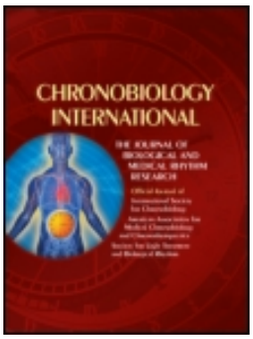

Taylor & Francis
Taylor & Francis Group

Chronobiology International

The Journal of Biological and Medical Rhythm Research

ISSN: 0742-0528 (Print) 1525-6073 (Online) Journal homepage: informahealthcare.com/journals/icbi20

Evening types are prone to depression

Ilona Merikanto, Tuuli Lahti, Erkki Kronholm, Markku Peltonen, Tiina Laatikainen, Erkki Vartiainen, Veikko Salomaa & Timo Partonen

To cite this article: Ilona Merikanto, Tuuli Lahti, Erkki Kronholm, Markku Peltonen, Tiina Laatikainen, Erkki Vartiainen, Veikko Salomaa & Timo Partonen (2013) Evening types are prone to depression, Chronobiology International, 30:5, 719-725, DOI: 10.3109/07420528.2013.784770

To link to this article: https://doi.org/10.3109/07420528.2013.784770

Chronobiology International, 2013; 30(5): 719–725

ISSN: 0742-0528 print / 1525-6073 online
DOI: 10.3109/07420528.2013.784770

informa
healthcare

Evening types are prone to depression

Ilona Merikanto[1,2], Tuuli Lahti[1,3], Erkki Kronholm[4], Markku Peltonen[4], Tiina Laatikainen[4,5,6], Erkki Vartiainen[4], Veikko Salomaa[4], and Timo Partonen[1]

[1]Department of Mental Health and Substance Abuse Services, National Institute for Health and Welfare, Helsinki, Finland, [2]Department of Biosciences, University of Helsinki, Helsinki, Finland, [3]Department of Behavioural Sciences and Philosophy, University of Turku, Turku, Finland, [4]Department of Chronic Disease Prevention, National Institute for Health and Welfare, Helsinki and Turku, Finland, [5]Institute of Public Health and Clinical Nutrition, University of Eastern Finland, Kuopio, Finland, and [6]Hospital District of North Karelia, Joensuu, Finland

Certain preferences for the timing of daily activities (chronotype) may predispose an individual to sleep problems and mood disorders. In this study, we have examined the link between chronotypes and depression. Participants ($N = 6071$) were recruited from a random sample of the general population aged 25 to 74 yrs living in defined geographical areas, as part of the National FINRISK Study in 2007 in Finland. Chronotype assessment was based on six items from the original Horne-Östberg Morningness-Eveningness Questionnaire. Depression was assessed with four self-reported items, including two probes for a diagnosis of a major depressive episode, diagnosed or treated depression, and use of antidepressants. We also analyzed correlations between chronotype and several health indicators, such as systolic and diastolic blood pressures, resting heart rate, weight, and waist circumference. The odds ratios for a range of indicators of depression were higher for evening types (2.7- to 4.1-fold) and intermediate types (1.5- to 1.9-fold) than for morning types. Our results suggest that individuals having a preference for evening hours to carry out their daily activities are prone to depression. (Author correspondence: ilona.merikanto@helsinki.fi)

Keywords: Antidepressant, chronotype, circadian, depressive, diurnal, morningness

