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Inter-individual variability in morningness-eveningness across the lifespan:

Influence of age and sex

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INTRODUCTION

- Morningness-eveningness, referring to individual differences in sleep-wake schedules and preferred time of activity, is influenced by genetics and undergoes significant changes throughout the lifespan [1]. Sex differences have been reported in some studies, with women generally obtaining higher morningness scores than men [2].
- Morningness-eveningness shows a near-Gaussian distribution in a given population, ranging from early to late types [3]. Individuals exhibit varying degrees of morningness-eveningness, leading to significant variability.
- Morningness-eveningness variability (MV) has received relatively little attention, and the factors influencing this variability remain largely unknown. We aimed to study MV across the lifespan, assess the influence of age and sex, and uncover sex-specific trajectories.

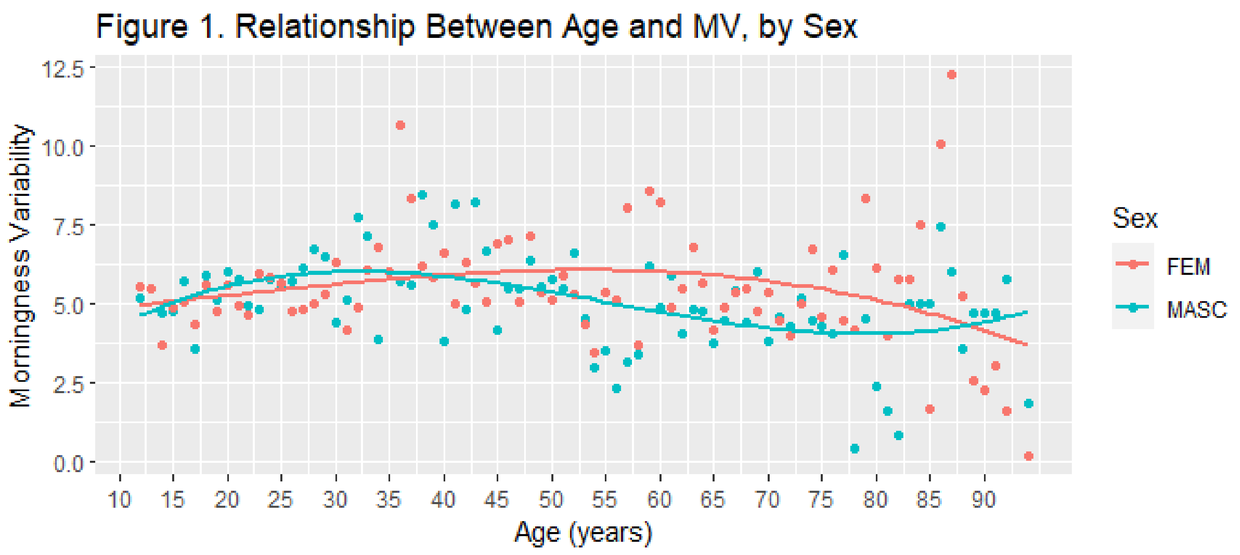
METHOD

- **Participants:** The overall sample comprised 2890 participants (12 – 94 years old, M = 39.31 years, SD = 21.22), with a sex composition of 55.8% female (n = 1614) and 44.2% male (n = 1276).
- **Instrument:** The Portuguese version of the Composite Scale of Morningness (CSM) was used as a measure of morningness-eveningness, with higher scores indicating greater morningness.
- **Procedure:** Data analysis was performed using IBM SPSS Statistics (v27) and R Studio with a significance level set at α = .05. To obtain a measure of MV, we conducted a linear regression with CSM scores as the dependent variable and age, age², and age³ as predictors. Residuals from this regression were saved and absolute values obtained. Multiple linear regression analyses followed, with the MV measure as the dependent variable, incorporating age, age², age³, sex, and their interaction terms. We employed a hierarchical step-down procedure, eliminating non-significant predictors, starting with higher-order terms [4]. For interaction terms in the final regression model, we constructed a moderation model (Model 1) using the PROCESS macro [5]. The Johnson-Neyman (JN) technique identified age points where sex effects shifted from non-significant to significant (or vice-versa). The final multiple regression model revealed an age-sex interaction, indicating distinct MV trajectories for each group. To explore this further, we conducted a segmented regression analysis [6, 7] in the overall sample to identify breakpoints (BPs) in the age variable defining different linear segments in the age-MV relationship. To examine age-MV trajectories for each sex, we separately conducted segmented regression analyses for males and females, utilizing the BP identified in the overall sample as a reference point for these analyses. Within each linear segment, we calculated slopes, 95% confidence intervals, and p values from t-statistics.

RESULTS

- The final regression model showed significant influences on MV: the quadratic (β = -.14, p < .001) and cubic (β = .11, p = .02) age terms, along with the age-sex interaction (β = -.06, p = .02). This model was statistically significant (F(5, 2884) = 6.33, p < .001), explaining 1.1% of the variance. The presence of a significant cubic age term indicates a non-linear age-MV relationship.
- We identified a BP at 37 years of age within the overall sample, which served as the reference point for the subsequent analyses conducted separately for each sex. Further examination by sex revealed distinct BPs. In males, a BP was found at 36.99 years, with a positive relationship between linear age and MV in the first segment (b = .06, t(77) = 2.62, p = .01) and a negative relationship in the second segment (b = -.03, t(77) = -2.58, p = .01). In females, a BP was identified at 33 years, with a positive relationship in the first segment (b = .06, t(78) = 2.62, p = .04) and a negative relationship in the second segment (b = -.04, t(78) = -3.18, p < .01).
- Due to the significant interaction between the linear age term and sex, we conducted a moderation analysis. The JN technique showed that before the age of 50, there were no sex differences in MV. Beyond that age, men exhibited lower MV compared to women.

Figure 1. Relationship Between Age and MV, by Sex



Note. Relationship between age (in years) and MV (absolute values of residuals), by sex, plotted with a cubic polynomial fit.

CONCLUSIONS

We observed a non-linear relationship between MV and age, characterized by distinct trajectories for each sex, with different BPs identified for men (36.99 years) and women (33 years). Both sexes exhibit a pattern of increasing MV before reaching their respective BP and subsequent declines afterward. After the age of 50, men display lower MV than women. The greater MV in adolescence and young adulthood may result from transitions in social and biological factors influencing sleep-wake cycles. Adolescence exhibits variable phase delays, with the magnitude of the phase delay depending both on baseline morningness and school timing [8]. This variability may be influenced by genetic, hormonal, and environmental factors. Social cues, such as school start times, extra-curricular commitments, and parental involvement in regulating adolescent bedtimes may also play a role in MV. In young adulthood, MV may increase due to life events like job changes, cohabitation, or starting a family [9]. Beyond this stage, MV diminishes, potentially due to increased lifestyle regularity, including more stable sleep-wake patterns and social and photic *zeitgebers* [9, 10]. As individuals age, there is a reduction in circadian amplitude [11], which might contribute to explain a narrower distribution of sleep timing and of MV. Furthermore, males experience a more rapid decline of the suprachiasmatic nucleus and undergo a more rapid narrowing of circadian amplitude [11], which might be responsible for the lower MV observed after the age of 50. In conclusion, it is possible that the complex interplay of biological, environmental, and lifestyle factors contributes to the intricate landscape of MV changes over a lifetime.

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