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Critical Fusion Frequency A Simple Non-Invasive Tool to Measure Fatigue in Granite Factory Workers

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Abstract: *Fatigue at work is a normal everyday experience & most common problem which affect different aspects of an individual quality of life. Granite factory workers are more prone to experience physical & mental fatigue due to noise, cutting, vibrations, irregular work timings & lack of sleep. Evidence showed that workers complained of pain & fatigue, which ultimately affects their safety & work performance. Visual Analogue scale (VAS) is frequently used to assess subjective fatigue. CFF (Critical fusion frequency) is an objective test commonly applied to study the effect of fatigue. The present study aims to study the effect of fatigue with CFF which is a non invasive simple physiological technique. Cross sectional observational data was collected from 96 male workers in granite factory in the age group 20-50 years. Subjective symptom of fatigue was obtained by visual analogue scale-fatigue score CFF was measured using in house built LED based CFF M1 Model instrument.*

Continuous variables Descriptive statistics & Pearson's correlation test was done to analyze the quantitative data & P<0.05 was considered statistically significant. Mean CFF among 96 granite workers was 29.83±3.03 Hz which is statistically significant (P<0.01) from one sample t test. VAS-fatigue median is 3.50±2.66. There was weak negative correlation between CFF & VAS-fatigue (r=-0.151,P=0.14).There was weak positive correlation between CFF & duration of years of working in granite factory workers(r=0.109,P=0.29).

CFF can be used as a simple non invasive test to measure fatigue objectively among granite factory workers.

Keywords: *CFF, Fatigue, Granite factory workers.*

I. Introduction

Fatigue at work is a normal everyday experience & most common problem which affect different aspects of an individual quality of life. Fatigue is defined as"The change in the psychological control mechanism that regulates task behavior, resulting from preliminary mental and/or physical efforts which have become bothersome to such an extent that the individual in no longer able to adequately meet the demands that the job requires on his or her mental functioning, or that the individual is able to meet these demands only at the cost of increasing mental effort and the surmounting psychic resistance [1]. AsFatigue increases, it affects occupational, social & basic activities of daily living. Burnout can be defined as feelings of exhaustion, a cynical attitude toward the job and people involved in the job and through a reduced personal accomplishment or work efficiency. In a radical meaning burnout takes away a person's spirit and will[2].

Granite factory workers are more prone to experience physical & mental fatigue due to noise, cutting, vibrations, irregular work timings & lack of sleep. Evidence showed that workers complained of pain & fatigue, which ultimately affects their safety & work performance. In healthy individuals, increased demands or activities can induce fatigue which is also determined by one's subjective feeling about the state of his or her mental resources & also by the demands of activity performed.

Visual Analogue scale (VAS) is frequently used to assess subjective fatigue[3]. CFF (Critical fusion frequency) is an objective test commonly applied to study the effect of fatigue. It is defined as "the frequency to which a stimulus of intermittent light sources to be completely stable to the observer". It assesses the central nervous fatigue by measuring the frequency at which the flicker of a light can be detected visually.

As fatigue is associated with decreased arousal, CFF provides a measure to evaluate fatigue in occupational health. In a study, where, with high usage of machines, eye fatigue has been measured using CFF & has showed decreased CFF value & working quality [4]. As most of the studies have concentrated on subjective methods to assess fatigue, the present study aims to study the effect of fatigue with CFF which is a non invasive simple physiological technique.

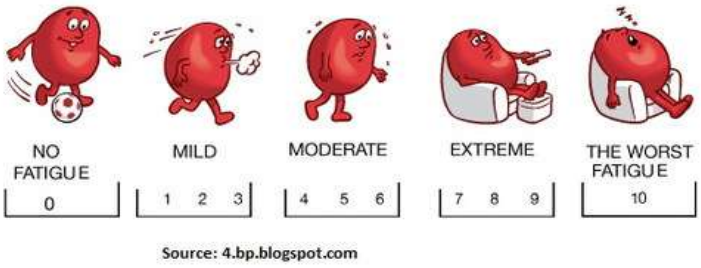
II. Objectives

- To assess fatigue in granite factory workers by VAS-fatigue
- To determine CFF in granite factory workers
- To correlate CFF& duration of years of working in granite factory workers

- To correlate CFF & fatigue obtained by VAS score.

III. Material & methods

A community based Cross sectional observational study was conducted in 96 male granite factory workers in the age group 20-50 years. Sample size was estimated based on the Prevalence of Fatigability at 31.33% from previous studies and a sample of 96 subjects were required to obtain a 95% confidence interval of +10% error. Ethical clearance was obtained from institutional ethical committee and Written Informed consent was obtained from all subjects prior to the study. The subjects were recruited from various granite factories in and around Kolar district. Subjective symptom of fatigue was obtained by visual analogue scale-fatigue score in which each line is 100mm in length where the scores range between 0 and 10.



