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The Association between Sleep Deprivation and Periodontitis: A Cross Sectional Study

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Abstract
Background: *Sleep deprivation is becoming increasingly common in today's society. Epidemiologic data indicates that sleep disturbance and short sleep duration adversely impact human physical health and mortality risk. It increases inflammatory and pro-inflammatory markers due to its potential to influence inflammation and oxidative stress which are the main pathologic mechanisms actually recognised in periodontal disease. Therefore, the present study aimed to assess if there is an association of sleep deprivation with periodontitis.* ***Materials and Methods:*** *85 subjects were categorized into 3 groups viz. clinically healthy, gingivitis and periodontitis. Periodontal status of subjects was assessed by gingival index and pocket probing depth. All the study subjects were administered Pittsburgh Sleep Quality Index (PSQI) questionnaire for the assessment of sleep deprivation.* ***Results:*** *Present investigation revealed that mean PSQI was highest in the periodontitis group as compared to other two groups with statistically significant difference amongst three groups.* ***Conclusion****: Within the limits of the study, it can be concluded that direct association exists between sleep deprivation and periodontitis.*

Key words: *Periodontitis, Chronic periodontitis, Pittsburgh Sleep Quality Index, sleep deprivation, inflammatory host response, host immunity, hypothalamic pituitary adrenal axis.*

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I. Introduction

Periodontal disease is the most common cause of tooth loss worldwide, due to infection of the supporting tissues of the tooth. (1) Periodontal diseases are inflammatory diseases in which microbial etiologic factors induce a series of host responses that mediate inflammatory events. Bacteria and inflammatory mediators are not only confined to periodontal tissue but may also enter the blood and disseminate systemically having a measurable impact on systemic inflammation. (2) In susceptible individuals, dysregulation of inflammatory and immune pathways leads to chronic inflammation, tissue destruction, and disease.(3)

In recent years, there has been great interest in potential associations between periodontal disease and various chronic systemic diseases and conditions, including cardiac diseases, diabetes, respiratory diseases, chronic kidney disease, rheumatoid arthritis, cognitive impairment, obesity, metabolic syndrome, and cancer. (4) A wide range of risk factors (smoking, diabetes, immunosuppression, genetic factors, stress, and age) contribute to the susceptibility of individuals to periodontal diseases and to the pathogenesis and severity of the disease. Studies of the influence of risk factors on disease progression have been focused on the inflammatory reaction. (5) These studies concluded that a sound inflammatory host response is needed for successful periodontal defense. (6)

Sleep is defined by Cambridge University as the resting state in which the body is not active and the mind is unconscious. (7) Adequate sleep is incredibly important for health and it's just as important as eating healthy and exercising. Unfortunately, the current environment and modern lifestyle is interfering with natural sleep patterns. Most of the individuals are now sleeping less than they did in the past, and sleep quality has declined as well. Inadequate sleep has its effects on learning, memory processing, the repair of cell damage, brain development, neurobehavioral performance, hormonal regulation, risk of depression, increased cortisol, and ghrelin, impaired glucose metabolism, and increased inflammatory and proinflammatory markers among many other influences. (8) It is also known that there has been a worldwide decline in the average number of hours that individuals sleep since the mid-1970s. Currently, the average number of hours that a person sleeps is less than seven hours a night. Inadequate sleep has been independently linked to several systemic diseases, like to diabetes mellitus, metabolic syndrome, hypertension, stroke and coronary artery disease.(9–15) Sleep deprivation may activate inflammatory processes, leading to increasing C-reactive protein (CRP)

concentrations, rise in peripheral circulation of leukocytes, increase levels of interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF-α). (16)

Recently, the researchers highlighted the association between short sleep duration with the risk of systemic infections, explained by the experimental evidence of host immunity. (17) Since inflammation is characteristic of both periodontitis and sleep deprivation, few studies in recent years suggested the association of sleep duration and periodontitis with varying results in India, the USA, and South Korea. (6,18,19) Therefore, this study has been undertaken with the primary objective, to investigate the potential association between sleep deprivation and periodontitis.

