A more accurate assessment of circadian typology is achieved by asking persons to indicate their preferred times rather than comparing themselves with most people

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ABSTRACT

The aim of the present work was to compare two circadian questionnaires: the Preference Scale (PS) and the reduced version of the Morningness-Eveningness Questionnaire (rMEQ). A sample of 849 (35.10% men) university students, 421 of whom were Spanish (27.55% men; mean age 21.07+2.31) and 428 Italian (42.52% men; mean age 23.26+3.01), were administered both questionnaires. Gender (higher morningness in women) and nationality (higher eveningness in Spaniards) differences were replicated with rMEQ but not with PS, in which an inverse association between nationality and circadian preference was observed (i.e., higher morningness in Spaniards). Taking into account that the formulation of the rMEQ items, with its specific times, makes the answers less influenced by socio-cultural bias, we conclude that rMEQ is preferable to PS when evaluating circadian preference in young adults.

Keywords: Morningness-Eveningness Questionnaire; Chronopsychology; Preference Scale; Circadian preference; Circadian Rhythms.

Introduction

Morningness-eveningness refers to individual preferences in the timing of daily activity and sleep (Adan et al., 2012). From a chronobiological point of view, we refer to three major categories: morning-, intermediate- and evening-type people. Individuals who spontaneously wake up early in the morning (also called "larks"), are more active during the first part of the day, and tend to go to bed early in the evening, belong to the first category, representing around 15%-20% of the general population. On the contrary, evening-type individuals (also called "owls"), constituting about 15%-20% of the general population, find it difficult to wake up in the morning and tend to be more active during the second part of the day. Finally, those who show patterns of behaviour that belong to an intermediate area between the two extremes of this continuum (Natale & Cicogna, 2002) are called intermediate- or neither-type individuals, with a prevalence among the general population of around 60%-70%.

Investigations in chronobiology and chronopsychology have provided important differential results, especially between the extreme groups (morning- and evening-types). The most extensively-studied parameters have been body temperature and subjective alertness. Evening-type individuals start their waking day with a lower body temperature than morning-type people, and their body temperature increases throughout the day to reach its peak in the late afternoon. Morning types show a steeper rise in body temperature and reach their peak approximately 1 or 2 hours earlier than evening types (Adan et al., 2012). But what distinguishes morning types from evening types even more is the circadian variation of subjective alertness (Natale & Cicogna, 1996). The peak of the subjective alertness curve in a morning type occurs late in the morning while it occurs in the late afternoon in an evening type. These differences have also

been found in conditions in which the individuals are environmentally isolated or under a constant routine (Kerkhof, 1998; Kerkhof and van Dongen, 1996).

Taking these data into account, it has been shown that monitoring the peak of oral temperature and wrist monitor activity for a period of two weeks can provide a reliable means with which to select morning and evening types (Kerkhof, 1998; Natale et al., 2006; Paciello et al., 2022). Unfortunately, this method in not easily achievable, partly because shared cut-off values are not available (Paciello et al., 2022). For these reasons the construction of a self-evaluation instrument appears to be a useful means for the distinction of morning or evening types. Several self-report instruments have been developed with the purpose of identifying individual circadian preference (Di Milia et al., 2013). Below, for each questionnaire, the number of citations of the original study, according to the database Web of Science investigated on the 25th of August of 2023, is reported between brackets.

The first questionnaire for circadian preference self-assessment dates back to the 1970s when Öquist, a young PhD student, developed a Morningness-Eveningness Questionnaire (Öquist, 1970). This questionnaire was successively modified twice (Östberg 1973a,b) for use in studies examining circadian rhythms of food intake and shift work. In 1976 Horne and Östberg (n=3370 citations) designed and evaluated an English language version of the Morningness-Eveningness Questionnaire, usually known by the acronym MEQ. The MEQ is a 19-item mixed-format scale, in which the individual is requested to indicate his/her own life rhythms and habits as far as going to sleep and waking up are concerned. Each answer is assigned a value; the sum gives scores ranging from 16 to 86, approximating a normal distribution in the population (Adan and Natale, 2002; Posey & Ford, 1981). Low scores (16-41) identify evening types, high scores (59-86)

correspond to morning types, and scores from 42 to 58, found in more than 60% of the population, refer to an intermediate type.

