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Sources of Information and Beliefs About the Health Effects of Marijuana

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BACKGROUND: Marijuana is currently legal for recreational use in 10 states and Washington DC while a total of 34 states have implemented varying degrees of medical marijuana. The commercialization of marijuana has been accompanied by a proliferation of false claims regarding the therapeutic potential of marijuana, which are popularized by several different information sources. To date, no study has examined where US adults get their information regarding marijuana.

OBJECTIVE: To determine the sources of information associated with believing unsupported claims about marijuana.

DESIGN: Probability-based online survey

PARTICIPANTS: 16,820 adults, with a response rate of about 55% (N = 9003)

MAIN MEASURES: Most influential sources of information about marijuana and belief of statements consistent with misinformation, for example, smoking marijuana has preventative health benefits, secondhand marijuana smoke or use during pregnancy is completely or somewhat safe, and marijuana is not at all addictive.

KEY RESULTS: There were 9003 respondents (response rate 55%). Forty-three percent believed unsupported claims about marijuana. The most influential sources of information were health professionals, traditional media, friends/relatives, and social media/internet. Individuals reporting social media or the Internet (1.46 CI [1.30, 1.64]), the marijuana industry (e.g., advertisements, dispensaries) (2.88 CI [2.15, 3.88]), and friends or relatives (1.41 CI[1.26, 1.58]) as the most influential source of information about marijuana were more likely to believe any statement consistent with misinformation about marijuana in comparison with those who reported other sources as most influential.

CONCLUSIONS: Individuals reporting the most significant source of information regarding marijuana was from social media or the Internet, the marijuana industry, or friends or relatives were more likely to believe unsupported claims about marijuana. Public health campaigns to counter the misinformation about marijuana to the public are needed.

INTRODUCTION

The prevalence of marijuana use has increased in the past decade in the United States (US) population and worldwide.[1, 2] In tandem with increasing marijuana use, there has also been a substantial drop in the public's perception of risks from marijuana use in the US and other Western countries.[3, 4] Moreover, the marijuana industry has experienced tremendous growth in the past decade and is projected to exceed $57 billion in annual revenue within the next decade.[5] In tandem with the growth in marijuana marketing, sales, and use, there has been a proliferation of misinformation.[6–8]

National surveys suggest the perception of "great risk" from weekly marijuana use has dropped from 50.4% in 2002 to 33.3% in 2014[3] and has dropped further since.[9] A recent national survey demonstrated that the public attributes benefit to marijuana without any evidence to support such beliefs (e.g., improvement in sleep, focus, or concentration). Moreover, recent data also suggests that many Americans believe that marijuana has no risks and that it prevents health problems.[9]

The main drivers of this favorable perception in the US are unclear, but it is likely multifactorial and includes the liberalization of medical marijuana laws[10] and promotion by advocacy organizations and business interests. For example, Business Insider, a website with an audience of over 100 million visitors a month,[11] recently touted the ability of marijuana to "reverse carcinogenic effects of tobacco and improve lung health." The source research article cited by Business Insider did not support such a claim.[12] In addition, legalization has been accompanied by the commercialization of marijuana, with projections estimating that marijuana sales will exceed $25 billion by 2025.[13] There is overt marketing to consumers of marijuana on the Internet and social media with inadequate regulatory oversight.[8, 14] It is possible that sources of information are playing a role in furthering misinformation among

the public, which in turn is resulting in decreases in risk perception, particularly among adolescents.[10, 15]

Determining the public's main sources of information about marijuana use is essential to curbing misinformation and improving public health outcomes. In this national survey of US adults, we examined where US adults receive information about marijuana. We also examined whether the sources of information were associated with believing unsupported claims about marijuana.

