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# Factor structure and psychometric properties of the Persian versions of the Pediatric Daytime Sleepiness Scale and Morningness–Eveningness Scale for Children

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**Abstract:**

**BACKGROUND:** The Pediatric Daytime Sleepiness Scale (PDSS) and the Morningness–Eveningness Scale for Children (MESC) are widely used to measure two important facets of sleep patterns, but neither have been adapted and validated for use in Iran. The purpose of this study was to examine the psychometric properties and factor structure of the Persian versions of the PDSS and the MESC in a sample of Iranian adolescents.

**MATERIALS AND METHODS:** The Persian versions of PDSS and MESC were translated and administered to a representative sample ($n$ = 407) of Iranian early adolescents, aged 9–15 years, who attended school in morning shifts. The factor structure of both scales, found in prior studies, was tested using Confirmatory Factor Analyses to assess their validity and reliability.

**RESULTS:** The results revealed that the model fit indices of the one factor solution of the PDSS and the two factor solution of the MESC were acceptable to good. A high Pearson correlation was found between raw and latent factor scores for the PDSS and the two factors derived from the MESC (i.e., Morningness and Planning). Furthermore, the higher the PDSS score (more daytime sleepiness), the lower the MESC scores (more eveningness), indicating criterion validity of the scales showing the expected increase in daytime sleepiness in evening oriented adolescents who wake up early for attending school.

**CONCLUSION:** The Persian versions of the PDSS and the MESC can be considered reliable and valid tools for evaluating, respectively, daytime sleepiness and morningness-eveningness in the adolescent population of Iran.

**Keywords:**

Adolescence, circadian preference, confirmatory factor analyses, daytime sleepiness, factorial structure, psychometric properties, sleep measures

## Introduction

Adolescents experience a period of physical, psychological, and social transition that mark the passage from childhood to adulthood.[1] This transition is accompanied by profound changes in the timing and amounts of sleep and wakefulness that, in turn, affect their quality of life, health, and academic achievement. Indeed, many adolescent students tend to have less sleep than is needed at their age. This results from a confluence of two factors,[2] including (1) a biologically determined delay in their internal body clock, together with the impact of family schedule, social



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media, and other sociocultural influences[3, 4] that lead them to postpone the time they go to sleep; and (2) early school start time that makes them rise before they have fulfilled their sleep needs. Therefore, insufficient sleep during adolescence is a widespread problem and can lead to major negative effects as it is often related to a wide range of physical diseases,[5] mental disorders,[6] reduced educational achievement, and other negative school-related outcomes[7] and increased likelihood of accidents.[8,9]

Apart from the fact that adolescence is a phase of life in which people become more evening oriented, there are also significant individual differences with respect to the time of day in which a person is most alert and productive. Morning-type individuals or "larks" prefer to wake up early in the morning and usually have difficulty staying up late beyond their usual early bedtime compared with evening-type individuals, or "owls," who prefer to sleep at late hours in the night and often find it difficult to get up in the morning. Morningness-eveningness describes the range of this trait[10,11] with the majority of people being classified between larks and owls (intermediate-types).[12]

The level of morningness-eveningness affects performance on a wide range of cognitive tasks measuring attentional capacities, executive functioning, and memory.[13] Furthermore, the observed shift toward an evening circadian preference in adolescence, combined with early morning school start times, often results in daytime sleepiness,[14] leading to lower academic performance.[3] Therefore, daytime sleepiness and developmental changes in the sleep-wake cycle during adolescence, including individual differences in morningness-eveningness, are interrelated facets which may be associated with impaired cognitive, affective, and academic difficulties, increases in psychiatric symptoms, and many other health problems.[7,10]

Sleep researchers and clinicians are increasingly recognizing the importance of measures of sleep habits in both research and clinical practice. This has led to the development of several rating scales that evaluate different facets of sleep-wake patterns. Sleep scales and questionnaires provide standardized measures that not only allow a quick and accurate assessment of complex clinical problems but also enable the replication of previous studies and facilitate the organization and dissemination of new research in a way that is accessible and rapid.[15]

