Chapter

Impact of Insomnia in the Elderly: The Correlation between Snoring and Apnea/Hypopnea Index

Bing Tang

Abstract

The purpose of this study was to examine the relationship between snoring and obstructive sleep apnea/hypopnea index in community dwelling older men and women. In this retrospective case-series study, the author was using a sequential collection of clinical datum design. There were 124 community-dwelling elders (mean age=71.85 years, Standard Deviation=4.85 years) with complaints of sleep disturbance. Including 46 females (F: M= 1:1.71), all the total subjects with sleep disturbance, after meeting the following criteria of exclusion: age below 65 years, heart failure, and chronic obstructive lung disease, were admitted to the sleep medicine laboratory where sleep questionnaire was used. They underwent in laboratory over-night polysomnography (PSG). The period of this study was 13 months; the total number of subjects whom took PSG in this Sleep Center Laboratory was 1,087 individuals during this period. The proposed neural model used is a generalized regression neural network (GRNN). This neural model has some advantages such as cost and time efficiencies in relation to experimental measurements. The training speed of the proposed technique is faster and the network architecture is simpler. In all likelihood, this model can be used in clinical applications that can reduce the necessity of in-laboratory nocturnal sleep studies since it has surpassed current classification approaches in terms of accuracy, simplicity, cost, time efficiency, and generalization. The correlation between snoring and AH1 was evaluated, though there was no measurement of vasopressin-positive and vasoactive-intestinal-polypeptide (AVP) neurons in postmortem examination of suprachiasmatic nucleus (SCN), as there was no death case. To the contrary, focus was set on the analysis of sleep disturbances that could be interpreted as the result of altered SCN function. The relationship between Snoring and AHI for the elderly with regard to its clue and impact on INSOMNIA is presented. The relationship between clinical sleep apnea and the physiological events surrounding the octogenarians was assessed. Clinically no indication for any brain tissue biopsy.

Keywords: apnea/hypopnea index (AHI), insomnia, obstructive sleep apnea, polysomnography (PSG), snoring, suprachiasmatic nucleus (SCN) nucleus, vasoactive-intestinal-polypeptide (AVP) neurons

1. Introduction

Sleep apnea is a condition that causes breathing to stop and start repeatedly during sleep. It can leave a person extremely exhausted and sleepy during the day; it is even

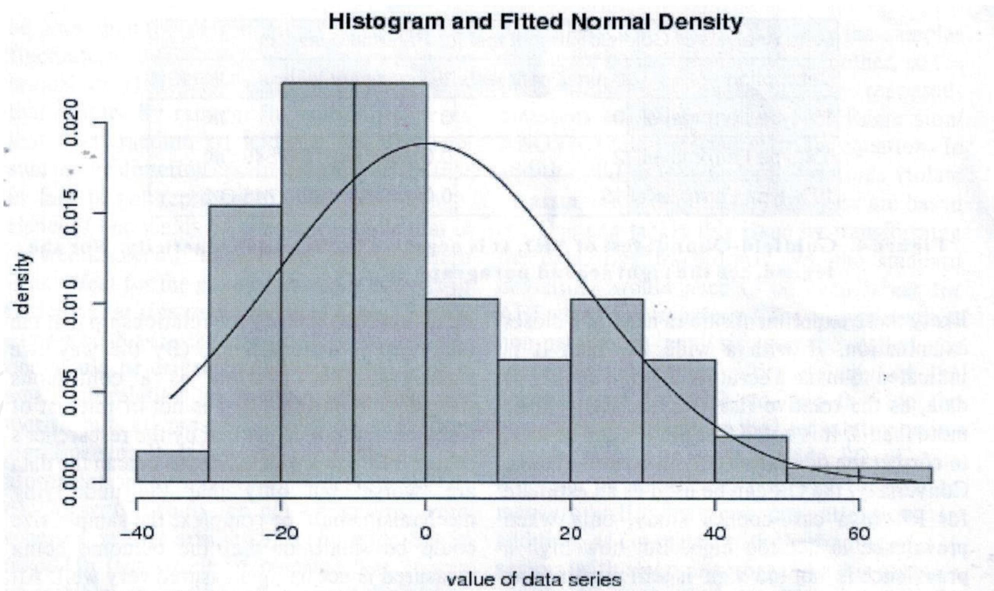

Figure 1.
Histogram of AHI distribution.

