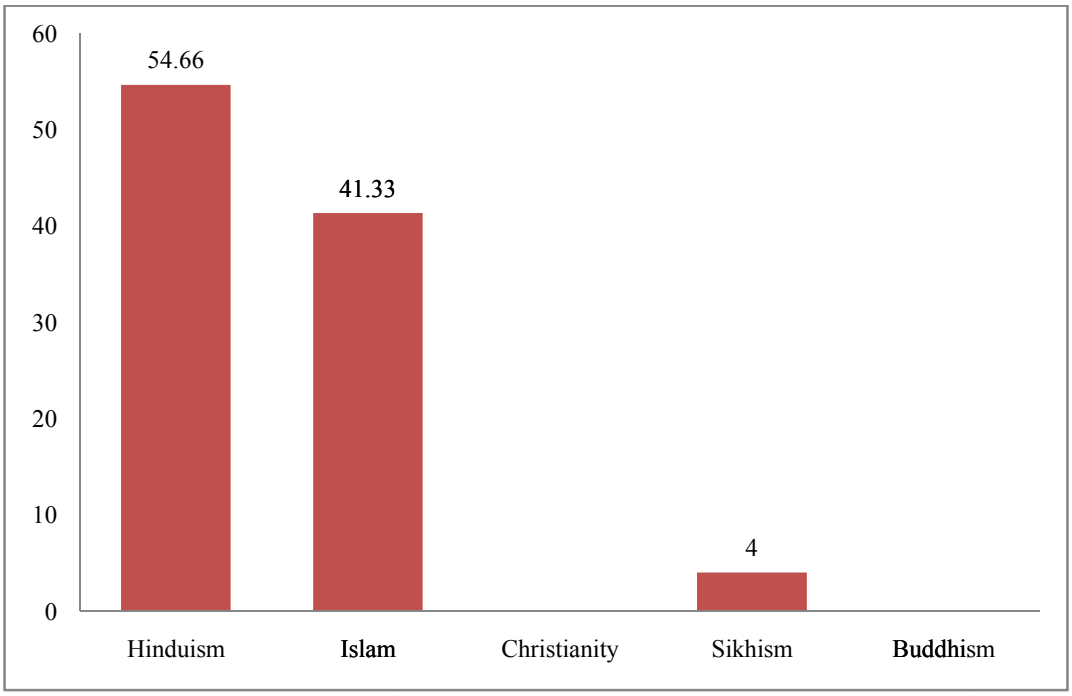


Figure 4.6: Percentage distribution of workers based on religion

4.1.7 Living in a type of house

Majority of workers (78.67%) living in pakka with tin shade type of house whereas 12 per cent of workers living in kachcha type of house and least 9.34 per cent of workers living in a mixed type of house.

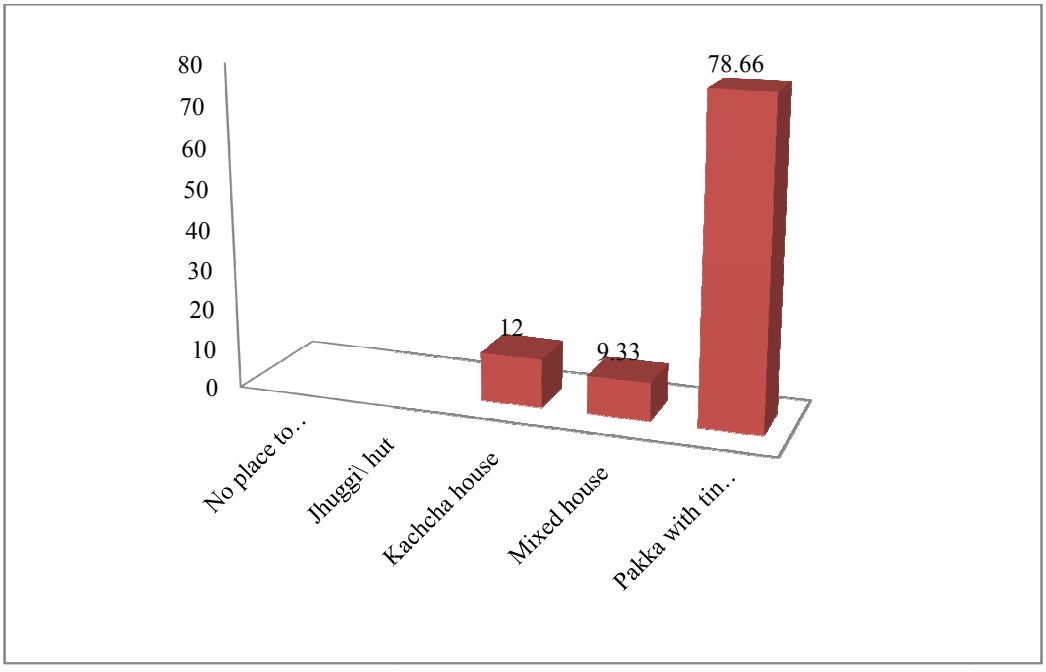


Figure 4.7: Percentage distribution of workers based on living in a type of house

Table 4.1: Demographic profile of the garage workers

S.NO	Characteristics	Frequency	Percentage
1.	**Age**		
a)	19-28 years	35	46.66
b)	29-38 years	19	25.33
c)	39-48 years	13	17.33
d)	49-58 years	5	6.66
e)	59-68 years	3	4
2.	**Type of family**		
a)	Single (one person living alone)		
b)	Nuclear(one married couple with a child)	46	61.33
c)	Joint (two or more married couple)	28	37.33
d)	Extended (three or more generation)	1	1.34
3.	**Size of family**		
a)	Small (1 to 3 members)	5	6.66
b)	Medium (4 to 6 members)	52	69.33
c)	Large (7 to 9 members	18	24
4.	**Marital status**		
a)	Married	52	69.33
b)	Unmarried	23	30.66
3.	**Caste of the family**		
a)	General	23	30.66
b)	OBC	27	36
c)	SC	23	30.66
d)	ST	2	2.66
6.	**The religion of the family**		
a)	Hinduism	41	54.66
b)	Islam	31	41.33
c)	Christianity		
d)	Sikhism	3	4
e)	Buddhism		
7.	**Living in a type of house**		
a)	No place to live, pavement, mobile cart		
b)	Jhuggi\ hut		
c)	Kachcha house	9	12
d)	Mixed house	7	9.33
e)	Pakka with tin shade	59	78.66

4.2 Socio-Economic Status of garage workers

Socioeconomic status (SES) is described as "a place within a framework of the hierarchical social structure obtained by any individual." In searching for health care services, accessibility problems, affordability costs, adoption by recipients, and overall use of services by people, SES has a major role to play.

4.2.1 Occupation of the head of the family

The occupation of the head of the family was divided into ten categories i.e, (a) Legislators, Senior Officials & Managers, (b) Professionals, (c) Technicians and Associate Professionals, (d) Clerks (e) Skilled Workers and Shop & Market Sales Workers, (f) Skilled Agricultural & Fishery Workers, (g) Craft & Related Trade Workers, (h) Plant & Machine Operators and Assembler, (i)Elementary Occupation, (j)Unemployed. The majority of workers (64%) belonged to Skilled Workers and Shop & Market Sales Workers whereas 1.33 per cent, 4 per cent, 4 per cent, 8 per cent, and 18.66 per cent belonged to Plant & Machine Operators and Assembler, Craft & Related Trade Workers, Unemployed, Skilled Agricultural & Fishery Workers and Elementary Occupation respectively.

Table 4.2: Occupation of the head of the family of garage workers

(n=75)

S. no	Characteristics	Frequency	Percentage
1.	**Occupation of the head of the family**		
a)	Legislators, Senior Officials & Managers		
b)	Professionals		
c)	Technicians and Associate Professionals		
d)	Clerks		
e)	Skilled Workers and Shop & Market Sales Workers	48	64
f)	Skilled Agricultural & Fishery Workers	6	8
g)	Craft & Related Trade Workers	3	4
h)	Plant & Machine Operators and Assembler	1	1.33
i)	Elementary Occupation	14	18.66
j)	Unemployed	3	4

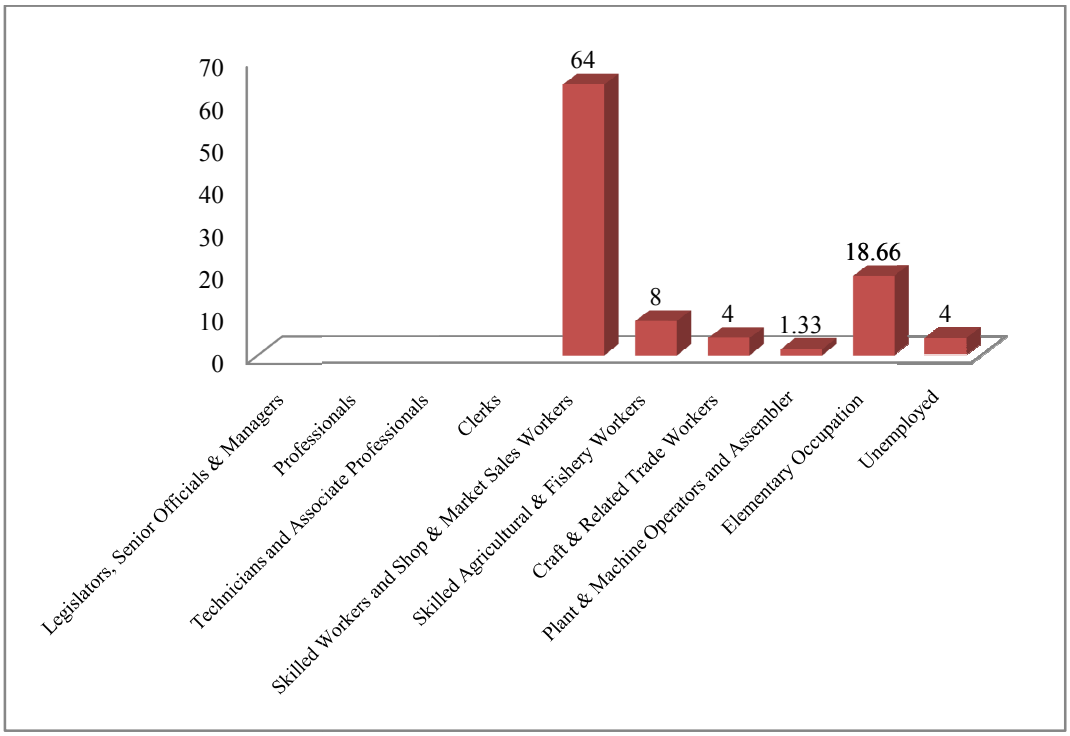


Figure 4.8: Percentage distribution of workers based on Occupation of the head of the family

4.2.2 Education of the head of the family

The education of the head of the family was divided into seven categories i.e, Profession or Honours, Graduate, Intermediate or diploma, High school certificate, Middle school certificate, Primary school certificate, Illiterate. The majority of workers (30.66%) reported that their head of the family was having high school certificate education whereas 5.33 per cent, 14.66 per cent, 26.66 per cent, 20 per cent, and 2.66 per cent of workers belonged to Graduate, Intermediate or diploma, Middle school certificate, Primary school certificate, Illiterate.

Table 4.3: Education of the head of the family of the garage workers

(n=75)

S. no	Characteristics	Frequency	Percentage
2.	**Education of the head of the family**		
a)	Profession or Honours		
b)	Graduate	4	5.33
c)	Intermediate or diploma	11	14.66
d)	High school certificate	23	30.66
e)	Middle school certificate	20	26.66
f)	Primary school certificate	15	20
g)	Illiterate	2	2.66

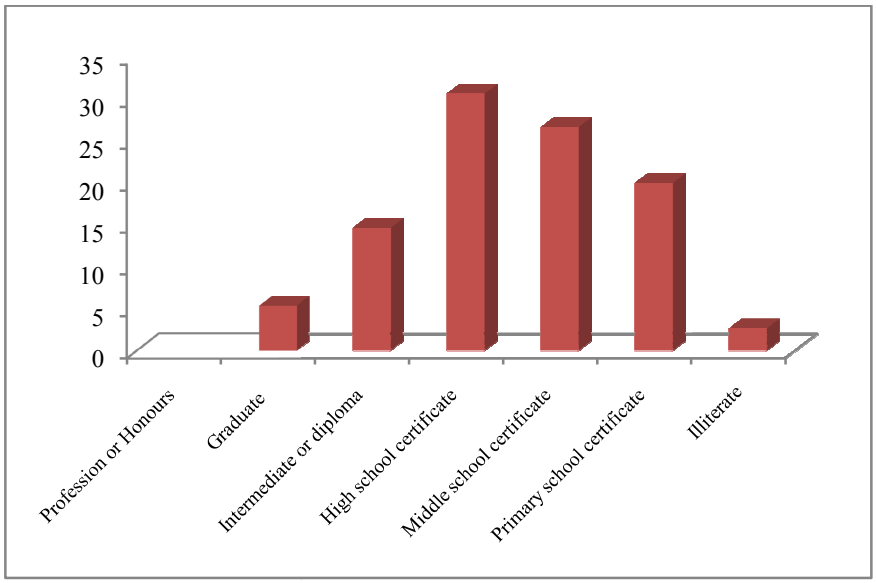


Figure 4.9: Percentage distribution of workers based on the education of the head of the family

4.2.3 Total monthly income of the family

Total monthly income of family were divided into seven categories i.e, a) Rs. ≥ 199,862 b) Rs.99,931-199,861 c)Rs.74,755-99,930, d) Rs.49,962-74,755 e) Rs.29,973-49,961, f) Rs.10,002-29,972 and g) Rs.≤10,001. Majority of workers (56%) were representing the 10,002-29,972 total monthly income of family whereas 22.66 per cent, 21.33 per cent workers belonged to Rs.29,973-49,961 and Rs.≤10,001 total monthly income of family.

Figure 4.10: Percentage distribution of workers based on a total monthly income of the family

Table 4.4 Total monthly income of the family of the garage workers

(n=75)

S.No	Characteristics	Frequency	Percentage
3.	**Total monthly income of the family**		
	Updated Monthly Family Income in Rupees (2020)		
a)	≥199,862		
b)	99,931-199,861		
c)	74,755-99,930		
d)	49,962-74,755		
e)	29,973-49,961	17	22.66
f)	10,002-29,972	42	56
g)	≤10,001	16	21.33

4.2.4 Norms for interpretation of the level of socio-economic status

The total score was calculated by adding up all the three scores, namely, education, occupation, and total family income as shown in table 4.5, table 4.6, table 4.7. According to the total score thus calculated, the family is placed in the appropriate socioeconomic class as explained in the following table 4.8. The total score of Kuppuswamy SES ranges from 3-29 and it classifies families into 5 groups, ”upper class, upper-middle-class, lower middle class, upper lower and lower socio-economic class.”

Table 4.5: Occupation of the head of the family

S.No	Occupation Of The Head Of The Family	Score
a)	Legislators, Senior Officials & Managers	10
b)	Professionals	9
c)	Technicians and Associate Professionals	8
d)	Clerks	7
e)	Skilled Workers and Shop & Market Sales Workers	6
f)	Skilled Agricultural & Fishery Workers	5
g)	Craft & Related Trade Workers	4
h)	Plant & Machine Operators and Assembler	3
i)	Elementary Occupation	2
j)	Unemployed	1

Table 4.6 Education of the head of the family

S.No.	Education Of The Head Of The Family	Score
a)	Profession or Honours	7
b)	Graduate	6
c)	Intermediate or diploma	5
d)	High school certificate	4
e)	Middle school certificate	3
f)	Primary school certificate	2
g)	Illiterate	1

Table 4.7: Total monthly income of the family

S. No	Total Monthly Income Of The Family	Score
	Updated Monthly Family Income in Rupees (2020)	
a)	≥199,862	12
b)	99,931-199,861	10
c)	74,755-99,930	6
d)	49,962-74,755	4
e)	29,973-49,961	3
f)	10,002-29,972	2
g)	≤10,001	1

Table 4.8: Kuppuswamy's socioeconomic status scale 2020

S.No	Score	Socioeconomic Class
1.	26-29	Upper
2.	16-25	Upper Middle
3.	11-15	Lower Middle
4.	5-10	Upper Lower
5.	<5	Lower

4.2.5 Categorization of the socio-economic class of the selected garage workers (n=75)

The socioeconomic status of selected garage workers was categorized into five classes with different scores as an upper class (26-29), upper-middle-class (16-25), lower middle class (11-15), upper lower class (5-10), and lower class(<5) respectively.

Table 4.9: Categorization of socio-economic class

S.No	Score	Socioeconomic Class	Frequency	Percentage
1.	26-29	Upper	-	-
2.	16-25	Upper Middle	-	-
3.	11-15	Lower Middle	43	57.33
4.	5-10	Upper Lower	30	40
5.	<5	Lower	2	2.66

Based on classified categories, the perusal of the analyzed data revealed that the majority of garage workers 57.33 per cent belonged to the lower middle class, 40 per cent of garage workers belonged to the upper lower class, and the minority of garage workers 2.66 per cent belonged to the lower class.

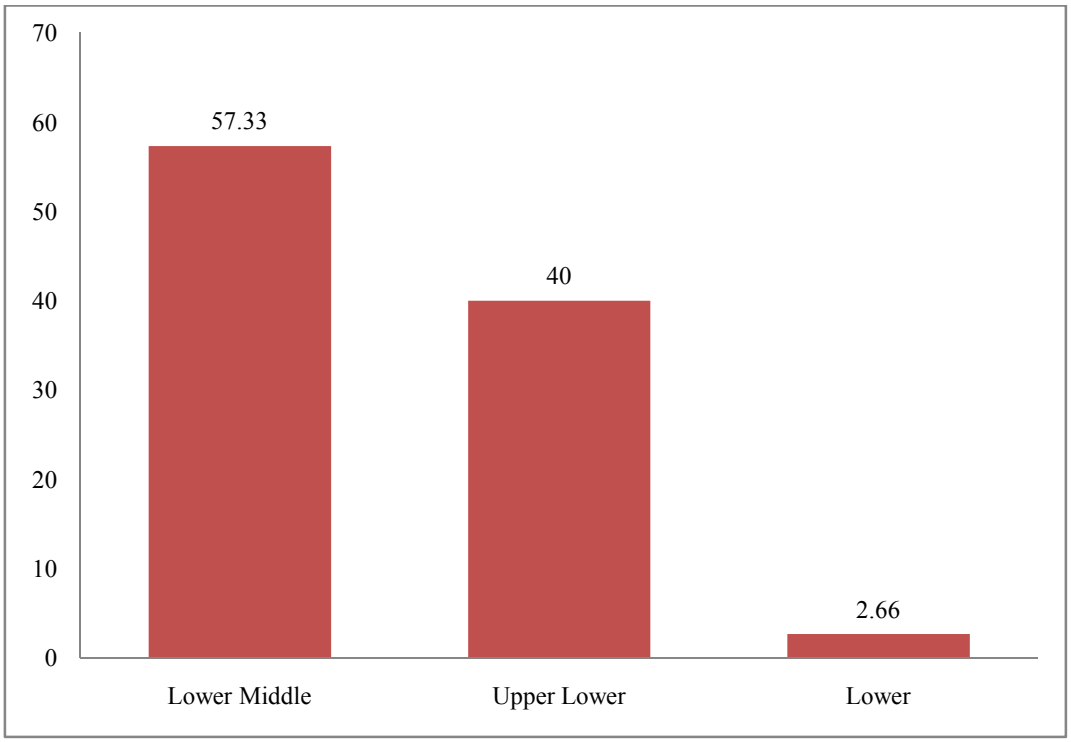


Figure 4.11: Percentage distribution of workers based on socio-economic status

4.3 Assessment of Health Status of garage workers

Health status is the relative level of well-being and disability of a person, taking into consideration the nature of the biological or physiological deficiency, symptoms, and functional disability. Workers' well-being is an important topic of concern in the age of safety.

The statements were developed to take into account the diverse types of diseases that may contribute substantially to the garage workers' occupational health.

The responses as table 4.10 revealed that 66.66 per cent of the garage workers suffer from dyspepsia (indigestion) or bowel disturbance whereas 64 per cent of garage workers reported to suffer occasionally from muscle or bone pain and 44 per cent of the garage workers felt stress at the workplace that resulting on to the high level of fatigue.

The garage workers when enquired, whether they suffer from chronic cough or repeated breathlessness of breath 40.66 per cent reported that they felt.

In the present investigation, 12 per cent of garage workers reported having skin irritation or rashes from the chemical or grease that used while working in the garage and 6.66 per cent of garage workers had other symptoms like high/low blood pressure, headache, eye pain, weakness, cold, and hepatitis C whereas no respondent reported that they suffer from pallor(pale skin).

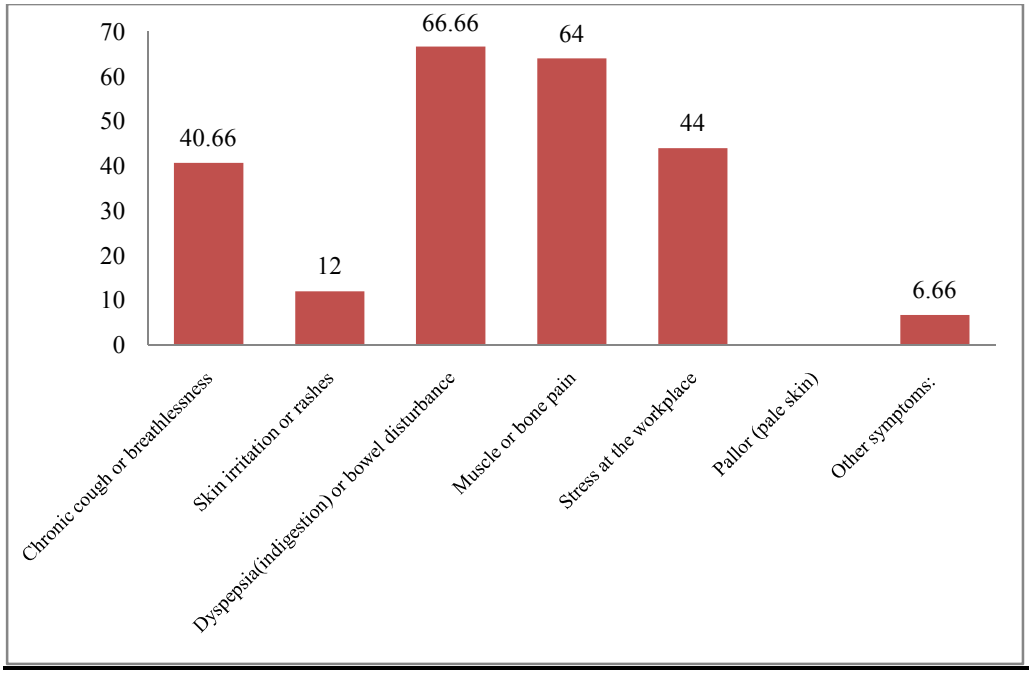


Figure 4.12: Percentage distribution of workers based on health status

Table 4.10: Assessment of common health symptoms among garage workers

(n=75)

S.No	Sign/symptoms	Frequency	Percentage
a)	Chronic cough or breathlessness	35	40.66
b)	Skin irritation or rashes	09	12
c)	Dyspepsia(indigestion) or bowel disturbance	50	66.66
d)	Muscle or bone pain	48	64
e)	Stress at the workplace	33	44
f)	Pallor (pale skin)	-	-
g)	Other symptoms:	05	6.66

4.4 Assessment of Coping Strategies of garage workers

Coping techniques are constructive practices implemented by people when faced with a situational threat or potential danger from stressors to interact with tension. The causes of stress can not be avoided in most situations, but by using effective methods to deal with stress, we can resolve the consequences. In various ways, people deal with difficult circumstances.

4.4.1 Religious/Meditation

Data about mental stress management strategies revealed that 9.33 per cent were doing yoga as a meditation whereas 93.33 per cent were offering prayers.

