

Prevalence of Snoring and Witnessed Apnea in Taiwanese Adults

Li-Pang Chuang¹, MD; Shih-Chieh Hsu², MD; Shih-Wei Lin¹, MD; Wen-Shan Ko³, MD; Ning-Hung Chen^{1,4}, MD; Ying-Huang Tsai¹, MD

Background: Sleep-disordered breathing (SDB) is a prevalent disorder that has a huge impact on the public. It has been proposed that Chinese populations have a higher incidence of SDB than Caucasians due to a narrow cranial base and flat mid-face structure. Few studies have investigated the prevalence of SDB in Taiwan. This study prospectively assesses the complaints of SDB and related conditions via telephone interviews with individual older than fifteen in Taiwan to calculate a possible prevalence.

Methods: Computer-assisted telephone interviews were conducted from Oct. 25, 2006 to Nov. 6, 2006. Individuals aged over 15 years were interviewed. The number of successful interviews was calculated based on the population prior to the study. Demographic data and data for symptoms of SDB and medical conditions were obtained.

Results: In total, 4,011 individuals, 1,634 males and 2,377 females, completed the interviews. The prevalence of snoring in these Taiwanese individuals was 51.9% [95% confidence interval (CI) 51.13%-52.67%], 60.8% (95% CI 58.67%-62.93%) in males and 42.5% (95% CI 40.26%-44.74%) in females. The prevalence of witnessed apnea during sleep was 2.6% (95% CI 2.1%-3.1%), 3.4% (95% CI 2.6%-4.2%) in males and 1.9% (95% CI 1.28%-2.52%) in females. The prevalence of snoring and witnessed apnea was significantly higher in males than in females ($p < 0.05$). Prevalence of hypertension, cardiovascular disease, diabetes mellitus, arthritis and backache was higher in those who snored or had witnessed apnea than those without these symptoms ($p < 0.05$).

Conclusion: This study determined that 51.9% (95% CI 51.13%-52.67%) of Taiwanese snore and 2.6% (95% CI 2.1%-3.1%) have witnessed apnea. Those who snore or have witnessed apnea have a higher incidence of comorbidity with major medical diseases compared to those who do not snore or do not have witnessed apnea.

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Key words: snore, witnessed apnea, prevalence, Taiwan

From the ¹Sleep Center, Department of Pulmonary and Critical Care Medicine; ²Department of Psychiatry; ³Department of Family Medicine, Chang Gung Memorial Hospital, Taipei, Chang Gung University College of Medicine, Taoyuan, Taiwan; ⁴Chang Gung Institute of Technology, Taoyuan, Taiwan.

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Correspondence to: Dr. Ning-Hung Chen, Sleep Center, Department of Pulmonary and Critical Care Medicine, Chang Gung Memorial Hospital, 5, Fusing St., Gueishan Township, Taoyuan County 333, Taiwan (R.O.C.) Tel.: 886-3-3281200 ext. 2281; Fax: 886-3-3287787; E-mail: ninghung@yahoo.com.tw

Sleep-disordered breathing (SDB) is a prevalent disorder. Notably, SDB is associated with daytime sleepiness, poor memory, decreased ability to concentrate, and increased vascular events such as hypertension, strokes and heart attacks.⁽¹⁾ Snoring is almost invariably a symptom of obstructive sleep apnea (OSA) and may be a precursor to OSA.⁽²⁾ Early studies have shown that even trivial snoring may be the first step in a continuum leading to full-blown sleep apnea syndrome.⁽³⁾ Isolated studies imply that snoring may be a risk factor for some major medical conditions, such as diabetes mellitus.⁽⁴⁾

A study has proposed that Chinese populations have a higher incidence of SDB than Caucasians due to a narrow cranial base and flat mid-face structure.⁽⁵⁾ However, few studies have investigated the prevalence of SDB in Taiwan. This study prospectively evaluates complaints of SDB and related conditions by telephone interviews with individuals in Taiwan to calculate a possible prevalence.

