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Sleep, chronotype, social jetlag, and mental health in resident physicians: A cross-sectional study

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Abstract

Study Objectives: Social jetlag, the difference between imposed and endogenous sleep schedules, may be detrimental to resident physicians' health. The current profiles of sleep habits, particularly the differences between workdays and free days, are unknown in that population. This cross-sectional study of Quebec resident physicians aimed at assessing sleep habits on workdays and free days, and predictors of social jetlag.

Methods:

Residents were recruited via their residency programs and social media to complete an online questionnaire. Measures included means of sleep duration and timing, chronotype, sleep debt, sleep disturbances, and social jetlag. A range of socio-demographic variables, lifestyle characteristics, and mental health indicators were examined as predictors of severe social jet lag using logistic regressions.

Results: A total of 492 residents were included in the study (mean [SD] age, 27.6 [3.6] years; 330 women [67.1%]). The mean sleep duration was 7.15h (95%CI, 7.02-7.28h) on workdays and 8.36h (95%CI, 8.18-8.54h) on free days. The mean sleep debt was 1.59h (95% CI, 1.37-1.81h), and mean social jetlag was 1.37h (95% CI, 1.28-1.47h), with 31.9% (95% CI, 25.0%-39.6%) of residents experiencing ≥2 hours of sleep debt, and 21.8% (95% CI, 16.5%-28.3%) experiencing severe social jetlag. The prevalence of sleep disturbances was 51.7% (95% CI, 44.4%-58.8%). Severe social jetlag was associated with earlier stage of training, later chronotype, decreased physical activity, increased sleep debt, and depressive symptoms.

Conclusions: Many residents experience severe social jetlag, chronic sleep deprivation and sleep disturbances. Importantly, severe social jetlag was associated

with depressive symptoms, suggesting a potential intervention target for promoting resident mental health.

Keywords: sleep; circadian rhythms; residency; medical doctors

Brief Summary

Prior studies note short sleep durations among resident physicians on workdays, yet comprehensive investigations into sleep-wake patterns across their work and free days are lacking. This study aimed to address this gap by examining sleep habits' timing and regularity in residents.

The study unveils a high prevalence of severe social jetlag, chronic sleep deficit, and sleep disturbances among residents. Notably, the association between severe social jetlag and depressive symptoms underscores the potential for interventions to enhance resident mental health. With a link found between severe social jetlag and a late chronotype, this highlights the relevance of considering chronotherapies to alleviate social jetlag among this population.

Introduction

Medical residency has traditionally involved heavy schedules at the detriment of sleep – but paradigms are shifting, with evidence linking poor sleep in resident physicians to poorer functioning such as increased risk of medical errors[1-3] and motor vehicle collisions[3-5]. Sleep is regulated by the interaction of homeostatic and circadian processes[6] and influenced by societal obligations, as reflected by the variation of sleep habits across workdays and free days[7]. The disruption in sleep patterns caused by differing sleep times on workdays and free days is coined social jetlag, akin to traveling across multiple time zones westward on Fridays and returning on Mondays[8]. A misaligned circadian system causes various symptoms, including problems in sleep and digestion[8]. Whereas travel-induced jetlag symptoms are transient, social jetlag and its symptoms persist throughout a working career[9].

Previous studies in resident physicians found a short sleep duration on workdays, and sleep compensation on post-call days[5,10]. Yet, we are not aware of any studies having explicitly investigated the sleep-wake timing and regularity of sleep habits across workdays and free days in residents. The primary aim of this study was to examine the sleep duration, and sleep-wake timing on workdays and free days among resident physicians and to document social jetlag, sleep debt, and sleep disturbances. Importantly, social jetlag is associated with negative long-term outcomes such as depressive symptoms in the general population [11-13]. The evening chronotype (e.g., late circadian clock) typically found in young adults [14] may make residents particularly susceptible to social jetlag. Some evidence also suggests lifestyle factors, such as screen use and physical activities, may modulate social jetlag [15,16]. We therefore also

examined association of sociodemographic, mental health and lifestyle factors with social jetlag.

