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Review Article

Sleep quality of adult recreational cannabis users: a systematic review of literature

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Sleep quality of adult recreational cannabis users: a systematic review of literature

Short title: Sleep quality of cannabis users

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ABSTRACT

Introduction: Human sleep is fundamental for the proper occurrence of organic functions. Hence, the lack of sleep can impair cognitive function, resulting in emotional problems, memory changes and disease onset. However, it is worth noting that sleep is influenced by outside factors, such as drug use. In this sense, the aim of this work is to analyze studies that had as their research object the influence of recreational marijuana on the sleep quality of adults. **Methods**: A high-sensitivity research was conducted in databases (*Biblioteca Virtual em Saúde*, Medline via Pubmed, Cochrane, Embase, Web of Science and Scopus) using descriptors linked to marijuana and sleep habits. **Results**: Eighteen studies from four countries were included with a total sample size of 29,858 participants. It was identified that marijuana affects sleep characteristics–such as latency and duration–with these changes being more evident in users who make greater use of marijuana and in those who started premature use. **Conclusions**: It was observed that most articles demonstrated a detrimental effect of recreational cannabis use on the quality of sleep in adults.

Keywords: Sleep; Cannabis; Recreational Marijuana Use; Quality of life.

INTRODUCTION

The circadian rhythm is something that most organisms possess, as the decrease in wakefulness is fundamental during some part of the 24 hours day. Human sleep is divided into two main phases, REM (rapid eye movement sleep) and NREM (non-rapid eye movement sleep). During such phases, physiological changes such as muscle relaxation and changes in respiratory rate are common. These oscillations are essential for the sleep phases to be reached, promoting a decrease in the state of consciousness and in sensory and motor responses, so that sleep acquires its restorative function.[1]

From childhood, the maintenance of an ideal circadian rhythm is important, as inadequate sleep can promote morphological changes in the hippocampus, amygdala and prefrontal cortex.[2] Insufficient restorative sleep can bring harm to human health. It is known that lack of sleep can increase the risk of obesity, thus contributing to the emergence of chronic non-communicable diseases – diabetes mellitus and arterial hypertension –and cardiovascular diseases, such as acute myocardial infarction, in addition to being associated with stress and depression.[3]

The adequate sleep pattern is influenced by external factors. In this way, psychological health, the appearance of infections, the use of medications and even lifestyle habits can affect sleep in a negative way. In fact, these different scenarios can prevent individuals from reaching deep sleep, causing nighttime awakenings, or they can generate hypersomnia, resulting in sleep disorders–which impair their patient's studies, work and mood.[4]

One of the main lifestyle habits that damage sleep quality is the use of drugs, which is considered the main risk factor for the onset of sleep disorders. One such drug is marijuana. It is believed that marijuana derivatives can be useful in the treatment of insomnia, being considered study objects in patients who suffer from sleeping difficulties.[5] However, long-term marijuana use can be harmful to the quality of sleep, potentially reducing users' total sleep time.[6]

Data from the United Nations Office on Drugs and Crime reveal that marijuana is the most used drug in the world, with an estimated 219 million users.[7] It should be noted that the number of people who consider marijuana as harmful has reduced, while

the potency of cannabis has increased by up to four times with the advancement of its legalization in the 21st century, causing damage to the health of its users that are only noticeable after years of use.[8] Within this context, this research aims to analyze studies that address the effects of recreational marijuana on the sleep of adult users.