METHODS

Subjects

This study used computer-assisted telephone interviewing (CATI),⁽⁶⁾ a method of telephone interviews assisted by a computer. Subjects aged over 15 years living in Taiwan (including Taiwan island, Penghu County, Kinmen County and Lienchiang County) were investigation targets. The number of subjects to be interviewed was calculated according to the population distributions in each county and an estimated SDB prevalence (3%-4%). From Oct. 25, 2006 to Nov. 6, 2006, 11,649 individuals chosen randomly based on Taiwan's phone book were approached by CATI. In total, 3,862 (33.2%) refused to be interviewed for any reason, and 3,776 (32.4%) persons did not complete the interview due to problems such as language barriers and poor telephone/cell phone quality. In total, 4,011 (34.4%) persons successfully completed the interview during the investigation period. This number reached the requirement of a 95% confidence interval (CI) and bias of 3%.

Operation of CATI

A CATI system for counseling provides scripted prompts to a counselor to gather specified information and enter it into the computer. The computer

then automatically displays the next scripted prompt in a structured protocol depending on the subject's response. Prompts were the questions that list in the next paragraph. The subjects were interviewed by 40 well-trained telephone investigators. CATI systems help to standardize counseling protocols across multiple users, and also serve as excellent data management tools for report generation and analysis.

Questions on the CATI

Questions during the telephone interview obtained data on SDB symptoms, major medical conditions and demographic information. Demographic data, such as age, gender, weight, height, body mass index (BMI), occupation and marriage status, were obtained. Questions regarding SDB included the following: "Do you or your family hear you snore when you sleep?" and "Have you or your family ever witnessed apnea when you sleep?" Questions also addressed major medical diseases in the past year, such as hypertension (defined as a self-reported diagnosis of hypertension made by a physician or under treatment for hypertension), cardiovascular disease (defined by self-reported angina, myocardial infarction or heart attack), diabetes mellitus, arthritis, backache, respiratory disease (such as chronic bronchitis, asthma, emphysema or dyspnea), anemia, mental disease (such as depression or manic-depressive disorder) or hemodialysis.

Statistical analysis

The chi-square test was applied to compare categorical data for health conditions among those who snored. All statistical tests utilized SAS software (SAS Institute, Cary, NC, U.S.A.). A value of $p < 0.05$ was considered statistically significant. Raking ratio estimation was used after data was collected for the differences between gender and age compared to the normal population.

RESULTS

A total of 4,011 subjects, include 1,634 males (40.7%) and 2,377 females (59.3%), were interviewed successfully. The percentage of age distribution was 15.8%, 36.1% and 48.1% among ages 15-30, 31-50 and > 50 years, respectively. The mean weight of these subjects was 60.9 ± 11.6 kilograms and mean height was 162.2 ± 8.1 centimeters. Most

of them were married (72.6%) and about half of them (51.4%) had a job when interviewed.

Table 1 presents the prevalence and gender distribution of snoring and witnessed apnea during sleep. The prevalence of snoring among these individuals in Taiwan was 51.9% (95% CI 51.13%-52.67%), significantly higher in males than females [60.8% (95% CI 58.67%-62.93%) vs. 42.5% (95% CI 40.26%-44.74%), $p < 0.001$]. The prevalence of witnessed apnea during sleep was 2.6% (95% CI 2.1%-3.1%), also significantly higher in males than females [3.4% (95% CI 2.6%-4.2%) vs. 1.9% (95% CI 1.28%-2.52%), $p < 0.05$]. The prevalence of snoring in males aged ≤ 50 and > 50 years, and in females ≤ 50 and > 50 years was 57.9% (95% CI 55.32%-60.48%), 63% (95% CI 59.26%-66.74%), 37.1% (95% CI 35.78%-38.42%) and 49.1% (95% CI 45.12%-53.08%), respectively. This suggested a higher trend for those aged > 50 years. The prevalence of witnessed apnea in males ≤ 50 and > 50 years, and in females ≤ 50 and > 50 years was 2.3% (95% CI 1.52%-3.08%), 5.3% (95% CI 3.56%-7.04%), 1.4% (95% CI 1.08%-1.72%) and 2.8% (95% CI 1.49%-4.11%), respectively. This indicated a higher trend for those aged > 50 years, especially for males. The mean BMI of snorers and non-snorers, and of those with witnessed apnea and without witnessed apnea was 21.8 ± 3.4 , 23.8 ± 3.8 , 22.7 ± 3.7 and 24.5 ± 3.8 , respectively. This showed that snorers and those with witnessed apnea had a significantly higher BMI (both $p < 0.001$). Occupation and marriage status were not significantly related to snoring or witnessed apnea during sleep.

