Association between Subjective and Objective Assessment of Fatigue

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ABSTRACT

Occupational fatigue is increasingly affecting all workplaces. The assessment of fatigue is important because it is a factor that can lead to injury at work and reduce work performance. At present, there are several instruments used to assess fatigue which can be classified into subjective and objective assessment. However, little is known about the relationships between subjective and objective measures. Therefore, the purpose of this study was to examine the association between subjective and objective assessment of fatigue. Participants were workers who work in an oil and gas company in Thailand. They were asked to complete the Piper Fatigue Scale (PFS) which is a subjective assessment of fatigue that measures four dimensions of fatigue: behavioral/severity; affective meaning; sensory; and cognitive/mood. After completed the PFS, each participant performed the simple reaction time (SRT) and finger tapping (FT) tests which are the objective measures of fatigue using an android application. The total of 227 workers (157 males and 70 females) with a mean age of 36.35 ± 9.84 years participated in this study. The results of PFS showed that 49.8%, 47.1%, and 3.1% of the workers had mild fatigue, moderate fatigue, and severe fatigue, respectively. The mean SRT and FT rates (right and left sides) were 502.27 ± 97.16 milliseconds, 64.28 ± 8.60 (times/10 seconds) (right side), and 59.06 ± 7.71 (times/10 seconds) (left side), respectively. The results also showed that there were no associations between subjective (i.e. PFS) and objective (i.e. SRT and FT tests) measures of fatigue ($p > 0.05$). However, there were moderate, negative relationships between SRT and FT tests ($r_s = -.403$, $p < 0.001$ (right side); $r_s = -.363$, $p < 0.001$ (left side)). In addition, there was a strong, positive relationship between FT (right side) and FT (left side) ($r_s = .623$, $p < 0.001$). This study analyzed the correlations between the subjective and objective measures of fatigue among workers. The findings revealed that there were no relationships between subjective and objective assessments of fatigue. However, there were moderate to strong relationship between the two objective measures of fatigue. Fatigue is related to multidimensional aspects thus, it is not easy to measure. Therefore, in order to assess fatigue both subjective and objective measures should be considered.

Keywords: Association, Fatigue, Subjective assessment, Objective assessment

1. Introduction

Occupational fatigue is increasingly affecting all workplaces. Fatigue is a result of prolonged physical and mental activity which can lead to decreased alertness and performance (Sadeghniai-Haghighi & Yazdi, 2015). Fatigue is a complex phenomenon which can be classified as physical and mental fatigue (Lal & Craig, 2001). A study on fatigue in Thai employees found that 65.4% of them had moderate fatigue. Other studies showed that 36.6% of the working population reported fatigue (Franssen et al., 2003; Nakhareonvaree et al., 2015). Furthermore, a study in the U.S. showed that fatigue costs

more than \$136 billion annually due to decline performance of the workers rather than absences of the workers (Ricci et al., 2007).

The assessment of fatigue is important because fatigue can lead to errors and injury at work and reduced work performance. At present, there are several instruments used to assess fatigue which can be classified into subjective and objective assessments (Shahid et al., 2010). Subjective assessment is a type of qualitative assessment which depends on individual's perception and experience such as Visual Analog Scale (VAS), Multidimensional Assessment of Fatigue (MAF), Piper Fatigue Scale (PFS), and Checklist Individual Strength (CIS) (Sadeghniai-Haghighi & Yazdi, 2015; Shahid et al., 2010). Meanwhile, objective

assessment has been used in a number of studies to measure fatigue (Shahid et al., 2010). For example, Critical Flicker Fusion frequency (CFF) and simple reaction time (SRT) test are widely used to measure fatigue in healthy population, while finger tapping (FT) test is widely used to measure fatigue in patients such as Parkinson's disease (Ajjimaporn et al., 2015; Arias et al., 2012; Langner et al., 2010; Nivetha et al., 2016).

A study by Setyawati et al. (1995) studied the relationship between subjective and objective measurements of fatigue in Indonesian workers. They found that there was no significant correlation between subjective measurement of fatigue using a fatigue questionnaire (KAUPK2) and reaction time test. To date, there are only few studies on the relationships between subjective and objective measures of fatigue. Therefore, the purpose of this study was to examine the association between subjective and objective assessment of fatigue.

2. Method

A cross sectional survey study was conducted among workers in an oil and gas company in Thailand. This study was approved by Mahidol University Institutional Review Board. All participants were asked to sign an informed consent before enrolling in the study. The data collection process is composed of a subjective assessment and two objective assessments. The details are as follows:

2.1 Subjective assessment

Each participant was asked to complete the Piper Fatigue Scale (PFS) Thai version (Nakchareonvaree et al., 2015) which is the subjective assessment that measures four dimensions of fatigue in 22 items: behavioral/severity (5 items); affective meaning (6 items); sensory (6 items); and cognitive/mood (5 items). PFS can classify fatigue into three levels which are mild (1.00 - 3.99); moderate (4.00 - 6.99); and high (7.00 - 10).

