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# Observational Analysis of the Influence of Medical Marijuana Use on Quality of Life in Patients

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**Keywords**
Cannabis · Medical Marijuana · Pennsylvania Medical Marijuana Program · Quality of life · THC

**Abstract**

***Introduction:*** A significant gap exists in the understanding and utilization of medical marijuana and its effects on a patient's quality of life. This is largely attributed to *Cannabis'* sp. Schedule 1 classification, which has impeded the scientific investigation of its effects on the endocannabinoid system (ECS) and quality of life. Additionally, conflicting results from previous studies highlight the need for more research to provide guidance to both patients and clinicians regarding the therapeutic potential of medical marijuana. ***Methods:*** Patients over 18 years of age who were members of the Pennsylvania Medical Marijuana Program (PAMMP) were recruited from regulated Pennsylvania medical marijuana dispensaries. Eligible patients were enrolled through informed consent, following a study design that received approval from the LECOM Institutional Review Board (IRB). Over 90 days, participants were remotely administered an electronic survey every 30 days to collect medical marijuana use patterns and assess changes in quality of life. ***Results:*** Of the 103 participants who completed the study, significant improvements were observed in physical and social functioning, emotional well-being, and energy levels within the first 30 days. Participants reported significant decreases in emotional limitations, fatigue, and pain levels. Notably, participants who used inhaled or vaped products (defined as vape cartridges and concentrates) were younger and exhibited a significantly higher increase in emotional well-being scores compared to those who used flower products (defined as dry leaf only). Participants who consumed medical marijuana for opioid use demonstrated significantly higher THC consumption compared to those seeking treatment for anxiety, chronic pain, or inflammatory bowel disease (IBD). Improvements in the first 30 days also remained constant for the remainder of the study. ***Discussion:*** This study contributed valuable insights into the effects of medical marijuana on quality of life and highlighted potential benefits associated with its use. Moreover, ongoing research aims to assess the observed sustained improvements beyond 90 days, investigating potential long-term trends. While further research is needed to explore the underlying mechanisms of action and long-term effects of medical marijuana, clinicians and patients can gain a better understanding of medical marijuana's therapeutic potential, enabling more informed decisions regarding its use in clinical settings.



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**Plain Language Summary**

This research looks at the effects of medical marijuana on a patient's quality of life. The study involved 103 participants from Pennsylvania who were using medical marijuana for various health conditions. They answered four surveys over 90 days, reporting on their experiences with marijuana and their well-being. The results showed that many participants experienced improvements in their physical and social functioning, energy levels, and emotional well-being within the first 30–60 days of using medical marijuana. Interestingly, the study found that how often someone used medical marijuana could affect their overall health. Those who used it once a day tended to have better general health scores compared to those who used it more frequently. Alcohol use seemed to have an impact too. People who used both alcohol and medical marijuana had lower energy levels and emotional well-being, suggesting that the combination might not be ideal. The study also looked at how people consumed medical marijuana, whether by inhaling it or using it as a flower, and found differences in THC consumption and emotional well-being. However, the study had some limitations, like relying on self-reported data and having a small sample size. Still, it provides valuable insights into how medical marijuana can affect people's lives and highlights the need for personalized approaches to its use.



## Introduction

In the early 20th century, reports of cannabis' inconsistent efficacy and psychoactive effects in recreational use resulted in the immediate ban of the production and sale of *C. sativa L.* by the International Opium Convention of 1925 [1]. Furthermore, while *C. indica* production was still permitted, the "Marihuana Tax Act" of 1937 imposed strict penalties for the use of cannabis throughout the USA [1]. Afterward, cannabis experienced a significant downfall, ultimately resulting in its Schedule 1 designation by the US Drug Enforcement Agency (DEA) Controlled Substances Act of 1970 [1, 2].

Nonetheless, the Pennsylvania Medical Marijuana Program (PAMMP) was established in April of 2016 as part of the Pennsylvania Medical Marijuana Act (Act No. 16 Of 2016) to research the medicinal effects of cannabis. This program allows residents of the Commonwealth to partake in the certified medical use of marijuana (also, cannabis) for one or more qualifying medical condition(s) outlined by the Pennsylvania Department of Health (DOH).

