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Sleep and chronotype in relation to work-related stress and negative affect: The moderating role of a flexible start of work

Introduction

Sufficient sleep is an important aspect of people's overall health and well-being [20]. There is considerable evidence that sleep deprivation is associated with a spectrum of negative health consequences, such as poor subjective health, bad mood, and a higher mortality risk [4, 14, 15], even though sleep restriction therapy for treating insomnia and depressive symptoms can also have antidepressant effects [6]. Several studies also found enhanced stress levels after sleep reduction [18, 21]. The relationship between sleep duration and stress, however, is reciprocal and work stressors, such as high work demands, or work overload have also been associated with sleep problems [1, 2]. Stress is often accompanied by a negative mood, yet the relationship between sleep duration and negative affect is still inconclusive [32]. Some studies found a linkage between sleep duration and negative affect [4, 12]. Others were not able to confirm these results [5, 11]. Considering these results and the fact that about 40% of the German population sleeps less than 7 h a night with similar results found for an American sample a great proportion of these populations are at risk for impaired health [16, 19].

A major factor why many people lack enough sleep time can be a person's work schedule. For many working adults, their start of work determines when they get up in the morning. Late chronotypes in particular suffer from shorter sleep duration on workdays because they must often get up earlier as their internal clock suggests [33]. Different chronotypes show characteristic activity levels and sleep timing at different times of the day. Early chronotypes tend do go to bed and get up early and are more active in the morning, whereas late chronotypes get up and reach their maximum activity levels later in the day [24]. Because chronotype is an approximately Gaussian distributed variable, extremely early and extremely late chronotypes are rather rare in the general population, with most of the people ranging from moderate early chronotypes to moderate late chronotypes [24]. So far, a later chronotype was associated with disadvantageous sleep habits, poorer sleep quality, and more daytime sleepiness and shorter sleep duration on weekdays [24, 25, 28, 33]. As mentioned above, late chronotypes often accumulate a sleep debt during the workweek due to early working hours and try to compensate with longer sleep duration on weekends [26, 31]. Since late chronotypes report a shorter sleep duration and a greater daytime sleepiness on weekdays, we expect they should also report a greater need for additional sleep in the morning. Knowing how much additional sleep is needed could help to arrange working hours in accordance with people's individual preferences. A late chronotype was also associated with higher stress and arousal levels and an elevated stress response after stress induction, which might occur due to lower self-regulation capacities, more coping difficulties and poorer sleep quality in late chronotypes [8, 25, 26]. Regarding chronotype and negative affect studies examining samples of adolescents, students, and older adults (most of them retired) failed to confirm a relationship between negative affect and chronotype [5, 11]. Yet none of these studies examined negative affect in daytime workers. As stress and impaired well-being are associated with a variety of negative health consequences, late chronotypes may be especially at risk to experience negative health consequences [9, 14]. So far, existing research on chronotype, stress, and work mainly focused on shift workers. Nevertheless, daytime workers could also suffer from a mismatch between their individual chronotype and their working schedule.

If the start of work is indeed an important factor for worker's sleep and well-being, later work starting times due to a flexible start of work could have beneficial effects, especially for workers with shorter sleep duration or a later chronotype. Most people work in regular daytime jobs with more or less flexible work time arrangements. A flexible start of work is one aspect of several facets of flexible work time arrangements. Flexible worktime arrangements can be differentiated in company-based flexibility (flexibility for employers, e.g., shift work) and individual-oriented flexibility (flexibility for employees, e.g., individual autonomy over time schedules), whereas individual-oriented flexibility is associated with positive effects for both employees and

Table 1 Descriptive statistics and bivariate correlations

	M	*SD*	*Min*	*Max*	1	2	3	4	5	6	7	8	9
1 Chronotype	53.81	10.36	21	81	1	–	–	–	–	–	–	–	–
2 NAS	50.22	47.11	0	240	–0.41**	1	–	–	–	–	–	–	–
3 Sleep duration	0.55	0.77	0	3	–0.20**	0.15**	1	–	–	–	–	–	–
4 Work starting time	07:57	01:08	04:45	15:00	–0.26**	–0.10*	0.03	1	–	–	–	–	–
5 Flexible start of work	4.32	1.93	1	7	0.19*	–0.18**	–0.08	0.07	1	–	–	–	–
6 Work-related stress	2.41	0.79	1	4.82	–0.21**	0.21**	0.14**	0.00	–0.03	1	–	–	–
7 Negative affect	1.91	0.64	1	4.40	–0.09*	0.20**	0.16**	–0.07	–0.02	0.49**	1	–	–
8 Age	37.68	12.39	18	73	0.19**	–0.08	0.12*	–0.09	0.06	–0.11*	–0.15**	1	–
9 Gender	–	–	–	–	–0.03	–0.03	0.06	–0.02	0.02	–0.10*	–0.05	0.07	1

