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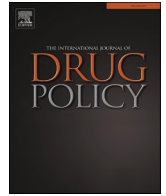


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Research Paper

# What can we learn from low-THC cannabis growers in Europe? A comparative transnational study of small-scale cannabis growers from Italy and Switzerland

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## ABSTRACT

**Background:** A market for cannabis with low levels (LT) of Tetrahydrocannabinol (THC) has recently emerged in Europe alongside an ongoing trend of domestic cannabis cultivation with high-THC content (HT). This phenomenon may have diversified the growers' profile. This study investigates LT growers' (LTG) characteristics (demographics, consumption patterns, growing experience) and growing motivations with a subsequent comparison with HT growers (HTG).

**Methods:** Data from 11,479 small-scale growers was collected through an online survey (ICCQ 2) conducted by the Global Cannabis Cultivation Research Consortium (GCCRC) from 2020 to 2021. This exploratory study analyses a subsample of the 1618 respondents residing in Italy and Switzerland. A quantitative approach was used, performing comparative bivariate and multivariate analyses between participants who have only grown HT plants in the previous year (HTG;  $n = 1303$ ) and those who have either grown LT only or alongside HT (LTG;  $n = 315$ ).

**Results:** LTGs differ significantly from HTGs. LTGs are older than HTGs. Growing medical cannabis for oneself and others is more likely among them than HTGs. Compared to HTGs, LTGs have lesser odds to grow for recreational use and to have problematic cannabis use. Growing for legality, pleasure and accessing milder cannabis is more likely for LTGs than HTGs. HTGs have greater experience than HTGs, growing for longer, more extensively and better meeting their consumption needs. There is a wider production of by-products, such as oils and extracts, among LTGs than HTGs. Having been in contact with the police for growing is also more likely among them than HTGs.

**Conclusion:** LTGs reported significantly more growing experience when compared to HTGs and should be considered a distinct group of growers. The results suggest that the emergence of the legal LT market has more likely drawn previous HTGs into growing LT, mainly medically, rather than attracting new individuals toward cannabis cultivation.

**Abbreviations:** CBD, cannabidiol; CFLA, commission fédérale pour les questions liées aux addictions [Swiss Federal Commission for Drug Issues]; CHE, Switzerland; EMCDDA, European monitoring centre for drugs and drug addictions; GCCRC, global cannabis cultivation research consortium; HT, High-THC cannabis; HTG, HT growers; ICCQ, international cannabis cultivation questionnaire; ITA, Italy; LT, low-THC cannabis; LTG, LT growers; THC, tetrahydrocannabinol.

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## Introduction

In recent years, policy discussions about cannabis markets have evolved considerably, with legalization in some countries. In Europe, changes have been modest despite cannabis being the most consumed illicit drug (EMCDDA, 2019a). The plant is primarily consumed for the psychoactive effects induced by delta-9-tetrahydrocannabinol (THC). Over the past decades, THC content and variability have been increasing (EMCDDA, 2012; McLaren et al., 2008; Zobel et al., 2020). While THC has medical benefits (EMCDDA, 2019a), the exposure to high levels raises public health concerns (CFLA, 2019a, 2019b; EMCDDA, 2012; McLaren et al., 2008).

The plant produces many other phytocannabinoids, of which cannabidiol (CBD). Scientific interest in this non-psychoactive molecule has expanded in recent times given its potential therapeutic applications, including substance use disorders (Britch et al., 2021; Crippa et al., 2018; Freeman et al., 2020; Grotenhermen & Müller-Vahl, 2016; Morgan et al., 2010; Russo & Guy, 2006; Sholler et al., 2020; Whiting et al., 2015). In European countries, a market for cannabis with high-CBD and lower-THC content has recently emerged. Due to legal loopholes rather than clear-cut regulations, it has primarily developed in Switzerland, then Italy. There, prevalence of cannabis use ranks among the highest in Europe with respective estimates of 9.4 % and 10.2 % (Been et al., 2016; EMCDDA, 2019b; Zobel & Gmel, 2016).

To facilitate agrotexile uses of hemp while avoiding contributing to the psychoactive use of cannabis, Switzerland legislated in 2011 a change in the threshold of THC differentiating hemp from illicit cannabis from 0.2 % to less than 1.0 % (Ordonnance du Département, 2011). However, the content in other phytocannabinoids has not been regulated; resulting unintentionally in the development of a legal market of Low-THC cannabis (LT) with higher CBD concentrations (CFLA, 2019a). Consequently, LT is fully legal for commercialization (tobacco, consumable and cosmetic products regulations) and domestic purposes without restrictions. For cannabis with High(er)-THC (HT) content, handling and growing are subject to either civil or criminal penalties depending on quantity and purpose of use. Possession of 10 g for personal use is authorized and consumption is subject to a fine (Loi Fédérale, 1951).

In Italy, legislative reforms in 2017 increased the THC limit from 0.2 % to 0.6 % to remove bureaucratic barriers in hemp production. This enabled the commercialization of LT marketed as non-consumable (Fortin et al., 2020). Although, while LT products are legally commercialized, their consumption is not regulated. Handling and growing non-commercial LT are subject to civil penalties, similar to the consumption and possession of small amounts of HT for personal use. Handling and growing larger amounts of HT are subject to criminal charges (D. P. 309, 1990).

