Morning preference is associated with subjective happiness among Japanese female workers: A moderation analysis by sleep characteristics from the SLEPT study

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ABSTRACT

Research on mental health in working populations has predominantly focussed on negative outcomes, while studies on the positive aspects of life remain very limited, especially in Japan. Although morningness has recently been considered a factor for being happy, the role of sleep characteristics as it relates to the association between morningness and happiness has not been substantiated. The aim of this study is to investigate the associations between diurnal preference and level of subjective happiness in healthy, full-time, daytime workers in Japan. We also tested the moderation effect of sleep parameters on the relationship between diurnal preference and subjective happiness. This is an exploratory analysis from the cross-sectional data of the Sleep Epidemiology Project at the University of Tsukuba (SLEPT Study). Subjective happiness was evaluated using a single-item question. Diurnal preference was assessed using the Morningness–Eveningness Questionnaire (MEQ), in which higher scores indicate greater tendency to have morning preference. The participants underwent assessment of sleep parameters for 7 consecutive days using a waist-worn actigraphy device and kept a sleep diary. Sleep parameters investigated were subjective sleep quality, sleep disturbance, daytime sleepiness, weekend oversleep, total sleep time, sleep onset time, wake time, and sleep efficiency. A total of 205 males (average 42.6 ± 10.4 years) and 272 females (41.1 ± 9.8 years) were eligible for analysis. Hierarchical liner regression analysis was used to show the relationships of subjective happiness with MEQ score, and the sleep parameters. Further, moderation analysis was conducted by adding the interaction between MEQ score and the sleep parameters. After adjusting for age, psychological distress, self-rated health, and occupational stress, we found that subjective happiness was significantly associated with higher MEQ score but only in female. The moderating role of sleep parameters was not found. We discussed the implications of the obtained results and a possible strategy to maintain and improve objective and subjective happiness of female workers who have evening preference.

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Introduction

Subjective happiness, also referred to as subjective well-being, is recognized as a fundamental human goal around the world (Helliwell et al. 2021). It refers to a general evaluation of an individual’s life, characterized by satisfaction, positive affect, and low levels of negative affect (Diener 2000). Subjective happiness can be measured using a self-administered questionnaire (VanderWeele et al. 2020). From the perspective of psychology, the symptoms of mental health and mental illness do not reflect opposite ends of the same continuum; rather, they are loaded onto 2 separate, but related, continua (Westerhof and Keyes 2010). Over the past decade, increased interest in positive psychology has cast a spotlight on subjective happiness, in contrast to the precedent dominant disease model which focuses on risk factors and negative outcomes of mental illness, such as illness and depression (Seligman and Csikszentmihalyi 2014). Subjective happiness has also gained increasing attention amongst policy-makers and researchers from various fields (Ryan and Deci 2001). Subjective happiness has been found to be beneficial to
health in multiple ways. For example, it has been reported to suppress the activation of stress hormones and inflammatory markers (Steptoe et al. 2008). High levels of subjective happiness have been linked to lower incidence of cardiovascular diseases and diabetes (Steptoe et al. 2005), and contribute to longevity (Diener and Chan 2011). Subjective happiness also helps people achieve success in different aspects of working life: it improves decision-making, work engagement, job performance, and job satisfaction (Boehm and Lyubomirsky 2008; Fisher 2010; Halbesleben and Wheeler 2008; Kadoya et al. 2020); it promotes creativity and innovation (Kamel et al. 2017; Tenney et al. 2016); and it reduces burnout, absence from work, and intention to leave (Gavin and Mason 2004; Halbesleben and Wheeler 2008; Tenney et al. 2016). Organizations have, therefore, recognized the importance of employees’ well-being and increased investment in programs to promote it (Ton 2014).

Diurnal preference, also referred to as circadian typology or morningness-eveningness, plays an important role in our daily lives and sleep patterns. Chronotype is a similar concept to diurnal preference, but chronotype is based more on an individual’s behaviour rather than preference (Bauducco et al. 2020). Diurnal preference is determined primarily by an individual’s genes (Barclay et al. 2014; Jones et al. 2019) and is also related to age, sex, and surrounding environment (Duffy and Czeisler 2002; Fischer et al. 2017). A person’s diurnal preference is situated on a spectrum with morning-type (morningness) and evening-type (eveningness) as the opposite endpoints; the majority of people, however, belongs to an intermediate-type (Adan et al. 2012; Horne and Ostberg 1976). Morning-type people prefer to go to bed early at night and wake up early in the morning, and physically and mentally perform well early in the day. This makes it easier for them to adapt to social activities that require them to wake up early, such as going to school or working (Wittmann et al. 2006). On the contrary, evening-type people prefer to stay up late at night and wake up later in the morning. They have to wake up earlier than they would want and perform their job at non-preferred times of the day. A growing number of studies revealed that evening-type in itself could be a risk factor for various physical diseases and all-cause mortality (Allada and Bass 2021; Knutson and Von Schantz 2018; Reutrakul and Knutson 2015). Eveningness is also related to various types of mental illness (Bauducco et al. 2020; Cox and Olatunji 2019; Kivelä et al. 2018; Melo et al. 2017; Snitselaar et al. 2017; Taylor and Hasler 2018).

