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Sustained cannabis use does not predispose clinical hypertension: Findings from a national survey

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Abstract

Cannabis is among the most used recreational and medicinal drugs in the United States. The effects of chronic use on hypertension remain poorly understood. Our study retrospectively evaluated data collected by the National Health and Nutrition Examination Survey from 2017 to 2018. Cannabis use was measured with five metrics: (1) sustained use at any point in the past, (2) sustained use within the past year, (3) frequency of use, (4) age of first cannabis use, and (5) current use. Hypertension status was determined by individuals reporting having been diagnosed in the past. Multivariable logistic regressions were performed, controlling for age, race, and gender. A total of 4565 respondents were identified, of which 867 (19.0%) reported sustained cannabis use in the past. Participants who reported past sustained cannabis use did not have statistically different odds of having hypertension (OR: 1.12; 95% CI: .66–1.91; $p = .6$). Moderate (OR: 1.08; 95% CI: .36–3.25; $p = .8$) and highly-frequent users (OR: 1.30; 95% CI: .56–3.03; $p = .4$) did not have different odds of having hypertension than infrequent users. No relationship between the age of first cannabis use and hypertension was observed. The recency of sustained cannabis use was not associated with hypertension status. Current cannabis users had similar odds of hypertension as past users (OR: 1.03; 95% CI: .59–1.79; $p = .9$). The findings of this study indicate that neither past nor current cannabis use is associated with clinical hypertension.

KEYWORDS
hypertension—general, lifestyle modification/hypertension, risk assessment

1 | INTRODUCTION

Cannabis is among the most commonly used recreational and medicinal drugs in the United States.[1] Also known as marijuana and hashish, the drug can be consumed in various ways, including inhalation (smoking) or eating food products that contain cannabis extract (edibles).[2] The two most commonly described compounds within the cannabis plant are Δ^9-tetrahydrocannabinol (Δ^9-THC) and cannabidiol (CBD), with

Δ^9-THC being the primary psychoactive cannabinoid.[3] Consequently, the concentration of Δ^9-THC found within a product is directly related to its recreational or medicinal effectiveness. Importantly, CBD has also been found to have a clinically noticeable effect, potentially having a combined therapeutic use with Δ^9-THC.[4]

With greater legalization for recreational and/or medicinal use in the United States, the popularity of cannabis has increased in recent years.[5,6] Considering the increased prevalence of cannabis use across

the country, its acute and chronic effects are of concern.[7] Current studies show conflicting findings regarding potentially harmful effects, and evidence has suggested potential benefits in several conditions, including glaucoma, chronic pain, and multiple sclerosis.[8–10]

The potential effects of cannabis use on blood pressure have been investigated, however, findings have been inconsistent and inconclusive. There remains a lack of knowledge regarding differences in acute and chronic effects, the effects of different doses of use, and whether different methods of ingestion yield varying implications (i.e., smoking vs. edible consumption).[11] Altogether, it remains unclear if the sustained use of cannabis can affect the risk of developing clinical hypertension. Understanding the associations between cannabis use and hypertension can better inform clinical guidelines, direct future clinical trials, and help providers better counsel patients.

The present study intends to evaluate if the sustained use of cannabis is associated with the likelihood of having clinical hypertension. The frequency of cannabis use and age at first use were analyzed to determine if dose or chronicity of use had an impact on the association with hypertension. Additionally, the effects of current cannabis use were evaluated. We employed a retrospective design utilizing data collected by the National Health and Nutrition and Examination Survey (NHANES).

2 | METHODS

2.1 | Study population

We evaluated survey responses and demographic information from individuals that completed both hypertension and drug use questionnaires as part of the National Health and Nutrition Examination Survey from 2017 to 2018.[12–14] The NHANES is a cross-sectional sample collected using a multistage, probability sampling design and includes both adult and pediatric respondents.[15] NHANES performs data collection in 2-year cycles and includes both interview responses and physical examination data on a variety of demographic, socioeconomic, dietary, and health-related subjects. Our study uses the most recent cycle of NHANES data, which is therefore most reflective of cannabis use patterns today.

