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A STUDY OF THYROID FUNCTION TESTS (TFT) AND OBESITY WITH SLEEP QUALITY IN APPARENTLY HEALTHY SUBJECTS OF SHARDA UNIVERSITY

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Abstract

Background: Thyroid dysfunction, a prevalent endocrine condition worldwide, can disrupt various bodily functions. Obesity, characterized by excessive fat accumulation, contributes to several health issues, including diabetes, heart disease, and thyroid disorders. Adequate sleep is essential for regulating hormonal and metabolic processes and managing appetite. This study underscores the importance of identifying and addressing thyroid dysfunction and obesity in individuals experiencing poor sleep quality. **Aim:** To study the thyroid hormones (TSH, fT3, fT4) levels and obesity in relation to sleep quality in apparently healthy subjects. **Material & Methods:** A cross-sectional study, 104 apparently healthy subjects in the age group 18-60 were included. Anthropometric measures (height, weight, BMI) were measured by Welcare Accuniq BC 310. Sleep quality was calculated by using Pittsburgh Sleep Quality Index (PSQI) and serum TSH, free T3 and free T4 were measured using dry chemistry fully automated Biochemistry Analyser, Vitros 5600. **Result:** Sleep score showed highly significant positive correlation with BMI ($r = 0.474$, p-value < 0.001) and TSH ($r = 0.603$, p-value < 0.001) and significant negative correlation with fT3 ($r = -0.206$, p-value $= 0.036$), whereas it was not significantly affected by fT4. BMI has highly significant positive correlation with sleep score ($r = 0.474$, p-value < 0.001), highly significant negative correlation with fT4 ($r = -0.280$, p-value $= 0.004$), significant negative correlation with fT3 ($r = -0.248$, p-value $= 0.011$) and significant positive correlation with TSH ($r=0.250$, p-value $= 0.010$). **Conclusion:** Apparently healthy subjects having higher BMI were having decreased fT3, fT4 levels and increased TSH levels within the normal range. They were also having more sleep disturbances. Poor sleep quality was associated with increase in TSH and decrease in free T3. Thyroid dysfunction can cause obesity and affect our sleep quality and vice versa.

Keywords: Thyroid Dysfunction, Obesity, Sleep, Thyroid Stimulating Hormone, Free T3, Free T4, Pittsburgh Sleep Quality Index.

1. INTRODUCTION

In the “National Family Health Survey V” (NFHS V), the prevalence of self-reported goiter was 2.9%, while it was 2.2% in NFHS IV [1]. With an incidence of 11% in Indians, 4.6% in the UK, and 2% in the US general population, thyroid dysfunction is the most common endocrine condition in the globe including Hypothyroidism, hyperthyroidism, Hashimoto's thyroiditis, and thyroid cancer [2]. Nearly 1.9 billion people are overweight and 650 million people are obese globally, according to current estimates. It is estimated that there are 2.8 million deaths worldwide that are linked by obesity. In India, the obesity rate exceeds 135 million. The consumption of energy-dense food

(i.e., bad eating habits), sedentary lifestyles, a lack of health care facilities, and financial constraints all contribute to a large risk of obesity and its negative consequences (such as diabetes, ischemic heart disease, etc.) in developing countries. The Indian Council of Medical Research–India Diabetes (ICMR-INDIAB) survey found that obesity prevalence rates fell between 11.8% to 31.3%, in 2015 [3]. Many parameters, including as weight, height, body mass index (BMI), waist circumference (WC), hip circumference (HC), and waist to hip ratio (WHR), can be used to assess obesity [4].

According to A Misra et al.'s study, obesity in the Indian population is defined as a BMI of 25 or more [5]. BMI equal or more than 25 is obese, 23 to 24.9 is overweight, 18 to 22.9 is normal weight, and less than 18 is underweight. Thyroid dysfunction is associated with changes in body temperature, body composition and weight, and resting and total energy expenditure even in the absence of physical activity. Furthermore, weight gain is a common side effect of thyroid dysfunction medications [6]. The risk of hypothyroidism was significantly raised with obesity [7]. A higher quality of life is a result of maintaining excellent health and wellness, which may be achieved via getting enough sleep [8]. The quantity and quality of sleep are crucial for maintaining normal function. Additionally, it assists in the management of hunger and supports to maintain regular metabolic and hormonal processes [9]. Utilising the Pittsburgh Sleep Quality Index (PSQI), people's quality of sleep is evaluated [10]. The PSQI was developed in 1988 (Buysse et al. [10]), and trials were used to prove its validity and reliability.

