

# Relationship of Duration of Work Exposure and Feeling of Subjective Fatigue: A Case Study on Jewelry Manufacturing Workers in India

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## Abstract

**Aims:** Fatigue can be defined in various conditions. In literature it has been defined and explored by various researches through different aspects. This study was conducted to establish the relationship between the duration of work exposure and feeling of subjective fatigue. **Materials and Methods:** Twenty-one jewelry manufacturing workers as study group and 27 students as control group participated with their signed informed consent. The daily diary method and feeling of subjective fatigue evaluation questionnaire were used as a tool in this study. Three categories of feeling of subjective fatigue were considered in this study. The study was conducted mainly in the middle of the week. The data regarding feeling of subjective fatigue were collected before starting of work and after completion of the work day. **Results:** The results showed that The time spent on the job by the workers engaged in jewelry manufacturing was 670 min and were in four slots with the longest work period being 240 min. Sleeping time was found to be around 480 min. **Conclusion:** The study revealed that all three dimensions (general, mental, and physical) were affected by the whole day work exposure. Among three types of fatigues, general fatigue was observed at the beginning and end of the work shift.

**Keywords:** Fatigue, jewelry manufacturing, work exposure

## INTRODUCTION

Fatigue is a state of a relatively temporary inability or decrease in ability or strong disinclination to respond to a situation. There are many factors or causes that affect the fatigue level. The major causes of fatigue are mental workload (both overload and under load), prolonged physical exertion, adverse environmental condition, monotony or boredom, and disturbance of sleep.<sup>[1]</sup> Bills in 1943, classified fatigue into subjective fatigue: feeling of discomfort and pain, objective fatigue: change in work output, and physiological fatigue: physiological change in muscle activation process.<sup>[2]</sup> The measurement of fatigue requires proper understanding of the nature of fatigue and essential instrumentation.<sup>[3]</sup> Literatures have shown that there is an effect on the feeling of subjective fatigue due to work exposure.<sup>[4-8]</sup>

The jewelry manufacturing process involves designing, casting, model making, setting (metal and stone), finishing, and polishing. At every step, this process requires higher concentration and quality checking, as any mistake at any step involves metal loss which is expensive. In India, gold

jewelry manufacturing is mainly home based and work is mainly intensive-based work. As it is majorly unorganized sector the working hours are not under supervision of any legislative body. Therefore, they are prone to work according to the requirement of the market. In a pilot study, it was observed that the workers were engaged in jewelry manufacturing work for more than 14 h a day and 6 days a week. Therefore, it was expected that this long working hours may have an impact on the feeling of fatigue, health and well-being of the workers engaged in jewelry manufacturing. Keeping the above fact in mind, a study was formulated with an objective to find out the effect of work exposure on feeling of subjective fatigue.

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## MATERIALS AND METHODS

### Study population

Workers engaged in jewelry manufacturing (Group 1): 21 students participate in this part of the study.

Control group (Group 2): 27 students participated in this part of the study.

### Study of habitual activities

Times spent on habitual activities were collected using modified diary method of Weiner and Lourie.<sup>[9]</sup>

### Feeling of subjective fatigue

In the present study, the questionnaire developed by Research Committee on Industrial Fatigue of Japan Society for Occupational Health was used to assess the feeling of subjective fatigue. This questionnaire is widely in use to quantify the feeling of subjective fatigue.<sup>[6-8,10-14]</sup> The questionnaire includes thirty expressions identifying the current subjective feeling of a surveyed individual and is divided into three parts, Part “A,” Part “B,” and Part “C” representing general (feeling of dull, drowsy and exhaustion and general feeling of incongruity in the body), mental [specific (sensory) and nervous (dysfunction of autonomic nervous systems)], and physical (purely mental, lacking of physical basis) fatigue, respectively.<sup>[15]</sup> Each part contains ten questions.