Methods

Study Design

This study follows the Checklist for Reporting Results of Internet E-Surveys[17]. Participants eligible for this cross-sectional study were resident physicians actively affiliated to any residency program in Québec, Canada. There were no exclusion criteria. Residents were recruited by email via their residency programs and on social media. Recruitment and data collection via open survey were conducted between September and November 2022. Questionnaires were administered online through a custom survey platform (https://www.elaborer.org). View rates were not collected. Electronic informed consent was obtained prior to completing the online questionnaire (either in French or English). Cookies and IP check were not used given that multiple residents might complete the survey from the same hospital computers. A random draw for 50 gift cards of 75 CAD was offered, requiring participants to provide a unique email address. The study received ethical approval from the institutional review board of the University of Quebec in Montreal (#4552_e_2021).

Measures

Sociodemographic information

Participants reported their sex, age, racialized group, residency year of training, and program. Racialized minority group (vs. White) was defined as self-identifying as Arab, Asian, Indigenous, Hispanic, Black or African, or others. Age was stratified as <27, 27 to <29, and ≥ 29 years old. Level of training (post graduate year) was grouped into PGY1, PGY2-3, and PGY4-5.

Sleep Habits

Seven core items of the Munich ChronoType Questionnaire were used to investigate the sleep-wake timing on workdays and free days (Table S1)[18]. Midsleep on free days (sleep corrected) was used as a proxy for chronotype and treated as a continuous variable. Reported sleep-wake timing was used to determine sleep duration on workdays and free days. Sleep debt was calculated as the difference between sleep duration on free days and the mean weekly sleep duration. Social jetlag was calculated as the absolute difference between midsleep time on workdays and midsleep time on free days[9,19]. Social jetlag and sleep debt were further dichotomized as mild (<2 hours) or severe (≥2 hours) in concordance with previous studies[7-9,19,20]. We also asked participants the number of nights of sleep significantly affected by clinical duties in the past month (1 item, range 0-30 nights/month). Sleep disturbances were derived from the third item of the Patient Health Questionnaire (PHQ-9) ("Trouble falling or staying asleep, or sleeping too much").

Mental Health and Lifestyle

The PHQ-9 assessed depressive symptoms in the 2 past weeks (range 0-27; α=0.84, Table S2)[21]. A score >4 defined the presence of at least mild depressive symptoms[21]. The third item (sleep disturbances) was removed for sensitivity analyses. The 7-item General Anxiety Disorder assessed anxiety symptoms in the past 2 weeks (range 0-21; α=0.89), and a score >4 defined the presence of at least mild anxious symptoms[22].

Alcohol use in the past 2 weeks was reported on a 5-point scale ("never", "1-2 times", "3-5 times", "6-10 times", and "everyday") and was recoded dichotomously as 0= "1-2 times" or less and 1= "3-5 times" or more[23]. Cannabis use in the past 2 weeks

was reported on a 4-point scale (“never”, “1-2 times per week”, “3 or more time per week”, and “everyday”) and was recoded dichotomously as 0= never and 1= “1-2 times per week” or more[23].

Daily digital media use in the past 3 months was measured for (1) TV or streaming platforms, (2) social media, and (3) video games[24]. Response options for each type of media included: “never/did not use”, “under 1 hour”, “1–3 hours”, “4–6 hours”, and “more than 6 hours” per day. These categories were recoded as numeric values according to their midpoints (0, 0.5, 2, 5, and 7 hours per day) and were summed to estimate total digital media use (maximum=18 hours/day). Physical activity was measured in Metabolic Equivalent Task (MET)–minutes/week using the International Physical Activity Questionnaire – Short Form[25] and rescaled to mean=0, SD=1.

Statistical Analyses

First, to approximate characteristics of the resident physicians, all analyses below were adjusted using sample weights derived from census data of resident physicians in Québec (Table S2). Raking ratio estimation[26] was applied to calibrate weights to gender, language, age, medical school, and program of training. We examined the weighted means or prevalence of sleep parameters, affective symptoms, and substance use for the total population and as a function of social jetlag severity. Sample means were compared using analysis of variance, and sample prevalence or proportions were compared using Rao-Scott $\chi 2$ tests [27]. Associations of severe social jetlag with sociodemographic, mental health, and lifestyle measures were examined using , age and gender-adjusted logistic regression models. Analyses were conducted in R version 4.1.2[28]. Non-overlapping 95% confidence intervals or $p<0.05$ were

considered statistically significant.

