THE VALIDITY AND RELIABILITY OF THE BAHASA MALAYSIA VERSION OF THE STOP-BANG QUESTIONNAIRE FOR IDENTIFYING OBSTRUCTIVE SLEEP APNEA

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LIST OF ABBREVIATIONS

AASM	American Academy of Sleep Medicine
AHI	Apnea Hypopnea Index
BMI	Body Mass Index
BP	Blood Pressure
BQ	Berlin Questionnaire
Dr	Doctor
CPAP	Continuous Positive Airway Pressure
EDS	Excessive Daytime Sleepiness
EEG	Electroencephalography
EMG	Electromyography
ENT	Ear, Nose and Throat
ESS	Epworth Sleepiness Scale
GERD	Gastroesophageal Reflux Disease
HUSM	Hospital Universiti Sains Malaysia
LPR	Laryngopharyngeal Reflux
NPV	Negative Predictive Value
ORL-HNS	Otorhinolaryngology – Head and Neck Surgery
OSA	Obstructive Sleep Apnea
PPSP	School of Medical Sciences
PPV	Positive Predictive Value

PSG	Polysomnography
SBQ	STOP-Bang Questionnaire
SDB	Sleep Breathing Disorder
UARS	Upper Airway Resistance Syndrome
WHO	World Health Organization

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ABSTRAK

Pendahuluan : Apnia tidur obstruktif adalah salah satu masalah yang paling utama dalam Otorinolaringologi. Ia dicirikan oleh gangguan pernafasan yang terhenti atau cetek secara berulang semasa tidur yang disebabkan oleh obstuktif saluran pernafasan atas yang lengkap atau separa. Apnia tidur obstruktif adalah masalah tidur yang sering dijumpai tetapi jarang dilaporkan oleh penyedia penjagaan kesihatan asas. Antara faktor-faktor risiko untuk apnia tidur obstruktif adalah obesiti, usia lanjut, lelaki, ukur lilit leher dan sejarah keluarga dan kecenderungan genetik. Polisomnogram kekal sebagai "gold standard" untuk membuat diagnosis apnia tidur obstruktif. Walau bagaimanapun, ujian ini mengambil masa yang lama menyebabkan masa menunggu meningkat. Soal selidik STOP-Bang ialah soal selidik yang mudah diisi sendiri oleh pesakit dan telah disahkan bagi mengesan apnia tidur obstruktif dengan kepekaan yang tinggi. Ini membolehkan pengamal perubatan untuk mengutamakan rujukan pesakit berisiko tinggi apnia tidur obstruktif ke klinik gangguan tidur.

Objektif : Menilai kesahihan dan kebolehpercayaan soal selidik STOP-Bang versi Bahasa Melayu dalam menyaring pesakit apnia tidur obstruktif berdasarkan perbandingan dengan polisomnogram.

Cara kajian dilaksanakan : Kajian ini merupakan kajian keratan rentas yang dijalankan di klinik tidur Hospital Universiti Sains Malaysia. Terjemahan ke hadapan dan ke belakang SBQ dilakukan dengan kehadiran kakitangan perubatan dan pakar dwibahasa untuk menghasilkan versi akhir BM SBQ. Versi terakhir telah diuji kepada 10 pesakit untuk "face validity". Semua 134 orang pesakit yang datang secara ulangan ke klinik tidur yang telah menjawab soal selidik STOP-Bang versi Bahasa Malaysia akan menjalani ujian tidur. Kesahihan dan kebolehpercayaan versi terjemahan soal selidik diuji terhadap polisomnogram (PSG).

Keputusan : Kami memerhatikan 134 pesakit, dengan puratanya berumur 41.22 $\pm$ 12.66 tahun dan 63.4% adalah pesakit lelaki. Antara semua pesakit, 28.4% mempunyai apnia tidur obstruktif pada tahap sedikit, 33.6% mempunyai apnia tidur obstruktif sederhana dan 38.1% mempunyai apnia tidur obstruktif yang teruk. Skor STOP-Bang mempunyai kepekaan, kekhususan, nilai ramalan positif dan nilai ramalan negatif untuk apnia tidur obstruktif masing-masing adalah 61.42%, 71.05%, 84.06% dan 41.54%.

Kesimpulan : Soal selidik STOP-Bang versi Bahasa Malaysia adalah alat yang efektif untuk menyaring pesakit apnia tidur obstruktif berdasarkan nilai kepakaan dan kekhususan yang diperoleh.

