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# Sleep habits, circadian preferences and substance use in a Mexican population: the use of the Morningness-Eveningness-Stability-Scale improved (MESSi)

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# Sleep habits, circadian preferences and substance use in a Mexican population: the use of the Morningness-Eveningness-Stability-Scale improved (MESSi)

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**ABSTRACT**

This study aimed to validate the Morningness-Eveningness-Stability-Scale improved (MESSi) in Mexico, analyzing the factor structure and sleep habits, combined with the proposal of cutoff values for the scales, and to assess the relationship with substance use. We applied the questionnaires through an online survey to a total sample of 510 Mexicans, aged 18–77 years (M = 27.79, SD = 10.24). The MESSi showed an acceptable fit and the Cronbach's alpha coefficients were good to satisfactory in the Mexican sample in every subscale: Morning Affect (MA, α = 0.90), Eveningness (EV, α = 0.88), Distinctness (DI, α = 0.80). In order to obtain a better interpretation of the MESSi subscales, we decided to propose cutoff points corresponding to the 25th–75th percentile. The categories were depicted as strong trait presence, intermediate trait presence and weak trait presence. When applying the cutoff points for the MESSi sub-scales, with Morning Affect (MA), strong-types went to bed and woke up earlier and had more sleep than weak-types during weekdays and weekends and reported less social jetlag. For Eveningness (EV), strong-types went to bed and woke up later than weak-types on weekdays and weekends. Also, strong-types had a shorter time in bed during weekdays but not on weekends and reported more social jetlag. Lastly, with Distinctness (DI), the results reported that those with a strong-type showed greater amplitude on weekdays and weekends. Furthermore, the MESSi scale found that evening people consumed more alcohol and tobacco. Our study supported the validity and reliability of the MESSi in a Mexican population and the relationship between eveningness and substance consumption. Furthermore, the proposed cutoff scores for the MESSi sub-scales add a novel approach for the measurement and interpretation of the scale.

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Morningness-Eveningness; MESSi; substance consumption; chronotype; sleep

## Introduction

Morningness-eveningness refers to interindividual differences in the timing of circadian rhythms, and people can be classified as morning, neither or evening-type. Morning-types prefer waking up early and feel at their best in morning hours for both, intellectual and physical activities, whereas evening-types prefer waking up later and perform and feel best late in the afternoon or at night. Depending on the biological and behavioral parameters (e.g. sleep-wake cycle, body temperature, morning cortisol levels, and dim light and peak melatonin secretion) phase and amplitude differences between extreme types may vary from 2 to 12 h (Adan et al. 2012). Morningness-eveningness orientation can be estimated via self-report questionnaires such as the Morningness-Eveningness Questionnaire (MEQ; Horne and Östberg 1976) and its reduced version (rMEQ; Adan and Almirall 1991), or the Composite Scale of Morningness (CSM; Smith et al. 1989). All of them have been used as an evaluation of the phase of circadian activation rhythm, describing a relatively stable trait of the subjective diurnal rhythm of activation (Di Milia et al. 2013).

Recently, Randler et al. (2016) developed an instrument called the Morningness-Eveningness Stability Scale improved (MESSi) by combining three questionnaires: CSM (Smith et al. 1989), Caen Chronotype Questionnaire (CCQ; Oginska 2011), and Circadian Energy Scale (CIRENS; Ottoni et al. 2011) in order to assess circadian preference (Morning Affect – MA and Eveningness – EV) and

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circadian amplitude (Distinctness – DI). The circadian amplitude or the range of diurnal fluctuations is thought to reflect the strength of the human circadian system. Oginska (2011) proposed that the subjective amplitude of the circadian rhythm can be evaluated by the distinctness scale (DI), representing the subjective feeling of distinctness of daily changes, with some people showing higher fluctuations than others (Dosseville et al. 2013).

The improvements of the MESSi regarding previous measures are multiple: a) this new measure was developed out of previously existing measures; b) it integrates the concept of stability or amplitude, which means the range of diurnal fluctuations during the day (Dosseville et al. 2013; Folkard et al. 1979; Oginska 2011); c) items have been updated and new items should be reflected in evolving scales (i.e. two questions about energy feeling in the morning and in the evening); d) it avoids specific clock times in questions from previous questionnaires; e) in most scales, there is a bias toward morning items whereas the MESSi contains a similar number of items referring to morningness and eveningness; f) in previous scales the scoring was not balanced since some items were coded 1–4 on Likert scale and some 1–5. Further aspects and a detailed discussion of the scale can be found in Randler et al. (2016).

The MESSi has been already applied in seven countries (Spain, Germany, Portugal, Slovenia, Iran, China and Turkey; see Carciofo and Song 2019; Dermirhan et al. 2019; Díaz-Morales et al. 2017; Rahafar et al. 2017; Randler et al. 2016; Rodrigues et al. 2018; Tomažič and Randler 2019), also the three-factor structure has been confirmed in psychometric analyzes (Vagos et al. 2019), and MESSi scores have been validated with objective actigraphy (Faßl et al. 2019) as well as skin temperature measurements, although the latter provided only weak evidence (Weidenauer et al. 2019a). The MESSi has been related to personality traits and mental health symptoms (Díaz-Morales et al. 2017) and recently the MESSi has been applied in an adolescent sample (Weidenauer et al. 2019b). However, one important aspect in comparison to some other scales is the categorization (e.g., into morning types and evening types). This has still to be done with the MESSi.