Responses obtained from the workers were expressed as percentage of feeling of fatigue using the follow in:

Percentage of complain for each

$$= \text{dimension} \frac{\frac{\text{The numbers of statements checked in each dimensions } 10 \times \text{no. of Subjects}}{10 \times \text{no. of Subjects}}}{10} \times 100$$

Percentage of complain for all

$$= \frac{\text{The numbers of statements checked in all dimensions}}{30 \times \text{no. of Subjects}} \times 100$$

### Experimental protocol

The daily habitual activities were recorded. The data were collected in the middle of the work week. Individuals were asked to respond to the questionnaire at the beginning of the work and after completion of a complete work day. The same protocol was followed for the control group individuals also. The responses were analyzed using  $\chi^2$  test and Kruscal–Wallis one-way ANOVA.

## RESULTS

### Study of habitual activities

The results of the habitual activities are presented in Table 1 and 2.

The time spent on the job by the workers engaged in jewelry manufacturing was 670 min and were in four slots with

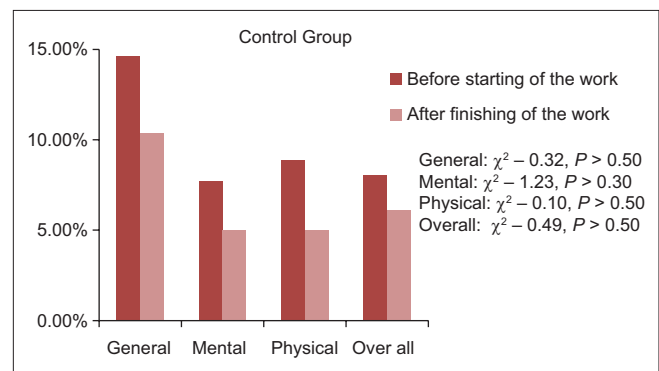
the longest work period being 240 min. Sleeping time was found to be around 480 min. Workers normally carried out their work for 6 days in a week; from Tuesday to Sunday, Monday was the rest day. The time spent on reading/study by the control group was also in four slots with the longest work period being 190 min with 10 min break in between. The study was carried out on work common work days, i.e. Tuesday to Friday.

**Table 1: A representative daily habitual activity schedule of workers engaged in jewelry manufacturing**

Activities	Time (h)	Duration (min)
Washing and getting ready	830-900	30
Morning (work)	900-1030	90
Bathing, breakfast, and morning food	1030-1100	30
Work	1100-130	150
Lunch break and rest	130-300	90
Work (afternoon)	300-1800	180
Break	1800-1900	60
Work (night)	1900-2300	240
Dinner	2300-2400	60
Cleaning up the place and preparation for sleep	2400-0030	30
Sleep	30-830	480

**Table 2: A representative daily habitual activity schedule of the control group**

Activities	Time (h)	Duration (min)
Get up, washing and getting ready, breakfast	830-930	60
Attending classes	930-1240	190
Lunch break and rest	1240-1400	80
Attending classes	1400-1710	190
Refreshment, rest, play, etc.	1710-1800	50
Studying	1800-2030	150
Dinner, rest	2030-2130	60
On computer	2130-2330	90
Resting/gossiping/playing	2330-0130	120
Sleep	130-830	420



**Figure 1: Percentage of feeling of subjective fatigue among the control group**

### Feeling of subjective fatigue

The result of the feeling of subjective fatigue (obtained from Fatigue questionnaire developed by Yoshitake, 1978, questionnaire is presented in Appendix I) were analyzed and presented in Figures 1 and 2. The results revealed that there were no significant changes in the feeling of subjective fatigue of all the dimensions along with the overall percentage of feeling of fatigue in the control group. On the contrary, the percentage of feeling of subjective fatigue increased significantly in all the dimensions along with the percentage of overall feeling of fatigue among the workers engaged in jewelry manufacturing.

