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Original Article

# Translation, cross-cultural adaptation and psychometric properties of the Sleep-Related Breathing Disordered–Pediatric Sleep Questionnaire for obese Thai children with obstructive sleep apnea

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## ARTICLE INFO

## ABSTRACT

Objective: Obstructive sleep apnea (OSA) is a comorbid condition with obesity that can produce deleterious effects on children's health and well-being. Unfortunately, valid instruments for screening OSA in obese Thai children are limited. This study aimed to translate and cross-culturally adapt, from English to Thai, the Sleep-Related Breathing Disordered–Pediatric Sleep Questionnaire (SRBD-PSQ) and to determine its psychometric properties.
Methods: The SRBD-PSQ was translated into Thai and cross-culturally adapted. It was administered to 62 parents of obese children and adolescents 7–18 years of age who had polysomnographically confirmed OSA. The psychometric properties including validity, reliability, and diagnostic accuracy were examined.
Results: The Thai SRBD-PSQ possessed excellent content validity index for scale (S-CVI = 0.95). An acceptable internal consistency (cronbach's $\alpha \geq 0.7$) and good to excellent test–retest reliability (intraclass correlation coefficients [ICCs] = 0.82–0.90) of the Thai SRBD-PSQ and subdomain were observed. There was a significant correlation between the SRBD scale and polysomnography (PSG) indices: apnea–hypopnea index (AHI) and oxygen desaturation index (ODI) ($r = 0.35$, $p < 0.01$, and $r = 0.27$, $p < 0.05$, respectively). The Thai SRBD-PSQ had an area under the curve of 0.71 ($p < 0.05$) with a sensitivity of 72% and a specificity of 54%.
Conclusion: The Thai SRBD-PSQ is a reliable and valid instrument for use in obese children with OSA. However, the Thai SRBD-PSQ should be used in combination with other investigations.

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## 1. Introduction

Obstructive sleep apnea (OSA), a subtype of sleep-disordered breathing (SDB), is commonly found in obese children and adolescents [1]. Its prevalence ranges from 19% to 60% depending on age range, definition of obesity, OSA severity, and ethnicity [2,3]. Its clinical features are not easily recognized, varying from habitual snoring with the absence of apnea, gas exchange abnormalities, and altered sleep pattern to pulmonary hypertension, or cor pulmonale [4]. Furthermore, OSA can be a cause of fatality in obese children [3]. Therefore, early detection is needed to reduce the risk of morbidity and other deleterious consequences. Unfortunately, in Thailand, the availability of valid instruments such as polysomnography (PSG) or questionnaires for screening OSA risk in obese children are limited.

The Sleep-Related Breathing Disordered (SRBD) scale, a subscale of the Pediatric Sleep Questionnaire (PSQ) (SRBD-PSQ), is of interest because it is feasible, cost and time effective, and applicable to a wide age range (2–18 years) [5]. The SRBD-PSQ is considered to be a

reliable and valid tool to determine obstructive sleep-related breathing disorders (SRBDs) or associated symptom constructs in clinical research, in particular when polysomnography is not feasible [5]. In addition, it has been extensively studied and translated into several languages, such as Spanish [6], Turkish [7], Malaysian [8], Chinese [9], and Portuguese [10]. A Thai version of the SRBD-PSQ may assist health care professionals and researchers to monitor and measure changes in OSA patients after intervention. Thus, the aims of this study were to translate into Thai and conduct a cross-cultural adaptation of the original English version of the SRBD-PSQ and to confirm its psychometric properties. The responsiveness of the questionnaire to determine the diagnostic accuracy among obese children with OSA was also elucidated. The study's hypothesis stated that the Thai SRBD-PSQ has adequate content equivalence, psychometric properties, and responsiveness to be used in research and clinical settings for obese children with OSA.

