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# Assessment of Mental Fatigue among Chikan Embroidery Workers of West Bengal

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## ABSTRACT

Chikan embroidery is one of the most popular forms of hand embroidery in villages of West Bengal. Embroidery production employs poor women workers on piece rates. The aim of this study was to assess the extent of mental fatigue among the workers. Modified Nordic questionnaire was performed among the embroiders. Afterwards, Critical flicker fusion frequency(cycles/sec) was performed on 100 chikan embroidery workers and 100 same aged female post graduate students and research scholars using critical flicker fusion frequency test apparatus. The embroiders were asked to embroider for an hour, while the control group was asked to play a boring computer game for an hour. Flicker and fusion frequencies were deliberated before and after the assignments in both cases. Student's t test was performed between embroiders and the control group to observe whether there was any significant difference between before and after work critical flicker and fusion frequencies. Before work flicker frequency was  $34 \pm 3.6$  in embroiders and  $35.4 \pm 3.0$  in control group. After work flicker frequency was  $30 \pm 2.1$  in embroiders and  $32.2 \pm 2.9$  in control group. Before work fusion frequency was  $33 \pm 2.6$  in embroiders and  $34.6 \pm 2.2$  in control group. After work fusion frequency was  $30.8 \pm 2.5$  in embroiders and  $32.9 \pm 2.7$  in control group. Significant differences were observed ( $P < 0.05$ ) between the values of differences of fusion and flicker frequencies before and after work. This suggests that both flicker and fusion frequencies decrease significantly in chikan embroiderers after one hour of embroidering. The result entails the fact that as chikan embroidery is a highly monotonous job, the embroiders usually get mentally fatigued after the task and this is a matter of grave concern.

**Key words:** Chikan embroidery, mental fatigue, monotonous job, Critical flicker fusion frequency

## INTRODUCTION

According to the final report of the National Commission for Enterprises in the Unorganized Sector (NCEUS), also known as the Arjun Sengupta Committee, released in April 2009, workers in the unorganized sector constitute more than 93 percent of the total workforce of India (1). In rural areas, the percentage of women workers (94.50%) is more than men workers (90.34%) (1). Majority of women in the unorganized sector work for low and highly unequal wages compared to their male counterparts. India is a land of craftsmen. Chikan embroidery is one of the most ancient and popular art forms in Indian villages. Widely portrayed as a leisure-time activity, embroidery production employs poor women workers on piece rates. While women are heavily involved in this handicraft production, their contribution is

often masked by discourses that tend either to ignore or marginalize them, or portray their work as use-value production. While, there are no reliable approximations of the number of embroiderers worldwide, Wilkinson-Weber estimates that there are between 30,000 to 1,00,000 in India (2).

Mental fatigue is a diffuse sensation of weariness; it is a functional state, one of several intermediate conditions between the two extremes of alarm and sleep. Mental fatigue, in contrast, is a diffuse sensation which is accompanied by feelings of indolence and disinclination for any kind of activity.

The critical flicker fusion frequency (CFF) is a concept of psychology. CFF measured in both eyes is used to evaluate mental load during work. As CFF increases it implies that brain is more active and vice versa. It is said that the CFF shows the level of the activity of the brain. CFF measured with both eyes is used widely to evaluate the mental or physical load during work, and many authors have estimated the critical level of various kinds of work with CFF (3,4,5,6). CFF is regarded as a measure of fatigue, in particular mental fatigue associated with performance of repetitive or vigilance type task demanding sustained attention over a prolonged period of time. Chikan embroidery also involves repetitive stitching using the hands and wrists. Usually the intermittence of light is measured in cycles/sec (cps), meaning the no. of flashes of light, each followed by a discrete dark interval, which occur in 1 sec of time. The CFF is defined as the rate of successive light flashes from a stationary light source at which the sensation of flicker disappears and the light becomes steady and vice versa (3). This is a measure that appears to reflect the number of impulses that are capable of being processed by the retinal-cortical system per unit time. As the chikan embroidery work is a highly dreary occupation and the embroiders execute this extremely droning job throughout the working day, they often get tired and fatigued. Repetitive tasks requiring great skill are considered as high mental loads (7). A repetitive task with a high degree of difficulty produces a state of 'fatigue' due to a high mental load. With recent years, CFF is considered as a measure of mental fatigue, in particular the mental fatigue, associated with repetitive or vigilance-type work, demanding sustained attention with prolonged period of time (8, 9). Weber et al in their study examined that CFF declined significantly over time due to fatigue caused by heavy task load (10).