Since then, the LT market has become increasingly attractive in certain European countries. In France, lifetime use rates of 10 % have been recently reported (Casanova et al., 2022). It provides accessibility and guarantees of low levels of THC. In Italy, the black-market revenues may have fallen by 3–5 % due to users transitioning to LT (Carriero et al., 2019). In comparison, the LT market offers lower average prices (Casanova et al., 2022; Zobel et al., 2020) and a wider range of cannabis products, such as oils, edibles, and extracts, which likely altered consumption patterns (Fortin et al., 2023; Zobel et al., 2019). Although, in Switzerland, surveyed users predominantly consumed LT in its herbal form (94.6 %,  $n = 210$ ;  $N = 222$ ) (Granville et al., 2022). With CBD possessing many therapeutic properties, LT has been particularly appealing to those users seeking to self-medicate without psychoactive effects (CFLA, 2019b; EMCDDA, 2020; Granville et al., 2022). In a survey conducted in Switzerland with 1500 LT users, LT was identified as a substitute for, or as a means to reduce, HT use. Most respondents in the survey who consumed both types of cannabis reported a decrease in their HT use. They were driven to substitute HT with LT either to reduce their THC consumption, to improve their well-being, or simply out of

curiosity (Zobel et al., 2019). Alongside its attractiveness, the LT market raises several health concerns (CFLA, 2019b; EMCDDA, 2020). While it can provide quality control (Swissmedic, 2021), in Italy, products cannot be marketed for human consumption and thus do not contain any public health messaging. This enables the circumvention of regulations or restrictions that govern LT commercialization and shifts responsibility for consumption onto users (Baumann et al., 2013).

The market creates a new blind spot in a complex cannabis market in which domestic cultivation is a rising phenomenon and estimated to 10 % of the Swiss black-market volume (Decorte et al., 2011; Decorte & Potter, 2015; EMCDDA, 2020; Zobel et al., 2020). The LT market may have increased opportunities for cultivation, potentially diversifying the profile of growers and users' social-/supply. In Italy among 2608 LT users, 4.4 % ( $n = 166$ ) reported having cultivated LT domestically (Fortin et al., 2023). Although this issue has not been investigated to our knowledge, it seems reasonable to assume that the LT market has attracted a population of growers similar to LT users. Users who limit themselves to LT use are generally older than those who consume HT as well (Zobel et al., 2019). The majority are women, many of whom have disclosed a medical condition and the use of cannabis oil. Like LT users who consume mostly for health reasons, research has shown similar differences between HT growers (HTG) using cannabis for recreational and medical use, the latter being older and consisting more of women (Hakkorainen et al., 2019). The boundaries between both HT *versus* LT users and HT medical *versus* recreational growers remain blurred. It is nonetheless relevant to investigate if LT growers (LTG) differ from HTGs in keyways. Growers must be examined as a distinctive group of users. Older and more integrated (Granville et al., 2018), they are mostly men in their mid-twenties and above (Potter et al., 2016). While herb is predominant for both (Granville et al., 2018; Potter et al., 2016), growers' intensive and diversified consumption (Decorte & Potter, 2015; Zobel et al., 2020) exceeds that of users (Granville et al., 2018).

This exploratory study aims to fill this gap by investigating growers within this dual market. Bivariate and multivariate methods are employed to compare LTGs and HTGs' profiles with respect to their characteristics (demographics, consumption patterns and growing experience) and growing motivations. Consistent with legal frameworks in Italy and Switzerland, LT refers to cannabis with  $\leq 0.6$  % of THC in Italy and  $< 1.0$  % in Switzerland. HT refers to cannabis with higher THC contents than these respective thresholds. Used alone, 'cannabis' refers to any type of cannabis.

## Method

### Data collection

The data was collected by the Global Cannabis Cultivation Research Consortium (GCCRC) through an online survey using the International Cannabis Cultivation Questionnaire Version 2 (ICCQ 2; GCCRC, 2020). With a similar questionnaire (ICCQ 1; Decorte et al., 2012) to the GCCRC's first survey and methodology (Barratt et al., 2012, 2015), the ICCQ 2 was administered to individuals aged at least 18 years old through convenience sampling. Using Qualtrics (2005), the survey was translated in 12 languages and distributed between August 2020 and September 2021 in 18 countries (Australia, Austria, Belgium, Canada, Denmark, Finland, France, Georgia, Germany, Italy, Israel, the Netherlands, New Zealand, Portugal, Switzerland, the United Kingdom, the United States, and Uruguay). Ethical approval for the international survey was granted by Curtin University's ethics committee as the data is hosted by the Australian research team.

A broad-base recruitment strategy was used to maximize respondent heterogeneity. Different promotional strategies were implemented including launching feature articles and media releases, engaging with alternative/mainstream media outlets and cannabis communities through online forums and social media groups, inviting alternative shops to promote the survey with flyers and posters either directly to

their customers or online, and promoting/advertising the study through online social media platforms like Facebook and Twitter.

