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Physiology

ASSESSMENT OF SLEEP QUALITY IN ADULTS WITH METABOLIC SYNDROME

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ABSTRACT **INTRODUCTION:** Metabolic syndrome is a major public health problem in India .It is evident that there is a direct association between sleep status and metabolic syndrome. **OBJECTIVES:** To assess sleep quality by Pittsburgh sleep quality index (PSQI) in metabolic syndrome patients and to explore an association between sleep quality and metabolic syndrome. **METHODS:** It is a Cross sectional study. This study includes 140 subjects of both gender aged 30yrs and above without acute and severe illness who satisfy metabolic syndrome criteria. Sleep Quality was assessed by PSQI which includes subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleep medication and daytime dysfunction. Score of 5 or more indicates poor sleep quality. Metabolic syndrome was defined according to the modified diagnostic criteria of National Cholesterol Education Program Adult treatment panel- III (NCE-ATP III). The following risk factors were assessed for metabolic syndrome. Abdominal obesity, fasting blood glucose, Blood pressure measurement, fasting HDLc, and Triglycerides. **RESULTS:** On comparison of metabolic syndrome components between good sleepers and poor sleepers the prevalence of abdominal obesity, elevated glucose and low HDLc were greater in poor sleepers. Waist circumference (91.65±9.4) was significantly higher in poor sleep quality group with p value of 0.04. The mean sleep duration was 5.9±1.1. The percentage of subjects sleeping less than 7hrs was 72% and greater than 7hrs was only 10%. The mean global score was 9.17±2.5 in males and 10.02±2.4 in females and was significantly higher in females with a p value of 0.04. On analysis of median value of each of seven components of PSQI we found that sleep latency and sleep disturbance score was 3 and 2 respectively. **CONCLUSION:** Overall Global score was not related significantly to metabolic syndrome. However subjects with metabolic syndrome had poor sleep quality, prolonged sleep latency and sleep disturbances.

KEYWORDS : Pittsburgh sleep quality index, metabolic syndrome, sleep quality, sleep duration

INTRODUCTION:

According to global burden of disease study 62.7% of total mortality in 2016 was contributed by non-communicable diseases [1]. Various risk factors that contribute to Non- communicable diseases were found to be associated with metabolic syndrome. Metabolic syndrome is a major public health problem in India and its prevalence in adults is about 30%. 1 in among 5 young adults are prone to develop metabolic syndrome depending on their lifestyles [2]. Metabolic syndrome is defined by coexistence of several factors that include Abdominal obesity, Hypertension , High fasting serum Triglycerides & glucose and low HDLc[3]. Insulin resistance and hyperinsulinemia are the major underlying causes for metabolic syndrome [4]. Metabolic syndrome is responsible for approximately 7% of deaths worldwide as it increases the risk of cardiovascular diseases by 2 fold and type 2 Diabetes by 5 fold placing a significant burden on patients and also on health care system [2, 4]. Also Patients with metabolic syndrome have four fold increased risk of developing stroke and myocardial infarction. So, it is necessary to identify modifiable risk factors and develop screening protocols to decline morbidity and mortality caused by metabolic syndrome.

Sleep is one of the fundamental need of life. It plays an important role as a modulator of metabolic homeostasis that in turn regulate physiological, hormonal and psychological processes [5]. Sleep deficiency has become common in modern society which in turn interrupt the homeostatic mechanisms. Imbalance or defect in sleep contribute to adverse health outcomes including hypertension, diabetes, depression and mortality [6]. There is also evidence in literature that imbalance in sleep wakefulness cycle act as a risk factor for developing Metabolic syndrome and also poor sleep quality increases appetite (hyperphagia), overweight and chances of insulin resistance that lead to metabolic syndrome[2]. Association of sleep duration with obesity, diabetes, hypertension and cardiovascular diseases have been reported by many studies. Previous studies have also reported disturbed sleep duration and quality increases risk of metabolic syndrome [6,7,8]. However the results were inconsistent in previous studies due to different diagnostic criteria used to define metabolic syndrome, other factors like sociodemographic factors and ethnic disparity. The aim of this study is to clarify whether normative variation in sleep quality is associated with metabolic syndrome.