Results

Participants

Of 3906 resident physicians in Québec, 564 (14.4%) participated in the study, and 561 completed the full questionnaire. Data from 492 individuals was used in the present analyses (mean [SD] age, 27.6 [3.6] years; 330 women [67.1%]): 44 participants [7.8%] excluded for missing any demographics and 28 participants [5.0%] for missing sleep-wake timing. Sociodemographic characteristics of the sample are presented in Table 1.

Sleep Duration and Sleep-Wake Timing

The mean sleep duration was significantly shorter on workdays (7.15h [95%CI, 7.02-7.28h]) than on free days (8.36h [95%CI, 8.18-8.54h]; Figure 1A). Sleep-wake timing also differed markedly across workdays and free days. The wake time was significantly earlier on workdays (6.31h [95%CI, 6.24-6.38h]) than on free days (8.26h [95%CI, 8.09-8.44h]). Bedtime was significantly earlier on workdays (22.79h [95%CI, 22.66-22.92h]) than on free days (23.62h [95%CI, 23.46-23.79h]). Mean chronotype was 3.56h [95%CI, 3.42-3.69h], corresponding to an intermediate chronotype (Figure 2)[19]. On average, 5.24 (95% CI, 4.56-6.52) nights were impacted by work in the past month (Figure S1).

Sleep Debt, Social Jetlag, and Sleep Disturbances

The mean sleep debt was 1.59h (95% CI, 1.37-1.81h), with 31.9% of residents (95% CI, 25.0-39.6%]) reaching ≥2 hours per week (Figure S2). Only 0.8% (95% CI, 0.3-2.2%) had negative relative sleep debt (e.g., weekly sleep duration longer than sleep preceding free days). The mean social jetlag was 1.37h (95% CI, 1.28-1.47h), and

21.8% (95% CI, 16.5-28.3%) of residents had a severe social jetlag (Figure 3). Only 1.6% [0.6-4.1%] of residents had a midsleep later during workdays than free days. The estimated prevalence of sleep disturbances was 51.7% (95% CI, 44.4-58.8%). Sleep-onset latency ≥30 minutes was more common on workdays (37.3% [29.9-45.3%]) than on free days (23.9% [18.3-30.5%]). The correlation matrix of sleep variables is presented in Table S3.

Subgroup and Multivariable Analysis

Severe social jetlag was more frequent at earlier levels of training (Table 2). Sleep duration was shorter during workdays in residents with severe social jetlag compared to other residents (6.88h [6.4–7.35h] vs. 7.18h [7.04–7.32h], p=0.001; Figure1B and 1C) but longer during free days (8.79h [8.38 – 9.21h]vs. 8.23h [8.03 – 8.44h], p<0.001). Residents with severe social jetlag (Table 3) more commonly had a severe sleep debt (55.1% [38.0-71.1%] vs. 25.3% [17.8-34.6%]) and a later chronotype (4.12h [3.80 – 4.44h] vs. 3.38 [3.24-3.52h]). Depressive symptoms were also more prevalent (65.4% [54.2%-75.2%] vs. 46.1% [37.7%-54.8%]), even after removing the sleep item of the PHQ-9. Anxiety symptoms did not differ significantly between the groups. There was a non-significant trend for more cannabis and less alcohol use in the severe social jetlag group.

After age and sex adjustment, severe social jetlag was associated with younger age, surgical programs, and earlier level of training (Table 2). Severe social jetlag was also associated with a later chronotype, severe sleep debt, less physical activity, and presence of depressive symptoms. No significant interactions were found between the gender variable and other factors (data not shown).

Interpretation

This cross-sectional study found that 21.8% of resident physicians have severe social jetlag, 31.9% of resident physicians have a severe sleep debt, and 51.7% report sleep disturbances. Severe social jetlag was associated with earlier stage of training, later chronotype, being in a surgical program, decreased physical activity, as well as increased sleep debt. Importantly, depressive symptoms were more common in residents with a severe social jetlag, which corroborates findings in other populations[13,29]. Although the mechanisms remain unclear, there is evidence suggesting that circadian disruption and depressive symptoms are bidirectionally associated[30,31]. In a study of patients with delayed sleep phase disorder, a delayed circadian phase compared to bedtime was found to be strongly associated with depressive symptoms, even after controlling for total sleep time and other potential confounding variables[32]. Reduction of social jetlag and circadian misalignment, namely via psychoeducation and light therapy, are thus interesting avenues to potentially reduce depressive symptoms in resident physicians[33,34].