N = 438; ***Gender*** (1 = female, 2 = male), one participant reported diverse and was not included in the correlation with the gender variable; ***Max*** maximum, ***Min*** minimum, ***SD*** standard deviation, ***M*** mean, ***NAS*** need for additional sleep time in the morning
**$p \leq 0.01$, *$p \leq 0.05$

companies, such as better work–life balance, higher job satisfaction, better performance, well-being, and health [3, 11, 22]. Individual-oriented flexible worktime arrangements give workers the ability to adapt daily working hours to their own personal preferences and have positive effects on sleepiness and mood [31]. An interventional study also found increased sleep duration for employees with more control over working hours, compared to those with a traditional work time schedule [23]. An individual-oriented flexible start of work in particular may be important regarding sleep and chronotype, since the beginning of work marks the end of sleep for many working adults. Late chronotypes could delay their start of work according to their individual biological clock and consequently prolong their sleep duration, reduce sleep deficits, decrease stress levels, and enhance well-being. A similar effect could be expected for people reporting shorter sleep durations and a greater need for additional sleep time in the morning. It has already been shown that delaying school starting times can have positive effects on sleep, performance, and well-being for children, adolescents, and college students [7, 13, 30]. Whether delaying work starting times could have similar effects for daytime workers is still not sufficiently examined yet, although results from a recent study showed that home-office, which often offers great work time flexibility, is associated with a longer sleep duration and a decreased social jetlag [29]. Therefore, the aim of our study is to examine the relationships between sleep duration, need for additional sleep, chronotype, and aspects of well-being (work-related stress and negative affect) in daytime workers and to investigate the protective role of a flexible start of work.

Methods

Participants

Since we were interested in employees with a regular daytime work schedule, only people who were of age, worked at least 20 h a week, and did not work in shifts were asked to participate. Participants not meeting these criteria were excluded from data collection at the beginning of the questionnaire. The questionnaire was distributed via social media platforms and mailing lists. Data collection took place from August 1 to October 31, 2019. The total sample consisted of 438 German participants (247 female) with a mean age of 37.68 years (standard deviation [SD] = 12.39). Up to 40.5% of the sample graduated from university, 24.8% successfully passed the Abitur (highest school leaving certificate in Germany), and 34.7% reported a lower school certificate. Mean start of work was 07:58 am (SD = 01:08 h) and mean end of work was 16:35 pm (SD = 01:41 h) with a mean work time of 08:37 h (SD = 01:37 h) per day. Participants worked on average 5 days a week (mean = 4.83, SD = 0.79). In all, 90% of the sample consisted of employees and less than 10% were self-employed or freelancers.

Measures

All relevant data were collected with an online questionnaire, including demographics, working hours (average start and end of work), number of workdays per week, and the following questionnaires. We used the "sleep duration" subscale from the Pittsburgh Sleep Quality Index to assess sleep duration [9]. Participants rated how long on average they have slept in the past 4 weeks. Need for additional sleep time in the morning (NAS) was measured by one item with an open response format questioning the subjects how many minutes they would like to sleep longer in the morning. Chronotype was measured with the Morningness–Eveningness Questionnaire (MEQ) [17]. The questionnaire consists of 19 Items. The lower the sum score the greater the tendency towards eveningness. The reliability of the instrument was high ($\alpha = 0.87$). We used three items of the subscale "work overload" and three items of the subscale "excessive demands from work" from the Trier Inventory for the Assessment of Chronic Stress (TICS) to assess work-related stress experienced during the past 4 weeks [27]. The items are answered on a scale from 1–5, higher scores indicating higher stress levels. Because the six items had high factor loadings on the first principal component (0.69–0.83) and the subscales were highly correlated ($r = 0.66$), we computed one global mean score ($\alpha = 0.88$). Negative affect was measured with the Positive and Negative Affect Schedule (PANAS) [32]. The

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Sleep and chronotype in relation to work-related stress and negative affect: The moderating role of a flexible start of work