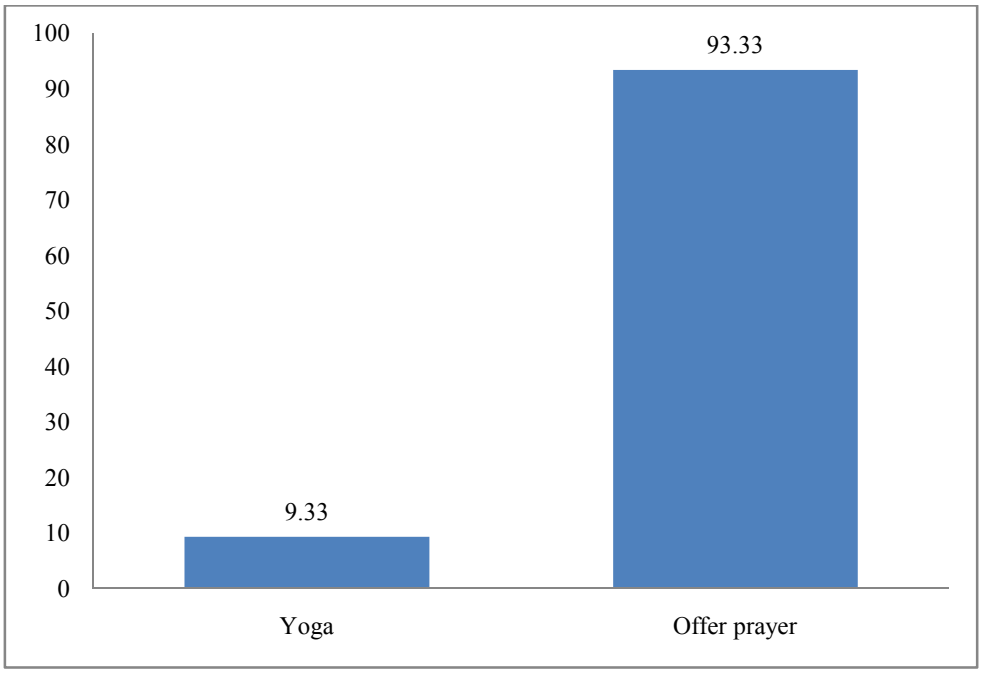


Figure 4.13: Percentage distribution of workers based on coping strategies (religious/meditation)

4.4.2 Reducing responsibilities

It was observed that the majority of garage workers (48%) were reducing responsibilities by postponing certain tasks, 21.33 per cent of garage workers were legitimately avoiding disliked tasks, 10.66 per cent were delegating the work and only 4 per cent of garage workers were changing their jobs from their present work.

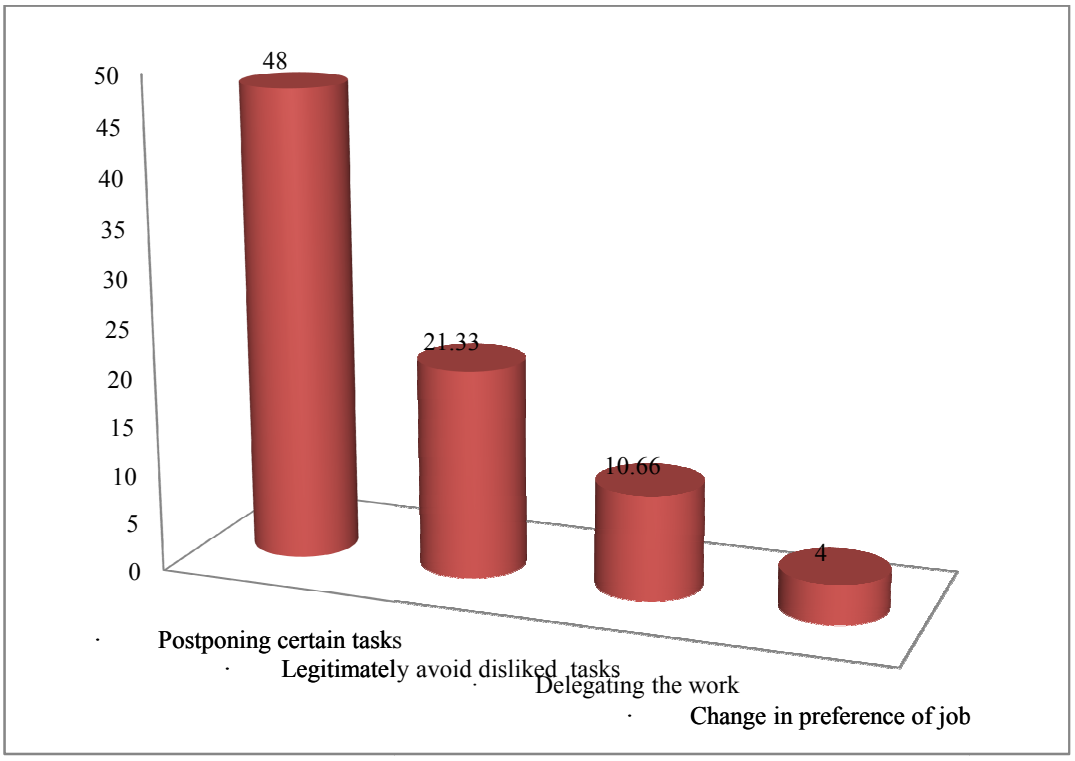


Figure 4.14: Percentage distribution of workers based on coping strategies (Reducing responsibilities)

4.4.3 Performing Most Liked Activities

Data regarding the performance of most liked activities revealed that 73.33 per cent of garage workers were watching T.v. 65.33 per cent of garage workers were listening to songs whereas 46.66 per cent of garage workers were spending time in the park with nature, 37.33 per cent of garage workers were doing the cooking, 33.33 per cent were doing gardening, 28 per cent were singing and 17.33 per cent were doing exercise as their most liked activities.

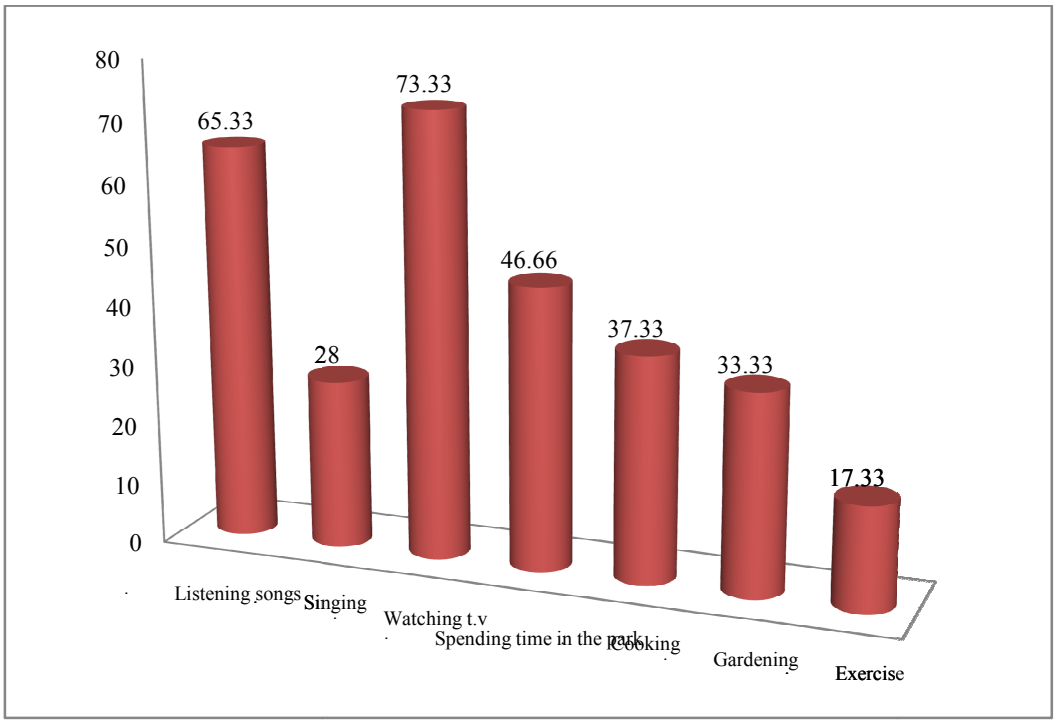


Figure 4.15: Percentage distribution of workers based on coping strategies (Performing Most Liked Activities)

4.4.4 Eating habits

A common form of smokeless tobacco is chewing tobacco. Smokeless tobacco products consist of tobacco or a combination of tobacco which, rather than smoked, is chewed, sucked on, or sniffed. Chewing tobacco raises the risk of certain health issues for consumers, like smoking. In the present report, when asked about their indulgence in tobacco chewing, the selected garage workers reported that 73.33 per cent of them used to chew tobacco daily most of the time.

Smoking is society's leading cause of preventable death. For example, blue-collar and service workers continue to smoke at higher rates than white-collar and professional workers **(Fagan *et al* ., 2004).**

The overall collected data shown in table 4.11 revealed that 57.33 per cent of garage workers were involved in smoking and all of them have a habit of smoke after 60 minutes of wakeup. When enquired about the consumption of cigarettes/bidi per day, out of the total garage workers who were still in a regular habit of smoking,

58.13 per cent smoke less than 10 cigarettes/day, and 41.86 per cent smoke 11-20 cigarettes/ bidi per day.

In the present investigation of garage workers, the data collected from selected garage workers revealed that out of a total (75) garage workers, 60 per cent were found to be addicted to alcohol consumption. 22.22 per cent of garage workers consume alcohol daily and 77.77 per cent of garage workers consume alcohol 2-3 days per week.

As discussed previously, a similar study was carried out by **Pandey and Vinay (2014)**, who reported that smoking, tobacco chewing, and alcohol consumption was found to be 86.66 per cent, 81.66 per cent, and 76.66 per cent respectively among rice mill workers.

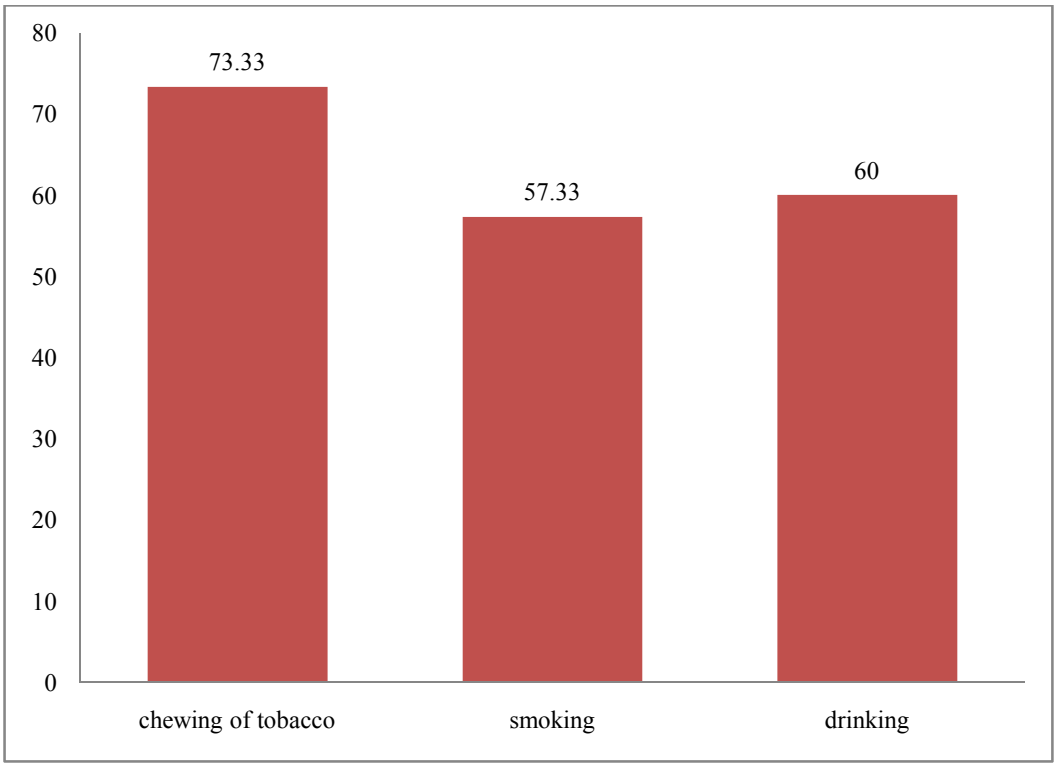


Figure 4.16: Percentage distribution of workers based on coping strategies (Eating habits)

Table 4.11 Distribution of garage workers as per stress coping strategies

(n=75)

S.No.	Statements	Frequency	Percentage
1.	**Religious\meditation**		
	• Yoga	7	9.33
	• Offer prayer	70	93.33
2.	**Reducing responsibilities**		
	• Postponing certain tasks	36	48
	• Legitimately avoid disliked tasks	16	21.33
	• Delegating the work	8	10.66
	• Change in preference of job	3	4
3.	**Performing Most Liked Activities**		
	• Listening songs	49	65.33
	• Singing	21	28
	• Watching t.v	55	73.33
	• Spending time in the park	35	46.66
	• Cooking	28	37.33
	• Gardening	25	33.33
	• Exercise	13	17.33
4.	**Eating habits**		
	Chewing of tobacco	55	73.33
	• Monthly		
	• Fortnightly		
	• Weekly		
	• Daily	55	100
	• Occasionally		
	Smoking	43	57.33
	First cigarette \bidi of the day after wakeup		
	• Within 5 min		
	• 31-60 min		
	• After 60 min	43	100
	Number of cigarette\bidi per day		
	• 10 or less	25	58.13
	• 11-20	18	41.86
	• 21-30		
	• More than 30		
	Drinking	45	60
	• Daily	10	22.22
	• 2-3 times in a week	35	77.77
	• Weekly		
	• Monthly		

4.5 Work environment

The data collected from the total garage workers related to their working environment revealed that 93.33 per cent of respondent were regular, permanent employee, 4 per cent worked as an independent contractor, independent consultant, or freelance worker, and only 2.66 per cent of the respondent worked for a contractor who provides services to others under contract.

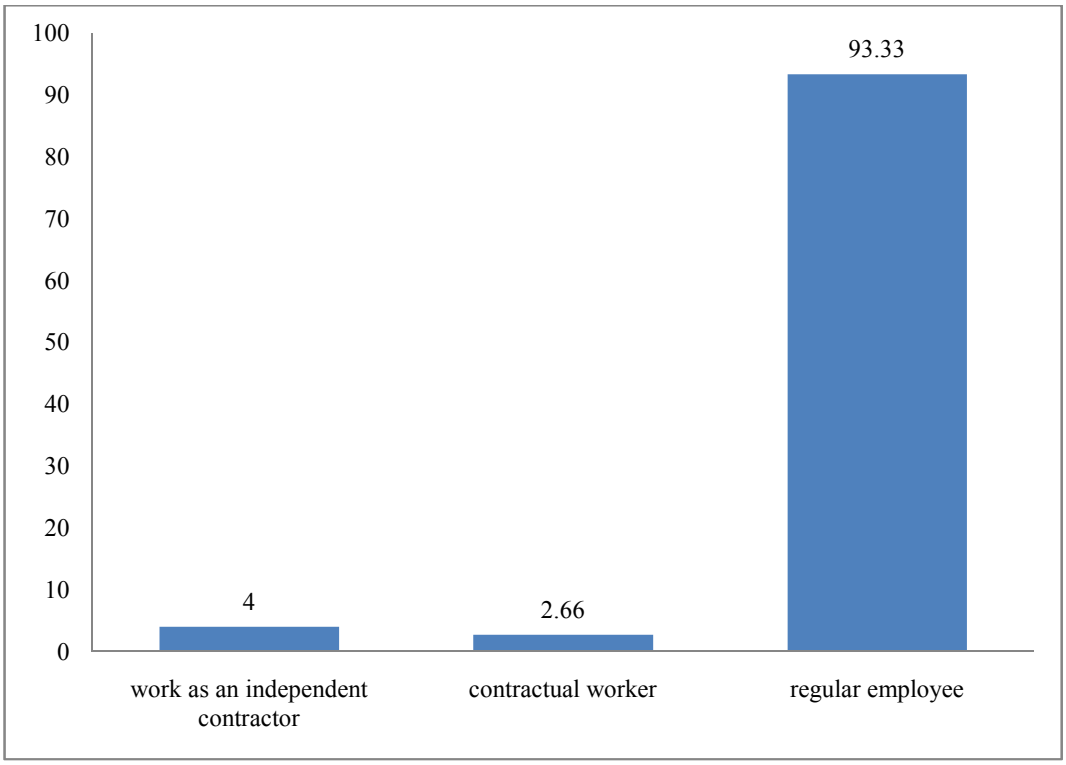


Figure 4.17: Percentage distribution of workers based on work arrangement in the main job

In terms of mode of payment, it is found that 66.66 per cent of garage workers received their payment monthly whereas only 33.33 per cent of garage workers received it daily.

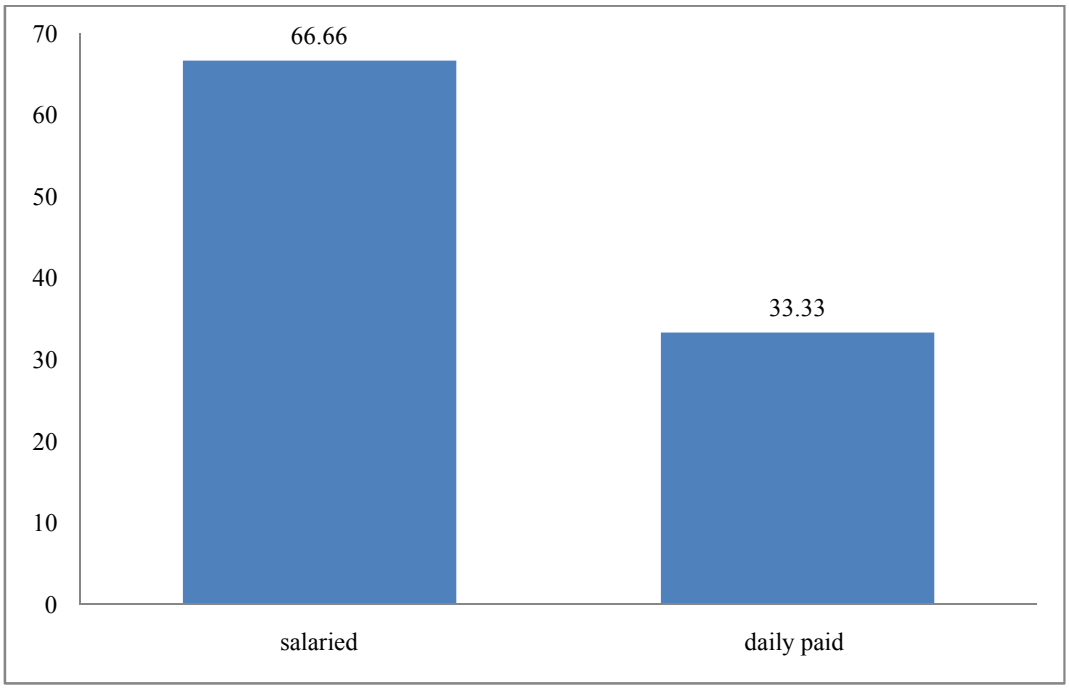


Figure 4.18: Percentage distribution of workers based on salary or wages

Only 12% of garage workers work besides their main job or do any other work for payment.

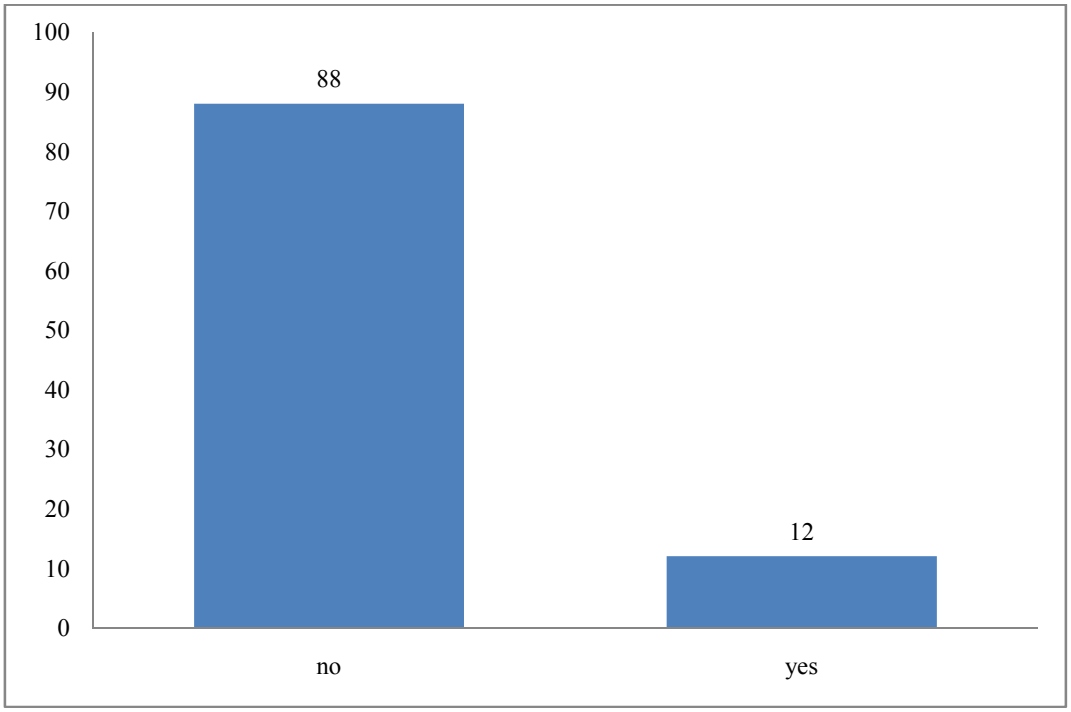


Figure 4.19: Percentage distribution of workers based on jobs besides the main job

It was found that 69.33 per cent of garage workers were trained for garage work where 30.66 per cent do not have any skill, education, diploma, and training for garage work.

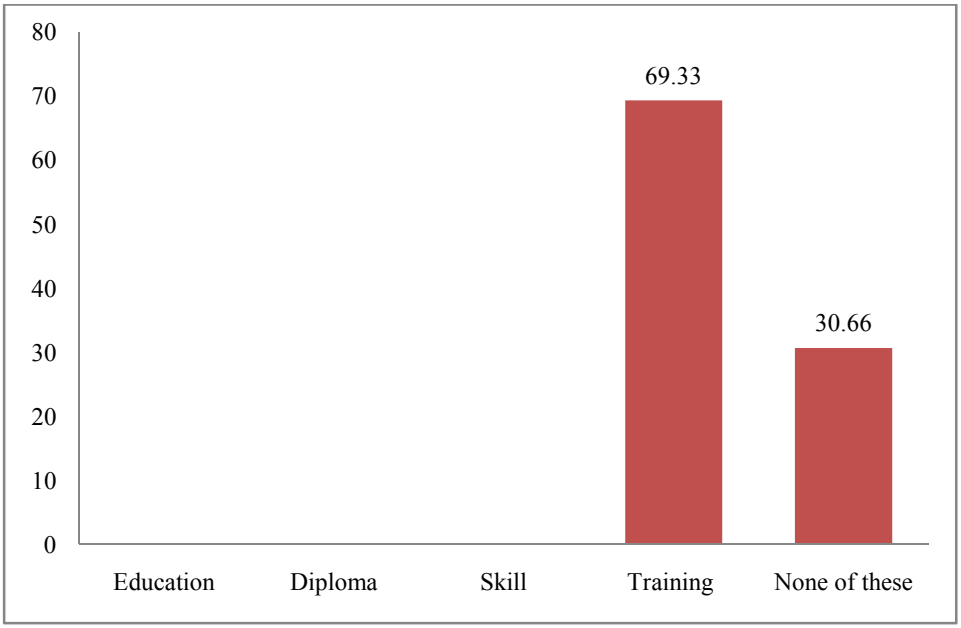


Figure 4.20: Percentage distribution of workers based on essential skills or qualifications

When data gathered related to the task done, it revealed that 73.33 per cent of garage workers were doing technical work,12 per cent denting work 9.33 per cent painting work, 2.66 per cent involved in electrical work, and only 1.33 per cent of garage workers were equal in welding and washing work.

