Available online www.ijpras.com

International Journal of Pharmaceutical Research & Allied Sciences, 2018, 7(3):108-115

Research Article

ISSN : 2277-3657
CODEN(USA) : IJPRPM

Impact of Sleep on Glycemic Control in Type 2 Diabetic Patients in Prince Mansour Hospital, Taif, KSA

Zafar Hamzah Obaid[1*], Mohammed Deifallah Alzaydi[2], Mubarak Ali Safar[3], Abdulrahman Ghurmullah S Almalki[4], Dhafar Yahia Obaid A[5], Abdulrahman Rafat Shalwala[6], Sarah Obaid Dhafar[7]

[1]Family Medicine Resident, Prince Mansour Military Hospital, Taif, KSA,
[2]Family medicine consultant, postgraduate department for Family Medicine, MOH, Taif, KSA
[3]Family Medicine Consultant, Prince Mansour Military Hospital, Taif, KSA.
[4]Lecturer, Family Physician, Family and Community Medicine Department, College of Medicine, Taif University, KSA
[5]Family medicine resident, Prince Mansour Military Hospital, Taif, KSA.
[6]MBBS Student, King Abdulaziz University (KAU), Jeddah, KSA
[7]MBBS Student, Taif university, KSA
Email: hod1911@hotmail.com

ABSTRACT

While increasing the prevalence of diabetes mellitus and its complications, with its negative effect on personal and public health, the intensive glycemic control becomes more desirable. Sleep disturbance could be one of causes that impair glycemic control. A cross sectional study aimed to measure the prevalence of sleep disturbance and its impact on glycemic control among type 2 diabetic patients attending the diabetic center in Prince Mansour Military Hospital in Taif was done. The target populations composed of 360 patients diagnosed with type 2 diabetes mellitus. An Arabic version of the Pittsburgh sleep quality index (PSQI), a valid and reliable self-administered questionnaire was distributed to the participants to evaluate their quality of sleep. This study highlighted the incidence of poor sleeping quality among patient s with uncontrolled DM with a statistical significant correlation between sleeping quality and presence of DM complication and BMI.

Key words: *Sleep Duration, Sleep Quality, Glycemic Control, Diabetes Mellitus.*

INTRODUCTION

Diabetes mellitus (DM) is one of the most growing diseases worldwide. Globally in 2013, it is estimated that about 382 million people suffer from diabetes with a prevalence of 8.3%. Saudi Arabia is one of the top 10 countries worldwide with highest prevalence of DM that is estimated by 23.9%. The direct national health care burden because of diabetes is likely to exceed $0.87 billion in Saudi Arabia [1].

Sleep is a fundamental biological process that has been associated with physiological, psychological and neurological systems' wellbeing [2]. Generally, most of healthy adults need seven to nine hours of sleep per night [3].

Insufficient sleep is one of the most common problems encountered by general physician [4]. Repeated difficulty with sleep initiation, maintenance, consolidation, or quality despite adequate opportunity and time for sleep and that leads to some form of daytime impairment is defined by insomnia [5]. Insomnia has a bad effect on the quality of life and the efficiency of work [4].

Many epidemiological and experimental studies mentioned that sleep disturbance, poor sleep quality and quantity are related to increasing the risk of systemic chronic diseases such as hypertension, obesity, depression, cardiovascular diseases and insulin resistance [4, 6].

In diabetic patients, sleep disorders may lead to poor glycemic control, nocturnal hypoglycemia and diabetic neuropathy. Some studies have shown that there is association between diabetes mellitus and sleep and illustrated that diabetes can cause sleep disturbance, while sleep disturbance may make the control of diabetes more complicated [7].

Recently, sleep disturbance become a potential risk factor for diabetic patients [8] and about 50%-70% of diabetic patients have sleep disorders [7]. While increasing the prevalence of diabetes mellitus and its complications, with its negative effect on personal and public health, the intensive glycemic control becomes more desirable by identifying the potential risks that magnify the problem. Sleep disturbance could be one of them [4].

