# CHAPTER IV

# FINDINGS & DISCUSSIONS

The findings of the present investigation as obtained after the analysis of the data collected through the survey and experiment are described and discussed in this chapter. The findings have been supported by relevant discussions and interpretations. For systematic presentation of the results, the chapter has been divided into the following sections:

Section I : Demographic profile of the Respondents

Section II :Anthropometric data of the respondents and their Workstation Dimensions

Section III : Perceived Musculoskeletal Pain

Section IV : Postural Discomfort of the Respondents

Section V : Environment of the Workplace of the Respondents

Section VI : Physiological Cost of Work of the Respondents and the Perceived Fatigue experienced by them

Section VII : Testing of Hypotheses

Section VIII : Ergonomic Intervention Programme for the selected owners and the Respondents

## Section I

## Demographic Profile

### 4.1. Demographic profile of the Respondents

According to Park (2007), Demography is the scientific, statistical study of human populations. Demographic analysis can be applied to whole societies or to groups defined by criteria such as education, religion and ethnicity and the data can be elicited through a survey. In the view of Ahuja (2003) "Survey" is a fact-finding study and is a method of research involving collection of data directly from a population or a sample, at a particular time. It requires expert and imaginative planning, careful analysis and rational interpretation of the findings. The demographic profile of the respondents was arrived at by collecting the demographic data of the respondents through survey by personal interviewing the respondents. A descriptive analysis of the demographic data of the respondents is presented in this section.

The respondents were selected based on the purposive sampling method. Data collected from 220 respondents were analyzed for achieving the research objectives. The age (in years), educational qualifications, working experience (in years), handedness and perceived physical wellness were the parameters for demographic profile of the respondents.

### 4.1.1. Age (in years) of the Respondents

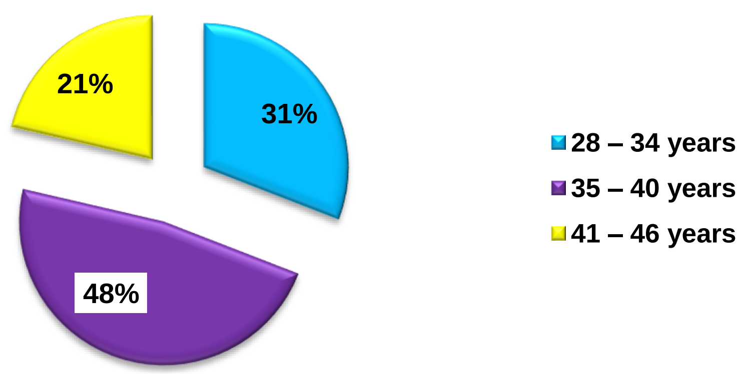
While comparing the age of the respondents it was found that a larger percentage of them (47.73 per cent) belonged to the age group of (35-40 years). The youngest respondent was aged 28 years and the eldest 46 years. The findings further revealed that less than one-third respondents (30.91 per cent) were aged between 28 – 34 years and 21.36 per cent of the respondents belonged to the age group of 41 – 46 years. The mean age of the respondents was 36.77 years (Table 6 & Figure 6).

**Table 6: Distribution of Respondents according to their Age (in years)**

n = 220

| Age (in years) | f | % |
|---|---|---|
| **28 – 34** | 68 | 30.91 |
| **35 – 40** | 105 | 47.73 |
| **41 – 46** | 47 | 21.36 |
| **Total** | 220 | 100 |
| | **Mean =36.77** | **SD= ±4.22** |

Figure 6: Distribution of Respondents according to their Age (in years) (n=220)




The fig. in the pie graph are rounded by the computer as a default setting. However, the figures depicted in the figures are actual ones (not rounded ones)

### 4.1.2. Educational Qualification of the Respondents

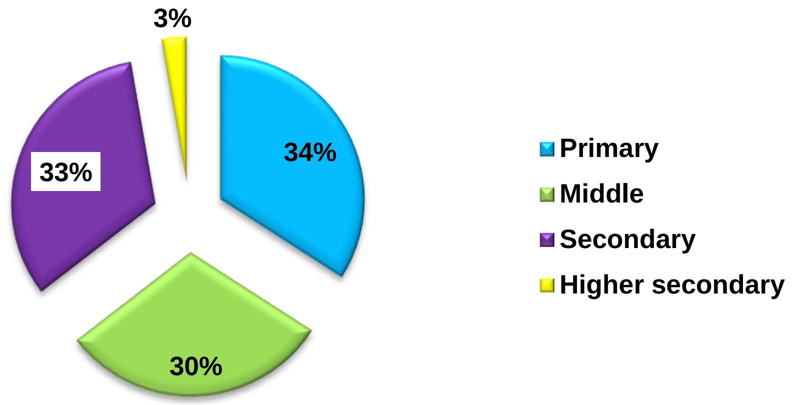
While viewing the educational qualifications of the respondents, the findings revealed that the respondents with Primary Education (upto 5th standard) slightly succeeded in percentage (34.09 per cent) as compared to the ones who pursued Secondary Education (upto 10th standard) (32.73 per cent). The Table 7 & Figure 7 also revealed that only 2.73 per cent respondents had pursued Higher Secondary Education (upto 12th standard). The findings also reported that no respondent had pursued higher education. This clearly became evident that the respondents were unaware about the potential risk factors that arose from the ergonomic environmental threat of the workplace. Thus, it indicates that the respondents had to be educated about the details of aggravating role of potential environmental ergonomics risk factors since education plays a major role in becoming aware of the surroundings and its effects.

**Table 7: Distribution of Respondents according to their Educational Qualification**

n = 220

| Educational Qualification | f | % |
|---|---|---|
| **Primary** | 75 | 34.09 |
| **Middle** | 67 | 30.45 |
| **Secondary** | 72 | 32.73 |
| **Higher secondary** | 6 | 2.73 |
| **Total** | 220 | 100 |

FIgure 7: Distribution of Respondents according to their Educational Qualification (n=220)




The fig. in the pie graph are rounded by the computer as a default setting. However, the figures depicted in the figures are actual ones (not rounded ones)

### 4.1.3. Total Working Experience (in years)

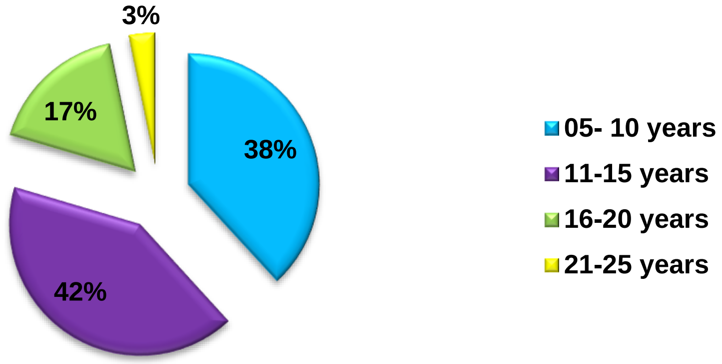
A probe on the work experience (in years) of the respondents (Table 3) elicited that 41.36 per cent of the respondents had a work experience in the range of 11 – 15 years. The Table 3 also revealed that 38.18 per cent of the respondents had total work experience in the range of 5 to 10 years. Very few respondents (3.18 per cent) had a total work experience between 21 to 25 years. Thus, it can be concluded that a higher percentage of the respondents had their work experience ranging between 11-15 years. It was found out that few respondents were working on daily wages in Construction Industry before joining the Marble Industry. Most of the respondents were working in the same profession but had gained their experience by working in other industry. The data revealed that the lowest working experience of the respondents was 5 years and the highest was 25 years (figure 8).

**Table 8: Distribution of Respondents according to their total Working Experience (in years)**

n = 220

| Working Experience (in years) | f | % |
|---|---|---|
| **05-10** | 84 | 38.18 |
| **11-15** | 91 | 41.36 |
| **16-20** | 38 | 17.27 |
| **21-25** | 7 | 3.18 |
| **Total** | 220 | 100 |
| **Working Experience (in years)** | **Mean = 12.26 years** | **SD= ±4.97 years** |

Figure 8: Distribution of Respondents according to their total Working Experience (in years) (n=220)




The fig. in the pie graph are rounded by the computer as a default setting. However, the figures depicted in the figures are actual ones (not rounded ones)

### 4.1.4. Working Experience (in years) in the present Industry

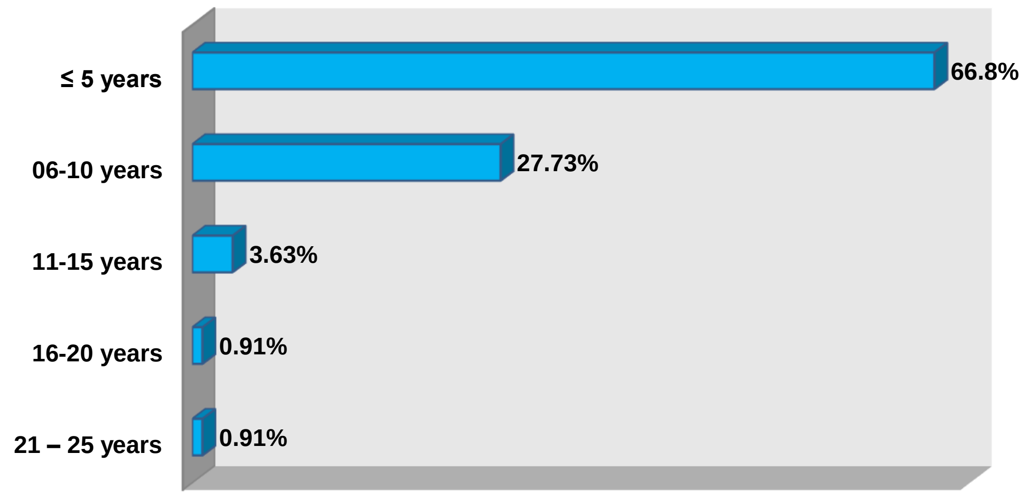
An enquiry for additional information was conducted by the investigator to know the working experience in the present industry. Work experience is the experience that a person has during working a job, or working in a specific field or occupation[14]. The present industry means the marble industry in which the respondents were employed at the time of data collection. The work experience of the respondents hereby denoted their experience of working in cutting of the tiles from the marble in Marble Industry. While viewing the working experience of the respondents in the present industry, the data in Table 9 revealed that almost two-third of the respondents (66.82 per cent) had been working in the marble cutting workers since less than 5 years.

**Table 9: Distribution of Respondents according to their Working Experience in the present Industry**

n = 220

| Working Experience in the present Industry (in years) | f | % |
|---|---|---|
| **≤ 5** | 147 | 66.82 |
| **06 – 10** | 61 | 27.73 |
| **11 – 15** | 08 | 3.63 |
| **16 – 20** | 02 | 0.91 |
| **21 – 25** | 02 | 0.91 |
| **Total** | 220 | 100 |
| **Working Experience** | **Mean =** 5.66 years | **SD=** ±3.39 years |

**Figure 9: Distribution of Respondents according to their Working Experience in the present Industry (n=220)**




The data also revealed that slightly more than one-fourth of the respondents (27.73 per cent) had their working experience in the present industry ranging between 6 to 10 years. Figure 9 further elicited that very few respondents (3.63 per cent) had a working experience ranging from 11 to15 years in the existing industry. It was very interesting to find that two of the respondents were working in the same industry for more than two decades (21 to 25 years).

### 4.1.5. Handedness of the Respondents

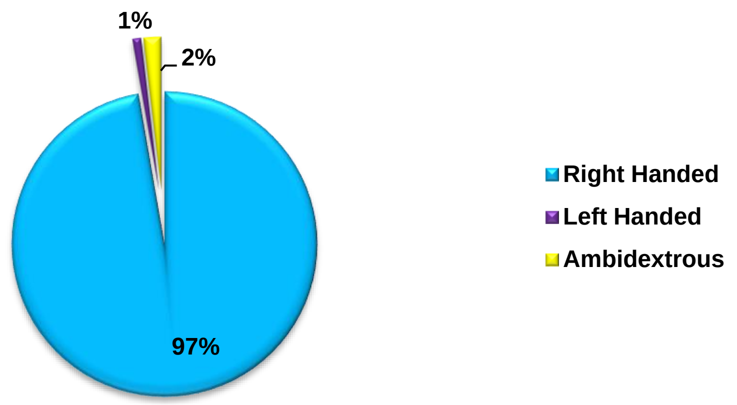
According to the Oxford Dictionary (2017) "handedness is the tendency to use either the right or the left hand more naturally than the other". The data in Table 10 revealed that majority of the respondents (97.27 per cent) were right-handed which means that they carried their work with the right hand. Only two respondents (0.91 per cent) were reported to be using their left hand as the dominating one.

**Table 10: Distribution of Respondents according to their Handedness**

n = 220

| Handedness | f | % |
|---|---|---|
| **Right Handed** | 214 | 97.27 |
| **Left Handed** | 2 | 0.91 |
| **Ambidextrous** | 4 | 1.82 |
| **Total** | 220 | 100 |

**Figure 10: Distribution of Respondents according to their Handedness (n=220)**




The fig. in the pie graph are rounded by the computer as a default setting. However, the figures depicted in the figures are actual ones (not rounded ones)

It was also evident from the data that only four respondents (1.82 per cent) were ambidextrous (using left and right hand equally well) for carrying out the work (Figure 10).

### 4.1.6. Feeling of Physical Wellness of the Respondents as perceived by them

The respondents worked from 6:00 a.m. to 2:00 p.m.. The physical wellness was inquired to understand the feeling of their wellness before, during and after the work so that an insight can be derived regarding which time affects their physical wellness the most. The data in Table 11 & Fig. 11 clearly elicit that the feeling of Physical Wellness in general among the higher percentage (57.73 per cent) of the respondents were found to be best (Good) before the start of their work as compared to "during work" and after their work. This is obvious as the energy levels of the respondents were higher in the morning after the sleep in the night. Further while comparing the feeling of Physical Wellness with "Very Good" and the next qualitative level "Good". It was found to be declined from before the work to during the work.

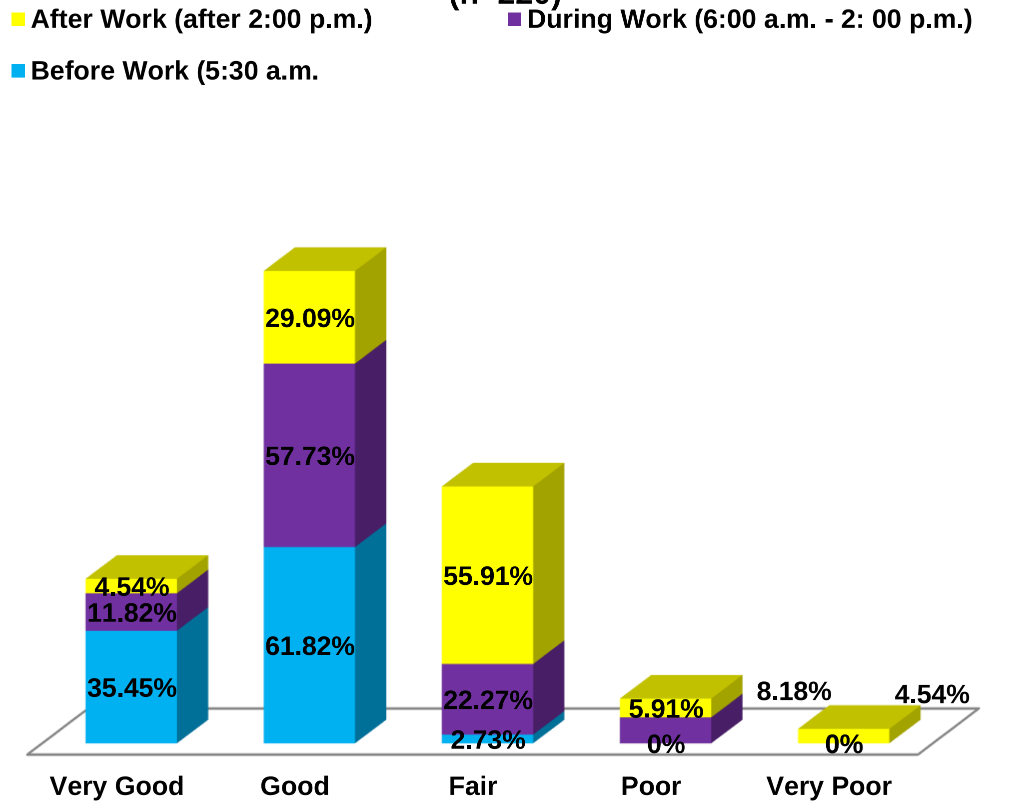
A very minimal percentage of the respondents (4.54 per cent) reported to experience a feeling of their physical wellness as "Poor" at the time and after completion of their work. The reason could be that they may not be accustomed to work physically or mentally whole heartedly.

**Table 11: Distribution of Respondents according to the feeling of Physical Wellness as perceived by them**

n = 220

| Feeling of Physical Wellness | Very good | | Good | | Fair | | Poor | | Very poor | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Work Timings** | **f** | **%** | **f** | **%** | **f** | **%** | **f** | **%** | **f** | **%** |
| **Before work (5.30 a.m.)** | 78 | 35.45 | 136 | 61.82 | 6 | 2.73 | - | - | - | - |
| **During work 6.00 a.m. – 2.00 p.m.)** | 26 | 11.82 | 127 | 57.73 | 49 | 22.27 | 18 | 8.18 | - | - |
| **After work (after 2.00 p.m.)** | 10 | 4.54 | 64 | 29.09 | 123 | 55.91 | 13 | 5.91 | 10 | 4.54 |

**Figure 11: Distribution of Respondents according to the feeling of Physical Wellness as perceived by them (n=220)**




A probe was also made to find out whether age has any impact on the feeling of physical wellness among the respondents as perceived by them. The comparative data of three age groups made it evident (Table 11.1) that the 46.81 per cent and 53.19 per cent of the respondents belonging the age-group of 41-46 years were found to be having had "Very good" and "Good" feeling of their physical wellness respectively “Before work” as compared to the younger ones belonging to the age group of 23-34 years and 35-40 years. Not a single respondent was found to having “Fair” status of feeling of physical wellness “before work”.

It is worth noting that “During work” comparatively higher percentage (34.04 per cent) of the respondents belonging to the eldest group (41-46 years) had feeling of Physical Wellness of “Very Good” as compared to the younger age group (28-34 years (2.94 per cent) and 35-40 years (7.62 per cent)). The lowest percentage (10.64 per cent) of the eldest age group (41-46 years) had perceived their feeling of Physical Fitness as “fair” and none of them as “Poor” during work.

**Table 11.1: Age wise distribution of Respondents according to the Feeling of Physical Wellness as perceived by them**

n = 220

| Work timings | Feeling of Physical Wellness | Age (in years) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 28 – 34 (68) | | 35 - 40 (105) | | 41 – 46 (47) | |
| | | f | % | f | % | f | % |
| Before work | Very good | 23 | 33.82 | 33 | 31.43 | 22 | 46.81 |
| | Good | 43 | 19.55 | 68 | 64.76 | 25 | 53.19 |
| | Fair | 2 | 2.94 | 4 | 3.81 | - | - |
| During work | Very good | 2 | 2.94 | 8 | 7.62 | 16 | 34.04 |
| | Good | 40 | 58.82 | 61 | 58.09 | 26 | 55.32 |
| | Fair | 14 | 20.58 | 30 | 28.57 | 5 | 10.64 |
| | Poor | 12 | 17.65 | 6 | 5.71 | - | - |
| After work | Very good | 10 | 14.70 | - | - | - | - |
| | Good | 5 | 7.35 | 33 | 31.42 | 26 | 55.32 |
| | Fair | 39 | 57.35 | 66 | 62.86 | 18 | 38.29 |
| | Poor | 4 | 5.88 | 6 | 5.71 | 3 | 6.38 |
| | Very Poor | 10 | 14.70 | - | - | - | - |

The more number of younger respondents (28-34 years of age) perceived their Feeling of Physical Wellness as “Poor” (17.65 per cent) during work. The similar trend is seen among the same age group (14.70 per cent) event after work where they reported “Very Poor” feeling of physical wellness (table 11.1).

**Table 11.2: Working Experience in the present industry wise distribution of Respondents according to their feeling of Physical Wellness as perceived by them**

n = 220

| Work timings | Perceived health status | Working Experience in the present industry (in years) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2-10 (208) | | 11-18 (8) | | 19-26 (4) | |
| | | f | % | f | % | f | % |
| Before work | Very good | 74 | 35.57 | 2 | 25.00 | 2 | 50.00 |
| | Good | 128 | 61.54 | 6 | 75.00 | 2 | 50.00 |
| | Fair | 6 | 2.88 | - | - | - | - |
| During work | Very good | 24 | 11.54 | 2 | 25.00 | - | - |
| | Good | 123 | 59.13 | 2 | 25.00 | 2 | 50.00 |
| | Fair | 43 | 20.67 | 4 | 50.00 | 2 | 50.00 |
| | Poor | 18 | 8.65 | - | - | - | - |
| After work | Very good | 10 | 4.81 | - | - | - | - |
| | Good | 56 | 26.92 | 4 | 50.00 | 4 | 100 |
| | Fair | 119 | 57.21 | 4 | 50.00 | - | - |
| | Poor | 13 | 6.25 | - | - | - | - |
| | Very Poor | 10 | 4.81 | - | - | - | - |

The researcher was inquisitive to find out whether working experience in the present industry has any role to play with the “Feeling of Physical Wellness” or not. The findings in Table 11.2 shows that the respondents with more number of experience had a better “Feeling of Physical Wellness” as compared to the ones who were having less number of experience “Before work”, “During work” and “After work”.

The finding in Table 11.2 very interestingly highlighted that a higher percentage of the respondents (57.12 per cent) having lesser experience (2-10 years) have perceived their “Feeling of Physical Wellness” as “Fair” “after work” as compared to the ones having higher experience of 11-18 years.