II. Materials And Methods

A total of 85 subjects categorized in 3 groups viz. clinically healthy, gingivitis and periodontitis were identified and selected from among the patients visiting the Department of Periodontology and Oral Implantology, S.M.B.T. Dental College & Hospital and Post Graduate Reasearch Center, Sangamner (Mahatrastra). All subjects underwent detailed medical history and periodontal examination before enrolling into the study which also included information for demographics such as age, gender, and socioeconomic status. As none of the subjects belonged to poor or rich classes, subjects were categorized into low middle class, middle class, and high middle class on the basis of collected data.

Subjects were excluded if they were edentulous, pregnant or lactating, smokers, suffering from known systemic diseases which could alter healing response of periodontium, who had received any periodontal therapy in 6 months before study or those who had history of medication (antibiotics or anti-inflammatory drugs) in 3 months before study. Subjects were examined by a single examiner for the assessment of gingival index (GI) (Loe, 1963) and pocket probing depth (PD). William's periodontal probe was used to measure the PD from the gingival margin to the bottom of the periodontal sulcus or pocket at 4 sites (Labial/Buccal, mesial, distal and Lingual/Palatal) of each tooth.

Subject grouping:
Group 1 (Clinically Healthy): GI score: 0, PD: ≤4mm
Group 2 (Gingivitis): GI score: ≥1, PD: ≤4mm
Group 3 (Periodontitis): PD: ≥4mm in ≥30% of sites

The Pittsburgh Sleep Quality Index (PSQI)

All the study subjects were administered PSQI questionnaire. The PSQI is an effective tool used to measure the quality and patterns of sleep in the older adult. It is brief, reliable, valid, and standardized self-reported measure of sleep quality. It differentiates "poor" from "good" sleep by measuring seven domains: Subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction over the last month. All subjects rated each of these seven areas of sleep. PSQI questionnaire was modified from the original in order to include the first 9 items only these items contribute to the total score. Scoring of the answers was based on a 0 to 3 scale, whereby 3 reflected the negative extreme on the Likert scale. The component scores were summed to produce a global score (range 0 to 21). A global sum of "5" or greater indicated a "poor" sleep. Higher PSQI scores represented worse sleep quality. (20)

STATISTICAL ANALYSIS

Statistical analysis was performed using (SPSS) version 21 for Windows (SPSS Inc, Chicago, IL).
Descriptive quantitative data was expressed in mean and standard deviation respectively.
Descriptive qualitative data will be expressed in percentage. Intergroup comparison between three study groups for each continuous parameters like age, sleep index, gingival index, probing depth was done using ANOVA F test followed by Tukey's post hoc test to find intergroup pair wise comparison. Chi square test was used to compare between two or more proportions of variable like gender, socioeconomic status. Pearson 'r' correlation coefficient was used to find correlation between sleep index score with gingival and periodontal conditions. Confidence interval set at 95% and probability of alpha error set at 5%. The power of the study set at 80%.

III. Results

Sixty systemically healthy subjects (29 females and 56 males) in age group of 15–60 years were assessed for association of sleep deprivation with chronic periodontal disease. [Table 1 and Graphs 1, 2, 3]

Present study revealed that mean GI in group 1, 2 and 3 were 0.67 ± 0.44, 1.31 ± 0.19 and 2.05 ± 0.51, respectively, whereas PD were 2.16 ± 0.33, 2.73 ± 0.38 and 5.19 ± 1.31, respectively [Table 2 and Graph 4]. Mean PSQI score in three groups was 3.03 ± 1.14, 4.44 ± 1.28, and 9.03 ± 2.17, respectively [Table 2 and Graph 5]. Intergroup comparison of PSQI scores was significantly different amongst all three groups. The

results showed a positive correlation of PSQI with GI and PD in gingivitis and periodontitis group. [Table 3 and Graph 6]

After controlling for age, gender, and socioeconomic status, association of PSQI and periodontal disease was still significant between the 3 groups, viz., healthy, gingivitis and periodontitis.