Aim of this study was carried out to improve the quality of life among diabetic patients in our area by evaluating sleep disturbance as a potential risk for poor glycemic control.

MATERIALS AND METHODS

This study was conducted in 2018 in diabetic center in Prince Mansour Military Hospital in Taif city.

Study Design :

This is a cross sectional study.

Study Population and Selection Criteria

The target populations are those diagnosed with type 2 diabetes mellitus that are attending the diabetic center in Prince Mansour Military hospital in Taif and accepted the request to participate in this study.

Inclusion Criteria :

Patients with type 2 diabetes mellitus
Both genders.
Age above 18 years
All nationalities
Arabic speakers

Exclusion Criteria :

Younger than 18 years old.
Non-Arabic speakers.
Type 1 or gestational diabetics.
Patients with connective tissue disorders (e.g. rheumatoid arthritis)
Patients with psychiatric problems.
Patients taking hypnotic or alerting medications.

Sample Size :

Based on the statistics of the patients' affairs in Prince Mansour Hospital in Taif, the researcher found that the average number of daily attendees in male and female clinics of an adult diabetic clinic at diabetic center is (100) attendees / day. Multiplying this average by the number of working days during the period of study (one month); the estimated population of the study found to be 2200 subjects.

Using EPI info version 7, sample size of population is determined as follows : with expected frequency of participants' awareness equal 50%. Worst acceptable result equal 5% with 95% confidence interval ; it's believed that a sample size of about 360 participants (327 plus 10% increase in the number to compensate for drop rate) is adequate to achieve degree of precision in estimating the true prevalence across the population.

Sampling Method :

Systematic random sampling technique was adopted to select the study population from the hospital. An average of 100 diabetics patients attended to an adult diabetic clinics at diabetic center during working days were reported daily (25/clinic/day). One clinic was selected randomly every shift (one morning and one afternoon). Every 2nd patient was selected, to select 12 patients daily. Accordingly, approximately one month was needed to collect data. In case of illegible patients, the next ones were selected till the required number reached every working day. During the study period, the researcher invited the selected clinics attendees to participate in the study while they are in the clinics. For those who accepted to participate in the study, a self-administered Arabic questionnaire was distributed. Any question or clarification was clarified by the researcher.

Data Collection Tool and Technique :

Information about socio-demographic characteristics including age, sex, marital status, education level, occupation, height, weight, Body Mass Index (BMI) and smoking habits have been taken from the participants as well as the complications of diabetes mellitus with a cover letter explaining the purpose of the study without mentioning names to ensure confidentiality.

An Arabic version of the Pittsburgh sleep quality index (PSQI), a valid and reliable self-administered questionnaire was distributed to the participants to evaluate their quality of sleep.

The PSQI is a score conducted by a self-rated questionnaire containing 9 questions that establish a wide variety of factors related to sleep quality in the last month. These included estimates of sleep latency and duration as well as severity and frequency of specific sleep-related problems. The nine questions were grouped into seven component scores, each weighted equally on a 0–3 scale. The seven components will be gathered to give a global PSQI score (range : 0–21); higher scores indicate worse sleep quality. The seven components of the PSQI are : (1) subjective sleep quality, (2) sleep latency, (3) sleep duration, (4) sleep efficiency, (5) sleep disturbances, (6) use of sleeping medications and (7) daytime dysfunction. Scores equal or less than five are categorized as good sleep quality and score of more than five is categorized as poor sleep quality [4, 9].

The levels of HbA1C were taken from the medical charts of the participants as an indicator of the glycemic control for the past two to three months. The level of HbA1c < 7% was considered as good glycemic control while a level of HbA1c ≥ 7% was considered as poor glycemic based on the American Diabetes Association 2017 Guidelines [10].

