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► **To cite this version:**

Julien Coelho, Ilaria Montagni, Jean Arthur Micoulaud Franchi, Sabine Plancoulaine, Christophe Tzourio. Study of the association between cannabis use and sleep disturbances in a large sample of University students. *Psychiatry Research*, 2023, 322, pp.115096. <10.1016/j.psychres.2023.115096>. <hal-04028734>

HAL Id: hal-04028734

<https://hal.science/hal-04028734v1>

Submitted on 31 Mar 2025

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Title: Study of the association between cannabis use and sleep disturbances in a large sample of University students

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1 **1. Introduction**

2 Sleep quality and quantity among University students is a topic of growing concern (Manzar
3 et al., 2015). Emerging adulthood is a vulnerable developmental period characterized by a
4 high frequency of impaired sleep. Previous international studies have shown that poor sleep
5 quality is predominant and concerns 55% of students (Jahrami et al., 2020). Notably, 19% of
6 students complain of insomnia (Jiang et al., 2015). Increased autonomy, academic and social
7 pressure, and irregular sleep-wake times at an age when the circadian rhythm is delayed
8 (Wolfson, 2010) and the central nervous system is still maturing (Drake et al., 2004) could
9 explain the altered sleep patterns in this population. These sleep alterations are all the more
10 concerning because of their detrimental effects on mental and physical health and cognitive
11 capacities, which is especially important for the daily-functioning and academic success of
12 students (Buysse, 2014; Garbarino et al., 2016; Shochat et al., 2014). The Covid-19 health
13 crisis has further aggravated sleep complaints in the French population (Santé Publique
14 France [Public Health France], 2021).

15 Cannabis use, despite being illegal in France, is common among young adults within the
16 country: in 2020, 13.9% used it monthly and 4.0% daily (Nézet et al., 2021). While
17 controversies about its legalization or decriminalization have been ongoing for decades, its
18 high level of consumption in young French adults is of concern as cannabis abuse could set
19 the stage for poor mental and physical health outcomes that persist through adulthood (Brown
20 et al., 2001).

21 In particular, some studies have explored the effect of cannabis use on sleep as an important
22 determinant of health (Angarita et al., 2016; Babson et al., 2017; Kesner and Lovinger, 2020).
23 Early contributions focused on experimental assessment of the immediate effects of cannabis
24 on sleep in small samples via polysomnography (Barratt et al., 1974; Freemon, 1972; Karacan
25 et al., 1976; Nicholson et al., 2004). These studies showed that acute cannabis use decreases

26 sleep latency and wake after sleep onset, increases slow wave sleep, and decreases rapid-eye
27 movement sleep, whereas withdrawal has the opposite effect (Angarita et al., 2016; Babson et
28 al., 2017; Kesner and Lovinger, 2020). However, chronic cannabis users may develop a
29 tolerance for acute effects, leading to increased sleep latency and decreased slow wave sleep
30 (Babson et al., 2017), which is essential to cerebral restoration, recovery, and memorization
31 (Roth, 2009). More recently, observational studies have investigated the relationship between
32 sleep and cannabis use in real-life conditions (Johnson and Breslau, 2001; Kwon et al., 2021;
33 Leger et al., 2022; Navarro-Martínez et al., 2020; Ogeil et al., 2015; Pasch et al., 2012; Roane
34 and Taylor, 2008; Troxel et al., 2021). Some of these studies found an increased frequency of
35 sleep disturbances with increased cannabis use in adolescents (Kwon et al., 2021; Pasch et al.,
36 2012) and young adults (Roane and Taylor, 2008; Troxel et al., 2021).

37 Few studies have focused on University students, although they are particularly affected by
38 sleep complaints. Sample sizes of these studies were often limited and they did not take into
39 account important suspected confounders in the association such as mental health disorders,
40 economic situation, or sleeping drug intake (Hunt and Eisenberg, 2010; Navarro-Martínez et
41 al., 2020; Phillips et al., 2018; Wang and Bíró, 2021; Yurasek et al., 2020). Besides, sleep
42 measurement was usually focused on one single dimension (i.e., insomnia or sleep quality)
43 and cannabis use on one frequency (used/not used in the past month) (Pasch et al., 2012;
44 Troxel et al., 2021).

45 The main aim of this study was to have a thorough analysis of the association between
46 cannabis use and sleep complaints and in a large sample of University students, and to take
47 into account several important individual and behavioral characteristics. Our secondary aim
48 was to evaluate the role of previous mental health diagnoses in this association.

49

50 **1. Methods**

51 *1.1. Study design, setting, and participants*

52 This was a cross-sectional analysis of i-Share, an observational e-cohort study of French-
53 speaking students recruited from universities and higher education institutes in France that
54 started in February 2013. This project (www.i-share.fr) is supported by the French
55 Universities of Bordeaux, Versailles, and Nice. In these partner universities, students were
56 informed about the purpose and aims of the study by flyers, information stands at
57 registrations, during lectures, and via social media and newsletters. Additionally, students not
58 belonging to the three partner universities could also participate in the study. Each participant
59 signed an online informed consent form prior to completing the web-based questionnaire.
60 Information on their health status, socio-demographic characteristics, and lifestyle habits were
61 collected at baseline and by follow-up questionnaires. The i-Share project was conducted in
62 accordance with the Declaration of Helsinki. The protocol was approved by the national
63 authority that ensures that data collection in research does not violate freedoms, rights, and
64 human privacy (number: DR-2013-019). The study protocol was evaluated by the Local
65 Committee for the Protection of Persons of Bordeaux University which indicated that this
66 research was outside the scope of the provisions governing biomedical research. For this
67 study, we used data available up to 21 November 2019.

68 This study concerned only data from the baseline questionnaire for a total of 15,118
69 participants. Exclusion criteria were: being aged under 18 years ($n=26$) for legal
70 considerations or above 30 years ($n=119$) since it was a small sample probably in vocational
71 training rather than initial training; and reporting missing data on variables of interest
72 ($n=186$). The final sample included 14,787 participants ([Figure 1](#)).

