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**Sarmistha Mishra**  
M.sc Scholar, Family Resource Management and Consumer Studies, College of Community Science, Assam Agricultural University, Jorhat, Assam, India

**Dr. Nandita Bhattacharyya**  
HOD and Professor, Family Resource Management and Consumer Studies, College of Community Science, Assam Agricultural University, Jorhat, Assam, India

**Dr. Moonty Baruah**  
Assistant Professor, Family Resource Management and Consumer Studies, College of Community Science, Assam Agricultural University, Jorhat, Assam, India

**Corresponding Author:**  
**Dr. Nandita Bhattacharyya**  
HOD and Professor, Family Resource Management and Consumer Studies, College of Community Science, Assam Agricultural University, Jorhat, Assam, India

## Prevalence of work related health problems & ergonomic risk factors among the workers engaged in silver filigree art of Cuttack, Odisha

Sarmistha Mishra, Dr. Nandita Bhattacharyya and Dr. Moonty Baruah

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### Abstract

Ergonomic risk factors are prevailed among the workers, especially the workers in the production units leading to work related health problems. This study was conducted on 222 workers engaged in performance of different activities in silver filigree work, exclusively found in Cuttack district, Odisha, India. Flexi curve was used to study the postural deviations at lumbo- sacral and cervical regions. Analyses of postures revealed that the workers used to assume a variety of joint awkward postures while performing different filigree activities due to the demand of work and workstation design. As regards to exertion perceived in performance of various filigree activities, it was found that design making activities was reported as the heaviest activity. Work related musculoskeletal problems like lower back, upper back and finger pain were quite prevalent among the workers. Analysis of data revealed that significant positive relationships existed between age, year of involvement, perceived joint discomfort and work related musculoskeletal problems faced by the works. Hence it can be concluded that there is relationship between the work related musculoskeletal disorders with perceived joint discomforts.

**Keywords:** Musculoskeletal disorder, filigree, flexi curve, postural deviation

### 1. Introduction

A wide variety of jewellery is being used in Indian culture among which silver jewellery are one of it's kind. Filigree is an ancient art form that dates back over 500 years and is used in making both gold and silver jewellery. Filigree work on gold jewellery is frequently practiced in major parts of the country, but silver filigree work is an exclusive example of Odisha's handicrafts industry, which is rarely seen elsewhere in India. The silver filigree is distinguished from other ornaments and jewellery by its exquisite finish, dexterous foils, fine texture and snow like gloss. Cuttack, the Millennium City or Silver City in Odisha, is a 1000-year old city known for its silver filigree works. More than 100 families in Cuttack are involved in this traditional art form of jewellery-making for several generations. These artisans locally called 'Ropyakaras', are renowned for their impeccable craftsmanship, design, and forms (Aisurya & Dhir, 2020) <sup>[1]</sup>. These craftsmen have been creating silver filigree articles, which are one of the most appealing articles, for centuries. People have been captivated by the beauty of both decorative objects and designer jewellery made of silver filigree work.

Musculoskeletal disorders among the workers engaged in jewellery manufacturing were found to be specific to the occupation (Salve, 2015) <sup>[2]</sup>. The workers need to sit in constrained posture, assuming an unnatural posture and holding work tools tightly to perform the activities. The most inappropriate design of work method/work tools/work station, fast pace of work, heavy lifting, and repetition or working in an awkward and uncomfortable position are all ergonomic risk factors related to workload. Maintaining any static posture, such as sitting, puts more strain on the muscles, ligaments, and other soft tissue of the musculoskeletal system. Workers who sit for the majority of their workday report general discomfort and pain in their backs, necks, and shoulders; prolonged sitting can cause disc compression (Ijadunola *et al.*, 2003) <sup>[3]</sup>. Chronic back pain and possible nerve damage can have a negative impact on a worker's ability. According to (Kapandji, 1974) <sup>[4]</sup> degeneration of the cervical spine, also known as cervical spondylitis, can have serious consequences. Compression of the spinal cord at the level of the cervical spine can result in upper-limb weakness and wasting. Workers in the jewellery industry were found to have a higher rate of visual disturbances (De *et al.*, 2012) <sup>[5]</sup>.

