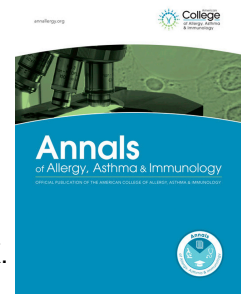


Journal Pre-proof

Cannabis attitudes and patterns of use among followers of the Allergy & Asthma Network

Joanna S. Zeiger, MS, PhD, William S. Silvers, MD, Tonya A. Winders, MBA, Mary K. Hart, RRT, Robert S. Zeiger, MD, PhD



PII: S1081-1206(21)00022-3

DOI: <https://doi.org/10.1016/j.anai.2021.01.014>

Reference: ANAI 3470

To appear in: *Annals of Allergy, Asthma and Immunology*

Received Date: 30 October 2020

Revised Date: 14 December 2020

Accepted Date: 10 January 2021

Please cite this article as: Zeiger JS, Silvers WS, Winders TA, Hart MK, Zeiger RS, Cannabis attitudes and patterns of use among followers of the Allergy & Asthma Network, *Annals of Allergy, Asthma and Immunology* (2021), doi: <https://doi.org/10.1016/j.anai.2021.01.014>.

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20-11-0716R1

Background: Cannabis use in allergy/asthma patients, a high-risk group for adverse effects to cannabis, is unknown.

Objective: To determine patterns of use and attitudes toward cannabis in allergy/asthma patients.

Methods: An anonymous online survey on cannabis attitudes and use was conducted through the Adult Allergy & Asthma Network (AAN). The Asthma Control Test assessed asthma burden. Cluster analyses determined group phenotypes and factor analyses condensed cannabis subjective effects into similar response patterns. **Results:** Eighty-eight of 489 (18.0%) respondents currently use cannabis with the majority <50 years-old, female, and White. Of non-cannabis users (N=401), 2.5% reported cannabis allergy. Cluster analysis revealed a liberal attitude towards cannabis was associated with current cannabis use ($P<0.001$). Among current cannabis users, 40.9% of physicians inquired about cannabis use; only 37.5% wanted to discuss cannabis. 65.9% used cannabis for medical or medical/recreational purposes. Cannabinoids used were tetrahydrocannabinol (33.0%), cannabidiol (19.3%), or both (47.7%). Smoked and vaped cannabis were reported by 53.4% and 35.2%, respectively. Fifty-one cannabis users (58.0%) reported current asthma with 39.2% uncontrolled; of these, 50% smoked cannabis. Compared to current asthma patients not using cannabis, those currently using cannabis experienced similar levels of asthma control, quality of life, and frequency of asthma exacerbations. Positive effects were endorsed more than negative effects to cannabis ($P<0.001$). 19.3% reported coughing which was associated with smoking cannabis ($P<0.001$).

Conclusion: Cannabis was used by <20% of respondents with positive effects more frequent than negative effects. Half of cannabis users with uncontrolled asthma smoke cannabis, but a minority of physicians inquire about its use.

INTRODUCTION

In the US, cannabis use is increasing in the general population and various disease populations due to legalization and perceived benefit to combat primary symptoms of pain, insomnia, and anxiety.¹⁻⁴ Cannabis use is poorly studied in allergic/asthmatic patients a group in which smoking and vaping cannabis could lead to increased symptoms of cough and wheeze, as well as increased use of asthma medications and exacerbations.^{5,6} Short-term use of cannabis can act as a bronchodilator or cause coughing or wheezing, whereas long-term use could cause increased respiratory symptoms.⁷ Particularly detrimental in asthmatics, cannabis smoking's effect on the lungs may be similar to that of tobacco smoking and persistent cannabis smoking may lead to peripheral airway resistance.⁸ These potential risks must be balanced with the potential beneficial effects from cannabis including decreased anxiety, improved sleep, decreased pain, and greater health satisfaction.⁹⁻¹²

Cannabis use among allergic individuals may increase risk for cannabis allergy.¹³ Cannabis exposure may arise from direct use or occupational exposure, potentially causing respiratory symptoms, contact urticaria, angioedema, and uncommonly anaphylaxis.¹⁴⁻¹⁶ In addition, inhalation of cannabis may manifest in allergic rhinitis, conjunctivitis, wheezing, and throat edema.¹⁶

Given the potential for detrimental effects of cannabis in allergic/asthmatic individuals, it is important to understand the prevalence and patterns of use of cannabis in this population. To accomplish this goal, we surveyed individuals through the Allergy & Asthma Network, a patient advocacy group that works to unite and educate Americans with asthma, allergies and related conditions. We conducted the Allergy & Asthma Network (AAN) Pain, Exercise, and Cannabis Experience (PEACE) Survey study to examine cannabis knowledge, attitudes, patterns of use

and relate these factors to outcomes of disease exacerbation, scores on validated questionnaires that assess disease burden, and positive and adverse effects to cannabis.

METHODS

Study population and setting

Eligible participants ≥ 18 years of age who were English speaking were eligible to participate. The anonymous online survey was administered using LimeSurvey. The survey link was sent with a call to action via AAN newsletter and their social media channels, including Twitter and Facebook and ran from May 7 through September 7, 2020. The number of participants taking the survey in the present study ($n=873$) was consistent with the higher number of participants in previous AAN survey studies.^{17,18} Solutions Institutional Review Board (<https://www.solutionsirb.com/>) gave the study exempt status.

Validated questionnaires

The Asthma Control Test (ACT)^{19,20} and the MiniAsthma Quality of Life Questionnaire (mAQLQ)^{21, 22} captured asthma control and asthma specific quality of life, respectively. The 16 item, 5 scale Nijmegen dysfunctional breathing questionnaire²³ with a total score >23 supportive of hyperventilation^{24,25} was completed by all respondents.

Other characteristics

Background characteristics including age, gender, race/ethnicity, education, employment, household income, legal stimulants, height and weight were captured. Body Mass Index (BMI) was calculated from the reported body measurements.

Respondents reported on whether they were diagnosed ever by a physician or other health care provider for asthma, exercise-induced bronchoconstriction, hay fever, and eczema. They were queried on whether they still had asthma (current asthma) or had a problem with sneezing,

or a runny, or blocked nose when they did not have a cold or the flu during the past year. The types of asthma exacerbations experienced over the past 12 months and the medications used during the past week to treat asthma and nasal symptoms were captured. Physicians' inquiry of cannabis use either verbally or on an intake form and also whether participants wanted to discuss cannabis use with their physicians was reported.

Cannabis assessments

Cannabis use was assessed with two questions, "Have you ever used cannabis?" and "Have you used cannabis in the past two weeks?" Cannabis use was classified into 3 categories: (1) current user, (i.e. used in the past 2 weeks); (2) ever, not current user (i.e. tried cannabis, but not a current user); and (3) never user. Current cannabis users were asked about: frequency of use; duration of use; route of administration; positive and adverse subjective effects to cannabis; whether they used cannabis medically, recreationally or both; if they primarily used tetrahydrocannabinol (THC), cannabidiol (CBD) or both; and where they purchased their cannabis.

