


# Psychometric Analysis Of The Sleep Hygiene Index And Correlation With Stress And Anxiety Among Saudi University Students

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**Aims:** This study aimed to assess the psychometric properties of the Sleep Hygiene Index (SHI) instrument in screening poor sleep hygiene practices among Saudi university students. As a secondary goal, the association of sleep hygiene practices with stress and anxiety scores were assessed.

**Methods:** Two-hundred and four healthy college and university students aged 18 to 25 years participated in this cross-sectional questionnaire-based survey. Participants were asked to complete the English version of the SHI instrument, the Perceived Stress Scale (PSS-10), the Generalized Anxiety Disorder (GAD-7) scale, and to provide demographic details.

**Results:** The average scores for the SHI, the GAD-7, and the PSS-10 were 6.6, 5.3, and 16.2, respectively. The internal consistency of the SHI was adequate (McDonald's Omega 0.76). The corrected item-total correlations for all the items were fair (range, 0.31–0.50). A statistically significant positive correlation/association of the SHI scores with the PSS score, GAD-7, and self-reported poor sleep were obtained in this sample of Saudi university students. Factor analysis favored a 4-factor model of the SHI in the study sample.

**Conclusion:** The SHI scale demonstrated an adequate level of internal consistency as a self-reported instrument in the assessment of sleep hygiene among Saudi university students. In addition, poor sleep hygiene was correlated with stress and anxiety scores.

**Keywords:** sleep hygiene, stress, anxiety, mood, university student, adolescent

## Introduction

Inadequate sleep at night causes day-time sleepiness in approximately half to three-quarters of college students.<sup>1</sup> In addition, family histories of anxiety or depression and individuals who manifest lifelong anxiety and depression from early childhood onwards are at greater risk for insomnia in later life.<sup>2</sup> Furthermore, previous studies reported a high prevalence of inadequate sleep among youth who exhibit clinical anxiety<sup>3,4</sup> as well as high levels of stress and anxiety in university students.<sup>5</sup> Similarly, many studies suggested that anxiety is one of the risk factors for future insomnia,<sup>6,7</sup> while others reported a bidirectional association of anxiety and depression with insomnia.<sup>8,9</sup> Moreover, another study reported highest comorbidity of insomnia among individuals with generalized anxiety disorder (GAD).<sup>10</sup>

College and university students often reduce their sleep time to provide additional hours for school work and studying.<sup>1</sup> As a consequence, students are more likely to develop poor sleeping patterns, especially during examination periods.<sup>11</sup> About 59% and 51% of medical students reported inadequate sleep quality in the

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Europe and Western countries, respectively.<sup>12,13</sup> A high prevalence of poor sleep and sleep disturbances have been reported in Afro-Asian university students,<sup>14,15</sup> which has often been found to have an association with mental health conditions like anxiety and depression.<sup>16</sup> Previous studies have been conducted among Saudi medical students to assess their sleep qualities and their results indicated that about 37% of students reported a poor sleep quality.<sup>17,18</sup>

Sleep plays a vital role in maintaining mental and physical well-being as well as the cognitive processes.<sup>19,20</sup> Lack of sleep can negatively influence the academic performance of college/university students<sup>11</sup> and several previous studies have reported reduced academic performance in students with poor sleep hygiene compared to those who had good sleep hygiene.<sup>21–23</sup> Another study conducted in China has reported that about 19% of the students had poor sleep hygiene.<sup>24</sup> Similarly, more than 90% of undergraduate medical students in Chinese university reported excessive sleepiness during day-time, with women being more affected than men.<sup>25</sup>

Clinical scales are important tools for evaluating various human behaviors,<sup>26</sup> and quality of sleep is commonly evaluated by various scales.<sup>27–29</sup> Poor sleep habits are also referred to as poor sleep hygiene.<sup>30</sup> Sleep hygiene includes environmental factors, habits, and daily practices that are necessary for good quality of night-time sleep.<sup>31</sup> There are three scales that have been developed to assess sleep hygiene: the Sleep Hygiene Index (SHI),<sup>32</sup> the Sleep Hygiene Self-Test (SHST),<sup>33</sup> and the Sleep Hygiene Awareness and Practice Scale (SHAPS).<sup>34</sup>