METHODS

Survey Administration

We conducted a survey of a nationally representative sample of 16,280 US adults on risks and benefits of marijuana use. The survey was conducted using KnowledgePanel (GfK Custom Research North America), a nationally representative panel of civilian, noninstitutionalized US adults aged 18 years and older that has been used to survey public opinion since 1999.[16–21] GfK created a representative sample of US adults by random sampling of addresses. The address-based sampling covers 97% of the country and encompasses a statistical representation of the US population. Households without Internet access are provided with an Internet connection and a tablet to ensure participation. All participants in the panel are sampled with a known probability of selection. No one can volunteer to participate and are instead selected randomly by GfK based on address. We sent out the survey on September 27, 2017, and responses were completed by October 9, 2017. Participants are reminded to complete the survey 3 days after the initial survey is sent. As modest incentives to encourage survey completion, participants are entered into raffles or sweepstakes with both cash rewards and other prizes. Participants are provided with no more than six surveys a month and are expected to complete an average of four surveys a month (further details on the sampling strategy of GfK's KnowledgePanel are provided here: http://www. knowledgenetworks.com/knpanel/docs/knowledgepanel(R)-design-summary-description.pdf). The median time for survey completion was 8 min. Sampling was stratified by legalization status of marijuana in the state of residence (i.e., recreational, medical, and non-legal). California residents and young adults aged 18 to 26 years old were oversampled to facilitate a future investigation into the role of recreational legalization on use patterns among young adults in California. Sampling weights were provided by GfK. The University of California, San Francisco Committee on Human Research considered this study to be exempt.

Survey Development

Details of survey development have been previously published.[9] The survey development team comprised multidisciplinary research staff and investigators. We asked about a wide range of topics, including perception of risks and benefits associated with marijuana use, comparisons of marijuana to other substances (tobacco, alcohol), and pertinent public health questions relevant to implementing marijuana legalization. We also asked detailed questions about marijuana use and conducted reliability testing among 300 current marijuana users. Reliability testing was only conducted on questions related to marijuana use. Questions were either derived from previously published national surveys (e.g., Monitoring the Future, the National Household Survey on Drug Use and Health) or created internally after several iterations and pilot tests with volunteers (survey available in online appendix). Volunteers were comprised of a panel of patients from the investigator's (SK, BC) clinics and were offered no incentives to volunteer.

Sources of Information About Marijuana

We asked about the most influential source of information about marijuana as follows: "Which information source about the benefits and risks of marijuana is the most influential for you?" Response options were friends, relatives, health professionals (e.g., doctor, nurse), politicians, law enforcement professionals, traditional media platforms (e.g., television, radio, newspaper), Google or other Internet searches, social media platform (e.g., Twitter, Facebook, Snapchat), advertisement (e.g., commercial, billboard), marijuana dispensary or other marijuana industry sources (e.g., conventions, trade publications), and other. Only one most influential source was allowed per respondent. For the purposes of analysis, some response categories were grouped as follows: friends or relatives; social media platform or the Internet; politician or law enforcement professional; and advertisement, marijuana dispensary, or other marijuana industry sources.

Unsupported Claims About Marijuana (e.g.. Misinformation)

We asked several questions aimed at assessing the extent to which individuals endorsed commonly circulated misinformation about marijuana. A Likert scale was used to respond to each question. The questions were as follows: (1) smoking marijuana has preventative health benefits, (2) how safe is it to expose adults to secondhand marijuana smoke?, (3) how safe is it for pregnant women to use marijuana?, and (4) how addictive is marijuana? A 4-point Likert scale was used to answer questions 1 through 3 and a 3-point Likert scale was used to answer question 4. We chose these statements given that the evidence to support these claims is lacking. The notion that marijuana has preventative health benefits remains unproven.[22] While less is known about the harms of secondhand exposure to marijuana compared with secondhand exposure to tobacco,[23] there is an emerging body of literature using animal studies and studies in humans suggesting that marijuana smoke may be toxic.[24, 25] In addition, exposure to particulate matter is associated with cardiovascular and respiratory

risks.[25–27] There is an emerging evidence base suggesting marijuana use during pregnancy may adversely affect fetal development.[28–31] The American College of Obstetricians and Gynecologists recommends avoidance of marijuana use during preconception, pregnancy, and lactation, citing concerns for impaired neurodevelopment and maternal and fetal exposure to the adverse effects of smoking.[32] Finally, while the threshold for addiction to marijuana is higher compared with other addictive substances among adults, it is a recognized clinical problem which is encapsulated within the Diagnostic Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) diagnosis of "cannabis use disorder."[33]

