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Research article

Development and psychometric properties of an instrument to measure sleep behavior self-regulation in adolescent students

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ABSTRACT

Background: The prevalence of inadequate sleep among adolescents is a significant worry due to its potential to adversely affect their health and academic performance. Addressing this matter necessitates a comprehensive grasp of the underlying factors influencing sleep regulation and the formulation of evidence-based interventions to counteract its detrimental consequences. Hence, the central objective of this study is to create and assess a dependable questionnaire designed to evaluate adolescents' self-regulation of sleep behavior.

Methods: In this cross-sectional study, data from 401 high school students randomly selected from west Iran were incorporated and subjected to psychometric assessments. The average age of the participants was 16.5 ± 0.92. Initially, 136 preliminary items were formulated, drawing from a contextual framework and comprehensive literature review. The subsequent steps involved specialized analyses, including content validity analysis, item analysis, exploratory and confirmatory factor analysis, as well as convergent validity analysis.

Results: Both exploratory and confirmatory factor analyses support a strong structural model, including factors like self-control, outcome expectation, goal setting, and self-efficacy, which are linked to regulating sleep behavior. The model fit was satisfactory. The instrument had 22 items which demonstrated good internal consistency, adequate test-retest reliability, and evidence of convergent validity.

Conclusion: In future studies exploring sleep behavior, the present questionnaire, which has demonstrated initial validity and reliability, holds the potential to provide valuable assistance in evaluating and enhancing self-regulation in sleep behavior, particularly within school environments.

1. Introduction

Studies conducted worldwide indicate that many teenagers have poor sleep health, with insufficient sleep being common, especially on weekdays [1–4]. This can lead to a range of health, behavioral, and cognitive issues, such as obesity, anxiety, poor academic performance, and excessive daytime sleepiness [5–10]. Given the importance of healthy sleep for adolescents' physical and mental well-being, as well as their academic performance [11–13], sleep health has become a significant concern [1,4]. As a result, there has

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been an increasing emphasis on identifying potential indicators and methods to enhance interventions to improve adolescents' sleep health [14–16]. By maintaining good sleep habits and sleep hygiene, teenagers can significantly improve their productivity at school and during the day [17,18].

Previous research has demonstrated the crucial role of self-regulation (SR) in promoting healthy sleep habits [19–21]. Inadequate self-regulation has been linked to smartphone addiction and poor sleep quality, as there is a correlation between self-regulation and sleep quality [19]. Additionally, researchers have found a significant correlation between self-regulation, the amount of nighttime sleep, and daytime sleepiness levels [20]. Furthermore, poor self-regulation skills may lead to an excessive delay in sleep time [22].

Addressing self-regulation is important to promote healthy behaviors and improve short-term and long-term outcomes because SR is considered a valuable skill that enables an individual to better adapt to various contextual circumstances and consequently lead a healthy and fulfilled life [23,24]. Certainly, adolescence is a pivotal phase of self-regulation due to the effects of puberty and elevated self-reliance, making this a focal point for intervention [25,26].

Using accurate and reliable tools to measure the self-regulatory abilities of adolescents and gaining a deeper understanding of their individual capacities, especially for health-enhancing behaviors such as having regular and sufficient sleep, is necessary. The self-regulation questionnaire (SRQ) is frequently used in studies examining self-regulation [27]. Additionally, the behavior rating inventory of executive function (BRIEF) was one of the first attempts to measure executive function, and it was the first published measure of these self-regulatory proficiencies in children and adolescents. The BRIEF assesses everyday behaviors associated with EF at home and in academia [28]. To the best of our knowledge, there is no specific scale in the literature to evaluate the self-regulation of sleep behaviors. Current sleep studies have only used general questionnaires to assess self-regulation [20,29,30].

In the present study, a specific instrument was designed according to self-regulation theory, focusing on cognitive, behavioral, and motivational factors that influence students' ability to regulate behaviors that improve sleep. This instrument is based on the idea that positive strategies in three phases are involved in self-regulating sleep. The first phase is the forethought phase, where beliefs about goal-setting and self-motivation are important. The two main variables affecting self-motivation are outcome expectations and self-efficacy. Outcome expectancy refers to the potential outcomes resulting from engaging in a specific behavior, while self-efficacy involves belief in one's ability to perform a task effectively [24,31]. Our study explores how self-efficacy and outcome expectations impact sleep behavior among adolescents. These factors are believed to directly influence behavior and the development of self-regulation. Regarding the performance phase, students need to employ different techniques to manage their compulsive urges and establish a consistent sleep pattern. The third phase involves self-reflection, where students evaluate their work and contemplate the reasons behind their behavioral outcomes [24].

The study aims to develop and evaluate a self-regulation questionnaire for sleep behavior in students aged 14–18 years, with a focus on determining its psychometric properties.

2. Materials and method

The study was carried out in two phases: development and psychometric evaluation. Both phases are described below.

2.1. Item development

The questionnaire development process started with a literature review. 'Sleep' and 'self-regulation' were searched using multiple databases, including PubMed, Science Direct, Scopus, Google Scholar, and ProQuest.

2.2. Content and face validity

A panel of 12 experts in instrument design, sleep behavior, self-regulation, and psychology reviewed the initial questionnaire. The CVR was calculated using the formula CVR=(Ne - N/2)/N/2, where Ne is the number of experts considering an item "essential," and N is the total number of reviewers. Items with CVR values below 0.56, determined by the Lawshe table, were excluded from further consideration [32]. Simultaneously, the item content validity index (I-CVI) was employed to assess each item for clarity, simplicity, and relevance. Items achieving an I-CVI value exceeding 0.79 were deemed appropriate and retained in the questionnaire [33].

