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Monitoring adherence and abstinence of cannabis use disorder patients: Profile identification and relationship with long-term treatment outcomes

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ABSTRACT

Background: Patients with cannabis use disorder (CUD) show heterogeneous sociodemographic and consumption patterns. Although previous studies, focused on identifying subgroups of CUD patients using input variables, have yielded useful results for planning individualized treatments, no published research has analyzed the profiles of CUD patients according to their therapeutic progress. This study therefore aims to identify subgroups of patients using adherence and abstinence indicators and to explore whether these profiles are associated with sociodemographic characteristics, consumption variables, and long-term therapeutic outcomes.
Methods: This was a retrospective observational study with a multisite sample of 2055 CUD outpatients who were beginning treatment. The study monitored patient data at two-year follow-up. We conducted latent profiles analysis on the appointment attendance ratio and percentage of negative cannabis tests.
Results: A three profile solution emerged: i) moderate abstinence/moderate adherence (n = 997); ii) high abstinence/moderate adherence (n = 613); and iii) high abstinence/high adherence (n = 445). The study found the most marked differences at the beginning of treatment for education level (chi^2 (8) = 121.70, $p < .001$), source of referral (chi^2 (12) = 203.55, $p < .001$), and frequency of cannabis use (chi^2 (10) = 232.39, $p < .001$). Eighty percent of patients from the "high abstinence/high adherence" group were relapse-free at two year follow-up. This percentage decreased to 24.3 % in the "moderate abstinence/moderate adherence" group.
Conclusions: Research has shown adherence and abstinence indicators to be useful for identifying subgroups of patients with different prognoses regarding long-term success. Recognizing the sociodemographic and consumption variables associated with these profiles at the beginning of treatment could help to inform the design of more individualized interventions.

1. Introduction

Cannabis is, after alcohol, the most widely consumed substance worldwide (SAMHSA, 2020; UNODC, 2019). The use of this substance has a high public health impact (Gutkind et al., 2021), and has been associated with the development of cannabis use disorder (CUD) and the emergence of comorbid mental disorders (Connor et al., 2021; Lowe et al., 2019). In terms of care, Europe saw approximately 111,000 treatment demands for this substance during 2019, which is a 45 % increase in the number reported in 2009 (EMCDDA, 2021). In the United States, the number of cannabis users in treatment remained relatively stable between 2015 and 2019, with only alcohol and opiates generating more treatment demands (SAMHSA, 2021).

Patients diagnosed with substance use disorders (SUD) in general, and cannabis use disorder (CUD) in particular, present heterogeneous sociodemographic profiles and consumption patterns (SAMHSA, 2021, EMCDDA, 2021). Therefore, the specialized literature commonly contains studies that identify subgroups of patients with similar characteristics (Fernández-Calderón et al., 2015; Martínez-Loredo et al., 2021; Moraleda et al., 2019; Witkiewitz et al., 2019). This information can be useful for developing more individualized treatments and increasing the efficacy of clinical approaches. However, to our knowledge, only three studies have identified subgroups of CUD patients in specialized addiction centers. First, Connor et al. (2013) applied latent class analysis

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using multi-drug use at the beginning of treatment as an indicator and identified three patient profiles in a sample of 828 cannabis users referred for treatment. Their results revealed that the profile most associated with multiple substance use was also characterized by the greater presence of other mental disorder symptoms (depression, anxiety, or psychotic symptoms). Second, a study by Ullrich et al. (2021) accessed a sample of 302 patients diagnosed with CUD. They applied latent class analysis using the preferred methods of combustible cannabis use as indicators. Their results revealed that the patient profiles characterized by primarily joint and blunt use showed more problems in maintaining abstinence. Third, Fleury et al. (2022) applied latent class analysis to determine the profiles of 9836 patients in specialized addiction centers. These authors used sociodemographic indicators obtained at the beginning of treatment and identified six patient profiles that predicted various health indicators such as hospitalizations and suicides.

Previous studies, particularly that of Ulrich et al. (2021), have shown that patients' characteristics at baseline are significant factors in CUD treatment outcomes. Identifying these characteristics allows for tailoring treatment to the patients' context, increasing the likelihood of better therapeutic outcomes. However, as shown in program evaluation models (Simpson et al., 1997; Sorensen & Llamas, 2018), these are not the only characteristics that affect treatment outcomes. During the therapeutic process, different variables interact with each other and can impact treatment success. Therefore, some authors have pointed out the usefulness of monitoring indicators associated with the therapeutic process, such as treatment adherence and abstinence (Goodman et al., 2013; Lee et al., 2019). Treatment adherence can be understood as attending therapeutic sessions and complying with the treatment guidelines; it is an indicator of how patients adapt and commit to their treatment. In addition, this indicator is one of the most widely tested predictors of treatment efficacy (WHO, 2003). Abstinence is usually monitored through self-reports or toxicological tests and can be understood as an indicator of the treatment's effectiveness (Brezing et al., 2018). Thus, these indicators play a complementary role when reporting patients' progress during their therapeutic process and all have been equally associated with treatment success/failure (Daigre et al., 2021; Hser et al., 2004). For this reason, identifying patient profiles based on various indicators of their progress can help to develop tailored intervention strategies and improve treatment effectiveness.