INTRODUCTION

Humans can be classified into three chronotypes based on the timing of physiological functions and their preference in daily activities (Duffy et al., 1999, 2001; Horne & Östberg, 1976). Several earlier studies with relatively small sample sizes have demonstrated that evening types have a greater likelihood for depressive symptoms or major depression compared with other chronotypes (Abe et al., 2011; Antunes et al., 2010; Drennan et al., 1991; Chelminski et al., 1999; Gaspar-Baba et al., 2009; Hasler et al., 2010; Hidalgo et al., 2009; Kim et al., 2010; Kitamura et al., 2010; Levandovski et al., 2011; Meliska et al., 2011; Selvi et al., 2010). Gaspar-Baba and colleagues (2009) have reported that evening types had more severe depressive symptoms, and Selvi and colleagues (2011) found that evening types were also more prone to attempt violent suicides than other chronotypes. Further, in a study by Paine and colleagues (2006), eveningness was related to a greater likelihood of self-reported morbidity than morningness. The finding that phase-delayed depressed women reported more frequently atypical depressive symptoms is also in line with these reports (Meliska et al., 2011). Moreover, Selvi and colleagues (2007) reported that morningness, not eveningness, increased the likelihood for depressive symptoms after sleep deprivation in healthy individuals. However, there have been some conflicting findings too, as in the study by Taillard and colleagues (2001) where both morningness and eveningness were associated with a more frequent self-reported morbidity related to sleep problems.

In this study, we sought to establish whether evening types have an increased susceptibility to depression. Our aims were to examine any associations between chronotype and depression. Further analyses were undertaken to establish (a) whether such an association is independent of gender, age, education level, and smoking status; and (b) whether there is a physiological marker (based on health examination measures) specific to a chronotype. In contrast to previous studies, our random sample is large and representative of the general adult population of Finland. We use several

Submitted October 4, 2012, Returned for revision January 31, 2013, Accepted March 1, 2013

Correspondence: Ilona Merikanto, Department of Mental Health and Substance Abuse Services, National Institute for Health and Welfare, FI-00271 Helsinki, Finland. Tel.: +358 295248213; E-mail: ilona.merikanto@helsinki.fi

indicators of depression to examine for the first time whether there is a difference in usage of antidepressants between different chronotypes. We also analyze correlations between chronotype and health indicators, such as systolic and diastolic blood pressures, resting heart rate, weight, and waist circumference.

METHODS

Participants

The National FINRISK 2007 Study consisted of a sex- and 10-yr age group–stratified random sample, aged 25–74, living in five geographically defined areas of Finland. From each of the five geographical areas, 2000 inhabitants were randomly sampled from the Population Information System of the national Population Register Centre. Participants were sent self-report questionnaires and attended a health examination that took place locally between 22 January 2007 and 30 March 2007. The total response rate was 67%, with complete data on depression and chronotype available for 6071 participants (90% of the total participation rate).

Assessment

Chronotype was assessed in the self-report questionnaire using six questions taken from the 19-item Horne-Östberg Morningness-Eveningness Questionnaire (MEQ) (Horne & Östberg, 1976). These six original items correlated best with the sum score of the original 19 items in the regression analysis (Hätönen et al., 2008), which represent the timing preference of the intrinsic circadian period (Duffy et al., 1999, 2001). Since our questionnaire was a modified version of the original Horne-Östberg Morningness-Eveningness Questionnaire (MEQ), its psychometric properties were tested. Using regression analyses, the six items used in our study explained 83% of the variation in the sum score (Hätönen et al., 2008). The subsequent covariance structure analysis using maximum likelihood estimation produced a goodness-of-fit index, adjusted for degrees of freedom, of 0.98, with a root mean square residual of 0.023, and a Hoelter's critical N of 658 for a model with a single latent factor behind the correlation matrix, thus justifying the use of the sum score of the six items (CALIS procedure, SAS system; SAS Institute, Cary, NC, USA). These six items indicated that the modified questionnaire is valid.

The sum score on the selected six MEQ items ranged from 5 (evening types) to 27 (morning types) and the mean value for the entire sample of those with information on chronotype (3578 women and 3155 men) was 17.7 (standard deviation being 4.2). The sum score was categorized into three classes, including the definite or moderate morning types (19 to 27 points), the intermediate types (13 to 18 points), and the definite or moderate evening types (5 to 12 points), reflecting the original MEQ sum score scaling.