Attitudes toward cannabis were determined using a 10-item, three choice (yes, no, unsure) questionnaire that was previously reported and provided useful information for a TwoStep Cluster analysis.²⁶ Knowledge about cannabis was assessed using a 5-item, 5 choice (THC, CBD, Both, Neither, Don't know) questionnaire in which each question had a single correct answer, also used in a previous study (E-Supplement).²⁶

Statistical analyses

Fisher's exact test, Chi-square and analysis of variance were used for group comparisons. Two data reduction techniques were used to simplify the analyses and to make them more clinically understandable. TwoStep cluster analysis was used to (1) create attitudes groups and

(2) cannabis user-types and an exploratory factor analysis was used to create subjective effects scales.^{11,26}

The SPSS TwoStep Cluster method was used to determine both the number of clusters and to allocate subjects to their respective clusters as published previously^{11,26,27} (See E-Supplement). Once clusters were identified, post-hoc ANOVA tests were conducted to determine whether there was adequate separation of the clusters to determine inter-cluster heterogeneity and intra-cluster homogeneity.^{28,29}

The first cluster analysis was performed to create groups based on attitudes toward cannabis, which were answered by all 489 participants. The 10 attitudes questions were the input variables. The second cluster analysis was used to identify cannabis user phenotypes to determine how these user phenotypes respond to cannabis, i.e. do subjective effects differ by cannabis user phenotypes? Four cannabis use variables were used: frequency of cannabis use (<daily, $\geq$ daily), duration of cannabis use (less than 3 years, 3 years or more), cannabinoid used (CBD, THC, or both), and reason for use (medical, recreational, both). These variables were chosen as each item represents an important motive for use or pattern of use.¹¹

Subjective effects items were used in a principal components Exploratory Factor Analysis (EFA) with a varimax rotation in an effort to achieve data reduction and data summarization.³⁰

Details of the factor analysis^{31, 32} are noted in the E-Supplement. Summated scales were created for each factor by adding together the items in the factor. This creates the “ability to represent the multiple aspects of a concept in a single measure” and the scales can then be used for multivariate analysis.³⁰ Due to the different number of items in each scale, we examined the data by looking at the percentage of the total for each scale.

Multivariate analysis using the SPSS generalized linear model procedure was used to examine whether there were associations between cluster membership (fixed factor) and subjective effects factors (independent variables) adding in covariates that were significant in the univariate analysis (see E-Supplement).³⁰ P values <0.05, 2 sided, was set for significance. Analyses were conducted using IBM SPSS Statistics for Windows, version 26 (2019).

RESULTS

Entire population characteristics

Of the 873 participants initiating the survey, 489 (56.0%) completed it and provided useable data (Figure 1). The majority of respondents were <50 years-old (60.2%), female (72.4%), White (71.6%), $\geq$ college graduate (71.5%), employed (80.5%), household yearly earnings $\geq$ \$70,000 (61.9%), and not obese (69.8%). Alcohol and cigarettes were used in the last month by 63.2% and 4.9% of respondents, respectively (Table 1). Respondents reported being given the following physician diagnoses ever: asthma (N=272, 55.6%), hay fever (N=239, 48.9%), and eczema (N=142, 29.0%) (Table 2). The frequency of hyperventilation by the Nijmegen test was 19.6%. Upper respiratory symptoms in the past year not associated with a cold or flu was reported by 76.1% (Table 2). Ten (2.5%) of the 401 non-current cannabis users reported an allergy to cannabis. Of total respondents, only 173 (35.4%) had physicians who queried about cannabis use; but only 82 (16.8%) wanted to discuss cannabis with their physician (Table 2).

Current asthma was reported in 90.1% of those ever diagnosed with asthma. The distribution of asthma exacerbations in the past 12-month included 4.9% hospitalizations, 19.6% emergency department or urgent visits, and 45.7% requiring oral corticosteroids (Table 2). Among current asthma patients ACT score was 20.2 ± 4.6 , with uncontrolled status noted in 97

(39.6%) and mAQLQ was 5.4 ± 1.4 with 74 (30.2%) reporting scores ≤ 4.7 indicating increased risk for future asthma exacerbations (Table 2) and did not differ by cannabis use status. Current cannabis users (37.5%) wanted to discuss cannabis with their physician more often than ever, not current users (16.8%) and never users (8.3%) ($P < 0.001$) (Table 2).

Mean scores for ACT, mAQLQ, and Nijmegen questionnaire were poorer in those with uncontrolled versus controlled asthma ($P < 0.001$), and exercise-induced bronchoconstriction was more frequent in uncontrolled compared to controlled asthma ($P < 0.01$) (Table 3). Although there was no difference in queries about cannabis use by physicians regarding asthma control status, more patients with uncontrolled asthma wanted to discuss cannabis use with their physicians ($P < 0.01$) (Table 3). Current cannabis users (37.5%) wanted to discuss cannabis with their physician more often than ever, not current users (16.8%) and never users (8.3%) ($P < 0.001$) (Table 2).

Attitudes clusters. A two-cluster solution for the entire cohort based on their attitudes toward cannabis which were named ‘liberal’ ($n=234$; 47.9%) and ‘conservative’ ($n=255$; 52.1%). The liberal cluster was associated with ethnicity (higher in non-white others, $P < 0.05$), age (higher in younger respondents, $P < 0.001$), gender (relatively higher in males, $P < 0.05$), employment (less with 40+ hours weekly work, $P < 0.001$), and education (lower advanced degree, $P < 0.001$) (Table 3). Knowledge of cannabis was significantly greater in those with a more ‘liberal’ attitude ($P < 0.05$), (Table 3).

Characteristics by cannabis use

There were 88 (18.0%) current users, 184 (37.6%) ever, but not current users, and 217 (44.4%) never users (Table 1). Demographics were similar by cannabis use subgroups except that current users had less advanced education and lower household income ($P < 0.05$) (Table 1).

The frequency of the following was similar among the cannabis user subgroups (1) asthma, exercise-induced bronchoconstriction, hyperventilation, hay fever, and eczema; (2) asthma control, quality of life status, and exacerbations; and (3) medications used for asthma and nasal symptoms (Table 2). The inquiry of cannabis use by physicians were similar among cannabis user subgroups. Current cannabis users (37.5%) wanted to discuss cannabis use with their physician more frequently than the ever, but not current users (16.8%) and in cannabis never users (8.3%), ($P<0.05$). Sixty-eight percent of cannabis users indicated that they use cannabis to treat pain. There was a significant difference in cannabis knowledge scores by cannabis use history (Table 2). Current users had the highest mean score (2.94, SD=1.23) followed by ever, not current users (mean:2.59, SD: 1.12) with never users scoring the lowest (mean: 2.10, SD: 1.36) ($p<0.001$). Education and employment status were not associated with cannabis knowledge; however, cannabis knowledge was lower in participants with household income $< \$70,000$ vs $\geq \$70,000$ per year. The most common reasons participants did not use cannabis were: 'I don't need to use cannabis' (59.6%), 'It is not legal at my job' (36.4%), 'It is not legal in my state' (28.4%), and 'I am scared to use cannabis' (15.5%).

Attitude clusters by cannabis use. All ten of the input variables were significantly different between the two clusters ($P<0.001$). A more liberal attitude towards cannabis use was seen in current cannabis users (95.5%) more frequently than both of the other subgroups, ever, but not current cannabis users (59.2%), and never cannabis users (28.6%) ($P<0.001$), (Table 4). The liberal cluster had a higher mean knowledge score about cannabis (mean: 2.55, SD: 1.27) compared to the conservative cluster (mean: 2.31, SD: 1.33), $P<0.05$. There was no statistically significant difference in attitude cluster membership by whether a participant lived in a state in which cannabis was or wasn't legal (Table 4).

