

A Case-Control Study on Association of Perceived Stress Score and Quality of Sleep between Type 2 Diabetes Mellitus Patients and Healthy Adults

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ABSTRACT

Type 2 diabetes mellitus (T2DM), a major worldwide cause of morbidity and mortality is mainly due to lifestyle factors and genetics. Physical and psychological stresses contribute to the development of hyperglycemia in the setting of T2DM. Sleep is essential for life. Glucose metabolism can be affected adversely by poor quantity of sleep. Excessive stress and sleep disturbances are the major barrier to effective glucose control and a danger to diabetic control. Thus, our study focused on the correlation between stress and sleep that are related to the progression of disease in cases and controls. The main objective of the present study is to compare the perceived stress score (PSS) and quality of sleep between T2DM patients attending in Hospital Pekan, Pahang with healthy adults. A case control study was conducted at Diabetes Clinic in Pekan hospital. The Malay validation of Pittsburgh Sleep Quality Index (PSQI) and Perceived Stress Scale (PSS) questionnaire were prepared and contributed to volunteer subjects. Total volunteer participants 208 adults with ages ranged from 30- 70 years both genders were recruited; 104 had T2DM and 104 were healthy subjects. Descriptive analysis was done to compare two parameters by using SPSS version 21. T2DM participants reported a higher PSS (48.93±2.92) with maximum PSS of 56.00 compared to healthy adults (28.51 ± 4.28) with maximum PSS of 41.00. Objectively measured in sleep quality was reflected by PSQI global scores in which T2DM experienced worsen sleep deprivation (7.31±2.02) in contrast with healthy adults (4.40±2.58). Both populations also had significant association of PSQI global and PSS factor scores ($p < 0.05$). The study indicated that T2DM patients have poorer psychological wellbeing contrasting with control. Findings of this research suggested that patients with T2DM have poorer psychological well-being (high PSS) and poorer quality of sleep contrasting with normal healthy persons ($p < 0.005$). Nobel finding of this study were evident in this sample size, these variables warrant further study.

Keywords: Perceived Stress Score, Pittsburgh Quality Index, Type 2 Diabetes Mellitus, Stress, Quality of sleep.

INTRODUCTION

According to National Health and Morbidity Survey (NHMS) conducted by Ministry of Health in 2006, Malaysian adults above 30 years old that have been diagnosed with Type 2 Diabetes Mellitus

(T2DM) rose from 8.3% in 1996 to 14.9% in 2006 [1] and extended to 15.2% (NHMS, 2011) with adults 18 years and above [2]. This figure repeatedly alarming the community as the prevalence of T2DM among Malaysians ≥ 30 years increased to

20.8% (NHMS, 2013) [3]. T2DM is a metabolic disorder characterized by high blood glucose in the context of insulin resistance and relative insulin deficiency [4].

Stress is a condition where our body needs to respond to external changes with adjustment in physical and emotional state and one of the most psycho-social life experiences among people worldwide. The major stress hormones known as cortisol, epinephrine and norepinephrine play a great role behind the wide range of both physical and mental reactions to stress.⁵ The uncontrolled homeostasis of these hormones can lead to the catastrophic phenomenology on metabolic activity. As a result of an imbalanced release of various hormones due to stress, causes the elevation of blood glucose level [6]. In patients with T2DM, the stress-induced cortisol release increases the plasma glucose levels. However, glucose metabolism including utilization is impaired due to impaired insulin level [5, 18].

Multiple studies have recognized sleep disorder as a novel risk factor for diabetes. Sleep disorders play a pivotal role in the occurrence and development of diabetes via the neuro endocrine metabolic pathway. People suffering from sleep disorders may result in insulin sensitivity and consequently, elevated blood glucose, aggravating the progress of diabetes.