A large number of circadian questionnaires has been proposed, however, the most often-used in chronopsychological research is still the MEQ. Despite its spread and adaptation into many languages, the MEQ has been criticised (Greenwood, 1994), first of all in relation to the procedures for constructing the questionnaire. In fact, in their first presentation Horne and Östberg did not supply detailed information regarding the psychometric characteristics of the instrument, the type of item analysis which was carried out, or the criterion used to provide the scores. However, further research showed that MEQ had adequate internal measurement properties with a full-scale coefficient alpha that was always higher than .80 (Adan and Natale, 2002; Chelminski et al., 1997).

Another criticism concerns the length of the questionnaire. The numerous data collected by the MEQ, besides requiring a longer time for compilation, are not correlated with a single dimension (Larsen, 1985; Neubauer, 1992), and therefore may assume a confusing value. Thus, problems could arise regarding the internal coherence of the questionnaire; deleting some questions corrects the issue. For example, Minervini and co-authors (1980) found items no. 5, 6, 8, 13, and 16 to be of scarce utility, while Adan and Almirall (1991) deemed items 6, 11, 13, and 15 to be superfluous.

For the above reasons, the attempt to realise a reduced version of the MEQ was considered to be useful, such as that put forward by Adan & Almirall (1991; n=450 citations) that contains only five items: the rMEQ. Adan and Almirall (1991), in their analysis of the MEQ, identified three factors: morningness-eveningness, rigidity-flexibility, and subjective alertness-fatigue. They selected the items belonging to the morningness-eveningness factor because these were able to explain the higher degree of variance. It is interesting to point out that the items included in the

rMEQ, usually considered as a pure measure of morningness, are mostly able to discriminate between extreme chronotypes (Tonetti and Natale, 2019). The psychometric characteristics of the scale are satisfactory, with adequate stability and good predictive validity, as stated in the review by Di Milia et al. (2013). More in detail, Di Milia et al. (2013), in their psychometric review, reported that reliability ranges from 0.69 to 0.73, test-retest reliability ranges from 0.76 to 0.79, homogeneity is 0.32, and correlation with MEQ ranges from 0.87 to 0.90. Moreover, rMEQ has been validated, in university student and adolescent populations, using motor activity (Natale et al., 2006; Tonetti et al., 2023), body temperature, and subjective alertness as external criteria (Natale, 1999). On the whole, the rMEQ seems to take the form of a particularly reliable tool, which can be used to advantage in chronopsychological (Correa et al., 2017) and chronobiological (Di Milia et al., 2013) research as well as within the clinical (Coleman and Cain, 2019) field.

In addition to the MEQ, alternative questionnaires have been developed. We wish to quote the Munich Chronotype Questionnaire (MCTQ) (Roenneberg et al., 2003; n=1452 citations) which uses the midpoint between sleep onset and offset on free days (mid-sleep on free days, MSF) to assess chronotype. Such value shows a good correlation (.70) with MEQ score (Zavada et al., 2005). Moreover, although they do not include clock times, we also wish to quote the lastly developed questionnaires to assess chronotype, i.e., the Caen Chronotype Questionnaire (Dosseville et al., 2013; n=45 citations) and the Morningness-Eveningness-Stability-Scale Improved (MESSi) (Randler et al., 2016; n=81 citations), for completeness reasons.

Over the years, as recently summarized by Kim and Kim in their review (2020), some Authors pointed out that referring to a time of day, as done in well-established questionnaires **such** as **the** rMEQ, could be difficult, for example, in people, like shift-workers, which frequently

change sleep time. Furthermore, the different response format between items of the rMEQ may **be** a source of response bias leading to an inaccurate assessment of circadian typology.

On the basis of such reflections, it was considered opportune to develop a new measure of morningness without references to specific times of day and that has a common response format for all items. This questionnaire, named the Preference Scale (PS) (Bohle et al., 2001; n=43 citations), was specifically constructed to promote greater measurement standardisation in shift work research. Despite having this main aim, the PS has also been used in other populations, e.g., university students (Smith et al., 2002). For each question, the individual has to circle the alternative that best indicates his/her preference compared to that of most people. All items have a five-point scale ranging from "Much earlier than most people" (1) to "Much later than most people" (5). Scores on the PS are obtained by summing the scale items, and range from 12 (eveningness) to 60 (morningness). In three works the PS was compared to the Composite Scale of Morningness (CSM) (Smith et al., 1989; n=791 citations) and, although both questionnaires were psychometrically adequate, the authors recommended the PS over the CSM due to it being simpler in content and format (Smith et al., 2002; Zickar et al., 2002; Bohle et al., 2001). In other words, despite the changes, the PS is, from a psychometric point of view, equal to CSM. In this regard, Di Milia and colleagues (2013) also examined the PS in their review of psychometric properties of contemporary chronotype measures, showing a reliability ranging from 0.80 to 0.90, a test-retest reliability ranging between 0.77 and 0.92, a homogeneity of 0.30 and a correlation with MEQ of 0.75. The PS has been validated by subjective measures, i.e., through the self-reported sleep/wake timing and alertness ratings (Di Milia et al., 2013), and scarcely through objective measures (i.e., actigraphy; Thun et al., 2012).

