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The role of recovery from work and work-life spillover in the association between chronotype and mental health problems: A population-based study

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ABSTRACT

Objective: We examined the moderating and mediating role of work-life balance issues on mental health among circadian types using 2266 working participants of the population-based Healthy Finland Study (mean age = 44 years, 57% women).
Methods: Mental health was assessed with validated questionnaires: Mental Health Inventory (MHI-5), General Anxiety Scale (GAD-7), and Patient Health Questionnaire depression module (PHQ-9), a separate item for suicidal thoughts, and as actualized healthcare visits. Circadian type was assessed by the widely used single item from the Morningness/Eveningness Questionnaire (MEQ_{i19}). Work-life balance was measured by questions on work spillover to personal life and recovery from work. Generalized linear models were controlled for sex, age, sleep insufficiency, insufficient physical activity, and risky alcohol consumption.
Results: Evening-types had more work-life balance issues and symptoms of mental disorders. Evening-type was also associated with health behaviors but the associations with work-life balance problems and poor mental health remained even after adjustment for these. Work spillover to personal life and poor recovery from work had moderating roles in mental disorders, especially among moderate circadian types and definite Evening-types. Recovery from work partly mediated the association between Evening-type and anxiety disorders.
Conclusion: Work-life balance issues have an important contributing role in poor mental health associated with the Evening chronotype.
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Introduction

Rising mental health issues are one of the main causes of work disability among working-age populations worldwide.[1] Although several underlying factors have been identified, the role of circadian type remains poorly understood. There are only few studies on circadian type and work ability, although previous studies indicate that individual circadian type, that is, chronotype, is strongly associated with mental health outcomes and work ability.[2-5] Individuals differ innately on how their bodily functions and behavior are timed across the circadian period, which is approximately 24 hours. This individual circadian type determines, for instance, peak time in performance during the day, sleep-wake timing, body temperature rhythm, and daily hormonal peaks.[6] For Morning-types, these occur earlier in the day than for Evening-types. Circadian type is strongly influenced by genetics[7-9] and it is a very stable trait during adulthood.[10] From childhood to adolescence, there is a general shift toward eveningness regulated by genetic circadian tendency,[11-13] and Evening-type is the predominant chronotype during late adolescence and young adulthood.[2,14,15] Both cross-sectional and prospective epidemiological studies have shown that Evening-types have a higher risk for several health issues, including mental health

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What was known

Evening-types are at higher risk not only for mental health problems but also for impaired work ability. Yet, it is not known why these risks accumulate to Evening-types rather than other circadian types and whether issues related to work-life balance have a role in these associations.

What this study adds

Findings from this study showed, for the first time in a population-based working adult sample, that Evening-types had more issues regarding work spillover to personal life and poor recovery from work and that these factors moderated and partly mediated poor mental health among Evening-types. Based on these findings, work-life balance issues seem to have an important role in mental health among Evening-types and may reflect work ability and potentially also the use of hospital-required treatments due to mental disorders.

problems.[3,16-20] These manifest not only as symptoms but also as diagnoses and a higher likelihood of hospital treatments among Evening-types as compared with other circadian types.[3] Among working-age adults, as much as 12%-24% are of extreme Evening-types[4] presenting a high-risk group for mental health issues and impaired work ability.[2-5] It is still an open question why Evening-types in particular are at risk of having mental health issues and impaired work ability. It is possible that timing mismatch between societal schedules and innate rhythms among Evening-types predisposes them to sleep problems that then lead to mental health issues as sleep and mental health are very much intertwined.[21,22] Insufficient sleep has been shown to partially explain mental health problems among Evening-types,[3] but this does not completely reveal why Evening-types have a higher risk for mental health issues. In this previous study, the mediating effect of insufficient sleep on the associations between circadian type and depressive symptoms and hospital treatments for depressive episodes and anxiety disorders was stronger than the average direct effect of circadian type. However, regarding diagnosed depression, the mediating effect of insufficient sleep was weaker than the average direct effect of circadian type.[3] Evening-types may have more problems in coordinating time use between working life and personal life, as their best performance and alertness time may not align optimally with work time. It is possible that Evening-types feel more exhausted from work due to the mismatch between state of alertness and work schedules. Poor health behaviors that are more common among Evening-types[23-25] may contribute to mental health problems and potential issues in work-life balance. To answer these open questions, we examined the mediating and moderating role of work-life balance on mental health among circadian types in a population-based sample of Finnish working adults. We adjusted the role of sleep sufficiency and health behaviors in terms of sufficient physical activity and risk-level alcohol consumption on mental health and work-life balance problems among circadian types. We assessed mental health using both validated questionnaires, suicidal thoughts, and actualized healthcare visits.