METHODS

This systematic review was based on quantitative data published in articles, following the recommendations and criteria described on the preferred report items for systematic reviews and meta-analysis (PRISMA)[9] and the Cochrane Handbook.[10]

Search Strategy

Potential studies were identified through a comprehensive strategy. The systematic review was carried out through the following databases: Virtual Health Library (Biblioteca Virtual em Saúde – BVS), Medline via Pubmed, Cochrane, Embase, Web of Science and Scopus. There was no language restriction. The search strategy involved the crossing of selected keywords based on the Medical Subject Headings (Mesh) and on the Medical Subject Headings (Descritos de Ciência da Saúde – Decs):

VIRTUAL HEALTH LIBRARY (BVS)

(cannabis OR marihuana) AND (sono OR sueño OR sleep OR hábito de dormir OR hábitos de dormir OR hábitos do sono OR qualidade do sono OR avaliação do sono OR escala do sono OR questionário do sono)

MEDLINE via PUBMED

("Cannabis"[Mesh] OR Cannabi OR "Hemp Plant" OR "Hemp Plants" OR Marihuana OR Marijuana OR "Cannabis indica" OR "Cannabis sativa" OR Hemp OR Hemps OR Hashish OR Hashishs OR Bhang OR Bhangs OR Ganja OR Ganjas) AND ("Sleep"[Mesh] OR "Sleeping Habits" OR "Sleep Habits" OR "Sleep Habit" OR "Sleeping Habit" OR "Sleepiness Scale" OR "Sleep Scale" OR "Sleep Questionnaire")

COCHRANE

(Cannabis OR Cannabi OR “Hemp Plant” OR “Hemp Plants” OR Marihuana OR Marijuana OR “Cannabis indica” OR “Cannabis sativa” OR Hemp OR Hemps OR Hashish OR Hashishs OR Bhang OR Bhangs OR Ganja OR Ganjas):ti,ab,kw AND (Sleep OR “Sleeping Habits” OR “Sleep Habits” OR “Sleep Habit” OR “Sleeping Habit” OR “Sleepiness Scale” OR “Sleep Scale” OR “Sleep Questionnaire”):ti,ab,kw"

EMBASE

'sleep'/exp OR sleeping AND 'cannabis'/exp OR bhang OR "cannabis alkaloid" OR "cannabis constituent" OR "cannabis extract" OR "cannabis herba" OR "cannabis leaf" OR “Cannabis sativa extract" OR "Cannabis sativa leaf" OR "Cannabis sativa resin" OR cannador OR charas OR ganja OR ganjah OR hashish OR "hashish oil" OR "hemp extract" OR "herba cannabis" OR "Indian bhang" OR "Indian ganja" OR marihuana OR marijuana OR "mexican marihuana"

WEB OF SCIENCE

(ALL=(Cannabis OR Cannabi OR “Hemp Plant” OR “Hemp Plants” OR Marihuana OR Marijuana OR “Cannabis indica” OR “Cannabis sativa” OR Hemp OR Hemps OR Hashish OR Hashishs OR Bhang OR Bhangs OR Ganja OR Ganjas)) AND ALL=(Sleep OR “Sleeping Habits” OR “Sleep Habits” OR “Sleep Habit” OR “Sleeping Habit” OR “Sleepiness Scale” OR “Sleep Scale” OR “Sleep Questionnaire”)

SCOPUS

(TITLE-ABS-KEY (cannabis OR cannabi OR "Hemp Plant" OR "Hemp Plants" OR marihuana OR marijuana OR "Cannabis indica" OR "Cannabis sativa" OR hemp OR hemps OR hashish OR hashishs OR bhang OR bhangs OR ganja OR ganjas) AND TITLE-ABS-KEY (sleep OR "Sleeping Habits" OR "Sleep Habits" OR "Sleep Habit" OR "Sleeping Habit" OR "Sleepiness Scale" OR "Sleep Scale" OR "Sleep Questionnaire"))

Inclusion criteria

Eligibility criteria were established from the PVO model (Participants, Variables, Outcomes) that generated the question: Does recreational marijuana interfere with the sleep quality of its users? The following inclusion criteria were adopted for the study selection: observational studies carried out with humans over 18 years of age and which evaluated sleep quality or sleep-related problems in individuals who used recreational marijuana.

Exclusion criteria

Studies with the following characteristics were excluded: non-observational studies, sleep analysis without relating it to the use of marijuana, medicinal marijuana users, those in which the methodology was not clearly written, as well as books, letters from the editor and case reports.