The SHI has demonstrated relatively higher internal consistency (Chronbach's  $\alpha=0.66$ )<sup>32</sup> compared to the SHST (Chronbach's  $\alpha=0.54$ )<sup>33</sup> and SHAPS (Chronbach's  $\alpha=0.47$ )<sup>34</sup> in assessing sleep hygiene. In addition to moderate internal consistency, the SHI has shown good test–retest reliability ( $r=0.71$ ,  $p<0.001$ ) and was significantly correlated with sleep quality and sleepiness in day among nonclinical subjects.<sup>32</sup> However, despite the importance of sleep hygiene, there is a dearth of studies assessing sleep hygiene practices among college/university students in Saudi Arabia. Further, no previous studies have validated the use of the SHI to assess sleep hygiene practices among Saudi university students.

Given the seriousness of sleep problems and psychological issues (e.g., stress and anxiety) and their negative impact on the professional and academic life of university students, the current study aimed to assess the psychometric properties (including internal consistency and factor analysis) of the SHI

instrument in assessing sleep hygiene practices among Saudi university students. Secondly, the relationship between sleep hygiene practices and stress and anxiety scores were assessed.

## Methods

### Participants

A pool of healthy college and university students who were potential participants in this study were invited using a simple random sampling design. Inclusion criteria were that the students were aged 18 years and older and were willing to participate in the study. Participants with the presence of chronic disease, current or past history of schizophrenia, bipolar, or other psychotic disorders, memory problems, and the use of neuro-psychotic medications were excluded. Study aims and procedures were explained to each participant. Participants were asked to complete the English version of the SHI, the Perceived Stress Scale (PSS-10), the Generalized anxiety disorder (GAD-7), and to provide demographic details. Since potential participants were students of an English education system, the original English version of the questionnaire was used in this study. The current study was approved by the institutional Ethical committee, Rehabilitation Research chair, King Saud University, Saudi Arabia. The required sample size was estimated according to published criteria regarding the subject-to-item ratio (2–20 subjects per item).<sup>35</sup> Therefore, we enrolled more than 15 participants for each item of the SHI ( $n=204$ ). We hypothesized that the SHI would be a reliable tool for assessing sleep hygiene practices among Saudi university students. Additionally, we expected that there would be a positive correlation/association of the SHI scores with PSS, GAD, and self-reported poor sleep.

## Measures

### SHI Instrument

The SHI is a self-administered 13-item instrument designed to assess sleep hygiene behavioral during day-to-day life.<sup>32</sup> Items in the SHI were adopted from the diagnostic criteria for poor sleep hygiene in the International Classification of Sleep Disorders.<sup>36</sup> Participants were requested to indicate if they engaged in certain sleep hygiene behaviors. In this study, a dichotomized scoring system for each of the 13-items was employed with 0=no and 1=yes. The items were summed to obtain a global SHI score ranging from 0 to 13. A higher SHI score signifies poorer sleep hygiene. Previous research has shown adequate reliability and validity of the SHI.<sup>32</sup>

### PSS-10

The PSS is a 10-item instrument designed to evaluate the self-perceived amount of stress of the participants. Each item is scored on a 6-point Likert scale ranging from 0 (never) to 5 (very often). The items are added to obtain a total PSS score ranging from 0 to 40. Higher score indicates higher levels of stress.<sup>37</sup>

### GAD-7

The GAD scale is a self-administered 7-item instrument designed to evaluate the level of anxiety over a period of 2 weeks. Each item is scored on a 4-point Likert scale ranging from 0 (not at all) to 3 (nearly every day). The items are added to obtain a total GAD score ranging from 0 to 21. Higher scores indicate higher levels of anxiety. The items were designed to evaluate symptoms of anxiety according to the Diagnostic and Statistical Manual of Mental Disorders-IV-TR.<sup>38</sup>

### Self-Reported Poor Sleep

Self-reported sleep was assessed on dichotomous scale indicating normal or disturbed sleep.