## 2. Methods

### 2.1. Study population

Participants were children and adolescents aged 7—18 years who were classified as overweight or obese according to the International Obesity Task Force (IOTF) [11] and diagnosed with OSA. The study excluded individuals who had severe medical or mental impairment that might affect sleep variables, such as asthma, congenital heart disease, diabetes mellitus, psychiatric problems, or intellectual disabilities. Children or adolescents and parents or legal guardians were recruited during the admission of children to the Snoring Clinic at Chiang Mai University Hospital, Chiang Mai Province. Parents or legal guardians were defined as the respondents to complete a questionnaire. Respondents were excluded if they were unable to speak, read, and write Thai.

### 2.2. Study design

The study was a cross-sectional design conducted in two phases from December 2016 to December 2017. Phase 1 comprised the translation and cross-cultural validation of the SRBD-PSQ. Phase 2 determined the psychometric properties of the questionnaire including validity, reliability, and responsiveness of the translated SRBD-PSQ in obese Thai children and adolescents with OSA. The sample size for determining face validity was based on the study of Beaton et al., [12], whereas the sample size for examining content validity and reliability of the Thai SRBD-PSQ was based on the studies of Terwee et al., [13] and Javali et al., [14], respectively. This study was approved by the Research Ethics Committee, Faculty of Medicine, Chiang Mai University. Written informed consent was obtained from the parents or legal guardians of the children and adolescents prior to commencement of the study.

### 2.3. Instruments

#### 2.3.1. Medical records
The anthropometric data of the children and adolescents were obtained from their medical records. The data included body weight, height, and body mass index (BMI). The BMI for age and sex was defined according to IOTF guideline (2007) [11].

#### 2.3.2. SRBD scale of the PSQ
The SRBD scale of the PSQ (SRBD-PSQ) was developed by Chervin et al., in 2000 [5]. This questionnaire consists of 22 closed-ended questions divided into three domains: a nine-item snoring domain, a seven-item sleepiness domain, and a six-item behavioral

domain [15]. The questionnaire takes about 5 min to complete. The scoring system of the SRBD-PSQ consisted of the following: yes = 1, no = 0, and don't know = missing. The SRBD-PSQ score was computed by the number of "yes" answers divided by the total items answered "yes" and "no" [5]. A cut-off value of 0.33 was used to identify pediatric SRBDs [5].

#### 2.3.3. Polysomnography
A portable sleep machine *(SOMNOlab 2, Hamburg, Germany)* was conducted in children for monitoring polysomnography (PSG) indices at nighttime, including the apnea—hypopnea index (AHI), the oxygen desaturation index (ODI), $SaO_2$ nadir, and mean $SaO_2$. All of the sleep study procedures were performed by a pediatric sleep specialist and carried out as described in the study by Ficker et al., [16]. Children or adolescents were diagnosed with OSA if they had any of the following PSG indices values: AHI $\geq$1 time/h, ODI $\geq$1 time/h or $SaO_2$nadir <92%. Meanwhile, OSA severity was defined as mild, moderate, and severe according to AHI score (AHI < 1 = normal; $1 \leq$ AHI < 4 = mild; $4 \leq$ AHI < 10 = moderate; and AHI $\geq$ 10 = severe) [17].

### 2.4. Procedures

#### 2.4.1. Phase 1: translation and cultural adaptation of SRBD-PSQ
The translation of the English SRBD-PSQ into Thai was performed in accordance with the previously established five-step cultural adaptation process [12,18—20].

Step 1, the initial forward-translation of the document from English to Thai, was performed by two independent bilingual and bicultural Thai translators. Both translators are Ph.D. lecturers in the Departments of English and Physical Therapy, respectively, Chiang Mai University.

In Step 2, the two initial Thai translations and original English version were synthesized regarding ambiguities and discrepancies of words, sentences, and meanings into a preliminary initial Thai translation (PI-TL) by a group of three bilingual and bicultural translators included the translators from Step 1 and a Ph.D. lecturer in the Department of Occupational Therapy, Chiang Mai University, and the researcher.