ABSTRACT

Introduction : Obstructive sleep apnea (OSA) is one the most major problem in otorhinolaryngology. It is characterized by repetitive episodes of shallow or paused breathing during sleep which is cause by complete or partial obstructions of the upper airway. OSA are common but rarely reported and addressed by primary health care providers. Among the risk factors for OSA are obesity, advanced age, male gender, neck circumference and family history and genetic predisposition. In diagnosing OSA, polysomnogram (PSG) remains the "gold standard". However, this test takes time hence its waiting time increased. The STOP-Bang questionnaire (SBQ) is a self-administered, simple and validated questionnaire that detects OSA with high sensitivity which allows practitioners to prioritize the referral of patients at high risk of OSA to sleep disorders clinic.

Objectives : To determine construct validity and reliability of Bahasa Malaysia (BM) version of SBQ by comparing to PSG and apply it in clinical setting as a screening tool for OSA.

Methodology : This is a cross sectional study done in Sleep Clinic of Hospital Universiti Sains Malaysia. Forward and backward translation of SBQ was done with presence of medical personnel and bilingual experts to produce the final BM version of SBQ. The final version was tested to 10 patients for a face vailidity. All 134 patients under our sleep clinic follow up completed a translated version of the STOP-Bang questionnaire in Bahasa Malaysia and

underwent a sleep study. The concurrent validity and reliability of the translated version of the questionnaire was tested against polysomnogram (PSG).

Results : We observed 134 patients, mean age was 41.22 $\pm$ 12.66 years old and 63.4% were male patients. Among all patients 28.4% had mild OSA, 33.6% had moderate OSA and 38.1% had severe OSA. A STOP-Bang score had sensitivity, specificity, positive and negative predictive value (PPV) for OSA of 61.42%, 71.05%, 84.06% and 41.54%, respectively.

Conclusion : The Bahasa Malaysia version of STOP-Bang questionnaire is a powerful tool for stratifying patients in the diagnosis of OSA with acceptable sensitivity and specificity value.

CHAPTER 1
INTRODUCTION
AND
LITERATURE
REVIEW

CHAPTER 1 : INTRODUCTION AND LITERATURE REVIEW

1.1 BACKGROUND OF STUDY

Obstructive sleep apnea (OSA) is a serious, relatively common sleep disorder characterized by recurrent episodes of cessation of breathing during sleep due to upper airway narrowing and closure (Bahammam, 2009). The Sleep Health Heart Study, prospective study of adults aged over 40 years, found that approximately 17% of the subjects studied had clear evidence of OSA (Punjabi et al, 2009). The National Sleep Foundation poll in 2005 reported that as many as 25% of American adults are high risk of OSA (Hiestand et al., 2006). Sharma et al. (2006) in their cross-sectional study using sleep questionnaire and polysomnography (PSG) showed that the prevalence of OSA is 25.16%. According to *Singapore Sleep Society (2008),* sleep related disturbances affect an estimated 20% of adults and children, and are commonly encountered in general practice, while the prevalence of (OSA) was 2-4% which was highest in Malays. As for OSA in Malaysia, researchers in University of Malaya in 2007 estimated the prevalence of OSA syndrome in middle aged men and women to be 9% and 4% respectively while the prevalence of OSA in general population is between 2% and 4% which are comparable to the Singaporeans and Koreans; 4.5% in men and 3.2% in women (Pillar, 2009). In 2009, a study by Zalinawati et al among the medical students in University Malaysia Sarawak found that daytime sleepiness was 35.5% especially those undergoing clinical postings and 16.1% reported to have bad sleep quality. Nazatul et al (2009) reported that there was moderate prevalence of sleep disturbance among nurses working in Melaka Hospital which however was not associated with the work shifts.

1.2 DEFINITION OF OBSTRUCTIVE SLEEP APNEA

OSA is a common sleep breathing disorder characterized by repetitive partial or total obstruction of the upper airway, causing episodes of apnea and hypopnea during sleep (Young et al, 2004). It is part of sleep-related upper airway obstruction problems those range from upper airway resistance syndrome (UARS) to OSA. The most extreme condition is called obesity-hypoventilation syndrome or Pickwickian syndrome. The breathing pauses cause acute adverse effects, including oxyhemoglobin desaturation, fluctuations in blood pressure and heart rate, increased sympathetic activity, cortical arousal, and sleep fragmentation. Apnea is defined as a drop in the peak thermal sensor excursion greater than or equal to 90% of baseline for at least 10 seconds. Hypopnea is defined as a reduction in airflow of $\geq$ 30% of baseline that lasted for at least 10 seconds and resulted in either a $\geq$ 3% decrease in oxygen saturation from the pre-event baseline or an arousal (Berry et al, 2014).