## Statistical Analysis

The Statistical Package for the Social Sciences (SPSS 22.0) software (SPSS Inc., Chicago, USA) and Factor 10.8.04 were used for the statistical analyses. Descriptive statistics were calculated to present mean, percentages, frequencies, and indexes of skewness and kurtosis. Internal consistency was assessed using the McDonald's Omega and Cronbach's alpha tests. The correlation of the SHI scores with the PSS and GAD-7 scores was evaluated using the Spearman correlation test. Binary logistic regression was employed to assess relationship between the dichotomous measures of self-reported poor sleep with the SHI total score. Factor 10.8.04 was used for factor analyses: an exploratory factor analysis followed by a semi-confirmatory factor analysis.<sup>39</sup> Sample suitability and sample size adequacy for the factor analysis of the SHI scores were assessed using the Kaiser-Meyer-Olkin Test of Sampling Adequacy (KMO; 0.66), determinant (0.29), Bartlett's test of sphericity ( $\chi^2$  (78)=248.8,  $p<0.00001$ ),<sup>40</sup> and the communalities for all items were above the minimum criteria of 0.2.<sup>41</sup> Robust factor analysis for bias-corrected and accelerated solution using tetrachoric correlation dispersion matrix with bootstrapping for 500 samples was performed. Robust diagonally weighted least square methods for factor extraction with promax rotation were used in the EFA. Factor loadings in the EFA were estimated for linear models. Kaiser's criteria

(Eigenvalue  $\geq 1$ ),<sup>42</sup> the cumulative variance rule ( $>40\%$ ), and parallel analysis were used for the factor extraction in the EFA.<sup>43</sup> Model fit was evaluated using the weighted root mean square residual (WRMR), goodness of fit index (GFI), comparative fit index (CFI), root mean square error of approximation (RMSEA), and robust mean and variance-adjusted chi square. The values indicating acceptable and/or excellent fit were determined by the previously published guidelines.<sup>44,45</sup> These values included a  $p$ -value  $>0.05$  for  $\chi^2$ , the  $\chi^2/\text{df} < 2$ , the  $\text{GFI} > 0.95$ , the  $\text{CFI} > 0.95$ ,  $\text{RMSEA}$  and  $\text{WRMR} < 0.05$ .<sup>44,45</sup> The statistical level of significance was set at  $p < 0.05$ . A receiver operating curve (ROC) analysis with self-reported poor sleep as the state variable and SHI total score as the test variable was performed.

## Results

### Participants' Characteristics And Item Distribution

Table 1 presents the participants' demographic characteristics. Approximately 50% of the participants were in the 3rd, 4th, and 5th year of university education and about 40% of the participants were enrolled in nursing and allied healthcare courses; however, approximately 50% of the participants did not report about their courses. The average scores for the SHI, the GAD-7, and the PSS-10 were 6.6, 5.3, and 16.2, respectively. Seven SHI item scores had univariate asymmetry, with the absolute value of skewness greater than 1, while 10 items had kurtosis issues (Table 2). However, no major issues of multivariate asymmetry skewness and kurtosis were found as determined by a non-significant value of Mardia's coefficient of skewness and kurtosis.

### Internal Consistency

The internal consistency of the SHI is presented in Table 2. The internal consistency of the SHI was adequate as determined by the McDonald's Omega (0.76), though Cronbach's alpha (0.59) indicated a moderate level. The corrected item-total correlations for all the items were fair (range=0.31–0.50). The Cronbach's alpha values did not increase above 0.61 if individual items were deleted.

### Association/Correlation With Related Measures

Statistically significant positive correlations of the SHI scores with the PSS score ( $r=0.29$ ), GAD-7 ( $r=0.36$ ), and self-reported poor sleep (odds ratio: 1.20 95% Confidence interval (1.01–1.43),  $p<0.05$ ) were obtained.

**Table 1** Participant Characteristics Of Saudi University Students

Characteristics	Mean±SD/ Frequency (%)
Age (year)	20.49±1.94
BMI (kg/m <sup>2</sup> )	22.86±10.50
Years of University education	
1–3	57 (27.9)
4–5	75 (36.8)
6–7	13 (6.4)
Did not report	59 (28.9)
Courses	
Biomedical and dental technology	6 (2.9)
Radiology	17 (8.3)
Health and physical education	8 (3.9)
Nursing and allied healthcare (Physio/ Occupational/Speech-therapy)	81 (39.7)
Clinical laboratory sciences and technology	20 (9.8)
Others (Comprised of Biology, Biophysics, Engineering, etc.)	20 (9.8)
Did not report	52 (25.5)
PSS	16.2±6.0
SHI	6.6±2.3
GAD-7 scale	5.3±4.4
Self-reported sleep	
Normal	147 (72.1)
Disturbed	36 (17.6)
Did not report	21 (10.3)
Academic difficulties	
None	67 (32.8)
Some	119 (58.3)
Very much	18 (8.8)

**Abbreviations:** SD, standard deviation; BMI, body mass index; PSS, perceived stress scale; SHI, sleep hygiene index; GAD-7, generalized anxiety disorder-7.