The objective of present study is to explore an association between sleep duration & sleep quality and metabolic syndrome. Sleep quality was assessed by Pittsburgh sleep quality index (PSQI) a widely used, well validated and reliable measure of sleep quality.

AIM & OBJECTIVES:

1. To assess sleep quality determined by PSQI in Metabolic syndrome patients.
2. To evaluate an association between sleep quality and Metabolic syndrome.

Materials & methods:

This study was designed as a cross sectional study. Subjects were recruited from medicine OPD in a tertiary care hospital. A total of 140 individuals of both males and females aged 30yrs and above without acute and severe illness who satisfy metabolic syndrome criteria were included in the study. The study duration was 3 months from September 2022 to December 2022. Subjects with past or present history of atherosclerotic disease, liver disease, COPD and thyroid illness, subjects on drugs like statins, steroids, NSAIDs, insulin and psychotropic medications, pregnant or lactating women and shift workers were excluded from the study. The purpose of the study was explained to the subjects prior to the study and informed written consent was obtained from all the individuals. Approval for the study was obtained from the Institutional Ethics Committee.

Risk factor assessment:

After recruitment the participants were assessed for metabolic syndrome risk factors:

1. Anthropometric measurement:

Height (m), weight (kg), waist circumference (cm) were measured by measuring tape. The waist circumference was measured as per WHO recommendations, measured at the navel level with subjects standing straight as they exhale lightly. Body mass index was calculated as weight in kg divided by height in meter squared m^2(BMI= Weight /Height in m^2)

2. Blood Pressure Measurement:

Blood pressure was measured with subject in sitting position after 10

minutes of rest with the help of automatic sphygmomanometer. Blood pressure was measured twice and the average of two readings were noted.

3. Blood test:
Blood samples were collected after fasting of over 12hrs. Serum glucose was measured by glucose oxidase method and lipid profile including serum triglycerides and HDLc were measured by photometric method using semiauto analyser.

Diagnosis of Metabolic syndrome:
Metabolic syndrome was defined according to the modified diagnostic criteria of National Cholesterol Education Program Adult treatment panel- III (NCE-ATP III). To define a subject as having metabolic syndrome, 3 or more of the following risk factors should be present [9]:

1. Abdominal obesity (WC >90cm in males , >85cm in females)
2. Elevated fasting blood glucose (>100mg/dl) or on antidiabetic drugs
3. Hypertension (SBP >130 mmHg or DBP > 85mmHg or both) or on antihypertensive
4. Decreased fasting HDLc (< 40mg/dl)
5. Increased triglycerides (> 150mg/dl) or on dyslipidemic drugs.

Questionnaires:
After risk factor assessment the participants who fulfil metabolic syndrome criteria were given the following questionnaire to assess sleep duration and sleep duration. The study proforma includes sociodemographic characteristics (gender, age) & medical histories of present/ past illness, tobacco use, alcohol consumption & exercise habits were collected.

Sleep duration was assessed based on average sleep duration in past month. It is subdivided into 5 categories: less than 6hrs, 6 hrs, 7, 8 and more than 8 hrs. 7hr sleep duration is taken as a point of reference (normal sleep duration)[5,10].

Sleep quality is assessed by standard Pittsburgh sleep quality index (PSQI) [11] which is a widely used measure of sleep quality, is standardised, well validated and a reliable index. It evaluates subject's sleep quality over the previous month. PSQI includes 7 components with 19 questions. Subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication & day time dysfunction each weighing equally from 0-3. 0 indicates no difficulty and 3 indicates severe difficulty. Seven component scores are then added in order to obtain a global score rating from 0-21 with higher score indicating worse sleep quality. As per PSQI Global score of 5 and above is indicative of poor sleep quality. Seven component scores are as follows:

1. Subjective sleep quality assessed from 0-3

2. Sleep latency was assessed from 0-3 points (time required to go to sleep each night and frequency of getting sleep within 30 minutes in a week)

3. Sleep duration was assessed from 0-3 (0 - > 7 hrs, 1- 6-7 hrs, 2 – 5- 6 hrs, 3 - < 5 hrs).

4. Habitual sleep efficiency (proportion of hours slept to hours spent in bed) assessed from 0-3 with 0 - >85%, 1-75-84%, 2 indicating 65-74%, 3 - <65%.

