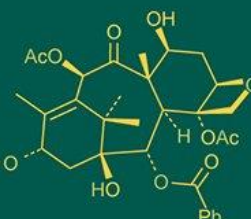
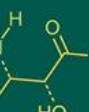
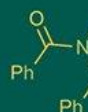
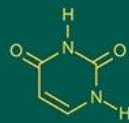


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An assessment of gender participation and work-related musculoskeletal disorders among fabric embellishment workers in Rajasthan and Uttarakhand

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Abstract

Fabric embellishment is an important component of India's textile heritage and serves as a means of preserving traditional craftsmanship while providing livelihood opportunities to a large number of artisans. Traditional embellishment techniques such as Aari, Danka, and Gota Patti embroidery in Rajasthan, along with Bead and Mirror work in Uttarakhand, continue to play a significant role in the cultural and economic life of these regions. Despite their importance, these occupations involve repetitive manual activities, prolonged static postures, and intensive visual concentration, which may expose workers to various musculoskeletal and ergonomic health problems. Therefore, the present study was undertaken to examine gender participation in selected fabric embellishment activities and to assess the musculoskeletal risks experienced by workers engaged in these occupations.

The study was conducted in Udaipur, Rajasthan, and Haldwani, Uttarakhand. A total of 75 respondents were selected through purposive sampling, comprising workers engaged in Aari work, Danka work, Gota Patti work, Bead work, and Mirror work. Only workers aged between 20 and 45 years with a minimum of two years of occupational experience were included in the study. Data were collected using a structured interview schedule. Ergonomic risk associated with repetitive upper-limb activities was evaluated using the Strain Index developed by Moore and Garg (1995) [4]. The collected data were analysed using percentage, mean, standard deviation, and Analysis of Variance (ANOVA).

The findings revealed distinct gender-based participation patterns in fabric embellishment activities. Aari and Danka work were performed exclusively by male workers, whereas Mirror work was carried out entirely by female workers. The majority of respondents belonged to the 30-40 years age group, were married, and had educational qualifications below the tenth standard. Most workers had acquired their skills through informal learning and practical experience rather than formal training.

The ergonomic assessment indicated that fabric embellishment work involves considerable physical strain. The results showed that level of exertion, duration of exertion, efforts per minute, hand and wrist posture, and daily work duration had a significant influence on strain levels among workers. Repetitive hand movements, prolonged working hours, forceful exertions, and awkward postures were identified as the major contributors to ergonomic stress. In contrast, work speed did not show a significant effect on strain levels.

The Strain Index evaluation further revealed that the dominant hand experienced greater ergonomic stress than the non-dominant hand. Higher strain index values were observed in the right hand, placing it within the hazardous risk category, while the left hand generally fell within the moderate-risk category. Continuous exposure to repetitive and forceful upper-limb activities may increase the likelihood of developing musculoskeletal disorders affecting the wrists, forearms, shoulders, neck, and lower back.

The study concludes that fabric embellishment workers are exposed to moderate to high ergonomic risks that may adversely affect their health, productivity, and overall well-being. The findings highlight the need for ergonomic interventions, including improved workstation design, suitable seating arrangements, periodic rest breaks, and occupational health awareness programmes. Implementing such measures can help reduce musculoskeletal strain, improve working conditions, and promote the long-term sustainability of traditional fabric embellishment occupations.

Keywords: Fabric embellishment, gender participation, ergonomic risks, musculoskeletal disorders, strain index

Introduction

India's textile tradition has evolved throughout the years, deeply rooted in regional cultures and workers skills. In areas such as Rajasthan and Uttarakhand, textile production historically developed through community-based and home-centric craft methods, where weaving, dyeing, embroidery, and fabric embellishment played a vital role in social and

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cultural life. Until the mid-twentieth century, fabric embellishment in these regions primarily occurred as a familial custom, with methods transmitted orally and through practical experience within artisan households. Embroidery techniques such as Aari, Danka, and Patti flourish in Rajasthan, while ritual textile adornments in Uttarakhand are closely tied to local customs, festivals, and ceremonial attire. During the post-independence period, particularly between the 1960s and the 1980s, India's textile sector experienced limited technological advancement, with traditional craft methods largely remaining informal and centered on subsistence. Nonetheless, the economic liberalization that started in the early 1990s resulted in significant structural changes in the textile industry. With the rapid growth of large-scale manufacturing and exports, traditional fabric decoration techniques in Rajasthan and Uttarakhand increasingly evolved into subcontracted, home-based, and small workshop production systems. This change resulted in improved market access and income opportunities for artisans while also elevating work requirements, production targets, and informal job conditions.

