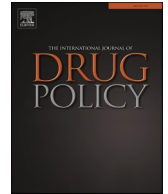


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## Research Paper

## Impact of the COVID-19 pandemic on cannabis cultivation and use in 18 countries

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## ABSTRACT

**Background:** The COVID-19 pandemic and the accompanying measures to mitigate infection affected many areas of society, including the supply and use of cannabis. This paper explored how patterns of behaviour among people who cultivate cannabis were affected by the COVID-19 pandemic and restrictions.

**Methods:** An anonymous web survey of people who cultivated cannabis was conducted from Aug 2020 to Sep 2021, spanning 18 countries and 11 languages ( $N = 11,479$ ). Descriptive statistics and mean comparison tests were conducted.

**Results:** Most cannabis growers reported that their practices were relatively unaffected by the COVID-related restrictions. While 35.2 % reported difficulties buying cannabis from their usual dealer, <10 % stated that access to materials needed for growing was impaired during the pandemic. Over one-quarter (28.2 %) of respondents increased their cannabis use and 21.4 % also increased cannabis cultivation (more than twice as many as those who said they were growing less or not anymore) while COVID restrictions were in place. People who lost their job or were casually employed were more likely to increase use and cultivation. Overall, the pandemic had little impact on reasons for growing, however, difficulties obtaining cannabis were mentioned as the most prevalent COVID-19-related growing motive. A small number (16 %) reported starting their growing activity during the pandemic. Italian and Portuguese growers were more likely to report shortages in supply and increases in their growing activity.

**Conclusions:** This study is the first to document an increase in cannabis cultivation activity following COVID restrictions. Increased home cultivation was not only driven by higher use as a result of home isolation, but also by disruptions of wider illegal cannabis supply. Limitations of this study include the non-representativeness of the sample as well as differences in approaches and duration of restrictions in different countries.

## Introduction

The COVID-19 pandemic affected many areas of public life,

including the use and supply of cannabis. While some studies detected no significant changes in the prevalence and patterns of cannabis use (Vanderbruggen et al., 2020), other scholars reported increased use,

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particularly among people who already regularly used it (Van Laar et al., 2020; Werse & Kamphausen, 2021; Imtiaz et al., 2021; Puljević et al., 2023), while others found a mixed situation where some consumers increased use, and some decreased use (Health Canada, 2022). People who increased their use often reported anxiety and depressive symptoms as reasons for this increase, but also boredom as well as more leisure time available due to mandatory home lockdowns (Deimel et al., 2022; Chong et al., 2022).

While some researchers in the very early phases of the pandemic predicted that increased border controls and global travel restrictions would lead to major disruptions of international drug supply chains, including drug shortages and increased prices in consumer countries (Barratt & Aldridge, 2020; Dietze & Peacock, 2020), subsequent empirical research suggested a more nuanced picture. Studies from Europe, North America, and South America suggested that although the pandemic had some impact on drug production and transportation, the international drug trade seemed remarkably resilient (EMCDDA & Europol, 2020; Sanín, 2020; Palamar et al., 2021). The United Nations Office on Drugs and Crime (UNODC), for instance, concluded that the large seizures of cannabis during the first phases of the pandemic, indicated that cannabis trafficking from North Africa to Europe was still active, even though some countries did experience a rise in price and decrease in cannabis availability (UNODC, 2020). Expert reports also suggested that domestic large-scale illegal cannabis cultivation was not disrupted by COVID restrictions. A possible explanation for the lack of disruptive impacts was the resilience of cultivation sites, and the relatively short supply chains of cannabis markets (EMCDDA & Europol, 2020; UNODC, 2020).

Although research indicates that the COVID-related restrictions had some degree of impact on the retail level of drug markets and individual use patterns (Aldridge et al., 2021; Armstrong et al., 2022; Gaume et al., 2021; Namli, 2021; Newport et al., 2023; Nygaard-Christensen & Søgaard, 2023), very little is known about the impacts of COVID-related restrictions on small-scale cannabis cultivation. Qualitative research indicates that restrictions on border-crossing boosted domestic cannabis production both for profit and personal use in certain countries such as Latvia (Zile-Veisberga, 2022). Commentators have also speculated that domestic cannabis cultivation may have increased and become less risky, as law enforcement resources were directed to enforce compliance with COVID restrictions. Alternatively, others have suggested that COVID restrictions may have inhibited growers' access to seeds, fertilisers, and other equipment (EMCDDA & Europol, 2020; UNODC, 2021).