### Sample

From the survey, a total of 11,479 valid responses were recorded. The responses regarding the type(s) of cannabis grown were collected from the two countries with legal LT markets at the time of the survey. Consequently, this study only includes data from Italy (ITA) and Switzerland (CHE). As presented in Table 1, the selected subsample ( $N = 1618$ ) includes participants who grew LT and/or HT in the 12 months preceding the survey completion and who reported living either in Italy (83.2 %,  $n = 1346$ ) or Switzerland (16.8 %,  $n = 272$ ). This subsample is largely male (88.12 %,  $n = 1380$ ;  $N = 1566$ ). The median age of the total sample is 25 years old ( $M = 29.8$ ,  $SD = 11.81$ ), 24 for Italy ( $M = 27.8$ ,  $SD = 10.51$ ;  $n = 1346$ ) and 37 for Switzerland ( $M = 39.2$ ,  $SD = 13.26$ ;  $n = 272$ ). Most of the respondents had grown only HT in the 12 months preceding the survey completion ( $n = 1303$ ; 80.53 %) and almost one fifth had grown LT in some capacity ( $n = 315$ ; 19.47 %). This subsample distribution shows a higher proportion of LTGs in the Swiss sample (30.15 %,  $n = 82$ ;  $N = 272$ ) than in the Italian one (17.31 %,  $n = 233$ ;  $N = 1346$ ).

### Measures

Given the exploratory approach of the study, a wide range of variables was selected to investigate potential differences between the two groups pertaining to the characteristics of growers and their motivations to grow. Although research on LTGs is lacking to our knowledge, variable selection was guided by extrapolation from relevant literature on LT users (Fortin et al., 2023; Granville et al., 2022), versus HT users (Zobel et al., 2019) and medical versus recreational growers (Hakkarainen et al., 2019) presented in the introduction.

The dependent variable measures the type(s) of cannabis, based on the THC content, cultivated in the 12 months preceding the survey completion. Participants were divided into two groups: 1) high-THC growers only (HTG = 0) and 2) low-THC growers (LTG = 1) regardless of whether they also grow HT. As to the independent variables, a total of 43 variables were included, 36 of which were binary variables and 7 quantitative as introduced below.

To establish the growers' profile according to the type(s) of cannabis produced, 16 variables of growers' characteristics and growing experience were used: 9 binary variables and 7 quantitative. Growers are described by their 1) gender (female = 0; male = 1), 2) age, 3) age at first cannabis use and, if any, 4) the severity of their cannabis dependence (Severity of Dependence Scale [SDS score]). Their SDS score was assessed by using a quantitative variable which is a sum of scores [0;20] from 5 ordinal variables (Likert scale). The variables measure (from 1 =

never or almost never/not difficult to 4 = always or nearly always/impossible) whether, in the past 3 months, their use of cannabis i) felt out of control, ii) if the prospect of missing a dose was worrying, iii) if their use troubled them, iv) if they wished they could stop, and v) how difficult stopping might be. This study examines 5) the use of any other drugs or non-medical pharmaceuticals (besides cannabis) in the 12 months preceding the survey completion (0 = absence; 1 = presence), 6) the respondents' age when they first started growing cannabis, 7) the number of years since then, 8) the usual number of plants grown per crop, as well as 9) the percentage of their cannabis consumption covered by their self-grown cannabis in the past 12 months. It measures which form of cannabis (0 = absence; 1 = presence) has been self-produced in the 12 months preceding the survey completion, whether 10) herbal, 11) hashish, 12) edibles, 13) oils, and/or 14) extracts. If applicable, participants were assessed for their 15) lifetime contact with the police due to growing cannabis (0 = absence; 1 = presence) and the perpetration of 16) a non-criminal offence in the 12 months preceding the survey completion (0 = absence; 1 = presence).

To capture reasons for LTG and HTG to grow and potential differences between them, this study assesses 27 indicators. These indicators are derived from a single comprehensive multiple-choice question. For each response category, a binary variable was generated (0 = absence; 1 = presence). The indicators are as follows: to provide oneself with 17) recreational and/or 18) medical cannabis, to provide others for 19) recreational and/or 20) medical use, 21) to sell, 22) to experiment, for 23) the pleasure of growing, 24) the beauty of the plant, 25) to remove chemicals, 26) to ensure no adulterant is added, 27) to avoid contact with criminals, for either 28) political, 29) ecological/environmental and/or 30) fair trade ideologies. Were included practical motives for growing: because growing is 31) tolerated/decriminalized/legal; 32) less risky, 33) easier and/or 34) cheaper than buying; 35) the plant is easy to take care of; compared to bought cannabis, self-grown is 36) stronger, 37) more consistent, 38) milder, and/or 39) healthier; due to COVID, cannabis 40) was in short supply, 41) more expensive, 42) more difficult to physically obtain and/or 43) more time was spent at home.

### Analytical strategy

The first analytical step aimed to identify at the bivariate level differences between the two populations of growers (dependent variable). To measure the association between the dependent variable and the binary indicators, a chi-square test of independence was implemented. To assess normality assumptions, skewness and kurtosis were analyzed for each quantitative predictor and a Shapiro-Wilk test ( $p \leq 0.05$ ) was performed. As no variables followed a normal distribution, potential relationships were explored with the dependent variable using the nonparametric Mann-Whitney U test. To limit size sample bias, the chi-square test was complemented with either Cramer's V/Phi or the Yule's

**Table 1**

Description of the sample and participants' characteristics according to the country of residency.