IV. Discussion

The current research was aimed at exploring the association of sleep deprivation with periodontitis. Results of the present research showed that mean PSQI was highest in the periodontitis group followed by gingivitis subjects and lowest in healthy subjects and the difference among three groups was statistically significant. A positive correlation of PSQI with GI and PD was observed in all 3 groups suggesting that PSQI scores are in accordance with periodontal destruction. The association was still significant after controlling for age, gender, and socioeconomic status.

Various of methods have been utilized for assessing sleep quantity and quality like administration of the questionnaire, clinical interviews, sleep diaries, etc., In our study, we have selected PSQI for assessing sleep deprivation. The PSQI has 89.6% sensitivity and 86.5% specificity for identifying "good" and "bad" sleep using a cut-off global score of 5. It also has internal consistency and a reliability coefficient (Cronbach's alpha) of 0.83 for its seven components. Numerous studies using the PSQI in a variety of older adult population internationally have supported high validity and reliability. (20,21)

The results of this study are in agreement with previously conducted studies. Study by **Romandini et. al (2017)** has highlighted an independent direct association between sleep duration and prevalence of periodontitis. (19) **Grover et al. (2015)** also showed that mean PSQI was highest in the periodontitis group as compared to other two groups (clinically healthy, gingivitis groups) of 60 subjects, ages 25 to 50 years living in Punjab. (6) However, the present study results are in disagreement with **Weiner et al. (2016)** which revealed that association of sleep duration and periodontitis in subjects who were aged 30 years and above failed to reach the association at a significant level in the adjusted analysis. (18)

Sleep-wake cycles have also emerged as important regulators of the immune system. Central nervous system regulation of immune responses is primarily driven by two effector signalling pathways: Activation of the hypothalamic pituitary adrenal (HPA) axis and the sympathetic nervous system (SNS). Sleep loss activates sympathetic activity with less robust evidence of effects on the HPA axis. (8) Whereas activation of HPA axis inhibits both antiviral and pro-inflammatory genes, SNS activation suppresses antiviral responses (Th1-type gene expression such as interferon-γ and IL-12B) while stimulating pro-inflammatory genes (Th2-type cytokine genes such as IL-4 and IL-5), which together provides a plausible mechanism to connect sleep disturbance with various infectious and inflammatory diseases. Thus, sleep deprivation decreases immunity and ensues systemic inflammation. (4,8) As many of cytokines have a significant role in the pathogenesis of periodontal disease, there might occur potentiation of periodontal destruction in a sleep deprived individual. Further short sleep duration has been shown not only increase pathogen susceptibility; but also decrease in the immunologic protection offered by standard vaccines. (22–25)

Cognitive function and motor performance is adversely affected by sleep deprivation. (26) This might impair an individual's capacity to perform sufficient oral hygiene practices, thus increasing the risk of periodontal disease. Due to multifactorial etiology of both sleep deprivation and periodontal disease other unknown confounding factors might explain this association too. (6)

It has been revealed that in sleep-deprived individuals there is increased lymphocyte activation with over productions of IL-1, IL-6, IL-7, and TNF-α. (27) A study conducted by **Irwin et al. (2006)** found that 4 hr of sleep restriction in one night lead to increase in monocyte production of IL-6, TNF-α and messenger RNA. (27,28) They have also found that there is a significant increase in IL-1β and IL-1ra and a significant decrease in CRP and IL-6 in 40 hours sleep-deprived individuals.

More extensive research is required in this field so as to confirm the association between sleep deprivation and periodontitis.

LIMITATIONS

- This study included participants from Sangamner (India), but it is problematic to generalize the observations to the worldwide population.
- Sleep duration was self-reported by the participants and not measured by any unbiased instrument or technique.
- Additional longitudinal and interventional studies are needed to better understand the directionality of the relationship between sleep deprivation and periodontitis.