dangerous to one's own health. On the other hand, obstructive sleep apnea is the most common type of sleep apnea and it happens when the potential patients' airway is blocked and causes pauses in breathing and subsequently loud snoring. Normal snoring usually does not interfere with the quality of sleep almost as much as sleep apnea does. The author's data set were checked for normality of AHI distributions using the Kolmogorov-Smirnov's and Shapiro-Wilk's tests. The results (**Figure 1**) suggest that the data significantly deviate from a normal distribution, therefore, The null hypothesis of a normal distribution is rejected in this data set [1].

2. Materials and methods

2.1 Data collection

This study utilized the sequential collection of nocturnal EEG data from a community dwelling of older adults.

It was conducted from January 1, 2002 to January 31, 2003 at the Sleep Medicine Center (Laboratory) of Changhua Christian Hospital, Taiwan. Subjects with heart failure and chronic obstructive lung disease were excluded from the study, since there was no physician at night in the Sleep Medicine Laboratory.

The Hospital Internal Research Board and Ethical Committee approved the study, which was in conformity with the Declaration of Helsinki. The author reports no conflict of interest. Under these circumstances, among the consecutive subjects who underwent nocturnal polysomnography (PSG) during that period, there were alltogether 1,087 cases of PSG performed. The data belonged to individuals who were younger than 65 years were excluded. Hence, the inclusion criteria were (1) the chief complaint of sleep disturbance and (2) aged 65 years and over.

Therefore, 124 participants were selected out of 1,087 cases of PSG taken during study period. Not one of the participants was demented and they aged from 65 to 88.5 years. Also, no pairs of individuals were related to each other. Body mass index (BM1) data were available from 117 individuals and there were 11 octogenarians. The participants of this study provided consents that also include their personal and medical data. In addition, at the time of their initial evaluation and enrollment, they all authorized clinical data in the research database to be used in this study. All data used in accordance with the spirit and principles of Health Insurance Portability and Accountability Act regulations (H1PAA, 1996) [2]. All other data referred from other published studies with all their sources were respectively specified for the purpose of comparison. The Author reports no conflict of interest. Each individual gave a written informed consent. This author reports no conflict of interest.

2.2 Apnea hypopnea index

Initially, the subjects accomplished the Epworth Sleepiness Scale and Quality of Life SF-36 (QOL) sleep questionnaires to measure excessive daytime sleepiness (ESG). This tool is widely recognized and accepted because it is simple to use. The results of polysomnography (PSG) were collected from the participants and evaluated based on the apnea hypopnea index (AH1). There was a significant reduction in QOL for the apneic subjects. The degree of reduction was proportional to severity. For apneics with AH1 >30, there was greater impact on vitality, physical functioning, social functioning, mental health, and emotional functioning. Among the total 124 individuals, there was no single one who was demented. There was no pair of individuals related to each other.

2.3 Obstructive sleep apnea

The sleep recordings were scored according to the classification developed by Rechtschaffen and Kales [1, 3]. Kales et al used special techniques that allow subject mobility and obtain continuous electroencephalographic recordings of sleepwalkers [4]. An apneic event was defined as a reduction in airflow greater than ≥ 90% for a duration of 10 seconds or longer. A hypopneic event was scored if there is a decrease of airflow for at least 10 seconds in respirations, a 30-percent reduction in ventilation, and a decrease in oxygen saturation. The apnea hypopnea index (AH1) was calculated as the sum of events of apneas and hypopnea as per hours of nocturnal sleep. Subject with an AH1 of five or more was considered as having a diagnosable case of obstructive sleep apnea (OSA).