## Factor Analysis

### Measures Of Sample Suitability And Adequacy For Factor Analysis

The Kaiser-Meyer-Olkin Test of Sampling Adequacy (KMO) (0.66) indicates that the sample size is adequate.<sup>46</sup> The Bartlett's test of Sphericity (<0.001) ruled out the issue of singularity in the SHI item scores.<sup>46</sup> Further, the determinant score (0.29) indicates that there was no problem of multicollinearity in the SHI item scores.<sup>46</sup>

### Exploratory Factor Analysis

Table 3 and Figure 1 detail the factor extraction measures used in the exploratory factor analyses of the SHI scores in our sample of Saudi university students. The three tests showed heterogenous findings, that is, the cumulative

variance rule (>40%), the Kaiser's criteria (Eigenvalue >1), and the parallel analysis based on principal component analysis (Figure 1A) and parallel analysis based on minimum rank factor analysis (Figure 1B) indicated disparate models; 2-factor, 4-factor, 4-factor model and 1-Factor solution for the SHI (Table 4).

### Model Fit

Table 5 indicates that the 4-factor model had the best fit with lowest values for RMSEA, WRMR,  $\chi^2$  and  $\chi^2/df$ , and optimal value for CFI, non-significant  $\chi^2$  and highest value for GFI.

### Screening For Self-Reported Poor Sleep

A ROC analysis found that a cutoff total score of 7.5 for the SHI total score showed the highest accuracy (sensitivity: 57.6% and specificity: 67.6%) for classifying cases with self-reported poor sleep among the sample of Saudi university students in this study (area under the curve=0.62, 95% confidence interval=0.52–0.73).

## Discussion

The present study supports the evidence for the psychometric analysis of the SHI in Saudi university students. We found that the SHI scale had an acceptable level of internal consistency in our sample. Given that SHI with dichotomous scoring for individual items was used in this study, McDonald's Omega is better suited to assess internal consistency. However, Cronbach's alpha was also presented for inter-study comparisons. A recent study reported a moderate level of internal consistency of SHI among Nigerian university students.<sup>43</sup> However, previous studies reported higher values of the Cronbach's alpha (ranges, 0.66–0.89). Ozdemir et al<sup>47</sup> reported a Cronbach's alpha value of 0.70–0.71 in a Turkish sample, while Cho et al<sup>48</sup> identified a Cronbach's alpha value of 0.75 in a Korean sample. Further, Chehri et al<sup>49</sup> and Mastin et al<sup>32</sup> noted Cronbach's alpha values of 0.89 and 0.66 in Persian and United States samples, respectively. However, a direct comparison between previous studies and the current study is difficult since the previous studies were carried on the non-clinical and clinical patients,<sup>47</sup> chronic pain,<sup>48</sup> and the general population.<sup>49</sup> In the present study, there were minor variations in the Cronbach's alpha value if items were deleted, especially for items 2, 6, and 8, suggesting the importance and relevance of each item for the structural validity of the SHI among Saudi university students.

**Table 2** Internal Consistency And Univariate Distribution Characteristics Of The Sleep Hygiene Index (SHI) In Saudi University Students