Generally, evening-types suffer from more negative sleep characteristics relative to morning-types, in both adolescent and adult samples. Previous studies have found that evening-types reported more sleep problems (Merikanto et al. 2012; Rose et al. 2015), shorter sleep duration (Arrona-Palacios and Díaz-Morales 2017; Arrona-Palacios et al. 2015; Escribano and Díaz-Morales 2016) and longer weekend delay and oversleep (Randler et al. 2017; Soehner et al. 2011) than morning-types. Furthermore, evening-types have reported greater social jetlag by delaying their mid-point of sleep approximately 2 h from weekdays to weekends (Díaz-Morales and Escribano 2015; McMahon et al. 2017; Vollmer et al. 2016).

Cross-culturally, and across adolescents and adult samples, self-reported eveningness is associated with later circadian phase, later and more irregular sleep schedules (Bin et al. 2012; Shochat et al. 2014), as well greater substance consumption and dependence across substance types, including alcohol, nicotine, caffeine and marijuana (Prat and Adan 2011). Also, recent studies have reported that evening-types tend to consume more caffeine and alcohol beverages (Pereira-Morales et al. 2019) and more nicotine (Danielsson et al. 2019) than morning-types. Furthermore, chronic consumption of psychoactive substances has a negative effect on the expression of circadian rhythmicity and in extreme cases may even disappear, which suggests a worse quality of the wake and sleep periods. This chrono-disruption may be the result of a less favorable adaptation to environmental changes (Adan 2013). The studies with human drug addicts show circadian rhythm variations mostly ruled by factors associated with the type of drugs, such as metabolism, tolerance, and sensitivity to the drug reward (Kosobud et al. 2007). This increased substance use and sleep instability among evening-types may be a consequence of a mismatch between biological timing and societal demands (Hasler et al. 2012; Wittmann et al. 2006). However, in two studies, one by Nowakowska-Domagala et al. (2016) and the other by Capella et al. (2018) showed that alcohol-dependent patients and patients with substance use disorders (SUD) reported a circadian preference toward morningness and less circadian amplitude. Suggesting that the circadian typology of the alcohol-dependent and SUD patients may differ from the typology of the at-risk population. In general, results have provided substantial evidence that the evening circadian typology is a risk factor for the development of drug consumption and that it should be considered both in preventive and treatment approaches (Adan 2013). However, the assessment of substance use concerning circadian preference has been done in the past with the aforementioned questionnaires, but not with the MESSi. Thus, neglecting the possible relationship between substance use and aspect of distinctness/amplitude and the two-dimensional construct of morningness versus eveningness.

The present study has three main objectives: First, proving the factor structure of the MESSi in a Mexican population and the assessment of categories (cutoff values) for each sub-scale of the MESSi; second, validate the MESSi with sleep habits according with the assessment of the cutoff values of each of the MESSi sub-scales and third, assess whether the MESSi, could be relevant in relation with substance use.

## Methods

### Participants

The sample included a total of 510 Mexicans, aged 18–77 years (M = 27.79, SD = 10.24) of which 228 (44.7%) were female and 282 (55.3%) male. The marital status of the participants was as follows: singles (71.8%), partnership (2%), married (23.3%), divorced (2.5%) and widowed (0.4%); children: 75.9% had no children. Most of them were working (45%), whereas 55% were unemployed or studying. The study level of the participants was high school (2.4%), university (75.5%) and post-university (master and doctoral studies, 22.2%).

### Variables and instruments

#### The Morningness-Eveningness-Stability-Scale improved (MESSi)

The MESSi, Spanish version (Díaz-Morales and Randler 2017) was used. The Morning Affect (MA) sub-scale measures the affective facet of Morningness trait, which is considered as the relative freshness and energy after waking up and the time needed to recover the senses (e.g. *How alert do you feel during the first half-hour after having awakened in the morning? In general, how is your energy level in the morning?*). Higher scores represent higher morning orientation. The Eveningness (EV) sub-scale mainly contains feelings (affect) and energy in the evening as well as studying and learning during evening hours (*e.g. I feel I can think the best in the evening; In general, how is your energy level in the evening?*). Higher scores indicate higher eveningness. Finally, Distinctness (DI) measures the subjective amplitude or the range of diurnal variation, which is the awareness of the difference between hyper- and hypo-activation phases, the ability to volitionally modulate one's own psychophysiological state and feeling the variation of daily changes *(I can focus at any time of the day; There are moments during the day where I feel unable to do anything)*. Higher scores show higher fluctuations. Each sub-scale is composed of five items with a Likert format of response from 1 to 5.

#### Habitual sleep-wake times

In addition to the score-based questionnaires, habitual sleep-wake times were assessed by asking for usual bedtimes and rise times on weekdays and weekends. From these data, the time spent in bed, and social jetlag was calculated. The social jetlag was measured by calculating the absolute difference between mid-sleep on weekdays (MSW) and mid-sleep on weekends (MSF): $\Delta MS = | MSF - MSW |$ (Wittmann et al. 2006). Furthermore, we also reported the sleep-corrected formula elaborated by Jankowski (2017) to exclude the effects of sleep deprivation/debt on values resultant from the first proposed equation: $SJL_{sc} = | MSF_{sc} - MSW_{sc} |$.

#### Substance consumption

For the assessment of substance consumption, the participants were asked for their frequency of daily intake of several legal and illegal substances (i.e. tobacco, caffeine, alcohol, energy drinks, cannabis, cocaine, amphetamines, ecstasy and hallucinogens), considering as answers the categories: during weekends, 2–3 days/week, 4–5 days/week, 6–7 days/week and daily. None of the participants reported using amphetamine, ecstasy, and hallucinogens.