Data extraction

The material obtained through the data search was exported to the Rayyan® and Mendeley® platforms and displayed in the PRISMA diagram (Figure 1). The first screenings, that were selected by title and abstract, were carried out by three independent researchers (WCSS, NLC and MLS), selecting possible articles to be included in the final compilation. In cases in which there were disagreements, discrepancies were resolved by a third independent researcher (KCC). Regarding data extraction, the three independent researchers (WCSS, NLC and ML) used Microsoft Excel® spreadsheets to record the following: study data (authors, title and publication year) and method information (design, sample size, aspect or sleep quality variables and instruments used on assessment).

Quality Analysis

Two authors (WCSS and NLC) performed independent assessments on the quality of the studies based on two scales, Newcastle-Ottawa and the Joana Briggs Institute. The assessment on the Newcastle-Ottawa scale is shown on table 2. This

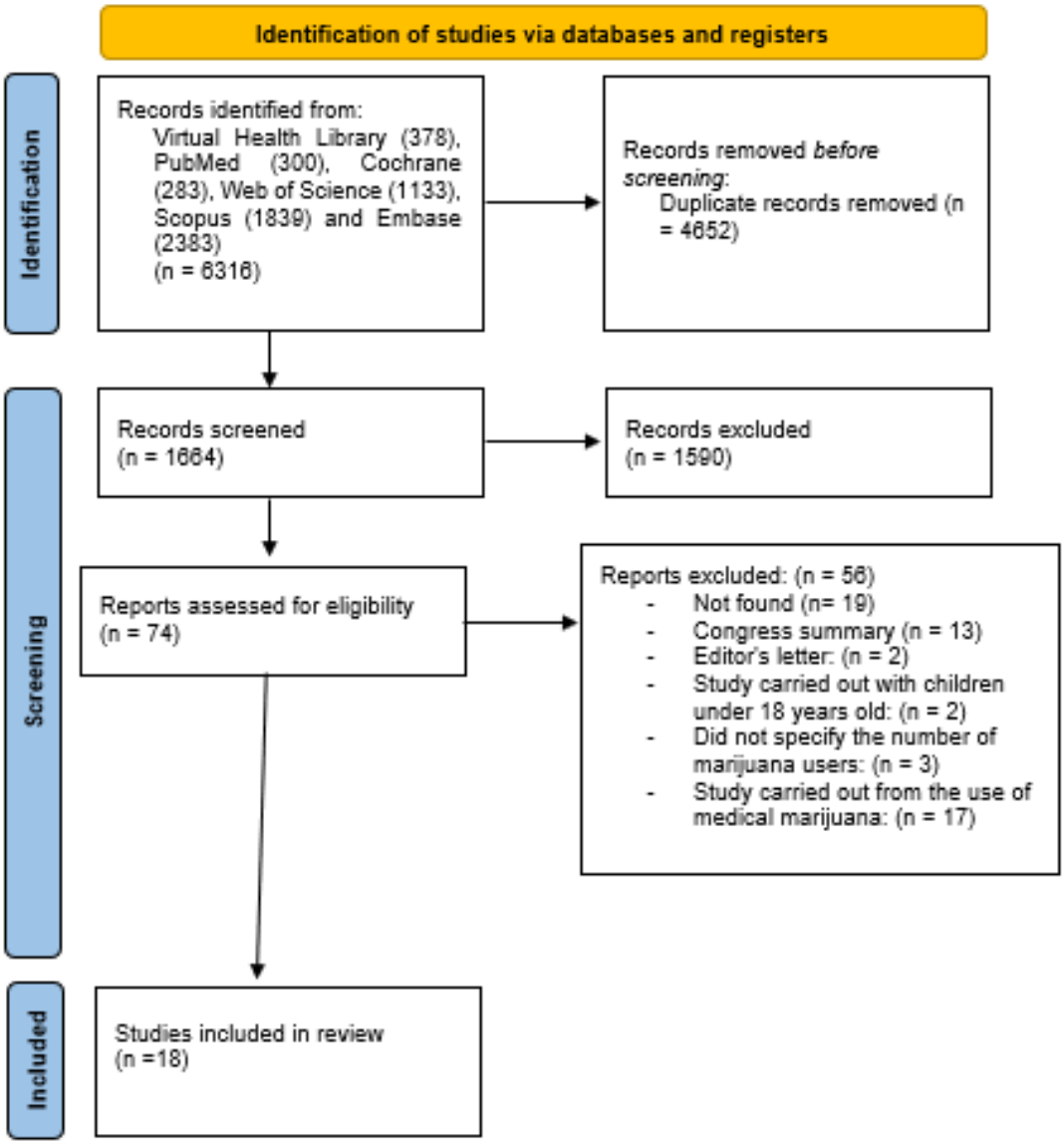
scale uses star scores (0-10) to assess studies in three domains: selection, comparability and results. Higher scores point to higher quality studies. The risk of bias, also assessed by both authors (WCSS and NLC), was based on the Joanna Briggs Institute's checklist method. This checklist contains 9 questions, which were divided into 3 domains: participants (questions 1, 2, 4 and 9), measurement of results (6 and 7) and statistics (3, 5 and 8).

