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Pain Profiles among Young Adult Cannabis Users: An Analysis of Antecedent Factors and Distal Outcomes

Janna Ataiants[a], **Ekaterina V. Fedorova**[a], **Carolyn F. Wong**[b,c], **Ellen Iverson**[b,c], **Jeffrey I. Gold**[b,d,e,f], **Stephen E. Lankenau**[a]

[a]Dornsife School of Public Health, Department of Community Health and Prevention, Drexel University, Philadelphia, Pennsylvania, USA;

[b]Department of Pediatrics, Keck School of Medicine, University of Southern California, Los Angeles, California, USA;

[c]Division of Adolescent and Young Adult Medicine, Children's Hospital Los Angeles, Los Angeles, California, USA;

[d]Department of Anesthesiology, Keck School of Medicine, University of Southern California, Los Angeles, California, USA;

[e]Department of Psychiatry & Behavioral Sciences, Keck School of Medicine, University of Southern California, Los Angeles, California, USA;

[f]Department of Anesthesiology Critical Care Medicine, The Saban Research Institute at Children's Hospital Los Angeles, Los Angeles, California, USA

Abstract

Background: Pain is a primary reason for medical cannabis use among young adults, however little is known about the patterns of pain in this group. This study identified pain profiles among young adult cannabis users and examined related antecedents and distal outcomes.

Methods: Past 30-day cannabis users aged 18–26, both medical cannabis patients and non-patients, were enrolled in Los Angeles in 2014–2015. A latent class analysis was used to identify pain classes based on history of chronic pain conditions and recent non-minor pain. The study assessed the predictors of membership in pain classes and examined the association of classes with recent mental health characteristics, cannabis use motives and practices.

Results: Three classes were identified: *Low pain* (56.3%), *Multiple pain* (27.3%), and *Nonspecific pain* (16.4%). In adjusted models, lifetime insomnia was associated with membership in *Multiple pain* and *Nonspecific pain* classes versus the *Low pain* class. Medical cannabis patients and Hispanics/Latinos were more likely to belong to the *Multiple pain* class than the other classes. Regarding recent outcomes, the *Multiple pain* and *Nonspecific pain* classes were more likely than

✉**CONTACT** Janna ataiants ja633@drexel.edu Dornsife School of Public Health, Department of Community Health and Prevention, Drexel University, 3215 Market Street, Philadelphia, PA 19104, USA.

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the *Low pain* class to use cannabis to relieve physical pain. Additionally, the *Multiple pain* class had a higher probability of psychological distress, self-reported medical cannabis use, consuming edibles, and using cannabis to sleep compared to one or both other classes.

Conclusion: Findings suggest that young adult cannabis users can be separated into distinct groups with different pain profiles. The *Multiple pain* profile was associated with medically-oriented cannabis use motives and practices.

Keywords

Cannabis; pain; young adults; mental health; latent class analysis

Introduction

Young adults, i.e. youth aged 18 to 25, are generally free of chronic illnesses, however episodic, lasting, recurrent or chronic pain is not uncommon at this age. In 2019, an estimated 8.5% of 18–29-year-olds in the United States reported chronic pain, i.e. pain occurring on every day or most days in the past 3 months, and 2.2% experienced chronic pain that resulted in activity restrictions (Zelaya et al., 2020), i.e. functional disability. Limited evidence about the causes of chronic pain among youth suggests that musculoskeletal injuries (Reuter & Fichthorn, 2019), lower back pain (Kennedy et al., 2008; Nyland & Grimmer, 2003), and headaches (Kennedy et al., 2008) could be sources of chronic and recurrent pain in this age group. Those findings are corroborated by studies that documented back/musculoskeletal pain (19%) and injury (12%) to be primary reasons for prescribing opioid pain relievers to youth aged 15–29 (Fortuna et al., 2010), and back pain to be the most commonly reported pain condition among 17–23-year-olds with chronic pain (Anastas et al., 2018).

Young adults have the highest prevalence of past year cannabis use among any age group in the U.S. (SAMHSA, 2019), however estimates of medical cannabis use in this group are rare. Analysis of a national sample of past year adult cannabis users found that 17% self-reported medical use, i.e. recommended by a doctor, with 25% being young adults (Lin et al., 2016). Consistent with this estimate, Los Angeles County reported that 23.9% and 26.2% of 18–20- and 21–29-year olds respectively had either a medical marijuana ID card or doctor's recommendation in 2015 (Los Angeles County Department of Public Health, 2018). Importantly, pain is the most common qualifying condition for medical cannabis in the U.S. (Boehnke, Gangopadhyay, Clauw, & Haffajee, 2019), as well as a primary reason for medical cannabis use among young adults (Fales et al., 2019; Lankenau et al., 2018). Moreover, the lifetime prevalence of pain conditions is higher among young adult medical cannabis patients compared to non-patients (Lankenau et al., 2018). A few studies have identified a range of pain clusters among adolescents, typically including a group with no or low pain and at least one group with a high probability of pain in one or several body sites (Adamson et al., 2007; Auvinen et al., 2009; Dunn et al., 2011). Yet, evidence on patterns of pain among young adult cannabis users or even young adults in the general population is limited. Of particular interest is also the association of pain with specific cannabis use practices. Some evidence suggests that young adults with chronic pain are more likely than their peers without chronic pain to use oral cannabis products (edibles or drinks), more

methods of cannabis administration, and higher quantity of cannabis per episode (Fales et al., 2019).