In India, fabric decoration functions as an economic activity and an important means of cultural expression and artistic tradition. The art involves different techniques such as embroidery, appliqué, beadwork, and sequin application to improve texture, detail, and aesthetic appeal of fabrics. Historically, the embellishment of fabrics has been vital in Indian textiles, reflecting regional identities, cultural traditions, and societal values. The skills required for decoration are often inherited across generations, allowing artisans to preserve traditional techniques while sustaining their means of living (Upadhyay and Pandey, 2016)^[9].

Rajasthan, known for its vibrant cultural heritage and rich textile traditions, has long been a centre for beautiful embroidery techniques that reflect both artistic sophistication and skilled craftsmanship. Among these traditional surface decoration methods, Aari, Danka, and Gota embroidery play a crucial role due to their historical relevance, intricate artistry, and continued significance in contemporary fashion. These stitching methods enhance the visual appeal of textiles while also offering a livelihood for numerous artisans, thereby improving the area's socio-economic environment.

Gota Patti is an opulent and classic embroidery technique where tiny, petal-like fragments referred to as Pattis are meticulously cut from a lustrous metallic ribbon called Gota. These small components are creatively organized to create stunning and intricate floral designs. This elaborate craftsmanship is often found on classic Rajasthani attire like sarees, Ghagra cholis, and odhanis. Today, Gota Patti is utilized to embellish various products and accessories.

Historically, Gota was crafted from solid gold, rendering the art form highly costly and exclusive. Nonetheless, synthetic materials are now utilized more frequently, leading to greater affordability and accessibility. In addition to the classic golden hue, artisans now incorporate Gota in colours such as silver, bronze, copper, and rose gold to add diversity to their designs.

The quantity of artisans engaged varies based on the fabric's dimensions and the intricacy of the design. Typically, they gather on the floor around the frame and collaboratively sew with delicate needles and threads. Gota Patti embroidery is frequently paired with other sewing methods to elevate its charm.

Aari embroidery stands out as one of the most intricate and labour-intensive methods employed throughout India, especially in areas like Rajasthan and Gujarat. The word 'Aari' signifies the hooked needle employed to form chain stitches on fabric held taut over an adda frame, facilitating swift execution with great accuracy. Aari embroidery has developed over time to include various materials like beads, sequins, and metallic threads, leading to textured surfaces that are richly detailed. Current studies emphasize that Aari embroidery is appreciated for its eco-friendly and artisanal qualities, along with its flexibility to meet contemporary design needs, rendering it significantly applicable in both clothing and home textile industries (Shewale, 2026)^[8]. Its ability to create complex floral and paisley patterns with a three-dimensional appearance adds to its significance in textile design.

Danka embroidery is a classic type of Zari craftsmanship that began in the Mewar area of Rajasthan, especially near Udaipur. This is a distinct surface decoration method where tiny metal elements, referred to as "Danka," crafted from gold or silver leaf, are placed onto vibrantly coloured textiles to produce elaborate and ornamental designs. Traditionally, this embroidery was mainly utilized to embellish women's attire like lehenga and odhni, showcasing the vibrant cultural legacy and artistry of Rajasthan. As time has passed, Danka work has developed and is currently being modified for a range of value-added textile items, such as shawls, increasing their visual attractiveness and marketability because of its unique luster and cultural importance.

Uttarakhand possesses a distinct folk-art legacy that greatly influences its fabric decoration techniques. The state is culturally divided into two regions, Kumaun and Garhwal, each with unique artistic traditions and practices. The Kumauni community participates energetically in social and artistic activities, rooted deeply in spiritual beliefs, traditions, festivities, local markets, and respect for regional deities. Their creative methods and fabric customs highlight their environmental awareness and engaged community participation. In the Kumaun region, fabric embellishment is closely linked to rituals and ceremonial activities. A notable textile tradition is the vivid embellishment of Anchal fabric, particularly the Pichhora, also known as Rangwali Kusumia, worn by women during ceremonial events. The Pichhora is a rectangular piece of muslin fabric that is approximately three meters long and one and a half meters wide. The fabric is first dyed yellow and allowed to dry in the sun, after which traditional patterns are applied with a padded wooden stick soaked in red dye.