2.4 Polysomnography

Polysomnography (PSG) was conducted from 9:30 pm to 6:30 am in the sleep laboratory using Alice 4 Sleep Diagnostic System, Respironics, Carlsbad, Calif, USA and finger pulse oxymetry (model N 200. Nellcor, Hayward, California, U. S.). As far as the recordings are concerned, the latter included recording the central and occipital electroencephalogram (EEG) derivations (C3, C4, Ol, O2), bilateral electrooculogram (left outer canthus and right outer canthus), submental and anterior tibialis electromyogram (EMG), electrocardiogram, nasal/oral airflow were using a thermistor, respiratory effort using chest and abdominal inductance belts.

2.5 Sleep-disordered breathing

Sleep-disordered breathing (SDB) has been defined as having AH1 score of five or higher.

3. Results

3.1 Data analysis

The variables used in the analysis of the studied data contain some missing height data. Consequently, there is same small amount of missing BMI data, with less than 5.64 % (7/124) of the sample. Conversely, as compared with another data of 1,014 (aged 65 and over) control subjects came from 15,798 subjects who had participated in the Nutrition and Health Survey in Taiwan (NSC 93WFD2000205), between 1993 and 1996, one can tell that a missing rate of 5.64% is rather small. Age and blood pressure of those 1,014 subjects were analyzed and there were 665 subjects with complete data of their age, blood pressure, weight, height, and BMI, while 95.79% (15,133/15,798) of the control subjects were missing one or more of the above listed information. AH1 is classified according to the following 4 classes: < 5, between 5-15, between 15 and 30, and those > 30. For those AH1 equate and greater than 15, t test was done, and its p value is 0.023, which is significant. An independent t test was done to compare snorers and non-snorers who had AH1 at least 15, the result shows that there is a significant difference with a p value = 0.023. The point-biserial correlation coefficient which is used to measure the strength and direction of the association between one continuous variable and one dichotomous variable. It is symbolized here as rpb and pertains to the case that were collected where the variable of snoring is dichotomous and the other variable, AH1, is non-dichotomous. The dichotomous variable is treated as the X variable, its two possible values being coded as X=0 and X=l; and the non dichotomous variable, AH1 is treated as the Y variable (rpb = 0.39, two tailed p < 0001). On the other hand, the Spearman rank correlation coefficient between AHI and snoring, now as the continuous variable, reveals that there is a correlation coefficient rs = 0.26, with a confidential interval (Cl) of 0.09-0.42, and two tailed p = 0.0035. There is no inconsistency here: rpb and rs would tend to provide different measures of correlation because they are measuring correlation independently.

However, from the graph of Spearman's Rank Correlation test between AHI (RD1/T) and Snoring, it appears to be heteroskedastic, would tend to have the effect of artificially inflating the value of rpb. Among the 124 subjects of this study with sleep disturbance in this author's original study, there were 60 insomniacs. There are other related studies in 'super-healthy' elderly also independently found reduced amplitude of circadian output, whether from melatonin secretion or the ability to stay awake in the evening or stay asleep at the end of the night.

Both research teams, actually independently approximate the changes in the sleep homeostat with physiological measurements. Both involve in circadian rhythm reduction in amplitude phase. Both apply the same concept that the suprachiasmatic nucleus (SCN) declines with age, and more diminished with advanced age. Both independently follow the theory that there is a marked decrease in the total number of arginine vasopressin-positive (AVP), and vasoactive-intestinal-polypeptide neurons, and a diminishing in the suprachiasmatic (SCN) nucleus volume in 80- to 100-year-old individuals. SCN decreases in normal aging, which changes the circadian rhythms.

Those other studies independently investigate physiological mechanisms and clues resulting in diminishing SCN function, while this author's study focuses on physiological measurement of sleep disturbance and its fragmentation that could be interpreted because of altered SCN function. Obviously, sleep disturbances with the related sleep fragmentation are in the forefront to be linked by old age.

3.2 A novel finding of AHI: a quantile-quantile plots (q-q plots)

The quantile-quantile (q-q) plot is a graphical technique for determining if two data sets come from populations with a common distribution. The quantile-quantile plots of AHI suggest how far it deviates from being normal; the result is supported with kurtosis and skewness that are greater, / less than a -2 to +2 range when their standard deviations are considered. This implies that the assumption of normality appears to be not met; however, none of the measures of kurtosis and skewness on multiple linear regressions of AHI are being significant or worrisome.