In Step 3, the PI-TL was backward-translated into the English by two different Ph.D. lecturers in the Departments of English and Physical Therapy, Chiang Mai University. The translators worked independently to produce two backward-translations from Thai to English.

In Step 4, the pre-final Thai SRBD-PSQ was derived by the expert committee comprising four translators involved in Step 1 and Step 3, as well as an otolaryngologist, and a researcher. The committee worked cooperatively to evaluate, revise, and verify the cross-cultural equivalence of the original English questionnaire, the PI-TL produced in Step 2, and the two backward-translations produced in Step 3 into a pre-final Thai SRBD-PSQ.

Step 5 was a three-phase process. The initial phase involved the pilot testing of the pre-final questionnaire to determine face and content validity. The next phase evaluated the pilot test data. The last phase produced the final Thai SRBD-PSQ. The pilot test used two test groups. The first group consisted of 30 parents or legal guardians of children or adolescents selected from the study population identified in Methods 2.1 and determined face validity using a dichotomous scale (clear/unclear). The second group consisted of three otolaryngologists in the Department of Ear Nose Throat, Chiang Mai University, two senior cardiopulmonary physiotherapists in the Department of Medicine and Physical Therapy, Khon Kaen University, and a senior cardiopulmonary physiotherapist in the Department of Physical Therapy, Chiang Mai University, who determined content validity index using a four-point Likert scale (4 = very relevant to 1 = not relevant). The content validity

index for the items (I-CVI) and the content validity index for the scale (S-CVI) were calculated according to a previously published equation [21]. The pilot test results, including feedback and suggestions from two test groups, were analyzed by the six expert committee members who determined the specific modifications that were needed in the pre-final questionnaire. Their work resulted in the final Thai SRBD-PSQ.

### 2.4.2. Phase 2: psychometric properties

The psychometric properties of the final Thai SRBD-PSQ, including reliability (internal consistency, test–retest reliability, and agreement of measurement) and validity (concurrent validity and diagnostic accuracy) were investigated in the following manner:

(1) Internal consistency: Cronbach's α coefficient was used to determine the internal consistency of the SRBD-PSQ. The questionnaire was administered on one occasion to 62 respondents.
(2) Test–retest reliability: A total of 62 respondents were asked to complete the questionnaire on two separate occasions within an interval of two weeks, first at the snoring clinic and second via a mobile cellular application or by telephone call. The test–retest reliability of the SRBD-PSQ was analyzed using an intraclass correlation coefficient ($ICC_{3,1}$).
(3) Agreement of measurement: The smallest detectable change (SDC) and Bland–Altman analysis of data from 62 respondents were used to assess the measurement error and the degree of test–retest agreement, respectively [13,22].
(4) Concurrent validity: A total of 62 obese children with OSA underwent an overnight PSG at their homes or at the hospital. Simultaneously, their parents or legal guardians were asked to complete the Thai SRBD-PSQ. Correlations between the SRBD scale and PSG indices were analyzed using the Spearman rank correlation coefficient.
(5) Diagnostic accuracy: To determine criterion-referenced standards for the Thai SRBD-PSQ score cutoff points that identify the OSA risk of 62 respondent, receiver operating characteristic (ROC) curves were constructed and the area under the ROC curve (AUC) was computed. The sensitivity and specificity were also derived.

### 2.5. Statistical analysis

The Shapiro–Wilk test was used to test for normality of data. Descriptive data were summarized as median (interquartile range [IQR]). The minimum value of 0.70 was accepted as a measure of good internal consistency, test–retest reliability, and AUC [13,23,24]. The data analyses were undertaken using the Statistical Package for Social Sciences (SPSS version 19.0 for Windows, IBM Inc., Armonk, NY).