#### Procedure

The sample was recruited from several cities from Mexico via an online procedure from November 2016 to September 2017. Participants were encouraged to voluntarily participate in the research through an e-mail list, virtual university campus, and social networks. Then, each participant distributed the link of the study among their contacts in what is known as the snowball procedure. They provided their informed consent and the reward was to receive their scores and categories at the end of data collection. The research project was approved by the Academic Board of the University and complied with the principles of the Declaration of Helsinki of research on human participants.

### *Data analysis*

To test the MESSi's factorial structure, Exploratory Structural Equation Modeling (ESEM) with Mplus methodology (Asparouhov and Muthén 2010) was used. A three-factor model in each group was estimated using a robust variance-adjusted weighted least squares estimator (WLSMV), with THETA parameterization and TARGET rotation. Model fit was based on several recommended criteria (Bentler 1992), the chi-square test ($\chi^2$), the comparative fit index (CFI > 0.90), the Tucker-Lewis index (TLI > 0.90), the goodness of fit index (GFI > 0.90), the root-mean-square error of approximation (RMSEA < 0.06 acceptable, between .08–.10 mediocre and >0.10 poor fit). Pearson's correlation coefficients were computed to analyze relationships between all variables of the study and a regression model for each sub-scale of the MESSi was calculated to assess the importance of the independent variables simultaneously.

A multivariate analysis of variance (MANOVA) was performed considering sex and the cutoff points of the MESSi (strong-, intermediate- and weak-type) with each of the sub-scales as factors and all sleep variables of the study as dependent variables. The partial eta-squared ($\eta_p^2$) was used as a measure of effect size considering that partial eta-squared between 0.01 and 0.05 is low, between 0.06 and 0.13 is moderate, and higher than 0.14 is large (Cohen 1992). Furthermore, a Kruskal-Wallis non-parametric test, and a Mann–Whitney non-parametric test was used for group comparisons for the daily intake of drug consumption and the MESSi sub-scales. Sex differences in these variables were investigated using a split file of data. The Statistical Program for the Social Sciences (version 19) was used (IBM Corp. Released, 2010).

## Results

The descriptive statistics of the study can be found in Table 1, considering participant's sleep variables, the three sub-scales of the MESSi, and legal and illegal substances consumed. Amphetamine, ecstasy, and hallucinogens do not appear in the table because participants did not consume those substances.

### *Factorial structure and reliability*

ESEM of the MESSi (with correlated error covariance between items 13 and 14 allowed) indicated mediocre fit considering the RMSEA (i.e. the square root of the discrepancy between the sample covariance matrix and the model covariance matrix), but acceptable fit considering CFI (i.e. the discrepancy between the data and the hypothesized model) and GFI (i.e. the fit between the hypothesized model and the observed covariance matrix), ($\chi^2$ = 380.209, df = 62, CFI = 0.990, TLI = 0.983, RMSEA = 0.100) (Figure 1). The internal consistencies (Cronbach's alpha coefficients) of all scales of the current study were satisfactory: MA ($\alpha$ = 0.90), EV ($\alpha$ = 0.88), DI ($\alpha$ = 0.80). In order to test normality of all frequency

**Table 1.** Descriptive statistics for participants according to sleep, MESSi, and substance variables.

| | Mean | SD |
|---|---|---|
| Weekdays Bedtime | 23:39 | 1:00 |
| Weekdays Rise time | 06:44 | 0:47 |
| Weekdays Time in bed | 7:05 | 0:54 |
| Weekends Bedtime | 01:20 | 1:30 |
| Weekends Rise time | 09:33 | 1:35 |
| Weekend Time in bed | 8:12 | 0:42 |
| Social jetlag[a] | 02:14 | 1:13 |
| Social jetlag[b] | 01:33 | 1:04 |
| Morning Affect | 13.20 | 4.22 |
| Eveningness | 18.51 | 5.37 |
| Distinctness | 12.60 | 4.52 |
| | No | Yes |
| Tobacco use: *n* | 239 | 271 |
| Coffee use: *n* | 193 | 317 |
| Energy drink use: *n* | 490 | 20 |
| Alcohol use: *n* | 139 | 371 |
| Cannabis use: *n* | 461 | 49 |
| Cocaine use: *n* | 501 | 9 |

*Note: for tobacco, coffee, energy drink, alcohol, cannabis and cocaine.
[a]Formula applied from Wittmann et al. (2006).
[b]Formula applied from Jankowski (2017).

