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Cannabis and cannabidiol use among autistic and non-autistic adults in the UK: a propensity score-matched analysis

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ABSTRACT

Objectives To assess whether autistic and non-autistic adults differ in their cannabis and cannabidiol (CBD) use, their perceptions of cannabinoid products and their cannabinoid-related support-seeking behaviours.

Design Cross-sectional survey.

Participants Respondents to an online survey, who self-reported an autism-spectrum disorder diagnosis (autistic participants) or no issues relating to autism (controls). Exclusion criteria were: related/subclinical issues relating to autism, non-UK residence, under 16 years old. Propensity score matching was used to match autistic participants and controls on age, gender and ethnicity. The full-sample analysis included 269 participants and the propensity-matched sample analysis included 166 participants. Propensity-matched analysis was used for primary analysis and was considered robust if supported by triangulation with full-sample analysis.

Results Autistic participants were more likely to have used CBD in the past 12 months compared with controls (OR=3.52, 95% CI 1.57 to 7.87, p=0.002). They used CBD on more days in the past 12 months (M=34, SD=93) compared with controls (M=17, SD=69, p=0.002). Autistic participants reported trusting the news and doctors less as sources of cannabinoid-related information than controls (p=0.024 and p=0.003, respectively). Autistic participants endorsed the following barriers to cannabinoid-related support seeking more than controls: 'worrying they won't understand me' (OR=3.25, 95% CI 1.67 to 6.33, p<0.001), 'going somewhere unfamiliar' (OR=5.29, 95% CI 2.62 to 10.67, p<0.001) and 'being in a crowded or chaotic place' (OR=9.79, 95% CI 4.18 to 22.89, p<0.001).

Conclusion Results indicate a higher prevalence and frequency of CBD use, but not cannabis use, among autistic individuals compared with controls. Findings also suggest appropriate methods to disseminate cannabinoid-related support to autistic individuals, and indicate differences in the potential barriers autistic and non-autistic individuals may face when seeking cannabinoid-related support.

Strengths and limitations of this study

► Propensity score matching allows differences between autistic and non-autistic participants to be likelier attributable to autism-spectrum disorder.

► Triangulation of the matched sample analysis to a full-sample analysis increases the robustness of findings when considering exclusion bias introduced through matching.

► Autistic and non-autistic participants were matched on age, gender and ethnicity. It is possible that non-included or unmeasured variables still represent confounding factors.

► Given the exploratory nature of this research, correction for multiple testing was not applied for the majority of analysis. Results should, therefore, be interpreted cautiously.

► Autistic participants were predominantly White, university-educated, and their self-reported diagnoses were not verified by a clinician. Results may not generalise across ethnicities or to individuals who are unable to access online research studies.

INTRODUCTION

Autism-spectrum disorder (ASD) is a neuro-developmental condition defined by social communication difficulties and restricted, repetitive behaviours.[1] ASD may be additionally associated with anxiety and low mood among other challenges.[2 3]

To manage these challenges, autistic individuals may self-medicate using substances.[4] Studies have shown autistic individuals to be two to four times more likely to endorse tobacco, alcohol or other drug-related problems compared with their non-autistic relatives.[5] Even in those without an ASD diagnosis, autism-related difficulties including social communication difficulties and repetitive behaviours may be associated with greater tobacco, alcohol and cannabis use, as evidenced by a large survey of the general adult population.[6] These findings may indicate that substances are used to alleviate difficulties associated with ASD, which is noted in qualitative interviews with substance-using autistic individuals.[7] In line with this notion of self-medication, expectancy theory proposes that substance use is motivated by expectancies that this behaviour will produce a positive effect.[8] A previous study found that the expectancy that alcohol would benefit autism-related difficulties was associated

with higher frequency of alcohol use in autistic individuals.[9] However, expectancies among autistic individuals for other substances have been understudied. One such group of substances is compounds derived from the cannabis plant, called cannabinoids. The two most abundant of these are cannabidiol (CBD), a non-intoxicating cannabinoid, and delta-9-tetrahydrocannabinol (THC), which is intoxicating.