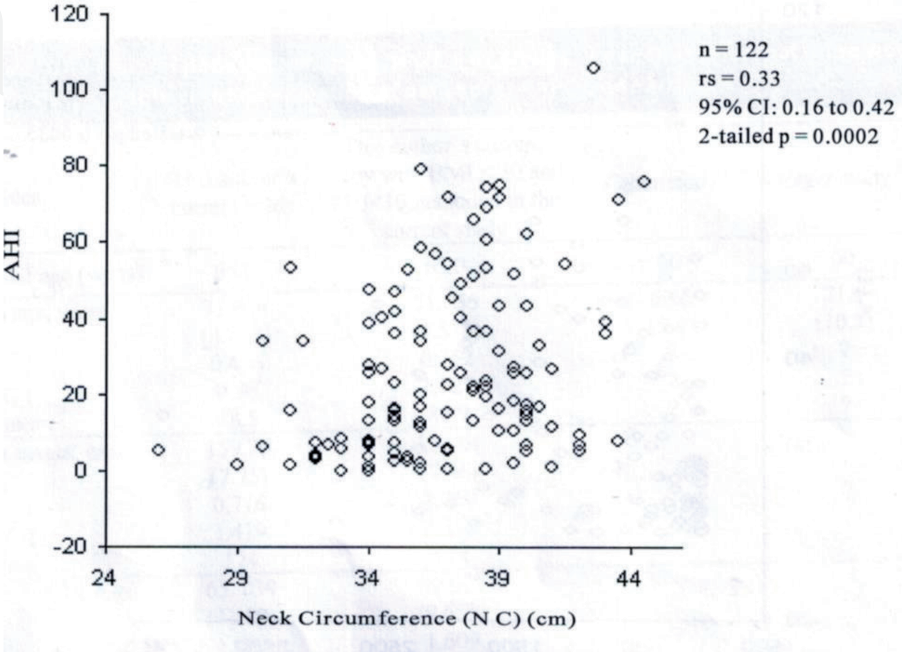

Figure 2.
The Spearman rank correlation coefficient between AHI and neck circumference.

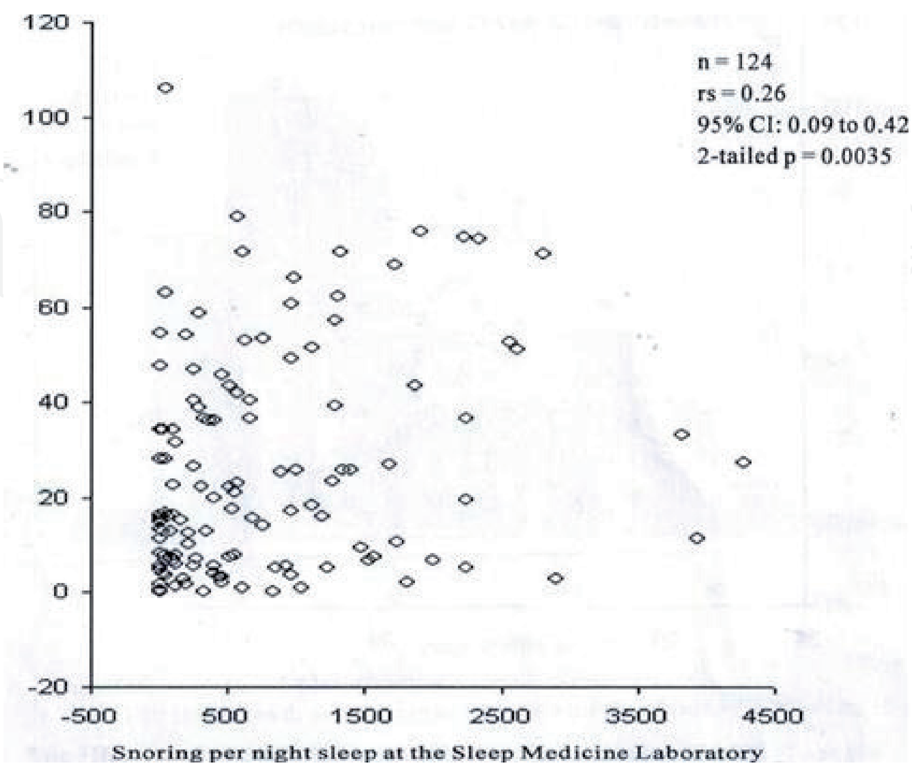

Figure 3.
The Spearman rank correlation coefficient between AHI and snoring.

