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# Chinese translation and validation of the adolescent sleep wake scale

Ya-Ting Carolyn Yang<sup>1,2</sup>, Han-Yun Chang<sup>1</sup>, Chung-Yao Hsu<sup>3</sup>, Cheng-Yu Lin<sup>4,5</sup> and Jamie M Zeitzer<sup>2,6\*</sup> 

## Abstract

**Background:** Inadequate sleep is a problem for teens world-wide. Identifying the biological and cultural factors that underlie this phenomenon is dependent on tools that can accurately query sleep-related behaviors. While there are many sleep-related questionnaires available in English, there are a paucity of validated Chinese language versions. As such, it was the purpose of this study to translate the Adolescent Sleep Wake Scale into Chinese and to provide a preliminary validation of this questionnaire.

**Methods:** We used a dual forward translation-back translation approach to translate the Adolescent Sleep Wake Scale into Chinese. We then tested the sensitivity, specificity, and internal consistency of the translated questionnaire using 517 adolescents from Taiwan. Preliminary criterion validity was examined through comparison with a measure of chronotype, with the a priori assumption that evening chronotypes would have worse sleep-related behavior.

**Results:** Internal consistency for both the overall scale ( $\alpha = .86$ ) and five subscales ( $\alpha$ 's  $> .81$ ) were good. These five subscales explained 62.6% of the total variance. Confirmatory Factor Analysis indicated a good fit of the data. The overall scale and each of the subscales also showed the expected relationship with chronotype, with worse sleep-related behavior in evening-types.

**Conclusion:** Our Chinese translation of the Adolescent Sleep Wake Scale is valid and has preliminary criterion validity. This can be a useful tool to explore sleep quality among Chinese-speaking adolescents as well as cross-cultural aspects of sleep behavior between Chinese- and English-speaking adolescents.

**Keywords:** Sleep, Adolescence, Chinese, Translation, Sleep quality

## Background

Normal, healthy sleep is characterized by sufficient duration, good quality, appropriate timing and regularity, as well as the absence of sleep disturbances and disorders. Worldwide, many teens lack this type of healthy sleep as they have insufficient sleep duration, poor sleep quality, and irregular sleep timing. At the most basic level, adolescents who get an insufficient amount of sleep are more likely to report a wide range of health problems,

including cognitive and behavioral problems (Baum et al. 2014), unstable emotional regulation (Browne and Cudeck 1992; Buysse 2014), poor academic performance (Chen et al. 2014; Crowley et al. 2018) and a lower health-related quality of life (Essner et al. 2015). While there are several questionnaires that have been validated for the examination of sleep in children, one such scale was specifically designed to examine sleep problems in teens, the Adolescent Sleep Wake Scale (ASWS) (Garson 1998).

The ASWS is a measure of behavioral sleep problems that is widely used in general adolescent populations and, more recently, in adolescent populations with specific comorbidities such as depression (Gau et al. 1998) and chronic pain (George 2003). The internal consistency of ASWS is good for the total scale in Italian ( $\alpha = 0.80$ )

\*Correspondence: [jzeitzer@stanford.edu](mailto:jzeitzer@stanford.edu)

<sup>2</sup> Department of Psychiatry and Behavioral Sciences, Stanford University, Stanford, CA 94305, USA  
Full list of author information is available at the end of the article



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and English ( $\alpha=0.86$ ) (Garson 1998). There may be differences in internal consistency, however, in different cultures (Giannotti et al. 2002). To examine the utility of this scale in non-English speaking adolescents, however, requires validated translation. The ASWS has been translated into Chinese, with internal consistency and test–retest reliability reported, but no test of validity was performed (Hu 1999).

To extend the use of the ASWS as a tool to examine sleep behavior in Chinese speaking adolescents, about which we have already published (Kaplan 2017; LeBourgeois et al. 2005; Lin et al. 2020), we translated and developed a Chinese language version of the Adolescent Sleep Wake Scale (C-ASWS). We tested the C-ASWS to establish the sensitivity, specificity, and internal consistency. To examine construct validity data, we compared the results to that of a chronotype questionnaire with the a priori assumption that teens with a later chronotype would have worse scores on the C-ASWS.