Severe social jetlag was recently estimated to affect 30.4% of U.S adults aged 20 to 39 [7]. The lower prevalence in our sample might be explained by a tendency towards morningness in resident physicians compared to the general population[19]. Yet, despite a 2-hour advancement of wake time on workdays in our sample, there was only a 50-minute advance of bedtime. This small shift in bedtime may reflect challenges associated with going to bed earlier, including a strong circadian arousal signal preceding bedtime[35]. Accordingly, a ≥30min sleep onset latency was more common on weekdays then free days. Sleep disturbances were reported by more than half of our sample, which is yet lower than a recent Syrian study (n=514) in which 79.5% of

residents had poor sleep quality, as defined by the Pittsburgh Sleep Quality Index[36]. Working conditions might account for differences in estimated prevalence[36]. Nonetheless, sleep disturbances appeared more common in our sample than in the general population, with U.S. studies reporting that 20-30% of adults have sleep disturbances[7,37]. Differences in measurement methods and definitions prevent definitive comparisons between populations, but our results underscore that sleep disturbances is a major challenge among resident physicians. The proportion of residents having symptoms severe enough to meet criteria for shiftwork disorder remains to be investigated. Social jetlag and shiftwork disorder both result from circadian misalignment, but shiftwork disorder's definition adds the dimension of symptoms resulting from the irregular work schedule. Shiftwork disorder is defined by insomnia or excessive daytime sleepiness associated with work schedule overlapping time for sleep[38].

Chronotype was a strong risk factor for severe social jetlag among residents in our study, despite some prior evidence for a fit between speciality choice and one's biological clock[39]. Extremely early schedules, like in surgical programs, might challenge the biological clock beyond its entrainment capacity. We accordingly found that a surgical speciality program was a risk factor for severe social jetlag. A more advanced level of training was associated with less social jetlag, even after controlling for age. We hypothesize that this finding might reflect changes in expectations towards residents as they move towards practice (e.g., junior residents on site and senior residents taking home calls). Additional studies are warranted to further understand whether this trend maintains after graduation, and how it might differentially impact clinicians in academic vs. community centres.

Aligning biological and social clocks is increasingly considered in the management of obesity, diabetes, and cardiovascular disease [8,9,40,41]. According to a cross-sectional study of Portuguese working adults, each additional hour of social jetlag increases cardiovascular risk by 31% (OR= 1.31 [95%CI, 1.02-1.68][42]. Among healthcare workers specifically, social jetlag was shown to be associated with obesity [43]. Although metabolic measurements were not available, we found that residents with severe social jetlag reported less physical activity.

Alcohol and cannabis are known to disrupt sleep[44,45], and previous study found increased substance use in individuals with a later chronotype[8,46,47]. Although earlier studies suggested social jetlag might mediate this association[8], later studies did not corroborate such hypothesis[29,46]. A 3-year longitudinal study of undergraduates indeed found no support for social jetlag as a predictor of substance use, and rather suggested that this association pertains to shared psychological factors, including lower self-control and increased sensation-seeking[46,47]. Accordingly, our study did not identify substance use as a major risk factor for social jetlag in residents. The effects of other substances on social jetlag in resident physicians, including prescription drugs, remain to be explored.

The estimated sleep duration on workdays was 7.15h in our study, which is longer than the sleep duration of 6.9h (± 1.0h; free days and workdays combined) recently reported in a sample of 4826 U.S. resident physicians[3]. The latter study, however, did not report sleep differences across free days and workdays. The longer sleep duration in our sample may be attributed to Quebec's 16-hour work shift cap [3,48]. Accordingly,

