Title:

DSPS-4: A brief measure of perceived daytime sleepiness

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Abstract

Sleepiness is a key issue in sleep medicine but its definition remains ambiguous and difficult to address. Some studies have reported that sleepiness should be conceptualized as a multidimensional construct. One of these dimensions is sleepiness propensity accurately assessed by the Epworth Sleepiness Scale. However, in the literature, data on other important sleepiness dimensions, such as sleepiness perception, are lacking. In an attempt to fulfil the literature gaps, this study aims at presenting data regarding the development of a brief self-report instrument to assess daytime sleepiness perception, the Daytime Sleepiness Perception Scale (DSPS-4). A sample of 692 undergraduate Medicine students was initially enrolled. The sample was randomly split in order to perform independent exploratory (EFA) and confirmatory factor analyses (CFA). A one-factor solution was examined. The DSPS-4 showed good indicators of reliability and validity. The CFA confirmed the one-factor structure of the DSPS-4. The unidimensional structure of the scale was invariant for both sexes. Results highlight the usefulness of DSPS-4 to measure and assess sleepiness perception at daytime. The short length of this scale enables its incorporation in routine assessment protocols for example regarding insomnia complaints. However, more studies are now required to check its suitability for other samples, specifically well-defined clinical groups.

Keywords: subjective daytime sleepiness; sleepiness perception; scale development; validation; sleep.

1. Introduction

Sleepiness is a complex construct difficult to define and to measure (Cluydts, De Valck, Verstraeten, & Theys, 2002; Shen, Barbera, & Shapiro, 2006; Young, 2004). Despite its high prevalence in both community and clinical populations (Ohayon, 2008; Rohers, Carskadon, Dement, & Roth, 2011), no clear consensus exists as to what constitutes sleepiness (Shen et al., 2006; Young, 2004). Traditionally, it has been considered as the physiological tendency to fall asleep (i.e., sleep propensity). However, this definition is limited since sleepiness is not a unitary phenomenon (Cluydts et al., 2002). As shown in several studies, subjective sleepiness has multiple dimensions that go beyond an increased tendency to fall asleep (Jordan, 2012; Kim & Young, 2005; Pilcher, Pury, & Muth, 2003; Pilcher, Schoeling, & Prosansky, 2000).

Several available tools can be used to assess objective and subjective daytime sleepiness (for an overview see Cluydts et al., 2002). The Multiple Sleep Latency Test (MSLT) is considered to be the “gold standard” assessment tool for objectively measuring daytime sleepiness. The MSLT is intended to measure physiological sleep tendency, based on the premise that the degree of sleepiness is reflected by sleep latency (AASM, 2005).

The most well-known measures of subjective daytime sleepiness are the Stanford Sleepiness Scale (SSS), the Karolinska Sleepiness Scale (KSS) and the Epworth Sleepiness Scale (ESS). The KSS and the SSS are measures of state sleepiness. Both of these scales assess the momentary/acute level of alertness-sleepiness, whereas the ESS enables the measurement of an individual’s global level of sleepiness, measuring a more “trait”-like aspect of sleepiness. The latter is the sleepiness scale most used in research and clinical settings, however, its measurement properties need more high methodological quality studies (Kendzerska, Smith, Brignardello-Petersen, Leung, & Tomlinson, 2014). The SSS is based on seven statements, describing a mixture of sleep propensity, energy/fatigue and cognitive performance (Shen, Barbera, & Shapiro, 2006). Indeed, as revealed in a principal components analysis, the SSS is not a unidimensional scale of sleepiness (MacLean, Fekken, Saskin, & Knowles, 1992). Since the objective and laboratorial tests of sleepiness are not feasible in most of clinical practice, the use of subjective measures appears to be a suitable alternative (Åkerstedt, Anund, Axelsson, & Kecklund, 2014). Besides, Ohayon (2012) posits that “surprisingly, almost no epidemiological studies have questioned the participants about the impact of excessive sleepiness on their daytime functioning” (p.422). For example, Avidian and Chervin (2002) state that the well-known ESS is objectionable since it does not include any questions on the subjective perception of the sleepiness difficulty on everyday life. Hence, one should note that until now there is no gold standard test to adequately assess sleepiness in all its complexity. Moreover, the chosen test to evaluate it, will always depend on the specific purpose of the researcher or clinician. That is, if one is more interested in sleepiness propensity, sleepiness perception or both (Johns, 2009).