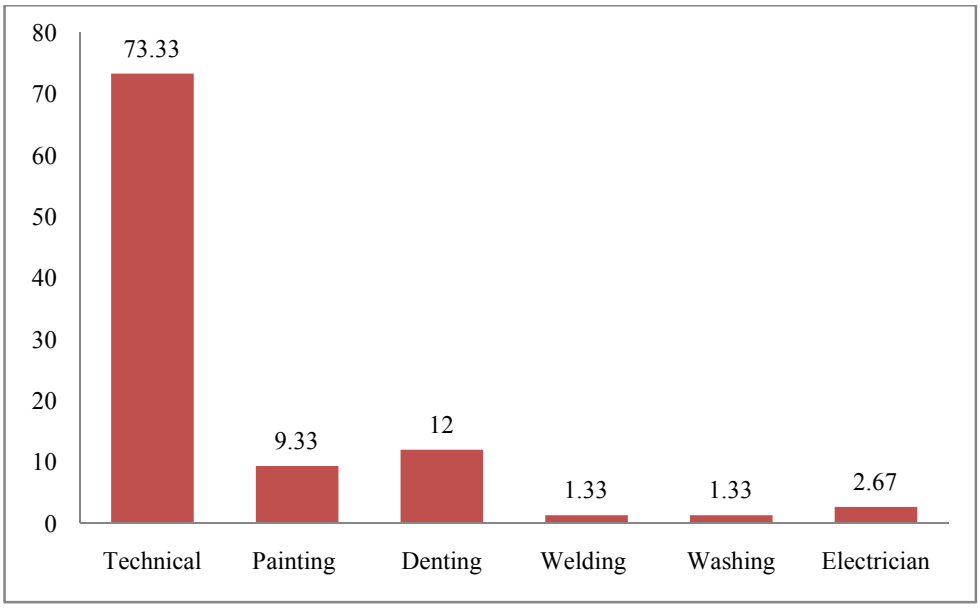


Figure 4.21: Percentage distribution of workers based on work expert

The majority of garage workers 34.66 per cent had 5-9 years of work experience, 20 per cent has 10-14 years, 17.33 per cent were 20-24 years, 10.66 per cent were 15-19 years, 8 per cent were 30-34 years, 5.33 per cent were 25-29 per cent, 2.666 per cent of 40-44 years, and only 1.333 per cent were having 35-39 years of experience.

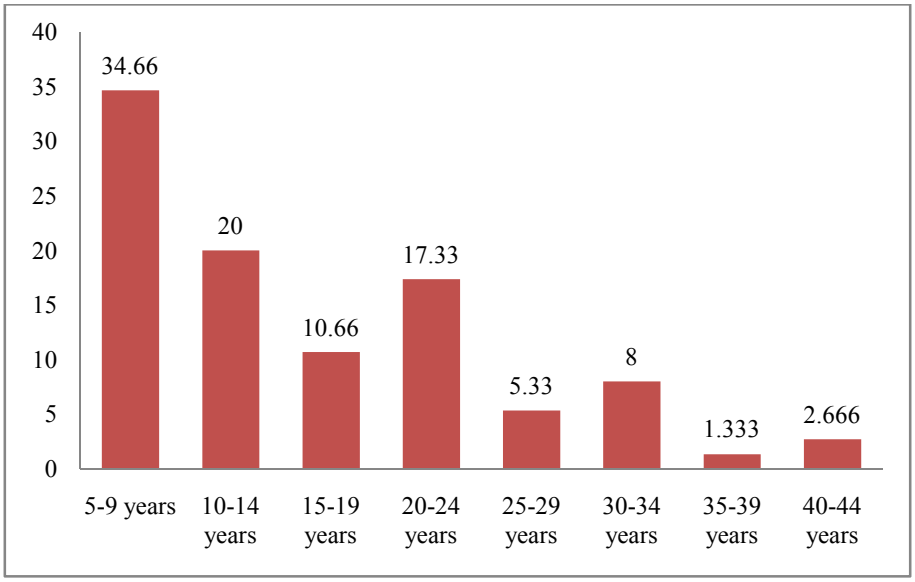


Figure 4.22: Percentage distribution of workers based on work experience

Responses related to the number of working hours showed that the majority of garage workers 80 per cent had long working hours per day which means they worked 2-8 hours/ day and 20 per cent had very long working hours per day that means 8-12 hours/day.

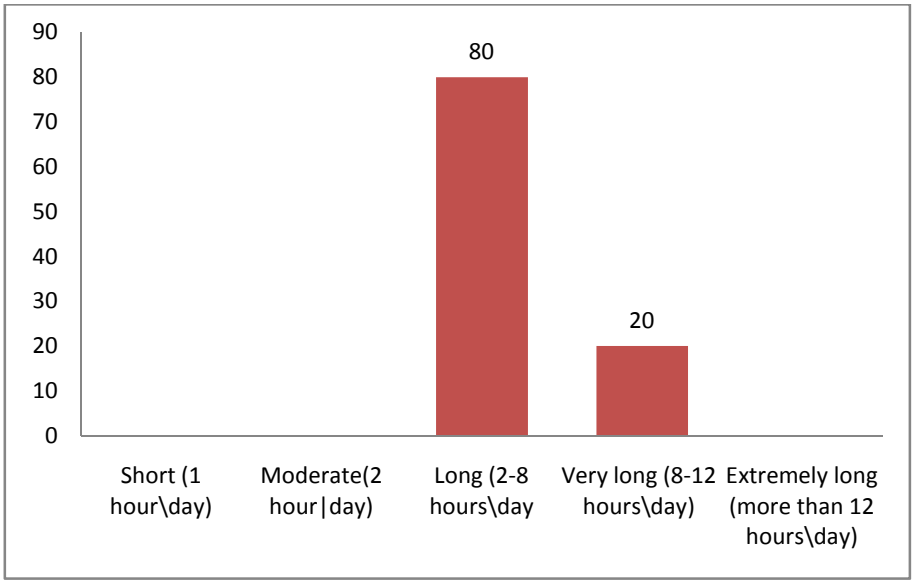


Figure 4.23: Percentage distribution of workers based on working hours

When enquired about a working experience in the present job it was found that 70.66 per cent of garage workers work experience up to 1-10 years, 12 per cent garage workers have had the experience of 11-20 years, 8 per cent garage workers had less than 12 months or 21-30 years and 1.33 per cent worked 31-40 years for their current employers.

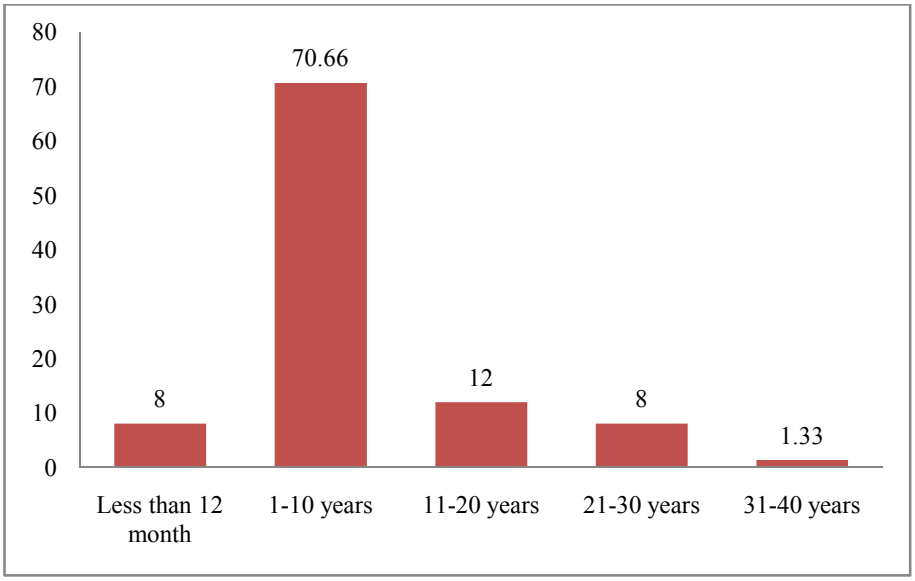


Figure 4.24: Percentage distribution of workers based on working experience in the present job

When data was gathered related to the usual work schedule of the garage workers it was found that the majority of garage workers 97.33 per cent had a day shift whereas only 2.66 per cent had irregular shift/on-call.

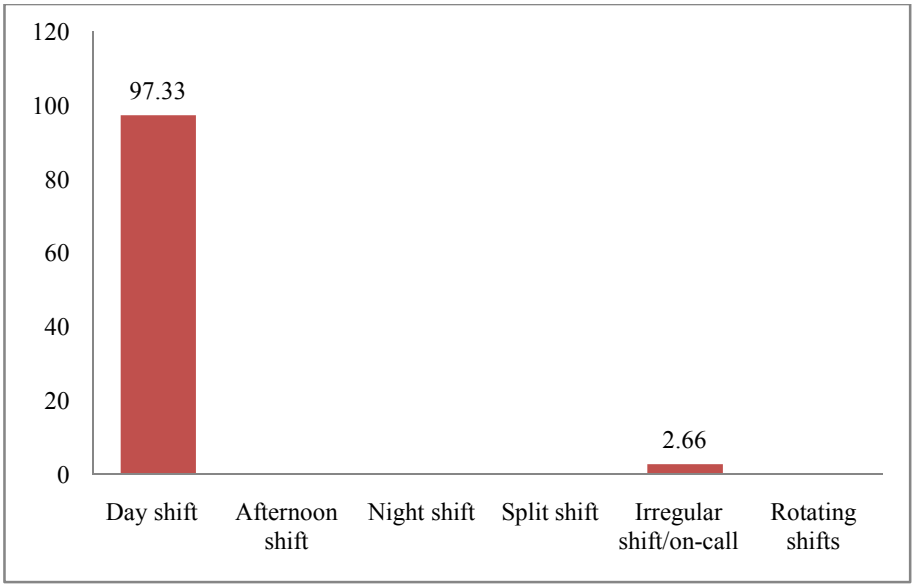


Figure 4.25: Percentage distribution of workers based on the usual work schedule

The majority of garage workers 86.66 per cent rarely change their starting and quitting times daily, 10.66 per cent of garage workers sometimes and only 2.66 per cent of garage workers never change their starting and quitting times daily.

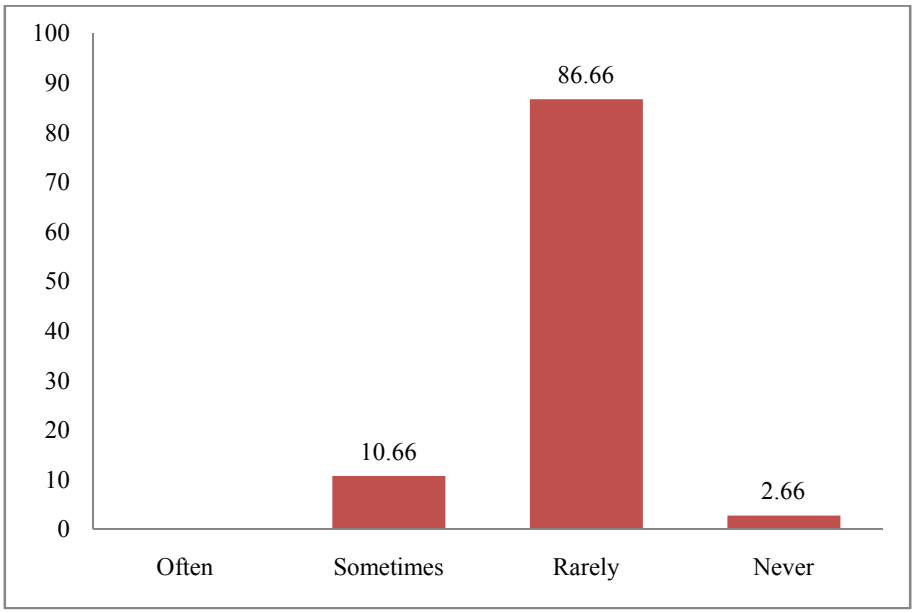


Figure 4.26: Percentage distribution of workers based on the change in starting and quitting times daily

Furthermore, all workers (100 per cent) reported that 4 off days per month they had and no seasonal off period.

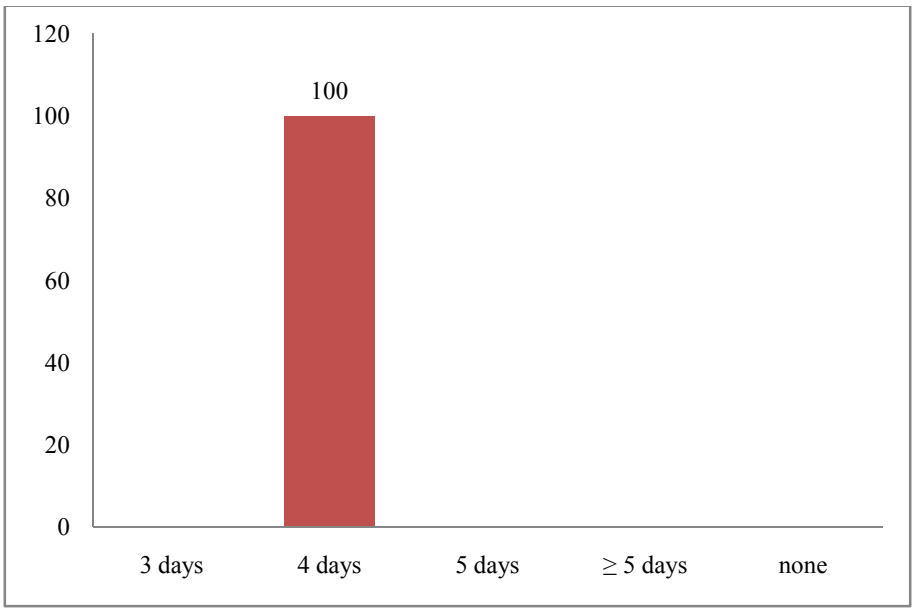


Figure 4.27: Percentage distribution of workers based on off days per month

Figure 4.28: Percentage distribution of workers based on seasonal off period

The majority of garage workers 59 per cent had prescribed (schedule) rest is taken and 48 per cent had rest according to their work condition (not fixed).

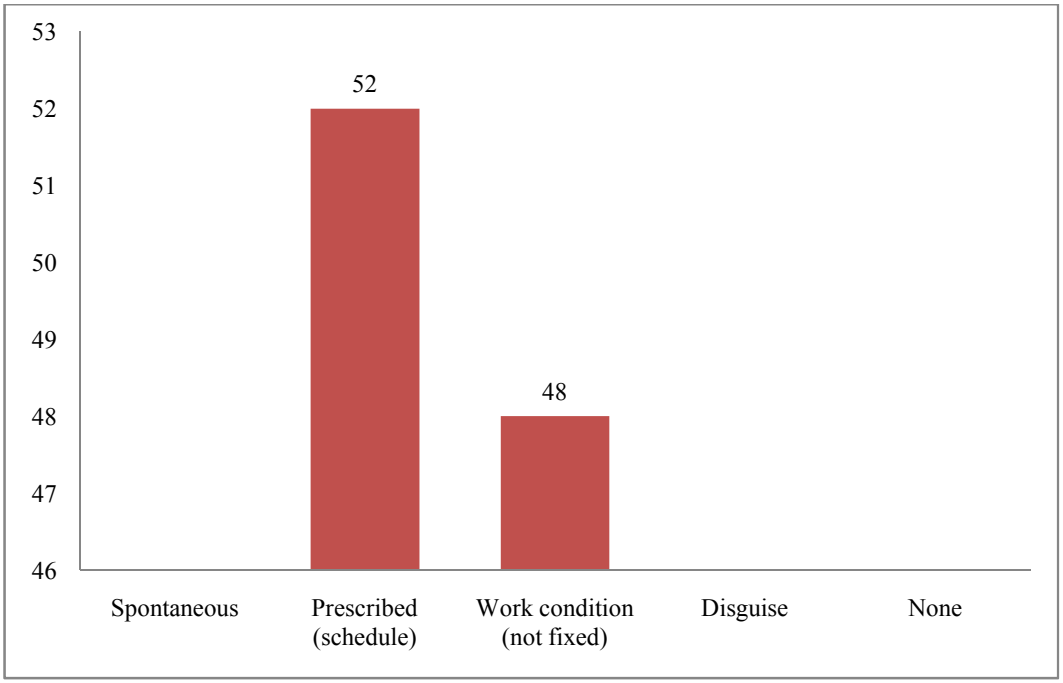


Figure 4.29: Percentage distribution of workers based on rest taken

Table 4.12: Distribution of garage workers based on the working environment of the workers

(n=75)

S.No	Statements	Frequency	Percentage
1.	**How would you describe your work arrangement in your main job?**		
a)	Work as an independent contractor, independent consultant, or freelance worker	3	4
b)	I am on-call and work only when called to work		
c)	I am paid by a temporary agency		
d)	I work for a contractor who provides workers and services to others under contract	2	2.66
e)	I am a regular, permanent employee (standard work arrangement)	70	93.33
2.	**In your main job, are you salaried, paid by the hour, or what?**		
a)	Salaried	50	66.66
b)	Paid by the day	25	33.33
c)	Other (SPECIFY): _____		
3.	**Do you have any jobs besides your main job or does any other work for pay?**		
a)	Yes	9	12
b)	No	66	88
4.	**Essential skills or qualifications:**		
a)	Education		
b)	Diploma		
c)	Skill		
d)	Training	52	69.33
e)	None of these	23	30.66
5.	**Expert in:**		
a)	Technical	55	73.33
b)	Painting	7	9.33
c)	Denting	9	12

d)	Welding	1	1.33
e)	Washing	1	1.33
f)	Electrician	2	2.67
g)	Any other specify		
6.	**Work experience**		
a)	5-9 years	26	34.66
b)	10-14 years	15	20
c)	15-19 years	8	10.66
d)	20-24 years	13	17.33
e)	25-29 years	4	5.33
f)	30-34 years	6	8
g)	35-39 years	1	1.333
h)	40-44 years	2	2.666
7.	**Working hours**		
a)	Short (1 hour\day)		
b)	Moderate(2 hour|day)		
c)	Long (2-8 hours\day	60	80
d)	Very long (8-12 hours\day)	15	20
e)	Extremely long (more than 12 hours\day)		
8.	**How long have you worked in your present job for your current employer?**		
a)	Less than 12 month	6	8
b)	1-10 years	53	70.66
c)	11-20 years	9	12
d)	21-30 years	6	8
e)	31-40 years	1	1.33
9.	**Which of the following best describes your usual work schedule?**		
a)	Day shift	73	97.33
b)	Afternoon shift		
c)	Night shift		
d)	Split shift		
e)	Irregular shift/on-call	2	2.66
f)	Rotating shifts		

10.	**How often are you allowed to change your starting and quitting times daily?**		
a)	Often		
b)	Sometimes	8	10.66
c)	Rarely	65	86.66
d)	Never	2	2.66
11.	**Off days per month**		
a)	3 days		
b)	4 days	75	100
c)	5 days		
d)	≥ 5 days		
e)	none		
12.	**Seasonal off period**		
a)	Winter(December- Early March)		
b)	Summer (March-June		
c)	Rainy (June-October)		
d)	Autumn (October-December)		
e)	None	75	100
13.	**Rest is taken**		
a)	Spontaneous		
b)	Prescribed (schedule)	39	52
c)	Work condition (not fixed)	36	48
d)	Disguise		
e)	None		
14	Length of resting period between activities		
15	Length of resting period in different activities		

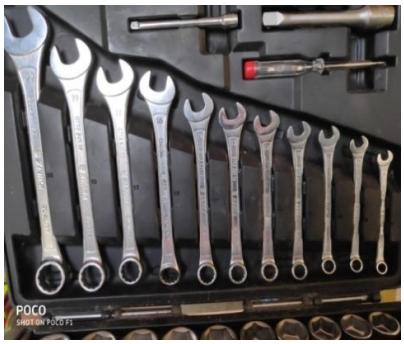
Data about the length of resting periods between different activities of garage workers showed that the scheduled rest period. Workers had at least a 30-minutes meal break with a 15-minutes tea break.

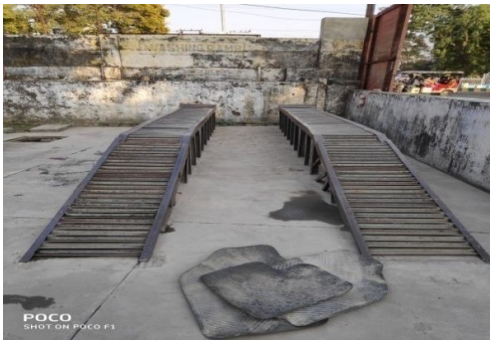
4.5.1 Tools and equipment used

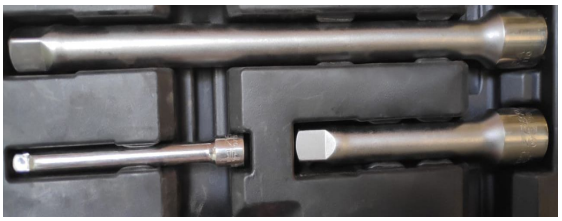
Various tools and equipment are being used by the garage workers to carry out their job. The garage workers were asked about the functioning of the tool they were using. Table 4.13 shows the picture of the tools used along with their details.

Table 4.13: Tools and equipment used by the garage workers

Tools & equipment name	Tools	Task performed
(oil pana)		Oil pana is attached to the bottom of the engine with bolts in this reservoir for oil that gets pumped throughout the engine to lubricate, clean, and cool moving parts.
Oil filter wrench (filter pana)		For removing spin-on type oil filters
open-ended wrench (chabi)		Used for hardening & fasten nuts and bolts, and the open design makes it possible to attach itself either vertically or horizontally onto the target fitting.
Screwdriver		Used for handling the screws

Combined wrench (chabi)		Used for difficult nuts, the closed-end loosens the nut so that the open end can be used to quickly unscrew it.
Wheel balancer		Tire balancing is the process of equalizing the weight of the combined tire and wheel assembly so that it spins smoothly at high speed.
Vacuum cleaner		Used for cleaning the indoor area of the car.
Two post lift		Provide access to the underside area of the vehicle for many types of service.

air compressor		Used for touch up paints on a car with the help of spray gun, inflate the tires, remove the dirt and debris and remove loose surface rust
Electric sander		Used for car polishing
Ramp		Car ramp provides a simple method of raising an automobile from the ground to access the undercarriage
Bits		It applies torque to the screw
Plier plas		Used for gripping, twisting wires, and cutting the wires.

Lug wrench		They are used for tightening or loosening the lug nuts.
Line tester		Used for detecting voltage and current.
Tire changers		A tire changer is a machine used by the tire technicians to dismount and mount tires with automobile wheels
smoke meter		Smoke meters are also referred to as opacity meters. Used to detect and measure the amount of light blocked due to smoke emitted by diesel engines from cars, trucks, ships, buses, motorcycles, locomotives, and large stacks from industrial operations.

4.6 Awareness of occupational hazards

In the study it was investigated that majority of garage workers were aware of occupational hazard by electrical current (72%), followed by sharp metals (64%), welding fumes (62.66%), heat (60%), sparks, and light/radiation (56%), chemicals (54.66%) and (46.66%) vibration.

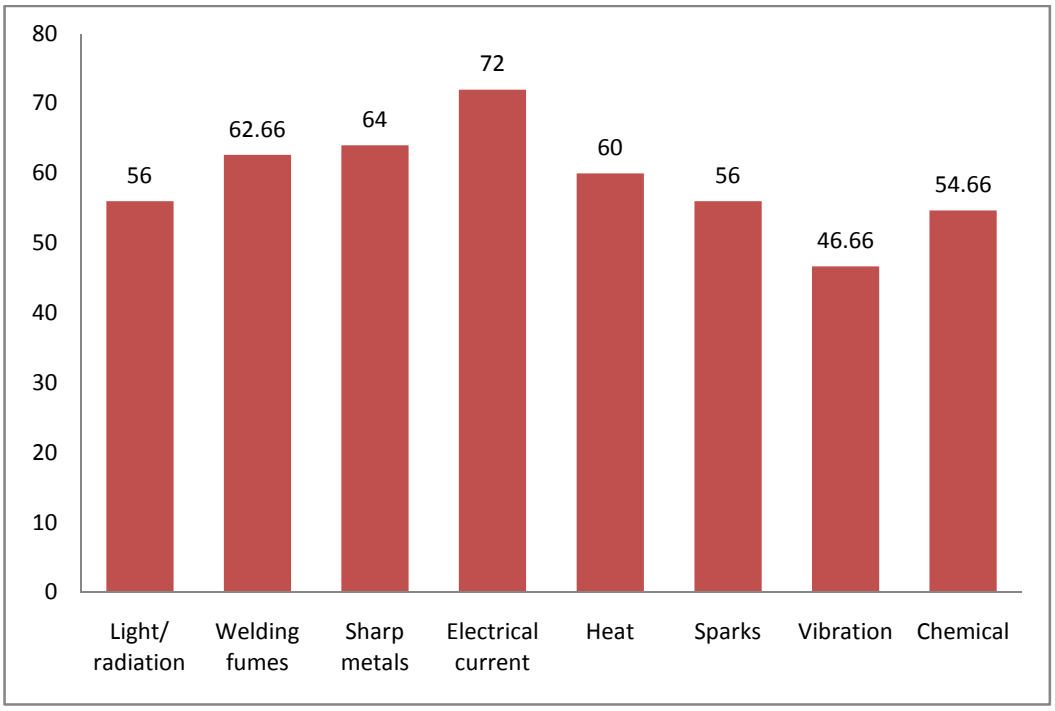


Figure 4.30: Percentage distribution of workers based on awareness of occupational hazards

Table 4.14: Awareness of occupational hazard

(n=75)

S.No	Statement	Frequency	Percentage
1.	Light/ radiation	42	56
2.	Welding fumes	47	62.66
3.	Sharp metals	48	64
4.	Electrical current	54	72
5.	Heat	45	60
6.	Sparks	42	56
7.	Vibration	35	46.66
8.	Chemical	41	54.66

4.7 Use of Personal Protective Equipment

In the investigation, it was reported that the majority of the workers i.e, 53.33 per cent were using PPE (personal protective equipment) clothing followed by hard hats (41.33%), shoes (40%), gloves (33.33%), mask (26.66%), and goggles (24%).