Questionnaire Validity

The PSQI has internal consistency and a reliability coefficient (Cronbach's alpha) of 0.83 for its 7 components. The PSQI was used internationally in a wide variety of studies that have supported its high validity and reliability. The Arabic PSQI demonstrated good convergent validity and preliminary reliability evidence [11, 12].

Pilot Study :

A pilot study was carried out on (36) attendees of the diabetic center in Prince Mansour Hospital in Taif that met the inclusion criteria. The purpose is to examine the clarity of the questionnaire, to estimate the time needed to complete it as well as to give an actual situation of the main study.

Data Entry and Analysis :

Collected data was coded, verified and analyzed with a help of a biostatistician using Statistical Package for the Social Sciences (SPSS) program version 20 developed by International Business Machines (IBM®) corporation. Descriptive statistics, e.g., number, proportions, cumulative proportions, mean and standard deviation, etc. were displayed, as appropriate.

Analytically, parametric and non-parametric techniques were used as required. In order to control for the effect of confounding, multivariate logistic regression was adopted. All results of tests with p-values less than <0.05 was considered "statistically significant."

Ethical Considerations :

The Regional Research and Ethics committee in Armed Hospitals in Taif was approved the study protocol. Written consent was obtained from the administration of the Prince Mansour Military Hospital before starting the study.

Also, a verbal consent was taken from each participant to voluntary participate in the study and the data was treated confidentially and used only for the purpose of research.

RESULTS

Distribution according to sociodemographic characteristics :

Regarding age, the results showed that more than half of patients (54.2%) were over than 60 years of age. Concerning gender, approximately two thirds of patients (71.9%) were female. Regarding marital status, two thirds of patients (77.3%) were married. As regard education, three fifth of patients (60%) were illiterate, while one quarter of patients (24.7%) were less than secondary education. Regarding occupation, the highest proportion of patients (70.3%) were not work and one fifth (21.9%) were retired. the majority of patients (89.7%) were non-smokers, more than half of patients (60.3%) were diagnosed by diabetes mellitus for more than 10 years ago.

Distribution according to DM complications :

It was notices that among the studied patients, certain DM complications were found as retinopathy (37.7%), neuropathy (31.1%) followed by nephropathy (13.06%) and PAD (12.5%).

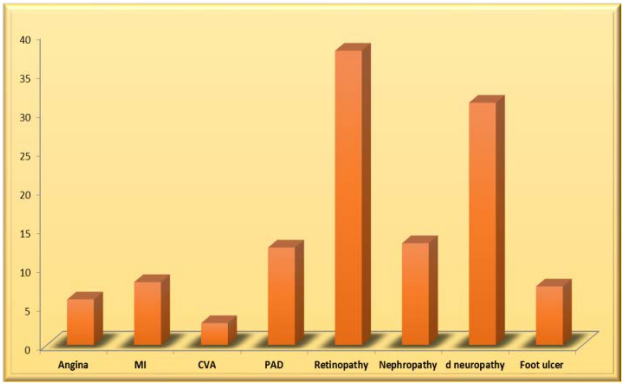

Figure 1 : DM complications

Distribution according to BMI :

Concerning body mass index, it was observed that one thirds of patients (31.9%, 30.6%) were overweight and obesity I respectively. Approximately less than one fifth (18.1%) of patients were obesity II and (11.4%) were have morbid obesity.

Table 1 : frequency distribution according to HbA1C :

HbA1C		
	N	%
Controlled group	60	16.7
Uncontrolled group	300	83.3
Total	360	100.0
Range	5.30-15.80	
Mean±SD	9.037±2.19	

According to HbA1C, the majority of patients were having uncontrolled DM.

