Received: 10 February 2021 | Revised: 21 June 2021 | Accepted: 19 July 2021

DOI: 10.1111/jsr.13453

Journal of Sleep Research ESRS

RESEARCH ARTICLE

# Seasonal variations in sleep duration and sleep complaints: A Swedish cohort study in middle-aged and older individuals

Olga E. Titova[1] | Eva Lindberg[2] | Sölve Elmståhl[3] | Lars Lind[4] | Christian Benedict[5]

[1]Unit of Medical Epidemiology, Department of Surgical Sciences, Uppsala University, Uppsala, Sweden

[2]Department of Medical Sciences, Respiratory, Allergy and Sleep Research, Uppsala University, Uppsala, Sweden

[3]Division of Geriatric Medicine, Department of Clinical Sciences in Malmö, Skåne University Hospital, Lund University, Malmö, Sweden

[4]Department of Medical Sciences, Cardiovascular Epidemiology, Uppsala University, Uppsala, Sweden

[5]Department of Neuroscience, Sleep Science (BMC), Uppsala University, Uppsala, Sweden

**Correspondence**
Christian Benedict and Olga E. Titova, Department of Neuroscience, Uppsala University, Box 593, 751 24 Uppsala, Sweden.
Email: christian.benedict@neuro.uu.se; olga.titova@surgsci.uu.se

**Funding information**
Swedish Research Council, Grant/Award Number: 2015-03100; Hjärnfonden, Grant/Award Number: FO2019-0028; Novo Nordisk Fonden, Grant/Award Number: NNF19OC0056777; Börjeson, Emil and Ragna Foundation

## Summary

Subjective sleep reports are widely used research tools in epidemiology. Whether sleep reports can differ between seasons is less clear. Using multivariable binary or multinomial logistic regression analyses, in the present Swedish cross-sectional two-centre cohort study ($N$ = 19,254; mean age 61 years), we found that participants surveyed during the summer (June–August) were more likely to report short sleep duration (defined as ≤ 6 hr) compared with those interviewed during the autumn (odds ratio [95% confidence interval] = 1.14 [1.04–1.25]). Individuals interviewed in the winter (December–February) were less likely to report early awakenings compared with participants surveyed in the autumn (September–November; odds ratio [95% confidence interval] = 0.85 [0.75–0.96]). Complaints of difficulties in falling asleep and disturbed sleep were less common among participants interviewed during spring (March–May) compared with those interviewed during the autumn (odds ratio [95% confidence interval] = 0.86 [0.74–0.99] and 0.88 [0.79–0.98], respectively). No seasonal variations in reports of long sleep, difficulty maintaining sleep, or feeling not rested after sleep were observed. Additional subgroup analysis revealed that summer participants were more likely to report short sleep duration and early morning awakenings than individuals surveyed in winter. In conclusion, this Swedish study indicates that self-reported sleep characteristics may vary across seasons. Further studies are needed to confirm our findings.

KEYWORDS
seasonal variations, sleep complaints, sleep duration

## 1 | INTRODUCTION

Sleep plays an essential role in maintaining our physical and mental health (Medic, Wille, & Hemels, 2017) and has, therefore, become a focus for health science, including epidemiological research. Noteworthy, evidence suggests that self-reported and objectively measured sleep characteristics can vary across seasons, especially in areas with a large variation in daylight and temperature across the year (Friborg, Bjorvatn, Amponsah, & Pallesen, 2012; Husby & Lingjaerde, 1990; Itani et al., 2016; Johnsen, Wynn, & Bratlid, 2012; Kantermann, Juda, Merrow, & Roenneberg, 2007; Suzuki et al., 2019). For example, in a cross-sectional study of 8,951 Norwegian women and men (age range 30–87 years), individuals who participated in the study in winter were more likely to report sleep problems than other seasons attendees (Johnsen et al., 2012). However, no seasonal variation in reports of insomnia symptoms or sleep duration was observed in other cohorts (Johnsen, Wynn, Allebrandt, & Bratlid, 2013; Sivertsen, Overland, Krokstad, & Mykletun, 2011). Given these discrepant results, more large-scale studies are needed to investigate whether the prevalence of common sleep complaints, such as difficulties initiating sleep (DIS) and short sleep duration, varies across seasons. In this context, middle-aged and older subjects appear particularly applicable for studying the seasonal impact on human sleep, as aging increases the prevalence of sleep problems (Crowley, 2011) and results in more shallow and fragmented sleep (Ohayon, Carskadon, Guilleminault, & Vitiello, 2004).