V. Conclusion

Within the limits of the study following conclusions were drawn:

- Positive correlation is seen of PSQI with GI and PD in gingivitis and periodontitis groups.
- PSQI increases as the periodontal status changes from healthy to periodontitis.
- Gradual increase in GI and PD is seen as the periodontal disease progresses.
- Direct association exists between sleep deprivation and periodontitis.

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TABLES

Table 1: Comparison of gender, socio-economic status in study groups

Gender	Group 1 (Healthy) n = 29 n (%)	Group 2 (Gingivitis) n = 27 n (%)	Group 3 (Periodontitis) n = 29 n (%)	Total n (%)
MALE	23 (79.3%)	16 (59.3%)	17 (58.6%)	56 (65.9%)
FEMALE	6 (20.7%)	11 (40.7%)	12 (41.4%)	29 (34.1%)
	Chi square value =3.534 p =0.171			
SOCIO ECONOMIC STATUS	Group 1 (Healthy) n = 29 n (%)	Group 2 (Gingivitis) n = 27 n (%)	Group 3 (Periodontitis) n = 29 n (%)	Total n (%)
LOWER MIDDLE	6 (20.7%)	6 (22.2%)	12 (41.4%)	24 (28.2%)
MIDDLE	9 (31%)	12 (44.4%)	9 (31%)	30 (35.3%)
HIGHER MIDDLE	14 (48.3%)	9 (33.3%)	8 (27.6%)	31 (36.5%)
	Chi square value = 5.452, p = 0.244			

p >0.05 – no significant difference * p <0.05 – significant **p<0.001 – highly significant

Table 2: Comparison of age, sleep index score, gingival index, probing depth in study groups

	AGE (in years) MEAN (SD)	SLEEP INDEX MEAN (SD)	G.I SCORE	PD VALUE
GROUP 1 (Healthy gingivally) n = 29	28.62 (11.08)	3.03 (1.14)	0.67 (0.44)	2.16 (0.33)
GROUP 2 (Gingivitis) n =27	32.48 (11.01)	4.44 (1.28)	1.31 (0.19)	2.73 (0.38)
GROUP 3 (Periodontitis) n =29	46.75 (13.35)	9.03 (2.17)	2.05 (0.51)	5.19 (1.31)
ANOVA F TEST	F = 18.64	F = 109.65	F = 80.577	F = 110.345
p value, Significance	p <0.001**	p <0.001**	p <0.001**	p <0.001**
Tukey's post hoc test to find pairwise comparison				
Comparison	Mean Difference, p value	Mean Difference, p value	Mean Difference, p value	Mean Difference, p value
HEALTHY vs GINGIVITIS	3.86, p =0.448	1.40, p =0.004*	0.63, p < 0.001**	0.57, p =0.028*
HEALTHY vs PERIODONTITIS	18.13, p<0.001**	6.00, p < 0.001**	1.37, p < 0.001**	3.03, p < 0.001**
GINGIVITIS Vs PERIODONTITIS	14.27, p < 0.001**	4.59, p <0.001**	0.73, p < 0.001**	2.45, p < 0.001**

p >0.05 – no significant difference * p <0.05 – significant **p<0.001 – highly significant