Table 2 : frequency distribution according to Pittsburgh sleep quality index :

	N	%
Last month when did you usually go to bed ?		
8-10pm	16	4.4
10-12pm	140	38.9
12-2am	149	41.4
2-5am	45	12.5
After 5am	10	2.8
Last month when did you get up from bed in the morning ?		
2-5am	84	23.3
6-7am	81	22.5
7-10am	83	23.1
10am-12pm	40	11.1
After 12pm	72	20.0
During the last month, how many minutes did you spend until you slept every night ?		
<5min.	223	61.9
16-30min.	74	20.6
31-60min.	44	12.2
>60min.	19	5.3
Sleep duration		
<5	32	8.9
5-6h	48	13.3
6-7h.	54	15.0
>7h.	226	62.8

This table clarified that less than half of patients (41.4%) go to bed at (12-2) am during the last month, while more than one third of patients (38.9%) go to bed at (10-12) pm. Regarding the time that the patients get up from bed in the morning during the last month, this table shows that more than one fifth of patients (23.3%, 23.1%, 22.5%) get up from bed at (2-5 am, 7-10 am, 6-7 am) respectively.
During the last month, less than two thirds of patients (61.9%) spent less than 5 minutes to sleep every night, and (62.8%) of patients sleep more than seven hours per day.

Table 3 : frequency distribution according to overall sleep quality :

Sleep quality		
	N	%
Very good	186	51.7
Fairly good	133	36.9
Fairly bad	33	9.2
Very bad	8	2.2
Total	360	100.0

According to overall sleep quality, more than half of patients (51.7%) were have very good sleeping followed by (36.9%) of patients were fairly good.

Table 4 : frequency distribution according to total Pittsburgh sleep quality index score :

PSQI		
	N	%
Good sleep quality	173	48.1
Bad sleep quality	187	51.9
Range	0-15	
Mean±SD	4.930±2.911	

According to Pittsburgh sleep quality index score, more than half of patients (51.9%) had a poor sleep quality.
The results shows a statistical significant correlation between sleep quality and patient gender (p= 0.001), marital status (p= 0.001), education (0.003), and occupation (p=0.002). The results concluded that female, married, illiterates, not working, overweighed, and newly diagnosed with type II DM had bad PSQI.
In addition, it reveals that there is a statistical significant correlation between PSOI score and presence of diabetic nephropathy (p= 0.02) and neuropathy (0.001). The highest proportion of patients with nephropathy and neuropathy shows good sleep quality (17.3%, 40.5%) respectively.

DISCUSSION

Sleep is a basic biologic function and is essential for life. It is an active state that is critical for our physical, mental and emotional well-being. Defects in sleep quality and quantity can result in metabolic errors and cardiovascular dysfunction. Sleep is an emotional issue and all diseases particularly chronic diseases like diabetes invites emotional reactions which can also affect sleep adversely [13].
There is a close relation between sleep, circadian rhythm, obesity, insulin resistance, hypertension and cardiovascular disorders which needs to be dissected and managed. There is evidence to show sleep disorders are potential risk factors for insulin resistance, glucose intolerance, type 2 diabetes mellitus and metabolic syndrome. In addition, difficulty maintaining sleep, short and long sleep duration was consider a novel risk factors for developing type 2 diabetes in men and women from the general population [14, 15].
Regarding age, more than half of patients included in the study were more than 60 years of age. This result is in accordance with Gozashti et al., [16] who confirmed that diabetes mellitus is associated with aging. While this result was in opposite with study finding in which the majority of patients were less 60 years of age [17].
The highest proportion of patients was females, illiterate and obese. This result is constant with [18, 19] who reported that the prevalence of type 2 diabetes continues to increase and affects an estimated 92.4 million people in China. It has become a major public health problem in the country. Ageing, being female, obesity and an unhealthy

lifestyle are generally considered to be risk factors for diabetes. They also found that half of patients included in the study were illiterate.

Socioeconomic status indicators, including education, occupation and marital status are associated with diabetes mellitus risk factors. In the present study, 60% of patient was illiterate, 70% of patients don't work and the majority of patients were overweight. This result may ascertain that no work is associated with inadequate physical activity and illiteracy may associate with unhealthy life style. These results were also demonstrated and confirmed in Kodakandla K, et al., [20] study.