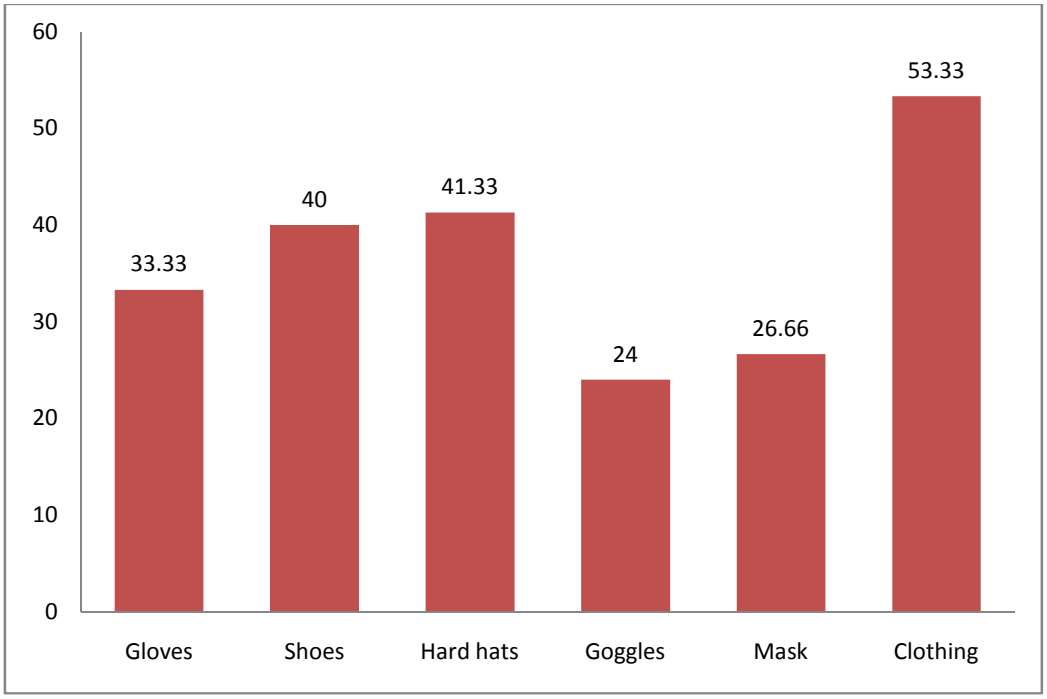


Figure 4.31: Percentage distribution of workers based on the use of Personal Protective Equipment

Table 4.15: Use of Personal Protective Equipment by garage workers (n=75)

S.No	PPE	Frequency	Percentage
1.	Gloves	25	33.33
2.	Shoes	30	40
3.	Hard hats	31	41.33
4.	Goggles	18	24
5.	Mask	20	26.66
6	Clothing	40	53.33

4.8 Assessment of Musculoskeletal Discomfort (MSD)

WMSDs (Working Musculoskeletal Disorders) is a global problem in both developed and developing countries. Musculoskeletal disorder is the term assigned to

several physical disorders which affect the human body movement or musculoskeletal system involving the joints, limbs, and muscles which are also known as RSI (Repetitive Strain Injury), ULD (Upper Limb Disorder) and WRULD tenosynovitis, carpal tunnel syndrome, writer's cramp, tendonitis, and tennis elbow. Symptoms include numbness, paresthesia, discomfort or aching, muscle fatigue, loss of job accident reduction services in industrially developed countries have resulted in a very high prevalence of MSD. Risk factors for WMSD include occupational activities such as heavy load carrying, routine activity such as heavy load loading, repeated duties, and uncomfortable working postures. Relevant predictive variables are now considered to have population features and psychosocial influences **(Haynes and Williams, 2008).**

The musculoskeletal issues and body pain encountered during MMH (Manual Material Handling) activity with various perspectives were calculated by the use of a Standardized Nordic Questionnaire. The research also documented an appreciable amount of musculoskeletal issues, such as back pain and pain in the upper limbs and side. Common causative for upper extremity musculoskeletal disorders include biomechanical factors (force, repetition, stance, and psychosocial factors (job stress) as stated by **Morse *et al.* (2007)** and **Menzel and Cohn (2007)** also established the role of psychosocial influences (job pressure, social work support, and job dissatisfaction) in musculoskeletal disorders. He also recommended steps to minimize the occurrence of musculoskeletal conditions with the aim to resolve the psychosocial risk factors to discourage prolonged recovery. **William *et al.*(2007)** carried out a thorough analysis of the psychometric appraisal of health-related work outcome measures for musculoskeletal disorders.

4.8.1 Perceived Body Discomfort

Maintaining a constant pose for extended periods is tiresome and increases the risk of body aches and pains. **Yu and Wong (1996)** observed in a review that regular users of VDUs have slight musculoskeletal issues in the neck and shoulder than infrequent users. Individual musculoskeletal symptoms were associated with different risk factors, including personal characteristics, working posture, repetitive motions, and the nature of the workstation. Back, neck, and shoulder issues were more related to adverse working postures, white limbs, hand, and wrist issues were more affected by repeated movements.

Work-related musculoskeletal disorders and perceived body pain among employees were calculated by the execution of a structured Nordic questionnaire. Workers were asked a few questions about reported pain/discomfort that lasted for at least 24 hours. Pain has been assessed for the last 12 months, 1 month, and 7 days.

The work-related musculoskeletal problems and the perceived body discomfort by the workers were determined by administering a Standardized Nordic questionnaire. Workers were asked a few questions about perceived pain/discomfort, which lasted, for at least 24 hours. The pain was measured for the past 12 months, one month, and 7 days.

All of the selected garage workers gave their responses, which were analyzed and the outcome (Table 4.15) indicates that the majority of garage workers felt pain and discomfort in various areas of the body.

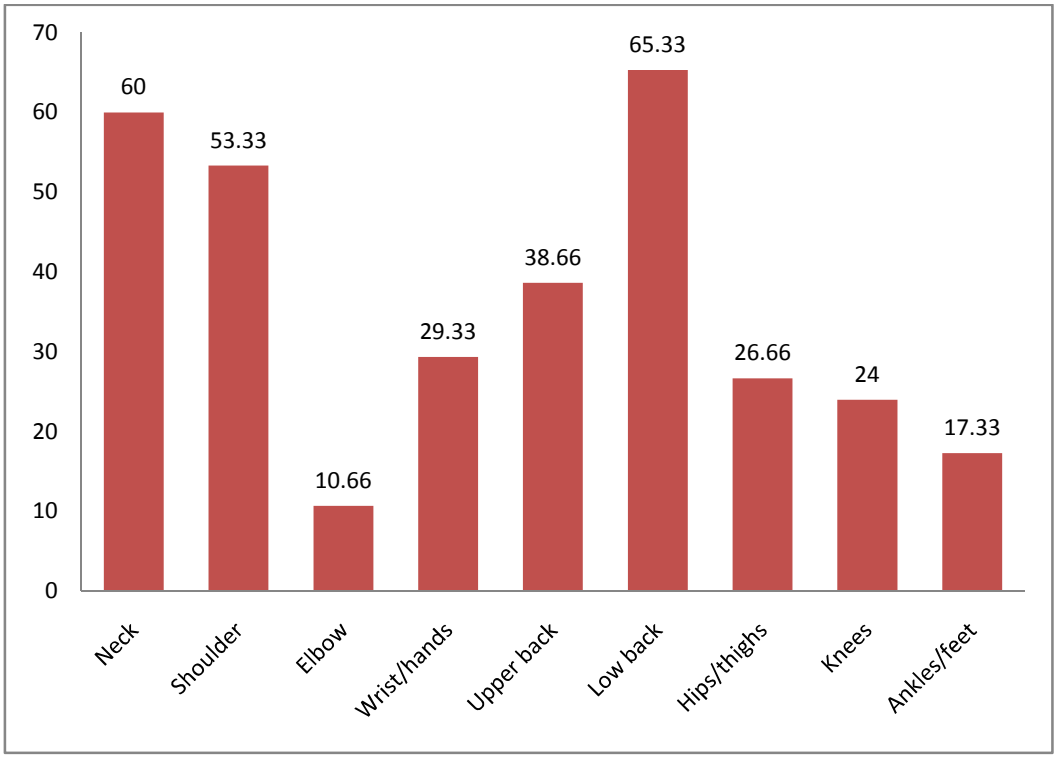


Figure 4.32: Prevalence in last 12 months musculoskeletal pain /discomfort as reported by garage workers

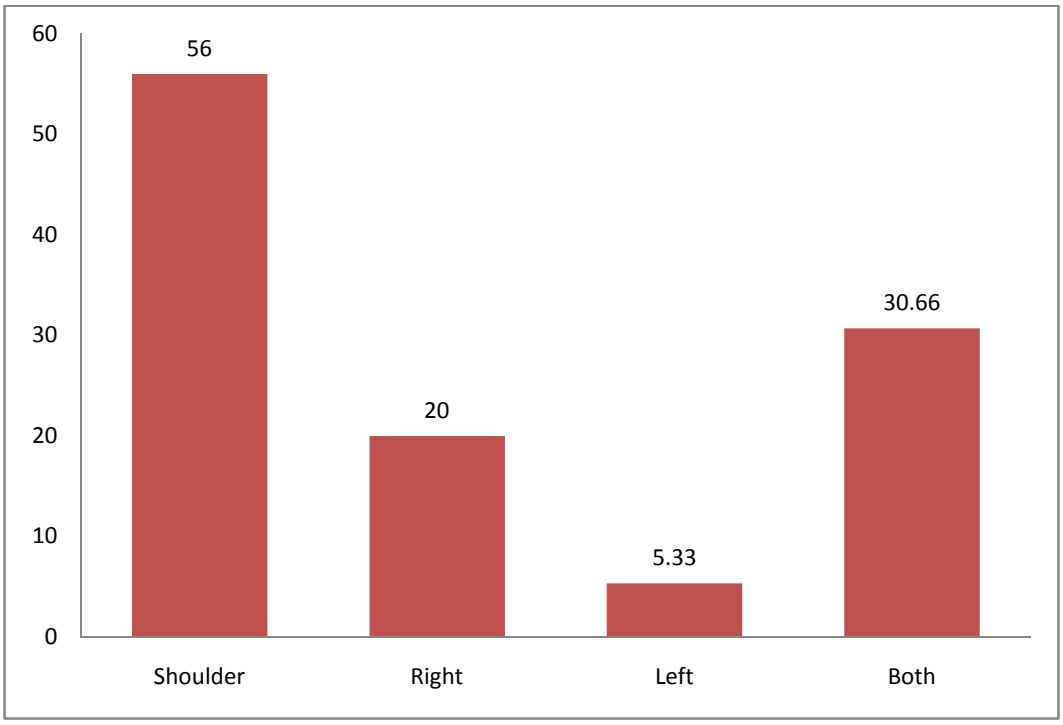


Figure 4.33: Prevalence in last 12 months musculoskeletal pain /discomfort in shoulders (right, left and both)

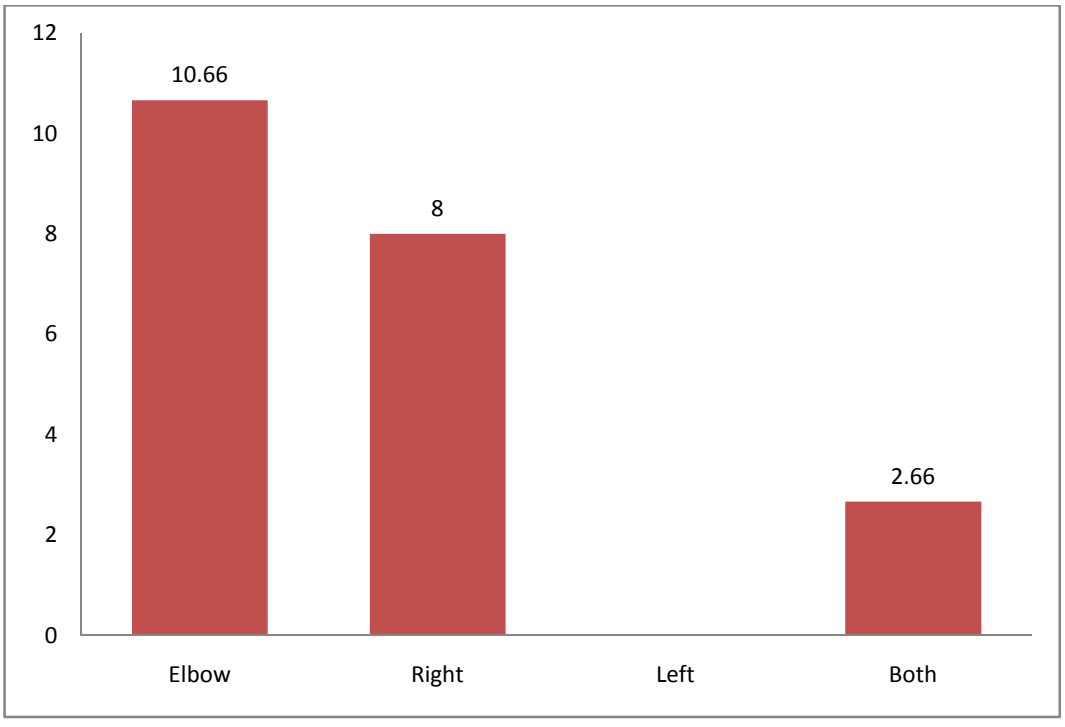


Figure 4.34: Prevalence in last 12 months musculoskeletal pain /discomfort in elbows (right, left and both)

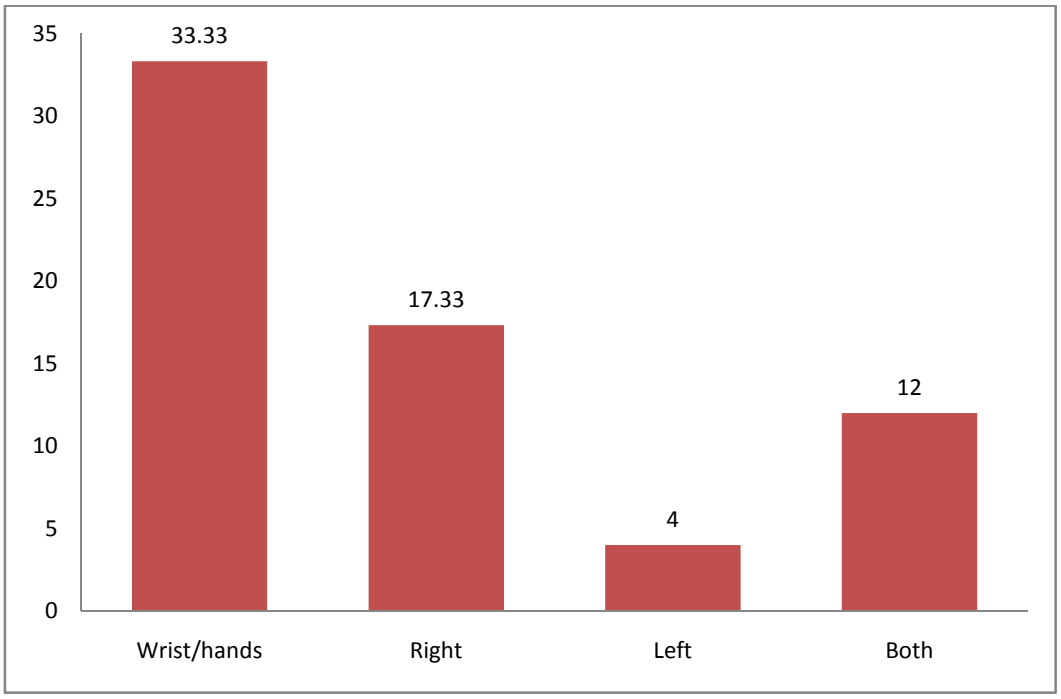


Figure 4.35: Prevalence in last 12 months musculoskeletal pain /discomfort in wrists/hands (right, left and both)

Table 4.16: Prevalence in last 12 months musculoskeletal pain /discomfort as reported by garage workers

(n=75)

Body parts	Frequency	Percentage
Neck	48	61.33
Shoulder	42	56
• Right	15	20
• Left	4	5.33
• Both	23	30.66
Elbow	8	10.66
• Right	6	8
• Left		
• Both	2	2.66
Wrist/hands	25	33.33
• Right	13	17.33
• Left	3	4
• Both	9	12
Upper back	30	40
Low back	49	65.33
Hips/thighs	21	28
Knees	20	26.66
Ankles/feet	15	20

Data revealed that during the last 12 months 61.33 per cent of the garage workers reported pain in neck pain and 20 per cent, 5.33 per cent, and 30.66 per cent in the right shoulder, left shoulder, and both shoulders respectively. Garage workers had pain in the right elbow (8%) whereas 2.66 per cent of the garage workers reported pain in both elbows.

Garage workers had 17.33 per cent pain/discomfort in right wrist/hand, 4 per cent in left wrist/hand, and 12 per cent in both wrist/hand. 40 per cent, 65.33 per cent, 28 per cent, 26.66 per cent, and 20 per cent of garage workers pain and discomfort in the upper back, low back, hips/thighs, knees, and ankles/feet respectively.

4.8.2 Prevalence of one month perceived musculoskeletal pain/discomfort

When enquired about the occurrence of pain/discomfort during last month total of 60 per cent of the garage workers complained of neck pain and 20 per cent, 2.66 per cent, and 30.66 per cent of garage workers complained of pain and discomfort in right, left, and both shoulder respectively. On the other hand, only 6.66 per cent of garage workers complained of pain in the right elbow, whereas 2.66 per cent of garage workers reported pain in both elbows.

Garage workers also reported pain/discomfort in the right wrist/hand (14.66%), in the left (4%), and in both wrist/hand (12%). 38.66 per cent garage workers had pain/discomfort in the upper back, 65.33 per cent, 26.66 per cent, 24 per cent, and 17.33 per cent garage workers had pain/discomfort in, low back, hips/thighs, knees, and ankles/feet.

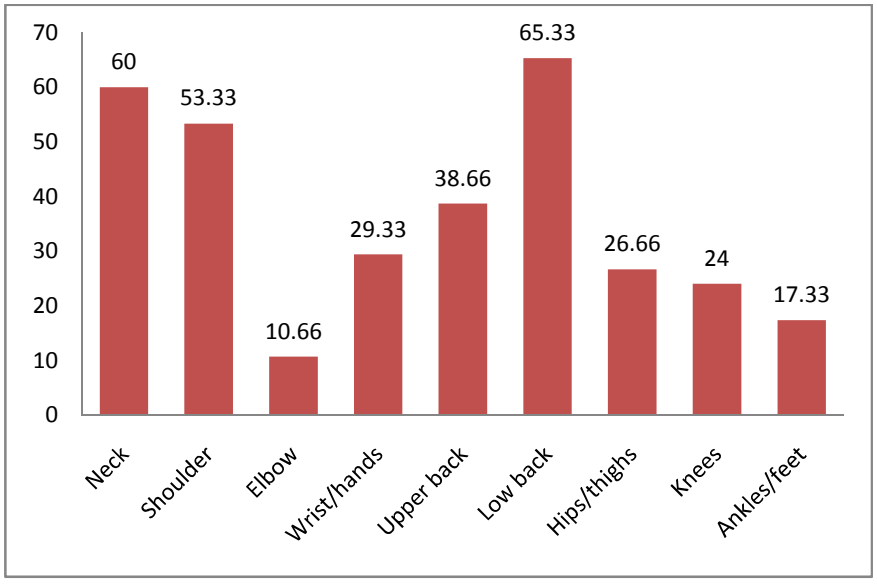


Figure 4.36: Prevention in their daily work activities during the last 1 month because of musculoskeletal disorder

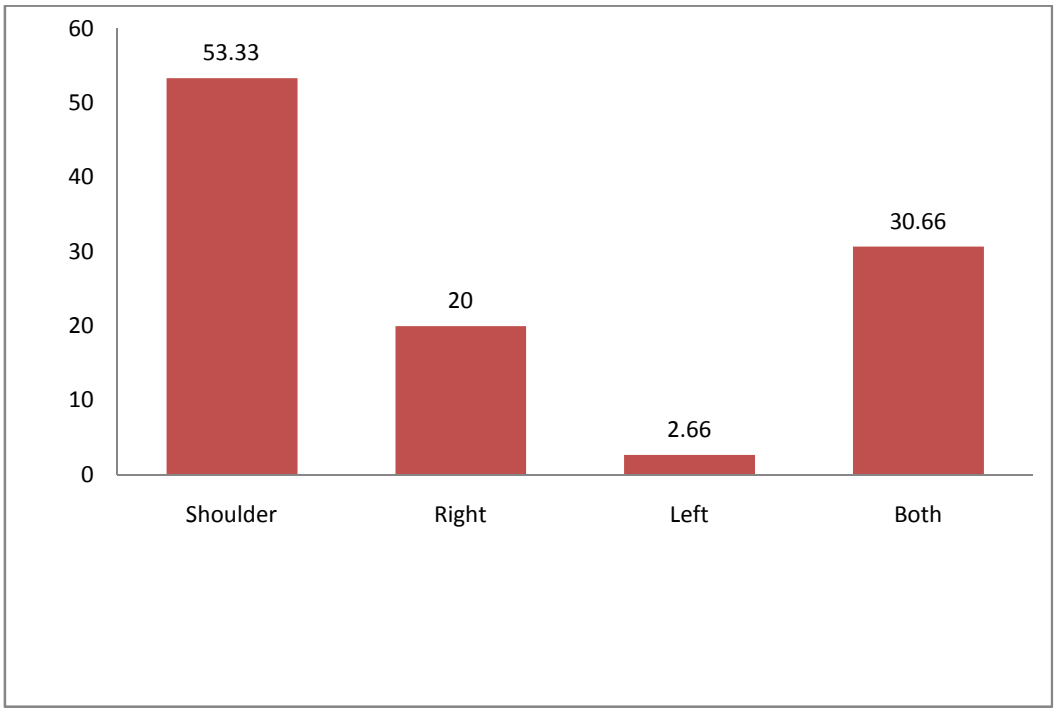


Figure 4.37: Prevention in their daily work activities during the last 1 month because of musculoskeletal disorder in shoulder (right, left and both)

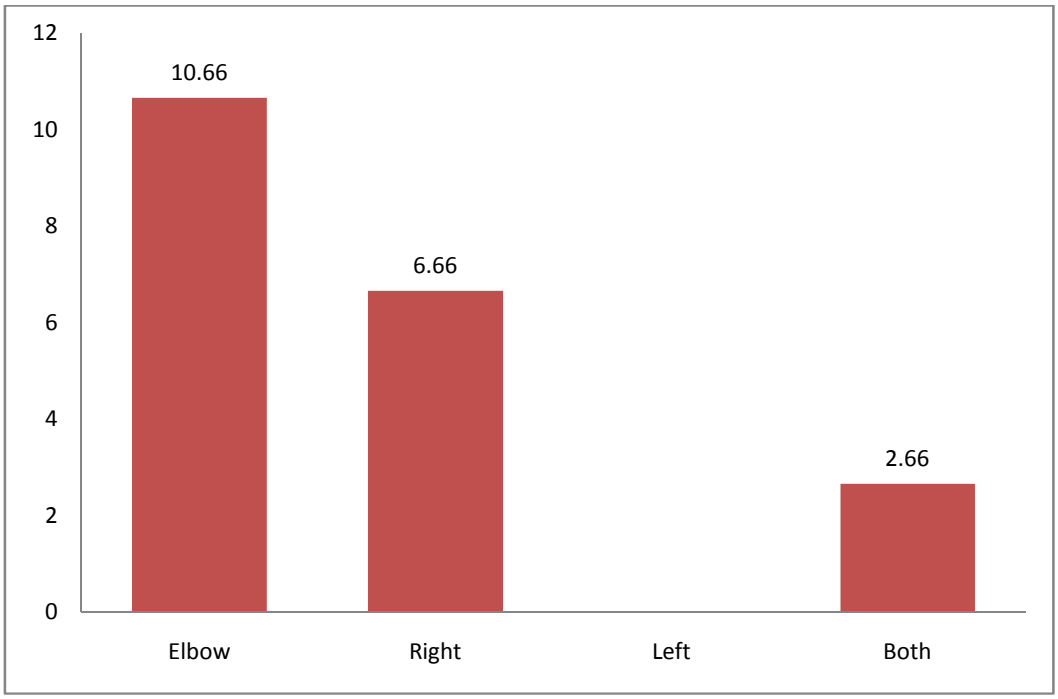


Figure 4.38: Prevention in their daily work activities during the last 1 month because of musculoskeletal disorder in elbow (right, left and both)