Sleepiness in insomnia has been investigated over the last years, producing contradictory findings (Shekleton, Rogers, & Rajaratnam, 2010). Some studies found that excessive daytime sleepiness is a major symptom in insomnia, whereas other studies were not able to significantly relate diurnal sleepiness with insomnia (Buysse et al., 2007; Shekleton et al., 2010). Despite that, sleepiness is an important topic in insomnia research. In the main official classifications of insomnia, daytime sleepiness is included as one of the criteria to indicate associated daytime impairment (AASM, 2014; APA, 2013). Secondly, in the past few years there have been calls from insomnia expert panels (NIH State-of-the-Science Conference, 2005; Buysse, Ancoli-Israel, Edinger, Lichstein, & Morin, 2006) for the development of measures of the diurnal consequences of insomnia, including sleepiness. Therefore, we need to reflect on how insomnia affects the various sleepiness dimensions.

Put simply, one can differentiate two different dimensions of sleepiness (Johns, 2009): sleepiness propensity and sleepiness perception. *Sleepiness propensity* is the type of sleepiness measured by instruments such as the ESS which focus on unintended propensity for dozing/falling asleep in various everyday situations. In turn, *sleepiness perception* refers to the subjective evaluation of the patient about her/his feeling of sleepiness (Kim & Young, 2005). As stated by Sateia, Doghramji, Hauri, and Morin (2000) "(…) instead of being truly sleepy, they may be mislabelling their internal state, which might be more accurately described as fatigue, lethargy, or tiredness" (p.5).

Sleepiness and fatigue are related constructs whose definitions may overlap considerably. However, it is important to differentiate them (Dittner, Wessely, & Brown, 2004). According to Dittner et al. (2004), fatigue is "essentially a subjective experience that can be defined as extreme and persistent tiredness, weakness or exhaustion – mental, physical or both" (p.157). Additionally, according to Cluydts et al. (2002) fatigue "is generally considered as a condition resulting from physical effort and prolonged activity. Moments of rest, without sleep, will ameliorate it. On the contrary, sleepiness does not imply any prior physical effort per se and decreases as a consequence of a sleep period" (p.84)." By and large, fatigue seems to be a more complex dimension than sleepiness since there is no objective indicator to evaluate it (APA, 2013). However, both fatigue and sleepiness share the subjectivity characteristic as they both concern an internal state. Thus, there is no consensual definition for fatigue.

Our main hypothesis is that in insomnia/sleep quality, sleep propensity measures (e.g., ESS) might be of little help. Instead we suggest the use of a sleepiness perception measure as a more appropriate instrument to assess insomnia/sleep quality. This might be explained by the close relationship between sleep-wake regulation process and stress system regulation. As hyperarousal is a 24-h construct (Marques, Gomes, Clemente, Santos, & Castelo-Branco, 2016), even the sleep deprivation or poor sleep quality that individuals present will not be noticeable because of the generalized over activity of physiological, emotional and cognitive systems (Riemann et al., 2010; Shekleton et al., 2010). However, the fatigue level may be significant but it is often misinterpreted as sleepiness by the patients (Cluydts et al., 2002; Shen, Barbera, & Shapiro, 2006). This *sleepiness perception bias* in individuals with insomnia complaints should be investigated appropriately and taken into consideration for treatment purposes, namely within cognitive-behavioral therapies for insomnia (CBT-I) (Harvey, 2002).

Thus, our aim in this paper is to present the development and initial validation of a new measure on sleepiness perception which, among other applications, may be very useful in insomnia disturbance assessment and treatment protocols. Moreover, we intend to study the measurement invariance of this new measure across gender.

2. Methods

In this section, we will present the details regarding both studies carried out. In study 1, our aim was to develop the DSPS and to examine its exploratory structure, internal consistency and convergent, divergent, and criterion validity analyses. In study 2, our aim was to test the preliminary factor solution observed in study 1 using confirmatory analysis. Additionally, we tested the invariance of the measure across gender.

In total, we recruited a sample size of 692 participants. However, in order to perform Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) we decided to split the total sample in two halves to conduct two distinct studies. The assignment of participants in each study was carried out randomly recurring to IBM SPSS Statistics v.22 program. When comparing the two sample subsets no differences were found in the proportion of males and females (χ^2 = .012; *p* = .72; Cramer´s *V* = .01; *p* = .66). The mean difference concerning age was statistically significant albeit of small magnitude ($t_{(689)}$ = 3.256; *p* <.001; Cohen´s *d* = 0.24). These results allowed the two samples to be analyzed as independent groups.

2.1. Study 1

2.1.1. Participants

In this study 344 medical students participated (mean age = 19.4; *SD* = 1.25; range: 17-24). One hundred twenty (34.9%) students were males (mean age = 19.3; *SD* = 1.19) and 244 (65.1%) were females (mean age=19.5; *SD* = 1.28). No differences concerning mean age were found between both groups ($t_{(341)}$ = -1.400; *p* = .16). There were missing values for the age variable.