Statistical Analysis

Characteristics of the survey respondents and most influential sources of information were weighted using weights provided by GfK to approximate the US population based on age, sex, race/ethnicity, education, household income, home ownership, and metropolitan area. All analyses used weighting commands using the weight variable provided by GfK to generate national estimates. To determine how well our sample compared with a national federally sponsored survey on substance use and marijuana use, we first compared the socio-demographic characteristics of our survey respondents with those of the National Survey on Drug Use and Health (NSDUH).[34] The NSDUH is an annual federal survey implemented by the Substance Abuse and Mental Health Services Administration (SAMHSA), which is an agency of the Department of Health and Human Services (DHHS). The NSDUH provides data on substance use epidemiology in the US.[35] We conducted multivariate logistic regression analyses to examine the association between each source of information about marijuana (compared with the referent of all other sources), the belief of any or all statements defined as misinformation about marijuana adjusted for socio-demographic characters (age, gender, race/ethnicity, education, income, employment), and legalization status in the state of residence. There was a separate model for each source of information, and the referent in each model was all other sources of information. Analyses were performed using R statistical software (version R-3.4.0).

RESULTS

Characteristics of Survey Respondents and Belief of Misinformation

There were 9003 respondents, corresponding to a response rate of 55% (9003 out of 16,280). The mean age was 48 years, 48% were male, 64% were white, and 64% resided in a state in which marijuana was legal (Table 1). Age, gender, race/ethnicity, education, employment, household size, and past year marijuana use of our survey respondents were similar to those of the NSDUH (online Appendix Table 1). Our survey respondents had slightly higher incomes compared with

Table 1 Characteristics of Survey Respondents (*n* = 9003)

Characteristic	Survey respondents (*n* = 9003) *n* (%)*
Age (years)	
18–24	434 (9)
25–34	1383 (20)
35–49	1862 (24)
50–64	2757 (27)
≥ 65	2567 (20)
Gender	
Male	4307 (48)
Female	4696 (52)
Race/ethnicity	
Black/non-Hispanic	666 (12)
Hispanic	918 (16)
Other/non-Hispanic	591 (8)
White/non-Hispanic	6828 (64)
Education	
High school or less	2477 (40)
Some college	2868 (29)
Bachelor's degree or higher	3658 (32)
Employment status	
Not working	3694 (38)
Working	5309 (62)
Status of marijuana legalization in state of residence	
Recreational	3369 (21)
Medical	2541 (43)
Non-legal	3093 (36)
Frequency of marijuana use	
Current (within the past 30 days)	781 (9)
Past year (more than 30 days but within the past 12 months)	489 (6)
More than past year	3012 (32)
Never	4668 (53)
Refused	53 (1)
Type of marijuana use	
Medical	154 (11)
Recreational	623 (53)
Both	456 (36)
Refused	4 (0)

Numbers are unweighted, and percentages are weighted to approximate the US population

participants in the NSDUH. Agreement with any statement consistent with misinformation was endorsed by 43%, and agreement with all statements was endorsed by 3%.

Most Influential Sources of Information About Marijuana and Associations between Sources of Information and Belief of Misinformation

The most influential sources of information about marijuana were health professionals (*N* = 2178, 24%), traditional media platforms (*N* = 1866, 20%), friends or relatives (*N* = 1579, 19%), and social media or the Internet (*N* = 1316, 17%) (Table 2).