As a result of the NHANES representative design, the sample was weighted and had its variance adjusted to better reflect the overall United States population. Institutional review board approval was not required since the NHANES is a publicly available limited data set. Our study included all participants aged 18 or older.

2.2 | Study variables

2.2.1 | Hypertension

Hypertension status was determined by a respondent indicating a diagnosis by a medical professional. This was assessed using responses to the prompt, "Have you ever been told by a doctor or another health professional that you had hypertension, also called high blood pressure?" Additionally, respondents who indicated having been prescribed antihypertensive medications were considered to have hypertension. This was determined by the question "Because of your high blood pressure/hypertension, have you ever been told to take prescribed medicine?"

2.2.2 | Cannabis use

Five parameters of cannabis use were evaluated: (1) whether respondents reported sustained use in the past, (2) how frequently they used cannabis, (3) the age that they began using cannabis, (4) whether they regularly used cannabis within the past year, and (5) whether they currently used cannabis. Sustained cannabis use was measured using responses to the yes/no question, "Have you ever smoked marijuana or hashish at least once a month for more than one year?" It is important to recognize that, while the NHANES grouped marijuana and hashish use in the same question, there is a slight difference between the two substances in that hashish can be differentiated as having a higher concentration of THC. Nonetheless, both are forms of cannabis and have the same active ingredient.

The NHANES interview only questioned participants about sustained cannabis use if they responded affirmatively to having tried cannabis in the past. We recoded the data to include individuals who had never tried cannabis as responding "no" to ever regularly using cannabis. Participants were only asked whether they had smoked cannabis for a sustained period, meaning that other methods of ingestion such as edible products or unsustained use were not included. Respondents who did not provide valid responses for hypertension status or cannabis use were excluded.

Individuals who responded "yes" to sustained cannabis use were given follow-up questions regarding frequency, age, recency of sustained cannabis use, and their most recent incidence of cannabis use.

Participants were asked about how long ago they regularly used cannabis via the question: "How long has it been since you last smoked marijuana or hashish at least once a month for one year?" Responses were given in days, weeks, months, or years. Recent sustained cannabis use was defined as ≤1 year ago, qualified by responses of 365-days, 52-weeks, 12-months, and 1-year. Similarly, participants provided responses in days, weeks, months, or years to the question: "How long has it been since you last used marijuana or hashish?" Current cannabis use was defined as being within the past 30 days, 4 weeks, or 1 month. Past users were those who responded within any timeframe > 1 month.

Frequency was measured using the question "During the time that you smoked marijuana or hashish, how often would you usually use it?" Response options given by NHANES were "once per month," "2–3 times monthly," "4–8 times per month (about 1–2 times per week)," "9–24 times per month (about 3–6 times per week)," and "25–30 times per month (one or more times per day)." We combined the provided NHANES categories to improve interpretation into: "infrequent users"

(1–8 times per month), "moderate users" (9–24 times monthly), and "high-frequency users" (25–30 times monthly).

Age was queried via an open-ended question: "How old were you the first time you used marijuana or hashish?" We grouped the responses to represent "youth" ($\leq$19 years), "young adults" (20–39), and "adults" (40–59 years). Individuals who did not provide responses for either of the two questions were excluded.

2.3 | Statistical analyses

Four multivariable logistic regressions were performed to evaluate associations of cannabis use traits with clinical hypertension. The first regression evaluated whether any past sustained cannabis use was associated with the likelihood of having clinical hypertension. The remaining models only included individuals who reported sustained cannabis use sometime in the past. The second model evaluated whether frequency and age of first use predisposed clinical hypertension. The third model evaluated if recent sustained cannabis use (within the past year) was associated with having clinical hypertension. The final model compared the effects of current cannabis use and past cannabis use on hypertension. All models controlled for race/Hispanic origin, gender, and age. Race/Hispanic origin was grouped into the following categories as per the NHANES survey: Mexican American, other Hispanic, non-Hispanic White, non-Hispanic Black, non-Hispanic Asian, and other race, which included multi-racial participants.