Abstract

Objectives. The present study investigated the relationships between sleep (sleep duration and need for additional sleep time in the morning), chronotype, work-related stress, and negative affect in daytime workers. Furthermore, it was examined whether a flexible start of work moderates these relationships.
Methods. A cross-sectional online study was conducted. Participants were 438 (247 female) daytime workers between 18 and 73 years (mean = 37.68, standard deviation = 12.39). The questionnaire included the "sleep duration" subscale of the Pittsburgh Sleep Quality Index (PSQI), the Morningness–Eveningness Questionnaire (MEQ), two subscales of the Trier Inventory for the Assessment of Chronic Stress (TICS), the negative affect scale of the Positive and Negative Affect Schedule (PANAS), questions regarding how many minutes participants would like to sleep longer in the morning, and how flexible their start of work is.
Results. Short sleep duration and a greater need for additional sleep in the morning were significantly associated with late chronotype. Shorter sleep duration, a greater need for additional sleep, and a late chronotype were associated with higher work-related stress and negative affect. A flexible start of work moderated these relationships: People with longer sleep duration, less need for additional sleep time, and an early chronotype showed lower stress and negative affect levels when having a flexible start of work. A flexible start of work showed no or negative effects on workers with shorter sleep duration, a greater need for additional sleep time, or a late chronotype.
Conclusions. The effect of a flexible start of work for daytime worker's well-being depends on a person's individual sleep timing and chronotype.

Keywords

Sleep duration · Morningness-Eveningness Questionnaire · Sleepiness · Life stress · Well-being

Schlaf und Chronotyp im Hinblick auf arbeitsbedingten Stress und negative Stimmung: die moderierende Wirkung eines flexiblen Arbeitsbeginns

Zusammenfassung

Ziel der Arbeit. In der vorliegenden Arbeit wurden Zusammenhänge zwischen der Schlafdauer, dem Bedürfnis nach mehr Schlaf am Morgen, dem Chronotyp, Arbeitsstress und negativem Affekt bei Arbeitnehmern untersucht. Außerdem wurde überprüft, inwieweit ein flexibler Arbeitsbeginn diese Zusammenhänge beeinflusst.
Methoden. Es wurde eine Online-Querschnittstudie durchgeführt. Die Teilnehmer waren 438 (247 Frauen) Arbeitnehmer zwischen 18 und 73 Jahren (Mittelwert: 37,68; Standardabweichung: 12,39). Der Fragebogen enthielt die Subskala „Schlafdauer" des Pittsburgh Sleep Quality Index (PSQI), den Morningness-Eveningness Questionnaire (MEQ), 2 Subskalen des Trierer Inventars zum chronischen Stress (TICS), die Skala „negativer Affekt" des Formulars Positive and Negative Affect Schedule (PANAS) und Fragen dazu, wie lange die Teilnehmer gern morgens länger schlafen würden und wie flexibel ihre Arbeitszeiten sind.
Ergebnisse. Eine kurze Schlafdauer und ein stärkeres Bedürfnis nach Schlaf am Morgen waren signifikant mit einem späteren Chronotyp verbunden. Eine kürzere Schlafdauer, ein stärkeres Bedürfnis nach mehr Schlaf und ein später Chronotyp zeigten Zusammenhänge mit mehr Arbeitsstress und negativem Affekt. Ein flexibler Arbeitsstart wirkte sich auf diese Zusammenhänge aus: Arbeitnehmer mit längerer Schlafdauer, einem niedrigeren Bedürfnis nach mehr Schlaf oder einem frühen Chronotyp wiesen weniger Stress und negativen Affekt auf, wenn sie flexiblere Arbeitszeiten hatten. Flexible Arbeitszeiten zeigten keinen oder einen negativen Effekt für Arbeitnehmer mit einer kürzeren Schlafdauer, einem stärkeren Bedürfnis nach mehr Schlaf oder einem späten Chronotyp.
Schlussfolgerung. Der Effekt eines flexiblen Arbeitsbeginns auf das Wohlbefinden von Arbeitnehmern hängt von individuellen Schlafzeiten und dem Chronotyp ab.