Slightly more than one – half of the respondents (59.13 per cent) having 2-10 years of working experience reported “Good” feeling of physical wellness It was interesting to note that one – half of the respondents (50 per cent) with experience of 19-26 years reported “Fair” feeling of physical wellness during work. The findings also revealed that cent per cent respondents with higher working experience (19-26 years) had reported “Good” feeling of physical wellness “After Work”.

## Section II

## 4.2. Anthropometric Data and Workstation Dimensions

This section dealt with the information regarding the anthropometric measurements of the respondents. The mean, Standard Deviation, 95$^{th}$ and 5$^{th}$ percentile for anthropometric data were computed. The workstation dimension were also recorded for gaining an insight of the environment of the workplace and to set a probe if the workstation is in compliance with the anthropometric measurements of the respondents.

### 4.2.1. Anthropometric data of the Respondents

Anthropometry is the study of the people in terms of their physical body dimensions. It includes measurement of various human body characteristics such as size, breadth, circumferences and distance between anatomical points. The anthropometric data can be used for designing equipments, workspace, workplace, layout, personnel selection in sports, defense services etc. (Chauhan, 2015). The anthropometric data are used in ergonomics to ensure that physical mismatches between the dimensions of equipment and products and the corresponding user dimensions are avoided (Bridger, 1997)

The mean anthropometric measurements of the respondents were calculated in the present study. The mean height of the respondents was logged as 67.09 inches. The mean forearm length of the respondents was measured as 16.33 inches. Their mean vertical maximum reach was recorded as 63.14 inches and horizontal maximum reach as 23.92 inches (table 12).

According to Chauhan (2015), in order to design for accommodating the variation of the human beings, they are divided into three major categories depending on the dimension i.e. 5$^{th}$, 50$^{th}$ or 95$^{th}$ percentile range. A percentile score shows what percent of other scores is less than the data point one is investigating. Depending on the nature of the design and the context of use, the design must be conceived to accommodate the population in between 5$^{th}$ and 95$^{th}$ percentile, keeping 50$^{th}$ as mid value, so that most of the population is covered. Thus, the data was calculated in 95$^{th}$ and 5$^{th}$ percentile.

The reporting and collection of anthropometric data is also depicted in other studies (Tiwana, 2013; Mondal and Mridha, 2015) the researchers had computed Mean and Standard Deviation of the anthropometric Data of the respondents.

**Table 12: Distribution of Respondents according to their Anthropometric Measurements**

**n=220**

| Anthropometric Measurements | Mean* | SD | 95th *Percentile | 5th * Percentile |
|---|---|---|---|---|
| **Height** | 67.09 | 5.43 | 70.47 | 63.78 |
| **Arm span** | 61.97 | 5.43 | 65.35 | 58.66 |
| **Standing Shoulder Height** | 55.28 | 5.43 | 58.66 | 51.97 |
| **Standing Elbow height** | 42.29 | 5.43 | 45.67 | 38.97 |
| **Standing Upper arm length** | 11.66 | 1.04 | 12.2 | 11.02 |
| **Standing Forearm length** | 16.33 | 1.45 | 16.93 | 15.35 |
| **Standing Eye height** | 58.05 | 5.53 | 61.42 | 54.72 |
| **Reaches** | | | | |
| **Vertical Maximum Reach** | 63.14 | 5.39 | 66.53 | 59.84 |
| **Vertical Minimum Reach** | 60.79 | 5.43 | 64.17 | 57.48 |
| **Horizontal Maximum Reach** | 23.92 | 2.50 | 24.8 | 22.83 |
| **Horizontal Minimum Reach** | 15.14 | 1.45 | 15.75 | 14.17 |

*The unit of measurements was inches

Plate 9: Recording anthropometry measurements with the non-stretchable

Plate 10: Recording anthropometry measurements with the non-stretchable

### 4.2.2. Dimensions of the Workstation

The workstation of the industry comprised of a cement vertical structure on which a horizontal iron hinges were placed with a gap of 2 -5 cms. There was a rotating blade for cutting the marble slabs into pieces. While the blade rotates for cutting the marble, water runs on the blade for smooth cutting. The water then mixes with the marble dust and forms marble slurry. There was no such provision of water drainage at this workstation thus leading to accumulation of marble slurry which after drying up used to become marble dust. The respondents were not observed wearing gum boots instead they barely had slippers on their feet. The slurry was reported to be accumulated on the feet of the respondents which could lead to silicosis and other skin diseases.

**Table 13: Dimensions of the Workstation**

| Measurements | Existing Dimensions |
|---|---|
| Height from the floor to the horizontal plane for keeping marble | 34 inches 5 cm |
| Height from the floor to the pulley | 64.5 inches |
| Width | 43 inches |
| Length | 77 inches |

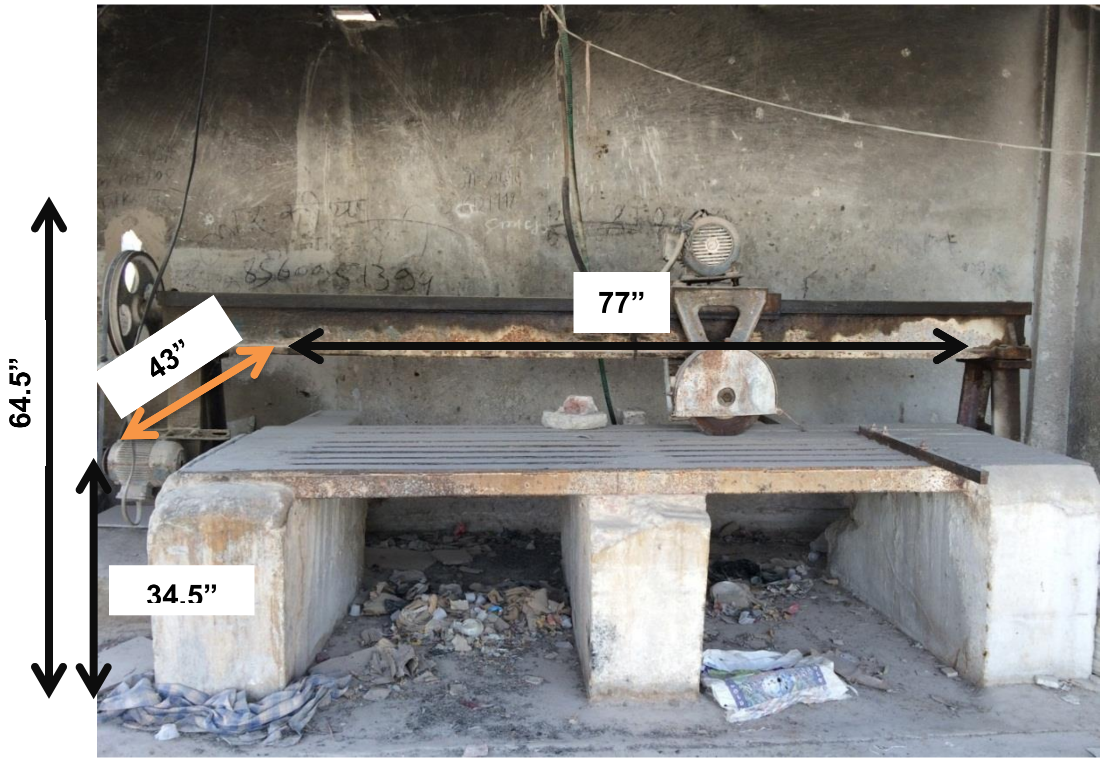



**Figure 12: Dimensions of the Workstation**

The height of the workstation was measured 34.5 inches which was reported to be according to the recommended height as per OSHA (2018)[15]. According to OSHA guidelines 2018, for heavy work and demanding downward forces the work height should be 8-15 inches below elbow height. As per the guidelines the present workstation was reported to be 13 inches below the ($95^{th}$ percentile was 45.67 inches) elbow height of the respondents. Thus, there were no recommendations in changing the elbow height of the respondents (Table 13, fig 12).

The width of the workstation was 43 inches which was designed to fit larger size of marble for cutting because while cutting the marble, it should have a strong base for bearing vibration, if such strong sturdy base is not provided, it can break the marble thus causing wastage. Therefore, standard width cannot be proposed as the width should be according to the marble size than the respondent. The length of the workstation was 77 inches for fitting to the length of the marble and thus aid in smooth running of the machine and less wastage of the marble.

## Section III

## 4.3. Perceived Musculoskeletal Pain

The findings pertinent to perceived musculoskeletal pain of the marble cutting workers are projected in this section. The subjective data regarding the perceived pain of the respondents in the body parts namely neck, shoulders, arms, elbows, wrists, palms, back, hips, thighs, legs, knees, feet and ankles while doing various movements while performing their task of cutting tiles from waste marble slabs, and during rest are also presented in this section. The data regarding the confirmation of existence of musculoskeletal pain among the respondents through their medical report information about visit to a doctor for curing the pain could not be gathered as the economic background of the respondents was very poor. An enquiry was also made if the respondents visit any nearby Public Health Center or any local doctor but the respondents quoted that their work gets suffered if they visit doctors so they avoid going for checkup. Very few respondents had visited the doctor for their pain related queries but they visited a physician and also did not complete the full course prescribed to them stating that their work was suffering.

### 4.3.1. Perceived Musculoskeletal Pain as perceived by the respondents in their Neck

The neck is more or less a cylindrical region connecting the head to the trunk. It extends from the lower border line of the lower jaw up to the lower edge of the collar bone. The posterior part of the neck is ligamentous which connects the spines of the cervical vertebrae and extends up to the occiput (Datta, 2015). The data in table 14, it was observed that the respondents were constantly involved in lifting waste marble slabs weighing from 25 – 75 kgs in a day to cut into tiles which might affect the neck muscles if proper posture is not maintained. The respondents had to move each marble slab (36”- 50”) into the machine precisely to ensure that similar sized marble cut tiles (7”-10”, 6”-10”), though the size varies as per the demands of the customers. Thus, the perceived Musculoskeletal Pain in the neck of the respondents was inquired. The findings in Table 14 affirmed that the respondents were suffering from pain while making movements of their neck during the performance of their work. A probe was made that which neck movement was affected most with pain.

#### 4.3.1.1. Perceived Musculoskeletal Pain experienced since Past 7days

While analyzing the data for the pain experienced in movements of neck while pursuing their task of cutting marbles in the past 7 days depicted that slightly more than one-tenth of the respondents (14.55 per cent) experienced pain while rotating their neck clockwise and anticlockwise as compared to the other neck movements. The reason for experiencing pain while rotating can be speculated to be muscle spasm. A similar number of respondents reported that pain hindered the continuance of their daily activities. One-tenth of respondents (10.91 per cent) were found to be experiencing certain pain while resting. It was highlighted in the findings, very few respondents (6.36 per cent) experienced pain while moving the neck to the left side since there were very few controls on the left side of the workstation. The findings also revealed that all the respondents who were experiencing pain in either movement of the neck since 7 days reported that the pain hindered in continuing their daily work. Krause et. al. (2005) conducted a study on Nine hundred forty-one unionized hotel room cleaners to assesses the prevalence of back and neck pain. The study revealed that there was a one-month prevalence of severe bodily pain was 47 per cent in general, 43 per cent for neck, 59 per cent for upper back, and 63 per cent for low back pain (Table 14).

#### 4.3.1.2. Perceived Musculoskeletal Pain since experienced Past 12 Months

On scrutiny of the musculoskeletal pain in neck in the past 12 months, the more than one-half of the respondents (54.54 per cent) were found to be experiencing musculoskeletal pain while moving their neck upwards which could be most likely due to development of spondylitis. On consulting doctor, it was suggested that the pain could be due to spondylitis which is caused by poor posture of the neck and the vertebrae.

**Table 14: Distribution of Respondents according to the Pain experienced in Neck**

n = 220

| Pain experienced in Neck | Pain Experienced since | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Past 7 days | | | | Past 12 months | | | |
| | Yes | | No | | Yes | | No | |
| | f | % | f | % | f | % | f | % |
| **While moving the neck** | | | | | | | | |
| a. Upwards | 18 | 8.18 | 202 | 91.82 | 120 | 54.54 | 100 | 45.45 |
| b. Down | 18 | 8.18 | 202 | 91.82 | 81 | 36.82 | 139 | 63.18 |
| c. Right side | 18 | 8.18 | 202 | 91.82 | 40 | 18.18 | 180 | 81.82 |
| d. Left side | 14 | 6.36 | 206 | 93.64 | 28 | 12.73 | 192 | 87.27 |
| e. Rotating clockwise | 32 | 14.55 | 188 | 85.45 | 59 | 26.82 | 161 | 73.18 |
| f. Rotating Anticlockwise | 32 | 14.55 | 188 | 85.45 | 65 | 29.55 | 155 | 70.45 |
| g. While Resting | 24 | 10.91 | 196 | 89.09 | 94 | 42.73 | 126 | 57.27 |
| Hindrance in continuing daily activity due to pain | 32 | 14.55 | 188 | 85.45 | 73 | 33.18 | 147 | 66.82 |

The table 14 highlighted that 42.73 per cent of the respondents were found to be experiencing pain while resting which is also caused due to degenerative changes. The muscles are in spasm while working, while resting the bones come in contact to the joints which leads to experience of pain. Jansen et.al (2012) carried a research to analyse subjective self-evaluation of musculoskeletal discomfort conducted by female production assembly workers in Estonia. Thirty-seven female assembly workers aged 20–54 years participated in this study, whereas 35 of them were right-handed. Discomfort in neck, shoulder, upper back, upper arm, low back, forearm, wrist, hips, thigh, knees, lower legs and heels was subjectively evaluated by Cornell Musculoskeletal Discomfort Questionnaire. The results indicated that female assembly workers felt most work-related discomfort in the neck (44 per cent), lower back (19.7 per cent) and in the right wrist (15 per cent). Discomfort was less pronounced in the right knee (0.01 per cent), left upper arm (0.04 per cent) and left hip buttocks (0.1 per cent). The study of the present research are also in line with the study. Another study conducted on the prevalence of musculoskeletal Disorder among the dental students were supporting the present research is as the most prevalent regions reported were the neck 66 per cent (217/329) and low back 62.2 per cent (202/325), while the hips/thighs 10.1 per cent (36/358) and elbows 12.8 per cent (45/352) regions were the least prevalent regions (Rayes, 2011).

### 4.3.2. Musculoskeletal Pain as perceived by the respondents in their Shoulders

The shoulder region includes the a) the pectoral or breast region on front of the chest, b) the axilla or armpit, and c) the scapular region on the back comprising parts around the scapula. The arm (upper arm or brachium) extends from the shoulder to the elbow. Humerus, the bone of the arm meets the scapula, bone of the scapular region and forms the shoulder joint. The shoulder joint permits movement of the arm (Chaurasiya,2015). The perceived Musculoskeletal Pain in the shoulders of the respondents was inquired. It was observed that the respondents were constantly involved in lifting waste marble slabs weighing from 25 – 75 kg in a day to cut into tiles (size) which can affect the shoulder muscles while lifting the marble slab from the floor onto the machine.

#### 4.3.2.1. Perceived Musculoskeletal Pain experienced since Past 7 days

The data on the pain experienced by the respondents in the past 7 days revealed that slightly more than one-tenth of the respondents (14.55 per cent) were experiencing pain in the left shoulder while lifting the marble slab which could be due to inflammation of the shoulder muscles. Slightly more than one-tenth of the respondents (11.82 per cent) experienced pain in their right shoulder while resting. The pain in right shoulder can be experienced since majority of the respondents were right-handed. The data in table 15 also highlighted that almost nearly more than one-tenth of the respondents (10.91 per cent) were found to be experiencing pain in right shoulder while keeping the marble slab on a surface, while carrying marble slab as well as while rotating right shoulder clockwise. Pain in left shoulder was also experienced by similar number of respondents (10.91 per cent) while keeping the marble slab on the workstation for cutting it into tiles. Very few respondents (4.09 per cent) were suffering from pain while lifting marble slab overhead. It was observed that the heavy marble slabs were rarely lifted above chest level by the respondents thus not causing pain while lifting marble slab above chest level.

**Table 15: Distribution of Respondents according to the Pain experienced in Shoulder**

n = 220

| Shoulder | Pain Experienced since | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Past 7 days | | | | Past 12 months | | | |
| | Yes | | No | | Yes | | No | |
| | f | % | f | % | f | % | f | % |
| **While lifting the marble slab** | | | | | | | | |
| **Overhead** | | | | | | | | |
| a. Right side | 13 | 5.91 | 207 | 94.09 | 73 | 33.18 | 147 | 66.82 |
| b. Left side | 9 | 4.09 | 211 | 95.90 | 65 | 29.55 | 155 | 70.45 |
| **Chest Level** | | | | | | | | |
| a. Right side | 15 | 6.82 | 205 | 93.18 | 73 | 33.18 | 147 | 66.82 |
| b. Left side | 19 | 8.64 | 201 | 91.36 | 73 | 33.18 | 147 | 66.82 |
| **Below Chest** | | | | | | | | |
| a. Right side | 13 | 5.91 | 207 | 94.09 | 96 | 43.64 | 124 | 56.36 |
| b. Left side | 13 | 5.91 | 207 | 94.09 | 94 | 42.73 | 126 | 57.27 |
| **While keeping the marble slab** | | | | | | | | |
| a. Right side | 24 | 10.91 | 196 | 89.09 | 124 | 56.36 | 96 | 43.64 |
| b. Left side | 24 | 10.91 | 196 | 89.09 | 116 | 52.73 | 104 | 47.27 |
| **While carrying the marble slab** | | | | | | | | |
| a. Right side | 24 | 10.91 | 196 | 89.09 | 140 | 63.64 | 80 | 36.36 |
| b. Left side | 32 | 14.55 | 188 | 85.45 | 134 | 60.91 | 86 | 39.09 |
| **While lifting the hand** | | | | | | | | |
| a. Right side | 14 | 6.36 | 206 | 93.64 | 83 | 37.73 | 137 | 62.27 |
| b. Left side | 22 | 10.00 | 198 | 90.00 | 73 | 33.18 | 147 | 66.82 |
| **While resting** | | | | | | | | |
| a. Right side | 26 | 11.82 | 194 | 88.18 | 122 | 55.45 | 98 | 44.55 |
| b. Left side | 18 | 8.18 | 202 | 91.82 | 102 | 46.36 | 118 | 53.64 |
| **While rotating the shoulder clockwise** | | | | | | | | |
| a. Right Side | 24 | 10.91 | 196 | 89.09 | 140 | 63.64 | 80 | 36.36 |
| b. Left Side | 18 | 8.18 | 202 | 91.82 | 122 | 55.45 | 98 | 44.55 |
| **While rotating the shoulder anticlockwise** | | | | | | | | |
| a. Right Side | 16 | 7.27 | 204 | 92.73 | 84 | 38.18 | 136 | 61.82 |
| b. Left Side | 16 | 7.27 | 204 | 92.73 | 78 | 35.45 | 142 | 64.55 |
| **Hindrance in continuing the daily activities due to pain** | 14 | 6.36 | 206 | 93.64 | 50 | 22.73 | 170 | 77.27 |

#### 4.3.2.2. Perceived Musculoskeletal Pain experienced since Past 12 Months

The data in table 15 revealed that 63.64 per cent of the respondents experienced pain in the right shoulder while carrying the marble slab and while rotating the shoulder clockwise. The pain could be speculated to be due to adhesive capsulitis (stiffness and pain in the shoulder). Pain in left shoulder while carrying marble was experienced by 60.91 per cent of the respondents. Slightly more than one-half of the respondents (56.36 per cent) experienced pain in the right shoulder while keeping the marble slab. Slightly more than one-half of the respondents (55.45 per cent) were also experiencing pain in right shoulder while resting and in left shoulder while rotating shoulder clockwise. As per the opinion of an orthopaedician, the pain could be induced due to rotator cuff injury which is caused due to chronic degenerative wear and tear of the tendons among other causes. It was also observed that 66.82 per cent of the respondents did not experience any pain while lifting the marble slab overhead on the right side as well as while lifting marble slab at chest level.

### 4.3.3. Musculoskeletal Pain as perceived by the respondents in their Elbows

It is a compound and hinge variety of synovial joint between the arm and forearm. It consists of humero-ulnar and humero-radial parts; basically, formed between the humerus (arm bone) and ulna and radius (medial and lateral forearm bones respectively) (Datta,2017).

The perceived Musculoskeletal Pain in the Elbows of the respondents was inquired. It was observed that the respondents were constantly involved in lifting waste marble slabs weighing from 25 – 75 kg in a day to cut into tiles (size). The pain experienced was asked whether they experienced in the past 7 days or in the past 12 months.

#### 4.3.3.1. Perceived Musculoskeletal Pain since Past 7 days

While interrogating the respondents on experiencing pain in their elbows, nearly one-tenth (10.91 per cent) were found to be experiencing pain in the right elbow while at rest. The pain induced at rest is due to the reason that bones come in contact with joints while in resting position thus causing pain. One-tenth of the respondents (10.00 per cent) experienced pain in the left elbow while carrying the marble slab and while doing movement of tightening a screw (i.e. while doing a supination movement with the hand). The data also revealed that majority of the respondents (96.36 per cent) were not found to be experiencing any pain on both sides while lifting marble slab at chest level and below chest. The respondents were not found to be suffering any pain while lifting marble slab overhead as lifting marble slab was very rare practice at workplace.

#### 4.3.3.2. Perceived Musculoskeletal Pain since Past 12 months

The assessment of the perceived musculoskeletal pain in elbows since 12 months elicited that 59.09 per cent of the respondents were experiencing pain while doing supination movement (i.e. while doing a movement of tightening a screw). The pain could be due to bicep tendinitis (inflammation of tendons). Slightly more than one-half of the respondents (50.90 per cent) experienced pain in the right elbow while carrying the marble slab which can be speculated to be due to golfer's elbow (inflammation of tendons). Pain in left elbow while tightening the screw was experienced by 47.27 per cent of the respondents. As well as, 45.91 per cent of the respondents were found to be experiencing pain while carrying marble slab. Majority of the respondents (84.55 per cent) were not found to be experiencing pain on left side while lifting marble slab at chest level. As per the opinion of the doctor, the reason could be since majority of the respondents were right-handed (Table 16).