Knowledge is also limited concerning the comorbidity of pain with mental health (i.e. anxiety and depression) and sleep problems among young adult cannabis users. These three conditions - anxiety, depression and insomnia – are also common reasons for medical cannabis use among young adults (Lankenau et al., 2018), as well as measures of quality of life related to pain (Boehnke et al., 2020; Niv & Kreitler, 2001). While high-quality evidence on cannabis use for chronic pain is still limited (Häuser et al., 2018; Mücke et al., 2018; Stockings et al., 2018), evidence on its anxiolytic and sedative effects is only beginning to emerge (Kamal et al., 2018; Turna et al., 2017). Some studies found that adolescent cannabis use may actually increase the risk of mental health disorders in young adults (Hayatbakhsh et al., 2007; Patton et al., 2002). Those reports, however, did not examine whether incident mental health disorders among young adult cannabis users could be related to the presence of lifetime pain conditions, including pediatric chronic pain. This is important in light of an association of adolescent chronic pain with depression and anxiety during adulthood (Noel et al., 2016), as well as documented comorbidity of chronic pain with mental health conditions in the general population (Hooten, 2016). Additionally, while sleep disturbances were found to be associated with chronic and musculoskeletal pain among young adults in the general population (Bonvanie et al., 2016), little evidence exists on how sleep problems relate to pain among cannabis-using young adults.

Sociodemographic characteristics, including gender and racial/ethnic minority status, can also contribute to pain experiences among young adult cannabis users. In the general population (Dahlhamer et al., 2018) and among cannabis users (Fales et al., 2019), young adult females report higher levels of pain than their male counterparts. Also, while non-Hispanic Whites report higher level of chronic pain than other subgroups in the U.S. (Zelaya et al., 2020), studies show considerable racial and ethnic disparities in access to optimal pain care (Anderson et al., 2009; Campbell & Edwards, 2012; Hollingshead et al., 2016). Particularly, Hispanics/Latinos, the U.S. largest ethnic minority group (U.S. Census Bureau, 2018), have the highest uninsured rates relative to the other subgroups (U.S. Department of Health and Human Services, Office of Minority Health, 2019). Still, reports investigating the effect of gender or racial/ethnic minority status on pain experiences of young adult cannabis users are rare.

The present study pursued three interrelated goals. First, we intended to fill a gap in knowledge about patterns of pain among young adult cannabis users by exploring and identifying distinct pain profiles. Second, we sought to characterize individuals within different pain classes, e.g. medical cannabis patient status, lifetime mental health and sleep problems, and sociodemographic characteristics. Third, we investigated whether membership in pain classes is related to recent mental health, cannabis use practices, and motivations for medical cannabis use.

Methods

Recruitment and data collection

Data for this analysis comes from the Cannabis, Health, & Young Adults (CHAYA) Project (https://www.chayala.org/) – a prospective cohort study examining medical and non-medical cannabis use among young adults in Los Angeles. This analysis utilized cross-sectional baseline data collected in 2014–2015. Eligibility criteria included age between 18 and 26 years, living in Los Angeles metropolitan area, using cannabis at least four times in the past 30 days, and the ability to read and speak English. By utilizing targeted and chain referral sampling techniques, 710 individuals were approached and screened, 436 met eligibility criteria, and 366 were enrolled at baseline. The participants were either 1) current medical cannabis patients or 2) non-patient users who had never been issued a recommendation for medical use. Detailed information on recruitment procedures and sample characteristics can be found in other study publications (Lankenau et al., 2017; 2018).

A data collection instrument was developed in Research Electronic Data Capture (REDCap) platform. Data were collected through structured interviews administered in private and semi-private locations by project interviewers experienced in recruiting participants from community settings. All participants received a $25 incentive and provided voluntary consent to participate in the study. The research was approved by the Institutional Review Boards at Children's Hospital Los Angeles and Drexel University.

Measures

Pain variables used to form latent classes—Six dichotomous indicators of chronic pain, including lifetime pain conditions and current/recent pain, were used for latent class analysis. Lifetime history of pain conditions was assessed with questions adapted from previous research on medical cannabis patients (Gieringer, 2002; Nunberg et al., 2011) and based upon codes in the International Classifications of Diseases (ICD-9). The participants were initially asked, *Have you ever experienced any physical or psychological problems in the following areas?* Participants could endorse several broad categories, three of which were related to various dimensions of pain, such as "Chronic pain or discomfort," "Neurological problems," and "Spinal and musculoskeletal problems." Follow-up questions asked about the presence of specific pain conditions, for which separate dummy yes/no variables were created. The most prevalent lifetime pain conditions included nonspecific chronic pain (originally labeled as "other pain" response under the "Chronic pain or discomfort" category), migraine/headaches (a response choice under the "Neurological problems" category), lower back pain, and injury (response choices under the "Spinal and musculoskeletal problems" category).

In addition to the four lifetime pain conditions, two indicators were used to determine the presence of current and recent chronic pain. Current non-minor pain was measured with a question adapted from the Brief Pain Inventory (Short Form) (Cleeland, 2009): *Throughout our lives, most of us have had pain from time to time (such as minor headaches, sprains and toothaches). Have you had pain other than these everyday kinds of pain today?* Recent chronic pain was measured with the following question: *Besides minor pain, have you had*

any pains over the last 3 months that occur repeatedly, such as migraine pain, or recurrent pain from an old injury?