On the other hand, sleep disorder can facilitate the hypothalamic pituitary adrenocortical system to release excess glucocorticoid. Thus, the glucose production increases while the consumption decreases. This affects the glycaemic control. Therefore, good sleep quality is crucial for maintaining an effective glycaemic control and improving the quality of life of patients with diabetes.

The Perceived Stress Score (PSS) was developed by Sheldon Cohen and his colleagues and published in 1983. The PSS questionnaire was established to measure the degree to which situations in one's life are appraised as stressful [7]. Higher PSS scores are associated with failure among diabetics to control blood sugar levels, to quit smoking and those with greater vulnerability to stressful-life-event elicited depressive symptoms [8]. It has been used in many studies assessing the effectiveness of stress-reducing interventions and the extent to which there are associations between psychological stress and psychiatric and physical disorders.

MATERIALS AND METHODS

This case-control study was carried out among 208 consecutive subjects with the age range from 30-70 years old. 104 were T2DM patients attending an outpatient clinic (OPD) of Hospital Pekan, Pahang. 104 were controls who were residents of the Pekan district. Sample Size was thoroughly calculated by using PS: Power and Sample Size Calculation Version 3.1.2 (2014) software. The PSS and PSQI, a well-validated questionnaire were used for stress and quality of sleep assessment measurement. In PSS, it is originally composed of 14 items. Respondents were inquired to rate the extent to which they experienced certain thoughts and feelings over the previous month using a five-point scale (1 = 'never' to 5 = 'Always').

Then, all 14 items were summed to derive a total score (range 0–40). The questionnaires were attached along during appointment or follow up in OPD. In PSQI, a total of 19 self-rating items were categorized into seven factors, all subjective, sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, use of sleeping medications,

and daytime dysfunction. Each factor was scored from 0 to 3. The scores for the seven factors yield PSQI global score, which ranges from 0 to 21. It is observed, that the higher the PSQI global score, the poorer the sleep quality.

For healthy subjects, the surveys were distributed using the convenience sampling method. Whereby, the purpose of the study, procedures, and benefits were explained to them thoroughly. The willing participants who have been diagnosed with T2DM and controls were recruited for the study by getting informed written consent. For Type 1 Diabetes Mellitus (T1DM), gestational diabetes, Cushing's syndrome, Addison's disease, terminally ill cases (bed-bound patient) such as cancer, pulmonary disease, liver disease, end stage renal failure and cerebral vascular accident, mental illness or family history of mental illness, and patients with intelligence and cognitive impairment were excluded in this study.

The study was carried out after obtaining approval from Human Research Ethics Committee of International Islamic University Malaysia Kuantan, Pahang (reference number: IREC 2017-031) and Medical Research & Ethics Committee (MREC), Ministry of Health, Malaysia (reference number: NMRR-16-1566-32115).

Statistical analysis was conducted using SPSS version 21.0 software. Frequency, percentage, and mean \pm standard deviation was used for statistical demographic description, 14 items of PSS and total PSS. The Independent Sample t-test is used for testing the statistical significance and a P-value of less than 0.05 is considered as statistically significant.

RESULTS

All of 208 subjects returned the questionnaire from which all fourteen items of PSS and seven components of PSQI were being answered completely. As such 208 respondents were included in this study giving a response rate of 100%. One hundred and four subjects (50%) were T2DM patients and another 104 (50%) were healthy subjects. Regarding the gender of the respondents, 77 (36.3%) subjects were male while 131 (61.8%) were female (Table 1). Table 1 also shows the number of age distribution of the subjects. Majority of the respondents, $n=118$ (56.7%) were around 30- 50 years old, followed by 43.3% ($n=90$) in group of 51- 70 years old.

In addition, the smoking and alcohol profile of the subjects being revealed as well. Overall, 26.4% ($n=55$) and 73.6% ($n=153$) respondents admitted that they were smokers and not a smoker respectively. Meanwhile, only 2.4% ($n=5$) out of 208 subjects confessed that they were taking alcohol while the rest 97.6% ($n=203$) were never taking alcohol.