**Table 16: Distribution of Respondents according to the Pain experienced in Elbow**

n = 220

| Elbows | Pain Experienced since | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Past 7 days | | | | Past 12 months | | | |
| | Yes | | No | | Yes | | No | |
| | f | % | f | % | f | % | f | % |
| **While lifting the marble slab** | | | | | | | | |
| • Overhead | | | | | | | | |
| a. Right side | 10 | 4.55 | 210 | 95.45 | 62 | 28.18 | 158 | 71.82 |
| b. Left side | 10 | 4.55 | 210 | 95.45 | 52 | 23.64 | 168 | 76.36 |
| • Chest level | | | | | | | | |
| a. Right side | 8 | 3.64 | 212 | 96.36 | 44 | 20.00 | 176 | 80.00 |
| b. Left side | 8 | 3.64 | 212 | 96.36 | 34 | 15.45 | 186 | 84.55 |
| • Below chest | | | | | | | | |
| a. Right side | 8 | 3.64 | 212 | 96.36 | 61 | 27.73 | 159 | 72.27 |
| b. Left side | 8 | 3.64 | 212 | 96.36 | 48 | 21.82 | 172 | 78.18 |
| • While keeping the marble slab | | | | | | | | |
| a. Right side | 16 | 7.27 | 204 | 92.73 | 82 | 37.27 | 138 | 67.73 |
| b. Left side | 16 | 7.27 | 204 | 92.73 | 65 | 29.55 | 155 | 70.45 |
| • While carrying the marble slab | | | | | | | | |
| a. Right side | 18 | 8.18 | 202 | 91.82 | 112 | 50.90 | 108 | 49.09 |
| b. Left side | 22 | 10.0 | 198 | 90.00 | 101 | 45.91 | 119 | 54.09 |
| **While tightening the screw** | | | | | | | | |
| a. Right side | 18 | 8.18 | 202 | 91.82 | 130 | 59.09 | 90 | 40.91 |
| b. Left side | 22 | 10.0 | 198 | 90.00 | 104 | 47.27 | 116 | 52.73 |
| **While resting** | | | | | | | | |
| a. Right side | 24 | 10.91 | 196 | 89.09 | 75 | 34.09 | 145 | 65.91 |
| b. Left side | 18 | 8.18 | 202 | 91.82 | 59 | 26.82 | 161 | 73.18 |
| **Hindrance while continuing the daily activity due to pain** | 22 | 10.0 | 198 | 90.00 | 91 | 41.36 | 129 | 58.64 |

### 4.3.4. Musculoskeletal Pain as perceived by the respondents in their Wrists

The movements of the hand are permitted chiefly at the wrist joint. The thumb moves at carpometacarpal joint and the other digits move at metacarpophalangeal and interphalangeal joints (Chaurasiya, 2015). The Musculoskeletal Pain as perceived by the respondents in the Wrists inquired. To record the acute and chronic condition of pain it was asked if they experienced pain in the past 7 days or 12 months.

#### 4.3.4.1. Perceived Musculoskeletal Pain experienced since Past 7 days

The data in table 17 on the musculoskeletal pain as perceived by the respondents in their wrists highlighted that one-tenth of the respondents (10.00 per cent) experienced while resting in their right wrist. Pain in their right wrist while at rest was experienced by 8.18 per cent respondents.

**Table 17: Distribution of Respondents according to the Pain experienced in their Wrists**

n = 220

| Wrist | Pain Experienced since | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Past 7 days | | | | Past 12 months | | | |
| | Yes | | No | | Yes | | No | |
| | f | % | f | % | f | % | f | % |
| **While lifting marble slab** | | | | | | | | |
| • **Overhead** | | | | | | | | |
| a. **Right side** | 4 | 1.82 | 216 | 98.18 | 68 | 30.91 | 152 | 69.09 |
| b. **Left side** | 4 | 1.82 | 216 | 98.18 | 60 | 27.27 | 160 | 72.73 |
| • **Chest level** | | | | | | | | |
| a. **Right side** | 2 | 0.91 | 218 | 99.09 | 60 | 27.27 | 160 | 72.73 |
| b. **Left side** | 2 | 0.91 | 218 | 99.09 | 56 | 25.45 | 164 | 74.54 |
| • **Below chest** | | | | | | | | |
| a. **Right side** | 2 | 0.91 | 218 | 99.09 | 72 | 32.73 | 148 | 67.27 |
| b. **Left side** | 2 | 0.91 | 218 | 99.09 | 58 | 26.36 | 162 | 73.64 |
| • **While keeping the marble slab** | | | | | | | | |
| a. **Right side** | 12 | 5.45 | 208 | 94.55 | 98 | 44.55 | 122 | 55.45 |
| b. **Left side** | 12 | 5.45 | 208 | 94.55 | 86 | 39.09 | 134 | 60.91 |
| • **While carrying the marble slab** | | | | | | | | |
| a. **Right side** | 10 | 4.55 | 210 | 95.45 | 110 | 50.00 | 110 | 50.00 |
| b. **Left side** | 10 | 4.55 | 210 | 95.45 | 94 | 42.73 | 126 | 57.27 |
| **While moving** | | | | | | | | |
| a. **Upward** | | | | | | | | |
| • **Right Side** | 12 | 5.45 | 208 | 94.55 | 82 | 37.27 | 138 | 62.73 |
| • **Left Side** | 14 | 6.36 | 206 | 93.64 | 62 | 28.18 | 158 | 71.82 |
| b. **Downward** | | | | | | | | |
| • **Right Side** | 6 | 2.73 | 214 | 97.27 | 66 | 30.00 | 154 | 70.00 |
| • **Left Side** | 6 | 2.73 | 214 | 97.27 | 56 | 25.45 | 164 | 74.55 |
| c. **Clockwise** | | | | | | | | |
| • **Right Side** | 10 | 4.55 | 210 | 94.55 | 118 | 53.64 | 102 | 46.36 |
| • **Left Side** | 10 | 4.55 | 210 | 94.55 | 92 | 41.82 | 128 | 58.18 |
| d. **Anti clockwise** | | | | | | | | |
| • **Right Side** | 2 | 0.91 | 218 | 99.09 | 68 | 30.91 | 152 | 69.09 |
| • **Left Side** | 2 | 0.91 | 218 | 99.09 | 53 | 24.09 | 167 | 75.91 |
| **While resting** | | | | | | | | |
| a. **Right side** | 18 | 8.18 | 202 | 91.82 | 88 | 40.00 | 132 | 80.00 |
| b. **Left side** | 22 | 10.0 | 198 | 90.00 | 76 | 34.55 | 144 | 65.45 |
| **Hindrance in continuing the daily activity due to pain** | 20 | 9.09 | 200 | 90.91 | 58 | 26.36 | 162 | 73.64 |

As per Doctor's opinion, during night as the muscles relax, the articular surfaces of the joint come in contact with each other, in such cases if there is a damage to the hyaline cartilage of the joints it can lead to pain only termed as night crisis of the joint pain. Very few respondents (0.91 per cent) were found to be experiencing pain while lifting marble slab below chest and at chest level on both wrists.

#### 4.3.4.2. Perceived Musculoskeletal Pain experienced since Past 12 months

The data in table 17 revealed that more than one-half of the respondents (53.64 per cent) experienced pain in the right wrist while rotating it clockwise. The pain could be due to neuropathic changes which are caused due to exposure to vibration produced by the machine. One-half of the respondents (50.00 per cent) experienced pain in the right wrist while carrying the marble slab. It was reported that majority of the respondents were right-handed thus experiencing more pain in the right wrist. Pain was experienced in the right wrist while keeping the marble slab on a surface of the workstation by 44.45 per cent of the respondents. According to Doctor's opinion, the pain could be induced due to DRUJ disruptions (distal radial ulnar joint injuries) under which the tendons of the joints. The findings concluded that there were a higher number of respondents experiencing pain in the past 12 months than the past 7 days. The reason can be that the respondents have had developed chronic pain and it may occur on days when they have more work. The respondents were also found to be ignoring medical attention since they did not belong to good economic background (Table 17).

### 4.3.5. Musculoskeletal Pain as perceived by the respondents in their Arms

The forelimbs and hind limbs were evolved basically for bearing the weight of the body and for locomotion as seen in quadrupeds, e.g. cows and dogs. The two pair of limbs are, therefore, built on the same principle. Each limb is made of a basal segment or girdle, and a free part divided into proximal, middle and distal segments. The girdle attaches the limb to the axial skeleton. The distal segment carries 5 digits. However, with the evolution of the erect posture in man, the function of weight-bearing was taken over by the lower limbs. Thus the upper limbs, especially the hands, became free and gradually evolved into organs having great manipulative skills. This has become possible because of a wide range of mobility at the shoulder. The whole upper limb works as a jointed lever.

The upper limb is made up of 4 parts

- Shoulder region
- Arm
- Forearm
- Hand

The forearm (antebrachium) extends from the elbow to the wrist. The bones of the forearm are radius and ulna. At the upper ends, they meet the lower end of the humerus to form the elbow joint. The lower ends meet the carpal bones of the hand to form the wrist joint. The radius and ulna meet each other to form the radioulnar joints. The elbow joints and radioulnsr joints permit movements of the forearm (Chaurasiya,2015).

The Musculoskeletal Pain as perceived by the respondents in the Arms was inquired. To record the acute and chronic condition of pain it was asked if they experienced pain in the past 7 days or 12 months. While lifting the marble slab the arms are used thus the occurrence of pain in arms was inquired.

#### 4.3.5.1. Perceived Musculoskeletal Pain experienced since Past 7 days

The data in table 18 revealed that slightly less than one-tenth of the respondents (9.09 per cent) experienced pain in their left and right forearms while carrying the marble slab. A similar number of respondents (8.18 per cent) experienced pain while keeping marble slab on the surface in right and left forearm. Majority of the respondents did not experience pain while doing movement of supination (i.e. tightening of a screw). Slightly less than one-tenth of the respondents (7.27 per cent) were found to be experiencing pain in their left and right arm while carrying the marble slab. Pain in the right and left arm while lifting the marble slab below chest and while keeping the marble slab on a surface of the workstation was experienced by 6.36 per cent respondents. It can be observed that lifting of weight causes chronic pain to the respondents. The activity of lifting marble slabs weighing 25-75 kg approximately can cause repeated muscle spasm as per the opinion of the doctor consulted.

**Table 18: Distribution of Respondents according to the Pain experienced in Arms**

n = 220

| Arms | Pain Experienced since | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Past 7 days | | | | Past 12 months | | | |
| | Yes | | No | | Yes | | No | |
| | f | % | f | % | f | % | f | % |
| **Left forearm** | | | | | | | | |
| **a. While lifting the marble slab** | | | | | | | | |
| • Overhead | 10 | 4.55 | 210 | 95.45 | 58 | 26.36 | 162 | 73.64 |
| • Chest level | 12 | 5.45 | 208 | 94.55 | 78 | 35.45 | 142 | 64.55 |
| • Below chest | 12 | 5.45 | 208 | 94.55 | 66 | 30.00 | 154 | 70.00 |
| • While keeping the marble slab on a surface | 18 | 8.18 | 202 | 91.82 | 90 | 40.91 | 130 | 59.09 |
| • While carrying the marble slab | 20 | 9.09 | 200 | 90.91 | 119 | 54.09 | 101 | 45.91 |
| a. While resting | 10 | 4.55 | 210 | 95.45 | 58 | 26.36 | 162 | 73.64 |
| b. While tightening a screw | 8 | 3.64 | 212 | 96.36 | 85 | 38.64 | 135 | 61.36 |
| **Right forearm** | | | | | | | | |
| a. While lifting the marble slab | | | | | | | | |
| • Overhead | 10 | 4.55 | 210 | 95.45 | 78 | 35.45 | 142 | 64.55 |
| • Chest level | 12 | 5.45 | 208 | 94.55 | 92 | 41.82 | 128 | 58.18 |
| • Below chest | 12 | 5.45 | 208 | 94.55 | 84 | 38.18 | 136 | 61.82 |
| • While keeping the marble slab on a surface | 18 | 8.18 | 202 | 91.82 | 108 | 49.09 | 112 | 50.91 |
| • While carrying the marble slab | 20 | 9.09 | 200 | 90.91 | 137 | 62.27 | 83 | 37.73 |
| b. While resting | 12 | 5.45 | 208 | 94.55 | 70 | 31.82 | 150 | 68.18 |
| c. While tightening a screw | 8 | 3.64 | 212 | 96.36 | 97 | 44.09 | 123 | 55.91 |
| **Left upper arm** | | | | | | | | |
| a. While lifting any object | | | | | | | | |
| • Overhead | 12 | 5.45 | 208 | 94.55 | 61 | 27.73 | 159 | 72.27 |
| • Chest level | 12 | 5.45 | 208 | 94.55 | 73 | 33.18 | 147 | 66.82 |
| • Below chest | 14 | 6.36 | 206 | 93.64 | 69 | 31.36 | 151 | 68.64 |
| • While keeping the marble slab on a surface | 14 | 6.36 | 206 | 93.64 | 87 | 39.55 | 133 | 60.45 |
| • While carrying the marble slab | 16 | 7.27 | 204 | 92.73 | 103 | 46.82 | 117 | 53.18 |
| b. While resting | 6 | 2.73 | 214 | 97.27 | 70 | 31.82 | 150 | 68.18 |
| **Right upper arm** | | | | | | | | |
| a. While lifting the marble slab | | | | | | | | |
| • Overhead | 12 | 5.45 | 208 | 94.55 | 89 | 40.45 | 131 | 59.54 |
| • Chest level | 12 | 5.45 | 208 | 94.55 | 91 | 41.36 | 129 | 58.64 |
| • Below chest | 14 | 6.36 | 206 | 93.64 | 91 | 41.36 | 129 | 58.64 |
| • While keeping the marble slab on a surface | 14 | 6.36 | 206 | 93.64 | 105 | 47.73 | 115 | 52.27 |
| • While carrying the marble slab | 16 | 7.27 | 204 | 92.73 | 127 | 57.73 | 93 | 42.27 |
| b. While resting | 6 | 2.73 | 214 | 97.27 | 88 | 40.00 | 132 | 60.00 |
| **Hindrance in continuing your daily activities due to pain** | 14 | 6.36 | 206 | 93.64 | 51 | 23.18 | 169 | 76.82 |

## Findings

#### 4.3.5.2. Perceived Musculoskeletal Pain experienced since Past 12 months

The table 18 on pain experienced by the respondents in their arms revealed that nearly two-third (62.27 per cent) of the respondents experienced pain in their right forearm while carrying the marble slab. Slightly more than one-half of the respondents (54.09 per cent) were found to be experiencing pain in their left forearm while carrying the marble slab. Slightly less than one-half of the respondents (49.09 per cent) had pain in their right forearm while keeping the marble slab on the surface of the workstation. The respondents (40.91 per cent) also experienced pain in the left forearm while keeping the marble slab on the surface of the workstation. The respondents experienced pain while carrying marble slab in their right arm (57.73 per cent) and left arm (46.82 per cent). The findings also revealed that pain was induced in the respondents while keeping the marble slab on a surface in their right and left arm (47.73 per cent and 39.55 per cent) respectively. A similar percentage of respondents (41.36 per cent) were found to be experiencing pain in their right arm while lifting marble slab at the chest level and below chest. It can be noted that a slightly higher percentage of respondents had pain in their right side of the arm, it could be due to majority of the respondents were right-handed. It can also be concluded that the working condition has induced pain in their forearms as well as the arms. According to the Doctor's opinion, the pain also can be induced due to myalgia i.e. repeated muscle spasm or radial nerve entrapment under which the nerved of the arms are compressed due to excess weight lifting in improper posture. The findings concludes that the respondents had developed more chronic pain since there were more number of respondents experiencing pain since 12 months, it could be due to higher number of respondents had experience more than 2 years.

### 4.3.6. Musculoskeletal Pain as perceived by the respondents in their Palms

The hand (manus) includes a) the wrist or carpus, supported by 8 carpal bones arranged in two rows, b) the hand proper or metacarpus, supported by 5 metacarpal bones, c) five digits (thumb and four fingers). Each finger is supported by three phalanges, but the thumb has only two phalanges. The carpal bones form the wrist joint with the radius, intercarpal joints with one another, and carpo-metacarpal joints with the metacarpals. The phalanges form metacarpophalageal joints with the metacarpals and interphalangeal joints with one another (Chaurasiya,2015).

The Musculoskeletal Pain as perceived by the respondents in the palms was inquired. To record the acute and chronic condition of pain it was asked if they experienced pain in the past 7 days or 12 months. While lifting the marble slab the palms are used thus the occurrence of pain in palms was inquired.

#### 4.3.6.1. Perceived Musculoskeletal Pain experienced since Past 7 days

The table 19 revealed that slightly less than one-tenth of the respondents (7.27 per cent) experienced pain in their right and left fingers while grasping the marble slab. It was followed by experience of pain in the left-hand fingers while gripping an object by 6.36 per cent of the respondents.

**Table 19: Distribution of Respondents according to the Pain experienced in Palm**

n = 220

| Palms | Pain Experienced since | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Past 7 days | | | | Past 12 months | | | |
| | Yes | | No | | Yes | | No | |
| | f | % | f | % | f | % | f | % |
| **While gripping marble slab** | | | | | | | | |
| **a. Right hand fingers** | 12 | 5.45 | 208 | 94.55 | 150 | 68.18 | 70 | 31.82 |
| **b. Left hand fingers** | 14 | 6.36 | 206 | 93.64 | 136 | 61.82 | 84 | 38.18 |
| **While grasping** | | | | | | | | |
| **a. Right hand fingers** | 16 | 7.27 | 204 | 92.73 | 150 | 68.18 | 70 | 31.82 |
| **b. Left hand fingers** | 16 | 7.27 | 204 | 92.73 | 136 | 61.82 | 84 | 38.18 |
| **Hindrance in continuing your daily activity due to pain** | 12 | 5.45 | 208 | 94.55 | 63 | 28.64 | 157 | 71.36 |
| **While resting** | 10 | 4.55 | 210 | 95.45 | 77 | 35.00 | 143 | 65.00 |

#### 4.3.6.2. Perceived Musculoskeletal Pain experienced since Past 12 months

The data in the Table 19 highlighted that more than two-third of the respondents (68.18 per cent) experienced pain in their right-hand fingers while gripping and grasping the marble slab and tile. The pain could be induced due to Morton's neuralgia which is occurred due to exposure to vibration. The data also revealed that 61.82 per cent of the respondents were found to be experiencing pain in their left-hand fingers while gripping and grasping an object. The respondents complained of numbness in their fingers and palm area due to exposure to heavy vibration produced by the machinery. As per the Doctor's opinion, due to exposure of vibration, the fat pad of the palms is depleted thus the pain are more prone to pain. It was observed that the respondents had development of corns on their palms.

### 4.3.7. Musculoskeletal Pain as perceived by the respondents in their Back

The back consists of muscles, fasciae and bones of the posterior portions of the neck, thorax, abdomen and pelvis. It is of utmost importance in posture, in support of the weight, in locomotion and in protection of the spinal cord and spinal nerves. The bones of the back form the vertebral column, which is composed of 33 vertebrae and their intervertebral discs. The vertebral column along with its muscles and joints, is the axis of the body, a pillar capable of rigidity or flexibility (Dutta,2015). The Musculoskeletal Pain as perceived by the respondents in the upper, middle and lower back was inquired. To record the acute and chronic condition of pain it was asked if they experienced pain in the past 7 days or 12 months.

#### 4.3.7.1. Perceived Musculoskeletal Pain experienced since Past 7 days

The assessment of the musculoskeletal pain as perceived by the respondents in their back revealed that one-tenth of the respondents (10 per cent) experienced pain in their upper back and lower back while carrying marble slab, while bending down and while keeping the marble slab on the surface of the workstation respectively. It was reported by 9.09 per cent of the respondents experienced pain in their upper back and middle back while keeping the marble slab on a surface. Slightly less than one-tenth of the respondents (9.09 per cent) also experienced pain in the lower back while resting. According to the expert's opinion, the pain while resting can be induced since the muscles relax at night, the articular surfaces of the joint come in contact with each other, in such cases if there is a damage to the hyaline cartilage of the joints it can lead to pain only termed as night crisis of joint pain (table 20).