Filigree work is a time-consuming and labour-intensive process in which silver is drawn into fine wires and foils, which are artistically joined together in a framework of delicate designs. It is also extremely detailed, requiring precision, patience, and skilled handwork, in addition to the artisans' ingenuity and creativity. Mostly it is seen that all the activities of filigree art work are performed manually. Sketches of the design are the first step in the process. It allows the artists to choose the ornament's final size and shape. Fine silver wire is manually twisted, lopped, cut, coiled, and curled to follow the design on the paper. Thin silver wires are slowly strung together to form a design, one piece at a time. To achieve desired designs, various techniques such as lopping, nipping, weaving, plaiting, pilling, filling, and twisting are used. After that, the individual silver wire pieces are soldered together with care. Because uniformity, evenness, and neatness are so important, the artisans must be extremely cautious not to make any mistake that could cause the patterns to be broken. Hence, filigree artisans sometimes work in unhealthy and uncomfortable work environment, leading to occupational health problems. Workers who work in filigree art have a variety of work-related issues and suffer from eye, finger, back, head, and neck pain as a result of long working hours in an awkward posture. Thus, this study was aimed to identify the ergonomic risk factors faced by the silver filigree workers of Odisha, India.

## 2. Methodology

### 2.1 Selection of participants

A total sample of 222 filigree workers actively engaged in all activities of filigree work in the age group 16 – 45 years and above was selected by following purposive sampling procedure. The size of the sample was decided at 95% confidence level by following (Yamane, 1967) <sup>[6]</sup> formula. All the participants included in the study were randomly selected from 6 wards of Cuttack town, Cuttack district, Odisha, India.

### 2.2 Postural analysis

Postural analysis while performing different silver filigree art activities was done in terms of angle of deviation from neutral posture by using flexi-curve.

### 2.3 Rating of Perceived exertion (RPE)

Rating of feeling of tiredness was studied by using the rating scale of RPE developed by (Varghese *et al.*, 1994) <sup>[7]</sup>. The exertion perceived by workers in the activity was recorded and categorized as very heavy, heavy, moderate heavy, light and very light based on the scores from 5,4,3,2 and 1 accordingly.

## 3. Result

### 3.1 Physical and demographic characteristics of the respondent

#### 3.1.1 Age and weight

From the present study, it was observed that highest 49.1 percent of the respondents belonged to the age group above 45 years with a mean age of 56.23 years and the highest mean body weight i.e., 74.46 kg was found among the

workers belonging to the age group above 45 years. It may be due to the fact that while performing activities related to filigree art, the workers mostly sit on the floor for the entire shift, requiring static effort which permits to deposition of subcutaneous fat in their body. The results conform to the study conducted by (Lahkar, 2017) <sup>[8]</sup> on workers engaged in fruit processing activities wherein the workers perform the activities involving static effort.

#### 3.1.2 Sex and marital status

It was revealed that, among the surveyed workers 98.2 percent were male and 1.8 percent were female workers, indicating filigree art is a male dominated art. Female participation was found negligible. The findings of the present study is in conformity with (Dayashankar, 2015) <sup>[9]</sup>. Among the selected respondents, 76.6 percent were married, 23.4 percent were unmarried.

#### 3.1.3 Year of involvement of the respondents in filigree activity

Art of Filigree is a male-dominated craft. It was revealed, nearly 50 percent of the total respondents belonged to the age group above 45 years who were engaged in this occupation as family earnings.