Antecedents/covariates—Six dichotomous variables, including demographic characteristics, medical cannabis patient status, and lifetime anxiety, depression, and insomnia, were used as antecedents or covariates of latent classes based on the conceptual relevance. Demographic covariates included sex assigned at birth (female/male) and Hispanic/Latino ethnicity. Medical cannabis patient status was assigned to participants who presented a valid medical cannabis recommendation issued by a California-based physician. Participants designated as non-patients had never been issued a medical cannabis recommendation by a physician. Lifetime anxiety, depression, and insomnia were assessed, first, by the initial endorsement of "Sleep, mood, or other psychological problems" broad category in response to the question, *Have you ever experienced any physical or psychological problems in the following areas?*, and then, by specifically endorsing these conditions in response to the follow-up question, *What kind of mood or other psychological conditions have you experienced?*

Outcomes—Distal outcomes involved a combination of continuous and dichotomous variables, representing current mental health, recent cannabis use practices and motivations, and self-reported medical cannabis use.

Current mental health.: The Brief Symptom Inventory-18 (BSI-18) (Derogatis, 2001) was used to assess past 7-day psychological distress. The measure uses a 5-point Likert scale with responses ranging from "not at all" (0) to "extremely" (4), and consists of three subscales, including anxiety, depression, somatization, with 6 items and scores ranging 0–24 each. Additionally, the BSI-Global Severity Index measures overall distress and is calculated as a composite score of the three subscales ranging 0–72. Higher scores represent higher levels of psychological distress.

Cannabis use practices.: Questions asked about past 90-day frequency of cannabis use, the typical number of daily hits (pull of a pipe, joint, bong, etc.), and the use of different cannabis forms, including edibles and concentrates.

Cannabis use motivations.: Motivations for cannabis use were assessed by asking participants to indicate different reasons for cannabis use in the past 90 days, which were categorized into "medical" and "non-medical" motivations, in accordance to a prior publication from the study (Lankenau et al., 2018). Seven medical motivations included: "to relieve feeling uptight or anxious," "to cope with feeling depressed," "to help sleep," "to relieve physical pain," "as a substitute for alcohol," "to help relax or feel more confident," and "to help me focus." Five non-medical motivations included: "to have fun," "to experiment," "to celebrate," "to help think differently," and "to relieve boredom."

Self-reported medical use.: This construct was measured with a question asking about the degree of recreational or medical cannabis use over the past 90 days; the latter was defined as "to treat or help cope with any physical ailments, such as pain or discomfort, or psychological conditions, such as feeling anxious or sad, insomnia, etc." The instrument

used an ordinal 5-item scale ranging from “exclusively medical (no recreational uses)” to “exclusively recreational (no medical uses).” For the purposes of this analysis, we collapsed response options into two categories: “self-reported medical use” (“exclusively medical” or “primarily medical”) and “other use” (from “equally medical and recreational” to “primarily recreational” and then “exclusively recreational”).

Additional details of study questions related to health conditions and cannabis use motivations (Lankenau et al., 2018), as well as cannabis use practices (Lankenau et al., 2017) are available in prior study publications.

Analysis

To determine pain profiles of young adult cannabis users, we conducted a latent class analysis (LCA), a person-centered statistical approach, which identifies unobserved distinct groups based on item response patterns (Lanza & Cooper, 2016). The analysis was completed in MPlus 8.2 (Muthén & Muthén, 1998–2018).

First, we determined latent class enumeration. We ran a series of LCA models with the six pain indicators, increasing the number of classes with each subsequent model. We compared the models by commonly used fit indices, including the Akaike Information Criterion (AIC), the Bayesian information Criterion (BIC), and the sample-adjusted BIC (SABIC), where lower values indicate a better balance between model fit and parsimony (Roesch et al., 2010). We also used a measure of entropy that indicates how well classes are separated from each other, with values ranging from 0 to 1.0 and higher values indicating a better separation. To obtain statistical tests comparing models with one class difference, we used the Lo–Mendell–Rubin adjusted likelihood ratio test (LMRT) and bootstrapped likelihood ratio test (BLRT). In addition to fit criteria and likelihood ratio tests, we also considered interpretability of the most optimal solution (Muthén, 2003).

Second, we estimated associations between latent classes and six auxiliary observed covariates, i.e. potential antecedents of latent class membership. Testing of covariates was done using the auxiliary R3step approach – a recommended method for LCA with covariates in MPlus (Asparouhov & Muthén, 2014a, 2014b; Vermunt, 2010). We estimated the unadjusted effects of each covariate by including them in a multinomial logistic regression model with latent classes as a dependent variable and then analyzed the cumulative effect of covariates on latent classes by including all of them in the model.