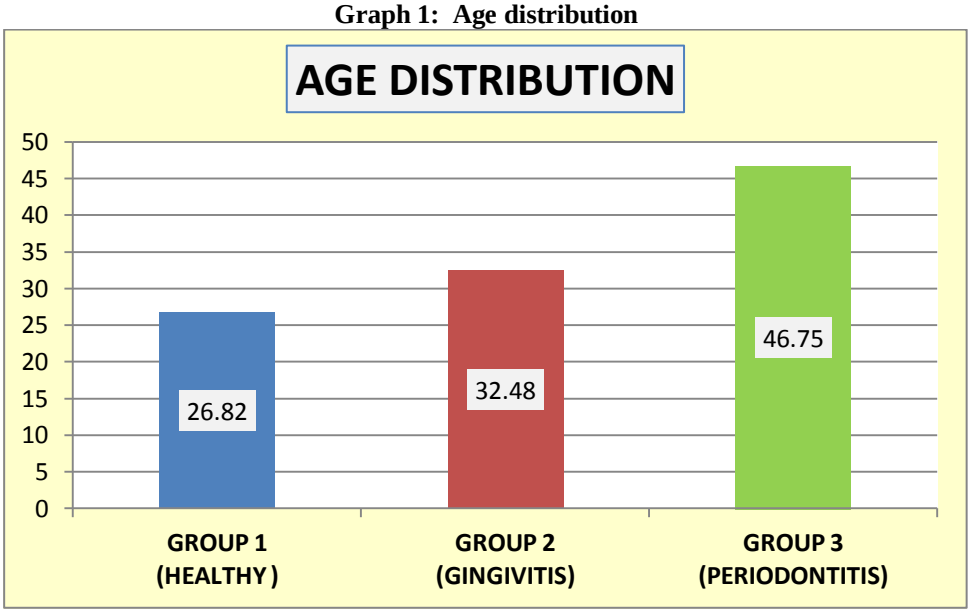
Table 3: Correlation of sleep index score with Gingival index (GI) score & Probing Depth (PD) using Pearson 'r' correlation coefficient

	Sleep index score vs	
	Gingival Index (GI)	**Probing depth (PD)**
GROUP 1 (Healthy) n = 29	**r = 0.390(moderate +) p =0.037***	**r = 0.170(weak +) p =0.379**
GROUP 2 (Gingivitis) n =27	**r = 0.258 (weak +) p = 0.177**	**r =0.405 (moderate +) p = 0.029***
GROUP 3 (Periodontitis) n =29	**r = 0.334 (moderate +) p = 0.076**	**r =0.758 (strong +) p <0.001****

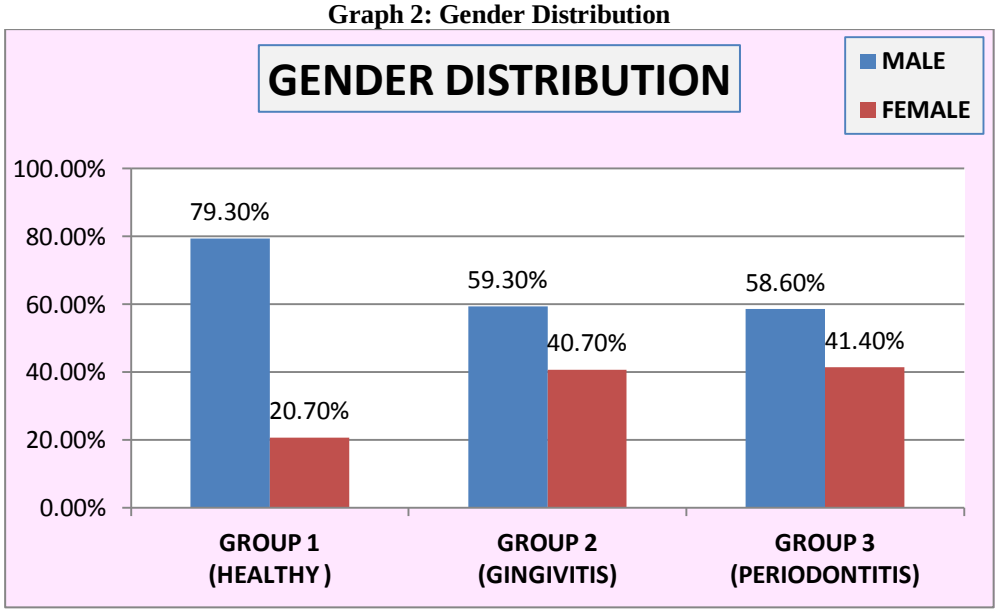
p >0.05 – no significant difference * p <0.05 – significant **p<0.001 – highly significant