The seven components of the PSQI are subjective sleep quality, sleep latency, sleep duration, sleep disruption, sleep efficiency, usage of sleep medication and daytime dysfunction. Every component has a difficulty level between 0 (no difficulty) and 3 (severe difficulty). The overall score is between 0 and 21. Poor sleep shows score above 5. Metabolic conditions like obesity, insulin resistance, and diabetes are linked to sleep deprivation and circadian clock disruption [11]. Sleep deviation is linked to changed levels of TSH, T4, and T3, which can affect the hypothalamic-pituitary-thyroid axis functions in humans [12]. Recent research indicates that insufficient sleep duration is increasingly recognized as a potential contributor to the onset of obesity and associated health conditions, based on findings from both population studies and controlled experiments [13, 14]. This study showed the correlation between thyroid function and obesity with sleep quality in apparently healthy subjects. Lifestyle modifications including sleep quality and stress management therapy will help to undertake preventive measures at an early stage to avoid metabolic disorders like Diabetes Mellitus, Metabolic Syndrome, and Ischemic Heart Disease etc.

2. MATERIAL AND METHODS

Cross-sectional research carried out at Sharda University, Greater Noida, Uttar Pradesh, India, on 104 apparently healthy individuals in the age range of 18 to 60 years after obtaining ethical clearance from the Institutional Ethical Committee.

Inclusion criteria: Apparently healthy individuals aged between 18 and 60 years, regardless of gender.

Exclusion criteria: Above or below the age criteria, pregnancy, hormonal disorders.

Anthropometric Measurements

BMI was calculated using standard method by WHO. Weight of the body (in kgs) is divided by Height (in meters) expressed in Kg/m^2. BMI was measured by using Welcare Accuniq BC 310, a fully automated body composition analyser.

Biochemical Measurements

Fasting blood samples were collected according to standard procedures and centrifuged at 3000 rpm for 20 minutes to separate the serum. Serum was stored at 2°C to 8°C for processing. Estimation of serum free T3, serum free T4 and TSH were estimated using dry chemistry fully automated Biochemistry Analyser, VITROS 5600.

Sleep Score Calculation

Sleep quality was measured by Pittsburgh Sleep Quality Index (PSQI) [10] questionnaire after the receival of written consent. Questionnaire was given in printed form to subject and asked them to fill according to their last one-month sleep pattern. Sleep score was calculated according to their responses in questionnaire. The seven components of the PSQI are subjective sleep quality, sleep latency, sleep duration, sleep disruption, sleep efficiency, usage of sleep medication and daytime dysfunction. The difficulty of each component has a value from 0 (no difficulty) to 3 (extreme difficulty). The overall score is between 0 to 21. A total score of more than 5 indicates poor sleep.

Statistical Analysis

Statistical software in version 22 of Statistical Package for the Social Sciences (SPSS) was used to conduct the analysis. Significant results are those with a p-value derived at a 95% confidence level of reliability of less than 0.05. A highly significant p-value is one that is less than 0.01, significant is less than 0.05, and nonsignificant is greater than 0.05. Correlations were calculated using the Pearson correlation coefficient.

3. RESULT

The total number of subjects were 104 consisting of 60 males and 44 females.