However, no studies have identified profiles of CUD patients based on different indicators of their therapeutic progress. Thus, the current study aimed to i) identify subgroups of patients diagnosed with CUD based on adherence and abstinence indicators; ii) analyze the baseline sociodemographic characteristics and consumption patterns associated with the various patient subgroups; and iii) examine the relationship between patients' subgroups and long-term therapeutic outcomes.

2. Methods

2.1. Design

This was a retrospective observational study.

2.2. Participants

The sample consisted of 2055 outpatients diagnosed with CUD who began treatment for the first time in one of the 121 public network for addiction care centers in Andalusia (Spain) between January 1, 2015 and December 31, 2016. The patients were followed up for two years from the start of treatment. Therefore, the time frame of the study covered the period up to December 31, 2018. The mean number of days of follow-up after treatment was 488.5 (SD = 153.3).

The public network for addiction care in Andalusia serves more than 95 % of patients with addiction problems in this region. During the therapeutic process, patients attend individual appointments and group treatment sessions. Patients attending these centers follow cognitive-behavioral therapy (Araque et al., 2005). In this regard, the "active ingredients" of treatment that keep patients engaged and have positive outcomes include training in coping skills, self-instruction, anxiety control, discrimination in high-risk situations, and self-control (Araque et al., 2005).

Patients initiating treatment for CUD may have a wide range of therapeutic goals, whether these are focused on reducing use, improving quality of life, or abstaining from cannabis use. In the case of the patients in this study, the therapeutic objectives focus on achieving abstinence from cannabis use. To this end, patients start treatment without a set duration. The treatment program is determined by the patient's progress and ends when abstinence is achieved. Therefore—and for the patients treated for CUD in this study—therapeutic success is considered to have been achieved when the patient abstains from use. However, patients may drop out of treatment without achieving the proposed therapeutic objective. In these cases, from a clinical perspective, patients are considered to have voluntarily withdrawn from treatment.

The sample of this study was 85.5 % male. The mean age at the time of admission to treatment was 24.5 years, although the study had high variability (SD = 8.30; range = 13 to 71 years). When dividing the sample according to age range, 16.6 % were between 13 and 17 years old, 63.2 % were between 18 and 29 years old, 16.7 % were between 30 and 44 years old, and 3.5 % were over 44 years old. Of the total sample, 39 % had completed primary school education, 26.8 % had completed secondary school, and 17.0 % had completed higher education. Twenty-one percent of the patients were employed, 40.2 % were unemployed, and 34.3 % were in school. Analysis of the sociodemographic variables revealed statistically significant gender differences in employment status (males in employment: 22 %; females in employment: 15.2 %, $p = .008$), although the effect size was small (Cramér's V = 0.059). The study did not statistically significant differences in the rest of the variables.

All patients had been diagnosed with cannabis dependence according to DSM-IV criteria and did not have a diagnosis of any other drug dependence or misuse. During the month before the start of treatment, 51.9 % reported daily cannabis consumption, 6.2 % consumed cannabis 4–6 days a week, and 10.2 % consumed this substance 2–3 days a week. Of the sample, 10.7 % consumed the substance on one day or fewer per week, and 21 % reported being abstinent during the previous month.

The main route of use was smoking (97.9 %), and the mean age at which they started using was 17.7 (SD = 12.8) years. On average, the participants had been using cannabis for a total of 8.47 (SD = 7.33) years. Other drugs used during the 30 days before treatment initiation were alcohol (38.4 %), cocaine (6.5 %), nonprescribed hypnotics and sedatives (1.0 %), and opiates (0.3 %). Analysis according to gender revealed that during the 30 days before treatment, women consumed less alcohol than men (males: 40.1 %; females: 28.6 %, $p = .000$), although the effect size was small (Cramér's V = 0.083).

2.3. Procedure

The data used in the current study belong to the electronic health records (EHR) of the patients treated in public addiction centers in Andalusia. The Information System of the Andalusian Plan on Drugs (SiPASDA) registers the EHR and stores its information in a centralized database for all addiction centers. The EHR begins with recording information collected according to the standards set by the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA, 2012), including sociodemographic variables, drug use history, previous treatments, and infectious diseases. Members of the clinical team supplement this information with clinical data (e.g., diagnosis of SUD and other mental disorders, prescribed pharmacological treatment, psychological evaluation and treatments, and results of toxicological tests) during the patients' routine appointments.

The EHR is automatically programmed to prevent the loss of important medical record variables. This system can also detect mistakes

and inconsistent patterns of response to treatment. On the other hand, the information used in this study does not present missing data in any of the variables analyzed, since the program for collecting EHRs is designed so that clinicians have to enter the required information on the variables used in this study.

2.4. Ethics and approvals

The storage and encoding of this data comply with the General Health Law of April 25, 1986 (Spain) and Law 41/2002 of November 14 on patient autonomy, rights, and obligations regarding clinical information and documentation. This procedure also complies with the Organic Law 3/2018 of December 5, 2018, on protecting personal data and guaranteeing digital rights, according to European regulations.

The researchers requested permission from the General Secretary of Social Services of the Department of Equality and Social Policies of the Regional Government of Andalusia (Spain) to access the EHRs. This agency provided the principal investigator with a fully anonymized database.

The Research Ethics Committee of the Andalusian Ministry of Health certified the compliance with the ethical handling of the information.