Depression was assessed with the following four questions (response alternatives in parentheses): (1) ''Have you had during the last 12 months at least a two-week continuous period when you have felt dispirited or depressed?'' (Yes, No); (2) ''Have you had during the last 12 months at least a two-week continuous period when you have lost interest in most of the things that normally feel good, such as hobbies or work?'' (Yes, No); (3) ''Have you been diagnosed or treated for depression by a medical doctor during the last year (12 months)?'' (Yes, No); and (4) ''When is the last time you have used medication for depression?'' (During the past week; 1–4 weeks ago; 1–12 months ago; Over a year ago; Never). These four questions appeared separately in the self-report questionnaire (158 questions in all) and are explicitly referred to as indicators of depression. In the analysis, indicators of depression were dichotomized into ''no symptoms'' and ''one or two symptoms'' for the logistic regression analysis, whereas for the chi-square test they were combined into three dichotomized categories: none vs. one or two symptoms (questions $1+2$); none vs. a diagnosis or treatment (question 3); and none vs. antidepressant medication (question 4).

Health Examination

In the health examination, systolic and diastolic blood pressures (arithmetic mean of three measurements [mm Hg]), the resting heart rate (as beats in 30 s), weight (kg), and waist circumference (cm) were measured. The health examinations took place between 10:55 and 20:10 h, the attendance time being at 14:50 h on average, and there was no marked difference in the assessment time by chronotype.

Statistics

Complete data (on depression and chronotype) were available for 6071 participants. The distribution of chronotypes by key sociodemographic, socioeconomic, and health characteristics are presented in Table 1. First, two-sided chi-square tests were used to judge the statistical significance of the differences in the distribution of chronotypes by each categorized indicator of depression. The level of significance was set at $p<0.005$ (a priori 10 tests to compare evening types with morning types). Subsequently, if there was a significant difference, the post hoc tests to compare evening types with intermediate types were calculated for which the level of significance was set at $p<0.005$ (10 tests). These tests are presented in Table 2.

Second, binary logistic regression analyses were used to estimate the odds ratios (ORs) with 95% confidence limits (CLs) for the indicators of depression for each chronotype, after controlling for gender, age (in years), education level (basic, secondary, higher), and smoking status (no, yes). Depressive symptoms were coded as $1=$ no symptoms and $2=$ one or two depressive symptoms. First, the crude (univariate) association with chronotype was analyzed; second, the model was

TABLE 1. Sociodemographic, socioeconomic, and health-related characteristics across chronotypes.

	Chronotype					
	Men			Women		
Characteristic	Morning (49.8%)	Intermediate (43.1%)	Evening (41.6%)	Morning (50.2%)	Intermediate (56.9%)	Evening (58.4%)
Age (years; mean ± SD)	53.9 ± 12.9	48.4 ± 13.9	43.3 ± 13.1	52.3 ± 13.2	47.9 ± 14.0	44.2 ± 13.6
Education level (%)						
Basic	33.0	19.4	15.6	27.8	17.7	21.6
Secondary	52.9	55.8	58.9	53.1	54.4	53.6
Higher	14.2	24.8	25.5	19.1	28.0	24.8
Smoked in past or present (%)						
No	28.9	29.4	22.4	51.3	47.3	35.9
Yes	71.1	70.6	77.6	48.7	52.7	64.1
Systolic blood pressure (mm Hg; mean ± SD)	140.8 ± 19.0	136.9 ± 18.0	133.3 ± 17.0	136.8 ± 22.1	130.4 ± 19.4	127.6 ± 19.0
Diastolic blood pressure (mm Hg; mean ± SD)	81.9 ± 11.6	81.2 ± 11.3	80.4 ± 11.4	78.2 ± 10.8	76.1 ± 10.4	75.5 ± 10.9
Resting heart rate (beats in 30 s; mean ± SD)	33.6 ± 6.0	33.6 ± 5.8	35.7 ± 6.6	34.4 ± 5.8	34.6 ± 5.6	35.0 ± 6.0
Weight (kg; mean ± SD)	85.2 ± 14.3	84.2 ± 13.8	85.7 ± 14.9	71.3 ± 14.1	70.1 ± 13.9	71.5 ± 15.8
Waist circumference (cm: mean ± SD)	99.0 ± 11.8	96.6 ± 11.8	97.1 ± 12.6	88.3 ± 13.4	86.8 ± 13.4	87.5 ± 14.5

SD = standard deviation.

controlled for gender and age; and finally, the model was for gender, age, education level, and current smoking. Current smoking status was considered because previous studies have pointed out an association of smoking with eveningness and with depression (Broms et al., 2011, 2012; Wittmann et al., 2010). These models are presented in Table 3.