2.1.2. Measures

Daytime Sleepiness Perception Scale (DSPS-4)

The DSPS-4 comprises 4 items intended to evaluate subjective perception of sleepiness as a general trait. The response options are: 0=never; 1=rarely; 2=often; 3=almost always; 4=always. The sum of the four items originates a composite score which indicates the overall subjective perception of sleepiness. No specific time frame is specified in the instructions.

Epworth Sleepiness Scale (ESS)

The propensity to daytime sleepiness was assessed with ESS (Johns, 1991; 1992). ESS comprises eight items evaluating unintended propensity to being sleepy/falling asleep in various everyday situations (except when fatigue is the cause), rated from 0= “No probability of being sleepy/falling asleep” to 3= “High probability of being sleepy/falling asleep”. The scores may range from 0 to 24 points.

Eysenck Personality Inventory (EPI)

The short version of the EPI (EPI-12, Eysenck & Eysenck, 1964) was used to evaluate Extraversion (E) and Neuroticism (NE). The item 12 "I suffer from sleeplessness" was removed from NE, as it might constitute a confounding variable. These measures seem relevant since they are related to sleep health / quality (cf. Duggan et al., 2014).

Self-reported insomnia

Self-reported insomnia was assessed with item 12 (“I suffer from sleeplessness/insomnia”) from the EPI-12, scored from 1=almost never to 4=almost always.

Pre-Sleep Arousal Scale (PSAS)

The PSAS contains 16 items, each rated on a 5-point scale that describes symptoms of arousal at bedtime (Nicassio, Mendlowitz, Fussell, & Petras, 1985). Eight items evaluate cognitive arousal and eight evaluates somatic arousal. Higher scores suggest higher pre-sleep arousal.

Profile of Mood States (POMS)

The POMS (McNair, Lorr, & Droppleman, 1971) is constituted by 65 adjectives describing feelings and emotions that people usually experience. Each item is responded on a 5-point scale: 0="By no means" to 4="Very much". Six mood states are evaluated: Tension-Anxiety, Depression-Rejection, Fatigue-Inertia, Anger-Hostility, Vigour-Activity and Agreeableness. In this study, participants should consider the previous month (not the previous week, as originally requested), as we wanted to evaluate affect associated with traits, not transitory states of humor (McNair et al., 1971). The "Negative Affect" (NA) dimension was constituted by summing the scores from anxiety, depression and anger scales. The "Positive Affect" dimension (PA) was calculated by summing the scores on the vigor and friendliness scales.

Sleep Quality Index (SQI)

SQI is a composite measure constituted by items concerning sleep depth, subjective sleep quality, sleep latency and nocturnal awakenings. The score varies from 3 to 21. Higher scores denote poorer sleep quality.

Snoring

Snoring was ascertained by the following question: "I snore during sleep" with response categories of Never, Rarely, Often, Almost, Always, Always, and Unknown. This variable is included due to its relevance in sleepiness studies (cf. Svensson, Franklin, Theorell-Haglöw, & Lindberg, 2008).

Body Mass Index (BMI kg/m^2)

Self-reported current body weight and height was used to calculate BMI. For the current study, this measure is very important given its association with sleepiness propensity as observed in several studies (Ficker, Wiest, Lehnert, Meyer, & Hahn, 1999; Shin, Joo, Kim, & Kim, 2003; Singh et al., 2012).

2.1.3. Scale development

The items included in DSPS-4 were based on the initial studies conducted by Manber, Bootzin, Acebo and Carskadon (1996) and Gomes (2005), both comprising college student populations. More specifically, an original 5-item sleepiness scale was planned by Manber et al. (1996) to be used as a screening tool to select university students displaying daytime somnolence, for an experiment about the impact of sleep-wake schedules irregularity on sleepiness. Although very few details about the scale were reported in the journal article, all authors are well-known specialists with recognized clinical and research experience in the sleep field. Therefore, the expertise of the team assures the content validity of the sleepiness measure. Later, in 2000/2001, a Portuguese adaptation of the Manber et al. (1996) scale was prepared by a psychologist and psychiatrist, both university professors with clinical practice at a sleep clinic at the University Hospital of Coimbra, and research experience in the adaptation, development, and validation of psychological and psychiatric assessment tools. This version was proposed in order to integrate a sleep survey in undergraduates, and was preliminarily tested in successive pilot studies (n=103 undergraduates, *n* = 5 secondary school teachers) using “thinking aloud” procedures to ensure item comprehensibility (Gomes, 2005; see also Gomes, Tavares & Azevedo, 2011). This measure revealed good psychometric properties in the final large sample of undergraduates (*n* = 1654), namely Cronbach´s alpha = 0.84, item-total correlations above .50, and a unidimensional structure emerging in the exploratory factor analysis, with the single component explaining 55.58% of the total variance (cf. Gomes, 2005). To sum up, the Manber et al. (1996) initial sleepiness scale tested in college students, in addition to content validity assured by Gomes (2005), showed also very appropriate internal consistency and factorial (construct) validity in the psychometric analyses of the Portuguese version.