**Table 3: Test results (feeling of subjective fatigue among Group 1 beginning of the work)**

Method	df	$\chi^2$	Probability	Level decision (0.05)
Not corrected for ties	2	6.187996	0.045320	Reject Ho
Corrected for ties	2	8.634471	0.013337	Reject Ho

**Table 4: Group detail (feeling of subjective fatigue among jewelry manufacturing workers at beginning of the work)**

Group	Count	Sum of ranks	Mean ranks	Z	Median
General	21	824.50	39.26	2.22351	1
Mental	21	529.50	25.21	-2.0777	0
Physical	21	662.00	31.52	-0.1458	0

**Table 5: Means and effects section (feeling of subjective fatigue among jewelry manufacturing workers beginning of the work)**

Term	Count	Mean	SE	Effect
All	63	0.6031746	0.6031746	
General (A)	21	1.190476	0.2062881	0.5873016
Mental (B)	21	0.1904762	0.2062881	-0.4126984
Physical (C)	21	0.4285714	0.2062881	-0.1746032

SE: Standard error

**Table 6: Test results (feeling of subjective fatigue among jewelry manufacturing workers after work)**

Method	df	$\chi^2$	Probability	Level decision (0.05)
Not corrected for ties	2	6.178005	0.045547	Reject Ho
Corrected for ties	2	6.628052	0.036369	Reject Ho

**Table 7: Group detail (feeling of subjective fatigue among jewelry manufacturing workers after work)**

Group	Count	Sum of ranks	Mean ranks	Z	Median
General	21	842.00	40.10	2.4787	3
Mental	21	576.00	27.43	-1.3997	2
Physical	21	598.00	28.48	-1.0789	2

### Identification of type of feeling of subjective fatigue

The type of feeling of subjective fatigue were tried to establish using Kruskal–Wallis one-way ANOVA. The results are presented in the Tables 3-14, along with Figures 3-8.

Kruskal–Wallis one-way ANOVA: The feeling of subjective fatigue score collected before starting of the work among the workers engaged in jewelry manufacturing.

The above result revealed that the type of feeling of subjective fatigue in the morning before starting of the work among the workers engaged in jewelry manufacturing was general in nature ( $A > C > B$ ).

**Table 8: Means and effects section (feeling of subjective fatigue among jewelry manufacturing workers after work)**

Term	Count	Mean	SE	Effect
All	63	2.095238	2.095238	
General	21	2.761905	0.2717486	0.6666667
Mental	21	1.666667	0.2717486	-0.4285714
Physical	21	1.857143	0.2717486	-0.2380952

SE: Standard error

**Table 9: Test results (feeling of subjective fatigue among control group beginning of the work)**

Method	df	$\chi^2$	Probability	Level decision (0.05)
Not corrected for ties	2	3.923316	0.140625	Accept Ho
Corrected for ties	2	0.107617	4.45836	Accept Ho

**Table 10: Group detail (feeling of subjective fatigue among control group beginning of the work)**

Group	Count	Sum of ranks	Mean ranks	Z	Median
General	27	1301.00	48.19	1.94361	1
Mental	27	977.00	36.19	-1.3024	0
Physical	27	1043.00	38.63	-0.6412	1

**Table 11: Means and effects section (feeling of subjective fatigue among control group beginning of the work)**

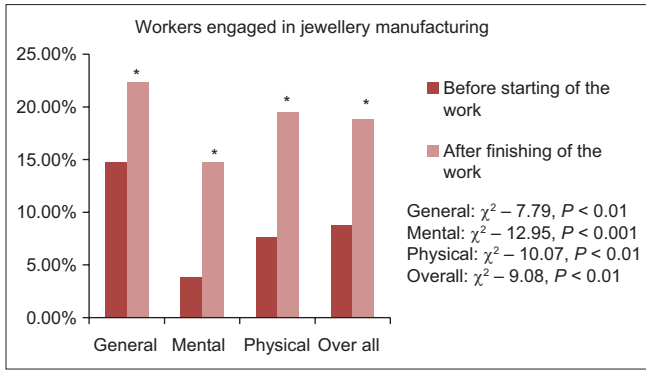
Term	Count	Mean	SE	Effect
All	81	0.9506173	0.9506173	
General	27	1.333333	0.2065543	0.3827161
Mental	27	0.7777778	0.2065543	-0.1728395
Physical	27	0.7407407	0.2065543	-0.2098765