Results were interpreted using adjusted odds ratios (OR) and 95% confidence intervals. The a priori level of significance was set at $p < .05$. R software (version 4.0.5) was utilized to perform statistical analysis.[16]

3 | RESULTS

Our study included 4565 respondents, of which 867 (19.0%) reported sustained cannabis use in the past. A total of 1409 participants (30.9%) indicated having received a hypertension diagnosis in the past. Of respondents who had received a hypertension diagnosis, 217 (15.4%) reported previous sustained cannabis use, compared with 650 (20.6%) of non-hypertension participants. Our chi-squared test of independence was significant, X^2 (1, N = 4565) = 17.1, $p < .01$. There was no increased incidence of hypertension in those with sustained cannabis use—in fact, there was a higher proportion of patients with hypertension in the group without cannabis use. The demographics of the sample are outlined in Table 1.

Table 2 outlines the descriptive statistics evaluating traits of cannabis use in respondents with (N = 217) and without (N = 650) hypertension who reported previous sustained use. Significantly more patients without hypertension reported sustained cannabis use within the past year (63.7% vs. 52.5%; $p < .01$) and currently using cannabis (49.7% vs. 43.3%; $p = .01$). In respondents with hypertension, 80 individuals (36.9%) reported infrequent use, 49 (22.6%) moderate use, and 88 (40.6%) highly-frequent use. In those without hypertension, 261 (40.2%) indicated infrequent use, 137 (21.1%) moderate use, and

252 (38.8%) highly-frequent use. The chi-squared test of independence was insignificant, X^2 (3, N = 867) = .75, $p = .69$. Most participants with hypertension began using cannabis in their youth (152 individuals; 70.0%), followed by as young adults (60; 27.6%), and adults (5; 2.4%). Similarly, those without hypertension typically began using cannabis in their youth (467 respondents; 71.8%), followed by as young adults (170; 26.2%), and adults (13; 2.0%). The chi-squared test of independence was insignificant, X^2 (3, N = 867) = .28, $p = .87$.

Participants who reported past sustained cannabis use did not have different odds of having hypertension (OR: 1.12; 95% CI: .66–1.91; $p = .6$). Individuals with recent sustained cannabis use were not more likely to have hypertension (OR: 1.09; 95% CI: .67–1.78; $p = .7$). When compared with past cannabis use, current use was not associated hypertension (OR: 1.03; 95% CI: .59–1.79; $p = .9$). The frequency of cannabis use was not associated with hypertension. With infrequent cannabis use set as a reference, moderate users (OR: 1.08; 95% CI: .36–3.25; $p = .8$) and highly-frequent users (OR: 1.30; 95% CI: .56–3.03; $p = .4$) did not have different odds of having hypertension. Respondents that first used cannabis as young adults (OR: 1.19; 95% CI: .18–8.12; $p = .8$) and adults (OR: 3.07; 95% CI: .57–16.4; $p = .12$) did not have different odds of having hypertension than those who first used cannabis in their youth. Results from our logistic regressions are outlined in Table 3.

4 | DISCUSSION

When compared with non-users, respondents who indicated sustained use of cannabis were not found to have an increased likelihood of developing hypertension. Among cannabis users, the frequency of use was not associated with an increased odds of hypertension diagnosis. The age that an individual first began regularly using cannabis was also not found to have an association with the odds of hypertension diagnosis. Current users were not more likely than past users to have hypertension. There was no effect of the recency of sustained use on hypertension status. Our study used patient-reported data from NHANES to evaluate the association between various aspects of cannabis use and having been given a hypertension diagnosis. The responses given by the participants indicate that sustained cannabis use and the degree of use are not associated with the development of hypertension. Though retrospective, our study is strengthened using a robust and large sample of data.