RESULTS

Selection and evaluation of studies

The initial search resulted in 6316 studies found in the databases, among which 4652 were duplicates that were removed, leaving a sample of 1664 studies. After screening by title and abstract, 1590 studies were removed. Thus, the remaining studies were screened based on the inclusion criteria, so that 18 studies were included in the qualitative analysis (Figure 1).

Fig. 1. PRISMA flow diagram of studies that assessed sleep quality



Characteristics of included studies

18 studies were included, 15 dos USA, one from United Kingdom, one from Australia and one from Israel. The total population was 29.750 participants, amongst which 9.043 were recreational cannabis users. All participants were over the age of 18 and 14.180 belonged to the male sex. Table 1 presents the characteristics of the included studies.

Table 1 – Characterization of included studies (n=18)

Author	Year	Country	Type of study	Instrument	Sample (n)	Cannabis users (n)
Diep, C. et al[11]	2021	USA	Cross-sectional	Questionnaire	21.729	3.132
Drazdowski, T. et al[12]	2021	USA	Cross-sectional	PSQI*	354	354
McPherson, K. et al[13]	2021	USA	Cohort	PSQI	340	170
Skobic, I. et al[14]	2021	USA	Longitudinal	Questionnaire	1639	80
Wheeler, P. et al[15]	2021	USA	Cross-sectional	STMSHQ†	79	20
Winiger E. et al[16]	2021	USA	Cross-sectional	PSQI	152	152
Winiger, E. et al[17]	2020	USA	Cross-sectional	Questionnaire	1882	1882
Winiger, E. et al[18]	2019	USA	Cross-sectional	JHQ‡	1656	1656
Winiger, E. et al[19]	2021	USA	Cross-sectional	JHQ	760	760
Sznitman, S. et al[20]	2020	Israel	Cohort	Questionnaire	54	54
Altman, B. et al[21]	2019	USA	Cross-sectional	PSQI	311	311
Bolla, K. et al[22]	2008	USA	Cross-sectional	Polysomnography	31	17

Fisk, J. et al[23]	2007	United Kingdom	Cross-sectional	ESS§ and KSS‖	227	53
Karacan, I. et al[24]	1976	USA	Cross-sectional	EEG-EOG¶	64	32
Lim, A. et al[25]	2018	USA	Cross-sectional	SATED	107	107
Ly, C. et al[26]	2013	USA	Cross-sectional	PSQI	76	29
Maple, K. et al[27]	2016	USA	Cross-sectional	PSQI	41	41
Ogeil, R. et al[28]	2015	Australia	Cross-sectional	PSQI and ESS	248	85

*Pittsburgh Sleep Quality Index; †Saint Mary's Hospital Sleep Questionnaire; ‡Jessor Health Questionnaire; §Epworth Sleepiness Scale; ‖Karolinska Sleepiness Scale; ¶Electroencephalographic-electrooculographic.