The Pediatric Daytime Sleepiness Scale (PDSS) and the Morningness-Eveningness Scale for Children (MESC) are widely used tools for measuring daytime sleepiness and sleep-wake cycles in pediatric populations, respectively.[15] Despite this, there is a need for studies to determine the extent to which existing measures such as these are reliable and valid in different cultural contexts.[12]

The PDSS is a self-report measure, initially designed by Drake *et al*.[7] for research purposes but that also possesses clinical and diagnostic utility.[15] Drake *et al*.[7] used 13 candidate questions regarding sleepiness-related behaviors for the development of this scale. Factor analysis (split-half samples) on the 13 questions yielded one primary factor ("pediatric daytime sleepiness;" 32% of variance). After removing questions with low factor loadings (<.4), the remaining questions (8 items) were used to determine scale reliability. Drake *et al*.[7] used Cronbach's alpha to report the internal consistency (i.e., 0.80) for the final 8-item scale.

More recently, some researchers have begun to translate and examine the psychometric properties of the PDSS across cultures. Internal consistency of the Korean PDSS was assessed using Cronbach's alpha reliability (0.67:[16]). Similar findings were reported for the Brazilian version (0.78:[17]). However, it is important to note that Cronbach's alpha is not a good measure of internal consistency because it is based on rigid and unrealistic assumptions, such as that all items of the scale must discriminate the intended measured behavior equally (i.e., all PDSS items should have the same amount of correlation with the underlying sleepiness factor.)[18] By this understanding, the psychometric properties of the Turkish,[19] Brazilian,[20] and Russian[21] versions of PDSS were evaluated using exploratory factor analysis (EFA) and/or confirmatory factor analysis (CFA), which do not have the same shortcomings as Cronbach's alpha. The results reported in these studies are also consistent with the original model confirming the adequate validity and reliability of the translated single-factor instrument.

The MESC was developed by Carskadon *et al*.[10] as an adaptation of the 13 item Composite Scale of Morningness.[22] It contains 10 questions (items) and measures the preferred timing for optimal activity in children and adolescent populations. The initial psychometric evaluation of the MESC showed a significant correlation between its scores and actual sleep and rise schedules.[10] The MESC has been confirmed to have both adequate validity and good internal reliability (Cronbach's alpha) from 0.65–0.82.[12,23-28]

Again, there is no evidence that Cronbach's alpha assumptions are met in the case of the MESC, especially concerning the assumption of unidimensionality of the scale[18] as most studies have shown the MESC to harbor more than one factor, named "Morningness" and "Planning." This two factor structure, nonetheless, varied

somewhat among published papers. In a study with an Italian adolescent sample, Natale and Bruni (2000) obtained this two factor structure excluding item 5.[12] In a study with Spanish adolescents, Díaz-Morales[29] found these same two factors using all items. Furthermore, the explanatory factor analysis on the 10 items of the Turkish MESC revealed three orthogonal factors including "sleep/wake planning," "having high performance" and "morningness."[27] However, Díaz-Morales[12] later found a better fit for a single factor for the MESC, this time including corrections for residuals of items 6 and 8. The only study that tested the stability of items in various different samples was carried out by Caci *et al*.[30] They again found a Morningness and a planning factors and this structure was stable across three samples after excluding items 1 and 4.

In sum, despite the fact that the psychometric properties regarding the reliability and validity of the PDSS and MESC have been replicated in some countries[12,16,17,19-21,24,27,30] this has not been undertaken in Iran, nor has the interrelations of these scales been investigated. Here, we intended to confirm the models of Drake *et al*.[7] for the PDSS, because it is the original model that has been replicated in various studies.[19-21] Among the published factor structure of the MESC, we chose to confirm the two-factor model proposed by Caci *et al*.,[30] because it was replicated in three samples, providing evidence of the reproducibility of the model's configural structure, and indicated which items are unreliable.