The available research investigating cannabis use and hypertension is limited and conflicting, with few studies being performed only in recent years. Two previous studies have been conducted utilizing NHANES data collected from 2005 to 2014 and 2005 to 2012, respectively.[17,18] Both studies investigated the association between cannabis use and hypertension; however, they utilized isolated measurements of blood pressure from examination data as a metric for hypertension. In contrast to our findings, Vidot et al. found a higher prevalence of elevated BP in current users and heavy users and Alshaarawy et al. found an association with increased systolic pressure, but none with diastolic pressure. Our conflicting findings may

TABLE 1 Demographics of overall sample

Characteristic	Non-Hypertension, N = 3156[a]	Hypertension, N = 1409[a]
Age in years at screening	40.0 (14.9)[b]	53.8 (12.1)[b]
Gender		
Male	1467 (46.5%)	715 (50.7%)
Female	1689 (53.5%)	694 (49.3%)
Race/Hispanic origin		
Non-Hispanic White	933 (29.6%)	417 (29.6%)
Mexican American	543 (17.2%)	144 (10.2%)
Other Hispanic	328 (10.4%)	127 (9.0%)
Non-Hispanic Black	643 (20.4%)	466 (33.1%)
Non-Hispanic Asian	536 (17.0%)	176 (12.5%)
Other race	173 (5.5%)	79 (5.6%)
Sustained marijuana use		
Yes	650 (26.4%)	217 (29.7%)
No	1813 (73.5%)	514 (70.3%)
Don't Know	2 (.1%)	0 (.0%)

[a]n (%).
[b]Mean (SD).

TABLE 2 Traits of cannabis use

Characteristic	Non-hypertension, N = 650[a]	Hypertension, N = 217[a]
Frequency of cannabis use		
Infrequent user	261 (40.2%)	80 (36.9%)
Moderate user	137 (21.1%)	49 (22.6%)
High-frequency user	252 (38.8%)	88 (40.6%)
Age of first use		
Youth	467 (71.8%)	152 (70.0%)
Young adult	170 (26.2%)	60 (27.6%)
Adult	13 (2.0%)	5 (2.3%)
Recent sustained cannabis use		
Yes	414 (63.7%)	114 (52.5%)
No	232 (35.7%)	97 (44.7%)
Unknown	4 (.62%)	6 (2.76%)
Type of cannabis use		
Past use	323 (49.7%)	94 (43.3%)
Current use	323 (49.7%)	117 (53.9%)
Unknown	4 (.62%)	6 (2.76%)

[a]n (%).

TABLE 3 Logistic regression results

Characteristic	OR	95% CI	p-value
Sustained cannabis use			
No	–	–	
Yes	1.12	.66, 1.91	.6
Frequency of cannabis use			
Infrequent user	–	–	
Moderate user	1.08	.36, 3.25	.8
High-frequency user	1.30	.56, 3.03	.4
Age of first use			
Youth	–	–	
Young adult	1.19	.18, 8.12	.8
Adult	3.07	.57, 16.4	.12
Recent sustained cannabis use			
No	–	–	
Yes	1.09	.67, 1.78	.7
Type of cannabis use			
Past use	–	–	
Current use	1.03	.59, 1.79	.9

Abbreviations: OR, Odds Ratio; CI, Confidence Interval.

reflect our different outcomes, as we investigated clinical hypertension, defined by receiving a medical diagnosis. A potential hypothesis may be that cannabis use increases short-term blood pressure without predisposing clinical hypertension. Both studies are limited by the likelihood for response bias, particularly considering the national attitudes toward cannabis during the years that data was collected. In contrast, our study uses the most recent data provided by NHANES, collected after recent waves of medical and recreational cannabis legalization.