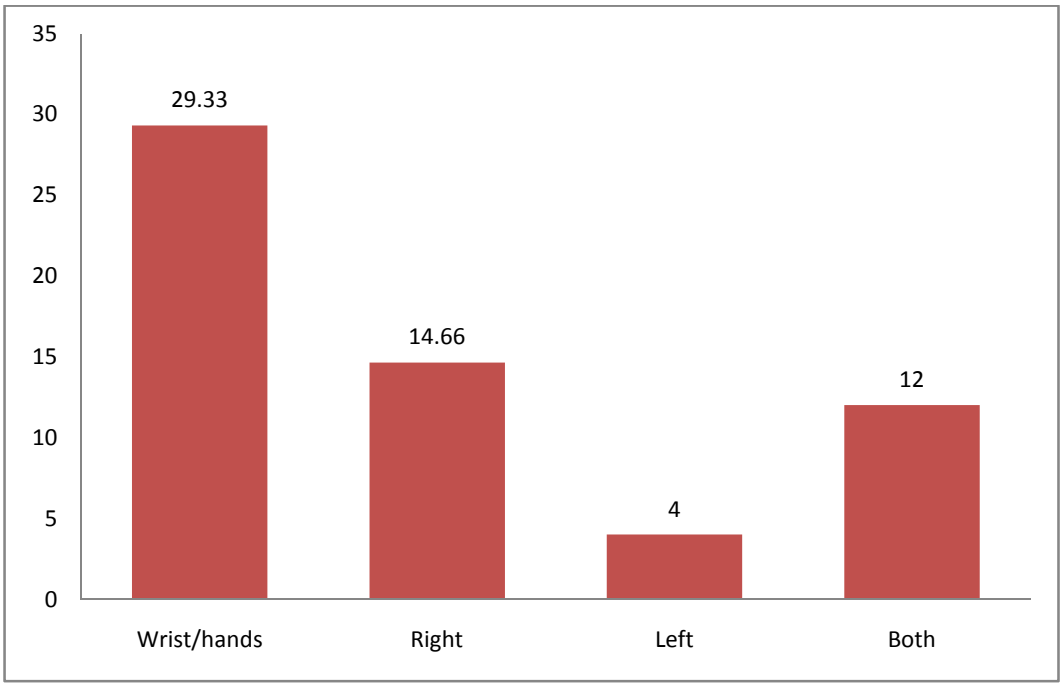


Figure 4.39: Prevention in their daily work activities during the last 1 month because of musculoskeletal disorder in wrist/hands(right, left and both)

Table 4.17: Prevention in their daily work activities during the last 1 month because of musculoskeletal disorder

(n=75)

Body parts	Frequency	Percentage
Neck	45	60
Shoulder	40	53.33
• Right	15	20
• Left	2	2.66
• Both	23	30.66
Elbow	8	10.66
• Right	5	6.66
• Left		
• Both	2	2.66
Wrist/hands	22	29.33
• Right	11	14.66
• Left	3	4
• Both	9	12
Upper back	29	38.66
Low back	49	65.33
Hips/thighs	20	26.66
Knees	18	24
Ankles/feet	13	17.33

4.8.3 Reporting of the feeling of trouble in the last 7 days

Data in table 4.18 investigated that 57.33 per cent of garage workers reported pain in the neck whereas 17.33 per cent reported pain in right, 2.66 per cent in the left, and 26.66 per cent in both shoulders during the last 7 days. On the other hand, 4 per cent of workers reported right elbow pain whereas only 2.66 per cent of garage workers complained of pain in both elbows. 18.66 per cent of garage workers had pain /discomfort in the right wrist/hands and 8 per cent of garage workers reported pain in both the wrist/hand.

About 34.66 per cent of garage workers reported upper back pain/discomfort, lower back (60%), hips/thighs (24%), knees (25.33%), ankles/feet (14.66%) in the last 7 days.

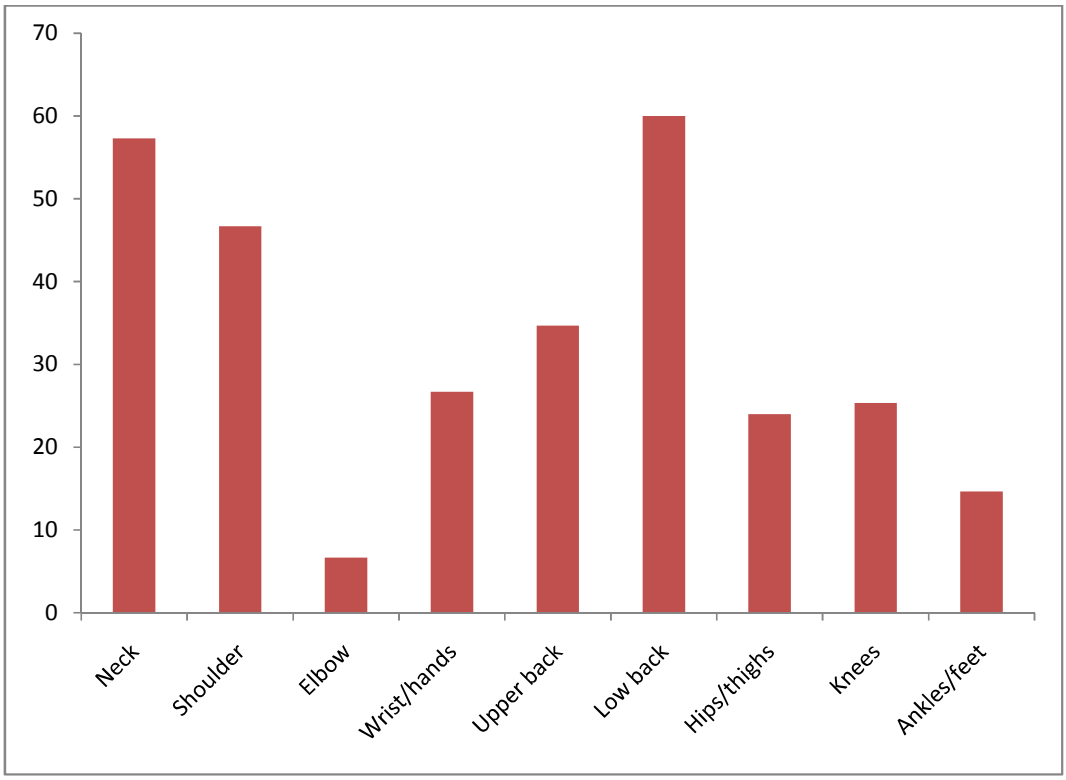


Figure 4.40: Distribution of garage workers as per feeling of trouble in the last 7 days

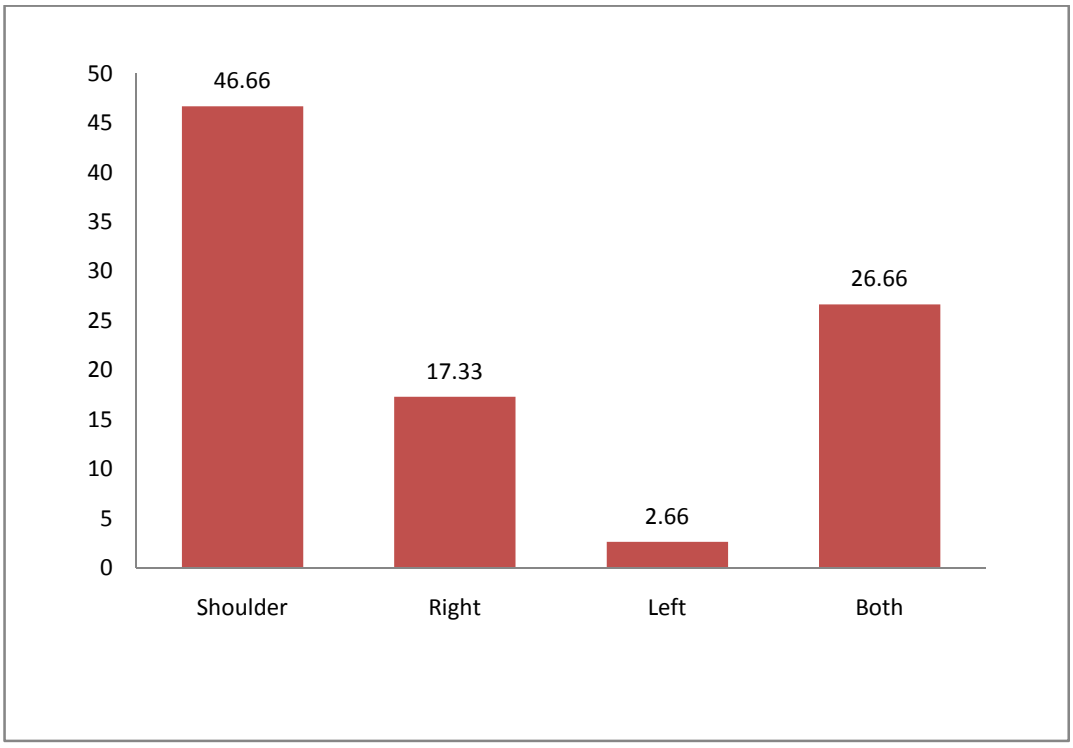


Figure 4.41: Feeling of trouble in the last 7 days in shoulder (right, left and both)

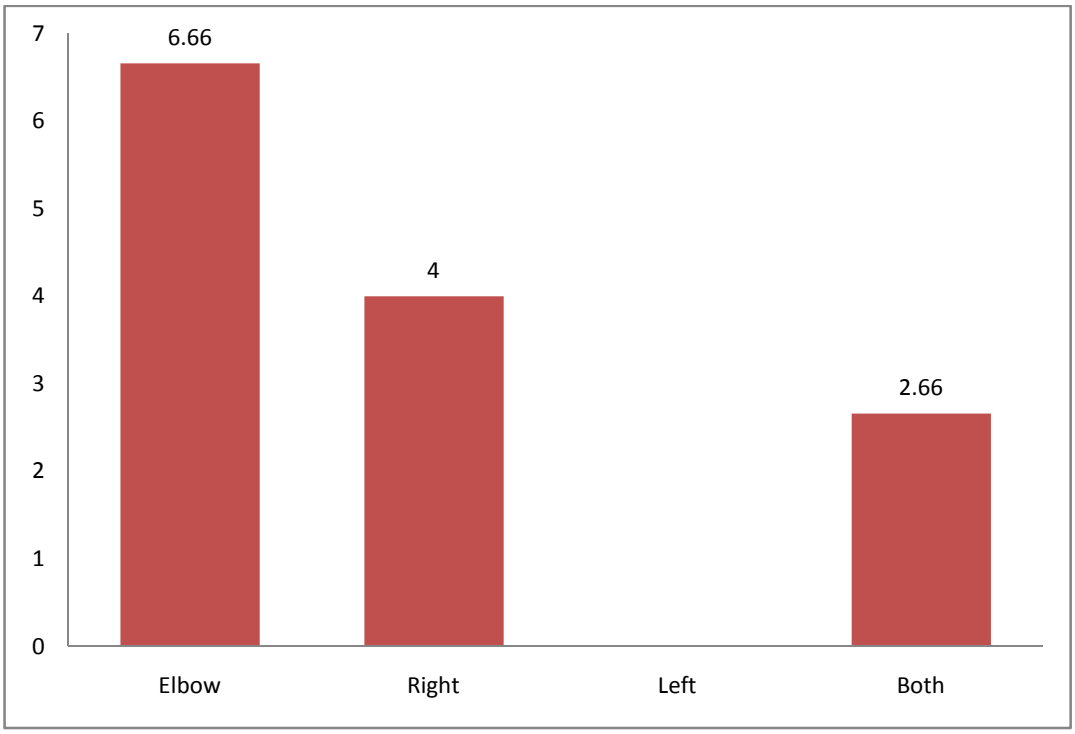


Figure 4.42: Feeling of trouble in the last 7 days in elbows (right, left and both)

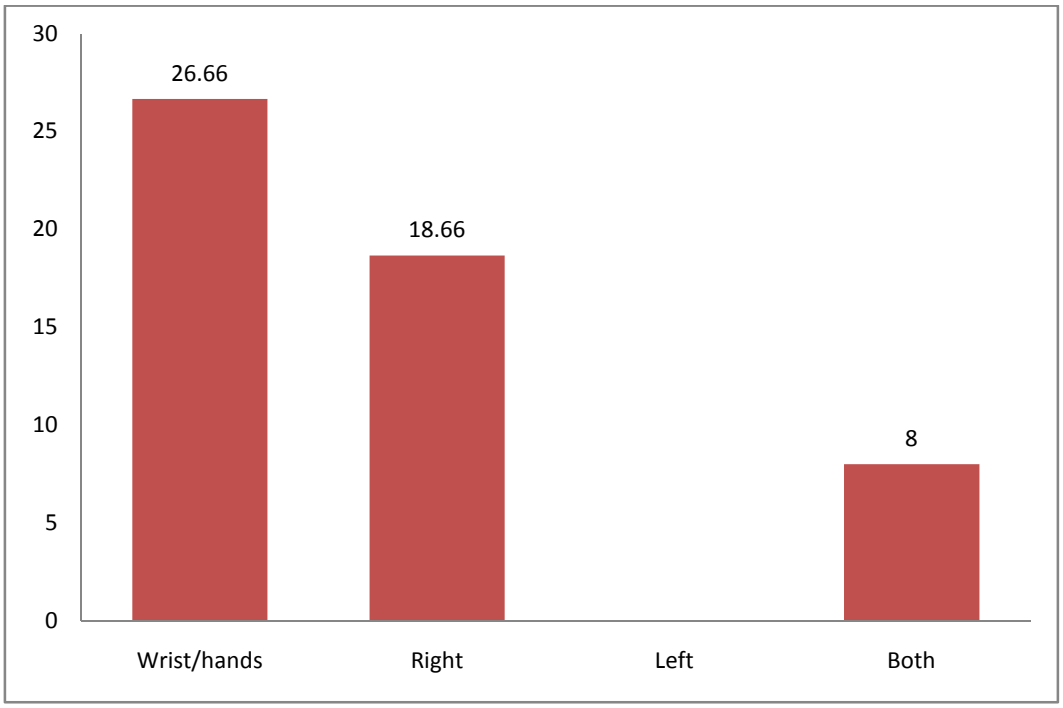


Figure 4.43: Feeling of trouble in the last 7 days in wrist/hands (right, left and both)

Table 4.18: Distribution of garage workers as per feeling of trouble in the last 7 days

(n=75)

Body parts	Frequency	Percentage
Neck	43	57.33
Shoulder	35	46.66
• Right	13	17.33
• Left	2	2.66
• Both	20	26.66
Elbow	5	6.66
• Right	3	4
• Left		
• Both	2	2.66
Wrist/hands	20	26.66
• Right	14	18.66
• Left	-	-
• Both	6	8
Upper back	26	34.66
Low back	45	60
Hips/thighs	18	24
Knees	19	25.33
Ankles/feet	11	14.66

4.9 Risk assessment

Risk assessment is a term used to describe the overall process or method where we can identify hazards and risk factors that have the potential to cause harm. For risk assessment, a checklist was used to identify whether the personal protective equipment, fire protective equipment, medical services, and first aid and general work environment facilities were provided to the garage workers or not. The responses of the employees were collected in term of Yes or No, the negative responses given by workers were considered as a basis for risk assessment.

4.9.1 Provision of Personal Protective Equipment to Garage Workers

As shown in table 4.19, it was found that authorized garages of Udham Singh Nagar were providing all personal protective equipment (100%) to their garage workers.

Company-owned garages of Nainital were providing gloves and protective clothing (100%) to their garage workers, whereas 50 per cent of garages were not providing hard hats and 25 per cent were not providing steel-toed shoes, goggles, and mask to their garage workers.

In the local garages of Almora district, no garages were providing steel-toed shoes, hard hats, and goggles to their workers and 87.5 per cent were not providing masks, gloves, and protective clothing to their garage workers.

Table 4.19: Providing personal protective equipment to garage workers

		NAINITAL (n_1=4)		ALMORA (n_2=8)		UDHAM SINGH NAGAR (n_3=2)		Total (n=14)	
		Yes	No	Yes	No	Yes	No	Yes	No
1.	Gloves	4(100%)	0	1(12.5%)	7(87.5%)	2(100%)	0	7(50%)	7(50%)
2.	Steel toed shoes	3(75%)	1(25%)	0	8(100%)	2(100%)	0	5 (35.71%)	9 (64.28%)
3.	Hard hats	2(50%)	2 (50%)	0	8(100%	2(100%)	0	4 (28.57%)	10 (71.42%)
4.	Goggles	3(75%)	1(25%)	0	8(100%)	2(100%)	0	5 (35.71%)	9 (64.28%)
5.	Mask	3(75%)	1(25%)	1(12.5%)	7(87.5%)	2(100%)	0	6 (42.85%)	8(57.14%)
6.	Protective clothing	4(100%)	0	1(12.5%)	7(87.5%)	2(100%)	0	7 (50%)	7(50%)

4.9.2 Use of fire protective equipment

Data about the use of fire protective equipment is presented in Table 4.20, indicated that the authorized garage of Udham Singh Nagar had (100%) fire alarm system and fire extinguisher whereas 25 per cent of company-owned garages of Nainital district had no fire alarm system and fire extinguisher while 75 per cent had no fire alarm system and a fire extinguisher in the local garages of Almora district

Table 4.20: Use of fire protective equipment

		Nainital (n_1=4)		**Almora(n_2=8)**		**Udhamsinghnagar (n_3=2)**		**Total (n=14)**	
		Yes	**No**	**Yes**	**no**	**Yes**	**no**	**yes**	**No**
1.	Fire alarm system	3 (75%)	1 (25%)	2 (25%)	6 (75%)	2 (100%)	0	3 (21.42%)	11(78.57%)
2.	Fire extinguisher	3 (75%)	1 (25%)	2 (25%)	6 (75%)	2 (100%)	0	7 (50%)	7(50%)

4.9.3 Medical services and first aid

Data presented in table 4.21, revealed that authorized garages of Udham Singh Nagar had (100%) facility of the hospital, clinic for medical care in the proximity of workplace, first- aid kits and means provided for flushing of the eyes and body in areas where corrosive liquids or materials are handled and 50 per cent of garages had no emergency phone number posted in the garage.

In company-owned garages had (100%) facility of the hospital, clinic for medical care in the proximity of workplace, 50 per cent, 75 per cent, and 100 per cent garages had no first- aid kits, no means provided for flushing of the eyes and body in areas where corrosive liquids or materials are handled and no emergency phone numbers posted and in the local garage of Almora district had a hospital, clinic for medical care in the proximity of workplace(100%) while it was also reported that there are no emergency phone numbers posted(100%), no first- aid kits available (87.5%) and no means provided for flushing of the eyes and body in areas where corrosive liquids or materials are handled (62.5%).

Table 4.21: Medical services and first aid

		Nainital (n_1=4)		Almora (n_2=8)		Udham singh nagar (n_3=2)		Total(n=14)	
		Yes	**no**	**yes**	**no**	**yes**	**no**	**Yes**	**no**
1	Is there a hospital, clinic for medical care in proximity of your workplace	4 (100%)	0	8 (100%)	0	2 (100%)	0	14 (100%)	0
2.	Are first- aid kits available	2 (50%)	2 (50%)	1 (12.5%)	7 (87.5%)	2 (100%)	0	7 (50%)	7 (50%)
3.	Are emergency phone numbers posted?	0	4 (100%)	0	8 (100%)	1 (50%)	1(50%)	1 (7.142%)	13 (92.85%)
4.	Are means provided for flushing of the eyes and body in areas where corrosive liquids or materials are handled?	1 (25%)	3 (75%)	3 (37.5%)	5 (62.5%)	2(100%)	0	6(42.85%)	8(57.14%)

4.9.4 General work environment

As shown in table 4.22, it was reported that there was no facility of worksites clean, sanitary, and orderly in the authorized garage of Udham Singh Nagar(50%), in the company-owned garage of Nainital district (50%), and local shops of Almora district (62.5%), there was no slip-resistant facility in the authorized garage of Udham Singh Nagar(50%), in the company-owned garage of Nainital district (25%) and local shops of Almora district (75%).

There was no provision of paint spray booths, dip tanks cleaned regularly in the authorized garage of Udham Singh Nagar(50%), in the company-owned garage of Nainital district (100%) and local shops of Almora district (100%) whereas there was no availability of minimum numbers of toilets and washing facility in the authorized garage of Udham Singh Nagar(0%), in the company-owned garage of Nainital district (0%) and local shops of Almora district (100%) and there was no provision of toilets and washing facilities clean and sanitary in the authorized garage of Udham Singh Nagar(50%), in the company-owned garage of Nainital district (100%) and local shops of Almora district (100%).

Table 4.22: General work environment

		Nainital (n_1=4)		Almora(n_2=8)		Udham singh nagar (n_3=2)		Total(n=14)	
		yes	**no**	**Yes**	**no**	**yes**	**no**	**Yes**	**no**
1.	Are all worksites clean, sanitary, and orderly	2(50%)	2(50%)	3(37.5%)	5(62.5%)	1(50%)	1 (50%)	6(42.85%)	8(57.14%)
2.	Are work surfaces kept dry or appropriate means taken to assure the surfaces are slip-resistant?	3(75%)	1(25%)	2(25%)	6(75%)	1(50%)	1 (50%)	6(42.85%)	8(57.14%)
3.	Our paint spray booths, dip tanks, etc cleaned regularly?	0	4(100%)	0	8(100%)	1 (50%)	1 (50%)	1(7.14%)	13(92.85%)
4.	Are the minimum number of toilets and washing facilities provided?	4(100%)	0	0	8(100%)	2 (100%)	0	6(42.85)	8(57.14%)
5.	Are all toilets and washing facilities clean and sanitary?	0	4(100%)	0	8(100%)	1 (50%)	1 (50%)	1(7.14%)	13(92.85%)

4.10 Workplace assessment

Workplace assessment was done by implementing a workplace checklist which was practically designed and easy to implement solutions for improving safety, health, and working conditions. The workplace checklist was introduced by Kazutaka Kogi. Kazutaka Kogi was established by the IEA to prepare the basis for a joint review by the IEA & ILO, which was conducted at a workshop in Bali, Indonesia, in 2005.

4.10.1 Material handling

Data presented in table 4.23, revealed that there was need to plan action in clear and marked transport ways of authorized garage of Udham Singh Nagar (50%), in company owned garage of Nainital district (25%) and in local shops of Almora district (100%), provision of multi- level racks near the work area for materials, tools and products in company owned garage of Nainital district (75%) and in local shops of Almora district (87.5%), use of carts, hand- truks and mobile racks when moving materials need action cent per cent in company owned garages of Nainital district and in local shops of Almora district, instead of carrying heavy weights, divide them into smaller lightweight packages, containers or trays authorized garage of Udham Singh Nagar(50%), cent per cent in company owned garage of Nainital district and local shops of Almora district, use lifting devices or lift trucks for lifting heavy materials in company owned garage of Nainital district (50%) and in local shops of Almora district (100%) and provision of good grips or holding points containers and packages in company owned garage of Nainital district (50%) and in local shops of Almora district (100%).