Current cannabis users

Asthma control status was similar by cannabis user subgroups (Table 2). Similar to non-current cannabis users, cannabis users with uncontrolled asthma exhibited poorer m-AQLQ ($P<0.05$) and Nijmegen scores ($P<0.05$) and a higher frequency of hyperventilation ($P<0.01$) (Table E 1). Medications used to treat current asthma or nasal symptoms was similar by cannabis user subgroups (Table 2).

Clusters by cannabis patterns of use. A 2-cluster solution was seen for a cluster analysis by duration of cannabis use (Table 4). The input variables were significantly different for the two clusters, named “long-term users” and ‘short-term users’. The long-term versus short-term cannabis user clusters had a significantly higher frequency of (1) cannabis use for ≥ 3 years (90.2% versus 5.4%), (2) daily use (58.8% versus 13.5%), (3) use for both medical and recreational purposes (52.9% vs 27.0%), (4) primarily THC use singly (54.9%) vs 2.7%), (all $P<0.001$). With regards to cannabis route of administration, compared to short-term cannabis users, long-term cannabis users took cannabis more frequently through smoking (74.5% versus 24.3%) and vaping (49.0% versus 16.2%), ($P<0.001$ for both), but not other routes (Table 5). The following variables were not significantly different by user type cluster including gender, age, ethnicity, education, disease status (e.g. controlled vs uncontrolled asthma), and days per week of exercise (Table 5).

Factor analysis by subjective effects. A three-factor solution was found for the subjective effects of cannabis use which included one positive effects factor and 2 adverse effects factors. Positive effects were reported more frequently than both adverse effects (Figure 2). Positive effects included increased energy, sleep aid, euphoria, decreased anxiety, improved athletic performance, less pain, opening of lungs, fewer muscle spasms, and decreased nausea (Table 6).

Adverse factor 1 included the following subjective effects: cardiovascular (increased heart rate and palpitations), psychological (anxiety, paranoia, or feeling uneasy), nasal symptoms, and difficulty concentrating. Adverse factor 2 mainly involved respiratory symptoms including wheezing, coughing, shortness of breath but also included itchy eyes and increased appetite (Table 5). The most highly endorsed positive items included: helps with sleep (75.0%), calms me down (68.2%), less pain (68.2%), and decreased anxiety (67.0%); the most commonly endorsed adverse items were: increased appetite (29.5%), anxiety (21.6%) and coughing (19.3%).

There were no mean differences for the factors by gender, BMI, education, income, and disease status, therefore they were not included in the multivariate model. However, there were mean differences for the positive factor by age ($P < 0.001$), smoking (positive factor, $P < 0.001$; adverse factor 2, $P < 0.01$), and vaporizing (positive factor, $P < 0.001$); these variables were added as covariates to the multivariate model and were only retained if they were significant. When the three covariates were added to the model, only age was statistically significant, and therefore was the only covariate retained in the model. The model was significant, $F = 7.55$, $P < 0.001$, partial eta squared = 0.21. observed power = 0.98. Positive subjective effects and adverse subjective effects factor 2 occurred significantly more in the long-term compared to short-term user clusters, $P < 0.001$ and $P < 0.01$, respectively (Figure 2). The proportion of items endorsed for each factor out of the total number of items, for long terms users were: Positive factor (52.2%), Adverse factor 1 (14.5%), Adverse factor 2 (18.7%); and for short term users were: Positive factor (33.1%), Adverse factor 1 (9.8%), Adverse factor 2 (6.2%).

DISCUSSION

Studies have reported that the legalization of cannabis has proceeded more quickly than the science to document objectively its risk/benefits profile.³⁴ Little is known how cannabis is

being consumed in disease populations nor on its impact on disease status. We determined cannabis knowledge, attitudes, and patterns of cannabis use in a high-risk population with asthma and allergies, recruited through the AAN. No difference in cannabis patterns of use in current cannabis users was found between individuals with controlled or uncontrolled asthma. However, there was a high rate of smoking and vaping cannabis, despite the potential for a negative impact on disease status. Adverse effects associated with cannabis use included coughing, wheezing, and shortness of breath in a minority of participants (Table 6). Given the potential detrimental effects of smoking or vaping cannabis including the spate of electronic cigarette or vaping-associated lung injury (EVALI) attributed to the additive Vitamin E acetate from illegally purchased cartridges,³⁵ we suggest that edibles, tinctures, topicals or less common routes of use (e.g. suppositories or sprays) are more appropriate routes for cannabis use. However, even with increased coughing in the cannabis users, they did not score worse on the ACT, mAQLQ, the Nijmegen questionnaire or have increased asthma exacerbations than non-cannabis users.

Only 2.5% of the respondents indicated that they were allergic to cannabis, while 19.3% reported cough from cannabis use. Unfortunately, we did not capture information on the type or seriousness of the reported allergy to cannabis in the non-cannabis users. In addition, the positive benefits of cannabis use outweighed the adverse effects of cannabis, in the asthma/allergy participants, similar to findings in other populations including athletes,¹¹ patients with multiple sclerosis³⁶ and those with neuropathy³⁷. Finally, both knowledge and attitudes impacted whether a participant used cannabis currently or ever.

Eighteen percent of the allergic/asthmatic individuals recruited through the AAN reported cannabis use in the past two weeks, a frequency higher than the general population

without medical conditions (8.3%) or with a medical condition (8.8%).³⁸ These numbers may underestimate the prevalence of cannabis use, though, prevalence's as high as 42% have been reported in multiple sclerosis³⁶; although this figure was determined on past year use. Daily use was 84% in fibromyalgia patients.³⁹

Pain was a frequent reason given for use of cannabis in the present study, consistent with other studies^{11,40,41}; however, we did not capture non-allergy comorbidities such as rheumatologic illnesses or trauma that might be underlying the cause of pain. We found that 26% of athletes, a non-medical population, used cannabis in the past two-weeks, which is more consistent with the present study.¹¹ Cannabis use varies with age in most studies, with younger people using cannabis more often than older individuals, a pattern overserved in the present study (Table 1); over half the cannabis users in the present study were ≥ 40 years, and 40% were greater than 50 years, which could be driving the prevalence of use in the present study.^{38,42}

Although the present population is potentially at higher risk for adverse effects to cannabis^{14,43,44} and increased risk for cough, wheeze, and asthma exacerbations^{16,45}, the positive effects of cannabis were more prevalent than adverse effects. A factor analysis of the positive and adverse effects revealed three factors, a single 10-item positive factor which encompassed items such as decreased pain, improved sleep and decreased anxiety, a four-item adverse factor that was comprised of nasal and cardiovascular symptoms, and a five-item adverse factor that contained cough, wheeze, and shortness of breath. The proportion of positive effects, particularly in long-term cannabis users, was over 50%, while the highest proportion of adverse effects, also seen in long-term users, was less than 20%.