Variables	Country of residency		ITA ( $N = 1346$ )		CHE ( $N = 272$ )		Total ( $N = 1618$ )	
			$N$		$N$		$N$	
	$n$	%	$n$	%	$n$	%	$n$	%
Gender	1299		267		1566			
Male	1144	88.07	236	88.39	1380	88.12		
Female	143	11.01	27	10.11	170	10.86		
Non-binary	12	0.92	4	1.50	16	1.02		
Age	1346		272		1618			
	27.81 <sup>a</sup> [18;69] <sup>b</sup>	23.50 <sup>c</sup>	39.22 <sup>a</sup> [18;74] <sup>b</sup>	37.00 <sup>c</sup>	29.73 <sup>a</sup> [18;74] <sup>b</sup>	25.00 <sup>c</sup>		
Type of cannabis grown (12 months)	1346		272		1618			
High-THC cannabis only	1113	82.69	190	69.85	1303	80.53		
Low-THC cannabis or both	233	17.31	82	30.15	315	19.47		

<sup>a</sup> The mean.

<sup>b</sup> The minimum and maximum values.

<sup>c</sup> The median.

Q coefficient when exceeding 3/2 of Cramer's Phi value. The Mann-Whitney U test was complemented by Pearson's coefficient (Howell, 2008).

The second analytical step aimed to better apprehend, at the multivariate level, the association between the grower's group and various conceptually relevant factors. A multivariate model was built using sequential logistic regression to determine which variables are the most explanatory. This method is appropriate for exploratory analyses. Three separate regressions were performed to identify correlates with the outcomes. To build the final aggregated model, the study implemented two preliminary models. For each, a binomial logistic regression was performed focusing on one predetermined block of independent variables, the first being the growers' characteristics and the second the motivations to grow. Generally, it is not advised to perform multivariate analyses when there is no relationship between two variables at the bivariate level (Hosmer & Lemeshow, 2004; Tabachnick & Fidell, 2018). A significant relationship at the multivariate level only is likely to be due to interaction effects with other variables. Consequently, only indicators that have shown significant correlations at  $p \leq 0.05$  in the bivariate analyses were considered eligible for these preliminary models. However, with a sample exceeding 1000 participants, it is recommended to include variables of theoretical interest with less conservative  $p$ -values ( $p \leq 0.1$ ) (Tabachnick & Fidell, 2018). Among users the use of LT is

predominantly for health-related purposes, and it is common practice to opt for alternative forms like oil. It can reasonably be assumed that it also applies to LTGs. Consequently, the preliminary models include as indicators of theoretical interest growing to avoid adulterants and growing hashish. By extrapolation to the hypothetical predisposition to medical use by LTG, growing to provide others with recreational use is also retained. Variables were then selected in a backward stepwise procedure ( $p \leq 0.05$ ) for the preliminary models. Associations were assessed using odds ratios (OR) for the three logistic regressions. For cases with missing data, listwise deletion was employed. All analyses were conducted using IBM SPSS Statistics© SPSC (2022) software.

## Findings

Results of the bivariate analysis on the growers' characteristics presented in Table 2 shows a high percentage of male participants among both groups, without significant statistical differences between LTGs and HTGs. LTGs are significantly older than HTGs with a median age of, respectively, 29 and 25 years [ $U = 233,650.50$ ,  $p \leq 0.001$ ,  $r = 0.10$ ]. On average, both groups first used cannabis during their teens, with no significant differences between them. While LTGs' use of other drugs or non-medical pharmaceuticals in the past 12 months is not statistically lower than their peers, LTGs show lower SDS scores for

**Table 2**  
Descriptive and bivariate statistics of the growers' characteristics according to the type(s) of cannabis.

Variables	Total N	High-THC cannabis only		Low-THC cannabis or both		$\chi^2$ Mann-Whitney U	Yule's Q R
		N		N			
		n	%	n	%		
Gender (Male)	1550	1253		297			
		1108	88.43	272	91.58	2.45	0.18
Age	1618	1303		315			
		29.22 <sup>a</sup> [18;71] <sup>b</sup>		31.84 <sup>a</sup> [18;74] <sup>b</sup>		233,650.50***	0.10
		25.00 <sup>c</sup>		29.00 <sup>c</sup>			
Age at first cannabis use	1601	1293		308			
		15.78 <sup>a</sup> [10;51] <sup>b</sup>		16.66 <sup>a</sup> [11;64] <sup>b</sup>		209,651.50	0.04
		15.00 <sup>c</sup>		16.00 <sup>c</sup>			
SDS score	1290	1059		231			
		2.61 <sup>a</sup> [0;14] <sup>b</sup> 2.00 <sup>c</sup>		2.29 <sup>a</sup> [0;9] <sup>b</sup> 2.00 <sup>c</sup>		111,972.00*	0.06
Any other drug or non-medical pharmaceutical use (12 months)	1526	1233		293			
		279	22.63	57	19.45	1.39	0.10
Age when first growing cannabis	1604	1291		313			
		21.90 <sup>a</sup> [10;61] <sup>b</sup>		22.32 <sup>a</sup> [10;64] <sup>b</sup>		189,994.50	0.04
		20.00 <sup>c</sup>		19.00 <sup>c</sup>			
Years since first growing cannabis	1601	1289		312			
		7.39 <sup>a</sup> [0;51] <sup>b</sup> 3.00 <sup>c</sup>		9.63 <sup>a</sup> [0;44] <sup>b</sup> 5.00 <sup>c</sup>		236,212.00***	0.12
Number of plants per crop (usually)	1568	1265		303			
		5.50 <sup>a</sup> [1;101] <sup>b</sup>		18.17 <sup>a</sup> [1;101] <sup>b</sup>		226,298.50***	0.12
		3.00 <sup>c</sup>		4.00 <sup>c</sup>			
Percentage of consumption covered by self-grown cannabis (12 months)	1278	1034		244			
		51.85 <sup>a</sup> [0;100] <sup>b</sup>		61.03 <sup>a</sup> [0;100] <sup>b</sup>		148,294.00***	0.12
		50.00 <sup>c</sup>		71.50 <sup>c</sup>			
Self-produced form of cannabis (12 months)	1525	1231					
Herbal		864	70.19	216	73.47	1.24	0.08
Hashish		223	18.12	66	22.45	2.90†	0.13
Edibles		196	15.92	79	26.87	2.91***	0.32***
Oils		47	3.82	44	14.97	52.56***	0.63***
Extracts		78	6.34	45	15.31	25.75***	0.46***
Police contact for growing cannabis (lifetime)	1467	1189		278			
		125	10.51	54	19.35	16.50***	0.34***
Non-criminal offence (12 months)	1454	1177		277			
		100	8.50	19	6.86	0.80	0.12