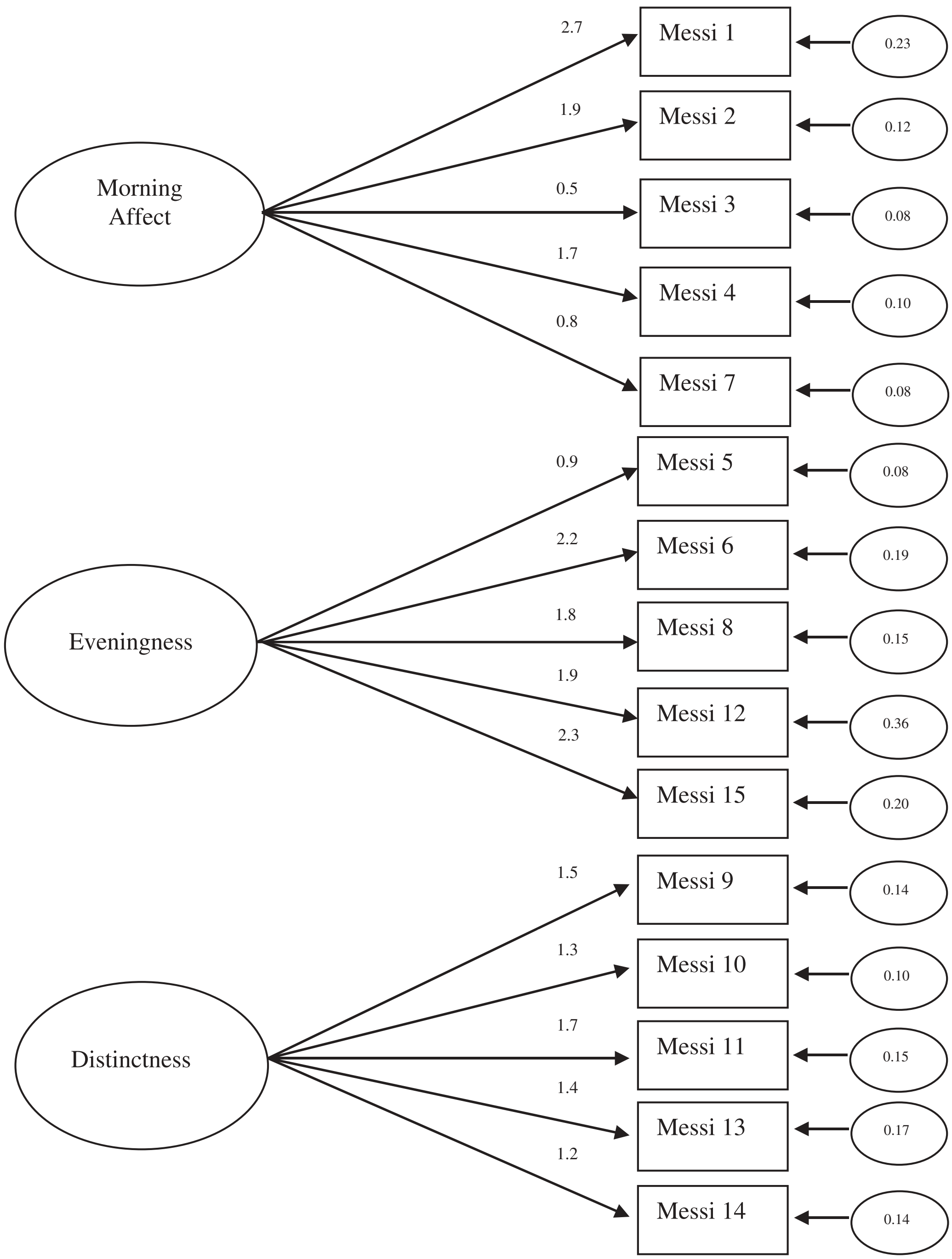


**Figure 1.** Morningness-Eveningness-Stability-Scale improved (MESSi)'s factorial structure (Exploratory Structural Equation Modeling, ESEM).

Messi 1 = CSM 3; Messi 2 = CSM 4; Messi 3 = CSM 12; Messi 4 = CIRENS 1; Messi 5 = CIRENS 2; Messi 6 = CCQ 2 (revised); Messi 7 = CCQ4; Messi 8 = CCQ 5; Messi 9 = CCQ 6; Messi 10 = CCQ 8; Messi 11 = CCQ10; Messi 12 = CCQ 11(revised); Messi 13 = CCQ 14; Messi 14 = CCQ 15; Messi 15 = CSM 13 (revised). CSM = Composite Scale of Morningness (Smith et al. 1989); CIRENS = Circadian Energy Scale (Ottoni et al. 2011); CCQ = Caen Chronotype Questionnaire (Dosseville et al. 2013). See MESSi's Spanish version (Díaz-Morales and Randler 2017).

distributions of MESSi sub-scales, the Kolmogorov–Smirnov test indicated that empirical distributions of MA ($Z = 0.11$, $p < .001$), EV ($Z = 0.12$, $p < .001$) and DI ($Z = 0.11$, $p < .001$) was different from normal distribution. However, the frequency distributions of MA did show skewness ($S = 0.365$), whereas EV ($S = -0.428$) and DI ($S = -0.014$) showed slight negative skewness.

### The MESSi and sleep habits

One focus of the present study was the assessment of categories for each sub-scale of the MESSi. According to this sample, the score ranges for MA from 5 to 21, EV from 6 to 25 and DI from 5 to 25, with a higher score indicating a stronger trait presence for MA, EV and DI. For the creation of the categories from each sub-scale, we decided to use cutoff points corresponding to the 25–75th percentile of the present sample. According to the cutoff points corresponding to the 25–75th percentile of each of the MESSi sub-scales, the categories were depicted as follows: MA values 10/16: strong trait presence (n = 136, 26.7%), intermediate trait presence (n = 229, 44.9%) and weak trait presence (n = 145, 28.4%); EV values 14/24: strong trait presence (n = 138, 27.1%), intermediate trait presence (n = 234, 45.9%) and weak trait presence (n = 138, 27.1%); DI values 9/16: strong trait presence (n = 137, 26.9%), intermediate trait presence (n = 228, 44.7%) and weak trait presence (n = 145, 28.4%).