We are convinced that three important problems are still pending in terms of the PS. First, data regarding PS validation with objective measures are still yet scarcely available (Thun et al., 2012). Second, it is possible that the new response format proposed for the PS raises important methodological problems. When a person has to answer the first question (When would you prefer to get up?) and choose from among five possibilities, ranging from "much earlier than most people" to "much later than most people", who will she/he take as her/his point of reference? We know that circadian preference changes over the life span, between gender and cultures. Which categories will be considered by the respondent? Moreover, an individual living in the midst of a prevalence of evening types would be conditioned to answer as a morning type and vice versa. Third, the lack of any reference to the time of the day is certainly a disadvantage because it does not allow for collection of additional detailed information on sleep-wake behaviour such as sleep onset time, wake up time, and midpoint of sleep.

While we are aware that the PS has been proposed more than twenty years ago, in order to overcome the previously highlighted limitations of questionnaires as the rMEQ, we are also aware that no study has yet been carried out in order to assess its supposed superiority over this last questionnaire. On the basis of the above reflections, the aim of the present study is to further explore the validity of the PS comparing it to the more frequently tested rMEQ. We chose to focus on these questionnaires because the PS has been proposed in order to overcome the supposed limitation regarding the reference to the time of day which is present in some of the rMEQ items. However, as previously highlighted, we believe that the lack of any reference to the time of day may lead to some bias in circadian typology assessment. Without focusing on the psychometric properties of either of the questionnaires, which have already been analysed in the literature, we wish to assess whether, from an operative point of view, the removal of any references to the time

of day in the formulation of items within the PS may be associated with a rather inaccurate assessment of circadian typology. To reach this aim, we decided to assess circadian preference in relation to well-known gender and cultural differences. Indeed, the same variables were considered in previous research**es** that used **different measures of circadian typology - e.g., MEQ, as reported by Adan and Natale (2002) as well as Natale et al. (2009), and the MCTQ**, **as highlighted by Roenneberg et al. (2004) -** with women tending more towards morningness that men (Randler and Engelke, 2019), especially between puberty and menopause (Roenneberg et al., 2004), therefore highlighting the potential role of sex hormones in such a modulation**. Moreover,** Spanish participants **were more** shifted towards eveningness than **Italians, as shown by** Adan and Natale **(**2002**) as well** as Natale et al. **(**2009**) using the MEQ and by Caci et al. (2005) through the CSM**, perhaps due to Spanish life being more evening-oriented compared to life in Italy, or even for the potential role played by longitude, as it was found a higher degree of evening orientation moving from east to west (Fischer and Lombardi, 2022; Roenneberg et al., 2007). On the basis of the explanations above, by using the rMEQ we would expect to confirm the well-known gender and country differences that have previously been observed in studies adopting the MEQ (Adan and Natale, 2002; Natale et al., 2009; Randler and Engelke, 2019), while we expect no significant results or, paradoxically, specular results using the PS.

Methods

Participants

An overall sample of 849 (298 male and 551 female) university students took part in this study. Among them, 428 (182 men and 246 women) were Italian while 421 were Spanish (116

men and 305 women). The distribution of men and women between the two countries, Italy and Spain, was significantly different, with a more unbalanced proportion among the Spanish (72.45 % women and 27.55 % men) than among the Italian (57.48 % women and 42.52 % men) participants (χ^2_1=20.88; p<.001). Moreover, the age of Italian participants (23.26$\pm$3.01) was significantly higher compared to that of Spanish students (21.07$\pm$2.31) (t_{847}=11.88; p<.001).

rMEQ

The Spanish (Adan and Almirall, 1991) and Italian (Natale, 1999) versions of the rMEQ were used in the current study. The rMEQ is composed of five items taken from the original MEQ (Horne & Östberg, 1976), three with an open-choice response and two with a multiple-choice format. As an example, item number 1 is: "Considering only your own "feeling best" rhythm, at what time would you get up if you were entirely free to plan your day?". By adding up the scores of all the items, a total score ranging between 4 (extreme eveningness) and 25 (extreme morningness) is obtained.