Thus, the purpose of the present study was to assess the extent of mental fatigue among the chikan embroidery workers who perform this highly repetitive job.

## **METHODS**

### **Study design**

This cross-sectional study was carried out on the women Chikan embroidery workers of Babnan, Hooghly in West Bengal, India.

### **Selection of sector and selection of embroiders**

The present study was carried on 100 women chikan embroidery workers who were selected randomly from a chikan embroidery sector situated in Babnan, Hooghly, West Bengal, India. Babnan has been a traditional center of the Chikan Embroidery for long time. Subject selection was based on the meeting the inclusion criterion, i.e. having working experience of more than 5 years. The exclusion criteria were those workers with a history of rheumatoid arthritis, diabetes mellitus and pregnancy of over three months. 100 post-graduate female students were selected as the control group. These control group were chosen randomly from the same locality, belonging to the similar socio-economic status as the embroiders.

### **Measurement of physical parameters**

The height and weight of the chikan embroidery workers were measured by an anthropometer (Martin's Anthropometer) and "Crown" weighing machine (Mfg. by Raymon Surgical Co.) respectively. The Body Mass Index (BMI) of all the embroiders was also computed (11,12).

### **Questionnaire Study**

Nordic questionnaire was performed among the embroiders which included a number of questions emphasizing individual details, type of job, skill requirement, working behavior, measurement of work stress, accident analysis, previous history of illness, and Musculoskeletal disorder symptoms to find out the feeling of discomfort. Data were collected through personal interview (13).

### **Study of the repetitiveness of work**

The ART tool (Assessment of Repetitive Tasks of the upper limbs) was used to study repetition of the work process and was administered to the embroidery workers only since the control group was primarily engaged in educational activities and not repetitive tasks (14). The ART assesses tasks that require repetitive movement of the upper limbs (arms and hands) and can be used to identify some common risk factors in repetitive work that contribute to the development of Upper Limb Disorders (ULDs). The ART assessment is divided into the following stages: stage A, is the assessment of frequency and repetition of movements; stage B is the assessment of force; stage C, is the assessment of awkward postures; and stage D, is the assessment of additional factors, such as, breaks during the total working period, work pace, whether the task requires fine precise movements of the hand or fingers, how many times the hand is struck per hour, duration of task in a day.

### **Assessment of Mental Fatigue among the embroiders**

As the chikan embroidery work is a highly dreary occupation and the embroiders execute this

extremely droning job for around 6-7 hours a day, they often get tired and fatigued as revealed by the questionnaire analysis. To assess the extent of mental fatigue, critical flicker fusion test was performed on both the embroiders and the control group to find the significant difference between the two groups using critical flicker fusion test apparatus (Fig 1). Two types of measurements were taken: “up” and “down” measurements-

Up/Ascending (Fusion) Threshold- This is an indicator of human sensitivity to the perception of the end of light flickering. It is measured with the lowest frequency of flashing light (Hz), at which the subject perceives a steady light instead of flickering one.

Down/Descending (Flicker) Threshold- This is measured with the highest frequency of flashing light when the flicker appears. When the light is steady, the subject reduces the frequency of intermittence, a rate will be reached, where the steady appearance quickly changes to an unsteady appearance called as ‘flicker’. The threshold point where intermittent illumination appears to fuse or an apparently steady light first appears to flicker is commonly designated as critical flicker frequency and is usually expressed in cps. The CFFT is regarded as a function of the activity of both the eye and the cerebral cortex. The highest degree of cortical response that is registered when a subject is exposed to flicker is found in the occipital lobe.

The embroiders were asked to embroider for an hour, while the control group was asked to play a boring computer game for an hour. Flicker and fusion frequencies were deliberated before and after the assignments in both cases. Student’s t test was performed between embroiders and the control group to observe whether there was any significant difference between before and after work critical flicker/down and fusion/up frequencies.