73 *1.2. Variables*

74 *1.2.1. Sleep complaints*

75 Self-reported sleep complaints were related to the past 3 months and were: (1) insomnia:
76 “have you had difficulty falling asleep and/or staying asleep (nocturnal awakening)” (3 times
77 or more per week, less than 3 times per week); (2) excessive daytime sleepiness (EDS): “have
78 you been extremely sleepy during the day?” (3 times or more per week, less than 3 times per
79 week); (3) poor sleep quality: “how did you sleep?” (poor, good); and (4) sleep deprivation:
80 “do you feel you lack sleep (at least 1 hour less than your needs)” (weekly or more, less than
81 weekly). Each of these variables referred to a dimension of Sleep Health: insomnia for
82 “Efficiency” (i.e., the ease of falling asleep and returning to sleep), EDS for “Alertness” (i.e.,
83 the ability to maintain attentive wakefulness), poor sleep quality for “Satisfaction” (i.e., the
84 subjective assessment of “good” or “poor” sleep), and sleep deprivation for “Duration” (i.e.,
85 the total amount of sleep obtained per 24h) (Buysse, 2014). We therefore considered that
86 these four sleep complaints conveyed the same sleep construct based on both the Sleep Health
87 framework (Buysse, 2014) and their strong associations with each other and similar
88 relationships with cannabis use and other covariates in preliminary analyses (Table 1,
89 Table S1). For the sake of clarity, we chose to present only insomnia as a representative of the
90 other three categories. Compared to the other three items, the duration (3 months) and
91 frequency (≥ 3 per week) used to define insomnia were consistent with the diagnostic criteria
92 for chronic insomnia disorder in the Diagnostic and Statistical Manual of Mental Disorders
93 (American Psychiatric Association, 2017). Data for other sleep complaints are presented in
94 the supplementary materials. The duration (3 months) and frequency (≥ 3 per week) used to
95 define EDS were close to the definition of the International Classification of Sleep Disorders
96 (i.e., almost daily for at least three months) (American Academy of Sleep Medicine, 2014).

97 1.2.2. Cannabis use

98 Use of cannabis was assessed by asking, “In the last 12 months, have you used cannabis (shit,
99 joint, hashish, weed...)?” This question referred to cannabis as a smoking product containing

100 tetrahydrocannabinol (THC), which is illegal in France and only available on the black
101 market. Cannabidiol use was not included in this definition. Anonymization guaranteed the
102 confidentiality of sensitive data. Responses were categorized into four frequency modalities:
103 daily, weekly (1 to 6 days per week), monthly (1 to 3 times per month), or never/rarely (less
104 than 1 time per month). For the sake of clarity, the variable was dichotomized in stratified and
105 sensitivity analyses and the choice of the threshold was data-driven to regroup categories with
106 similar prevalence of sleep complaints (“daily or weekly” versus “monthly or never/rarely”).

107 *1.2.3. Covariates*

108 Covariates included socio-demographic characteristics, including age (≤ 20 , >20 ,
109 corresponding to the median age), sex (female, male), study field (health studies, scientific
110 disciplines, law and economy, literature, languages and social sciences, other, missing
111 variable), year of study (1st, 2nd, 3rd, $>3^{\text{rd}}$, missing variable), and perceived economic situation
112 (good, neither good nor poor, poor); health behaviors, including usual physical activity
113 (never, ≤ 1.5 h/week, >1.5 h/week), usual tobacco use (no smoking, ≤ 10 cigarettes/day, >10
114 cigarettes/day), alcohol use (≤ 3 days/week, >3 days/week), and sleeping drug intake in the
115 last 3 months (yes, not in the last 3 months), including prescription (42.5%) and over-the-
116 counter (50.9%) medications; and previous mental health diagnoses on lifetime (a health
117 professional has diagnosed depression or anxiety in the past).

118 *1.3. Statistical analysis*

119 Initially, socio-demographic characteristics and health behaviors were described using counts
120 (n) and percentages. *Chi*² or *Fisher's exact test* were used as appropriate for univariate
121 analyses with sleep complaints (insomnia, EDS, poor sleep quality, and sleep deprivation) and
122 cannabis use. The level of significance was set at $p < 0.05$.
123 Multivariate logistic regression was used to explore the relationship between sleep complaints
124 and cannabis use in the main analysis and sensitivity analyses, with sleep complaints as the

125 dependent variable and cannabis use as the main explicative variable. Covariates were
126 selected as adjustment factors if they were associated with sleep complaints and cannabis use
127 in previous studies (age, sex, perceived economic situation, physical activity, tobacco, alcohol
128 and sleeping drug intake) (Phillips et al., 2018; Wang and Bíró, 2021) or in our data (field and
129 year of study). The interaction between each covariate and cannabis use was tested in adjusted
130 models. None were significant at the $p < 0.20$ threshold.

131 To explore whether the relationship was persistent and similar in students with and without
132 previous mental health diagnoses, we performed stratified analyses on the association
133 between cannabis use and sleep complaints according to a previous diagnosis of depression or
134 anxiety. Previous mental health diagnoses were also included as covariates in a sensitivity
135 analysis. Further exploratory stratified analyses were conducted to study the homogeneity of
136 the relationship between sleep complaints and cannabis use according to covariates (age, sex,
137 perceived economic situation, physical activity, tobacco, alcohol and sleeping drug intake).

138 To control for the increase in type I error related to multiple comparisons, all p -values in the
139 stratified analyses were corrected by the Benjamini-Hochberg method (Chen et al., 2017).

140 Finally, to estimate the probability that an unmeasured confounder would have explained
141 away the association between sleep complaints and cannabis use, the *E-value* and lower limit
142 of its *confidence interval (CI)* were calculated (VanderWeele and Ding, 2017). For purposes
143 of comparison, the observed associations of the measured covariates with insomnia and
144 cannabis use were plotted on a graphical representation of the *E-value*.

145 Field and year of study data were missing for a third of the sample. Participants were kept in
146 the analyses and missing values were coded as a separate category. Since the missing data on
147 the other covariates concerned a very small sample (1.2%) and the characteristics of this
148 sample were similar to the population with complete data, it was considered to be data

149 “missing completely at random” and a complete case analysis was performed. Statistical
150 analyses were performed using R version 4.1.2.