However, prior studies conducted with both medicinal and recreational cannabis use have failed to identify a significant relationship between cannabis use and quality of life metrics while accounting for age, sex, race/ethnicity, income, and comorbid conditions including alcohol and tobacco/nicotine use [3, 4]. Furthermore, there is a gap in the literature specifically regarding longitudinal studies examining the impact of cannabis on the quality of life of patients with chronic, debilitating medical conditions. Thus, leveraging the fact that historical cannabis proved effective in reducing pain and improving quality of life, this study sought to identify a potential relationship between cannabis use and quality of life measures including physical and emotional limitations, energy and fatigue, pain, and physical and social functioning.

## Methods

*Participants*

This was a prospective observational cohort study that consisted of 103 participants. Patients were recruited remotely from certified dispensaries in Pennsylvania owned and operated by CannTech PA LLC, d/b/a Ayr Wellness, Inc. Eligibility criteria included age 18 years and older, present members of the PAMMP, having access to an electronic device with internet connectivity, being proficient in English, and being able to obtain medical marijuana products from a CannTech PA LLC d/b/a Ayr Wellness dispensary in Pennsylvania. Exclusion criteria included pregnancy, current recreational marijuana use (obtaining marijuana products from sources other than dispensaries), and excessive alcohol use (4+/5+ drinks in one occasion for females/males). Patients were screened for eligibility and enrolled through informed consent in accordance with study protocol approved by the LECOM IRB. During their involvement, patients were exclusively instructed to purchase medical marijuana (MMJ) products from Ayr Wellness Inc. dispensaries to ensure access to valid and reliable product data. Furthermore, patients were strictly instructed that no recreational marijuana use was permitted during their involvement.

*Data Collection*

Four electronic surveys were conducted remotely using SurveyMonkey® over the course of 90 days, with the first being administered upon enrollment and the remaining three every 30 days post-enrollment. The beginning of the initial survey collected education level, primary qualifying condition for which the patient was seeking treatment, and a list of current prescription medications. The remainder of the survey, in agreeance with the three follow-up surveys, collected recent tobacco and nicotine use, alcohol use, mode of administration of MMJ, frequency of administration of MMJ, and responses to the RAND® 36-Item Short Form Health Survey, Version 1.0 (RAND® SF-36). Side effects of marijuana consumption, including cough, fast heart rate (100+ bpm), dry mouth, irritated eyes, short-term memory loss, dizziness/lightheadedness, hallucinations or altered senses, difficulty thinking or problem solving, impaired movement, altered

**Table 1.** Demographics of all participants

| | *N* | % |
|---|---|---|
| Age | | |
| 18–24 | 7 | 6.8 |
| 25–34 | 40 | 38.8 |
| 35–44 | 28 | 27.2 |
| 45–54 | 16 | 15.5 |
| 55–64 | 9 | 8.7 |
| 65+ | 3 | 2.9 |
| Sex | | |
| Male | 62 | 60.2 |
| Female | 41 | 39.8 |
| Race | | |
| White or Caucasian | 93 | 90.3 |
| Black or African American | 10 | 9.7 |
| Education | | |
| High school | 17 | 16.5 |
| Some college | 27 | 26.2 |
| Trade school | 10 | 9.7 |
| Associate's degree | 6 | 5.8 |
| Bachelor's degree | 30 | 29.1 |
| Master's degree | 11 | 10.7 |
| Professional/doctorate degree | 2 | 1.9 |
| Tobacco use | | |
| Yes | 23 | 22.3 |
| No | 80 | 77.7 |
| Alcohol use | | |
| Yes | 55 | 53.4 |
| No | 48 | 46.6 |

