

Young adults' knowledge, perceptions and use of cannabidiol products: a mixed-methods study

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Abstract

Cannabidiol (CBD) product regulatory efforts must be informed by research regarding consumer perceptions. This mixed-methods study examined CBD product information sources, knowledge, perceptions, use and use intentions among young adults. This study analyzed (i) Fall 2020 survey data from 2464 US young adults ($M_{age} = 24.67$, 51.4% ever users, 32.0% past 6-month users) and (ii) Spring 2021 qualitative interviews among 40 survey participants (27.5% past-month users). Overall, 97.9% of survey participants reported having heard of CBD, 51.4% ever/lifetime use and 32.0% past 6-month use. Survey participants learned about CBD from friends/family (58.9%), products/ads at retailers (36.4%), online content/ads (34.8%), CBD stores (27.5%) and social media (26.7%). One-fourth believed that CBD products were required to be US Food and Drug Administration-approved (24.9%), tested for safety (28.8%) and proven effective to be marketed for pain, anxiety, sleep, etc. (27.2%). Survey and interview participants perceived CBD as safe, socially acceptable and effective for addressing pain, anxiety and sleep. Interview findings expanded on prominent sources

of marketing and product exposure, including online and specialty retailers (e.g. vape shops), and on participants' concerns regarding limited regulation and/or evidence regarding CBD's effectiveness/risks. Given young adults' misperceptions about CBD, surveillance of CBD knowledge, perceptions and use is critical as the CBD market expands.

Introduction

The Agriculture Improvement Act of 2018 (i.e. the Farm Bill) allowed cannabis derivatives containing $\leq 0.3\%$ tetrahydrocannabinol (THC) to be excluded from the category of federally controlled substances [1–3]. Since then, there has been rapid popularization of products containing cannabidiol (CBD) [4, 5], one of the main active cannabinoids of the cannabis plant. CBD, which does not have the psychoactive properties of THC [6], is advertised as a food and health supplement [7]. In 2019, over 25% of US adults reported ever trying CBD products at least once in the past 2 years [8] and ~14% reported 'personally using' CBD products [9]. CBD use is particularly prominent among those aged 18–29 years, with 2019 reports indicating 39.7% ever used in their lifetime [8, 10], 40%

used at least once in the past 2 years [8] and 20% ‘personally use’ CBD products [9].

Many types of retailers sell CBD products, including pharmacies, gas stations, convenience stores, health/vitamin shops and coffee shops [6, 11–14]. CBD is typically consumed as pills, edibles or beverages [15], but can also be vaped, applied topically (e.g. oils and lotions) and used in other ways [12, 16–18]. Among young-adult CBD users, edibles, tinctures and vape products were most commonly used for stress relief, relaxation and sleep [10, 18].

Recent evidence has shown that people hold positive perceptions of CBD despite having limited knowledge of its evidence base or regulation [10, 19]. In one study of US adult CBD users, 75.9% of respondents reported learning about CBD from internet research, family members or friends [20]. A social media analysis of Pinterest indicated that pins portrayed an overall positive view of CBD use for health promotion but failed to provide reliable sources and contained limited information regarding US Food and Drug Administration (FDA) regulation, dosage or side effects [21]. The same study found that 42% of pins endorsed CBD use for treating problems with mental or physical health, which is concerning given that social media communications are outside of the purview of FDA regulation [21].

However, the FDA has not yet approved CBD-based treatments for conditions other than epilepsy (i.e. Epidiolex [11, 22]), even though CBD use has been associated with significant improvements in conditions such as psychotic symptoms, anxiety, seizures, pain and Crohn’s disease [23, 24]. This is especially important given that people have limited knowledge of CBD’s evidence base or regulation [10, 19] and are often exposed to unreliable sources of information [21], particularly via the internet, which is among the most common sources of information [20].

As CBD product marketing and product use increase, there is also an increased need to enhance the evidence base informing its regulatory oversight. Such regulatory oversight is critical [25], as indicated by recent legislation that includes

three bills introduced by the US Congress in 2021 [26–28] and several state efforts to regulate CBD product retail, marketing, packaging and labeling [25]. Such regulatory efforts must be informed by research regarding CBD use, perceptions and correlates of use and intentions to use. This is particularly relevant among young adults who represent a group especially likely to use CBD [8–10]. Unfortunately, the existing literature is limited by relatively small sample sizes, limited geographic diversity and assessments limited in scope (i.e. few survey items and only closed-ended questions), among other limitations [6, 10, 18, 20].

Thus, this paper adds to the evidence base regarding CBD perceptions and use among a large sample of young adults across the United States, using a mixed-methods design with comprehensive quantitative and qualitative assessments. More specifically, this study used data from surveys and semi-structured interviews to examine CBD product information sources, knowledge, perceptions, use and use intentions among young adults.

Methods

This study analyzed data among young adults (ages 18–34) in a 2-year longitudinal study, the Vape shop Advertising, Place characteristics and Effects Surveillance (VAPES) study. VAPES examines the vape retail environment and its impacts on young-adult e-cigarette and other substance use. This study recruited participants from six US metropolitan statistical areas (MSAs; Atlanta, Boston, Minneapolis, Oklahoma City, San Diego and Seattle) representing different tobacco control policies [29] and different policies with respect to legal CBD product sales (as of 2020 when survey data were collected) [30]. This study, detailed elsewhere [31], was approved by the Institutional Review Boards of [omitted for blind review].