PS

The Spanish and Italian translated versions of the PS (Bohle et al., 2001) were used. **The procedure of back translation was adopted for both Spanish and Italian versions of the PS.** The PS is composed of 12 items with a multiple-choice format (Likert scale with 5 points) requesting individuals to compare themselves with most other people. As an example, item number 1 taken from this scale is: "Compared with most people, and assuming you were entirely free to choose, when would you prefer to get up?". The sum of the scores of all items results in a total score ranging between 12 (extreme eveningness) and 60 (extreme morningness).

Procedure

Each participant originally provided written informed consent before being enrolled in the study that was approved by the Bioethics Committee of the University of Bologna (Bologna, Italy; ethical committee report of 13/04/2015) and the Institutional Review Board of University of Barcelona (Barcelona, Spain; IRB00003099 of 01/03/2016). Moreover, participants were requested to fill in the rMEQ and PS in a balanced order. Data were collected in the pre-Covid period with the administration of questionnaires in university classrooms during classes to convenience samples of university students. Spaniards were enrolled in the city of Barcelona which is located at 2° E of longitude while Italians were recruited in the city of Bologna, located at 11° E of longitude. Moreover, the difference between local time and apparent solar time is markedly higher in Barcelona than Bologna. To provide an example, taking as a reference the local time of 17:20:00 of December 3, 2022, the corresponding apparent solar time is 16:36:32 in Barcelona while it is 17:12:48 in Bologna, therefore with a mismatch of around 44 minutes in Barcelona against about 8 minutes in Bologna.

Statistical Analyses

For the rMEQ and PS total score, separately, we computed descriptive statistics (mean, standard deviation, skewness, and kurtosis). In addition, the distribution of scores was verified through the Kolmogorov-Smirnov test; in the case of non-normal distribution, scores underwent a square root transformation.

With reference to the rMEQ and PS total scores, separately examined as dependent variables, we performed an ANCOVA with gender (two levels, men and women) and country (two

levels, Spain and Italy) as independent variables, while age was considered as a covariate. In the case of a significant effect, the estimation of the effect size through the partial eta-squared was reported, while for the non-significant effects the observed power was added. Statistical analyses were performed using SPSS software.

Additionally, using the software G*Power, we carried out a post-hoc power analysis computing the achieved power (given alpha, sample size, and effect size) that resulted equal to .83.

Results

rMEQ

With reference to the overall number of participants, 849, comprising both Spaniards and Italians, the mean and standard deviations of the total rMEQ score were 13.3 and 3.6, respectively. The Kolmogorov-Smirnov test, carried out on the total rMEQ score, reached significance (d=.09; p<.01), showing that data were not normally distributed (skewness=.13; kurtosis=-.35). Therefore, the total rMEQ score underwent a square root transformation before the ANCOVA was applied. However, when presenting the results of the ANCOVA, we chose to report the untransformed total rMEQ values because they were more meaningful.

The gender effect on the total rMEQ score was significant (F1,844=7.85; p<.01; partial eta-squared=.009) with men (13+3.8) scoring lower than women (13.4+3.5). The effect of country on total rMEQ score was also significant (F1,844=16.98; p<.001; partial eta-squared=.02), with Spanish (12.6+3.3) obtaining lower scores than Italian (13.9+3.7) participants. The interaction

between gender and country did not reach significance (F1,844=.09; p=.76; observed power=.06) (Figure 1).

Please, insert about here Figure 1

PS

Within the overall sample composed of 849 participants, including both Spaniards and Italians, the mean and standard deviations of the PS total score were 33.1 and 6.4, respectively. The Kolmogorov-Smirnov test, carried out on the PS total score, did not reach significance (d=.05; p=.10), showing that data were normally distributed (skewness=.18; kurtosis=.16)

Men (32.5$\pm$6.6) and women (33.5$\pm$6.3) did not significantly differ in the total score of the PS ($F_{1,844}$=2.22; p=.14; observed power=.32). The effect of country on the PS total score was significant ($F_{1,844}$=9.94; p<.005; partial eta squared=.01), with higher scores reported by Spanish (34.2$\pm$6.7) compared to Italian (32.1$\pm$5.9) students. The interaction between gender and country showed a tendency towards significance ($F_{1,844}$=3.66; p=.06; observed power=.48) (Figure 2), with the higher scores of the Spanish participants especially determined by the women.