To assess face validity, a multifaceted approach was used. Qualitatively, ten students aged 14 to 18 participated in interviews utilizing loud thinking and verbal probing techniques. This qualitative phase aimed to discover potential issues in comprehension, question interpretation, and the identification of ambiguous or misleading questions. Subsequently, a quantitative assessment was performed, wherein students evaluated the comprehensibility of each item using a 4-point Likert scale.

2.3. Psychometric testing

2.3.1. Pilot study

The 69 respondents, aged between 14 and 18, were randomly selected, and a test-retest was performed with a three-week interval. The questionnaire was completed by 20 respondents upon re-administration. We computed split-half reliability (spearman-brown coefficient) and test-retest reliability (intraclass correlation coefficient (ICC)). Values equal to or greater than 0.7 were considered acceptable [34,35].

2.3.2. Participants and settings

Participants for the study were high school students recruited from eight schools in Abdanan, Ilam province in western Iran. Both public and private high schools from various geographical areas were included. The inclusion criteria were an age range between 14 and 18 years, signed parental consent for students under 18, and consent to participate in the study. An online questionnaire was used to collect data in 2021.

2.3.3. Construct validity

We examined the construct validity based on data obtained from the cross-sectional study, employing item analysis, exploratory factor analysis (EFA), and confirmatory factor analysis (CFA). In the item analysis phase, items demonstrating weak psychometric attributes within the SBSRQ were identified. This involved scrutinizing distributions for significant skewness departure (±2), identifying floor or ceiling effects, and setting criteria for item-total correlation (ITC) between ≥0.3 and 0.80. Items of paramount importance to the measured domain were retained, even if deviating from these standards.

Subsequently, in order to assess the construct validity, a maximum-likelihood exploratory factor analysis (MLEFA) with Promax rotation was conducted on the first 200 responses. The number of factors was determined based on an eigenvalue of 1.00. A threshold of 0.3 for factor loading was used to maintain the items. The Kaiser-Meyer-Olkin (KMO) and Bartlett tests were used to evaluate the sampling adequacy [36]. The construct validity assessment culminated in confirmatory factor analysis (CFA) using the remaining sample (N = 201). Employing the maximum-likelihood method, the model fit was rigorously evaluated through multiple indices. This included assessing chi-square goodness-of-fit (CMIN/DF) < 3, goodness-of-fit index (GFI) > 0.90, adjusted GFI index (AGFI) > 0.90, root-mean-square error of approximation (RMSEA) < 0.08, and comparative fit index (CFI) > 0.90 [37]. Additionally, measurement invariance for the second-order factor model was examined across genders, testing both configural and metric invariance. This holistic approach solidified the construct validity of the SBSRQ, ensuring its robustness and applicability across diverse groups.

2.3.4. Reliability assessment

The study's internal consistency was evaluated using Cronbach's alpha (α), McDonald's omega coefficient (ω), and average inter-item correlation (AIC). Acceptable consistency was α > 0.7 [34] and AIC between 0.2 and 0.4 [38]. The composite reliability (CR) was computed and CR values exceeding 0.7 were considered acceptable [39]. Analysis was conducted using SPSS version 23 and AMOS version 24, along with an SPSS extension for McDonald's Omega. Composite reliability was computed, in Excel.

2.3.5. Convergent validity

The convergent validity was examined via Spearman's correlation between the final version of the SBSRQ and the Cleveland Adolescent Sleepiness Questionnaire (CASQ). Aghajani et al. translated this questionnaire into Iran and confirmed its validity and reliability. The CASQ's Cronbach's alpha coefficient was a satisfactory 0.84 [40]. The Cronbach's alpha of 0.81 was observed for the CASQ instrument in this study.

2.3.6. Scoring

The SBSRQ included the assessment of 22 items utilizing a five-point Likert scale. Scores on the scale spanned from 22 to 110, with ranges categorized as follows: 22–44 (low),45–88 (moderate), and 89 or above (high). Elevated scores corresponded to enhanced sleep behavior self-regulation.

3. Results

After examining existing research and identifying risk factors for adolescent sleep deprivation, three key categories were

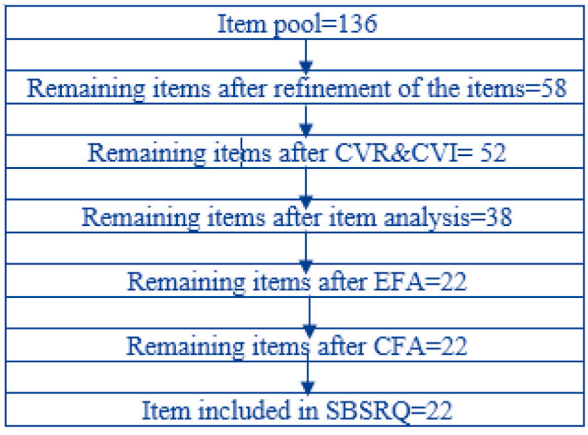

Fig. 1. Items selection process.

established to facilitate sleep self-regulation. Initially, a total of 136 self-regulation items related to sleep behavior were identified. Following a refinement process, the number was reduced to 58 items. These 58 items were then categorized into subgroups, encompassing goal-setting, motivational beliefs (outcome expectations and self-efficacy), self-control, self-observation, causal attribution, and self-satisfaction. The response choices for the scale were presented as a 5-point Likert scale, ranging from "never" [1] to "always" [5], and from "not confident" [1] to "highly confident" [5] (see Fig. 1).