151

152

153 **2. Results**

154 **2.1. Sample description**

155 The mean participant age was 20.4 years (SD=2.3, range=18-30 years), 11,166 (75.5%) in the
156 whole sample were female, 5799 (39.2%) were freshmen, and 3430 (23.2%) were attending
157 Health Studies. A total of 1771 (12.0%) students reported a previous diagnosis of depression
158 and 2054 (13.9%) a previous diagnosis of anxiety (Table 1).

159 Regarding the frequency of cannabis consumption, 3030 (20.5%) students reported monthly
160 use, 645 (4.4%) weekly use, and 219 (1.5%) daily use. Weekly or daily cannabis use was
161 more common among male students and those reporting poor perceived economic situation,
162 not being physically active, smoking cigarettes >10 times a day, drinking alcohol >3 times a
163 week, or the use of sleeping drugs. Age was not associated with cannabis use. Students with
164 previous diagnosis of depression and anxiety used more cannabis.

165 Insomnia was declared by 3362 (22.7%) students. Insomnia was more common among female
166 students and those reporting poor perceived economic situation, not being physically active,
167 smoking cigarettes >10 times a day, and the use of sleeping drugs. Age and alcohol
168 consumption were not associated with insomnia. Students with a past history of diagnosed
169 depression or anxiety had more insomnia. Data for other sleep complaints are presented in the
170 supplementary materials (Table S1).

171 **2.2. Association between sleep complaints and cannabis use**

172 The prevalence of insomnia was higher in cannabis users, from 22.3% for never/rarely users
173 to 21.6% for monthly users, 28.8% for weekly users, and up to 41.1% for daily users.
174 Increased frequency of cannabis use was associated with higher likelihood of insomnia (*odds*
175 *ratio* [OR]=1.65 [95% CI 1.42-1.91]). After adjusting for age, sex, field and year of study,
176 perceived economic situation, physical activity, tobacco and alcohol use, and sleeping drug
177 intake, weekly or daily cannabis use remained associated with insomnia (OR=1.45 [1.23-

178 1.72], [Table 2](#)). Estimates increased with the frequency of cannabis use (weekly use: $OR=1.23$
179 [1.01-1.49] and daily use: $OR=1.97$ [1.46-2.66]). Additional adjustments for previous mental
180 health diagnoses as covariates did not modify the estimate. All results were similar for the
181 other sleep complaints ([Table S2](#)).

182 ***2.3. Relationships between sleep complaints, cannabis use, and previous mental health*** 183 ***diagnoses***

184 Insomnia was more common in cannabis users regardless of their previous history of
185 depression ($p=0.005$ for students with a history and $p<10^{-4}$ for students without a history,
186 [Figure 2](#)). Similarly, insomnia was more common in cannabis users regardless of their history
187 of anxiety ($p<10^{-4}$ for students with a history and $p=0.003$ for students without a history).
188 Estimates for daily cannabis use compared to never/rarely use were higher in students with a
189 previous history of depression (OR 4.62 versus 1.58) and anxiety (OR 2.62 versus 1.80).
190 These results were similar for the other sleep complaints ([Figure S1](#)).

191 ***2.4. Stratified and sensitivity analyses***

192 [Figure 3](#) shows the stratified analyses of the association between cannabis use and insomnia
193 according to covariates age, sex, perceived economic situation, physical activity, tobacco,
194 alcohol and sleeping drug intake. The association between cannabis use and insomnia mostly
195 remained significant across all strata and there was no evidence of differences between strata.
196 These results were similar for the other sleep complaints ([Figure S2](#)).

197

198 **3. Discussion**

199 In this large sample of University students, we found that the likelihood of having insomnia
200 was higher by 45% in cannabis users compared to non-users. The estimates steadily increased
201 with frequency of use, reaching a 2.0-fold higher likelihood of insomnia in daily users
202 compared to never/rarely users. Other sleep complaints showed similar associations with
203 cannabis use. Individual and behavioral characteristics, including sex, perceived economic
204 situation, physical activity, tobacco, and alcohol and sleeping drug intake did not entirely
205 explain or modify the association.

206 These findings are consistent with previous observational studies in adolescents and adults
207 that showed that cannabis users have higher rates of insomnia (Roane and Taylor, 2008), EDS
208 (Ogeil et al., 2015), poor sleep quality (Navarro-Martínez et al., 2020; Ogeil et al., 2015), and
209 short sleep duration (Kwon et al., 2021; Pasch et al., 2012), reporting similar estimates for the
210 association between cannabis use (*ORs* between 1.2 in Navarro-Martínez et al. (Navarro-
211 Martínez et al., 2020) and 1.9 in Johnson and Breslau (Johnson and Breslau, 2001)). One
212 study reported no difference in adult participants' sleep quality and insomnia and cannabis
213 use, but the authors analyzed addiction to cannabis (Leger et al., 2022). Associations between
214 sleep complaints and cannabis use were consistent in adults (Ogeil et al., 2015) and
215 adolescents (Kwon et al., 2021; Pasch et al., 2012). One cross-sectional study performed in
216 European medical students found a result similar to ours in a small sample ($n=676$) (Navarro-
217 Martínez et al., 2020). However, cannabis consumption was measured as an overall illicit
218 drug use variable and some confounders (tobacco, sleeping drug intake, and mental health
219 disorders) were not assessed.

220 Mental health disorders, which are known to be associated with both sleep complaints and
221 cannabis use (Hunt and Eisenberg, 2010; Phillips et al., 2018; Wang and Bíró, 2021), were
222 not systematically considered in previous studies (Navarro-Martínez et al., 2020; Yurasek et

223 al., 2020). However, our study showed that students with a previous diagnosis of anxiety or
224 depression had higher rates of sleep complaints and cannabis use than those without previous
225 mental health diagnoses. In addition, by using a stratified analysis, sleep complaints were
226 more common in cannabis users regardless of previous mental health diagnoses. However, the
227 estimates of associations were stronger in students with previous diagnosis of anxiety or
228 depression, suggesting that they deserve special attention, especially as cannabis use is high in
229 this subgroup.