Apnea-hypopnea index (AHI) is the combined numbers of both apnea and hypopnea divided by patient's total sleep time in hours. However, there are several studies that defined AHI differently. Iber et al (2007) defined AHI as only events with an associated oxygen desaturation. Other definitions count all events that produce a physiologic response. In addition to the oxygen desaturation, arousal on EEG, surrogates of arousal, changes in sympathetic activity like pulse, and so forth are used to validate a detected respiratory event and allow it to contribute to the AHI (Berry, 2012). To date, AHI remains the best, and certainly the most used value to evaluate patients with OSA for diagnosis and its severity. Therefore, in diagnosing OSA, PSG is gold standard in addition to the clinical symptoms and physical findings.

1.3 SEVERITY OF OSA

The severity of OSA is assessed by several methods. The test can be either subjective like Epworth sleepiness scale (ESS) or objectively measured like individual's AHI, which indicates how many times per hour the patient experiences obstructive events during PSG testing.

The ESS questionnaire was introduced in 1991 (Murray, 1991). ESS questionnaire was developed as a simple screening tool to quantify the level of daytime sleepiness in adults. It is a brief scale that asks the subject to rate on a scale of 0 to 3 (0 = none, 3 = high chance of dozing) the level of sleepiness during eight daily activities. It is a quick, inexpensive and flexible in measuring patient's chronic sleepiness (Kryger, 2000). ESS is the best available tool in guiding the clinician to the patient's perception of their daytime sleepiness. Figure 1.1 and Table 1.1 showed the validated Malay version of ESS questionnaires and severity scoring respectively.

Questionnaire adapted from The Epworth Sleepiness Scale. Validated by Kumar (2002)

Apakah kebarangkalian anda untuk berasa mengantuk atau tertidur dalam keadaan di bawah berbanding sekadar terasa letih? Gunakan skala berikut untuk memilih nombor yang bersesuaian bagi setiap situasi.(sila tandakan)

0= Tidak pernah terasa mengantuk

1= Kebarangkalian kecil untuk berasa mengantuk

2= Kebarangkalian sederhana untuk berasa mengantuk

3= Kebarangkalian besar untuk terasa mengantuk

	K eadaan	**0**	**1**	**2**	**3**
1.	Duduk dan membaca				
2.	Menonton TV				
3.	Duduk ,tidak aktif di tempat awam, seperti di pawagam atau mesyuarat				
4.	Sebagai penumpang kereta selama satu jam tanpa henti				
5.	Berbaring untuk berehat waktu tengahari ketika lapang				
6.	Duduk sambil berbual dengan seseorang				
7.	Duduk berehat selepas makan tengahari (tanpa alkohol)				
8.	Dalam kereta yang berhenti beberapa minit semasa trafik				
	JUMLAH				

Figure 1.1 Validated Malay version of ESS Questionnaire

Table 1.1 ESS Scoring

Scoring	Severity
<11	Normal
11-14	Mild
15-18	Moderate
>18	Severe

The total score of the eight questions is calculated and the higher the total score, the higher the level of sleepiness (0-24). Although ESS has high internal consistency, it showed inconsistent sensitivity and specificity values (Jennifer et al, 2016). ESS also has been reported to have high positive predictive values but lower negative predictive values (El-Sayed, 2012).

The more objective and widely used method in determining the severity of OSA AHI. AHI is the average number of apnea and hypopnea per hour sleep during PSG testing. The American Academy of Sleep Medicine in 2008 has classified the severity of OSA based on the AHI and degree of sleepiness. Table 1.2 shows the classification of severity of the OSA.