There were 14 items of PSS were asked in the survey. The highest percentage of response by T2DM patients is "How often have you felt confident about your ability to handle your personal problems?" (74.0%), majority of them answered "Sometimes".

Meanwhile in healthy subjects, statement regarding "How often have you felt nervous and "stressed?" is the most favor item (74.0%) with "Sometimes" were their choice of response.

Table 1: Gender Distribution

Item	T2DM	Healthy	Mean ± SD
Age			
30- 50	18 (10.21%)	100 (46.49%)	1.43 ± 0.50
51- 70	86 (41.57%)	4 (1.73%)	
Gender			
Male	43 (23.96%)	34 (12.34%)	1.63 ± 0.48
Female	61 (24.10%)	70 (37.70%)	
Races			
Malay	100 (48.12%)	103 (49.57%)	1.04 ± 0.26
Chinese	2 (0.93%)	1 (0.47%)	
Indian	2 (1.0%)	0	
Smoking			
Yes	41 (15.58%)	14 (10.82%)	1.74 ± 0.44
No	63 (27.23%)	90 (46.37%)	
Drinking			
Yes	5 (2.40%)	0	1.98 ± 0.15
No	99 (0.98%)	104 (96.62%)	

Perceived stress scoring of diabetes male was 48.81(3.21) and female was 49.02(2.72) whereas that of healthy adult male was (27.85±3.77) and female was (28.83±4.50) (Table-2). PSS of two different genders between T2DM and healthy adults were also compared but no significant differences in gender’s PSS were detected (*0.267). There was no gender differences observed in PSQI scoring as well (Table- 3).

Table 2. Comparison of total PSS Scores between Gender of Both Population

Respondent	Mean (SD)		*p-Value
	Male	Female	
T2DM	48.81(3.21)	49.02(2.72)	* 0.267
Healthy	27.85(3.77)	28.83(4.50)	

*Two Way ANOVA

*p>0.0005

Table 3. Comparison of total PSQI Scores between Gender of Both Population

Respondent	Mean (SD)		**p-Value
	Male	Female	
T2DM	6.34 (2.01)	7.10 (6.72)	*0.232
Healthy	3.21 (1.11)	5.32 (4.50)	

*p>0.005

**Two Way ANOVA

According to the analysis, T2DM’s PSS scoring (48.93 ±2.92) is significantly higher than that of healthy adults (28.51 ±4.28) with p<0.05. (Table -4). PSS score of almost all T2DM (103) were observed very high except only one whereas almost all control (102) were low except two subjects. (Table-5)

Table 4. Comparison of total mean of PSS score in between Healthy and T2DM

Respondent	Mean (SD)	Minimum Value	Maximum Value	**p-Value
Healthy	28.51 (4.28)	16.00	41.00	*p<0.001
T2DM	48.93 (2.92)	36.00	56.00	
Overall	38.72 (10.87)	16.00	56.00	

*p<0.05

**Independent Sample t-Test

Table 5. Comparison of Range of PSS Scores with Both Healthy and T2DM Population

Respondent	Range of PSS Mean (SD) = 38.72 (10.87)		Total
	Low PSS (Minimum=16.00) (16.00<PSS<38.72)	High PSS (Maximum=56.00) (38.72<PSS<56.00)	
Healthy	102	2	104
T2DM	1	103	104
Total	103	105	208

The analysis showed that T2DM's PSQI scoring (7.31 ±2.02) is significantly higher than that of the controls (4.40 ±2.58)) with p<0.05. (Table -6).

Table 6. Comparison of total PSQI Scores for Healthy, T2DM and Overall

Respondent	Mean (SD)	Minimum Value	Maximum Value	**p-Value
Healthy	4.40 (2.58)	0.00	15.00	*p<0.001
T2DM	7.31 (2.02)	3.00	15.00	
Overall	5.86 (2.73)	0.00	15.00	

*p<0.05

**Independent Sample t-Test

Moreover, PSQI factors such as subjective sleep quality, sleep latency, sleep disturbance, use of sleeping medications and day time sleep dysfunction between case and control were statistically different with p<0.05.