Please, insert about here Figure 2

Discussion

The main goal of the current study was to compare the performance of two questionnaires, PS and rMEQ, taking into account what is well known in literature about gender and nationality factors, with the final aim of understanding, between the two, which is the most suitable questionnaire, i.e., method, with which to assess circadian preference in young adults.

With reference to PS, no significant gender differences were observed. This pattern of results disagrees with a large body of literature showing that women are more likely to be morning types compared to men, in particular when sex hormones are active (Natale et al., 2009; Roenneberg et al., 2004). This last result indicates that sex hormones may play a primary modulating role in the higher predisposition of women towards morningness compared to men, also confirming previous data reported in other mammalians (e.g., hamsters; Morin et al., 1977). As regards the nationality differences in the PS total score, we observed a higher tendency towards morningness in Spaniards compared to Italians. This datum is not in line with results reported by previous studies, either (Adan and Natale, 2002; Natale et al., 2009]; using a different measure of circadian preference (e.g., the MEQ), these studies highlighted a higher orientation towards eveningness in Spaniards than Italians, in participants with a similar age range. This datum could be explained by taking into account the potential role played by longitude, within the same time zone, in the direction of a higher degree of evening orientation moving from east to west (Fischer and Lombardi, 2022; Roenneberg et al., 2007), highlighting the higher relevance of sun time, compared to social time, in the entrainment of the human circadian clock. In an attempt to interpret the potential meaning of the higher morningness observed in the present study in Spaniards compared to Italians in the PS, we could suggest that this could be potentially due to the

formulation of items. Indeed, taking into account the necessary comparison with "most people", we could suppose that people living in an area characterized by a prevalence of evening types may be biased towards a self-assessment as "much earlier", i.e., as being more morning-types. In other words, due to the formulation of PS items, we strongly believe that cultural factors may play a significant role in the modulation of the answers.

Moving onto the discussion of the results observed in the rMEQ, we confirmed a significant gender difference, with higher morningness in women compared to men. As regards the nationality factor, we observed a higher predisposition towards eveningness in Spaniards compared to Italians. Both significant gender (Randler & Engelke, 2019) and nationality (Adan and Natale, 2002; Natale et al., 2009) differences are in line with previous literature.

Keeping in mind the final aim of the current study, i.e., to determine which is the most suitable questionnaire, the PS or the rMEQ, to assess circadian preference in young adults, we believe that the pattern of results observed here indicates the rMEQ as the preferable questionnaire. Moreover, supporting this proposal, we believe that the open questions of the rMEQ regarding the ideal bedtime (item 3) and get-up time (item 1) are of utmost importance, as they allow other parameters to be computed, such as the ideal midpoint of sleep and ideal total sleep time, the main markers of sleep timing (Roenneberg et al., 2003; Zavada et al., 2005), and sleep quantity. Finally, while Spanish (Adan and Almirall, 1991) and Italian (Natale, 1999) rMEQ cut-off values are available, this is not the case for the PS, which could limit its use.

While we are confident about the strengths of this study (e.g., a large sample size), we are also aware of a few limitations, such as, for example, the greater number of women in both nationalities and the slight age difference between the Italians and Spaniards, that, in any case, was controlled from a statistical point of view. We did not collect information concerning the physical

or mental health of the participants, nor did we examine objective data regarding circadian rhythmicity (i.e., a sort of independent measure of circadian typology that could have been obtained through actigraphy) or habits such as physical exercise or substance use that may influence the results. **Finally, both Spanish and Italian versions of the PS have not been formally validated.**

Taking into account the observed pattern of results, it seems that the rMEQ is preferable over the PS because only for the first questionnaire the observed gender and nationality differences are in line with the current literature. However, the last word in absolute terms on which is the best tool to assess circadian typology is not yet been said. Indeed, over the last years other questionnaires have been proposed, as the MESSi in which authors (Randler et al., 2016) purposely avoided to ask for clock times in questions. From our point of view, it could be interesting whether future studies should try to understand if asking for the clock times is a fundamental feature of a questionnaire on circadian typology or not. Currently, we believe in any case that asking for the clock times could be considered in general terms a pro since it allows to compute few ideal sleep timing parameters, getting a richer picture of circadian typology. However, we are also aware that asking for the clock times could be problematic in specific populations, e.g., the shift workers, representing a potential con.