## Methods

### Translation of the ASWS

#### Questionnaire translation

To deliver an accurate translation, we used two independent individuals at each step and instructed them to consider conceptual, rather than literal, translation, and to use language that would be understandable to adolescents (Mateo et al. 2012). Using a decentered strategy, we attempted to ensure the cross-cultural and conceptual equivalence between the original and the final, translated questionnaires. The ASWS was translated into Chinese by two native Taiwanese speakers, both of whom graduated from a Chinese literature department and whose current research relates to health education. The initial translations by both translators were carried out without any communication between the translators. Researchers and the two translators analyzed the translations together. After discussing the variations of each translation (T1 and T2), a single version (T3) was agreed upon.

#### Back translation

From the synthesis (T3), two independent back translations (BT1 and BT2) were done. Both translators were university professors and native English speakers who had no knowledge of the original instrument. One had lived in Taiwan for over 15 years, completed his doctoral degree in Taiwan, and had full command of both English and Chinese. The other was bilingual in Chinese and English, a health expert, and lived in the United States. As with the forward translation, back translators were asked to emphasize conceptual rather than literal translation and to use language appropriate for adolescents. The researchers and the two back translators analyzed

the back translations together. After discussing the variations of each back translation (BT1 and BT2), a single version (BT3) was agreed upon. A Chinese version (T4) was revised based on BT3.

#### Experts committee

The translations and back translations (T1–T4 and BT1–BT3) were assessed by two experienced clinicians who specialized in sleep for 15 years and 31 years, respectively. The clinicians examined the versions and the relevant annotations from the translators and discussed the individual questionnaire items to ensure a clear, final version equivalent to the original in terms of semantics, language, culture, and concepts.

#### Research design and participants

Reliability and validity were assessed using a two-stage research design. Internal consistency reliability and exploratory factor analysis (EFA) were examined in Stage 1. We used a sample of 298 adolescents (47% male and 53% female, 15.5 years old) to satisfy the requirement of a sample size of 5–10 participants for each of the 28 items in EFA (Medic et al. 2017). Confirmatory factor analysis (CFA) and preliminary criterion validity (sleep quality differs by chronotype) were examined in Stage 2. We examined a separate sample of 219 adolescents (51% male and 49% female, 15.4 years old) to satisfy a sample size of at least 200 for CFA (Murray et al. 2012). All participants ( $N=517$ , 49% male and 51% female, 15.5 years old) were full-time, Taiwanese high school students (grades 9–12) tested at all times throughout the day, were randomly selected, and not prescreened for the presence of any sleep or other medical issue. We have previously published on sleep characteristics in this population including the translation of other sleep questionnaires (Kaplan 2017; LeBourgeois et al. 2005; Lin et al. 2020).

#### Measures

##### Chinese version of the adolescent sleep wake scale (C-ASWS)

The C-ASWS is a 28-item instrument, with each item scored on a 6-point Likert scale (eight of the statements are negatively scored); higher scores indicate better sleep quality. The five factors of the original ASWS are: going to bed, falling asleep, maintaining sleep, reinitiating sleep, and returning to wakefulness.

##### Morningness eveningness scale for children (MESCC)

A Chinese version of the MESCC (Myers et al. 2011) was administered to determine chronotype, a measure of the degree of morning or evening preference. This measure, initially validated in 11–12 years old, has frequently been used in adolescent samples. The test–retest reliability of the Chinese version is 0.75 (Myers et al. 2011); the

internal consistency reliability of our sample is 0.74. We used cut-off values at the 25<sup>th</sup> and 75<sup>th</sup> percentile to parse chronotypes (Palermo et al. 2008), which corresponds to values of 10–23 for evening type, 24–28 for intermediate type, and 29–43 for morning type. While not a direct test of sleep quality, several studies have shown that morning-types have better sleep quality than evening-types (Palmer et al. 2018; Sufrinko et al. 2015). As such, we used the MESCS to establish preliminary criterion validity for the C-ASWS by comparing sleep quality in morning- versus evening-types, excluding the middle 50% (neither-types).