230 Another important issue is the threshold used to define chronic cannabis use. In the present
231 study, the significant association with sleep mostly appeared from weekly consumption and
232 was exacerbated with daily frequency. This result is consistent with a previous study that
233 found a significantly increased risk of sleeping trouble from a consumption rate of more than
234 50 times per year (Johnson and Breslau, 2001) and supports the conclusions of a
235 comprehensive review defining the lower risk use of cannabis below weekly consumption
236 (Fischer et al., 2017). To date, the choice of a threshold for chronic cannabis use varies
237 greatly, from “once a year” (Turner et al., 2003) to “daily use” (Conroy et al., 2016), with the
238 majority of studies using the category “monthly use” (Pasch et al., 2012; Troxel et al., 2021).
239 Our study shows that the use of the “weekly” threshold for chronic cannabis use could better
240 describe its association with sleep, at least in young adults. Therefore, we suggest applying it
241 in future studies in this field of research.

242

243 There are several hypotheses on the mechanism underlying the relationship between sleep and
244 cannabis use. Previous longitudinal studies found that shorter sleep duration and insomnia at
245 baseline are associated with higher rates of cannabis use in follow-up (Pasch et al., 2012;
246 Roane and Taylor, 2008; Troxel et al., 2021), suggesting that sleep may predict chronic
247 cannabis use. The beneficial effects of acute cannabis use on sleep, explained by the

248 inhibition of tricyclic adenosine methyl phosphate (cAMP) at the synapses of the central
249 nervous system (Kesner and Lovinger, 2020), are a frequent motive for consumption
250 (Angarita et al., 2016; Azcarate et al., 2020). In fact, medical cannabis is already used in some
251 countries as a treatment for sleep disorders (AminiLari et al., 2022). As a result, poor sleep
252 quality is found to be a risk factor for relapse following an attempt to quit using cannabis
253 (Babson et al., 2013). Conversely, chronic cannabis use may lead to long-term reduced
254 potentiation of synapses in the release of cAMP, a highly important component of sleep-wake
255 regulation (Zimmerman et al., 2008), resulting in cannabis tolerance and sleep disturbances
256 (Kesner and Lovinger, 2020), in particular in case of withdrawal (Gates et al., 2016).
257 Ultimately, the relationship between sleep and cannabis use may depend on consumption
258 parameters (type of product, time of intake, other consumer factors) and the type of sleep
259 disturbance (insomnia, EDS, or short sleep duration).

260

261 The study findings must be considered in light of certain limitations. First, student recruitment
262 partially used the snowball method and inclusion in the study was on a voluntary basis, which
263 limits the representativeness of our sample for all French students. In particular, females were
264 over-represented (75.5%) and showed more frequent sleep alterations and lower level of
265 cannabis use. Therefore, cautiousness should be taken in interpreting prevalences.

266 Nevertheless, our sample had a 5.8% prevalence of weekly use, which was similar to the
267 results of a 2020 survey of the French general population that showed a prevalence of 6.6%
268 for regular cannabis use (10 times per month) among 18 to 25-year-olds (Nézet et al., 2021).

269 Similarly, the prevalence of insomnia in our sample (22.7%) was equivalent to the 21%
270 prevalence of insomnia found in a 2020 representative study in the general population
271 (Institut National du Sommeil et de la Vigilance [National Institute of Sleep and Alertness],
272 2021), suggesting that our sample was comparable to the general population for the variables

273 of interest. Moreover, stratified analyzes showed consistent results across strata, including
274 both sexes, which further supports that the lack of representativeness of this sample should
275 not hinder the interpretation of associations between variables of interest (Rothman et al.,
276 2013).

277

278 Second, both sleep complaints and cannabis use were self-reported and not based on validated
279 questionnaires, and there was no assessment of the daytime impact of insomnia, which may
280 have led to some misclassifications. Cannabis use is illegal in France, so it is possible that
281 some students underreported its use even if they were informed that their answers were
282 confidential. In addition, our study focused on frequency of cannabis use and did not take into
283 account the dose and duration of use or addiction. This measurement difference could explain
284 the inconsistent results of previous studies (Leger et al., 2022) and should be explored further
285 to understand which dimension has to be considered in the relationship with sleep. Third,
286 sleep complaints could be subject to variability when reported in association with
287 consumption. In addition, self-assessment of the quality of sleep could be ambiguous
288 depending on whether the subject describes typical nights with consumption or typical nights
289 without it. This response variability probably depends on cognitions relating to the
290 substances, the duration and frequency of consumption, and other factors, such as sleep and
291 health representations. However, sleep complaints were assessed over the last 3 months,
292 which is indicative of habitual sleep, regardless of recent cannabis consumption. Fourth, we
293 discuss only one sleep complaint, insomnia, which had a duration and frequency consistent
294 with the diagnostic criteria for chronic insomnia disorder . However, results for the other sleep
295 complaints showed the same tendencies. This was expected because these four sleep
296 complaints convey the same sleep health dimension. Sensitivity analyses showed similar
297 results using an overall sleep health score summing all the four sleep variables ([Table S3](#)).

298 However, sleeping drugs intake, a proxy of sleep alterations, was not associated with cannabis
299 use in adjusted analyses (Table S4). Indeed, cannabis use can also be used to self-medicate for
300 sleep problems instead of using sleeping drugs, which results in no association even if sleep is
301 disturbed. There is a need to replicate these analyses in further studies specifying the
302 molecule, the dosage, and the frequency of use. Fifth, the cross-sectional design of this study
303 does not allow the establishment of hypotheses regarding the direction of the relationship
304 between cannabis use and sleep.