Potential participants were recruited via ads on social media (Facebook and Reddit) in Fall 2018. Eligibility criteria were (i) 18–34 years old; (ii) residing in the six aforementioned MSAs and (iii) English speaking. After clicking an ad, individuals

were directed to a webpage with a consent form, completed an online eligibility screener and then completed the online baseline survey. Participants were notified that, 7 days later, they would receive an email to confirm their participation. Upon confirming, they were officially enrolled and emailed their first incentive (\$10 e-gift card). Purposive, quota-based sampling was used to ensure sufficient proportions of e-cigarette and cigarette users and to obtain roughly equal numbers of men and women and 40% racial/ethnic minority; subgroup enrollment was capped by MSA. Of 10 433 who clicked on ads, 9847 consented, of which 2751 (27.9%) were not allowed to advance due to (a) ineligibility ($n = 1472$) and/or (b) their subgroup target being met ($n = 1279$). Of those allowed to advance, 48.8% (3460/7096) provided complete data and 3006 (86.9%) confirmed participation at the 7-day follow-up.

Quantitative measures

Current analyses used baseline sociodemographic and Wave 5 (W5) data ($n = 2476$, 82.4% retention), which was collected in October–December 2020. Analyses were restricted to those who completed the assessment of ever/lifetime CBD use ($n = 2464$ total, excluding 12 who reported ‘prefer not to answer’).

Sociodemographics

Baseline measures assessed: age, sex, sexual orientation, race, ethnicity and education. MSA of residence at W5 was also included.

CBD information sources

Participants were asked, ‘Where did you first learn about CBD? friends/family; products/ads at convenience store, grocery store and/or gas station; CBD-related content/ads online (e.g. online advertisements or ads shared via social media); social media postings; CBD stores; healthcare provider; fliers, ads, promotions, etc. in print media (newspapers, magazines); TV; radio; other; have not heard of CBD’ [20, 32].

CBD knowledge

Participants were asked to indicate ‘true’ or ‘false’ (or ‘don’t know’) to the following statements: ‘CBD can get you “high”’; ‘CBD, hemp, and marijuana are all the same’ and ‘CBD products are required to be: (i) tested and proven safe in order to be sold to consumers; (ii) approved by the Food and Drug Administration (FDA) in order to be sold to consumers; and (iii) proven to be effective in order to be marketed for pain relief, anxiety reduction, sleep, etc.’ [10, 18, 32].

CBD perceptions

Participants were asked the following questions (1 = not at all to 7 = extremely): ‘How addictive do you think using CBD is? How harmful to your health do you think using CBD is? How socially acceptable among your peers do you think using CBD is?’ Using the same response options, they were also asked to respond to: ‘CBD is effective in: (i) relieving pain; (ii) reducing anxiety; (iii) helping people sleep; and (iv) therapy for epilepsy/seizures’ [10, 18, 32].

CBD use and use intentions

Participants were asked, ‘Have you ever used CBD products?’ Ever users (i.e. those who used at least once in their lifetime) were asked, ‘In the past 6 months, on how many days have you used CBD products?’ These items were used to categorize participants as never versus ever users; ever users were further subcategorized as past 6-month users versus those not using in the past 6 months. Participants were asked the following questions (1 = not at all to 7 = extremely): ‘How likely are you to try or continue to use CBD products in the next year?’ [32].

Data analysis

Descriptive analyses were conducted to characterize the overall sample. Bivariate analyses were then conducted to characterize CBD never users versus ever users who had not used in the past 6 months versus past 6-month users in relation to sociodemographics and CBD information sources,

knowledge, perceptions and use intentions. Analyses were conducted in Stata SE v16, and alpha was set at 0.05.

Qualitative data collection

In February–April 2021, past 30-day e-cigarette users identified at W5 were recruited via email to participate in semi-structured interviews (as the interviews focused on e-cigarette use broadly, with CBD being a component of the interviews). The Consolidated Criteria for Reporting Qualitative Research guidelines were used to guide the qualitative research [33]. Quota-based sampling was used to achieve a sample with representation across the sexes, sexual orientation and racial/ethnic backgrounds. Of the 139 participants recruited via email, 105 (75.5%) began the eligibility screener, of whom 11 (10.5%) only partially completed it and 94 (89.5%) completed it. Of the 94, 34 (36.2%) were not eligible (i.e. not past 30-day e-cigarette users) and 60 (63.8%) were eligible and consented. Of the 60, 40 (66.7%) were successfully scheduled for and participated in an interview, at which point saturation had been reached.

The semi-structured interview guide was developed by the study team, based on the existing evidence base [6, 10, 18, 20] and preliminary survey data, to explore experiences with tobacco and cannabis product use. The initial interview guide was piloted for phrasing, clarity and necessary probes through mock interviews among four graduate research assistants and then revised after the first three interviews were conducted to ensure clarity and comprehensiveness. The current paper focused on interview questions regarding CBD. This section began by asking, ‘CBD is commonly found in vape shops, but people know very little about the product. Do you know what CBD is? If so, how did you learn about it? What do you know about CBD? How do you think it differs from marijuana?’ If participants reported no or little knowledge about CBD, they were provided information: ‘As you may or may not know, CBD – or cannabidiol – is part of the cannabis plant which is made up of CBD and THC. CBD is the

non-psychoactive portion of the plant. CBD products come in various forms – for example, in foods, lotions, or vaped liquids. They are marketed for use for various purposes – for example, anxiety, pain, movement disorders – but the scientific evidence is limited. Given this information, tell me what you think about CBD?’ Participants were then asked: (i) ‘What do you find appealing about CBD?’ (ii) What concerns do you have regarding CBD use? (iii) How do you think it compares to marijuana? (iv) Would you try CBD? Why or why not? (v) Have you used CBD? Why? Where did you get it? What did you think?’