4.10.2 Workstations

Data presented in Table 4.23, revealed that there was need to plan action in adjusting working height at elbow level necessary, use foot platforms for small workers and work item holders for tall workers of cent per cent of authorized garage of Udham Singh Nagar, company owned garage of Nainital district and local shops of Almora district , put frequently used materials in small containers placed within easy reach from normal working position in company owned garage of Nainital district (75%) and in local shops of Almora district (100%), use of hanging tools or conveniently fix tools for operations repeated at the same place cent per cent in authorized garage of Udham Singh Nagar, company owned garage of Nainital district and local shops of Almora district, provide standing workers with conveniently placed chairs or stools for occasional sitting of authorized garage of Udham Singh Nagar(100%), in company owned garage of Nainital district (75%) and in local shops of Almora district (100%), provide chairs of correct

height(with both the feet flatly placed on the floor) and with a good backrest of authorized garage of Udham Singh Nagar(100%), in company owned garage of Nainital district (75%) and in local shops of Almora district (100%), attach simply worded labels and use colours so as to avoid mistakes in authorized garage of Udham Singh Nagar(50%), cent per cent in company owned garage of Nainital district and in local shops of Almora district and introduce a work- rotation system to avoid repetition of the same types of work cent per cent of authorized garage of Udham Singh Nagar company owned garage of Nainital district and in local shops of Almora district.

4.10.3 Teamwork environment

Data presented in Table 4.23, revealed that there was need to plan action in providing sufficient lighting for workers by repositioning lights or providing task lights for precision work in company owned garage of Nainital district (75%) and in local shops of Almora district (100%), attach proper guards or interlocking devices to avoid contact with moving parts of machines in company owned garage of Nainital district (25%) and in local shops of Almora district (100%), use safety devices that prevent operations of machines while the worker's hands are in danger in company owned garage of Nainital district (100%) and in local shops of Almora district (100%), label containers of hazardous chemicals and store them in appropriate places cent per cent in authorized garage of Udham Singh Nagar, company owned garage of Nainital district and in local shops of Almora district, ensure safe wiring connections for supplying electricity to equipment 50% in authorized garage of Udham Singh Nagar and company owned garage of Nainital district ,in local shops of Almora district (100%), clearly designate and marked areas requiring the use of protective equipment, and make sure everyone uses it there in authorized garage of Udham Singh Nagar(50%), in company owned garage of Nainital district and in local shops of Almora district (100%), provide rest corners with comfortable facilities and refreshing drinks in authorized garage of Udham Singh Nagar(50%), in company owned garage of Nainital district (25%) and in local shops of Almora district (100%), provide first-aid equipment near the workplace, and the train a qualified first-aider in company owned garage of Nainital district (75%) and in local shops of Almora district (100%), provide opportunities to take short breaks for repetitive or arduous work, in company owned garage of Nainital district (75%) and in local shops of Almora district (100%) and rearrange layout and the order of operations to improve production flow in company owned garage of Nainital district (75%) and in local shops of Almora district (100%).

Table 4.23: Assessment of workplace

S. No	Statements	Nainital(n_1=4)		ALMORA (n_2=8)		UDHAM SINGH NAGAR ((n_3=2)		TOTAL (n=14)	
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
	Material handling								
1.	Clear and mark transport ways.	1	25	8	100	1	50	10	71.42
2.	Provide multi-level racks near the work area for materials, tools and products.	3	75	7	87.5	0	0	10	71.42
3.	Use carts, hand-trucks, and mobile racks when moving materials.	4	100	8	100	0	0	12	85.71
4.	Instead of carrying heavy weights, divide them into smaller lightweight packages, containers or trays.	4	100	8	100	1	50	13	92.85
5.	Use lifting devices or lift trucks for lifting heavy materials	2	50	8	100	0	0	10	71.42
6.	Provide good grips or holding points for all containers and packages.	3	75	8	100	0	0	11	78.57

	Workstation								
7.	Adjust working height at the elbow level(if necessary, use foot platforms for small workers and work item holders for tall workers).	4	100	8	100	2	100	14	100
8.	Put frequently used materials in small containers placed within easy reach from normal working position.	3	75	8	100	0	0	11	78.57
9.	Use hanging tools or conveniently fixed tools for operations repeated at the same place.	4	100	8	100	2	100	14	100
10.	Provide standing workers with conveniently placed chairs or stools for occasional sitting.	3	75	8	100	2	100	13	92.85
11.	Provide chairs of the correct height (with both the feet flatly placed on the floor) and with a good backrest.	3	75	8	100	2	100	11	92.85

12.	Attach simply worded labels and use colors to avoid mistakes.	4	100	8	100	1	50	13	92.85
13.	Introduce a work-rotation system to avoid repetition of the same types of work	4	100	8	100	2	100	14	100
	Teamwork environment								
14.	Provide sufficient lighting for workers by repositioning lights or providing task lights for precision work.	3	75	8	100	0	0	11	78.57
15.	Attach proper guards or interlocking devices to avoid contact with moving parts of machines.	1	25	8	100	0	0	9	64.28
16.	Use safety devices that prevent operations of machines while the Workers' hands are in danger.	4	100	8	100	1	50	13	92.85
17.	Label containers of hazardous chemicals and store them in	4	100	8	100	2	100	14	100

	appropriate places.								
18.	Ensure safe wiring connections for supplying electricity to equipment	2	50	8	100	1	50	11	78.57
19.	Designate and mark areas requiring the use of protective equipment, and make sure everyone uses it there.	4	100	8	100	1	50	13	92.85
20.	Provide rest corners with comfortable facilities and refreshing drinks.	1	25	8	100	1	50	10	71.42
21.	Provide first-aid equipment near the workplace, and train a qualified first-aider.	3	75	8	100	0	0	11	78.57
22.	Provide opportunities to take short breaks for repetitive or arduous work.	3	75	8	100	0	0	11	78.57
23.	Rearrange layout and the order of operations to improve production flow.	3	75	8	100	0	0	11	78.57

Section B: It dealt with the various observational methods to assess the ergonomic problems or MSDs and divided into 3 parts:

Assessment of different work posture adopted by garage workers during their work

In the present investigation among garage workers, the different photographs and videos were taken during their tasks and were analyzed. The different postures were selected which were mostly similar for different other tasks.

Posture 1- The RULA score was 6 for left hand and 5 for right hand which indicates that medium risk, need to investigate further and require changes soon and the ART score was 17 for left and 26 for right hand which indicates that medium, high exposure level and REBA score was 5 which indicates that medium risk and need further investigation and require changes soon.

Posture 2- The RULA score was 6 for left hand and 5 for right hand which indicates that medium risk, need to investigate further and require changes soon and the ART score was 21 for left hand and 26 for right hand which indicates that medium and high exposure level and REBA score was 10 which indicates that high risk and need to investigate and implement changes.

Posture 3- The RULA score was 6 for left hand and 7 for right hand which indicates that medium risk, need to investigate further and require changes soon and very high risk, need to implement changes now and ART score was 17 for left hand, 24 for left hand which indicates that medium and high exposure level and REBA score was 11 which indicates that very high risk and need to implement changes.

Posture 4- The RULA score was 7 for both left and right hand which indicates that very high risk, need to implement changes now and ART score was 21 for right hand and 25 for left hand which indicates medium and high exposure level and REBA score was 11 which indicates very high risk and need to implement changes.

Posture 5- The RULA score was 6 for left hand and 5 for right hand which indicates medium risk, need to investigate further and require changes soon and ART score was 28 for both hands which indicates high exposure level and REBA score was 11 which indicates very high risk and need to implement the change.

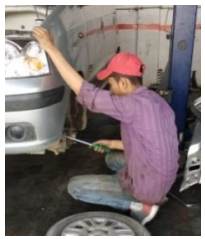
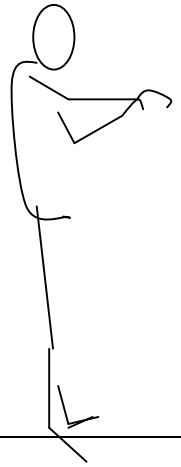
Posture 6- The RULA score was 7 for both left and right hand which indicates very high risk and need to implement changes now and ART score was 29 for left hand and 20 for right hand which indicates high and medium exposure level and REBA score was 10 which indicates that high risk and need to investigate and implement changes.

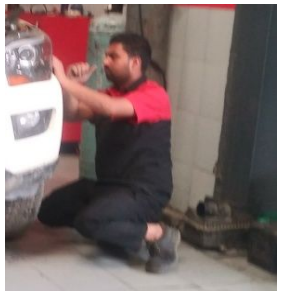
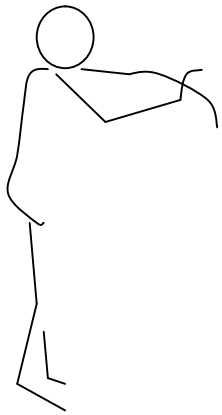
Posture 7- The RULA score was 6 for both left and right hand which indicates medium risk, need to investigate further and require changes soon and ART score was 29 for left hand and 25 for right hand which indicates high exposure level and REBA score was 5 which indicates medium risk and need to investigate further and implement changes soon.

Posture 8 – The RULA score was 4 for left hand and 6 for right hand which indicates low risk and medium risk and need to investigate further and ART score was 12 for left hand and 25 for right hand which indicates medium and high exposure level and REBA score was 7 which indicates medium risk and need to investigate further and implement changes soon.

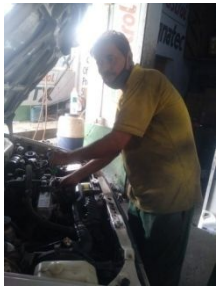
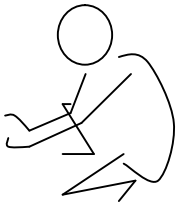
Posture 9- The RULA score was 6 for both the hands which indicates medium risk and need to investigate further and implement changes soon and ART score was 11 for left hand and 17 for right hand which indicates low and medium risk and REBA score was 5 which indicates medium risk and need to investigate further and implement changes soon.

Table 4.24: Postural Analysis of Garage workers

S.no	Body posture	Line diagram	RULA score (left, right)	Action category	ART score (left, right)	Action category	REBA score	Action category
1.			6,5	(Medium risk, further investigation, change soon)	17,26	(medium, high)	5	Medium risk. Further investigation. Change soon
	Posture 1							
2.			6,5	(Medium risk, further investigation, change soon)	21,26	Medium, high	10	High risk. Investigate and implement change
	Posture 2							

3.			6,7	(Medium risk, further investigation, change soon) (very high risk, implement change now)	17,24	Medium, high	11	Very high risk. Implement change
	Posture 3							
4.			7,7	(very high risk, implement change now)	21,25	Medium, high	11	Very high risk. Implement change
	Posture 4							

5.			6,5	(Medium risk, further investigation, change soon)	28, 28	High, high	11	Very high risk. Implement change
	Posture 5							
6.			7,7	(very high risk, implement change now)	29,20	High, medium	10	High risk. Investigate and implement change
	Posture 6							

7.			6,6	(Medium risk, further investigation, change soon)	29,25	High, high	5	Medium risk. Further investigation. Change soon
	Posture 7							
8.			4,6	(low risk, change may be needed) (Medium risk, further investigation, change soon)	12,25	Medium, high	7	Medium risk. Further investigation. Change soon
	Posture 8							
9.			6,6	(Medium risk, further investigation, change soon)	11,17	Low, medium	5	Medium risk. Further investigation. Change soon
	Posture 9							

4.11 Rapid Upper Limb Assessment (RULA)

The RULA (Rapid Upper Limb Assessment) is an ergonomic assessment tool that analyzes the postural load on upper extremities due to the adopted body posture, repetitive movements, and force exertion. The selected nine postures were analyzed and scored. Then, the grand score of all the working postures was calculated.

Table 4.25 shows the distribution of garage workers based on RULA scores. The analysis revealed that the majority of garage workers of authorized garages of Udham Singh Nagar 44.44 per cent scored in the 7 range which indicates that there was a need for investigation and change should be immediately implemented. While it was found that garage workers 33.33 per cent scored in the range of 3-4 which indicates that there was a need to investigate further and 22.22 per cent garage workers scored in the range of 5-6 which indicates that there was the need to investigate further and change soon (left hand).

The analysis revealed that the majority of garage workers of the authorized garage of Udham Singh Nagar 44.44 per cent scored in the range of 5-6 which indicates that there was a need to investigate further and change soon, 22.22 per cent scored in the range of 3-4 which indicates that there was need to investigate further, 22.22 per cent garage workers scored in 7 range which indicates that there was need to investigate and change immediately (right hand).

The analysis revealed that the majority of garage workers of company-owned garages of Nainital district 88.33 per cent scored in the range of 5-6 which indicates that there was a need to investigate further and change soon and only 16.66 per cent scored in the range of 3-4 which indicates that there was need to investigate further (left hands and right hand).

The garage workers of Almora district the majority 87.5 per cent garage workers scored in the range of 5-6 which indicates that there was a need to investigate further and change soon, 12.5 per cent scored in the range of 3-4 range which indicates that there was need to investigate further (left hand).

The majority 75 per cent garage workers scored in the range of 5-6 which indicates that there was a need to investigate further and only 25 per cent scores 3-4 range which indicates that there was a need to investigate further (right hand). The mean RULA score was observed to be 5.47 & 5.21 implying that the garage workers adopt awkward postures during most of the activities which caused the risk of developing disorders associated with upper extremities.

Table 4.25: Distribution of garage workers based on RULA scores

RULA score	Nainital (n_1=6)				ALMORA (n_2=8)				UDHAM SINGH NAGAR (n_3=9)				Total (n=23)				Mean RULA score
	Frequency		Percentage		Frequency		Percentage		Frequency		Percentage		Frequency		Percentage		
	left	right	left	right	left	Right	left	right	left	right	left	right	left	right	left	right	
1-2										1		11.11		1		4.34	
3 - 4	1	1	16.66	16.66	1	2	12.5	25	3	2	33.33	22.22	5	5	21.73	21.73	5.475.21
5 - 6	5	5	83.33	83.33	7	6	87.5	75	2	4	22.22	44.44	14	15	60.86	65.21	
7									4	2	44.44	22.22	4	2	17.39	8.69	

4.12 Application of REBA for postural analysis of garage workers

The REBA (Rapid Entire Body Assessment) tool analyzes the postural risk and musculoskeletal disorders associated with the whole body by taking into account the adopted body posture, type of actions and movements, repetition, and coupling scores. The selected postures were analyzed and scored based on the REBA assessment sheet and the grand scores for all selected postures were calculated. As shown in Table 4.26, it was reported that 33.33 per cent of the authorized garage of Udham Singh Nagar reported their scores equal in the range of 4-7, 8-10, 11+ which means that garage workers had medium, high, and very high-risk level.\

In company-owned garages of Nainital district, it was found that majority of garage workers 50 per cent scores 4-7 which means that there was a medium risk, 33.33 per cent scores 8-10 which means that the level of risk was high and in local shops of Almora district analysis revealed that majority of garage workers 87.5 per cent scores in the range of 4-7 which means medium risk and only 12.5 per cent respondent had its scores in the range of 8-10 which means high-risk level. The mean REBA score was observed to be 7.30 implying that the garage workers adopt awkward postures during most of the activities which caused the risk of developing disorders associated with upper extremities and lower extremities.

Table 4.26: Distribution of garage workers based on REBA scores

REBA score	NAINITAL (n_1=6)		ALMORA (n_2=8)		UDHAM SINGH NAGAR (n_3=9)		Total (n=23)		Mean REBA score
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	
1									
2-3	1	16.66					1	4.34	
4-7	3	50	7	87.5	3	33.33	13	56.52	**7.30**
8-10	2	33.33	1	12.5	3	33.33	6	26.08	
11+					3	33.33	3	13.04	

4.13 Application of ART for postural analysis of garage workers

The Assessment of Repetitive Tasks is a tool designed to help and assess repetitive tasks involving the upper limbs. It assesses some of the common risk factors in repetitive work that contribute to the development of upper limb disorders. The selected postures were analyzed and scored based on the ART assessment sheet and the grand scores for all selected postures were calculated.

Table 4.27 depicts that in authorized garages of Udham Singh Nagar district it was found that majority of garage workers 55.55 per cent scores 12-21 which means that there was medium risk exposure and 44.44 per cent garage workers had score 21 or more which means that there was high-risk exposure in the left hand. On the right hand, the majority of garage workers of Udham Singh Nagar 55.55 per cent score 21 or more which means that high-risk exposure and 44.44 per cent score 12-21 which means that medium risk exposure and in company-owned garages of Nainital district it was found that majority of garage workers 83.33 per cent score 12-21 which means that medium risk exposure and 16.66 per cent garage workers score 22 or more which means that high-risk exposure level (left hand) and in the right-hand majority of garage workers 66.66 per cent score 22 or more which means that high-risk exposure level and 33.33 per cent garage workers score 12-21 which means that medium risk exposure.

In local shops of Almora district, it was found that majority of garage workers 50 per cent scores 12-21 which means that medium risk exposure, 25 per cent garage workers score 0-11 which means that low-risk exposure and 25 per cent garage workers score 22 or more which means that high-risk exposure in the left hand and right hand, majority of garage workers 75 per cent score 22 or more which means that high-risk exposure and only 25 per cent score 12-22 which means that medium risk exposure. The mean ART score was observed to be 19.47 & 23.47 implying that the garage workers adopt awkward postures during most of the activities which caused the risk of developing disorders associated with upper extremities.

Table 4.27: Distribution of garage workers based on ART scores

ART score	NAINITAL (n_1=6)				ALMORA (n_2=8)				UDHAM SINGH NAGAR (n_3=9)				Total (n=23)				Mean ART score
	Frequency		Percentage		Frequency		Percentage		Frequency		Percentage		Frequency		Percentage		
	left	right	left	right	left	Right	left	right	left	right	left	right	left	right	left	right	
0-11					2	-	25										19.47 & 23.47
12-21	5	2	83.33	33.33	4	2	50	25	5	4	55.55	44.44	14	8	60.86	34.78	
22 or more	1	4	16.66	66.66	2	6	25	75	4	5	44.44	55.55-	7	15	30.43	65.21	

4.13.1 Psychological Factors Among Garage Workers

Data presented in Table 4.28 revealed that the garage workers of the authorized garage of Udham Singh Nagar district, company-owned garage of Nainital district, and local shops of Almora district had complete control over how the work was done, and no incentives were given to the workers who skip their breaks or finish their work early. Authorized garage of Udham Singh Nagar had cent per cent monotonous work whereas company-owned garages of Nainital district do not had monotonous work (100%) and in local garages of Almora district 75 per cent had monotonous work. All three garages authorized, company-owned and local shops reported that they require a high level of attention and concentration while doing work and they had frequent tight deadlines to finish their work. In authorized garages of Udham Singh Nagar, 44.44 per cent of garage workers get support from supervisors or co-workers, in company-owned garages of Nainital district 33.33 per cent get support and 37.5 per cent get support in local shops of Almora district. There was cent per cent excessive work demand in the authorized garage of Udham Singh Nagar and company-owned garage of Nainital district but no excessive demand of Almora district (100%).

Table 4.28 Psychological Factors Among Garage Workers

Psychosocial factors	NAINITAL (n_1=6)		ALMORA (n_2=8)		UDHAM SINGH NAGAR ((n_3=9)		Total (n=23)	
	Frequency		Frequency		Frequency		Frequency	
	YES	NO	YES	NO	YES	NO	YES	NO
• Little control over how the work is done	6(100%)		8 (100%)		9 (100%)		23 (100%)	
• Incentives to skip breaks or finish early	-	6(100%)	-	8 (100%)	-	9 (100%)	-	23 (100%)
• Monotonous work		6 (100%)	6(75%)	2 (25%)	9(100%		15(65.21%)	8(34.78%)
• High levels of attention and concentration	6(100%)	-	8(100%)	-	9(100%)		23 (100%)	
• Frequent tight deadlines	6(100%)	-	8(100%)	-	9(100%)		23 (100%)	
• Lack of support from supervisors or co-workers	2 (33.33%)	4(66.66%)	3(37.5%)	5(62.5%)	4 (44.44%)	5(55.55%)	5 (21.73%)	18 (78.26%)
• Excessive work demands	6(100%)	-	-	8(100%)	9(100%)	-	17(73.91%)	6(26.08%)

Section C: This section covers the experimental part and direct measurement

4.14 Work Environment (Environmental Parameters)

4.15 Testing of hypothesis

4.14 Work Environment (Environment parameters)

The physical nature of the working environment has a significant effect on the efficiency, health and safety, job satisfaction, and wellbeing of the individuals within it.

When people operate in positions that complement their physical and mental capacities, the best match between the individual and the job is accomplished. People are then in the greatest position to learn, function, and achieve without detrimental health effects, e.g. injury, and disease. Physical environmental conditions can have adverse effects on humans. Relevant physical conditions that restrict efficiency can vary based on the work environment and human variations. These workers are employed in an environment that can recognize factors that influence their job. At the workplace, the following environmental hazards can need consideration:

4.14.1 Temperature

The perfect thermal atmosphere for people to work in is a "thermally comfortable" atmosphere. People do their jobs more effectively, but they are less likely to make accidents that might lead to an injury. Although the thermal atmosphere that causes discomfort does not actively cause damage, it has several drawbacks. People may have been frustrated and irritable. They could be less efficient and making more mistakes in their jobs. There is a greater chance that someone would make mistakes that might lead to an injury. Therefore, thermally stressful conditions are not suitable for people to operate.

Based on thermal physiology, a high degree of direct heat exposure to workers is expected to impair their ability to do work continuously. Core body temperature should be kept close to 37 °C. The heat pressure can occur with fatigue as an essential consequence for workers. Sweat dehydration still tends to induce heat exhaustion and even heat stroke symptoms. Heat exposure is also an essential factor for the productivity of workers.

As long as the hot work climate is comfortable, neither light physical activity nor mental task efficiency can impact by the warm environment. However, as the

temperature increases above the comfort limit, issues can occur which may affect the productivity of workers. It can be expected that relative humidity can fluctuate between 30 and 70 per cent at 18-24 degrees Celsius without causing thermal discomfort.

The value measured was compared with the **Thermal Environmental Standards for Human Occupation, 2010** approved by the American National Standard Institute, and the table 4.29 presented that the maximum and minimum temperature values measured at the various facilities, storage units, and garage workstations exceeded the appropriate operating temperatures to a significant degree.

Table 4.29: Acceptable humidity and operating temperature in summer and winter

S.No	Conditions	Relative Humidity(%)	Acceptable operating temperature (°C)
1.	Summer	30	24.5-28.0
		60	23.0-25.5
2.	Winter	30	20.5-25.5
		60	20.0-24.0

The temperature and humidity were measured using a Thermo hygrometer from February to July. The mean temperature was found to be 27.65°C with a standard deviation of 1.819. The temperature was found to be ranging from a minimum of 22.6°C to a maximum of 30.33°C. The temperature of Udham Singh Nagar, Nainital and Almora was 24.45±2.61, 28.12±0.76 and 28.38±1.12 respectively.

The mean humidity was found to be 58.49 with a standard deviation of 8.84. It was observed that humidity range from a minimum of 42 to a maximum of 65. The humidity of Udham Singh Nagar, Nainital and Almora was 54.99±8.83. 48.83±9.78 and 64.2±0.83 respectively.

4.14.2 Light

Light intensity or luminance is the overall luminous flux occurring per unit area of the surface. A workplace is a place where the most important activities were done in the room or space. Earlier, light levels in the 100-300 lux range were typical for daily activities. But today the level of light normally lies in the range of 500-1000 lux depending on the operation. The light level can also reach 1500-2000 lux for precision and thorough work.

The light was measured with the help of a lux meter. The mean of the light was 1693.56 with a standard deviation of 563.64. The light was found to be ranging from a minimum of 1083.33 lux to a maximum of 2396.66 lux. The light level of Udham Singh Nagar Nainital and Almora was 1534.99±591.61, 1772.49±659.62 and 1693.74±585.47 respectively.

The minimum light level for rough work (50-100 lux), moderately accurate work (250-500 lux), accurate work (500-1000 lux), and for all fine work (1000-2000 lux) given by **Grandjean (1975).**

Table 4.30 Recommended Illumination Level

S.No	Activity	Illumination level (in lux)
1.	Public areas with dark surroundings	20-50
2.	Simple orientation for short visits	50-100
3.	Working areas where visual tasks are only occasionally performed	100-150
4.	Warehouses, homes, theatres, archives	150
5.	Easy office work classes	250
6.	Normal office work, pc work, study library, groceries, sow rooms, laboratories	500
7.	Supermarkets, mechanical workshops, office landscapes	750
8.	Normal drawing work, detailed mechanical workshops, operation charts,	1000
9.	Detailed drawing work, very detailed mechanical workers	1500-2000
10.	Performance of visual tasks of low contrast and very small size for prolonged periods	5000-20000
11.	Performance of very prolonged and exacting visual tasks	5000-10000
12.	Performance of very special visual tasks of extremely low contrast and small size	10000-20000

4.14.3 Noise

For a healthy young person, the standard hearing range ranges from about 20 Hz (Hertz) to 20,000 Hz. Human ears are more receptive to the middle pitch, which can vary from 500 Hz to 4000 Hz. Noise-induced hearing loss is one of the most serious workplace conditions, contributing to health issues for many workers, with substantial social and economic costs.