2.5. Measures

Sociodemographic data and variables related to the consumption patterns analyzed in this study correspond to those recorded in the treatment demand indicator (TDI) standard protocol 3.0 (EMCDDA, 2012). The indicators of the therapeutic process used were:

a) Appointment attendance ratio. This indicator is determined by dividing the number of therapy sessions attended by the total number of sessions scheduled by the therapy team. This number indicates the percentage attendance to scheduled appointments during treatment (Dacosta-Sánchez et al., 2022). Thus, a value of 1 is an indicator of 100 % attendance to scheduled appointments.
b) The percentage of negative cannabis tests. Patients are subjected to urine controls for the detection of cannabis. Samples are taken at addiction centers and sent to hospital laboratories for analysis, after which these laboratories issue reports in terms of positive or negative results. This indicator is the ratio of negative cannabis tests to the total number of cannabis tests administered, where a value of 1 indicates 100 % negative cannabis tests.

The outcomes used in this study were:

a) Therapeutic outcome (therapeutic success vs. dropout/readmission). Patients were classified according to whether they had received a therapeutic discharge and did not need additional therapeutic sessions after treatment (therapeutic success group), or whether they dropped out of treatment or required readmission to the treatment center after completion of the first treatment (dropout/readmission group).
b) Retention. This outcome is measured by the number of days in treatment, from the time the patient enters treatment until treatment ends. Several authors have proposed that retention in treatment is a positive indicator of patient change during treatment (Hser et al., 2004).

2.6. Statistical analysis

The study applied latent profiles analysis (LPA), introducing gender and age as covariates to identify subgroups of patients based on the percentage of sessions attended and the percentage of negative toxicological tests. Following Nylund-Gibson and Choi (2018), statistical fit indices and substantive interpretability determined the number of latent profiles. Therefore, this study adopted the following statistical criteria as indicators of model fit (the Bayesian information criterion -BIC-; Akaike information criterion – AIC - and the Akaike variant - CAIC - based on log-likelihood (LL) values), parsimony in the explanation of data (number of parameters -Npar-), and replicability of the latent profiles (misclassified cases). The study also applied a cross-validation procedure by randomly selecting 50 % of the participants.

We used binary logistic regression analyses to determine the relationships between sociodemographic characteristics, consumption patterns, and latent profiles.

Finally, the study applied a Cox regression analysis to establish the hazard ratio (HR) of dropout/relapse for each patient profile as a function of time in treatment.

The LPA was performed with Latent Gold 4.0 software, while the remaining statistical analyses used STATA software (Version14).

3. Results

Patients spent a mean of 242.25 (SD = 153.27) days in treatment. During this time, the mean number of scheduled appointments was 9.52 (SD = 7.82), with a median of 8 and a mode of 7. The percentile values were P25 = 5 and P75 = 12, while the semi-interquartile range was 3.5. The mean number of appointments attended was 7.42 (SD = 6.0), with a median of 6 and mode of 7. The percentiles took the values of P25 = 4 and P75 = 9, so the semi-interquartile range was 2.5. The mean number of toxicology tests performed was 7.6 (SD = 9.61; median = 5; mode = 2). The percentile values were P25 = 2 and P75 = 9, and the semi-interquartile range was 3.5.

The mean proportion of appointments attended by patients was 0.79 (SD = 0.20), with the 25th percentile being 0.67, the 50th percentile 0.83, while the 75th percentile was 1. The mean percentage of negative toxicology tests was 0.82 (SD = 0.27), the 25th percentile was 0.27, and the 50th percentile was 1.

Analysis according to gender revealed statistically significant differences in the appointment attendance ratio and the percentage of negative cannabis tests. However, as Supplementary Table S1 shows, the effect sizes were small (Cohen, 1992). No statistically significant differences were observed in the study for the remaining variables. Analysis by age group (Supplementary Table S2) also revealed small effect sizes for the different variables analyzed.

3.1. Latent profiles and patient characterization

Table 1 shows the fit indicators of the latent profiles for four possible models (between two and five latent profiles). The table shows that the models with three and five profiles have the lowest values of BIC, AIC, and CAIC. Comparing the models with three and five latent profiles, the model with three latent profiles is more parsimonious and has a lower classification error. Bootstrap analysis revealed that the five-profile model does not produce a statistically significant improvement. Thus, in light of these results, the three-profile model is considered to have the best fit.

Fig. 1 plots the mean scores for the percentage appointments attended by patients and the percentage of negative toxicology tests. Latent profile 1 consists of 997 patients with a mean probability of class membership of 0.99 (SD = 0.02) and includes those patients with the lowest percentage of negative toxicology tests (63 %) who have attended 74 % of the scheduled appointments. This group was therefore labeled *lowest abstinence/lowest adherence*. Latent profile 2 includes 613 patients with a mean probability of membership of 0.98 (SD = 0.01). This group of patients maintain abstinence during treatment (100 % negative toxicology tests), although they show the lowest attendance (72 %) to the therapeutic sessions (group: *highest abstinence/lowest adherence*). The third latent profile comprises 445 patients, with a mean probability of class membership of 0.99 (SD = 0.01). These patients strictly comply with treatment, maintain abstinence, and attend all scheduled appointments (group: *highest abstinence/highest adherence*). These three

Table 1
Fit indicators of the latent class analysis.