Cases did not have quality duration of sleep hour compared to controls but the finding showed that there was not significantly different. (Table -7)

Almost all T2DM higher PSQI scoring but only one third (28/104) of case also had high PSQI. (Table-8)

Table 7. Characteristics of Sleeping from the PSQI for T2DM and Control Subjects

PSQI Factor	T2DM	Healthy	*p-Value
Subjective Sleep Quality	1.54(0.56)	0.56(0.62)	0.000**
Sleep latency	1.25(0.52)	0.89(0.59)	0.000**
Sleep duration	1.15(0.65)	0.94(0.97)	0.067
Sleep efficiency	0.20(0.45)	0.10(0.43)	0.084
Sleep disturbance	1.58(0.55)	1.01(0.57)	0.000**
Use of sleeping medications	0.47(0.56)	0.09(0.28)	0.000**
Daytime dysfunction	1.12(0.67)	0.80(0.87)	0.004**

Note: Values were expressed as mean ± SD (n = 208)

*Independent Sample t-Test

**p<0.05

Table 8. Comparison of Range of PSQI Scores with Both Healthy and T2DM Population

Respondent	Range of PSQI Mean (SD) = 5.86 (2.73)		Total
	Low PSQI (Minimum=0.00) (0.00<PSS<5.86)	High PSQI (Maximum=15.00) (5.86<PSS<15.00)	
Healthy	76	28	104
T2DM	1	103	104
Total	77	131	208

We found that T2DM patients' stress levels were significantly higher than that of controls and quality of sleep is poorer than them. However, this study highlighted that the higher stress was inversely correlated with the quality of sleep regardless of types of participants. (Table-9)

Table 9. The Association between Total PSS and PSQI Global Score on Overall Participants

Respondent	Good Sleep	Poor Sleep	**p-Value (Overall)
Low Stress	76	28	* p<0.005
High Stress	21	83	

DISCUSSION

Diabetes is a chronic and progressive disease that occurs either when the pancreas does not produce enough insulin (a hormone that regulates blood sugar, or glucose) (T1DM), or when the body cannot effectively use the insulin it produces (T2DM) [9]. The role of stress in the aetiology of diabetes is difficult to define and measure, but there is significant

evidence of its metabolic consequences in individuals already suffering from diabetes [4, 19]. This study is aimed to compare the PSS between T2DM patients and healthy subjects. From the data collected (Table VII), it is found that the mean value of overall T2DM patients and healthy subjects' PSS score in the study which has the value of 38.72 ± 10.8 . In general, the analysis of the present study indicates

people with T2DM, perceive more stress than those who are not suffering from diabetes.

In term of T2DM PSS score, the mean value is higher (48.93 ± 2.92) compared to the healthy subjects (28.51 ± 4.28). The comparative mean value between both populations shows T2DM patients were more stressful compared to healthy subjects. Regarding the minimum and maximum value of the PSS score for overall (T2DM patients and healthy subjects), the study shows the minimum value of 16.00 and the maximum value of 56.00. In terms of T2DM patients, the minimum value is 36.00 while the maximum value is 56.00 for healthy subject; the value is 16.00 and 41.00 for minimum and maximum value respectively. This explains that the PSS score for specific individuals among T2DM is higher for both the minimum and maximum value.