a study of U.S. pediatric residents with working shifts ≤16h found a mean sleep duration of 7.5h[49]. The sleep duration in our sample was slightly shorter than the estimated sleep duration of 7.63h reported amongst 20- to 39-year-old US adults[7], but the high prevalence of sleep extension on free days in our sample suggests unmet needs for sleep. We indeed estimated that the sleep debt among resident physician was 1.37 hours, and 31.9% accumulated at least 2 hours per week which is much higher than 12.8% reported amongst young US adults[7]. Sleep compensation has been documented in studies assessing pre/post-call sleep in internal medicine residents, with sleep episodes often >9h while recuperating[10,50,51]. In Quebec, some regulations might facilitate sleep compensation including calls of a 16-hour duration, an 8-hour sleep period protected following calls and a maximum of five-night call periods in a row[51]. Regular workdays are limited to 12 hours daily from Monday to Friday. Moonlighting is also uncommon in Quebec given strict regulation[52]. A growing body of evidence suggests that sleep debt is associated with obesity, diabetes, and poorer cardiovascular health[31,53-56], and it is unclear that sleep compensation attenuates those risks[57]. There is a need for prospective studies in physicians to assess the efficacy of sleep compensation for mitigating negative outcomes associated with chronic sleep debt.

Limitations

This study is novel in its detailed assessment of sleep patterns in a large, well-characterized sample of residents. However, information on sleep data was self-reported rather than objectively measured and is therefore subject to a recall bias. Data on sleep disturbances was derived from a single item of the PHQ-9 rather than more extensive scales, such as the Pittsburgh Sleep Quality Index . The extent of

impact of night-time work is unknown and participants were not assessed for shiftwork disorder or other sleep or medical disorders. Although uncommon in Quebec, data on moonlighting was not collected. The response rate was low, and limited representation of racialized minority groups constrained subgroup analyses. Data on other provinces was not available.

Conclusion

In this cross-sectional study, resident physicians of Quebec showed variability in sleep habits across workdays and free days, with longer sleep duration and later sleep-wake phase on free days. A high percentage residents experienced long-term sleep deprivation, severe social jetlag, and frequent sleep disturbances. Severe social jetlag was associated with higher levels of depression. These findings underscore the prevalence of sleep disruptions in resident physician and the potential need for environmental and chronotherapeutic approaches to optimize sleep health in this population.

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ABBREVIATIONS

CI : Confidence Interval

IPAQ: International Physical Activity Questionnaire

PHQ-9: Patient Health Questionnaire

PGY: Post Graduate Year

MET: Metabolic Equivalent Task

OR: Odds ratio

SD: Standard Deviation

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Figure 1. Average sleep episodes of resident physicians on workdays and free days

Figure 2. Distributions of chronotype

Legend. Color-coding and population classification as reported in Roen
[19]. For illustrative purposes only, as chronotype was treated as a contin
in the study.

Figure 3. Distributions of Social jetlag

Legend. SJL: social jetlag. Social jetlag was calculated as the absolute difference between midsleep time on workdays and midsleep time on free days [9,19].

Table 1 Participant characteristics

Characteristic	N = 492[1] (Weighted %)
Age	
<27	216 (15%)
27-29	142 (28%)
≥29	134 (57%)
Gender	
Woman	330 (66%)
Man	162 (44%)
Racialized minority group	
No	386 (75%)
Yes	106 (25%)
Faculty	
University of Montreal	31 (31%)
Laval University	205 (21%)
University of Sherbrooke	136 (16%)
McGill University	120 (32%)
Residency program	
Family Medicine	124 (25%)
Medical specialties	191 (42%)
Pediatric specialties	17 (4%)
Surgical specialties	63 (10%)
Psychiatry	57 (13%)
Other specialties	40 (6%)
Level of training	
PGY1	134 (20%)
PGY2-3	216 (39%)
PGY4-5	142 (41%)

Legend: PGY: post graduate year

Table 2. Estimated prevalence and adjusted odds ratio of severe social jetlag in resident physicians by sociodemographic groups