Table 2 summarizes the relationship between SDB symptoms and major medical diseases. The incidence of hypertension in the snoring population and those with witnessed apnea was significantly higher than for those without these symptoms ($p < 0.001$). The incidence of cardiovascular disease

was 6.9% (95% CI 5.8%-8.0%) and 15.8% (95% CI 8.7%-22.9%) among snorers and those with witnessed apnea, respectively. These values were higher than those for the population without SDB symptoms.

The incidences of diabetes mellitus, arthritis and backache among snorers were 4.7% (95% CI 3.8%-5.6%), 9.4% (95% CI 8.1%-10.7%) and 33.7% (95% CI 31.6%-35.8%), respectively. These values were higher than those for non-snorers (Table 2). The incidence of diabetes mellitus, arthritis and backache among those with witnessed apnea was 10.9% (95% CI 4.8%-16.9%), 14.9% (95% CI 7.9%-21.8%) and 48.5% (95% CI 38.8%-58.2%), respectively. These values were also significantly higher than those for people without SDB symptoms.

Subjects with symptoms of snoring and witnessed apnea showed no difference for the incidence of anemia and hemodialysis compared with those without these symptoms. The incidence of respiratory disease and mental disease was significantly higher among those with witnessed apnea ($p < 0.001$), but not snorers ($p = 0.127$ and 0.087), than for those without these symptoms.

Figures 1 and 2 illustrate the incidence of major medical diseases in snorers vs. non-snorers, and witnessed apnea vs. no witnessed apnea. Statistical significance is denoted by * = $p < 0.05$, † = $p < 0.01$ and ‡ = $p < 0.001$.

DISCUSSION

Snoring is a common symptom. Although the prevalence of snoring varies between studies due to its highly subjective nature, reported prevalence is 5%-78% in males and 2%-59% in females.^(7,8) These differences between males and females primarily depend on two issues: who answers the question (the snorer or bed partner) and what methods are used

Table 1. Gender Differences of Snorers and Those with Witnessed Apnea

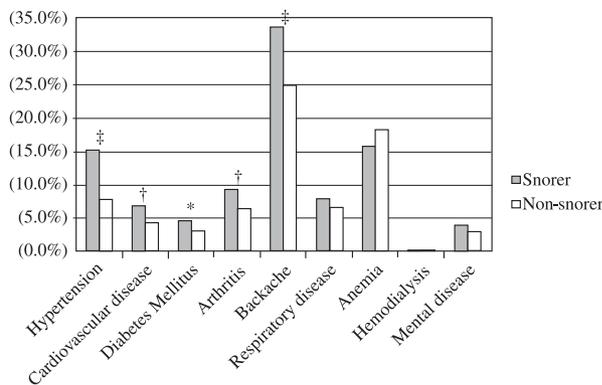
	Snoring n = 2019 (51.9%, 95% CI, 51.13%-52.67%)		Witnessed apnea n = 101 (2.6%, 95% CI, 2.1%-3.1%)	
Male	n = 1223 (60.8%, 95% CI, 58.67%-62.93%)	$p < 0.001$	n = 66 (3.4%, 95% CI, 2.6%-4.2%)	$p < 0.05$
Female	n = 796 (42.5%, 95% CI, 40.26%-44.74%)		n = 35 (1.9%, 95% CI, 1.28%-2.52%)	

Abbreviation: CI: confidence interval

Table 2. Incidences of Major Medical Diseases in a Population of Snorers or Those with Witnessed Apnea Compared to Non-Snorers and Those without Witnessed Apnea