Central to the Pichhora, emblematic motifs such as the swastika, along with images of the sun, moon, bell, and conch shell, are prominently featured. Red concentric circles are formed around these designs using soft small coins, with the outer edge often finishing in a zig-zag pattern. Various styles of the Rangwali or Kusumia tradition showcase lemon-yellow backgrounds decorated with pink or red floral patterns, as well as traditional yellow bases imprinted with crimson or red designs. Colour use in Kumauni textile decoration carries profound symbolic meaning. Red symbolizes lasting marital life (Suhaag), the heat of fire and the sun, health, wealth, and the joy of spring, while yellow and golden tones signify earthly connections and monetary success. The blend of these colours represents the fundamental idea of a balanced and productive existence. In Kumauni visual arts, the primary colours are red, yellow,

white, and black, while secondary and tertiary hues are used to maintain visual balance.

The technique of fabric decoration is highly labour-intensive and relies primarily on manual skills rather than machines. Workers are required to perform repetitive and exact tasks for long durations, often in constrained positions, using sharp instruments, fine needles, metal fibers, and chemically treated ornamental objects. While it greatly aids in sustaining livelihoods, this segment of the textile industry primarily functions within the unregulated and informal sector, where oversight and worker protections are limited. As a result, the OHS risks associated with fabric embellishment tasks are frequently overlooked, particularly in the rural and semi-urban regions of Rajasthan and Uttarakhand.

Occupational health hazards refer to the physical, chemical, ergonomic, and psychosocial threats originating from work settings that may lead to injuries, illnesses, or long-term health problems. In industries that demand significant manual work, such as textiles, workers encounter multiple hazards including inadequate ergonomics, poor lighting, exposure to dust and fibers, inadequate ventilation, excessive noise, electrical hazards, and lack of personal protective equipment (Özbakır, 2023; Shah *et al.*, 2015) [6]. These risks are increased in small textile units and subcontracted workshops, where the understanding and implementation of occupational safety standards remain considerably lacking. Among these hazards, ergonomic risks are particularly common in tasks involving fabric embellishment. Workers frequently sit for long periods on the floor or low seats, bending their necks and backs while focusing on intricate manual jobs. Extended uncomfortable postures result in musculoskeletal problems such as neck pain, lower back discomfort, shoulder tension, and repetitive strain injuries. Continuous accurate hand movements can result in wrist pain, finger numbness, and joint problems. Over time, these elements reduce work efficiency, increase fatigue, and negatively impact employees' overall quality of life (Rençber and Ceylan, 2022) [7].

Material and method

The current research was carried out in the city of Udaipur in Rajasthan and Haldwani city in Uttarakhand. These areas were chosen because of the notable number of artisans involved in fabric decoration and their solid reputation for

traditional textile and craft techniques. The study included a total of 75 workers. The workers were chosen based on the requirement that they had participated in specific fabric embellishment projects for a minimum of two years and were aged between 20 and 45 years. The employees were selected from various departments based in Udaipur and Haldwani. From the overall sample, 15 workers were chosen from Aari work, Danka work, and Gota Patti work in Rajasthan, and 15 workers were selected from Bead work and Mirror work in Uttarakhand. Respondents were selected through purposive sampling. Consent was previously secured from both the owners of the fabric embellishment units and the workers prior to their inclusion in the study. To evaluate musculoskeletal issues linked to repetitive activities in fabric embellishment tasks, the Strain Index Tool created by Moore and Garg (1995) [4] was employed. This instrument assisted in assessing the degree of ergonomic risk connected to repetitive movements of the hands and arms required in the job.

The data collected from the respondents were carefully coded, classified, and tabulated to ensure systematic analysis. The analysis was performed using MS Excel and SPSS software. Statistical tools such as percentage, mean standard deviation, and analysis of variance (ANOVA) were applied to interpret the data and derive meaningful conclusion.

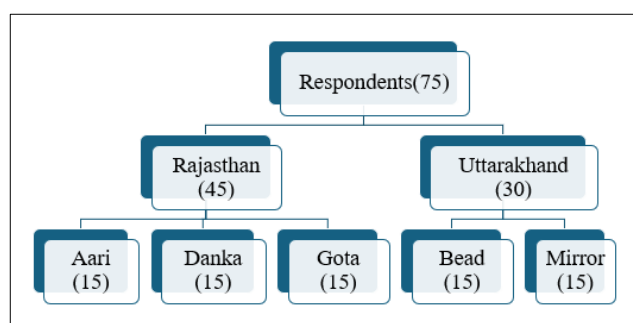


Fig 1: Sampling design of the study

Result and discussions

The analyzed data are presented in the form of tables and figures in this section. Each result is interpreted and discussed in relation to the objectives of the study.