Comparing the range of PSS for both healthy and T2DM population, T2DM patients surmount the high PSS group ($n=103$). This proves that they are very stressful while only one T2DM patient in low PSS group. Meanwhile, in healthy subjects, expectedly, the majority of the respondents are not considered to be merely stressful ($n=102$). Only two people in this population experience high perceived stress. It was reported in previous study¹⁰, the level of depression is higher among individual with T2DM (poorer psychological well-being and psychological stress compared with persons without T2DM) which supported the finding of our present study. PSS scores around 38.72 are considered as average. Scores of 39 or higher are considered as high stress, and those in this range need to consider stress reduction techniques. High psychological stress is associated with high blood pressure, higher BMI, larger waist-to-hip ratio,

higher cortisol levels, suppressed immune function, decreased sleep, and increased alcohol consumption [6, 17]. These are all important risk factors for cardiovascular diseases.

According to our finding, the present study revealed that perceived stress was found to be higher among T2DM subjects than among healthy ($p<0.005$). This difference was statistically significant. Similarly, the relationship between psycho-social factors and the glycaemic control of patients with T2DM also done and proved by Takehiro [11] which supported the present study results. Stress influenced glycaemic levels in different ways in diabetics [12]. Stress directly affects the blood glucose level by influencing the neuroendocrine systems [13]. Stressful conditions cause cortisol levels to rise within about 10–15 minute and becomes apparent in saliva approximately 5–10 min subsequently [14]. Impairment in psychological well-being also increases impairment in glycaemic control that leads eventually diabetic complications [15].

Sleep can be influenced by various factors. Sleep disorder is commonly seen nowadays with reported <10% of the general population suffering from at least one form of sleep disorders. When it comes to people with T2DM, the incidence of sleep disorder is even more of a concern. So far, there have been a variety of methods available for sleep evaluation, among which PSQI is the most widely used parameter due to its convenience and accuracy in practice. In this study, the sleep quality of patients with T2DM was evaluated using PSQI, where 8 as the cutting point. The results showed that the incidence rate of sleep disorder in patients with T2DM was higher (7.31 ± 2.02) than healthy subjects. Nevertheless, this value is lower than the reported values in other studies. A potential explanation is that our PSQI cut-off value was higher than that in

other reports, potentially lowering the chance to recognize sleep disorder. Meanwhile, the wide age range of our participants may have affected the results, since age is a known factor that can affect sleep. All of this taken together could have been responsible for the comparatively low incidence rate of sleep disorder among our participants. Moreover, this study highlighted that the higher stress was inversely correlated with the quality of sleep regardless of types of participants whether they have disease. It can be interpreted as the higher the stress level encountered, the poorer quality of sleep. However, the inverse association between stress and poor sleep quality are commonly found in diabetes patients with chronic complications such as neuropathy [12]. (Table-9)

Compared with the general population, diabetic people experience a higher prevalence of sleep disorder further exerting detrimental influence on glycaemic control. Our findings provide basis for verifying the inter-relationship between sleep and glycaemic control. Despite these worrisome findings, the data of this study provided essential information about T2DM patients in Pekan, concerning: perceived stress level, compared with persons without T2DM. The findings also suggest the importance for psychological practice in order to overcome stress. Healthcare practitioners need to pay attention to psychological state of patients with T2DM. This should be ensured that the government and health services of the Malaysia diabetic association to take this into concern and act wisely for the improvement of the psychological issue of persons with diabetes. Through psychosocial interventions, professionals need to assist patients in using varieties of coping skills may be useful in reducing stress and improving both coping skills, control and management of diabetes eventually

assist them to have a better quality of sleep.

CONCLUSION

Findings of this research suggests that patients with T2DM have poorer psychological (high PSS) well-being in comparison with normal healthy persons. Individuals with chronic diabetes are facing more difficulties in maintaining tight glycaemic control in long term duration of disease and its complications. Moreover, sometimes devastating long-term effects on their financial and social wellbeing can affect negatively to their family and interpersonal relationships which leads them to become more stressful. Our study highlighted that prolonged exposure with stress and poor quality of sleep among patients with chronic disease trigger the big issue in mental health problems nowadays. T2DM patients need intensive guidance from the caregiver and the physicians to motivate and prevent diabetes-related distress.

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