In recent years, epidemiological research on the relationship between positive aspects of mental health and diurnal preference has been accumulating (Biss and Hasher 2012; Jankowski 2012; Tan et al. 2020). Circadian rhythm and related physiological functions, such as melatonin and cortisol secretion and deep body temperature, showed clear group differences by diurnal preference (Adan et al. 2012). Similarly, positive affect has diurnal variations depending on the person’s diurnal preference (Murray et al. 2009). Jankowski and Ciarkowska (2008) reported that those who are morning-types experience better mood in the morning and consequently during most of the day; while evening-types exhibit poorer mood in the morning. Miller et al. (2015) employed an ecological momentary assessment method in healthy middle-aged adults and demonstrated that evening-types experienced delayed timing of peak positive affect (PA) and blunted amplitude of PA compared to morning-types. Compared to eveningness, several key factors which foster or protect subjective happiness are reported to be related to morningness, such as higher satisfaction with life (Randler 2008), health-related quality of life (Suh et al. 2017), emotional intelligence (Antúnez et al. 2013), resilience, optimism (Antúnez et al. 2015), emotion regulation (Antúnez 2020), locus of control, conscientiousness trait (Jackson and Gerard 1996; Lenneis et al. 2021), and physical activity (Vitale and Weydahl 2017). In sum, these results support a positive association between morningness and a high level of subjective happiness, and also between eveningness and a low level of subjective happiness.

The mechanism linking the diurnal preference to subjective happiness is yet to be established. However, several plausible mechanisms have been proposed (Bullock 2019), including sleep, circadian rhythm, health behaviours, perceived stress, developmental process, personality trait, social connectedness, and genetic explanations. For example, evening-types may have a lower level of subjective happiness due to social jetlag, defined as the discrepancy between internal and external life rhythms (Jankowski 2017; Wittmann et al. 2006). In general, the business start time is set at a time when morning-type people are most likely to perform at their best. Obviously, better arrangement of morning-types to social activities in the morning is likely to foster a higher level of subjective happiness than it would for evening-types (Diaz-Morales et al. 2015). Evening-types among the working population are under societal pressures to adjust their daily rhythms, not by their own preference, but times set by working circumstances. As a result of the discrepancy of the sleep–wake cycle between workday and day off, evening-types are more likely to exhibit shorter sleep duration, daytime sleepiness, poor
subjective sleep quality, more sleep disturbance, and long weekend sleep than their morning-type peers (Bakotic et al. 2017; Fernández-mendoza et al. 2010; Kitamura et al. 2010; Merikanto et al. 2012; Soehner et al. 2011; Vollmer et al. 2017; Wittmann et al. 2006). Aside from diurnal preference, the relationship between sleep and human well-being is well documented in the literature (Baglioni et al. 2010; Jackowska et al. 2011; Meerlo et al. 2008; Steptoe et al. 2008). Ong et al. (2017) conducted a systematic review and concluded that there was a consistent correlation between sleep and PA in non-clinical populations, and there was also a bi-direct relationship between them. Therefore, it can be assumed that the evening-types suffer from the twofold blow of poor daytime adaptability and sleep problems, resulting in a low sense of subjective happiness.

However, within the evening-type people, there are individual differences in their sleep characteristics: some of them are free from sleep problems. Researchers have been working to unravel the complex relationship between morningness-eveningness, sleep characteristics, and psychosocial functioning (Bakotic et al. 2017; Horne et al. 2019; Lau et al. 2017; Roesser et al. 2012). For example, Tavernier and Willoughby (2014) focused on the individual differences of sleep characteristics within the morning- and evening-types and classified the subjects (aged 17–25 years) into five subgroups (e.g., morning-poor sleep group, and evening-good sleep group) by latent class analysis. Their two-year longitudinal study suggested that intrapersonal adjustment, including depressive symptoms, daily hassles, and self-esteem, was associated more with differences in sleep characteristics, than with diurnal preference itself. Their results suggest that sleep may have a moderating effect in explaining the link between diurnal preference and human well-being. However, concrete conclusions about the role of sleep as a mechanism underlying the link between diurnal preference and subjective happiness have not been drawn. One reason for this is that few studies have used objective indicators. Due to the discrepancy between subjective assessment and objectively measured sleep (Jackowska et al. 2011; Lockley et al. 1999), it is important to employ an objective assessment to reduce methodological bias. Further, objective measurement of sleep also helps to provide a behavioral basis for the diurnal preference. Although polysomnography is the gold standard for objective sleep evaluation, it requires participants to attach electrodes to their head and sleep on a bed in hospital. Actigraphy, however, has the advantage of making it possible to measure sleep indicators in the participants’ normal lives. Ong et al. (2017) also indicated the limitation of inadequate control of confounders such as psychological distress and self-rated health in the investigation of the link between subjective happiness and sleep. Perceived stress level, physical activity, and other lifestyle habits should also be considered when investigating the effect of diurnal preference (Harasztzi et al. 2014).

Thus, our general aim in the current study was to deepen the understanding of the role of sleep characteristics in the relationship between diurnal preference and subjective happiness among the working population. We were interested in analysing whether and, if so, the extent to which sleep characteristics moderate the relationship between diurnal preference and subjective happiness. We predicted that participants’ subjective well-being would be positively related to morningness and also to better sleep status (better subjective sleep quality, less sleep disturbance, less sleep quality, lack of weekend oversleep, longer sleep duration, or higher sleep efficiency). Moreover, we expected that sleep characteristics could moderate the effects of diurnal preference on subjective happiness. According to Tavernier and Willoughby’s study (2014), we hypothesized that good sleep characteristics would attenuate the link between eveningness and poor subjective happiness; conversely, poor sleep characteristics would attenuate the link between morningness and good subjective happiness. In testing these hypotheses, we conducted a moderation analysis using data of Japanese workers excluding those with a medical history of mental illness or sleep disorders. It should be noted that the level of subjective happiness in Japan ranked 56 out of 149 countries, a relatively low ranking among developed countries (Helliwell et al. 2021). Japan is also ranked highly for short sleeping duration (Organisation for Economic Co-operation and Development Gender Data Portal 2021). Men in their 30s and 40s reported their work as the most significant cause of sleep deprivation (MHLW 2020). Thus, we believe that studies on the association between subjective happiness and sleep is particularly relevant in this population. Furthermore, Japan has a different socio-cultural background than Western countries, where the majority of positive mental health research have been conducted to date. Because socio-cultural background influences the level of subjective happiness (Inglehart and Klingemann 2000), positive mental health needs to be examined among Japanese populations as well. The findings of our study could have clinical implications for maintaining and enhancing the well-being of workers from a chronobiological approach.
Method