Disease	Snorer	Non-snorer	<i>p</i>	Witnessed apnea	No witnessed apnea	<i>p</i>
	n = 2019	n = 1867		n = 101	n = 3715	
Hypertension	305 (15.1%; 95% CI 13.5-16.7%)	148 (7.9%; 95% CI 6.7-9.1%)	<i>p</i> < 0.001	36 (35.6%; 95% CI 26.3-44.9%)	398 (10.6%; 95% CI 9.6-11.6%)	<i>p</i> < 0.001
Cardiovascular disease	139 (6.9%; 95% CI 5.8-8.0%)	82 (4.4%; 95% CI 3.5-5.3%)	<i>p</i> = 0.001	16 (15.8%; 95% CI 8.7-22.9%)	189 (5.1%; 95% CI 4.4-5.8%)	<i>p</i> < 0.001
Diabetes mellitus	95 (4.7%; 95% CI 3.8-5.6%)	58 (3.1%; 95% CI 2.3-3.9%)	<i>p</i> = 0.01	11 (10.9%; 95% CI 4.8-16.9%)	134 (3.6%; 95% CI 3.0-4.2%)	<i>p</i> < 0.001
Arthritis	190 (9.4%; 95% CI 8.1-10.7%)	121 (6.5%; 95% CI 5.4-7.6%)	<i>p</i> = 0.001	15 (14.9%; 95% CI 7.9-21.8%)	286 (7.7%; 95% CI 6.8-8.6%)	<i>p</i> = 0.009
Backache	680 (33.7%; 95% CI 31.6-35.8%)	467 (25.0%; 95% CI 23.1-26.9%)	<i>p</i> < 0.001	49 (48.5%; 95% CI 38.8-58.2%)	1044 (28.1%; 95% CI 26.7-29.6%)	<i>p</i> < 0.001
Respiratory disease	161 (8.0%; 95% CI 6.8-9.2%)	125 (6.7%; 95% CI 5.6-7.8%)	<i>p</i> = 0.127	17 (16.8%; 95% CI 9.5-24.1%)	256 (6.9%; 95% CI 6.1-7.7%)	<i>p</i> < 0.001
Anemia	323 (16.0%; 95% CI 14.4-19.2%)	342 (18.3%; 95% CI 16.6-20.1%)	<i>p</i> = 0.55	19 (18.8%; 95% CI 11.2-26.4%)	632 (17.0%; 95% CI 15.8-18.2%)	<i>p</i> = 0.635
Hemodialysis	2 (0.1%; 95% CI 0-0.2%)	3 (0.2%; 95% CI 0-0.4%)	<i>p</i> = 0.592	1 (1.0%; 95% CI 0-2.9%)	4 (0.1%; 95% CI 0-0.2%)	<i>p</i> = 0.16
Mental disease	81 (4.0%; 95% CI 3.6-4.4%)	56 (3.0%; 95% CI 2.2-3.8%)	<i>p</i> = 0.087	10 (9.9%; 95% CI 4.1-15.7%)	119 (3.2%; 95% CI 2.6-3.8%)	<i>p</i> < 0.001

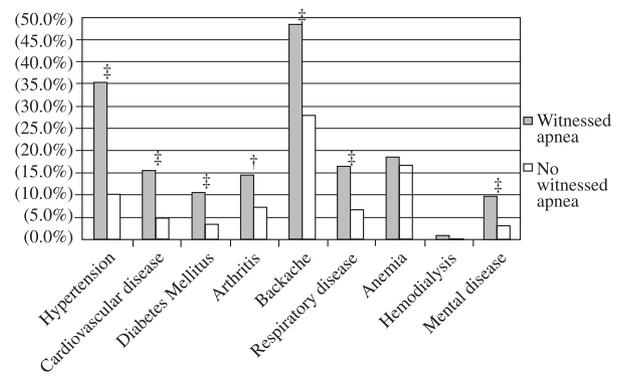
Abbreviation: CI: confidence interval



*: *p* < 0.05; †: *p* < 0.01; ‡: *p* < 0.001

Fig. 1 Incidence of major medical diseases in snorers and non-snorers.