Interviews were conducted via Webex by four female graduate research assistants trained in qualitative data collection, digitally recorded and lasted about 45 min. Participants were debriefed and compensated with a \$35 Amazon e-gift card following completion of the interview. Digitally recorded interviews were uploaded to a secure, password-protected computer and transcribed verbatim by a professional transcription service.

Data analysis

Qualitative data were analyzed using QRS Software NVivo v12 and thematic analyses. Transcripts were systematically coded using NVivo and cross-checked for agreement about the application of the codes. Team discussions took place regularly where the codebook themes were re-defined, inclusion and exclusion criteria set and representative passages identified. Discrepancies regarding code choices were resolved through discussion in a process of constant comparison and until consensus was reached (Kappa = 93.3%). Inter-rater reliability was calculated for each code through the use of an intra-class correlation coefficient and was deemed acceptable if the coefficient was ≥ 0.80 . Content codes were used to thematically group similar interview text; themes were organized into overarching domains compiled with representative quotations, which were edited for readability. Balancing the controversy in qualitative research regarding whether to quantify qualitative results, the frequency with which participants reported themes were indicated by ‘quantizing’

them as ‘most’, ‘many’, ‘almost half’, ‘some’ and ‘a few’ [34, 35]. Additionally, descriptive statistics were conducted to characterize the qualitative study sample, using SPSS 24.0.

Results

Quantitative results

Table I presents quantitative findings from the survey data ($N = 2464$). Participants were an average age of 24.67 years old, 57.4% female, 68.9% heterosexual, 28.7% racial minority and 11.0% Hispanic. Overall, 51.4% reported ever using CBD, and 32.0% were past 6-month users. Only 2.1% had never heard of CBD. The greatest proportion of participants had learned about CBD from friends/family members (58.9%), followed by

products/ads at retail stores (36.4%), online content/ads (34.8%), exposure to CBD stores (27.5%) and social media (26.7%). While few participants believed that CBD could get one ‘high’ (9.8%) or that CBD, hemp and marijuana were the same (6.3%), roughly a quarter of participants indicated ‘true’ to CBD products are required to be ‘approved by FDA to be sold to consumers’ (24.9%), ‘tested/proven safe to be sold to consumers’ (28.8%) and ‘proven effective to be marketed for pain relief, anxiety reduction, sleep, etc.’ (27.2%). As shown in **Fig. 1**, participant means indicated low average perceived risk (addictiveness: $M = 2.34$ [$SD = 1.64$], harm to health: $M = 2.30$ [$SD = 1.62$]; scale: 1–7) and high perceived social acceptability ($M = 5.87$ [$SD = 1.62$]) and effectiveness for pain, anxiety, sleep and epilepsy/seizures (M values > 4.5).

Table I. Participant characteristics overall and across never users, ever but not past 6-month users and past 6-month CBD users

Variables	Overall $N = 2464$ (100.0%)	Never use ^a $N = 1198$ (48.6%)	Ever but not past 6-month use $N = 477$ (19.4%)	Past 6-month use $N = 789$ (32.0%)	<i>P</i>
	N (%) or M (SD)	N (%) or M (SD)	N (%) or M (SD)	N (%) or M (SD)	
Sociodemographics					
MSA, N (%)					<0.001
Atlanta metro area	382 (15.5)	207 (17.3)	67 (14.1)	108 (13.7)	
Boston metro area	326 (13.2)	175 (14.5)	63 (13.2)	89 (11.3)	
Minneapolis metro area	343 (13.9)	154 (15.5)	74 (15.5)	114 (14.6)	
Oklahoma City metro area	153 (6.2)	83 (6.9)	25 (5.2)	45 (5.7)	
San Diego metro area	365 (14.8)	170 (14.2)	66 (13.8)	129 (16.4)	
Seattle metro area	312 (12.7)	125 (10.4)	53 (11.1)	134 (17.0)	
Other ^b	583 (23.7)	285 (23.8)	129 (27.0)	169 (21.4)	
Age (M , SD)	24.67 (4.69)	24.28 (4.67)	24.51 (4.57)	25.35 (4.71)	<0.001
Female, N (%) ^c	1374 (57.4)	618 (52.8)	281 (61.0)	475 (62.3)	<0.001
Sexual minority, N (%)	766 (31.1)	312 (26.0)	174 (36.5)	280 (35.5)	<0.001
Race, N (%)					<0.001
White	1756 (71.3)	809 (67.5)	363 (76.1)	584 (74.0)	
Black	133 (5.4)	77 (6.4)	17 (3.6)	39 (4.9)	
Asian	315 (12.8)	206 (17.2)	44 (9.2)	65 (8.2)	
Other	260 (10.6)	106 (8.9)	53 (11.1)	101 (12.8)	
Hispanic, N (%)	272 (11.0)	145 (12.1)	39 (8.2)	88 (11.2)	0.068
Education \geq Bachelor’s degree, N (%)	1860 (75.5)	936 (78.1)	356 (74.6)	568 (72.0)	0.007

P-values reflect omnibus tests of differences across three subgroups (i.e. never, ever/not past 6 months and past 6-month users).

^a $n = 73$ ‘don’t know’ to ‘Have you ever used CBD?’ recoded as ‘never users’.

^bMoved since baseline.

^c $n = 69$ chose ‘other’.