CFF was measured using in house built LED based CFF M1 Model instrument. CFF M1 model instrument has 2 components. One component has a flickering light source placed in a board of white background (to provide central field stimulation). Light source is presented separately to the individual eye by covering the other eye. A monochromatic light, red light (light emitting diode) with wave length 630nm is used as it is perceived for longer time in the retina. There is no delay period for switching on as the light source is designed so that the on period and off period are kept equal. Second component is a variable frequency square wave oscillator which can give oscillations in the range of 10-60 hertz with an accuracy of 0.5 hertz. To measure CFF, examination room is partially illuminated; subject is made to sit comfortably and presented with a red light source at a distance of 25-30cms. Frequency of oscillations is gradually increased. Subject was instructed to respond when the flickering light source appears as a single fused light and that particular frequency is critical flicker fusion frequency (CFF). The frequency was measured from the recorded data using Sweepgen software. CFF was measured in right and left eye separately and average of two frequencies was considered as final CFF value for that subject. The subjects who are blind, h/o diabetes mellitus, hypertension & cataract were excluded from the study. [3].

SPSS17.0 was used for the statistical analyses. All continuous variables are shown as mean + standard deviation. Descriptive statistics & Pearson's correlation test was done to analyze the quantitative data & $P<0.05$ will consider statistically significant.

IV. Results

Fig- I: Percentage of different occupational groups in granite factory workers.

In this study majority of them was in polishing work i.e. 43.8% followed by cutting i.e. 33.3%.

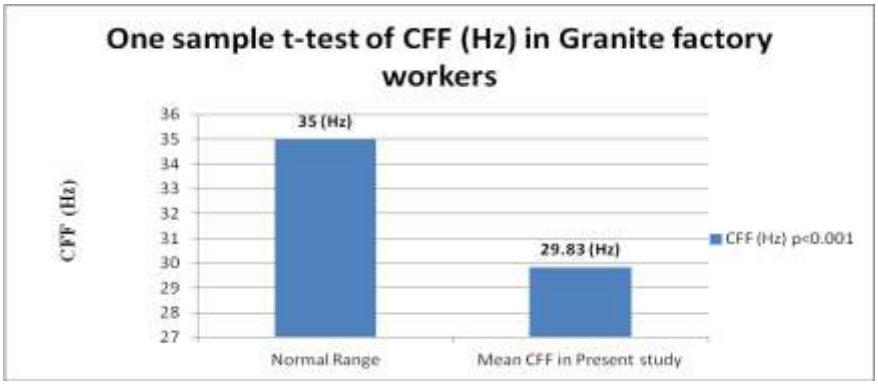


Fig -II: One sample t-test of CFF (Hz) in Granite Factory workers.

Mean CFF among 96 granite workers was 29.83±3.03 Hz which is statistically significant (P<0.01) from one sample t test. There was a negative correlation between CFF (Hz) and VAS-Fatigue score in the granite factory workers (r= -0.151, P= 0.14) which is not statistically significant.

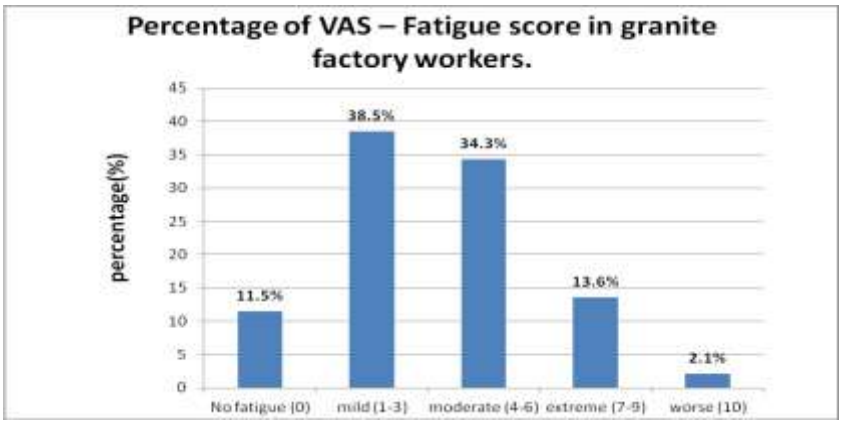


Fig - III: Percentage of VAS – Fatigue score in granite factory workers.

In this study, among granite factory workers, majority of VAS- Fatigue scores was in mild and moderate fatigue.