(self-reported data or a sleep laboratory study). In this study, which used CATI, overall prevalence of snoring was 51.9% (95% CI 51.13%-52.67%) in Taiwanese individuals. The prevalence of snoring among males was higher than among females (60.8% vs. 42.5%, *p* < 0.001). This analytical result is simi-



*: *p* < 0.05; †: *p* < 0.01; ‡: *p* < 0.001

Fig. 2 Incidence of major medical diseases in those with witnessed apnea and no witnessed apnea.

lar to that obtained in a previous study (57% in males and 37% in females in the Taichung area).⁽⁹⁾ Possible factors accounting for male snoring predominance are differences in pharyngeal anatomy and function differences in hormones, as well as differences in the perceptions of snoring between males and females.⁽¹⁰⁾

Snoring is the major symptom of SDB but is not synonymous with SDB. Although snoring is not a prerequisite for upper airway resistance syndrome (UARS), which was described by Guilleminault *et al.*⁽¹¹⁾ and is characterized by sleepy patients with fragmented sleep rather than apnea, the presence of snoring implies an elevated upper airway resistance with limited inspiratory flow.⁽¹²⁾ Such episodes of flow limitation are frequently terminated by an arousal, so-called respiratory effort-related arousals (RERA), which lead to OSA.

This study demonstrates a high incidence of hypertension and cardiovascular disease among snorers and those with witnessed apnea. Compared with a large study of hypertension prevalence in Taiwan,⁽¹³⁾ this study shows a slightly higher incidence of hypertension (15.1% vs. 13%) than that in the snorer group and an even higher prevalence (35.6%) in the witnessed apnea group. Some studies have confirmed that snoring is highly correlated with hypertension and cardiovascular disease.⁽¹⁴⁾ Lugaresi *et al.* determined that snoring is associated with acute elevation of blood pressure.⁽¹⁵⁾ However, the Sleep Heart Health Study⁽¹⁶⁾ and another study⁽¹⁷⁾ identified no significant association between self-reported snoring and hypertension or cardiovascular disease.

The incidence of diabetes mellitus, arthritis and backache were higher for snorers and subjects with witnessed apnea than for those without these symptoms. Compared with an epidemiology study of diabetes mellitus prevalence in Taiwan, this study demonstrates a lower prevalence in both the snorer group and the witnessed apnea group (4.7% and 10.9% vs. 12%).⁽¹⁸⁾ This analytical finding can be explained by the large fraction of undiagnosed diabetes mellitus in the general population.⁽¹⁹⁾ A prospective study suggested that snoring is an independent factor related to an elevated risk of type II diabetes. The possible mechanism was thought to be through insulin resistance via elevated sympathetic tone and intermittent hypoxia.⁽²⁰⁾ A previous study also demonstrated that snoring is positively correlated with marital status and alcohol use by males, and obesity, diabetes and arthritis in females.⁽²¹⁾ The strong correlation between arthritis and backache, and SDB may be due to disruption in slow wave sleep, resulting in unrefreshing sleep, diffuse musculoskeletal pain, tenderness and fatigue in normal

healthy subjects.⁽²²⁾

Previous data imply a link between sleep-related breathing disorders (both snoring and witnessed apnea) and asthma-related symptoms.⁽²³⁾ However, for schizophrenic patients, the incidence of SDB was not higher than that of a control group.⁽²⁴⁾ This study demonstrated that the incidences of respiratory disease and mental disease are statistically significant in people with witnessed apnea but not snorers. This is due to the different definitions used in questions that may underestimate the prevalence of SDB by asking respondents about witnessed apnea. A previous study also demonstrated a high prevalence of SDB in hemodialysis patients, which is frequently underdiagnosed.^(25,26) This study identified no statistically significant relationship between hemodialysis and SDB, a finding that may be due to an excessively small number of hemodialysis cases in this study.