**Table 2.** Medical marijuana characteristics of all participants

| | *N* | % |
|---|---|---|
| Condition | | |
| Anxiety | 50 | 48.5 |
| Chronic pain | 26 | 25.2 |
| Other (PTSD, IBD, OUD, etc.) | 27 | 26.3 |
| Product | | |
| Flower | 53 | 51.5 |
| Vape cartridge | 29 | 28.2 |
| Concentrate | 17 | 16.5 |
| Infused | 2 | 1.9 |
| Not recorded | 2 | 1.9 |
| THC% | | |
| 0–10 | 0 | 0 |
| 11–20 | 0 | 0 |
| 21–30 | 21 | 20.4 |
| 31–40 | 14 | 13.6 |
| 41–50 | 15 | 14.6 |
| 51–60 | 15 | 14.6 |
| 61–70 | 16 | 15.5 |
| 71–80 | 12 | 11.7 |
| 81–90 | 5 | 4.9 |
| 91+ | 0 | 0 |
| Not recorded | 5 | 4.9 |
| Frequency | | |
| Once a day | 8 | 7.8 |
| Twice a day | 19 | 18.4 |
| Three to 4 times a day | 35 | 34.0 |
| Five or more times a day | 38 | 36.9 |
| Not recorded | 3 | 2.9 |

sense of time (e.g., time feels like it is moving slow), anxiety/panic, confusion, excessive fatigue, nausea, trouble breathing, and increased hunger, were also captured. All side effects were taken from the National Institute of Drug Abuse (NIDA) "Cannabis (Marijuana) Drug Facts" webpage.

The remaining demographic information, along with marijuana usage data, including product category (Concentrate, Flower, Infused, Topicals, Vape Cartridge), THC+THCA%, and CBD+CBDA%, was collected from the operating system "MJFreeway" – a technical cannabis "seed-to-sale" tracking system owned by MJ Platform and mandated by the state of Pennsylvania – and their associated cloud-based platform "Domo™." If no medical marijuana information was found, those participants were excluded from the analysis and denoted as "not recorded."

*Statistical Analysis*

Once data collection was complete, all data were exported to Microsoft Excel and uploaded to IBM® SPSS® Statistics (Version 28.0) for statistical analysis. Descriptive statistics are reported to summarize baseline characteristics of all participants (Tables 1, 2).

Furthermore, any continuous variables – including age, average THC%, and each of the eight SF-36 domain score changes (i.e., from 0 to 30 days, 30–60 days, and 60–90 days) – were tested for statistical outliers and normal distribution using Shapiro-Wilk's method. The only variables that were normally distributed were the change in scores from 0 to 30 days of Energy and Fatigue, Emotional Well-Being, and General Health, along with the change in scores from 60 to 90 days of Energy and Fatigue. Outliers were only removed from the variables with normally distributed data, as non-parametric tests are robust to outliers. These changes in scores were analyzed using either a Paired Samples *t* test or non-parametric equivalent Mann Whitney U test. Confounding variables included age, sex, race, education, condition (Anxiety, Chronic Pain, PTSD, IBD, Opioid Use Disorder (OUD), Glaucoma, Neuropathic Disease, Cancer, or Epilepsy), tobacco use, alcohol use, average THC%, mode of administration (Inhaled or Vaporized, Flower or Dry Leaf, Pills, Liquids or Tinctures, or Topical), and frequency of administration.

To determine alcohol and/or tobacco use, participants had to regularly consume alcohol or tobacco for at least half of the study period, including at least once within the first 30 days. One-way ANOVA or the non-parametric equivalent Kruskal-Wallis tests were administered to analyze categorical confounding variables with more than two values and the SF-36 domain score changes. For binary confounding variables,

**Table 3.** SF-36 domain score changes between 0 and 30 days

| SF-36 domain | 0 days median (IQR) | 30 days median (IQR) | $z^a$ | $p$ value | $r^b$ |
|---|---|---|---|---|---|
| Physical functioning | 90 (77.5–100) | 95 (77.5–100) | −1.98 | 0.048 | −0.20 |
| Emotional limitations | 66.7 (33.3–100) | 100 (33.3–100) | −3.15 | 0.002 | −0.31 |
| Social functioning | 62.5 (50–87.5) | 75 (56.3–87.5) | −3.19 | 0.001 | −0.31 |
| Pain | 57.5 (45–77.5) | 67.5 (45–80) | −3.29 | 0.001 | −0.32 |
| | 0 days mean (SD) | 30 days mean (SD) | *t*(102) | $p$ value | $d^c$ |
| Energy and fatigue | 46.1 (21.4) | 51.7 (20.7) | 3.83 | 0.001 | 0.377 |
| Emotional well-being | 61.7 (18.8) | 65.7 (19.7) | 3.07 | 0.003 | 0.302 |