The purpose of the present study was to examine the psychometric properties of the Persian versions of the PDSS and MESC through a series of CFA with a sample of Iranian adolescents. A secondary aim was to examine the extent to which raw scores in the PDSS and MESC were associated with their respective latent factors and to each other, expecting that more eveningness would be associated with higher daytime sleepiness.

## Materials and Methods

### Study design and setting

This study used an explanatory and cross-sectional descriptive design which carried out in elementary and secondary schools in Tehran, Iran, from February 2018 to June 2019. Initially, the Persian versions of the PDSS and the MESC were determined with a standard forward–backward translation method as detailed below. Next, the sample of 407 students were selected through a cluster sampling technique. Participants were tested individually at their local school. They were required to fill in questionnaires about their behavior and carry out cognitive tasks. Here, we only address the data from the PDSS and MESC scales. Other results will be published elsewhere.

### Study participants and sampling

Data were collected from a sample of 407 Iranian adolescents (41.82% females) aged 9–15 years (the mean (±SD) of the sample was 11.6 (±1.7) years; from grades 4–9) during the 2018–2019 academic year. Participants were selected by multi-stage cluster sampling from 32 public and private schools selected out of each education districts of North, South, East, and West Tehran. From each of the 32 schools, 15 students aged between 9 and 15 years were randomly included. Subjects were excluded if they had possible neurodevelopmental or mental disorders, determined by a questionnaire filled in by their legal guardians. They should have normal or corrected vision and expected intelligence quotient compatible with their age and academic grade.

### Ethical considerations

All procedures were approved by the institutional ethics committee of the Education Office of Tehran (Approval code: D/100/10247; DATE: 2018-11-01). Participants and their parents were also provided with a brief explanation about the study purposes and the students whose parents gave their written consent were included in the study, as per local ethical guidelines.

### Data collection tools and techniques

#### *Pediatric Daytime Sleepiness Scale*

The PDSS is an 8-item scale designed by Drake *et al*. (2003) to measure sleepiness in children and adolescents. Based on the Likert-scale ratings, each of the 8 items is scored from 0 to 4 (never = 0; seldom = 1; sometimes = 2; frequently = 3; always = 4). To reduce the possibility of response bias, responses to item number 3 is reverse scored. The total score is obtained from the sum of 8-item scores ranging from zero to 32 points. Higher scores indicate greater daytime sleepiness.[7]

### Morningness-Eveningness Scale for Children

The MESC is the most widely used scale to assess morningness-eveningness and includes 10 items written in a language style adapted for children and adolescents.[30] Response to each item is done by choosing one among four or five options that are coded in an ordinal scale. Three questions (1, 6, and 8) have a response scale of five points (range 1–5) and seven questions (2, 3, 4, 5, 7, 9, and 10) have a response scale of four points (range 1–4). Outcome scores are the sum of points for all items (items 1, 3, 4, 5, 6, 8, 10 are reversed scored) and range from 10 (extreme evening preference) to 43 (extreme morning preference).[10,30]

### Translation and adaptation

Regarding the cultural validation, a standard forward–backward translation method was used. After permission received by E-mail from Christopher

Drake and Mary Carskadon to adapt the PDSS and the MESC scales to Persian, both scales were translated from English to Persian (Iran's official language) by three experienced researchers who were fluent in English. The first author of this paper compared these translations, and two single version of the translated PDSS and MESC were obtained. Next, two professional translators who were blinded to the original questionnaire translated them back to English. These translations were evaluated by a bilingual educational neuroscientist who suggested a few alterations in the translations. To determine the content validity of the scales, four experts with expertise in the field of educational evaluation were given the original scales and the Persian versions together. The experts were asked to assess the clarity and convenience of the items on a scale of 1–4 (1: Completely inappropriate; 4: Completely appropriate). The scale level (S-CVI) and item level (I-CVI) were calculated based on their responses. Accordingly, the both values for each scale were more than 0/80 and then it was interpreted as indicative of a high content validity. Finally, a pilot study was carried out with 25 middle school students who were asked to fill in the questionnaires. They were then submitted to a debriefing interview to assess the face validity of the scales. There was no negative feedback regarding clarity of the scale items and thus their content comprehensibility given the target population was evaluated to be sufficient for administration in the study sample. The factor analysis was used to explore evidences based on the internal consistency (formerly called construct validity) in the study with 407 participants.[31] The final Persian versions for PDSS and MESC can be found in Appendices A and B.