Given the scientific evidence of general garden-related activities, we could expect an increase in cannabis cultivation: Generally, gardening activities in the Western world increase during economic downturns (Burgin, 2018). For instance, home gardening became the most common form of food procurement during the COVID pandemic in Vermont (Niles et al., 2021). In Europe, there was a parallel trend during COVID with people turning to gardening for different reasons (e.g., utilitarian, social, therapeutic) (Schoen et al., 2021; Turnšek et al., 2022). At the same time, an aesthetic shift in social media could be observed, giving more visibility to the natural world in the context of growing societal and individual anxiety, simmering anger, and escalating disparities relating to COVID (Kay, 2020). In parallel, the pandemic left many people with more time to engage in gardening due to the flexibility that came with home-working options (Kingsley et al., 2021). However, there is no scientific evidence yet whether these observations also apply to (mostly illegal) self-supply with cannabis.

Based on an online survey conducted between August 2020 and September 2021 of 11,479 primarily small-scale cannabis growers in 18 countries, this article aims to explore the overall effects of COVID-related restrictions on home cannabis growing as well as cross-country differences. More specifically, our analysis investigates whether COVID-related restrictions impacted growers' access to cannabis and materials for growing, and to what extent the growers' cultivation changed because of the pandemic restrictions. We also examine

correlations between COVID-related increases in cannabis use and increases in cultivation activity, and to what degree growers experienced COVID-related changes in law enforcement against cannabis cultivation.

## Methods

The International Cannabis Cultivation Questionnaire (ICCQ 2) is a standardised online convenience web survey, developed by the Global Cannabis Cultivation Research Consortium (GCCRC, see <https://worldwideweeds.nl>) to measure and compare patterns of cannabis cultivation across different countries. The methodology used in this study was closely based on that described in detail from the ICCQ 1 conducted in 2012–13 (see Barratt et al., 2012, 2015). For the ICCQ 2, data were collected in 18 countries, from August 2020 to September 2021.

The online survey was promoted in the 18 participating countries<sup>m</sup> via a range of channels including an international website, social media, online forums, drug policy influencers, mainstream media, flyers, street press, events and grow shops. The mix of recruitment strategies varied between countries, but all potential recruits were directed to the project website where they could choose the survey and language associated with their country of residence (see also Barratt et al., 2015). 19,444 respondents initiated the online survey. After screening for data quality, completeness, and duplicates, and applying eligibility criteria, we retained 11,479 cases, which comprise the core international dataset, and is, to our knowledge, the largest dataset solely looking at people who grow cannabis

The core questionnaire, which was used in all 18 countries, included questions on a wide range of subjects relating to cannabis cultivation, such as the level and mode of growing, use of fertilisers, and if growers grow alone or with others. Furthermore, participants were also asked questions about the impact of the COVID-19 pandemic and related restrictions. This included some general questions about the effects on the everyday life of respondents, e.g., their general adherence to COVID-related mitigation measures and possible changes in their income due to COVID. The questionnaire also included questions about COVID-related motives for growing and to what extent the pandemic and related restrictions had impacted on growers' own cannabis and other psychoactive substance use. Other questions focused on possible COVID-related changes in cannabis cultivation activity, effects on the growers' ability to procure growing equipment, and an assessment of changes in the risk of being subject to law enforcement. The full questionnaire can be accessed at <https://worldwideweeds.nl/iccq2-2/>.

The results section includes country comparisons for all relevant questions. Given the size of the sample, all show statistically significant differences. We decided to not include coefficients and significance levels, since it is mostly not clear whether different general conditions of countries, different conditions of COVID mitigation measures, or other factors might be reasons for between-country differences (see discussion). Other comparisons, particularly those between COVID-related questions and work status as well as income, were calculated using common statistical coefficients.

We received ethical approval for the survey from the Human Research Ethics Committee of Curtin University (Perth, Australia; HRE2019-0542), with additional ethical approval obtained through national or institutional review processes where required.