Methods

Participants

Our sample was derived from the nationwide population-based Healthy Finland Study, which used a random sample of adults aged 20 and older without any upper age limit, stratified by sex and 10-year age-group distribution of the population, from each 22 counties, collected between years 2022 and 2023 from mainland Finland.[26] We included those aged 20-65 years in our sample, representing the general working-age population in Finland, who had responded to the questions on their circadian type as part of a subsample invited to health examination and answered the questions on work-life balance.[26] Employment status was self-reported with the question "What is your present state of employment?" (Answer options: Full-time employment, Part-time employment, Pensioned due to old age, On disability pension, On part-time pension, Unemployed or temporarily laid-off, On family leave or Housewife/Househusband, and Student or on study leave). We omitted those reporting pensioned due to old age, those on disability pension, unemployed or temporarily laid-off, and those on family leave or Housewife/Househusband (N = 376) from the sample. Thus, our analytic sample of 2266 participants consisted of those of ages between 20 and 65 years old with information on circadian type and work-life balance (mean age = 44.3 years, SD = 11.9 years, 57.1% women). Healthy Finland Study was approved by the Helsinki and Uusimaa Hospital District Regional Committee on Medical Research Ethics (decision number HUS/900/2022) and conducted according to accepted international ethical standards in accordance with the Declaration of Helsinki and its amendments. All participants provided their written informed consent.

Circadian type

Circadian type was assessed with the widely used single item of the original Morningness/Eveningness Questionnaire (MEQ),[27] $MEQ_{i19,}$ for the self-assessed behavioral trait of morningness-eveningness. Circadian type was asked with the following question: "There are so-called "Morning-people" (early to rise, early to bed) and "Evening-people" (late to rise, late to bed). Which are you?" The response options were as follows: Definitely a "Morning" person (definite Morning-type scoring = 1), More a "Morning" than an "Evening" person (moderate Morning-type scoring = 2), More an "Evening" than a "Morning" person (moderate Evening-type scoring = 3), or Definitely an "Evening" person (definite Evening-type scoring = 4). MEQ_{i19} is a feasible and reliable assessment method for circadian type.[3,28]

Work-life balance

Work-life balance measures included assessment of work spillover and recovery from work. Work-life spillover was assessed by answering the two following statements: "Work takes too much time or energy away from my family or the rest of my life?"[29] and "Work-related matters weigh on my mind during my free time."[30] These were answered with the Likert scale from 1 (completely agree) to 5 (strongly disagree). These two items were assessed as a sum score (Cronbach's alpha = 0.71). Scoring of work-life spillover sum was reversed to ease interpretation of the results, so lower work-life spillover score indicated less problems in work influencing negatively the rest of life. Recovery from work was assessed by answering the following question: "Do you recover from the strain of the working day before the next day?," answered with a scale from 0 (Not at all) to 10 (Completely). Scoring of recovery from work was reversed to ease interpretation of the results, so higher recovery from work score indicated poorer recovery.

Mental health

Information on mental health was available both based on self-report measures and as nationwide register-based healthcare use. The latter included treatment due to depressive and anxiety disorders in inpatient wards in specialized health care and outpatient visits in public specialized health care (Hilmo) and primary healthcare activities (Avohilmo) between 2022 and 2023, derived from the Care Registers for Social Welfare and Health Care. Hilmo and Avohilmo include the International Statistical Classification of Diseases and Related Health Problems (ICD) by World Health Organization (ICD-10 coding since 1996). The following ICD-10 codes were used in this study: to indicate healthcare-treated depression (Yes/No), the diagnosis codes F32 for Depressive episode and F34 for Persistent mood (affective) disorders were grouped together and to indicate healthcare-treated anxiety disorders (Yes/No), the diagnosis codes F40-F48 for Neurotic, stress-related, and somatoform disorders were grouped together for both information on Avohilmo and Hilmo collectively.