Cannabinoids may help mitigate several difficulties that can be associated with ASD. Epilepsy has been regarded as a frequent comorbidity and exacerbator of behavioural difficulties in autistic individuals.[10] Recently, CBD was approved as an effective treatment for certain forms of epilepsy. Additionally, some evidence suggests that there may be a more substantial effect when CBD is combined with THC.[11] Autistic individuals may also face difficulties with recognising emotions.[12] A randomised placebo-controlled trial found that a single dose of CBD improved emotional face recognition, whereas THC impaired performance on the same task.[13] Animal studies have further shown CBD to exert agonist effects on 5-HT1a serotonin receptors similarly to antidepressants, and so CBD may produce benefits to mood and anxiety.[14] THC may also have benefits for autistic individuals by reducing locomotor activity[15] and in tandem with CBD, improve on hyperactivity and impulsivity.[16] Most recently, a double-blinded randomised controlled trial of CBD and THC in a 20:1 ratio found significant improvements to social responsiveness and disruptive behaviours compared with placebo, among 150 autistic children and adolescents.[17]

While some research indicates potential medicinal uses of cannabinoids for autistic individuals, current research on efficacy and safety is limited[18]. Therefore, cannabinoids are currently not approved as pharmacological interventions for ASD. In the absence of prescribed cannabinoids, or any pharmacological intervention for autistic individuals,[19] some may turn to non-prescribed cannabinoid use. A growing public interest in the use of cannabinoids for medicinal or wellness purposes may facilitate such behaviours.[20] Within the UK, non-prescribed use of cannabinoids largely takes the form of CBD products, which are legally available in health food shops and online, and of non-prescribed cannabis, which is currently illegal.[21]

Overall, CBD has been regarded as a well-tolerated drug with few side effects.[22 23] However, levels of CBD in available CBD products are typically far lower than those administered in clinical trials;[24] hence, the effectiveness of these products remains unknown. Moreover, THC levels in these products are often variable and have been found at times to exceed legal limits in some jurisdictions.[25] Thus, CBD products may currently lack quality assurance and data on their safety or efficacy. It is notable that the recent classification of CBD as a novel food by the European Food Standards Agency has facilitated tightened safety regulations within the UK since March 2021, which may influence these issues with CBD products in the future.[26] Conversely, cannabis use has been associated with increased risk of developing cannabis use disorder and psychosis.[27 28] These effects are attributable to THC, which has been shown during acute administration to produce transient psychotic symptoms and impaired memory in a dose-dependent manner.[29]

Despite the potential risks of cannabis and the lack of quality assurance for CBD products as well as the potential benefits of cannabinoids for ASD, there is a current lack of data on the prevalence and characteristics of their use, across autistic and non-autistic individuals. Current data are limited to diagnosis rates of substance use disorders among autistic adults,[30 31] which fails to capture subclinical cannabinoid use, and how and why autistic individuals use these products. Without this information, the extent of potential benefits or harms caused by unregulated cannabis use among autistic people remains unknown. Moreover, this precludes understanding the aetiological factors of cannabinoid use for autistic individuals, which impedes the development of evidence-based support programmes.[32] To address this gap in the literature, we sought to provide a comprehensive survey of cannabinoid-related behaviours in autistic versus non-autistic individuals, including prevalence and frequency of use, expectancies regarding cannabis and CBD, cannabinoid-use support-seeking behaviours and whether cannabis/CBD use is associated with use of other drugs.
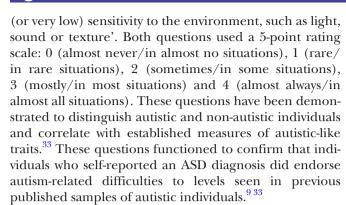
METHOD
Participants and design
A cross-sectional, observational online survey design was used. The survey was open from 4 February to 7 April 2020. Participants were contacted to participate from the Centre for Applied Autism Research, the University of Bath Research Participation Scheme, the Cambridge Autism Research Database and via direct recruitment of friends and family by university students. Participants recruited via the Research Participation Scheme were given course-relevant credits and no other reimbursements were given. Inclusion criteria were as follows: fluency in written English and residing within the UK. Exclusion criteria were as follows: non-UK residence, not providing consent to analyse data, related/subclinical issues relating to ASD and under 16 years old.

Procedure and measures
Respondents accessed the online survey on their personal devices. Respondents were asked for demographic and clinical information. Two questions were then asked regarding autism-related difficulties: 'How often do you have difficulties with social communication and social interaction with other people? (eg, difficulties with normal back-and-forth social conversation or making normal eye contact or making friends)' and 'How often do you have difficulties with restricted and repetitive patterns of behaviours, activities or interests? (eg, difficulties with repetitive movements, or insisting on sameness (or routines), or fixated and intense interests, or very high