3.3 AHI and BMI

BMI was calculated as weight (kilograms) divided by height squared (meters squared). It has direct relationship to obstructive sleep apnea. The upper limit of normal BMI in Far- East Asian is 23.5 kg/m2 from current WHO data. From the same set of data from one of Taiwanese studies [4–8], using the Spearman's rank correlation coefficient (rs), the correlation between AHI and BMI is 0.295 with a confidential interval (CI) of 0.09-0.42 (**Figure 2**). This rs is close to 0.330 which is the rs between AHI and neck circumstance. Therefore, the relationship between AHI and Neck Circumference can be used to approximate with that between AHI and BMI.

3.4 AHI and snoring

The Taiwanese study [5] is able to disclose that the AHI mode was 9.4 per hour; its count for 40 subjects. The highest number of AHI was 106 per hour in that study. There appears at least some effect on frequency of snoring by grouping factor of AHI. Spearman's rank correlation coefficient (rs) test revealed a mildly positive correlation between AHI and snoring (rs was 0.26) (**Figure 3**).

4. Discussion

Insomnia has been frequently caused by Sleep-disordered breathing. Sleep-disordered breathing (SDB) is defined as having AHI score of five or higher. It was 9 percent for women and 24 percent for men. According to US study, obesity, and male sex were strongly associated with the presence of sleep-disordered breathing [9]. It is important to recognize the signs and symptoms of sleep apnea, namely excessive daytime sleepiness and snoring. Prompt treatment of an underlying sleep disorder, such as OSAS, can relieve symptoms of psychiatric disease such as depression.

4.1 AHI values

A high percentage of over-65-years subjects have AHI > 5 in the US. Not all elders need to be all treated only if their AHIs are greater than five are, including but not limited to those degree 1 of Severity in our current studied subjects. An AH1 > 5 have conventionally been a cutoff point for the existence of SDB. A relatively higher point of cut-off of AHI > 15 has been used, especially for the elderly, in most of sleep studies. Those that have an AHI > 20 require treatment. Without treatment, obstructive sleep apnea can lead to serious complications and may lead to several life-threatening conditions. The responses to any treatment at different levels of AHI have received scant research attention, therefore, it is unclear that AHI is a risk factor for those aged over 65 years. However, a report in English by Ancoli-Israel et al [10] presented that it was central sleep apnea that is largely a risk factor and not obstructive apnea. Central sleep apnea occurs when the brain does not send proper signals to the muscles that control breathing. Therefore, central apnea predicts mortality above age of 65 years; others also published almost similar data [5, 11].

4.2 AHI and age

There are some other published studies that reported there is a marked decrease in the total number of AVP and vasoactive-intestinal-polypeptide neurons, as well as the SCN volume decreases in 80- to 100-year-old people compared with that are found in the younger normal adults. To analyze sleep disturbance as the result of altered SCN function, the age range of the sample in this study is within the assortment of 80 to 100 years of age. Attentions have been paid not only to Arginine Vasopressin-Positive (AVP) but as well to vasoactive- intestinal-polypeptide neurons, along with SCN regarding its volume and its number of neurons. With this regard, the study had 11 among the total 124 individuals being octogenarian and over, the finding will be compared with other studies [12].

In comparison, the aforementioned studies as well as the current study both independently approximate the changes in sleep homeostat with physiological measurements. Both involve in circadian rhythm reduction in amplitude phase. Both apply the same concept that the suprachiasmatic nucleus (SCN) declines with age, and more diminished with advanced age. Both independently follow the theory that there is a marked decrease in the total number of vasoactive-intestinal-polypeptide neurons, and a diminishing in the suprachiasmatic (SCN) nucleus volume in 80- to 100-year-old individuals. SCN decreases in normal aging, which changes the circadian rhythms.

