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Knowledge about and attitudes towards medical cannabis among Austrian university students

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ABSTRACT

Background: The relevance of medical cannabis (MC) increases; and, educating those who are at the forefront of patient care is imperative. Yet, research on medical students' expertise and opinions is still scarce.
Objective: This study set out to evaluate Austrian medical students' knowledge about and attitudes towards MC and compare them with other academic disciplines. Additionally, gender was controlled for.
Methods: An online survey was conducted with N = 404 students enrolled in (1) medical studies, (2) studies with a medical background and (3) studies without a medical background.
Results: In contrast to non-medical students, 64 % of medical students said they learnt about MC at the university. Although students were confident about their knowledge, they struggled to differentiate between CBD and THC. Chronic pain, oncological diseases and palliative care were the most frequently cited indications, psychiatric indications, however, were mentioned less often. Medical students were more reserved in their attitudes towards increasing medical usage and legalizing cannabis than the two other groups. Also, they were more skeptical about whether physicians should be allowed to prescribe MC and whether they should be obliged to offer it. Males showed more confidence regarding cannabis knowledge and were more favorable of legalizing and prescribing cannabis; females perceived cannabis as more physically addictive and as a gate-way drug.
Conclusions: Considering that beliefs and attitudes shape behavior, it is expected that future health care professionals will struggle with recommending cannabis for medical treatment. A coordinated approach for medical training is needed to ensure high standard medical care.

1. Introduction

Apart from being the most frequently consumed illicit drug worldwide,[1–3] cannabis has been used throughout history for the treatment of various ailments.[4] *Cannabis sativa* comprises over 100 different cannabinoids, with Δ9-tetrahydrocannabidiol (THC) and cannabidiol (CBD) being the two most important agents.[5,6] While THC unfolds a psychoactive effect through stimulating CB_1 receptors, CBD is less affine for CB_1 receptors, and is considered an antagonist and inverse agonist to the same receptors. Although this interaction pattern provides no direct psychoactive effect, it does regulate the psychoactive effect of THC.[7] THC has been associated with – amongst others – anxiety, dysphoria, positive psychotic symptoms, and sedation. CBD, in turn, is considered to have anxiolytic, anticonvulsive and antipsychotic effects.[6]

In Austria, THC containing products or combinations of THC and CBD have been approved for medical purposes in 2018.[8] Epidiolex was approved by the EMA in 2019,[9] however CBD is not classified as a drug but as aromatic oil and can therefore be purchased over the counter. Pharmacies provide CBD with certified quality and content and some doctors prescribe CBD for various conditions. The use and prescription of the whole plant is not legal for medical or other purposes in Austria.

While systematic data on efficacy, safety, dosing, and drug-drug interactions continues to accumulate,[10,11–13] medical curricula have failed to keep pace.[14] Past studies on physicians have revealed gaps in knowledge and have shown a lack of confidence to prescribe it.[10,14–20] Similar to their more experienced colleagues, pharmacy students[4,21,22] and medical students[23] report low levels of comfort answering patient questions about medical cannabis (MC). At the same time, there is a strong desire for more formal education on MC among students.[4,20]

When asked about specific indications, accurate responses were low

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for both student groups (pharmacy[3,4,22]; medicine[24,25]). Students most frequently mentioned cancer, nausea, glaucoma and pain as indications for MC. Past studies also suggest gender differences in cannabis specific knowledge among students, yet existing findings are inconclusive. While Sobczynski et al.[26] found females to be more knowledgeable about associated health risks and males to be more supportive of the medical use of cannabis, others[27] reported no gender differences.

Given that medical students will play a significant role in patient care, not only their state of knowledge but also their attitudes are expected to impact their actions.[28] Accordingly, a study[27] succeeded in showing that those physicians who adopt a more favorable attitude towards cannabis tended to recommend it more often. Generally, past research has found the majority of pharmacy and medical students to encourage legalization of cannabis.[3,4,24,25] Again, gender differences have been reported for attitudes towards cannabis with males being more supportive of legalization in most studies[24,25,28]; and only one study reports vice versa results.[23]

As the relevance of MC continues to increase, formally educating those who are at the forefront of patient care seems imperative. In contrast to pharmacy students, only little research (none so far for Austria) exists on cannabis related knowledge and attitudes of medical students. Moreover, past studies have failed to ask students about the difference between THC and CBD. Prior research, however, shows that physicians are poor at differentiating the two.[29] Also, they mostly do not know products containing CBD alone and thus, tend not to prescribe them.[30] Furthermore, there is still a lack of evidence on possible gender differences with regards to cannabis related knowledge and attitudes.