	LL	BIC (LL)	AIC (LL)	CAIC (LL)	Npar	C. Error	% Cross validation agreement (50% sample)					*Kappa*
Model 2 latent profile	3382.77	-6681.64	-6743.55	-6670.64	11	0.0059	99.8			100		.998
Model 3 latent profile	4398.98	-8660.67	-8761.97	-8642.67	18	0.0074	100		99.7		100	.999
Model 4 latent profile	4357.44	-8524.18	-8664.88	-8499.18	25	0.0474	99.7	83.8	100	64		.453
Model 5 latent profile	5388.42	-10532.73	-10712.83	-10500.73	32	0.0387	99.7	100	100	88.5	99.0	.979
Bootstrap model 5 vs. model 3: -2LLL Diff: 1978,56; p-value = 1.00; S.e. : 0.001												

Npar: number of parameters; C. error: classification error.

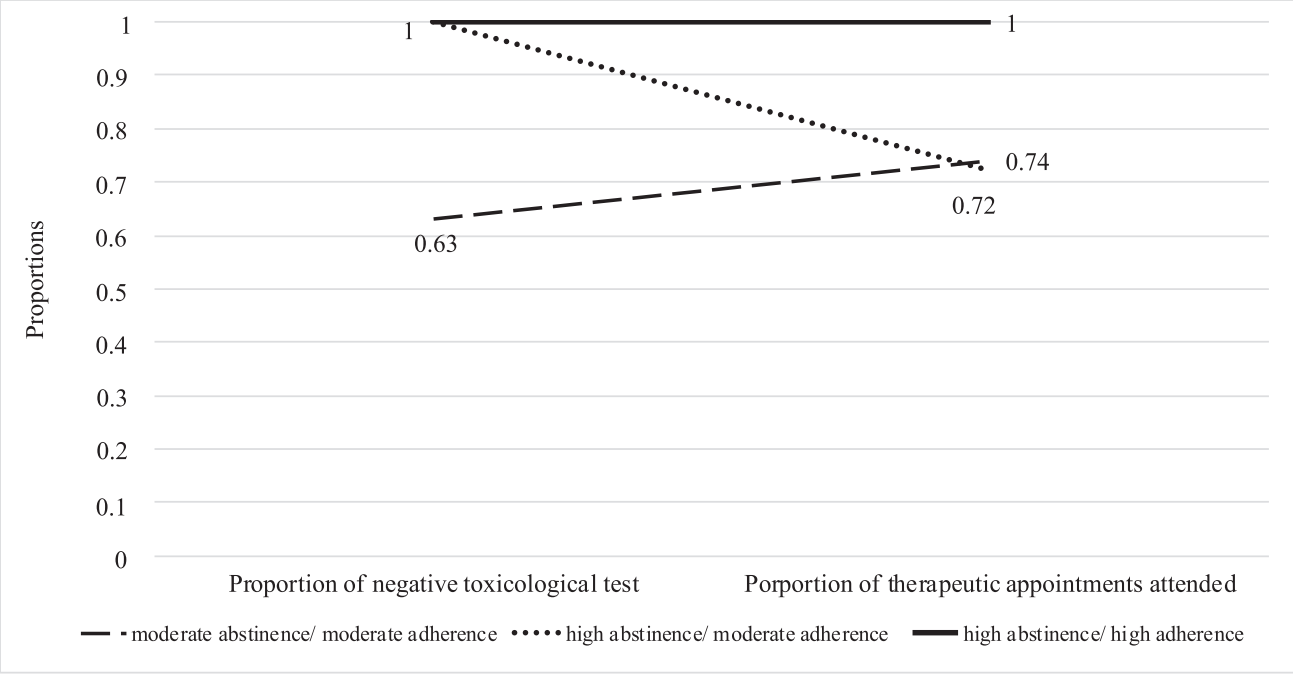

Fig. 1. Latent profiles description on abstinence and adherence indicators.

patient profiles differed significantly in the percentage of negative toxicology tests (F (2,2052) = 80.063; p = .000; η^2 = 0.46) and the percentage attendance to therapeutic sessions (F (2,2052) = 444.431; p = .000; η^2 = 0.30). Supplementary Table S3 displays information on the probabilities of belonging to the profiles according to score intervals, together with the standard errors.

3.2. Sociodemographic characteristics and consumption patterns associated with the latent profiles

Tables 2 and 3 show, respectively, the sociodemographic and consumption-related characteristics of the patients in each latent class and a comparison of these variables between the latent profiles. In general terms, the "lowest abstinence/lowest adherence" group includes younger patients with a lower level of education who are referred by family members to start treatment for CUD. Concerning the main route of cannabis use, they consume more smoked cannabis and have the highest frequency of use in the 30 days prior to starting treatment. A higher level of education generally characterizes patients in the "highest abstinence/highest adherence" group compared to the other two groups. In addition, these patients mostly enter treatment through referrals by legal services. These patients also present a lower frequency of cannabis use. Finally, the "highest abstinence/lowest adherence" group shows sociodemographic similarities with the "lowest abstinence/lowest adherence" group. However, the source of referral is more similar to the "highest abstinence/highest adherence" group. The cannabis use pattern of this group is also similar to that observed in the "highest abstinence/ highest adherence" group, except that more patients were reported to have used cocaine during the previous month.