Third, analyses of covariance were calculated to test whether chronotype and depression are associated with each of five parameters (systolic and diastolic blood pressures, resting heart rate, weight, and waist circumference) measured in the health examination. These analyses were adjusted for gender, age, education level, and smoking status, and are presented in Table 4.

Ethics

The National FINRISK 2007 Study was approved by the Coordinating Ethics Committee of the Hospital District of Helsinki and Uusimaa, Finland (no. 20.2.2007/229/E0/06). It was conducted according to accepted international ethical standards (Portaluppi et al., 2010) in accordance with the Declaration of Helsinki and its amendments. All the participants gave written informed consent.

RESULTS

Association of Chronotype With Depression

When compared with morning types, evening types reported having one or both of the two key depressive symptoms (depressed mood, loss of interest) more frequently. Diagnosed depression and use of prescribed antidepressant medication was reported more frequently among evening types as compared with morning types. These results were similar in men and women (see Table 2).

Results from the binary logistic regression analyses confirmed that there was a significant difference in the frequencies of these indicators of depression between all three chronotypes, with evening types having the highest odds ratios and the intermediate types being between evening types and morning types (see Table 3).

Health Examination Findings by Chronotype

Evening types had significantly lower systolic (with no depressive symptoms: $p<0.0001$; with one depressive symptom: $p<0.01$; and with two depressive symptoms: $p<0.0001$) and diastolic (with no depressive symptoms: $p<0.01$ and with two depressive symptoms: $p<0.05$) blood pressures than morning types. Interestingly, morning types with two depressive symptoms had lower systolic ($p<0.01$) and diastolic ($p<0.05$) blood pressures than morning types with no depressive symptoms (see Table 4).

Evening types also had a higher resting heart rate (with no depressive symptoms: $p<0.05$) than morning types, especially those with two depressive symptoms ($p<0.0001$). Concerning waist circumference and weight, evening types with no depressive symptoms or with one depressive symptom had a smaller waist circumference than morning types. This was particularly obvious in those with no depressive symptoms ($p<0.0001$), but less obvious in those with depressive symptoms ($p<0.05$). Also, the t test showed that evening types with two depressive symptoms had significantly bigger waist circumference than evening types with no depressive symptoms ($p<0.05$). Similarly, evening types with no depressive symptoms had lower weight ($p<0.05$) than morning types, but there was no significant weight difference seen in those with depressive symptoms (see Table 4).

DISCUSSION

In terms of key indicators of depression (one or two of the key depressive symptoms, diagnosis or treatment of

TABLE 2. Distribution (%) of depression indicators across chronotypes[a].