The selected studies used four different scales to assess the sleep quality of their sample: Pittsburgh Sleep Quality Index Questionnaire, Saint Mary's Hospital Sleep Questionnaire, Jessor Health Questionnaire, Epworth Sleepiness Scale, Karolinska Sleepiness Scale and SATED. The Pittsburgh Sleep Quality Index Questionnaire (PSQI) assesses sleep quality and changes, consisting of 19 questions that assess seven aspects (subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep changes, use of sleeping pills and daytime sleep dysfunction) and the sum of the scores of the seven aspects will vary from zero to 21 points– higher points indicate more changes in sleep quality – and scores above 5 points already indicate dysfunctions in the sleep components.[29]

The Saint Mary's Hospital Sleep Questionnaire is a questionnaire consisting of 14 items that assess the quality of sleep of the previous night from questions that measure sleep duration, number of awakenings and sleep satisfaction.[30] The Jessor Health questionnaire has two questions related to sleep: “How many hours do you typically sleep during the week?” and “How many hours do you typically sleep during the weekend?”, in order to characterize sleep based on its short or long duration.[19] The Epworth Sleepiness scale consists of eight items that assess the chance of the patient to nap in some everyday situations, such as watching television or stopped during traffic in the car, its score ranges from 0 to 24 points and the higher the score, the greater the level of sleep abnormality – with medical help indicated from 10 points.[31]

The Karolinska Sleepiness scale measures the individual's sleepiness at a given time during the day, being indicated to measure sleep during work, jet lag, or situations that require attention, such as driving tests.[32] The SATED scale measures some sleep-related characteristics, such as satisfaction, alertness, time, efficiency and duration–a score of 10 indicates healthy sleep.[33]

Method quality of the selected studies

The Newcastle-Ottawa scale was used to assess the quality of each study based on three domains: selection, comparability, and outcome. The score of the articles is evaluated in a star way, ranging from zero to nine stars and the higher the number of stars, the better the quality of the articles. In this study, we chose to

represent the scale in absolute numbers. As shown in table 2, the studies with excellent methodological quality were Wheeler et al (2021)[15] and Winiger et al (2020)[17] with a total score of 9. Among the studies with the lowest score, 6 points, were Skobic et al (2021)[14] and Lim et al (2018)[25] that lost more points in the sample representativeness item. Regarding the outcome, the studies Bolla et al (2008)[22] and Karacan et al (1976)[24] were the ones who achieved the maximum score when assessing sleep by polysomnography and by electroencephalogram-electrooculogram respectively, while the others relied on self-report to carry out their assessments.

Table 2 – Methodological quality of the studies by Newcastle-Ottawa Scale.

Author	Representativiness of the sample	Comparability	Outcome	Total score
Diep, C. et al[11]	5	1	2	8
Drazdowski, T. et al[12]	4	1	2	7
McPherson, K. et al[13]	5	1	2	8
Skobic, I. et al[14]	3	1	2	6
Wheeler, P. et al[15]	5	2	2	9
Winiger E. et al[16]	4	1	2	7
Winiger E. et al[17]	5	2	2	9
Winiger E. et al[18]	3	1	2	7
Winiger E. et al[19]	4	2	2	8
Sznitman, S. et al[20]	3	1	2	7
Altman, B. et al[21]	4	2	2	8
Bolla, K. et al[22]	4	1	3	8
Fisk, J. et al[23]	4	1	2	7
Karacan, I. et al[24]	3	1	3	7
Lim, A. et al[25]	3	1	2	6
Ly, C. et al[26]	4	1	2	7
Maple, K. et al[27]	4	1	2	7
Ogeil, R. et al[28]	4	2	2	8

In the assessment carried out through the Joana Briggs Institute, the studies of Wheeler et al (2021)[15], Winiger et al (2021)[16], Winiger et al (2020)[17], Winiger et al (2021)[19], Altman et al (2019)[21], Bolla et al (2008)[22], Fisk et al (2007)[23], Lim et al (2018)[25], Ly et al (2013)[26], Maple et al (2016)[27], Ogeil et al (2015)[28] were considered of high quality. The Skobic et al (2021)[14] study was the one with the lowest quality score, once it did not use three of the evaluation items. The complete assessment list is shown in Table 3.