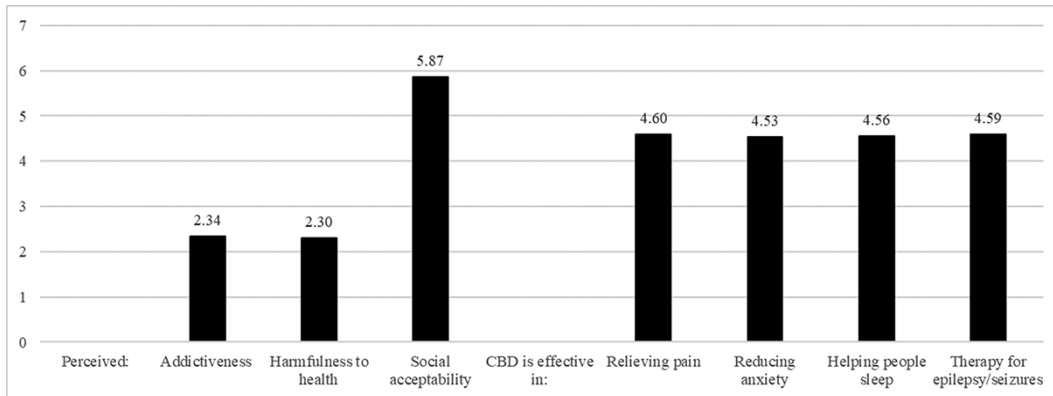


Fig. 1. Key perceptions and beliefs regarding CBD among US young adults. [^]Scale of 1 = not at all to 7 = extremely. Standard deviations range from 1.62 (harmfulness to health, social acceptability) to 1.78 (for therapy for epilepsy/seizures).

The mean regarding use intentions was 3.17 (SD = 2.18, scale: 1–7).

Bivariate analyses indicated differences across never, ever (but not past 6 month) and past 6-month users with respect to age, sex, sexual orientation, race and education (see footnote in [Table I](#) for details). As shown in [Table II](#), those most misinformed (i.e. those providing inaccurate [‘true’] or ‘don’t know’ responses) to the CBD knowledge items were never users and past 6-month users (P -values < 0.01). Never users reported the lowest CBD use intentions, while past 6-month users reported the highest (P < 0.001). In terms of perceptions, never users perceived CBD least favorably (i.e. most addictive and harmful to health, least socially acceptable and effective for treating health issues), with past 6-month users perceiving CBD the most favorably across these dimensions (P -values < 0.001).

Qualitative results

Interview participants ($N = 40$) were from across MSAs (range: 3 [7.5%] in Oklahoma City to 10 [25.0%] in Minneapolis-St. Paul), were an average age of 26.30 years (SD = 4.39), 35.0% ($n = 14$) female, 45.0% ($n = 18$) sexual minority, 57.5% ($n = 23$) White, 5.0% ($n = 2$) Black, 22.5% ($n = 9$) Asian, 15.0% ($n = 6$) other race, 12.5% ($n = 5$)

Hispanic and 75.0% ($n = 30$) educated at least the Bachelor’s degree level (not shown in tables). Overall, 27.5% ($n = 11$) reported past 30-day CBD use and 45.0% ($n = 18$) reported past 30-day cannabis use.

Health benefits of CBD

[Table III](#) provides themes, subthemes and representative quotations from the qualitative interviews. There was wide variability in terms of participants’ general knowledge about CBD. Regarding health benefits, many participants noted CBD’s usefulness for anxiety, sleep and pain. Some participants indicated that CBD might be better as a ‘natural’ or ‘holistic’ approach to treat anxiety compared with a more medicated treatment. Some participants also indicated the potential for CBD to aid with sleep due to its calming effect and to alleviate pain. In addition, some participants indicated that CBD products provided the health benefits of medicinal cannabis without psychoactive effects.

Concerns about CBD use

Some participants expressed concerns of CBD being too closely related to cannabis and thus the potential for CBD use to lead to cannabis use. Additionally, some participants noted concerns regarding the potential of CBD addiction and/or overdose. Many were concerned by the lack of

Table II. CBD-related characteristics overall and across never users, ever but not past 6-month users and past 6-month CBD users

Variables	Overall	Never use ^a	Ever but not past 6-month	Past 6-month use	P
	N = 2464 (100.0%)	N = 1198 (48.6%)	N = 477 (19.4%)	N = 789 (32.0%)	
	N (%) or M (SD)	N (%) or M (SD)	N (%) or M (SD)	N (%) or M (SD)	
CBD-related characteristics					
<i>How first learned about CBD, N (%) ~</i>					
From friends/family members	1451 (58.9)	637 (53.2)	318 (66.7)	496 (62.9)	<0.001
Products/ads at retail stores	897 (36.4)	486 (40.6)	171 (35.9)	240 (30.4)	<0.001
Content/ads online	858 (34.8)	451 (37.6)	150 (31.5)	257 (32.6)	0.015
Exposure to CBD stores	678 (27.5)	347 (29.0)	122 (25.6)	209 (26.5)	0.276
Social media postings	659 (26.7)	329 (27.5)	118 (24.7)	212 (26.9)	0.522
TV	261 (10.6)	143 (11.9)	47 (9.9)	71 (9.0)	0.096
Fliers, ads, promotions, etc. in print media	235 (9.5)	117 (9.8)	49 (10.3)	69 (8.8)	0.623
Radio	160 (6.5)	95 (7.9)	24 (5.0)	41 (5.2)	0.019
Healthcare provider	152 (6.2)	52 (4.3)	22 (4.6)	78 (9.9)	<0.001
Other	191 (7.8)	65 (5.4)	41 (8.6)	85 (10.8)	<0.001
Never heard of CBD	52 (2.1)	52 (4.3)	0 (0.0)	0 (0.0)	n/a
<i>CBD knowledge; indicated 'true' to: N (%)^b</i>					
CBD can get you 'high'	241 (9.8)	159 (13.3)	32 (6.7)	50 (6.3)	<0.001
CBD, hemp and marijuana are same	154 (6.3)	105 (8.8)	13 (2.7)	36 (4.6)	<0.001
<i>CBD products must be:</i>					
Approved by FDA to be sold to consumers	613 (24.9)	309 (25.8)	111 (23.3)	193 (24.5)	<0.001
Tested/proven safe to be sold to consumers	710 (28.8)	343 (28.6)	129 (27.0)	238 (30.2)	0.002
Proven effective to be marketed for pain relief, anxiety reduction, sleep, etc.	670 (27.2)	323 (27.0)	121 (25.4)	226 (28.6)	0.004
<i>CBD use intentions (next year), M (SD)^c</i>	3.17 (2.18)	1.99 (1.46)	2.83 (1.78)	5.17 (1.88)	<0.001