Items Of The Sleep Hygiene Index (Description)	Skewness	Kurtosis	Item-Total Correlation	Cronbach's Alpha If Item Deleted
SHI-1 (I take daytime naps lasting two or more hours)	-0.318	-1.889	0.48*	0.56
SHI-2 (I go to bed at different times from day to day)	-1.397	-0.053	0.48*	0.55
SHI-3 (I get out of bed at different times from day to day)	-0.994	-1.010	0.42*	0.57
SHI-4 (I exercise to the point of sweating within 1 hr of going to bed)	2.469	4.073	0.46*	0.61
SHI-5 (I stay in bed longer than I should two or three times a week)	0.030	-1.985	0.44*	0.56
SHI-6 (I use alcohol, tobacco, or caffeine within 4 hrs of going to bed or after going to bed)	0.708	-1.488	0.48*	0.55
SHI-7 (I do something that may wake me up before bedtime)	-2.535	4.421	0.31*	0.57
SHI-8 (I go to bed feeling stressed, angry, upset, or nervous)	0.419	-1.811	0.50*	0.55
SHI-9 (I use my bed for things other than sleeping or sex)	-1.098	-0.788	0.38*	0.57
SHI-10 (I sleep on an uncomfortable bed)	1.627	0.640	0.41*	0.56
SHI-11 (sleep in an uncomfortable bedroom)	2.230	2.979	0.35*	0.56
SHI-12 (I do important work before bedtime)	-0.139	-1.971	0.36*	0.58
SHI-13 (I think, plan, or worry when I am in bed)	-0.731	-1.458	0.46*	0.56

Note: \*P<0.01.

**Table 3** Exploratory Factor Analysis: Eigenvalues And Total Variance Explained Of The Sleep Hygiene Index (SHI) In Saudi University Students

Factor	Eigenvalues	% Of Variance	Cumulative %
1	3.53	27.16	27.16
2	1.81	13.88	41.04
3	1.78	13.72	54.76
4	1.23	9.5	64.26
5	0.98	7.55	71.81
6	0.76	5.9	
7	0.7	5.37	
8	0.61	4.66	
9	0.57	4.37	
10	0.42	3.22	
11	0.31	2.39	
12	0.18	1.41	
13	3.53	27.16	

Note: Exploratory factor analysis for initial unrotated solution.

The expected relationship between poor sleep and stress-related anxiety is supported in the present study by the significant correlations between the SHI total score and the PSS score, GAD-7 score, and self-reported poor sleep score. Previous studies have reported a bidirectional association of anxiety and depression with insomnia.<sup>8,9</sup> Additionally, another study reported poor sleep hygiene and sleep problems among individuals with GAD.<sup>10</sup>

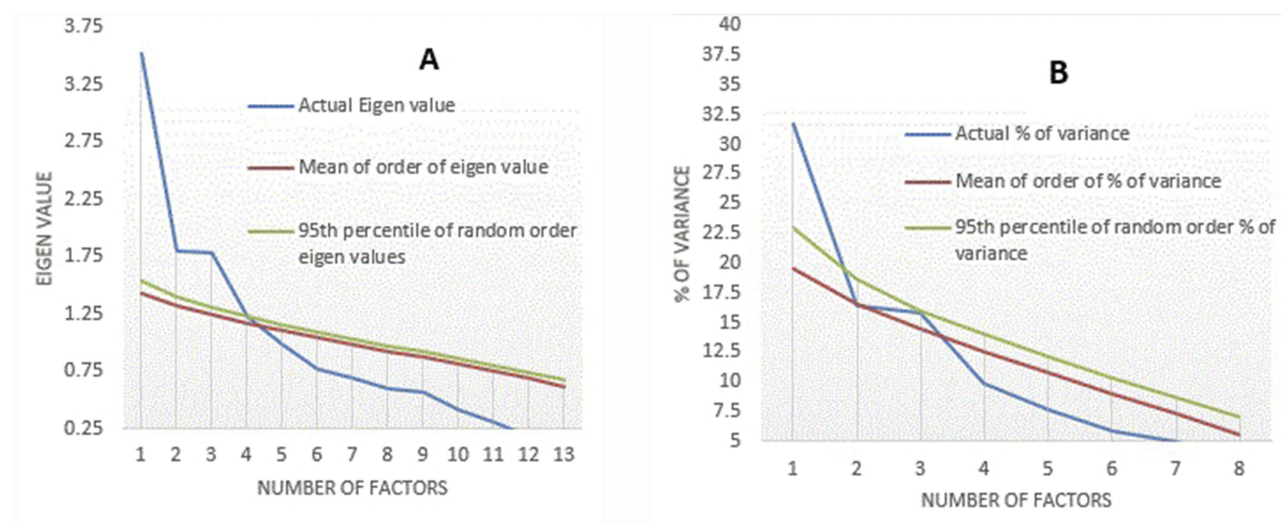
The results of the exploratory factor analysis indicated three different factor structures for the SHI among Saudi university students. The model fit indices employed