Table 1: Demographic parameters of granite factory workers

Parameters	**Mean ± SD (n=96)**
Age (years)	32.53± 9.98
BMI(Kg/m^2)	23.80±4.21
Height (m)	1.6±0.6
Weight (Kg)	65.5±10.9
CFF(Hz)	29.83±3.03
VAS-Fatigue	3.50±2.66
Work hours/week	51.19±11.98
No. of hours of sleep	7.51±1.14
Duration of experience(years)	10.29± 7.31
Cups of coffee/day	2.33± 1.87

In the study sample which consisted of 96 male granite factory workers, Table-1 shows the demographic parameters. The mean CFF (Hz) among 96 granite factory workers was 29.83±3.03 Hz, and VAS-Fatigue score was 3.50±2.66.

Table 2: Pearson's correlation between CFF & VAS, duration of years of experience, sleeping time, work hours /week in granite factory workers.

Parameters	**'r' value**	**P value**
VAS-Fatigue	-0.151	0.14
Duration of years of working	0.109	0.290
Work hours/week	-0.086	0.407
Cups of coffee per day	0.075	0.143

V. Discussion

Fatigue is an important phenomenon resulting from various factors and it manifests itself in various forms. It is an important risk factor in granite factory workers. However, data with respect to occupational health in granite factory workers is relatively less in our country. Hence, the present study focused on evaluating the effect of fatigue on factory critical fusion frequency (CFF) in granite workers in Kolar district.

Granite factory workers are more prone to experience physical & mental fatigue due to noise, cutting, vibrations, irregular work timings & lack of sleep and it compromises the work efficiency of the individual.

In the present study, the objective method of assessment of fatigue was CFF, which showed mean value of 29.83$\pm$3.03 Hz, which showed an average decrease of 6Hz in granite factory workers, compared to the normal range of 35-40 Hz [5]. In the present study, the fatigue was also assessed by subjective method i.e. Visual Analogue Scale–Fatigue among granite factory workers which showed mild (38.5%) to moderate (34.3%) fatigue. There was a negative correlation between CFF (Hz) and VAS-Fatigue score in the granite factory workers (r= -0.151, P= 0.14) which is not statistically significant.

However other factors such as years of experience, intake of coffee per day, sleep hours per day, working hours per week may have influenced subjective assessment of fatigue. The years of experience was assessed and showed mean of 10.29$\pm$7.31 years and the workload per week in the present study showed 51.19$\pm$11.98 hrs.

In the present study the number of cups of coffee taken per day is 2.33$\pm$1.87 and showed a weak positive correlation with CFF which is not statistically significant. As literature suggests that with moderate amount of caffeine intake it can increase alertness and reduce fatigue, hence it can be a confounding factor. Thus in our study, though CFF is showing negative correlation with VAS- Fatigue score, due to the effect of caffeine & it is not statistically significant [7].

Furthermore, a study reported that fatigue measured among inspectors in manufacturing factories with high usage of machines comparing to general task of clerk position, CFF value and working quality decreased gradually after the work began in both and clerk and inspector position [6]. One more study showed that the work rest period type significantly does not affect the mental fatigue reduction as measured by CFF.

Nowadays the main topics in the study of fatigue are evaluation of work load and capacity, evaluation of muscular fatigue, subjective symptoms of fatigue, indicators of nervous strain, etc. Thus we have to understand the physiological characters of fatigue to measure or evaluate fatigue. Thus in our study, CFF was used as an objective tool to assess fatigue. As most studies on granite factory workers focus on physical fatigue, caused due to excess workload, mental fatigue can be assessed using CFF.

Thus assessment of fatigue in the workplace has to be assessed, which requires expensive instruments and complicated procedures that are not suitable for work setting fatigue assessment, where a simple, accurate method is needed. Hence, to simplify the assessment of fatigue in the workplace, CFF instrument can be used, which is portable, light weighted and inexpensive and fatigue can be assessed easily during work and workload be adjusted to improve health.

The effects of fatigue have important implications for safe conduct at work: this is reflected by the large body of health and safety-related literature on the subject. The CFF test has been applied extensively in this area, despite the apparent lack of evidence supporting its validity in this respect.

VI. Conclusion

CFF is a simple, affordable test, which is easy to perform. It is thus realistic to apply CFF to study the effect of fatigue in industrial workers for safe conduct at work. The test does not require specialist personnel to conduct and is extremely well tolerated and easily understood by the industrial workers. Thus further studies could be conducted to determine effect of fatigue on CFF and data could be interpreted for the purpose of developing health and safety policy and to have a good understanding of significance of reduced or elevated CFF thresholds. An acknowledgement section may be presented after the conclusion, if desired.

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