We found no significant association between past sustained cannabis use and clinical hypertension. Additionally, there was no

effect on the recency of sustained cannabis use. In a similar study by Haleem et al., the authors found that 12-month use and lifetime use were not associated with the odds of hypertension diagnosis.[19] Frequency of use was also not associated with the incidence of hypertension. Similarly, Kalla et al. found that cannabis use did not independently predict hypertension status.[20] Our study reinforces the existing research indicating a lack of association between smoking cannabis and hypertension. In contrast, Parekh et al. found that cannabis use decreased the likelihood of hypertension in young adults (aged 18–44) and Abuhasira et al. found that a 3-month cannabis therapy decreased 24-h systolic and diastolic values in older adults.[21,22] Our study indicates that recreational use does not appear to increase the risk of hypertension.

The frequency of use and age that respondents began regularly using cannabis was not associated with hypertension status. Though many differences in the effects of cannabis have been noted between adolescents and adults,[23] research stratifying cardiovascular impacts by age is limited. Our finding suggests early evidence that there may not be delayed or long-term effects of cannabis on hypertension, since participants who began using cannabis earlier in life were not more likely to have hypertension. However, further prospective clinical trials are necessary to make conclusive claims. To our knowledge, this study is the first to evaluate the relationship between the frequency of cannabis use and hypertension status. That even the most chronic users were not at different odds of developing hypertension provides further evidence that there is not a relationship between cannabis use and hypertension. There was also no difference in hypertensions status between current and past cannabis users.

Notably, respondents in this study were only asked whether they smoked cannabis, as opposed to other methods such as through edible products or vaporization. Smoking in the context of cigarettes has been long associated with increased blood pressure, as the release of inflammatory and proatherogenic cytokines following smoke exposure leads to the development of endothelial dysfunction.[24] One may speculate that smoking cannabis could have different effects than smoking tobacco in humans, but further research is necessary to better understand the pathophysiology of cannabis use. The current literature regarding the effects of smoking cannabis on endothelial dysfunction in humans is limited.

Our study is limited by the potential for recall bias, due to the self-reported nature of responses. Although our study may be limited by response bias, the survey was administered digitally in a private setting, strengthening the utility of responses. The survey focused on smoking cannabis, which leaves out other routes of administration such as via food products containing cannabis. Additionally, we did not have quantitative measurements for cannabis use or dosages. There is also the potential that individuals with uncontrolled or previously unidentified hypertension were not captured in our sample, as we assessed hypertension status by whether individuals had received a previous clinical diagnosis or medication. The authors also note the possibility of further confounders that were not controlled via multivariable analysis.

5 | CONCLUSIONS

The findings of this study indicate that neither past nor current cannabis use are associated with the likelihood of having clinical hypertension. Among cannabis users, frequency of use was not associated with hypertension. Similarly, the age of first cannabis use was not associated with hypertension status. Prospective clinical trials are needed to further determine the effects of cannabis on developing or perhaps even mitigating hypertension, particularly regarding long-term outcomes. The effects of cannabis dosage, length of chronic use, and method of ingestion also require further research. The current literature regarding the pathophysiology through which cannabis affects the cardiac system, including blood pressure, is inconclusive, marking another area for future investigations.

AUTHOR CONTRIBUTIONS
Drs. Joseph A. Diamond and Angela Li conceptualized and designed the study and drafted the manuscript. Rohan M. Shah conceptualized and designed the study, prepared descriptive statistics, and drafted the initial manuscript. Shiv Patel carried out the initial statistical analyses, data cleaning, sample weighting, and prepared the initial manuscript. Sareena Shah and Sahil Doshi contributed to the statistical analysis, reformed the study design, and prepared the manuscript. All authors participated in reviewing the study design, interpreting results, and preparing the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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CONFLICT OF INTEREST
The authors do not have any relevant conflicts of interest, sources of financial support, corporate involvement, or patent holdings.

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