A multivariate analysis of variance was used to analyze the effect of the MESSi typology of each of the sub-scales with sleep habits. No sex differences were found. However, there were significant differences regarding sleep habits and the cutoff values for the MESSi sub-scales. Those who had a strong-type MA during weekdays, went to bed earlier and spent more time in bed than those with a weak-type MA. There were no significant differences concerning rising time. During weekends, those who had a strong-type MA rose up earlier, went to bed earlier and spent more time in bed than those with a weak-type MA. Also, those with a strong-type MA reported less social jetlag and were more oriented to morningness than those with a weak-type MA.

Regarding EV, during weekdays, those who had a strong-type EV rose up later, went to bed later and had a shorter time in bed than those with a weak-type EV. On weekends, those with a strong-type EV rose up later, went to bed later than those with a weak-type EV. There were no significance differences with time in bed. Also, those with a strong-type EV reported more social jetlag and were more oriented to eveningness than those with a weak-type EV.

Finally, with DI, during weekdays, those with a strong-type DI rose up later and spent more time in bed but went to bed at the same time than those with a weak-type DI. On weekends, those with a strong-type DI rose up later and went to bed later but had a shorter time in bed than those with a weak-type DI. Also, those with a strong-type DI reported more social jetlag and were more oriented to eveningness than those with a weak-type DI (Table 2).

### The MESSi and substance use

Tables 3 and 4 show the mean ranks of daily drug intake for the total sample and for the MESSi subscales and sex. Significant differences were observed between the MESSi sub-scales in the consumption of tobacco (MA: $p < .01$; EV: $p < .05$; DI: $p < .01$), caffeine (DI: $p < .001$), and alcohol (DI: $p < .001$). As for the MESSi typology in each of the sub-scales, for MA, weak-types showed more intake of tobacco than intermediate-types and strong-types ($Z = -3.18$, $p < .001$; $Z = -2.81$, $p < .01$, respectively), also, intermediate-types showed more intake of caffeine than weak-types ($Z = -2.77$, $p < .01$). Regarding EV, weak-types showed more intake of caffeine than strong-types ($Z = -4.14$ $p < .001$), further, intermediate-types reported more frequent consumption of alcohol than weak-types and strong-types ($Z = -3.68$, $p < .001$; $Z = -2.28$, $p < .05$, respectively) also, strong-types showed more intake of cannabis than intermediate-types ($Z = -2.88$, $p < .01$). Lastly, DI intermediate-types showed more intake of caffeine than weak-types ($Z = -3.19$ $p < .001$) and strong-types and intermediate-types reported more frequent consumption of alcohol than weak-types ($Z = -4.25$, $p < .001$; $Z = -5.21$, $p < .001$, respectively).

Sex differences were observed in tobacco, caffeine, and alcohol consumption in each of the MESSi sub-scales. For MA, men reported more intake of tobacco for 2–3 days/week than women ($p < .01$). Regarding DI, women showed more intake of tobacco for 4–5 days/week than men ($p < .01$), also, men reported more intake of caffeine for 2–3 days/week ($p < .01$) and women also reported more intake for 6–7 days/week ($p < .05$). Furthermore, men showed more intake of alcohol for 2–3 days/week ($p < .05$) and women reported more intake for 6–7 days/week ($p < .01$).

For men, according to the MESSi typology in each of the sub-scales, for MA, weak-types reported more intake in tobacco than strong-types ($Z = -3.12$, $p < .01$). Also, weak-types showed more consumption

**Table 2.** Means and standard deviation (SD) according to the cutoff points of the MESSI sub-scales (based on 25/75 percentile cutoffs for every sub-scale) for sleep habits (h:mm), and social jetlag.