Table 1: Percentage distribution of background information of respondents

Details	Type	Fabric embellishment work					Total
		Aari work	Danka work	Gota work	Bead work	Mirror work	
Age (in years)	20-30	6.7	6.7	-	6.7	53.3	14.7
	30-40	66.7	80.0	86.7	80.0	46.7	72.0
	40-50	26.7	13.3	6.7	13.3	-	12.0
	Above 50	-	-	6.7	-	-	1.3
Gender	Male	100.0	100.0	46.7	40.0	-	57.3
	Female	-	-	53.3	60.0	100.0	42.7
Marital Status	Married	100.0	100.0	100.0	100.0	100.0	100.0
Literacy level	Illiterate	20.0	26.7	6.7	20.0	-	14.7
	Literate	-	-	-	26.7	40.0	13.3
	Below 10 th	66.7	73.3	86.7	33.3	60.0	64.0
	Intermediate	13.3	-	6.7	20.0	-	8.0
Hand Habituation	Right	93.3	86.7	80.0	100.0	66.7	25.3
	Left	6.7	13.3	20.0	-	33.3	14.7

Table 1 shows the percentage distribution of background information of the respondents engaged in various types of fabric embellishment work, including Aari work, Danka work, Gota work, Bead work, and Mirror work.

In terms of age, the majority of respondents 72.0 percent across all categories of embellishment work were in the 30-40 years age group. Individuals aged 20-30 made up 14.7 percent, while those in the 40-50 age range accounted for 12.0 percent. Only 1.3 percent of the respondents were older than 50 years.

In terms of gender, male respondents made up 57.3 percent of the overall sample, while female respondents represented 42.7 percent. All respondents involved in Aari and Danka work were male, while Mirror work was exclusively performed by 100 percent female workers.

The data on marital status indicates that 100 percent of respondents were married. Regarding literacy levels, most respondents 64.0 percent had an education level below the 10th standard. Illiterate respondents made up 14.7 percent, literate respondents represented 13.3 percent, and just 8.0 percent had attained an intermediate level of education.

The table indicates that the majority of respondents 85.3 percent were right-handed, whereas just 14.7 percent were left-handed. All the Bead work respondents 100 percent were entirely right-handed, while a relatively larger proportion 33.3 percent of left-handed respondents were seen in Mirror work. The results show that fabric embellishment is mainly undertaken by married, middle-aged individuals with limited education, and most of them were right-handed.

Table 2: Percentage distribution of income, training and experience of the respondents in fabric embellishment work (n=75)

Parameters	Details	Fabric embellishment work					Total
		Aari work (15)	Danka work (15)	Gota work (15)	Bead work (15)	Mirror work (15)	
Income (Rs per month)	10,000-12,000	-	-	-	-	100.0	20.0
	13,000-15,000	-	-	-	100.0	-	20.0
	16,000-20,000	66.7	-	-	-	-	13.3
	21,000-25,000	33.3	100.0	100.0	-	-	46.7
Took Training	Yes	13.3	6.7	20.0	13.3	-	10.7
	No	86.7	93.3	80.0	86.7	100.0	89.4
Experience (in years)	4-8 years	46.7	66.7	46.7	80.0	80.0	64.0
	9-12 years	26.7	20.0	46.7	20.0	20.0	26.7
	13-16 years	6.7	6.7	-	-	-	2.74
	17-20 years	6.7	6.7	6.7	-	-	4.0
	21-28 years	13.3	-	-	-	-	2.7