	Chronotype					
	Men ($N=2792$)			Women ($N=3268$)		
Depression indicator	Evening ($n=303$)	Intermediate (11)* ($n=1075$)	Morning (1) ($n=1414$)	Evening ($n=425$)	Intermediate (12) ($n=1416$)	Morning (2) ($n=1427$)
Have you had at least two weeks period during the last 12 months when you have felt depressed?						
No	68.0	84.4	91.1	62.8	75.1	84.1
Yes	32.0	15.6	8.9	37.2	24.9	15.9
	Men ($N=2781$)			Women ($N=3253$)		
	Evening ($n=303$)	Intermediate (13) ($n=1070$)	Morning (3) ($n=1408$)	Evening ($n=423$)	Intermediate (14) ($n=1415$)	Morning (4) ($n=1415$)
Have you had at least two weeks period during the last 12 months when you have lost interest in most of the things that normally feel good?						
No	63.4	82.2	87.8	66.7	78.9	85.5
Yes	36.6	17.8	12.2	33.3	21.1	14.5
	Men ($N=2777$)			Women ($N=3246$)		
	Evening ($n=302$)	Intermediate (15) ($n=1068$)	Morning (5) ($n=1407$)	Evening ($n=423$)	Intermediate (16) ($n=1409$)	Morning (6) ($n=1414$)
Depressive symptoms						
None	57.6	78.5	86.0	56.7	71.3	81.4
1 symptom	16.2	9.9	6.9	15.8	11.6	7.3
2 symptoms	26.2	11.6	7.1	27.4	17.1	11.3
	Men ($N=2794$)			Women ($N=3277$)		
	Evening ($n=304$)	Intermediate (17) ($n=1076$)	Morning (7) ($n=1414$)	Evening ($n=426$)	Intermediate (18) ($n=1425$)	Morning (8) ($n=1426$)
Depression diagnosed or treated during last 12 months						
No	87.2	95.2	96.9	82.9	90.4	94.7
Yes	12.8	4.8	3.1	17.1	9.3	5.3
	Men ($N=2752$)			Women ($N=3228$)		
	Evening ($n=297$)	Intermediate (19) ($n=1067$)	Morning (9) ($n=1388$)	Evening ($n=422$)	Intermediate (20) ($n=1405$)	Morning (10) ($n=1401$)
When was the last time you used medication for depression?						
Last week	9.4	3.8	2.6	14.0	8.0	6.1
Last 12 months	4.0	.9	.5	2.2	2.1	1.3
>1 year ago	7.7	6.2	3.8	10.4	9.4	5.6
Never	78.8	89.0	93.0	73.5	80.5	86.9

[a]Evening types as the reference category.
*Significance for (1) to (19): $p<0.001$ and for (20): $p=0.004$.

TABLE 3. Results from logistic regression models to identify independent predictors of depression[a].

Chronotype	Odds ratio	95% confidence limit	
		Lower	Upper
Depressive symptoms			
Model 1			
Evening types	3.86	3.23	4.61****
Intermediate types	1.77	1.55	2.02****
Model 2			
Evening types	3.32	2.77	3.99****
Intermediate types	1.62	1.41	1.85****
Model 3			
Evening types	3.06	2.43	3.87****
Intermediate types	1.56	1.30	1.87****
A diagnosis or treatment for depression			
Model 1			
Evening types	4.14	3.16	5.44****
Intermediate types	1.87	1.48	2.37****
Model 2			
Evening types	4.09	3.08	5.42****
Intermediate types	1.83	1.44	2.32****
Model 3			
Evening types	3.82	2.71	5.37****
Intermediate types	1.54	1.13	2.09**
Antidepressant medication			
Model 1			
Evening types	2.88	2.34	3.56****
Intermediate types	1.68	1.43	1.98****
Model 2			
Evening types	3.09	2.48	3.84****
Intermediate types	1.72	1.46	2.03****
Model 3			
Evening types	2.72	2.07	3.58****
Intermediate types	1.60	1.28	1.99***

[a]Model 1, crude (univariate); model 2, controlled for gender and age; model 3, controlled for gender, age, education level, and smoking status. Morning types as the reference category.
*$p<0.05$; **$p<0.01$; ***$p<0.001$; ****$p<0.0001$.

depression, and use of antidepressant medication), this study suggests that evening types are more prone to depression. This study is the first to correlate physical health measurements derived from a random sample of the adult general population of Finland. Levandovski and colleagues (2011) also drew from a large sample of participants, but because the sample was derived from a rural area, it might not be representative of the adult general population on a nationwide basis.

Our results offer the first evidence of more frequent prescriptions of antidepressant medication among evening types. These findings are in line with studies indicating that morning types appear to be protected from depression (Kitamura et al., 2010), at least if they are not sleep-deprived (Selvi et al., 2010). In a previous study, we found that evening types were also more prone to sleep problems than other chronotypes (Merikanto et al., 2012). Thus, it is not surprising that evening types are also more prone to depression than other chronotypes, since depression and sleep problems are often intertwined (Ivanenko et al., 2005; Tsuno et al., 2005; Urrila et al., 2012).