Table 1.2 Classification of severity of OSA

Severity	AHI	Degree of Sleepiness
Mild OSA	5-15	Involuntary sleepiness during activities that require little attention, such as watching TV or reading
Moderate OSA	15-30	Involuntary sleepiness during activities that require some attention, such as meetings or presentations
Severe OSA	>30	Involuntary sleepiness during activities that require more active attention, such as talking or driving

1.4 PATHOPHYSIOLOGY OF OSA

The pathophysiology of OSA is complex and incompletely understood. There are many factors contributing to the pathophysiology of OSA which are shown in Table 1.3. Segment of the upper airway which extends from the nasal choanae to the epiglottis lack rigid or bony support. Therefore, the patency and stability of the upper airway depends mainly on the action of oropharyngeal dilator and abductor muscles. These muscles actions are normally activated in a rhythmical fashion during each inspiration. The control of these muscles is regulated by a number of processes including respiratory drive, negative pressure reflexes, and state (sleep) effects. The upper airway will collapse in the absence of forces to maintain its patency i.e when the negative airway pressure generated by inspiratory activity of the diaphragm and intercostal muscles is greater than the force produced by these muscles. The contributing factors that can cause upper airway obstruction are anatomical narrowing of the upper airway, excessive loss of upper airway muscle tone and defective upper airway protective reflexes (Deegan, 1995). Fogel et al. (2004) discussed regarding concept of upper airway myopathy in OSA pathophysiology.

As compared to a normal healthy person, patient with OSA have a reduction both in tonic and phasic contraction of these muscles which leads to functional impairment of the upper airway dilating muscles during sleep. According to Mathew et al. (1984), apnea and hypopnea in OSA patient occurred in combination both anatomical abnormalities of the pharynx and reduced neural activation. Pharyngeal occlusion in patient with OSA can occur at multiple sites of the pharynx including nasopharynx, velopharynx, oropharynx and hypopharynx. The most common site of occlusion is at the velopharynx. Anatomical factors which contribute to a decrease in the

cross-sectional area of the upper airway are enlarged turbinates or nasal mass, enlarged tonsils and adenoids, small airway below the base of the tongue, a long bulky soft palate, an inferiorly placed hyoid bone and retrognathia and abnormal positioning of the maxilla and mandible. They also may contribute to increase of pressure surrounding the airway which predispose the airway to collapse (Schwab RJet al.,2003; P.C. Deegan, 1995). The Bernoulli's effect also plays an important dynamic role in OSA pathophysiology. In accordance with this effect, airflow velocity increases at the site of stricture in the airway. As airway velocity increases, pressure on the lateral wall decreases. If the transmural closing pressure is reached, it will cause the airway collapse. Total occlusion or critical narrowing of the upper airway either fully eliminates or reduced ventilation which leads to hypercapnea and hypoxia. This will further cause increase in respiratory effort and eventually triggers arousal.

This leads to a surge of pharyngeal dilator muscle activity and resolution of the upper airway obstruction. This is a repetitive process at night which allows intermittent hypercapnea and hypoxia, fragmented sleep and triggering adrenergic surges with each cycle (Weiner et al., 1982). Arousal mechanisms may have an important role in the pathophysiology of OSA. In normal individuals, when relief of upper airway occlusion is accompanied by arousal, the pharyngeal resistance will be reduced and there will be drop in end-tidal carbon dioxide tension due to hyperventilation. However, in patients with OSA, evidence of arousal usually precedes or coincides with the preferential increase in upper airway tone that restores airway patency and terminates the obstructive apnoea.

Table 1. 3 Factors contributing to the pathophysiology of obstructive sleep apnoea (Deegan et al., 1995)

General factors	Anthropometric (male sex, age, obesity) Drugs (ethanol, hypnotics) , Genetics
Reduced upper airway calibre	Specific anatomical lesions (enlarged tonsils, micrognathia) Neck flexion, Nasal obstruction
Mechanical factors	Supine posture Increased upper airway resistance Increased upper airway compliance
Upper airway muscle function	Abnormal upper airway dilator muscle activity Impaired relationship of UA muscle and diaphragm contraction
Upper airway reflexes	Impaired response to negative pressure Feedback from the lungs
Central factors	Reduced chemical drives Increased periodicity of central drive Inadequate response to breath loading
Arousal	Impaired arousal responses Postapnoeic hyperventilation

1.5 RISK FACTORS OF OSA

There are multiple risk factors that can contribute to OSA. These factors can be divided into structural and nonstructural factors. Structural factors include any craniofacial abnormalities such retrognathia and micrognathia, adenotonsillar hypertrophy, any cause of nasal obstruction such as deviated nasal septum or polyps among others. The nonstructural factors include obesity, central fat distribution, male sex, age and familial factor. Redline et al (1995) stated that patient who had family history of sleep breathing disorder (SBD) is more likely to have OSA which is about 2 to 4 fold increased risk. Among many population-based studies done regarding risk factors of OSA, obesity and male gender were found to be most consistent risks (Young et al, 2002). Table 1.4 shows several risk factors in developing OSA.