3.3. Relationship between patient subgroups and indicators of long-term therapeutic success

Long-term therapeutic success was shown by 24.3 % of the patients in the "lowest abstinence/lowest adherence" group, 50.1 % of the patients in the "highest abstinence/lowest adherence" group, and 80 % of

Table 2
Sociodemographic and consumption pattern-related characteristics, according to latent classes.

	Profile 1 (Lowest abstinence/ lowest adherence) n = 997	Profile 2 (Highest abstinence/ lowest adherence) n = 613	Profile 3 (Highest abstinence/ highest adherence) *n* = 445	Statistic (*d.f.*)	*p*	Effect size (Cramer's V or eta-square)
Sociodemographic variables						
Age (Mean, SD)	23.90 (8.14)	24.90 (8.51)	25.18 (8.28)	*F* (2, 2052) =4.815	0.008	$\eta^2 = 0.001$
Men (%)	83.9	86.9	87.4	χ^2 (2) = 4.550	0.103	V = 0.047
Educational level (%)						
No education	18.1	16.0	13.0	χ^2 (8) = 121.700	0.000	V = 0.172
Primary	45.1	40.0	24.0			
Secondary	25.4	25.1	31.9			
Baccalaureate/University	11.2	18.3	28.3			
Other	0.2	0.7	2.7			
Employment status (%)						
Employee	20.8	18.3	25.2	χ^2 (8) = 19.881	0.011	V = 0.070
Unemployed	41.7	43.1	33.3			
Retired	1.7	1.5	2.5			
Student	33.7	33.4	36.9			
Other	2.1	3.8	2.2			
Main reference source (%)						
Legal Services	25.2	44.0	57.3	χ^2 (12) = 202.520	0.000	V = 0.223
Own initiative	25.2	23.3	25.8			
Family members	26.1	13.1	8.3			
Health Services	12	12	3.4			
Social Services	11.2	7.3	5.2			
Unknown	0.3	0.2	0			
Variables related to cannabis and other drug use						
Age of onset of consumption (Mean, SD)	15.62 (3.49)	15.87 (3.41)	16.45 (4.06)	F(2,2052) = 7.797	0.000	η = . 008
Years consuming (mean, SD)	8.16 (7.16)	8.99 (7.74)	8.43 (7.13)	F(2,2052) = 2.411	0.090	η = . 002
Main route of cannabis use (%)						
Smoked	98.3	96.7	98.7	χ^2 (2) = 6.030	0.049	V = 0.051
Oral	1.7	3.3	1.3			
Frequency of cannabis use in the 30 days prior to starting treatment						
Consumption every day	64.5	44.2	34.4	χ^2 (10) = 232.39	0.000	V = 0.238
4–6 days a week	7.4	4.6	5.8			
2–3 days per week	11.3	8.2	10.3			
1 day week	3.4	3.8	4.5			
Less than 1 day per week.	4.8	8.3	9.9			
Did not consume	8.5	31.0	35.1			
Other drugs used in the 30 days prior to starting treatment						
Alcohol	37.8	37.4	41.3	χ^2(2) =2.060	0.357	V = 0.032
Cocaine	8.0	6.4	3.4	χ^2 (2) =10.966	0.004	V = 0.073
Opioids	0.3	0.3	0.4	χ^2 (2) = 0.205	0.902	V = 010
Hypnosedatives	1.3	1.0	0.2	χ^2 (2) =3.718	0.156	V = 043

those in the "highest abstinence/highest adherence." These group differences were statistically significant ($\chi^2 = 400.648$; $p = .000$; V = 0.44). Fig. 2 shows the hazard ratio (HR) for treatment dropout using the "highest abstinence/highest adherence" as the reference group. The results indicate that the HR for the "highest abstinence/ lowest adherence" group is 1.78 (CI: 1.403–2.253); while for the "lowest abstinence/ lowest adherence" group the HR is 2.55 (CI: 2.047–3.187).

Table 4 shows the indicators of the treatment process for the three profiles. For each of these profiles, patients with long-term therapeutic success are those who spend the longest time in treatment. However, patients in the "highest abstinence/highest adherence" group require less time in treatment. More sessions are associated with long-term success only for the "lowest abstinence/lowest adherence" and "highest abstinence/highest adherence" groups. Finally, a higher number of toxicological tests is associated with long-term success in Profile 1 but not in the other two clusters.

4. Discussion

Treatment assessment models have pointed to the utility of analyzing patients' characteristics at baseline (inputs) and indicators of therapeutic progress for their predictive capacity for treatment outcomes (Sorensen & Llamas, 2018). To our knowledge, this is the first study to identify profiles of patients with CUD based on adherence and abstinence indicators while analyzing how these profiles relate to baseline patient characteristics and their long-term therapeutic outcomes. In general, the results show high rates of both attendance to appointments and negative drug tests among CUD patients. However, we can distinguish three patient profiles based on these two indicators, which differ in their characteristics at the start of treatment and in their long-term therapeutic outcomes.