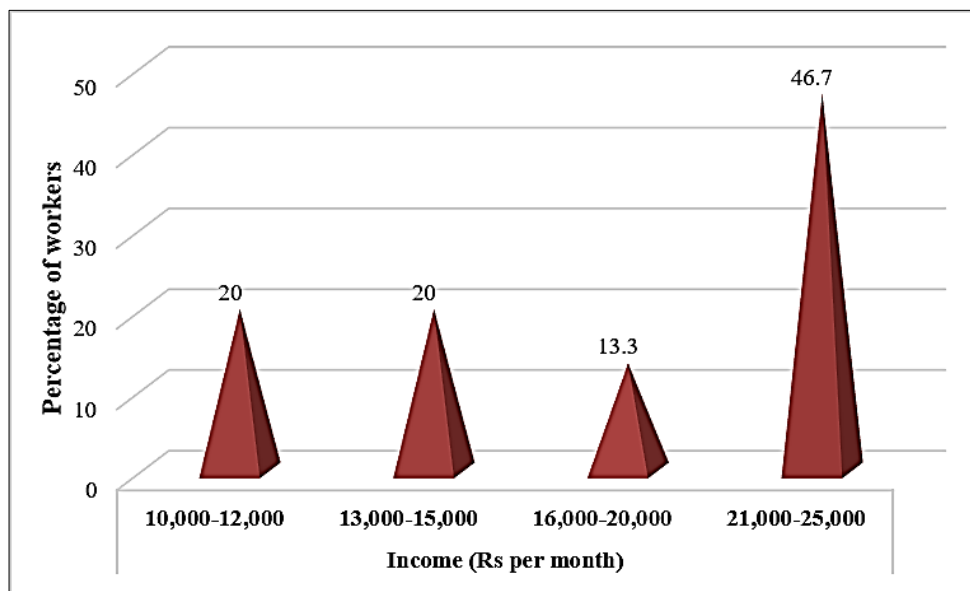


Fig 2: Percentage distribution of income of the respondents in fabric embellishment work

Table 2 shows the percentage distribution of income, formal training, and experience among respondents involved in various kinds of fabric embellishment work, including Aari work, Danka work, Gota work, Bead work, and Mirror work. In terms of earnings, as shown in Figure 4.1., all respondents engaged in Danka work and Gota work (100.0 percent for both) generated a monthly income ranging from ₹21,000 to ₹25,000 only. In Aari work, 66.7 percent of respondents

earned ₹16,000-20,000, whereas 33.3 per cent earned ₹21,000-25,000 only. All the respondents (100 percent) involved in Bead work earned ₹13,000-15,000, while all respondents participating in Mirror work 100.0 percent earned ₹10,000-12,000 only. In total, the largest share of respondents 20.0 per cent earned ₹10,000-12,000 per month, while 46.7 percent earned ₹21,000-25,000 only.

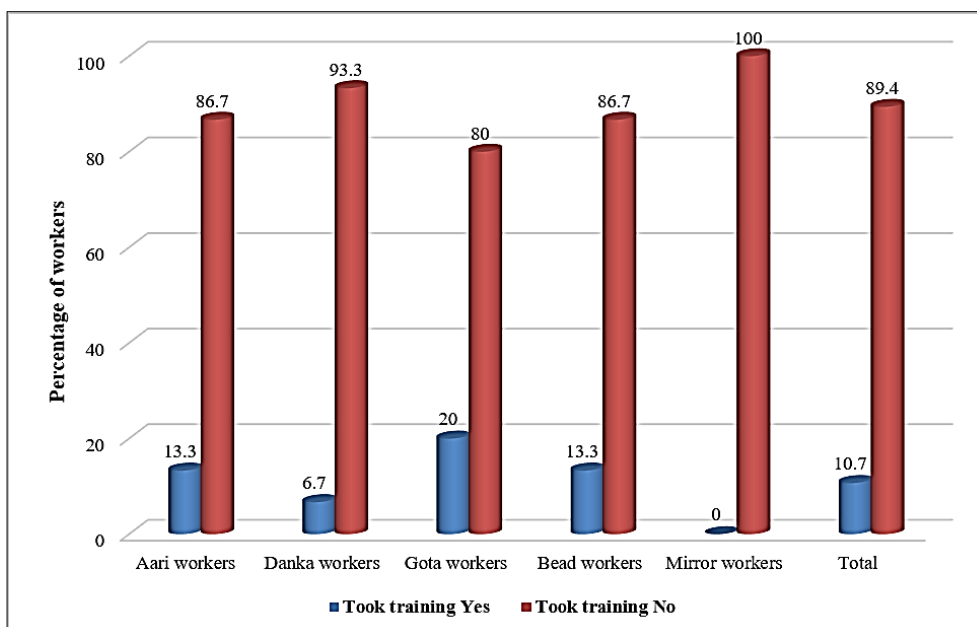


Fig 3: Percentage distribution of training of the respondents in fabric embellishment work