Self-reported information on mental health included The Mental Health Inventory (MHI-5), which is a five-item scale used to measure psychological distress and well-being.[31] Items include questions about whether over the past 4 weeks, the person has felt extreme anxiety, so down that nothing could cheer up, calm and composed, downhearted, and blue and happy. Each item is answered with the following options: All the time/Most of the time/Often/Sometimes/Seldom/Never with the responses to positive feeling scored in a descending order (5, 4, 3, 2, 1, and 0, respectively) and responses to negative feelings in ascending order. Score from the five items is further multiplied with 4 to have a total score of 0-100, with the most-used cutoff of 52 points and below applied here to indicate poor mental health.[32,33] A 7-item anxiety scale (GAD-7) for general anxiety disorder asks about symptoms related to anxiety over the last 2 weeks with the following responses: Not at all (0 points)/Several days (1 point)/More than half the days (2 points)/Nearly every day (3 points). Total scores of 0-4 indicate minimal anxiety, 5-9 mild anxiety, 10-14 moderate anxiety, and 15-21 severe anxiety.[34] GAD-7 was used here as dichotomized with scores 10 or more indicating moderate-to-severe anxiety. A 9-item module for depression (PHQ-9) of the Patient Health Questionnaire (PHQ) asks about depressive symptoms over the last 2 weeks with the same response options and scoring as GAD-7. Total scores of 0-4 indicate to no depression, 5-9 minimal depression, 10-14 mild depression, 15-19 moderate depression, and 20-27 severe depression.[35] PHQ-9 was used here as dichotomized with scores 10 or more indicating mild-to-severe depression. Suicidal thoughts over the last 12 months were asked with Yes/No answer options.

Health behaviors and sleep

Alcohol consumption was assessed based on The Alcohol Use Disorders Identification Test-Concise (AUDIT-C) questionnaire with the following three questions each scored from 0-4: "How often you have a drink containing alcohol?" (Answer options: Never/Monthly or less/Two to four times a month/Two to three times per week/Four or more times a week), "How many drinks containing alcohol you have on a typical day when you were drinking?" (Answer options: 1 or 2 drinks/3 or 4/5 or 6/7-9/10 or more), and "How often you have six or more drinks on one occasion?" (Never/Less than monthly/Monthly/Weekly/Daily or almost daily). Scores above 5 for women and above 6 for men indicate risk-level drinking. Physical activity was assessed whether meeting the World Health Organization (WHO) health guidelines or not for physical activity based on weekly physical activity over the last 12 months at work, commuting, and free time. Participants were asked about their physical activity in detail separately for different physical activity levels and separately for work, commuting, and free time: "How much exercise do you get in a week in the course of your work, commute, and spare time? *Think about the past 12 months. Take all regular, weekly physical exertion in consideration. You can write your answer on several lines if necessary.*" (Answer options: hardly any regular exercise/low-intensity aerobic exercise (= does not make you sweat or get out of breath, e.g., walking leisurely) in total ___hours and ___minutes a week/moderate-intensity aerobic exercise (= makes you sweat a bit or get slightly out of breath, e.g., walking briskly) in total ___hours and ___minutes a week/high-intensity aerobic exercise (= makes you sweat a lot or get out of breath, e.g., jogging or running) in total ___hours and ___minutes a week). Meeting the WHO guidelines was calculated based on this information. For adults, the WHO guidelines constitute at least 150-300 minutes of moderate-intensity physical activity or at least 75-150 minutes of vigorous-intensity physical activity, or combination of these two physical activity levels, per week.[36] The sufficiency of sleep was assessed on the basis of the self-estimation of getting enough sleep (Answer options: Nearly always/Often/Rarely or Never). The first two answers were grouped together with the answer Rarely or Never indicating insufficient sleep. Midpoint of sleep was calculated based on the self-reported bedtimes and wake-up times separately for working days and for free days. The midpoint of sleep on was determined by half of the time passed in sleep since going to bed in local time. Midpoint of sleep illustrates the phase entrainment of actualized sleep behavior, with midpoint of sleep on free days reflecting the innate circadian type.[37] Social jet lag was determined to indicate the average mismatch between social and biological rhythm as the difference between the average weekend and weekday midpoint of sleep in hours and minutes.[38]

Background characteristics

Information on sex and age (based on the year of birth) was derived from the Population Information System of the national Population Register Centre. Age and sex were controlled for in the statistical analyses, as there are age- and sex-related differences in circadian type in the Finnish adult population, as reported previously.[14,23] Education level was divided into basic (up to 9 years of education), secondary (general upper secondary school or vocational school), and higher education (university or university of applied sciences). Health behavior was assessed based on alcohol consumption and physical activity.