**Fig 1: Measurement of Critical flicker fusion frequency in Chikan embroidery worker**

## Statistical Analysis

Data were examined using the statistical package SPSS version 20.0.0. Statistical analysis included calculation of mean and standard deviation of demographic data of the study population. Differences in critical flicker and fusion frequencies between embroider and control group have been calculated using independent Student's t test.

## RESULTS

### Demographic data of the study population

Demographic data of the study population, including age, weight and height, BMI, regular working hours, years of experience are given in Table 1. It is observed that the average age of the chikan embroidery workers is about  $27.8 \pm 5.1$  years. The mean BMI value of the embroiders is  $22.6 \pm 4.0$ . They have an average working experience of around  $12.2 \pm 4.9$  years and a regular working schedule of  $6.0 \pm 1.9$  hours. The embroiders work with 1-2 intermittent breaks for doing their household jobs. Their average monthly wage is around Rs. 250-300. No significant difference was found in age and BMI values between the embroiders and control group, suggesting that both these groups belong to similar category.

**Table 1:** Demographic data of the Study Population

Individual characteristics	Embroiders [Mean $\pm$ Standard Deviation(SD)] (N=100)	Control group [Mean $\pm$ Standard Deviation(SD)] (N=100)
Age (years)	27.1 $\pm$ 2.8	26.9 $\pm$ 2.8
Height (cm)	151.4 $\pm$ 4.9	150.8 $\pm$ 4.7
Weight (kg)	51.8 $\pm$ 9.1	51.5 $\pm$ 8.7
BMI (kg/m <sup>2</sup> )	22.6 $\pm$ 4.0	22.7 $\pm$ 3.9
Years of Experience (years)	12.0 $\pm$ 2.8	-
Regular working hours	6.0 $\pm$ 1.9	-
No. of Breaks in a day	1.7 $\pm$ 0.7	
Monthly income (Rs.)	222.1 $\pm$ 74.8	

### Analysis of Nordic Musculoskeletal Questionnaire

The Nordic questionnaire analysis revealed that the embroiders use needle as special equipment for embroidering. After analyzing the responses (table 2) in the questionnaire, it is observed that the jobs they perform require both knowledge and skill. All of them reported that no frequent rotation is required in their job. This suggests that these individuals have to work in a constrained static sitting posture with rigidity in work methods over a prolonged period of time. There is no specific time for starting or finishing of job. From the third part of the questionnaire, it is found that all of them get tired easily because they work for a long time remaining in a constant posture. Most of them get annoyed and irritated easily (75%) and are also bored easily (100%).

**Table 2:** Analysis of Nordic musculoskeletal questionnaire Performed on the embroiders

General information	Responses	Number	Percentage
• Any special equipment used	Yes(Needle)	100	100%
<b>Skill requirement</b>			
• Job requires knowledge and skillful ability	Yes	100	100%
• Job demands frequent rotation for task and place	No	100	100%
<b>Job autonomy</b>			
• Rigidity in work methods and conditions	Yes	100	100%
• Job requires repetitive motions of body segments	Yes	100	100%
• No discretion on starting/finishing time of the job	Yes	100	100%
<b>Measurement of work stress</b>			
• Do you get fatigued easily?	Yes	100	100%
• Do you become annoyed and irritated easily	Yes	75	75%
• Do you get bored easily?	Yes	100	100%
• Do you in your work often have to sit for a prolong time?	Yes	100	100%

### Study of the Repetitiveness of work

The result of the study of the repetitiveness using the ART tool is given in Table 3. The exposure score of repetitiveness has been found to be  $26.2 \pm 1.7$ . From the several subdivisions of the ART tool, it has been analyzed that arm movements, repetition of the hand, forward bent posture of the neck and back, deviated posture of the elbow and wrist, finger grip and continuous use of the hand tool, i.e. needle belong to “Red” level which means that these tasks are at a high level of risk and prompt action is needed. Other tasks such as using hand tool with force and continuous task without a break fit in the “Amber” level, which implies that these tasks are at a medium level of risk and proper examination is required. Thus, chikan embroidery can be considered as repetitive and constrained work.