Individuals reporting social media or the Internet (1.46 CI [1.30, 1.64]), the marijuana industry (e.g., advertisements, dispensaries) (2.88 CI [2.15, 3.88]), and friends or relatives (1.41 CI [1.26, 1.58]) as the most influential source of information about marijuana were more likely to believe any statement consistent with misinformation about marijuana in comparison with those who reported other sources as most influential (Table 3). In contrast, those who reported health professionals (0.83 CI [0.75, 0.92]), traditional media platforms (0.81 CI [0.72, 0.90]), and politicians or law enforcement

Table 2 Most Influential Sources of Information About Marijuana

Source of information	Number (Percentage)*
Health professional (doctor, nurse, etc.)	2178 (24)
Traditional media platform (TV, radio, newspaper, etc.)	1866 (19)
Friends or relatives	1579 (19)
Social media platform (Twitter, Facebook, Snapchat, etc.), Google, or other Internet searches	1316 (16.5)
Politician or law enforcement professional	419 (4)
Advertisement (commercial, billboard, etc.), marijuana dispensary, or other industry sources (conventions, trade publications, etc.)	246 (3)
Other†	1088 (11)
Refused	103 (1)
Missing	208 (2.5)

Numbers are unweighted, and percentages are weighted to approximate the US population
†*Other unspecified sources besides the listed categories*

professionals (0.53 CI [0.42, 0.66]) as the most influential information source were less likely to believe any statement. Individuals reporting the marijuana industry (2.66 CI [1.66, 4.09]) as the most influential information source were more likely to believe all statements in comparison with those who reported other sources as most influential. Individuals reporting traditional media platforms (0.28 CI [0.16, 0.46]) as the most influential source were less likely to believe all statements. Findings on associations between sources of information and beliefs were also generally consistent when examined according to individual beliefs (Table 4).

DISCUSSION

In a nationally representative survey of US adults, the most influential sources of information about marijuana were health professionals, traditional media platforms, friends, relatives, social media, and the Internet. Individuals reporting social media or the Internet, the marijuana industry (e.g.,

advertisements, dispensaries), and friends or relatives as the most influential source of information about marijuana were more likely to believe unsubstantiated claims about marijuana.

We found that individuals who identified the marijuana industry as a source of information were more likely to believe misinformation. The marijuana industry is a growing multi-billion-dollar business, and it is supported by influential trade and lobbying groups and venture capital investment.[36, 37] Although there is little evidence to support these claims, the marijuana industry promotes marijuana as a potential treatment for nausea during pregnancy, in addition to a potential treatment for conditions such as autism, cancer, and diabetes.[38, 39] Both Health Canada and the US Food and Drug Administration (FDA) have issued warning letters to marijuana producers and distributors as a result of their advertising claims.[40, 41] In November 2017, the FDA issued warning letters to several online marijuana purveyors for making unsubstantiated claims that their products could prevent, diagnose, treat, or cure cancer. Thus, the marketing of marijuana, which inadequately regulated, may have a role in shaping misinformed public views on marijuana. Without more effective marketing regulations, the marijuana industry may continue to disseminate unfounded claims about marijuana with potentially harmful public health consequences.[42]

Unlike the growth of the tobacco industry, which came of age prior to the advent of the Internet, the marijuana industry has the opportunity to promote its expansion with marketing on the Internet and social media, where regulation is minimal and relatively undefined.[36, 43, 44] Despite policies restricting marijuana advertising on Facebook and Google,[45] prior work has demonstrated the predominance of positive messaging about marijuana and normalization of its use on Twitter and other Internet sources (e.g., YouTube, Instagram).[43, 46, 47] Furthermore, there is an abundance of articles listing unproven health benefits of marijuana on the Internet, many targeting consumers in different countries.[8, 48, 49] Given the extent of misinformation about marijuana on the worldwide web, it is

Table 3 Association between Sources of Information About Marijuana and Believing Misinformation About Marijuana