3.1. Content and face validity

The CVR for all the items was $\geq$0.56, indicating the essential nature of all items for the study's purposes, except for one item. I-CVI calculations resulted in I-CVI $\geq$0.79 for all items, except for five. Items with a CVI of $<$0.79 were eliminated from the item pool. The S-CVI/Ave was 0.89. During the qualitative face validation, students' remarks were reviewed collaboratively by two authors, and detailed notes were taken. Adjustments were made to the wording of items to enhance interpretability and comprehensibility. In the quantitative face validation stage, following the implementation of changes from the qualitative phase, all items were deemed comprehensible by the students.

3.2. Pilot study

In the pilot study, the Spearman-Brown coefficient for assessing split-half reliability was 0.71, and the intra-class correlation coefficient (ICC) for assessing test–retest reliability was 0.73.

3.3. Participants

The average age of the students was 16.53 $\pm$ 0.92 years old, with the majority being male (61%). About 66.5% (n = 209) of the fathers and 65.8% (n = 206) of the mothers had completed secondary and higher education, respectively. Initially, we received 450 questionnaires, but those with more than 15% missing data were excluded from the analysis. This left us with 401 valid samples, which were then randomly divided into two sub-samples: an exploratory sample, denoted as Sample A (n = 200), and a confirmatory sample, denoted as Sample B (n = 201). The detailed demographic characteristics of the participants can be found in Table 1.

3.4. Item analysis

Based on the evaluation of internal consistency, items with item-total correlation (ITC) less than 0.3 and greater than 0.8 were excluded. Furthermore, items with high skewness were also excluded.

3.5. Exploratory factor analysis

Items extracted from the item analysis stage were reviewed, and missing values were imputed using the mean of the items. The KMO value was 0.89, and Bartlett's test of sphericity was statistically significant ($\chi 2 = 2219.629$, df = 231, $p < 0.000$), indicating that the collected samples met the prerequisites for factor analysis. The factor analysis resulted in a 5-factor solution, explaining 56.002% of the total variance (see Table 2).

By the plot, the curve exhibits a smoother slope beginning at the fifth data point (refer to Fig. 2).

Here are the elaborate descriptions of the factors.

Factor 1. : The first factor is associated with the performance phase and encompasses inquiries concerning self-control and the reasoning behind delaying the sleep-wake cycle.

Factor 2. : The second factor corresponds to the anticipated outcomes of acquiring sufficient and consistent sleep. This includes its positive effects on education, mood, and energy levels.

Table 1
Demographic characteristics of the study Participant (n = 401).

Variable	Categories	Frequency	Percentage
Sex	Male	248	61.8
	Female	153	38.2
Age	15	53	13.3
	16	140	35.1
	17	144	36.1
	18	62	15.6
School type	Public	292	73.0
Grade	Private	108	27.0
	10	148	37.3
	11	140	35.3
	12	109	27.5

Table 2
Factor structure of the 22-item sleep behavior self-regulation.

Factor/Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Communality
Factor 1: Self-control	0.789					0.571
SC23. I resolved environmental stimuli(e.g., sound, light, and heat) that stopped me from following the sleep schedule.						
SC11. I identified the obstacles getting in the way of my regular sleep-wake program and found ways to solve them.	0.784					0.741
SC7. I resisted the temptations hindering my regular sleep-wake schedule (e.g., spending time on social networks.	0.750					0.550
SC8. To have a regular sleep-wake schedule, I set diet plans(e.g., I did not drink caffeinated beverages before going to bed).	0.713					0.460
SC10. I controlled negative thoughts and feelings before going to sleep.	0.701					0.551
SC9. To have a regular sleep-wake schedule, I set rules for screen time (e.g., limiting television time).	0.627					0.564
SC21. If I had trouble following my sleep-wake program, I would look for a solution.	0.568					0.594
Factor 1: Outcome expectation		0.809				0.645
OE11. Adequate and regular sleep at night increases my concentration in the classroom.						
OE9. I think getting enough sleep boosts my energy.		0.769				0.578
OE10. I think getting enough sleep makes me feel mentally well.		0.732				0.518
OE12. Adequate and regular sleep at night increases my alertness for the next day.		0.675				0.521
Factor 3: Goal setting			0.820			0.622
GS4. I was interested in following a regular sleep-wake schedule.						
GS31. I decided to get 8 h of sleep every night, I need To resort to a regular sleep-wake schedule.			0.750			0.770
GS2. I made changes to my lifestyle to follow a regular sleep-wake schedule.			0.669			0.512
GS5. I had enough motivation to follow a regular sleep-wake schedule.			0.644			0.593
Factor 4: Self-efficacy				0.674		0.567
SE5. I wake up at a specific time every day.						
SE4. I go to bed at a set time every night.				0.636		0.714
SE1. I go to bed before midnight during school days.				0.586		0.361
SE3. I will not let sleep deprivation from last night affect my plans for the next day.				0.521		0.339
Factor 5: self-efficacy					0.679	0.595
SE7.I do not place my phone or tablet next to the bed.						
SE9.I do not use the bed for anything other than sleeping (e.g., doing homework).					0.624	0.427
SE8. I do not engage in activities that need heavy concentration before going to sleep(e.g., playing a computer game).					0.555	0.528
Initial Eigenvalues	8.066	2.432	1.864	1.141	1.043	
Initial Variance(%)	36.664	11.055	8.473	5.188	4.742	
Eigenvalue	7.600	2.016	1.425	0.731	0.548	
Explained variance(%)	34.54	9.164	6.477	3.324	2.491	

Note. Self-control: SE; Outcome expectation: OE; Goal setting: GS; Self-efficacy: SE.