**Table 20: Distribution of Respondents according to the Pain experienced in Back**

n = 220

| Back | Pain Experienced since | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Past 7 days | | | | Past 12 months | | | |
| | Yes | | No | | Yes | | No | |
| | f | % | | % | | % | f | % |
| **Upper Back** | | | | | | | | |
| a. While bending down | 12 | 5.45 | 208 | 94.55 | 102 | 46.36 | 118 | 53.64 |
| b. While lifting marble slab | | | | | | | | |
| • Overhead | 14 | 6.36 | 206 | 93.64 | 132 | 60.00 | 88 | 40.00 |
| • Chest level | 18 | 8.18 | 202 | 91.82 | 156 | 70.91 | 64 | 29.09 |
| • Below chest | 14 | 6.36 | 206 | 93.64 | 146 | 66.36 | 74 | 33.64 |
| • While keeping the marble slab on a surface | 20 | 9.09 | 200 | 90.91 | 148 | 67.27 | 72 | 32.73 |
| • While carrying the marble slab | 22 | 10.00 | 198 | 90.00 | 168 | 76.36 | 52 | 23.64 |
| c. While resting | 12 | 5.45 | 208 | 94.55 | 109 | 49.55 | 111 | 50.45 |
| **Middle Back** | | | | | | | | |
| a. While bending down | 10 | 4.55 | 210 | 95.45 | 92 | 41.82 | 128 | 58.18 |
| b. While lifting marble slab | | | | | | | | |
| • Overhead | 10 | 4.55 | 210 | 95.45 | 102 | 46.36 | 118 | 53.64 |
| • Chest level | 10 | 4.55 | 210 | 95.45 | 104 | 47.27 | 116 | 52.73 |
| • Below chest | 14 | 6.36 | 206 | 93.64 | 104 | 47.27 | 116 | 52.73 |
| • While keeping the marble slab on a surface | 20 | 9.09 | 200 | 90.91 | 124 | 56.36 | 96 | 43.64 |
| • While carrying the marble slab | 16 | 7.27 | 204 | 92.73 | 134 | 60.91 | 86 | 39.09 |
| c. While resting | 14 | 6.36 | 206 | 93.64 | 95 | 43.18 | 125 | 56.82 |
| **Lower Back** | | | | | | | | |
| a. While bending down | 22 | 10.00 | 198 | 90.00 | 163 | 74.09 | 57 | 25.91 |
| b. While lifting marble slab | | | | | | | | |
| • Overhead | 16 | 7.27 | 204 | 92.73 | 154 | 70.00 | 66 | 30.00 |
| • Chest level | 16 | 7.27 | 204 | 92.73 | 164 | 74.55 | 56 | 25.45 |
| • Below chest | 16 | 7.27 | 204 | 92.73 | 168 | 76.36 | 52 | 23.64 |
| • While keeping the marble slab on a surface | 22 | 10.00 | 198 | 90.00 | 190 | 86.36 | 30 | 13.64 |
| • While carrying the marble slab | 22 | 10.00 | 198 | 90.00 | 190 | 86.36 | 30 | 13.64 |
| c. While resting | 20 | 9.09 | 200 | 90.91 | 131 | 59.55 | 89 | 40.45 |
| Hindrance in continuing daily activities due to pain | 16 | 7.27 | 204 | 92.73 | 101 | 45.91 | 119 | 54.09 |

#### 4.3.7.2. Perceived Musculoskeletal Pain experienced since Past 12 months

A relatively higher number of respondents (86.36 per cent) were found to be experiencing pain in their lower back while keeping the marble on the surface of the workstation and while carrying the marble slab. As per the expert's opinion, the pain can be due to PSMS (para vertebral muscle spasm). Slightly more than three-fourth of the respondents (76.36 per cent) experienced pain in the upper back while carrying the marble slab and in the lower back while lifting the marble slab below chest level (table 20). The pain can be due to lumbar spondylitis and spondylolisthesis. Slightly less than three-fourth of the respondents (74.55 per cent) experienced pain in the lower back while lifting the marble slab at the chest level. Pain was experienced in the lower back while bending down by 74.09 per cent of the respondents; the pain could be due to discitis according to the experts. The respondents complained pain in their lower back after work as well as upper back along with shoulders (table 20).

### 4.3.8. Musculoskeletal Pain as perceived by the respondents in their Hip

The hip joint constitutes the articulation between the hip bone, at the junction of the trunk to the lower limb and femur, thigh bone. Hip joint allows the same movement as the mobile shoulder joint, but the range of movement is restricted (Chaurasiya,2017).

The Musculoskeletal Pain as perceived by the respondents in the hip was inquired. To record the acute and chronic condition of pain it was asked if they experienced pain in the past 7 days or 12 months.

#### 4.3.8.1. Perceived Musculoskeletal Pain experienced since Past 7 days

While investigating the musculoskeletal pain as perceived by the respondents in their hip, it was highlighted that slightly less than one-tenth of the respondents (7.27 per cent) experienced pain in their right and left side of the hip while sitting on a chair. Very few respondents

(4.55 per cent) were found to be experiencing pain in left and right side of the hip while standing to sitting and sitting to standing (table 21).

#### 4.3.8.2. Perceived Musculoskeletal Pain experienced since Past 12 months

The data in table 21 revealed that 20.91 per cent and 20 per cent of the respondents experienced pain in their right side of the hip while sitting on a chair and while in squatting position.

**Table 21: Distribution of Respondents according to the Pain experienced in Hip**

n = 220

| Hip | Pain Experienced since | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Past 7 days | | | | Past 12 months | | | |
| | Yes | | No | | Yes | | No | |
| | f | % | f | % | f | % | f | % |
| **While sitting on a chair** | | | | | | | | |
| a. Right side | 16 | 7.27 | 204 | 92.73 | 44 | 20.00 | 176 | 80.00 |
| b. Left side | 16 | 7.27 | 204 | 92.73 | 38 | 17.27 | 182 | 82.73 |
| **While in squatting position** | | | | | | | | |
| a. Right side | 4 | 1.82 | 216 | 98.18 | 46 | 20.91 | 174 | 79.09 |
| b. Left side | 4 | 1.82 | 216 | 98.18 | 40 | 18.18 | 180 | 81.82 |
| **While walking** | | | | | | | | |
| a. Right side | 8 | 3.64 | 212 | 96.36 | 12 | 5.45 | 208 | 94.55 |
| b. Left side | 8 | 3.64 | 212 | 96.36 | 10 | 4.55 | 210 | 95.45 |
| **While standing still** | | | | | | | | |
| a. Right side | 6 | 2.73 | 214 | 97.27 | 22 | 10.00 | 198 | 90.00 |
| b. Left side | 6 | 2.73 | 214 | 97.27 | 12 | 5.45 | 208 | 94.55 |
| **While standing to sitting** | | | | | | | | |
| a. Right side | 10 | 4.55 | 210 | 95.45 | 12 | 5.45 | 208 | 94.55 |
| b. Left side | 10 | 4.55 | 210 | 95.45 | 4 | 1.82 | 216 | 98.18 |
| **Experience of pain while sitting to standing** | | | | | | | | |
| a. Right side | 10 | 4.55 | 210 | 95.45 | 22 | 10.00 | 198 | 90.00 |
| b. Left side | 10 | 4.55 | 210 | 95.45 | 12 | 5.45 | 208 | 94.55 |

It was also revealed that 18.18 per cent of the respondents were found to be experiencing pain in their left hip while in squatting position followed by 17.27 per cent who experienced pain in the left side while sitting on the chair. The findings may conclude that their work pattern doesn't affect the hip muscles to a larger extent. Although, the pain can be due to muscle spasm as per the expert's opinion. It could be also since the respondents had to stand more often than sit and work.

### 4.3.9. Musculoskeletal Pain as perceived by the respondents in their Knees

The knee joint is largest and a complex - compound synovial joint of the body formed by the condyles of femur (thigh bone) and tibia (medial leg bone) and posterior articular surface of patella. Hyperextension at the knee is counter-acted by the tension of various ligaments and antagonistic muscles (Datta, 2017).

The Musculoskeletal Pain as perceived by the respondents in the knees was inquired. To record the acute and chronic condition of pain it was asked if they experienced pain in the past 7 days or 12 months.

#### 4.3.9.1. Perceived Musculoskeletal Pain experienced since Past 7 days

One-tenth of the respondents (10.00 per cent) experienced pain in their left knee while resting. Slightly less than one-tenth of the respondents (9.09 per cent) experienced pain in their knees while sitting on the chair. The findings also revealed that no respondent was experiencing pain while standing still which denotes that the muscles were in spasm and thus did not cause pain. The respondents complained to the researcher that they had maximum pain in their knees and that it was very difficult for them to continue a routine life due to the pain. The pain in the past seven days could be less due to less load of work on the respondents.

#### 4.3.9.2. Perceived Musculoskeletal Pain experienced since Past 12 months

While investigating the perceived pain experienced by the respondents in their knees, it was reported that slightly less than three-fourth of the respondents (72.73 per cent) were experiencing pain in the right knee while carrying the marble slab. The pain can be induced due to popliteal bursitis.

**Table 22: Distribution of Respondents according to the Pain experienced in Knees**

n = 220

| Knees | Pain Experienced since | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Past 7 days | | | | Past 12 months | | | |
| | Yes | | No | | Yes | | No | |
| | f | % | f | % | f | % | f | % |
| **While sitting on a chair** | | | | | | | | |
| a. Right side | 20 | 9.09 | 200 | 90.91 | 52 | 23.64 | 168 | 76.36 |
| b. Left side | 20 | 9.09 | 200 | 90.91 | 50 | 22.73 | 170 | 77.27 |
| **While sitting on the floor/ mattress / cross-legged** | | | | | | | | |
| a. Right knee | 16 | 7.27 | 204 | 92.73 | 111 | 50.45 | 109 | 49.55 |
| b. Left knee | 16 | 7.27 | 204 | 92.73 | 105 | 47.73 | 115 | 52.27 |
| **While walking** | | | | | | | | |
| a. Right Knee | 12 | 5.45 | 208 | 94.55 | 42 | 19.09 | 178 | 80.91 |
| b. Left Knee | 12 | 5.45 | 208 | 94.55 | 36 | 16.36 | 184 | 83.64 |
| **While running** | | | | | | | | |
| a. Right side | 16 | 7.27 | 204 | 92.73 | 102 | 46.36 | 118 | 53.64 |
| b. Left side | 16 | 7.27 | 204 | 92.73 | 100 | 45.45 | 120 | 54.55 |
| **While sitting in squatting position** | | | | | | | | |
| a. Right Knee | 18 | 8.18 | 202 | 91.82 | 134 | 60.91 | 86 | 39.09 |
| b. Left Knee | 18 | 8.18 | 202 | 91.82 | 122 | 55.45 | 98 | 44.55 |
| **While lifting the marble slab** | | | | | | | | |
| • Overhead | | | | | | | | |
| a. Right side | 2 | 0.91 | 218 | 99.09 | 83 | 37.73 | 137 | 62.27 |
| b. Left side | 4 | 1.82 | 216 | 98.18 | 75 | 34.09 | 145 | 65.91 |
| • Chest level | | | | | | | | |
| a. Right side | 8 | 3.64 | 212 | 96.36 | 91 | 41.36 | 129 | 58.64 |
| b. Left side | 8 | 3.64 | 212 | 96.36 | 81 | 36.82 | 139 | 63.18 |
| • Below chest | | | | | | | | |
| a. Right side | 8 | 3.64 | 212 | 96.36 | 91 | 41.36 | 129 | 58.64 |
| b. Left side | 8 | 3.64 | 212 | 96.36 | 77 | 35.00 | 143 | 65.00 |
| • While keeping the marble slab on a surface | | | | | | | | |
| a. Right side | 4 | 1.82 | 216 | 98.18 | 125 | 56.82 | 95 | 43.18 |
| b. Left side | 4 | 1.82 | 216 | 98.18 | 115 | 52.27 | 105 | 47.73 |
| • While carrying the marble slab | | | | | | | | |
| a. Right side | 16 | 7.27 | 204 | 92.73 | 160 | 72.73 | 60 | 27.27 |
| b. Left side | 18 | 8.18 | 202 | 91.82 | 150 | 68.18 | 70 | 31.82 |
| **While standing still** | | | | | | | | |
| a. Right knee | 0 | - | 220 | 100 | 41 | 18.64 | 179 | 81.36 |
| b. Left Knee | 0 | - | 220 | 100 | 27 | 12.27 | 193 | 87.73 |
| **While standing to sitting** | | | | | | | | |
| a. Right side | 16 | 7.27 | 204 | 92.73 | 87 | 39.55 | 133 | 60.45 |
| b. Left side | 16 | 7.27 | 204 | 92.73 | 75 | 34.09 | 145 | 65.91 |
| **While sitting to standing** | | | | | | | | |
| a. Right side | 18 | 8.18 | 202 | 91.82 | 134 | 60.91 | 86 | 39.09 |
| b. Left side | 18 | 8.18 | 202 | 91.82 | 124 | 56.36 | 96 | 43.64 |
| **While resting** | | | | | | | | |
| a. Right Knee | 20 | 9.09 | 200 | 90.91 | 110 | 50.00 | 110 | 50.00 |
| b. Left Knee | 22 | 10.00 | 198 | 90.00 | 98 | 44.55 | 122 | 55.45 |
| **Hindrance with the daily work due to pain** | 12 | 5.45 | 208 | 94.55 | 114 | 51.82 | 106 | 48.18 |

## Findings

Pain experienced in the left knee while carrying marble slab was reported by 68.18 per cent of the respondents. The data in table 22 also revealed that 60.91 per cent of the respondents experienced pain in right knee while sitting in squatting position and while sitting to standing. The pain in such conditions according to Doctor's opinion it could be induced due to chrodromalacia patella (swelling in the knees). Slightly more than one-half of the respondents (56.82 per cent) were found to be experiencing pain in the right knee while keeping the marble slab as well as while sitting to standing in the left knee. Slightly more than one-half of the respondents (55.45 per cent) experienced pain in the left knee while sitting in squatting position. It was very interesting to note that 16.36 per cent respondents did not experience pain in the left knee while walking as the muscles are in spasm and thus no pain was experienced.

### 4.3.10. Musculoskeletal Pain as perceived by the respondents in their Thighs

The thigh extends between the hip and knee joints and constitutes the longest and the heaviest bone, the femur (Chaurasiya, 2017). The Musculoskeletal Pain as perceived by the respondents in the thighs was inquired. To record the acute and chronic condition of pain it was asked if they experienced pain in the past 7 days or 12 months.

#### 4.3.10.1. Perceived Musculoskeletal Pain experienced since Past 7 days

While investigating the pain experienced by the respondents in thighs revealed that slightly less than one-tenth of the respondents (8.18 per cent) were found to be experiencing pain while carrying the marble slab on both thighs. The data in table 23 revealed that 6.16 per cent of the respondents were found to be experiencing pain in thighs while resting. It is believed according to the expert's opinion, that soreness of the muscles may affect a person while at rest and if not cured it may disrupt the sleep which forms a vicious cycle of pain.

**Table 23: Distribution of Respondents according to the Pain experienced in Thigh**

n = 220

| Thigh | Pain Experienced since | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Past 7 days | | | | Past 12 months | | | |
| | Yes | | No | | Yes | | No | |
| | f | % | f | % | f | % | f | % |
| **While sitting on a chair** | | | | | | | | |
| a. Right side | 4 | 1.82 | 216 | 98.18 | 18 | 8.18 | 202 | 91.82 |
| b. Left side | 4 | 1.82 | 216 | 98.18 | 14 | 6.36 | 206 | 93.64 |
| **While sitting on the floor/ mattress / cross-legged** | | | | | | | | |
| a. Right side | 12 | 5.45 | 208 | 94.55 | 53 | 24.09 | 167 | 75.91 |
| b. Left side | 12 | 5.45 | 208 | 94.55 | 51 | 23.18 | 169 | 76.82 |
| **While walking** | | | | | | | | |
| a. Right side | 6 | 2.73 | 214 | 97.27 | 24 | 10.91 | 196 | 89.09 |
| b. Left side | 6 | 2.73 | 214 | 97.27 | 22 | 10.00 | 198 | 90.00 |
| **Experience of pain in the thigh while running** | | | | | | | | |
| a. Right side | 10 | 4.55 | 210 | 95.45 | 59 | 26.82 | 161 | 73.18 |
| b. Left side | 10 | 4.55 | 210 | 95.45 | 47 | 21.36 | 173 | 78.64 |
| **While sitting in squatting position** | | | | | | | | |
| a. Right side | 10 | 4.55 | 210 | 95.45 | 100 | 45.45 | 120 | 54.55 |
| b. Left side | 10 | 4.55 | 210 | 95.45 | 85 | 38.64 | 135 | 61.36 |
| c. | | | | | | | | |
| **While lifting marble slab** | | | | | | | | |
| • Overhead | | | | | | | | |
| a. Right side | 2 | 0.91 | 218 | 99.09 | 50 | 22.73 | 170 | 77.27 |
| b. Left side | 2 | 0.91 | 218 | 99.09 | 36 | 16.36 | 184 | 83.64 |
| • Chest level | | | | | | | | |
| a. Right side | 2 | 0.91 | 218 | 99.09 | 44 | 20.00 | 176 | 80.00 |
| b. Left side | 2 | 0.91 | 218 | 99.09 | 32 | 14.54 | 188 | 88.45 |
| • Below chest | | | | | | | | |
| a. Right side | 2 | 0.91 | 218 | 99.09 | 46 | 20.91 | 174 | 79.09 |
| b. Left side | 2 | 0.91 | 218 | 99.09 | 34 | 15.45 | 186 | 84.55 |
| • While keeping the marble slab on a surface | | | | | | | | |
| a. Right side | 10 | 4.55 | 210 | 95.45 | 74 | 33.64 | 146 | 66.36 |
| b. Left side | 10 | 4.55 | 210 | 95.45 | 59 | 26.82 | 161 | 73.18 |
| • While carrying the marble slab | | | | | | | | |
| a. Right side | 18 | 8.18 | 202 | 91.82 | 97 | 44.09 | 123 | 55.91 |
| b. Left side | 18 | 8.18 | 202 | 91.82 | 82 | 37.27 | 138 | 62.73 |
| **While standing still** | | | | | | | | |
| a. Right side | 6 | 2.73 | 214 | 97.27 | 18 | 8.18 | 202 | 91.82 |
| b. Left side | 6 | 2.73 | 214 | 97.27 | 12 | 5.45 | 208 | 94.55 |
| **While standing to sitting** | | | | | | | | |
| a. Right side | 10 | 4.55 | 210 | 95.45 | 66 | 30.00 | 154 | 70.00 |
| b. Left side | 10 | 4.55 | 210 | 95.45 | 54 | 24.55 | 166 | 75.45 |
| **While sitting to standing** | | | | | | | | |
| a. Right side | 12 | 5.45 | 208 | 94.55 | 88 | 40.00 | 132 | 60.00 |
| b. Left side | 10 | 4.55 | 210 | 95.45 | 78 | 34.45 | 142 | 64.55 |
| **While resting** | | | | | | | | |
| a. Right side | 14 | 6.36 | 206 | 93.64 | 63 | 28.64 | 157 | 71.36 |
| b. Left side | 14 | 6.36 | 206 | 93.64 | 51 | 23.18 | 169 | 76.82 |
| **Hindrance with the daily work due to pain** | 4 | 1.82 | 216 | 98.18 | 52 | 23.64 | 168 | 76.36 |

## Findings

#### 4.3.10.2. Perceived Musculoskeletal Pain experienced since Past 12 months

The data in table 23 highlighted that 45.45 per cent of the respondents were found to be experiencing pain in their right thigh while sitting in squatting position. Carrying the marble slab also induced pain in right thigh among 44.09 per cent of the respondents. Sitting to standing was also one of the reasons for inducing pain among 40 per cent respondents in right thigh and among 34.45 per cent respondents in their left thigh. As per the Doctor's opinion, the reason for pain can be speculated to be myalgia (muscle spasm).

### 4.3.11. Musculoskeletal Pain as perceived by the respondents in their Legs

The lower limb in its basic structure is similar to the upper limb. Each lower limb has a hip girdle by which it is attached to the axial skeleton. In general, the lower limbs attain stability at the cost of mobility and are thus bulkier and stronger.

The lower limb is made up of 4 parts

- Hip joint
- Thigh
- Leg
- Foot

The Lower ends of femur articulate with tibia, bone of the leg and patella, which acts a knee cap to form the knee joint. The lower ends of tibia and fibula articulate with the tarsal bones to form the ankle joint complex. The leg extends from the knee to the ankle joint and constitutes the tibia and fibula bone (Chaurasiya,2017). The Musculoskeletal Pain as perceived by the respondents in the legs was inquired. To record the acute and chronic condition of pain it was asked if they experienced pain in the past 7 days or 12 months.

**Table 24: Distribution of Respondents according to the Pain experienced in Leg**

n = 220

| Leg | Pain Experienced since | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Past 7 days | | | | Past 12 months | | | |
| | Yes | | No | | Yes | | No | |
| | f | % | f | % | f | % | f | % |
| **While walking** | | | | | | | | |
| a. Right side | 2 | 0.91 | 218 | 99.09 | 24 | 10.91 | 196 | 89.09 |
| b. Left side | 2 | 0.91 | 218 | 99.09 | 12 | 5.45 | 208 | 94.55 |
| **While running** | | | | | | | | |
| a. Right side | 4 | 1.82 | 216 | 98.18 | 43 | 19.55 | 177 | 80.45 |
| b. Left side | 4 | 1.82 | 216 | 98.18 | 29 | 13.18 | 191 | 86.82 |
| **While sitting in a squatting position** | | | | | | | | |
| a. Right side | 6 | 2.73 | 214 | 97.27 | 102 | 46.36 | 118 | 53.64 |
| b. Left side | 6 | 2.73 | 214 | 97.27 | 86 | 39.09 | 134 | 60.91 |
| **While lifting marble slab** | | | | | | | | |
| • Overhead | | | | | | | | |
| a. Right side | 4 | 1.82 | 216 | 98.18 | 60 | 27.27 | 160 | 72.73 |
| b. Left side | 4 | 1.82 | 216 | 98.18 | 52 | 23.64 | 168 | 76.36 |
| • Chest level | | | | | | | | |
| a. Right side | 2 | 0.91 | 218 | 99.09 | 64 | 29.09 | 156 | 70.91 |
| b. Left side | 2 | 0.91 | 218 | 99.09 | 56 | 25.45 | 164 | 74.55 |
| • Below chest | | | | | | | | |
| a. Right side | 2 | 0.91 | 218 | 99.09 | 66 | 30.00 | 154 | 70.00 |
| b. Left side | 2 | 0.91 | 218 | 99.09 | 58 | 26.36 | 162 | 73.64 |
| • While keeping the marble slab on a surface | | | | | | | | |
| a. Right side | 8 | 3.64 | 212 | 96.36 | 93 | 42.27 | 127 | 57.73 |
| b. Left side | 8 | 3.64 | 212 | 96.36 | 85 | 38.64 | 135 | 61.36 |
| • While carrying the marble slab | | | | | | | | |
| a. Right side | 10 | 4.55 | 210 | 95.45 | 112 | 50.91 | 108 | 49.09 |
| b. Left side | 6 | 2.73 | 214 | 97.27 | 97 | 44.09 | 123 | 55.91 |
| **While resting** | | | | | | | | |
| a. Right Side | 4 | 1.82 | 216 | 98.18 | 42 | 19.09 | 178 | 80.91 |
| b. Left side | 6 | 2.73 | 214 | 97.27 | 28 | 12.73 | 192 | 87.27 |
| **While standing still** | | | | | | | | |
| a. Right side | 4 | 1.82 | 216 | 98.18 | 53 | 24.09 | 167 | 75.91 |
| b. Left side | 4 | 1.82 | 216 | 98.18 | 43 | 19.55 | 177 | 80.45 |
| **While standing to sitting** | | | | | | | | |
| a. Right side | 6 | 2.73 | 214 | 97.27 | 65 | 29.55 | 155 | 70.45 |
| b. Left side | 6 | 2.73 | 214 | 97.27 | 55 | 25.00 | 165 | 75.00 |
| **While sitting to standing** | | | | | | | | |
| a. Right side | 6 | 2.73 | 214 | 97.27 | 94 | 42.73 | 126 | 57.27 |
| b. Left side | 6 | 2.73 | 214 | 97.27 | 84 | 38.18 | 136 | 61.82 |
| **Hindrance in the daily activities due to pain** | 6 | 2.73 | 214 | 97.27 | 73 | 33.18 | 147 | 66.82 |

## Findings

#### 4.3.11.1. Perceived Musculoskeletal Pain experienced since Past 7 days

The investigation on the experience of pain by the respondents while working revealed that very few respondents (4.55 per cent) experienced pain in the right leg while carrying the marble slab. Very few respondents (3.64 per cent) of the respondents were found to be experiencing pain in both legs while keeping the marble slab on a surface.