Finally, to determine the effect of latent classes on distal or observed outcomes (Lanza et al., 2013) while accounting for covariates, we used the manual 3-step BCH approach (Asparouhov & Muthén, 2014b), a modified version of a method originally developed by Bolck et al. (2004). This method obtains latent class enumeration without the effect of other auxiliary variables, i.e. covariates or distal outcomes, while also computing and saving class-specific weights for each case as a variable. In the next step, the latent class variable is used to estimate a regression model with covariates and distal outcomes. This method is preferred to other stepwise approaches, such as the classify-analyze approach or pseudo-class draw approach (Nylund-Gibson et al., 2019). The overall difference in the estimates of the distribution of distal outcomes across classes accounting for covariates was assessed with a

Wald chi-square test, utilizing the Model Test command in MPlus. Pairwise class-comparisons of intercepts of distal outcomes were estimated with Z-test using the Model Constraint command.

Figure 1 shows the analytical model used to assess latent classes and the relationship between latent classes, covariates, and distal outcomes.

Results

Latent class enumeration

We estimated four latent class models, from two- to five-class solutions; the goodness of fit statistics for those models are shown in Table 1. The entropy measure was moderate (0.611 and 0.652) for 2- and 3-class solutions and high (0.822 and 0.797) for 4- and 5-class solutions; still, according to simulation studies, the entropy level of 0.6 and above provides good separation of latent classes (Asparouhov & Muthén, 2014a). The AIC and sample-adjusted BIC were decreasing from the 2-class through the 4-class solution, while the BIC was gradually increasing from 2- to 5-class solution. The examination of LMRT and BLRT pointed toward a 3-class model, which was also the most interpretable among the four tested models.

Characteristics of latent classes

Table 2 presents estimated class membership along with the prevalence and probabilities of the pain indicators across three latent classes. In the total sample, nonspecific chronic pain (49.5%) was the most prevalent lifetime pain condition, followed by lower back pain (22.4%), headaches/migraines (18.3%), and injury (11.2%). More than a third of participants (35.0%) reported non-minor pain “today” and 32.2% experienced recurrent pain in the past 3 months.

Class 1, *Low pain*, was the largest (56.3% of the sample) and had a low probability (<.5) of endorsing any pain indicator. Class 2, labeled as *Multiple pain*, had 27.3% prevalence. Among the three classes, this group was characterized by the highest probability of reporting a history of lower back pain, injury, and headaches/migraines, as well as past 3-month recurrent pain. Additionally, participants in this class had a high probability of experiencing current non-minor pain. Of the three classes, Class 3, *Nonspecific pain*, was the smallest (16.4%). Individuals assigned to this class had a 100% likelihood of ever experiencing nonspecific chronic pain and the highest probability of having current non-minor pain compared to other two classes. Like Class 2, participants in this class were also likely to experience recurrent pain in the past three months.

Antecedents/covariates of latent classes

As shown in Table 3, in the adjusted model, participants with lifetime insomnia (adjusted odds ratio (AOR) = 2.62, 95% CI 1.22–5.65), medical cannabis patient status (AOR = 2.88, 95% CI 1.34–6.20), and Hispanic/Latino ethnicity (AOR = 2.39, 95% CI 1.13–5.06) had higher odds of membership in the *Multiple pain* class compared to the *Low pain* class. Lifetime insomnia predicted membership in the *Nonspecific pain* versus the *Low pain* class

(AOR = 3.32, 95% CI 1.05–10.46). Hispanic/Latino participants (AOR = 6.38, 95% CI 1.11–36.73) and medical cannabis patients (AOR = 5.00, 95% CI 1.37–18.19) had higher odds of belonging to the *Multiple pain* compared to the *Nonspecific pain* class. The effect of sex at birth on latent class membership was not significant.

Distal outcomes of latent classes

Table 4 reports the associations of latent classes with recent mental health conditions, cannabis use practices, and motivations for medical cannabis use, taking into account all six covariates. Adjusted associations between latent class membership and non-medical cannabis use motivations are shown in Supplemental Table 1.

Participants in the *Multiple pain* class had a significantly higher mean on BSI-anxiety than *Low pain* or *Nonspecific pain* classes (overall $\chi^2 p = .027$) and a higher mean on BSI-somatization than the *Low pain* class (overall $\chi^2 p = .014$).

Young adults in the *Multiple pain* and *Nonspecific pain* classes were more likely than *Low pain* class participants to use cannabis to relieve physical pain (overall $\chi^2 p = .0001$). Compared to *Low pain* and *Nonspecific pain* groups, participants in the *Multiple pain* class had a higher likelihood of self-reported medical cannabis use in the past 90 days (overall $\chi^2 p = .0001$). *Multiple pain* class participants were also more likely to report using cannabis to help sleep compared to *Nonspecific pain* class (overall $\chi^2 p = .026$). Additionally, compared to the *Low pain* class, participants in the *Multiple pain* class were more likely to use the edible form of cannabis (overall $\chi^2 p = .046$). A pairwise comparison ($p = .021$) indicated higher frequency of daily cannabis hits for the *Multiple pain* class compared to the *Low pain* class, though the overall test of parameter differences was not significant ($\chi^2 p = .063$). Neither days of cannabis use nor use of cannabis concentrates were associated with any of the pain classes.

Additionally, all covariates were significantly associated with one or more distal outcomes (Supplemental Table 2). Particularly, lifetime depression was positively associated with all three BSI subscales, BSI-Global Index, and a motivation of using cannabis to cope with feeling depressed. Lifetime anxiety correlated with BSI-anxiety, BSI-Global Index, and using cannabis to relieve feeling uptight or anxious. Lifetime insomnia was positively associated with using cannabis to help sleep, while Hispanic/Latino ethnicity had reverse correlation with this motivation. Female sex at birth was positively associated with BSI-somatization and negatively associated with cannabis concentrate use. Finally, medical cannabis patient status correlated with the number of cannabis use days, use of concentrates, and using cannabis to help focus.