P-values reflect omnibus tests of differences across three subgroups (i.e. never, ever/not past 6 months and past 6-month users).

^an = 73 'don't know' to 'Have you ever used CBD?' recoded as 'never users'.

^b'Don't know' responses were 376 (15.3%), 241 (9.8%), 931 (37.8%), 866 (35.2%) and 796 (32.3%), respectively.

^cScale of 1 = not at all to 7 = extremely.

research or scientific evidence regarding the utility or consequences of CBD use. For example, one participant commented on the implications of people relying on CBD use for symptom management despite no clinical evidence base, but another commented that they felt that one should be able to freely try CBD products for symptom management if they so choose. Others noted concerns regarding the limited regulation of CBD. Relatedly, some reported specifically the concern that there is no real way to know what is in a specific CBD product or how much or little should be used.

Lastly, participants discussed CBD as being costly. This was also linked to concerns about limited regulation and whether there was an evidence base regarding its effectiveness for certain conditions.

Marketing exposure

Some participants noted relatively high levels of marketing exposure. Some commented that the marketing they had seen largely focused on health benefits—particularly for anxiety, epilepsy and pain—and that product novelty was highlighted

Table III. Participants describe the health aspects and knowledge of CBD

Theme and subtheme	Representative quotation
General knowledge	<ul style="list-style-type: none"> - <i>I think it's the exact same thing without the THC.</i> (Minneapolis; 27-year-old male; past-month CBD and cannabis use) - <i>It doesn't get you high and I guess that's it. I think that it has everything marijuana has except the THC if I'm not mistaken. That's what I've always thought.</i> (Atlanta; 25-year-old female; past-month CBD and cannabis use) - <i>It's supposedly not getting you high and not very addictive.</i> (Boston; 26-year-old female; past-month CBD and cannabis use)
Health benefits	
Anxiety and sleep	<ul style="list-style-type: none"> - <i>I like holistic medicine and essential oils and stuff. If they could help me with a headache versus popping a pill or anxiety versus popping pills, I find that very appealing definitely</i> (Atlanta; 25-year-old female; past-month CBD and cannabis use) - <i>It could help with anxiety. Compared to marijuana, with the THC component, it isn't psychoactive, so you wouldn't really be impaired as strongly in my opinion.</i> (Boston; 22-year-old male; no past-month CBD; past-month cannabis use) - <i>I know a lot of people that say that helps calming people down.</i> (Minneapolis; 25-year-old male; no past-month CBD use; former cannabis use) - <i>It's an alternative to general treatment of anxiety. CBD doesn't seem to have any negative side effects, unlike other standard pharmaceutical anxiety medications. So, I could see how that would definitely be preferable for people. I've also heard it can help people with sleep and pain. So, that's definitely appealing, I would prefer something natural over a pharmaceutical that can have side effects.</i> (Oklahoma City; 20-year-old female; no past-month CBD use; past-month cannabis use)
Pain	<ul style="list-style-type: none"> - <i>My mom felt like all of her pain just went away. And I was like, if it makes you feel good, even if it's just psychologically, right, like placebo effect.</i> (Seattle; 26-year-old female; past-month CBD and cannabis use) - <i>It's very helpful to help me reduce pain and relax when I get home from a stressful day at work.</i> (Minneapolis; 30-year-old male; past-month CBD use; former cannabis use)
Benefits of medicinal cannabis without psychoactive effects	<ul style="list-style-type: none"> - <i>Marijuana gets you stoned, but it definitely has positive medical effects. Helps people deal with anxiety and depression, helps with people who are sick with cancer. I think that the CBD is probably the better alternative as it's the pure form without the THC. So you don't get that component of it. You just get the medical benefits. I feel like it's probably a healthier alternative to the mind-altering nature of marijuana.</i> (Atlanta; 33-year-old male; no past-month CBD use; past cannabis use) - <i>I think a lot of people are worried about using something that could get them high or alter how they feel just to deal with things. CBD gives you that alternative. That's great. There were a lot of stories about people taking THC pills to help with seizures and stuff. And that's great. I just don't think you should be able to do that, unless it's an extreme case, if you're not a legal adult. CBD would be an alternative for that.</i> (Oklahoma City; 28-year-old male; no past-month CBD use; former cannabis use)
Concerns about CBD use	
Implications of THC in CBD products; too close to cannabis	<ul style="list-style-type: none"> - <i>The only concern I had was that, even if it's marketed as CBD, it can still have small traces of THC in it. And I was out job hunting at the time. So you still could pop on a drug test, even though it was just CBD? That was a concern. But other than that, no real concerns. It's a plant. It's medicinal.</i> (Oklahoma City; 28-year-old male; no past-month CBD use; former cannabis use) - <i>I feel like it would just lead to using marijuana eventually.</i> (Boston; 26-year-old female; past-month CBD and cannabis use) - <i>I link CBD to marijuana. In my mind, the oil comes from the CBD side of a marijuana plant. So you have CBD and THC. And I wouldn't try based off of that.</i> (Minneapolis; 25-year-old male; past-month CBD use; former cannabis use)