	Any misinformation endorsed N* = 3609			All misinformation endorsed N* = 245		
	N*	Unadj OR (95% CI)	Adj OR (95% CI)	N*	Unadj OR (95% CI)	Adj OR (95% CI)
Social media platform, Google, or other Internet search	667	1.56 (1.40, 1.75)	1.46 (1.30, 1.64)	38	1.02 (0.74, 1.38)	0.93 (0.67, 1.26)
Advertisement, marijuana dispensary, or other industry sources	172	3.33 (2.52, 4.45)	2.88 (2.15, 3.88)	20	3.71 (2.36, 5.60)	2.66 (1.66, 4.09)
Friends or relatives	783	1.54 (1.39, 1.72)	1.41 (1.26, 1.58)	54	1.26 (0.95, 1.66)	1.07 (0.80, 1.42)
Health professional	784	0.83 (0.75, 0.91)	0.83 (0.75, 0.92)	58	1.11 (0.84, 1.44)	1.16 (0.88, 1.51)
Traditional media platform	626	0.66 (0.60, 0.74)	0.81 (0.72, 0.90)	14	0.22 (0.13, 0.35)	0.28 (0.16, 0.46)
Politician or law enforcement professional	107	0.55 (0.44, 0.69)	0.53 (0.42, 0.66)	6	0.52 (0.23, 1.03)	0.51 (0.22, 1.00)

OR odds ratio, CI confidence interval
*Unweighted N
Odds ratios for the sources of information about marijuana are presented for multivariate models that included each source of information about marijuana, adjusted for socio-demographic characters (age, gender race/ethnicity, education, income, employment) and legalization status in the state of residence. There was a separate model for each source of information, and the referent in each model was all other sources of information

Table 4 Association between Sources of Information About Marijuana and Believing Misinformation About Marijuana According to Individual Statements

	Smoking marijuana has preventive health benefits (strongly or somewhat agree) $N* = 2334$			Secondhand marijuana smoke is completely or somewhat safe $N* = 1418$			Marijuana use during pregnancy is completely or somewhat safe $N* = 567$			Marijuana is not at all addictive $N* = 1988$		
	N*	Unadj OR (95% CI)	Adj OR (95% CI)	N*	Unadj OR (95% CI)	Adj OR (95% CI)	N*	Unadj OR (95% CI)	Adj OR (95% CI)	N*	Unadj OR (95% CI)	Adj OR (95% CI)
Social media platform, Google, or other Internet search	439	1.40 (1.24, 1.57)	1.32 (1.17, 1.49)	273	1.43 (1.25, 1.64)	1.27 (1.11, 1.46)	102	1.31 (1.07, 1.59)	1.17 (0.95, 1.44)	376	1.49 (1.31, 1.69)	1.42 (1.24, 1.61)
Advertisement, marijuana dispensary, or other industry sources	119	2.56 (1.97, 3.31)	2.11 (1.61, 2.77)	87	3.56 (2.73, 4.62)	3.00 (2.27, 3.96)	44	3.91 (2.83, 5.32)	2.91 (2.07, 4.03)	113	2.60 (1.99, 3.37)	2.48 (1.89, 3.25)
Friends or relatives	517	1.45 (1.29, 1.62)	1.30 (1.15, 1.46)	355	1.63 (1.43, 1.85)	1.43 (1.25, 1.63)	138	1.44 (1.19, 1.73)	1.21 (0.99, 1.46)	400	1.21 (1.07, 1.37)	1.17 (1.03, 1.33)
Health professional	524	0.90 (0.81, 1.00)	0.92 (0.82, 1.03)	293	0.91 (0.80, 1.03)	0.93 (0.82, 1.07)	115	0.83 (0.68, 1.01)	0.86 (0.70, 1.04)	438	0.90 (0.80, 1.01)	0.90 (0.79, 1.01)
Traditional media platform	375	0.67 (0.59, 0.76)	0.82 (0.73, 0.94)	164	0.40 (0.34, 0.47)	0.50 (0.42, 0.60)	52	0.38 (0.29, 0.49)	0.51 (0.38, 0.67)	314	0.64 (0.56, 0.73)	0.71 (0.62, 0.81)
Politician or law enforcement professional	68	0.60 (0.47, 0.77)	0.55 (0.42, 0.71)	42	0.60 (0.44, 0.81)	0.60 (0.43, 0.81)	21	0.72 (0.45, 1.09)	0.70 (0.44, 1.07)	56	0.61 (0.46, 0.79)	0.60 (0.45, 0.79)