<sup>m</sup> Australia (AUS), Austria (AUT), Belgium (BEL), Canada (CAN), Switzerland (CHE), Germany (DEU), Denmark (DNK), Finland (FIN), France (FRA), United Kingdom of Great Britain and Northern Ireland (GBR), Georgia (GEO), Israel (ISR), Italy (ITA), Netherlands (NLD), New Zealand (NZL), Portugal (PRT), United States (USA) and Uruguay (URY).

## Results

### Sample characteristics

Of the 11,749 cannabis growers, 85.8 % were male, 13.4 % female and 0.8 % non-binary. The median age was 37 years (interquartile range 27–49, range 18–80, arithmetic mean 39.1). Due to the varying recruitment strategies and related successes, the number of participants differed considerably between countries: The small country of Belgium is represented by 2112 persons, followed by the USA (1833), Italy (1404), Denmark (887), Germany (807), Australia (738), France (639), Finland (541), Canada (519), the Netherlands (362), the UK (343), Uruguay (342), Switzerland (285), Georgia (218), New Zealand (198), Portugal (115), Israel (87) and Austria (44). When looking at country differences, these highly varying subsample sizes should be considered.

On average, respondents started growing cannabis at the age of 27 (median 23 years). The typical grower had grown 5 cannabis crops (median) in their lifetime, with a median number of three mature plants per crop covering 2.2 m<sup>2</sup>. 40.5 % grew indoors, 34.1 % outdoors and 25.4 % both indoors and outdoors. Although there is a significant proportion of the sample reporting larger cultivation operations (e.g., 22.1 % grew crops covering >10 m<sup>2</sup>), the typical participant in this study is a small-scale grower who cultivates to provide himself and sometimes also friends and acquaintances with cannabis (see also [Sogaard et al., 2024](#)).

### General effects of the pandemic

Generally, most participants adhered to the most common infection mitigation measures such as maintaining recommended physical distance (80.8 %), avoiding public spaces and events (70.8 %), avoiding public transport (61.8 %), avoiding personal gatherings (55.1 %) and self-isolation (52.1 %). 35 % started working from home. 61.4 % answered that during the pandemic their personal income (from all sources) had stayed the same, while 32.2 % answered that their income decreased. Only 6.4 % stated that their income had increased. This indicates how a substantial proportion of growers had less income during the pandemic. 6 % stated that they lost their job (temporarily or permanently) due to COVID and 1.5 % were still employed, but government-supplemented due to COVID. Among these respondents, the proportion who claimed that their income had decreased was significantly higher (88.1 % and 83.5 % respectively) than among other growers. However, 29.9 % of those in 'ordinary employment' also stated a decrease in their income.

### Impact on access to cannabis and materials for growing

Around one-third-of respondents (35.2 %) stated that due to COVID restrictions it had become "more difficult" for them to obtain cannabis from their usual dealer/supplier, closely followed by 34.5 % who stated that it had become more difficult to obtain cannabis via their personal social network. A similar percentage (33.4 %) stated that it had become more difficult to meet in-person with people they grew cannabis with (note that this question was only asked of those who stated that they grew together with others). Relatively few respondents stated that access to seeds (10.9 %), nutrients/fertilisers/chemicals (9.9 %), lights and other growing equipment (8.8 %), or cuttings to grow cannabis (7.2 %) became harder. Even fewer respondents stated that their access to their own cannabis plants (3.5 %), their ability to harvest (3.1 %) and their ability to dry/process crops (2.6 %) had become harder. On the contrary, a higher proportion of growers felt that these activities had become easier (14.6 %, 13.1 %, and 12.4 %, respectively) during the pandemic.

These results indicate that while there was a tendency towards limited access to (illegal market) cannabis, the conditions for cultivation were only affected to a small extent, and there was even some tendency that cannabis growers were better able to attend to plants during the COVID restrictions.

### Changes in cannabis use and cultivation practice

Just over one quarter (28.2 %) stated that their cannabis use increased during the pandemic, while only 6.6 % reported a decrease; 63.5 % said it stayed the same and 1.7 % "stopped altogether". When looking at country differences, respondents from Israel were most likely to report increased use (46.8 %), followed by Italy (37.3 %) and Austria (36.8 %). Respondents from Denmark (17.6 %), Finland (17.9 %), and Portugal (19.5 %) were least likely to report increased cannabis use.