Hence, the current study set out to evaluate Austrian medical students and contrast their knowledge about and attitudes towards MC with other academic disciplines (with and without a medical background). Additionally, a possible influence of gender was controlled for. Based on prior literature, we expected medical students to show gaps in knowledge regarding the properties of MC and specific indications for its use in medicine. Furthermore, we anticipated to find differences between male and female students with regards to their knowledge of and attitudes towards MC.

2. Methods

2.1. Procedure and participants

An online survey was conducted via *SoSci Survey* (https://www.soscisurvey.de/). Data were collected anonymously, and no sensitive background information (i.e., IP-address) was stored. For recruitment, we targeted those groups on Facebook and Instagram, which contained information pertinent to different academic fields of study. To ensure representativeness, we aimed for an inclusion of a broad range of disciplines in academia. Furthermore, to prevent a possible cross-cultural bias, we only targeted those social media groups which were related to an Austrian academic institution. Upon agreeing to the online informed consent, participants were asked to fill out a set of questionnaires which took about 20 min to be completed. The current study was approved by the local institutional review board (#1014/2019).

2.2. Measures

Apart from a survey assessing demographic variables such as gender, age, educational level and field of study, participants completed the following measures:

2.2.1. Cannabis in curriculum

A single dichotomous item ("Have you learned about medical cannabis at the university?" – yes/no) measured whether participants had previously heard about the usage of MC at the university (in the context of one of their courses).

2.2.2. Confidence

Participants were asked to evaluate their own general knowledge about MC ("How would you rate your knowledge about medical cannabis?") on a visual analogue scale (VAS, 100 mm, coded as 1 = non-existent, 101 = extensive).

2.2.3. Factual knowledge

Factual cannabis knowledge was assessed using three questionnaires which were developed based on prior research.[5,6,11,13,31]

First, participants indicated whether they knew the difference between CBD and THC (yes/no single item: "Do you know the difference between CBD and THC?"). Second, they rated their agreement on a 5-point-Likert-scale (1 = do not agree at all, 5 = fully agree) to the following 12 statements (6 each for CBD and THC): CBD/THC leads to (1) increase in appetite; (2) high-state; (3) decrease in pain; (4) anti-emetic effect; (5) decrease in anxiety; and, (6) inflammatory inhibition.

Finally, participants were asked to decide whether MC was indicated for (yes/no items): (1) multiple sclerosis; (2) chronic pain; (3) oncological diseases; (4) in palliative care; (5) addiction; (6) epilepsy; (7) acquired immune deficiency syndrome (AIDS); (8) rheumatic diseases; (9) arthritis; (10) Tourette syndrome; (11) glaucoma; (12) anxiety disorder; (13) depression; (14) schizophrenia; (15) obsessive compulsive disorder (OCD); (16) attention deficit hyperactivity disorder (ADHD); (17) psychosis; and, (18) eating disorders (ED). In the current study, analyses were conducted on the item level; however, when computing the internal consistency for an overall sum score, Cronbach's alpha is acceptable: $\alpha = 0.768$.

2.2.4. Attitudes

A self-constructed questionnaire[3,24,32] assessed attitudes towards cannabis using 12 items on a 5-point-Likert-scale (1 = do not agree at all, 5 = fully agree). Participants rated their approval to statements like "every doctor should be allowed to prescribe medical cannabis" or "cannabis should never be used in psychiatry" (see Appendix A). To address the main research question, this scale was analyzed on the item level. Yet, internal consistency for a sum sore of overall attitude towards cannabis (after accounting for reverse items) is good: Cronbach's $\alpha = 0.811$.

3. Results

Data were analyzed using IBM SPSS 26 (SPSS, Inc. Chicago, USA), considering a significance level of $p < .05$. Univariate Analyses of Variance (ANOVAs) with between-factors gender (male/female) and field of study (medical studies/studies with a medical background/studies with no medical background) were used to analyze students' knowledge about and attitudes towards MC. Post-hoc tests (Tukey, 95 %-CI) were conducted, and effect sizes (par. η^2, Cohen's d) are reported for all comparisons. In addition, χ^2-tests were used for categorical variables.