The expense of humanity is also high. This means lost employment, increased absenteeism, diminished efficiency, injuries in the workplace, and much more. Long stretches of repeated occupational noise penetration ranging from 75 dB to 80 dB pose a minor chance of experiencing hearing impairment. The frequency becomes higher as the noise level increases. For occupational sensitivity to ambient noise levels between 75 dB and 80 dB, the appropriate noise intensity requirement presents a minor risk of experiencing hearing damage. The danger becomes higher as the number of noise increases. In the office, the appropriate noise level norm is 85 dB (A) and a protected environment occurs. This essentially means that an eight-hour exposure of 85 dB(A) is deemed to be an optimal standard of occupational hearing protection.

The noise was measured with the help of a sound level meter. The mean of the noise was 61.95 with a standard deviation of 7.50. The noise was found to be ranging from a minimum of 55.6 dB to a maximum of 78.06 dB. The noise level of Udham Singh Nagar, Nainital and Almora was 76.06±2.82, 63.43±7.27 57.68±1.31 respectively.

Table 4.31: Environmental Parameters

Environmental Parameters	Recommended level	Range	Udham Singh Nagar	Nainital	Almora	Mean ± SD
			Mean ± SD			
Lighting (lux)	1500-2000 lux (Grandjean, 1975)					
Maximum		1083.33	1534.99±591.61	1772.49±659.62	1693.74±585.47	1693.56±563.64
Minimum		2396.66				
Noise (dB)	90dB (OSHA)					
Maximum		55.6	76.06±2.82	63.43±7.27	57.68±1.31	61.95±7.50
Minimum		78.06				
Humidity(%)	30-60 (Thermal environmental standards for human occupation,2010)					
Maximum		42	54.99±8.83	48.83±9.78	64.2±0.83	58.49±8.84
Minimum		65				
Temperature (°C)	24.5-28.0°C (Thermal environmental standards for human occupation,2010)					
Maximum		22.6	24.45±2.61	28.12±0.76	28.38±1.12	27.65±1.819
Minimum		30.33				

4.16 Testing of hypothesis

$H_0$1: There is no significant relationship between work experience and muscle pain among garage workers.

Table 4.32: Pearson's Correlation value (R) for years of employment and muscle pain

	Muscle Pain	
Years of employment	Correlation coefficient	Significance level
	.286*	p‹0.05

*Significant at 5% level of significance, NS: non-significant

The data in table 4.32 revealed that years of employment was positively and significantly correlated with muscle pain (R=0.286) and results were obtained by using SPSS software.

$H_0$2: There is no significant relationship between a working hour and muscle pain among garage workers.

Table 4.33 Pearson's Correlation value (R) for a working hour and muscle pain

	Muscle Pain	
Working hour	Correlation coefficient	Significance level
	.111NS	p‹0.05

*Significant at 5% level of significance, NS: non-significant

The data in table 4.33 revealed that working hour was positively and non significantly correlated with muscle pain (R=0.111) and results were obtained by using SPSS software.

$H_0$3: There is no significant relationship between age and muscle pain among garage workers.

Table 4.34 Pearson's Correlation value (R) for age and muscle pain

	Muscle Pain	
Age	Correlation coefficient	Significance level
	.152NS	p‹0.05

*Significant at 5% level of significance, NS: non-significant

The data in table 4.34 revealed that age was positively and non significantly correlated with muscle pain (R=0.152) and results were obtained by using SPSS software.

4.16 Training

The sensitization sessions were conducted for the workers of garage. The workers in their rest time were informed and sensitized about their work environment and prevention measures they can follow for coping with occupational hazards in workplace The poster was developed to add value to the safety and efficiency of the garage workers.

Plate 1: Poster design on reducing occupational hazards

Plate 2: Sensitization program for garage workers

Summary and Conclusion

SUMMARY AND CONCLUSION

The Indian auto industry is the 4th biggest in the world. 7.1 percent of GDP in the country is contributed by the industry. The global demand for automotive repair and maintenance services is expected to be USD 810.3 billion by 2026. The rising number of cars, the increasing disposable income of people, the need for improved passenger safety in vehicles, and the increasing average age of the vehicle are the factors expected to fuel the demand for automotive repair and maintenance services over the forecast period.

In India, there are 20 times more occupational accidents than in the UK. There are an estimated 48,000 job-related deaths per year in India, although there were 144 work-related deaths in Britain in 2017 **(British Safety Council,2019).** The death rate of the world's workers is much higher each year, according to the International Labor Organization **(ILO,2018)** report. It is around 6300 a day and in terms of occupational safety and health, 2.3 million workers are lost annually.

One of the major causes of disability and work-related accidents in developed and industrialized developing countries is musculoskeletal disorders (MSDs). High job repetition, strong efforts, and repeated or prolonged uncomfortable postures are workplace ergonomic risk factors to take into account, whereas individual risk factors are bad to work practices, poor nutrition, poor health habits **(Middlesworth, 2016).** "MSDs are the single largest category of workplace injuries and account for nearly 30% of all employee compensation costs" (CDC, 2017). For all the workplaces in India, poor health and safety standards are still a problem. MSD reports involved low back pain, upper back pain, leg cramps, carpal tunnel syndrome, bursitis, and tendentiousness.

Justification of the study

The research was intended to improve the current working conditions in the automotive industry, where the role of precision is played by mechanics. In the workshop, repetitive activity is normal and has been developed as a potential contributor to the development of musculoskeletal disorders (WMSDs). Most garage employees are engaged in work such as welding, servicing, cutting, painting, spraying, grinding, fixing car engines, etc. where they are vulnerable to various workplace

hazards such as vibration, chemical, sharp metal, light, noise, electrical current, and work climate.

The automotive center or garages is therefore chosen as a workplace of the study because it requires many forms of manual handling jobs, taking into account the above scenario. Moreover, it is a major concern that contributes to workplace occupational hazards. Therefore, to access the working conditions of the garage workers and the influence of the work environment on the worker's health.

Also, the study of garage workers as a result of their occupational exposure has not been examined in Uttarakhand to the best of the investigator's knowledge. The goal of this work is to raise awareness of the risk factors in the automotive sector and to explain practice guidelines. The researcher will be able to assess the prevalence and associated physical risk factors of musculoskeletal symptoms among the mechanics of the automobile from this study.

Considering the above points in mind**, "Assessment of Musculoskeletal Disorder Among Garage Workers"** is planned with the following objectives:

1. To study the demographic profile and socio-economic status of garage workers.
2. To observe the existing conditions of garage workers in terms of activity profile, duration, an instrument used, and the working environment.
3. To identify the prevalence of ergonomic risk factors among garage workers with an assessment of MSD.
4. To assess the different work postures while mending vehicles and appraise the cause of MSD.
5. To conduct sensitization training for garage workers.

Hypothesis

The hypothesis is formulated in
light of the presumed relationship and based on the objectives of the study:

$H_0$1: There is no significant difference between years of employment and muscle pain.

$H_0$2: There is no significant difference between working hours and muscle pain.

$H_0$3: There is no significant difference between age and muscle pain.

Limitations:

The study was limited to the garage workers having more than 5 years of experience.

The study was limited to 3 districts of Uttrakhand i.e Udham Singh Nagar,Nainital and Almora.

Materials and Methods

An interview schedule was deemed to be an acceptable process. Therefore a close-ended interview schedule was developed for the present review to obtain data collection information from garage workers.

A questionnaire was created to get the demographic profile of garage workers and included questions concerning the worker's demographic profile (age, employment, type of family, family size, etc.).

Updated Modified Kuppuswamy's Socioeconomic Scale (2020) was used to elicit information on the socio-economic characteristics of the respondents. This scale was initially developed by Kuppuswamy in the year 1976.

Checklist was developed to get the information about health status of garage workers, awareness of occupational hazard, use of personal protective equipment, risk assessment and workplace analysis.

Questionnaire was used to elicit the information about the stress coping strategies used by garage workers, their work environment and standardized nordic questionnaire was used to know the information about discomfort /pain of garage workers.

RULA (Rapid Entire Body Assessment) REBA (Rapid Entire Body Assessment) and ART (Assessment of Repetitive Tasks) ergonomic assessment tool were used to identify the ergonomic problem or MSDs in garage workers and environmental parameters: temperature, humidity, light, and noise were also measured using thermohygrometer, lux meter and sound level meter.

Selection of the locale, sample design, and sample size

The present study was carried out in Uttarakhand at Udhamsinghnagar district, block-Rudrapur, Nainital district, block- Haldwani and Almora district,block-Dwarahat. Purposive and random sampling technique was used to select the study area

and samples. For descriptive data 75 and experimental data 23(30 % of the total sample) samples were selected.

5.2 Major Findings Of The Study

General Information

The majority of garage workers i.e, 46.66 per cent fell under the category of 19-28 years and about 61.33 per cent were living in a nuclear family and were having a family size of 4-6 members (69.33%), whereas the respondents were married. While 36 per cent belongs to OBC and 54.66 percent were Hindu and 78.67 per cent were living in pakka with tin shade house.

Socio-Economic Status

Socio-economic status consist of 3 parameters i.e, occupation of the head of the family in which the majority 64 per cent were skilled workers(shop, maket sales workers), eduction of the head of the family in which mostly having high school certificate and middle school certificate and total monthly income of the family in which majority 56 per cent were having Rs.10,002-26,972. Based on classified categories of SES, the majority 57.33 per cent garage workers belonged to the lower middle class.

Health status of garage workers

Majority of garage workers reported of having dyspepsia (indigestion) or bowel disturbance problem.

Coping strategies of garage workers

It was found that the majority of garage workers i.e, 93.33 per cent were religious they offer prayer, 48 per cent of workers change their preference of job while they were stress, and a majority of them watch t.v (73.33 %) and 73.33 per cent consume tobacco as a stress coping strategy.

Work environment

The findings revealed that majority of garage workers i.e, 93.33 percent were regular, permanent employee, 66.66 percent were received their payment monthly and 12 percent work beside their main job, 69.33 per cent of workers were trained for garage work, 73.33 per cent of respondents were doing technical work whereas 34.66 per cent had 5-9 years of work experience, 80 per cent had long working hours per day,

70.66 per cent have had the experience of 11-20 years, 97.33 per cent had a day shift, 86.66 per cent rarely change their starting and quitting times daily and no seasonal off period and 100 percent had 4 off days per month and 59 per cent had prescribed(schedule) rest period and aware of electrical current (72%).

Assessment of Musculoskeletal Discomfort

When enquire about Musculoskeletal discomfort, it was found that majority of garage workers reported pain in the lower back, neck, and shoulder.

Risk assessment:

Provision of Personal Protective Equipment to Garage Workers

When enquire about the availability of personal protective equipment to garage workers it was found that garages of Udham Singh Nagar provides cent per cent all PPE to their garage workers and garages of Nainital and Almora district do not had proper facility to provide all PPE to their garage workers.

Use of fire protective equipment

It was found that garages of Udham Singh Nagar had cent per cent facility of fire alarm system and fire extinguisher whereas 75 per cent of Nainital and 25 per cent of Almora district had facility of the fire alarm system and fire extinguisher.

Medical services and first aid

Cent per cent of garages of Udham Singh Nagar, Nainital, and Almora district had no facility for providing emergency phone number to their garage workers.

General work environment

Nearly half of garage workers of Udham Singh Nagar had no facility for worksite cleaning, garages do not had slip-resistant floor, cleaning at spray booth, dip tanks, and clean toilet facility whereas garage workers of Nainital and Almora district had no facility of cleaning at spray booth, dip tanks and clean toilet.

Workplace assessment

The findings revealed that cent per cent of garages of Udham Singh Nagar, Nainital, and Almora district need action in adjusting the working height at elbow level, use foot platforms for small workers and work item holders for tall workers, introduce a work- rotation system to avoid repetition of the same types of work, use hanging toolbox or conveniently fix tools for operations repeated at the same place, label containers of hazardous chemicals and store them at appropriate places.

Rapid Upper Limb Assessment (RULA)

The analysis revealed that the majority of garage workers of authorized garages of Udham Singh Nagar 44.44 per cent scored in the range 7 which indicates that there was a need for investigation and change should be immediately implemented (left hand), whereas 44.44 per cent scored in the range of 5-6 which indicates that there was a need to investigate further and change soon (right hand).

The analysis revealed that garage workers of company-owned garages of Nainital district 88.33 per cent scored in the range of 5-6 which indicates that there was a need to investigate further and change soon (left hand and right hand).

The garage workers of Almora district 87.5 per cent scored in the range of 5-6 which indicates that there was a need to investigate further and change soon (left hand) whereas 75 per cent scored in the range of 5-6 which indicates that there was need to investigate further(right hand).

Rapid Entire Body Assessment (REBA)

The REBA analysis reveled that 33.33 per cent of authorized garage workers lies in each category i.e medium (4-7), high (8-10) and very high-risk level(11+). In company-owned garages of Nainital district, it was found that 50 per cent garage workers scored 4-7 which means that there was a medium risk and in local garages of Almora district analysis revealed that 87.5 per cent garage workers scored in the range of 4-7 which means medium risk level.

Assessment of Repetitive Tasks (ART)

In authorized garages of Udham Singh Nagar district, it was found that 55.55 per cent scores 12-21 which means that there was medium risk exposure (left hand) and 55.55 per cent garage workers score 21 or more which means that high-risk exposure (right hand.

In company-owned garages of Nainital district, it was found that 83.33 per cent score 12-21 which means that medium risk exposure (left hand) and 66.66 per cent workers score 22 or more which means that high-risk exposure level (right hand). In local garages of Almora district, it was found 50 per cent scores 12-21 which means that medium risk exposure (left hand) and 75 per cent score 22 or more which means that high-risk exposure (right hand).

Cent per cent of garage workers do not get any incentives to skip their breaks or finish early.

Environmental parameters

In garages of Udham Singh Nagar, Almora and Nainital district, all environmental parameters light, humidity, temperature and noise were within recommended level.

Training

The poster was developed to add value to the safety and efficiency of the garage workers and training sessions were organized for the them.

Implication of the Study

The findings of the investigation brought out a number of important implications:

1. The results of the study are applicable to all the workers involved in the automobile industry who are exposed to the heavy work load.
2. Academics, researchers, workers, and other relevant stakeholders will use the outcomes of the analysis as a reliable resource. Several of these concerned people will enjoy the rewards of study results by bringing them into effect in their respective job environments.
3. The workstation research results will help companies in the automotive sector upgrade their respective workstations, which will minimize the occurrence of employees' occupational health hazards.
4. The study's results further focus on raising awareness and sensitizing workers on how they can reduce occupational risks and the level of tension in the workplace. In this sense, it is possible to arrange formal training courses, seminars, and sessions for staff.

Recommendations for Future Research

1. A study can be planned on a larger sample size to ensure better reliability of the findings.
2. The analysis conducted in the current study on garage workers engaging in repetitive practice can be extended to the other industry's associated work environment to more generalize the outcomes.
3. A comparative study can be conducted between the authorized, company owned and local garage workers.

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Appendices

Appendix – 1
Section – 1

S.NO	Demographic profile
	Characteristics
1.	**Age**
a)	19-28 years
b)	29-38 years
c)	39-48 years
d)	49-58 years
e)	59-68 years
2.	**Type of family**
a)	Single (one person living alone)
b)	Nuclear(one married couple with child)
c)	Joint (two or more married couple)
d)	Extended (three or more generation)
3.	**Size of family**
a)	Small (1 to 3 members)
b)	Medium (4 to 6 members)
c)	Large (7 to 9 members
4.	**Marital status**
a)	Married
b)	Unmarried
3.	**Caste of the family**
a)	General
b)	OBC
c)	SC
d)	ST
6.	**The religion of the family**
a)	Hinduism
b)	Islam
c)	Christianity
d)	Sikhism
e)	Buddhism
7.	**Living in a type of house**
a)	No place to live, pavement, mobile cart
b)	Jhuggi\ hut
c)	Kachcha house
d)	Mixed house
e)	Pakka with tin shade

Section – 2

S.No	Socio-Economic Status
	Occupation Of The Head Of The Family
a)	Legislators, Senior Officials & Managers
b)	Professionals
c)	Technicians and Associate Professionals
d)	Clerks
e)	Skilled Workers and Shop & Market Sales Workers
f)	Skilled Agricultural & Fishery Workers
g)	Craft & Related Trade Workers
h)	Plant & Machine Operators and Assembler
i)	Elementary Occupation
j)	Unemployed

S.No.	Education Of The Head Of The Family
a)	Profession or Honours
b)	Graduate
c)	Intermediate or diploma
d)	High school certificate
e)	Middle school certificate
f)	Primary school certificate
g)	Illiterate

S. No	Total Monthly Income Of The Family
	Updated Monthly Family Income in Rupees (2020)
a)	≥199,862
b)	99,931-199,861
c)	74,755-99,930
d)	49,962-74,755
e)	29,973-49,961
f)	10,002-29,972
g)	≤10,001

Section - 3

S.No.	Stress Coping Strategies
	Statements
1.	**Religious\meditation**
	• Yoga
	• Offer prayer
2.	**Reducing responsibilities**
	• Postponing certain tasks
	• Legitimately avoid disliked tasks
	• Delegating the work
	• Change in preference of job
3.	**Performing Most Liked Activities**
	• Listening songs
	• Singing
	• Watching t.v
	• Spending time in the park
	• Cooking
	• Gardening
	• Exercise
4.	**Eating habits**
	Chewing of tobacco
	• Monthly
	• Fortnightly
	• Weekly
	• Daily
	• Occasionally
	Smoking
	First cigarette \bidi of the day after wakeup
	• Within 5 min
	• 31-60 min
	• After 60 min
	Number of cigarette\bidi per day
	• 10 or less
	• 11-20
	• 21-30
	• More than 30
	Drinking
	• Daily
	• 2-3 times in a week
	• Weekly
	• Monthly

Section - 4

S.No	Working Environment
	Statements
1.	**How would you describe your work arrangement in your main job?**
a)	Work as an independent contractor, independent consultant, or freelance worker
b)	I am on-call and work only when called to work
c)	I am paid by a temporary agency
d)	I work for a contractor who provides workers and services to others under contract
e)	I am a regular, permanent employee (standard work arrangement)
2.	**In your main job, are you salaried, paid by the hour, or what?**
a)	Salaried
b)	Paid by the day
c)	Other (SPECIFY): _____
3.	**Do you have any jobs besides your main job or does any other work for pay?**
a)	Yes
b)	No
4.	**Essential skills or qualifications:**
a)	Education
b)	Diploma
c)	Skill
d)	Training
e)	None of these
5.	**Expert in:**
a)	Technical
b)	Painting
c)	Denting
d)	Welding
e)	Washing
f)	Electrician
g)	Any other specify
6.	**Work experience**
a)	5-9 years
b)	10-14 years
c)	15-19 years
d)	20-24 years
e)	25-29 years
f)	30-34 years
g)	35-39 years
h)	40-44 years
7.	**Working hours**
a)	Short (1 hour\day)
b)	Moderate(2 hour|day)

c)	Long (2-8 hours\day
d)	Very long (8-12 hours\day)
e)	Extremely long (more than 12 hours\day)
8.	**How long have you worked in your present job for your current employer?**
a)	Less than 12 month
b)	1-10 years
c)	11-20 years
d)	21-30 years
e)	31-40 years
9.	**Which of the following best describes your usual work schedule?**
a)	Day shift
b)	Afternoon shift
c)	Night shift
d)	Split shift
e)	Irregular shift/on-call
f)	Rotating shifts
10.	**How often are you allowed to change your starting and quitting times daily?**
a)	Often
b)	Sometimes
c)	Rarely
d)	Never
11.	**Off days per month**
a)	3 days
b)	4 days
c)	5 days
d)	≥ 5 days
e)	none
12.	**Seasonal off period**
a)	Winter(December- Early March)
b)	Summer (March-June
c)	Rainy (June-October)
d)	Autumn (October-December)
e)	None
13.	**Rest is taken**
a)	Spontaneous
b)	Prescribed (schedule)
c)	Work condition (not fixed)
d)	Disguise
e)	None
14	Length of resting period between activities
15	Length of resting period in different activities

Section- 5

S.No	Awareness of occupational hazard
	Statement
1.	Light/ radiation
2.	Welding fumes
3.	Sharp metals
4.	Electrical current
5.	Heat
6.	Sparks
7.	Vibration
8.	Chemical

Section-6

S.No	Use of personal protective equipment
	PPE
1.	Gloves
2.	Shoes
3.	Hard hats
4.	Goggles
5.	Mask
6	Clothing

Section- 7

Musculoskeletal Discomfort Form		
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	No	No
Yes	Yes	Yes
Shoulders		
No	No	No
Yes, Right Shoulder	Yes	Yes
Yes, Left Shoulder		
Yes, Both Shoulders		
Elbows		
No	No	No
Yes, Right Elbow	Yes	Yes
Yes, Both Elbows		
Wrists/Hands		
No	No	No
Yes, Right Wrist/Hand	Yes	Yes
Yes, Left Wrist/Hand		
Yes, Both Wrists/Hands		
Upper Back		
No	No	No
Yes	Yes	Yes
Lower Back (small of back)		
No	No	No
Yes	Yes	Yes
One or Both Hips/Thighs		
No	No	No
Yes	Yes	Yes
One or Both Knees		
No	No	No
Yes	Yes	Yes
One or Both Ankles/Feet		
No	No	No
Yes	Yes	Yes

Appendix – 2

Section-1

	Providing personal protective equipment to garage workers
1.	Gloves
2.	Steel toed shoes
3.	Hard hats
4.	Goggles
5.	Mask
6.	Protective clothing

	Use of fire protective equipment
1.	Fire alarm system
2.	Fire extinguisher

	Medical services and first aid
1	Is there a hospital, clinic for medical care in proximity of your workplace
2.	Are first- aid kits available
3.	Are emergency phone numbers posted?
4.	Are means provided for flushing of the eyes and body in areas where corrosive liquids or materials are handled?

	General work environment
1.	Are all worksites clean, sanitary, and orderly
2.	Are work surfaces kept dry or appropriate means taken to assure the surfaces are slip-resistant?
3.	Our paint spray booths, dip tanks, etc cleaned regularly?
4.	Are the minimum number of toilets and washing facilities provided?
5.	Are all toilets and washing facilities clean and sanitary?

Section-2

	Assessment of workplace
S.No	**Statements**
	Material handling
1.	Clear and mark transport ways.
2.	Provide multi-level racks near the work area for materials, tools and products.
3.	Use carts, hand- trucks, and mobile racks when moving materials.
4.	Instead of carrying heavy weights, divide them into smaller lightweight packages, containers or trays.
5.	Use lifting devices or lift trucks for lifting heavy materials
6.	Provide good grips or holding points for all containers and packages.
	Workstation
7.	Adjust working height at elbow level(if necessary, use foot platforms for small workers and work item holders for tall workers).
8.	Put frequently used materials in small containers placed within easy reach from normal working position.
9.	Use hanging tools or conveniently fixed tools for operations repeated at the same place.
10.	Provide standing workers with conveniently placed chairs or stools for occasional sitting.
11.	Provide chairs of the correct height (with both the feet flatly placed on the floor) and with a good backrest.
12.	Attach simply worded labels and use colors to avoid mistakes.
13.	Introduce a work-rotation system to avoid repetition of the same types of work
	Teamwork environment
14.	Provide sufficient lighting for workers by repositioning lights or providing task lights for precision work.
15.	Attach proper guards or interlocking devices to avoid contact with moving parts of machines.
16.	Use safety devices that prevent operations of machines while the workers' hands are in danger.
17.	Label containers of hazardous chemicals and store them in appropriate places.
18.	**Ensure safe wiring connections for supplying electricity to equipment**
19.	Designate and mark areas requiring the use of protective equipment, and make sure everyone uses it there.
20.	Provide rest corners with comfortable facilities and refreshing drinks.
21.	Provide first-aid equipment near the workplace, and train a qualified first-aider.
22.	Provide opportunities to take short breaks for repetitive or arduous work.
23.	Rearrange layout and the order of operations to improve production flow.

Section -3

ART tool- Psychological factors

S.No	Statement	
1.	Little control over how the work is done	
2.	Incentives to skip breaks or finish early	
3.	Monotonous work	
4.	High levels of attention and concentration	
5.	Frequent tight deadlines	
6.	Lack of support from supervisors or co-workers	
7.	Excessive work demands	

Section-4

Environmental parameters

Light

s. no.	Location name	Observed reading from location			Average reading
		r1	r2	r3	
1.					
2.					
3.					
4.					
5.					
6.					