#### 4.3.11.2. Perceived Musculoskeletal Pain experienced since Past 12 months

Slightly more than one-half of the respondents (50.91 per cent) were found to be experiencing pain while carrying the marble slab in their right leg. Slightly less than one-half of the respondents (46.36 per cent) experienced pain in the right leg while running indicating that the work pattern developed soreness in the muscles thus causing pain while running as per the opinion of the expert. Pain was experienced in the left leg due to carrying marble slab by 44.09 per cent respondents. The pain can be due to myalgia (muscle spasm). The data in table 24 revealed that 42.73 per cent of the respondents were found to be experiencing pain while sitting to standing which indicated that the soreness of the leg muscles due to work hindered in the movements of contraction and relaxation thus causing pain as per the opinion of the experts. It was also found that 42.27 per cent of the respondents experienced pain while keeping the marble slab on the surface of the workstation.

### 4.3.12. Musculoskeletal Pain as perceived by the respondents in their Feet

The foot in lower primates is a prehensile organ. In man, however, the foot has changed from a grasping to a supporting organ. It is made up of seven tarsal bones, arranged in two rows. Calcaneus, the largest of the tarsal bone forms the prominence of the heel. The anterior part of the foot is completed by 5 miniature long bones, the metatarsals, which further articulate with 14 phalanges in each foot. Homologous to the hand, the foot forms the intertarsal, tarsometatarsal and metatarsophalangeal and interphalangeal joints (Chaurasiya,2017).

**Table 25: Distribution of Respondents according to the Pain experienced in Feet**

n = 220

| Feet | Pain experienced since | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Past 7 days | | | | Past 12 months | | | |
| | Yes | | No | | Yes | | No | |
| | f | % | f | % | f | % | f | % |
| **While walking** | | | | | | | | |
| a. Right side | 8 | 3.64 | 212 | 96.36 | 26 | 11.82 | 194 | 88.18 |
| b. Left side | 8 | 3.64 | 212 | 96.36 | 28 | 12.73 | 192 | 87.27 |
| **While sitting in a squatting position** | | | | | | | | |
| a. Right side | - | - | 220 | 100 | 30 | 13.64 | 190 | 86.36 |
| b. Left side | - | - | 220 | 100 | 34 | 15.45 | 186 | 84.55 |
| **While running** | | | | | | | | |
| a. Right side | - | - | 220 | 100 | 47 | 21.36 | 173 | 78.64 |
| b. Left side | - | - | 220 | 100 | 41 | 18.64 | 179 | 81.36 |
| **While lifting marble slab** | | | | | | | | |
| • Overhead | | | | | | | | |
| a. Right side | 2 | 0.91 | 218 | 99.09 | 32 | 14.55 | 188 | 85.45 |
| b. Left side | 2 | 0.91 | 218 | 99.09 | 26 | 11.82 | 194 | 88.18 |
| • Chest level | | | | | | | | |
| a. Right side | - | - | 220 | 100 | 30 | 13.64 | 190 | 86.36 |
| b. Left side | - | - | 220 | 100 | 26 | 11.82 | 194 | 88.18 |
| • Below chest | | | | | | | | |
| a. Right side | - | - | 220 | 100 | 26 | 11.82 | 194 | 88.18 |
| b. Left side | - | - | 220 | 100 | 24 | 10.91 | 196 | 89.09 |
| • While keeping the marble slab on a surface | | | | | | | | |
| a. Right side | 8 | 3.64 | 212 | 96.36 | 28 | 12.73 | 192 | 87.27 |
| b. Left side | 8 | 3.64 | 212 | 96.36 | 30 | 13.64 | 190 | 86.36 |
| • While carrying the marble slab | | | | | | | | |
| a. Right side | 10 | 4.55 | 210 | 95.45 | 65 | 29.55 | 155 | 70.45 |
| b. Left side | 10 | 4.55 | 210 | 95.45 | 61 | 27.73 | 159 | 72.27 |
| **While resting** | | | | | | | | |
| a. Right Side | 6 | 2.73 | 214 | 97.27 | 36 | 16.36 | 184 | 83.64 |
| b. Left side | 6 | 2.73 | 214 | 97.27 | 30 | 13.64 | 190 | 86.36 |
| **While standing still** | | | | | | | | |
| a. Right side | 4 | 1.82 | 216 | 98.18 | 16 | 7.27 | 204 | 92.73 |
| b. Left side | 4 | 1.82 | 216 | 98.18 | 12 | 5.45 | 208 | 94.55 |
| **While standing to sitting** | | | | | | | | |
| a. Right side | 6 | 2.73 | 214 | 97.27 | 31 | 14.09 | 189 | 85.91 |
| b. Left side | - | - | 220 | 100 | 29 | 13.18 | 191 | 86.82 |
| **While sitting to standing** | | | | | | | | |
| a. Right side | 6 | 2.73 | 214 | 97.27 | 33 | 15.00 | 187 | 85.00 |
| b. Left side | 6 | 2.73 | 214 | 97.27 | 33 | 15.00 | 187 | 85.00 |
| **Hindrance in daily activities due to pain** | 6 | 2.73 | 214 | 97.27 | 45 | 20.45 | 175 | 79.55 |

The foot not only acts as a pliable support to the body weight in upright posture but also acts a s lever to propel the body forwards in walking, running or jumping. To meet these requirements, the human foot is designed in the form of elastic arches or springs (Chaurasiya,2017). The Musculoskeletal Pain as perceived by the respondents in the legs was inquired. To record the acute and chronic condition of pain it was asked if they experienced pain in the past 7 days or 12 months.

#### 4.3.12.1. Perceived Musculoskeletal Pain experienced since Past 7 days

It was observed that very few respondents (4.55 per cent) were found to be experiencing pain while carrying the marble slab in both feet. Very few respondents (3.64 per cent) were also found to be experiencing pain while keeping the marble slab on a surface indicating that while keeping the marble slab on a surface caused pressure on the feet as well as while walking. It was also found that no respondents experienced pain while sitting in squatting position, while running, while lifting marble slab at chest level and below chest level and while standing to sitting.

#### 4.3.12.2. Perceived Musculoskeletal Pain experienced since Past 12 months

The data in table 25 revealed that 29.55 per cent were found to be experiencing pain in the right feet while carrying the marble slab indicating that carrying weight induced pressure on the feet of the respondents. Slightly more than one-fourth of the respondents (27.73 per cent) also experienced pain in their left feet while carrying the marble slab. Running was also found to be one of the causes for pain among 21.36 per cent of the respondents in their right feet and among 18.64 per cent respondents in the left feet. The pain in the feet according to the Doctor’s opinion may be due to fat burn disorder thus affecting the tendons directly.

### 4.3.13. Musculoskeletal Pain as perceived by the respondents in their Ankles

An ankle joint is modified hinge variety of synovial joint formed between the articular surfaces of tibia and fibula (medial and lateral leg bones respectively) and the body of talus, which forms a connecting link between the leg and the foot (Datta, 2017). The Musculoskeletal Pain as perceived by the respondents in the ankles was inquired. To record the acute and chronic condition of pain it was asked if they experienced pain in the past 7 days and 12 months.

#### 4.3.13.1. Perceived Musculoskeletal Pain experienced since Past 7 days

The data in table 26 revealed that 8.18 per cent of the respondents experienced pain in their right ankle while sitting in a squatting position and in left ankle while carrying the marble slab. A similar per cent of the respondents Pain in the left ankle while sitting in squatting position and in right ankle while carrying the marble slab and in both ankles while sitting to standing was reported by 7.27 per cent of the respondents. The results imply that the work thus affected the ankles.

#### 4.3.13.2. Perceived Musculoskeletal Pain experienced since Past 12 months

Further investigation on the musculoskeletal pain experienced by the respondents since past 12 months revealed that slightly more than one-half of the respondents (54.55 per cent) experienced pain in right ankle while sitting in squatting position. The data in the table also highlighted that 52.27 per cent of the respondents were experiencing pain in the right ankle while carrying the marble slab. The data in table 26 revealed that 43.18 per cent of the respondents were found to be experiencing pain in the left side while sitting in squatting position. Carrying the marble slab was also found to be causing pain in the left ankle of 40.91 per cent respondents. It was also found out that slightly more than one-tenth of the respondents (12.73 per cent) experienced pain while walking in their left ankle.

**Table 26: Distribution of Respondents according to the Pain experienced in their Ankles**

n = 220

| Ankles | Pain Experienced since | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Past 7 days | | | | Past 12 months | | | |
| | Yes | | No | | Yes | | No | |
| | f | % | f | % | f | % | f | % |
| While walking | | | | | | | | |
| a. Right side | 8 | 3.64 | 212 | 96.36 | 40 | 18.18 | 180 | 81.82 |
| b. Left side | 8 | 3.64 | 212 | 96.36 | 28 | 12.73 | 192 | 87.27 |
| While sitting in a squatting position | | | | | | | | |
| a. Right side | 18 | 8.18 | 202 | 91.82 | 120 | 54.55 | 100 | 45.45 |
| b. Left side | 16 | 7.27 | 204 | 92.73 | 95 | 43.18 | 125 | 56.82 |
| While running | | | | | | | | |
| a. Right side | 8 | 3.64 | 212 | 96.36 | 62 | 28.18 | 158 | 71.82 |
| b. Left side | 0 | - | 220 | 100 | 58 | 26.36 | 162 | 73.64 |
| While lifting marble slab | | | | | | | | |
| • Overhead | | | | | | | | |
| a. Right side | 8 | 3.64 | 212 | 96.36 | 52 | 23.64 | 168 | 76.36 |
| b. Left side | 8 | 3.64 | 212 | 96.36 | 46 | 20.91 | 174 | 79.09 |
| • Chest level | | | | | | | | |
| a. Right side | 6 | 2.73 | 214 | 97.27 | 48 | 21.82 | 172 | 78.18 |
| b. Left side | 6 | 2.73 | 214 | 97.27 | 40 | 18.18 | 180 | 81.82 |
| • Below chest | | | | | | | | |
| a. Right side | 6 | 2.73 | 214 | 97.27 | 50 | 22.73 | 170 | 77.27 |
| b. Left side | 8 | 3.64 | 212 | 96.36 | 42 | 19.09 | 178 | 80.91 |
| • While keeping the marble slab on a surface | | | | | | | | |
| a. Right side | 10 | 4.55 | 210 | 95.45 | 79 | 35.91 | 141 | 64.09 |
| b. Left side | 10 | 4.55 | 210 | 95.45 | 66 | 30.00 | 154 | 70.00 |
| • While carrying the marble slab | | | | | | | | |
| a. Right side | 16 | 7.27 | 204 | 92.73 | 115 | 52.27 | 105 | 47.73 |
| b. Left side | 18 | 8.18 | 202 | 91.82 | 90 | 40.91 | 130 | 59.09 |
| While resting | | | | | | | | |
| a. Right side | 14 | 6.36 | 206 | 93.64 | 86 | 39.09 | 134 | 60.91 |
| b. Left side | 14 | 6.36 | 206 | 93.64 | 68 | 30.91 | 152 | 69.09 |
| While standing still | | | | | | | | |
| a. Right side | 10 | 4.55 | 210 | 95.45 | 36 | 16.36 | 184 | 83.64 |
| b. Left side | 8 | 3.64 | 212 | 96.36 | 30 | 13.64 | 190 | 86.36 |
| While standing to sitting | | | | | | | | |
| a. Right side | 14 | 6.36 | 206 | 93.64 | 67 | 30.45 | 153 | 69.55 |
| b. Left side | 14 | 6.36 | 206 | 93.64 | 58 | 26.36 | 162 | 73.64 |
| While sitting to standing | | | | | | | | |
| a. Right side | 16 | 7.27 | 204 | 92.73 | 82 | 37.27 | 138 | 62.73 |
| b. Left side | 16 | 7.27 | 204 | 92.73 | 68 | 30.91 | 152 | 69.09 |
| Hindrance in the daily activities due to pain | 14 | 6.36 | 206 | 93.64 | 101 | 45.91 | 119 | 54.09 |

### 4.3.14. Overall Perceived Musculoskeletal Pain in Body Part

The researcher was inquisitive to find out the overall perceived musculoskeletal pain experienced by the respondents. Weighted mean was calculated to see to gain an insight regarding which body part pains the most since the past 7 days and past 12 months.

**Table 27: Weighted Mean for the Perceived Musculoskeletal Pain in the Body Parts**

| Body Parts | Weighted Mean out of 2 | |
|---|---|---|
| | Past 7 days | Past 12 Months |
| **Neck** | 1.11 | 1.32 |
| **Shoulder** | 1.08 | 1.44 |
| **Elbows** | 1.07 | 1.34 |
| **Wrists** | 1.04 | 1.34 |
| **Arms** | 1.02 | 1.34 |
| **Palms** | 1.06 | 1.54 |
| **Back** | 1.07 | 1.61 |
| **Hip** | 1.04 | 1.10 |
| **Knees** | 1.06 | 1.42 |
| **Thighs** | 1.07 | 1.27 |
| **Legs** | 1.02 | 1.29 |
| **Feet** | 1.02 | 1.15 |
| **Ankles** | 1.05 | 1.30 |

On calculating the weighted mean for perceived musculoskeletal pain for each body part of the respondents for the past 7 days and past 12 months, it was observed shoulder was ranked highest in the past seven days followed by elbows and back. The third in number was palms in the past seven days as the palms were in direct contact with the vibration produced by the workstation. The analysis of the perceived musculoskeletal pain in the past 12 months it was revealed that back was ranked highest followed by palms and shoulder.

## Section IV

## 4.4. Postural Discomfort of the Respondents

Posture is the position or carriage of the body in a sitting or standing position. The analysis of posture was conducted for 50 respondents who experienced High Musculoskeletal Pain. REBA (Rapid Entire Body Assessment) developed by (Hignett and McAtamney,2000) was used as a tool for collecting the data. The REBA is a postural analysis tool sensitive to musculoskeletal risks in a variety of tasks and assessment of working postures found in health care and other service industries. The use of this tool is efficient and the end scoring provides an action list which indicates the level of intervention required to reduce the risk of injury due to the specific task in question. It is a screening tool which assesses biomechanical and postural loading on the whole body, focusing on the wrists, forearms, elbows, shoulders, neck, trunk, back, legs and knees. After the data for each region is collected and scored, tables on the form are then used to compile the risk factor variables, generating a single score that represents the level of MSD risks.

### 4.4.1. Postural Discomfort

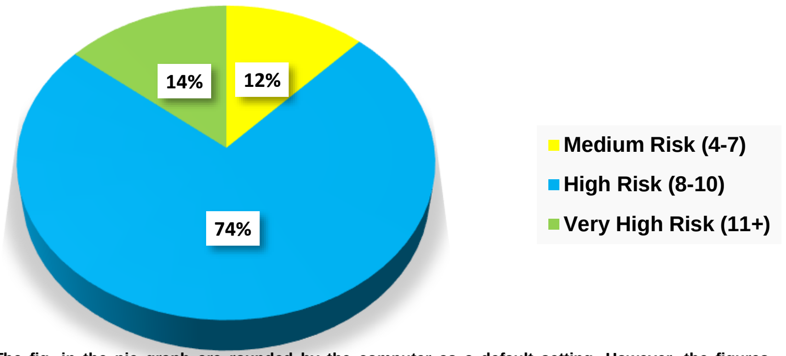
The postural discomfort analysis was conducted on 50 respondents who had high musculoskeletal pain. A video recording was conducted and the screenshots were taken of awkward postures of the respondents and the data were then analysed in the REBA analysis sheet. The scores were assigned to each awkward posture and computed in the REBA scoresheet. The computed scores in Table 28 depicts that majority of the respondents (74 per cent) were at “High risk” of Musculoskeletal Disorder scoring 8-10 which meant that the respondents required further investigation and changes on an immediate basis. Only 14 per cent of the respondents were found to be at a “Very High risk” suggesting implementation of changes recommended and bettering the workplace environment thus reducing the risk of Musculoskeletal Disorder. The data in table 28 also revealed that slightly more than one-tenth of the respondents (12 per cent) of the respondents were at “Medium risk” of Musculoskeletal Disorder. The findings also revealed that no respondent were not found to be at "negligible risk" and at "low risk" scoring 1 and 2-3 respectively (figure 13).

**Table 28: Distribution of Respondents according to the Postural Discomfort**

n = 50

| Level of MSD Risk | f | % |
|---|---|---|
| Medium Risk (4-7) | 6 | 12 |
| High Risk (8-10) | 37 | 74 |
| Very High Risk (11+) | 7 | 14 |

**Figure 13: Distribution of Respondents according to the Postural Discomfort (n=50)**




NOTE : The fig. in the pie graph are rounded by the computer as a default setting. However, the figures depicted in the figures are actual ones (not rounded ones)

The findings are very well supported by a study conducted on porcelain industry workers wherein the majority of the workers obtained an average or high REBA score, and 86.4 per cent of them needed to practice corrective measures (Ahmadi et.al., 2015). A survey conducted by Ansari and Sheikh (2014) around 53 per cent of the workers were working at high risk levels. It was also found that, if the workers of a small-scale industry in Maharashtra continued to work in the same posture, they suffer from the MSDs related to neck, trunk and wrist in the near future. It was recommended to take the corrective action as soon as possible. On the working posture of lifting bag and shouldering the sack, the analysis using RULA and REBA methods obtained dangerous risk level of handling should be done so immediately and needed improvements in the transfer of grain sacks rice milling in Malang in a study conducted on Rice Milling (Hutabarat, 2019).

Plate 11: Posture of the respondent placing the marble slab for cutting on the Marble Cutting

Plate 12: Posture of the Respondent while cutting the Marble on the Marble Cutting Workstation

## Section V

## 4.5. Environment of the Workplace

Ergonomics focuses on human beings and their interaction with products, equipment, facilities and environments used in the work (Jayakumar, 2009). Work environment means the milieu around a person - the room, home or place where one is working. It is all about materialistic things and living beings that are around when one is working, literally called the 'working condition'. In recent years as Pal (2001) state 'working conditions' has emerged as a multi-attribute function. This section deals with the information related to the working environment and its attributes. Objective data were collected regarding the light, noise, temperature and humidity and vibration of the work place. The data were collected through digital lux meter, digital sound meter and thermo hygrometer. The vibration produced by the machinery was also measured with the aid of vibrometer. Subjective data was collected wherein the respondents were interviewed regarding their preference and comfort level regarding light on the workplace. An attempt was also made to observe the conditions of the workplace including the cleanliness the color of the surface of the workplace, provision of artificial lighting and protective aids used or provided by the industry. The data were collected in the peak hours of the marble cutting work so as to assure precise data. This section also deals with the information regarding the training provided by the industries and protective aids used by the respondent to avoid injuries to them.

### 4.5.1. Presence of Light

The working unit had natural lighting; the marble cutting machine was placed under a heighted roof (14 feet approx.) and was open from all sides. The working unit had no doors and was an open shed.

The researcher observed that there was no artificial lighting provided for the work. The Recommended light limit was identified to be as 1000 lux for conducting the activity normally (RQQ,1980). The table 29 elicited that 62.86 per cent of the industries had presence of light below recommended levels. It was surprising to record that 4-5 industries had light ranging from 520-546 lux.

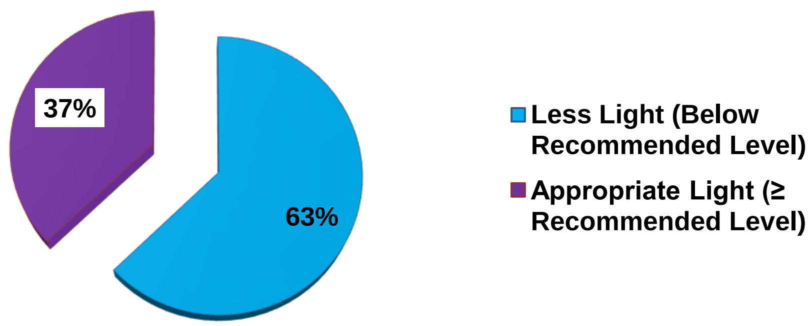
The data also revealed that 37.14 per cent of the industries had equal to more than recommended light (figure 14).