Data collection

The current study is an exploratory analysis using data from the SLEPT Study (Sleep Epidemiology Project at the University of Tsukuba) (Morita et al. 2020). In the SLEPT Study, we conducted a cross-sectional survey from 2016 to 2017, in which data were collected through a self-administered questionnaire, participants’ sleep diaries, and a waist-worn actigraphy device (used for 1 week). The results of medical examination were also obtained from those who gave their consent. The target population was workers from four different workplaces in Japan: a national university with an affiliated hospital, a national institute, and a company research institute based in Ibaraki Prefecture, and a health care company located in Tokyo. On average, their basic working hours were approximately 8 hours and began at 08:30 h. Flyers, posters, workplace group e-mails, and online workplace bulletin boards were used to recruit participants. In addition, some of the participants were introduced by the research staff or other participants. There was no monetary reward for participation. A total of 785 workers participated in the study. Written informed consent was obtained from all participants. Subsequently, 4 participants withdrew their consent, and their data were deleted. The estimated participation rate was approximately 5–10%. The study protocol was approved by the Medical Ethics Committee of the University of Tsukuba (approval number: 1065).

Subjective happiness

In this study, a single-item measure of subjective happiness was used. Because this survey had more than 100 questions, we aimed to reduce the burden on the participants and increase compliance by assessing their well-being through a single question. It has been reported that a single-item questionnaire measuring subjective happiness have sufficient validity and reliability (Abdel-Khalek 2006). According to a survey conducted by the Japanese Cabinet Office (2012), the participants answered the following question, “Currently, how happy do you feel?” with 5 response options (0: very unhappy, 1: somewhat unhappy, 2: neither happy nor unhappy, 3: somewhat happy, 4: very happy). Subjective Happiness was scored according to the number of response options and treated as a continuous variable, ranging from 0 to 4.

Diurnal preference

Diurnal preference was evaluated using the Morningness-Eveningness Questionnaire (MEQ) (Horne and Ostberg 1976). The questionnaire is composed of 19 questions addressing aspects of sleep habit such as an individual’s preferred bedtime, preferred wake time, or preferred time for performing physically or intellectually demanding activities. Questionnaire scores range from 16 to 86 with higher scores indicating morningness, whereas lower scores indicating eveningness. In this study, Taillard et al.’s (2004) criteria was applied to determine three diurnal types using the MEQ score: evening type (16–52), intermediate type (53–64), and morning type (65–86). The criteria are considered to better fit a middle-aged population.

Sleep-related factors

The Pittsburgh Sleep Quality Index (PSQI) was used to assesses sleep quality and sleep disturbance over a 1-month period (Buysse et al. 1989). The PSQI consists of 19 items that assess seven components: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, sleep medication usage, and daytime dysfunction. PSQI scores of ≥6 indicate the incidence of sleep disturbance. Because some components of the PSQI overlapped with variables measured with the actigraphy or the Epworth Sleepiness Scale (ESS), for the subsequent linear regression analysis, just 2 of the 7 components of the PSQI were used: subjective sleep quality and sleep disturbance. Subjective sleep quality was scored using a single question item asking participants to rate their overall sleep quality over the past month, scored as follows: very good (0), fairly good (1), fairly bad (2), and bad (3). Sleep disturbance was scored using 9 items that ask participants about the frequency of disruptive sleep events such as nocturnal awakening, nocturnal urination, breathing difficulties, etc., with scores for each item ranging between 0 and 2 points. Higher total scores indicate poorer subjective sleep quality and higher frequency of experiencing sleep trouble. Sleepiness was assessed using the ESS (Johns 1991, 1992). The ESS includes 8 questions on habitual likelihood of dozing or falling asleep, with each item scored with a 4-point rating scale (total scores ranging from 0 to 24). ESS scores ≥11 indicate the incidence of significant sleepiness. Weekend oversleep was assessed using a single-item question. The participants were asked “Do you tend to sleep much longer on holidays (free days) than on weekdays (work days)?” with “No” or “Yes” as the response options. Those who answered “yes” scored 1 and those who answered “no” scored 0.

Objectively measured sleep parameters were obtained using an actigraphy device (MTN-220, ACOS Co Ltd., Nagano, Japan) worn on the participant’s waist. The
participants also kept a sleep diary and recorded their sleep and wake status for 7 consecutive days. The overall matching rate between the built-in accelerometer of the device and polysomnography is reported to be 84.7–86.9% (Enomoto et al. 2009; Nakazaki et al. 2014). The program SleepSignAct (KISSEI COMTEC Co Ltd., Nagano, Japan) was used to curate the data. The sleep onset time (h), wake time (h), total sleep time (min), and sleep efficiency (%) were calculated by combining the data from sleep diary and the actigraphy. During the 7 days that the participants wore the actigraphy device, it was not possible to identify which day was a workday or free day; thus, mid-sleep times on workdays or free days, which reflect objectively-measured sleep debt could not be separately calculated. Instead, an average mid-sleep time for the seven days was calculated. In this study, only the longest sleep duration within 24 h was used; naps were not considered.