Table 1: Descriptive Statistics showing mean and SD of all parameters

	N	Minimum	Maximum	Mean	Std. Deviation
BMI (kg/m2)	104	15.70	34.80	23.13	3.23
fT3 (pg/mL)	104	2.68	5.63	4.30	0.69
fT4 (ng/dL)	104	0.80	1.48	1.08	0.15
TSH (uIU/mL)	104	0.19	6.40	2.30	1.19
Sleep Score	104	1.00	10.00	4.01	1.86

Table 2: Pearson Correlation between Sleep Score, BMI, fT3, fT4 and TSH

		BMI	fT3	fT4	TSH
Sleep Score	Correlation Coefficient	0.474**	-0.206*	0.005	0.603**
	Sig. (2-tailed)	<0.001	0.036	0.96	<0.001
	n	104	104	104	104

Table 3: Pearson Correlation between BMI, Sleep Score, fT4, fT3 and TSH

		Sleep Score	fT4	fT3	TSH
BMI	Correlation Coefficient	0.474**	-0.280**	-0.248*	0.250*
	Sig. (2-tailed)	<0.001	0.004	0.011	0.010
	n	104	104	104	104

***. Correlation is highly significant at the 0.01 level (2-tailed). p-value, *. Correlation is significant at the 0.05 level (2-tailed). p-value<0.05, Correlation is nonsignificant at p-value>0.05*

4. DISCUSSION

Thyroid dysfunctions are one of the major issues related to obesity, and it can affect our normal sleep pattern also. Obese people commonly have moderately elevated Thyroid Stimulating Hormone (TSH) [15]. Many medical issues are associated with obesity. Research indicates that obesity is linked to a number of morbidities, including hypertension, non-alcoholic fatty liver disease, diabetes, heart disease, asthma, obstructive sleep apnea, osteoarthritis, and polycystic ovarian syndrome. Additionally, weight loss is beneficial and should be a key component of treating these conditions [16]. Both obesity and thyroid disorders can affect sleep quality, and vice versa.

The present study has been conducted in 104 apparently healthy subjects (60 males, 44 females) in order to correlate thyroid profile with BMI and sleep quality. It has been found that Body Mass Index has a significant positive correlation with TSH (r-value = 0.250 and p-value = 0.010), and significant negative correlation with free T3 (r-value = -0.248 and p-value = 0.011) and free T4 (r-value = -0.280 and p-value = 0.004). Mahdi Mahdavi, Atieh Amouzegar et al.'s study in Iran in 2021 revealed consensus with our results, i.e. a positive correlation between BMI and serum TSH, as well as Thyroid Peroxidase Antibody, and a negative correlation with serum fT4 levels. It may be due to increased serum leptin levels in obese individuals, which correlate positively with elevated TSH levels, potentially due to leptin's stimulation of TRH synthesis in the hypothalamus. In obesity, adipocytes exhibit reduced expression of TSH receptors, inducing peripheral resistance to thyroid hormones, thereby triggering elevated plasma TSH levels as a compensatory response [17]. Another study supporting these results is the study done by Ladan Mehran, Atieh Amouzegar et al. in 2021.Their study showed a negative association between free T4 and both BMI and waist circumference, irrespective of TSH levels, highlighting cumulative effects of thyroid hormones.

This cohort study took place in Iran for over 10 years taking into consideration, the risk of general and abdominal obesity [18]. In a study conducted in Poland in 2021 on "Obesity and Thyroid axis," Krzysztof Walczak and Lucyna Sieminsika also concluded that obesity, lipotoxicity and inflammatory states can result in thyroid dysfunction, potentially activating the hypothalamic-pituitary-thyroid axis. They suggested that assessing fT3 levels could help determine the cause of elevated TSH levels, hypothesizing that weight loss through lifestyle and dietary changes is necessary to prevent complications arising from thyroid malfunction due to obesity, inflammation, and lipotoxicity [19]. In the condition of excessive fat accumulation, we can see high level of TSH to induce the production of fT3 and fT4. Thyroid hormones (T3 and T4) may induce lipolysis in the condition where excess lipid is present [20].