## 3. Results

### 3.1. Sample characteristics

According to the PSG criteria, two subjects had AHI ≥1 time/h (3.23%), 23 had ODI ≥ 1 time/h (37.09%), two had SaO2 nadir <92% (3.23%), and 35 (56.45%) had a combination of AHI, ODI, and/or SaO2 nadir. Based on the AHI cutoff for OSA, 25 subjects had normal PSG (40.32%), 19 mild OSA (30.65%), 10 moderate OSA (16.13%), and eight severe OSA (12.90%). The characteristics of the children and adolescents with OSA are shown in Table 1. For determining the psychometric properties, the median (IQR) age of the respondents was 42.00 (10.00) years. Of the respondents, 45% possessed a bachelor degree or higher.

**Table 1**
Characteristics of children and adolescents with OSA ($n = 62$).

| Characteristics | Boys ($n = 51$) | Girls ($n = 11$) | Total ($n = 62$) |
|---|---|---|---|
| Age (y)[a] | 10.00 (3.00) | 10.00 (3.00) | 10.00 (3.25) |
| Classification by age ($n$) | | | |
| Children (7–12 y) | 42 | 9 | 51 |
| Adolescents (>12 y) | 9 | 2 | 11 |
| BMI (kg/m²)[a] | 28.53 (8.48) | 27.42 (9.11) | 28.14 (8.55) |
| Overweight/obese ($n$) | 9/42 | 2/9 | 11/51 |
| PSG indices[a] | | | |
| AHI (times/h) | 1.50 (4.5) | 1.40 (8.60) | 1.45 (4.93) |
| ODI (times/h) | 3.00 (2.90) | 5.40 (5.60) | 3.05 (3.33) |
| SaO2 nadir (%) | 83.00 (6.00) | 79.00 (6.00) | 82.00 (7.00) |
| MeanSaO2 (%) | 97.00 (1.00) | 97. (1.60) | 97.00 (1.13) |
| AHI cutoff for OSA ($n$) | | | |
| Normal (AHI < 1) | 20 | 5 | 25 |
| Mild (1 ≤ AHI < 4) | 17 | 2 | 19 |
| Moderate (4 ≤ AHI < 10) | 8 | 2 | 10 |
| Severe (AHI ≥ 10) | 6 | 2 | 8 |

AHI, apnea–hypopnea index; BMI, body mass index; IQR, interquartile range; MeanSaO2, mean oxygen saturation; ODI, oxygen desaturation index; OSA, obstructive sleep apnea; PSG, polysomnography; SaO2 nadir, lowest oxygen saturation.

[a] Data are expressed as median (IQR).

### 3.2. Phase 1: translation and cross-cultural adaptation

#### 3.2.1. Response process validity

The response process validity results revealed that five of the 22 items of the translated SRBD-PSQ were adapted to achieve clarity of content. The changes were question items A2 (ie, "snore more than half the time" was changed to "snore more than half of the sleeping time"); A3 (ie, "always snore" was changed to "snore every time when sleeping"); A6 (ie, "struggle to breathe" was changed to "breathing difficulty"); B9 (ie, "stop growing at a normal rate" was changed to "have ever stopped growing"); and C5 (ie, "difficulty organizing tasks and activities" was changed to "hardly manage task and activities"). To identify the respondents correctly, their children's surnames were added in a personal data section. To make the 22-item questionnaire easy to complete, a table was created to contain each question separately. The right column, which contained the code for each question item, was removed to reduce the possibility of confusing the respondents.

#### 3.2.2. Content validity

The content validity results showed that the Thai SRBD-PSQ had a S-CVI score of 0.95. All of the I-CVI scores ranged from 0.67 to 1.00, as described in Table 2. Potential changes involving difficult and ambiguous words or sentences were applied for items with unacceptable I-CVI scores, for example, items A2 and A3. The revised terms and sentences were approved by expert committee discussion.