Other explanatory factors

Self-rated health was assessed by the question “Would you say that your health for the last month or two is . . .” with 5 options: very good (=0), good (=1), fair (=2), bad (=3), and very bad (=4). Psychological distress was evaluated based on Kessler Psychological Distress Scale (K6) scores (Furukawa et al. 2008; Kessler et al. 2002; Sakurai et al. 2011). The K6 contains 6 question items on depression and anxiety, with each item measured on a 4-point rating scale. The K6 was treated as continuous variable by adding the scores of 6 items (total range from 0 to 24).

Potential confounders taken into consideration were lifestyle habit and chronic occupational stress. Items regarding factors of lifestyle habit were dichotomized, including exercise habit (yes = “at least 30 min, twice a week, for 1 year” or no = “other”) (MHLW 2020), drinking habit (“less than once a week” or “more than once a week”), and smoking habits (“non-smoker” or “current smoker”). Chronic occupational stress as perceived by the participants was assessed using the Brief Scales for Job Stress (BSJS) (Nishikido et al. 2000). The BSJS is a 20-item questionnaire developed based on the demand–control–support model. The reliability and validity of this scale has been reported (Hori et al. 2020; Takahashi et al. 2019). The questionnaire asked participants to “select the response that most closely matches your feelings with regard to the descriptions about your current working circumstances.” Responses were rated on a 4-point scale (from 1 = “disagree” to 4 = “agree”), and the mean scores (range = 1–4) were calculated for 6 subscales: quantitative workload, qualitative workload, interpersonal difficulties, reward from work, job control, and social support. Higher scores of the former 3 subscales indicated higher augmentation of occupational stress. Higher scores of the latter 3 subscales indicated higher mitigation of occupational stress.

Statistical analysis

Of the 781 participants, those with missing values for the variable of interest, and those with factors that could cause sleep patterns to depart significantly from the usual conditions expected for healthy full- and daytime workers aged under 60 were excluded from the analysis. A total of 304 were excluded according to the following criteria: lack of data on self-administered questionnaire (n = 21), lack of sufficient data or non-compliance on actigraphy measurement (n = 29), 60 years and older (n = 61), shift or night workers (n = 106), and working 29 hours or less last week (n = 54). Next, those who were undergoing treatment for mental illness (schizophrenia, mood disorders, etc.), sleep disorders such as insomnia or sleep apnea, or regularly taking antidepressant, methylphenidate, or any sleep medication were excluded (n = 30). Lastly, those who answered they were “very unhappy” were exclude (n = 3). Due to their longest sleep duration and highest sleep efficiency, the relationships between subjective happiness and sleep parameters showed J-shaped curve. This exclusion allowed us to clearly interpret subsequent moderation analysis results. In sum, data from 477 workers (205 males and 272 females) were eligible for analysis. The age distributions (mean ± standard deviation [SD]) were 42.6 ± 10.4 years for males and 41.1 ± 9.8 years for females.

Because there are differences between male and female regarding sleep pattern, diurnal preference, and level of subjective happiness (Adan and Sánchez-Turet 2001), data were analysed separately by sex. Spearman’s rank correlation test was used to calculate correlation coefficient subjective happiness, MEQ score, and sleep-related factors. The descriptive statistics for continuous variables are shown as medians, and first and third quartiles, because all the continuous variables in this manuscript except MEQ score, total sleep time, sleep onset time, and wake time had a non-normal distribution according to the results of the Shapiro-Wilk test. The linear correlation between level of subjective happiness and each other variable was confirmed.

To identify associations between subjective happiness and MEQ score, and to test the moderation hypothesis, a series of hierarchical linear regression analysis was performed. Subjective happiness score was used as the dependent variable. In the step 1, the forcedly entered explanatory variables were age, self-rated health, and K6 score. In step 2, a forward stepwise selection method was
used (likelihood ratio) for the 3 types of lifestyle habit and the 6 subscales of chronic occupational stress to adjust for possible confounders. In step 3, MEQ score was additionally forcedly entered as an explanatory variable. In step 4a-h, one of the sleep-related parameters were entered: (a) subjective sleep quality, (b) sleep disturbance, (c) ESS score, (d) weekend oversleep, (e) total sleep time, (f) sleep onset time, (g) wake time, or (h) sleep efficiency. In step 5, interaction between MEQ score and each of the sleep-related variables was added to test the moderation effect. To reduce multicollinearity, the sleep-related variables were centered on their means before computing the interaction terms.

All statistical tests were two-tailed, with p values of <0.05 considered statistically significant. IBM SPSS for Windows (version 26.0; IBM Corp., Armonk, NY, USA) was used for all analyses.