In the present study, we investigated whether the odds of reporting short sleep duration, long sleep duration and sleep complaints (e.g. difficulty falling asleep) differ between seasons in middle-aged and elderly men and women. We used cross-sectional data of 19,254 residents from two Swedish towns, Uppsala and Malmö, both of which have large variation in daylight and temperature across the year.

## 2 | MATERIALS AND METHODS

### 2.1 | Cohort description

The present study was based on data from the EpiHealth cohort study, including participants from both Uppsala and Malmö (Lind et al., 2013). Uppsala is situated in east-central Sweden at 59.9° north latitude, and Malmö is located in the southwest part of Sweden at 55.6° north latitude. Both towns have a continental climate with cold winters and mild summers. The length of daytime varies from approximately 6–7 hr in December to about 17–18 hr in June (Figure S1; https://www.suncalc.org).

The participants were randomly selected by season, and the proportions of age group and sex were randomized by season. However, in the summer, slightly fewer participants visited the test centre and completed the questionnaire. From the initial sample size (*n* = 20,534), 462 individuals were excluded because of missing data on covariates (i.e. education, physical activity, smoking, alcohol intake, body mass index [BMI] or the place of residence). Besides, 818 participants were excluded because they did not provide information on one or more sleep variables. Following these exclusions, data from 19,254 subjects (93.8% of the initial sample size) were available for the analysis. The Ethics Committee at Uppsala University approved the general procedures of the EpiHealth study. All subjects gave written informed consent in accordance with the Declaration of Helsinki. Additional ethical approval for the data analyses was obtained from the Ethics Committee at Uppsala University.

### 2.2 | Sleep variables, seasonality and covariates

Participants' sleep habits were assessed by an online questionnaire. The participants were asked to report how many hours per day they habitually sleep by choosing one of the following response options: "4 hr or less", "5 hr", "6 hr", "7 hr", "8 hr", "9 hr", "10 hr or more" and "don't know/don't want to answer". For the analysis, we categorized sleep duration into three levels: *short sleep*, ≤ 6 hr of sleep per day; *normal sleep*, 7–8 hr of sleep per day; and *long sleep*, ≥ 9 hr of sleep per day. Participants also indicated how often they experienced the following sleep problems: DIS; early morning awakenings (EMA); difficulties maintaining sleep (DMS); overall disturbed sleep; and not feeling rested after sleep. Response options were: "never/seldom"; "one to three times per month"; "one to three times a week"; "four or more times a week"; or "don't know/don't want to answer". The answer "four or more times a week" was classified as having the respective sleep problem. The answer "don't know/don't want to answer" was treated as a missing value. Four seasonal categories were created: autumn (September, October, November); winter (December, January, February); spring (March, April, May); and summer (June, July, August) based on when the questionnaire was filled in.

Early-life educational attainment, leisure time physical activity, alcohol consumption frequency, history of depression (ever diagnosed), and current smoking status were also assessed by the online questionnaire. Chronotype was assessed on a five-point scale, which was defined in the present study as: 1 = "Definitely a morning person"; 2–4 = Intermediate; 5 = "Definitely an evening person". A similar definition of the chronotype was used in other studies (Vetter et al., 2018). Age and place of residence (Uppsala or Malmö) were recorded, and weight and height were measured when participants visited one of the two test centres in Malmö or Uppsala.