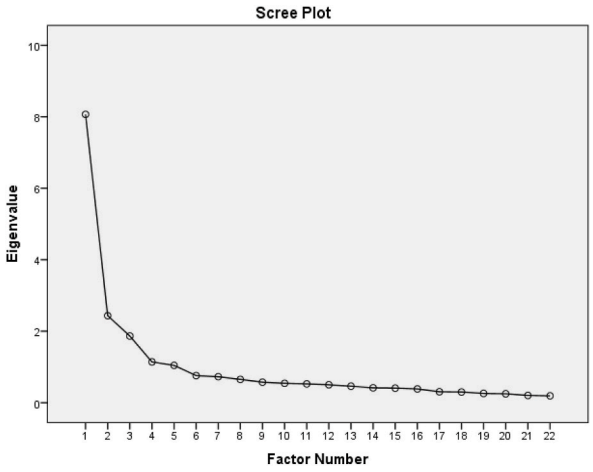

Fig. 2. Scree plot of EFA.

Factor 3. : The third factor addresses questions related to goal-setting and beliefs regarding motivation.

Factor 4. : The fourth factor pertains to queries about self-efficacy and the ability to engage in actions that facilitate timely sleep.

Factor 5. : The fifth factor involves the latter portion of self-efficacy questions, focusing on the capability to undertake necessary actions for maintaining a regular sleep schedule.

3.6. Confirmatory factory analysis

Following the EFA results, a model was constructed using Sample B (n = 201). In the first-order confirmatory factor analysis, after modifying the model and establishing a correlation between the measurement errors e8 and e11, the Chi-squared test for goodness-of-fit was the initial fitting index ($\chi 2 = 326.087$, DF = 198, p = 0.000). To assess model fit, additional indices were considered (IFI = 0.951, CFI = 0.951, GFI = 0.88, AGFI = 0.85, PNFI = 0.772, PCFI = 0.82, RMSEA = 0.055, CMIN/DF = 1.61), all of which strongly supported the adequacy of the final model (Table 3, Fig. 3).

A second CFA was conducted to validate the overall concept of "sleep behavior self-regulation" after the first-order CFA. Fig. 3 shows the structural model and the second-order CFA of the SBSRQ. Most items had factor loadings for the SBSRQ above 0.7. Table 3 displays the fit indices for the second-order CFA in comparison to the first-order model (Table 3, Fig. 4).

Findings from the instrument's gender invariance assessment indicated no significant differences between groups, as evidenced by the non-significant $\Delta\chi 2$ and ΔCFI values that were below 0.01. Consequently, the results supported the gender invariance of the SBSRQ among adolescent students ((See Table 4 and Figs. 5 and 6).

3.7. Convergent validity

We examined the convergent validity of the SBSRQ by assessing the correlation between levels of sleepiness and self-regulation of sleep behavior. Our analysis revealed a moderately negative linear relationship, indicating that higher sleepiness scores were linked to decreased self-regulation of sleep behavior (see Table 5).

Lastly, the adolescent sleep hygiene scale-revised (ASHS-r) was employed [41]. The correlation between the ASHS-r and SBSRQ was determined using Spearman's correlation coefficient, revealing a moderate correlation (r = 0.41). To assess the overall reliability of the ASHS-r tool, Cronbach's alpha was employed, yielding a score of 0.72.

3.8. Tests of reliability

Reliable estimates were achieved for all five proposed dimensions, as shown in Table 6.

4. Discussion

This paper describes the development and validation of a questionnaire assessing sleep behavior self-regulation in adolescent students. We used the structural dimensions of self-regulation theory as the basis for designing the questionnaire, making such an attempt undoubtedly contributes to a greater comprehension and improvement of health behaviors, along with research, education, and practice. It was tested using a random sample to evaluate its psychometric properties, including internal consistency, structural validity, and convergent validity.

The questionnaire consists of 22 items categorized into five factors. The loadings of items onto their respective factors fell within an acceptable range, indicating both statistical significance and the relevance of the included items. Notably, the overall reliability of the instrument was exceptional, as evidenced by a Cronbach's alpha coefficient of 0.92 and an Omega McDonald's alpha of 0.93.

The first factor encompasses self-control items from the performance phase. These items are related to individual variables that regulate factors affecting sleep delay. As revealed by the exploratory factor analysis, this factor accounts for the largest proportion of self-regulatory variance in sleep behavior (36.45%). Self-control is an integral element of conscious and intentional self-regulation. Various studies have demonstrated that a deficiency in self-control is linked to difficulties in behavior, emotions, academics, and other areas [42]. The interplay between adequate sleep habits and self-control might lead to enhancements in long-term health and quality of life [43].

The fourth and fifth aspects constitute 10% of the variance in self-regulation of sleep behavior, which includes self-efficacy items. Research has shown that changing one's self-efficacy can have a significant impact on altering health behavior by affecting self-regulation mechanisms [44]. Earlier, the sleep self-efficacy scale was developed to forecast different signs of insomnia [45]. In this study, we aimed to examine how self-efficacy relates to self-regulation. We assessed self-efficacy in regulating sleep-wake time, overcoming sleep barriers, and how it affects sleep-related behaviors. Contrary to our expectations, seven validated items related to

Table 3
Fit indices of the first and second-order confirmatory factor analysis of the SBSRQ.