When asked whether the pandemic affected the amount that was grown, 21.4 % of the respondents stated that it increased, while 4.5 % reported a decline, 69.9 % stated that it stayed the same and 4.2 % reported stopping their growing activity (see [Table 1](#)).

One third (33.2 %) noted that they increased the time spent tending to plants, while 3.5 % stated that they reduced their time, and 59.7 % reported it stayed the same (3.6 % said they "stopped altogether"). Italy (30.9 %) and Portugal (26.2 %) were the two countries with the highest proportions of respondents who increased the amount they were growing, closely followed by the US, Canada and Belgium. The Netherlands, Finland and Denmark had the lowest proportions (see [Table 1](#)). Israel showed the highest proportion of cannabis cultivators who increased the time spent tending to the plants (48.7 %), followed by Italy (45.4 %), Uruguay (42 %) and Portugal (38.6 %), while in Austria (21.7 %), Denmark (21.6 %), Finland and Switzerland (23 % each), rather few respondents reported an increase.

Work status had an impact on changes in cultivation practice: Those who were employed, but received supplementary income from the state due to COVID, showed the highest proportion of those who increased the amount they were growing (32.3 %), followed by those who were unemployed due to COVID (28.7 %). The percentage of persons who increased growing among those who were ordinarily employed (21.3 %) hardly differed from those who were unemployed since before COVID (18.7 %) and those who did not work for other reasons (20.9 %;  $\chi^2=61.6, p<.001$ ). A more pronounced statistical association with work status could be observed with regard to the time spent tending to plants: 48.6 % of those who were unemployed due to COVID and 44.1 % of those who were employed, but supplemented due to COVID, stated that they spent more time growing, while only 33.4 % of ordinarily employed respondents, 27.2 % of those who were unemployed since before COVID, and 31.4 % of those who did not work for other reasons increased their time spent growing cannabis ( $\chi^2=102.5; p<.001$ ). No significant associations were found between these questions and the available income.

Changes in work status due to COVID also showed significant associations with patterns of cannabis use: While 41.1 % of those who were unemployed due to COVID and 38.1 % of those who were employed, but supplemented due to COVID, stated that they increased their use. This was only true for 28.7 % of ordinarily employed respondents, 23.8 % who were unemployed before COVID and 25.6 % of those who did not work for other reasons ( $\chi^2(12)=84.3, p<.001$ ).

As one might expect, there are highly significant associations between the impact of the pandemic on cannabis use and on growing activities. For instance, 44.6 % of those who reported an increase in use due to COVID also stated an increase in the amount of cannabis they were growing. At the other end of the continuum, 61.5 % of those who stated that they stopped their use also stopped their growing activity. Most (83.7 %) of those who did not change their use also did not change the amount they were growing ( $\chi^2(9)=2573.4; p<.001$ ).

### The pandemic as motivating factor for cannabis cultivation

A small proportion (16 %) of the respondents reported they only started growing cannabis after the imposition of COVID-19 restrictions. It has to be noted though that there is an almost linear correlation between age and this question: The younger the respondents, the more likely they were to have started cannabis cultivation after the

**Table 1**  
How COVID affected the amount grown by the respondents, by country.

	AUS	AUT	BEL	CAN	CHE	DEU	DNK	FIN	FRA	GBR	GEO	ISR	ITA	NLD	NZL	PRT	USA	URY	Total
Increased <sup>a</sup> , %	18.2	16.7	23.3	25.3	14.9	16.1	14.6	13.8	17.7	21.1	20.7	17.9	30.9	11.7	17.5	26.2	25.9	17.3	21.4
Stayed the same, %	72.7	69.4	68.2	71.3	78.6	73.5	75.5	76.0	74.8	74.6	65.9	71.8	55.8	79.5	68.3	59.5	68.4	75.0	69.9
Decreased, %	5.2	5.6	3.8	3.1	3.0	4.5	4.8	4.4	3.5	1.8	11.0	5.1	5.6	2.4	10.3	11.9	4.3	6.5	4.5
Stopped altogether, %	3.9	8.3	4.7	0.3	3.6	5.8	5.2	5.8	4.0	2.6	2.4	5.1	7.8	6.3	4.0	2.4	1.3	1.2	4.2
Total N <sup>a</sup>	407	36	1330	320	168	514	563	363	453	228	82	39	774	205	126	84	1187	168	7047