### 3.2 Extent of involvement of workers in different activities of filigree art

In the present study extent of involvement of workers in performance of filigree art activities was studied in terms of extent of rarely, sometimes and daily and was scored as 1, 2 and 3 respectively. Mostly performed activities were ranked based on the calculated weighted scores and mean scores. The data presented in Table.1 indicate that more than 90 percent of the respondents were found involved in matching the frame with the sketch /design making activity and soldering the frame (90.54 percent) daily. From the analyses of data it can be concluded that matching the frame with the sketch /design making activity was found to be highly involved activity (rank I). This was followed by soldering the frame (rank II), polishing (rank III), sketching the design (rank IV), finishing (rank V), making silver string (rank VI) and melting silver (rank VII) Table.2.

### 3.3 Hours of work and Rest period

The workers engaged in filigree art work for 10 to 12 hours daily. On an average of 3 hours of the break was found to be taken by the respondents for their lunch and rest.








### 3.4 Angle deviation from neutral postures

The results showed (Fig.1) awkward postures were present in almost all evaluated filigree activities. The highest angle of deviation from normal posture was observed at upper back (17°) and lower back (8.66°), in performance of matching the frame with sketch/ design making. The lowest angle of deviation from normal posture was observed at upper back (3.66°) and lower back (1.66°) while giving finish to the work.

**Table 1:** Extent of involvement of workers in different activities

Activities	Extent of involvement			Weighted score	Mean (X)	Rank
	Daily (3)	Sometimes (2)	Rarely (1)			
1. Sketching the design	(6.75)	126(56.75)	79(35.58)	376	1.69	IV
2. Melting of Silver	6(2.7)	105(47.29)	(49.54)	338	1.52	VII
3. Making of Silver string	11(4.95)	103(49.36)	102(45.94)	341	1.53	VI
4. Matching the frame with the sketch / Design making	202(90.99)	13(5.85)	1(0.45)	633	2.85	I
5. Soldering the frame	201(90.54)	13(58.55)	M(0.90)	631	2.84	II
6. Polishing	90 (40.54)	107 (48.2)	20 (9.00)	504	2.27	III
7. Finishing	18 (8.10)	100 (45.04)	97 (43.69)	351	1.58	V

**Table 2:** Posture assumed by the respondents in performance of various activities in filigree work

Sl. No	Activities	Types of Posture	Illustration	Description
1.	Sketching the design	Sitting on the floor and Bending		While performing the activity, the worker sits in a squatting posture, and his neck and low back banding towards the table.
2.	Melting of silver	Sitting		The worker sits on the floor with folded legs and his lower back are straight when he does the work.
3.	Making of silver string	Standing and Hand moving		The workers do their work in a standing posture. When he pulled the silver wire his hand also move forward to the machine.
4.	Matching the frame with the sketch / Design making	Sitting, Bending, and Hand moving with a steady and slow movement		The worker uses tweezers to make a filigree design. While performing the activity the worker squats on the floor with a forward bending at low back. A stool is used for making the designs.
5.	Soldering the frame	Sitting and Bending		The worker uses a flame torch to attach the parts of silver pieces to make the design. While performing the activity the worker sits on the floors with a forward bend at the low back with both arms below the shoulder level
6.	Polishing	Sitting and Bending		The worker sits in a squatting posture, and his neck and lower back bend towards forward.
7.	Finishing	Sitting and Bending		They sit on the ground with a mat and bend at the upper back and neck while doing finishing.