3.1. Sample

Initially, N = 481 participants filled out the online survey. However, dropouts, incomplete data (> 50 % missings) or sets with conspicuous response patterns were excluded. Additionally, only Austrian students were included to avoid a bias due to national differences in academic curricula. This was controlled for via a single item asking participants at the beginning of the survey whether they were studying in Austria. Hence, the final sample consisted of N = 404 students. Based on their field of study, participants were divided into three groups: n = 186 medical students, n = 95 students with a medical background (e.g.,

psychology, pharmacology, nursing, veterinary medicine, physiotherapy and social work), and n = 123 students without a medical background (i.e., sociology, legal studies, philosophy, languages, study of natural resources and life sciences, art history). The majority (73 %) of participants were female (27 % male), and the mean age was M = 23.11 years (SD = 3.96). Participants' enrolled semesters ranged between 1–18 semesters (M = 5.68, SD = 3.31), see Table 1.

3.2. Knowledge about cannabis

Significantly more medical students reported to have *previously heard about MC at the university* than the other two groups. Also, more males than females indicated to have learnt about MC. No differences were found regarding the knowledge about the *difference between CBD and THC*, neither for gender nor for study discipline (see Table 1). With regards to *evaluating their confidence* (Table 2), a univariate ANOVA revealed a main effect of gender, with males (M = 49.78, SD = 26.52) rating their level of knowledge higher than females (M = 41.33, SD = 21.07), $t(161.75)$=-2.991, p = .003, d=0.35).

Univariate ANOVAs (Table 2) revealed a main effect of discipline with medical students more often affirming that *CBD affected appetite* than those without a medical background (Tukey post-hoc p = .037). Another main effect of discipline was detected for *CBD and pain reduction*, yet Tukey was non-significant; the interaction gender x field of study revealed that male medical students were more convinced that CBD reduced pain (M = 3.63, SD = 0.87) than female medical students (M = 4.27, SD = 0.69). Similarly, field of study revealed a main effect for *CBD and anxiety reduction* (Tukey was n.s). The interaction gender x discipline indicated that male students with a medical background (M = 4.50, SD = 0.53) more often agreed that CBD intake lead to a reduction of anxiety than females (M = 4.00, SD = 0.812).

When looking at THC effects, males without a medical background (M = 3.26, SD = 0.65) more often agreed that *THC led to an inhibition of inflammatory processes* than females (M = 2.81, SD = 0.72). Also, a main effect of discipline showed that students without a medical background were more convinced that *THC led to a high* than students with a medical background (Tukey p = .033).

Finally, χ^2-tests were conducted for *MC indications*. Almost unanimously, chronic pain was cited by virtually all students (no group difference) (Fig. 1). Oncology ($\chi^2(2) = 58.282$, $p < .001$) and palliative care ($\chi^2(2) = 74.989$, $p < .001$) received the highest rates of approval from

Table 1
Sample characteristics.

	medical studies (n = 186)	medical background (n = 95)	no medical background (n = 123)	females (n = 294)	males (n = 109)
% female	64.5 %	81.1 %	79.5 %	73.0 %	27.0 %
age *M* (*SD*)	23.29 (3.04)	22.19 (3.34)	23.61 (5.41)	22.82 (4.06)	23.96 (3.56)
range	18–41	18–38	18–54	18–54	18–41
semester M (SD)	7.08 (3.05)	3.97 (2.30)	4.68 (3.41)	5.34 (3.19)	6.64 (3.45)
range	1–15	1–11	1–18		
Learnt about MC at university (yes)	63.4 %	44.2 %	22.0 %	40.5 %	62.4 %
Group difference	$\chi^2(2) = 51.478$, p<.001			$\chi^2(1) = 15.347$, p<.001	
Knows difference THC vs. CBD (yes)	77.4 %	81.1 %	82.9 %	77.6 %	86.2 %
Group difference	$\chi^2(1) = 3.737$, p = .053			$\chi^2(2) = 1.495$, p = .474	

Note: MC = medical cannabis.

Table 2
Differences between gender and field of study regarding confidence and actual knowledge on medical cannabis.