Those other studies, just like this study, independently investigate physiological mechanisms and clues resulting in diminishing SCN function, while the current study focuses on physiological measurement of sleep disturbance and its fragmentation that could be interpreted because of altered SCN function. Obviously, sleep disturbances with the related sleep fragmentation, which in turn, results in INSOMNIA, are in forefront to be linked by old age (**Figure 4**).

4.3 The estimated prevalence of sleep-disordered breathing

It is known that the estimated prevalence of sleep-disordered breathing defined as an AH1 score of five or higher, was 9 percent for women and 24 percent for men. Male sex and obesity were strongly associated with the presence of sleep-disordered breathing (SDB). Conversely, habitual snorers, both men and women, tend to have a higher prevalence of AH1 of 15 or higher.

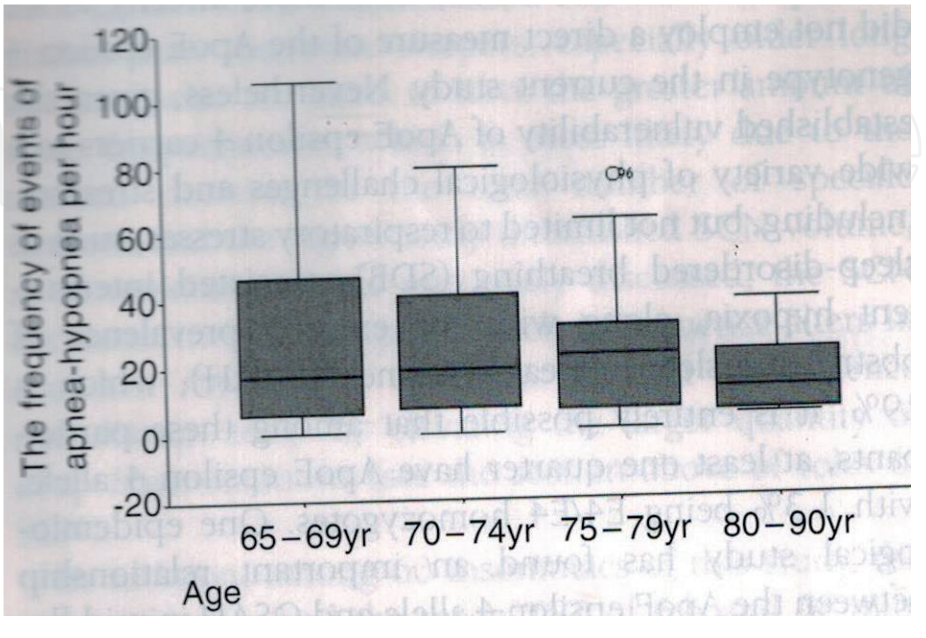

Figure 4.
Among participants who were aged 80 years and above, the minimal apnea/hypopnea index (AHI) was highest among all the age groups, while the median and maximum AHI were both lowest among all the age groups.

4.4 Difference in the two different ASSM criteria

As per the American Society of Sleep Medicine (ASSM) criteria for 1999 and 2007 respectively, it may differ on the oxyhemoglobin saturation study, but definitely, there is no difference in the sleep apnea criteria for the AHI cutoff of moderate obstructive sleep apnea. For those items that are different from both year criteria, for example, the recommended hypopnea definition of 2007, have to be met at least for the criteria as follows. The nasal pressure signal excursions decline by at least 30% of baseline. The duration of this diminishing, take place for a period lasting 10 seconds. There is an at least 4% desaturation for pre-event baseline. In addition, minimally, 90% of the event's duration must meet the amplitude reduction of criteria for hypopnea.

In addition, the difference between AASM's 1999 and 2007 in the definition of the respiratory events with regard to the severity of degree of obstructive sleep apnea is obviously identical with each other. In fact, the degrees of Sleep Apnea severity was AF11> 15/hr and > 30/hr representing respectively moderate and severe OSA according to the above criteria [13, 14]. With regard to the roles and function of the SCN, it has been clearly presented with the tabulation.