### Results

Table 1 summarizes the respondents’ sociodemographic characteristics, history of chronic diseases and lifestyle. According to Taillard et al.’s (2004) criteria, 20.5% of male workers were classified as morning-type, 46.3% as intermediate-type, and 33.2% as evening-type. For female workers, morning-, intermediate-, and evening-types were 15.4%, 50.0%, and 34.6%, respectively. Average midpoint of sleep for the 7 consecutive days by sex (male/female) were 02:34 ± 0:53 h/02:32 ± 0:52 h for morning-types, 03:27 ± 0:46 h/03:15 ± 0:47 h for intermediate-types, 04:20 ± 1:00 h/04:11 ± 0:54 h for evening-types, respectively (data not shown in Tables). In addition, average sleep duration (min) for the 7 consecutive days by sex (male/female) were 316.00 ± 54.29/339.16 ± 63.88 for morning-types, 315.08 ± 47.38/339.61 ± 54.59 for intermediate-types, 314.92 ± 56.08/335.29 ± 52.65 for evening-types, respectively. There were no statistically significant differences among the diurnal preference for both male and female regarding physical activity, smoking, drinking habit, and the 6 subscales of occupational stress.

Tables 2 and 3 show the results of Spearman’s rank test for male and female workers, respectively. MEQ score was significantly correlated with subjective happiness only in female, but not in male. For both male and female, subjective happiness was correlated with subjective sleep quality. In male, higher MEQ score which indicates morningness was significantly correlated with lower subjective sleep quality, less sleep disturbance, and weekend oversleep. In female, higher MEQ score was significantly correlated with lower subjective sleep quality, higher ESS score, and weekend oversleep.

### Table 1. Characteristics of the subjects by gender.

| Catetgorical variables | Male n = 205 | Female n = 272 |
|------------------------|-------------|---------------|
| Diurnal preference (MEQ score) |             |               |
| Evening type (16–52) | 68 (33.2) | 94 (34.6) |
| Intermediate type (53–64) | 95 (46.3) | 136 (50.0) |
| Morning type (65–86) | 42 (20.5) | 42 (15.4) |
| Physical activity |             |               |
| Yes | 50 (24.4) | 38 (14.0) |
| No | 155 (75.6) | 234 (86.0) |
| Drinking habit |             |               |
| Less than once a week | 86 (42.0) | 175 (64.3) |
| Once a week or more | 119 (58.0) | 97 (37.5) |
| Smoking habit |             |               |
| Non-smoker | 180 (87.8) | 254 (93.4) |
| Current smoker | 25 (12.2) | 18 (6.6) |
| BMI |             |               |
| ≤18.4 | 7 (3.4) | 31 (11.4) |
| 18.5–24.9 | 150 (73.2) | 200 (73.5) |
| ≥25.0 | 48 (23.4) | 41 (15.1) |
| Medical history of chronic disease |             |               |
| No | 141 (68.8) | 221 (81.3) |
| Yes | 62 (30.7) | 44 (16.2) |
| Non-specific | 1 (0.5) | 7 (2.6) |
| Occupation |             |               |
| Clerical work | 53 (25.9) | 169 (62.1) |
| Professional/technical | 114 (55.6) | 77 (28.3) |
| Manager | 28 (13.7) | 7 (2.6) |
| Sales job | 2 (1.0) | 2 (0.7) |
| Service job | 6 (2.9) | 17 (6.3) |
| Employment status |             |               |
| Full-time regular employees | 176 (85.9) | 122 (44.9) |
| Short-time regular employees | 0 (0.0) | 6 (2.2) |
| Fixed-term employees | 21 (10.2) | 78 (28.7) |
| Part-time employees | 1 (0.5) | 60 (22.1) |
| Managers, executives | 3 (1.5) | 2 (0.7) |
| Others | 4 (2.0) | 4 (1.5) |

### Table 4 summarizes the results of a moderation analysis for male workers. In step 2, reward from work and social support were added through the stepwise selection. As shown in the results of step 3, MEQ score was not significantly correlated with subjective happiness. There were no statistically significant associations between subjective happiness and sleep-related variables, nor between subjective happiness and interactions of sleep-related variables and MEQ score. Subjective happiness remains statistically significantly associated with self-rated health, reward from work and social support in step 5a-h.
Table 2. Median, IQRs, and correlations among subjective happiness, MEQ score, and sleep-related factors (male).

|                | Median (IQR) | 1 | 2 | a   | b   | c   | d   | e   | f   | g   |
|----------------|--------------|---|---|-----|-----|-----|-----|-----|-----|-----|
| 1. Subjective happiness | 3 (3–3)      |   |   |     |     |     |     |     |     |     |
| 2. MEQ score       | 57 (49–64)   | 0.109 |     |     |     |     |     |     |     |     |
| a. Subjective sleep quality | 1 (1–2)      | −0.286** | −0.201** |     |     |     |     |     |     |     |
| b. Sleep disturbance | 1 (0–1)      | −0.109 | 0.168* | 0.212** |     |     |     |     |     |     |
| c. ESS score       | 10 (7–12)    | −0.122 | −0.128 | 0.281** | 0.085 |     |     |     |     |     |
| d. Weekend sleep   | 0 (0–1)      | −0.031 | −0.372** | 0.072 | −0.105 | 0.050 |     |     |     |     |
| e. Total sleep time, min | 319.1 (280.7–350.9) | 0.027 | −0.034 | −0.076 | 0.030 | −0.102 | 0.008 |     |     |     |
| f. Sleep onset time, h | 00:23 (23:38–01:14) | −0.010 | −0.560** | 0.179* | −0.027 | 0.161* | 0.334** | −0.343** |     |     |
| g. Wake time, h    | 06:41 (06:01–07:25) | 0.015 | −0.669** | 0.149* | −0.007 | 0.061 | 0.353** | 0.143* | 0.754** |     |
| h. Sleep efficiency, % | 80.2 (72.5–85.9) | −0.022 | −0.042 | 0.048 | −0.005 | −0.004 | 0.031 | 0.616** | 0.029 | 0.035 |

Spearman’s rank correlation coefficient.
* p < .05, ** p < .01.
Abbreviations: IQR = interquartile range, MEQ = Morningness-Eveningness Questionnaire, ESS = Epworth Sleepiness Scale.