	FEMALES			MALES			univariate ANOVAs								
	(1) medical studies	(2) medical background	(3) no medical background	(1) medical studies	(2) medical background	(3) no medical background	Main effect field of study			Main effect gender			Interaction		
	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	F	*p*	par. η^2	F	*p*	par. η^2	F	*p*	par. η^2
Confidence (VAS)	42.17 (18.88)	42.32 (22.60)	39.51 (22.42)	47.67 (25.41)	60.61 (30.40)	47.56 (25.59)	2.358	.096	.012	**13.887**	**.000**	**.034**	1.741	.177	.009
CBD – appetite	3.68 (1.01)	3.57 (1.00)	3.26 (1.23)	3.46 (1.11)	3.60 (1.12)	3.05 (1.28)	**3.176**	**.043**	**.023**	0.737	.391	.003	0.228	.796	.002
CBD – high	2.07 (1.21)	1.68 (0.89)	2.01 (1.20)	1.57 (0.94)	1.93 (1.10)	1.57 (1.08)	0.014	.986	.000	2.192	.140	.008	2.116	.122	.015
CBD – pain	4.27 (0.69)	4.20 (0.88)	4.23 (0.83)	3.63 (0.87)	4.43 (0.65)	4.05 (0.41)	**3.960**	**.020**	**.028**	3.143	.077	.011	**5.566**	**.004**	**.039**
CBD – antiemetic	4.03 (0.71)	3.70 (0.91)	3.64 (0.92)	3.70 (0.69)	4.08 (0.79)	3.63 (0.90)	1.719	.181	.013	0.018	.894	.000	2.906	.057	.022
CBD – anxiety	4.08 (0.82)	4.00 (0.81)	3.90 (1.04)	3.64 (1.01)	4.50 (0.53)	3.75 (0.85)	**3.283**	**.039**	**.024**	0.044	.833	.000	**4.044**	**.019**	**.030**
CBD – inflammat.	3.65 (0.86)	3.78 (0.83)	3.83 (0.83)	3.49 (0.99)	4.00 (0.91)	3.68 (0.89)	2.292	.103	.018	0.057	.811	.000	0.757	.470	.006
THC – appetite	4.43 (0.74)	4.41 (0.70)	4.37 (0.77)	4.48 (0.71)	4.71 (0.47)	4.57 (0.51)	0.394	.674	.003	3.426	.065	.012	0.631	.533	.004
THC – high	4.64 (0.74)	4.44 (0.90)	4.67 (0.60)	4.78 (0.64)	4.53 (0.72)	4.96 (0.21)	**3.350**	**.036**	**.022**	3.230	.073	.011	0.360	.698	.002
THC – pain	4.01 (0.67)	3.79 (0.89)	3.74 (0.80)	3.79 (0.90)	4.06 (0.75)	3.95 (0.95)	0.169	.844	.001	0.590	.443	.002	2.366	.096	.017
THC – antiemetic	3.28 (1.01)	2.75 (1.06)	2.73 (0.97)	3.20 (0.89)	3.27 (1.16)	3.15 (1.14)	1.999	.138	.015	3.735	.054	.014	2.052	.131	.015
THC – anxiety	3.00 (1.11)	3.02 (1.07)	2.78 (1.13)	2.72 (1.07)	2.94 (1.48)	2.36 (1.36)	2.095	.125	.015	2.626	.106	.009	0.298	.743	.002
THC – inflammation	3.01 (0.93)	2.90 (0.77)	2.81 (0.72)	2.77 (0.77)	2.75 (1.18)	3.26 (0.65)	0.894	.410	.007	0.028	.867	.000	**3.381**	**.036**	**.026**

Note: Bold values indicate significant results with p < .05.