<sup>a</sup> The mean.

<sup>b</sup> The minimum and maximum values.

<sup>c</sup> The median.

\*\*\* $p \leq 0.001$ , \*\* $p \leq 0.01$ , \* $p \leq 0.05$ , † $\leq 0.1$ .

cannabis [ $U = 111,972.00, p \leq 0.05, r = 0.06$ ] compared to HTGs. As to their growing activities, both groups started growing on average in their twenties, with no significant differences between them. LTGs reported growing for longer [ $U = 236,212.00, p \leq 0.001, r = 0.12$ ] and with a much higher average of usual plants per crop compared to HTGs [ $U = 226,298.50, p \leq 0.001, r = 0.12$ ]. The percentage of consumption provided by domestic cultivation is also on average higher for LTGs than HTGs [ $U = 149,294.00, p \leq 0.001, r = 0.12$ ]. Furthermore, the majority have self-produced herbal cannabis in the 12 months preceding the survey. Self-producing hashish ( $\chi^2 = 2.90, p \leq 0.1$ ), edibles ( $\chi^2 = 2.91, p \leq 0.001$ ), oils ( $\chi^2 = 52.56, p \leq 0.001$ ) and/or extracts ( $\chi^2 = 25.75, p \leq 0.001$ ) is more likely among LTGs than HTGs. One fifth of LTGs and one out of ten HTGs have been in contact with the police for their growing activities during their lifetime, indicating a greater likelihood for LTGs compared to HTGs ( $\chi^2 = 16.50, p \leq 0.001$ ). Though, with fewer than one out of ten growers having perpetrated non-criminal offences in the 12 months preceding the survey, no significant statistical differences were found between the two groups.

The results of the bivariate analysis on motivations to grow presented in Table 3 show statistical differences between groups. While most cannabis is produced for oneself, LTGs are more likely to grow for one's medical use ( $\chi^2 = 28.25, p \leq 0.001$ ) and less for recreational use ( $\chi^2 = 24.90, p \leq 0.001$ ) in comparison to HTGs. And though only a minority of participants grow cannabis to supply others, this is more likely among LTGs than HTGs; for both recreational ( $\chi^2 = 3.33, p \leq 0.1$ ) and medical use ( $\chi^2 = 42.51, p \leq 0.001$ ). Only a few participants declared growing in order to sell, with no statistical differences between the groups.

A majority of both types of growers cultivate cannabis for hobby-like reasons. Yet, a higher percentage of LTGs grow for the pleasure of growing it ( $\chi^2 = 3.94, p \leq 0.05$ ) compared to HTGs. In addition, while some grow for ideological reasons (political, ecological and/or fair trade), LTGs have a greater likelihood of doing so for ecological concerns than HTGs ( $\chi^2 = 5.10, p \leq 0.05$ ). Relatively few growers are motivated by legal reasons, either due to perceived tolerance (HT) or because it is legal/decriminalized (LT). Growing for this reason is more likely among LTGs than HTGs ( $\chi^2 = 25.25, p \leq 0.001$ ). On the other hand, there is a greater likelihood for HTGs to grow cannabis as an experiment in comparison to LTGs ( $\chi^2 = 4.57, p \leq 0.05$ ).

Additionally, growing cannabis can also be a means to solve some concerns with buying. Compared to LTGs, HTGs have a greater likelihood to grow because they view it as less risky ( $\chi^2 = 4.58, p \leq 0.05$ ) and cheaper ( $\chi^2 = 12.62, p \leq 0.001$ ) than buying, and because the cannabis is thought to be healthier ( $\chi^2 = 4.79, p \leq 0.05$ ). Though there were no differences in growing to remove chemicals, growing to ensure adulterants are not added is slightly more likely among HTGs than LTGs ( $\chi^2 = 2.75, p \leq 0.1$ ). Also, while it concerns only a few growers, HTGs have been significantly more pressured into growing during the COVID-19 pandemic compared to LTGs: due to reduced supply of cannabis ( $\chi^2 = 4.05, p \leq 0.05$ ), increased prices ( $\chi^2 = 6.42, p \leq 0.05$ ) and home confinement ( $\chi^2 = 4.61, p \leq 0.05$ ). Meanwhile, compared to HTGs, growing to produce milder cannabis than otherwise available is more likely among LTGs ( $\chi^2 = 25.91, p \leq 0.001$ ).