CFA Index	IFI	CFI	AGFI	PNFI	PCFI	RMSEA	CMIN/DF	P-Value	df	X2
First-order after construct Modification	0.95	0.95	0.84	0.75	0.81	0.057	1.647	0.000	198	326.087
Second-order after Construct modification	0.95	0.95	0.85	0.77	0.82	0.055	1.612	0.000	201	323.917

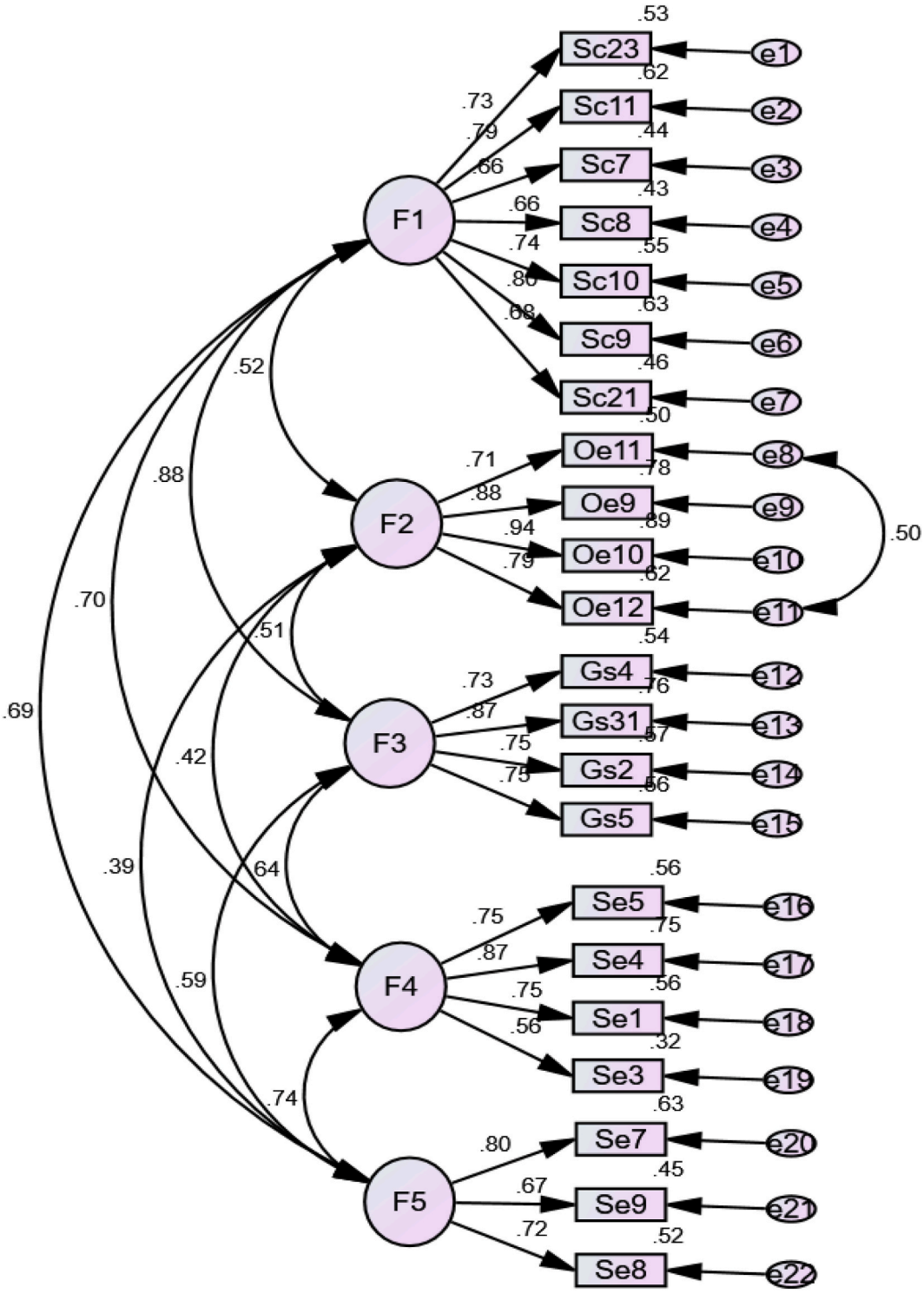

Fig. 3. The SBSRQ constructs a modified model of first-order confirmatory factor analysis.

self-efficacy loaded onto two factors instead of loading onto a single factor. The study found that both factors of self-efficacy had a significant association with sleepiness. However, the fourth factor, which pertains to the ability to regulate sleep-wake time, showed the strongest negative correlation with sleepiness in adolescent students.