Even after controlling for depressive symptoms, evening types had lower systolic and diastolic blood pressures as well as a smaller waist circumference than morning types. Evening types also have a significantly faster resting heart rate than morning types (and a faster resting heart rate than intermediate types), whereas intermediate types have a significantly lower weight than morning types (and a lower weight than evening types). These findings might explain some of the reported difference in indicators of morbidity and mortality between chronotypes (Cooney et al., 2010; Lemogne et al., 2011; Nabi et al., 2011).

Moreover, our data indicate that depressed individuals have lower blood pressure, whereas especially among morning types, the more depressed the individual is, the lower the systolic and diastolic blood pressures. In addition, evening types with two symptoms of depression had faster resting heart rates and greater waist circumferences, and they were heavier than those with no symptoms. This indicates that depression might increase the risk of morbidity among evening types. Noradrenergic transmission has been implicated as dysfunctional in depressed individuals (Checkley, 1980; Stone et al., 2011) and may underlie some of the associations we found herein such as a faster resting heart rate. However, because we did not assess any direct indicators of this transmission pathway, it remains speculative.

Cross-sectional studies have shown that the older the individual is, the more likely the individual is a morning type, implying that evening types have a higher total mortality rate than others. Our findings may go some way to explaining this, together with a cluster of other health hazards (see Merikanto et al., 2013, and the references therein) found among evening types (type 2 diabetes, hypertension, insomnia, depressive and anxiety disorders, substance use, nicotine dependence, unhealthy dietary habits). Higher risks for health hazards among evening types might be at least partly related to elevated sleep problems associated with eveningness (Merikanto et al., 2012). On the other hand, there might be a longer-term circadian misalignment underlying a higher risk for these health hazards among evening types. All in all, assessment of chronotype may help indicate certain health characteristics, such as a tendency towards lower blood pressure or higher heart rate, as well as providing additional scope for screening for risks of depression and other potential health hazards.

Limitations

Certain limitations in the study need to be considered. First, the assessment of chronotype was based on self-report only. Confirming the chronotype with the use of physiological measures of circadian rhythms, e.g., core body temperature, would have given more reliable information. However, the large sample size meant that such measurements would be challenging. Second,

TABLE 4. Means ± standard deviations of health examination parameters by chronotype and depressive symptoms[a].

	Chronotype		
Parameter	Morning types ($N=2616$)	Intermediate types ($N=2284$)	Evening types ($N=673$)
Systolic blood pressure			
No depressive symptoms	139.7 ± 21.0	134.4 ± 19.5****	130.9 ± 18.7****
1 depressive symptom	136.3 ± 19.8	129.9 ± 18.0****	128.4 ± 17.6**
2 depressive symptoms	132.0 ± 17.9**	129.9 ± 17.1****	128.6 ± 18.1****
Diastolic blood pressure			
No depressive symptoms	80.3 ± 11.2	78.8 ± 11.2**	77.9 ± 11.1**
1 depressive symptom	80.4 ± 11.8	76.5 ± 10.3**	76.9 ± 10.1
2 depressive symptoms	77.7 ± 11.8*	77.3 ± 10.9****	76.9 ± 12.6*
Resting heart rate			
No depressive symptoms	33.9 ± 5.9	34.2 ± 5.8	35.2 ± 6.4*
1 depressive symptom	33.9 ± 6.1	33.4 ± 5.3	34.7 ± 5.3
2 depressive symptoms	34.9 ± 5.9	34.2 ± 5.3	35.8 ± 6.3****
Waist circumference			
No depressive symptoms	93.4 ± 13.5	91.2 ± 13.4****	91.0 ± 13.8****
1 depressive symptom	95.1 ± 13.9	88.5 ± 14.0****	90.7 ± 14.6*
2 depressive symptoms	94.5 ± 15.9	92.2 ± 14.5*	92.8 ± 16.0
Weight			
No depressive symptoms	78.1 ± 15.5	76.5 ± 15.2*	77.2 ± 16.3*
1 depressive symptom	79.1 ± 15.9	73.5 ± 15.9*	76.7 ± 16.0
2 depressive symptoms	79.0 ± 18.2	77.3 ± 15.5*	78.1 ± 19.0

[a]Analyses of covariances adjusted for gender, age, education level, and smoking status. Morning types and those with no depressive symptoms as the reference categories.
*$p<0.05$; **$p<0.01$; ***$p<0.001$; ****$p<0.0001$.