Statistical analyses

Descriptive information on mean age, background characteristics, health behaviors, and sleep by circadian type was analyzed with one-way ANOVA (for continuous variables) and with chi-square test (for categorical variables). Generalized linear models (GLM) with linear and binary logistic models, respectively, were used to analyze the association between (1) circadian type and work-life balance measures, (2) circadian type and mental health, and (3) work-life balance and mental health. All GLMs were adjusted for age and sex in model 1 and further adjusted for risky alcohol use, physical activity, and sleep sufficiency, which differed between circadian types in the descriptive analyses. Definite Morning-types or the highest score indicating no issues regarding work-life balance were set as the reference group. Moderating effect of work-life spillover and recovery from work scores on the association between circadian type and mental health was analyzed with binary logistic GLM by adding an interaction effect to the model. All the moderation analyses were adjusted for sex and age. For these analyses, we used the IBM SPSS Statistics, version 29.0. Finally, we analyzed whether work-life spillover or recovery from work mediated the association of circadian type and mental health. Here, we used the R mediation package[39] in binary logistic GLM employing the bootstrapping

Table 1
Descriptive information on the sample by circadian type

	Definite morning-type (N = 413)	Moderate morning-type (N = 659)	Moderate evening-type (N = 735)	Definite evening-type (N = 459)	*p*-value
Age (mean in years, SD)	48.2 (10.6)	45.2 (11.8)	42.8 (12.1)	41.9 (11.8)	< .001
Sex (%)					< .05
Men	37.3	41.7	46.9	43.4	
Women	62.7	58.3	53.1	56.6	
Education level (%)					.4
Basic	3.8	5.4	3.2	4.0	
Secondary	38.5	32.4	34.9	35.6	
Higher	57.6	62.3	62.0	60.4	
Employment (%)					.3
Full-time employment	88.4	85.1	83.0	83.2	
Part-time employment	7.5	8.5	9.0	9.6	
On part-time pension	0.7	1.1	0.8	0.4	
Student or on study leave	3.4	5.3	7.2	6.8	
AUDIT-C: risk-level drinking (%)					< .01
No	72.7	77.2	72.7	67.7	
Yes	27.3	22.8	27.3	32.3	
Physical exercise below guideline (%)					
No	53.3	48.5	47.0	42.0	< .05
Yes	46.7	51.5	53.0	58.0	
Insufficient sleep (%)					< .001
Getting enough sleep nearly always or often	81.0	78.2	75.6	61.4	
Getting enough sleep rarely/never	19.0	21.8	24.4	38.6	
Midpoint of sleep on free days (mean in hh:m, SD)	2:54 (1:40)	3:31 (0:51)	¤:04 (0:52)	4:57 (1:09)	< .001
Social jet lag (mean in hh:m, SD)	0:20 (3:12)	0:57 (1:47)	1:08 (1.36)	1:25 (1:53)	< .001

Abbreviation: AUDIT-C, The Alcohol Use Disorders Identification Test-Concise.

method with 1000 bootstrapping resamples with the bias-corrected confidence intervals (CI). All the mediation analyses were adjusted for sex and age. For the mediation analysis, we used the R software version 4.5.0.

Results

Descriptive characteristics

As shown in Table 1, Evening-types were on average younger than Morning-types in our sample ($p < .001$) and more often men than women ($p < .05$). Regarding health behaviors, risk-level drinking was more common among Definite circadian types, especially among Definite Evening-types ($p < .01$). Evening-types, especially Definite Evening-types, had more often insufficient sleep ($p < .001$) and physical activity below guidelines ($p < .05$). Education level and employment status did not differ significantly among circadian types. In line with self-estimated circadian type, midpoint of sleep on free days was significantly later among Evening-types as compared with Morning-types, being latest among Definite Evening-types and earliest among Definite Morning-types ($p < .001$). The average amount of social jet lag was significantly higher among Evening-types as compared with Morning-types, being highest among Definite Evening-types and lowest among Definite Morning-types ($p < .001$).

Work-life balance and mental health among circadian types

As shown in Table 2, in both models, Definite Evening-types had more often problems regarding work spillover and poorer recovery from work as compared with Definite Morning-types. Moderate Morning-types also had poorer recovery from work in both models than Definite Morning-types, although not as poor as Definite Evening-types.

Regarding mental health, Definite Evening-type was associated with healthcare-treated depression, healthcare-treated anxiety, MHI-5-based psychological distress, GAD-7- based general anxiety, and suicidal thoughts in both models. Definite Evening-type was associated with PHQ-9-based depression in model 1 (adjusted for sex and age), but the association was no longer significant in model 2. In both models, Moderate Evening-type was also associated with healthcare-treated depression, healthcare-treated anxiety, MHI-5-based psychological distress, and suicidal thoughts than Definite Morning-types. Compared with Definite Morning-type, Moderate Morning-type was associated with healthcare-treated anxiety in both models (Table 2).