SE: Standard error

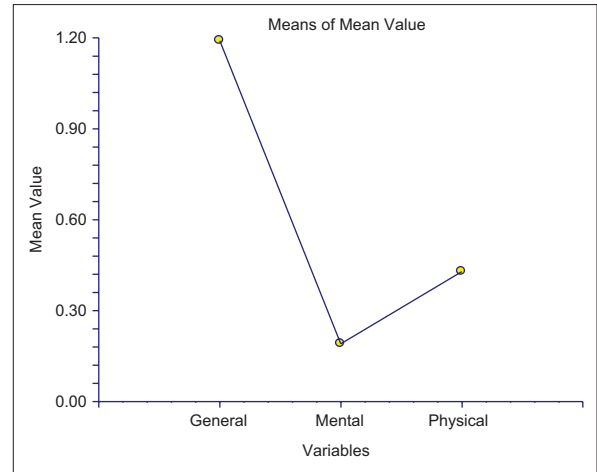
**Table 12: Test results (feeling of subjective fatigue among control group after work)**

Method	df	$\chi^2$	Probability	Level decision (0.05)
Not corrected for ties	2	6.908194	0.031616	Reject ho
Corrected for ties	2	8.330015	0.015530	Reject ho

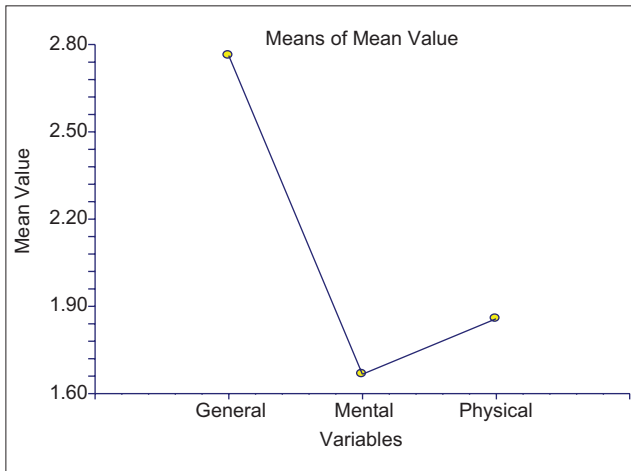
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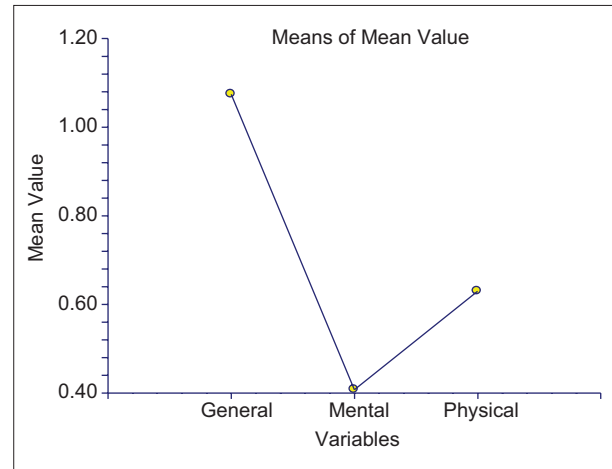
**Figure 2:** Percentage of feeling of subjective fatigue among the workers engaged in jewelry manufacturing



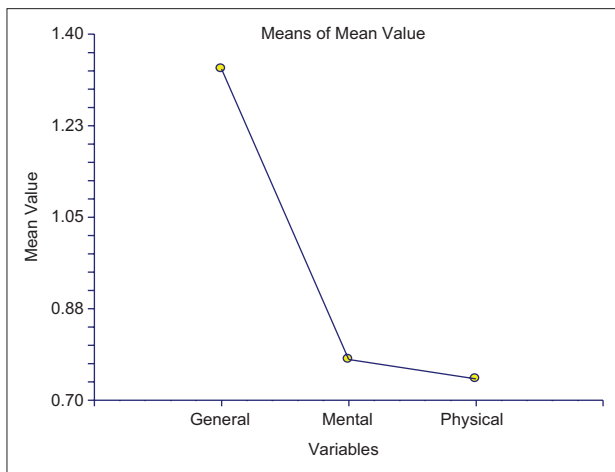
**Figure 3:** Plots of means section (feeling of subjective fatigue among jewelry manufacturing workers beginning of the work)