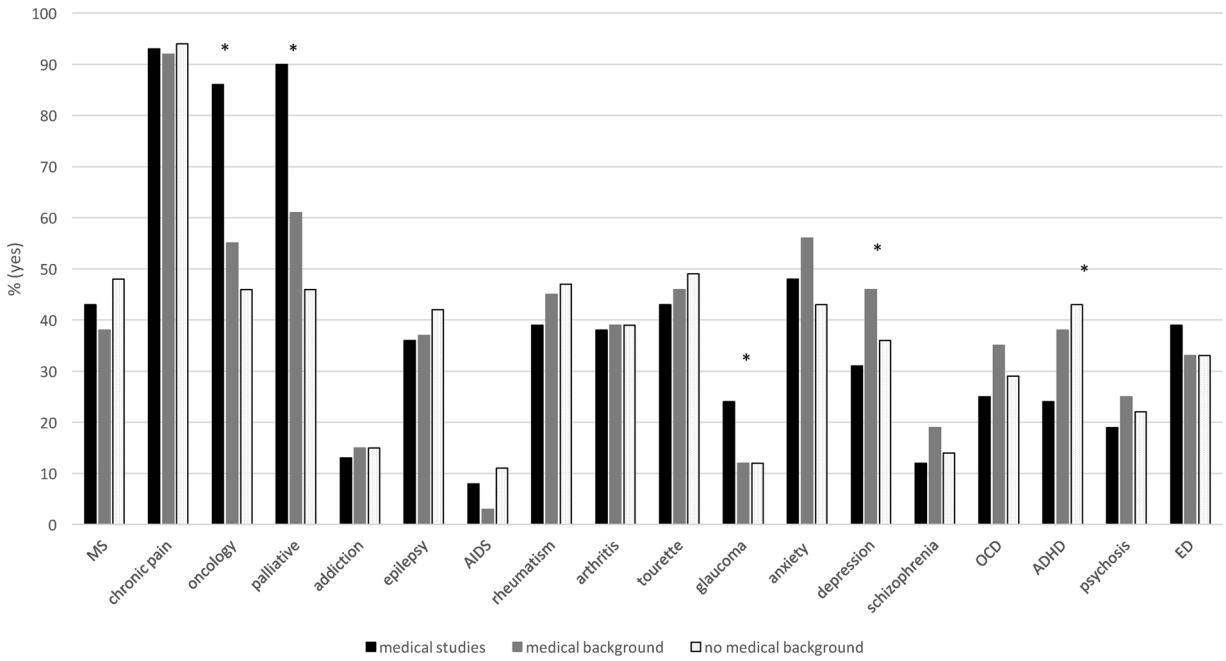

Fig. 1. Percentages of students' affirmative responses regarding the indications for MC.
Note: * indicates a significant difference at $p < .05$ (χ^2), MS: multiple sclerosis, AIDS: acquired immune deficiency syndrome, OCD: obsessive compulsive disorder, ADHD: attention deficit hyperactivity disorder, ED: eating disorder.

medical students. Similarly, medical students more often indicated glaucoma as a possible indication ($\chi^2(2) = 10.440$, $p = .005$). Among psychiatric conditions, anxiety was the most frequently cited indication (no group differences). Depression, in turn, was more frequently chosen by students with a medical background ($\chi^2(2) = 6.250$, $p = .044$), and ADHD was endorsed most by those with no medical background ($\chi^2(2) = 13.178$, $p = .001$). With regards to gender, the only differences in approval ratings emerged for glaucoma (males: 31 %, females: 13 %, $\chi^2(1) = 18.970$, $p < .001$) and ED (males: 52 %, females: 28 %, $\chi^2(1) = 19.051$, $p < .001$), see Fig. 2.

3.3. Attitudes towards cannabis

Univariate ANOVAs (see Table 3) revealed a main effect of discipline and of gender with regard to the question whether *doctors should be allowed to prescribe* MC. In particular, males (M = 3.59, SD = 1.32) more