### 2.3 | Statistical analysis

Descriptive data are presented as mean (standard deviation) for continuous variables and as the number of participants (%) for categorical variables. Analysis of variance (ANOVA) or the Pearson chi-square test were used to investigate group differences for continuous and categorical variables, respectively. Binary logistic regression was used to obtain odds ratios (OR) with 95% confidence intervals (CI) to analyse sleep complaints (no/yes) across the seasons (reference group = those interviewed during the autumn). Multinomial logistic regression was applied to analyse seasonal variations in sleep duration (≤ 6 hr of sleep/day; 7–8 hr of sleep/day; and ≥ 9 hr of sleep/day; reference group = sleep duration between 7 and 8 hr per day). We used two statistical models. In the first model, we adjusted for age, sex and place of residence. In a second multivariable model, we additionally adjusted for education (primary and elementary school, upper secondary school, university, or other), physical activity during leisure time (low, moderate or high level), alcohol consumption frequency during the last 12 months (never, ≤ 1 time per week, 2–3 times per week, and ≥ 4 times per week), current smoking status (yes/no), chronotype, history of depression (no/yes) and BMI (continuous). Covariates were selected based on our a priori knowledge of the relationships among potential confounders, intermediate variables and outcome variables, as well as on existing information regarding factors associated with a season of investigation and sleep characteristics. Cross-product interaction terms (geographical region × season or sex × season) were included in separate regression models to assess possible statistical interactions on the multiplicative scale. No interaction of geographical region with season and sex was observed for any sleep characteristic in the main analyses ($p$-value for interaction > 0.05 in fully adjusted model). Also, a contrast analysis was performed comparing sleep reports between winter and summer participants.

Because the length of daily illumination (in the following named photoperiod or day length) can vary considerably based on latitude and season, we collected the site-specific photoperiod length for each day when participants filled out the questionnaire (Figure S2; Retrieved in June 2021 from https://www.timeanddate.com/). The non-parametric Kruskal–Wallis test was used to assess the difference in day length between the seasons. To test whether the day length would account for possible seasonal variations in sleep complaints, we also adjusted for individual photoperiod lengths in separate regression models. We hypothesized that adjusting for the photoperiod length would weaken the association of season with sleep characteristics. All statistical tests were two-sided. All statistical analyses were performed using SPSS version 26.0 (SPSS).

## 3 | RESULTS

Baseline characteristics of study participants are shown in Table 1. Summer participants were slightly younger. Those interviewed in the spring were more often residents of Uppsala, had higher educational attainment, and reported more often a history of depression ($p < 0.05$). The prevalence of sleep complaints, short sleep duration and long sleep duration is shown in Table 2. The largest number of participants was interviewed in autumn (35%), while the lowest number of participants filled in the questionnaire in the summer months (15%). The highest prevalence of early awakenings reports was observed in summer participants (12.1%), whereas the lowest proportion was found in winter participants (9.7%; $\chi^2 = 12.4$, df = 3, $p = 0.006$). Also, the highest proportion of short sleep duration was observed in summer participants (34.5%), while long sleep was more common in participants who attended the study in autumn (4.1%; $\chi^2 = 12.8$, df = 6, $p = 0.047$; Table 2).

In the fully adjusted model, summer participants were more likely to report short sleep duration (defined as ≤ 6 hr) compared with autumn participants ($p = 0.008$; Table 3). In addition, participants interviewed during the winter were less likely to report EMA compared with autumn participants ($p = 0.01$; Table 3). Moreover, spring participants had lower odds of reporting DIS and disturbed sleep ($p = 0.034$ and $p = 0.024$ respectively; Table 3) compared with autumn participants; however, these associations were rather weak. There were no seasonal variations in reports of DMS, feeling not rested after sleep, or long sleep duration (Table 3).

Additional multivariable analysis revealed that, compared with winter participants, individuals who attended the study in summer were more likely to report EMA ($p = 0.001$) and more likely to indicate short sleep duration ($p = 0.014$; Table 4).