Table 3. Median, IQRs, and correlations among subjective happiness, MEQ score, and sleep-related factors (female).

|                | Median (IQR) | 1 | 2 | a   | b   | c   | d   | e   | f   | g   |
|----------------|--------------|---|---|-----|-----|-----|-----|-----|-----|-----|
| 1. Subjective happiness | 3 (2–3)      |   |   |     |     |     |     |     |     |     |
| 2. MEQ score       | 56 (50–62)   | 0.243** |     |     |     |     |     |     |     |     |
| a. Subjective sleep quality | 1 (1–2)      | −0.123* | −0.132* |     |     |     |     |     |     |     |
| b. Sleep disturbance | 1 (1–1)      | −0.105 | 0.035 | 0.278** |     |     |     |     |     |     |
| c. ESS score       | 10 (8–13)    | −0.167** | −0.140* | 0.140* | −0.027 |     |     |     |     |     |
| d. Weekend sleep   | 0 (0–1)      | −0.158** | −0.476** | 0.144* | −0.055 | 0.046 |     |     |     |     |
| e. Total sleep time, min | 338.7 (304.1–376.8) | 0.107 | 0.018 | −0.103 | 0.097 | −0.112 | 0.011 |     |     |     |
| f. Sleep onset time, h | 00:07 (23:34–01:05) | −0.121* | −0.558** | 0.142* | −0.061 | 0.032 | 0.377** | −0.339** |     |     |
| g. Wake time, h    | 06:39 (05:59–07:15) | −0.092 | −0.606** | 0.019 | 0.016 | −0.064 | 0.358** | 0.285** | 0.623** |     |
| h. Sleep efficiency, % | 85.1 (79.3–90.3) | 0.117 | 0.019 | −0.034 | 0.000 | 0.009 | 0.091 | 0.477** | 0.051 | −0.005 |

Spearman’s rank correlation coefficient.
* p < .05, ** p < .01.
Abbreviations: IQR = interquartile range, MEQ = Morningness-Eveningness Questionnaire, ESS = Epworth Sleepiness Scale.

Table 4. Results of a series of moderation analysis, subjective happiness as dependent variable (male).

|                | B       | SE      | β      | t      | P-value |
|----------------|---------|---------|--------|--------|---------|
| Step 1, R² = 0.247 | Age     | 0.002   | 0.004  | 0.03   | 0.491   | .624   |
| Step 2, R² = 0.207 | Self-rated health | −0.241 | 0.054 | −0.309 | −4.421 | <.001 |
| K6 score | −0.05 | 0.013 | −0.265 | −3.783 | <.001 |
| Step 3, R² = 0.311 | MEQ score | 0.005 | 0.005 | 0.071 | 1.131 | .260 |
| Step 4a, R² = 0.314 | Subjective sleep quality | −0.075 | 0.082 | −0.062 | −0.911 | .364 |
| Step 5a, R² = 0.315 | Subjective sleep quality × MEQ score | −0.003 | 0.007 | −0.029 | −0.482 | .630 |
| Step 6a, R² = 0.311 | Sleep disturbance | −0.014 | 0.101 | −0.009 | −0.139 | .889 |
| Step 7a, R² = 0.312 | Sleep disturbance × MEQ score | −0.005 | 0.010 | −0.029 | −0.475 | .635 |
| Step 8a, R² = 0.315 | ESS score | 0.005 | 0.011 | 0.028 | 0.433 | .665 |
| Step 9a, R² = 0.315 | ESS score × MEQ score | 0.001 | 0.001 | 0.060 | 1.002 | .318 |
| Step 10a, R² = 0.312 | Weekend overnight | −0.046 | 0.100 | −0.030 | −0.463 | .644 |
| Step 11a, R² = 0.318 | Weekend overnight × MEQ score | 0.014 | 0.010 | 0.088 | 1.345 | .180 |
| Step 12a, R² = 0.311 | Total sleep time | 0.000 | 0.001 | 0.005 | 0.081 | .935 |
| Step 13a, R² = 0.312 | Total sleep time × MEQ score | 0.000 | <0.001 | 0.015 | 0.241 | .809 |
| Step 14a, R² = 0.314 | Sleep onset time | 0.000 | <0.001 | 0.059 | 0.788 | .431 |
| Step 15a, R² = 0.314 | Sleep onset time × MEQ score | 0.000 | <0.001 | −0.023 | −0.374 | .709 |
| Step 16a, R² = 0.320 | Wake time | 0.000 | <0.001 | 0.134 | 1.586 | .114 |
| Step 17a, R² = 0.321 | Wake time × MEQ score | 0.000 | <0.001 | 0.029 | 0.489 | .626 |
| Step 18a, R² = 0.311 | Sleep efficiency | −0.001 | 0.004 | −0.011 | −0.184 | .854 |
| Step 19a, R² = 0.314 | Sleep efficiency × MEQ score | 0.000 | <0.001 | −0.055 | −0.916 | .361 |

Hierarchical multiple regression analysis.
Abbreviations: K6 = Kessler Psychological Distress Scale, MEQ = Morningness-Eveningness Questionnaire, ESS = Epworth Sleepiness Scale.
Table 5 shows the moderation analysis results for female. In step 2, only reward from work was added through the stepwise selection. Self-rated health was no longer associated with subjective happiness in step 2. MEQ score persisted to have a statistically significant association with subjective happiness from step 3 through step 5a-h. We observed a statistically significant association between subjective happiness and sleep efficiency. However, none of the interactions of sleep-related variables and MEQ score were significantly associated with subjective happiness. The association between subjective happiness and MEQ score hardly changed with the addition of the interaction terms in step 5a-h. Subjective happiness remains statistically significantly associated with K6 score and reward from work in step 5a-h.