Martins et al. and Corrêa et al. [21, 22] pointed out that obesity should be addressed as both a disease and a lifestyle issue. A majority of individuals suffering from type 2 diabetes are obese, with central visceral adiposity, and an imbalance in energy intake and expenditure that leads to numerous metabolic abnormalities. The majority of patients included in the study were nonsmokers. This may be due to the highest proportion of females included. In the current study, more than half of diabetic patients have a poor sleeping quality based on Pittsburgh sleep quality index score and the majority of patients have uncontrolled HbA1C. This is in agreement with Suraniet al. [23] who reported that DM has a numerous clinical implication, DM also exerts a negative effect on patient's sleep quality. Impaired sleep quality disrupts the adequate glycemic control regarded as corner stone in DM management and also lead to many deleterious effects causing a profound impact on health related quality of life. On the other hand, this result may be far away from results of Gozashti et al. [16] who found that sleep quality is not related with HbA1c.

The present study finding reveals a statistical correlation between sleep pattern and presence of diabetes mellitus complication. The researcher found that presence of neuropathy ; nephropathy and retinopathy negatively affect the sleep quality. This is consistent with Kodakandla et al. [20] who concluded that the prevalence of poor sleep quality is very high in diabetic patients and is strongly associated with diabetic neuropathy. Poor sleep quality is associated with poor glycemic control.

The study results show no association between glycemic control represented through HbA1C and sleep pattern, quality and duration. This is not in the same line with Barone et al. and Li et al. [24, 25]. who reported that associations between sleep impairment and glucose control in individuals with diabetes have been unveiled. In addition, sleep disorders and curtailment were shown to deteriorate glycemic control, while glycemic extremes impacts sleep quality and melatonin secretion, forming a vicious circle.

Regarding the relationship was between sleep quality and duration of DM diagnosis. It was observed that there was a statistical correlation between sleep quality and duration of DM diagnosis represented through poor sleep quality in patients with less than ten years duration of DM diagnosis. This is in harmonious with Kawakami et al. [15] who stated that sleep disturbance is often observed among patients with diabetes possibly caused by impaired glucose metabolism or physical and psychological discomfort due to the disorder. In addition, a recent prospective study of women has indicated an interesting association between sleep patterns and later onset type 2 diabetes, with a greater incidence among both short-term (6 h) and long-term (8 h) sleepers. Disturbance in sleep quality may also affect the later onset of overt diagnosis of type 2 diabetes.

The study finding reveals a statistical correlation between sleep quality and patient's gender, marital status, occupation, body mass index. It shows poor sleeping pattern and quality founded in female, married, not occupied and obeses patients. This in line with Kodakandla et al. [20] who found that sleep pattern (PSQI global score ≥5) was poor in 64% of the study subjects. The odds of poor glycemic control were 3.56 times higher in people with poor sleep quality, compared to people with good sleep quality and conclude that The prevalence of poor sleep quality is very high in diabetic patients and is strongly associated with diabetic neuropathy. Poor sleep quality is associated with poor glycemic control. While the study results was in opposite with Fukuda et al. [26] who found multivariate logistic regression analysis showed higher risk of poor sleep with increasing age, male gender.

Moreover, Ghanbari [19] found that the mean quality of life including sleep quality among diabetic patients is higher in men than in women. In addition, [26] stated that type 2 diabetes mellitus patients with visceral fat accumulation had significantly later bedtime and shorter estimated sleep duration compared with those without.