### Statistical psychometric analyses

CFA were conducted to provide evidence based on the internal consistency of the PDSS and MESQ separately. Since CFA is a theory driven analytical technique,[32] we sought to confirm prior measurement models underlying the PDSS[7] and the MESC[30] in the Western literature. The weighted least square with mean and variance adjusted estimator was used for both CFAs given the type of response of the scales (ordered-categorical response types;[33]). Mplus version 8.4 was used to run all the analyses.

The criteria used to evaluate the goodness-of-fit of the models were those described by Schermelleh-Engel *et al*.[34] The following cutoff scores were applied to decide which models provided acceptable to well-fitting ones: (a) *P* value of Chi-square should be higher than 0.05; (b) Root Mean Square Error Approximation (RMSEA) should be approximate to or <0.08 for an acceptable fit and <0.05 for a good fit (the corresponding *P* value should be higher than 0.05); c) Tucker-Lewis index (TLI), and confirmatory fit index (CFI), should be approximate to or higher than 0.95 (acceptable) or 0.97 (good fit); and d) Root Mean Square Residual (SRMR) lower than 0.10 (acceptable) or 0.05 (good). Since the hypothesized models sometimes do not supply a perfect reproduction of the observed covariance matrix,[35] CFA with modification indices (MI) were tested for if necessary in order to reach better model fits. These modifications can be applied to the original hypothesized model to achieve better fit indices or more parsimonious models.[35]

Total Information Curves (TIC) were obtained for each latent variable as a measure of reliability. TICs indicate the extent to which a given (latent) domain under assessment is informative throughout its spectrum. It is important to measure this across the spectrum where the scales and their domains provide the maximum amount of information (precision). Ideally, it is expected that a scale be highly informative throughout the entire latent trait although this information may vary over the spectrum.

Pearson linear correlations were calculated between raw scores in the PDSS and the Morningness and Planning factors of the MESC (calculated by adding raw scores of the items in each factor) and their respective latent factor results to explore whether raw scores adequately capture their latent factors. In addition, to determine how raw scores of these scales were interassociated, Pearson correlations were calculated between the total raw scores of both scales. The total explained variance of the both scales was analyzed using an EFA.

## Results

### Descriptive statistics

Tables 1a and b describe proportion and counts for each category of answer for every item of the PDSS and MESC, respectively.

### Confirmatory factor analysis

Model fit indices of the factor solution of the CFA for the PDSS were not good: $\chi^2_{(20)} = 64.058$, $P \leq 0.001$; RMSEA = 0.074 (90% Confidence Interval (CI) = 0.054–0.094; $P = 0.026$); CFI = 0.956 and TLI = 0.930, SRMR = 0.037. To evaluate likely improvement in the model fit, MI returned that an additional residual covariance between residuals of items 5 and 7 would improve the model. Therefore, we re-specified the model correlating these residuals. The model fit indices improved significantly: $\chi^2_{(19)} = 35.194$, $P = 0.0132$; RMSEA = 0.046 (90% CI = 0.021–0.069; $P = 0.585$); CFI = 0.982 and TLI = 0.973, SRMR = 0.027. The majority of these indices indicate a good fit except