Schlüsselwörter

Schlafdauer · Morningness-Eveningness Questionnaire · Schläfrigkeit · Lebensbelastung · Wohlbefinden

negative affect scale consists of 10 items that assess negative affect in the past four weeks. Average ratings differ between 1 (*not at all*) and 5 (*extremely*). Reliability was high ($\alpha = 0.87$). We used three items to measure a flexible start of work. The items were "My working hours are flexible", "I can choose the start of my working hours due to my preference", and "The start of my working hours is decided by my profession or my boss". The items were answered from *I strongly disagree* = 1 to *I strongly agree* = 7, item three had to be recoded. A higher mean score stands for more flexibility. The reliability was high ($\alpha = 0.86$).

Control variables

Because sleep and chronotype are associated with age [24], which in our data is also correlated with work-related stress and negative affect (**Table 1**), we included age as a control variable. Gender is often associated with insufficient sleep and chronotype as well [24], but showed no or only minor correlations with the relevant variables in our data and was therefore not included as a control variable (**Table 1**).

Statistical analysis

We first report bivariate correlations with a significance level of $p < 0.05$. To examine whether the predicted associations

Table 2 Partial (and bivariate) correlations

Control variables		Work-related stress	Negative affect
NAS, chronotype, start of work, work hours, age	*Sleep duration*	0.11* (0.14**)	0.16** (0.16**)
Sleep duration, chronotype, start of work, work hours, age	*NAS*	0.12* (0.21**)	0.15 (0.20**)
Sleep duration, NAS, start of work, work hours, age	*Chronotype*	–0.10* (–0.21**)	0.02 (–0.09*)

N = 438, *NAS* need for additional sleep time in the morning
**$p \leq 0.01$, *$p \leq 0.05$, bivariate correlations in parentheses

Table 3 Moderating effects of a flexible start of work

		Criteria			
		Work-related stress		Negative affect	
Regression	Predictor	β	*p*	β	*p*
1	Sleep duration	0.15	<0.01	0.18	<0.001
	Flexible start of work	–0.01	0.77	0.00	0.98
	Sleep duration × Flexible start of work	0.12	0.01	0.15	<0.01
	–	$F(3, 434) = 5.05$, $p < 0.01$, $R^2 = 0.03$		$F(3, 434) = 7.06$, $p < 0.001$, $R^2 = 0.05$	
2	NAS	0.22	<0.001	0.22	<0.001
	Flexible start of work	0.01	0.81	0.02	0.62
	NAS × Flexible start of work	0.13	<0.01	0.13	<0.01
	–	$F(3, 434) = 9.50$, $p < 0.001$, $R^2 = 0.06$		$F(3, 434) = 9.38$, $p < 0.001$, $R^2 = 0.06$	
3	Chronotype	–0.21	<0.001	–0.10	0.04
	Flexible start of work	0.01	0.78	0.01	0.91
	Chronotype × Flexible start of work	–0.10	0.04	–0.14	<0.01
	–	$F(3, 434) = 7.94$, $p < 0.001$, $R^2 = 0.05$		$F(3, 434) = 4.29$, $p < 0.01$, $R^2 = 0.03$	

N = 438, *NAS* need for additional sleep time in the morning

remain stable after controlling for age, work starting time, work duration, the remaining sleep variables respectively, partial correlations were computed. We used multiple regression analyses to test moderating effects of a flexible start of work. All predictors were transformed into z-scores to avoid problems of multicollinearity. Missing data of a person on a maximum of one single item per scale was replaced through mean imputation. The total number of imputations did not exceed 5% of the data per variable and should therefore not lead to a bias in the data. All data analyses were conducted with SPSS Statistics (version 26, IBM, Armonk, NY, USA).

Ethical considerations and declaration of interest

This study was approved by the Ethics Committee of the Universität der Bundeswehr München and all participants gave informed consent prior to the online questionnaire in digital form.

Results

Correlations

All relevant descriptive statistics and bivariate correlations are shown in **Table 1**. Late chronotypes reported a significantly shorter sleep duration and a greater NAS compared to early chronotypes. A shorter sleep duration was associated with a greater NAS. A short sleep duration and a greater NAS were both significantly associated with greater work-related stress and negative affect, even after controlling for start of work, work duration, age, the remaining sleep variable, and chronotype (**Table 2**). Greater work-related stress and negative affect were significantly associated with a later chronotype (**Table 1**). Yet only the association between chronotype and work-related stress remained significant, after controlling for sleep duration, NAS, start of work, work duration, and age (**Table 2**).

Moderation analyses

To test the moderating effect of a flexible start of work six multiple linear regression analyses were conducted (**Table 3**).