CONCLUSION :

The results showed that the large proportion of patients were more than 60 years of age, female, married, don't work, illiterates, non-smokers, newly diagnosed, overweight with uncontrolled DM. The results suggest that sleep of poor quality assessed through Pittsburgh sleep quality index score is associated with presence of uncontrolled diabetes that assessed through HbA1C. It's also explained through the statistical significant correlation between poor sleep

quality and female sex as a high risk group for DM, newly diagnosed patients with DM, presence of diabetic complications as neuropathy, nephropathy and retinopathy. A statistical significant correlation was also found between obesity assessed through body mass index and poor sleep quality and duration. Considering that, health care professionals should be encouraged to pay attention to sleep patterns and complaints of patients, in order to identify and address hidden poor glycemic control, and, this way, help to improve this population's sleep and life quality

RECOMMENDATIONS :

- Study the other aspects that affect the diabetic patients' quality of life.
- Involving sleep assessment as a tool for predicting diabetic patients glycemic control.
- Study the effect of sleep disturbance in the development and prevention of type 2 diabetes.
- Study the effect of napping and segmented sleep on glycemic control among diabetic patients
- Utilization of sleep hygiene program for patients that can improve theirsleep quality as well as their glycemic control and reflected positively ontheir general health and wellbeing.
- Development of educational module of “sleep hygieneprogram” that must be explained for all T2DM patients and how they can utilize it.
- In-service education program and continuing educational sessions should beconducted for health care givers about importance of sleep, sleep physiology, sleepdisturbances and its negative impact on general health as well as wellbeing. Inaddition to, how they can management of raised sleep problems and its preventivemeasures.
- Further research is recommended as involving large samples, forbeing generalization.

ACKNOWLEDGEMENT

To my parents who are the source of compassion and care. To my wife and son for their continuous support and motivation. I would like to thank the following doctors for thier great participation in data collection : Reema Aloufi, Amal Alsofyany, Raneem Alsayali, Tahani Bukhari, Futon Almafrji, Hanaa Alrbeeai, Munirah Alsahel and Sarah Al-Zahrani. Finally, I would like to thank all the responsible persons in Prince Mansour Military hospital in Taif and all those participated in the study

REFERENCES

1. Naeem Z. Burden of Diabetes Mellitus in Saudi Arabia. International Journal of Health Sciences. 2015 ;9(3) : V-VI.
2. Al-Tannir M, Kobrosly SY, Al-Badr AH, Salloum NA, Altannir YM. Characterizing sleeping habits and disturbances among Saudi adults. Saudimedical journal. 2016 ;37(12) :1372-80.
3. sleepfoundation.org arlington, virginia [updated 2017 ; cited 2017 Feb 26]. Available from: https://sleepfoundation.org/sleep-news/25-random-facts-about-sleep.
4. Tsai YW, Kann NH, Tung TH, Chao YJ, Lin CJ, Chang KC ,et al. Impact of subjective sleep quality on glycemic control in type 2 diabetes mellitus. Family practice. 2012 ; 29(1) :30-5.
5. medscape.com New York [updated 2016 ; cited 2017 Feb 19]. Available from: http://emedicine.medscape.com/article/1187829-overview.
6. Li Y, Gao X, Winkelman JW, Cespedes EM, Jackson CL, Walters AS, et al. Association between sleeping difficulty and type 2 diabetes in women. Diabetologia. 2016 ;59(4) :719-27.
7. Keskin A, Unalacak M, Bilge U, Yildiz P, Guler S, Selcuk EB, et al. Effects of Sleep Disorders on Hemoglobin A1c Levels in Type 2 Diabetic Patients. Chinese medical journal. 2015 ; 128(24) :3292-7.
8. Jaser SS, Ellis D. Sleep in Adolescents and Young Adults with Type 1 Diabetes : Associations with Diabetes Management and Glycemic Control. Health psychology and behavioral medicine. 2016 ;4(1) :49-55.
9. Gozashti MHM, Eslami NM, Radfar MHM, Pakmanesh HM. Sleep Pattern, Duration and Quality in Relation with Glycemic Control in People with Type 2 Diabetes Mellitus. Iranian journal of medical sciences. 2016 ;41(6) :531-8.