Table 1.4 Risk Factors for Obstructive Sleep Apnea (Malhotra A et al., 2002)

Risk Factor	Evidence
Obesity—present in roughly 70% of OSA	+++
Male gender	+++
Aging	++
Postmenopausal state	++
Black race	+
Alcohol, smoking, hypothyroidism, acromegaly	+/-

OSA, Obstructive sleep apnea, level of evidence +++ >++> +

1.5.1 Obesity

The prevalence of overweight and obesity in developed and developing country continue to grow at an alarming rate and is associated with significant morbidities. It has been estimated that globally 1.6 billion adults are overweight (BMI>25 kg/m^2) and 400 million are obese (BMI >30 kg/m^2). Table 1.5 shows WHO classification for BMI. According to Young et al (2002), obesity is one of the most important risk factor in OSA. One of the possible reasons for this strong relationship between obesity and OSA is that the upper airway is narrowed in obese patients as a result of increased fat deposition in the pharyngeal walls (Deegan et al, 1995). Other explanations for this association are increase in neck circumference and smaller lung volumes particularly functional residual capacity (FRC) in obese patient. There is about 3 to 4 fold increased risk of upper airway obstruction during sleep in obese individual as compared to non-obese person (Young et al, 1993). These associations are particularly notable amongst male adults who display comparatively more central fat deposition. Peppard et al (2000) also found the association of the body weight and AHI. Based on their study, a 10% weight gain has been shown to predict about 32% increase in AHI while 26% decrease in AHI predicted in 10% weight loss. Another study concluded that with 3-18% of weight loss, there is improvement in AHI about 3-62% (Henri et al., 2013).

Table 1.5 The International Classification of adult underweight, overweight and obesity according to BMI (Nishida C. et al., 2004)

Classification	BMI(kg/m^2)	
	Principal cut-off points	Additional cut-off points
Underweight	<18.50	<18.50
Severe thinness	<16.00	<16.00
Moderate thinness	16.00 - 16.99	16.00 - 16.99
Mild thinness	17.00 - 18.49	17.00 - 18.49
Normal range	18.50 - 24.99	18.50 - 22.99
		23.00 - 24.99
Overweight	≥25.00	≥25.00
Pre-obese	25.00 - 29.99	25.00 - 27.49
		27.50 - 29.99
Obese	≥30.00	≥30.00
Obese class I	30.00 - 34.99	30.00 - 32.49
		32.50 - 34.99
Obese class II	35.00 - 39.99	35.00 - 37.49
		37.50 - 39.99
Obese class III	≥40.00	≥40.00

1.5.2 Aging

Although OSA can occur in any age group, the prevalence of OSA appears to be higher in older adults compared to the middle-aged populations. Patient with OSA commonly presented at age group of 40-60 years old (Young et al, 1993). Ancoli et al (1985) found that 28% of randomly selected patients (>65 yrs) in their study had apnoea frequencies of more than 5 episodes per hour. However, these patients were asymptomatic of OSA of which they had come to the conclusion that the result may be normal in this age group. Evidence from the Sleep Heart Health Study shows that the prevalence of OSA in age group more than 65 years old was almost 2 to 3 fold higher compared to age group 30-64 years old (Young et al, 2002). According to this study, the increment of risk became plateau after 65 years old. One of the reasons given is that possibility of increased mortality from OSA and its complications after age of 65. White DP et al (1985) found that pharyngeal resistance increases with age in normal men and its possible related to greater body weight. Based on this study, they postulate that risk of developing OSA increases with age in men. Later a study done shows prevalence of OSA increase in older age group due to the age related anatomical changes in pharynx which lead to increase upper airway collapsibility (Malhotra et al, 2000). There is no definite conclusion from the previous studies to ascertain the causes of age-related risk factor for OSA. Lam (2010) proposed several factors which lead to it. There are increase deposition of fat in the parapharyngeal area, lengthening of the soft palate, and changes in body structures surrounding the pharynx in elderly patients. This anatomical changes will cause reduce in upper airway calibre which leads to increase upper airway resistance, with the generation of a more negative pharyngeal pressure during inspiration and thereby predispose to upper airway occlusion during sleep.