<sup>a</sup> Missing data on that question for 4460 participants; percentages calculated on valid responses.

restrictions, with a sharp drop in numbers between young and middle-aged participants, and by far the largest proportion of “yes” (38.4 %) among the youngest age group (18–20 years; see Fig. 1). Given that the median age of first growing operation is at 23, this suggests that a significant proportion of those who started growing during the pandemic might have done so regardless of the pandemic.

When looking at country differences, Italy shows the highest proportion of respondents who started growing during the pandemic (27.8 %), followed by Israel (21.7 %), Portugal (19.6 %) and the UK (18.3 %). The countries with the lowest proportions of persons who started growing during COVID-19 are Georgia (7.5 %), Finland (8.5 %), Uruguay (8.9 %) and the Netherlands (9 %). To some extent, the higher proportion of newly started growers in Italy may be explained by the observation that on average, Italian respondents are the youngest population among all participating countries (average age of Italians: 27.8 years compared to 39.1 on average). However, when controlled for age, there is still a statistically significant difference between countries ( $F = 43.6; p < .001$ ).

The GCCRC questionnaire contained a question about motives for growing cannabis with a 29-item list of answers, including four COVID-related reasons. Compared to the other answer categories, relatively few respondents nominated COVID-related reasons: 9.6 % stated that one reason for growing was “Because I had / have more time at home due to the COVID-19 situation”; 7.7 % agreed with the statement “Because cannabis was more expensive to buy due to COVID-19” and 7.4 % with “Because it was difficult to physically obtain cannabis due to COVID-19”. Additionally, 7.3 % affirmed the statement “Because cannabis was in short supply due to COVID-19” (see Table 2).

Portugal and Italy were the two countries with the highest proportions of respondents stating COVID-related motives for growing, particularly for the three items that indicate more difficult market conditions for sourcing cannabis: 26.3 % of Portuguese and 20 % of Italian respondents referred to “short supply”, 21.9 % of Portuguese and 20.4 % of Italians to “more expensive to buy”, and 22.8 % of Portuguese and 17.2 % of Italians to “difficult to physically obtain”. Australia was the only other country with a double-digit proportion of responses for these items, while for all of these questions, Uruguay and the Netherlands showed the lowest proportions (Table 2). Portugal (17.5 %) and Italy (13.8 %) were the countries with the highest proportions of respondents who grew cannabis because they had “more time at home due to the COVID-19 situation”, closely followed by Canada, Belgium, and Israel. The lowest approval rates were in New Zealand, Denmark, and Switzerland (see Table 2).

#### Changes in the risk of being prosecuted by law enforcement

One fifth (19.7 %) of the total sample perceived that their risk of getting caught by law enforcement increased due to the COVID pandemic and the accompanying measures, while a slightly lower number (16 %) felt that this risk had decreased. Consequently, almost two-thirds (64.4 %) thought that this risk stayed the same. A slightly different picture emerges with the question whether the trouble the persons would get into if caught has changed: considerably more respondents felt that this risk has increased (13.3 %) than decreased (6.2 %). However, the vast majority (80.5 %) stated that this risk stayed the same.

The countries with the highest percentages of respondents stating that risks of getting caught by law enforcement had increased were France (37 %), Italy (36 %) and Portugal (33 %), while on the other end of the range, respondents from the USA (3.7 %) and Canada (3.8 %), countries where cannabis is legal at least in some states, were least likely to state an increased risk of law enforcement, followed by Switzerland (8.5 %), Georgia (10.1 %) and Finland (10.3 %). A similar picture emerges when looking at the question whether the trouble one can get into when caught has increased, with Italy (35.1 %), France (25.6 %) and Portugal (19.3 %) as the top three countries and the USA (3 %),