Results of the binomial logistics regressions are presented in Table 4. With the growers' characteristics and motivations to grow, three models were estimated. The first model compares the characteristics and

Table 3

Descriptive and bivariate statistics of the motivations to grow according to the type(s) of cannabis ( $N = 1613$ ).

Variables	Type of cannabis grown		High-THC cannabis only ( $N = 1300$ )		Low-THC cannabis or both ( $N = 313$ )		$\chi^2$	Yule's $Q$
	n	%	n	%	n	%		
To provide oneself with								
Recreational cannabis	861	66.23	160	51.12	24.90***	0.30***		
Medical cannabis	371	28.54	138	44.09	28.25***	0.33***		
To provide others with								
Recreational cannabis	93	7.15	32	10.22	3.33 <sup>†</sup>	0.19 <sup>†</sup>		
Medical cannabis	78	6.00	54	17.25	42.51***	0.53***		
To sell	76	5.85	22	7.03	0.62	0.10		
To experiment growing	426	32.77	83	26.52	4.57*	0.15*		
For the pleasure of growing	973	74.85	251	80.19	3.94*	0.15*		
For the beauty of the plant	856	65.85	220	70.29	2.41	0.10		
To remove chemical residues	432	33.23	97	30.99	0.57	0.05		
To ensure no adulterant is added	850	65.38	189	60.38	2.75 <sup>†</sup>	0.10		
To avoid contact with criminals	921	70.85	208	66.45	2.32	0.10		
For [see below] ideologies								
Political	375	28.85	97	30.99	0.56	0.05		
Ecological/Environmental	295	22.69	90	28.75	5.10*	0.16*		
Fair trade	255	19.62	58	18.53	0.19	0.04		
Because it is either tolerated, decriminalized or legal	25	1.92	22	7.03	25.25***	0.59***		
Because compared to buying, growing is...								
Less risky	382	29.38	73	23.32	4.58*	0.16*		
Easier	261	20.08	68	21.73	0.42	0.05		
Cheaper	811	62.38	161	51.44	12.62***	0.22***		
Because the plant is easy to care of	202	15.54	50	15.97	0.04	0.02		
Because compared to bought cannabis, self-grown is...								
Self-grown cannabis is stronger	267	20.54	57	18.21	0.85	0.07		
More consistent	343	26.38	87	27.80	0.26	0.04		
Milder	107	8.23	56	17.89	25.91***	0.42***		
Healthier	1067	82.08	240	76.68	4.79*	0.16*		
Because due to COVID...								
Cannabis was in short supply	246	18.92	44	14.06	4.05*	0.18*		
Cannabis was more expensive to buy	250	19.23	41	13.10	6.42*	0.23**		
It was difficult to physically obtain	213	16.38	36	11.50	4.61*	0.20*		
More time was spent home	163	12.54	38	12.14	0.04	0.02		

\*\*\*  $p \leq 0.0001$ .

\*\*  $p \leq 0.01$ .

\*  $p \leq 0.5$ .

<sup>†</sup>  $\leq 0.1$ .

Table 4

Binomial logistic regression of the type of cannabis grown using the characteristics and motivations of growers.

Variables	Model 1 (N = 1447)			Model 2 (N = 1613)			Model 3 (N = 1445)		
	$\beta$	Exp ( $\beta$ )	(95 % CI)	$\beta$	Exp ( $\beta$ )	(95 % CI)	$\beta$	Exp ( $\beta$ )	(95 % CI)
Growers' characteristics									
Self-produced Oils (12 months)	1.14	3.12***	[1.88–5.19]				1.03	2.79***	[1.63–4.78]
Self-produced Extracts (12 months)	0.48	1.62*	[1.01–2.59]				0.53	1.69*	[1.03–2.79]
Police contact for growing cannabis (lifetime)	0.60	1.83***	[1.27–2.63]				0.35	1.42 <sup>†</sup>	[0.97–2.10]
Motivations to grow									
To provide oneself with recreational cannabis				–0.51	0.60***	[0.46–0.78]	–0.52	0.59***	[0.44–0.79]
To provide oneself with medical cannabis				0.50	1.64***	[1.25–2.16]	0.42	1.51**	[1.13–2.04]
To provide others with medical cannabis				0.91	2.48***	[1.66–3.72]	0.72	2.06***	[1.33–3.20]
For the pleasure of growing				0.39	1.48*	[1.07–2.06]	0.32	1.38 <sup>†</sup>	[0.97–1.97]
Because it is either tolerated, decriminalized or legal				1.22	3.37***	[1.81–6.29]	1.27	3.55***	[1.79–7.03]
Because compared to buying, growing is less risky				–0.35	0.70*	[0.52–0.96]	–0.34	0.71*	[0.51–1.00]
Because compared to buying, growing is cheaper				–0.46	0.63***	[0.48–0.84]	–0.45	0.64**	[0.47–0.86]
Because compared to bought cannabis, self-grown is milder				0.86	2.37***	[1.63–3.45]	0.89	2.45***	[1.63–3.67]
Constant									
n	–1.67	0.19***		–1.50	0.22***		–1.61	0.20***	
%	277		313	276					
Pseudo-Nagelkerke R <sup>2</sup>	19.14		19.40	19.10					
Log-likelihood		0.06	0.12		0.15				
	1360.40		1462.72	1264.66					

\*\*\*  $p \leq 0.0001$ .\*\*  $p \leq 0.01$ .\*  $p \leq 0.5$ .†  $\leq 0.1$ .

growing experiences of LTGs to those of HTGs, including all indicators significant at the bivariate level. LTGs represent 19.14 % ( $n = 277$ ;  $N = 1447$ ) of the sample. From the three retained variables, results indicate that having self-produced extracts and oils is, respectively, one and a half ( $OR = 1.62$ ,  $p \leq 0.05$ ) and three times ( $OR = 3.12$ ,  $p \leq 0.001$ ) more likely among LTGs than HTGs. LTGs also have nearly twice the odds of having been in contact with the police in their lifetime for their growing activities ( $OR = 1.83$ ,  $p \leq 0.001$ ) than HTGs.