Work-life balance and mental health

As shown in Table 3, poorer work-life balance was associated with poorer mental health. In both models, higher work-life spillover was associated with higher risk for healthcare-treated depression, healthcare-treated anxiety, MHI-5-based psychological distress, GAD-7-based general anxiety, PHQ-9-based depression, and suicidal thoughts. Similarly, poorer recovery from work was associated with healthcare-treated depression, healthcare-treated anxiety, MHI-5-based psychological distress, GAD-7-based general anxiety, PHQ-9-based depression, and suicidal thoughts.

Role of work-life balance in the associations between circadian type and mental health

As shown in Table 2, work-life spillover moderated the associations between circadian type and mental health in such a way that higher work-life spillover was associated with a greater risk for mental health problems. Higher work-life spillover was associated with increased risk for healthcare-treated depression, especially among Moderate Morning-types, while the effect was smaller among Moderate Evening-types and Definite Evening-types. Higher work-life spillover was associated with increased risk for MHI-5-based psychological distress, GAD-7-based anxiety, and PHQ-9-based depression among all circadian types. Higher work-life spillover was associated with increased risk for healthcare-treated anxiety among moderate circadian types and suicidal thoughts among Moderate Morning-types. Similarly, poor recovery from work was associated with increased risk for healthcare-treated depression, MHI-5-based psychological distress, GAD-7-based anxiety, and PHQ-9-based depression among all circadian types. Poor recovery from

Table 2
Generalized linear models (GLM) on work-life balance measures and mental health by circadian type and moderation by work-life balance on the association between mental health and circadian type

	Definite evening-type			Moderate evening-type			Moderate morning-type			Definite morning-type		
	Est	95% CI		Est	95% CI		Est	95% CI		Est	95% CI	
		Lower	Upper		Lower	Upper		Lower	Upper		Lower	Upper
Work-life balance												
Work-life spillover												
Model 1	0.6	0.3	0.9***	0.2	-0.09	0.5	0.2	-0.05	0.5	*Ref.*		
Model 2	0.5	0.2	0.8**	0.08	-0.2	0.4	0.2	-0.1	0.5	*Ref.*		
Recovery from work												
Model 1	0.9	0.6	1.2***	0.3	0.08	0.6*	0.3	0.0.8	0.6*	*Ref.*		
Model 2	0.9	0.6	1.2***	0.3	0.02	0.5	0.3	0.01	0.6*	*Ref.*		
Mental health												
Healthcare register-based depression (Yes N = 140, No N = 2126)												
Model 1	3.5	1.8	6.7***	2.5	1.3	4.7**	1.8	0.9	3.6	*Ref.*		
Model 2	4.2	1.9	9.0***	3.0	1.4	6.5**	2.1	0.9	4.7	*Ref.*		
Work-life spillover × Circadian type	1.2	1.1	1.3*	1.3	1.1	1.2***	1.5	1.2	1.7***	1.1	0.9	1.5
Recovery from work × Circadian type	1.3	1.1	1.4***	1.3	1.1	1.4***	1.5	1.3	1.7***	1.3	1.1	1.6*
Healthcare register-based anxiety disorder (Yes N = 257, No N = 2009)												
Model 1	2.6	1.6	4.2***	2.8	1.8	4.5***	2.0	1.2	3.2**	*Ref.*		
Model 2	2.7	1.5	4.8***	3.1	1.8	5.3***	2.1	1.2	3.7**	*Ref.*		
Work-life spillover × Circadian type	1.1	0.9	1.2	1.2	1.1	1.3**	1.1	1.1	1.3*	1.2	0.9	1.4
Recovery from work × Circadian type	1.1	0.9	1.2	1.2	1.1	1.3***	1.2	1.1	1.4***	1.3	1.1	1.6**
MHI-5 cutpoint 52p (Yes N = 268, No N = 1961)												
Model 1	2.2	1.4	3.5***	1.8	1.2	2.7**	1.2	0.8	1.8	*Ref.*		
Model 2	1.9	1.2	3.0*	1.7	1.1	2.7*	1.0	0.6	1.7	*Ref.*		
Work-life spillover × Circadian type	1.3	1.1	1.4***	1.3	1.2	1.4***	1.3	1.2	1.5***	1.3	1.1	1.6***
Recovery from work × Circadian type	1.4	1.3	1.6***	1.5	1.3	1.6***	1.5	1.3	1.6***	1.6	1.4	1.9***
GAD-7 cutpoint 10p (Yes N = 96, No N = 2112)												
Model 1	2.8	1.4	5.7**	1.3	0.6	2.6	1.5	0.7	3.0	*Ref.*		
Model 2	2.6	1.2	5.6*	1.1	0.5	2.5	1.4	0.7	3.2	*Ref.*		
Work-life spillover × Circadian type	1.3	1.1	1.5**	1.6	1.3	2.0***	1.5	1.2	1.8***	1.7	1.2	2.3**
Recovery from work × Circadian type	1.3	1.1	1.5***	1.5	1.3	1.8***	1.4	1.2	1.7***	1.7	1.3	2.2***
PHQ-9 cutpoint 10p (Yes N = 164, No N = 2045)												
Model 1	1.8	1.1	3.0*	1.2	0.8	2.0	1.1	0.7	1.8	*Ref.*		
Model 2	1.5	0.9	2.6	1.1	0.7	1.9	1.1	0.6	1.9	*Ref.*		
Work-life spillover × Circadian type	1.3	1.1	1.5**	1.4	1.2	1.6***	1.3	1.1	1.5**	1.5	1.2	1.8***
Recovery from work × Circadian type	1.6	1.4	1.9***	1.6	1.4	1.8***	1.3	1.2	1.5***	1.5	1.3	1.8***
Suicidal thoughts (Yes N = 121, No N = 2137)												
Model 1	2.7	1.4	5.1**	2.1	1.1	3.8*	1.2	0.6	2.4	*Ref.*		
Model 2	2.9	1.4	6.2**	2.3	1.1	4.8*	1.6	0.8	3.6	*Ref.*		
Work-life spillover × Circadian type	1.1	0.9	1.3	1.1	0.9	1.3	1.3	1.1	1.6*	1.2	0.9	1.6
Recovery from work × Circadian type	1.2	1.1	1.4**	1.3	1.1	1.5***	1.4	1.2	1.7***	1.4	1.1	1.7**