4.5 Maximum and minimum BMI

Females had mean height, weight, and cervical circumference less than the male counterparts. The female subjects had a mean BMI of 26.550 kg/m2, while male 25.19. The mean BMI of total 124 subjects was 25.574 + 4.521 kgs/m2, while that of control was 23.768 + 3.662 kg/m2, the difference was significant (the p-value < 0.0009). The Pearson's correlation coefficient between height and BMI was significantly different between males (-0.227) and females (-0.0854). In these data, the female subjects were about one year older than the male in the average. However, the female subjects had average (mean) height, weight, and cervical circumference, which were respectively less than the counter parts of the males. The 95% confidential interval for mean BM1 was 24.746-26.402. The minimum BM1 was 15.20, and maximum was 39.15.

4.6 Snoring and BMI

AH1 was noted to be correlated with BM1, snoring, body height and weight, and cervical circumference respectively. There was a highly significant correlation between BM1 and snoring. The subjects whose BMls were more than 25 had more frequent snoring than those whose BMls were less than 25 in the studied population. BM1 of patients was higher than control subjects. There were significant positive correlation between AH1 and BMI; Spearman's rank correlation test revealed that the relationship between snoring and BMI was highly significant.

4.7 The effect of BMI grouping on the frequency of snoring in a Taiwanese study

BMls were classified as following three groups; group 1 (BMI > 30), group 2 (BMI between 25 and 30), and group 3 (BMI < 25). Mann-Whitney test reveals as follows. The two groups of BMI were selected for comparison. Group difference between group 1 and group 2 was insignificant (Grouping factor BMI: Mann-Whitney test, degree of freedom (d.f.) = 1, p = 0.432). Group differences either between group 1 and group 3, or group 2 and group 3 were significant (Grouping factor BMI: Mann- Whitney test, d.f. = 1, p < 0.001, p= 0.001, respectively) [5]. The groups of subjects with their BMI > 30, and a BMI between 25 and 30 snored more frequent than those in the group with a BMI < 25.

4.8 A discussion on Asian OSA prevalence

There is little information on the prevalence and severity of obstructive sleep apnea in Asian snorers although OSA may not be uncommon in Asian patients. Nevertheless, there is a single report on Singapore population that is predominantly Chinese [15]. The authors maintain that the sleep apnea syndrome is more common than the 2-4% prevalence that is quoted frequently [9]. From the snorers aged from 30-60 years in an adult population in Singapore, the authors evaluate how many snorers suffer from pathological apnea as well as sleep apnea syndrome. Within a similar age group in the same population studied with PSG in their sleep laboratory, there were 106 consecutive habitual loud snorers. The authors have found that 24.1% were loud habitual snorers. 87.5% of loud habitual snorers had significant OSA on PSG and 72% of these apneics complained of excessive daytime sleepiness (EDS). Based on the assumption that all apneics snored, the authors speculate that sleep apnea syndrome affects about 15% of the population by extrapolating these figures. EDS in their cases were validated with clinical hypersomnia [16].

There are four stages of sleep; one for rapid eye movement (REM) sleep and three that form non-REM (NREM) sleep. Less than half of brain waves consist of delta waves during stage 3 while more than half of brain activity consists of delta waves during REM sleep. Poor delta wave sleep is obviously related to hypersomnolence. OSA occurred mainly in stage 1 and 2 non-rapid eye movement (NREM) sleep instead of in REM sleep. Frequently, the arousals prevented sleep from going beyond stage 1 and 2. Because the prevalence of sleep apnea syndrome in Singaporean population aged 30-60 years exceeds one's expectations, therefore, it is likely that the people in that population, aged 30 to 60 years, suffer more hypersomnolence, which is associated with the repression of delta wave sleep by apnea occurring taking place mostly in stage 1 and 2 NREM sleep [15]. Conversely, the reported prevalence of OSA reveals as follows. The 19% of 1,775 subjects with a mean age of 71 years, SD 10.5, range 40-100 had OSA [6]. In the Philippines and Taiwan, there is no such above study.