The second model reports the retained predictors of LTGs *versus* HTGs for the 'motivations to grow' measures. LTGs represent 19.40 % ( $n = 313$ ;  $N = 1613$ ) of the sample. Results show that growing medical cannabis for one's own use and that of others' is, respectively, one and a half times ( $OR = 1.64$ ,  $p \leq 0.001$ ) and twice ( $OR = 2.48$ ,  $p \leq 0.001$ ) as likely among LTGs than HTGs. LTGs have lesser odds to grow for their own recreational use than HTGs ( $OR = 0.60$ ,  $p \leq 0.001$ ). Similarly, growing because it is perceived as less risky ( $OR = 0.70$ ,  $p \leq 0.05$ ) and/or cheaper ( $OR = 0.63$ ,  $p \leq 0.001$ ) than buying is less likely among LTGs compared to HTGs. On the other hand, LTGs have twice the odds to grow to secure a milder cannabis than HTGs ( $OR = 2.37$ ,  $p \leq 0.001$ ). LTGs have three times the odds to grow because it is now legal/decriminalized than HTGs who would perceive it as tolerated ( $OR = 3.37$ ,  $p \leq 0.001$ ). Additionally, growing for the pleasure of it is one and a half times ( $OR = 1.48$ ,  $p \leq 0.05$ ) more likely for LTGs than HTGs.

The final model includes indicators retained in the two preliminary models. LTGs represent 19.10 % ( $n = 276$ ;  $N = 1445$ ) of the sample. While, they all remain significant in this aggregated model, for some indicators there is a decrease in the level of explanatory power. This includes the greater likelihood for LTGs compared to HTGs to have been in contact with the police in their lifetime for growing ( $OR = 1.42$ ,  $p \leq 0.1$ ) as well as to grow for providing themselves with medical cannabis ( $OR = 1.51$ ,  $p \leq 0.01$ ), for pleasure ( $OR = 1.38$ ,  $p \leq 0.1$ ) and/or because it is cheaper than buying ( $OR = 0.64$ ,  $p \leq 0.01$ ). For the remaining variables, the explanatory power remains similar.

## Discussion

This exploratory study was carried out to investigate and compare growers' profiles according to the type(s) of cannabis grown, LT and/or HT. Results revealed significant differences suggesting that LTGs are a distinctive group of growers.

With many therapeutic applications allocated to CBD (Britch et al., 2021; CFLA, 2019a; Grotenhermen & Müller-Vahl, 2016; Whiting et al., 2015), research has shown LT users commonly use it to self-medicate for relieving symptoms of various health concerns (Fortin et al., 2023; Granville et al., 2022; Zobel et al., 2019). In Italy, the opening of LT shops has even reduced the sales of prescription drugs (Carrieri et al., 2019). As it could therefore be expected, providing oneself and others with medical cannabis was more likely among LTGs compared to HTGs. And while there were no statistical differences to produce recreational cannabis for others, growing for oneself was more likely among LTGs than HTGs. Producing cannabis oils and extracts, forms that are more appreciated among LT users (Zobel et al., 2019), was also more likely among LTGs than HTGs. Additionally, such as LT users (*versus* HT) or medical growers (*versus* recreational) (Hakkarainen et al., 2019; Zobel et al., 2019), LTGs were significantly older than HTGs. This result is in line with a UK survey in which age was positively associated with using LT therapeutically (Corroon & Phillips, 2018). Considering that older age and health correlate negatively, an older population is more likely to seek various means to relieve their different symptoms. Combined to LT consumption, this could explain their lower dependence levels to cannabis. In addition, higher-THC content is associated with more addiction severity (Curran et al., 2016). In Fortin et al.'s (2022) study, a majority of those using LT to substitute HT reported an effective decrease in their HT use. The decrease was associated with daily LT use, which was mostly reported to reduce THC withdrawal symptoms. CBD has indeed proven to be a protective factor to cannabis dependence by modulating the effects of THC (Morgan et al., 2010; Niesink & van Laar, 2013).

However, while in this sample and other research (Decorte & Potter, 2022) male growers were predominant, studies have shown that LT users and medical growers include relatively more females than their counterparts (Hakkarainen et al., 2019; Zobel et al., 2019). This study found no such differences. Results revealed that LTGs have been growing more plants per crop than HTGs, even among those without selling and sharing motivations. This may be influenced by the legal framework (legality in Switzerland, decriminalization/perceived legality in Italy) and larger volumes consumed, perhaps in association with medical use. Although, LTGs have also been growing cannabis for a longer period of time than HTGs and with greater rates in covering their own cannabis use. This experience could result in a greater yield. And

depending on growing practices and preferences, the production of other forms could require a larger quantity of plants. The access to LT is only available since 2016 in Switzerland and 2017 in Italy. The longer LTG growing experience implies that they have been growing HT prior to the legislation change. Furthermore, growing as an experiment was less likely among LTGs than HTGs. However, growing to access a milder cannabis than the one sold on the market (referring most logically to HT) was more likely among LTGs compared to HTGs. All combined, this suggests that the LT market has more so converted former HTGs to grow LT instead or in conjunction with HT, rather than attract new growers. Hypothetically, it may also have drawn former HT users to substitute their consumption, even just partly, with self-produced LT.