5. Sleep disturbance is having trouble in sleeping because of some reasons and their frequency was assessed from 0-3 points (0- 0, 1- 1 to 9, 2 – 10 to 18, 3- 19 to 27).

6.Use of sleep medication was assessed from 0-3 points (0-not during the past month, 1- less than once a week, 2- once or twice a week, 3- three or more times a week).

7. Daytime dysfunction is frequency of having trouble staying awake while driving, eating meals, engaging in social activity and frequency of having trouble to keep up enough enthusiasm to get things done was assessed from 0-3 points.

Statistical analysis:
Data collected was analysed using Descriptive and inferential statistics, using Statistical software SPSS v23 and MS Excel. By Descriptive Statistics, data is summarised using following procedure like distribution of Demographic data was expressed in frequency and percentages, Ordinal data was expressed in Median and continuous data was expressed in mean and standard deviation. By inferential Statistics: To find the significant difference among the parameters of the study Z test and t test unpaired was used. All the statistical analysis was carried out at 5% level of significance and a p-value of < 0.05 was considered as significant.

RESULTS:
Out of 140 subjects 64 were males and 76 were females and the mean age of the subjects were 52 ± 10.8. As shown in table 1: In males the mean BMI in kg/m2 was 21.14± 3.5 and 22.33± 4.45 in females which was found to be higher in females with a p value of 0.08. The mean waist circumference (cm) was 93.06±8.2 in males and 89.8±11 in females with a p value of 0.05. Subject 's with smoking and drinking habit were greater in males. Proportion of subjects involved in physical activity were 46 (72%) in males and 55(73%) in females and found to be statistically insignificant (p value 0.95).

Table No.1. Description Of Subjects And Variables

	Male(n=64)	Females (n=76)	p value
Age, y	52.9± 10.7	51.05±11	0.57
BMI, kg/m2	21.14±3.5	22.33±4.4	0.08
Physical activity	46(72%)	55(73%)	0.9
Waist circumference, cm	93.06±8.2	89.8±10.9	0.05
Sleep duration, hrs	6.10±1.2	5.73±1.8	0.06
Global score PSQI	9.17±2.52	10.02±2.4	0.04

Characteristics of sleep parameters were shown in table no.2. The mean sleep duration was 6hrs with majority of participants were in 6hrs and 5hrs sleep duration. Based on sleep duration, subjects were grouped into five categories. The percentage of subjects sleeping less than 7hrs was 72% and greater than 7hrs was only 10%. So overall in our study sleep duration was reduced in adults with metabolic syndrome.

Table No.2 Characteristics Of Sleep Parameters:

	Category	N(%) / mean ± SD
Sleep duration		5.9±1.1
	<6hrs 6hrs 7hrs 8hrs >8hrs	52(37%) 48(34%) 26(18%) 13(9%) 1(0.7%)
Sleep quality		9.63±2.5
	Good sleep quality(≤5) Poor sleep quality (>5)	6(4%) 34(96%)

The association between the Global PSQI Score and individual components of metabolic syndrome were analyzed using multiple regression analysis (table no.3). The mean Triglyceride level was 188.01± 131 and the mean fasting glucose was 156 ± 9.8. The mean HDLc level was 37.42±14.4 in males and in females 36.7±4.1. The systolic and diastolic blood pressure was 141.75±18.7 and 87.22±10.2 respectively. The mean global PSQI score was 9.17±2.52 in males and 10.02±2.44 in females and was found to be significantly higher in females with P value of 0.04. As in table N0.3 in our study global score is not related significantly to any of the features of metabolic syndrome.

However out of 140 subjects 96% of subjects reported poor sleep quality (score >5) as in table No.2. On comparison of metabolic syndrome components between good sleepers and poor sleepers the prevalence of abdominal obesity, elevated glucose and low HDLc were greater in poor sleepers. Waist circumference (91.65±9.4) was significantly higher in poor sleep quality group with p value of 0.04.