**Table 1a: Proportion and counts of each alternative answer (category) of each item of the Pediatric Daytime Sleepiness Scale (*n*=407)**

| Item | Category | Proportion | Counts |
|---|---|---|---|
| 1 | 1 | 0.287 | 117 |
| | 2 | 0.405 | 165 |
| | 3 | 0.229 | 93 |
| | 4 | 0.061 | 25 |
| | 5 | 0.017 | 7 |
| 2 | 1 | 0.366 | 149 |
| | 2 | 0.317 | 129 |
| | 3 | 0.216 | 88 |
| | 4 | 0.074 | 30 |
| | 5 | 0.027 | 11 |
| 3 | 1 | 0.511 | 208 |
| | 2 | 0.361 | 147 |
| | 3 | 0.076 | 31 |
| | 4 | 0.027 | 11 |
| | 5 | 0.025 | 10 |
| 4 | 1 | 0.133 | 54 |
| | 2 | 0.408 | 166 |
| | 3 | 0.317 | 129 |
| | 4 | 0.118 | 48 |
| | 5 | 0.025 | 10 |
| 5 | 1 | 0.236 | 96 |
| | 2 | 0.162 | 66 |
| | 3 | 0.224 | 91 |
| | 4 | 0.189 | 77 |
| | 5 | 0.189 | 77 |
| 6 | 1 | 0.403 | 164 |
| | 2 | 0.253 | 103 |
| | 3 | 0.170 | 69 |
| | 4 | 0.111 | 45 |
| | 5 | 0.064 | 26 |
| 7 | 1 | 0.157 | 64 |
| | 2 | 0.147 | 60 |
| | 3 | 0.170 | 69 |
| | 4 | 0.194 | 79 |
| | 5 | 0.332 | 135 |
| 8 | 1 | 0.174 | 71 |
| | 2 | 0.256 | 104 |
| | 3 | 0.305 | 124 |
| | 4 | 0.152 | 62 |
| | 5 | 0.113 | 46 |

**Table 1b: Proportion and counts of each alternative answer (category) of each item of the Morningness-Eveningness Scale for children (*n*=407)**

| Item | Category | Proportion | Counts |
|---|---|---|---|
| 2 | 1 | 0.145 | 59 |
| | 2 | 0.371 | 151 |
| | 3 | 0.339 | 138 |
| | 4 | 0.145 | 59 |
| 3 | 1 | 0.037 | 15 |
| | 2 | 0.044 | 18 |
| | 3 | 0.398 | 162 |
| | 4 | 0.521 | 212 |
| 5 | 1 | 0.066 | 27 |
| | 2 | 0.455 | 185 |
| | 3 | 0.344 | 140 |
| | 4 | 0.135 | 55 |
| 6 | 1 | 0.079 | 32 |
| | 2 | 0.079 | 32 |
| | 3 | 0.398 | 162 |
| | 4 | 0.310 | 126 |
| | 5 | 0.135 | 55 |
| 7 | 1 | 0.044 | 18 |
| | 2 | 0.221 | 90 |
| | 3 | 0.499 | 203 |
| | 4 | 0.236 | 96 |
| 8 | 1 | 0.037 | 15 |
| | 2 | 0.111 | 45 |
| | 3 | 0.410 | 167 |
| | 4 | 0.307 | 125 |
| | 5 | 0.135 | 55 |
| 9 | 1 | 0.167 | 68 |
| | 2 | 0.204 | 83 |
| | 3 | 0.275 | 112 |
| | 4 | 0.354 | 144 |
| 10 | 1 | 0.017 | 7 |
| | 2 | 0.052 | 21 |
| | 3 | 0.201 | 82 |
| | 4 | 0.730 | 297 |

that the Chi square *P* value was lower than the 0.05 threshold. Since this metric is sensitive to sample size,[36] the other indices were considered as it is not a requirement that all indexes exhibit adequate fits for a model solution to be acceptable. Other elements such as replication of prior published models must be considered.

Regarding the MESC, fit indices of the two factor solution were mostly acceptable to good ($\chi^2_{[19]} = 60.851$, $P \leq 0.001$; RMSEA = 0.074 [90% CI = 0.053–0.095; $P = 0.029$]; CFI = 0.973 and TLI = 0.096, SRMR = 0.042) except for the Chi-square *P* value, which does not invalidate the adequacy of model fit (see above).