Discussion

This is the first study that identified subgroups of young adult cannabis users with similar pain profiles. Slightly over half of participants fell into the *Low pain* class; the rest, however, clustered around profiles characterized by lifetime history of chronic pain conditions and the presence of current and recurrent pain. Hispanic/Latino ethnicity, medical cannabis patient status, and lifetime insomnia predicted membership in one or both higher pain profiles, i.e.

Multiple pain and *Nonspecific pain* relative to *Low pain*. After taking those factors into consideration, the *Multiple pain* class was more likely than the *Low Pain* class to be associated with recent psychological distress and medically-oriented motives, e.g. relieve pain, help sleep, and cannabis use practices. Overall, the results suggest that young adult cannabis users have varying pain experiences and those in the higher pain profiles appear to be more likely to use cannabis for medical purposes, and more susceptible to poorer mental health compared to those with low pain.

The major finding of this study – the unobserved pain classes among young adult cannabis users – is notable because to date, literature primarily examined individual pain conditions in this population (Fales et al., 2019; Lankenau et al., 2018). This study highlighted the covariation of pain conditions in a subset of young adult cannabis users whose lifetime lower back pain co-occurred with history of headaches/migraines and injury, and with current and recurrent non-minor pain. Interestingly, the comorbidity of lower back pain with headaches was also reported by studies examining non-cannabis using populations, including a recent systematic review among adult and pediatric populations (Vivekanantham et al., 2019), and a study of youth of 12–22 years of age (Hestbaek et al., 2006).

Our study found that medical cannabis patient status, Hispanic/Latino ethnicity, and lifetime insomnia significantly distinguished the latent pain classes. The association of medical cannabis patient status with a higher pain class, such as the *Multiple pain* class, was not surprising given that similar to national registry statistics (Boehnke et al., 2019), chronic pain is a common qualifier for a medical cannabis recommendation in California (California Department of Justice, 2019). This finding also aligns with previous studies showing that among medical cannabis patients, pain is a common reason for cannabis use (Kosiba et al., 2019; Lankenau et al., 2018; Lucas & Walsh, 2017; Walsh et al., 2013). Hispanic/Latino ethnicity was another antecedent of the *Multiple pain* class, which is a novel finding. Prior research among young adults, though not specifically focused on cannabis users or chronic pain, did not identify differences in the overall frequency or intensity of past 6-month pain between Hispanics/Latinos and non-Hispanic Whites or African Americans (Hastie et al., 2005). Young adults of Hispanic/Latino origin, however, have been found to have lower rates of medical insurance relative to non-Hispanic Whites (Callahan et al., 2006; Hastie et al., 2005). Future studies should elucidate possible reasons for ethnic differences in pain among young adult cannabis users, particularly with regard to unrelieved pain due to poor healthcare access or utilization.

Young adults with lifetime insomnia were more likely to belong to the *Multiple pain* and *Nonspecific pain* classes than *Low pain* class. This finding is supported by previous research suggesting that problematic sleep is a risk factor for chronic pain among adolescents (Harrison et al., 2014) and young adults (Bonvanie et al., 2016). Moreover, among three psychological conditions – insomnia, anxiety, and depression - only insomnia was significantly associated with two higher-pain classes in adjusted models. These results suggest the importance of insomnia relative to anxiety or depression in this sample of young adults. Indeed, prospective studies have shown that insomnia increases the risk of depression among young adults (Buysse et al., 2008) and in the general population (Baglioni et al.,

2011), as well as the risk of both depression and anxiety among adults (Neckelmann et al., 2007; Thun et al., 2019).

Surprisingly, males and females were equally likely to be in all three pain classes, which is in contrast with recent research. Particularly, among young adult cannabis users, females were found to report significantly higher level of chronic pain than males (Fales et al., 2019). Since we controlled for the effects of not only gender, but also other pain antecedents, it is possible that among young adult cannabis users, differences in pain are less attributable to gender compared to other factors, such as mental health and ethnicity.

In regard to class differences on outcomes, the *Multiple pain* and *Nonspecific pain* classes were more different from each other than they were similar. The only similarity between these groups was that they were more likely than the *Low pain* class to use cannabis to relieve pain in the past 90 days. Apart from that, the *Multiple pain* class emerged as an especially adverse pain profile. Compared to the other two classes or one of them, individuals in *Multiple pain* group had a higher likelihood of recent psychological distress, including anxiety and somatization, as well as self-reported medical cannabis use, and using cannabis to help sleep. Notably, the associations of lower back pain, one of the key indicators of the *Multiple pain* class, with psychological distress, including anxiety and somatization (Bener et al., 2013), as well as sleep disturbance (Kelly et al., 2011) were reported by prior general population studies.