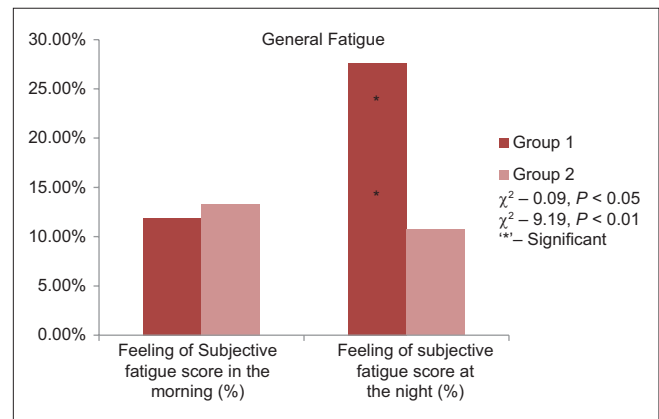
**Figure 4:** Plots of means section (feeling of subjective fatigue among jewelry manufacturing workers after work)



**Figure 5:** Plots of means section (feeling of subjective fatigue among control group beginning of the work)



**Figure 6:** Plots of means section (feeling of subjective fatigue among control group after work)



**Figure 7:** Comparison of general fatigue score between two groups (morning and night)

Kruskal–Wallis one-way ANOVA: The feeling of subjective fatigue score collected after the work among the workers engaged in jewelry manufacturing.

The above result revealed the similar trend as observed before starting of the work. Therefore, it

may be concluded that general nature of fatigue was more as compared to physical and mental nature of fatigue. The data of the control group were also analyzed using

**Table 13: Group detail (feeling of subjective fatigue among control group after work)**

Group	Count	Sum of ranks	Mean ranks	Z	Median
General	27	1328.50	49.20	2.2191	1
Mental	27	874.50	32.39	-2.3293	0
Physical	27	1118.00	41.41	0.1102	1

**Table 14: Means and effects section (feeling of subjective fatigue among control group after work)**

Term	Count	Mean	SE	Effect
All	81	0.7037037	0.7037037	
General	27	1.074074	0.1611136	0.3703704
Mental	27	0.4074074	0.1611136	-0.2962963
Physical	27	0.6296296	0.1611136	-7.407407E-02

SE: Standard error

Kruskal–Wallis one-way ANOVA and presented in Tables 9-11.

Kruskal–Wallis one-way ANOVA: The feeling of subjective fatigue score collected before starting of the work among the control group individuals.

Any specific type of feeling of subjective fatigue (General, Mental, and Physical) could not be established among the control group individuals in the morning.

Kruskal–Wallis one-way ANOVA: The feeling of subjective fatigue score collected after work among the control group individuals.

The above result revealed that at the end of the day the type of feeling of subjective fatigue among the control group individuals were general in nature ( $A > C > B$ ).

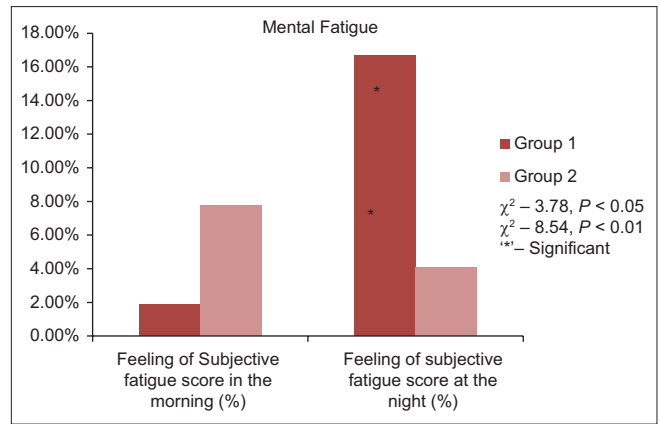
The comparison of feeling of subjective fatigue between both groups.

The results of the comparison are presented in Figures 7-10.