### 3.3. Phase 2: psychometric properties

#### 3.3.1. Internal consistency

The internal consistency for the SRBD scale and subdomain was acceptable (cronbach's α = 0.72–0.86) (Table 3). After item reduction, Cronbach's α for the SRBD scale, which ranged from 0.84 to 0.86, did not improve.

#### 3.3.2. Test–retest reliability

Test–retest reliability of the SRBD scale and subdomain were good to excellent (ICC = 0.82–0.90) (Table 3).

#### 3.3.3. Agreement of measurement

The mean score of the SRBD scale for two measurements was 8.09. The standard errors of the mean and SDC for the SRBD scale

**Table 2**
I-CVI and S-CVI scores for the Thai SRBD-PSQ.

| SRBD-PSQ domain | Item | Expert 1 | Expert 2 | Expert 3 | Expert 4 | Expert 5 | Expert 6 | I-CVI |
|---|---|---|---|---|---|---|---|---|
| Snoring | A.2 | 4 | 4 | 2 | 4 | 2 | 4 | 0.67 |
|  | A.3 | 4 | 4 | 2 | 4 | 2 | 4 | 0.67 |
|  | A.4 | 4 | 4 | 4 | 3 | 2 | 4 | 0.83 |
|  | A.5 | 4 | 4 | 4 | 4 | 3 | 4 | 1 |
|  | A.6 | 4 | 4 | 3 | 4 | 4 | 4 | 1 |
|  | A.7 | 4 | 4 | 4 | 4 | 4 | 4 | 1 |
|  | A.24 | 4 | 4 | 4 | 4 | 4 | 3 | 1 |
|  | A.25 | 4 | 4 | 4 | 3 | 3 | 4 | 1 |
|  | A.32 | 4 | 4 | 4 | 4 | 3 | 3 | 1 |
| Sleepiness | B.1 | 4 | 4 | 4 | 4 | 4 | 4 | 1 |
|  | B.2 | 4 | 4 | 4 | 4 | 4 | 4 | 1 |
|  | B.4 | 4 | 4 | 3 | 4 | 4 | 4 | 1 |
|  | B.6 | 4 | 3 | 4 | 4 | 3 | 4 | 1 |
|  | B.7 | 4 | 4 | 4 | 4 | 4 | 4 | 1 |
|  | B.9 | 3 | 4 | 4 | 4 | 3 | 3 | 1 |
|  | B.22 | 3 | 4 | 4 | 4 | 3 | 4 | 1 |
| Behavior | C.3 | 4 | 4 | 4 | 3 | 3 | 3 | 1 |
|  | C.5 | 3 | 3 | 3 | 3 | 3 | 4 | 1 |
|  | C.8 | 3 | 3 | 4 | 3 | 3 | 3 | 1 |
|  | C.10 | 4 | 4 | 2 | 3 | 3 | 3 | 0.83 |
|  | C.14 | 3 | 4 | 2 | 4 | 3 | 3 | 0.83 |
|  | C.18 | 4 | 3 | 4 | 3 | 3 | 3 | 1 |
|  | S-CVI | 1 | 1 | 0.81 | 1 | 0.86 | 1 | 0.95 |

I-CVI, content validity index for items; S-CVI, content validity index for scale.

**Table 3**
Internal consistency and test–retest reliability for the Thai SRBD-PSQ ($n = 62$).

| SRBD-PSQ domain (item) | Cronbach's α | ICC ($p$) |
|---|---|---|
| SRBD scale (22) | 0.86 | 0.90 (<0.001) |
| Snoring (9) | 0.77 | 0.81 (<0.001) |
| Sleepiness (7) | 0.74 | 0.86 (<0.001) |
| Behavior (6) | 0.72 | 0.88 (<0.001) |

ICC, intraclass correlation coefficient; PSQ, Pediatric Sleep Questionnaire; SRBD, sleep related breathing disordered.

were 1.55 and 4.29, respectively. Bland–Altman analysis showed that the mean difference ($\pm$SD) among the first and the second SRBD scale measurement was $0.08 \pm 2.21$ (95% confidence interval [CI] = $-4.25$ to 4.41). There were three participants (5%) whose results were not within the limit of agreement (Fig. 1).