Additionally, compared to the *Low pain* class, the *Multiple pain* class had a higher likelihood of using edibles – a finding also documented in previous research among young adult cannabis users (Fales et al., 2019). To a certain extent, the use of edibles can be considered a medically-oriented practice. Compared to smoked cannabis, oral administration of cannabis produces a longer analgesic effect established in a clinical study (Cooper et al., 2013) and confirmed by users' subjective experiences (Giombi et al., 2018). Notably, use of cannabis concentrates was not significantly associated with any pain profile. However, the highest proportion of concentrate users (and edible users) was found in the *Multiple pain* class, which may also suggest the use of high potency cannabis products to alleviate pain.

Interestingly, while frequency of cannabis use, measured as the number of days in the past 90 days, was not significantly different among the pain groups, the intensity of daily cannabis consumption was higher for the *Multiple pain* class compared to the *Low pain* class. Similar findings were reported by recent research on pain among cannabis users. In particular, Fales et al. (2019) found no significant differences in the days of cannabis use per week between young adult cannabis users with and without chronic pain, but participants with chronic pain used more cannabis per each use. Likewise, a study by Cooke, Chavez, and Freisthler (2020) among medical cannabis patients in Los Angeles reported no association between the level of pain and daily cannabis use in the past 28 days, yet, patients with the high and moderate levels of pain were more likely to use cannabis more than three times per day than those in the low pain category.

As our research represents the first attempt to characterize latent pain classes within a population of young adults who use cannabis, the pain classification reported in this study

should be treated as preliminary. Still, by shifting the focus from individual pain histories to key patterns of pain among young adult cannabis users, our results may have implications for clinical practice and future research. Clinicians should be aware of a potential cluster of cannabis-using youth with chronic pain who may benefit from identification and interventions offering interdisciplinary pain care to assure quality of life. Given the cross-sectional association between insomnia and higher pain profiles, prospective studies are warranted to determine the directionality of such a relationship and the impact of cannabis use on both insomnia and chronic pain. Importantly, given the potential benefits of sleep interventions in chronic pain patients with comorbid insomnia (Tang et al., 2015), clinicians should consider the utility of treatments for insomnia to improve pain outcomes among young adult cannabis users. Our findings also suggest that certain cannabis use practices, such as using edibles, and medical motivations for cannabis use, such as coping with depression and relieving pain or insomnia, may be indicative of unaddressed pain in this group. Moreover, as some chronic pain can be particularly impactful (Zelaya et al., 2020), leading to pain-associated functional disability (Bursch et al., 1998), future research needs to improve our understanding of functional outcomes among young adult cannabis users with chronic pain, especially in such developmentally relevant areas as education and employment, independence from family, and peer and romantic relationships (Rosenbloom et al., 2017).

Our study also raises a question of how the legalization of cannabis for adult use in California in 2016, which followed data collection for this report, would have affected our results. Early evidence indicates that recreational cannabis laws may increase, to some degree, cannabis use among young adults (Melchior et al., 2019), particularly those over 21 years of age (Parnes et al., 2018). Then, it would be plausible to expect an increase in incident cannabis use among youth over 21 years old with chronic pain conditions, especially given a positive association of younger age with substituting cannabis for prescription medications among adults (Lucas et al., 2016). Also, medical cannabis patient status may be less relevant to pain classes since fewer young adults over 21-year-old may choose to remain patients in a fully legal environment. Future prospective research needs to examine how legalization of adult-use cannabis affects cannabis initiation, motivations, consumption practices, and medical use among young adults with history of chronic pain.

Several limitations of this study should be noted. Since the study used cross-sectional data, results are not indicative of a causal link between different pain classes and associated mental health and cannabis use characteristics. Also, all data, except medical cannabis patient status, are self-reports. Additionally, as the study was not originally designed to assess different pain profiles, the pain indicators were chosen from somewhat heterogeneous categories, such as history of various pain conditions and recency of non-minor pain. Other studies of pain-focused latent classes tend to use more homogeneous indicators, including either pain sites (Dunn et al., 2011) or various dimensions of pain (de Luca et al., 2017). Still, the heterogeneity of pain indicators used in this study may contribute to deriving “typical pain profiles,” which offer “a more realistic approach” (Adamson et al., 2007) in understanding variability of pain among young adult cannabis users. Additionally, although significant relationships were found with respect to ethnicity, only participants who could read or speak English were included, which may not reflect the greater Hispanic/Latino

community. Finally, as California has the longest history of medical cannabis in the U.S., results may not extrapolate to other settings. Still, the total proportion of young adult cannabis users under two higher pain classes in our study (44%) was almost identical to the proportion of young adult cannabis users with chronic pain reported by another study conducted in metropolitan areas of different states (Oregon and Washington) (Fales et al., 2019).