Long-term studies are assessing about cannabis use in adolescents, young adults, and adults living in states in which cannabis is legal and illegal (See E-Supplement).^{46,47,48} Only

37.5% of current cannabis users indicated wanting to discuss cannabis with their physician and current cannabis users indicated that 41% of their physicians asked about cannabis either verbally or on an intake form. Perhaps so few cannabis users want to discuss cannabis with their physician because they are deriving beneficial effects that outweigh the impact on their disease and do not want to be told to stop smoking or vaping cannabis, despite the scant research on the long-term effects of inhaling cannabis on the lungs. That so few physicians are inquiring about cannabis use indicates the lag between patient adoption of cannabis for therapeutic purposes and physicians' recognition of patient use. This is of particular concern for patients who may have uncontrolled asthma due to cannabis use, which may be a missed opportunity for education by physicians. Physicians are historically reluctant to discuss cannabis with patients due to their own lack of knowledge and negative attitudes on the subject.⁴⁹⁻⁵²

Cannabis knowledge was lower in participants with household income <\$70,000 vs $\geq 70,000$ per year consistent with other studies.⁵³ Age is associated with income, ethnicity, and education, as well as attitude cluster membership, and therefore is a confounder in this relationship. Younger age is associated with more permissive views of cannabis.⁵⁴ The finding that no difference in attitude cluster membership was observed by state legalization of cannabis is consistent with the literature which notes that state cannabis laws do not directly affect attitudes about cannabis in young individuals.⁵⁴

We found that participants with higher knowledge scores about cannabis had more liberal attitudes toward cannabis, and those with more liberal attitudes toward cannabis tended to use cannabis more frequently than those with more conservative attitudes. Additionally, those with more knowledge tended to use cannabis more frequently than participants with lower knowledge scores. This is a similar pattern to what we observed in a study of athletes.²⁶ This presents an

277 opportunity for physicians to not only educate themselves about cannabis use and its positive and
278 adverse effects on their patients, but to also educate their patients who want to use cannabis on
279 changing their route of administration from inhalation to non-inhalational consumption routes.

280 A high percentage of the present population indicated use of cannabis for pain (68.2%)
281 and only 34% used cannabis solely recreationally, indicating that this population may be using
282 cannabis to treat other conditions beyond their asthma or allergies. Given the success of cannabis
283 at reducing pain, improving sleep, and decreasing anxiety, the medical benefits are important and
284 should be discussed by physicians with their patients.

285 This study has limitations. We recruited participants through a patient advocacy group,
286 which may not be generalizable to others with asthma and allergies. The present findings are
287 similar to those found in an athlete population regarding positive and adverse effects, clustering
288 of user groups, and the impact of knowledge and attitudes on cannabis use^{11,26}, indicating that
289 disease status may not play as specific a role in how people react to cannabis or their attitudes
290 towards cannabis. Indeed, several studies of subjective effects to cannabis have shown similar
291 results to those observed here.⁵⁵⁻⁵⁷ The completion rate of the survey was only 56%. The impact
292 of the non-completers on the overall results is unknown. This led to fewer current cannabis users
293 than planned. Future studies of larger cohorts are needed. Selection bias is inherent in survey
294 studies in which participation, as in the present study, is decided entirely by individual
295 preferences and characteristics. As such, consistent with other surveys, the study findings may
296 not be generalizable to other cohorts. Anytime survey analysis is used to collect information,
297 there is concern about honesty in answering questions. This could lead to an underestimation of
298 the number of cannabis users, as some of the participants may have been reluctant to admit to
299 cannabis use, particularly if they live in a state in which cannabis is not legal. Females

participated in the survey more frequently than men, consistent with other survey studies by the AAN which have been between 62% to 75% female.^{17,18} and other studies.⁵⁸

In summary, in a population of allergy/asthma patients recruited through AAN, we found that 18% of the participants used cannabis in the past two weeks. The cannabis users were clustered into two groups, those who used for three years or more and primarily used THC daily and those who used cannabis for less than three years and primarily used CBD less than daily. Positive subjective effects to cannabis were endorsed more often than adverse effects (including cough and wheeze), even though there was a high prevalence of smoking and vaping. High cannabis knowledge scores and liberal attitudes toward cannabis had an impact on cannabis use. Compared to current asthma patients not using cannabis, those currently using cannabis experienced similar levels of asthma control and quality of life, and frequency of asthma exacerbations (Table 2). Finally, only a minority of participants want to discuss cannabis with their physicians and physicians are not routinely querying their patients about cannabis use. Education regarding cannabis use, both its positive and adverse effects, should be discussed with patients, as well as selecting the safest route of administration.

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Table 1. Demographics of AAN members stratified by cannabis use [Data as N (%) or as noted]

Demographics	Total (N = 489)	Current user (N = 88)	Ever, not current user (N = 184)	Never user (N = 217)
Age, years				
18-39	102 (20.9)	34 (38.6)	34 (18.5)	34 (15.7)
40-49	97 (19.8)	19 (21.6)	42 (22.8)	36 (16.6)
50-59	141 (28.8)	19 (21.6)	44 (23.9)	78 (35.9)
≥60	149 (30.5)	16 (18.2)	64 (34.8)	69 (31.8)
Gender*				
Female	407 (83.2)	63 (72.4)	151 (82.5)	193 (91.5)
Male	74 (15.1)	24 (27.6)	32 (17.5)	18 (8.5)
	(N=481)	(N=87)	(N=183)	(N=211)
Ethnicity				
White	360 (73.6)	63 (71.6)	134 (72.8)	163 (75.1)
Non-White	129 (26.4)	25 (28.4)	50 (27.2)	54 (24.9)
Highest education level*				
< College degree	139 (28.4)	35 (39.8)	60 (32.6)	44 (22.3)
College degree	187 (38.2)	32 (36.4)	63 (34.2)	92 (42.4)
Advanced degree	163 (33.3)	21 (23.9)	61 (33.2)	81 (37.3)
Employment				
≥40 hours	144 (29.4)	22 (25.0)	55 (29.9)	61 (28.1)
1-39 hours	250 (51.1)	42 (47.7)	93 (50.5)	67 (30.9)
Other	95 (19.5)	24 (27.3)	36 (19.6)	115 (53.0)
Household earnings yearly (\$)*				
<70,000	89 (18.2)	21 (23.9)	35 (19.0)	33 (15.2)
70,000 - <100,000	141 (28.8)	23 (26.1)	62 (33.7)	56 (25.8)
100,000 or more	162 (33.1)	31 (35.2)	64 (34.8)	67 (30.9)
Prefer not to answer	97 (19.8)	13 (14.8)	23 (12.5)	61 (28.1)
Used in past month				
Alcohol [†]	309 (63.2)	58 (65.9)	131 (71.2)	120 (55.3)
Cigarettes ^{††}	24 (4.9)	10 (11.4)	13 (7.1)	1 (0.5)
Juul/E-cigarettes	12 (2.5)	5 (5.7)	3 (3.3)	1 (0.5)
Chewing tobacco	2 (0.4)	1 (1.1)	1 (0.5)	0 (0.0)
Anthropometrics (N=475)				
Body Mass Index (kg/m ²), mean (SD)*	28.6 (7.2)	28.2 (7.6)	29.7 (7.7)	27.8 (6.5)
Obese (≥30)*	148 (31.2)	29 (34.1)	60 (33.5)	59 (28.0)

*p<0.05; [†]p<0.01, ^{††}p<0.001

Table 2. Features of AAN members stratified by cannabis use [Data as N (%) or as noted]