**Table 29: Distribution of the Marble Industries According to the Presence of Light**

n = 70

| | Presence of Light (lux) | f | % |
|---|---|---|---|
| **Recommended Light Level (1000 Lux)** (Source: RQQ,1980) | **Less Light (Below Recommended Level)** | 44 | 62.86 |
| | **Appropriate Light (≥ Recommended Level)** | 26 | 37.14 |
| | **Total** | 70 | 100 |
| | **Mean** | 1092.17 | |

**Figure 14: Distribution of the Marble Industries according to the Presence of Light (n=70)**




**NOTE: The fig. in the pie graph are rounded by the computer as a default setting. However, the figures depicted in the figures are actual ones (not rounded ones)**

### 4.5.1.1. Perceived Comfort level and Preference of light of the respondents at the Workplace

An attempt was made to identify the preference and perceived comfort level of the respondents regarding light while working. The researcher interviewed the respondents regarding the same. The perceived comfort level was rated from much too light to slightly dark. The respondents were asked their Perceived comfort level and the scores were recorded. Similarly, preference for light of the respondents was judged with three cards ranking from 1 to 3 wherein the criteria's were "wishes to have less light", "likes as it is", "wishes to have more light" respectively. The responses were recorded and then analyzed.

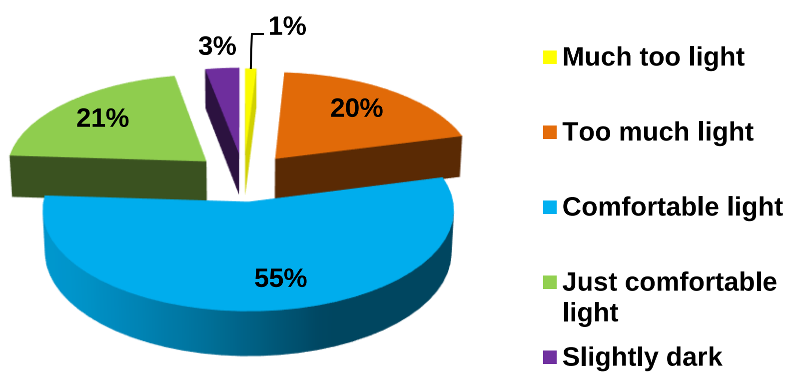
**Table 30: Distribution of Respondents according to their Perceived Comfort Level and Preference of Light at the Workplace**

n = 220

| Perceived Comfort level of the respondents for light | | | Preference for Light of the respondents | | |
|---|---|---|---|---|---|
| Criteria's | f | % | Criteria's | f | % |
| Much too light | 2 | 1.00 | Wishes to have less light | 16 | 7.00 |
| Too much light | 44 | 20.00 | Likes it as it is | 182 | 83.00 |
| Comfortable light | 121 | 55.00 | Wishes to have more light | 22 | 10.00 |
| Just comfortable light | 47 | 21.00 | | | |
| Slightly dark | 6 | 3.00 | | | |

The analysis of the perceived comfort level of the respondents revealed that slightly more than one-half (55 per cent) respondents perceived that the lighting was "comfortable". Slightly less than one-fourth of the respondents (21 per cent) opined that the light in the industry was "just comfortable light". The respondents who opined that there can be some changes made in the lighting suggested that there could be some cloth or temporary shed be developed specially on days when it's sunny since it causes glare and discomfort while working.

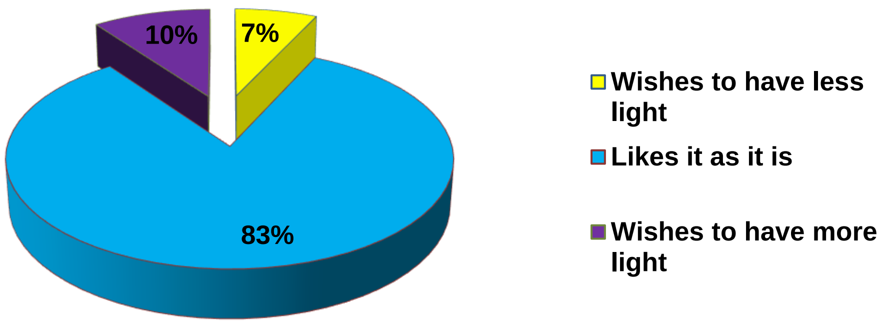
**Figure 15: Distribution of Respondents according to their Perceived Comfort Level of Light at the Workplace (n=220)**




NOTE : The fig. in the pie graph are rounded by the computer as a default setting. However, the figures depicted in the figures are actual ones (not rounded ones)

To support the suggestions 20 per cent respondents opined that there was "too much light" in the working place. Very few respondents opined that the working place was "too dark" (3 per cent) and "much too light" (1 per cent) (table 30, figure 15).

**Figure 16: Distribution of Respondents according to their Preference of Light at the Workplace (n=220)**




**NOTE : The fig. in the pie graph are rounded by the computer as a default setting. However, the figures depicted in the figures are actual ones (not rounded ones)**

The findings on preference for light of the respondents in table 30 revealed that majority of the respondents (83 per cent) "liked as it is". The data revealed that one-tenth (10 per cent) of respondents "wished to have more light" followed by 7 per cent of the respondents who preferred to have less light in the workplace (figure 16).

### 4.5.2. Noise Level

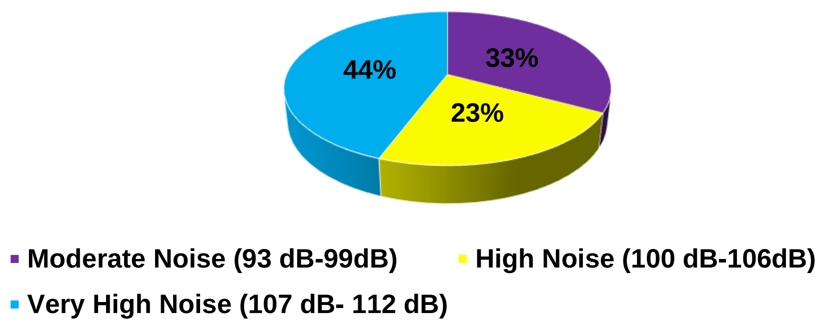
The Noise Meter was placed near the working station, three recordings were recorded at an interval of five minutes and then an average reading was recorded. The findings (Table 31) revealed that workers in the marble industry work for more than 8 hours per day and 6 days per week (>48 hrs/wk) and are exposed to high noise level. The noise exposure levels in the present industry were high as compared to the maximum permissible noise exposure limit of excessively high as compared to the maximum permissible noise exposure limit of 85 – 90 dB for 8 hours per day[17]. The lowest measurement of noise produced by the machinery was 93 dB and the highest was 112 dB. The data in table 31 revealed that 32.86 per cent of the industries were found to be having "Moderate Noise Level" (93-99 dB per day). The data also revealed that slightly less than one-half of the industries (44.28 per cent) had "Very High Noise" ranging from 107-112dB while working which was more than the prescribed limits OSHA. Such high level of noise not only hinders the communication between the workers, but its long-term exposure may also result in ill effects especially in permanent hearing threshold shift (Figure 17).

**Table 31: Distribution of the Marble Industries according to their Noise Level**

n = 70

| Recommended Level | Noise Level (dB) | f | % |
|---|---|---|---|
| **Recommended Level (85 – 90 dB for 8 hours per day)** ***(Source: OSHA, 2019)*** | **Moderate Noise (93 – 99)** | 23 | 32.86 |
| | **High Noise (100 – 106)** | 16 | 22.86 |
| | **Very High Noise (107 – 112)** | 31 | 44.28 |
| | **Total** | **70** | **100** |

**Figure 17: Distribution of the Marble Industries according to the Noise Level (n=70)**




**NOTE : The fig. in the pie graph are rounded by the computer as a default setting. However, the figures depicted in the figures are actual ones (not rounded ones)**

The findings of the present studies were supported by a study conducted in Turkey, by Atmaca et.al. (2005) to assess the problem of noise in the industries around Sivas was examined in this study; and noise measurement and survey studies were carried out at concrete traverse, cement, iron and steel and textile factories located in Sivas. The findings revealed that 73.83 per cent of the workers in these industries were disturbed from the noise in their workplaces, 60.96 per cent of them had complaints about their nervous situations, 30.96 per cent of these workers were suffering hearing problems although they had not had any periodical hearing tests and they were not using ear protection equipment.

The findings of the present study were also supported by a study conducted on effect of noise on industrial workers in Malaysia by Mokhtar et. al. (2007). The findings of the study revealed that the effects of noise were statistically significant or not. It was found from the results of the survey, at a level of significance, α= 0.05, physiological, hearing loss, auditory, and sleep disturbances effects of noise were statistically significant. Thus, it can concluded that there must be some measures to be taken to control and manage the excessive noise as it can be harmful for the respondents.

#### 4.5.3. Presence of Humidity

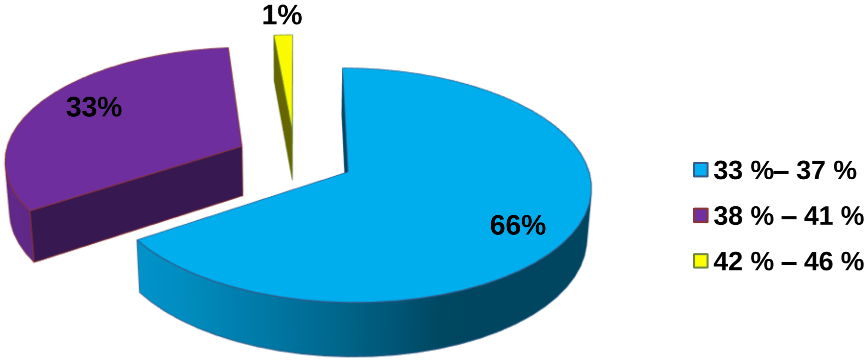
The researcher recorded three readings of the presence of humidity which were taken between 10:00 a.m. to 11:00 a.m. when it was the middle of the shift which used to start from 6:00 a.m. to 2:00 p.m. An average was derived from the recorded three readings from each industry. The data in table 32 (figure 18) revealed that the lowest humidity recorded was 33% and highest humidity recorded while the respondents were working was 46%.

**Table 32: Distribution of the Marble Industries according to their Presence of Humidity**

n = 70

| Presence of Humidity (%) | f | % |
|---|---|---|
| **33 – 37** | 46 | 65.71 |
| **38 – 41** | 23 | 32.86 |
| **42 – 46** | 01 | 1.43 |
| **Total** | 70 | 100 |
| **Mean** | 36.92% | |

**Figure 18: Distribution of Marble Industries according to the Presence of Humidity (n=70)**




NOTE : The fig. in the pie graph are rounded by the computer as a default setting. However, the figures depicted in the figures are actual ones (not rounded ones)

The data reflected that slightly less than two third of the industries (65.71 per cent) had presence of humidity ranging from 33-37%. The table 32 (figure 18) also highlighted that humidity ranging between 38-41% was recorded in 32.86 per cent industries.

### 4.5.4. Existing Temperature

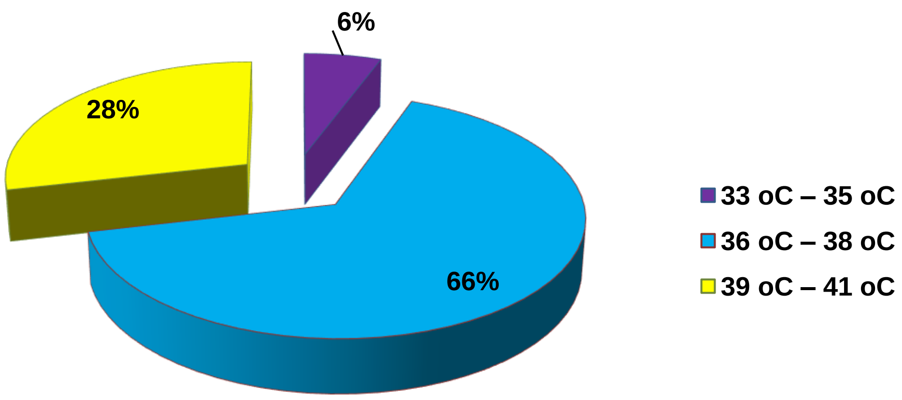
The researcher recorded three readings of the existing temperature which were taken between 10:00 a.m. to 11:00 a.m. when it was the middle of the shift which used to start from 6:00 a.m. to 2:00 p.m. An average was derived from the recorded three readings from each industry.

**Table 33: Distribution of the Marble Industries according to their Existing Temperature**

n = 70

| Existing Temperature (ºC) | f | % |
|---|---|---|
| **33 – 35** | 04 | 5.72 |
| **36 – 38** | 46 | 65.71 |
| **39 – 41** | 20 | 28.57 |
| **Total** | 70 | 100 |
| **Mean** | 37.64 ºC | |

**Figure 19: Distribution of the Marble Industries according to the Existing Temperature (n=70)**




NOTE : The fig. in the pie graph are rounded by the computer as a default setting. However, the figures depicted in the figures are actual ones (not rounded ones)

A study was conducted by Seppänen et.al. (2006) in Finland on 100 workers to draw a elation between performance and temperature which showed a decrease in performance by 2 per cent per degree Celcius increase of the temperature in the range of 25-32$^{o}$ C, and no effect on performance in temperature range of 21-25 $^{o}$C.

The data in table 32 highlighted that slightly less than two third of industries (65.71 per cent) were having temperature ranging from 36-38 $^{o}$C. The researcher also found that 28.57 per cent of industries had extreme high temperature ranging from 39–41 $^{o}$C. Studies in various other industries have also concluded that high temperatures decrease the working ability of the worker. Such unpleasant environment have found to be resulting in absenteeism and lower productivity[19]. The researcher also observed that the respondents used to get exhausted soon due to such high temperatures. Although, the working area gets cool while working since the marble is cut with continuous flow of water, thus aiding in reducing the heat stress (figure 19).

### 4.5.5. Vibration Produced by the Marble Cutting Workstation

Vibration is the mechanical oscillations of an object about an equilibrium point. The oscillations may be regular such as the motion of a pendulum or random such as the movement of a tire on a gravel road. The study of health effects of vibration requires measures of the overall "pressure waves" (vibration energy) generated by the vibrating equipment or structure[20].

Vibration enters the body from the part of the body or organ in contact with vibrating equipment. When a worker operates hand-held equipment such as a chain saw or jackhammer, vibration affects hands and arms. Such an exposure is called hand-arm vibration exposure. When a worker sits or stands on a vibrating floor or seat, the vibration exposure affects almost the entire body and is called whole-body vibration exposure[20].

**Table 34: Vibration Produced by the Marble Cutting Workstation**

| Sr. No. | Location of the Measurement of Vibration | Measurement |
|---|---|---|
| 1. | At the Pulley | 46.67 Hz |
| 2. | Slab near Marble Cutter | |
| 3. | Slab away from the Marble Cutter | |
| 4. | On the Wooden bar on the Machine | |
| 5. | On the Floor | |

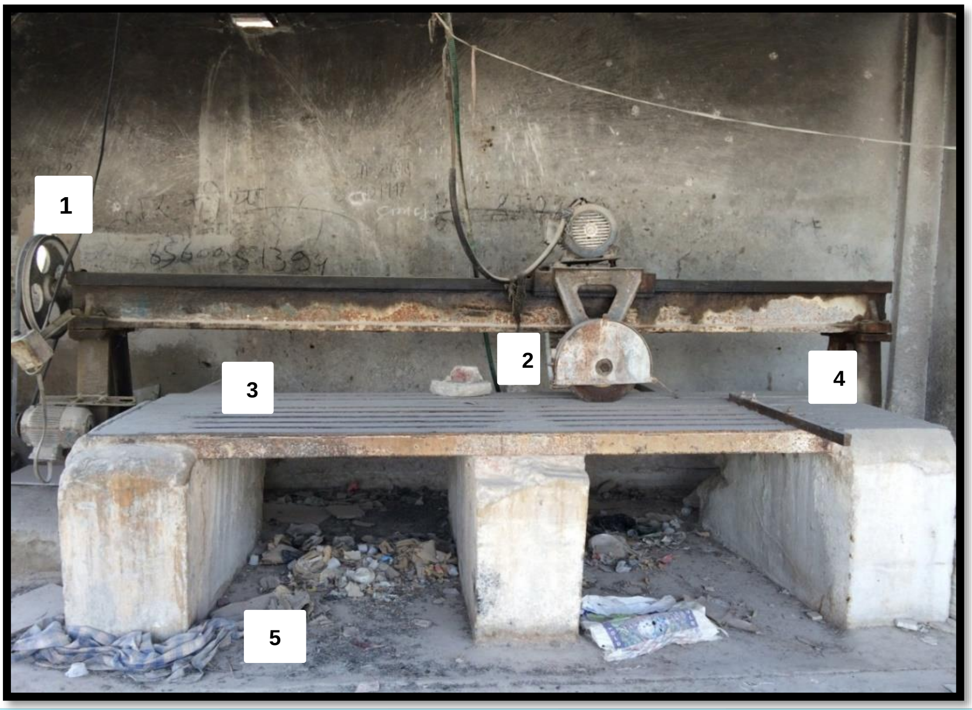



**Figure 20: Marked points at which the Vibration was measured on the Marble Cutting Workstation**

The risk of vibration induced injury depends on the average daily exposure. An evaluation of the risk takes into account the intensity and frequency of the vibration, the duration (years) of exposure and the part of the body which receives the vibration energy[20]. Thus, the vibration produced by the machinery was measured.

The results in the Table 34 depict that 46.67 Hertz (Hz) were produced by the Marble cutting Workstation. According to Encyclopedia of Occupational Health and Safety (2019), the effects of whole-body vibration are usually greatest at the lower end of the range, from 0.5 to 100 Hz. For hand-transmitted vibration, frequencies as high as 1,000 Hz or more may have detrimental effects.

Further studies have highlighted that the workers who used vibration tools like jackhammers and drillers had developed neurological symptoms in the hands (Dasgupta and Harrisom, 1996).

### 4.5.6. Ergonomic Parameters for Assessing Risk at Workplace

This section deals with information regarding the Ergonomic Parameters for Assessing Risk at Workplace were collected with the aid of modified on the various ergonomic aspects with the help of modified PMA Ergonomic checklist. There were two aspects covered in this section. The first aspect was related to the training provided to the respondents by the industries. The second aspect was regarding the provision of rest breaks and protective aids provided for hands and excessive noise by the industry to the respondents.

The data in table 35 depicted that majority of the respondents were not provided any training for vibration (80.91 per cent) and posture (72.73 per cent). It was also observed that slightly less than one-half of the respondents (49.09 per cent) were provided training for avoiding repetition of work.

The aspect on providing training concerning the use of tools to decrease the injuries revealed that 76.36 per cent of respondents were provided training for the same. Similarly, slightly more than one-half of respondents (59.55 per cent) were found to be trained regarding performing jobs to decrease injuries.

**Table 35: Distribution of Respondents according to the Ergonomic Parameters for Assessing Workplace**

n = 220

| Parameters for Assessing Risk at Workplace | Provided | | Not Provided | |
|---|---|---|---|---|
| | f | % | f | % |
| **A. Training for** | | | | |
| **a. Maintaining Posture** | 60 | 27.27 | 160 | 72.73 |
| **b. Avoiding Repetition of work** | 108 | 49.09 | 112 | 50.91 |
| **c. Overcoming Stress** | 82 | 37.27 | 138 | 62.73 |
| **d. Vibration** | 42 | 19.09 | 178 | 80.91 |
| **e. Injuries while performing task** | 131 | 59.55 | 89 | 40.45 |
| **f. Injuries while using Tools** | 168 | 76.36 | 52 | 23.64 |
| **B. Provision of Rest Breaks** | 40 | 18.18 | 180 | 81.82 |
| **C. Protective Aids for Hands** | | | | |
| **a. Gloves** | 24 | 10.91 | 196 | 89.09 |
| **b. Cloth wrapped around hands** | 20 | 9.09 | 200 | 90.91 |
| D. **Excessive Noise** | | | | |
| **a. Ear plugs** | 12 | 5.45 | 208 | 94.55 |
| **b. Cotton** | 36 | 16.36 | 184 | 83.64 |
| **c. Cloth wrapped around ears** | 30 | 13.64 | 190 | 86.36 |
| **d. Cap** | 4 | 1.82 | 216 | 98.18 |

An in-depth analysis of the working environment revealed that majority of the respondents (81.82 per cent) were not provided any rest breaks to relieve stress from repetitive motions. The use of any protection of hands was not found to be a practice by majority of the respondents (90.91 per cent). The gloves were also not found to be in use by majority of the respondents (89.09). Marble cutting work machinery produces vibration as well as it can cause the hands to get rough. Slightly more than one-tenth of the respondents (10.91 per cent) were also found wearing gloves provided by the industry while working. The further investigation on the use of protective aids for excessive noise revealed that majority of the respondents were not using cap (98.18 per cent) and ear plugs (94.54 per cent). Although slightly more than one-tenth of the respondents (16.36 per cent) used cotton to avoid the damage by excessive noise. It was also observed that 13.64 per cent of the respondents wrapped a cloth around their ears to protect themselves from the noise. Thus, the researcher opines that an educational programme must be developed in a way that can sensitize the industry owners and the marble cutting workers regarding good posture while working and use of protective aids.

**Plate 13: Interviewing the Respondents regarding the preference and Comfort Level of Light**

**Plate 14: Recording vibration measurements with the aid of Vibrometer**

## Section VI

## 4.6. Perceived Fatigue and Physiological Cost of Work

This section dealt with the information regarding the perceived fatigue of the respondents and physiological cost of work of the respondents. Fatigue is extreme tiredness that can manifest as physical weakness or mental exhaustion. It is characterized by decreased energy, motivation and difficulty concentrating. Fatigue is a non-specific symptom but one of the most common ones reported in several studies[21]. It is defined as one's state of overwhelming, debilitating, sustained exhaustion and decreased ability to perform daily activities, and that cannot be relieved by rest (Zhang et.al., 2015). The energy expenditure is the amount of energy (or calories) that a person needs to carry out a physical function such as breathing, circulating blood, digesting food, or a physical movement. The data on fatigue experienced by the respondents were collected via questionnaire and an observation sheet was used for collecting data on physiological cost of work.