The day length differed significantly between the seasons, with the longest duration in summer and shortest in winter (Figure S2). When adding day length as a covariate to the regression analysis, seasonal variations of DIS, disturbed sleep and short sleep did not remain statistically significant (Tables S1 and S2). Winter participants had lower odds of EMA complaints compared with autumn participants, but this association was attenuated when four seasons and day length were considered (OR [95% CI] = 0.87 [0.76–0.99]). In addition, this association did not remain significant when comparing summer versus winter (Tables S1 and S2).

We also analysed among the initial cohort of 20,534 subjects if the response option "I don't know/don't want to answer" differed between seasons, as it may indicate a response bias. As summarized in Table S3, overall, the frequency of subjects selecting the response option "I don't know/don't want to answer" was rare. When comparing the distribution of this response option between seasons, except for DIS, no major seasonal differences were found.

Finally, as revealed by the Poisson regression analysis, the number of insomnia symptoms occurring four or more times a week (DIS, EMA and DMS) did not differ among all seasons or when comparing summer versus winter (fully adjusted model, $p > 0.05$, data are not shown).

## 4 | DISCUSSION

This cross-sectional study of middle-aged and older women and men investigated whether self-reported sleep duration and sleep complaints differ among seasons. Compared with participants interviewed during the autumn, those surveyed during the summer were more likely to report a short sleep duration. Individuals interviewed during the winter were less likely to report EMA. Furthermore, DIS and disturbed sleep complaints were less common among spring than autumn participants, although these associations were relatively weak. Reports of feeling not sufficiently rested after sleep, long sleep duration and DMS did not differ among seasons. We also found that participants surveyed during the summer, i.e. the warmest season with the longest daylight length, were more likely to report EMA and short sleep duration than individuals interviewed during the winter (coldest season of the year with the shortest daylight length). Finally, no association between the number of insomnia symptoms (DIS, EMA and DMS) and the survey season was observed.

Similar to our findings, a Finish study of 982 adult women and men (age range 18–100 years) reported that 20% of participants indicated a worsening of sleep quality in summer, whereas the proportions for the remaining seasons were between 4% and 10% (Ohayon & Partinen, 2002). However, there are also conflicting data. Several observational studies conducted in Norway found that insomnia symptoms and daytime impairment are more prevalent during winter than summer (Husby & Lingjaerde, 1990; Johnsen

**TABLE 1** Baseline characteristics of study participants

| Parameter | Total | Autumn | Winter | Spring | Summer |
|---|---|---|---|---|---|
| Participants, *n* | 19,254 | 6,735 | 4,524 | 5,141 | 2,854 |
| Age, years, mean (SD) | 60.7 (8.5) | 61.2 (8.4) | 61.1 (8.3) | 60.4 (8.7) | 59.5 (8.7) |
| Women, % | 56.4 | 56.6 | 56.8 | 56.1 | 56.0 |
| Residents of Uppsala town, % | 65.5 | 64.2 | 63.0 | 71.1 | 62.6 |
| Education, % | | | | | |
| Primary/elementary school | 15.5 | 16.2 | 17.0 | 14.0 | 13.8 |
| Upper secondary school | 25.5 | 24.8 | 27.0 | 24.7 | 26.1 |
| University | 48.0 | 47.1 | 45.8 | 50.8 | 48.4 |
| Other | 11.1 | 11.9 | 10.3 | 10.4 | 11.7 |
| Leisure-time physical activity level, % | | | | | |
| Low | 39.5 | 39.1 | 39.5 | 39.8 | 40.2 |
| Moderate | 42.0 | 42.2 | 43.0 | 41.4 | 40.7 |
| High | 18.5 | 18.7 | 17.5 | 18.8 | 19.1 |
| Current smokers, % | 7.4 | 7.5 | 8.2 | 7.3 | 6.4 |
| Alcohol consumption frequency, % | | | | | |
| Never | 5.6 | 5.2 | 6.1 | 5.7 | 5.5 |
| ≤ 1 time per week | 52.9 | 52.7 | 53.3 | 53.1 | 52.3 |
| 2–3 times per week | 32.5 | 32.8 | 31.5 | 32.5 | 33.3 |
| ≥ 4 times per week | 9.0 | 9.3 | 9.0 | 8.7 | 9.0 |
| Chronotype, % | | | | | |
| Definitely morning | 20.7 | 21.0 | 20.0 | 21.3 | 20.2 |
| Intermediate | 63.2 | 63.8 | 63.2 | 62.5 | 63.1 |
| Definitely evening | 16.1 | 15.2 | 16.8 | 16.2 | 16.7 |
| BMI, kg $m^{-2}$, mean (SD) | 26.2 (4.0) | 26.2 (4.0) | 26.3 (3.9) | 26.3 (4.0) | 26.2 (4.1) |
| History of depression, % | 10.7 | 10.7 | 9.7 | 11.4 | 11.1 |