Features	Total (N = 489)	Current cannabis users (N = 88)	Ever, Not Current (N = 184)	Never used Cannabis (N = 217)
Physician diagnosed asthma, ever				
Yes	272 (55.6)	55 (62.5)	105 (57.1)	112 (51.6)
No	212 (43.8)	33 (37.5)	78 (42.4)	103 (47.5)
Don't know	3 (0.6)	0	1 (0.5)	2 (0.9)
Asthma, current	245 (50.1)	51 (58.0)	91 (49.5)	103 (47.4)
ACT score, mean (SD)	20.2 (4.6)	19.6 (5.1)	20.4 (4.4)	20.3 (4.6)
Controlled, ACT ≥ 20	148 (60.4)	31 (60.8)	59 (64.8)	58 (56.3)
Uncontrolled, ACT ≤ 19	97 (39.6)	20 (39.2)	32 (35.2)	45 (43.7)
mAQLQ, mean (SD)	5.4 (1.4)	5.2 (1.5)	5.5 (1.4)	5.3 (1.4)
mAQLQ > 4.7	171 (69.8)	34 (66.7)	68 (74.7)	69 (67.0)
mAQLQ ≤ 4.7	74 (30.2)	17 (33.3)	23 (25.3)	34 (33.0)
Asthma exacerbations during past year				
Hospitalization	12 (4.9)	3 (5.9)	3 (3.3)	6 (5.8)
Emergency department or urgent care	48 (19.6)	14 (27.5)	16 (17.6)	18 (17.5)
Oral corticosteroids for asthma flare	112 (45.7)	22 (43.1)	38 (41.8)	52 (45.7)
Asthma medication during the past week				
ICS singly or combined with LABA	138 (56.3)	25 (49.0)	54 (59.3)	59 (57.3)
Short-acting β_2 -agonist	121 (49.4)	26 (51.0)	45 (49.5)	50 (48.5)
Montelukast	90 (36.7)	18 (35.3)	33 (36.3)	39 (37.9)
Corticosteroids (oral)	21 (8.6)	4 (7.8)	4 (4.4)	13 (12.6)
Biologics	16 (6.5)	3 (5.9)	3 (3.3)	10 (9.7)
Physician diagnosed exercise-induced bronchoconstriction ever	127 (26.0)	22 (25.0)	54 (27.7)	51 (24.9)
Nijmegen				
Score, mean (SD)	13.1 (11.8)	14.7 (13.3)	13.5 (11.5)	12.1 (11.4)
Hyperventilation score (> 23)	96 (19.6)	19 (21.6)	41 (22.3)	36 (16.6)
Physician diagnosed hay fever ever	239 (48.9)	46 (52.3)	91 (49.5)	102 (47.0)
Upper respiratory symptoms past year with no upper respiratory infection or flu*	372 (76.1)	70 (79.5)	149 (81.0)	153 (70.5)
Medication for nasal symptoms during the past week				
Intranasal steroids	142 (38.2)	31 (44.3)	50 (33.6)	61 (39.9)
Other intranasal meds	36 (9.7)	5 (7.1)	14 (9.4)	17 (11.1)
Oral antihistamines	266 (71.5)	47 (67.1)	106 (71.1)	113 (73.9)
Physician diagnosed eczema ever	142 (29.0)	31 (35.2)	44 (23.9)	67 (30.9)
Physician intake or verbal cannabis query				
Yes	173 (35.4)	36 (40.9)	71 (38.6)	66 (30.4)
No	286 (58.5)	45 (51.1)	99 (53.8)	142 (65.4)
Don't know	30 (6.1)	7 (8.0)	14 (7.6)	9 (4.1)

Features	Total (N = 489)	Current cannabis users (N = 88)	Ever, Not Current (N = 184)	Never used Cannabis (N = 217)
Want to discuss cannabis with MD [†]				
Yes	82 (16.8)	33 (37.5)	31 (16.8)	18 (8.3)
No	362 (74.0)	45 (51.1)	139 (75.5)	178 (82.0)
Don't know	45 (9.2)	10 (11.4)	14 (7.8)	21 (9.7)
Cannabis attitudes [†]				
Liberal	255 (52.1)	84 (95.5)	109 (59.2)	62 (28.6)
Conservative	234 (47.9)	4 (4.5)	75 (40.8)	155 (71.4)
Cannabis knowledge score, mean (SD) [†]	2.3 (1.3)	2.8 (1.2)	2.6 (1.2)	1.8 (1.4)

*p<0.05; [†]p<0.001

Abbreviations: ACT: Asthma Control Test; mAQLQ: Mini Asthma Quality of Life Questionnaire;
ICS: inhaled corticosteroids; LABA: long-action β_2 -agonist.

Table 3. Association of asthma control by the Asthma Control Test (ACT) and cannabis in AAN members [Data as N (%) or as noted]

Asthma features	Total (N = 245)	Controlled (N = 148)	Uncontrolled (N = 97)
ACT, mean (SD)‡	20.0 (4.6)	23.0 (1.7)	15.4 (3.8)
m-AQLQ, mean (SD)‡	5.3 (1.4)	6.1 (0.7)	4.1 (1.3)
m-AQLQ ≤ 4.7‡	74 (30.2)	10 (6.8)	64 (66.0)
Nijmegen score, mean (SD)‡	16.6 (13.2)	11.7 (10.2)	24.2 (13.7)
>23 (Hyperventilation,)‡	69 (28.2)	21 (14.2)	48 (49.5)
Exercise-induced bronchoconstriction†	110 (44.9)	57 (38.5)	53 (55.7)
Allergy to cannabis (n=211)	8 (4.1)	4 (3.4)	4 (5.2)
Doctor asks either verbally or on an intake form about cannabis use?			
Yes	83 (33.9)	53 (35.8)	30 (30.9)
No	147 (60.0)	87 (58.8)	60 (61.9)
Don't know	15 (6.1)	8 (5.4)	7 (7.2)
Wants to discuss cannabis use with doctor†			
Yes	47 (19.2)	18 (12.2)	29 (29.9)
No	170 (69.4)	114 (77.0)	56 (57.7)
Don't know	28 (11.4)	16 (10.8)	12 (12.4)
Cannabis use			
Ever	91 (37.1)	59 (39.9)	32 (33.0)
Current	51 (20.8)	31 (20.9)	20 (20.6)
Never	103 (42.0)	58 (39.2)	45 (46.4)

†p<0.01, ‡p<0.001

Abbreviations: ACT: Asthma Control Test; mAQLQ: Mini Asthma Quality of Life Questionnaire.

Table 4. Attitudes clusters by attitudes questions, cannabis history, and knowledge score in AAN members

	Response	Conservative (N = 234) N (%)	Liberal (N = 255) N (%)	Total (N = 489) N (%)
<i>Cannabis attitudes questions used for cluster analysis</i>				
Do you think cannabis is addictive?	Yes	174 (74.4)	70 (27.5)	244 (49.9)
	No	14 (6)	131 (51.4)	145 (29.7)
	Unsure	46 (19.7)	54 (21.2)	100 (20.4)
Do you think cannabis is damaging to the brain?	Yes	182 (77.8)	41 (16.1)	223 (45.6)
	No	5 (2.1)	130 (51)	135 (27.6)
	Unsure	47 (20.1)	84 (32.9)	131 (26.8)
Do you think consuming edible cannabis is safer than smoking it?	Yes	77 (32.9)	188 (73.7)	265 (54.2)
	No	89 (38)	35 (13.7)	124 (25.4)
	Unsure	68 (29.1)	32 (12.5)	100 (20.4)
Do you think cannabis is less harmful to your health than alcohol?	Yes	22 (9.4)	203 (79.6)	225 (46)
	No	126 (53.8)	21 (8.2)	147 (30.1)
	Unsure	86 (36.8)	31 (12.2)	117 (23.9)
Do you think cannabis is less harmful to your health than tobacco?	Yes	28 (12)	220 (86.3)	248 (50.7)
	No	139 (59.4)	12 (4.7)	151 (30.9)
	Unsure	67 (28.6)	23 (9)	90 (18.4)
Do you think legalizing cannabis makes it seem safer?	Yes	88 (37.6)	198 (77.6)	286 (58.5)
	No	115 (49.1)	28 (11)	143 (29.2)
	Unsure	31 (13.2)	29 (11.4)	60 (12.3)
Do you think cannabis can be beneficial for people with certain medical conditions?	Yes	181 (77.4)	254 (99.6)	435 (89)
	No	14 (6)	0 (0)	14 (2.9)
	Unsure	39 (16.7)	1 (0.4)	40 (8.2)
Do you think legalizing cannabis makes it more socially acceptable?	Yes	135 (57.7)	226 (88.6)	361 (73.8)
	No	66 (28.2)	18 (7.1)	84 (17.2)
	Unsure	33 (14.1)	11 (4.3)	44 (9)
Do you support the legalization of cannabis for medical purposes?	Yes	166 (70.9)	252 (98.8)	418 (85.5)
	No	29 (12.4)	1 (0.4)	30 (6.1)
	Unsure	39 (16.7)	2 (0.8)	41 (8.4)
Do you support the legalization of cannabis for recreational purposes?	Yes	14 (6)	202 (79.2)	216 (44.2)
	No	174 (74.4)	22 (8.6)	196 (40.1)
	Unsure	46 (19.7)	31 (12.2)	77 (15.7)
<i>Potential covariates for regression path analysis</i>				
Is marijuana legal in your state or country (if not in the United States)?	Yes	101 (43.2)	121 (47.5)	222 (45.4)
	No	106 (45.3)	115 (45.1)	221 (45.2)
	Unsure	27 (11.5)	19 (7.5)	46 (9.4)