305

306 Our study also has several strengths. First, it provided results from a large sample of
307 University students from different fields of study and takes into account all identified
308 potential confounding factors, such as tobacco, sleeping drug intake, and previous mental
309 health diagnoses. The consistency of the results for the four sleep complaints decreases the
310 likelihood of the relationship being explained by a third underlying liability. Furthermore,
311 sensitivity analyses showed that the *E*-value was 1.7; that is, an unmeasured confounder
312 would have to be associated with both insomnia and cannabis use by an odds ratio of 1.7-fold
313 each through pathways independent of the covariates measured in our study. For purposes of
314 comparison, this factor should have associations as strong as tobacco use with both insomnia
315 and cannabis use to fully explain their relationship, which makes this hypothesis unlikely
316 (Figure S3). Second, this study is among the first to explore whether the association between
317 sleep and cannabis use is persistent and similar in students with and without previous mental
318 health diagnoses with sufficient power; though this relationship existed in both groups,
319 students with a previous diagnosis of anxiety or depression had slightly stronger estimates and
320 higher cannabis use.

321

322 Our results showed an association between cannabis use and sleep complaints, particularly
323 insomnia, in a large sample of University students. Although the direction of the association
324 and its causality cannot be established in this cross-sectional study, it was highly consistent
325 and independent of several demographic and behavioral parameters and previous mental
326 health diagnoses. Students and health professionals should be made aware of the possible
327 consequences of frequent cannabis use on sleep.

328
329

330 **Acknowledgments:**

331 We would like to thank the entire i-Share team who supported us in carrying out this study.

332 Also, we would like to thank Garance Perret and Edwidge Pereira for their involvement in

333 data management and Julie Arsandaux for helping us with the methodology and statistics.

334

335 **Funding:**

336 The i-Share team is currently supported by an unrestricted grant of the Nouvelle-Aquitaine

337 Regional Council (*Conseil Régional Nouvelle-Aquitaine*, grant no. 4370420). It has also

338 received grants from the Nouvelle-Aquitaine Regional Health Agency (*Agence Régionale de*

339 *Santé Nouvelle-Aquitaine*, grant no. 6066R-8), Public Health France (*Santé Publique France*,

340 grant no. 19DPPP023-0), and The National Institute against cancer INCa (grant no.

341 INCa_11502).

342 The funding bodies were not involved in the study design or in the collection, analysis, or

343 interpretation of the data.

344

345 **Non-financial Disclosure:** none

346

347 **Conflicts of interest:** none

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489 previous diagnosis of depression ($n=13,016$) or with previous diagnosis of depression ($n=1771$).

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492 Abbreviations: *CI*, confidence interval; *OR*, odds ratio.

493 ^a*p*-value adjusted by the Benjamini-Hochberg method to control for the false discovery rate.

494 ^b*OR* and *95% CI* adjusted for age, sex, field and year of study, perceived economic situation, physical
495 activity, tobacco, alcohol and sleeping drug intake.

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497 *Figure 3: Adjusted associations between insomnia and cannabis use stratified for each covariate*

498 Forest plot for stratified analyses of the association between insomnia and cannabis use.

499 Abbreviations: *CI*, confidence interval; *OR*, odds ratio.

500 ^a*OR* and *95% CI* adjusted for age, sex, field and year of study, perceived economic situation, physical
501 activity, tobacco, alcohol and sleeping drug intake.

502 ^b*p*-value adjusted by the Benjamini-Hochberg method to control for the false discovery rate.

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505 *Table 1: Characteristics of the study population and their distributions according to insomnia*
 506 *and cannabis use*

Variables	Total n (%)	Insomnia		Cannabis use	
		n (%)	p	n (%)	p
All	14,787	3362 (22.7%)		864 (5.8%)	
Age			0.26		0.14
- 20 years old or less	8906 (60.2%)	2053 (23.1%)		499 (5.6%)	
- More than 20 years old	5881 (39.8%)	1309 (22.3%)		365 (6.2%)	
Sex			<10 ⁻⁴		<10 ⁻⁴
- Male	3621 (24.5%)	654 (18.1%)		326 (6.0%)	
- Female	11,166 (75.5%)	2708 (24.3%)		538 (4.8%)	
Field of study			<10 ⁻⁴		<10 ⁻⁴
- Health Studies	3430 (23.2%)	643 (18.7%)		96 (2.8%)	
- Scientific disciplines	1587 (10.7%)	397 (25.0%)		111 (7.0%)	
- Law and Economy	1293 (8.7%)	283 (21.9%)		80 (6.2%)	
- Literature Languages and Social Sciences	2461 (16.6%)	648 (26.3%)		199 (8.1%)	
- Other	1306 (8.8%)	312 (23.9%)		74 (5.7%)	
- Missing	4710 (31.9%)	1079 (22.9%)		304 (6.5%)	
Year of study			<10 ⁻⁴		0.006
- First year	5799 (39.2%)	1503 (25.9%)		347 (6.0%)	
- Second year	2922 (19.8%)	583 (20.0%)		166 (5.7%)	
- Third year	2223 (15.0%)	512 (23.0%)		150 (6.7%)	
- Fourth year or more	2092 (14.2%)	407 (19.5%)		130 (6.2%)	
- Missing	1751 (11.8%)	357 (20.4%)		71 (4.1%)	
Perceived economic situation			<10 ⁻⁴		<10 ⁻⁴
- Good	8013 (54.2%)	1584 (19.8%)		412 (5.1%)	
- Neither good nor poor	5403 (36.5%)	1322 (24.5%)		331 (6.1%)	
- Poor	1371 (9.3%)	456 (33.3%)		121 (8.8%)	
Physical activity			<10 ⁻⁴		<10 ⁻⁴
- Never	7042 (47.6%)	1823 (25.9%)		492 (7.0%)	
- One hour and half per week or less	3820 (25.8%)	762 (19.9%)		173 (4.5%)	
- More than one hour and half per week	3925 (26.5%)	777 (19.8%)		199 (5.1%)	
Tobacco use			<10 ⁻⁴		<10 ⁻⁴
- No smoking	10,295 (69.6%)	2223 (21.6%)		132 (1.3%)	
- 10 cigarettes per day or less	3915 (26.5%)	928 (23.7%)		595 (15.2%)	
- More than 10 cigarettes per day	577 (3.9%)	211 (36.6%)		137 (23.7%)	
Alcohol use			0.08		<10 ⁻⁴
- 3 days per week or less	14,147 (95.7%)	3198 (22.6%)		744 (5.3%)	
- More than 3 days per week	640 (4.3%)	164 (25.6%)		120 (18.8%)	
Previous diagnosis of depression: Yes	1771 (12.0%)	675 (38.1%)	<10 ⁻⁴	176 (9.9%)	<10 ⁻⁴
Previous diagnosis of anxiety: Yes	2054 (13.9%)	759 (37.0%)	<10 ⁻⁴	162 (7.9%)	<10 ⁻⁴
Cannabis use			<10 ⁻⁴		
- Never/rarely	10,893 (73.7%)	2433 (22.3%)			
- Monthly	3030 (20.5%)	653 (21.6%)			
- Weekly	645 (4.4%)	186 (28.8%)			
- Daily	219 (1.5%)	90 (41.1%)			
Insomnia: 3 times or more per week	3362 (22.7%)			276 (8.2%)	<10 ⁻⁴
Excessive daytime sleepiness: 3 times or more per week	2703 (18.3%)	1251 (46.3%)	<10 ⁻⁴	195 (7.2%)	0.001
Sleep quality: Poor or very poor	3312 (22.4%)	2051 (61.9%)	<10 ⁻⁴	264 (8.0%)	<10 ⁻⁴
Sleep deprivation: Weekly	7760 (52.5%)	2475 (31.9%)	<10 ⁻⁴	552 (7.1%)	<10 ⁻⁴
Sleeping drug intake: Yes	1789 (12.1%)	879 (49.1%)	<10 ⁻⁴	125 (7.0%)	0.03