The discriminant validation was used to measure the differences in sleep self-regulation behavior between genders in the sample. It

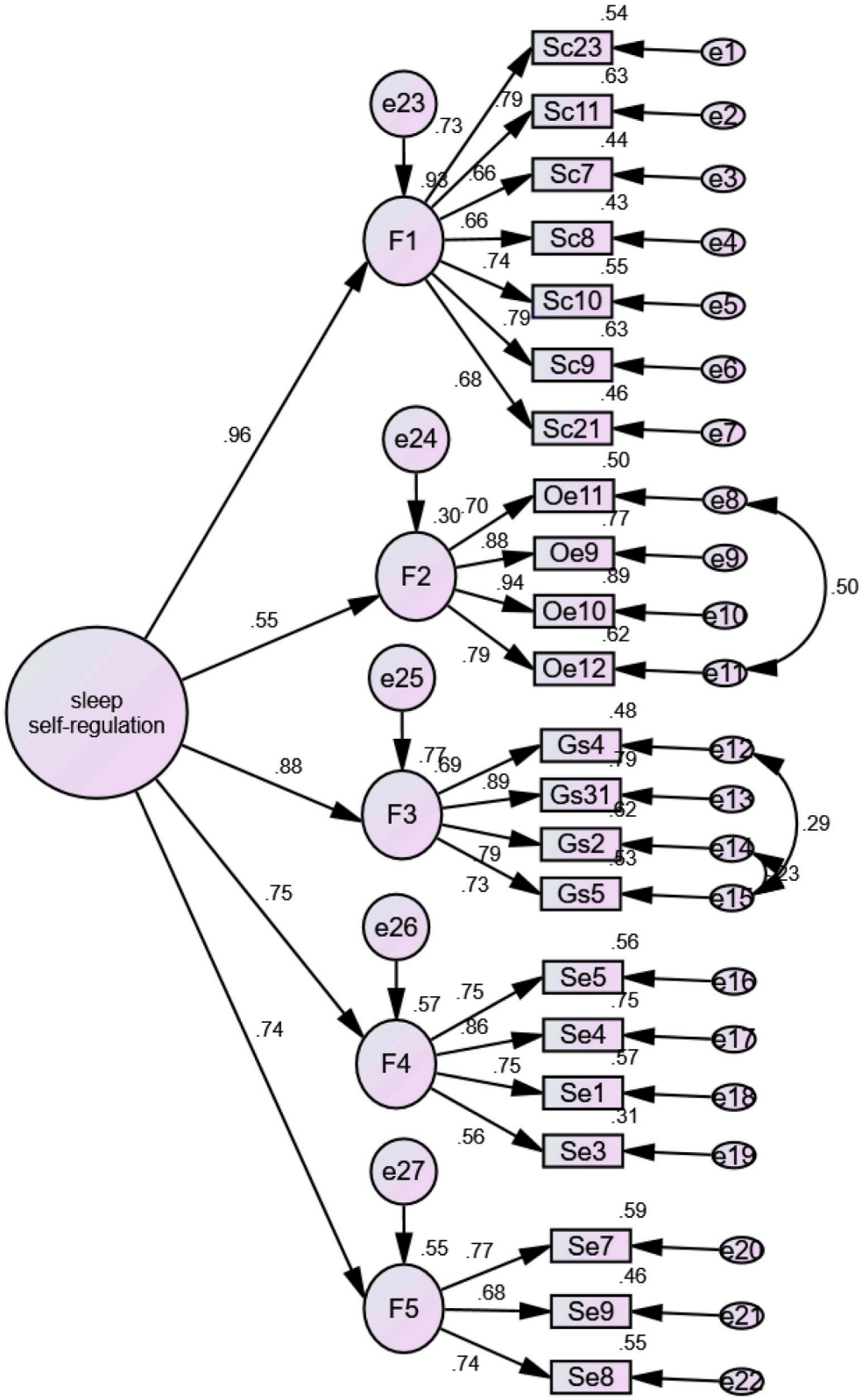

Fig. 4. The SBSRQ constructs a modified model of second-order confirmatory factor analysis.

Table 4
Multi-group confirmatory factor analysis: total model and invariance tests by gender.

Model	$\chi 2$(df)	χ^2/df	CFI	RMSEA [90% CI]	Model comparison	$\Delta_\chi 2$	Δdf	ΔCFI	ΔRMSEA
1. Configural	675.042(402)	1.67	0.882	0.059 [0.051, 0.066]	–	–	–	–	–
2. Metric	690.660 (419)	1.64	0.883	0.057 [0.050, 0.056]	Model 1 and Model 2	15.68	17	0.001	0.002

$\chi 2$ = chi square test; df = degrees of freedom; CFI = comparative fit index; RMSEA = root mean square error of approximation; 90%CI = 90% confidence interval.

was found that women had higher mean scores on the SBSRQ compared to men. This aligns with a study that examined differences in self-perceived self-regulation between adolescent males and females. The study found that females rated their attention higher than males, and reported greater levels of self-control and self-monitoring [46]. Additionally, another study found that females exhibited a higher level of self-regulation over time, as evidenced [23]. But these differences alone do not make women advantageous over men in self-regulation behaviors for instance, this raises the tendency of women to default to a ruminative, self-focused response to negative moods [47]. In general, the issues men face with self-regulation concern self-management of time and self-motivation, while women find it heavily challenging to self-regulate their emotions [48]. Acceptable invariance indicates that the SBSRQ similarly measures sleep behavior self-regulation among men and women. The crucial measurement property of invariance enabled comparisons between groups [49]. Thus, the observed difference in self-regulation proficiency among adolescents in terms of health-related behaviors can partly be attributed to gender. This difference poses a challenge when it comes to organizing health interventions and promoting behavior change.

The analysis of correlations for convergent validity revealed a moderate correlation between the SBSRQ and the sleep scales, with all correlations aligning with our expectations. In the future, studies should investigate how the five dimensions of sleep behavior self-regulation interact with other outcomes of poor sleep quality and inadequate sleep. This includes issues with emotion regulation, depression, anxiety, and low academic achievement.