Table 3 - Study bias risk included according to JBI critical apprisal checklist for analytical crosssectional studies.

Author	Were the criteria for inclusion in the sample clearly defined?	Were the study subjects and the setting described in detail?	Was the exposure measured in a valid and reliable way?	Were objective, standard criteria used for measurement of the condition?	Were confounding factors identified?	Were strategies to deal with confounding factors stated?	Were the outcomes measured in a valid and reliable way?	Was appropriate statistical analysis used?
Diep, C. et al[11]	No	Unclear	Yes	Yes	Yes	Yes	Yes	Yes
Drazdowski, T. et al[12]	No	No	Yes	Yes	Yes	Yes	Yes	Yes
McPherson, K. et al[13]	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Skobic, I. et al[14]	Yes	No	Yes	Yes	No	No	Yes	Yes
Wheeler, P. et al[15]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Sim
Winiger E. et al[16]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Winiger E. et al[17]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Winiger E. et al[18]	No	No	Yes	Yes	Yes	Yes	Yes	Yes

Winiger E. et al[19]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sznitman, S. et al[20]	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Altman, B. et al[21]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bolla, K. et al[22]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fisk, J. et al[23]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Karacan, I. et al[24]	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Lim, A. et al[25]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ly, C. et al[26]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Maple, K. et al[27]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ogeil, R. et al[28]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

DISCUSSION

The findings of this review demonstrate that cannabis use interferes with sleep in a predominantly negative way. Although participants in some studies had the expectation that marijuana could help with sleep quality, this effect was not achieved in most studies. This expectation was related to greater use of the substance by the participants and impaired sleep, especially among women.

Among the eighteen studies analyzed, fifteen[11-14,16-19,22-28] studies demonstrated that the use of marijuana has harmful effects on the sleep quality of users. The study by Sznitman et al (2021)[20], however, observed a positive effect on one of the items evaluated, sleep latency–a measure of time between the time of transition from the waking state to full sleep–, which was decreased. The study by Altman et al (2019)[21] observed both negative and positive effects of recreational marijuana use on sleep quality. These findings may reflect the low monthly use of cannabis by the participants of Altman et al (2019) and the lack of use of measures validated by Sznitman et al 2021, such as the PSQI, ESS and/or Polysomnography associated with lack of factor control confounders, such as use of sleeping pills or use of other substances that can interfere with sleep.

One of the sleep domains evaluated by the studies, sleep duration, was one of the most affected by cannabis use. Diep et al (2022)[11] observed that heavy marijuana users were at greater risk of exhibiting extremes of sleep duration, i.e., sleeping for less than six hours or more than nine hours, while recent marijuana users had mainly increased sleep duration. A slight increase was also observed in two other studies.[21,24] Other studies predominantly showed decreased sleep duration. These findings were found to be associated with the ingestion of cannabis,[16] the early onset of cannabis use[18] and the use of cannabis concomitantly with cocaine,[15] demonstrating that cannabis can make the decrease in sleep duration in cocaine users more intense. It is believed that early cannabis use can interfere with neural development, which can affect sleep in the future. Users with early onset of cannabis use have structural and functional changes in the prefrontal cortex and amygdala that can lead to changes in neuronal connections leading to sleep deprivation, altered sleep pattern and poor sleep quality as they age.[13,18]