Based on these initial versions and promising results, four items (2nd to 5th original ones) and the respective response options, were selected and refined, with the objective of composing the DSPS-4. These improved items were preliminary also tested in a clinical sample of oncological patients (Carvalho, Ribeiro, Martins, Ferreira, & Azevedo, 2005) and resulted from the clinical experience of one of the authors of the current work (MHPA). As the ESS, no specific time frame is specified in the instructions. In creating the DSPS-4, our aim was to develop a simple and easy measure to be used in clinical and research settings and to provide a deeper understanding of sleepiness in insomnia disturbance. Overall, this scale aims at assessing the feeling of excessive daytime sleepiness and its associated impairment.

2.1.4. Procedures

This study was approved by the Ethics Committee and the Scientific Council of the university where the data were collected. The professors were initially contacted in order to obtain authorization to administer the questionnaires to their students at the beginning/ending of classes (out of the evaluation period). The aims of the study were explained to the students and it was emphasized that their participation was entirely voluntary and results were confidential. All participants accepted to collaborate in the study.

2.1.5. Data Analysis

All the data concerning study 1 were analyzed with IBM SPSS Statistics™ v.22 for Windows. We computed descriptive statistics such as means, standard deviations and amplitudes. For inferential statistics purposes, we calculated Pearson product-moment correlations to examine associations among variables and *t*-tests and One-way *ANOVAs* to explore differences among groups. Pertaining to reliability, Cronbach`s alphas were computed.

2.2. Study 2

2.2.1. Participants

Three hundred and forty-eight medical students participated in this study (mean age = 19.1; *SD* = 1.23; range: 17-24). 116 students (33.3%) were males (mean age = 19.1; *SD* = 1.28) and 232 (66.7%) were females (mean age = 19.1; *SD* = 1.20). No differences concerning mean age were found between both groups ($t_{(346)} = 0.092$; $p = .92$).

2.2.2. Measures

All measures including the DSPS-4 were administered using the same format as presented in study 1.

2.2.3. Procedures

The procedure was identical to the one on study 1.

2.2.4. Data Analysis

To perform confirmatory factor analysis (CFA) we used the AMOS Graphics™ software v.22. Beforehand, we checked univariate skewness and kurtosis, multivariate kurtosis (Mardia´s D^2 critical ratio and outliers). Several goodness-of-fit indexes were computed and interpreted according to the recommendations of Byrne (2010) and Kline (2005): Chi-square test (χ^2 , ideally it should be no significant); Critical Ratio (χ^2 /df, should be at least < 5); Root Mean Square Error of Approximation with its associated 90% confidence interval (RMSEA should be < .10); Comparative fit index (CFI should be >.90) and Goodness-of-Fit Index (GFI should be >.90).

3. Results

3.1. Study 1

3.1.1. Descriptive statistics

The DSPS-4 total mean score was 5.45 (*SD* = 2.18). For males, the total mean score was 5.10 (*SD* = 1.95) and for females was 5.63 (*SD* = 2.28). The difference was statistically significant albeit of small magnitude ($t_{(342)}$ = -2.190; *p* = .02; Cohen´s *d* = 0.24). Normality of variables was assumed recurring to univariate skewness and kurtosis coefficients. All the values were within the +2/-2 interval.

3.1.2. Reliability

The DSPS-4 showed a satisfactory internal consistency index (α = .71). The corrected item-total correlation ranged between .41 and .58. The Cronbach's alpha if item deleted (item 4) increased to α = .72. However, considering the small increment of the result and the total items of the scale, this difference was considered not important (Field, 2013). Additionally, one should note that for some authors, the mean inter-item correlation is a more accurate test of reliability than Cronbach's alpha when scales have less than five items. They recommend to consider an optimum value between .2 -.4 (Briggs & Cheek, 1986). In our study, the inter-item correlations mean was .40.

3.1.3. Principal Component Analysis (PCA)

To study the structure of the DSPS-4 we performed a PCA with Varimax rotation. All the requirements to carry out the technique were fulfilled (Field, 2013): 1) The *R*-matrix displayed mostly correlation coefficients (*r*) above 0.3 and none of the items presented high correlations with other items ($r > .80$), excluding multicollinearity and singularity problems; 2) Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy = .73 (> .60), and a significant Bartlett's Test of Sphericity ($\chi^2 = 289.532$; $p < .001$).