Noise

s. no.	Location name	Observed reading from location			Average reading
		r1	r2	r3	
1.					
2.					
3.					
4.					
5.					
6.					

Temperature & humidity

s. no.	Location name	Observed reading from location			Average reading
		r1	r2	r3	
1.					
2.					
3.					
4.					
5.					
6.					

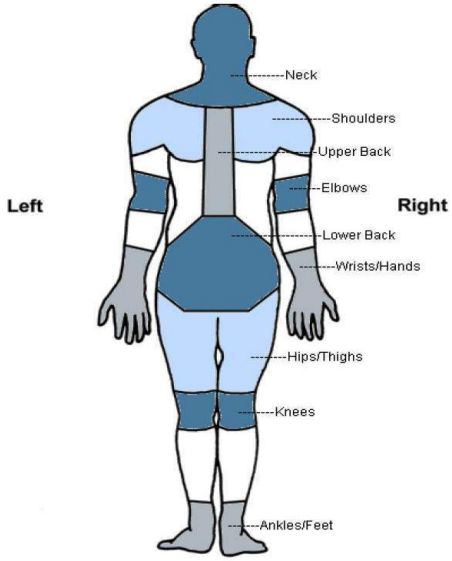
Musculoskeletal Discomfort Form (Based on the Nordic Questionnaire (Kourinka et al. 1987))

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

Appendices…

ERGONOMICS PLUS

REBA Employee Assessment Worksheet

Task Name: Date:

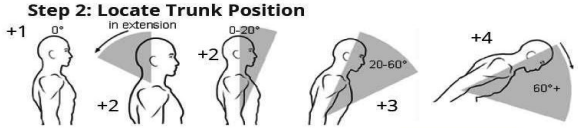
A. Neck, Trunk and Leg Analysis

Step 1: Locate Neck Position

Neck Score

Step 1a: Adjust...
If neck is twisted: +1
If neck is side bending: +1

Step 2: Locate Trunk Position



Step 2a: Adjust...
If trunk is twisted: +1
If trunk is side bending: +1

Trunk Score

Step 3: Legs

Leg Score

Step 4: Look-up Posture Score in Table A

Using values from steps 1-3 above,
Locate score in Table A

Posture Score A

+

Step 5: Add Force/Load Score

If load < 11 lbs. : +0
If load 11 to 22 lbs. : +1
If load > 22 lbs.: +2
Adjust: If shock or rapid build up of force: add +1

Force / Load Score

=

Step 6: Score A, Find Row in Table C

Add values from steps 4 & 5 to obtain Score A.
Find Row in **Table C**.

Score A

Scoring
1 = Negligible Risk
2-3 = Low Risk. Change may be needed.
4-7 = Medium Risk. Further Investigate. Change Soon.
8-10 = High Risk. Investigate and Implement Change
11+ = Very High Risk. Implement Change

Scores

Table A		Neck											
		1				2				3			
	Legs	1	2	3	4	1	2	3	4	1	2	3	4
Trunk Posture Score	1	1	2	3	4	1	2	3	4	3	3	5	6
	2	2	3	4	5	3	4	5	6	4	5	6	7
	3	2	4	5	6	4	5	6	7	5	6	7	8
	4	3	5	6	7	5	6	7	8	6	7	8	9
	5	4	6	7	8	6	7	8	9	7	8	9	9

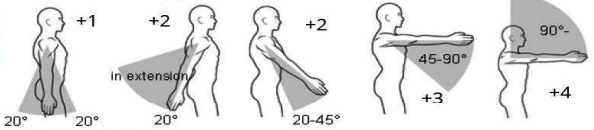
Table B		Lower Arm					
		1			2		
	Wrist	1	2	3	1	2	3
Upper Arm Score	1	1	2	2	1	2	3
	2	1	2	3	2	3	4
	3	3	4	5	4	5	5
	4	4	5	5	5	6	7
	5	6	7	8	7	8	8
	6	7	8	8	8	9	9

Score A	Table C Score B											
	1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	2	3	3	4	5	6	7	7	7
2	1	2	2	3	4	4	5	6	6	7	7	8
3	2	3	3	3	4	5	6	7	7	8	8	8
4	3	4	4	4	5	6	7	8	8	9	9	9
5	4	4	4	5	6	7	8	8	9	9	9	9
6	6	6	6	7	8	8	9	9	10	10	10	10
7	7	7	7	8	9	9	9	10	10	11	11	11
8	8	8	8	9	10	10	10	10	10	11	11	11
9	9	9	9	10	10	10	11	11	11	12	12	12
10	10	10	10	11	11	11	11	12	12	12	12	12
11	11	11	11	11	12	12	12	12	12	12	12	12
12	12	12	12	12	12	12	12	12	12	12	12	12

Table C Score + Activity Score = REBA Score

B. Arm and Wrist Analysis

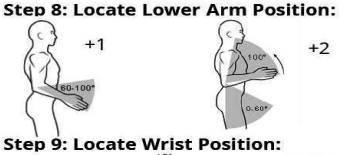
Step 7: Locate Upper Arm Position:



Step 7a: Adjust...
If shoulder is raised: +1
If upper arm is abducted: +1
If arm is supported or person is leaning: -1

Upper Arm Score

Step 8: Locate Lower Arm Position:



Lower Arm Score

Step 9: Locate Wrist Position:

Wrist Score

Step 9a: Adjust...
If wrist is bent from midline or twisted : Add +1

Step 10: Look-up Posture Score in Table B

Using values from steps 7-9 above, locate score in Table B

Posture Score B

+

Step 11: Add Coupling Score

Well fitting Handle and mid rang power grip, ***good: +0***
Acceptable but not ideal hand hold or coupling acceptable with another body part, ***fair: +1***
Hand hold not acceptable but possible, ***poor: +2***
No handles, awkward, unsafe with any body part, ***Unacceptable: +3***

Coupling Score

=

Step 12: Score B, Find Column in Table C

Add values from steps 10 &11 to obtain Score B. Find column in **Table C** and match with Score A in row from step 6 to obtain Table C Score.

Score B

Step 13: Activity Score

+1 1 or more body parts are held for longer than 1 minute (static)
+1 Repeated small range actions (more than 4x per minute)
+1 Action causes rapid large range changes in postures or unstable base

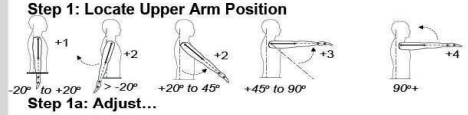
Original Worksheet Developed by Dr. Alan Hedge. Based on Technical note: Rapid Entire Body Assessment (REBA), Hignett, McAtamney, Applied Ergonomics 31 (2000) 201-205

RULA Employee Assessment Worksheet

Complete this worksheet following the step-by-step procedure below. Keep a copy in the employee's personnel folder for future reference.

A. Arm & Wrist Analysis

Step 1: Locate Upper Arm Position

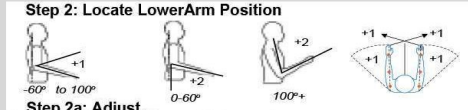


Step 1a: Adjust…

If shoulder is raised: +1;
If upper arm is abducted: +1;
If arm is supported or person is leaning: -1

Final Upper Arm Score = ☐

Step 2: Locate LowerArm Position

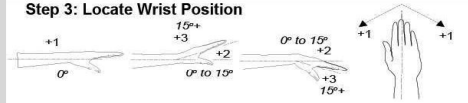


Step 2a: Adjust…

If arm is working across midline of the body: +1;
If arm out to side of body: +1

Final Lower Arm Score = ☐

Step 3: Locate Wrist Position



Step 3a: Adjust…

If wrist is bent from the midline: +1

Final Wrist Score = ☐

Step 4: Wrist Twist

If wrist is twisted mainly in mid-range =1;
If twist at or near end of twisting range = 2

Wrist Twist Score = ☐

Step 5: Look-up Posture Score in Table A

Use values from steps 1,2,3 & 4 to locate Posture Score in table A

Posture Score A = ☐

Step 6: Add Muscle Use Score

If posture mainly static (i.e. held for longer than 1 minute) or;
If action repeatedly occurs 4 times per minute or more: +1

Muscle Use Score = ☐

Step 7: Add Force/load Score

If load less than 2 kg (intermittent): +0;
If 2 kg to 10 kg (intermittent): +1;
If 2 kg to 10 kg (static or repeated): +2;
If more than 10 kg load or repeated or shocks: +3

Force/load Score = ☐

Step 8: Find Row in Table C

The completed score from the Arm/wrist analysis is used to find the row on Table C

Final Wrist & Arm Score = ☐

SCORES

Table A

Upper Arm	Lower Arm	Wrist 1 / Wrist Twist 1	1 / 2	Wrist 2 / Wrist Twist 1	1 / 2	Wrist 3 / Wrist Twist 1	1 / 2	Wrist 4 / Wrist Twist 1	1 / 2
1	1	1	2	2	2	3	3	3	3
	2	2	2	2	2	3	3	3	3
	3	2	3	3	3	3	3	4	4
2	1	2	3	3	3	3	4	4	4
	2	3	3	3	3	4	4	4	4
	3	3	4	4	4	4	4	5	5
3	1	3	3	4	4	4	4	5	5
	2	3	4	4	4	4	4	5	5
	3	4	4	4	4	4	5	5	5
4	1	4	4	4	4	4	5	5	5
	2	4	4	4	4	4	5	5	5
	3	4	4	4	5	5	5	6	6
5	1	5	5	5	5	5	6	6	7
	2	5	6	6	6	6	7	7	7
	3	6	6	6	7	7	7	7	8
6	1	7	7	7	7	7	8	8	9
	2	8	8	8	8	8	9	9	9
	3	9	9	9	9	9	9	9	9

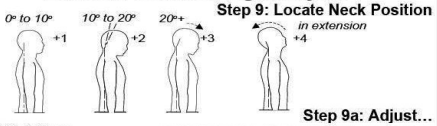
Table C

	1	2	3	4	5	6	7+
1	1	2	3	3	4	5	5
2	2	2	3	4	4	5	5
3	3	3	3	4	4	5	6
4	3	3	3	4	5	6	6
5	4	4	4	5	6	7	7
6	4	4	5	6	6	7	7
7	5	5	6	6	7	7	7
8+	6	6	6	7	7	7	7

Final Score= ☐

B. Neck, Trunk & Leg Analysis

Step 9: Locate Neck Position

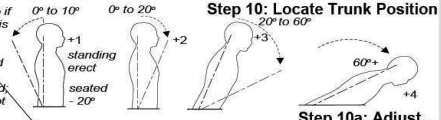


Step 9a: Adjust…

If neck is twisted: +1; If neck is side-bending: +1

=Final Neck Score ☐

Step 10: Locate Trunk Position



Step 10a: Adjust…

If trunk is twisted: +1; If trunk is side-bending: +1

= Final Trunk Score ☐

Step 11: Legs

If legs & feet supported and balanced: +1;
If not: +2

= Final LegScore ☐

Table B

Neck	Trunk Posture Score 1 / Legs 1	2	1 / Legs 2	2	3 / Legs 1	2	4 / Legs 2	2	5 / Legs 1	2	6 / Legs 2	2
1	1	3	2	3	3	4	5	5	6	6	7	7
2	2	3	2	3	4	5	5	6	7	7	7	
3	3	3	3	4	4	5	5	6	6	7	7	7
4	5	5	5	6	6	7	7	7	7	8	8	
5	7	7	7	7	7	8	8	8	8	8	8	
6	8	8	8	8	8	8	9	9	9	9	9	

Step 12: Look-up Posture Score in Table B

Use values from steps 8,9,& 10 to locate Posture Score in Table B

= Posture B Score ☐

Step 13: Add Muscle Use Score

If posture mainly static or;
If action 4/minute or more: +1

= Muscle Use Score ☐

Step 14: Add Force/load Score

If load less than 2 kg (intermittent): +0;
If 2 kg to 10 kg (intermittent): +1;
If 2 kg to 10 kg (static or repeated): +2;
If more than 10 kg load or repeated or shocks: +3

= Force/load Score ☐

Step 15: Find Column in Table C

The completed score from the Neck/Trunk & Leg analysis is used to find the column on Chart C

= Final Neck, Trunk & Leg Score ☐

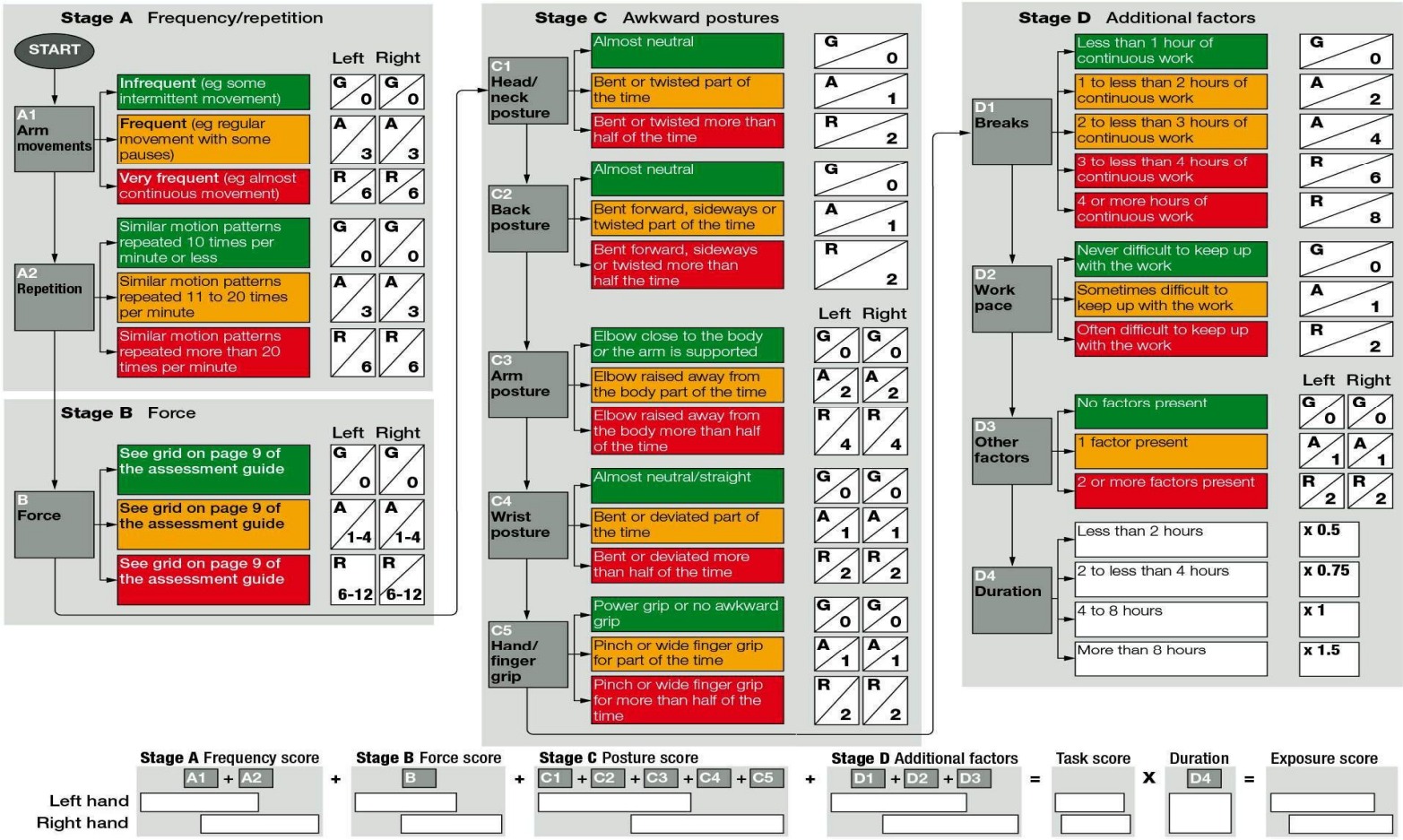
Subject: _____ Date: __/__/___

Company: _____ Department: _____ Scorer: _____

FINAL SCORE: 1 or 2 = Acceptable; 3 or 4 investigate further; 5 or 6 investigate further and change soon; 7 investigate and change immediately

Source: McAtamney, L. & Corlett, E.N. (1993) RULA: a survey method for the investigation of work-related upper limb disorders, Applied Ergonomics, 24(2) 91-99.

Flow chart


Stage A Frequency/repetition
START
Left Right
A1 Arm movements
Infrequent (eg some intermittent movement)
Frequent (eg regular movement with some pauses)
Very frequent (eg almost continuous movement)
A2 Repetition
Similar motion patterns repeated 10 times per minute or less
Similar motion patterns repeated 11 to 20 times per minute
Similar motion patterns repeated more than 20 times per minute
Stage B Force
B Force
See grid on page 9 of the assessment guide
See grid on page 9 of the assessment guide
See grid on page 9 of the assessment guide
Stage C Awkward postures
C1 Head/ neck posture
Almost neutral
Bent or twisted part of the time
Bent or twisted more than half of the time
C2 Back posture
Almost neutral
Bent forward, sideways or twisted part of the time
Bent forward, sideways or twisted more than half the time
C3 Arm posture
Elbow close to the body or the arm is supported
Elbow raised away from the body part of the time
Elbow raised away from the body more than half of the time
C4 Wrist posture
Almost neutral/straight
Bent or deviated part of the time
Bent or deviated more than half of the time
C5 Hand/ finger grip
Power grip or no awkward grip
Pinch or wide finger grip for part of the time
Pinch or wide finger grip for more than half of the time
Stage D Additional factors
D1 Breaks
Less than 1 hour of continuous work
1 to less than 2 hours of continuous work
2 to less than 3 hours of continuous work
3 to less than 4 hours of continuous work
4 or more hours of continuous work
D2 Work pace
Never difficult to keep up with the work
Sometimes difficult to keep up with the work
Often difficult to keep up with the work
D3 Other factors
No factors present
1 factor present
2 or more factors present
D4 Duration
Less than 2 hours
2 to less than 4 hours
4 to 8 hours
More than 8 hours
x 0.5
x 0.75
x 1
x 1.5
Stage A Frequency score
Stage B Force score
Stage C Posture score
Stage D Additional factors
Task score
Duration
Exposure score
Left hand
Right hand

VITA

The authoress was born on 16th Jan 1998 at Almora (Uttarakhand). She passed her High School examination in 2012 from Universal Convent School Dwarahat, Almora and Intermediate examination in 2014 from NNDM Ser. Secondary School, Ranikhet (Uttarakhand). She has completed her B.Sc.(Home Science) degree from G.B Pant University Of Agriculture and Technology, Pantnagar in 2018. She joined G.B. Pant University of Agriculture and Technology, Pantnagar in the year 2018 for Master's Degree in Home Science with major in Family Resource Management.

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ABSTRACT

Name	:	Alka Chandrakanta	**Id. No.**	:	46172
Sem. and year of admission	:	1st Sem., 2018-19	**Degree**	:	M.Sc. (H.Sc.)
			Department	:	Family Resource Management
Major	:	Family Resource Management			
Thesis title	:	**"Assessment of Musculoskeletal Disorder Among Garage Workers "**			
Advisor	:	**Dr. Deepa Vinay**			

The garage workers are highly exposed to heavy manual material handling. Due to heavy manual material handling and repetitive tasks in garage, leads to occupational health hazards among garage workers. The total sample of 75 respondents were selected randomly from three district of Uttrakhand (Udham Singh Nagar, Nainital and Almora) who were working in garage. For collection of experimental data, 30 per cent of the total respondents was selected and RULA, REBA and ART tools were used and for descriptive study demographic questionnaire, Standardized Nordic Questionnaire, stress coping strategies questionnaire, work environment questionnaire, updated Modified Kuppuswamy's Socioeconomic Scale(2020), health status checklist, personal protective equipment checklist, risk assessment and workplace checklist were used. The finding of present research investigation revealed that majority of garage workers were having lower middle socio-economic status. Most workers were suffering from low back, neck and shoulder pain and also having dyspepsia (indigestion) or bowel disturbance problem. As a stress coping strategies, majority of them reported that they consumed tobacco and offer prayers and cent per cent garage workers need of action in adjusting the working height at elbow level, use foot platforms for small workers introduce a work- rotation system to avoid repetition of the same types of work, use hanging tools, label containers of hazardous chemicals and store them inappropriate places. The result of RULA, REBA and ART revealed that almost all the postures adopted by the workers while repairing shows the medium and high level of risk exposure. The environment parameters like light (1693.56±563.64 lux), humidity (58.49±8.84%), temperature (27.65±1.819°C) and noise(61.95±7.50 dB) were within recommended level. The years of employment of garage workers was positively and significantly correlated with muscle pain (R=0.286) and results were obtained by using SPSS software. The sensitizing training program were also organized to add value and efficiency of garage workers.

(Deepa Vinay)
Advisor

(Alka Chandrakanta)
Authoress

सारांश

नाम	: अल्का चंद्रकांता	**परिचयांक**	: 46172
षट्मास एवं प्रवेष वर्ष	: प्रथम, 2018–2019	**उपाधि**	: स्नातकोत्तर (गृह विज्ञान)
प्रमुख विषय	: परिवार संसाधन प्रबंधन	**विभाग**	: परिवार संसाधन प्रबंधन

शोध का शीर्षक : **गैराज श्रमिको के बीच पेशीय कंकाल विकार का मूल्यांकन।**
सलाहकार : **डॉ0 दीपा विनय**

यह देखा गया है कि गैराज कर्मचारी अत्यधिक शारीरिक कार्य का सम्पादन करते है, जिसके कारण श्रमिक को व्यावसायिक स्वास्थ्य, सम्बन्धित जोखिम उठाने पड़ते है, उत्तराखण्ड के तीन जिले उधम सिंह नगर, नैनीताल और अल्मोड़ा से 75 उत्तरदाताओं का चयन किया गया तथा कुल उत्तरदाताओ में से 30 प्रतिशत में प्रायोगिक आंकड़ें इक्टठे किये गये, एर्गोनोमिक मूल्यांकन के लिए RULA, REBA और ART का उपयोग किया गया और वर्णनात्मक अध्ययन के लिए जन सांख्यिकीय प्रश्नावली, मानक नॉर्डिक प्रश्नावली, तनाव मुक्त रणनीतियाँ प्रश्नावली, कुप्पुस्वामी के सामाजिक आर्थिक स्केल (2020), स्वास्थ्य सम्बन्धित चेकलिस्ट, व्यक्तिगत सुरक्षा उपकरण चेकलिस्ट, जोखिम मूल्यांकन और कार्यस्थल चेकलिस्ट का उपयोग किया गया, वर्तमान अनुसंधान खोज से पता चलता है कि अधिकांश गैराज श्रमिक निम्न मध्य सामाजिक आर्थिक स्थिति वाले थे। गैराज श्रमिक पीठ, गर्दन और कंधे के दर्द से पीड़ित थे साथ ही साथ उन्हें अपच की समस्या भी थी। तनाव कम करने वाली रणनीतियों के रुप में उनमें से अधिकांश ने बताया कि वे तम्बाकू का सेवन करते है और भगवान की प्रार्थना करते है। शत–प्रतिशत गैराज कार्यस्थल को श्रमिकों के अनुसार सुधार करने की आवश्यकता है, जैसे कार्यस्थल की ऊँचाई कोहनी के स्तर के अनुसार, छोटे श्रमिकों के पैरों के लिए पटला का उपयोग, दोहराव से बचने के लिए एक कार्य रोटेशन प्रणाली, एक ही प्रकार के काम के लिए लटकने वाले उपकरणों का उपयोग करना, खतरनाक रसायनों के कंटनरों में नाम अंकित करना और उन्हे अनउपयुक्त स्थानों पर संग्रहित करना।

RULA, REBA और ART से पता चलता है कि गाड़ी की मरम्मत करते समय श्रमिकों द्वारा अपनाई गई सभी मुद्राऐं जोखिम के माध्यम और उच्च स्तर को दर्शाती है। प्रकाश (1693.56 ± 56.64 लक्स), आर्द्रत (58.49±8.84%), तापमान (27.65±1.819^{0}C) और शोर (61.95±7.55 dB) जैसे पर्यावरण मापक अनुशंसित स्तर के भीतर थे, गैराज श्रमिकों के रोजगार के वर्ष और मांसपेशियों के दर्द सकारात्मक रुप से सहबद्ध थे (R=0.286) गैराज श्रमिकों के कार्य के मूल्य और दक्षता को बढ़ाने के लिए संवेदी प्रशिक्षण कार्य{म भी आयोजित किया गया था।

(दीपा विनय)
सलाहकार

(अल्का चंद्रकांता)
लेखिका