4.1. Limitations

The COVID-19 pandemic compelled educational institutions worldwide to shut down. Consequently, we employed an online platform to administer questionnaires, which led to somewhat restricted communication with students. The pandemic significantly influenced people's lifestyles, notably their sleep patterns and habits. It's important to emphasize that our study exclusively focuses on adolescents within our specific geographical area and cultural context. Further research is imperative to generalize these findings to other communities and non-student teenagers.

Anticipations were that students would prioritize factors affecting academic performance, such as sleep patterns. However, the influence of online forms and formal education systems could have affected the results. Nevertheless, ceiling and floor effects were not observed. The proportion of respondents attaining the lowest or highest possible scores was less than fifteen percent.

5. Conclusion

The initial results of this study validate the reliability and validity of a questionnaire specifically crafted to evaluate adolescents' self-regulation of sleep behavior. This tool holds the potential to assess the impact of educational programs and interventions that target the enhancement of healthy sleep practices among teenagers. This tool is valuable in identifying the dimensions that require intervention.

Ethical approval and consent to participate

The study was conducted by the Declaration of Helsinki and after obtaining formal permission from Isfahan University of Medical Sciences and ethical approval from the university research deputy (grant number: 399239) and (Ethics committee reference number: IR.MUI.RESEARCH.REC.1399.460). The participants were briefed on the study objectives and methods submitted their informed consent and were ensured of the confidentiality of their data.

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Data availability statement

Data associated with this study has been deposited at Mendely Data under the accession number https://doi.org/10.17632/h4t9trw53r.1.

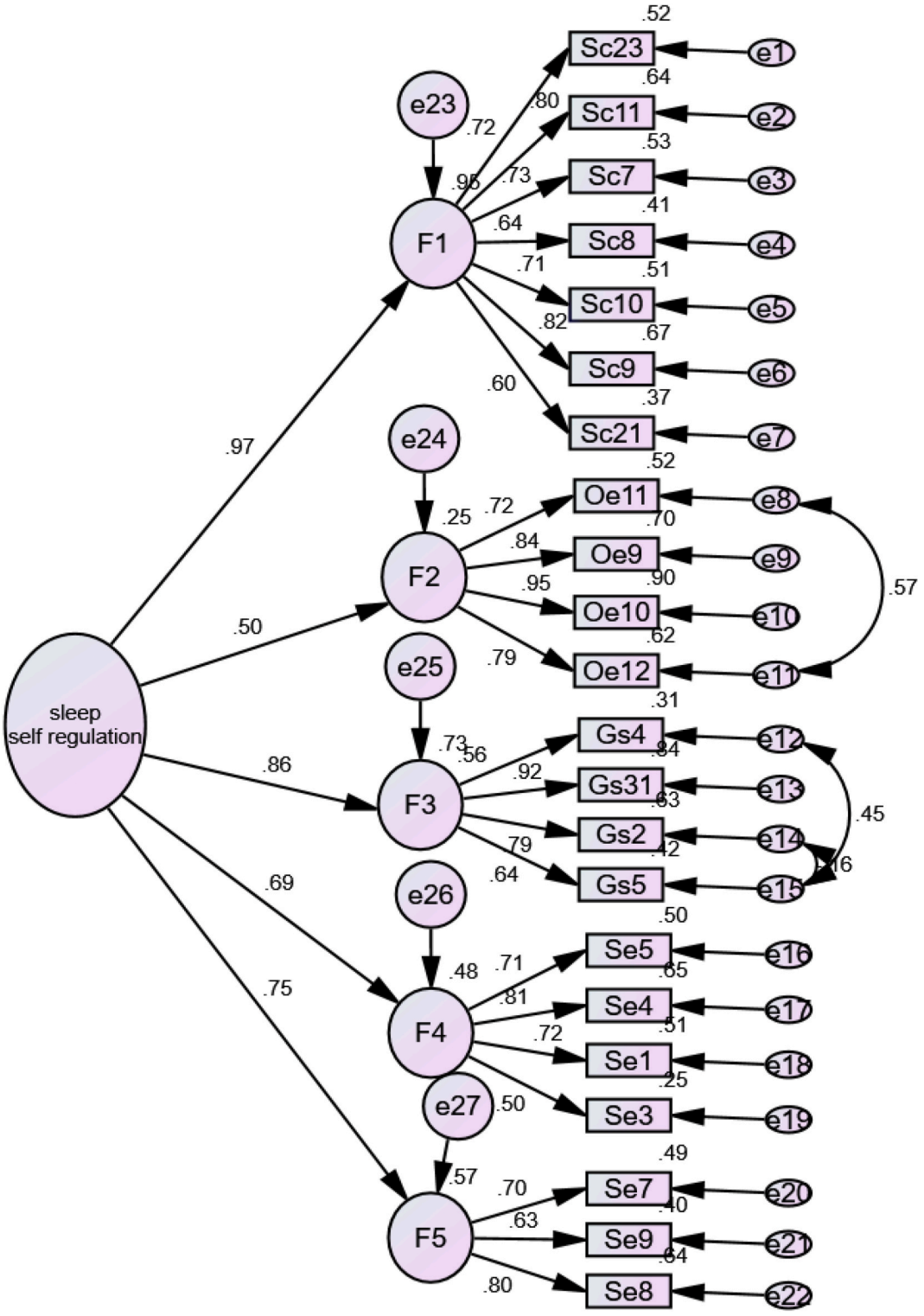

Fig. 5. The SBSRQ constructs a modified model of second-order confirmatory factor analysis for men.