Regarding components extraction, we used three available methods: Kaiser´s eigenvalue criterion > 1, Cattell´s Scree Plot and Parallel Analysis (O´Connor, 2000). As IBM SPSS Statistics program does not perform the Parallel Analysis calculation, we ran the SPSS syntax created by Brian O´Connor which is available from the following link: https://people.ok.ubc.ca/brioconn/nfactors/nfactors.html. We choose to test the results from these three methods in order to check their agreement. All the three methods suggested the extraction of a single component which accounted for 55.7% of total variance. As only one component was extracted, no rotation was obtained. The loading of the items are displayed in Table 1.

INSERT TABLE 1

3.1.4. Convergent and divergent validity

For purposes of convergent and discriminant validity assessment, we performed Product-Moment Pearson´s coefficient correlations. The analyses were carried out contrasting DSPS-4 and ESS (cf. Table 2). Regarding convergent validity, it was observed that DSPS-4 correlated significantly and in a positive way with SQI, NE, Fatigue/Inertia, NA, Cognitive Arousal and Somatic Arousal. The association between DSPS-4 and ESS was r = .45 which is the largest correlation observed. DSPS-4 showed negative association with E and PA. The correlations among ESS and all these variables were all of less magnitude and, in some cases, did not show statistical significance.

INSERT TABLE 2

3.1.5. Criterion validity

Based on the responses that participants gave to the question “I suffer from sleeplessness” three independent groups were created and analyzed the differences in all the four DSPS-4 items and DSPS-4 total score. As the category “almost always” had few participants, we decided to aggregate this category with “many times” category, constituting thus a single group for this analysis. As it can be observed in Table 3, the group that reported no insomnia (i.e., almost never) exhibited significantly less sleepiness perception than the remaining two groups.

INSERT TABLE 3

3.2. Study 2

3.2.1. Descriptive statistics

In terms of total score of DSPS-4, a mean score of 5.14 (*SD* = 1.92) was achieved. For males, the total mean score was 4.99 (*SD* = 1.79) and for females was 5.21 (*SD* = 1.98). The difference was statistically significant albeit of small magnitude ($t_{(346)}$=-1.025; p = .30; Cohen´s d = 0.11). Normality of variables was assumed recurring to univariate skewness and kurtosis coefficients. All the values were within the +2/-2 interval, except item 2, which presented a kurtosis value of 2.753 (*SE* = .261). However, this violation was not significant for the aims of the current study.

3.2.2. Confirmatory factor analysis (CFA)

To test the single structure of DSPS-4 it was performed a CFA. One must note that the assumptions for conducting a CFA were generally met: absence of multicollinearity and significant outliers (D^2 Mahalanobis squared distance) and normality distribution of the data ($sk < |3|$ and $ku < |7|$). Therefore, all the analyses were made according to Maximum Likelihood Estimator Type. In terms of local adjustment (cf. Figure 1), it was observed that all the standardized coefficients paths (λ) were superior to > .40 as recommended by Tabachnick & Fidell (2012). Regarding overall fit, we found the following indicators: $\chi^2_{(2)}$ = 5.854; p = .054; χ^2/ df = 2.927; CFI = .986; GFI = .992;

RMSEA = .075 [CI 90% = 0.000 – 0.148]. Overall, according to the recommendations presented by Byrne (2010), it may be concluded that our model achieved a good fit to the data.

INSERT FIGURE 1

3.2.3. Reliability analysis

The composite reliability (CR) is a new alternative to Cronbach's alpha, currently used within CFA, with the added advantage that it takes into account the measurement error (Byrne, 2010; Hair, Black, Babin, & Anderson, 2009). In our study, the CR was .72 which indicates good reliability of the scale (> .70).

3.2.4. Convergent validity

In structural equation models (SEM), when one performed CFA it is recommended to report Average Variance Extracted (AVE) as a convergent validity indicator. Convergent validity in SEM refers to the degree that a latent variable is explained by its observed variables. In our study, the AVE was .40, which is below the recommended value of .50. However, one must note that because of the reduced dimension of DSPS-4 (i.e., only four items) this value is somehow expected. Furthermore, another evidence of convergent validity should be: CR > AVE, which in our study is checked (Hair et al., 2009).

3.2.5. Multiple-group analysis for sex invariance

Finally, the hypothesis that the one-factor structure of DSPS-4 was invariant for both sexes was tested. It was observed that the unconstrained model was no different from the measurement model ($\Delta\chi^2_{(3)}$ = 1.196; p = .754). Therefore, it may be concluded that the factorial structure of DSPS-4 is equal to men and women (Byrne, 2010).