Conclusion

The aim of this study was to analyse the effectiveness to request individuals to compare themselves with most other people, eliminating any reference to the time of day, in a scale to assess circadian preference, taking into account gender and nationality factors. While well-known gender

and nationality differences are replicated with the rMEQ, in the direction of higher morningness in women than men and higher eveningness in Spanish than Italian, this was not the case of the PS, in which no differences in gender were observed while a significant-opposite effect of nationality was indicated, with higher degrees of morningness in Spanish than Italian participants. This last result is probably due to the misleading item formulation, asking participants to compare themselves with most people, with a significant role played by cultural factors. Considering the overall pattern of results, as well as additional information obtained through the rMEQ (e.g., midpoint of sleep), we conclude that, in order to assess morningness-eveningness preference in young adults, rMEQ can be considered as more useful in comparison to PS.

Disclosure statement

The authors report there are no competing interests to declare.

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Data Availability Statement

The data are not publicly available and cannot be shared due to ethical issues.

References

Adan A, Almirall H. 1991. Horne and Östberg morningness-eveningness questionnaire: a reduced version. Pers Individ Differ. 12:241-253.

Adan A, Archer SN, Hidalgo MP, Di Milia L, Natale V, Randler C. 2012. Circadian typology: a comprehensive review. Chronobiol Int. 29:1153–1175.

Adan A, Natale V. 2002. Gender Differences in morningness-eveningness preference. Chronobiol Int. 19:709-720.

Bohle P, Tilley AJ, Brown S. 2001. Psychometric evaluation of the Early/Late Preference Scale. Ergonomics. 44:887-900.

Caci H, Adan A, Bohle P, Natale V, Pornpitakpan C, Tilley A. 2005. Transcultural properties of the composite scale of morningness: the relevance of the "morning affect" factor. Chronobiol Int. 22:523-540.

Chelminski I, Ferraro FR, Petros T, Plaud JJ. 1997. Horne and Östberg questionnaire: a score distribution in a large sample of young adults. Pers Individ Differ. 23:647-652.

Coleman MY, Cain SW. 2019. Eveningness is associated with greater subjective cognitive impairment in individuals with self-reported symptoms of unipolar depression. J Affec Disord. 256:404–415.

Correa A, Ruiz-Herrera N, Ruz M, Tonetti L, Martoni M, Fabbri M, Natale V. 2017. Economic decision-making in morning/evening-type people as a function of time of day. Chronobiol Int. 34:139–147.

Di Milia L, Adan A, Natale V, Randler C. 2013. Reviewing the psychometric properties of contemporary circadian typology measures. Chronobiol Int. 30:1261–1271.

Dosseville F, Laborde S, Lericollais R. (2013). Validation of a chronotype questionnaire including an amplitude dimension. Chronobiol Int. 30:639–648.

Fischer D, Lombardi DA. 2022. Chronotypes in the US: Influence of longitude position in a time zone. Chronobiol Int. 39:460–464.

Greenwood KM. 1994. Long-term stability and psychometric properties of the Composite Scale of Morningness. Ergonomics. 37:377-383.

Horne JA, Östberg O. 1976. A self-assessment questionnaire to determine morningness-eveningness in human circadian rhythms. Int J Chronobiol. 4:97-110.

Kerkhof GA. 1998. The 24-hour variation of mood differ between morning- and evening-type individuals. Percept Mot Skills. 86:264-266.

Kerkhof GA, van Dongen HP. 1996. Morning-type and evening-type individuals differ in the phase position of their endogenous circadian oscillator. Neurosci Lett. 218:153-156.

Kim S, Kim SJ. 2020. Psychometric properties of questionnaires for assessing chronotype. Chronobiol Med. 2:16–20.

Larsen RJ. 1985. Individual differences in circadian activity rhythm and personality. Pers Individ Differ. 6:305-311.

Minervini MM, Leone D, Di Benedetta C, Montrone S, Ambrosi L, Amico P, Di Pietro G, Misigna G, Tamborrino B. 1980. Caratteristiche individuali e ritmi biologici. Nota 2: modificazione del questionario e dei punteggi utilizzato per la tipizzazione di mattinieri e serotini. Boll Soc Ital Biol Sper. LVI:2097-2103.

Morin LP, Fitzgerald KM, Zucker I. 1977. Estradiol shortens the period of hamster circadian rhythms. Science. 196:305–307.