BMI, body mass index; *n*, number; SD, standard deviation.

et al., 2012; Pallesen et al., 2001). It must also be acknowledged that several studies did not find seasonal variations in sleep characteristics (Johnsen et al., 2013; Sivertsen, Friborg, Pallesen, Vedaa, & Hopstock, 2020; Sivertsen et al., ,2011). For example, in a recent population-based study of 21,083 residents of Tromsø municipality, Norway, aged 40 years and older, no effect of season of examination on sleep duration was found (Sivertsen et al., 2020). However, it is important to note that the Norwegian studies included younger participants and had a different definition of seasons and sleep characteristics compared with our study. Moreover, the climatic conditions in Tromsø (e.g. Polar night) and elsewhere in Norway differ from those in central and south Sweden.

Seasonality in some physiological processes, disease incidence (e.g. seasonal affective disorder) and human behaviour (e.g. physical activity) has been previously reported (Melrose, 2015; O'Connell, Griffiths, & Clemes, 2014). Extending these findings, we found that respondents of the present survey study more often complained about short sleep duration and EMA when the survey took place during the summer as compared with the winter season. Due to the observational design of our study, we can only speculate about possible underlying mechanisms. Environmental light is the most powerful zeitgeber synchronizing the mammalian endogenous circadian rhythms to the solar 24-hr day. Light exposure inhibits melatonin secretion, a sleep/wake-cycle-regulatory hormone produced by the pineal gland primarily during darkness (Munch & Bromundt, 2012). A Swedish longitudinal experimental study of office workers has demonstrated that daily light exposure during summer is higher than in other seasons. In addition, seasonal variations in the circadian pattern of melatonin were observed, with the highest peak level of melatonin during the winter (Adamsson, Laike, & Morita, 2016). Thus, longer periods of light exposure during summer may explain the herein observed seasonal differences in reports of short sleep duration and EMA. Supporting this view, we found that seasonal variations in sleep complaints were no longer significant when controlling for the length of the photoperiod for each day when participants filled out the questionnaire.

Our study's essential strengths are the large sample size, the inclusion of two towns situated in different parts of Sweden, the

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**TABLE 2** The prevalence of sleep complaints, short sleep duration and long sleep duration across seasons

| Sleep complaints | Overall, *n* | Autumn | Winter | Spring | Summer | *p*-value[a] |
|---|---|---|---|---|---|---|
| Participants, *n* | 19,524 | 6,735 | 4,524 | 5,141 | 2,854 | |
| DIS, %[b] | 7.7 | 8.1 | 8.2 | 6.9 | 7.7 | 0.060 |
| EMA, %[b] | 11.0 | 11.3 | 9.7 | 11.1 | 12.1 | 0.006 |
| DMS, %[b] | 9.0 | 9.5 | 8.8 | 8.8 | 8.5 | 0.305 |
| Disturbed sleep, %[b] | 12.8 | 13.3 | 13.0 | 12.0 | 12.6 | 0.197 |
| Not feeling rested after sleep, %[b] | 14.2 | 14.3 | 13.7 | 13.8 | 15.5 | 0.152 |
| Habitual short sleep duration (≤ 6 hr of sleep/day), % | 32.0 | 31.4 | 31.6 | 31.7 | 34.5 | 0.047 |
| Habitual long sleep duration (≥ 9 hr of sleep/day), % | 3.9 | 4.1 | 4.0 | 3.5 | 3.8 | |

DIS, difficulties initiating sleep; DMS, difficulties maintaining sleep; EMA, early morning awakenings; *n*, number.