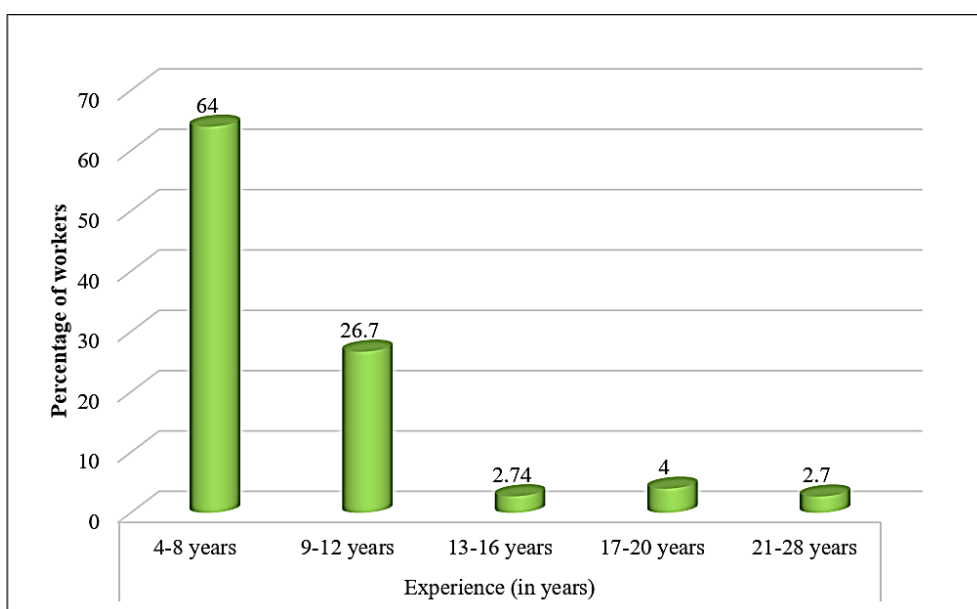


Fig 4: Percentage distribution of experience of the respondents in fabric embellishment work

In terms of training, as shown in Figure 4.2., most respondents (89.4 percent) had not undergone any official training in fabric embellishment techniques. Only 10.7 percent of respondents indicated they had received training. Among the trained respondents, the greatest percentage was noted in Gota work (20.0 percent), followed by Aari work and Bead work (13.3 percent each), whereas none of the respondents involved in Mirror work had undergone training. Regarding experience, as shown in Figure 4.3., most respondents (64.0 percent) possessed 4-8 years of experience in the field of fabric embellishment work. The highest

proportions in this category were found in Bead work and Mirror work (80.0 percent each), followed by Danka work, 66.7 per cent. Approximately 26.7 percent of respondents reported having 9-12 years of experience, while a limited percentage possessed experience varying from 13-28 years. Individuals with 21-28 years of experience were exclusively found in Aari work (13.3 percent).

In general, the results show that the majority of respondents had a moderate monthly income, did not have formal education, and held 4-8 years of experience in fabric embellishment work.

Table 3: Analysis of Variance (ANOVA) for strain index Characteristics of Fabric Embellishment workers

S. No.	Characteristics	Source	Sum of Squares	Degrees of Freedom	Mean Square	F Value	P Value
1	Intensity of Exertion	Between Group	83.920	4	20.980	7.713	0.000
		Within Group	190.400	70	2.720		
		Total	274.320	74			
2	Duration of Exertion	Between Group	148.080	4	37.020	8.743	0.000
		Within Group	296.400	70	4.234		

		Total	444.480	74			
3	Efforts per min	Between Group	2.452	4	0.613	4.860	0.002
		Within Group	8.833	70	0.126		
		Total	11.287	74			
4	Hand/Wrist Posture	Between Group	2.367	4	0.592	4.706	0.002
		Within Group	8.800	70	0.126		
		Total	11.167	74			
5	Speed of Work	Between Group	1.213	4	0.303	1.254	0.296
		Within Group	16.933	70	0.242		
		Total	18.147	74			
6	Duration of Task per Day	Between Group	2.847	4	0.712	5.415	0.001
		Within Group	9.200	70	0.131		
		Total	12.047	74			

Table 3 shows that the variance analysis (ANOVA) demonstrated statistically significant variations among the majority of the strain index attributes examined in the research. The findings indicate that the level of exertion ($F = 7.713, p < 0.05$) significantly affected strain levels, suggesting that changes in the force applied during fabric embellishment tasks greatly affect the ergonomic risk variations among workers. Greater levels of effort enhance muscle strain, thus raising the chances of fatigue and soreness.

In the same way, the length of exertion ($F = 8.743, p < 0.05$) was shown to be highly significant, indicating that extended stretches of uninterrupted work without proper breaks significantly contribute to elevated strain levels. Workers involved in extended periods of physical labour are more prone to cumulative fatigue, potentially resulting in musculoskeletal issues over time. Efforts per minute ($F = 4.860, p < 0.05$) demonstrated notable differences, suggesting that the rate of repetitive actions is a critical factor influencing strain. Increased repetition rates elevate the strain on muscles and joints, thus raising the likelihood of injury. Moreover, hand and wrist positioning ($F = 4.706, p < 0.05$) proved to be significant, highlighting that uncomfortable or non-neutral positions taken during embroidery activities elevate mechanical strain on the upper limbs.