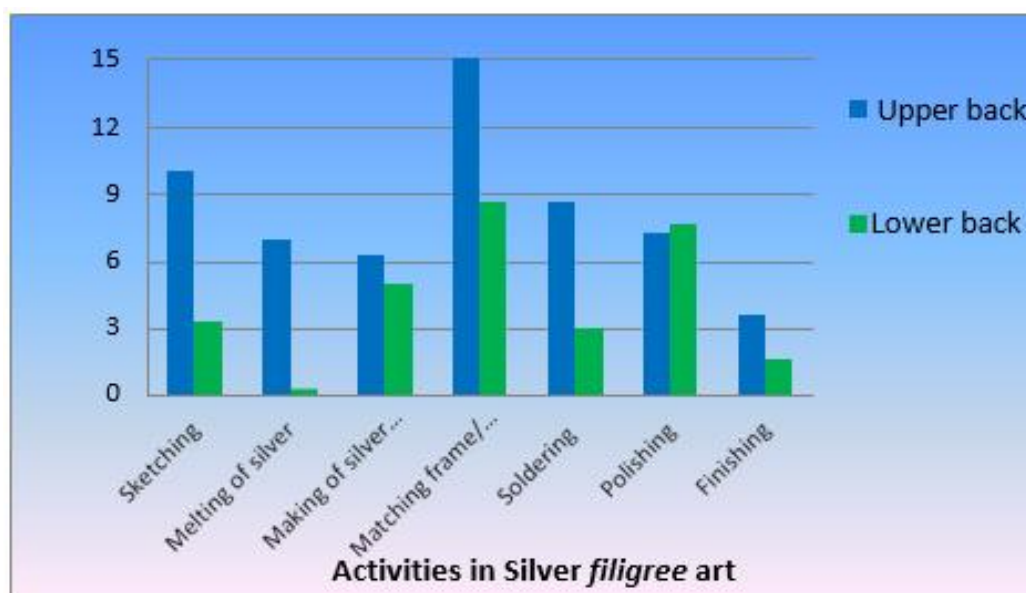


Fig 1: The angle of deviation of the body posture while performing different silver filigree activities

### 3.5 Joint discomfort perceived in performance of various activities in silver filigree work

Joints are the parts of the body where the bones meet. While performing any activity (Table.2), movements of bodily segments are possible due to the movements of joints (Kendall and McCreary, 2015) <sup>[10]</sup>. Most of the silver filigree art activities involve a variety of movements of bodily segments around a joint. Workers engaged in silver filigree activities are involved in the performance of multi-task activities. It is evident from the data that mostly involved joints in the performance of different silver filigree activities were upper back, neck, shoulder, wrist, fingers, and lower back. While performing matching the frame with sketch/design making activity the mean rating of perceived joint discomfort was found highest in waist i.e., 4.74 followed

by neck (4.73), finger (4.71), shoulder (4.27). This may be due to continuous working in awkward posture. Fingers were found being used continuously during the activities with co-contraction for holding the work tool i.e., tweezers.

### 3.6 Exertion perceived by the respondents in performance of various activities in silver filigree work

Table.3 indicate that highest RPE score (Rating of Perceived Exertion) i.e., 4.80 was observed while performing matching the frame with the sketch/Design making which was followed by sketching the design with mean RPE score of 4.08. While performing these activities the workers sit in a continuous awkward posture. Finishing activities recorded the lowest RPE score of 1.90.

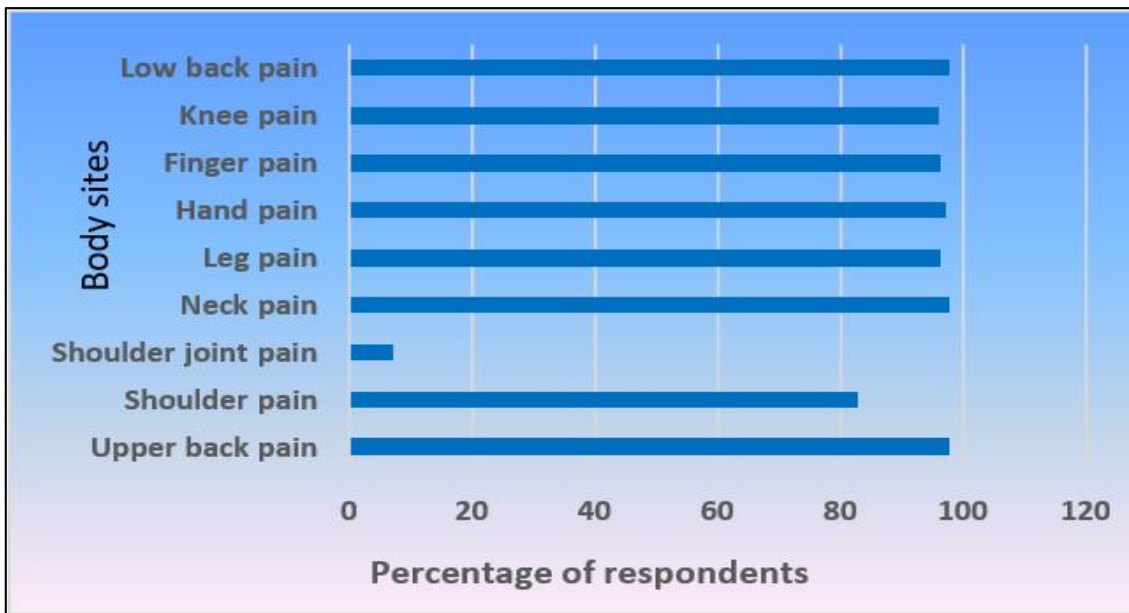
Table 3: Exertion perceived by the respondents in various activities of filigree work