[a]Wilcoxon signed ranks test statistic. [b]Wilcoxon signed ranks effect size. [c]Cohen's d effect size.

including sex, race, tobacco use, and alcohol use, independent samples *t* tests or Mann-Whitney U tests were administered to check for any significant correlation. Lastly, confounding variables were analyzed independently to determine if age, sex, race, education, condition, tobacco use, or alcohol use had any effect on average THC%, mode of administration, or frequency of administration. Significance level was set at $p < 0.05$ (two-tailed) for all analyses.

## Results

From 0 to 30 days, a significant improvement was observed in participants' physical and social functioning, energy levels, and emotional well-being. Alternatively, a significant decrease was observed in participants' emotional challenges and limitations along with pain levels (Table 3). Furthermore, a significant increase in participants' overall general health was observed between 30 and 60 days (Wilcoxon $z = -2.34$, $p = 0.019$, $r = -0.23$), and pain levels continued to significantly decline throughout this time period (Wilcoxon $z = -2.41$, $p = 0.016$, $r = -0.24$). The largest increase in general health was observed in those who consumed MMJ once a day compared to twice a day, 3–4 times a day, or 5 or more times a day, though more data are needed to confirm if this difference exists since the sample size of once a day users is small ($n = 8$) and thus results in low power calculations for each comparison ($1\text{-}\beta \leq 0.41$) (Table 4). None of the SF-36 domain scores changed significantly from 60 to 90 days (data not shown).

Those who reported alcohol use within the first 30 days consumed medical marijuana less frequently during this time period compared to those who did not drink alcohol (Mann-Whitney $z = -2.043$, $p = 0.041$, $\eta^2 = 0.04$). These participants also experienced lower energy with a mean score increase of 2.73 compared to non-drinkers with 8.85 ($t(101) = 2.13$, $p = 0.018$, $d = 0.42$), and emotional well-being levels with a mean score increase of 0.95 compared to non-drinkers with 7.5 ($t(101) = 2.58$, $p = 0.006$, $d = 0.51$) from 0 to 30 days. The amount and frequency of alcohol consumption proved to have no effect.

Comparing the mode of administration of only those participants who consumed MMJ via inhalation (i.e., vaporization using either a vape cartridge and pen or concentrate and battery) versus flower (i.e., dry leaf) and THC%, those who consumed MMJ via inhalation consumed a significantly higher amount of THC (Mann Whitney $z = -7.335$, $p < 0.001$, $\eta^2 = 0.566$) and tended to be younger in age (Mann Whitney $z = -2.521$, $p = 0.012$, $\eta^2 = 0.064$). Furthermore, those who consumed MMJ via inhalation showed a larger increase in emotional well-being scores within the first 30 days with a mean score increase of 7.29 compared to 1.82 for flower users ($t(98) = 2.117$, $p = 0.018$, $d = 0.426$). Frequency of use over all modes of administration proved to have no relation to THC% (Kruskal-Wallis $H(3) = 3.655$, $p = 0.301$, $\eta^2 = 0.007$).

Those participants using MMJ to treat opioid dependence consumed a significantly higher amount of THC on average, with a median of 69.3% (IQR = 59.9–78.7%), compared to those seeking treatment for anxiety (47.2%, IQR = 30.19–64.25%; $z = -2.52$, $p = 0.008$), chronic pain (44.9%, IQR = 30.11–59.69%; $z = -2.62$, $p = 0.005$), and inflammatory bowel disease (IBD; 29.2%, IQR = 16.10–42.31; $z = -2.45$, $p = 0.016$). Additionally, those seeking treatment for PTSD consumed a significantly higher amount of THC on average, with a median of 63.58% (IQR = 51.92–75.23%), compared to those seeking treatment for chronic pain ($z = -2.15$, $p = 0.031$) and IBD ($z = -2.49$, $p = 0.011$).