1.5.3 Gender

Most of the previous studies done consistently demonstrated a higher risk for OSA among male adults compared to women. However, there is no clear evidence to determine whether sex differences alone contribute to increase risk of OSA in men. Young et al (1993) found that the incidence of OSA men is twice higher compared with women. Data analysed by Sleep Heart Health also showed the risk of OSA in men was greater with odds ratio 1.5 (Young et al, 2002). According to Lam et al (2010), OSA is 2 to 3 times more common in men. Most of these studies also correlate obesity and increasing age as the cofactor contributed to gender differences. As mentioned by Deegan et al (1985), pharyngeal and supraglottic resistances in men are higher than women. This factor may contribute to the male predominance of OSA as they are more susceptible to pharyngeal collapse. The exact mechanism underlying that remains unclear. However, there are few possible associating factors which are greater incidence of obesity among males, possible deleterious effects of male sex hormones or possible protective effect of female sex hormones.

1.5.4 Neck circumference

Neck circumference is one of the risk factors for OSA and several studies done to determine the association between them. Incidence and severity of OSA depends more on the increased neck circumference rather than general obesity. This is due to external compression by superficially located fat masses that may cause narrowing of upper airway in obese patients with OSA (Deegan et al, 1985). Simpson, (2010) made a conclusion from their study that neck circumference correlate best with AHI in women while the abdominal girth correlated better with

AHI in men. However, according to Kamil et al (2007), found that BMI independently associated with OSA but not neck circumference.

1.5.5 Family history and genetic predisposition

There are several studies done to suggest association of familial or genetic predisposition as a risk factor for OSA. Patients with strong family history of OSA are more likely to have OSA as evidenced by the clinical symptoms and sleep laboratory result (Deegan, 1995). Lam et al (2010) in their study mentioned that there is relatively increase risk of 1.5 to 2 in first degree relatives of those with OSA as compared to those without OSA. The susceptibility for the patient to get OSA also increases directly with the number of affected relatives. However, they also relate that the genetics of obesity may play a role in the familial factor.

1.6 SYMPTOMS AND CLINICAL PRESENTATION OF OSA

Patient with obstructive sleep apnea (OSA) usually manifests with wide spectrum or variety of history and symptoms. The most common presenting complaints are snoring, observed apnea, and excessive daytime sleepiness (Shepertycky et al, 2005). As the symptoms are broad spectrum and non specific, patients often presented years after they actually had them. Lack of physician awareness also is one of the reason causing OSA to be underdiagnosed and undertreated (Lattimore et al, 2003). Symptoms of OSA are divided into daytime and nocturnal symptoms as listed in Table 1.6. The nocturnal symptoms are more specific as compared to daytime symptoms. According to Pagel (2009), sleep deprivation, medication effects, illicit

substance use and other medical and psychiatric conditions are among the other causes of excessive daytime sleepiness besides OSA. In OSA, recurrent episodes of apnea and hypopnea lead to recurrent hypoxia and repetitive arousals from sleep causing the excessive daytime sleepiness. Indeed, the only two symptoms that make OSA patients attend the clinic are loud snoring and EDS (Dobbin and Strollo, 2002). Shepertycky et al (2005) studied the differences between men and women in the clinical presentation of OSA. According to this study, men commonly presented with history of observed apnea while women always complaint of insomnia. However, it is not really conclusive as women are always more sensitive to their partner's breathing problems during sleep as compared to men. It is very important to recognize these symptoms early as OSA often associated with significant morbidity, largely due to impaired daytime function, with excessive daytime sleepiness and consequent increased risk of accidents and cardiovascular complications (Dobbin and Strollo, 2002).