4. Discussion

The aim of this paper was to present a new measure intended to evaluate sleepiness perception. This seems relevant as sleepiness is a multidimensional construct encompassing several dimensions. The most studied one has been sleepiness propensity (Cluydts et al., 2002).

In this study, several analyses of reliability and validity were performed. It is important when a new self-report instrument is preliminary proposed, to explore as far as possible, all the indicators that might meet evidence of its value.

For a scale with only 4 items as the DSPS-4, the results are very good, as one can observe from internal consistency index and the reliability of individual items which comprise the scale. The one-component structure of the DSPS-4 accounts for 56 % of the total variance, which for a measure comprising only four items is quite impressive. The CFA performed on an equivalent independent sample enhanced the reliability of the scale (e.g., composite reliability) and suggested that all the items and the unidimensional structure of the DSPS-4 is equivalent for both sexes. The comparison implemented among groups endorsing different levels of self-reported insomnia suggests that items belonging to the DSPS-4 discriminate fairly good extreme groups.

It is worth noting that there is a distinct correlation pattern for DSPS-4 and ESS. That is, the more relevant measures for insomnia such as arousal (cognitive and somatic) and sleep reactivity to stress are only significantly associated with sleepiness perception and not with sleepiness propensity. Further, the effect sizes of the other associations are higher for sleepiness perception except for extraversion and BMI. These findings are in line with previous studies which suggest that sleepiness propensity is not a very relevant measure to insomnia (Buysse et al., 2007; Faria et al., 2014; Pilcher et al., 1997; Sanford et al., 2006). In their study of daytime symptoms in primary insomnia patients, Buysse et al. (2007) found "somewhat unexpectedly" that negative mood, but not sleepiness/fatigue, correlated with sleepiness propensity (assessed with ESS) and that the ESS did not correlate with the Sleepiness/Fatigue dimension. Using the same sample of the current study, Faria et al. (2014) showed that perceived daytime sleepiness (assessed with the DSPS-4), but not daytime sleep propensity (assessed with the ESS), was significantly associated with both self-reported insomnia and worry-related sleep disturbance. Pilcher et al. (1997) also found in college students that sleepiness as measured by the SSS was more associated with sleep quality (Pittsburgh Sleep Quality Index) than the ESS, which was not related to either sleep quality or sleep quantity. For example, in the study by Sanford et al. (2006), it was observed that sleepiness propensity as measured by the ESS did not differentiate insomnia patients from healthy sleepers.

Significantly positive correlations were found between Fatigue/POMS subscale (defined by worn out, fatigued, exhausted, sluggish, and weary) and sleepiness measures with the highest correlation being with DSPS-4 (DSPS-4 r = .381; ESS r = .263; both p's = $p < .001$). In a factorial study in which the authors used two well-known measures of sleepiness and two well-known measures of fatigue in order to differentiate both constructs, it was observed that two disparate “pure” measures of sleepiness and fatigue emerged (Bailes et al., 2006). Interestingly, in our study, we found an association between DSPS-4 and ESS of = .45 and we observed that fatigue is more strongly associated with DSPS-4 than with ESS. The literature has indicated that fatigue seems to be a more important measure in insomnia than sleepiness propensity. The DSPS-4, evaluating the sleepiness perception - a dimension of the multidimensional sleepiness construct, suggests that sleepiness may be a relevant construct in insomnia. Despite some overlapping between fatigue and sleepiness perception, there is a substantial percentage of variance that is not shared. This finding is in accordance with the perspectives of Cluydts et al. (2002) and Shen et al. (2006).

In student populations, several studies have shown associations between snoring, body mass index (BMI) and subjective daytime sleepiness propensity (Ficker, Wiest, Lehnert, Meyer, & Hahn, 1999; Shin, Joo, Kim, & Kim, 2003; Singh et al., 2012). In a general population sample, Bixler et al. (2005) evaluated simultaneously a wide range of potential risk factors associated with excessive daytime sleepiness and showed that BMI was independently associated with sleepiness. In this study, the presence of excessive daytime sleepiness was established based on a moderate or severe rating on either of the following two questions: “Do you feel drowsy or sleepy most of the day but manage to stay awake?” and “Do you have any irresistible sleep attacks during the day?”. Also, Svensson, et al. (2008), found that excessive daytime sleepiness (ESS score >10) and daytime fatigue were related to habitual snoring independently of the apnea-hypopnea frequency, age, obesity, smoking, and sleep parameters, in a population-based sample of women.