(continued)

Table III. (Continued)

Theme and subtheme	Representative quotation
Potential for addiction or overuse	<ul style="list-style-type: none"> - <i>I think that overuse can happen with an addictive personality. Anything you use medicinally can be abused. People abuse Tylenol, people abuse cough syrup, people abuse narcotics. Everything we take for medical reasons can form an addiction.</i> (Minneapolis; 30-year-old male; past-month CBD use; past cannabis use) - <i>I guess there's potential for overdosing? I don't know. I really don't know.</i> (Boston; 28-year-old female; no past-month CBD use; former cannabis use)
Lack of research or scientific evidence	<ul style="list-style-type: none"> - <i>The scientific evidence for the effects are limited. But that's what they're marketed for. Some people speak really highly of CBD. Some don't think it is effective.</i> (Seattle; 28-year-old male; no past-month CBD use; former cannabis use) - <i>I know that CBD is much newer introduction to the like legal marketplace. So I don't think the FDA says anything on CBD like pros/cons or potential side effects and so forth. That being said, I don't see anything wrong if someone says, 'Well, I want to use a CBD product to self-treat an issue.' I can't see how that will be harmful. I just don't know how much proven research that I've seen on CBD.</i> (Minneapolis; 26-year-old male; no past-month CBD use; past-month cannabis use) - <i>My biggest concern is not with the product itself. I've seen it being sold as a cure for so many different ailments without any real backing to it. So I wouldn't want it to become something that a lot of people put a lot of weight in and then realize that there's really not much proven effect for treating something. Like, I don't think the concerns I have are about bad reactions from using the product. I just am concerned about there not being as much research and studies on what this can actually be clinically found to help treat people.</i> (Minneapolis; 26-year-old male; no past-month CBD use; past-month cannabis use)
Lack of regulation	<ul style="list-style-type: none"> - <i>It's not well regulated or, or measured and maintained. There's none of the science. It's a health supplement. That's how it's sold. So they can really put anything in the bottle and say it's CBD. It could have no CBD, it could have way too much, it could be something totally different from my understanding.</i> (Atlanta; 30-year-old male; past-month CBD and cannabis use) - <i>Just how unregulated it is. And there is no recommended daily allowance. There's the standard one shot, which can help people monitor how much they take, and they can do what is an unsafe level for each person, like drowsiness. I'm guessing that could be detrimental if you're driving and you can just have too much of it. So I'm just concerned about those aspects.</i> (Boston; 22-year-old male; no past-month CBD; past-month cannabis use) - <i>It doesn't seem to be something that's regulated. So, there could be some unfriendly chemicals and some of the things that have CBD in them, which is something that I worry about. Like buying it from a shop, especially one of those sketchy shops. That kind of worries me because you're not entirely sure if it's just CBD, or if there's like something else in it they're just not telling you.</i> (Oklahoma City; 20-year-old transgender woman; past-month CBD use; former cannabis use)
Cost	<ul style="list-style-type: none"> - <i>Seems kind of like a healthy-ish way to manage pain and stuff. It's like, really, really expensive. That's why I would not get it. But if it was, like, cheaper, maybe I would get it.</i> (San Diego; 25-year-old female; no past-month CBD use; former cannabis use)
CBD marketing exposure High levels of marketing exposure	<ul style="list-style-type: none"> - <i>I know that it has been marketed a lot for various health purposes. I've seen foods and drinks that say it'll help with anxiety. I've heard it's helped a lot of people that have seizures or epilepsy or autism, and I've also heard people use it for physical pain. So, I've seen it advertised quite a bit. I've seen CBD shops throughout the area. I see plenty of ads for it on Instagram from people.</i> (Minneapolis; 26-year-old male; no past-month CBD use; past-month cannabis use) - <i>It is being marketed really heavily right now. I think people are trying to capitalize on it. Until there are stronger studies and official things done about it, I wouldn't try it.</i> (Boston; 22-year-old male; no past-month CBD; past-month cannabis use)

(continued)

Table III. (Continued)