### 4.6.1. Perceived Fatigue

Fatigue is a condition characterized by a lessened capacity for work and reduced efficiency of accomplishment, usually accompanied by a feeling of weariness and tiredness[21]. Fatigue can be acute or chronic. The data were collected through FACIT scale version 4. The FACIT Fatigue Scale is a short, 13 item tool that measures an individual's level of fatigue during their usual daily activities over the past week. The level of fatigue was measured on a five point Likert scale.

**Table 36: Distribution of Respondents According to the Perceived Fatigue experienced by them.**

n=220

| Level of Fatigue | f | % |
|---|---|---|
| **Severe Fatigue (Below 29)** | 111 | 50.45 |
| **Less Fatigue (More than 29)** | 109 | 49.55 |

The data in the table 36 reflected that almost half of the respondents (50.45 per cent) were found to be experiencing “Severe Fatigue”. The data is supported by the findings of a study conducted in China by Lin et.al. (2015) on community health in Shunde (Guangdong Province, China) revealing that approximately 30 per cent of the respondents experienced fatigue. The fatigue was associated with age, marital status, employment status, regular exercise, number of self-reported chronic diseases, number of individual’s children and hospitalization in the last year in middle-aged and elderly males. The data also revealed that slightly less than one half of the respondents (49.55 per cent) experienced ‘”Less Fatigue”. Zhang et.al. (2015) also found while surveying presence of fatigue among the 606 construction workers of US, it was revealed that 49 per cent reported being ‘tired some days’ in the past 3 months and 10 per cent reported ‘tired most days or every day’ (Table 36).

### 4.6.2. Physiological Cost of Work

Physiological workload refers to the physical or muscular effort required on the part of the worker to accomplish a task or an activity. From the physiological point of view, the job-demand or workload refers to the demands placed on the cardiorespiratory system, determined from the energy cost and the cardiac cost of work (Chauhan, 2015).

**Table 37: Distribution of Respondents According to the Physiological**

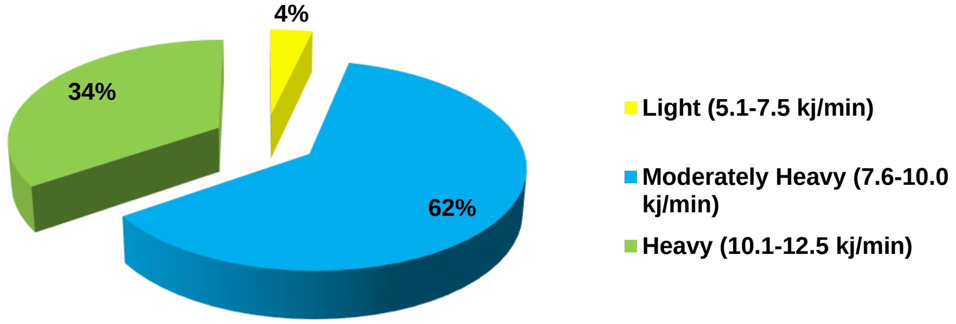
n=220

| Physiological cost of Work | f | % |
|---|---|---|
| **Light (5.1-7.5 kj/min)** | 08 | 3.64 |
| **Moderately Heavy (7.6-10.0 kj/min)** | 136 | 61.82 |
| **Heavy (10.1-12.5 kj/min)** | 76 | 34.54 |

*Source: Varghese et.al. (1994)*

The data were gathered by using the heart rate method. The use of this method has been advocated by many researchers in the field of physiology (Berggren and Christensen,1950; Malhotra et.al. 1962) and is now used worldwide as a measure of physiological workload in industries and other field situations.

Figure 21: Distribution of Respondents according to the Physiological Cost of Work (n=220)




NOTE : The figures in the pie graph are rounded by the computer as a default setting. However, the figures depicted in the figures are actual ones (not rounded ones)

The data in the table 37 revealed that for slightly less than two third of the respondents (61.82 per cent), the physiological workload was found to be "Moderately heavy" of the task performed by the respondents. "Heavy" physiological workload was recorded for the task performed by 34.54 per cent of the respondents. It was also interesting to note that very few respondents (3.64 per cent) physiological workload was computed for the task performed by them. The findings also revealed that the no respondent had "Very light", "Very Heavy" and "Extremely Heavy" physiological cost of work. The findings of the present study were supported by a study conducted by Santini et. al in 2012 in Italy revealing that the physiological cost of work was high among the construction workers. An assessment of physiological stress parameters of female workers engaged in selected cooking activities by Bhatt et.al (2011) revealed that according to the workload classification given by Varghese et al. (1994), the physiological workload of the activities can be interpreted as light activity for rolling and dish washing, whereas cutting and grating carrots and kneading dough as moderately heavy activity (Table 37, Fig.21).

## Section VII

## 4.7. Testing of Hypotheses

According to Kerlinger (2007), ‘A hypothesis is a conjectural statement of the relationship between two or more variables’. A research hypothesis is a specific, clear, and testable proposition or predictive statement about the possible outcome of a scientific research study based on a particular property of a population, such as presumed differences between groups on a particular variable or relationships between variables. Specifying the research hypotheses is one of the most important steps in planning a scientific quantitative research study (Lavrakas, 2008).

Bailey (1978) defines a hypothesis as:

> a proposition that is stated in a testable form and that predicts a particular relationship between two (or more) variables. In other words, if we think that a relationship exists, we first state it as a hypothesis and then test the hypothesis in the field.

In order to test the formulated hypotheses for the present investigation, as per the nature of variables t-test, chi-square, coefficient of correlation, Analysis of Variance were computed. For the purpose of statistical analysis, the hypotheses were formulated in null form. The results are presented in this section.

**$Ho_1$ : There is no variation in the Perceived Musculoskeletal Pain experienced by the respondents with their Age, Years of Working Experience, Perceived Health Status and Environment of the Workplace.**

To find out the difference between Perceived Musculoskeletal Pain experienced by the respondents with their Age, Years of Working Experience, Perceived Health Status and Environment of the Workplace “Analysis of variance” and “t test” were computed.

**$Ho_{1.1}$ :There is no variation in the Perceived Musculoskeletal Pain experienced by the respondents with their Age, , Years of Working Experience and Perceived Health Status.**

Analysis of Variance was computed to test this hypothesis.

**Table 38: Analysis of Variance showing variation in the Perceived Musculoskeletal Pain experienced by the respondents with their Age, Years of Working Experience and Perceived Health Status**

| Selected variables | df | Sum of squares | Mean squares | F value | Level of significance |
|---|---|---|---|---|---|
| **Age** | | | | | |
| Between Groups | 2 | 6251.7 | 3125.9 | 2.9 | N.S. |
| Within Groups | 217 | 230808.8 | 1063.6 | | |
| **Years of Experience** | | | | | |
| Between Groups | 2 | 605.7 | 302.9 | 0.3 | N.S. |
| Within Groups | 217 | 236454.8 | 1089.7 | | |
| **Perceived Health Status (during work)** | | | | | |
| Between Groups | 3 | 14473.7 | 4824.6 | 4.7 | 0.01 |
| Within Groups | 216 | 222586.9 | 1030.5 | | |
| **Perceived Health Status (after work)** | | | | | |
| Between Groups | 4 | 5544.4 | 1386.1 | 1.3 | N.S. |
| Within Groups | 215 | 231516.1 | 1076.8 | | |

**Note: *N.S. =Not Significant, df=Degrees of Freedom**

The results showed in table 38 a significant variation in the Perceived Musculoskeletal Pain of the marble cutting workers in various parts of the body with their Perceived Health Status during work. Hence, the null hypothesis was partially rejected. This reflected that the Perceived Health Status of the respondents during their work varied with their Perceived Musculoskeletal Pain experienced by the respondents. The F value was not found to be significant hence, it did not show any variation in the Perceived Musculoskeletal Pain of the marble cutting workers in various parts of the body with their age, years of experience and Perceived Health Status (after work). Thus, the null hypothesis was partially accepted. Hence, it was inferred that the Perceived Musculoskeletal Pain of the marble cutting workers in various parts of the body had no significant effect with their age, years of experience and Perceived Health Status (after work).

**Table 39: Scheffe's test showing the mean difference between the health status (during work) with their Musculoskeletal Pain**

| Perceived Health Status (during work) | Mean | df | Level of Significance |
|---|---|---|---|
| 1) Very Good | 365.12 | 217 | 0.05 |
| 2) Good | 354.05 | | |
| 3) Fair | 354.73 | | |
| 4) Poor | 328.94 | | |
| **Significantly differed pairs: 1) Very Good, 4) Poor<br>2) Good 4) Poor<br>3)Fair 4) Poor** | | | |

The significant 'F' ratio values were further subjected to Scheffe's test to find out whether there existed mean difference in the Perceived Musculoskeletal Pain and perceived Health status of the respondents during their work. The table 39 depicted that the respondents having Poor perceived health status (during work) differed significantly in their Perceived Musculoskeletal pain from the ones having very good perceived health status during their work, and from those who had Very Good, Good and Fair perceived health status during their work (Table 39).

**$Ho_{1.2}$: There is no variation in the Perceived Musculoskeletal Pain experienced by the respondents with the Environment of the Workplace.**

t test was computed for this hypothesis. Results of t test indicated that there was no significant difference in the Perceived Musculoskeletal Pain experienced by the respondents with the Low light and High Light and High Noise and Low Noise in the Marble Industry. Thus, the null hypothesis was accepted. Thus, it can be concluded that there was no effect of the Environment Condition of the workplace on the Perceived Musculoskeletal Pain experienced by the respondents (Table 40).

**Table 40: t-test showing the difference in Perceived Musculoskeletal Pain experienced by the respondents and Environment of the Workplace**

| Environment of the Workplace | Mean score | t-value | df | Level of significance |
|---|---|---|---|---|
| **Presence of Light** | | | | |
| Less Light | 350.86 | -1.554 | 218 | N.S. |
| Appropriate Light | 358.00 | | | |
| **Noise Level** | | | | |
| Moderate Noise | 355.16 | .753 | 218 | N.S. |
| High Noise | 351.81 | | | |

**Note: *N.S. =Not Significant, df=Degree of Freedom**

**$Ho_2$ : There is no variation in the Physiological Cost of Work of the respondents with their Age, Years of Working Experience, Perceived Health Status and Environment of the Workplace.**

To find out the difference between Physiological Cost of Work of the respondents with their Age, Perceived Health Status, Years of Working Experience and Environment of the Workplace analysis of variance and t test were computed.

**$Ho_{2.1}$ : There is no variation in the Physiological Cost of Work of the respondents with their Age, Years of Working Experience and Perceived Health Status**

Analysis of Variance was computed to test this hypothesis. The F values were not found to be significant for the Physiological Cost of Work of the respondents with their Age, Years of Working Experience and Perceived Health Status (during work) and (after work) (Table 33). Hence, the null hypothesis was accepted and it was concluded that Physiological Cost of Work of the respondents did not vary with their Age, Years of Working Experience and Perceived Health Status (during work) and (after work) (Table 41).

**Table 41: Analysis of Variance showing variation in the Physiological Cost of Work of the respondents with their Age, Years of Working Experience and Perceived Health Status**

| Selected variables | df | Sum of squares | Mean squares | F value | Level of significance |
|---|---|---|---|---|---|
| **Age** | | | | | |
| Between Groups | 2 | 9.5 | 4.8 | 2.1 | N.S. |
| Within Groups | 217 | 499.9 | 2.3 | | |
| **Years of Experience** | | | | | |
| Between Groups | 2 | 5.4 | 2.7 | 1.2 | N.S. |
| Within Groups | 217 | 504.0 | 2.3 | | |
| **Perceived Health Status (during work)** | | | | | |
| Between Groups | 3 | 0.2 | 0.1 | 0.0 | N.S. |
| Within Groups | 216 | 509.2 | 2.4 | | |
| **Perceived Health Status (after work)** | | | | | |
| Between Groups | 4 | 11.9 | 3.0 | 1.3 | N.S. |
| Within Groups | 215 | 497.5 | 2.3 | | |

**Note: *N.S. =Not Significant, df=Degree of Freedom**

**$Ho_{2.2}$: There is no variation in the Physiological Cost of Work of the respondents with the Environment of the Workplace.**

t test was computed for this hypothesis.

**Table 42: t-test showing the difference in Physiological Cost of Work of the respondents with the Environment of the Workplace.**

| Environment of the Workplace | Mean score | t-value | df | Level of significance |
|---|---|---|---|---|
| **Presence of Light** | | | | |
| Less Light | 9.4 | 0.66 | 218 | NS |
| Appropriate Light | 9.3 | | | |
| **Noise Level** | | | | |
| Moderate Noise | 9.1 | 2.97 | 218 | 0.01 |
| High Noise | 9.7 | | | |

**Note: df = Degree of Freedom, *N.S= Not Significant**

The t values were found to be partially significant (Table 42). Hence the null hypotheses were partially rejected. The t test was found to be highly significant at 0.01 level with the physiological cost of work of the respondents and the Noise level in the Marble Industry. Thus, it can be concluded that the Physiological Cost of Work of the respondents varied with the Noise level in the Marble Industry. It can also be concluded that the Physiological Cost of Work of the respondents does not differ with the Environment of the Workplace.

**$Ho_3$ : There is no variation in the Perceived Fatigue experienced by the respondents with their Age, Years of Working Experience, Perceived Health Status and Environment of the Workplace.**

To find out the difference between Perceived Fatigue experienced by the respondents with their Age, Perceived Health Status, Years of Working Experience and Environment of the Workplace analysis of variance and t test were computed.

**$Ho_{3.1}$ : There is no variation in the Perceived Fatigue experienced by the respondents with their Age, Perceived Health Status, Years of Working Experience.**

Analysis of Variance was computed to test this hypothesis. The results showed a significant variation in the Perceived Fatigue experienced by the respondents with their Perceived Health Status before and after work. Hence, the null hypothesis was partially rejected. This reflected that the Perceived Fatigue experienced by the respondents varied with their perceived Health Status (Table 43). The F value was not found to be significant hence, it did not show any variation in the Perceived Fatigue experienced by the respondents with their age and years of experience. Thus, the null hypothesis was partially accepted. Hence, it was inferred that the age and years of experience had no significant effect on their Perceived Fatigue experienced by the respondents.

**Table 43: Analysis of Variance showing variation in the Perceived Fatigue experienced by the respondents with their Age, Years of Working Experience and Perceived Health Status**

| Selected variables | df | Sum of squares | Mean squares | F value | Level of significance |
|---|---|---|---|---|---|
| **Age** | | | | | |
| Between Groups | 2 | 49.7 | 24.8 | 2.0 | N.S. |
| Within Groups | 217 | 2715.1 | 12.5 | | |
| **Years of Experience** | | | | | |
| Between Groups | 2 | 61.3 | 30.7 | 2.5 | N.S. |
| Within Groups | 217 | 2703.4 | 12.5 | | |
| **Perceived Health Status (during work)** | | | | | |
| Between Groups | 3 | 105.0 | 35.0 | 2.8 | 0.05 |
| Within Groups | 216 | 2659.7 | 12.3 | | |
| **Perceived Health Status (after work)** | | | | | |
| Between Groups | 4 | 206.4 | 51.6 | 4.3 | 0.01 |
| Within Groups | 215 | 2558.3 | 11.9 | | |

**Note: *N.S. =Not Significant, df=Degree of Freedom**

**Table 44: Scheffe's test showing the mean difference between the health status (during work) and health status (after work) with their Perceived Fatigue**

| Health Status (during work) | Mean | df | Level of Significance |
|---|---|---|---|
| 1) Very Good | 30.15 | 216 | 0.05 |
| 2) Good | 29.42 | | |
| 3) Fair | 28.08 | | |
| 4) Poor | 30.11 | | |
| **Significantly differed pairs:1) Very Good 4) Poor** | | | |
| **Health Status (after work)** | **Mean** | **df** | **Level of Significance** |
| 1) Very Good | 32.00 | 215 | 0.05 |
| 2) Good | 28.86 | | |
| 3) Fair | 29.03 | | |
| 4) Poor | 28.77 | | |
| 5) Very Poor | 32.60 | | |
| **Significantly differed pairs: 2) Good, 5) Very Poor; 3) Fair, 5) Very Poor** | | | |

The statistical analysis as shown in Table 44 in Scheffe's test on Perceived health status during their work categories stated that respondents having Poor perceived health status during their work differed significantly in their Perceived Fatigue with those having Very good health status (during work).

The mean comparison clearly shows that the respondents who were having Very Poor perceived health status after their work significantly differed in their Perceived fatigue of the respondents with those having good perceived health status after their work and those respondents having fair perceived health status after their work (Table 44).

**$Ho_{3.2}$ : There is no variation in the Perceived Fatigue experienced by the respondents with the Environment of the Workplace.**

t-test was computed to find out the difference in the Perceived Fatigue experienced by the respondents with the Environment of the Workplace.

**Table 45: t-test showing the difference in Perceived Fatigue experienced by the respondents and Environment of the Workplace**

| Environment of the Workplace | Mean score | t-value | df | Level of significance |
|---|---|---|---|---|
| **Presence of Light** | | | | |
| Moderate Light | 28.84 | 2.348 | 218 | N.S. |
| High Light | 30.00 | | | |
| **Noise Level** | | | | |
| Moderate Light | 28.62 | 2.674 | 218 | N.S. |
| High Light | 29.88 | | | |

**Note: *N.S. =Not Significant, df=Degree of Freedom**

The t values were not found to be significant (Table 45). Hence the null hypotheses were accepted. Thus, it could be concluded that the perceived fatigue of the respondents does not differ with environment of the workplace i.e. presence of light and noise level in the Marble Industry.

**$HO_4$: There is no association between Physiological Cost of Work and Perceived Fatigue experienced by the respondents.**

To find out the association between Physiological Cost of Work and Perceived Fatigue experienced by the respondents chi square were computed.

**Table 46: Chi-square values for Physiological Cost of Work and Perceived Fatigue experienced by the respondents**

| Variables | Chi-square values | df | Level of Significance |
|---|---|---|---|
| Physiological Cost of Work | 5.442 | 2 | N.S. |
| Perceived Fatigue | | | |

**Note: *N.S. =Not Significant, df=Degree of Freedom**

The results revealed no significant association between Physiological Cost of Work and Perceived Fatigue experienced by the respondents (Table 46). Thus, the null hypothesis was accepted.

**$HO_5$: There is no association between Physiological Cost of Work and Perceived Musculoskeletal Pain experienced by the respondents.**

Chi square was computed to test this hypothesis.

**Table 47: Chi-square values for Physiological Cost of Work and Perceived Musculoskeletal Pain experienced by the respondents**

| Variables | Chi-square values | df | Level of Significance |
|---|---|---|---|
| Physiological Cost of Work | 1.312 | 2 | N.S. |
| Perceived Musculoskeletal Pain | | | |

**Note: *N.S. =Not Significant, df=Degree of Freedom**

Computation of chi square indicated that there is no significant association between Physiological Cost of Work of the respondents and Perceived Musculoskeletal Pain experienced by the respondents (Table-47). Hence, the null hypothesis was accepted in this case.

**$HO_6$ : There exists no relationship among Perceived Fatigue and Perceived Musculoskeletal Pain experienced by the respondents.**

To find out the relationship between the Perceived Fatigue and Perceived Musculoskeletal Pain, co-efficient of correlation was computed.

**Table 48: Co-efficient of Correlation showing relationship between Perceived Fatigue and Perceived Musculoskeletal Pain**

| | Selected variables | n | r-value | Level of significance |
|---|---|---|---|---|
| I. | Perceived Fatigue<br>Perceived Musculoskeletal Pain | 220 | 0.136 | 0.01 |

The results revealed there was a significant positive relationship between the Perceived Fatigue of the respondents and Perceived Musculoskeletal Pain experienced by the respondents (Table 48). Since the relationship was found positive it can be concluded that more the perceived fatigue more will be the perceived musculoskeletal pain experienced by the respondents. Hence the null hypothesis was rejected.

## Section VIII

## 4.8. Ergonomic Intervention Programme

Ergonomics program that consider context, practice, and feedback promote generalization of learning and behavior change. A successful ergonomics program therefore must be specific to the individual, his or her environment, and the job performed (Cohen et al., 1997). The term intervention refers to efforts made to effect change and render such change stable and permanent (Westlander et al., 1995 and Westlander, 1993). Numerous ergonomics studies have demonstrated that ergonomics interventions emphasizing on-the-job education and training provide people with important practice opportunities and result in greater carryover. When ergonomic changes are introduced into the workplace, they should always be accompanied by worker training on how to work safely. With this in mind an Ergonomic intervention programme was organized for the selected marble industry respondents and marble cutting workers, not only to generate awareness, but also to insist on practicing safe practices and to follow a changed life style in their occupational settings.

The earlier plan of the researcher was to test the efficacy of the suggestions of proper posture and use of protective aids (ear plugs, safety gloves, safety shoes) for three months but due to lockdown the plan could not be implemented thus it had to be done for 7 days.

For implementing the Ergonomic Intervention Programme, the researcher had prepared posters in English Language first and then translated them in Hindi language with the help of experts. The posters prepared were regarding protection during work of the workers and maintaining posture while working (Plate 15,16,17 & 18).

### 4.8.1. Conducting the Ergonomic Intervention Programme

The proposed Ergonomic intervention programme was channelized to include providing sensitization and awareness among the Marble Cutting Workers regarding protection during work and maintaining postures at work.