Table 2: Unadjusted and adjusted associations between insomnia and cannabis use

Variables	Total	Insomnia	Unadjusted		Adjusted	
			OR [95%CI]	p	OR [95%CI]	p
Cannabis use				<10 ⁻⁴		<10 ⁻⁴
- Never/rarely or monthly	13,923 (94.2%)	3086 (22.2%)	Reference		Reference	
- Weekly or daily	864 (5.8%)	277 (31.9%)	1.65 [1.42-1.91]		1.45 [1.23-1.72]	
Cannabis use				<10 ⁻⁴		<10 ⁻⁴
- Never/rarely	10,893 (73.7%)	2433 (22.3%)	Reference		Reference	
- Monthly	3030 (20.5%)	653 (21.6%)	0.96 [0.87-1.05]		0.91 [0.81-1.01]	
- Weekly	645 (4.4%)	186 (28.8%)	1.41 [1.18-1.68]		1.23 [1.01-1.49]	
- Daily	219 (1.5%)	90 (41.1%)	2.43 [1.85-3.19]		1.97 [1.46-2.66]	

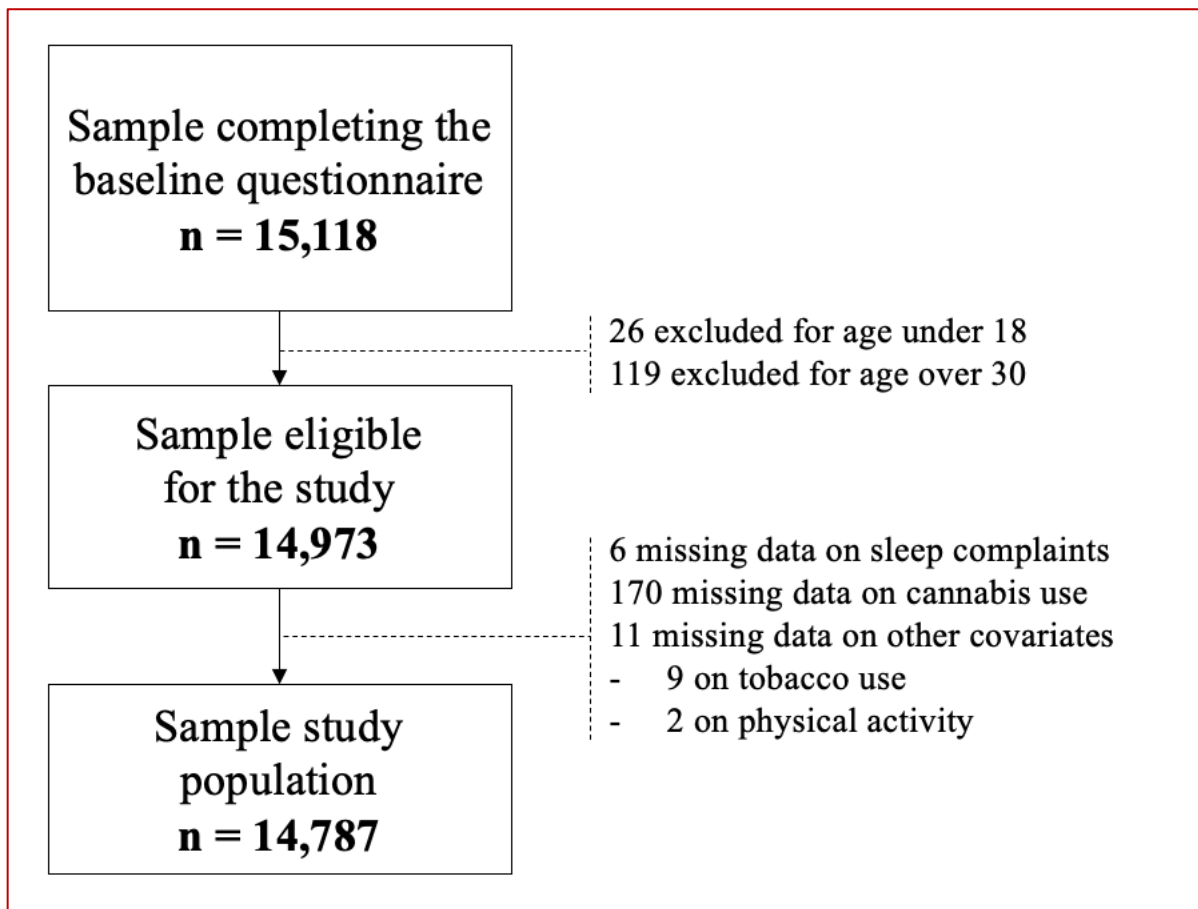
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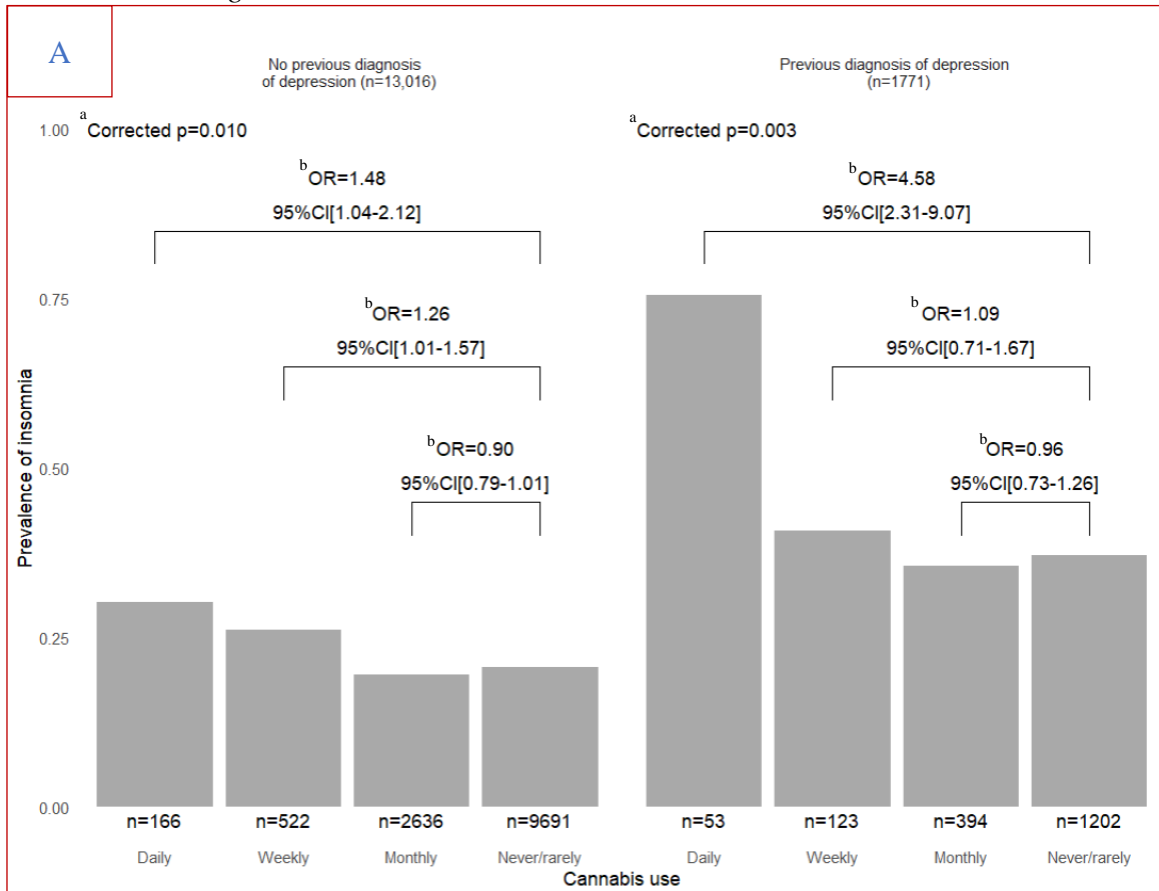
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512 *Figure 1: Flowchart of inclusion of students from the i-Share cohort into the ancillary study*
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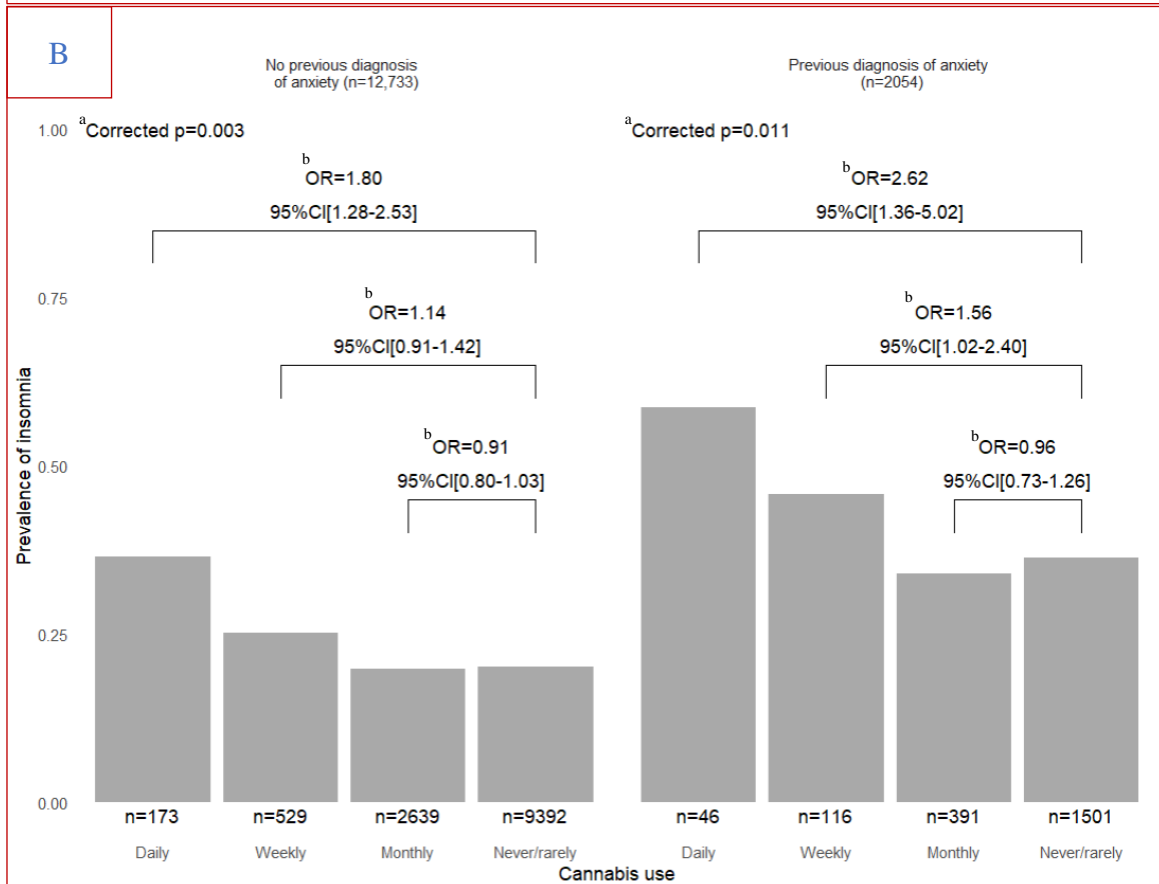