| | | MA | | | EV | | | DI | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Strong mean ± SD | Intermediate mean ± SD | Weak mean ± SD | Strong mean ± SD | Intermediate mean ± SD | Weak mean ± SD | Strong mean ± SD | Intermediate mean ± SD | Weak mean ± SD |
| Weekdays | | | | | | | | | | |
| Bedtime | | 23:13 ± 1:04 | 23:32 ± 1:01 | 00:14 ± 0:34 | 00:20 ± 0:42 | 23:39 ± 1:03 | 22:58 ± 0:40 | 23:46 ± 1:21 | 23:30 ± 0:51 | 23:46 ± 0:46 |
| | F(2,504) | | 37.46*** | | | 78.01*** | | | 3.67* | |
| | $\eta_p^2$ | | 0.13 | | | 0.24 | | | 0.01 | |
| Rise time | | 06:38 ± 0:57 | 06:48 ± 0:48 | 06:43 ± 0:29 | 06:55 ± 0:44 | 06:46 ± 0:53 | 06:29 ± 0:32 | 06:59 ± 0:58 | 06:40 ± 0:37 | 06:37 ± 0:45 |
| | F(2,504) | | 0.99 | | | 10.93*** | | | 9.55*** | |
| | $\eta_p^2$ | | 0 | | | 0.04 | | | 0.04 | |
| Time in bed | | 7:24 ± 0:43 | 7:15 ± 1:00 | 6:29 ± 0:33 | 6:35 ± 0:44 | 7:07 ± 0:55 | 7:30 ± 0:47 | 7:12 ± 1:06 | 7:09 ± 0:53 | 6:50 ± 0:38 |
| | F(2,504) | | 51.99*** | | | 39.38*** | | | 6.52** | |
| | $\eta_p^2$ | | 0.17 | | | 0.13 | | | 0.02 | |
| Weekends | | | | | | | | | | |
| Bedtime | | 00:01 ± 1:13 | 01:25 ± 1:18 | 02:28 ± 1:00 | 02:36 ± 0:53 | 01:24 ± 1:25 | 23:59 ± 0:53 | 01:47 ± 1:41 | 01:17 ± 1:27 | 01:02 ± 1:19 |
| | F(2,504) | | 127.52*** | | | 167.43*** | | | 10.30*** | |
| | $\eta_p^2$ | | 0.34 | | | 0.4 | | | 0.04 | |
| Rise time | | 08:19 ± 1:10 | 09:30 ± 1:29 | 10:46 ± 1:08 | 10:56 ± 1:06 | 09:31 ± 1:29 | 08:12 ± 0:49 | 09:58 ± 1:48 | 09:25 ± 1:31 | 09:21 ± 1:25 |
| | F(2,504) | | 105.13*** | | | 155.35*** | | | 7.36*** | |
| | $\eta_p^2$ | | 0.3 | | | 0.38 | | | 0.03 | |
| Time in bed | | 8:17 ± 0:39 | 8:04 ± 0:47 | 8:18 ± 0:37 | 8:19 ± 0:40 | 8:07 ± 0:44 | 8:12 ± 0:40 | 8:11 ± 0:49 | 8:08 ± 0:41 | 8:18 ± 0:37 |
| | F(2,504) | | 5.91** | | | 2.4 | | | 3.63* | |
| | $\eta_p^2$ | | 0.02 | | | 0 | | | 0.01 | |
| Social jetlag[a] | | 01:14 ± 0:44 | 02:17 ± 1:10 | 03:08 ± 0:52 | 03:08 ± 0:54 | 02:15 ± 1:12 | 01:21 ± 0:47 | 02:30 ± 1:15 | 02:15 ± 1:12 | 01:59 ± 1:10 |
| | F(2,504) | | 115.76*** | | | 94.07*** | | | 6.67*** | |
| | $\eta_p^2$ | | 0.31 | | | 0.27 | | | 0.03 | |
| Social jetlag[b] | | 00:42 ± 0:45 | 01:38 ± 1:03 | 02:13 ± 0:48 | 02:13 ± 0:48 | 01:35 ± 1:05 | 0:50 ± 0:47 | 01:48 ± 1:01 | 01:36 ± 1:05 | 01:15 ± 1:00 |
| | F(2,504) | | 93.57*** | | | 72.47*** | | | 9.28*** | |
| | $\eta_p^2$ | | 0.27 | | | 0.22 | | | 0.01 | |

*$p < .05$; ** $p < .01$; *** $p < .001$.
[a]Formula applied from Wittmann et al. (2006).
[b]Formula applied from Jankowski (2017).

**Table 3.** Distribution of the MESSi sub-scales according to daily drug consumption (mean ranks of the Kruskal-Wallis non-parametric test).

| | | MESSi sub-scales | | |
|---|---|---|---|---|
| Drug | Frequency | Morning Affect | Eveningness | Distinctness |
| Tobacco | Weekends | 142.48 | 128.57 | 100.02 |
| | 2–3 days/week | 176.22 | 102.59 | 148.5 |
| | 4–5 days/week | 155.46 | 123.42 | 167.71 |
| | 6–7 days/week | 181.25 | 82.25 | 217 |
| | Everyday | 123.95 | 143.48 | 130.74 |
| | $X^2$ | 15.47** | 9.99* | 15.01** |
| Caffeine | Weekends | 297.5 | 19.5 | 185.5 |
| | 2–3 days/week | 165.09 | 151.98 | 200.26 |
| | 4–5 days/week | 180.17 | 124.62 | 216 |
| | 6–7 days/week | 196.7 | 126.5 | 233.5 |
| | Everyday | 154.82 | 163.03 | 148.05 |
| | $X^2$ | 4.97 | 6.63 | 20.98*** |
| Energy drinks | Weekends | 11 | 8.88 | 10.58 |
| | 2–3 days/week | 8.67 | 13.75 | 7.75 |
| | Everyday | 6 | 1 | 16.5 |
| | $X^2$ | 1.26 | 5.74 | 2.45 |
| Alcohol | Weekends | 179.38 | 191.25 | 168.44 |
| | 2–3 days/week | 229.8 | 124.22 | 248.33 |
| | 4–5 days/week | 192.25 | 174.9 | 221.45 |
| | 6–7 days/week | 234.5 | 206.5 | 229 |
| | Everyday | 185.77 | 190.76 | 207.27 |
| | $X^2$ | 6.18 | 10.20* | 21.54*** |
| Cannabis | Weekends | 26.02 | 21.67 | 23.33 |
| | 2–3 days/week | 24.8 | 27.4 | 23.87 |
| | 4–5 days/week | 29.38 | 26.63 | 21.5 |
| | 6–7 days/week | 4.5 | 41.5 | 36 |
| | Everyday | 19.36 | 23.14 | 29.43 |
| | $X^2$ | 3.76 | 3.22 | 1.91 |
| Cocaine | Weekends | 4.07 | 5.5 | 4.43 |
| | 2–3 days/week | 8.25 | 3.25 | 7 |
| | $X^2$ | 3.65 | 1.06 | 1.4 |

*<.05, **<.01, ***<.001

4–5 days/week and 6–7 days/week in energy drinks it is not shown because the results were 0;

4–5 days/week, 6–7 days/week and everyday in cocaine it is not shown because the results were 0

Amphetamine, Ecstasy and Hallucinogens is not shown because it was 0 in all cases.

in tobacco, caffeine and cannabis than intermediate-types (Z = −2.74, p < .01; Z = −2.08, p < .05; Z = −2.13, p < .05, respectively). Also, intermediate-types reported more intake in cannabis than strong-types (Z = −2.40, p < .01). Women showed no differences.