	N, prevalence of severe social jetlag, weighted %	Difference between groups, p-value	Adjusted OR (95% CI), severe social jetlag
Age		0.09	
<27	52, 31.8 [21-42.6]		1 [Reference]
27-29	25, 14.8 [8.9-20.8]		0.37 (0.17-0.82)
≥29	32, 22.7 [17.8-27.6]		0.63 (0.31-1.29)
Gender		0.97	
Woman	62, 21.7 [16.9-26.6]		1 [Reference]
Man	47, 21.9 [16.4-27.5]		0.99 (0.5-1.95)
Racialized minority group		0.24	
No	78, 20.0 [15.9-24.1]		1 [Reference]
Yes	31, 27.1 [19.3-34.9]		1.54 (0.81-2.91)
Faculty		0.29	
University of Montreal	7, 16.3 [10.5-22.1]		1 [Reference]
Laval University	43, 21.8 [13.9-29.8]		1.28 (0.44-3.76)
University of Sherbrooke	24, 18.0 [9.4-26.7]		0.96 (0.28-3.26)
McGill University	35, 29.1 [22-36.2]		2.01 (0.66-6.09)
Residency program		0.12	
Family Medicine	25, 16.8 [10.2-23.3]		1 [Reference]
Medical specialties	43, 18.2 [13-23.5]		1.25 (0.55-2.82)
Pediatric specialties	3, 18.5 [0.2-36.8]		1.20 (0.18-7.84)
Surgical specialties	25, 45.1 [31.3-58.8]		4.30 (1.7-10.88)
Psychiatry	7, 27 [16.1-38]		1.84 (0.48-7.12)
Other specialties	6, 19.6 [5.6-33.6]		1.31 (0.4-4.31)
Level of training		0.01	
PGY1	34, 37.1 [27.5-46.7]		1 [Reference]
PGY2-3	49, 21.8 [16-27.6]		0.47 (0.21-1.06)
PGY4-5	26, 14.5 [9.6-19.3]		0.32 (0.13-0.79)

Legend. Odds ratio (OR) are adjusted for age and gender.

Table 3 Association of chronotype, sleep caracteristics, mental health, and lifestyle of residents with mild and severe social jetlag

Variables	Weighted % or mean		p-value	Adjusted OR (95% CI)
	Mild social jetlag	Severe social jetlag		Severe social jetlag
Chronotype	3.38 [3.24 – 3.52]	4.12 [3.80 – 4.44]	< 0.001	3.01 (1.76 – 5.15)
Nights	5.41 [4.19 – 6.62]	5.70 [4.26 – 7.15]	0.24	1.02 (0.97 – 1.08)
Severe sleep debt	25.3% [17.8%-34.6%]	55.1% [38.0%-71.1%]	< 0.001	1.65 (1.21 – 2.23)
Long sleep onset latency				
Free days	22.4% [16.2%-30.1%]	32.9% [20.2%-48.8%]	0.23	1.35 (0.83 – 2.19)
Workdays	36.1% [27.6%-45.5%]	46.6% [30.8%-63.0%]	0.44	1.24 (0.74 – 2.06)
Depressive symptoms	46.1% [37.7%-54.8%]	65.4% [54.2%-75.2%]	0.03	1.94 (1.04 – 3.62)
Sleep disturbances	50.3% [42.1%-58.4%]	60.6% [48.7%-71.3%]	0.32	1.35 (0.71 – 2.54)
Other symptoms†	39.2% [31.0%-48.0%]	57.5% [42.8%-71.0%]	0.04	2.01 (1.05 – 3.86)
Anxiety symptoms	54.0% [45.6%-62.1%]	50.5% [33.6%-67.3%]	0.59	0.79 (0.39 – 1.61)
IPAQ	0.18 [-0.02 – 0.39]	-0.42 [-0.56 - -0.28]	0.07	0.55 (0.37 – 0.80)
Screentime (h/day)	3.75 [3.17 – 4.33]	3.71 [2.85 – 4.57]	0.12	1.00 (0.92 – 1.1)
TV or streaming	1.67 [1.39 – 1.95]	1.60 [1.24 – 1.96]	0.36	1.01 (0.86 – 1.2)
Social media	1.83 [1.44 – 2.22]	1.95 [1.39 – 2.52]	0.13	1.02 (0.85 – 1.22)
Game	0.22 [0.13 – 0.32]	0.19 [0.02 – 0.35]	0.09	0.98 (0.72 – 1.34)
Alcohol use	47.5% [39.5%-55.7%]	34.3% [21.3%-50.1%]	0.06	0.53 (0.27 – 1.02)
Alcohol binge	14.6% [8.9%-23.0%]	16.2% [6.4%-35.4%]	0.40	1.52 (0.63 – 3.7)
Cannabis use	4.1% [2.2%-7.6%]	7.8% [3.5%-16.6%]	0.06	2.56 (0.86 – 7.64)

Legend. Odds ratio (OR) are adjusted for age and gender. † Score ≥4 on the PHQ-9 after excluding the third item (sleep disturbances) for sensitivity analyses . IPAQ: International Physical Activity Questionnaire (mean=0, SD=1).