**Discussion**

The aim of our study was to investigate the link between diurnal preference and subjective happiness among working adults, adjusting for various sleep parameters. We assessed sleep parameters both in subjective and objective ways. The main contribution of the current study is providing further evidence for the relationship of morningness with subjective happiness. This conclusion has been established mainly through research in Western countries. We have added to the existing literature by, for the first time, partially confirming the same results for workers in Japan. We also found that subjective happiness was associated with higher sleep efficiency after controlling for self-rated health and psychological distress symptoms in women. Further, we did not find a moderating effect of sleep parameters with the association between diurnal preference and subjective happiness.

Before interpreting the results, we need to keep in mind the characteristics of the study population. We focused on healthy full-time, daytime, workers in Japan. In the analysed sample, there was a higher percentage of women. More than half of the men were classified as professionals/technicians, i.e., academic researchers or healthcare professionals. In contrast, close to two thirds of the women were clerical workers. Women slept longer than men. There was no difference in sleep duration between morning-, intermediate-, and evening-types. MEQ scores showed that men were more likely to be morning-types than women; however, the midpoint of sleep was slightly earlier in women than in the same type for men. This is largely in line with Fischer et al. (2017) who reported that, after the age of 40, women develop an earlier chronotype than men. Studies have shown that the evening-types who live in a morning-oriented society are more likely to display characteristics that are negatively associated to their performance and health (Wittmann et al. 2006). Miller et al. (2015) suggested that delayed peak PA experienced by evening-types could attenuate their sense of reward. However, in the current population, we did not find significant difference in lifestyle habit or in the 6 subscales of occupational stress, across the morning-, intermediate-, or evening-types.

**Table 5. Results of a series of moderation analysis, subjective happiness as dependent variable (female).**

| Step | R² | B     | SE  | β    | t    | P-value |
|------|----|-------|-----|------|------|---------|
| 1    | 0.134 | Age  | -0.002 | 0.005 | -0.025 | -0.426 | .670 |
| 2    | 0.164 | Self-rated health | -0.107 | 0.053 | -0.216 | -2.025 | .044 |
| 3    | 0.193 | K6 score | -0.059 | 0.012 | -0.301 | -4.812 <.001 |
| 4a   | 0.193 | Reward from work | 0.159 | 0.052 | 0.174 | 3.044 | .003 |
| 4b   | 0.193 | MEQ score | 0.016 | 0.005 | 0.181 | 3.123 | .002 |
| 5a   | 0.193 | Subjective sleep quality | 0.005 | 0.078 | 0.004 | 0.060 | .952 |
| 5b   | 0.193 | Subjective sleep quality × MEQ score | -0.001 | 0.008 | -0.009 | -0.168 | .867 |
| 6a   | 0.193 | Sleep disturbance | -0.085 | 0.093 | -0.052 | -0.911 | .363 |
| 6b   | 0.193 | Sleep disturbance × MEQ score | -0.003 | 0.016 | -0.018 | -0.311 | .756 |
| 6c   | 0.193 | ESS score | 0.006 | 0.011 | 0.034 | 0.583 | .560 |
| 6d   | 0.193 | ESS score × MEQ score | 0.000 | 0.001 | -0.002 | -0.028 | .978 |
| 6e   | 0.193 | Weekend oversleep | -0.079 | 0.098 | -0.051 | -0.804 | .422 |
| 6f   | 0.193 | Weekend oversleep × MEQ score | -0.008 | 0.011 | -0.040 | -0.719 | .473 |
| 6g   | 0.201 | Total sleep time | 0.001 | 0.001 | 0.009 | 1.641 | .102 |
| 6h   | 0.202 | Total sleep time × MEQ score | 0.000 | <0.001 | -0.029 | -0.529 | .597 |
| 6i   | 0.194 | Sleep onset time | 0.000 | <0.001 | -0.034 | -0.506 | .613 |
| 6j   | 0.194 | Sleep onset time × MEQ score | 0.000 | <0.001 | -0.010 | -0.185 | .854 |
| 6k   | 0.194 | Wake time | 0.000 | <0.001 | -0.029 | -0.415 | .678 |
| 6l   | 0.207 | Wake time × MEQ score | 0.011 | 0.005 | 0.120 | 2.163 | .031 |
| 6m   | 0.210 | Sleep efficiency | 0.001 | 0.001 | 0.051 | 0.928 | .354 |

Hierarchical multiple regression analysis.

Abbreviations: K6 = Kessler Psychological Distress Scale, MEQ = Morningness-Eveningness Questionnaire, ESS = Epworth Sleepiness Scale.
Therefore, it is unlikely that their diurnal preference makes a great difference in adapting to their work. Regarding the timing of the survey, it should be also noted that our survey was conducted before the COVID-19 pandemic, when teleworking was not widespread in Japan.