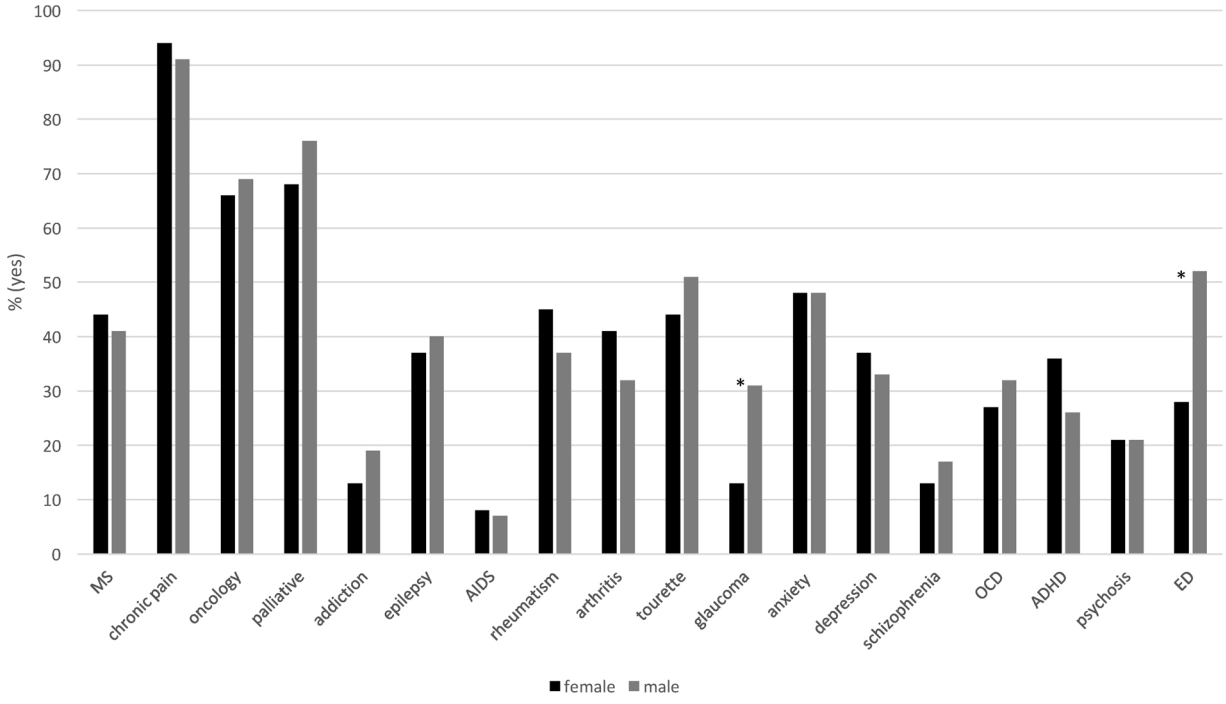

Fig. 2. Percentages of male and female affirmative responses regarding the indications for MC.
Note: * indicates a significant difference at $p < .05$ (χ^2), MS: multiple sclerosis, AIDS: acquired immune deficiency syndrome, OCD: obsessive compulsive disorder, ADHD: attention deficit hyperactivity disorder, ED: eating disorder.

Table 3
Differences between gender and field of study regarding attitudes towards medical cannabis.

	FEMALES			MALES			univariate ANOVAs								
							Main effect field of study			Main effect gender			Interaction		
	(1) medical studies M (SD)	(2) medical background M (SD)	(3) no medical background M (SD)	(1) medical studies M (SD)	(2) medical background M (SD)	(3) no medical background M (SD)	F	*p*	par. η^2	F	*p*	par. η^2	F	*p*	par. η^2
1) allowed to prescribe	2.88 (1.16)	3.27 (1.30)	3.27 (1.38)	3.34 (1.29)	4.00 (1.17)	4.00 (1.38)	**6.245**	**.002**	**.031**	**15.278**	**.000**	**.038**	0.430	.651	.002
2) obliged to offer	2.16 (1.05)	2.77 (1.29)	2.65 (1.28)	2.16 (1.17)	3.47 (1.38)	2.71 (1.40)	**14.692**	**.000**	**.071**	2.640	.105	.007	1.853	.158	.009
3) physically addictive	2.46 (1.13)	2.49 (1.16)	2.47 (1.29)	1.94 (1.05)	1.88 (1.17)	2.00 (1.08)	0.039	.962	.000	**12.916**	**.000**	**.033**	0.052	.949	.000
4) psychologically addictive	3.90 (0.80)	3.82 (0.83)	3.89 (0.94)	4.06 (0.81)	3.56 (0.86)	4.04 (1.02)	2.608	.075	.013	0.017	.897	.000	1.449	.236	.007
5) health insurance	3.95 (0.96)	4.09 (0.91)	4.18 (0.95)	3.98 (1.02)	4.44 (0.78)	4.13 (0.90)	2.544	.080	.013	0.869	.352	.002	0.829	.437	.004
6) medical curriculum	4.24 (0.72)	4.25 (0.78)	4.28 (0.91)	4.11 (0.94)	4.78 (0.43)	4.42 (0.65)	**4.121**	**.017**	**.021**	2.982	.085	.008	**3.824**	**.023**	**.019**
7) gateway drug	3.13 (1.27)	3.01 (1.21)	3.13 (1.30)	2.98 (1.34)	2.11 (1.13)	2.84 (1.52)	**3.241**	**.040**	**.016**	**7.508**	**.006**	**.019**	1.852	.158	.009
8) usage somatic medicine	1.80 (0.86)	2.15 (0.90)	1.98 (0.79)	1.69 (0.93)	1.94 (1.09)	1.67 (0.64)	2.495	.084	.013	3.559	.060	.010	0.336	.715	.002
9) usage psychiatry	2.19 (1.07)	2.50 (1.17)	2.75 (1.25)	1.86 (0.88)	2.12 (1.27)	2.71 (1.60)	**9.625**	**.000**	**.049**	2.884	.090	.008	0.500	.607	.003
10) legalized general use	3.13 (1.35)	3.21 (1.34)	3.44 (1.34)	3.64 (1.34)	4.35 (0.79)	3.88 (1.27)	2.401	.092	.012	**17.300**	**.000**	**.042**	1.409	.246	.007
11) used more in medicine	3.61 (0.96)	3.97 (0.95)	4.16 (0.78)	3.56 (0.99)	4.41 (0.87)	4.25 (0.74)	**16.710**	**.000**	**.081**	1.819	.178	.005	1.517	.221	.008
12) usage children	4.02 (1.08)	3.92 (1.16)	3.79 (1.12)	4.08 (1.19)	3.72 (1.41)	4.04 (1.08)	0.959	.384	.005	0.064	.800	.000	0.632	.532	.003

Note: Bold values indicate significant results with $p < .05$.

often agreed with the statement than females (M = 3.11, SD = 1.28), and students without a medical background more often affirmed this question than medical students (Tukey $p = .037$). Also, a main effect of study group was found for whether *doctors should be obliged to offer* MC: medical students significantly less often agreed to it than the other two study groups (Tukey *ps*<.001). Furthermore, a main effect of gender showed that females (M = 2.47, SD = 1.19) were more convinced that *cannabis was physically addictive* than males (M = 1.94, SD = 1.07).