This epidemiological study, which used telephone interviews to investigate the prevalence of SDB and diseases related to SDB in Taiwanese individuals, has some limitations. First, questions in this study have limitations in their definitions; for example, witnessed apnea when sleeping can be representative of problems other than SDB. Second, this study did not differentiate between habitual snoring and occasional snoring. Moreover, this study did not clearly define the level of anemia (such as hemoglobin level) and hypertension (such as mmHg level). Most limitations were due to the methods used via telephone interview, which cannot reach subjects face to face. Although the telephone investigators were well-trained and were asked to interpret the questions in detail, sometimes they still cannot clearly define the disease as physicians are able to do.

In conclusion, 51.9% (95% CI 51.13%-52.67%) of Taiwanese individuals have snoring symptoms and 2.6% (95% CI 2.1%-3.1%) have witnessed apnea. The incidences of hypertension, cardiovascular disease, diabetes mellitus, arthritis and backache were significantly higher in those with SDB symptoms than in those without SDB symptoms. Further research to define the correlation between SDB and these major medical diseases is warranted.

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睡眠打鼾和呼吸暫停在台灣成年人的盛行率

莊立邦¹ 許世杰² 林士為¹ 柯汶姍³ 陳濤宏^{1,4} 蔡熒煌¹

背景： 睡眠相關呼吸疾患是一個相當盛行且對社會有很大影響的疾病。有此一說，在漢民族中，因為顛底骨比較窄且中臉部位相對扁平，所以比西方人有著更高的睡眠呼吸疾病盛行率。到目前來講，還沒有相關於台灣睡眠呼吸疾患盛行率的大規模報告。因此，我們設計了一個前瞻性的研究，利用電話訪問的方式去探討台灣成年人睡眠呼吸疾患的盛行率，以及其所相關連的各種疾病狀況。

方法： 從西元 2006 年 10 月 25 日到同年 11 月 6 日，我們進行了電腦輔助的電話訪問調查。樣本取樣為居住於台灣地區 15 歲以上的成年人，且樣本分佈根據台灣各縣市的人口比例取樣。調查的項目包括睡眠呼吸疾病的相關症狀以及基本人口統計資料和健康狀態。

結果： 總共 4011 位成年人完成調查訪問，包括 1634 位男性及 2377 位女性。台灣成年人打鼾的盛行率為百分之 51.9 (95% 信賴區間 51.13%-52.67%)，其中男性的盛行率為百分之 60.8 (95% 信賴區間 58.67%-62.937%)，而女性的盛行率為百分之 42.5 (95% 信賴區間 40.26%-44.74%)。在睡眠呼吸暫停方面，其總括的盛行率為百分之 2.6 (95% 信賴區間 2.1%-3.1%)，男性和女性的盛行率分別為百分之 3.4 (95% 信賴區間 2.6%-4.2%) 和百分之 1.9 (95% 信賴區間 1.28%-2.52%)。不管是打鼾或是睡眠呼吸暫停，台灣男性的盛行率都顯著的比女性高 ($p < 0.05$)。在調查人口中，有睡眠相關呼吸患者，如打鼾或睡眠呼吸暫停，其高血壓、心血管疾病、糖尿病、關節炎、和背痛的部分，都顯著的比沒有睡眠相關呼吸患者高 ($p < 0.05$)。

結論： 本篇研究顯示台灣人的打鼾盛行率為百分之 51.9 (95% 信賴區間 51.13%-52.67%)，而睡眠呼吸暫停的盛行率為百分之 2.6 (95% 信賴區間 2.1%-3.1%)。有打鼾或睡眠呼吸暫停的成年人，比沒有者有更高的相關疾病發生率。

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長庚紀念醫院 台北院區 ¹胸腔科 睡眠中心，²精神科，³家庭醫學科；長庚大學 醫學院；⁴長庚技術學院

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通訊作者：陳濤宏醫師，長庚紀念醫院 胸腔科 睡眠中心。桃園縣333龜山鄉復興街5號。Tel.: (03)3281200轉2281;

Fax: (03)3287787; E-mail: ninghung@yahoo.com.tw