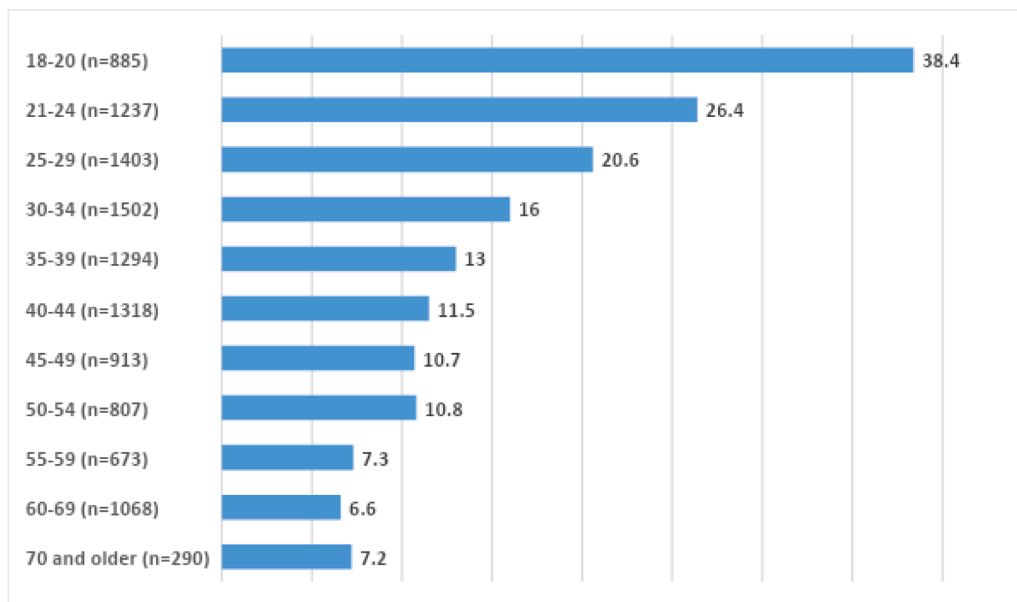


Fig. 1. Started growing cannabis during the COVID-19 pandemic by age groups (%; total  $n = 11,390$ ).

Canada (4.5 %) and Finland (5.5 %) with the lowest proportions.

## Discussion

As in the general population of most countries, the COVID pandemic affected the lives of cannabis growers, not only through the necessity to adhere to various quarantine measures, but also because a significant proportion of people lost their jobs and/or experienced a decrease in their income. Our findings also confirmed that, at least among people who already used cannabis regularly, there was a tendency to increase cannabis use (Van Laar et al., 2020; Werse & Kamphausen, 2021a; Imtiaz et al., 2021; Mehra et al., 2023; Puljević et al., 2023), with almost one-third of respondents reporting an increase in their cannabis use during the pandemic. In particular, those who worked less or lost their job during the pandemic were likely to use more cannabis. Our sample's relative youth may have contributed to the amount of free time they had as young people were particularly by changes to employment, socialisation (Vacchiano, Politi & Lueders, 2023), and a variety of other factors (Lundström, 2022), that inspired them to take on new activities. Among those who increased their cannabis use, a high proportion also stated that access to (illegal) cannabis had become more difficult.

Overall, the effects of the pandemic on cannabis cultivation activities, however, varied: Few respondents, for instance, reported difficulties in accessing the materials necessary to grow cannabis. A small, but significant proportion reported starting to grow during the time when COVID restrictions were in place. However, as the proportion of these newly started growers was highest among the youngest age groups, many of them may have started growing cannabis even if the pandemic had never occurred, given that the median age of this group is 20 years (Potter et al., 2014). Nevertheless, there were also some people who first started growing during the pandemic in older age groups. Furthermore, we also found that those who increased their cannabis cultivation activities the most during the pandemic were growers who had more available leisure time, while also having less money available, either because they lost their jobs or were required to work less hours than they desired. In addition, growers, including those whose work status was unchanged, had more leisure time available at home to spend for cultivation activities because of the restrictions on public life. The observation that this was a major reason for increasing cultivation activities is also in line with the notion that people generally tend to increase gardening activities in times of crises (Burgin, 2018).