	Response	Conservative (N = 234) N (%)	Liberal (N = 255) N (%)	Total (N = 489) N (%)
Cannabis use history	Tried	75 (32.1)	109 (42.7)	184 (37.6)
	Current	4 (1.7)	84 (32.9)	88 (18)
	Never	155 (66.2)	62 (24.3)	217 (44.4)
Ethnicity	Other	51 (21.8)	78 (30.6)	129 (26.4)
	White	183 (78.2)	177 (69.4)	360 (73.6)
Age, years	18-39	25 (10.7)	77 (30.2)	102 (20.9)
	40-49	43 (18.4)	54 (21.2)	97 (19.8)
	50-59	84 (35.9)	57 (22.4)	141 (28.8)
	60+	82 (35)	67 (26.3)	149 (30.5)
Gender	Male	26 (11.4)	48 (19)	74 (15.4)
	Female	202 (88.6)	205 (81)	407 (84.6)
Employment, hours per week	<40	73 (31.2)	71 (27.8)	144 (29.4)
	40+	135 (57.7)	115 (45.1)	250 (51.1)
	Other	26 (11.1)	69 (27.1)	95 (19.4)
Education, degree	< College	47 (20.1)	92 (36.1)	139 (28.4)
	College	92 (39.3)	95 (37.3)	187 (38.2)
	Advanced	95 (40.6)	68 (26.7)	163 (33.3)
Cannabis knowledge score, mean (SD)†		2.31 (1.33)	2.55 (1.27)	2.44 (1.30)

* Group differences were statistically significant at $p < .001$ as measured by chi-square for all questions except for whether cannabis is legal which was $p > 0.05$ and gender and ethnicity which was $p < 0.05$.

† Knowledge score mean differences (range 0-5) were measured by ANOVA, $p < 0.05$.

Table 5. Cluster analysis for cannabis patterns of use in current cannabis users (N=88)

		Cannabis User Clusters	
		Long-term use (N=51) N (%)	Short-term use (N=37) N (%)
Items used for the cluster analysis			
Cannabis length of use‡	Less than 3 years	5 (9.8)	35 (94.6)
	3 years or more	46 (90.2)	2 (5.4)
Frequency of cannabis use‡	Less than daily	21 (41.2)	32 (86.5)
	Daily	30 (58.8)	5 (13.5)
Reason for cannabis use‡	Medical	4 (7.8)	19 (51.4)
	Recreational	20 (39.2)	10 (27.0)
	Both	27 (52.9)	8 (21.6)
Primary cannabinoid(s) used‡	THC	28 (54.9)	1 (2.7)
	CBD	0 (0)	17 (45.9)
	Both	23 (45.1)	19 (51.4)
Potential covariates for multivariate analysis			
Smoke cannabis‡	No	13 (25.5)	28 (75.7)
	Yes	38 (74.5)	9 (24.3)
Vaporize cannabis‡	No	26 (51.0)	31 (83.8)
	Yes	25 (49.0)	6 (16.2)
Edible cannabis	No	18 (35.3)	16 (43.2)
	Yes	33 (64.7)	21 (56.8)
Topical cannabis	No	40 (78.4)	25 (67.6)
	Yes	11 (21.6)	12 (32.4)
Coughing from cannabis	No	37 (72.5)	34 (91.9)
	Yes	14 (27.5)	3 (8.1)
Wheezing from cannabis	No	46 (90.2)	37 (100)
	Yes	5 (9.8)	0 (0)
Positive factor‡	Mean (SD)	5.35 (2.5)	3.1 (2.2)
Adverse factor 1	Mean (SD)	0.61 (1.0)	0.35 (0.7)
Adverse factor 2†	Mean (SD)	0.94 (1.1)	0.30 (0.6)
Gender	Male	17 (33.3)	7 (19.4)
	Female	34 (66.7)	29 (80.6)
Age, years	18-39	22 (43.1)	12 (32.4)
	40-49	13 (25.5)	6 (16.2)
	50-59	7 (13.7)	12 (32.4)
	60+	9 (17.6)	7 (18.9)

		Cannabis User Clusters	
		Long-term use (N=51) N (%)	Short-term use (N=37) N (%)
Ethnicity	Other	12 (23.5)	13 (35.1)
	White	39 (76.5)	24 (64.9)
Education, degree	<College	22 (43.1)	13 (35.1)
	College	18 (35.3)	14 (37.8)
	Advanced	11 (21.6)	10 (27.0)
Days per week exercise	None	8 (15.7)	3 (8.1)
	1-4 days	29 (56.9)	21 (56.8)
	5-7 days	14 (27.5)	13 (35.1)
Controlled asthma	Yes	18 (64.3)	13 (56.5)
	No	10 (35.7)	10 (43.5)

†p>0.01; ‡p<0.001

Table 6. Factor analysis of adverse and beneficial effects of cannabis (N=88)*

Subjective effect	Subjective Effects Factors			
	% Yes	Positive	Adverse 1	Adverse 2
Wheezing	5.7	0.02	-0.17	0.72
Coughing	19.3	0.30	-0.02	0.45
Short of breath	6.8	0.23	-0.06	0.47
Itchy eyes	5.7	-0.06	0.15	0.69
Increased appetite	29.5	0.11	0.37	0.52
Nasal symptoms	4.5	-0.04	0.70	0.02
Cardiovascular (increased heart rate, palpitations)	8.0	-0.01	0.73	-0.00
Anxiety, paranoia, feeling uneasy	21.6	0.11	0.79	-0.03
Difficulty concentrating	15.9	-0.07	0.40	0.23
Increased energy	38.6	0.61	0.31	-0.16
Helps with sleep	75.0	0.49	-0.08	0.12
Euphoria	43.2	0.54	0.44	0.12
Calms me down	68.2	0.59	-0.01	0.27
Decreased anxiety	67.0	0.40	0.25	0.28
Improved athletic performance	13.6	0.53	-0.03	0.18
Less pain	68.2	0.42	-0.33	0.06
Opens my lungs	17.0	0.60	-0.19	-0.15
Fewer muscle spasms	21.6	0.75	0.08	0.10
Decreased nausea	29.5	0.72	0.08	0.08
<i>Factor characteristics</i>				
Cronbach's alpha		0.78	0.65	0.55
Range		0-10	0-4	0-5
Mean (SD)		4.42 (2.6)	0.50 (0.91)	0.67 (0.98)

*Kaiser-Meyer-Olkin Measure of Sampling Adequacy=0.67; Bartlett's Test of Sphericity $p < 0.001$; total variance explained=42.7%; items retained if factor loading ≥ 0.40 .