The question whether *cannabis should be part of the medical curriculum* revealed a main effect of discipline, yet Tukey was n.s. (all *ps*>.05). An interaction gender x field of study indicated that males with a medical background (M = 4.78, SD = 0.43) more often agreed to this statement than females (M = 4.25, SD = 0.78). Furthermore, there was a main effect of study group regarding *cannabis as a gateway drug*, yet Tukey was n.s. (all *ps*>.05). In addition, more females (M = 3.10, SD = 1.26) than males (M = 2.80, SD = 1.38) agreed that *cannabis was a gateway drug*. Correspondingly, the *legalization of cannabis* was approved less by females (M = 3.25, SD = 1.35) than males (M = 3.81, SD = 1.27). Moreover, we found a that medical students approved less of the *usage of cannabis in psychiatry* than the other student groups (Tukey $p < .001$). Similarly, medical students were significantly less convinced that *cannabis should be used more often in medicine* than students from other disciplines (Tukey *ps*<.001).

4. Discussion

More than half of medical students said they learnt about MC at the university. In comparison, only few participants with no medical background indicated that they learnt about this subject in the context of their academic studies. Furthermore, most students – regardless of gender and discipline – stated they knew the difference between CBD and THC.

Overall, students were quite confident about what they knew about MC; yet, when quizzed about their factual knowledge, they showed difficulties providing the correct answers. Chronic pain, oncological diseases and palliative conditions ranged among the most cited conditions for which cannabis was indicated. Especially those students who were enrolled in medicine agreed with these indications. Furthermore, medical students, in contrast to their peers from other disciplines, also correctly identified glaucoma as an indication for MC. Psychiatric indications, in turn, were mentioned less frequently by all students, except for depression and ADHD; and, students with a medical background, and those with no medical background significantly more often cited these indications than medical students.

The difficulty of correctly identifying indicated conditions corresponds with past findings.[3,4,22,24,25] On the one hand, this uncertainty may be due to a lack of formal education at the university; on the other hand, however, it may also reflect the largely contradictory data on the subject.[10,13,32] Particularly, evidence for effective usage of MC in psychiatry is still rather scarce.[11]

Even more striking, however, is that medical students were not significantly better than their non-medical peers at identifying known effects of CBD vs. THC. There were no notable differences between the three study groups when asked about CBD and THC. This lack of detailed expertise and ability to discriminate between component-specific effects highlights even more the need for a coordinated formal approach for including this subject in medical curricula.

Interestingly, medical students were more reserved in their attitudes towards increasing medical usage and legalizing cannabis than the two other groups. Overall, they were more skeptical about whether physicians should be allowed to prescribe MC, and about whether they should be obliged to offer it. In accordance with this opinion, medical students also less often agreed that cannabis should be used in psychiatry or in medicine in general. Similar restraints have been observed among physicians who were less supportive of MC than the public.[15] This reflects a discrepancy between the public's wish to be treated with MC and

the hesitancy of specialists.[33] Accordingly, patients' self-initiated use of cannabinoids – particularly in the context of pediatrics – has been reported to be on the rise.[34,35] This imbalance between the general public's and medical professionals' attitudes warrants additional training for medical students, particularly with regard to creating a safe, unprejudiced environment for sensibly taking a complete medical history[14] and for managing requests for MC by patients/caregivers adhering to existing guidelines.[36]

Furthermore, we found that males were more confident concerning their knowledge on cannabis than females. However, this confidence seems only partly rooted in factual knowledge: While male students were indeed more likely than females to correctly cite glaucoma and ED as indications (see also previous studies[37]), males were also no better able to discriminate between CBD and THC than females.