As for EV, for men, intermediate-types reported more intake in alcohol than weak-types (Z = −2.51, p < .01) and strong-types showed more consumption in alcohol and cannabis than intermediate-types (Z = −2.06, p < .05; Z = −2.24, p < .05, respectively). As for women, intermediate-types reported more intake in alcohol than weak-types (Z = −2.78, p < .01).

Moreover, for DI, for men, intermediate-types reported more intake in caffeine and alcohol than weak-types (Z = −2.45, p < .01; Z = −5.54, p < .001, respectively), also, intermediate-types had more intake in cocaine than strong-types (Z = −2.00, p < .05). Lastly, weak-types reported more intake in caffeine than strong-types (Z = −3.31, p < .001) and strong-types reported more intake in alcohol than weak-types (Z = −3.48, p < .001). As for women, intermediate-types showed more consumption in caffeine than weak-types (Z = −2.17, p < .05), also, weak-types reported more intake than strong-types (Z = −2.56, p < .01) and strong-types reported more intake in alcohol than weak-types (Z = −2.41, p < .01).

## Discussion

The MESSi scale provides multiple improvements to the measure of circadian preference, both psychometrically and conceptually, including the Distinctness scale, as a measure of the subjective amplitude, and separately measuring morningness and eveningness. One aim of this study was to test the Spanish version for the MESSi (morning affect – MA, eveningness – EV, and distinctness – DI sub-scales) in Mexican participants. The ESEM showed an acceptable fit after the correlation between error covariances of items 13 and 14. RMSEA index was mediocre, but GFI and CFI were acceptable (Schreiber et al. 2006). These items correspond to items 13 (There are moments during the day where I feel unable to do anything) and 14 (There are moments during the day when it is harder for me to think). Although this adjustment is worse than the one found in Spanish participants, the fit is within the limit considered minimum to acknowledge the structure of the scale as acceptable. The results obtained in other countries with respect to the RMSEA ranged between 0.07 and 0.10, it seems that the discrepancy between the hypothesized model and the covariance matrix in the different populations was small (Díaz-Morales and Randler 2017; Rahafar et al. 2017; Vagos et al. 2019).

Similarly, Cronbach's alphas were good to satisfactory, and as in the Spanish sample, the alpha level of the Distinctness scale was the lowest. This is similar to studies in other countries, where usually the Cronbach's alpha of the DI scale is lowest (see the comparison in Tomažič and

**Table 4.** Distribution of the MESSi sub-scales according to daily drug consumption by sex (mean ranks of the Kruskal-Wallis non-parametric test).

| | | MESSi sub-scales | | | | | |
|---|---|---|---|---|---|---|---|
| | | Morning Affect | | Eveningness | | Distinctness | |
| Drug | Frequency | Male | Female | Male | Female | Male | Female |
| Tobacco | Weekends | 94.06 | 50.35 | 81.5 | 51.04 | 72 | 32.69 |
| | 2–3 days/week | 115.21 | 62.7 | 61.71 | 40.33 | 99.43 | 51.33 |
| | 4–5 days/week | 112.22 | 45.55 | 71.84 | 52.4 | 92.97 | 73.8 |
| | 6–7 days/week | 113.63 | 0 | 52.75 | 0 | 141.63 | 0 |
| | Everyday | 77.37 | 47.53 | 91.16 | 51.76 | 82.21 | 49.46 |
| | $X^2$ | 15.00** | 3.65 | 8.2 | 2.03 | 7.99 | 11.72** |
| Caffeine | Weekends | 0 | 138.5 | 0 | 11.5 | 0 | 92 |
| | 2–3 days/week | 85.1 | 76.62 | 80.95 | 74.26 | 120.8 | 88.09 |
| | 4–5 days/week | 100.04 | 81.5 | 77 | 44 | 112.29 | 103.33 |
| | 6–7 days/week | 112.25 | 75.5 | 63.88 | 63 | 116.13 | 136 |
| | Everyday | 82.36 | 73.13 | 85.96 | 77.44 | 78.7 | 69.75 |
| | $X^2$ | 2.82 | 2.65 | 1.19 | 7.38 | 13.30** | 9.54* |
| Energy drinks | Weekends | 6.78 | 4.83 | 6.22 | 3.5 | 6.78 | 4.33 |
| | 2–3 days/week | 7 | 3.38 | 10.5 | 4.38 | 3.25 | 3.75 |
| | Everyday | 3 | 0 | 1 | 0 | 10.5 | 0 |
| | $X^2$ | 1.08 | 0.79 | 4.87 | 0.28 | 2.94 | 0.13 |
| Alcohol | Weekends | 108.71 | 70.54 | 115.61 | 76.82 | 102.65 | 66 |
| | 2–3 days/week | 146.42 | 84.72 | 77.39 | 44.56 | 141.78 | 109.22 |
| | 4–5 days/week | 121 | 74.92 | 112.46 | 56.5 | 129.29 | 95.5 |
| | 6–7 days/week | 168.5 | 54 | 154.25 | 40.5 | 101 | 141.5 |
| | Everyday | 110.84 | 77.14 | 118.96 | 68.95 | 128.65 | 79.41 |
| | $X^2$ | 7.05 | 1.5 | 6.9 | 6.87 | 11.00* | 14.80** |
| Cannabis | Weekends | 11.41 | 15.1 | 10.18 | 12.15 | 10.91 | 13.4 |
| | 2–3 days/week | 12.83 | 12.17 | 12.39 | 15 | 11.67 | 13.17 |
| | 4–5 days/week | 0 | 15.88 | 0 | 14.5 | 0 | 10.63 |
| | 6–7 days/week | 0 | 4 | 0 | 22.5 | 0 | 19 |
| | Everyday | 6 | 11.9 | 14.75 | 11.8 | 14 | 15.3 |
| | $X^2$ | 1.84 | 2.82 | 1.15 | 2.31 | 0.39 | 1.39 |
| Cocaine | Weekends | 3.5 | 1.5 | 4.5 | 1 | 3.5 | 2 |
| | 2–3 days/week | 7 | 1.5 | 1 | 2 | 7 | 1 |
| | $X^2$ | 2.25 | 0 | 2.29 | 1 | 2.33 | 1 |