Figures 1 and 2 show, respectively, the models with data from the Iranian adolescents replicating the single factor solution of the PDSS proposed by Drake *et al*.[7] (except for the added residual variance between items 5 and 7) and the two-correlated factor solution of the MESC proposed by Caci *et al*.[30]

## Total information curve

Figures 3 and 4 show, respectively, the TIC for the PDSS and the MESC latent factors. The majority of the information is centered around zero, meaning that the three factors (one from the PDSS and the two derived from the MESC) have the peak of the information (i.e., strongest reliability) for average scores. For participants scoring close to the extreme of the scales,

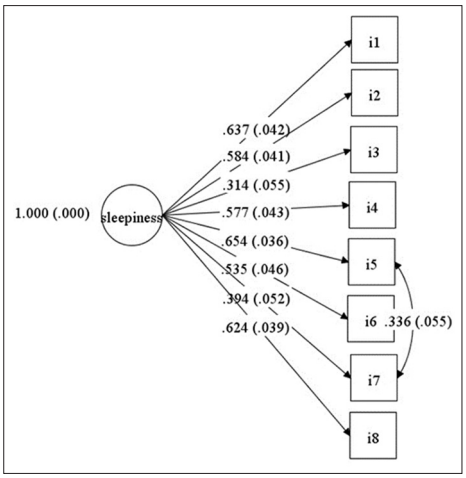


**Figure 1:** Confirmatory factor analysis of the Persian version of the Pediatric Daytime Sleepiness scale. Note: Continuous single-headed arrows indicate relations between observed (squares) and latent variable (circle); the curved double headed arrow indicates the residual relations among items 5 and 7. Numbers on single headed arrows indicate standardized factor loadings; standard errors are given in parentheses, and on the double headed arrow, the residual covariance. Fit indices were acceptable to good and are presented in the text

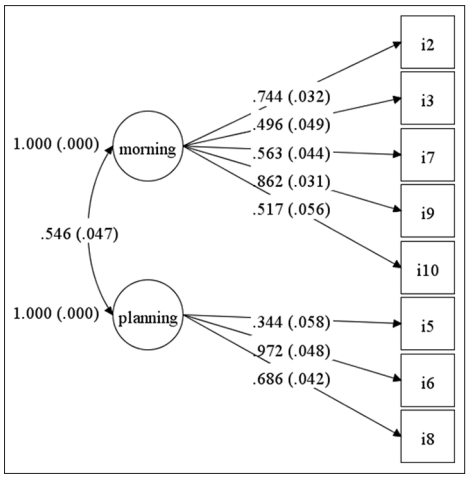


**Figure 2:** Confirmatory factor analysis of the Persian version of the Morningness-Eveningness Scale for Children including Morningness and Planning factors proposed by Caci *et al*.[30] Note: Continuous single-headed arrows indicate relations between observed (squares) and latent variables (circles); the curved double headed arrow indicates the relations between the latent factors. Numbers on single headed arrows indicate standardized factor loadings; standard errors are given in parentheses, and on the double headed arrow, correlations among the factors. Fit indices were acceptable to good and are presented in the text