All regression models revealed significant moderating effects (**Fig. 1a–f**). Post hoc analyses revealed that there were no differences for people with a shorter sleep duration on work-related stress regarding different levels of a flexible start of work, whereas people with a longer sleep duration benefited from a flexible start of work. Similarly, people with a longer sleep duration and greater flexibility showed lower negative affect levels, yet people with a shorter sleep duration even showed elevated negative affect levels. Moderating effects in the same direction were also found for NAS regarding work-related stress and negative affect. Workers with a lower NAS showed lower levels of stress and negative affect when they reported to have a flexible start of work. Workers with a higher NAS reported higher levels of stress and negative affect the more flexible their start of work was. Since the distribution of the variable NAS included five outliers with values above three standard deviations, we tested whether the two moderating effects remained stable after deleting the corresponding participants. Both moderating effects remained significant. Results also revealed that late chronotypes with more flexibility experienced more work-related stress and negative affect than late chronotypes with less flexibil-

ity and early chronotypes benefited from flexible working hours.

Discussion

The purpose of the present study was to investigate the relationship between sleep, chronotype, and facets of well-being in daytime workers. Late chronotype was associated with a shorter sleep duration and a greater NAS, and all three of these variables were related to work-related stress and negative affect. As expected, late chronotypes experienced higher stress and negative affect levels compared to early chronotypes, yet only the association between chronotype and stress remained significant after controlling for age, sleep, and work-related variables. These results support former findings that suffering from a short sleep duration and being a late chronotype increases the risk for stress and mood problems [4, 19, 23] and emphasize the interconnection of sleep, chronotype, and work-related well-being. However, the question remains how other work-related characteristics may play a part in these relationships.

A possible influencing factor may be work starting time. We found that a flexible start of work moderated the effect of sleep duration, NAS, and chronotype on work-related stress and negative affect, yet not in the expected direction. A flexible start of work did not have a beneficial effect for people reporting a shorter sleep duration, a greater NAS, or a late chronotype; in fact, they even showed enhanced work-related stress and negative affect levels. In contrast, people with a longer sleep duration, a lower NAS, or an early chronotype benefited from a flexible start of work and showed a decrease in work-related stress and negative affect. Since it is quite comprehensible that early chronotypes or people who get enough sleep in the morning, and sleep longer may benefit from a flexible start of work, as many studies report positive effects of flexible work time arrangements [3, 11, 22], it remains unclear why workers with a shorter sleep duration, a greater NAS, or a late chronotype did not benefit and even reported higher stress and negative affect levels.

Several factors may contribute to the explanation of our findings. For example, it was not investigated whether children or other external factors may influence daytime workers sleep timing and therefore effect our findings. Furthermore, studies found that high variability in working hours is linked to negative effects on sleep, well-being, and health [10, 11]. Stability in daily routines seems to be important for a person's overall well-being, makes life more predictable and subsequently may reduce stress levels. It is possible that a flexible start of work leads to more variability in work routines and consequently may also result in elevated stress and negative affect levels. Whether external factors, variability in start of work, or other aspects of flexible working hours may play a part regarding our findings needs to be further investigated.