### 3.3.4. Concurrent validity

The SRBD scale showed a significant correlation with the AHI and ODI. A significant relationship between the snoring domain and the AHI was observed, except for the ODI. The SRBD scale and subdomain had no correlations with the SaO$_2$ nadir (Table 4).

### 3.3.5. Diagnostic accuracy

Using an SRBD-PSQ cutoff of >0.33 and an AHI cutoff of $\geq 4$ and $\geq 1$, the sensitivities were 0.72 and 0.62, respectively, and the specificities were 0.54 and 0.60, respectively. Using a subdomain for snoring cutoff of >0.33 and an AHI cutoff $\geq 4$ and $\geq 1$, the sensitivity and specificity were 0.72 and 0.52, respectively, with similar specificities at 0.52. The AUC for the SRBD scale and snoring subdomain scores were 0.71 (95% CI = $0.53-0.88$, $p = 0.01$) and 0.71 (95% CI = $0.56-0.87$, $p = 0.01$), respectively for an AHI cutoff of $\geq 4$ (Fig. 2). The AUC for the SRBD scale and snoring subdomain scores were similar (AUC = 0.63, 95% CI = $0.49-0.77$, $p = 0.08$) for an AHI cutoff of $\geq 1$.

## 4. Discussion

In this study, the English SRBD-PSQ questionnaire was translated into Thai, cross-culturally adapted, and its psychometric

properties determined. The study identified several noteworthy findings: the translated questionnaire possessed excellent content validity, acceptable internal consistency and test–retest reliability. The study also found a significant correlation between the SRBD scale and PSG indices (AHI and ODI).

Furthermore, this study was the first pediatric OSA study to use a translated version of the English SRBD-PSQ and to report on both face validity and content validity. The response process validity results indicated that culturally specific adaptations are needed before using the Thai SRBD-PSQ. The content validity index for item (I-CVI = 0.8) was rated acceptable to excellent for all items, except question items A2 and A3. The content validity index for scale (S-CVI = 0.95) was rated as excellent. These findings supported that cross-cultural equivalence between the original English version and the translated Thai version was achieved.

Reliability of the Thai SRBD-PSQ was assessed in three ways. First, according to the general guidelines suggested by Terwee et al. [13], Cronbach's α of the SRBD scale and the subdomains used in this study were within acceptable range, that is, (ie, similar to the range in the original English version) [5] consistent with previous studies [7,9,10], and somewhat higher than in some studies in the subdomain for snoring [8,10] and sleepiness [5,7,8,10]. These discrepancies were explained by the difference source of study population. Children with OSA in the present study were recruited from a sleep clinic similar to those of three previous studies [5,7,9], whereas the other two studies were conducted using children without SDB from primary school [8,10].