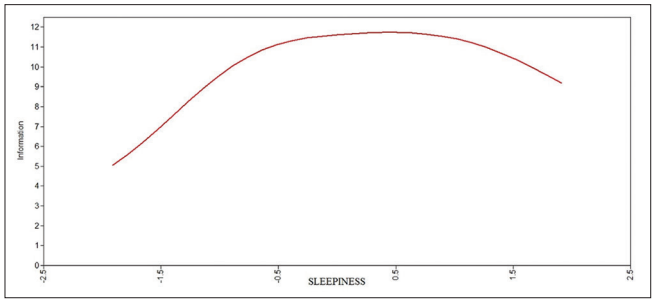


**Figure 3:** Total information curve of the sleepiness factor of the pediatric daytime sleepiness scale

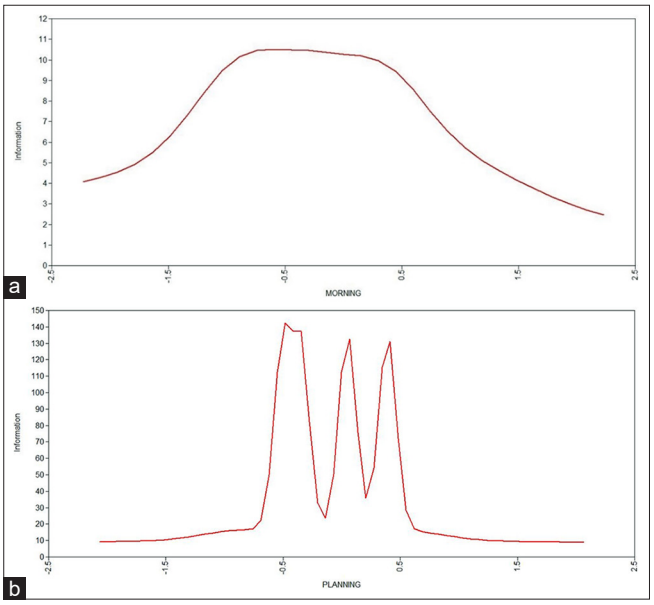


**Figure 4:** Total information curve of the morningness (a) and planning (b) factors of the Morningness-Eveningness Scale for Children

values have lower information (i.e., less precision). The exception is the planning factor in which the TIC indicated a range of variation among average scores.

## Descriptive statistics regarding raw and latent factor scores

The Pearson correlation between raw and latent factor scores of the PDSS was $r = 0.98$ ($P < 0.001$). Regarding the MESC, the Morningness factor scores and the sum of raw scores of its indicators (i.e., items related to this factor) had a linear correlation of $r = 0.96$ ($P < 0.001$). The correlation between factor scores and sum of raw scores of the Planning factor was $r = 0.92$ ($P < 0.001$).

Because of the high association between raw and latent scores of both scales we also assessed their linear intercorrelation, which equaled $r = -0.63$ ($P < 0.001$): The higher the PDSS score (more daytime sleepiness), the lower the MESC scores (more eveningness). This correlation indicates that both scales measure 39.69% of a common construct.

EFA analysis also used to explain common variance of the both scales. Accordingly, the total explained variance was 35.45% and 45.32% for PDSS and MESC, respectively.

## Discussion

Among various types of instruments used to measure various facets of sleep,[15] the PDSS and the MESC play important roles in research, clinical practice, and health assessment due to the ease of administration and

robust psychometric properties. The present study was conducted to examine whether the Persian versions of the PDSS and the MESC are valid and reliable to use in Iranian contexts. To this end, the original versions of the scales were translated and filled in by 407 adolescents in Tehran. To analyze data, CFA were conducted to provide evidence based on the internal consistency of the PDSS and the MESC separately.

The CFA results revealed that the model fit indices for the single factor solution of the PDSS were acceptable to good, confirming that the 8 items of the scale load onto a single factor as found by Drake *et al*.[7] However, this was obtained with the inclusion of residual covariance between items 5 and 7, which is a valid procedure that can improve model fits[34] and may have been necessary due to the specific characteristics of the sample and/or language adaptation into Persian. Similar findings were reported by Ferrari Junior *et al*.,[20] who included residual covariance among items 5, 6, and 7 in their Brazilian sample. The unidimensionality of this scale was also replicated in adaptations for the Turkish[19] and Russian[21] languages. This factor explained 35.45% of the variance. Although this amount of variance is low, it is compatible with the results from the original study[7] that explained 32% of variance. In addition, the CFA results show that the indices of model fit are acceptable and this the Persian version of PDSS have adequate internal consistency.