**Data analysis**

Analyses were conducted using SPSS 20.0 (IBM, Armonk NY). Internal consistency reliability was measured with Cronbach’s  $\alpha$  for overall score and subscale scores ( $\alpha \geq 0.7$  acceptable,  $\alpha \geq 0.8$  good,  $\alpha \geq 0.9$  may represent redundancy between scale items) (Tinsley and Tinsley 1987). EFA was assessed with the Kaiser–Meyer–Olkin (KMO) statistic and Bartlett’s test; KMO should be 0.60 or higher to proceed with factor analysis (Tsang et al. 2017). CFA (AMOS 24.0) was assessed using multiple goodness-of-fit indices (Tzischinsky and Shochat 2011; Wang et al. 2016): (Crowley et al. (Crowley et al. 2018))  $\chi^2/df$ , (Baum et al. (Baum et al. 2014)) root mean square error of approximation (RMSEA), (Palmer et al. (Palmer et al. 2018)) Comparative Fit Index (CFI), (Wang et al. (Wang et al. 2016)) Tucker-Lewis Index (TLI), (Lin et al. (Lin et al. 2020)) standardized root mean square residual (SRMR). Criterion validity was measured using independent samples *t*-tests for overall score and subscale scores, comparing sleep quality differences by chronotype.

**Results**

The two groups used to test for (Baum et al. 2014) internal consistency reliability and EFA, and (Browne and Cudeck 1992) CFA and criterion validity were not different (chi-square test for homogeneity) in regards to either gender ( $\chi^2 = 0.88, p = 0.35$ ) or age ( $\chi^2 = 2.15, p = 0.54$ ).

**Internal consistency reliability**

The internal consistency for the overall instrument is 0.86. All subscales show good internal consistency for the subscales: 0.81 (going to bed), 0.87 (falling asleep), 0.86 (maintaining sleep), 0.89 (reinitiating sleep), and 0.85 (returning to wakefulness).

**Exploratory factor analysis (EFA)**

Principal components analysis with the varimax method was applied to extract the factor structure. EFA was performed on each of the 28 items, with the KMO value of 0.84 and a Bartlett’s test of sphericity of 4528.53

( $p = 0.00$ ), indicating that the use of factor analysis was appropriate. The five factors have eigenvalues greater than 1 and explain the 62.6% of the total variance.

**Confirmatory factor analysis (CFA)**

The CFA model demonstrated a good fit of the data to the ASWS model with each of the five different summary metrics (Table 1; Fig. 1).

**Criterion validity**

Morning-types, as compared to evening-types, have better sleep quality on the ASWS overall score as well as each of its subscales (Table 2).

**Discussion**

The ASWS is one of the most widely used measures of sleep quality in adolescents and has been a valuable tool for estimating the multifaceted nature of subjective sleep quality (Yang et al. 2020). To establish the ASWS as a useful tool in the assessment of Chinese speaking adolescents, our work aimed to translate, adapt, and analyze the psychometric properties of a Chinese language version of the ASWS (C-ASWS) in a sample of adolescents in Taiwan. The C-ASWS displays satisfactory psychometric properties, though further criterion validity is necessary to ensure that the questionnaire is an accurate determination of sleep quality in Chinese speaking adolescents.