Table 1.6 Classification of OSA symptoms (Friedman, 2009)

Nocturnal symptoms	Daytime symptoms
Snoring Observed apneas Dyspnea (choking/gasping) Drooling Dry mouth Bruxism Restless sleep/frequent arousals Gastroesophageal reflux (GERD) Nocturia	Excessive daytime sleepiness Morning headaches Neurocognitive impairment: - vigilance (secondary impact on concentration and memory) - executive functioning - motor coordination Diminished quality of life Mood and personality changes: - Depression - Anxiety - Irritability Sexual dysfunction: - decreased libido - impotence - abnormal menses

Bakr et al (2015) studied the association between OSA and GERD. GERD is more common in OSA patients as compared to controls with rate of occurance of 43.3% and 13.3 % respectively. There is also a marked reduction of 61.5% in GERD symptoms after treated with continuous positive airway pressure (CPAP). Xavier (2013) in their cross-sectional study of 74 patients found that 89% of the studied population had signs and symptoms of laryngopharyngeal reflux (LPR). In LPR patient, the lower pH exposure in the upper airway may cause significant edema and tissue inflammation thus will make obstructive physiology of the upper airway worsened. Early treatment of LPR could reduce the severity of OSA. To date, all studies showed subjective improvement of OSA symptoms such as snoring, daytime sleepiness and GERD symptoms but not the AHI index (Zanation et al, 2005).

1.7 DIAGNOSIS OF OSA

1.7.1 Questionnaire

PSG remains the "gold standard" in diagnosing OSA. However, it is difficult to detect early and making a diagnosis with the limitation of the sleep laboratories availability (El-Sayed, 2012). The availability of a simple, validated and reliable screening tool that can stratify patients by their risk of having OSA will allow practitioners to prioritize the referral of patients at high risk of OSA to sleep disorders clinic. The definition for screening is "the act of doing a test on a person … to look for evidence of a disease". There are many questionnaires available as a screening tool and diagnosis of OSA. The frequently used are the Berlin questionnaire, STOP questionnaire and ESS. The Berlin questionnaire was developed in 1996 at the Conference on Sleep in Primary Care in Berlin-Germany. It has 11 questions grouped in 3 categories which are

nocturnal symptoms, daytime sleepiness and risk factors i.e hypertension and obesity. The individual is considered to be high-risk if two or three of the categories are positive. Later in 2008, the STOP questionnaire was developed for OSA screening in surgical patients. The STOP questionnaire includes four questions related to snoring, tiredness, observed apnea and high blood pressure. The ESS, was created by Murray W. Johns in 1991. However, as compared to the previous two, the ESS measures subjective daytime sleepiness rather than screening of OSA (El-Sayed, 2012).

1.7.2 STOP-Bang Questionnaire

The SBQ was developed as a screening tool for OSA in preoperative clinics setting as a guide in anticipating perioperative complications (Chung et al, 2008). The STOP-Bang questionnaire includes snoring, tiredness, observed apnea, high blood pressure, BMI, age, neck circumference and male gender. For each of the questions, answering "yes" scores as 1 and "no" equal to 0 which brings the total score ranges from 0-8. The scoring criteria are shown in Figure 1.2 (Chung et al., 2008)

Low risk of obstructive sleep apnoea (OSA): Yes to 0-2 questions
Intermediate risk of OSA: Yes to 3-4 questions
High risk of OSA: Yes to 5-8 questions
or Yes to 2 or more of 4 STOP questions + male gender
or Yes to 2 or more of 4 STOP questions + BMI > 35 kg/m2
or Yes to 2 or more of 4 STOP questions + neck circumference (17"/43cm in male, 16"/41cm in female)

Figure 1.2 : Scoring Criteria for STOP-Bang Questionnaire

SBQ is a self-administered, simple and validated questionnaire that detects OSA with high sensitivity. In detecting mild, moderate and severe OSA, the sensitivity is 84%, 93% and 100% respectively. (Chung et al, 2008). It has been shown to have superior predictive value compared with other commonly used questionnaires, such as the ESS and the Berlin questionnaire(BQ) (Luo et al, 2014). A validation study of the Portugese version of SBQ had been done in 2015 by Reis et al. From this study, they found that the SBQ showed high sensitivity and positive predictive value for OSA with the probability of severe OSA steadily increasing, the higher the scores. It showed 93.4 % of sensitivity and the specificity of 48.9 %. They also concluded that the SBQ can be a powerful tool stratifying patients in the diagnosis of OSA. In Hong Kong, a validation study of four translated Chinese questionnaires for OSA done in 2014. Among the four questionnaires studied, SBQ has the highest sensitivity compared to STOP, Berlin and ASA. This can potentially assist in prioritizing PSG and can be helpful in clinical or self-evaluation by the general public (Ha SC et al, 2014). BaHammam et al (2015) performed a validity and reliability study of an Arabic version of SBQ. It shows a sensitivity of 98% and positive and negative predictive values of 86% and 67% respectively.