Table: 3 Multiple Regression Analysis Of Global Score With Components Of Metabolic Syndrome

Variable	PSQI Global Sleep Quality Index			
Blood Pressure	β	SE	t	p value
Systolic	0.0099	0.0151	0.6563	0.5128
DiaSytolic	0.0050	0.0270	0.1857	0.8529
Glucose	0.0648	0.0616	1.0523	0.2946
Triglyceride	0.0004	0.0252	0.0174	0.9861
HDL	-0.0001	0.0035	-0.0412	0.9672

BMI	-0.0025	0.0017	-1.4758	0.1424
Waist Circumference	0.0131	0.0208	0.6286	0.5307

Table: 4. Comparison Of Metabolic Syndrome Components Between Good And Poor Sleep Quality Subjects By T Test.

	Sleep Quality		P value
	Good	Poor	
Waist circumference	83.5± 16.8	91.65±9.4	0.04
Triglycerides	204.5±141	187.27±131	0.75
HDLc	38.1± 7.5	37.05± 11.1	0.9
Fasting blood sugar	144.1±57	156±62.8	0.6
Systolic BP	148.3±16.8	141.45±18	0.35
Diastolic BP	90.3±0.5	87.08±10.2	0.44

In our study each of the seven components of PSQI were analyzed and expressed as mean ± SD and median values. Median values were shown in table No.5.The median values of four components subjective sleep quality, sleep duration, habitual sleep efficiency and daytime dysfunction was 1 whereas median values of sleep latency and sleep disturbance score was 3 and 2 respectively. This reveals that in our study about half of the subjects reported with sleep latency score of 5-6 (prolonged sleep latency) that indicates poor sleep quality and about 50% of subjects suffered from sleep disturbances due to breathing difficulty, snoring , pain and other reasons. The median value for sleep medication was 0. Though 96% of the subjects had poor sleep quality about 90% of them were not on any sleep medication.

The mean values of each component of PSQI were compared between males and female subjects. There was significant difference between two groups only in sleep latency score with p value of 0.001.

Table No.5. Comparison Of Mean Values Of Components Of Sleep Score Between Males And Females By Using T Test.

	Median value N(140)	Mean ±SD		Pvalue
		Male(64)	Female(76)	
Subjective sleep quality	1	1.52±0.68	1.32±0.53	0.05
Sleep latency	3	2.59±0.56	2.23±0.75	0.001
Sleep duration	1	1.56±0.82	1.42±0.7	0.27
Habitual sleep efficiency	1	1.53±0.79	1.39±0.84	0.3
Sleep disturbances	2	1.55±0.5	1.53±0.5	0.81
Sleep medication	0	0.1±0.34	0.14±0.53	0.6
Daytime dysfunction	1	1.14±0.39	1.15±0.44	0.93

DISCUSSION:

In this study we evaluated association between sleep duration, sleep quality assessed by PSQI and metabolic syndrome. Most of the previous studies have assessed only sleep duration to evaluate sleep status [7,8,12]. Our study results shows that in subjects with metabolic syndrome about 72% reported shorter sleep duration of <6hrs. These results were consistent with study done by J.K.choi et al.,[7] where the authors investigated the association between self-reported sleep duration and presence of metabolic syndrome. It was reported that shorter sleep duration (< 6hrs) was associated with metabolic syndrome among females. Many studies have reported that both short and long sleep duration increases the risk of metabolic syndrome [13,14,15]. But in this study 72% of subjects had shorter sleep duration. Also a study by Chaput et al. [8] revealed that sleeping ≤ 6hrs per night was associated with increased cardio metabolic risk score and an increase in odds of having metabolic syndrome.

The possible mechanism explained was shorter sleep duration alters the levels of endocrine hormones. It is evident from previous studies that in subjects with shorter sleep duration there is decreased leptin and increased ghrelin secretion which in turn increases appetite and leads to obesity, increased BMI that finally leads to development of metabolic syndrome. Lusardi et al., [16] reported that sleep restriction was associated with sympathetic hyperactivity and increased blood pressure. It was also reported that people with sufficient sleep duration had low levels of inflammation and oxidative stress and higher levels of antioxidants as compared to short or long sleepers.