The duration of tasks each day ($F = 5.415, p < 0.05$) indicated a significant impact, showing that extended working hours increase overall stress and lead to greater fatigue buildup. These results together suggest that force, repetition, posture, and duration are essential elements affecting ergonomic risk in fabric embellishment tasks.

Nonetheless, the speed of work ($F = 1.254, p > 0.05$) was deemed non-significant, indicating that the rate at which the task is executed does not significantly impact the differences in strain levels among workers. This suggests that despite a constant speed, other elements like force and posture have a more significant impact on assessing ergonomic stress.

The comparison of variation between groups and within groups shows that the variation among various worker groups exceeds the variation within a single group. This validates that the noted differences are statistically significant and not a result of random occurrence.

The ANOVA findings confirm the outcomes of the strain index analysis and emphasize that important ergonomic factors greatly affect upper limb strain in workers engaged in fabric embellishment work. These findings highlight the importance of tackling these elements through suitable ergonomic measures to enhance work environments and lower the likelihood of workplace health issues.

The results show that fabric embellishment work poses significant ergonomic hazards because of repetitive hand motions, intense effort, uncomfortable wrist positions, and

extended working hours. Ongoing engagement in these repetitive upper limb tasks may elevate muscle fatigue and discomfort, especially in the wrist and forearm areas, potentially resulting in musculoskeletal disorders (MSDs). The essence of embroidery tasks demands ongoing accuracy and repetitive movements, resulting in significant strain on the muscles and joints of workers.

Table 4: Hand- wise strain index assessment and risk classification of fabric embellishment work (n=75)

Hand	SI Score	Range	Risk Category
Right Hand	12-15	Mostly > 7	Hazardous
Left Hand	3-6	Mostly 3-7	Moderate Risk

Table 4 shows that the strain index evaluation of fabric embellishment workers demonstrated a significant disparity in ergonomic risk between the left and right hands. The findings indicate that the right hand demonstrated relatively elevated strain index values, usually categorizing them as hazardous ($SI \geq 7$). This clearly shows that the dominant hand experiences significant physical stress during embroidery tasks. The increased strain levels can be linked to the active participation of the right hand in executing essential task elements like needle insertion, thread pulling, and applying force, all of which demand ongoing effort and repetitive movement. In comparison, the left hand showed notably lower strain index values, primarily falling within the moderate risk category ($SI = 3-7$). This indicates that the non-dominant hand mainly plays a supportive role, like holding and stabilizing the material, requiring relatively less force, reduced repetition, and a more stable posture. Consequently, the total ergonomic strain on the left hand is less than that of the right hand.

The variation in strain levels between both hands underscores an imbalanced workload during embroidery activities. The primary hand experiences a higher level of physical exertion, resulting in heightened fatigue, discomfort, and an elevated risk of developing musculoskeletal disorders (MSDs). Prolonged exposure to these conditions, particularly in tasks requiring repetitive arm movements, can lead to chronic health problems like wrist discomfort, tendonitis, and decreased work productivity.

Moreover, the results indicate that the characteristics of fabric embellishment tasks intrinsically entail repetitive and strenuous movements, which substantially heighten ergonomic risk. The elevated strain index values observed in the right hand indicate the need for ergonomic interventions, particularly an elevated workstation with appropriate seating arrangements such as a chair or stool, to minimize repetitive strain and enhance workers posture during task performance.

The strain index evaluation distinctly shows that fabric embellishment tasks present a moderate to high ergonomic risk, with the dominant hand being more at risk due to its engaged role in performing the tasks. These results highlight the necessity of adopting preventive strategies to enhance the occupational health and safety of workers involved in these tasks.

The current research showed that fabric embellishment workers exhibited higher Strain Index (SI) values in their right hand compared to their left hand, suggesting a greater ergonomic risk in the dominant hand. This could result from repetitive actions, strenuous efforts, and constant wrist activity associated with embroidery tasks. Nag *et al.* (2013) [5] reported comparable results, noting a significant occurrence of wrist and forearm pain in embroidery workers caused by repetitive hand motions and uncomfortable positions. Similarly, Dianat and Karimi (2015) [1] found that repetitive upper limb tasks and static positions notably raise musculoskeletal discomfort in handicraft workers. Consequently, embroidery tasks put workers at moderate to high ergonomic risk and raise the chances of developing musculoskeletal disorders (MSDs).