The "lowest abstinence/lowest adherence" profile is characterized by a lower educational level and a decision to enter treatment that is more motivated by family members when compared with the other two patient groups. This profile also appears to be marked by a more severe pattern of drug use, as evidenced by a higher frequency of cannabis use and a higher percentage of cocaine use. These consumption-related characteristics are in accord with the latent profiles of cannabis users identified by other studies, which have also reported an association between cannabis use and riskier personality traits (Pearson et al., 2017) and behaviors (Krauss et al., 2017). For this reason, studies have hypothesized that these patients are highly impulsive, and therefore their treatment should be based on behavioral therapies suited to patients with high impulsivity traits (Kozak et al., 2019). In contrast, the "highest abstinence/highest adherence" group strictly comply with therapeutic guidelines. In sociodemographic terms, these patients have a higher

Table 3
Comparison of sociodemographic characteristics and consumption-related variables between latent profiles.

	Profile 1vs Profile 2 (Odds ratio (CI))	Profile 1 v s Profile 3 (Odds ratio (CI))	Profile 2 vs Profile 3 (Odds ratio (CI))
Sociodemographic variables			
Age	0.986 (0.974–0.998)*	0.982 (0.969–0.995)**	0.996 (0.982–1.011)
Women	0.091 (0.091–1.714)	1.338 (0.965–1.855)	1.043 (0.723–1.503)
Employment status			
Employee	1.172 (0.908–1.514)	0.779 (0.599–1.014)	0.665 (0.494–0.894)**
Unemployed	0.947 (0.772–1.160)	1.437 (1.137–1.816)**	1.518 (1.178–1.957)**
Studying	1.012 (0.818–1.252)	0.871 (0.690–1.100)	0.861 (0.667–1.111)
Retired	1.164 (0.516–2.628)	0.684 (0.318–1.473)	0.588 (0.242–1.431)
Level of study			
Unfinished primary	1.158 (0.884–1.516)	1.470 (1.068–2.024)*	1.270 (0.894–1.803)
Primary	1.236 (1.008–1.516)*	2.599 (2.023–3.339)**	2.103 (1.604–2.757)**
Secondary	1.014 (0.804–1.278)	0.726 (0.568–0.927)*	0.716 (0.546–0.938)*
Higher	0.566 (0.426–0.752)**	0.320 (0.241–0.426)**	0.566 (0.423–0.757)**
Source of referral			
Health services	0.970 (0.709–1.328)	3.701 (2.134–6.418)**	3.815 (2.156–6.570)**
Legal Services	0.427 (0.345–0.530)**	0.251 (0.198–0.317)**	0.587 (0.458–0.750)**
Family members	2.350 (1.787–3.092)**	3.890 (2.701–5.604)**	1.655 (1.098–2.495)*
Social Services	1.597 (1.113–2.293)*	2.322 (1.461–3.691)**	1.454 (0.866–2.440)
Own initiative	1.106 (0.874–1.400)	0–965 (0.747–1.247)	0.873 (0.658–1.159)
Variables related to cannabis and other drug use			
Age of onset of cannabis use	0.980 (0.952–1.009)	0.944 (0.916–9.74)**	0.958 (0.925–0.992)*
Years using cannabis	0.985 (0.972–0.999)*	0.995 (0.979–1.011)	1.010 (0.993–1.027)
Methods of cannabis use			
Oral	0.449 (0.244–1.020)	1.253 (0.449–3.501)	2.510 (0.919–6.855)
Smoked	1.944 (1.010–3.741) *	0.788 (0.309–2.012)	0.405 (0.161–1.017)
Cannabis use in the last month			
Daily consumption	2.292 (1.866–2.815) **	3.467 (2.741–4.384) **	1.512 (1.175–1.946) **
4–6 days/week	1.675 (1.071–2.619) *	1.292 (0.814–2.050)	0.771 (0.446–1.335)
2–3 days/week	1.439 (1.015–2.041) *	1.109 (0.772–1.593)	0.770 (0.506–1.173)
1 day/week	0.906 (0.528–1.553)	0.750 (0.427–1.319)	0.828 (0.449–1.528)
Less than 1 day/ week	0.557 (0.371–0.838) **	0.461 (0.301–0.705) **	0.827 (0.542–1.263)
Did not consume	0.207 (0.157–0.275) **	0.173 (0.128–0.232) **	0.832 (0.642–1.078)
Other drugs used in the last month			
Alcohol	1.020 (0.828–1.255)	0.863 (0.687–1.083)	0.846 (0.659–1.086)
Cocaine	1.284 (0.864–1.909)	2.501 (1.424–4.392) **	1.948 (1.060–3.579)*
Opioids	0.929 (0.154–5.534)	0.669 (0.111–4.015)	0.725 (0.102–5.167)
Hypnosedatives	1.337 (0.505–3.535)	5.866 (0.765–44.978)	4.389 (0.527–36.583)

* $p < .05$.
** $p < .01$.

educational level, and more than half decide to enter treatment due to administrative penalties. This group also shows a lower frequency of cannabis use. Thus, this latent profile includes patients who show a less severe pattern of cannabis use but who have been administratively sanctioned. The pressure to avoid legal sanctions could serve as an effective incentive to strictly comply with the therapeutic process (Urbanoski et al., 2005), although patients are not forced to undergo treatment for drug use under any circumstances. The "highest abstinence/lowest adherence" group presents both similarities and differences with regard to the two previous groups. This group also includes a high percentage of patients referred from legal services, which most likely encourages them to abstain from use, as this is a requirement to avoid penalties. However, this group may not perceive problems associated with their cannabis use, which is why they show less commitment to treatment, reflected in lower rates of attendance to therapeutic sessions.