Previous research has also shown an association between sleepiness and psychological factors (Buysse et al., 2008; Olson, Cole, & Ambrogeti, 1998; Bixler et al., 2005). With regard to the relationship between personality traits and sleep, Gray and Watson (2002) found that extraversion/positive emotionality was negatively correlated and neuroticism/negative emotionality positively correlated with sleep quality (the PSQI and subjective sleep inefficiency). In a more recent paper, Duggan et al. (2014) examined links of the personality traits of conscientiousness, neuroticism, agreeableness, extraversion, and openness with a range of factors related to sleep health including trait daytime sleepiness (Epworth Sleepiness Scale), in university students. Using multiple regressions, they found that low conscientiousness, low agreeableness, and high neuroticism explained approximately 11% of the variance in daytime sleepiness levels (extraversion was near statistical significance). The authors suggested that dependable, emotionally stable, sociable people tend to be less sleepy.

Regarding the studies presented here, some limitations should be outlined: Firstly, our subjects are young adults of high socioeconomic status. However, prevalence rates of self-reported insomnia and sleep loss over worry in this sample are similar to those found in epidemiological studies representative of the general population (Faria et al., 2014). Secondly, in college students, irregular sleep–wake patterns, insufficient sleep, daytime sleepiness and feelings of tiredness/fatigue are highly prevalent, thus, some results might not generalize to other populations (Gomes, 2005; Lund, Reider, Whiting, & Prichard, 2010). Thirdly, the test-retest stability was not performed. However, in a previous study (Marques, Marques, Gomes, & Azevedo, 2015) with a subset of the current sample, the one-year temporal stability of the DSPS-4 was high ($r = .610$; $p < .001$).

For future research, it will be important to recruit more diverse groups including normal samples of varying ages and clinical samples, in particular with insomnia disorder and disorders related with excessive diurnal sleepiness and to test the psychometric properties and factorial structure that we found in young adults. Moreover, given the results found, it would be interesting to study both dimensions of sleepiness (propensity and perception) and correlate them with an objective measure. Another suggestion for future research would be to investigate the eventual potential of the DSPS-4 in assessing therapeutic outcomes, where the assessment of cognitive distortions is emphasized; the sleepiness perception correction might be a relevant topic in insomnia management, specifically within the cognitive restructuring methods (Harvey, 2002). This situation might inspire the development of new behavioral experiments (Ree & Harvey, 2004).

In terms of practical implications, we think that the distinction between sleepiness propensity and sleepiness perception (and its accurate assessment) might bring important implications for the research and treatment of sleep disorders, in particular, insomnia.

Again, it is worth noting that sleepiness propensity and sleepiness perception are both different dimensions of the same construct (Kim & Young, 2005). Existing assessment tools have its own strengths and weaknesses, with each measuring different components of sleepiness, so they should be selected according to the assessment goal (Cluydts et al., 2002). Regarding this, we agree with Cluydts et al. (2002) when they refer that "(…) it might be more fruitful to attempt to find out which tests are better suited to assess specific aspects of sleepiness" (p. 93). In insomnia, it is suggested that sleepiness propensity is not as relevant as sleepiness perception (Buysse et al., 2007; Faria et al., 2014; Marques, Gomes, Ferreira, & Azevedo, 2016; Pilcher et al. 2000; Young, 2004). Thus, the DSPS-4 constitutes a questionnaire aimed at measuring the sleepiness perception as a psychological trait and can constitute a complement to the ESS. However, one should note that the DSPS-4 may also evaluate perceived daytime sleepiness as a state whether the instructions are adjusted accordingly.

One should note that new developments on sleepiness measures should be in line with the most recent studies on comprehension of the neurophysiological processes underlying sleep (Stepanski, 2002).

In summary, our new measure of perceived daytime sleepiness seems to be a useful instrument suitable to use in behavioral sleep medicine and other fields, particularly in situations in which insomnia disturbance/sleep quality is the focus of interest.

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Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

Informed consent: Informed consent was obtained from all individual participants included in the study.

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Appendix

Daytime Sleepiness Perception Scale (DSPS-4)

Instructions:

Please, for each of the following statements make a circle around the response that best applies to you. Please answer each question carefully.