10. diabetes.org USA [updated 2017 ; cited 2017 Feb 19]. Available from: http://care.diabetesjournals.org/content/40/Supplement_1/S48
11. Suleiman KH, Yates BC, Berger AM, Pozehl B, Meza J. Translating the Pittsburgh Sleep Quality Index into Arabic. Western journal of nursing research. 2010 ;32(2) :250-68.
12. Buysse D, Reynolds Cr, Monk T, Berman S, Kupfer D. The Pittsburgh Sleep Quality Index : a new instrument for psychiatric practice and research. Psychiatry Res. 1989 ;28(2) :193-213
13. Iyer S. Sleep and Type 2 Diabetes Mellitus- Clinical Implications. JAPI • October 2012 • VOL. 60.
14. Meisinger C, Heier M, Loewel H. Sleep disturbance as a predictor of type 2 diabetes mellitus in men and women from the general population. Diabetologia (2005) 48 : 235–241.
15. Kawakami N, Takatsuka N, Shimizu H. Sleep Disturbance and Onset of Type 2 Diabetes. Diabetes Care, 27(1) : January 2004
16. Gozashti MH, Eslami N, Radfar MH, Pakmanesh M. Sleep Pattern, Duration and Quality in Relation with Glycemic Control in People with Type 2 Diabetes Mellitus. Iran J Med Sci November 2016 ; Vol 41 No 6.
17. Akel RR. Effect Of Applying A Sleep Hygiene Program On Glycemic Control Among Type Two Diabetic Patients. Phd thesis. Faculty of nursing. Alexandria university. 2015
18. Lou P, Chen P, Zhang L, et al. Relation of sleep quality and sleep duration to type 2 diabetes : a population-based cross-sectional survey. BMJ Open 2012 ;2.
19. Ghanbari A, Yekta ZB, Roushan ZA, Lakeh NM. Assessment of Factors Affecting Quality of Life in Diabetic Patients in Iran. Public Health Nursing, 2005 ; Vol. 22 No. 4, pp. 311—322
20. Kodakandla K, Maddela G, Pasha MS. Factors influencing sleep quality and its impact on glycemic control in patients with type II diabetes mellitus - A hospital based cross sectional study. IAIM, 2016 ; 3(5) : 138-145.
21. Martins RC, Andersen ML, Tufik S. The reciprocal interaction between sleep and type 2 diabetes mellitus : facts and perspectives. Braz J Med Biol Res 41(3) 2008
22. Corrêa K, Gouvêa JR, Viera da Silva MA, Possobon R, Barbosa L, Pereira AC, Miranda LG, Cortellazzi KL. Quality of life and characteristics of diabetic patients. Ciência & Saúde Coletiva, 22(3) :921-930, 2017.
23. Surani S, Brito V, Surani A, Ghamande S. Effect of diabetes mellitus on sleep quality. World J Diabetes 2015 ; 6(6) : 868-873
24. Barone M, Ayumi-Sato A, Mitsuuchi E, Wey D, Schorr F, Franco D, Carra M, Lorenzi-Filho G, Giampaoli V, Menna-Barreto L. Type 1 diabetes mellitus and its glycemic control affect sleep. Diabetology & Metabolic Syndrome 2015, 7.
25. Li Y, Gao X, Winkelman J, Cespedes E, Jackson C, Walters8 A, Schernhammer E, Redline S, Hu F. Association between sleeping difficulty and type 2 diabetes in women. Diabetologia, 2015.
26. Fukuda S, Hirata A, Nishizawa H, Nagao H, Kimura T, Fujishima Y, Yamaoka M, Kozawa J, Imagawa A, Funahashi T, Maeda N, Shimomura L. Characteristics of sleep–wake cycle and sleep duration in Japanese type 2 diabetes patients with visceral fat accumulation. J Diabetes Investig 2018 ; 9 : 63–68.