**Table 4.** General health scores versus frequency of administration of MMJ between 30 and 60 days

| | *N* | *H(3)*[a] | *p* value |
|---|---|---|---|
| General health scores versus frequency of administration | 103 | 8.393 | 0.039 |
| | *N* | *z*[b] | *p* value |
| Once a day versus twice a day | 28 | −2.583 | 0.010 |
| Once a day versus 3–4 times a day | 45 | −2.858 | 0.004 |
| Once a day versus 5 or more times a day | 46 | −2.553 | 0.010 |
| Twice a day versus 3–4 times a day | 57 | −0.145 | 0.885 |
| Twice a day versus 5 or more times a day | 58 | −0.100 | 0.921 |
| 3-4 times a day versus 5 or more times a day | 75 | −0.070 | 0.944 |

[a]Kruskal-Wallis H(DOF) test statistic. [b]Mann Whitney U test statistic.

The most commonly reported side effects, regardless of average THC% and mode and frequency of administration, included 61.2% of participants experiencing cough (95% Cl = 54.8–73.8%), 75.7% experiencing dry mouth (95% Cl = 70.5–86.7%), and 69.9% experiencing increased hunger (95% Cl = 63.6–81.3%). None of these side effects differed significantly between modes of administration (Cough $\chi^2 = 2.789$, $p = 0.248$; Dry Mouth $\chi^2 = 1.788$, $p = 0.409$; Increased Hunger $\chi^2 = 0.412$, $p = 0.814$), or frequency of administration (Cough $\chi^2 = 0.783$, $p = 0.853$; Dry Mouth $\chi^2 = 4.983$, $p = 0.173$; Increased Hunger $\chi^2 = 2.853$, $p = 0.415$).

## Discussion

This study described the psychosocial profiles of patients exposed to medical marijuana, and is among the first of its kind. Several valuable insights into the use of medical marijuana were identified, and it is clear that medical marijuana, when administered safely, can improve an individual's quality of life. The observed increases in physical and social functioning, energy levels and reduced fatigue reflect the potential therapeutic benefits of medical marijuana in addressing various health-related challenges and stabilizing well-being. Improvements in emotional well-being and reduced emotional limitations and pain align with prior claims of the analgesic and mood-regulating properties of medical marijuana [5, 6]. Moreover, the sustained improvements observed throughout the study period are well-timed, considering the use of marijuana has shown a steady increase over the past 10 years, and is becoming increasingly accessible and regulated through certified medical dispensaries [7].

Notably, this study revealed that the frequency of administration of MMJ had contradictory effects on general health. Specifically, those who consumed MMJ once a day displayed a larger increase in general health scores compared to those who consumed it more frequently. This suggests there may be an optimal frequency for administration and a moderate dosage may be more conducive to overall health, while higher frequencies may not provide additional benefits. Further research should investigate the possibility of optimal dosing.

Participants who reported alcohol use consumed their MMJ less frequently and observed lower energy levels and emotional well-being, suggesting a potential interaction between alcohol and MMJ in subjective experiences. This supports the fact that alcohol has an additive effect of both substances' depressive symptoms, but conflicts with prior findings stating increased marijuana use with alcohol consumption [8, 9]. However, the amount and frequency of alcohol consumption did not influence the observed effects. Further research is necessary to reveal the underlying biological mechanisms and potential interactions between alcohol and MMJ with adult co-use.

The majority of participants consumed their medical marijuana via inhalation (vaporization or concentrate) or flower. This corresponds to the current most common methods of MMJ consumption [2]. Furthermore, those who consumed their MMJ via inhalation reported higher THC consumption and tended to be younger in age. Inhalation was also associated with a larger increase in emotional well-being scores within the first 30 days compared to flower users. This may be attributed to the faster onset of effects and shift in generational mindset associated with inhalation (i.e., "vaping"), which could result in more immediate and pronounced subjective

improvements [10]. Moreover, higher THC may have an increased effect on subjective quality of life measures, including emotional well-being. However, dose-related effects of THC have been inconclusive, and the small sample size necessitates additional research into medical marijuana's primary psychoactive ingredient when it comes to emotional regulation [11]. Importantly, it is crucial to consider potential risks associated with inhalation methods, and further exploration into the optimal modes of MMJ administration and THC levels for specific patient populations is warranted [12, 13].