In addition, males were significantly more supportive of legalizing cannabis for general use and more often stated that physicians should be allowed to prescribe MC. Female students, in turn, were more skeptical and voiced more concerns about cannabis being physically addictive and a gateway drug. These results are in line with past research which showed that more women mentioned adverse effects and health risks of cannabis use,[26] and more men were supportive of legalizing cannabis and using it for medical treatment.[24–26,28,38,39] This is consistent with the observation that if one believes that legalization has spill-over effects such as that it leads to increased recreational use, s/he will be less supportive of legalization.[28] In contrast, a non-moralistic attitude, and a conviction that MC has beneficial effects are both associated with stronger support for medical use.[15,28]

Relating these findings to the assumption that subjective norms and attitudes shape intentions to perform behaviors (see *Theory of Planned Behavior*[40]), it is expected that a more negative attitude towards MC will be accompanied by more reluctance to prescribe it. A recent study[27] supports this notion: Using vignettes, the authors were able to show that physicians' intentions to recommend MC significantly depended on the presence of favorable attitudes. Gender differences, however, were not evident in their study.[27] Nevertheless, based on the *Theory of Planned Behavior*[40] we may assume that in our sample, female students may also be more hesitant to recommend cannabis to their patients in their future role as physicians. Although longitudinal research is needed to explore causal associations between attitudes, intentions and factual behaviors, recent research (e.g.,[38,39]) seems to support the notion that gender differences among students persist past the completion of medical training. Both studies[38,39] show that male physicians were more positively minded towards cannabis than female physicians and were more likely to indicate that they would prescribe it. At the same time, there seems to be growing desire for more education on MC, particularly among those still in training.[41] Hence, more instruction and in-depth knowledge is advised, given that it is thought to positively impact attitudes as well as to increase comfort levels of appropriate and safe clinical use.

4.1. Strengths and weaknesses

The current study was the first in Austria to assess university students' knowledge about and attitudes towards cannabis. A large sample size may be counted among the strengths. It allowed us to – for the first time – contrast medical students with those who do not receive medical education and, hence, to examine whether the former have an advantage in knowledge. Also, by explicitly taking gender into account, we were able to accumulate evidence for gender specific attitudes towards cannabis. Finally, we incorporated a questionnaire assessing effects of CBD and THC separately. This was done in light of the increasing usage of CBD-only-products for self-medication[34] and with regards to physicians' inability to distinguish between the two.[29]

At the same time, we did not ask students about the sources of their cannabis related knowledge. Some indicated they had learned about it at the university, yet there was no way of controlling whether or to what extent this knowledge also stemmed from other sources such as newspapers, peers or own experiences. Assessing this in future research would allow to pick up on possible cannabis related prejudices. Finally, we exclusively evaluated Austrian students. While this approach was chosen to inform national education programs, possible cultural differences in attitudes could not be addressed. Prior studies, however, have shown that opinions on cannabis may differ depending on whether it is legalized or not.[28]

4.2. Conclusion

The current results suggest that medical students need additional training to be adequately prepared to answer patients' questions about efficacy, safety, indication and drug-drug interactions. Given the increasing popularity of cannabinoids, a detailed up-to-date knowledge of the scientific literature is indispensable. Appropriate curricular changes are necessary to counteract the risk of medical professionals falling back onto mere beliefs whenever they encounter a patient's desire to use cannabinoids. Overall, a more coordinated approach to include this subject in formal medical training is needed to ensure a high standard in medical care.

Author contributions

Anna Felnhofer designed the study, contributed to the data acquisition, did the data analyses and interpretation of data, drafted the manuscript and approved the final version.

Oswald D. Kothgassner did the data analyses and interpretation of data, also, he revised the manuscript critically and approved the final version to be published.

Astrid Stoll did the data acquisition and added substantially to the conception of the study, also, she revised the manuscript critically and approved the final version to be published.

Claudia Klier designed the study, revised the manuscript critically and approved the final version to be published.

All authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Declaration of Competing Interest

The authors declare that they have no conflict of interest.

Appendix A

Attitudes towards medical cannabis questionnaire

How much do you agree with the following statements?

	do not agree at all	rather not agree	undecided	rather agree	fully agree
1) Every doctor should be allowed to prescribe medical cannabis.					
2) Every doctor is obliged to offer cannabis as a treatment method.					
3) Cannabis is physically addictive.					
4) Cannabis is psychologically addictive.					
5) Health insurance should in any case cover the costs of cannabis treatment if it is prescribed by a doctor.					
6) The medical use of cannabis should be part of the medical curriculum.					
7) Cannabis is a gateway drug.					
8) Cannabis should never be used in somatic medicine.					
9) Cannabis should never be used in psychiatry.					
10) Cannabis should be legalized for general use.					
11) Cannabis should be used more widely in medicine.					
12) Cannabis should never be used in children/adolescents.					

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