S. No.	Activities	Rating of perceived exertion					Total RPE score	Mean (X)
		Very light (1)	Light (2)	Mod. Heavy (3)	Heavy (4)	Very Heavy (5)		
1.	Sketching the design	-	17	21	110	72	897	4.04
2.	Melting of silver	1	79	124	17	-	599	2.69
3.	Making of silver string	-	14	115	79	9	734	3.30
4.	Matching the frame with the sketch / Design making	-	-	-	18	199	1067	4.80
5.	Soldering the frame	-	-	23	190	4	849	3.82
6.	Polishing	-	-	6	190	26	908	4.09
7.	Finishing	36	174	10	2	-	422	1.90

### 3.7 Work-related musculoskeletal problem faced by the respondents while performing different activities in filigree work

The workers engaged in *filigree* art raised complaints when they were asked to tell about their work related health problems and the responses were found quite similar to the findings of (Bernard,1997) <sup>[11]</sup>. Mostly *filigree* workers had been adopting an awkward sitting posture for long periods during their work. A study on jewellery workers conducted by (Salve, 2015) <sup>[2]</sup> found that the workers engaged in jewellery making activities indicated that low back, neck, and knee problems were due to their work. Prolong exposure to

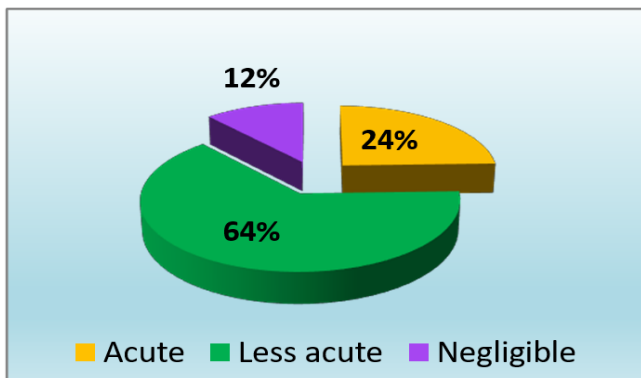
repetitive activity can give rise to the pain of different body parts. The analyses of data on (Fig.2) work related musculoskeletal disorders faced by the workers revealed that the most commonly affected body parts among more than 95 percent of the workers were low back, upper back, finger, leg, hand, knee, shoulder, and neck. This may be due to prolonged work in awkward postures, involving these body parts. The data revealed that out of total respondents, five respondents didn't have feel any pain in their body because they had been adopting the awkward postures for long period of time and they are continuing their daily life activities with those postures only.