The current study has provided novel and useful results that could help to inform patient treatment plans. First, adequate adherence to treatment produces high long-term success rates, as observed in the "highest abstinence/highest adherence" group. In contrast, the percentage of patients with long-term success is significantly reduced in the "lowest abstinence/lowest adherence" group. Therefore, attendance at therapeutic appointments and maintenance of abstinence during treatment produces a notable benefit for patients in the long term. In addition, the relationships found between patients' characteristics at the beginning of treatment and profiles in terms of therapeutic progress allow therapists to adapt treatment plans to increase the likelihood of obtaining successful treatment outcomes. In this regard, providing feedback to the patient about their progress in treatment constitutes one of the central components of motivational enhancement therapy (Chen et al., 2020; Guydish et al., 2010), and can be used by therapists to inform the patient about their likelihood of success. Such feedback could then serve to enhance the patient's intrinsic motivation (Chen et al., 2020). Likewise, strategies could be implemented to increase patients' extrinsic motivation through contingency management programs, which have also been shown to be useful for maintaining abstinence and promoting long-term therapeutic success (Budney et al., 2006; Pacheco-Colón et al., 2018). For example, patients in the lowest abstinence and lowest adherence group could benefit from contingency management programs to complement their treatment. Other notable aspects of our findings concern the time spent in treatment and the number of sessions attended. While some authors have pointed out that more time in treatment is associated with better therapeutic outcomes (Hser et al., 2004; Hubbard et al., 2003), others have highlighted the advantages and disadvantages associated with a greater or fewer number of sessions for patients with CUD, as well as the importance of providing treatment as needed (Copeland et al., 2001; Stephens et al., 2020). We believe that the results of this study complement the evidence reported in the previous literature. The analysis of time in treatment shows that, in general, more time in treatment is associated with long-term success. However, the time required to achieve therapeutic success varies according to patient profiles. Thus, the "highest abstinence/highest adherence" group requires the least amount of time, followed by the "highest abstinence/lowest adherence" group, and the "lowest abstinence/lowest adherence" group. The number of sessions required to obtain successful long-term results showed a similar trend. Thus, those patients who adhere to their therapeutic process as planned require fewer health care services. This finding emphasizes the need for tailored treatments, as this has a positive impact on patients and helps to maximize the efficiency of the services provided by addiction centers. That is, the identification of profiles—together with associated baseline variables—could help clinicians to decide whether it is appropriate to shorten the duration of treatment.

Taken together, the results of this study help to advance our understanding of CUD treatment in several ways. First, the relationship between certain sociodemographic characteristics and the profiles found

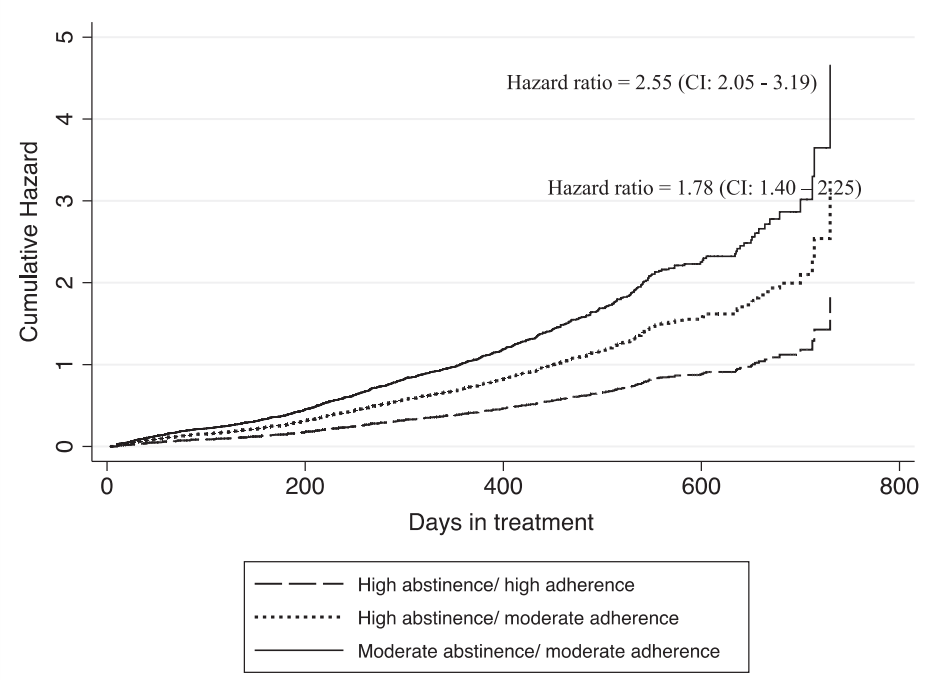

Fig. 2. Cox regression analysis predicting dropout risk on each latent profile.

based on therapeutic progress shows that at the beginning of treatment patients have different probabilities of maintaining therapeutic adherence. Therefore, professionals must be able to rapidly identify those patients who are likely to be "non-adherent to treatment" and, consequently, to apply therapeutic strategies to reduce the risk of abandonment. Second, the results of this study support the connection between adherence and treatment outcomes already shown by other authors. However, as the profiles have shown, more time in treatment does not necessarily imply better outcomes. On the contrary, patients' compliance with clinical recommendations may be more important for adequate therapeutic outcomes than the length of time spent in treatment. Finally, from a research perspective, most studies analyzing the effectiveness and efficacy of interventions in patients with CUD employed outcomes based mainly on consumption reduction, abstinence, or quality of life-based indicators (Lee et al., 2019). Moreover, these outcomes were measured in specific time periods (i.e., 3, 6, 9, or 12 months). The results of this study suggest that it could be useful to incorporate indicators of therapeutic progress to assess the effectiveness and efficacy of treatments. This information could then help to interpret the results found with commonly used indicators and provide guidance for potentially improving existing treatments.