**Plate 15: Poster regarding Guidelines for using safety gloves by the workers in English**


**Plate 16: Poster regarding Guidelines for using safety boots by the workers in English**


**Plate 17: Poster regarding Guidelines for using ear plugs by the workers in English**

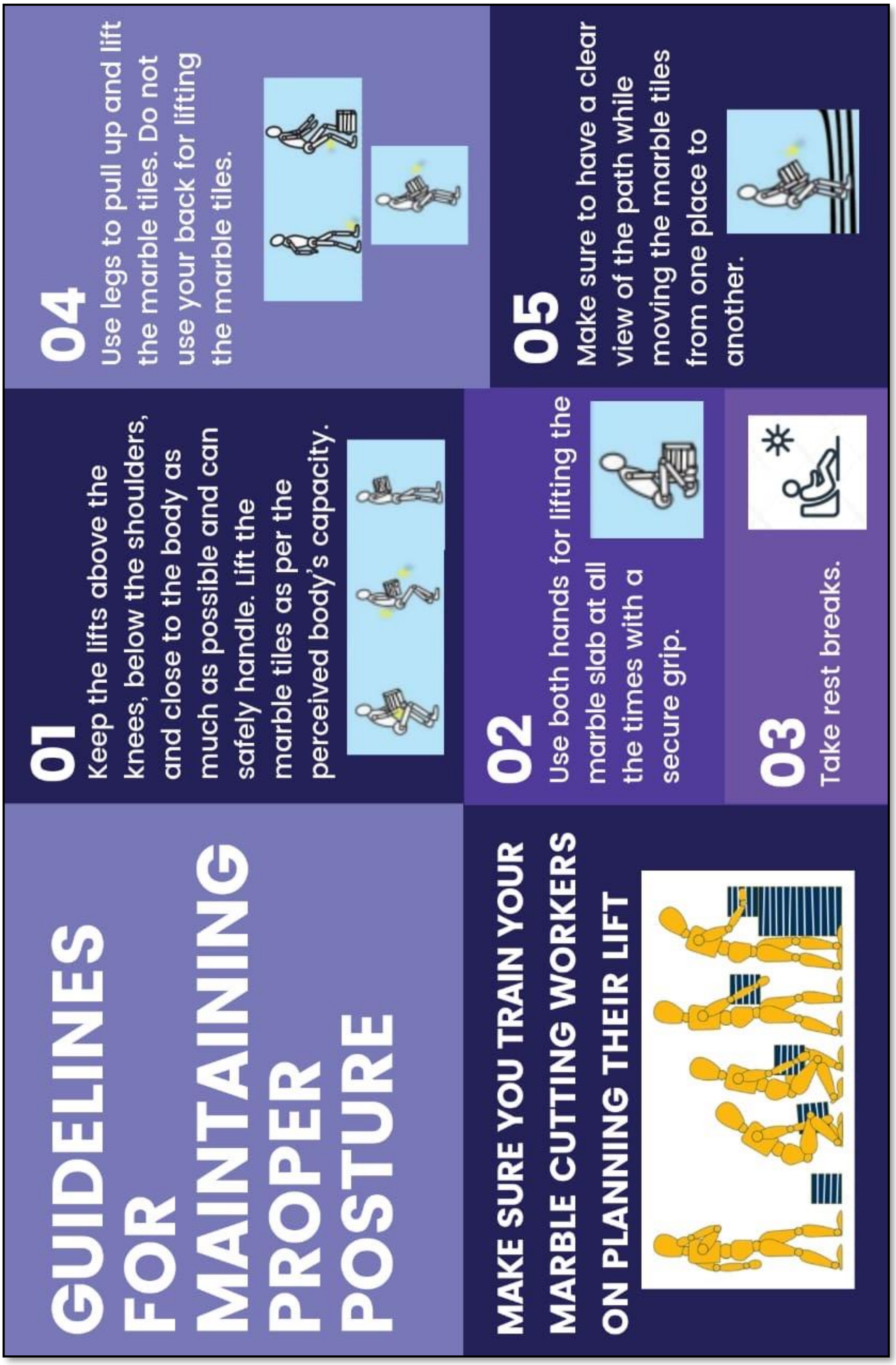



**Plate 18: Poster regarding Guidelines for Maintaining proper Posture in English**

#### 4.8.1.1. Orientation of the Owners of the Marble Industry

Out of the 220 marble cutting workers from 70 industries surveyed only two of them agreed for the intervention and giving their valuable time to the researcher. One of the reasons for not getting permission for conducting the educational programme was that due to pandemic situation most of the labourers had gone to their hometown and thus the marble cutting workstation was not functional in few of the industries. The posters prepared by the researcher were sent via local help to the owners of the marble industry. The owners of the marble industry were oriented by the researcher regarding the importance of protection during work and maintaining posture as it can help in reducing absenteeism. The researcher contacted the owners of the marble industry via telephonic conversation. The researcher sensitized the owners of the marble industry regarding the importance of the ergonomic intervention programme and also the benefits of using protective aids namely ear plugs, safety shoes and safety gloves and maintaining posture while working.

#### 4.8.1.2. Orientation of the Marble cutting workers

The researcher after due permission from the owners of the marble industry contacted the marble cutting workers via telephonic conversation due to lockdown and COVID 19. The researcher had requested the owners of the marble industry to keep the phone on speaker so that she could speak with the woekrs. Rapport building was done by the researcher followed by explaining the importance of the protection during work and maintaining posture while working. The researcher also sensitized the workers.

**A) Protection during work of the Marble Cutting workers**

The researcher had provided guidelines on the basis of the findings of the study. The guidelines were prepared in the form of posters which were displayed in the marble industry with due permission of owners of Marble industry. Posters were developed and designed for the marble cutting workers in English first and then translated to Hindi language with the help of Language Expert as the respondents did not have a command on English. The guidelines developed are as follows:

1. The guidelines for safety of workers included the guidelines for wearing safety gloves (Plate 19) wherein the benefits of wearing safety gloves were mentioned namely
    a. Keeps the hands warm.
    b. Lessens wrinkles caused by exposure to water for long duration.
    c. Prevents damage from the vibration of the machinery.
    d. Reduces the damage caused by shock.

2. The guidelines for safety included suggestions for using safety shoes (Plate 20). The benefits and reasons why the workers must wear safety shoes were enlisted which are as follows
    a. Prevents from falling
    b. Protects from electric shocks.
    c. Prevents from Slips, trips and falls.
    d. Provides cushion and arch support to avoid fatigue.
    e. Prevents skin lesions and dryness of feet from marble slurry and dust.
3. The guidelines for safety also included suggestions for using ear plugs (Plate 21) for reducing the damage caused by noise. The poster was developed wherein the benefits of wearing ear plugs were enlisted which are as follows
    a. Reduces noise exposure and hearing loss
    b. Easily wearable and manageable
    c. Comfortable in hot and humid areas.

#### 4.8.1.3. Permission undertaken from owners of Marble industry for the execution of the Ergonomic Intervention Programme

The researcher took permission from the owners of the Marble industry regarding conducting the intervention programme by requesting the owners to display the posters at key areas of the marble cutting workstation for the workers. The posters were displayed near the marble cutting workstation to ensure daily reminders for the workers (Plate 22, 23 & 24).


**Plate 19: Poster regarding Guidelines for using Safety Gloves in Hindi**


**Plate 20: Poster regarding Guidelines for using Safety Shoes in Hindi**

#### 4.8.1.4. Implementation of the Ergonomic Intervention Programme for the selected workers working in the selected Marble Industry

The researcher also took permission from the marble industry owners of the marble industry for implementing the guidelines prepared by the researcher. There was a lot of resistance experienced by the researcher from the owners of the marble industries as due to pandemic their business was affected. The owners also shared that the workers will not be much comfortable regarding the new changes in their workstyle. The researcher persuaded the owner of the industry and requested them to let the workers implement the suggestions and take the feedback after 7 days. Two industry owners agreed for the implementation of the intervention. The earlier plan of the researcher was to test the efficacy use of protective aids (ear plugs, safety gloves, safety shoes) for three months but due to lockdown the plan could not be implemented thus it had to be done for 7 days.

Ten workers in the industry were identified and were trained by the researcher via telephonic conversation as travelling was not possible due to the Lockdown and COVID 19. The workers were then asked to implement the suggested guidelines using the protective aids namely safety gloves, safety boots and ear plugs while working. Regular feedback and update were taken by the researcher to ensure the practice of guidelines and suggestions developed by the researcher.

#### 4.8.1.5. Providing the Protective Aids to the workers working in the selected Marble Industry

The researcher contacted the vendor in Jaipur via telephonic conversation who had delivery services to Kishangarh. The vendor had delivered the 10 ear plugs, 10 pairs of safety shoes and 10 pair of safety gloves to each marble industry. Before placing the order the shoe size of the respondents was enquired and confirmed by the researcher. The protective aids were then handed to the workers by the owner.


**Plate 21: Poster regarding guidelines for using Ear plugs by Workers in Hindi**

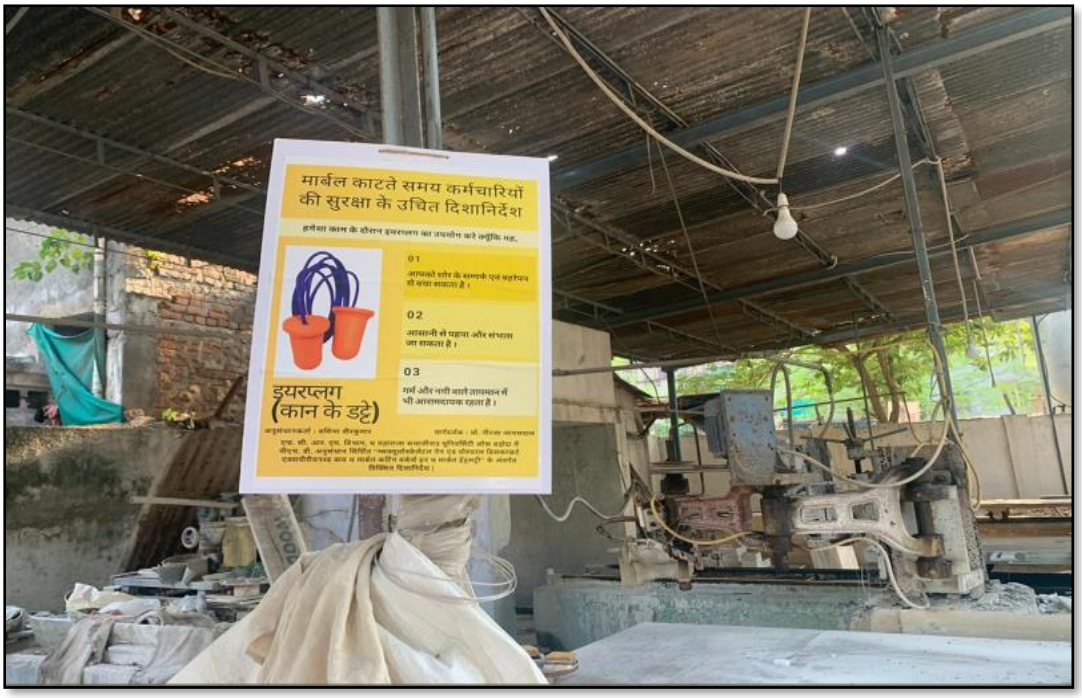



**Plate 22: Poster regarding guidelines for using ear plugs displayed near the marble cutting workstation at the Marble Industry**


**Plate 23: Poster regarding guidelines for wearing safety gloves near the marble cutting workstation at the Marble Industry**


**Plate 24: Poster regarding safety shoes displayed near the marble cutting workstation at the Marble Industry**

**Plate 25: Respondents reading the displayed posters on guidelines for wearing ear plugs at the Marble Industry**

**Plate 26: Polythene used for protecting the feet from marble slurry**

**Plate 27: Worker starting the machine for cutting the marble slab into tiles while wearing the Protective Aids**

**Plate 28: Worker cleaning the marble slab before cutting it into tiles while wearing the Protective Aids**

**4.8.2. Response from the participants regarding the posters:** Majority of the participants expressed their appreciation for conducting the programme and the purpose for which it was organized. They expressed the contents of the programme to be very useful as they were eye-openers to many of them on health issues and ergonomic concepts. The workers shared that the protective aids must be provided to them as they can help them work more comfortably.

**4.8.3. Feedback from the participants regarding the intervention**

The feedback was collected via telephonic conversation by the researcher. The feedback form was developed in English Language first and then translated in Hindi language with the help of the experts. The workers were ecstatic to use protective aids as they had to use other methods like wrapping fabric around the hands, feet and work. The researcher had taken a feedback of the respondents regarding the guidelines suggested. All the workers were very much comfortable using the ear plugs, safety gloves. The discomfort caused by the noise produced by the marble cutting machine was reduced by using ear plugs. There was no problem in communicating while working due to ear plugs.

The feedback regarding gloves was very positive as the workers did not have any harm caused due to marble slurry. The respondents also did not feel any issue with grip of lifting marble tiles while wearing gloves. The aquagenic wrinkles which used to be caused due to the exposure to water to the worker did not occur due to the use of safety gloves. The lesions on hands of the respondents was also found to be in control with the use of safety gloves. The respondents shared that the safety shoes were very comfortable in wear. It was earlier complained that since the workers worked in normal sandals or slippers they used to develop skin lesions and dryness of feet due to marble dust and slurry causing bleeding at times. It was reported that the safety shoes provided protection to the feet from marble dust and slurry. On being asked if they would continue implementing the guidelines, all the respondents readily agreed and were enthusiastic for the changes seen in their work. The respondents also shared that they will ask their other fellow members also to follow the guidelines as they are designed for the benefit of the worker.

B) **Maintaining appropriate posture while lifting marble tiles by the Marble Cutting workers:** The other objective of the Ergonomic Intervention Programme was to orient the workers to maintain appropriate postures while lifting marble tiles.

1. The guidelines for maintaining posture (Plate 29) were developed by the researcher wherein five points to remember by the workers were given namely
    a. Keep the lifts above the knees, below the shoulders, and close to the body as much as possible and can safely handle. Lift the marble tiles as per the perceived body's capacity.
    b. Use both hands for lifting the marble slab at all the times with a secure grip.
    c. Take rest breaks.
    d. Use legs to pull up and lift the marble tiles. Do not use your back for lifting the marble tiles.
    e. Make sure to have a clear view of the path while moving the marble tiles from one place to another.

The appropriate images were also provided with each point (Plate 30 & 31) for better understanding and implementation of the guidelines. The researcher had provided an orientation to the workers and also the owners of the marble industry regarding the guidelines prepared.

**4.8.1.6. Permission undertaken of the owners of the marble industry for the execution of the Ergonomic Intervention Programme**

The researcher after persuasion and orientation of the owners of the marble industry took prior permission regarding (Plate 32,33,34 & 35) allowing the researcher to display the posters. The poster was displayed near the area where the marble slabs are kept for cutting them into marble tiles so that the workers can be reminded everyday as how they should be lifting the marble tiles.

**4.8.1.7. Implementation of the Ergonomic Intervention Programme for the selected workers working in the selected Marble Industry:**

The researcher also procured permission regarding the implementation of the intervention programme prepared by the researcher. the researcher had requested them to let the workers implement the suggestions and take the feedback after 7 days. Two industry owners agreed for the implementation of the intervention. gloves, safety shoes) for three months but due to lockdown the plan could not be implemented thus it had to be done for 7 days.

The researcher trained the selected ten workers in the industry were via telephonic conversation as travelling was not possible due to the quarantine rules. The workers were then asked to implement the suggested guidelines for maintaining proper posture. Regular feedback and update were taken by the researcher to ensure the practice of guidelines and suggestions developed by the researcher.

**4.8.4. Response from the participants regarding the posters:** While the posters were being displayed after explanation, the workers shared that they should be practicing these posture techniques as it can help them lessen the pain experienced by them. The workers expressed their gratitude towards the researcher for developing the guidelines and educating them regarding the same.

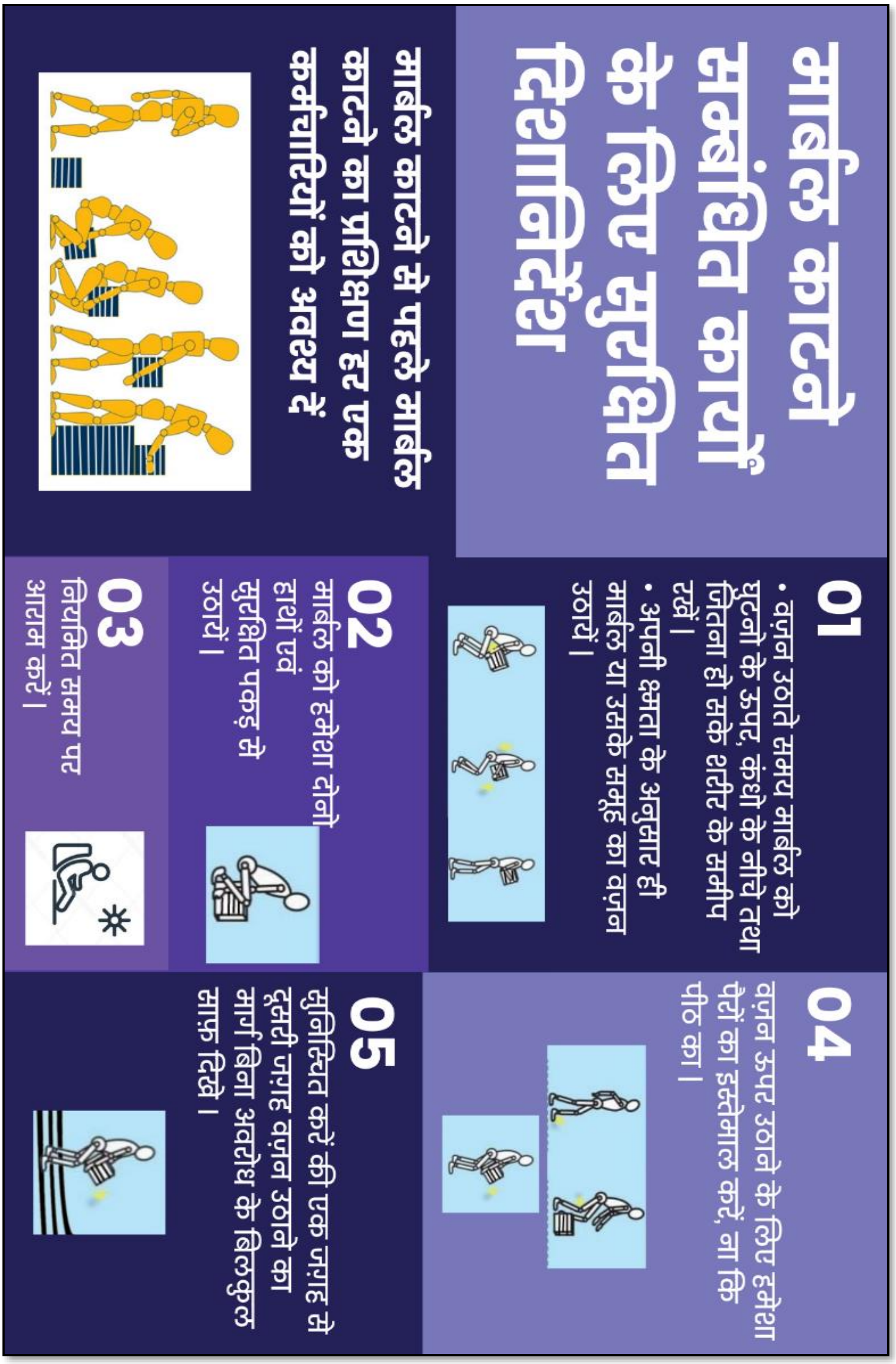



**Plate 29: Poster regarding Guidelines for Maintaining Proper Posture in Hindi**


**Plate 30: Poster regarding maintaining proper posture displayed at near the storage of the Marble Slabs in the Marble Industry**

**Plate 31: Respondents reading the guidelines for maintaining the proper posture displayed at the Marble Industry**

Plate 32: Respondent using legs to lift the marble tiles

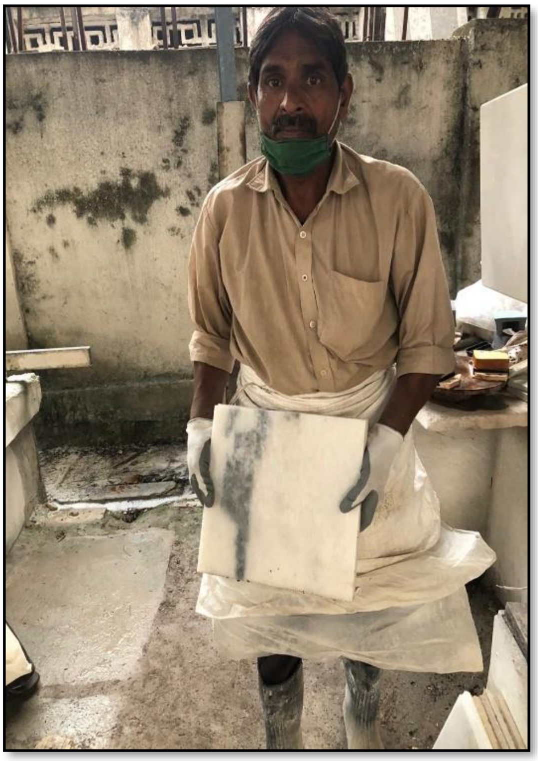


Plate 33: Worker lifting the marble tiles as per the perceived body's capacity

**Plate 34: Workers lifting the marble slab for cutting into marble tiles while wearing protective aids**

**Plate 35: Workers lifting the marble slab with a secure grip while wearing protective aids**

### 4.8.5. Feedback from the participants regarding the intervention

The feedback was collected via telephonic conversation by the researcher. The feedback form was developed in English Language first and then translated in Hindi language with the help of the experts. The researcher had taken a feedback of the respondents regarding the guidelines suggested. The workers opined that the posture guidelines helped them in doing the work easily. The rest breaks gave them more time to rejuvenate from the tiredness due to the work and stress in the body parts. They opined that learning new method of lifting especially with the use of safety shoes gave them more confidence and ease of lifting and moving marble tiles and slabs. The workers shared with the researcher that they were very happy to learn the techniques of lifting as it may help them in future and lessen the pain that is caused.

### 4.8.6. Response from the owners of Marble Industry

The owners of the Marble Industry where the respondent had conducted the intervention programme agreed and assured the researcher that they will follow the guidelines as they opined that the workers must also be given protection and safety at workplace.