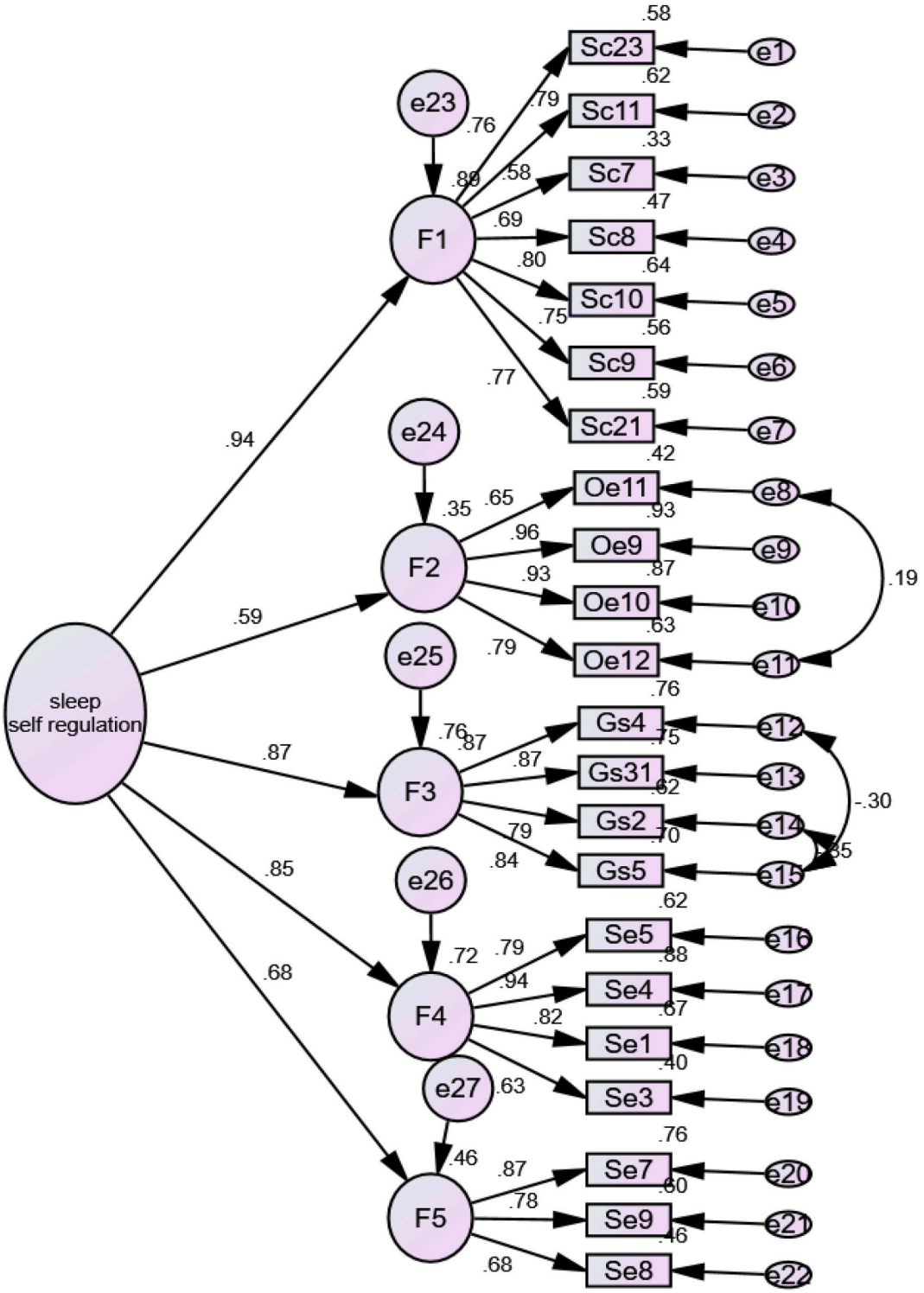

Fig. 6. The SBSRQ constructs a modified model of second-order confirmatory factor analysis for women.

CRediT authorship contribution statement

Parvin. Ghasemi: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ahmad Ali. Eslami:** Writing – review

Table 5
Correlations between SBSRQ of dimension and CASQ.

Dimension/SBSRQ	F1	F2	F3	F4	F5	SBSRQ
CASQ	−0.401**	−0.292**	−0.298**	−0.474**	−0.307**	−0.453**

**.Correlation is significant at the 0.01 level (2-tailed). correlation coefficient was calculated using Spearman's rho.

Table 6
Reliability indices of dimensions of SBSRQ.

factor	Alpha (95% CI)	AIC	Omega	Composite reliability	Alpha*	N of items
F1	0.893	0.547	0.893	0.873	0.894	7
F2	0.825	0.556	0.829	0.835	0.834	4
F3	0.875	0.590	0.857	0.814	0.875	4
F4	0.739	0.472	0.741	0.698	0.420	4
F5	0.750	0.515	0.757	0.652	0.501	3

Alpha Cronbach's alpha, CI Confidence Interval, AIC Average Inter-Item Correlation.
Omega McDonald's omega coefficient, Alpha* based on Standardized items.

& editing, Visualization, Validation, Supervision, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Maryam. Amidi Mazaheri:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Funding acquisition, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Abbreviation

SR	Self-regulation
SBSRQ	Sleep Behavior Self-Regulation Questionnaire
ASHS-r	Adolescent Sleep Hygiene Scale-revised
CASQ	Cleveland Adolescent Sleepiness Questionnaire
EFA	Exploratory Factor Analysis
CFA	Confirmatory Factor Analysis
SRQ	Self-regulation questionnaire
BRIEF	Behavior Rating Inventory of Executive Function

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