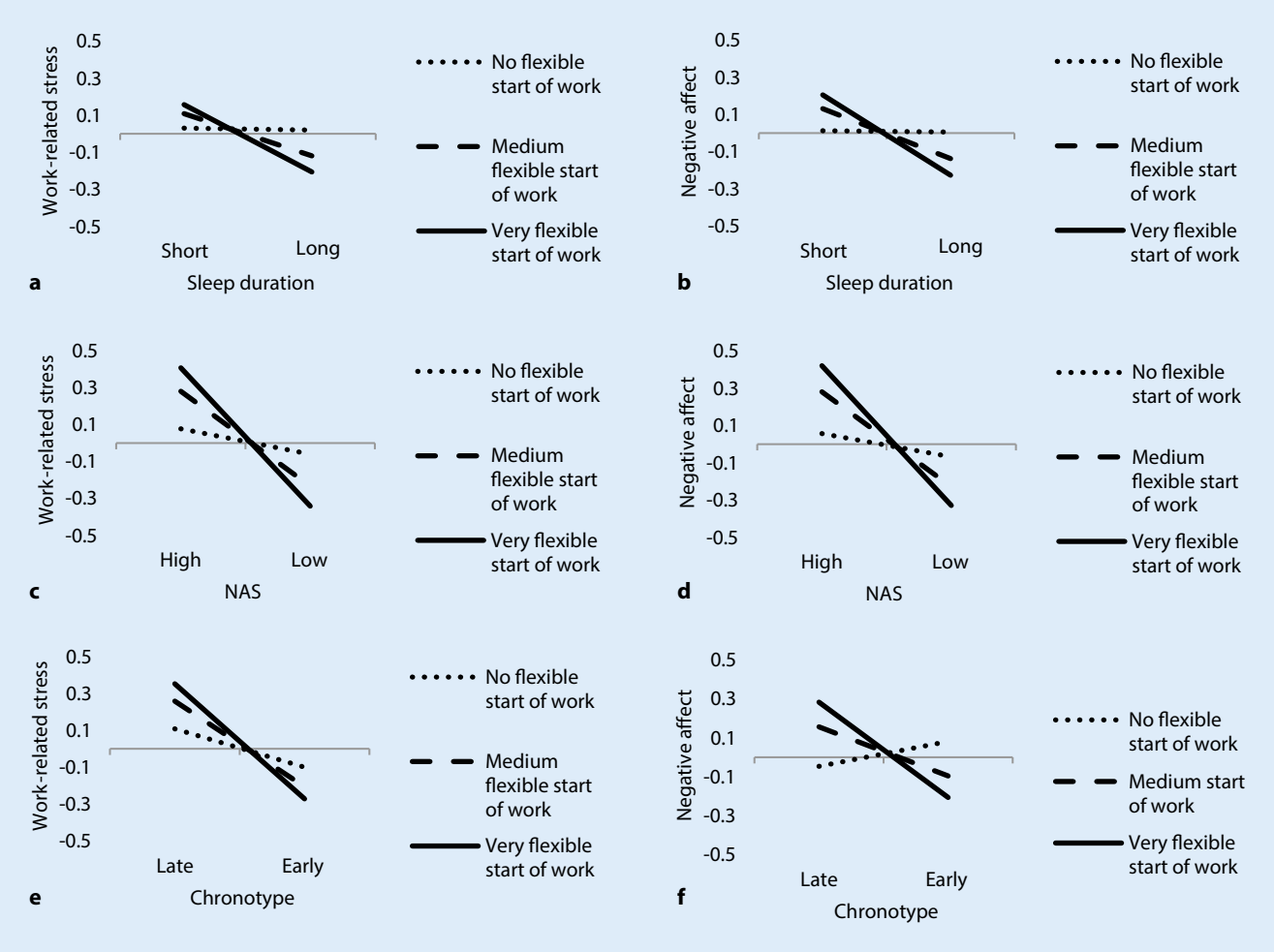

Fig. 1 ▲ The moderating effect of a flexible start of work between sleep duration and work-related stress (**a**), sleep duration and negative affect (**b**), need for additional sleep (NAS) and work-related stress (**c**), need for additional sleep and negative affect (**d**), chronotype and work-related stress (**e**), and chronotype and negative affect (**f**)

Limitations

The present study makes important contributions to previous research, yet the results consist of cross-sectional data, which do not allow a causal interpretation. Other explanations for the found relationships and moderations are possible but were not examined. We, for example, did not investigate whether a higher variability in start of work for later chronotypes or people with a shorter sleep duration might explain these relationships. Therefore, further investigations are needed, which include a broader set of control variables, such as variability in work starting time or other work- or sleep-related aspects, to control for confounding variables. Furthermore, research based on longitudinal data or intervention studies are needed to explore causal relationships and changes in sleep and well-being over time.

Conclusions

Sleep duration, need for additional sleep time in the morning, and chronotype are important factors for the well-being of daytime workers and should be considered as a prominent issue for overall health and satisfaction of employees. The results demonstrated that the presence of a flexible start of work is not beneficial for every employee, but rather depends on individual's sleep habits and chronotype. Late chronotypes and people with a shorter sleep duration or a greater need for additional sleep in the morning do not seem to profit from a flexible start of work. In contrast, early chronotypes and people with a longer sleep duration and a lower need for additional sleep time experience less negative affect and stress when having a flexible start of work. However, many of the underlying factors are at present still unknown and need to be further investigated.

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Compliance with ethical guidelines

Conflict of interest. C. Saalwirth and B. Leipold declare that they have no competing interests.

This study was approved by the Ethics Committee of the Universität der Bundeswehr München and all participants gave informed consent prior to the online questionnaire in digital form.

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