favoring the 4-factor model for the SHI in the study population. These findings are different from those reported in some of the previous studies. Cho et al<sup>48</sup> reported a 3-factor model for the SHI in chronic pain patients. However, it is noteworthy that the findings are based only on the EFA.<sup>48</sup> Seun-Fadipe et al<sup>43</sup> reported that a 2-factor model of the SHI was optimal in a Nigerian university student population. Chehri et al<sup>49</sup> also found a 3-factor model for the SHI in a Persian male population. It is therefore recommended that future studies with large sample sizes and multi-centre data collection should explore the dimensionality of the SHI using EFA, CFA, and measurement invariance across socio-demographic characteristics for a better understanding on this topic. The SHI was found to have adequate validity for screening students with self-reported poor sleep. The results are slightly better than those reported by Seun-Fadipe et al<sup>43</sup> for screening Nigerian undergraduate students with poor sleep quality based on the subjective evaluation by a questionnaire. In that study, sub-optimal specificity (below 50%) was reported for screening students with poor sleep quality using the SHI.

## Conclusion

The SHI had adequate levels of internal consistency as a self-reported instrument in the assessment of sleep hygiene practices among Saudi university students. In addition, poor sleep hygiene was associated with stress, anxiety, and self-reported





**Figure 1** (A) Parallel analysis based on principal component analysis of the Sleep hygiene index (SHI) in Saudi university students. (B) Parallel analysis based on minimum rank factor analysis of the Sleep hygiene index (SHI) in Saudi university students.

poor sleep in Saudi university students. Further research is needed to explore the effects of lifestyle behaviors such as

problematic use of internet, mobile devices, and online games on sleep hygiene practices.

**Table 4** Exploratory Factor Analysis: Factor Loadings And Community Of The Sleep Hygiene Index (SHI) In Saudi University Students

Items Of The Sleep Hygiene Index (Description)	Factor Loadings				Communality
	Factor-1	Factor-2	Factor-3	Factor-4	
SHI-1 (I take daytime naps lasting two or more hours)	-0.456				0.231
SHI-2 (I go to bed at different times from day to day)	-0.659				0.608
SHI-3 (I get out of bed at different times from day to day)	-0.351				0.229
SHI-4 (I exercise to the point of sweating within 1 hr of going to bed)			-0.596		0.444
SHI-5 (I stay in bed longer than I should two or three times a week)	-0.425				0.303
SHI-6 (I use alcohol, tobacco, or caffeine within 4 hrs of going to bed or after going to bed)	-0.465		-0.325	0.325	0.437
SHI-7 (I do something that may wake me up before bedtime)	-0.498		0.353		0.409
SHI-8 (I go to bed feeling stressed, angry, upset, or nervous)	-0.482			0.459	0.499
SHI-9 (I use my bed for things other than sleeping or sex)	-0.425		0.320		0.360
SHI-10 (I sleep on an uncomfortable bed)	-0.540			-0.356	0.505
SHI-11 (sleep in an uncomfortable bedroom)	-0.394		-0.537		0.594
SHI-12 (I do important work before bedtime)		0.873			0.862
SHI-13 (I think, plan, or worry when I am in bed)	-0.515	0.353			0.394

**Note:** Exploratory factor analysis for initial unrotated solution.

**Table 5** Fit Statistics Of The Sleep Hygiene Index Models In Saudi University Students

Models	WRMR	GFI	CFI	RMSEA	$\chi^2$	df	p	$\chi^2/df$
1-Factor	0.086	0.821	0.754	0.07 (0.05–0.08)	130.142	65	<0.01	2.01
2-Factor	0.07	0.856	0.856	0.06 (0.05–0.08)	92.065	53	<0.01	1.74
4-Factor	0.037	0.891	0.983	0.03 (0.01–0.05)	36.648	32	0.261	1.14

**Note:** <sup>#</sup>Robust Mean and Variance-Adjusted Chi Square.

**Abbreviations:** WRMR, weighted root mean square residual; GFI, goodness of fit index; CFI, comparative fit index; RMSEA, root mean square error of approximation.

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## Disclosure

The authors report no conflicts of interest in this work.

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