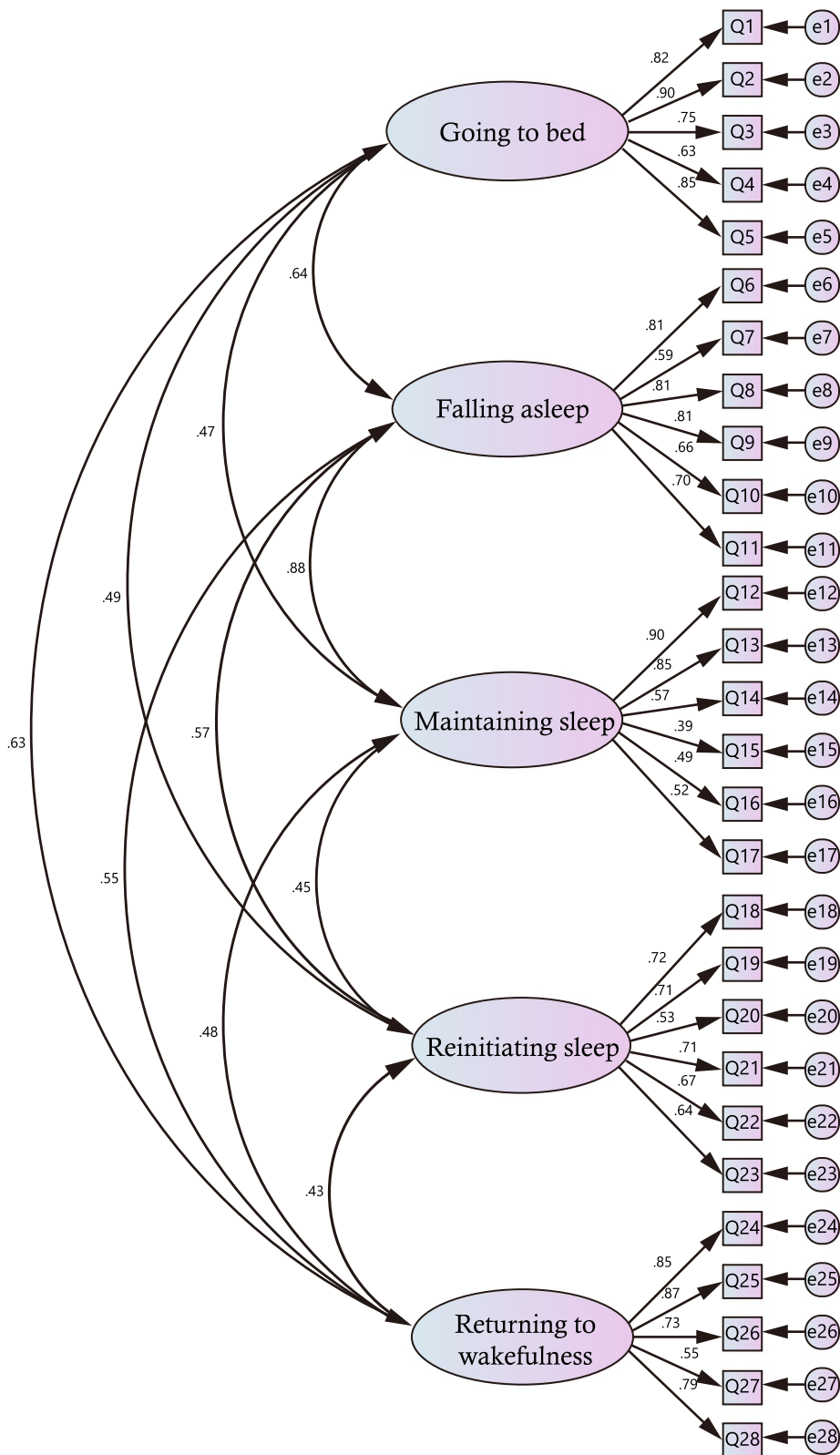
The Cronbach’s  $\alpha$  in the original scale is 0.80–0.86 (Italians:  $\alpha = 0.80$ ; Americans:  $\alpha = 0.86$ ). The Cronbach’s  $\alpha$  in our study is 0.86, without removing any item from the original ASWS scale, indicating that the scale has similar psychometric properties in different populations. The previously published Chinese translation of the ASWS (Hu 1999) had a lower Cronbach’s  $\alpha$  for both the overall scale (0.71) and individual subscales (current 0.81 → 0.89, previous 0.61 → 0.73). As with the original, the C-ASWS parses into five factors, reflecting separate, yet conceptually related constructs.