Natale V. 1999. Validazione di una scala ridotta di Mattutinià (rMEQ). Bollettino di Psicologia Applicata. 229:19-26.

Natale V, Adan A, Fabbri M. 2009. Season of birth, gender, and social-cultural effects on sleep timing preferences in humans. Sleep. 32:423-426.

Natale V, Cicogna PC. 1996. Circadian regulation of subjective alertness in morning and evening type. Pers Individ Differ. 20:491-497.

Natale V, Cicogna PC. 2002. Morningness-eveningness dimension: is it really a continuum? Pers Individ Differ. 32:809-816.

Natale V, Esposito MJ, Martoni M, Fabbri M. 2006. Validity of the reduced version of the Morningness-Eveningness Questionnaire. Sleep Biol Rhythms 4:72-74.

Natale V, Esposito MJ, Martoni M, Fabbri M. 2006. Validity of the reduced version of the Morningness-Eveningness Questionnaire (MEQr). Sleep Biol Rhythms 4:78-80.

Neubauer AC. 1992. Psychometric comparison of two circadian questionnaires and their relationship with personality. Pers Individ Differ. 13:125-131.

Öquist O. 1970. Kartlaggning av individuella dygnsrytmer [thesis]. Goteborg (Sweden): University of Goteborg.

Östberg O. 1973a. Circadian rhythms of food intake and oral temperature in morning and evening groups of individuals. Ergonomics. 16:203-209.

Östberg O. 1973b. Interindividual differences in circadian fatigue patterns of shift workers. Br J Ind Med. 30:341-351.

Paciello LM, Quante M, Weidenauer C, Rueschman M, Nieratschker V, Poets CF, Randler C. 2022. Validity of chronotype questionnaires in adolescents: Correlations with actigraphy. J Sleep Res. 31:e13576.

Posey TB, Ford JA. 1981. The morningness-eveningness preference of college students as measured by the Horne and Ostberg questionnaire. Int J Chronobiol. 7:141-144.

Randler C, Díaz-Morales JF, Rahafar A, Vollmer C. 2016. Morningness-eveningness and amplitude - development and validation of an improved composite scale to measure circadian preference and stability (MESSi). Chronobiol Int. 33:832-848.

Randler C, Engelke J. 2019. Gender differences in chronotype diminish with age: a meta-analysis based on morningness/chronotype questionnaires. Chronobiol Int. 36:888–905.

Roenneberg T, Kuehnle T, Pramstaller PP, Ricken J, Havel M, Guth A, Merrow M. 2004. A marker for the end of adolescence. Curr Biol. 14:R1038-R1039.

Roenneberg T, Kumar CJ, Merrow M. 2007. The human circadian clock entrains to sun time. Curr Biol. 17:R44–R45.

Roenneberg T, Wirz-Justice A, Merrow M. 2003. Life between clocks: daily temporal patterns of human chronotypes. J Biol Rhythms. 18:80–90.

Smith CS, Folkard S, Schmieder RA, Parra LF, Spelten E, Almiral H, Sen RN, Sahu S, Perez LM, Tisak J. 2002. Investigation of morning-evening orientation in six countries using the preferences scale. Pers Individ Differ. 32:949-968.

Smith CS, Reilly C, Midkiff K. 1989. Evaluation of three circadian rhythm questionnaires with suggestions for an improved measure of morningness. J Appl Psychol. 74:728-738.

Thun E, Bjorvatn B, Osland T, Steen VM, Sivertsen B, Johansen T, Lilleholt TH, Udnes I, Nordhus IH, Pallesen S. 2012. An actigraphy validation study of seven morningness-eveningness inventories. Eur Psychol. 17:222–230.

Tonetti L, Andreose A, Bacaro V, Giovagnoli S, Grimaldi S, Natale V, Crocetti E. 2023. External validity of the reduced Morningness–Eveningness Questionnaire for Children and Adolescents: an actigraphic study. J Sleep Res. e13948.

Tonetti L, Natale V. 2019. Discrimination between extreme chronotypes using the full and reduced version of the Morningness-Eveningness Questionnaire. Chronobiol Int. 36:181–187.

Zavada A, Gordijn MCM, Beersma DGM, Daan S, Roenneberg T. 2005. Comparison of the Munich Chronotype Questionnaire with the Horne-Ostberg's morningness-eveningness score. Chronobiol Int. 22:267–278.

Zickar MJ, Russel SS, Smith CS, Bohle P, Tilley AJ. 2002. Evaluating two morningness scale with item response theory. Pers Individ Differ. 33:11-24.