Abbreviations: Est, The parameter estimates B for linear GLM performed for work-life balance outcomes; GAD-7, General Anxiety Scale; MHI-5, Mental Health Inventory; OR, odds ratios for binary logistic GLM performed for mental health outcomes; PHQ-9, Patient Health Questionnaire depression module.
Statistical significance indicated by *$p < .05$, **$p < .01$, ***$p < .001$. *High score in work-life spillover and recovery from work indicates less problems in direct GLM analyses.*

work was associated with increased risk for healthcare-treated anxiety among moderate circadian types and Definite Morning-types but the moderation effect was nonsignificant among Definite Evening-types.

As illustrated in Fig. 1, recovery from work partially mediated the association between circadian type and healthcare-treated anxiety by explaining 12.7% of the association. There were no other significant mediation effects regarding recovery from work on the associations between circadian types and mental health and thus these are not reported.

Discussion

Findings from this study show—for the first time on a population-based working adult sample—that Evening-types had more issues than other circadian types regarding work spillover to personal life and poor recovery from work and that these factors moderated and partly mediated poor mental health among Evening-types. Our findings show that Evening-types not only have more issues regarding work-life balance but also poorer mental health than other circadian types. Our findings on mental health among circadian types are in line with the strong previous evidence that Evening-types are at a higher risk of mental health problems, also in terms of more visits to health care due to mental disorders, as shown in our study.[3,16-18] Previous studies on work-life balance issues among Evening-types, on the other hand, are lacking and therefore, our findings offer novel insights into work-life balance issues and circadian types.

Both healthcare treatments for depression and anxiety were more frequent among Evening-types as indicated also in a previous large population-based study among Finnish adults regarding hospital treatments.[3] Mental health questionnaires on psychological distress, general anxiety, and depression all confirmed poorer mental health among Evening-types in this study. Furthermore, our findings indicated more suicidal thoughts among Evening-types. Previous findings on higher suicidal ideation and behavior among Evening-types as compared with other circadian types have been suggested to be mediated through sleep problems and poor mental health.[40] However, suicidal thoughts in our study were emphasized among Evening-types even when insufficient sleep was controlled for, so poor sleep and poor lifestyle are unlikely to solely explain the elevated suicidal thoughts among Evening-types. Rather, suicidal ideation and behavior among Evening-types is likely a result of a combination of exposures.