	Never	*Rarely*	*Often*	*Almost always*	*Always*
During the day, I feel excessively sleepy, full of sleep	0	1	2	3	4
Being sleepy during the day is a problem for me	0	1	2	3	4
During the day, I feel that my performance is impaired by being sleepy	0	1	2	3	4
During the day, I feel the need to take a nap	0	1	2	3	4

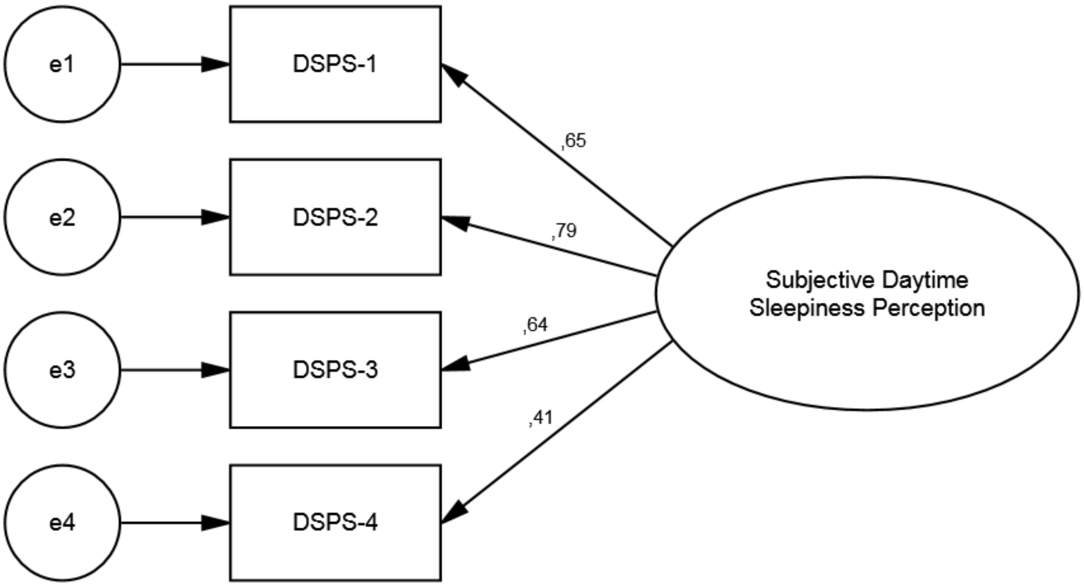

Figure 1. Confirmatory factor analysis of the one-factor structure for DSPS-4 (*N*=348). Standardized coefficients (β) and measurement errors (e) are displayed and all paths are statistically significant ($p < .001$).

Table 1. PCA solution for the DSPS-4

Items	I
Being sleepy during the day is a problem for me	.808
During the day I feel excessively sleepy, full of sleep	.787
During the day I feel that my performance is impaired by being sleepy	.740
During the day I feel the need to take a nap	.641
Eigenvalue	2.229
Variance explained (%)	55.72

Note. Only component loadings $\geq .40$ were considered.

Table 2. Matrix correlation of sleepiness perception (DSPS-4) and sleepiness propensity (ESS) with sleep and psychological variables

	DSPS-4 *r*	ESS *r*
Sleepiness Perception	-	
Sleepiness Propensity (ESS)	.45**	-
Sleep Reactivity to Stress (FIRST)	.21**	.03
Sleep Quality Index	.20**	- .12*
Snoring	.15**	.12*
Extraversion	-.01	.18*
Neuroticism	.29**	.18*
POMS-Fatigue/Inertia	.38**	.26**
POMS-Negative Affect	.34**	.25**
POMS-Positive Affect	-.22**	.02
Cognitive Arousal	.15*	-.03
Somatic Arousal	.17*	.03
Body Mass Index	.04	.11*

* p<.05 ** p<.001

Note. ESS = Epworth Sleepiness Scale; POMS = Profile of Mood States; FIRST = Ford Insomnia Response to Stress Test

Table 3. Mean differences among “insomnia” groups concerning DSPS-4 items and total score

	[1] “Almost never” group (n = 188)	[2] “Few times” group (n = 104)	[3] “Many times + Almost always” group (n = 35)	test		post hoc testing
	M (SD)	M (SD)	M (SD)	F / Welch	df	Tukey HSD / Games-Howell
1. During the day I feel excessively sleepy, full of sleep	1.33 (.58)	1.56 (.60)	1.63 (.73)	6.728*	(2, 326)	1<3=2
2. Being sleepy during the day is a problem for me	1.18 (.64)	1.41 (.78)	1.64 (.64)	98.587***	(2, 91.587)	1<3=2
3. During the day I feel that my performance is impaired by being sleepy	1.41 (.76)	1.66 (.79)	1.77 (.64)	5.677**	(2, 326)	1<3=2
4. During the day I feel the need to take a nap	1.12 (.85)	1.44 (.85)	1.20 (.90)	4.792**	(2, 326)	1<3=2
DSPS-4 total	5.03 (2.06)	6.07 (2.21)	6.22 (2.41)	10.104***	(2, 326)	1<3=2

** $p < .001$

Note. In item 2, it was computed an asymptotically F test (Welch test), as the homogeneity of variances was not assumed. Consequently, in post hoc comparisons, we calculated Games-Howell test. For the remaining items it was computed ANOVA F´s and Tukey HSD tests.