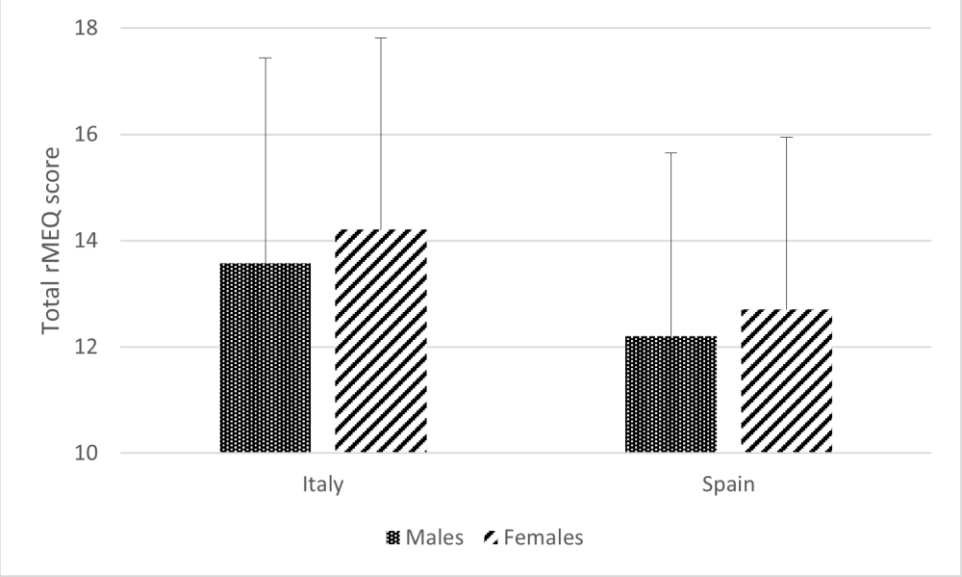

Figure 1. Interaction between gender and country on the total rMEQ score. Means and standard deviations are shown, and are also reported as follows. Italy: males=13.57±3.87; females=14.21±3.60. Spain: males=12.21±3.44; females=12.70±3.24. A higher total rMEQ score indicates a higher propensity towards morningness while a lower total rMEQ score shows a higher tendency towards eveningness.

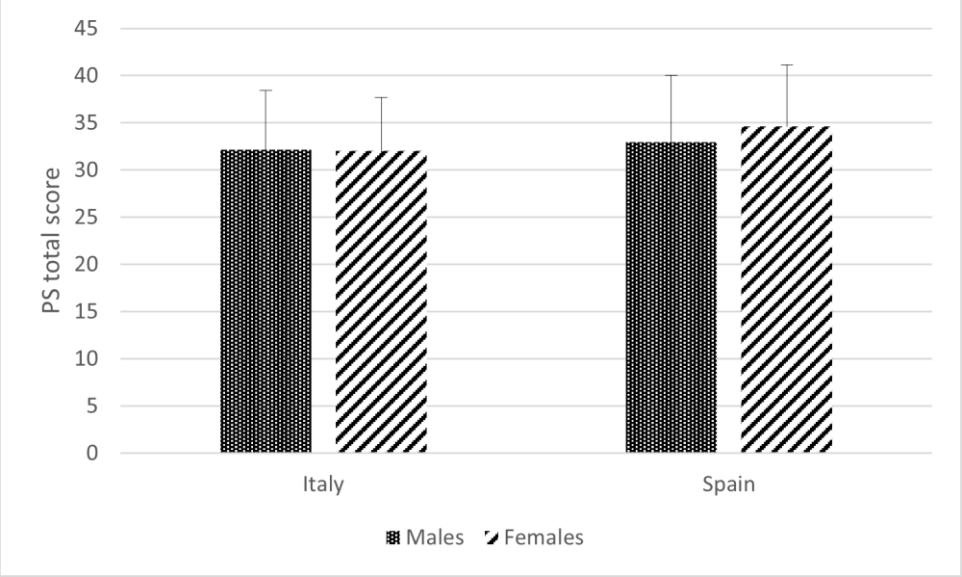

Figure 2. Interaction between gender and country on the PS total score. Means and standard deviations are shown and are also reported as follows. Italy: males=32.15±6.28; females=32.03±5.63. Spain: males=32.97±7.09; females=34.60±6.53. A higher PS total score points to a more marked morning preference, while a lower PS total score indicates a more prevalent evening preference.