GRAPHS

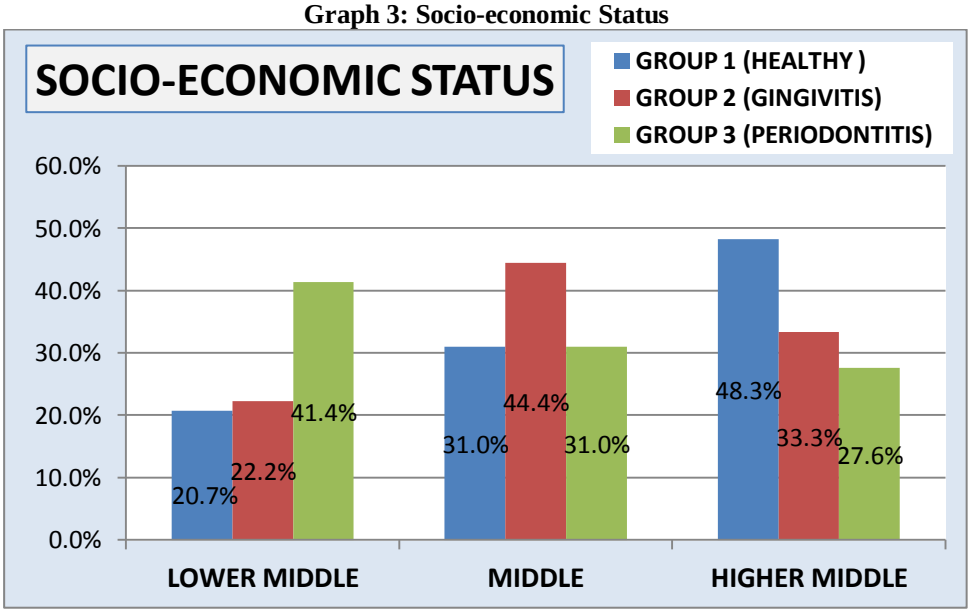
Graph 1: Age distribution



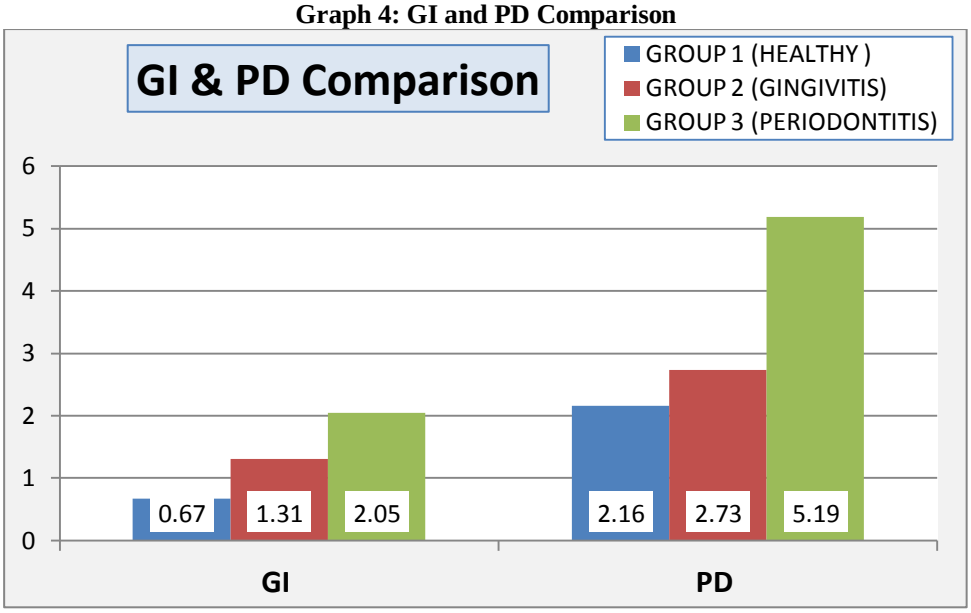
Graph 2: Gender Distribution



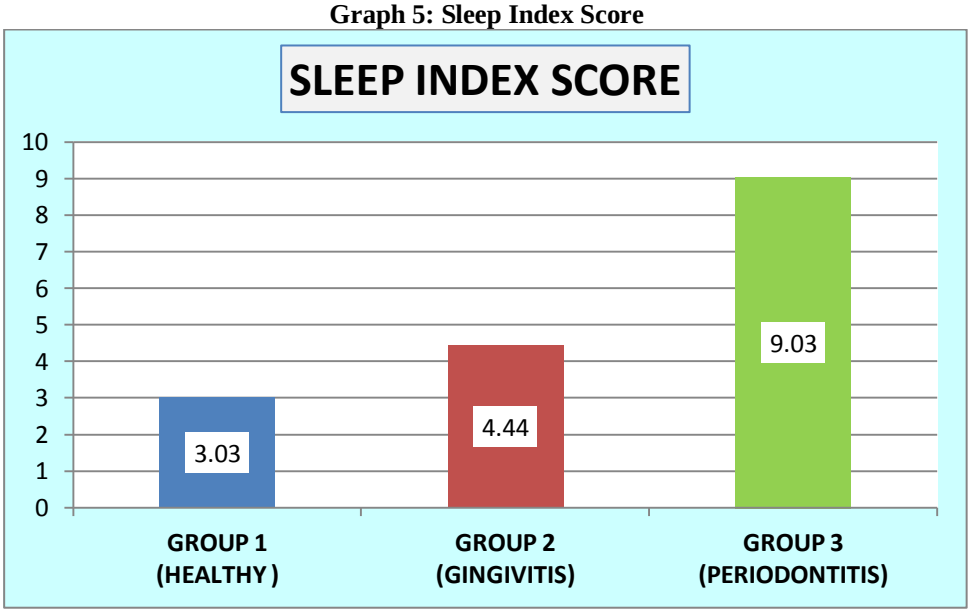
Graph 3: Socio-economic Status