Conclusion: India's textile heritage is widely recognized for its rich cultural value, traditional craftsmanship, and long-standing artisanal practices, among which fabric embellishment holds a significant position as both a cultural expression and a source of livelihood for rural artisans. Techniques such as Aari, Danka, and Gota Patti embroidery in Rajasthan, along with Bead and Mirror work in Uttarakhand, reflect regional identity and continue to sustain traditional skills passed down through generations. However, with the gradual commercialization of the textile sector, these activities have transformed into more production-oriented work systems, leading to increased workload, repetitive manual tasks, and prolonged working hours. Although these crafts contribute meaningfully to employment generation, they also expose workers to occupational health issues due to continuous hand movements, awkward postures, and physically demanding work conditions.

The present study was therefore conducted to examine gender participation in selected fabric embellishment work and to assess musculoskeletal disorders among workers engaged in these activities. The study was carried out in Udaipur (Rajasthan) and Haldwani (Uttarakhand) with a sample of 75 respondents selected through purposive sampling, comprising workers involved in Aari, Danka, Gota Patti, Bead, and Mirror work. Data were collected through a structured interview schedule, and the Strain Index developed by Moore and Garg (1995) [4] was used to evaluate ergonomic risk. Statistical analysis was performed using percentage, mean, standard deviation, and ANOVA. The findings revealed clear gender-based participation patterns, with Aari and Danka work predominantly performed by males, while Mirror work was exclusively carried out by females. Most respondents belonged to the 30-40 years age group, were married, and had low educational levels, with the majority lacking formal training and relying on traditional skill acquisition.

The analysis further showed significant variation in income levels across different types of embellishment work, with comparatively higher earnings in Danka and Gota Patti work and lower earnings in Bead and Mirror work. Ergonomic assessment indicated that factors such as exertion level,

duration of exertion, repetition rate, hand and wrist posture, and daily working hours significantly influenced strain levels, whereas work speed had no significant effect. The strain index results also demonstrated that the dominant hand experienced higher ergonomic risk compared to the non-dominant hand, mainly due to its continuous involvement in repetitive and forceful embroidery tasks, increasing the risk of musculoskeletal discomfort in the upper limbs. Overall, the study concludes that although fabric embellishment plays an important role in preserving cultural heritage and providing livelihood opportunities, workers are exposed to moderate to high ergonomic risks, highlighting the need for improved workstation design, proper seating arrangements, rest breaks, and occupational health awareness to ensure better health, safety, and sustainability of this traditional occupation.

References

1. Dianat I, Karimi MA, Hashemi AA, Bahrampour S. Association of individual and work-related risk factors with musculoskeletal symptoms among Iranian sewing machine operators. *Applied Ergonomics*. 2015;51:180-188.
2. Esther MD. Ergonomic Evaluation and Development of a Fixed Frame Workstation Design for Fabric Embellishment Workers [Doctoral dissertation]. Hyd: Dept of RMCS, CCSC, PJTSAU; 2016.
3. Joshi SC. Visuals and Words in Kumauni Folk Art of Uttarakhand, India. *Cognising Asian Societies Through Psychological Underpinnings*. 2022;204.
4. Moore JS, Garg A. The strain index: a proposed method to analyze jobs for risk of distal upper extremity disorders. *American Industrial Hygiene Association Journal*. 1995;56(5):443-458.
5. Nag A, Vyas H, Nag PK. Gender differences, work stressors and musculoskeletal disorders in weaving industries. *Industrial Health*. 2013;51(3):307-316.
6. Özbakır O. Evaluating occupational health and safety risks in the textile sector: A textile workshop case study in Iğdır. *Iğdır University Journal of Economics and Administrative Sciences*. 2023;10:47-58.
7. Rençber S, Ceylan A. Evaluation of risks faced by textile workers and occupational accident experiences. *Gümüşhane University Journal of Health Sciences*. 2022;11(2):748-759.
8. Shewale T. Sustainable surface ornamentation: Exploring the art and utility of Aari embroidery. *International Journal for Research in Applied Science & Engineering Technology*. 2026.
9. Upadhyay KK, Pandey AC. Occupational exposure and awareness of occupational safety and health among cloth dyeing workers in Jaipur, India. *Iranian Journal of Health, Safety and Environment*. 2016;3(2):540-546.