*<.05, **<.01
4–5 days/week and 6–7 days/week in energy drinks it is not shown because the results were 0;
4–5 days/week, 6–7 days/week and everyday in cocaine it is not shown because the results were 0
Amphetamine, Ecstasy and Hallucinogens is not shown because it was 0 in all cases.

Randler 2019). This might be owed to the fact that the distinctness component is the most recent addition to the scale (see also, Dosseville et al. 2013; Oginska 2011).

The correlations found among the subscales are in line with those reported in other studies (Díaz-Morales and Randler 2017; Rodrigues et al. 2018; Vagos et al. 2019). The correlations between Morning Affect and both Eveningness and Distinctness were negative and significant with a larger relation between the first two. The correlation between Distinctness and Eveningness was also significant but with a low positive correlation coefficient.

Also, all sleep-wake variables were correlated with MA and EV in the expected direction. Convergent validity was obtained with correlations of MA and rise times, as well as between EV and bedtimes. These results are in line with the results obtained in the MESSi adaptations in other countries. The use of percentiles with the MESSi to classify the participants in weak, intermediate and strong-type MA, EV and DI, tends to reflect the typologies established by the MEQ (Randler et al. 2017; Soehner et al. 2011; Vollmer et al. 2016). It seems that the new categories of the MESSi improved some of the issues that questionnaires as the MEQ and CSM tend to have regarding the bimodality in the intermediate category (Martynhak et al. 2010; Randler and Vollmer 2012). The cutoffs of the MESSi could be a new way to better understand the weight of the M and E oscillators and the amplitude or the range of diurnal variation. On the other hand, as the MEQ categories (morning-type, intermediate, and evening-type) are well-established

(Levandovski et al. 2013), for now it is suggested to use the raw scores of the MESSi, however, further research is needed with the new cutoff points of the MESSi for the validation of this proposed typology with a representative sample using psychological and physiological assessments and also samples from different cultural backgrounds.

The effect of substance consumption is well in the expected direction, with evening people consuming more alcohol and tobacco (Danielsson et al. 2019; Pereira-Morales et al. 2019; Prat and Adan 2011). The cause and effect are difficult to assess in a correlational design, but this can be considered a strategy to adjust the level of diurnal activation to the social-labor schedules (Adan 2013; Wittmann et al. 2006). Also, evening people tend to modify their sleep habits constantly and by adding to their systems certain legal or illegal substances this could bring it to a full breakdown. Thus, the organism will reach a state of dysregulation so severe that it cannot recover, generating a stress spiral that generates habitual or chronic consumption (Koob and Le Moal 1997). Moreover, there is evidence, that smoking, consuming alcohol and other stimulants can influence circadian dysregulation (Pereira-Morales et al. 2019).

Caffeine consumption is somewhat inconclusive. Usually, caffeine has a positive influence on cognitive performance and well-being (Adan and Serra-Grabulosa 2010; Smith 2002), which could enhance especially the early morning period. There may also cause and effects in two directions. First, people with higher eveningness may drink more coffee in the morning to get fully awakened. Also, drinking coffee in the morning may produce a higher morning affect. Another interpretation may occur because evening caffeine intake alters the circadian clock (Burke et al. 2015), which may shift people with a late caffeine intake toward eveningness. This request further experimental studies with morning types/evening types coffee choosers and non-choosers as well as studies asking for the specific clock times for coffee intake.

The present study makes a significant contribution to the literature; however, there are some limitations. This was a cross-sectional study; therefore, in regards to the sleep variables, future research should use objective measures, such as actigraphy, and to consider temperature measures and hormones sampling to establish validity. Furthermore, we did not consider to analyze any other variables to counteract the frequency levels of substance consumption, such as post-traumatic stress disorder or social isolation and loneliness, which are known to promote higher levels of substance consumption (Shankar et al. 2017; van den Berk-clark et al. 2018) and whether if the participants showed self-control or not, because it is known to have an important weight throughout life (Daly et al. 2016)

In sum, the study evidenced more support for the validity and reliability of MESSi with substance consumption and also in regards of the use of the questionnaire in Mexican population, further, the proposal of cutoff points for the MESSi sub-scales add a novel approach for the measurement and interpretation of the scale.

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