Theme and subtheme	Representative quotation
Online marketing	<ul style="list-style-type: none"> - <i>There are advertisements all day, every day on my Amazon feed. Gummies and such all day, every day.</i> (Minneapolis; 27-year-old male; past-month CBD and cannabis use) - <i>I know about it because of like social media and stuff like that and the news and YouTube.... I do online surveys and I sign up for samples and stuff like that. I have a sample of CBD balm right here with me. I'm kind of nervous to even try it. But I'm also supposed to be receiving drops and gummies.</i> (Seattle; 35-year-old female; no past-month CBD use; former cannabis use)
Personal experiences using CBD	
Methods of use	
Vaping	<ul style="list-style-type: none"> - <i>Through a vape and a brownie edibles.</i> (Minneapolis; 22-year-old male; no past-month CBD use; former cannabis use) - <i>I bought some liquids that I would mix with the liquid in my vape.</i> (Oklahoma City; 28-year-old male; no past-month CBD use; former cannabis use)
Smoking	<ul style="list-style-type: none"> - <i>I used it in foils and crystals, and used a heating coil device to smoke it. It gives you somewhat of particularly pure CBD flour. It gives you a calming effect, more like head high.</i> (Seattle; 29-year-old male; no past-month CBD use; former cannabis use) - <i>For a while, I was buying CBD cigarettes. It's just CBD bud in a cigarette wrap. There's no tobacco in it. That was helpful with the hand to mouth motion of trying to quit vaping. But they're really expensive, like \$20 a pack. So, I stopped using them because they didn't taste very good.</i> (Minneapolis; 20-year-old male; no past-month CBD use; past-month cannabis use)
Tinctures	<ul style="list-style-type: none"> - <i>I've used like little drops where you put some drops in your mouth, and rub it around on your gums. But other than that, it's mainly smoking it.</i> (Oklahoma City; 20-year-old transgender female; past-month CBD use; former cannabis use) - <i>The under the tongue stuff. Now I used to just vape CBD, I started just doing the liquid under the tongue stuff like you do with nitroglycerin. That seems to work really well. It helped me reduce pain and relax when I get home from a stressful day at work. So that's really kind of the reason why I haven't smoked as much as I used to, as well as the amount of vaping that I used to do. I can literally just put a couple drops under my tongue liquid concentrate form and be on my merry way and do what the rest I need to you know, get away with the rest of my day.</i> (Minneapolis; 30-year-old male; past-month CBD use; former cannabis use)
Topicals	<ul style="list-style-type: none"> - <i>My wife did use the lotion, and she said it was helping with her knees, muscle aches and stuff, but I didn't get that.</i> (Oklahoma City; 28-year-old male; no past-month CBD use; former cannabis use)
Product source	
Retailers	<ul style="list-style-type: none"> - <i>[I first learned about CBD] through a vape shop. [I first purchased CBD] through my local tobacco store.</i> (Minneapolis; 22-year-old male; no past-month CBD use; former cannabis use)
Online	<ul style="list-style-type: none"> - <i>Either my friend had it or I finally caved in from one of these millions of ads that Facebook and Amazon have. I think it's a gimmick. It was cute, but didn't actually live up to the hype.</i> (Minneapolis; 27-year-old male; past-month CBD and cannabis use)
Friends, family and others in social network	<ul style="list-style-type: none"> - <i>Word of mouth. From friends.</i> (Seattle; 32-year-old male; no past-month CBD use; former cannabis use) - <i>I got it from my mom, and I think she got it at Walgreens. She has since bought it for my grandmother, my aunt, and everybody loves it.</i> (Atlanta; 25-year-old female; past-month CBD and cannabis use)
Personal effects of CBD	
Limited effects	<ul style="list-style-type: none"> - <i>I've tried it and I don't really feel like it was working.</i> (Minneapolis; 22-year-old male; no past-month CBD use; former cannabis use) - <i>I've tried smoking pure CBD bud. I've tried a gummy. I've even tried a vape attachment with CBD. It does nothing for me, but I believe him [friend] that it helps him.</i> (Oklahoma City; 20-year-old female; no past-month CBD use; past-month cannabis use)

(continued)

Table III. (Continued)

Theme and subtheme	Representative quotation
Effects for anxiety, sleep	- <i>I think it's helpful, but it could possibly be placebo. If people find pain relief from it, or relaxation, I don't see an issue with it. It doesn't seem to be harmful.</i> (Oklahoma City; 20-year-old transgender female; past-month CBD use; former cannabis use)
	- <i>Before medical marijuana was legal. I wasn't able to get edibles for sleep. And I've been struggling with chronic insomnia since I was 15. I've tried the pharmaceutical route, didn't really help me. I've tried off the counter stuff. That didn't help me either. So, I tried CBD to see if it would help getting me into a relaxed state in order to sleep. It didn't work for me. But that's really the only reason why I tried it.</i> (Oklahoma City; 20-year-old female; no past-month CBD use; past-month cannabis use)
	- <i>I ordered some little gummies and drops, but I typically don't [use]. Last night, my boyfriend was having really bad anxiety and I gave him a little dropper of CBD oil under his tongue and he calmed down right away. So I was like, 'wow, that's crazy.' One time I use the CBD like roll on for back pain and it definitely worked. I was kind of skeptical about the whole CBD thing. I do think CBD is pretty awesome from what I've seen.</i> (Atlanta; 25-year-old female; past-month CBD and cannabis use)
Effects for pain relief	- <i>I think it has a lot of medical benefits to it. I think it does help a lot with the like anxiety piece that a lot of people do use it for as well as like insomnia. When I would use it, it would be like right before bed and it would give me like a really calm headspace. And get me in a place where I can fall asleep easier. As well as helping you with other weird things going on in my body feels like a lot more natural supplement like I guess I kind of compared to like other supplements that you would find like in a store but it feels a lot more natural.</i> (Seattle; 21-year-old male; no past-month CBD use; past-month cannabis use)
	- <i>Personally, I've used the tincture before. It definitely had a calming effect. But I also don't know how much of that is mind over matter. If you believe it works, maybe it works.</i> (Atlanta; 33-year-old male; no past-month CBD use; former cannabis use)
Negative experiences	- <i>I think the number one thing that I think is appealing is its potential. In my own mind, I think that it helps with my pain in my hands, but to be real, I have no idea if it did or not. The idea that it has the potential to help with pain and anxiety and all of those kinds of things.</i> (Minneapolis; 33-year-old male; no past-month CBD use; former cannabis use)
	- <i>I have an inflammatory thing going on with my spine or whatever right now. And I consume CBD products and it definitely helps with inflammation and relaxes me a little bit.</i> (Boston; 20-year-old male; past-month CBD and cannabis use)
	- <i>I've tried it. My friend's parents own a gas station, they had some gummies. It actually made me feel stoned and not in a good way. So I don't know if it was tainted with something because these things aren't regulated, right? I don't feel like it's well regulated, so I feel like it's dangerous. I don't use it regularly.</i> (Atlanta; 30-year-old male; past-month CBD and cannabis use)

frequently. Prominent sources of marketing exposure were online, particularly via social media and in large online retailers (e.g. Amazon).