BMI and sleep score (sleep disturbances) shows significant positive correlation in this study, where r-value is 0.474 and p-value is less than 0.001. When the BMI increased, sleep disturbances also increased. Lilla Bonanno, Daniela Metro et al.'s 2019 study in Italy revealed similar result, i.e. a significant positive correlation between sleep disturbance and BMI score in both genders, highlighting the substantial impact of sleep duration on BMI, with sleep hours serving as a significant predictor, particularly influenced by the clinical condition of the patients. Overeating due to short sleep duration heightens obesity risk, linked to alterations in hunger and appetite-regulating hormones like leptin and ghrelin. Neurons produce hypocretin which is a hormone responsible for wake/sleep cycle, appetite regulation and energy metabolism influenced by leptin. Sleep deprivation reduces leptin levels, potentially leading to increased hypocretin activity, which prolongs wakefulness, stimulates appetite, and encourages food-seeking behaviour [21]. Another study supporting these results is study done by Anisha Gohil and Tamara S. Hannon in 2018 at United States indicates that youth obesity and sleep disorders are epidemics that coexist. A higher BMI and indicators of cardiometabolic risk, such as insulin resistance, dyslipidemia, and elevated blood pressure in young people, are associated with shorter sleep duration and worse quality sleep. Sleep-restricted individuals experience reduced levels of leptin and elevated levels of ghrelin, leading to subjective feelings of hunger compared to well-rested individuals [22]. A study done by Hayes JF, Balantekin KN et al also found that number of weight-related behaviours and the degree of overweight or obesity are correlated with sleep patterns and quality. Promoting a consistent sleep schedule over the whole of the week may be a helpful therapeutic goal in the treatment of adolescents' obesity in order to improve behavioural and weight results. Changes in sleep schedules can disrupt circadian rhythms, potentially impacting energy levels [23].

Sleep disturbances (sleep score) shows significant positive correlation with TSH (r-value = 0.603 and p-value < 0.001), significant negative correlation with free T3 (r-value = -0.206 and p-value = 0.036) and nonsignificant positive correlation with free T4 (r-value = 0.005 and p-value = 0.960). A study conducted by Nazem MR, Bastanhagh E et al showed the same result, that thyroid function may be impacted by insufficient sleep. Specifically, in the population with poor sleep conditions, the T4 and Thyroid Stimulating Hormone (TSH) levels rose considerably. Additionally, associations between sleep, stress, and fT4 (free T4) scores were found, indicating that insufficient sleep may have an impact on thyroid hormones [24]. Review done by Coppeta L, Di Giampaolo L et al showed the same that, among the workers having work in different time schedules, higher TSH levels were more closely linked to night workers than dayworkers, due to disruption of circadian rhythm. Due to disturbed sleep wake cycle body's entire hormonal homeostatic properties loses including thyroid function [25]. Shekhar S, Hall JE, Klubo-Gwiezdzinska J reviewed and concluded the same that, conditions such as hypothyroidism and hyperthyroidism can also affect sleep architecture and quality while, sleep restriction can change the secretion of hormones in Hypothalamic Pituitary Thyroid (HPT) axis. When treating individuals having thyroid diseases, it is important to consider both the HPT axis and sleep [26]. Free T3 is more significantly correlated to BMI and sleep score compared to free T4, because T3 is more physiologically active than T4, 4 to 15 times, hence there is difference in the efficacy of the two hormones [20]. The mutual dependence between hormones and sleep in normal physiological functioning is widely recognized and supported by research [27].

Hence life style modifications, healthy diet and proper physical exercise can help to maintain healthy body, proper thyroid functions and a good sleep, vice versa. Particularly in obese individuals, they may lose their weight via healthy lifestyle which can achieve a good sleep and can achieve a state of proper endocrine functioning including thyroid function.

5. CONCLUSION

This study concludes that apparently healthy subjects with higher BMI are having decreased fT3, fT4 levels and increased TSH levels within the normal range, which means obesity can be the cause of abnormal thyroid hormone level or thyroid dysfunction, vice versa. This fact may exaggerate the progression of thyroid dysfunction, obesity, and possibility of further health risks such as hypertension, diabetes, obstructive sleep apnea, heart disease, non-alcoholic fatty liver disease, asthma, polycystic ovarian syndrome, and osteoarthritis etc. It is also concluded that poor sleep quality (sleep score) increased with increase in TSH and decrease with fT3 in apparently healthy subjects selected in this study. Additionally, individuals having high BMI were having more sleep disturbances. Maintaining healthy life style through lowering calorie intake, doing proper exercise and good sleep pattern may help for a proper thyroid function, and prevent from being obese. Hence, we may prevent further health risks arising as consequences of thyroid problems and obesity.

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