**Table 3:** Assessment of Repetitive Task (ART) score sheet for calculating risk for repetitiveness (n=100)

ART Exposure Score Mean $\pm$ Standard Deviation(SD)	Proposed exposure level	Remarks
26.2 $\pm$ 1.7	High	Further investigation required urgently

### Assessment of Mental Fatigue

The results of critical flicker fusion frequency test analysis are given in Table 4 and Table 5. Before work flicker frequency was  $34 \pm 3.6$  in embroiders and  $35.4 \pm 3.0$  in control group. After work flicker frequency was  $30 \pm 2.1$  in embroiders and  $32.2 \pm 2.9$  in control group. Before work fusion frequency was  $33 \pm 2.6$  in embroiders and  $34.6 \pm 2.2$  in control group. After work fusion frequency was  $30.8 \pm 2.5$  in embroiders and  $32.9 \pm 2.7$  in control group. Significant differences were observed ( $P < 0.05$ ) between the values of fusion and flicker frequencies before and after work both in embroiders and control group.

**Table 4:** Critical Flicker & Fusion frequency data

Before work flicker frequency		After work flicker frequency		Before work fusion frequency		After work fusion frequency	
embroiders	control	embroiders	control	embroiders	control	embroiders	control
34±3.6	35.4±3.0	30±2.1	32.2±2.9	33 ± 2.6	34.6±2.2	30.8 ± 2.5	32.9±2.7
Values expressed as mean ± SD							

**Table 5:** Analysis of Critical Flicker Fusion frequency test

After work flicker frequency				After work fusion frequency			
embroiders	control	t value	P value	embroiders	control	t value	P value
30±2.1	32.2±2.9	6.1	0.000*	30.8±2.5	32.9±2.7	5.7	0.000*
*Statistically significant (P < 0.05)							

## DISCUSSION

The present study highlights the fact that the chikan embroidery work is a highly repetitive manual job operation, which increases the susceptibility of the workers to mental fatigue. The informal sector and small scale industries are subjected to numerous occupational health hazards and women in this sector are always under-estimated (15,16). These workers belong to below poverty line socioeconomic class. They work rigorously around the clock along with maintaining their household chores. Generally, 1 out of 300 female workers suffer from some work related diseases (17).

Demographic data of the embroiders represent that they have a mean BMI of 22.6±4.0, suggesting normal range of BMI (18). Nordic questionnaire analysis revealed that all the embroiders work in a constrained static sitting posture with rigidity in work methods and suffer from boredom and mental fatigue. Thus, apart from lack of job autonomy, another factor that plays a significant role in generating mental agony is the practice of performing the same task repeatedly without any variation. Therefore, it is quite evident that monotony, boredom and mental fatigue are a part and parcel of their daily work schedule.

According to the ART tool, exposure score >22 implies that further investigation is required urgently for assessment of the task (14). Baschera and Grandjean (1979) in their study have stated that uniform and repetitive tasks requiring great skill must be considered as high mental loads which impair the performance and the well-being of the workers (7). Repetitive fabrication jobs have been found to be classified as monotonous, boring and demotivating, and can result in decreased worker productivity (19).

Significant differences were observed between the values of fusion and flicker frequencies before and after work both in the embroiders and the control group. The values decreased significantly more in the embroiders than the control group. Decrease in critical flicker fusion frequency means that the brain is less active. The Critical Flicker Fusion Threshold (CFFT) is often used as a measure of the current state of the central nervous system of an individual. So, decline in frequency threshold shows marked fatigue in the individual. As chikan embroidery

is a highly repetitive, monotonous job, the embroiders get mentally fatigued after the task. Saito and his colleagues (1972) carried out an investigation in the food industry and showed that this monotonous and repetitive job resulted in a distinct fall in CFF (20). The CFF has become an important measure in studies of Psychopharmacology. It has been shown to be a measure of 'total processing capacity' and has been validated in a number of studies (21,22). Chikan embroidery thus can be considered as a job requiring high mental load which decreases the levels of CFF and impair the subjective state and total processing capacity of these workers. This study is the first of its kind to determine the occupational health problems of the chikan embroiders in India. As chikan embroidery is one of the most ancient handicrafts in India, thus special attention should be provided to this much neglected sector. Further research work needs to be done on this group to analyze their mental and physical health; and positive ergonomics measures should be provided for betterment of their health and productivity.

### **Ethics approval**

Ethical approval for this study was provided by Human Research Ethics Committee of the researchers' academic institution. Informed consent was obtained from each subject.

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