Personal experiences with CBD use

Participants reported various modes of use and sources of CBD products. A few reported vaping CBD e-liquid, smoking it via flour or CBD cigarettes, using tinctures such as liquid drops under the tongue or as topicals (e.g. lotions,

particularly for pain). Participants indicated different sources of CBD. For example, a few indicated tobacco retailers (i.e. vape or smoke shops), online retailers and via friends, family and others in their social network.

In terms of effects of CBD use that participants experienced, most participants indicated limited effects of CBD. Some noted that the effects they experienced were possibly more of a placebo effect. Some noted that, despite their own experiences, they knew of others who experienced

benefits of CBD use. Several participants indicated positive personal experiences with CBD for anxiety, sleep and pain relief. Few participants reported any negative experiences resulting from CBD use. For example, one participant noted an experience where CBD use made them feel 'stoned', perhaps due to using a potentially tainted product.

Discussion

This study is among the few that have examined CBD-related knowledge, perceptions, use and use intentions among young adults in the United States [8–10]. Among survey participants, almost all had heard of CBD, over half had ever used CBD products and a third used CBD products in the past 6 months. The majority (58.9%) of survey participants reported first learning about CBD from friends/family, with roughly a third learning about it at retailers or online (respectively), which is consistent with prior literature [6, 11–14]. Interview participants elaborated on these points and also indicated that social media and other online advertisements played salient roles, perhaps because FDA does not regulate social media advertisement [21]. Similarly, previous research found the internet and informal sources were predominately where consumers learn about CBD (rather than from a physician, for example) [6, 20].

Participants generally held positive perceptions of CBD. On average, young adults in this study perceived CBD as safe to use and effective for addressing pain, anxiety and sleep. Interview participants indicated that it is a more 'holistic' and 'natural' remedy for headaches, anxiety, pain and sleep, despite the fact that the FDA does not approve of CBD as a dietary supplement and the limited available evidence regarding the effectiveness of CBD as a treatment for such conditions, as noted in prior research [6, 23]. Moreover, bivariate analyses of the survey data indicated that more favorable perceptions of CBD correlated with lifetime and

past 6-month use, as well as greater use intentions among never users, aligning with numerous health behavior theories that suggest that behavior is predicted by such perceptions of risks and benefits [36–38]. However, most interview participants noted that CBD produced limited effects and, fortunately, few reported any negative effects of CBD use, contrary to prior research indicating that over half of CBD users experienced at least one unexpected side effect [10, 20]. Notably, roughly a quarter of survey participants falsely believed that CBD products were required to be approved by FDA to be sold to consumers, proven safe to be sold to consumers and confirmed effective to be marketed for pain relief, anxiety reduction, sleep, etc. (respectively). In general, these findings add to the literature that suggest confusion about the legality and regulation of CBD, confounded by the limited and evolving regulation and manufacturing guidelines [10, 39]. However, it is encouraging that some interview participants indicated that prominent concerns included limited regulation and/or evidence regarding CBD's effectiveness or risks and that roughly 35–40% of survey participants were knowledgeable about CBD regulatory oversight.

Findings from this study have implications for research and practice. This study found that young-adult CBD use correlated with positive perceptions of CBD and that young adults generally perceived CBD positively, believed in its effectiveness in treating certain conditions (e.g. sleep, anxiety and pain) and largely learned about and obtained CBD via social networks, retailers and online. Importantly, roughly a quarter of survey participants held untrue beliefs regarding FDA's regulatory oversight of CBD products and marketing, and interview participants indicated concerns about limited CBD's evidence base and regulatory oversight. Collectively, these findings underscore for both research and regulators to monitor CBD retail and marketing (e.g. via website audits and brick-and-mortar store audits) and their impact on consumer perceptions and behavior, particularly as the market expands and policies evolve to further regulate CBD [25].

Furthermore, practitioners should consider taking measures to explicitly address retail claims regarding CBD's effects in order to prevent the spread of misinformation and/or misleading information to consumers.

Study strengths and limitations

This study is strengthened by a large diverse sample of young adults living in six distinct US MSAs and a rigorous mixed-methods design providing in-depth data regarding CBD perceptions. Study limitations include limited generalizability to other US young adults, given that this sample was drawn from six MSAs using purposive sampling to obtain target sample sizes of e-cigarette and cigarette users. Second, interview participants who were unfamiliar with CBD were provided with information about CBD, and most survey participants were exposed to CBD descriptions in the 2019 survey. These exposures may have impacted their awareness—and potentially use—of CBD. Lastly, assessments were self-reported (thus subject to recall bias [40]), and the data analyzed were cross-sectional, limiting the ability to determine causal associations.

Conclusions

Given CBD's growing popularity and marketing expansion advertising wide-ranging health benefits, this is a pivotal time for surveillance of perceptions and use of CBD, particularly among young adults. Young-adult participants in this study generally perceived CBD as safe and effective for treating various health conditions and had limited knowledge regarding CBD product regulation. These findings are concerning and further underscored by the limited regulation and clinical evidence regarding CBD's effectiveness in treating various health conditions, particularly those for which it is commonly marketed. Such gaps in the regulation of the CBD market and in consumer education leave vulnerable populations, such as young adults, at risk for uptake.

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Conflict of interest statement

None declared.

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