1 **FIGURE LEGENDS**

2 Figure 1: Consort diagram

3 Figure 2: Proportions of estimated marginal means expressed as percent from multivariate
4 analysis of subjective effects factors by cannabis user-type cluster membership as long-term (≥ 3
5 years) and short-term (< 3 years) cannabis use in allergic and asthmatic respondents. Adjusted for
6 age and Bonferroni correction. Positive factor items were increased energy, helps with sleep,
7 euphoria, calms me down, decreased anxiety, improved athletic performance, less pain, opens
8 my lungs, and fewer muscle spasms. Adverse factor 1 items were nasal symptoms,
9 cardiovascular, anxiety, and difficulty concentrating. Adverse factor 2 items were wheezing,
10 coughing, shortness of breath, itchy eyes, and increased appetite. Ranges: Positive factor items
11 (0-10; maximum score 10); Adverse factor 1 items (0-4; maximum score 4); Adverse factor 2
12 items (0-5; maximum score 5); * $p < 0.01$; ** $p < 0.001$.

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Figure 1: Consort Diagram

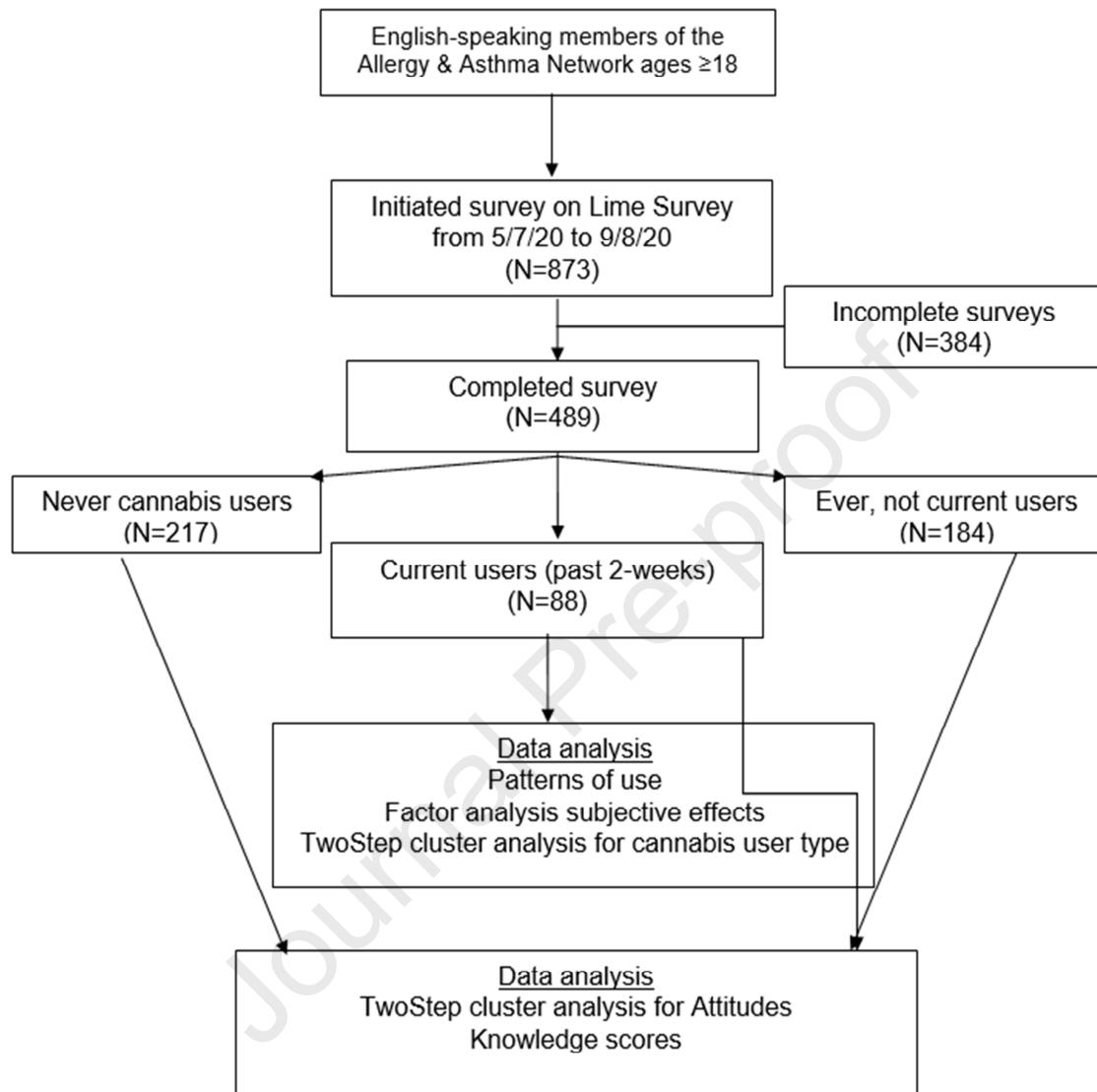
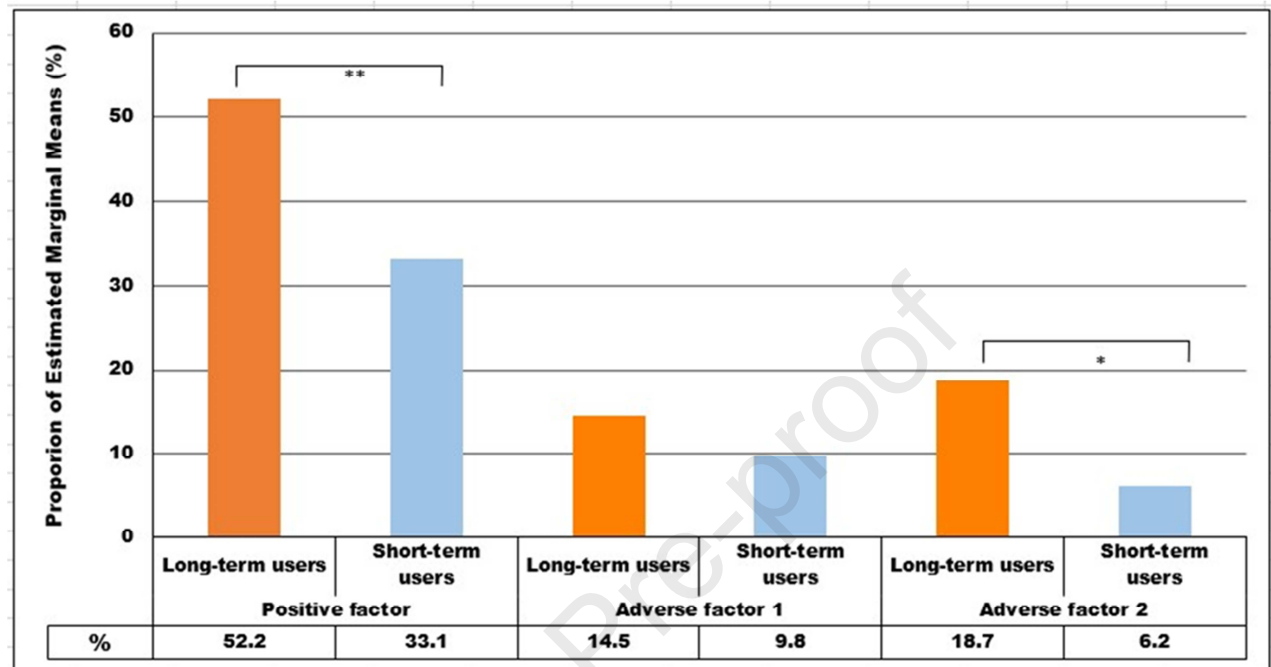


Figure 2



E-Supplement

METHODS

Consent verbiage on the front page of the survey was “By completing and submitting this survey, you are indicating your consent to participate in the study. Please print this page for your records prior to starting the survey.”