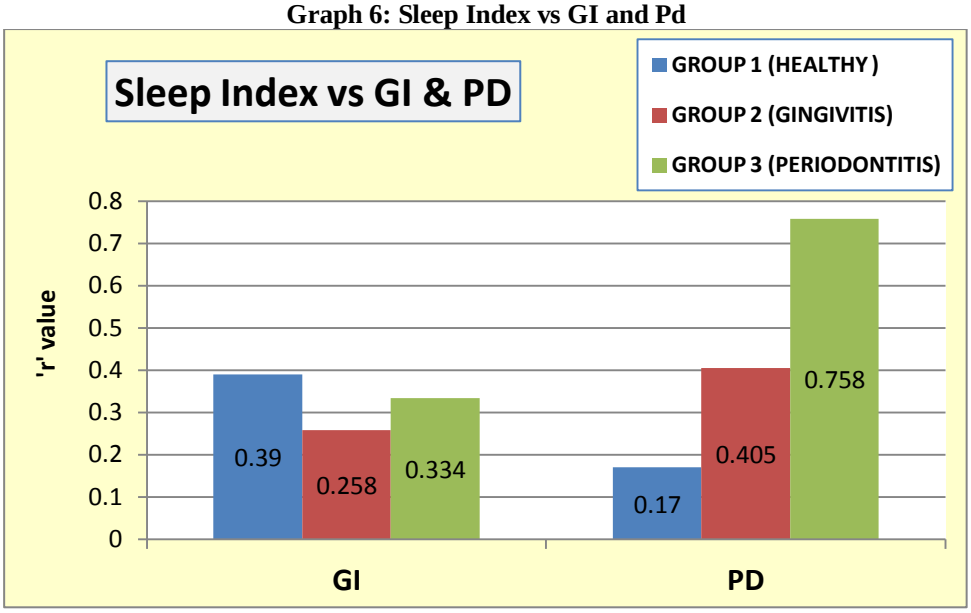
Graph 4: GI and PD Comparison



Graph 5: Sleep Index Score



Graph 6: Sleep Index vs GI and Pd



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