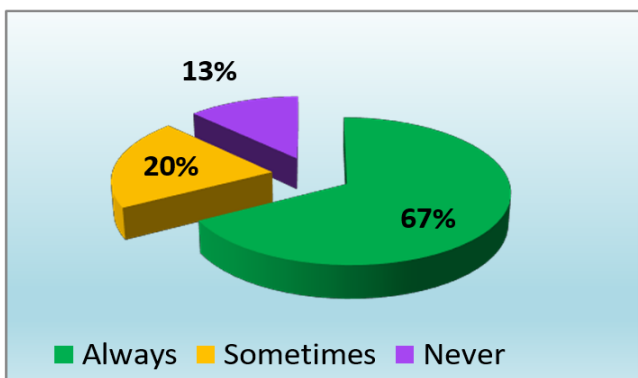
**Fig 2:** Distribution of respondents according to the musculoskeletal problem faced in performance of different activities in filigree work

**Severity and frequency of MSDs faced by filigree workers**

It was observed that 64 percent of the workers suffered from less acute incidences of body pains whereas 24 percent of the workers had negligible incidences which were followed by acute incidences i.e., 12 percent (Fig. 3). It was also observed from further analyses of data that the majority of the workers suffered upper back, neck, knee, and lower back pain in acute form.



**Fig 3:** Severity of MSDs



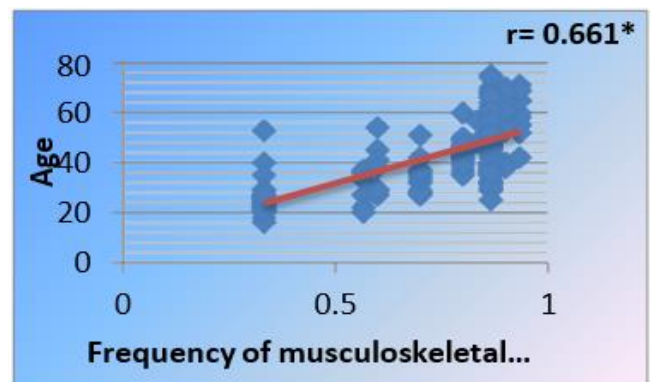
**Fig 4:** Frequency of MSDs

The frequency of musculoskeletal disorder was categorized as always, sometimes, and never based on the mean scores. Concerning the frequency of occurrence of work-related

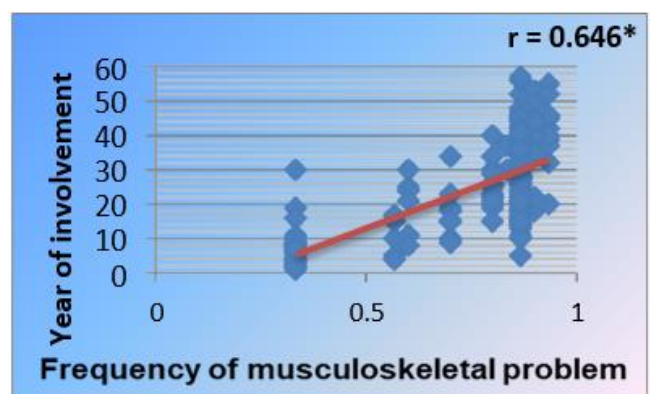
musculoskeletal problems (Fig. 4), 67 percent of the workers felt the pain always whereas, 20 percent of workers had the pain sometimes, followed by 13 percent of workers who never had pain during activities.

**3.8 Identification of the relationship between the selected independent variables and work stress of the respondents**

From the analysis of collected data (Fig. 5, 6, 7, 8, 9, 10) it can be inferred that the work related musculoskeletal problems increased with the increase in the age and years of involvement as observed in the filigree workers.