Concerning sleep quality, in our study about 96% of subjects reported poor sleep quality (global score >5). There is a significant association between sleep quality and with central adiposity component – waist circumference (p 0.04) and not with other features of metabolic syndrome. These results were in concordant with study done by J.Lee et al.,[5] the authors analyzed sleep duration, sleep quality and risk of sleep related breathing disorder in 301 subjects and reported that in those with poor sleep quality the prevalence of abdominal obesity, elevated triglycerides, low HDL cholesterol, high fasting insulin and high HOMA IR were higher.

Metabolic syndrome and Global PSQI score:

Multiple regression analysis was done to relate metabolic syndrome components with Global PSQI score. In our study the global score was not associated with any of the metabolic syndrome variables. These results were consistent with kazman et al..[17] study conducted in 248 community recruited Africans Americans and revealed that overall self-reported sleep quality may not contribute to metabolic syndrome but symptomatic snoring was related to metabolic syndrome.

Our study results were contradicted with results of Jennings et al.,[3] in which the authors evaluated sleep quality in 210 volunteers and found that global score was related significantly to presence of metabolic syndrome – an increase in score of 2.6 points was associated with odds of having metabolic syndrome by 1.44 and also showed that global score was related significantly to waist circumference, BMI, % of body fat, serum levels of insulin and glucose.

Metabolic syndrome and PSQI components:

In our study the sleep latency and sleep disturbance score median value was 3 and 2 respectively. It indicates that half of the subjects were presented with prolonged sleep latency and with sleep disturbances. This is in accordance with a study by Okubo et al.,[18] where they evaluated sleep quality and its components are in association with metabolic syndrome and found that global PSQI score and its components were associated with metabolic syndrome.

In a study by Troxel et al.,[19] a prospective study done in 812 participants to report the association between sleep symptoms and development of metabolic syndrome. The authors concluded that difficulty falling asleep, unrefreshing sleep and loud snoring predicted development of metabolic syndrome. These results are consistent with our results of prolonged sleep latency and with sleep disturbances like snoring and breathing difficulty.

Sleep rhythm is regulated by hypothalamus. Hypothalamo pituitary adrenal axis (HPA) is the major neuroendocrine mediator of stress [20]. Normal sleep onset time have an inhibitory effect on HPA axis, decreasing cortisol secretion and on the other side during morning awakenings there will be rise in cortisol secretion which is a fight or flight hormone that prepares the individual to meet the demands and to handle stressful conditions. In subjects with poor sleep quality and prolonged sleep latency the HPA gets activated thereby enhancing secretion of cortisol and catecholamine that in turn leads to sympathomimetic state – increased heart rate and blood pressure of the individual. So, sleep insufficiency leads to increased sympathetic activity and activates pro-inflammatory cytokines that increases insulin resistance which is a key factor in the development of metabolic syndrome. Though many studies were conducted on association between sleep and metabolic syndrome the results were variable and also they have compared sleep quality between metabolic and non-metabolic syndrome. Our study aimed at assessing sleep status only in subjects with metabolic syndrome and found that overall global PSQI score was not related significantly with metabolic syndrome. However individuals with metabolic syndrome had poor sleep quality (96%), prolonged sleep latency and sleep disturbances.

Limitations:

As it is questionnaire based study it is subjected to recall bias. Sleep study done by questionnaires and also by polysomnography would have been more reliable. In this study we did not test the interaction between each predictor variable and metabolic syndrome.

But however this simple, PSQI questionnaire on sleep quality should be included in regular checkup or in Out Patient Departments , that might alert the individual and physicians to think of possible risk of metabolic syndrome thereby reduce mortality and morbidity due to cardiovascular outcome and can be used as a screening test for early diagnosis and timely management.

CONCLUSION:

To conclude, sleep deficiency is a chronic stressor and a modifiable risk factor for metabolic syndrome. Having a balanced sleep of slow wave and REM sleep are the keys to reduce the risk. Appropriate sleep management (Early to bed and early to rise) help to prevent

development of metabolic syndrome.

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