Other sleep aspects affected by cannabis use were sleep efficiency and daytime dysfunction. Four studies[11,12,19,22] found a decrease in sleep efficiency– time the participant actually slept during the night of sleep–among marijuana users, and Diep et al (2022)[11] observed this effect mainly in recent users, while Winiger et al (2021)[19] observed this finding in edible marijuana use. Two studies[12,28] found an increase in daytime dysfunction among users and that this domain is related to greater problems with marijuana use, as a result, there is a subsequent worsening of sleep quality and an increase in marijuana consumption. These factors can be associated with the general impairment of sleep quality, which can cause irritability, lack of energy, negative impact on affection, decreased attention, cognition and worsening of memory and mood.[28,15]

The domain with the most divergent findings was sleep latency. In studies by Altman et al (2019)[21] and Sznitman et al (2021)[20] users reported taking less time to fall asleep through self-reported questionnaires. While the studies by Diep et al (2022)[11], Bolla et al (2008)[22] and Karacan et al (1976)[24] point out that marijuana users take longer to fall asleep, with the observation in the last two being made by objective criteria, such as polysomnography and the EEG-EOG. Such discrepancies may occur, in part, because recreational marijuana formulations may vary. Part of the negative effects of cannabis on sleep quality is its constituent delta-9-tetrahydrocannabinol (THC), which has a stimulant and hallucinogenic effect, which can precipitate sleep disruption.[11] On the other hand, cannabidiol (CBD), another constituent of marijuana, in medium to high doses has a sedative effect and is associated with improved sleep quality by PSQI, increased sleep duration and improved sleep efficiency. In general, recreational forms of marijuana have a higher proportion of THC than CBD, which can impair sleep, although there are cannabidioid formulations with a change in this proportion, taking less THC and more CBD than usual. These formulations are mainly found in the medicinal use of the drug, but they can help to elucidate possible discrepancies in findings.[19] Another possible explanation for these divergences is the low use of marijuana by participants by Altman et al (2019) and the lack of use of validated means of assessing sleep quality by Sznitman et al (2021).

The negative effects of cannabis on sleep quality were more described among women.[12,13,26,28] This finding can be explained by changes in the metabolism of substances among women, who may become dependent more quickly due to the

different metabolism and hormonal interactions with the drug,[26] this finding may be even more evident for women who started using marijuana at the beginning of adolescence.[13] In addition, women are at greater risk of having worse sleep quality due to social and cultural stressors,[12] which justifies the worse sleep quality in this group compared to men.

Several studies also showed that participants believed cannabis could improve their sleep problems,[12,14-16,21,22] although its use does not seem to have the desired effect of improving sleep quality.[12] This finding is evident in men, users of other drugs and unemployed people, who may use marijuana for this purpose even more often than other evidence-based treatments, such as hypnotics, cognitive behavioral therapy, among others.[14] The two biggest concerns regarding these findings consist on the influence of these expectations on the increase in cannabis use[16,21,22] and the risk of worsening sleep symptoms among users.[14] Despite insomnia being one of the most cited reasons for using cannabis, the evidence base is not consistent to allow its use recreationally in the general population, even in medicinal formulations. Indications are restricted to improving sleep quality in people with obstructive sleep apnea, post-traumatic stress disorder and chronic pain.[11]

This systematic review showed that recreational use of marijuana interferes with users' sleep, an effect observed both by subjective instruments, such as the PSQI, and objective ones, such as polysomnography. Overall, most studies have demonstrated a harmful effect of recreational cannabis on several domains of sleep quality. Among the limitations of this study, it is mentioned the non-inclusion of studies that evaluated the use of medical cannabis, which could allow identifying possible changes in sleep quality not described in this review. Furthermore, the cross-sectional nature of most of the articles did not allow a long-term follow-up of the progressive effects that the continuous use of marijuana can have on sleep quality. Even so, this study was important for demonstrating that cannabis can have a harmful effect on sleep, since the mentality on the part of cannabis users is that the use of the drug contributes to sleep quality, an effect that, in general, was not observed by most of the articles.

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