Our findings on Evening-types being more likely to engage in health risk behaviors, such as risk-level drinking, physical activity

Table 3
Generalized linear models (GLM) on mental health by the indicators of work-life balance

	Work-life spillover			Recovery from work		
	OR	95% CI		OR	95% CI	
		Lower	Upper		Lower	Upper
Healthcare register-based depression						
Model 1	1.3	1.2	1.4***	1.3	1.2	1.4***
Model 2	1.2	1.2	1.4***	1.3	1.2	1.4***
Healthcare register-based anxiety disorder						
Model 1	1.1	1.1	1.2***	1.2	1.1	1.3***
Model 2	1.1	1.1	1.2***	1.2	1.1	1.3***
MHI-5 cutpoint 52p						
Model 1	1.3	1.2	1.4***	1.5	1.4	1.6***
Model 2	1.3	1.2	1.4***	1.5	1.4	1.6***
GAD-7 cutpoint 10p						
Model 1	1.5	1.3	1.6***	1.5	1.3	1.6***
Model 2	1.4	1.3	1.6***	1.4	1.3	1.6***
PHQ-9 cutpoint 10p						
Model 1	1.4	1.3	1.5***	1.5	1.4	1.6***
Model 2	1.4	1.2	1.5***	1.5	1.4	1.6***
Suicidal thoughts						
Model 1	1.2	1.1	1.3***	1.3	1.2	1.4***
Model 2	1.2	1.1	1.3***	1.3	1.2	1.4***

Abbreviations: Est, The parameter estimates B for linear GLM performed for work-life balance outcomes; GAD-7, General Anxiety Scale; MHI-5, Mental Health Inventory; OR, odds ratios for binary logistic GLM performed for mental health outcomes; PHQ-9, Patient Health Questionnaire depression module.
Statistical significance indicated by $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$. High score in work-life spillover and recovery from work indicates less problems in these analyses.

below guidelines, and insufficient sleep than other circadian types, are in line with previous findings.[14,23-25] Poor health behaviors and sleep problems are known to increase the risk of mental health problems,[21,22,41,42] but controlling for these did not significantly alter the associations found between Evening-types and poor mental health. To be noted, we did not investigate smoking habits, diet, overweight, or sleep disturbances beyond insufficient sleep in this study, although these have been shown to associate with both circadian type and mental health outcomes.[43,44] Although insufficient sleep has previously been shown to partly mediate the association between Evening-type and mental health,[3] it does not seem to solely explain, or even when combined with excessive alcohol consumption or low physical activity, poor mental health among Evening-types. Also, the associations between Evening-type and work-life problems, in terms of work spillover to personal life and poor recovery from work, were robust even after adjustment for health behaviors and sleep. A previous population-based study on Finnish working-age adults found that insufficient sleep partly mediated poorer work ability among Evening-types.[2] Based on our results, it seems that work-life balance issues among Evening-types cannot be explained, at least not solely, by risky health behaviors or sleep. In this study, sleep and physical activity were based on self-report to describe habitual behavior instead of more accurate objective measurements,[45,46] which, on the other hand, may be limited in capturing behavior only on a certain time point rather than habitual behavior. Our findings suggest that Evening-types are more likely to have a mismatch between sleep-wake schedules on working days and free days—in line with a previous population-based study.[14] This supports our hypothesis that Evening-types are under more restrain due to differences in societal schedules and innate rhythms.

A small study from Italy found that workaholism was more common among Evening-types than among other circadian types.[47] If Evening-types indeed have a higher tendency toward workaholism, this could at least partly explain the issues found in our study, regarding work spillover to personal life. On the other hand, for Evening-types, some work tasks may be harder to perform during daytime work hours due to daytime tiredness and alertness peaking in the evening, and thus, those tasks may be left to be performed after work. Work-life spillover issues and poor recovery from work are a risk factor for work exhaustion, which has previously been shown to be more common among Evening-types than other circadian types.[2,48] A Swedish study found that work exhaustion was associated with high demands, low decision authority, and lack of support at work.[49] Differences in these types of psychosocial characteristics could also influence work-life balance problems among Evening-types, as previously, Evening-types have been shown to have less authority at work than Morning-types.[2]

Our findings bring novel insight into mental health among circadian types by showing that issues regarding work-life balance are associated with mental health and circadian types. All in all, work-life balance issues relating both to spillover of work to free time and poor recovery from work were associated with mental health problems regarding all mental health measures examined in this study from questionnaire-based to actual healthcare treatments.

We found that higher spillover of work to personal life had a moderating role in the association with depression treatments among Moderate Morning-types in particular, but also among moderate circadian types and Definite Evening-types. Higher spillover of work to free time was associated with increased risk for questionnaire-based psychological distress, anxiety, and depression among all circadian types but regarding suicidal thoughts and treated anxiety, only among moderate circadian types. The finding that the association of work spillover to free time with mental health was common particularly among moderate circadian types remains a question that needs further research. Poor recovery from work had