Lifetime contact with the police for growing was more likely among LTGs than HTGs. This could be a result of covariation from greater exposure, LTGs having grown larger crops and for longer (either LT and/or HT) than HTGs. Given the legal frameworks, their crops may be less concealed, which could further expose them to police investigations than HTGs. Growing LT does not prevent encounters with the police. Even in Switzerland, LT seizures have been reported. Due to the physical and olfactory similarities, only THC quantification methods could differentiate LT from HT before the implementation of field-testing tools (Zobel et al., 2017). Higher rates of contact with the police among LTGs could also be an indication of former HTGs who transitioned to LT perhaps for that same reason. Further research is needed to explore the nature of the relationship between LTGs and police contact more fully. There were indeed more LTGs motivated by legal/decriminalized reasons than HTGs due to perceived tolerance. It may also explain why more LTGs were to grow for the pleasure of it than HTGs. Additionally, commercialized, and controlled alternatives alongside with their lower need to buy, could influence LTGs to have less drive than HTGs to grow for safety, pricing, and supply concerns, yet more for ecological reasons.

## Conclusion

The current study compares the profiles of LTGs and HTGs from two European countries. While investigating their characteristics and growing motivations, LTGs presented several significant differences from HTGs, suggesting a distinctive type of grower. The findings suggest that problematic cannabis use is less likely among LTGs than HTGs. Growing for medical use rather than recreational was more likely for LTGs compared to HTGs. Overall, LTGs had greater experience in growing cannabis than HTGs, which suggests more importantly that the LT market may have converted former HTGs to grow LT instead or in conjunction with HT, rather than having attracted new growers.

Despite the current findings, this study is not without its limitations. The use of convenience sampling limits generalizable inferences, as demonstrated by the age difference between both countries. Recruitment from social networks can lead to an over-representation of younger participants. Social desirability bias from self-reported delinquent surveys can impact the validity of the data. Yet, providing anonymity can limit this bias (Aebi & Jaquier, 2008; Junger-Tas, 1989). Online surveys are most suited for the study of hidden populations such as growers (Barratt et al., 2015; Barratt & Lenton, 2010, 2015; Miller & Sønderlund, 2010; Temple & Brown, 2011). Additionally, the use of cross-sectional data has allowed the suggestion of a transition from former HTGs to actual LTGs though without the ability to establish it. Also, participants were categorized based on their knowledge of the type of cannabis grown. This may be subject to some degree of inaccuracy. Due to less than 5.0 % of the sample ( $N = 1618$ ) growing LT only (3.40 %,  $n = 55$ ), a conceptual regrouping with participants growing LT in addition to HT (16.07 %,  $n = 260$ ) had to be done (19.47 %,  $n = 315$ ). Differences within this group and from countries' legal frameworks could exist, requiring further investigations.

With many countries exploring cannabis regulation and with the spreading of LT, these findings can support public and health policies. As with users (Wenger & Schaub, 2019; Zobel et al., 2019), results suggest

that the LT market has provided an alternative for HT growers. There are different profiles of growers, needs, and thus a demand for a wider range of cannabis beyond HT and medical cannabis treatments. It is important for public policies to consider the existence of these differences and, in case of legal reforms, to consider establishing a diversified cannabis market to address them. Contrary to public health concerns, the LT market appears to have offered an opportunity for at least partial conversion rather than attracting new growers. Considering all the health risks associated with the exposure to increasing THC content, LT may be a pragmatic alternative in terms of public health. Given lower cannabis dependence rates compared to HT, it is an interesting option, especially considering the large proportion of medical growers who may be more vulnerable. This should also encourage the debate in recognizing the need and facilitating access to medical cannabis. While under-investigated, the self-medication phenomenon raises issues of therapeutic alliance (Hakkarainen et al., 2015) and the necessity for informed and safe guidance from healthcare professionals. Despite reduced risks from consuming LT, the product quality for human consumption must be ensured (Swissmedic, 2021). The quality of the self-cultivated cannabis (Lenton et al., 2018) and consumption practices (e.g. combustion and tobacco) can still present risks (CFLA, 2019b). The LT market calls for prevention and harm reduction campaigns on self-medication, consumption and growing practices.

## Ethics approval

Approvals from ethics committees and validations of data protection were obtained by the Australian research team through Curtin University, which hosted the survey, and by the respective institutions of the other research teams.

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## CRediT authorship contribution statement

**Ashely Granville:** Writing – original draft, Visualization, Validation, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Jodie Grigg:** Writing – review & editing, Validation, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Michala Kowalski:** Writing – review & editing, Validation, Methodology, Investigation, Conceptualization. **Eric Sevigny:** Writing – review & editing, Validation, Methodology, Investigation, Data curation, Conceptualization. **Frank Zobel:** Writing – review & editing, Validation, Methodology, Investigation, Conceptualization. **Davide Fortin:** Writing – review & editing, Validation, Methodology, Investigation, Conceptualization.

## Declaration of competing interest

No conflict declared.

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