Second, the SRBD scale and all the subdomains possessed good to excellent test–retest reliability (ICCs = $0.82-0.90$) in accordance with previous studies [5,9]. Finally, the degree of agreement in the Thai SRBD-PSQ was examined. The study found that the measurement error in the Thai SRBD-PSQ was quite small. The value of SDC remained lower than the mean of the SRBD scale. Moreover, the Bland–Altman plot showed minimal range in the limit of agreement compared to the mean of the SRBD scale. A near-zero degree of bias existed in each test–retest instance, which indicated that the Thai SRBD-PSQ had adequate agreement for determining the response of treatment or monitoring the progression of OSA in obese children. Results of reliability data confirmed that the
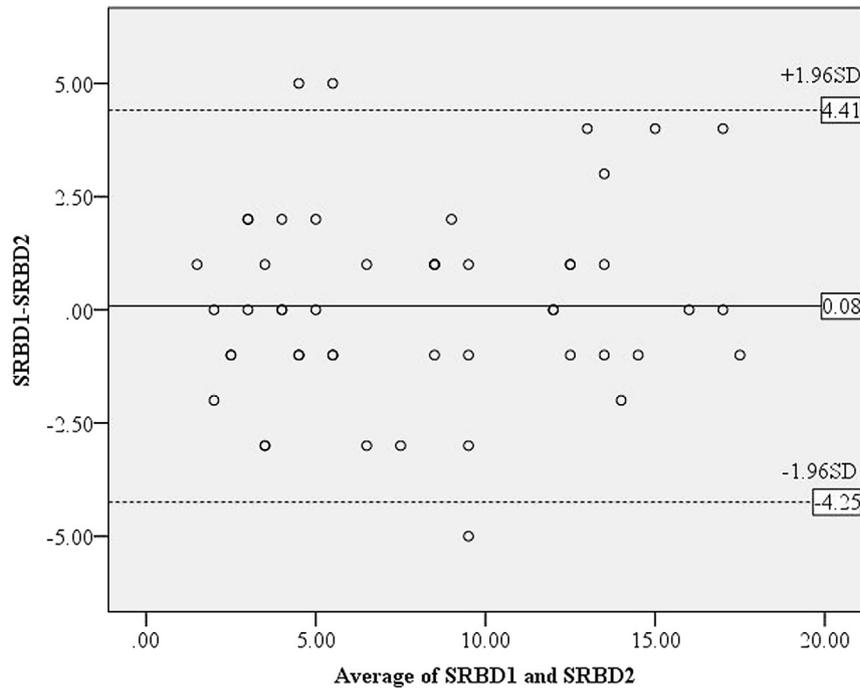
**Fig. 1.** Bland–Altman plot with differences in mean of the Sleep-Related Breathing Disordered (SRBD) scale between two measurements.

**Table 4**
Correlations between the Thai SRBD-PSQ and PSG indices (AHI, ODI, and SaO$_2$nadir) (n = 62).

| PSQ domain (item) | AHI | | ODI | | SaO$_2$ nadir | |
|---|---|---|---|---|---|---|
| | Spearman correlation | p | Spearman correlation | p | Spearman correlation | p |
| SRBD scale (1–22) | 0.35[a] | <0.01 | 0.27[a] | 0.04 | −0.15 | 0.24 |
| Snoring (1–9) | 0.39[a] | <0.01 | 0.23 | 0.08 | −0.11 | 0.39 |
| Sleepiness (10–16) | 0.23 | 0.07 | 0.17 | 0.18 | −0.05 | 0.71 |
| Behavior (17–22) | 0.12 | 0.37 | 0.15 | 0.25 | −0.13 | 0.30 |

AHI, apnea–hypopnea index; ODI, oxygen desaturation index; PSQ, Pediatric Sleep Questionnaire; SaO$_2$ nadir, lowest oxygen saturation; SRBD, Sleep-Related Breathing Disordered; SRBD-PSQ, Sleep-Related Breathing Disordered–Pediatric Sleep Questionnaire.
[a] Correlation is significant at the 0.05 level (two-tailed).



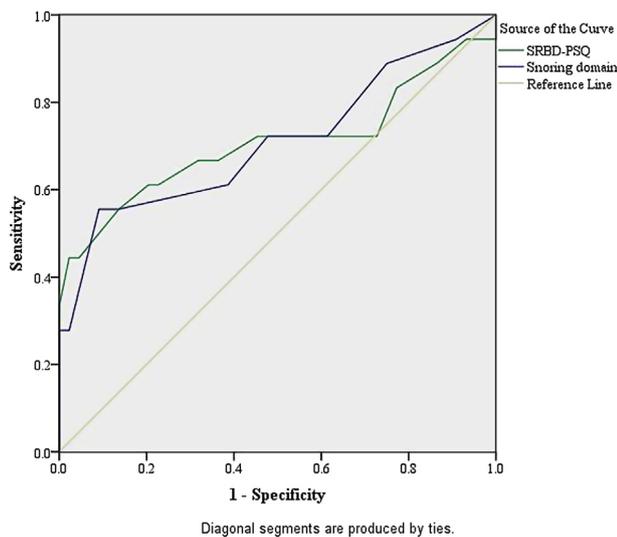Diagonal segments are produced by ties.