Regarding country comparisons, Giommoni (2020) reminds us that COVID-related restrictions and their length of enforcement varied between countries as did their likely effects on drug-related activities. For instance, Italy adopted strict restrictions on movement as people were allowed to travel only within a limited radius (e.g. 200 m) from their residence, except for necessary activities, such as going to work, buying essential goods, or for health matters (EMCDDA, 2020). As a result, Italians had a much harder time procuring cannabis with a large share who decided to turn on the low-THC market to compensate for the shortage compared to their neighbours in France where the walkable distance was five times larger (Fortin et al., 2023). Like France, lockdown measures in the UK were considerably more relaxed, insofar as people could go out once a day for shopping, to exercise, for medical issues, and to travel back and forth from work (Giommoni, 2020). Similar regulations were introduced in Germany (Grote et al., 2021). In Denmark, it was recommended that citizens stayed at home, but no legal enforcement was conducted (Nygaard-Christensen & Søgaard, 2023). New Zealand and Australia imposed some of the most restrictive COVID lockdowns in the world, mandating people to remain at home with no contact with anyone outside of their household, and limiting shopping to supermarket visits only by one household member (Baker et al., 2020; Cook et al., 2020). At the same time, Canadian political leaders deemed cannabis shops an 'essential service' and began allowing for home delivery of non-medical cannabis where previously only in-store purchasing was allowed (Myran et al. 2020). Moreover, the severity of containment measures within countries varied over time. As outlined, we identified some national variations regarding COVID-related impacts on cannabis cultivators, and it is likely that differences in levels of containment measures played a role in this as did differences in legal preconditions regarding cannabis use, given that several of the participating countries have decriminalised or legalised cannabis possession. This complexity must be considered when looking at differences between countries.

Particularly Italy and Portugal showed higher percentages of respondents claiming shortages in supply and higher prices for cannabis. In these countries, a relatively high proportion of respondents highlighted such general market distortions as a key motive for growing. Italy and Portugal also had the highest proportions of respondents who increased cultivation activities. The reasons for that may be (a) the feeling of a particularly high risk of being subject to law enforcement because of cannabis use/growing during the pandemic (although these

**Table 2**  
Agreement to COVID-related motives for growing cannabis, by country.

	AUS	AUT	BEL	CAN	CHE	DEU	DNK	FIN	FRA	GBR	GEO	ISR	ITA	NLD	NZL	PRT	USA	URY	Total
Because I had more time at home due to COVID,%	7.0	6.8	12.9	13.3	5.3	7.9	4.8	7.0	7.1	11.1	8.8	12.8	13.7	6.4	3.5	17.4	9.6	5.6	9.6
Because cannabis was in short supply due to COVID,%	9.9	9.1	6.2	2.5	6.3	7.2	4.8	3.7	6.6	6.7	3.3	5.8	19.9	1.7	5.6	26.1	3.8	1.8	7.3
Because cannabis was more expensive due to COVID,%	10.8	4.5	4.5	4.0	4.2	5.0	7.0	3.7	9.2	6.4	3.7	7.0	20.4	3.0	6.6	21.7	5.9	1.8	7.7
Because it was difficult to physically obtain cannabis due to COVID,%	10.2	4.5	6.8	3.3	4.9	6.8	5.1	4.8	7.4	7.9	5.1	5.8	17.1	1.9	7.6	22.6	4.6	1.8	7.4
Total N	738	44	2110	519	284	807	884	540	693	343	215	86	1400	362	198	115	1828	341	11,507

numbers are high as well in other countries such as France), (b) relatively strict contact restrictions in these countries (EMCDDA, 2020; Vinceti et al., 2022; Faria et al., 2022), leading to relatively pronounced market distortions during COVID, and (c) relatively high percentages of imported cannabis products, resulting in more pronounced market disruptions during COVID because of closed borders, which might have had a greater impact on import than domestic contact restrictions could have on the trade within the country (for instance, Italian consumers appeared to have the third highest preferences for cannabis resin among European countries, which is mostly imported (EMCDDA & Europol, 2019)). In the case of Italy, (d) national civil disobedience initiatives to advocate decriminalisation of cannabis cultivation for personal use by taking pictures of cannabis plants grown domestically (Catania, 2020) might also have been a factor resulting in increased growing activities. However strong the influence of these restrictions or other factors may have been, particularly in these countries, COVID has apparently led to an increase in private home cultivation. While we do not know whether these persons expected longer periods of cannabis shortages, which would be an apparent reason for growing a plant that takes at least four months to grow and dry, this can be regarded as an example of how repressive policies, not only on a highly prevalent drug, but also with regard to measures to contain a pandemic can spark evasive actions of concerned persons.