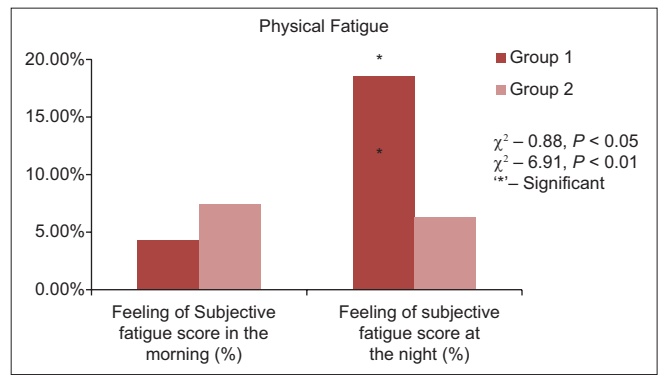
Figure 7 reveals there was no significant differences in feeling of general fatigue score between both groups ( $\chi^2 - 0.09, P > 0.05$ ) before the work exposure. However, feeling of general fatigue was significantly higher ( $\chi^2 - 9.19, P < 0.01$ ) among the workers engaged in jewelry manufacturing than that of control group after the work exposure.

Similar trends were also observed when the mental fatigue (morning and night) ( $\chi^2 - 3.78, P > 0.05$ ;  $\chi^2 - 8.54, P < 0.01$ ) and physical fatigue (morning and night) ( $\chi^2 - 0.88, P > 0.05$ ;  $\chi^2 - 6.91, P < 0.01$ ) were compared between two groups.

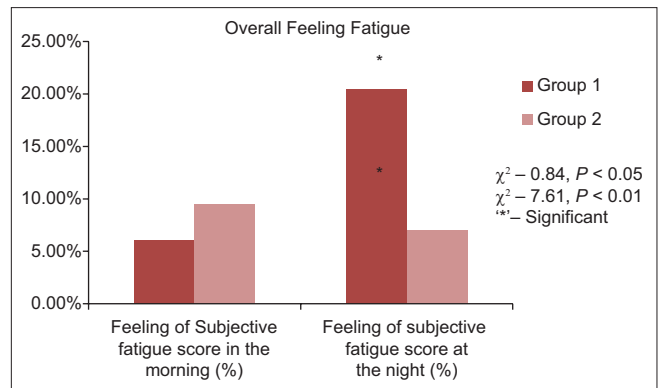
The overall fatigue score were also compared between the two groups (morning and night). It was revealed that the difference was not significant in the morning ( $\chi^2 - 0.84, P > 0.05$ ). Overall subjective fatigue of the workers engaged in jewelry manufacturing was significantly higher than control group ( $\chi^2 - 7.61, P < 0.01$ ) after the work exposure.



**Figure 8: Comparison of mental fatigue score between two groups (morning and night)**



**Figure 9: Comparison of physical fatigue score between two groups (morning and night)**



**Figure 10: Comparison of overall fatigue score between two groups (morning and night)**

**Comparison of the present study result with literature**

The results of feeling of subjective fatigue of the present study (after the work exposure) were compared considering same parameters with different work population available in literature and presented in Table 15.

Table 15 reveals the feeling of subjection fatigue of all the dimensions were significantly higher from responses of Scaffolder, steel fixer, firm worker, electrician, plumber,



**Table 15: Comparison of feeling of subjective fatigue (general, mental, and physical) with different work population**

Occupation	Reference data	OR	CI	Remarks
General fatigue				
Scaffolder	11	3.3321	1.5576-7.1284	Higher*
Steel fixer	5.1	7.6633	2.8481-20.6193	Higher*
Firm worker	5.3	7.3586	2.7746-19.5159	Higher*
Electrician/plumber	3.9	10.1479	3.3765-30.4989	Higher*
Concreter	11.9	3.0489	1.45-6.4108	Higher*
Miscellaneous workers	12.1	2.9917	1.4278-6.2684	Higher*
Mental fatigue				
Scaffolder	4.8	4.3301	1.5157-12.3702	Higher*
Steel fixer	1.7	12.6242	2.5488-62.5285	Higher*
Firm worker	4.8	4.3301	1.5157-12.3702	Higher*
Electrician/plumber	3.2	6.6043	1.9395-22.4889	Higher*
Concreter	5.8	3.5459	1.3282-9.4667	Higher*
Miscellaneous workers	7.1	2.8567	1.1402-7.1574	Higher*
Physical fatigue				
Scaffolder	14.5	2.2557	1.1108-4.5807	Higher*
Steel fixer	5.6	6.4487	2.473-16.8161	Higher*
Firm worker	10.3	3.3315	1.5278-7.2645	Higher*
Electrician/plumber	3.4	10.869	3.3839-34.9106	Higher*
Concreter	11.2	3.0331	1.4179-6.4882	Higher*
Miscellaneous workers	10.6	3.2264	1.4896-6.9883	Higher*