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517 *Figure 2: Adjusted associations between insomnia and cannabis use according to previous*
 518 *mental health diagnoses*

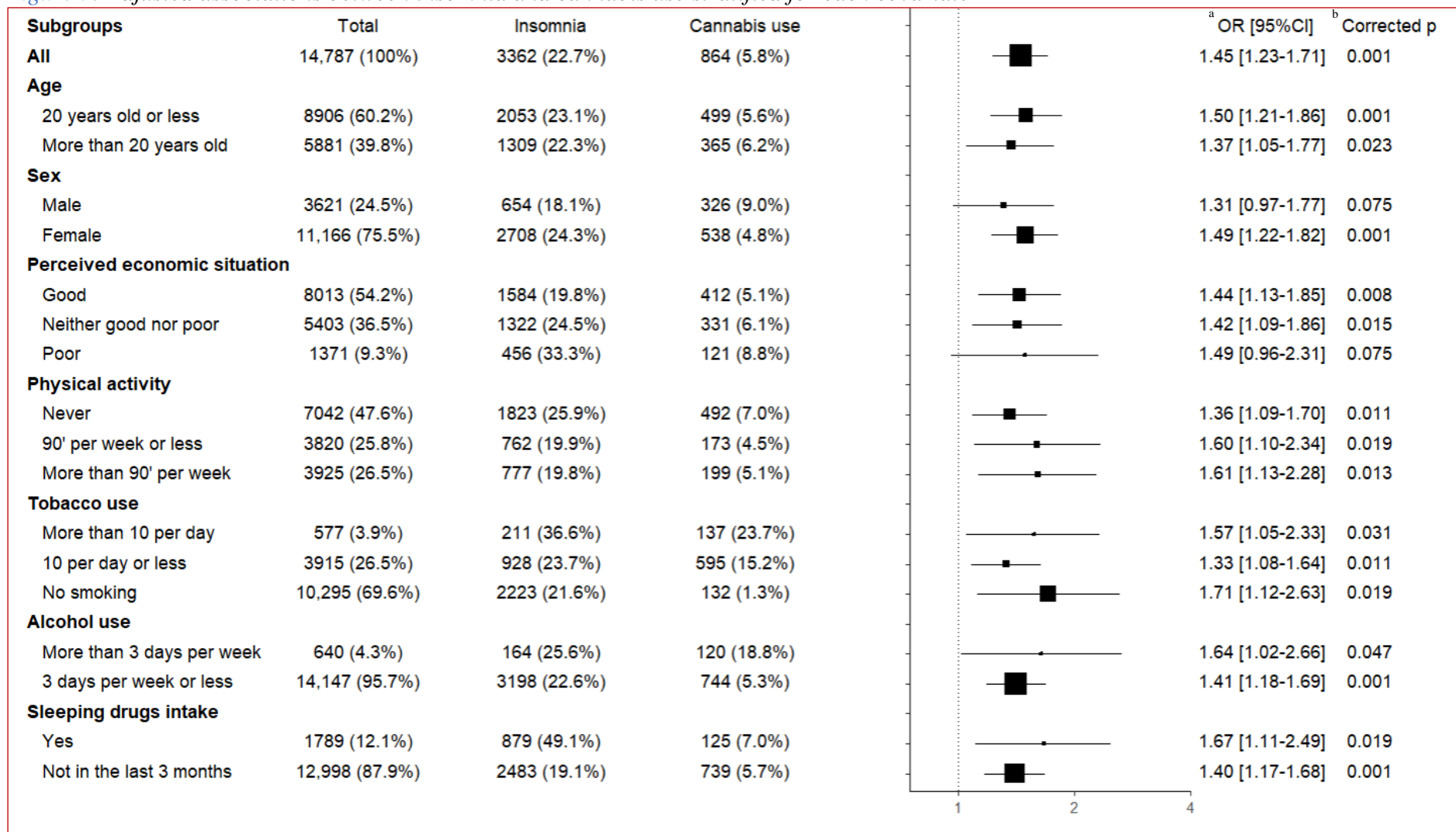


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Figure 3: Adjusted associations between insomnia and cannabis use stratified for each covariate



Study of the association between cannabis use and sleep disturbances in a large sample of University students

Population

Cross-sectional analysis

14,787 French University students

Mean age: 20.4 years {18-30}

75.5% females

Insomnia



Sleepiness



Poor quality



Deprivation



Cannabis use



Results

Insomnia



Subgroups	Depression (n=1771)	No depression (n=13,016)	Anxiety (n=1771)	No anxiety (n=12,733)
Rarely use	Ref	Ref	Ref	Ref
Monthly use	OR=0.96 [0.73-1.26]	OR=0.90 [0.79-1.01]	OR=0.96 [0.73-1.26]	OR=0.91 [0.80-1.03]
Weekly use	OR=1.09 [0.71-1.67]	OR=1.26 [1.01-1.57]	OR=1.56 [1.02-2.40]	OR=1.14 [0.91-1.42]
Daily use	OR=4.58 [2.31-9.07]	OR=1.48 [1.04-2.12]	OR=2.62 [1.36-5.02]	OR=1.80 [1.28-2.53]

Odds ratio (OR) of having insomnia. Similar results for other sleep disturbances

Conclusion

Sleep disturbances and cannabis use are common	Sleep disturbances and cannabis use are associated	Associations appeared to start from a weekly use	Associations are not explained by mental health disorders
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