2.2 Objective assessment

After complete the PFS, each participant performed two objective assessments of fatigue which are simple reaction

time (SRT) and finger tapping (FT) tests using an android application.

SRT is a response test to a visual stimulus. The participants were instructed to use the index finger of their dominant hand to press the "start" button to start the test. Then, they pressed the "stop" button as fast as possible when the red light appeared on the screen.

FT test is a motor speed test. The participants were instructed to use the index finger to press the "start" button; once the button with the letter "tap here" and green light appears, tap on that button as fast as possible within a 10-second time interval. Each participant performed the FT test 3 trials per session for each hand, starting with the left hand.

Statistical analyses were performed using SPSS version 23. Descriptive statistics (i.e. mean, standard deviation, frequency, and percent) were used to describe participant characteristics and fatigue assessments. Spearman's correlation coefficient was used to examine the association between subjective and objective assessment of fatigue. A *p*-value less than 0.05 was considered statically significant.

3. Results

3.1 Characteristics of participants

The total of 227 workers (157 males and 70 females) participated in this study. The mean age and work experience of the participants were 36.35 ± 9.84 years and 6.10 ± 5.02 years, respectively.

3.2 Subjective assessment

The results showed that mean scores of PFS were 4.14 ± 1.54 . The majority of the participants had mild fatigue (49.8%) and moderate fatigue (47.1%). Only 3.1% of them had high fatigue (Figure 1). The results of this study is in line with a previous study which showed that most industrial workers had moderate fatigue (65.4%) (Nakchareonvaree et al., 2015). Another study also found that the prevalence of fatigue among the U.S. workers was 37.9% (Ricci et al., 2007). However, it should be noted that there are many factors (e.g. instrument used for fatigue measurement, personal and work-related factors) that may affect the prevalence of

fatigue among workers in various studies (Sadeghniiat-Haghighi & Yazdi, 2015; Ahmed et al., 2016).

Figure 1. Fatigue level of all participants based on PFS (N = 227)

3.3 Objective assessment

Mean of SRT was 502.27 ± 97.16 milliseconds while FT rates of right and left side were 64.28 ± 8.60 times/10 seconds and 59.06 ± 7.71 times/10 seconds, respectively.

The average SRT in this study was about the same range with a study by Abraham et al. (2014) which assessed the reaction times in 14 healthy volunteers and reported a mean SRT of 531.4 milliseconds. However, the mean SRT in this study was greater than another study by Völker et al. (2016) which assessed the SRT in 28 employees and reported the SRT ranges from 250-350 milliseconds. The differences of SRT in various studies might be because of using different equipment. Furthermore, the FT rate in this study was in the same range with another study by Christianson and Leathem (2004).

3.4 Association between subjective and objective assessment

As shown in Table 1, there were no associations between subjective (i.e. PFS) and objective (i.e. SRT and FT tests) assessments of fatigue ($p > 0.05$). These findings are similar to a study by Setyawati (1995) which found that there was no correlation between

feelings of fatigue and reaction time test. Several studies (Langner et al., 2010; Setyawati, 1995) suggested that the SRT is not sensitive to mental fatigue assessment. In contrast, other studies showed that subjective fatigue assessment was correlated with SRT (Ferguson et al., 2016; Pierson, 1963).

However, the current study found that there was moderate negative relationships between SRT and FT of right side and FT of left side (Table 1). These findings are similar to a study by Klotz and colleagues (2012) which reported moderate negative correlation between SRT and right and left FT test in patients with attention deficit hyperactivity disorder. In addition, the results in this study found that there was a strong positive relationship between FT of right side and left side (Table 1). Similarly, previous study showed that FT test of nondominant was strong positive correlated with dominant hand (Austin et al., 2011).

Table 1. Spearman's correlation between subjective and objective assessments of fatigue (N = 227)

	PFS	SRT	FT of right side	FT of left side
PFS	1			
SRT	.051	1		
FT of right side	.044	-.403*	1	
FT of left side	.042	-.363*	.623*	1

* $p < 0.001$

4. Conclusion

The findings revealed that there were no relationships between subjective and objective assessments of fatigue. However, there were moderate to strong relationship between the two objective measures of fatigue. Fatigue is related to multidimensional aspects thus it is not easy to measure. Therefore, in order to assess fatigue both subjective and objective measures should be considered.

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