In conclusion, this study discerned three distinct pain profiles in a sample of young adult cannabis users. Two profiles - *Multiple pain* and *Nonspecific pain* - were characterized by the presence of current and recurrent non-minor pain and history of pain conditions. Both higher pain classes included a higher proportion of youth with lifetime insomnia, and *Multiple pain* class was also marked by a higher proportion of Hispanics/Latinos and medical cannabis patients. Moreover, membership in the *Multiple pain class* was associated with recent psychological distress and medically-oriented cannabis use motives and practices. Additional research is needed to examine the consistency of these empirically derived profiles in other cannabis using populations and whether they predict changes in cannabis use practices and health outcomes over time as cannabis laws continue to evolve toward legalization for adult use.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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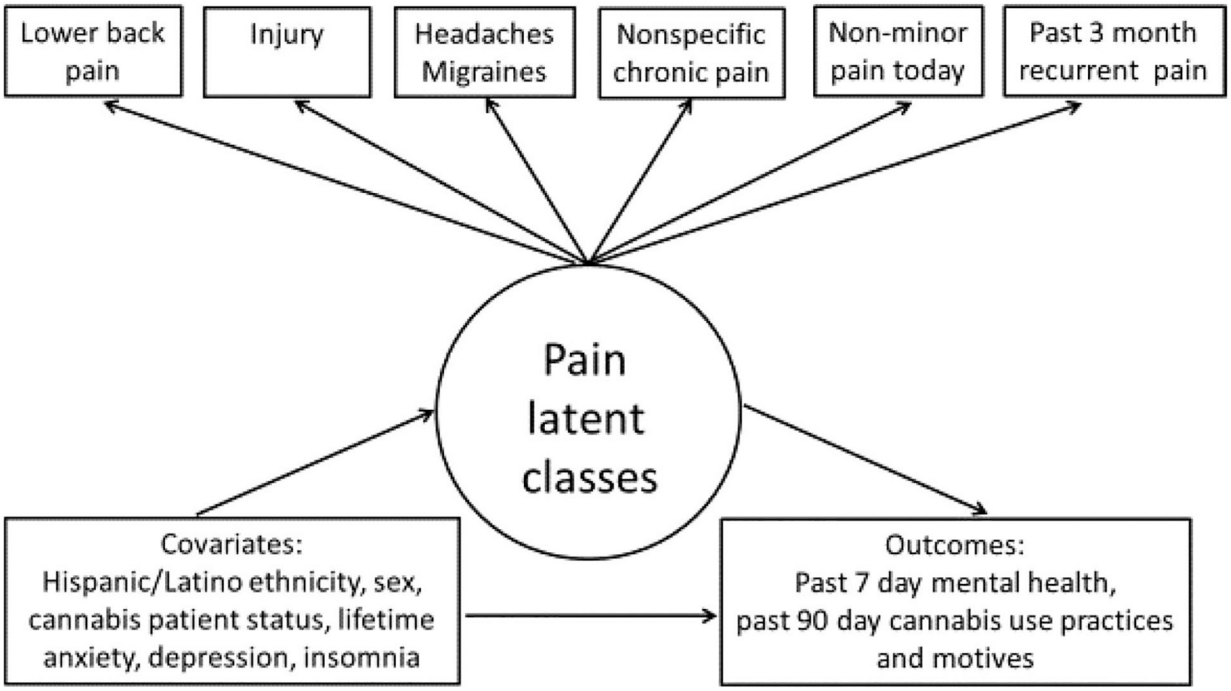

Figure 1.
Analytical model depicting the associations between latent classes, covariates and distal outcomes.

Table 1.

Measures of model fit from two through five latent classes.

Number of latent classes	AIC	BIC	SABIC	Entropy	LMRT p-value	BLRT p-value
Two classes	2345.333	**2396.067**	2354.823	0.611	1 vs. 2 classes **0.0003**	1 vs. 2 classes 0.0000
Three classes	2330.815	2408.867	2345.415	0.652	2 vs. 3 classes 0.0349	2 vs. 3 classes **0.0000**
Four classes	**2323.532**	2428.903	**2343.243**	**0.822**	3 vs. 4 classes 0.6174	3 vs. 4 classes 0.0128
Five classes	2328.597	2461.287	2353.418	0.797	4 vs. 5 classes 0.4045	4 vs. 5 classes 1.0000

Note. Bolded values indicate the best fit for each statistic.

AIC = Akaike information criterion; BIC = Bayesian information criterion; SABIC = Sample-adjusted BIC; LMRT = Lo–Mendell–Rubin adjusted likelihood ratio test; BLRT = Bootstrap likelihood ratio test.

Table 2.

Prevalence and estimated probability of pain indicators by latent class ($N = 366$).

		Endorsement probability by latent class		
Pain indicators	**Total sample % (n)**	**Low pain 56.3%**	**Multiple pain 27.3%**	**Nonspecific pain 16.4%**
History of nonspecific chronic pain	49.5 (181)	0.445	0.345	**1.000**
History of lower back pain	22.4 (82)	0.098	**0.541**	0.000
History of injury	11.2 (41)	0.083	0.209	0.008
History of headaches/migraines	18.3 (67)	0.069	0.423	0.082
Current non-minor pain[a]	35.0 (128)	0.078	**0.644**	**0.726**
Recurrent pain in the past 3 months[b]	32.2 (118)	0.062	**0.687**	**0.525**

Note. Bolded are endorsement probabilities greater than 0.5; underlined are the highest endorsement probabilities for each indicator across latent classes.

[a] n = 363.

[b] n = 362.

Table 3.

Comparison of latent pain classes by participant characteristics (N = 366).