Although the findings reported here have useful implications for research and interventions in patients with CUD, we should also acknowledge certain limitations. Two issues are worth noting concerning the sample. First, the sample included a much higher percentage of men than women, although this gender distribution is similar to that observed in Spain and Europe (EMCDDA, 2021). In this regard, and as Sherman et al. (2017) reported, the therapeutic needs for men and women may be different. Another aspect to consider is the type of CUD patients who were recruited for this study. As indicated in the Methodology section, the selected patients were starting treatment for the first time and had not been diagnosed with dependence on other drugs. We recognize that this limits the external validity of our results, which do not apply to other patients readmitted to treatment or dependent on other substances. In any case, the general profile of patients in this study represents more than 50 % of patients entering treatment for CUD in Spain and Europe (EMCDDA, 2021). Thus, the group of patients to which the results can be extrapolated is sufficiently broad to justify the use of our sample.

Another noteworthy limitation concerns patient follow-up. After the end of treatment, this study did not test whether patients consumed cannabis. We were only able to confirm that patients readmitted to treatment showed problematic cannabis use—that is, a recurrent use of cannabis that causes physical, psychological, or social deterioration of the individual. Moreover, we were not able to verify whether the patients who were discharged from treatment used cannabis. However, if this group of patients consumed cannabis, the levels of use would likely not have been clinically relevant. Thus, this study examines whether patients have required additional treatment (patients were readmitted) for relapsed cannabis use. Given the normalization of cannabis use and the legal status of this substance in some countries, this criterion could be a useful indicator for identifying whether patients are showing new cannabis use that is clinically relevant.

Finally, we would like to emphasize that the current study (using EHRs) is based on the combined use of two traditional indicators of therapeutic progress. In this regard, we consider it appropriate to highlight (as the results have shown) the heterogeneity in terms of scheduled and attended appointments, as well as in the number of toxicology tests performed. Therefore, the denominator for calculating the percentage of appointments attended and negative drug tests varies between patients. However, as Dacosta-Sánchez et al. (2022) show, the percentage of appointments is a better indicator of therapeutic success than the number of appointments attended by patients. Thus, we consider that the heterogeneity observed in the denominators of these indicators has a limited impact. Moreover, although employing indicators based on frequency and quantity of consumption would have been useful (see, for example, Witkiewitz et al., 2019), the EHRs employed in this study do not include data on the frequency of consumption during the period between sessions, which hinders interpretation of the results. Therefore, future studies should delve more deeply into the information collected during the treatment process to identify other variables that might determine patient profiles and serve as predictors of long-term therapeutic success. Future work could also analyze the relationship between patient profiles and treatment success using therapeutic outcomes other than abstinence, such as the reduction of problems associated with cannabis use (e.g., loss of employment,

Table 4
Treatment indicators of patient profiles according to success or treatment abandonment/readmission.

	Profile 1				Profile 2				Profile 3			
	Success (24.3 %)	Dropout/Readmission (75.7 %)	T	Cohen's d	Success (50.1 %)	Dropout/Readmission (49.9 %)	T	Cohen's d	Success (80 %)	Dropout/Readmission (20 %)	T	Cohen's d
Time in treatment (Mean, SD)	354.9 (160.3)	221.46 (158.7)	11.359**	0.836	279.2 (119.9)	232.2 (154.5)	4.216**	0.34	209.2 (119.8)	151.7 (122.4)	4.026**	0.47
No. of sessions attended (Mean, SD)	10.74 (7.07)	7.37 (6.93)	6.551**	0.48	7.50 (3.76)	7.51 (6.94)	0.025	0.00	5.81 (3.18)	4.60 (2.97)	3.263**	0.39
No. of toxicological tests conducted (Mean, SD)	11.50 (10.01)	9.64 (11.38)	2.280*	0.17	5.89 (6.55)	6.33 (7.01)	0.798	0.06	3.76 (7.92)	5.26 (6.34)	1.654	0.21

** $p < .001$.
* $p < .05$.

problems with education, and social problems) or improvements in quality of life. This type of study would most likely help to identify other patients who could benefit from more individualized treatments.

Declaration of competing interest

All authors of the present manuscript declare no conflict of interest.

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CRediT authorship contribution statement

Fermin Fernández-Calderón, Óscar M. Lozano and Carmen Díaz-Batanero have been implicated in the study design.

Daniel Dacosta and Andrea Blanc have been involved in database organization.

All authors have been involved in data analysis.

All authors contributed to the drafting and revision of the manuscript.

All authors have read and approved the final manuscript.

Ethics

The Research Ethics Committee of the Andalusian Ministry of Health certified the compliance with the ethical handling of the information.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.josat.2023.209019.

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