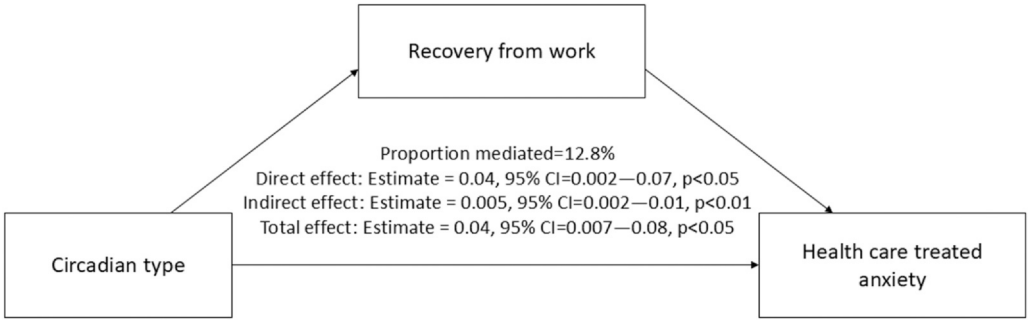


Fig. 1. Mediating effect of recovery from work on the association between circadian type and healthcare-treated anxiety. Indirect effect indicates the average mediation effects when the influence of circadian type on mental health goes through the mediator, recovery from work. Direct effect indicates the average direct association between circadian type and mental health when recovery from work is included in the model. Total effect indicates the influence of both indirect and direct effect on the association between circadian type and mental health. Proportion mediated describes the proportion of the effect of the circadian type on mental health that goes through the mediator, recovery from work

also a moderating effect regarding the associations between all examined mental health outcomes among all circadian types, with the exception of healthcare-treated anxiety for which the association was present only among moderate circadian types and Definite Morning-types. Recovery from work also had a moderated mediation effect on healthcare-treated anxiety, as it also partly mediated the association between circadian type and treated anxiety. All in all, issues in work spillover to private life and poor recovery from work seem to play a significant role in contributing to poor mental health among circadian types with Evening-types being of particular risk for these issues.

Strengths and limitations

The strengths of this study include the robust mental health measures including not only validated mental health questionnaires but also nationwide register-based healthcare information on depression and anxiety disorders. Furthermore, our study sample is derived from a representative population-based sample of working aged adults in Finland and not limited to a specific profession. Limitations include a relatively limited sample size when analyzing complex interactions, such as mediation and moderation. Also, our findings should be interpreted with caution in populations outside of Nordic or Western countries before they are replicated in other populations. Circadian-type assessment based on a single item may overestimate prevalence of Evening-types somewhat as compared with using a 6-item short MEQ questionnaire, although both have shown to be strong indicators for the innate circadian type.[28] Previously, it has also been shown that objectively measured circadian period correlates with self-reported circadian type.[8] The study would have benefitted from also having objective measurements of sleep and physical activity and further investigation on the influence of different sleep disturbances and health behaviors is warranted to estimate the role of lifestyle. We need to point out a limitation here. Common method variance is a potential problem in behavioral research, as correlations among variables assessed with the same method will likely be inflated.[50] It introduces a variance in scores attributable to the method used to measure a construct, rather than the construct it represents.[51] This bias refers to variance due to measurement methods that distort the relationships between variables because they are all measured using the same method, at the same point in time, and often from the same source such as a self-report questionnaire.[52] Common method bias is a concern in our study as well because our measures were taken at the same time from the same self-report. This bias in our findings, especially regarding those using a self-reported question on suicidal thoughts, needs to be considered. Therefore, our results that are based on self-reported mental health outcomes need cautious interpretation given that they are vulnerable to inflation due to common method variance.

Conclusion

This study shows, for the first time in a population-based working adult sample, how circadian types differ regarding work-life balance issues and how these are associated with mental health among circadian types. Work spillover to personal life and poor recovery from work was emphasized among Evening-types as compared with Morning-types. These work-life balance issues were also associated with all examined mental health problems. They also mediated healthcare-treated anxiety, among moderate circadian types and definite Evening-types. In line with previous studies, Evening-types were more likely to have psychological distress, general anxiety, depression and suicidal ideation, as well as healthcare treatments for depression and anxiety. Based on these findings, work-life balance issues may have an important role in contributing to mental health among circadian types and thus can be considered in potential future interventions to mitigate mental health problems, especially among Evening-types.

Author contributions

IM, MV: Conceptualization. IM: Data curation, Formal analysis, Investigation, Methodology, Project administration, Funding acquisition, Writing – original draft. TP, IM, and PV: Resources. All authors: Writing – review and editing, Approval of the final version.

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Data availability

Data supporting the findings are governed by Finnish Institute for Health and Welfare and restrictions apply to the availability of these data.

Declaration of conflicts of interest

None to declare.

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