In any case, while the pandemic had a limited yet considerable impact on illegal cannabis supply, people who were most affected by such shortages tended to compensate by starting or increasing cultivation activities. Similar to strategies of other samples of people who use cannabis, mostly either looking for additional dealers or buying larger amounts when available (Werse & Kamphausen 2021b), people who grow cannabis used a relatively easy way to bridge the shortage.

Summing up, both cannabis use and cannabis cultivation was used as a means to cope with pandemic-related shortcomings – the former because it helped some individuals to get over anxieties or to use additional spare time in a pleasant way. To utilize time that was unusually spent at home was also a main motive for starting or increasing cultivation activities, but also to compensate for shortages and limited financial resources.

### Limitations

Because of our convenience or purposive approach, our sample is not necessarily representative of the broader population of cannabis growers internationally or in any specific country. Purposive or targeted sampling is commonly used in research with hidden populations whose activities are illegal and/or stigmatised, as these individuals do not respond as well to standard population surveying techniques (Watters & Biernacki, 1989; Barratt et al., 2017). Furthermore, among populations who cultivate and use cannabis, the demographic characteristics of people who volunteer to complete household surveys and purposive web surveys are not vastly different (Barratt & Lenton, 2015; Barratt et al., 2017). Our sample will also be limited by volunteer bias, as the survey was unpaid, and involved a significant amount of time to complete. These factors, in addition to the specific focus of recruiting people based on the fact they grow cannabis and not simply on the fact they may consume cannabis, may explain some of the differences seen in this sample when compared to results obtained from commercial panels of respondents. In addition, there is likely also a bias towards smaller scale growers, who are less concerned about the possibility of criminal sanctions, although we tried to mitigate against this problem by maintaining anonymity, not collecting IP addresses or any other potentially identifying information and publishing a list of actions taken to reduce risks for participants on our website (see <https://worldwideweeds.nl/security-and-anonymity/>). Finally, sub-samples from different countries differed considerably in size, not only due to country populations, but also because of varying recruitment efforts. In Canada, the legalization of cannabis has led to a proliferation of research examining cannabis

consumers. This may have led to a reluctance to participate in the ICCQ 2.0, especially as there was no incentive offered to the participants.

## Conclusions and policy implications

Although the COVID-19 pandemic and related restrictions were the reasons for massive disruptions of international trade (including illegal trade) and often severe travel and social contact restrictions within countries, the pandemic apparently had only a limited impact on the cultivation and supply of cannabis. Where the effects of restrictions were more severe, people were more likely to compensate by starting or increasing home cultivation activity. This illustrates how futile the endeavour to prevent cannabis use (and cultivation) through prohibition is. In addition to public health and social equity considerations, this is another reason to reconsider repressive cannabis policies. Such reconsiderations should particularly take into account home cultivation, as it both contributes to the disempowerment of organised crime groups active in illegal cannabis markets and the avoidance of corporate capture of emerging cannabis markets.

## CRedit authorship contribution statement

**Bernd Wersé:** Writing – original draft, Formal analysis, Data curation, Conceptualization. **Gerrit Kamphausen:** Project administration, Formal analysis, Data curation. **Thomas Friis Søgaard:** Writing – review & editing, Data curation. **Daniel Bear:** Investigation, Writing – review & editing. **Martin Audran:** Formal analysis. **Chris Wilkins:** Writing – review & editing, Data curation. **Gary Potter:** Writing – review & editing, Formal analysis, Conceptualization. **Davide Fortin:** Writing – review & editing, Writing – original draft, Formal analysis. **Pekka Hakkarainen:** Writing – review & editing, Formal analysis. **Rita Faria:** Writing – review & editing, Formal analysis. **Jorge Quintas:** Writing – review & editing. **Jodie Grigg:** Software, Data curation, Conceptualization. **Marie Jauffret-Roustide:** Writing – review & editing, Data curation. **Monica J. Barratt:** Writing – review & editing, Methodology, Data curation, Conceptualization.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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