The Asthma Control Test (ACT) score of ≥ 20 indicates controlled asthma while a lower score indicates uncontrolled asthma. The 15 item, 7-point scale MiniAsthma Quality of Life Questionnaire (mAQLQ) captured asthma-specific quality of life in respondents with current asthma; a score of ≤ 4.7 indicates an increased risk for future asthma exacerbations.

Cannabis knowledge was determined using four knowledge questions that had a single correct answer and four incorrect answers. The four questions were converted into a knowledge score by summing the four answers, where a correct answer was “1” and an incorrect answer was “0”, with a minimum score of 0 and a maximum score of 4.

TwoStep Cluster starts with pre-clustering which uses a sequential clustering approach and then a final clustering using an agglomerative hierarchical clustering method.¹ The log-likelihood method with the BIC goodness-of-fit was used whereby a large ratio of distances is considered an optimal number of clusters.¹ First, the distribution of subjects per cluster was observed (intra-cluster homogeneity) and second, differences for the clustering variables were tested by chi-square to examine cluster separation (inter-cluster heterogeneity). Adequate power for cluster analysis is not agreed upon. Historically, cluster analysis requires, at a minimum, a sample size of 2^K , where K is the number of variables included in the clustering; it has been suggested that a preferable sample size is 5×2^K .² However, a systematic analysis of sample sizes for cluster analyses reviewed 243 cluster analyses and found that the median sample size for the cluster analyses was 293 participants.² A simulation study found valid solutions for cluster

analysis with samples as small as 20.³ The present sample size of 489 for the attitudes clusters analysis and 88 for the cannabis user cluster analysis was adequate for these analyses. The SPSS TwoStep cluster procedure automatically selected a two-cluster solution for the entire cohort based on their attitudes toward cannabis which were named ‘liberal’ (n=234; 47.9%) and ‘conservative’ (n=255; 52.1%). We named the clusters “liberal” and “conservative” based on the answers to the questions for each of the two cluster groups. For example, 79.2% of the ‘liberal’ cluster thought cannabis should be legalized for recreational purposes compared to only 6% of the ‘conservative’ cluster.

The following values of Cronbach’s alpha for establishing the internal consistency reliability were used: Excellent ($\alpha > 0.9$), Good ($0.7 < \alpha < 0.9$), Acceptable ($0.6 < \alpha < 0.7$), Poor ($0.5 < \alpha < 0.6$), Unacceptable ($\alpha < 0.5$)^{4,5}

The advantage of multivariate analysis is the ability to assess mean differences across multiple dependent variables simultaneously with a null hypothesis of equal means across groups.

Two items were not included in the factor analysis due to low endorsement: anaphylaxis (0%), and skin reactions (1.1%). Items were retained to a factor if the factor loading was > 0.40 and if the item loaded on a single factor (i.e. no cross-loading); factors were retained if they had 3 or more items, The Kaiser-Meyer-Olkin measure of sampling adequacy ranges from 0 to 1 with a value of 0.50 considered adequate and Bartlett’s Test of Sphericity should have a p-values less than 0.05.⁶ A value of 0.60 for the Cronbach’s alpha is acceptable for exploratory research and when there are fewer than 10 items in the scale.⁷

A multivariate F-test (Wilks’ Lambda) and partial eta squared (a measure of effect size) were calculated. Estimated marginal means were generated and post-hoc Bonferroni tests were

used to examine group differences of these marginal means. The estimated marginal means from the multivariate model were converted to mean proportions of items endorsed due to the different number of items that comprised each factor, [(mean/total number items) *100].

DISCUSSION

Cannabis users reported adverse respiratory symptoms such as coughing, wheezing, and shortness of breath from cannabis, but these negative effects were reported markedly less than the many positive effects from cannabis including less pain, increased activity, fewer muscle spasms (Table 6, Figure 2). Positive effects of cannabis use reported that may have helped participants' asthma included: opening my lungs, calming, improved athletic performance, and increased activity. Although asthma is not by itself associated with pain, reduction in pain may improve one's overall well-being, which could lead to some feeling of asthma improvement.

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Cannabis attitudes and patterns of use among followers of the Allergy & Asthma Network

Joanna S. Zeiger, MS, PhD¹; William S. Silvers, MD^{1,2}; Tonya A. Winders, MBA³; Mary K. Hart, RRT³; Robert S. Zeiger MD, PhD^{1,4}

¹Canna Research Foundation, Boulder, CO, USA

²University of Colorado School of Medicine, Denver, CO, USA

³Allergy Asthma Network, Vienna, VA, USA

⁴Kaiser Permanente Southern California, San Diego, CA, USA

Corresponding author: Joanna S. Zeiger, MS, PhD

Canna Research Foundation

Boulder, CO 80301, USA

Email: joannazeiger@comcast.net

Tel: 303-815-3914

Financial support: Allergy & Asthma Network and Canna Research Foundation

Author contributions:

JSZ (1) made major contributions to the conception, design, statistical analysis, execution of the study, and interpretation of the findings; (2) drafted the manuscript and revised it critically for important intellectual content; (3) gave final approval of the version to be published;

WSS, TAW, MH, and RSZ (1) made substantial contributions to the design of the study as well as interpretation of the findings; (2) revised the manuscript critically for important intellectual content; and (3) gave final approval of the version to be published.

ABBREVIATIONS

ACT: Asthma Control Test

AAN: Allergy & Asthma Network

BMI: Body mass index

CBD: cannabidiol

mAQLQ: Mini Asthma Quality of Life Questionnaire

PEACE: Pain, Exercise, and Cannabis Experience

SD: Standard deviation

THC: tetrahydrocannabinol

Keywords: allergy; asthma; cannabis; cluster analysis; factor analysis; survey.

[The information below was copied and pasted from the original submission because it was not include in the revision. Lmm]

Conflict of Interest:

JSZ: Advisor to the Canna Research Foundation and CEO of the Canna Research Group.

WSS: Advisor to the Canna Research Foundation and Chief Scientific Officer of the Canna Research Group.

TAW: President of the Allergy & Asthma Network

MKH: Employee of the Allergy & Asthma Network

RSZ: Advisor to the Canna Research Foundation and Chief Medical Officer of the Canna Research Group. Grants from NHLBI, Aerocrine, ALK Pharma, TEVA outside the present work. Grants and personal fees from Genentech, GlaxoSmithKline,

MedImmune/AstraZeneca, Merck outside the present work, personal fees from Novartis and Regeneron Pharmaceuticals outside the submitted work. Deputy Editor of JACI: In Practice.