OR odds ratio, CI confidence interval
*Unweighted N
Odds ratios for the sources of information about marijuana are presented for multivariate models that included each source of information about marijuana, adjusted for socio-demographic characters (age, gender race/ethnicity, education, income, employment) and legalization status in the state of residence. There was a separate model for each source of information, and the referent in each model was all other sources of information

not surprising that adults who believed misinformation were more likely to obtain information from social media and the Internet. Public health campaigns that use social media are necessary to combat misinformation about marijuana.

Unregulated promotion on the Internet and social media has public health ramifications for consumers worldwide and poses a challenge to public health leaders and policymakers. Our findings point to the need for investment in public health campaigns to better communicate risks to the public. Moreover, these results suggest the need for a targeted and cohesive strategy on the part of health providers to address misinformation with patients. Due to a lack of evidence and possible therapeutic benefit of some forms of cannabis for specific indications, physicians have not been able to provide a clear or unified message to the public.

In contrast, individuals who reported traditional media platforms as the most influential information source were less likely to believe misinformation. There is roughly equal representation of pro- and anti-legalization viewpoints by traditional news outlets,[50] and it is possible that balanced reporting could have counteracted the development of misperceptions. The lower risk of believing misinformation could also reflect restrictions on marijuana advertising on traditional media outlets.[45, 46] However, it is important to note that several unrelated factors could contribute to this association, including unaccounted for demographic information or the intended audience of a traditional media outlet (e.g., a nationally syndicated

newspaper such as the *Washington Post* versus a locally syndicated newspaper).

Limitations

The response rate of our survey was 55%. However, the response rate was similar to that of other Internet surveys.[16, 21] Use of an Internet survey might limit generalizability because individuals who choose to join an ongoing Internet panel may be different from individuals who choose not to participate. However, studies that have examined nonresponse to panel recruitment in GfK's KnowledgePanel have found no evidence of nonresponse bias in the panel on core demographic and socioeconomic variables. In addition, while there were some differences in income distribution in the sample compared with the NSDUH, the respondents of both panels were very similar in terms of age, gender, race/ethnicity, education, household size, and employment status. Additionally, it is important to note that the survey questions and response items analyzed in this paper could have been interpreted differently by respective respondents. We did not conduct reliability testing of the opinion questions, and it is possible that the wording of the questions introduced bias that may have impacted interpretation by the respondents. Specifically, describing information sources as "most influential" may be perceived differently between respondents. Additionally, we did not offer an "Other" or "Unknown" category for respondents

when choosing an answer. Though a deliberate decision to force participants to choose an answer to obtain an understanding of prevailing views, this may have biased responses. Future research should include more psychometric testing of the items to minimize bias introduced by the content and order of the questions. Finally, we were unable to examine causal relationships between sample characteristics and endorsement of misinformation. Our results are only able to demonstrate association.

Conclusions

In summary, US adults who were more likely to believe unsupported claims about marijuana reported their main source of information as being social media or the Internet, the marijuana industry, or friends or relatives. Our results underscore the need for greater consistency and clarity in the regulations for marijuana advertising and the need for investment in public health campaigns to counter potentially misleading views about marijuana and make widely known the potential for deleterious health effects associated with marijuana use.

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Compliance with Ethical Standards:

Conflict of Interest: The authors declare that they do not have a conflict of interest.

Ethical Approval: Not needed

Transparency: The manuscript's guarantor (SK) affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

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