Sleep-disordered breathing (SDB) is defined as having AH1 score of five or higher, it was 9 percent for women and 24 percent for men. According to a US study, obesity was strongly associated with the presence of sleep-disordered breathing in men [17]. In the US, a large percentage of over-65- years subjects have AH1 > 5 and elders do not need to be treated if their AHIs are greater than 5. An AHI > 5 have conventionally been a cutoff for the presence of SDB but in most of sleep studies, a higher cut-off of AHI > 15 have been used. An AHI > 20 might be better to distinguish those requiring treatment. There are not enough proposed studies that will shed light on the treatment responses at different levels of AHI. It is unclear that AHI is a risk factor for those aged over 65 years. Also, Asian's smaller upper airway merits attention. With respect to the risk factors for SDB, for example, it was reported from Singapore that other population also reported largely similar risk factors associated with habitual snoring and SDB [15]. Therefore, differential risks may highlight the importance of ethnicity in determining the burden of SDB. It is important for the health care development and research on SDB in Asia to remain alert of this circumstance in both lay and professional communities [18].

4.9 Risk factors of snoring

Snoring has independent and significant risk factor. It raises the risk for diabetes, obesity, hypertension, stroke, heart attack, and other cardiovascular problems. Snoring can create major relationship problems too. For all practical purpose, individuals were referred to the Sleep Studies because of their mixed sleep problems. It is common that an individual is unaware of his own snoring. It is not a correct assumption that subjects who did not give an account of snoring and sleepiness do not have OSA. We should always be ready to lend a hand by questioning the respective bedroom partner of a potential patient with chronic sleepiness and fatigue, or other type of sleep disturbances.

4.10 Studies on snoring

For examples, some other U S studies reveal that Tractenberg et al's findings [19, 20] were as follows. The large sample of their own 2005 and 2006 articles are originally derived from the community and they are not from a single sample with sleep disturbances. Their data still may be useful as an external and independent reference for the samples cited in this study. Hence, by comparing studies for what has been reported in this chapter, Tractenberg et al have obvious advantages on their data intake to a certain extent. This is true only if we are aggressively tracing data that have been achieved 29 years ago, for instance, as of September 2002 [19, 20]. In their studies, the criteria of the frequency of snoring were defined as: 0. for never; 1, for less than once per month; 2, for at least once per month; 3, at least, once per week; and finally, 4, nearly everyday per day/ night. Those participants who were non-demented elderly people had the frequency rating of heavily snoring from 0.7 +1.1 to 0.9 + 1.2. Those reports encounter the issue of the level of awareness of the sleep disturbance problems in the reporters at nights.

The literature estimates the prevalence habitual snoring in general population ranges from 3.6% to 35.7% [9, 21, 22]. In one of the studies in Taiwan [5], it interviewed 1,252 subjects of a sleep-medicine-laboratory based cohorts, who lived in the dwelling communities of Changhua area, Mid- Taiwan, which is adjacent to Taichung area. Their ages range from 10 to older than 60 years. 606 were males and 646 were females. The snoring prevalence in Taichung area, Taiwan, is 47.8 % for males, whereas 37.2% for females according to a report by Liu and Liu [23].

Sawit [24] has extensively reported that snoring is a risk factor for stroke, myocardial infarction, as well as acute vascular disease. In addition, habitual snorers are generally more at risk than occasional snorers. Except one by Liu and Liu [23], Taiwan does not have enough of such studies. Therefore, further studies to probe on the relationship of sleep apnea with snoring should have been carried out.

5. Conclusion

In short, other than the clarification for relationship between Snoring and AHI for the elderly as presented in this study, this study also successfully examined the relationship between clinical sleep apnea resulting in insomnia, as well as the physiological events surrounding the octogenarians among the elderly individuals studied.

Other than what has been discussed and mentioned previously, is there any model that we may follow accordingly? Certainly, there is. About twelve years ago, this author together with Yan proudly published an article entitled "A NOVEL MODEL USING GENERALIZED REGRESSION NEURAL NETWORK (GRNN) FOR ESTIMATING SLEEP APNEA INDEX IN THE ELDERLY SUFFERING FROM SLEEP DISTURBANCE. " The proposed model has sensitivity and specificity of 95.7% and 50% respectively for training cases, while 88.0% and 52.9%, respectively for the testing cases [25].

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