an apparent difference has been reported between morning types and evening types in the peak time of heart rate (13:30 vs. 17:30 h) during continuous monitoring (Taillard et al., 1990), indicating a circadian rhythm, which may also have influenced our findings on resting heart rate. This is, however, unlikely, since the health examinations during which resting heart rates were recorded in our study took place between 10:55 and 20:10 h, the attendance time being 14:50 h on average, and there was no marked difference in the assessment time by chronotype. Third, the assessment of depression was based on self-report only. However, we were able to use diverse data that have been indicative of depression.

Strengths

A key strength of our study was the large sample size derived from a representative sample of the general population aged 25 to 74 living in different parts of Finland. Second, the relatively high internal consistency of the assessment tools used for chronotype assessment increases the reliability of our results. Third, our study comprised health examinations and thus provided data on blood pressures, resting heart rate, and waist circumference from a population-based random sample.

Conclusions

Eveningness was robustly related to depression on the basis of the self-reported questionnaire data, but the findings from the health examination were more complex and not linear. Therefore, our study indicates that the behavioral trait of eveningness is associated with increased susceptibility to depression.

DECLARATION OF INTEREST

This work was supported by a grant from the Juho Vainio Foundation (to Ms. Merikanto).

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

REFERENCES

Abe T, Inoue Y, Komada Y, et al. (2011). Relation between morningness-eveningness score and depressive symptoms among patients with delayed sleep phase syndrome. Sleep Med, 12, 680–4.

Antunes LC, Jornada MN, Ramalho L, Hidalgo MP. (2010). Correlation of shift work and waist circumference, body mass index, chronotype and depressive symptoms. Arq Bras Endocrinol Metabol, 54, 652–6.

Broms U, Kaprio J, Hublin C, et al. (2011). Evening types are more often current smokers and nicotine-dependent-a study of Finnish adult twins. Addiction, 106, 170–7.

Broms U, Pennanen M, Patja K, et al. (2012). Diurnal evening type is associated with current smoking, nicotine dependence and nicotine intake in the population based National FINRISK 2007 Study. J Addict Res Ther, S2, 002.

Checkley SA. (1980). Neuroendocrine tests of monoamine function in man: a review of basic theory and its application to the study of depressive illness. Psychol Med, 10, 35–53.

Chelminski I, Ferraro F, Petros T, Plaud J. (1999). An analysis of the ''eveningness-morningness'' dimension in ''depressive'' college students. J Affect Disord, 52, 19–29.

Cooney MT, Vartiainen E, Laatikainen T, et al. (2010). Elevated resting heart rate is an independent risk factor for cardiovascular disease in healthy men and women. Am Heart J, 159, 612–19.

Drennan M, Klauber M, Kripke D, Goyette L. (1991). The effects of depression and age on the Horne-Ostberg morningness-eveningness score. J Affect Disord, 23, 93–8.

Duffy JF, Dijk DJ, Hall EF, Czeisler CA. (1999). Relationship of endogenous circadian melatonin and temperature rhythms to self-reported preference for morning or evening activity in young and older people. J Invest Med, 47, 141–50.

Duffy JF, Rimmer DW, Czeisler CA. (2001). Association of intrinsic circadian period with morningness-eveningness, usual wake time, and circadian phase. Behav Neurosci, 115, 895–9.

Gaspar-Barba E, Calati R, Cruz-Fuentes CS, et al. (2009). Depressive symptomatology is influenced by chronotypes. J Affect Disord, 119, 100–6.

Hasler BP, Allen JJ, Sbarra DA, et al. (2010). Morningness-eveningness and depression: preliminary evidence for the role of the behavioral activation system and positive affect. Psychiatry Res, 30, 166–73.

Hidalgo MP, Caumo W, Posser M, et al. (2009). Relationship between depressive mood and chronotype in healthy subjects. Psychiatry Clin Neurosci, 63, 283–90.

Horne JA, Östberg O. (1976). A self-assessment questionnaire to determine morningness-eveningness in human circadian rhythms. Int J Chronobiol, 4, 97–110.