\*Higher - present result (general - 29.17, mental - 17.92, and physical - 27.67) significantly higher. OR: Odds ratio, CI: Confidence interval

concreter, and miscellaneous workers.

## DISCUSSION

Effects of long working hours especially more than 60 h in a week is an important issue for the researchers involved in the ergonomics studies from past few decades. Studies have shown there are associations between the long hours of work, cumulative fatigue, job stresses, and long-term health effects.<sup>[16-20]</sup> Lipscomb *et al.* observed a relationship between hours of work and musculoskeletal disorders.<sup>[21]</sup> Similar relationships were also reported by Dembe *et al.* while studying the impact of overtime and long working hours on occupational injuries and illness in the United States.<sup>[22]</sup> Both the studies had indicated that long hours of work had increased the exposure to psychological and physical demands and may induce fatigue and stress in affected workers. The study of Park *et al.* had shown that mean percentage score of feeling of subjective fatigue “before going to work” increased with the increase in length of weekly working hours and the changes were found to be significant.<sup>[4]</sup> In the present study, it was observed that there were no significant differences in the feeling of subjective fatigue for all dimensions (general, mental, and physical) along with overall score between the

two groups before starting of the workday. However, all the dimensions significantly increased after whole day exposure to the daily activity schedule among the workers engaged in jewelry manufacturing. Literature supports the finding of the present study.<sup>[7,13,15]</sup> The feeling of fatigue is general in nature before starting of the work and at the end of the work. Values for general, mental, physical, and overall are comparable to the values of work exposure to <60 h a week as reported by Park *et al.*<sup>[13]</sup> Even though, the workers working for more than 70 h a week, the overall fatigue level was found to be lower probably due to breaks taken in between. Suggesting mild work breaks may have an impact on the level of fatigue. All the dimensions of feeling of subjective fatigue were significantly higher when those were compared with literature.<sup>[7]</sup>

## CONCLUSION

The major findings of this study can be concluded as follows:

- There is an effect of whole day work on the feeling of subjective fatigue in all three dimensions (general, mental, and physical) among the workers engaged in jewelry manufacturing
- The type of fatigue was reported as “general type” (A > C > B) at the beginning of the work as well as at the end of the work among the workers engaged in jewelry manufacturing.

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Nil.

## Conflicts of interest

There are no conflicts of interest.

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## APPENDIX 1

### Fatigue Questionnaire Developed by Yoshitake, 1978

Name of the Subject:

Date:

Before/After

Group A (General)

1. Feel heavy in the head
2. Feel tired in the whole body
3. Feel tired in the legs
4. Give a yawn
5. Feel the brain hot or muddled
6. Become drowsy
7. Feel strained in the eyes
8. Become rigid or clumsy in motion
9. Feel unsteady while standing
10. Want to lie down

Group B (Mental)

1. Find difficulty in thinking
2. Become weary while talking
3. Become nervous
4. Unable to concentrate attention
5. Unable to have interest in thinking
6. Become apt to forget things
7. Lack of self confidence
8. Anxious about things
9. Unable to straighten up in posture
10. Lack patience

Group C (Physical)

1. Have headache
2. Feel stiff in the shoulder
3. Feel a pain in the waist
4. Feel constrained in breathing
5. Feel thirsty
6. Have a husky voice
7. Have dizziness
8. Have a spasm of the eyelids
9. Have a tremor in the limbs
10. Feel ill