[a]Group comparisons were performed with the Pearson Chi-square test.

[b]Four or more times a week.

**TABLE 3** Seasonal variations in sleep complaints, short sleep duration and long sleep duration expressed as OR and 95% CI

| | Sleep complaints occurring four or more times a week[a] | | | | | Short and long habitual sleep duration compared with 7–8 hr of sleep[b] | |
|---|---|---|---|---|---|---|---|
| Seasons | DIS | EMA | DMS | Disturbed sleep | Not feeling rested after sleep | ≤ 6 hr | ≥ 9 hr |
| Model 1 | | | | | | | |
| Autumn | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Winter | 1.01 (0.88–1.16) | **0.84** (0.74–0.95) | 0.91 (0.80–1.04) | 0.98 (0.87–1.09) | 0.95 (0.85–1.06) | 1.00 (0.93–1.09) | 0.98 (0.81–1.19) |
| Spring | 0.87 (0.76–1.00) | 0.99 (0.88–1.11) | 0.93 (0.82–1.06) | **0.89** (0.79–0.99) | 0.93 (0.84–1.04) | 1.01 (0.93–1.09) | 0.90 (0.74–1.09) |
| Summer | 0.99 (0.84–1.16) | 1.09 (0.95–1.25) | 0.91 (0.78–1.06) | 0.94 (0.82–1.07) | 1.03 (0.91–1.17) | **1.14** (1.04–1.25) | 1.04 (0.82–1.31) |
| Model 2 | | | | | | | |
| Autumn | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Winter | 0.99 (0.86–1.14) | **0.85** (0.75–0.96) | 0.92 (0.80–1.05) | 0.98 (0.87–1.10) | 0.94 (0.84–1.05) | 1.00 (0.92–1.09) | 0.97 (0.80–1.18) |
| Spring | **0.86** (0.74–0.99) | 0.99 (0.88–1.11) | 0.93 (0.82–1.06) | **0.88** (0.79–0.98) | 0.91 (0.82–1.02) | 1.01 (0.93–1.09) | 0.88 (0.72–1.07) |
| Summer | 0.97 (0.82–1.15) | 1.10 (0.96–1.26) | 0.90 (0.77–1.05) | 0.93 (0.81–1.06) | 1.01 (0.89–1.15) | **1.14** (1.04–1.25) | 1.01 (0.80–1.28) |

Model 1: controlled for age, sex, place of residence. Model 2: Model 1 covariates, education, physical activity, alcohol consumption frequency, current smoking status, chronotype, history of depression and BMI.

DIS, difficulties initiating sleep; DMS, difficulties maintaining sleep; EMA, early morning awakenings.

[a]Binary logistic regression model.

[b]Multinomial logistic regression model

collection of several sleep characteristics, and the ability to adjust for important covariates. In addition, seasonality in sleep characteristics was not the primary objective of the EpiHealth study. Therefore, the participants were not informed about the research hypothesis of the present post hoc analysis. Several limitations, however, apply to the present study. Similar to other large epidemiological studies, sleep measures were based on self-reports and response bias could occur. However, no difference in a proportion of a response "don't know/don't want to answer" on questions about sleep duration and sleep complaints across the seasons was found, except for DIS. The precision of the results was low in the analysis of seasonal variation in DIS and disturbed sleep, and we are unable to discount the role of chance underlying these findings. Another limitation is that we did not assess the duration of how long participants had suffered from sleep complaints at the time of the survey (e.g. "Did you have troubles falling asleep during the last 4 weeks?"). Other factors that