Regarding the MESC, the present results confirmed the factor structure previous studies proposed[30] who identified two factors (Morningness, consisting of items 2, 3, 7, 9, and 10; Planning, consisting of items 5, 6, and 8) with acceptable to good fit indices. However, there are slight variations in the MESC factor structure in other prior studies (e.g.[12,27,29]). Overall, despite these slight differences, which may relate to specific characteristics of samples from different countries or to the way the items were translated, because we succeeded in replicating the same factor structure found by Caci *et al*.[30] in three samples of French adolescents in our Iranian population, we suggest that the items included in these factors are indeed stable (excluding item 1 and 4). This needs to be further investigated in cross-cultural studies in which invariance to culture is explored.

The EFA on the 10 items of the Persian version of MESC revealed that the extracted factors totally explained 45.32% of the variance. Similar findings were reported by previous studies,[27,29] in Turkish and Spanish samples. According to scale development literature,[37] the explained variance between 40.0% and 60.0% is accepted as sufficient. Hence, the obtained total variance of MESC was at an acceptable level.

We also showed that for both scales the factors had stronger reliability (TIC) among respondents with average scores, a type of analysis that indicated reliability and was not previously undertaken in the literature for these questionnaires. The only exception was the Planning factor of the MESC, which presented very high variability and may not be so reliable, possibly because one of its three items, item 5, had a particularly low factor loading. Low factor loadings in the PDSS also occurred, notably for item 3, but the other 7 items had acceptable to good loadings so this may not have interfered with the general reliability of the daytime sleepiness factor. In the present study, the Pearson correlation between the raw and latent factor scores for the one factor solution of the PDSS and the two factors derived from the MESC (e.g., Morning and Planning) were high and statistically significant. This indicates that raw scores adequately reflect the measured facets of sleep behaviors although it is always advisable to use latent factors because they account for measurement errors that are not corrected for using raw scores. Due to these high correlations, the linear intercorrelation between total raw scores of both scales was assessed and indicated that they measure 39.69% of a common construct (an evidence of validity based on relations to other variables): The higher the PDSS score (more daytime sleepiness), the lower the MESC scores (more eveningness).This confirms Carskadon's conceptualization[38] that bioregulatory and psychosocial forces that collude to push sleep onset later, measured by the MESC, may lead to higher daytime sleepiness, measured by the PDSS, when schools are timed to begin early across adolescence.

Regrettably, the potential negative impact of early school times on adolescents' health, safety, and well-being[3-9] is not understood by most educators. They assume that adolescents could learn better and improve their concentration if they simply got more sleep by going to bed earlier.[3] Parents and professionals who work in the area of education must be informed that later bedtime and difficulty getting up in the morning at this age are not a question of the lack of organization, ill will or such like and instead, in part reflect a set of biological changes that set in in early adolescence. Until it is recognized that adolescents' school start times must be changed to later hours it is paramount that school principals, teachers, students, and parents be made aware of scientific knowledge regarding proper sleep hygiene, a set of practices and habits that are necessary for adequate nighttime sleep and normal daytime alertness.

## Limitation and recommendation

A possible limitation of this study is that the Persian translations versions for the PDSS and the MESC have not been directly compared to other equivalent sleep-related scales, because there were not found reliable and valid

Persian scales. Furthermore, the effects of age, sex and socioeconomic status on the way participants responded to the scale items (invariance testing) and on the latent factors were not analyzed in the present study. These limitations need to be taken into account in the future studies.

## Conclusion

It is concluded that, the factor solutions proposed in European samples for both the PDSS[7] and the MESC[30] were replicated using a large representative sample of Iranian early adolescents who were selected by a cluster random sampling technique. Together, the findings show that these scales have adequate internal consistency, their raw scores share variance and that they can be used in the present Persian versions to study daytime sleepiness and circadian preference. Given their ease of administration and robust psychometric properties, these scales are potentially adequate for cross-cultural studies.

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### Conflicts of interest

There are no conflicts of interest.

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