1.7.3 Polysomnography (PSG)

Polysomnography (PSG) is a comprehensive sleep assessment tool, which is reliable for the diagnosis of OSA. Overnight polysomnography is the "gold standard" in diagnosing OSA (Epstein et al, 2009 & El-Sayed, 2012). Snoring, apneas, hypopneas, and respiratory effort-related arousals are the events of abnormal breathing in sleep. PSG detects, analyze, and summarize these events which are the result from three physiologic derangements during sleep.

They are upper airway obstruction or flow limitation, dysregulation of respiratory control and hypoventilation. The result of PSG reported using the AHI which can both diagnose and determine the severity of OSA. In order to study patient's typical sleep and its associated pathologies, this study is done at night and in a most conducive environment of sleep laboratory. Patients who regularly work night shifts should undergo PSG during the day to match their normal sleep-wake cycle. For full PSG with attended monitoring, data are collected in the laboratory in the presence of a qualified technician. This protocol provides the opportunity to directly observe a variety of sleep-associated disturbances. There are partial (8 channels) and full (16 channels) PSG. The PSG includes the following physiologic signals :

1. Electroencephalography (EEG) – to determine arousals from sleep
2. Electro-oculography (EOG) – to detect rapid eye movement sleep
3. Chin electromyography (EMG) – to record sleep stage
4. Oral and nasal airflow – to measure oxygen saturation
5. Chest wall monitor – to record respiratory effort
6. Electrocardiography – to monitor cardiac rhythm and rate
7. Anterior tibialis electromyography (EMG) – to detect movement arousals and periodic limb movement
8. Sleep position
9. Snoring level

The American Academy of Sleep Medicine (AASM) classifies sleep study devices (sometimes referred to as Type or Level) into 4 types as shown in Table 1.7 (Collop et al, 2007).

Table 1.7 : Level of PSG

Level	Description
I	Attended overnight full PSG 7 or more channels (include EEG, EOG, EMG, ECG, airflow, oxygen saturation, respiratory effort, snoring level & body position)
II	Unattended overnight full PSG (same as level I but conducted at patient's home)
III	Unattended limited PSG 4-7 channels (include airflow, respiratory effort, oxygen saturation +/- body position and snoring level)
IV	Unattended screening sleep study 1 or 2 channels (only oxygen saturation and airflow)

Trikalinos et al (2007) concluded that AHI measurements from portable monitors and facility-based PSG are not interchangeable, especially in the higher AHI spectrum based on review on 95 clinical studies. However, Bruyneel et al (2015) found that the efficacy of the unattended sleep study done at home and sleep laboratory were equally same with the failure rate as low as 4 to 8 %.

1.8 VALIDITY

Validity defines as a test's ability to produce results consistent with other measures of the same characteristic and requires external criteria (Karras, 1997). In other words, it measures what the investigator want to measure. In validity assessment of questionnaires, careful definition of the scope of the test and comparison with previously validated tools required. Table 1.8 shows several types of validity and its definition.

Table 1.8 : Types of validity and definition (Karras (1997)

Type	Definition
Face validity	The appearance that a test is adequate for its intended purpose (not a formal statistical term)
Content validity	Inclusion of questions representative of the qualities of the test attempts to measure; appropriate domain
Construct validity	Consistency of test results with other tests or indexes purporting to measure similar characteristics
Criterion-related validity	Consistency of test results with those of a reference criterion standard

In our study, validity of the questionnaire determined using face validity, content validity and construct validity by using sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV).

Face validity is the lowest form of validity and is established by interviews and patient's focus group. An instrument is said to have face validity if on the face of things, it measures the construct under consideration and appropriate for the intended respondents (Streiner and Norman, 1989). In this study, the initial interview was done on 10 OSA patients and 5 medical doctors to establish face validity and the appropriateness of the translated questionnaire.

Content validity is established when the degree to which an item or question on a test represents some defined universe or domain of content. Content validity is determined by panel of experts (Jackson and Furnham, 2000). During the translation process, the Bahasa Malaysia translated version of STOP-Bang was critically reviewed by 2 language experts and 2 medical experts managing OSA in our centre.