**Fig. 2.** Receiver operating characteristic curve for the Thai Sleep-Related Breathing Disordered–Pediatric Sleep Questionnaire (SRBD-PSQ) and snoring subdomain scores as a test for screening obstructive sleep apnea (OSA) risk in obese children (apnea–hypopnea index [AHI] cutoff of ≥4).

Thai SRBD-PSQ possessed adequate content validity, was reproducible, and was a valid instrument for detecting change over time.

The Thai SRBD-PSQ was validated using polysomnography to determine the concurrent validity and the diagnostic accuracy. This study found that AHI and ODI significantly correlated with the SRBD scale. AHI was only significantly associated with the snoring domain, a feature that resembled results of a previous study [25] that found a positive correlation between AHI and the SRBD scale (r = 0.31, p < 0.01). These results supported that AHI is the most favorable of the PSG indices for a diagnosis of OSA [26]. Consistent with several other studies [27–29], no correlations were observed between AHI and OSA-related impairments, that is, behavior problems and sleepiness.

Based on the AUC, sensitivity and specificity, our findings may indicate that the Thai SRBD-PSQ has modest accuracy [13,30], Using the Thai SRBD-PSQ cutoff of >0.33, which corresponds with AHI >1, the Thai SRBD-PSQ possessed lower sensitivity and specificity compared to the original English version [5]. Also, its sensitivity was lower than in other studies [25,31,32], but its specificity was higher. These differences were most likely caused by differences in the study population. Other studies used children with and without obesity [5], children with asthma [31], and children who habitually snored [25,32]. In addition, the differences may be due to a

relatively small degree of the variance in OSA severity. Alternatively, using a larger number of children who have severe OSA might improve the accuracy of the Thai SRBD-PSQ.

However, this study demonstrated that the sensitivity was higher when using the Thai SRBD-PSQ cutoff of >0.33 with an AHI cutoff of $\geq 4$ compared to using the Thai SRBD-PSQ with an AHI cutoff of $\geq 1$ (72% and 62%, respectively). Furthermore, the AUC value was found to be higher when using an AHI of $\geq 4$ (AUC = 0.71, $p = 0.01$), compared to using an AHI of $\geq 1$ (AUC = 0.63, $p = 0.08$), whereas the specificity was likely the same. The similar results were also observed for the snoring subdomain when changing the AHI cutoff from AHI of $\geq 1$ to AHI of $\geq 4$. These results suggest that the use of the standard PSG cutoff seemed more sensitive in individuals with moderate to severe degree of OSA. Based on the overall results, the Thai SRBD-PSQ is a relatively reliable and valid tool for use in obese children with OSA. Yet, the Thai SRBD-PSQ should still be used in combination with a physical examination and other investigative tools to improve its accuracy.

Some limitations of the study were identified. This study population consisted of overweight/obese children with OSA; thus, the use of the Thai SRBD-PSQ to screen SRBDs in other populations should be carefully considered. Moreover, the majority of our study population was pre-puberty; therefore, use of the Thai SRBD-PSQ might not be generalized into pubertal children or adolescents.

## 5. Conclusion

In conclusion, the Thai SRBD-PSQ is a relatively reliable and valid tool for use in obese children with OSA. The Thai SRBD-PSQ scores correlated with AHI and ODI indices. However, use of the Thai SRBD-PSQ in combination with other examinations is recommended.

## Acknowledgements

## Conflicts of interest

There is no conflict of interest.

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: https://doi.org/10.1016/j.sleep.2018.08.033.

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