**Fig 5:** Frequency of MSDs vs Age



**Fig 6:** Frequency of MSDs vs Year of involvement

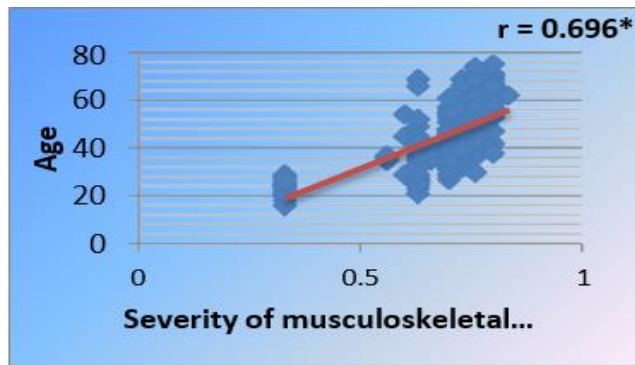


Fig 7: Severity of MSDs vs Age

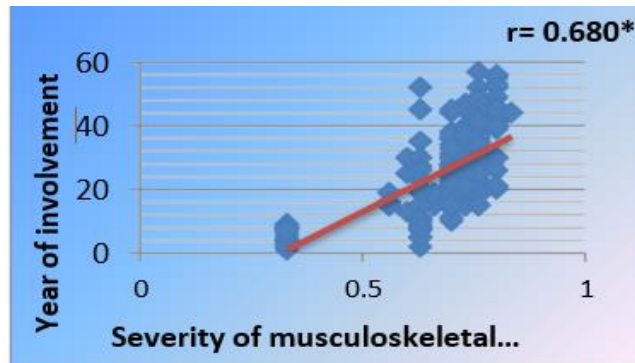


Fig 8: Severity of MSDs vs Year of involvement

Musculoskeletal disorders prevalence varies worldwide, and is dependent on the characteristics of the population, type of occupation and the tool used to report the symptoms (Teufer B. *et al.*, 2019) <sup>[12]</sup>. A cross sectional study was conducted by (Alomar *et al.*, 2021) <sup>[13]</sup> they revealed that age and years of

experience were positively associated with musculoskeletal symptoms. A significant positive relationship existed between the workers' age, year of involvement, perceived joint discomfort, and work-related musculoskeletal problems faced by the filigree workers.

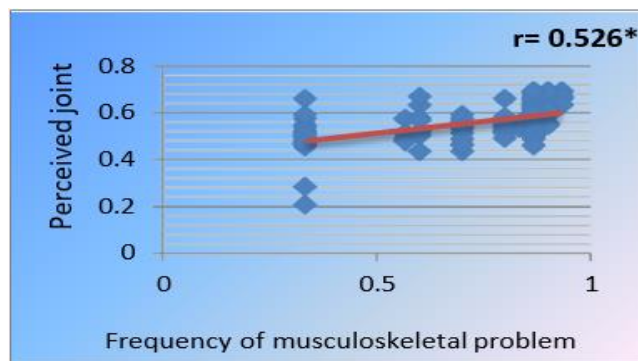


Fig 9: Frequency of MSDs vs perceived joint

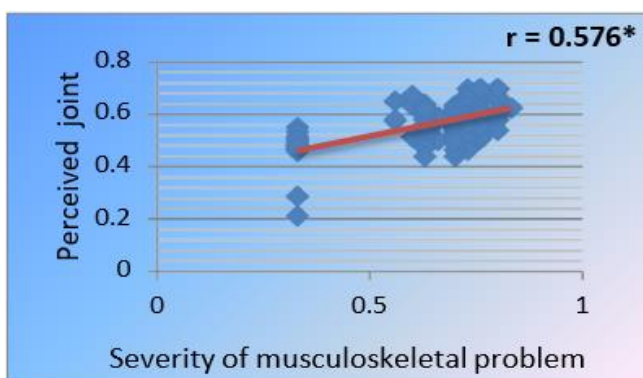


Fig 10: Severity of MSDs vs perceived joint

#### 4. Discussion

The workers engaged in silver filigree art work, worked in awkward postures for long duration. They performed the activities manually with repetitive and focused motions with static effort. All of this contributed to the later development of musculoskeletal disorders.

Through the findings of the present study, it was observed that the highest joint discomfort, pains/ injuries were observed in the design-making activities, and also more of the workers had acute pain in their lower and upper back, leg, and knee due to continuous work in an awkward posture. Finger pain is also more common for every artisan but it was not acute pain. It was also found that five workers had no pain in their bodies because they adopted the wrong posture while doing their activities. Ergonomic tool intervention for design- making

activities is necessary to reduce pains/injuries during working periods.

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