EDITORIAL

# Recent legalization of cannabis use: effects on sleep, health, and workplace safety

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The recent legalization of cannabis for medical and recreational use in many states in the United States and internationally[4,5] has resulted in a decrease in stigma and of perceived risk of cannabis use, more frequent use of cannabis, use of higher potency cannabis products, and increased dependence on cannabis use.[6–8] *Cannabis sativa* and its derivatives are often used for improved sleep and relaxation; characteristics originally attributed to Indian hemp in the nineteenth century.[1–3] Cannabis alters the sleep–wake cycle, increases the production of melatonin, and can inhibit the arousal system by activating cannabinoid type 1 ($CB_1$) receptors in the basal forebrain and other wake-promoting centers.[9–12] Investigations have shown that the major psychoactive compound in cannabis, $\Delta^9$-tetrahydrocannabinol (THC), can decrease sleep onset latency in naïve users or at low doses in experienced users (eg, 70 mg/day); however, higher doses in experienced users increased sleep latency and wake after sleep onset.[9,13,14] Indeed, frequent cannabis users (≥5 uses/week for 3 months and lifetime use ≥2 years) are reported to have shorter total sleep duration, less slow wave sleep, worse sleep efficiency, and longer sleep onset compared to controls.[15] The contrasting benefits of THC exposure may represent the biphasic influence of THC on $CB_1$ receptors whereby acute use causes more activation of $CB_1$ receptors and tendency toward sleep, but long-term use results in desensitization of the $CB_1$ receptor and decreased downstream signaling.

Any study of the effects of cannabis on sleep should take into consideration the route of ingestion, strain of cannabis, dose, prior cannabis exposure, and the method to quantify sleep. In this regard, it is noteworthy that over the last two decades, the average THC concentration has tripled and the products available for sale contain much higher concentrations than those that were generally available for laboratory studies.[16–19] In addition to THC, hundreds of other compounds exist in cannabis products such as the non-psychoactive cannabidiol, cannabinol, and terpenes, which can also impact sleep and wakefulness.[9,12,20] Individuals who obtain cannabis at medical dispensaries or for recreational use are also more likely to use alternative ingestion methods including edibles, concentrates (eg, dabbing), or extracts applied topically as oils or balms.[21–23] Studies on the impact of these ingestion methods are limited, and the health consequences specific to vaping and dabbing remain largely unknown. For example, absorption rate and bioavailability are dependent upon the route of ingestion.[24] Although the initial psychoactive effects of digested cannabis take longer to be felt, these effects are longer lasting compared to inhaled cannabis, which can

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often lead to overconsumption of cannabis compounds.[25] The effects of cannabis are also dependent on weight, metabolism, gender, and prior digested meals.[24,25] Given these complexities, prior laboratory studies are unlikely to reflect the users' naturalistic experiences of sleep and of cannabis use in the present day.

The greatest body of medical cannabis research centers around pain management, while sleep appears sparingly as an ancillary result of these studies. In a randomized trial of 21 patients with chronic pain, significant improvements in sleep onset and sleep maintenance were found with a thrice-daily controlled administration of smoked cannabis (9.4% THC) compared to a placebo control.[18] This suggests that the use of cannabis in place of opioids for pain management could be beneficial, but we are not aware of a head-to-head comparison of opioids versus cannabis with pain and sleep as outcomes. However, there may be some indirect evidence such as the 2014 mean annual opioid overdose mortality rates, which were 24.9% lower in states with legalized medical cannabis than in those without.[26] On an individual basis, patients using both cannabis and prescription pain medication have rated the efficacy of cannabis better for pain management and indicated improved sleep, quality of life, and a preference to reduce reliance on pain medication.[27,28]

The legalization of cannabis use inevitably brings concerns regarding the possibility that cannabis might impair workplace performance and safety. Results from the *2015 National Survey on Drug Use and Health* indicate that more than 13% of adults used cannabis in the past year and over 8% within the last month.[29] This is consistent with a 2006 report of past-year cannabis use in 11% and past-month use in 5% of the surveyed workforce with more than 3% of that population also reporting cannabis use at work during the past 12 months.[30] Concerns about workers' cannabis use range from acute physical and decision-making impairments to long-term cognitive deficits.[31,32] Occupational health guidelines are emerging to keep pace with increased cannabis legalization.[32,33] However, the evidence supporting these recommendations is as sparse and as inconsistent as the sleep data. In a recent study of simulated shift work, smoked cannabis in frequent users (3.6% THC) was found to lessen the impairments in attention and performance during a night shift schedule.[34] While there are few studies examining the risk of accidents in the workplace after exposure to cannabis, motor vehicle operation can serve as a model for performance of tasks involving safety. Individual user's opinions on cannabis-intoxicated driving vary wildly, as does the quantitative data.[35] For example, one group found significant increases in vehicle crash fatalities in California after decriminalization of cannabis use in 2012; however, a more recent study found no significant differences in the three years after recreational legalization in Colorado and Washington.[36,37] In a meta-analysis of observational studies from 1982 to 2015, THC intoxication detected via blood, saliva, or urine tests was associated with a "low to medium magnitude" increase in motor vehicle crash risk.[38] On the other hand, a case–control study of workplace accidents found no significant difference in risk between workers who tested positive for cannabis on a urine drug test versus a random sample of workers.[39] A problem with any such study is that THC is a fat-soluble compound and remains in the body and is detectable in urine for many days after the other effects have worn off. This limitation of not being able to detect and distinguish recent cannabis use via biological samples has likely contributed to the variability of empirical data and inconclusive or unsatisfactory recommendations. The growing workplace concerns demand targeted investigation to educate both employers and employees of dose–response effects of cannabis and daytime sleepiness, and to better inform workplace safety and health guidelines.

The future of cannabis research provides many avenues for discovery. While pain reduction and sleep promotion seem promising applications for cannabis use, there are still many unknowns. Broadly, there is a need for increased research to increase potential benefits while reducing harm. Specifically, there is a need for investigations of naturalistic cannabis use, its effects on sleep, and implications for safety. These studies could inform educational campaigns to promote healthy consumption of cannabis and evidence-based guidelines for public health and workplace safety.

## Disclosure

The authors report no conflicts of interest in this work.

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