TABLE 4 Seasonal variations in sleep complaints, short sleep duration and long sleep duration among participants surveyed either in the winter or summer season (*N* = 7,378) expressed as OR and 95% CI

| | Sleep complaints occurring four or more times a week[a] | | | | | Short and long habitual sleep duration compared with 7–8 hr of sleep[b] | |
|---|---|---|---|---|---|---|---|
| Seasons | DIS | EMA | DMS | Disturbed sleep | Not feeling rested after sleep | ≤ 6 hr | ≥ 9 hr |
| Model 1 | | | | | | | |
| Winter | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Summer | 0.99 (0.83–1.17) | **1.30** (1.12–1.51) | 0.99 (0.83–1.17) | 0.96 (0.83–1.11) | 1.10 (0.96–1.25) | **1.13** (1.02–1.25) | 1.07 (0.84–1.38) |
| Model 2 | | | | | | | |
| Winter | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Summer | 0.99 (0.83–1.19) | **1.29** (1.11–1.51) | 1.00 (0.83–1.17) | 0.95 (0.82–1.10) | 1.09 (0.95–1.25) | **1.14** (1.03–1.26) | 1.06 (0.82–1.36) |

Model 1: controlled for age, sex, place of residence. Model 2: Model 1 covariates, education, physical activity, alcohol consumption frequency, current smoking status, chronotype, history of depression and BMI.

DIS, difficulties initiating sleep; DMS, difficulties maintaining sleep; EMA, early morning awakenings.

[a]Binary logistic regression model.

[b]Multinomial logistic regression model.

could influence sleep, such as sleep-related medication and antidepressants, were not considered in the present analysis. Finally, our study's cross-sectional design does not allow considering individual variations in sleep across the seasons.

## 5 | CONCLUSIONS

Seasonal variations in sleep complaints and duration could represent relevant confounders for scientists studying associations between sleep and health outcomes. As suggested by our findings, reports of EMA, DIS, disturbed sleep and short sleep duration can vary in their prevalence across seasons in middle-aged and older subjects, i.e. a group at increased risk for sleep problems (Miner & Kryger, 2017). Whether seasonal variability in sleep characteristics also occurs in areas with minor variations in daylight and temperature remains to be investigated. Due to the explorative nature of our study, our results should be seen as hypothesis-generating. It is also important to keep in mind that our research does not provide insight into whether seasonality of reporting sleep problems may affect diagnostic accuracy of sleep disorders such as insomnia.

### ACKNOWLEDGEMENTS

The authors would like to thank all participants in the EpiHealth study. The authors' work is supported by Novo Nordisk Foundation, grant number NNF19OC0056777 (C.B.), Swedish Brain Foundation, grant number FO2019-0028 (C.B.), and the Geriatric Foundation, research for healthy aging, and Börjeson, Emil and Ragna Foundation (O.E.T.). The funders had no role in the design and conduct of the study; collection, management, analysis and interpretation of the data; preparation, review or approval of the manuscript; and decision to submit the manuscript for publication.

### CONFLICT OF INTEREST

None of the authors except for Benedict has conflicts of interest to report. Benedict reports that he served as a paid member of a scientific advisory board for Repha GmBH, Langenhagen, Germany. Benedict declares no other conflict of interest.

### AUTHOR CONTRIBUTIONS

O.E.T. and C.B. contributed to the conception and design of the study, and acquired the data; O.E.T. conducted the statistical analyses and drafted the manuscript. All authors contributed to the interpretation of the results and critical revision of the manuscript for important intellectual content, and approved the final version of the manuscript.

### DATA AVAILABILITY STATEMENT

The data that support findings of this study are available upon application to the EpiHealth consortium, Sweden (www.epihealth.se).

### ORCID

*Olga E. Titova* https://orcid.org/0000-0003-2747-1606
*Christian Benedict* https://orcid.org/0000-0002-8911-4068

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## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

**How to cite this article:** Titova, O. E., Lindberg, E., Elmståhl, S., Lind, L., & Benedict, C. (2021). Seasonal variations in sleep duration and sleep complaints: A Swedish cohort study in middle-aged and older individuals. *Journal of Sleep Research*, 00, e13453. https://doi.org/10.1111/jsr.13453