While not a direct test of sleep quality, we did see the expected association between chronotype and

**Table 1** Results of Confirmatory Factor Analysis (CFA)

Measure	Results	Recommended cutoff
$\chi^2/df$	1.8	< 5
RMSEA	.06	< .08
CFI	.92	> .90
TLI	.91	> .90
SRMR	.05	< .08

Note: RMSEA, root mean square of approximation; CFI, Comparative Fit Index; TLI, Tucker-Lewis Index; SRMR, standardized root mean square residual



**Fig. 1** Confirmatory Factor Analysis of the Chinese Version of ASWS

**Table 2** Sleep Quality Differences in Chronotype

	Evening (E) (n = 66)		Morning (M) (n = 66)		t	p	η <sup>2</sup>	Comparison
	Mean	SD	Mean	SD				
Overall	4.03	.69	5.04	.47	9.87	.00	.43	M > E
Going to bed	3.14	1.24	4.51	1.01	6.95	.00	.27	M > E
Falling asleep	4.51	1.03	5.30	.55	5.46	.00	.19	M > E
Maintaining sleep	4.92	.96	5.39	.55	3.42	.00	.08	M > E
Reinitiating sleep	5.16	.80	5.56	.48	3.50	.00	.09	M > E
Returning to wakefulness	2.41	.89	4.46	.93	12.9	.00	.56	M > E

sleep quality, such that evening-types had worse sleep quality. Future studies could examine the relationship between C-ASWS and other aspects of sleep quality, for example the timing, duration, and continuity of sleep (Yang et al. 2021). To our knowledge, direct criterion validity of the ASWS has yet to be established, which is likely due to the fact that while use of polysomnography to record the electrophysiologic characteristics of sleep appears to be an appealing validation of subjective quality, previous studies have not found a good correlation between these set of measures (Yang 2020). Future studies can also evaluate the test–retest reliability of the C-ASWS, which was not performed in the present study, though has been shown to be adequate in a previous Chinese translation of the ASWS (0.85) (Hu 1999). Although the internal consistency reliability is acceptable, further studies using data collected at different points in time to assess the reliability of the scale across time intervals is also suggested.

**Conclusions**

Given the relatively low sleep duration and poor subjective quality in many adolescents, and the association of such with negative health and academic outcomes (Baum et al. 2014; Browne and Cudeck 1992; Chen et al. 2014), use of accurately translated tools into multiple languages is critical for assessing biological and cultural components of insufficient sleep in teens. Our translation and initial validation of the C-ASWS allows for such comparisons in the Chinese speaking population and should enable future research in this area.

**Abbreviations**

ASWS: Adolescent Sleep Wake Scale; BT1,2,3,4: Back-translation version 1, 2, 3, and 4; C-ASWS: Chinese translation of the ASWS; CFA: Confirmatory factor analysis; CFI: Comparative Fit Index; EFA: Exploratory factor analysis; KMO: Kaiser–Meyer–Olkin statistic; MESCS: Morningness Eveningness Scale for Children; RMSEA: Root mean square error of approximation; SRMR: Standardized root mean square residual; T1,2,3: Translation version 1, 2, and 3; TLI: Tucker–Lewis Index.

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Not applicable.

**Authors' contributions**

YTY conceptualized the study, acquired and analyzed the data. HYC, CYH, and CYL were involved in translation and analysis of the data. JMZ was involved in analysis of the data and finalized the manuscript. All authors took part in drafting, revising or critically reviewing the article and gave final approval of the version to be published. All authors read and approved the final manuscript.

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**Availability of data and materials**

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

**Declarations**

**Ethics approval and consent to participate**

All participants completed ethics consent form and the study was approved by National Cheng Kung University's Institutional Review Board before the research commenced.

**Consent for publication**

Not applicable.

**Competing interests**

The authors declare that they have no competing interests.

**Author details**

<sup>1</sup>Institute of Education, National Cheng Kung University, Tainan City 701, Taiwan, ROC. <sup>2</sup>Department of Psychiatry and Behavioral Sciences, Stanford University, Stanford, CA 94305, USA. <sup>3</sup>Department of Neurology, Kaohsiung Medical University Hospital, Taiwan 807, Taiwan, ROC. <sup>4</sup>Department of Otolaryngology, National Cheng Kung University Hospital, College of Medicine, National Cheng Kung University, Tainan City 701, Taiwan, ROC. <sup>5</sup>Sleep Medicine Center, National Cheng Kung University Hospital, College of Medicine, National Cheng Kung University, Tainan City 701, Taiwan, ROC. <sup>6</sup>Mental Illness Research Education and Clinical Center, VA Palo Alto Health Care System, Palo Alto, CA 94304, USA.

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