Cough, dry mouth, and increased hunger were the most frequently reported side effects, consistent with previous literature and reflect the well-known acute effects of MMJ [14–16]. These effects can be primarily attributed to the primary activation of the cannabinoid receptors in the ECS of the central nervous system (CNS) and respiratory, salivary, and appetite-regulating pathways [14, 16, 17]. While these side effects are minor, the effects of both short- and long-term use of MMJ vary from mild to severe, and clinicians and patients should be aware of these potential side effects to consider individual tolerability when initiating MMJ treatment [14, 18].

## Limitations

Despite the valuable insights provided by this study, several limitations should be acknowledged. Firstly, the study relied on self-reported measures, which may introduce social desirability effects and, while clinical measures of quality of life were utilized, the long time span between administrations may introduce recall bias. Additionally, since the study was voluntary and had a relatively small sample size, self-selection bias may have been introduced, affecting the disproportionate racial profile of the sample and potentially affecting the generalizability of the findings to the broader population using MMJ.

Long-term follow-up assessments were conducted to try to gain insight into the longitudinal effects of MMJ, but due to certain constraints, were not conducted as frequently as necessary to draw affirmative conclusions about the sustained effects and changes in quality of life over time. Additionally, participants were provided with a discount incentive for medical marijuana products which may result in false beneficial results due to better product availability and affordability. Likewise, due to current legal regulations, participant access to high CBD products, including 1:1 ratios of CBD to THC products, was restricted during the study period. Subsequent investigations will incorporate these product categories, thus offering a full spectrum of marijuana products to participants.

Lastly, there was no way to include a comparable placebo group due to legal and ethical concerns, which may result in a beneficial bias toward MMJ since all participants were seeking treatment prior to study enrollment. Furthermore, the majority of patients were using MMJ to treat anxiety and/or chronic pain, both of which have shown positive results from MMJ use which may result in a bias toward positive effects [19–22]. Future studies should address these limitations and employ more rigorous designs, such as randomized controlled trials, to further identify the relationship between MMJ and quality of life outcomes.

## Conclusion

This study contributes to the growing body of literature on MMJ by examining its effects on quality of life and exploring various associated factors. The findings suggest that MMJ has the potential to improve physical and social functioning, energy levels, emotional well-being, and overall general health within the first 30–60 days of use. Factors including alcohol use, mode and frequency of administration, and specific medical conditions were found to influence the amount of THC consumption, as well as subjective outcomes associated with MMJ use. Due to the inherent nature of MMJ being derived from a plant, each batch can vary significantly in its components, making it challenging to regulate and standardize its composition. Therefore, this underscores the need for individualized approaches to MMJ treatment and highlights the importance of considering individual factors when assessing its potential benefits and risks.

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## Statement of Ethics

This study protocol was reviewed and approved by the LECOM IRB, approval number 28-125. All participants of this study voluntarily provided written informed consent prior to participation.

## Conflict of Interest Statement

The authors of this paper disclose that Edward Miller, MD and Marla Bowie, PharmD are employees of CannTech LLC d/b/a Ayr Wellness, Inc. Both are members of the Board of Directors for Ayr Wellness. Miller serves as the Chief Medical Officer for Pennsylvania, while Bowie holds the position of Director of Patients and Customer Care. Neither Miller nor Bowie received any personal benefit or financial gain from the progression, analysis, or publication of this study. The design, execution, and reporting of the research were conducted without bias, and the authors confirm their relationship with Ayr Wellness did not influence the study's outcomes or conclusions.


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## Author Contributions

Mark D. Kelley: conceptualization, methodology, formal analysis, investigation, data curation, and writing - original draft. Marwah Obaid: formal analysis, validation, and data curation. Edward M. Miller: writing – review and editing and supervision. Marla Bowie: resources, writing – review and editing, and funding acquisition. Zachary S. Heeter: resources, writing – review and editing, and supervision.

## Data Availability Statement

The data that support the findings of this study are not publicly available due to the sensitive nature of the study and due to privacy statements included in the protocol and consent form but may be requested from either the corresponding author [M.D.K.] or LECOM's Director of Medical Marijuana Research depending on the time the request is received.

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