		Multiple pain vs. Low pain		Nonspecific pain vs. Low pain		Multiple pain vs. Nonspecific pain	
Characteristic	**Total sample % (*n*)**	**UOR [95% CI]**	**AOR [95%CI]**	**UOR [95%CI]**	**AOR [95%CI]**	**UOR [95%CI]**	**AOR [95%CI]**
Lifetime anxiety	50.5 (185)	2.68 [1.44, 4.98]**	1.36 [.61, 3.02]	3.52 [1.39, 8.92]**	2.30 [.79, 6.67]	.76 [.28, 2.08]	.59 [.19, 1.82]
Lifetime depression	44.5 (163)	2.60 [1.40, 4.83]**	1.83 [.85, 3.94]	2.02 [.86, 4.74]	.94 [.30, 2.92]	1.29 [.51, 3.21]	1.95 [.59, 6.42]
Lifetime insomnia	62.8 (208)	4.28 [2.08, 8.81]***	2.62 [1.22, 5.65]*	3.07 [1.16, 8.11]*	3.32 [1.05, 10.46]*	1.40 [.45, 4.30]	.79 [.21, 3.05]
Medical cannabis patient	57.4 (210)	3.69 [1.85, 7.37]***	2.88 [1.34, 6.20]**	1.10 [.47, 2.54]	.58 [.19, 1.77]	3.37 [1.27, 8.95]*	5.00 [1.37, 18.19]*
Hispanic/Latino ethnicity	45.1 (165)	1.86 [1.01, 3.41]*	2.39 [1.13, 5.06]*	.43 [.15, 1.20]	.38 [.08, 1.77]	4.37 [1.46, 13.12]**	6.38 [1.11, 36.73]*
Female sex at birth	33.9 (124)	1.15 [.61, 2.16]	1.34 [.63, 2.85]	1.30 [.55, 3.09]	.99 [.39, 2.56]	.89 [.35, 2.26]	1.35 [.46, 3.97]

* $p < 0.05$.

** $p < 0.01$.

*** $p < 0.001$.

UOR = Unadjusted Odds Ratio, AOR = Adjusted Odds Ratio, CI = Confidence Interval.

Note. In adjusted models, all characteristics (covariates) were entered simultaneously.

Table 4.

Adjusted associations of latent classes with distal outcomes (N = 366).

Distal outcomes	Total sample	Class-specific distribution of distal outcomes			Pairwise comparisons of parameter estimates			
		Low pain	Multiple pain	Nonspecific pain	Multiple pain vs. Low pain	Nonspecific pain vs. Low pair	Multiple pain vs. Nonspecific pain	Overall comparison
Continuous outcomes	**Mean (SE)**		**Mean (SE)**			**p-value**		
BSI-anxiety[a]	3.28 (0.20)	2.52 (0.29)	4.70 (0.48)	2.92 (0.55)	**.013**	.639	**.017**	**.027**
BSI-depression[a]	3.96 (0.24)	3.81 (0.37)	4.24 (0.51)	3.93 (0.79)	.467	.496	.922	.663
BSI-somatization[a]	2.70 (0.17)	1.83 (0.24)	4.19 (0.43)	2.63 (0.46)	**.004**	.434	.067	**.014**
BSI-Global Severity lndex[a]	9.94 (0.52)	8.16 (0.75)	13.14 (1.22)	9.47 (1.49)	.088	.768	.114	.187
Days of cannabis use	69.05 (1.39)	64.68 (2.25)	76.09 (2.59)	69.87 (4.68)	.111	.320	.884	.248
Hits per day[b,c]	23.38 (1.40)	20.00 (2.02)	31.17 (3.57)	19.22 (4.54)	**.021**	.954	.083	.063
Categorical outcomes	**% (n)**		**β (SE)**			**p-value**		
Self-reported medical cannabis use	24.3 (89)	−2.25 (0.43)	−0.18 (0.59)	−1.55 (0.58)	**.000**	.288	**.036**	**.0001**
Use of edible forms of cannabis	59.0 (216)	−0.56 (0.27)	0.41 (0.49)	−0.31 (0.47)	**.013**	.577	.190	**.046**
Use of cannabis concentrates	58.7 (215)	−0.10 (.26)	0.46 (0.47)	−0.09 (0.47)	.145	.983	.313	.331
Motives for medical cannabis use To relieve feeling uptight or anxious	62.8 (230)	−0.11 (0.28)	0.28 (0.51)	−0.69 (0.50)	.348	.250	.099	.256
To cope with feeling depressed	41.3 (151)	−1.61 (.32)	−1.22 (.53)	−2.49 (0.68)	.326	.148	**.038**	.112
To help sleep	78.4 (287)	0.74 (0.31)	1.78 (0.61)	−0.04 (0.51)	.056	.133	**.007**	**.026**
To relieve physical pain	63.9 (234)	−0.65 (0.28)	2.36 (0.84)	0.54 (0.52)	**.000**	**.024**	**.040**	**.0001**
As a substitute for alcohol	38.0 (139)	−0.57 (0.27)	−0.52 (0.47)	−1.66 (0.59)	.904	.059	.065	.146
To help relax or feel more confident	83.6 (306)	1.17 (0.37)	1.53 (0.66)	0.19 (0.51)	.500	.064	.051	.109
To help me focus	57.7 (211)	−0.06 (0.25)	0.30 (0.45)	−0.28 (0.45)	.336	.622	.253	.472

Note. Bolded indicates statistical significance at α < .05. All models account for lifetime health conditions (depression, anxiety, and insomnia), medical cannabis patient status, Hispanic/Latino ethnicity, and sex at birth.

β = parameter estimate (logit), SE = standard error.

[a] n = 364.

[b] n = 362.

[c] 20 participants who reported consuming more than 100 hits per day were coded with “101” value.