Although the relationship between diurnal preference and subjective happiness was replicated in female workers, we did not find a significant relationship in male workers. As shown as the change of R² in Table 5, diurnal preference explained about 3% of the variance for subjective happiness in women. The magnitude of diurnal preference is in line with previous studies, which reported small to moderate partial correlations (Diaz-Morales et al. 2013; Drezno et al. 2019; Jankowski 2012; Randler 2008). We reconfirmed these findings and complemented them via both subjective and objective measures which allowed us to observe the individual’s diurnal preference and also their behavior. Possible explanations for the differences by sex in the association between diurnal preference and subjective happiness could be derived from traditional gender-related social roles. In Japan, women are typically responsible for duties within family life such as household chores and childcare; thus, we can hypothesize that female workers are under more pressure than male workers to adjust their rhythm to a morning lifestyle. In contrast, such traditional gender roles are likely to favor male workers with evening preference, because they can pass the morning duties, such as making breakfast, to their female spouses (Diaz-Morales and Sánchez-López 2008). While women with morning preference can cope with this situation, those of an evening-type would find this arrangement difficult. Another possible explanation for our findings is that a large percentage of our male participants were academics, who, relatively speaking, have some discretion with regards to their work schedule. In addition, the trait of conscientiousness, common to academics, could also explain the null result, because such personality trait could determine, and mediate their subjective happiness (Drezno et al. 2019). Our results underline the importance of considering sex when assessing the role of diurnal preference. The weakness of our study is that we did not investigate each participant’s roles and life at home, such as marital status, child-rearing, or whether their spouse was working. A person’s work schedule and how much discretion they have thereof, and their personality are also of importance. Future study should assess both those life- and work-related factors to better understand the relationships between a worker’s subjective happiness with their diurnal preference.

In our hierarchical regression analysis, we found that the higher level of subjective happiness observed in female workers was significantly associated with higher sleep efficiency. No significant association was found with the other sleep parameters (subjective sleep quality, sleep disturbance, sleepiness, weekend oversleep, total sleep time, sleep onset time, and wake time). In male workers, none of the sleep parameters were associated with subjective happiness. Our result is not consistent with the existing literature, which widely support the bidirectional relationship between better sleep and well-being in a healthy population. One possible explanation for the mostly null finding in the current study is that we adjusted for self-rated health and psychological distress symptoms, as recommended by Ong et al. (2017). By doing so, we were able to rule out the possibility that the relationship between subjective happiness and sleep reflects not merely physical health or the absence of negative affect (Winefield et al. 2012). Furthermore, we attempted to elucidate the moderating role of sleep characteristics in the relationship between diurnal preference and subjective happiness. Contrary to our hypothesis, significant interaction between diurnal preference and any of the sleep indices was absent for both male and female workers. This result suggests that the link between diurnal preference and subjective happiness is independent of sleep, which is contrary to the study among emerging adults by Tavernier and Willoughby (2014). The difference in the characteristics of the respective study populations may explain the difference. Our result should be interpreted while taking the healthy worker effect into account. There were few extreme morning-/evening-types, and few extremely poor sleepers among the participants. Those who could not keep up with the socially-expected rhythm of their work would have quit their jobs before our survey. Thus, the participants of the current study were considered to have adapted to their socially-expected rhythms, i.e., they did not suffer very much from social jetlag. In addition, it is possible that the participated middle-aged volunteers were health-conscious people. Therefore, our methodological limitations might somewhat underestimate the impact of sleep on the relationships between subjective happiness and diurnal preference.

**Directions for future research**

Although the mechanism is still unclear, our results partially support the idea that evening-type workers feel lower levels of subjective happiness than those of a morning-type. Our findings suggest a need for more research aimed at improving subjective happiness among workers of an evening-type. One possible strategy to improve subjective well-being of evening-types
would be tailoring their work schedules to suit the individual’s diurnal preference (Roenneberg and Merrow 2016). It is well-documented that intercommunications between individuals and their working environment, such as job control and social reward, are strong predictors of employees’ well-being (de Jonge et al. 2000; Hori et al. 2019; Yang et al. 2008). If workers can adapt their work schedule to suit those times when they feel more active and focused, it is expected that they would feel a higher sense of accomplishment, which in turn would foster a sense of happiness. Another possible strategy is teleworking. For evening-types, reduction of commuting time by working from home on occasion might be beneficial as they could enjoy free time in the morning. This would also allow them to enjoy the benefits of outdoor sunlight (Burns et al. 2021) and exercise. Slawińska et al. (2019) proposed that CrossFit training during the morning hours, when those of an evening-type are usually in a low mood, can boost their PA. Since the COVID-19 pandemic in 2020, the Japanese government has been encouraging companies to increase their implementation rates of telework or staggered-time commuting. The average telework implementation rate in Japan by the end of 2020 was approximately 23% and was particularly higher in the Tokyo metropolitan region and lower in provincial cities (MLIT 2021). However, at this time, such measures are mainly aimed at infection control and are not implemented with the individual’s diurnal preference in mind. There is room for improvement in the rate of telework implementation, especially in provincial cities. Future research focusing on the link between diurnal preference and work-related outcomes could lead to justifying a flexible work style or teleworking suited to an individual’s diurnal preference, regardless of the pandemic.

Conclusions

In sum, the findings of the current study demonstrate that morning preference was related to higher levels of subjective happiness than evening preference in female workers in Japan. In that relationship, we found no moderating effect of sleep parameters (subjective sleep quality, sleep disturbance, daytime sleepiness, weekend oversleep, total sleep time, sleep onset time, wake time, and sleep efficiency) in both male and female workers. Although a causal relationship cannot be elaborated, our study provides important insights towards further understanding the link between diurnal preference and subjective happiness. Future research is needed to address the mechanism linking diurnal preference and subjective happiness in order to implement effective measures to maintain and improve the mental health of our workforce.

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