Hätönen T, Forsblom S, Kieseppä T, et al. (2008). Circadian phenotype in patients with the co-morbid alcohol use and bipolar disorders. Alcohol Alcohol, 43, 564–8.

Ivanenko A, Crabtree VM, Gozal D. (2005). Sleep and depression in children and adolescents. Sleep Med Rev, 9, 115–29.

Kim SJ, Lee YJ, Kim H, et al. (2010). Age as a moderator of the association between depressive symptoms and morningness-eveningness. J Psychosom Res, 68, 159–64.

Kitamura S, Hida A, Watanabe M, et al. (2010). Evening preference is related to the incidence of depressive states independent of sleep-wake conditions. Chronobiol Int, 27, 1797–812.

Lemogne C, Thomas F, Consoli SM, et al. (2011). Heart rate and completed suicide: evidence from the IPC cohort study. Psychosom Med, 73, 731–6.

Levandovski R, Dantas G, Fernandes LC, et al. (2011). Depression scores associate with chronotype and social jetlag in a rural population. Chronobiol Int, 28, 771–8.

Meliska CJ, Martínez LF, López AM, et al. (2011). Relationship of morningness-eveningness questionnaire score to melatonin and sleep timing, body mass index and atypical depressive symptoms in peri- and post-menopausal women. Psychiatry Res, 30, 88–95.

Merikanto I, Kronholm E, Peltonen M, et al. (2012). The relation of chronotype to sleep complaints in the general Finnish population. Chronobiol Int, 29, 311–17.

Merikanto I, Lahti T, Puolijoki H, et al. (2013). Associations of Chronotype and Sleep With Cardiovascular Diseases and Type 2 Diabetes. Chronobiol Int 30:470–7.

Nabi H, Kivimäki M, Empana JP, et al. (2011). Combined effects of depressive symptoms and resting heart rate on mortality: the Whitehall II prospective cohort study. J Clin Psychiatry, 72, 1199–206.

Paine SJ, Gander PH, Travier N. (2006). The epidemiology of morningness/eveningness: influence of age, gender, ethnicity, and socioeconomic factors in adults (30–49 years). J Biol Rhythms, 2, 68–76.

Portaluppi F, Smolensky MH, Touitou Y. (2010). Ethics and methods for biological rhythm research on animals and human beings. Chronobiol Int, 27, 1911–29.

Selvi Y, Gulec M, Agargun MY, Besiroglu L. (2007). Mood changes after sleep deprivation in morningness-eveningness chronotypes in healthy individuals. J Sleep Res, 16, 241–4.

Selvi Y, Aydin A, Boysan M, et al. (2010). Associations between chronotype, sleep quality, suicidality, and depressive symptoms in patients with major depression and healthy controls. Chronobiol Int, 27, 1813–28.

Selvi Y, Aydin A, Atli A, et al. (2011). Chronotype differences in suicidal behavior and impulsivity among suicide attempters. Chronobiol Int, 28, 170–5.

Stone EA, Lin Y, Sarfraz Y, Quartermain D. (2011). The role of the central noradrenergic system in behavioral inhibition. Brain Res Rev, 67, 193–208.

Taillard J, Sanchez P, Lemoine P, Mouret J. (1990). Heart rate circadian rhythm as a biological marker of desynchronization in major depression: a methodological and preliminary report. Chronobiol Int, 7, 305–16.

Taillard J, Philip P, Chastang JF, et al. (2001). Is self-reported morbidity related to the circadian clock? J Biol Rhythms, 16, 183–90.

Tsuno N, Besset A, Ritchie K. (2005). Sleep and depression. J Clin Psychiatry, 66, 1254–69.

Urrila AS, Karlsson L, Kiviruusu O, et al. (2012). Sleep complaints among adolescent outpatients with major depressive disorder. Sleep Med 13:816–23.

Wittmann M, Paulus M, Roenneberg T. (2010). Decreased psychological well-being in late 'chronotypes' is mediated by smoking and alcohol consumption. Subst Use Misuse, 45, 15–30.