(or very low) sensitivity to the environment, such as light, sound or texture'. Both questions used a 5-point rating scale: 0 (almost never/in almost no situations), 1 (rare/in rare situations), 2 (sometimes/in some situations), 3 (mostly/in most situations) and 4 (almost always/in almost all situations). These questions have been demonstrated to distinguish autistic and non-autistic individuals and correlate with established measures of autistic-like traits.[33] These questions functioned to confirm that individuals who self-reported an ASD diagnosis did endorse autism-related difficulties to levels seen in previous published samples of autistic individuals.[9 33]

Respondents were then asked whether they had used alcohol, tobacco, cannabis or CBD products within the past 12 months. Subsequently, respondents were asked to rate how frequently they used cannabis and/or CBD products in the past 12 months, using the following scale: (1) not in the last year, (2) once or two times a year, (3) once every couple of months, (4) once or two times a month, (5) once or two times a week, (6) 3 or 4 days a week, (7) 5 or 6 days a week and (8) almost every day.

Alongside this, respondents completed the Severity of Dependence scale (SDS)[34] for cannabis and then CBD. Five items are scored on a 4-point scale with higher scores indicating greater dependence. A diagnostic cut-off for cannabis dependence has been suggested at a total score of at least 3.[35] The SDS has demonstrated strong internal and test–retest reliabilities, and good discriminant and construct validities in assessing dependence among several substances, including cannabis.[36] Within this study, internal reliability was good for cannabis ($\alpha=0.838$) and CBD ($\alpha=0.845$).

Respondents were then given a 15-item questionnaire adapted from a previous study on alcohol[9] to assess cannabis and CBD expectancies. The first six items relate to commonly endorsed expectancies for substance use identified in the general population[37] (1) global positive changes, (2) changes in social behaviour, (3) improved cognitive and motor abilities, (4) sexual enhancement, (5) cognitive and motor impairment and (6) relaxation and tension reduction. The next seven items are autism-specific expectancies related to diagnostic criteria for autism-spectrum disorder[1] (1) verbal communication; (2) non-verbal communication; (3) developing, maintaining and understanding relationships; (4) stereotyped or repetitive motor movements; (5) insistence on sameness; (6) highly restricted, fixated interests and (7) hyper-reactivity or hyporeactivity to sensory stimuli. Finally, two medical expectancies were included: (1) medicinal properties and (2) safety. A 5-point scale was used for this questionnaire, from (1) almost never/never to (5) almost always/always.

Following this, respondents were asked to rate the extent they agreed that accurate information and labelling of cannabis and CBD products were available to them on visual analogue scales from 0 (least agree) to 100 (most agree). Respondents were then asked to rate how much they trusted certain sources when finding out information about cannabis and/or CBD products from 0 (least trust) to 100 (most trust).

Finally, respondents were asked if they were to experience excessive cannabis/CBD use, where they would go for help, and what they would perceive as barriers to support-seeking. A full view of the survey, including all measures, may be seen in online supplemental materials.

Public involvement statement

No members of the public were involved in the design or analysis of this study. A draft of the manuscript was reviewed by an autistic individual, to ensure that the commentary of the study was appropriate and not out of line with the lived experiences of an autistic person. Specifically, they commented that the available support after their autism diagnosis was very limited, and this study's findings were concordant with their own use of CBD oil as a form of self-medication. Additionally, they reported that the identity-first language used in this paper (ie, 'autistic person' rather than 'person with autism') was preferred, as was the focus on the perspective of autistic individuals rather than the perspective of carers.

Analysis

The focus of our analysis was to compare autistic and non-autistic individuals on cannabinoid use behaviours and related factors. In order to account for the likelihood that autistic participants differed on key demographic variables to control participants, propensity score matching on age, gender and ethnicity was conducted to obtain groups with similar demographics. This allows differences between groups to be likelier attributable to ASD. Following recommendations, 1:1 nearest neighbour logistic regression matching with replacement, with a tolerance level of 0.03, was chosen.[38 39] Several authors have noted matching with or without replacement is generally comparable, and, indeed, this produced the same sample size in the current study.[40 41] Given the reduction in confounding by demographic factors in the matched sample, this method is more conservative than the full-sample analysis and was chosen as the primary method for analysis. Elimination of data to obtain matched samples may, however, introduce exclusion bias. Therefore, to ensure that any case–control differences were robust to different analytical methods, propensity score matching results were triangulated with full-sample analysis results. Group differences were only considered robust if supported by triangulation between propensity score matching and full sample analysis results.[42]

Differences between autistic and control groups were assessed using χ^2 independence tests, Fisher's exact tests, independent-sample t tests, and Mann-Whitney U tests as appropriate with an alpha level of 0.05. Effect sizes were computed as ORs or r ($Z/(\sqrt{N})$ for χ^2 independence tests and Mann-Whitney U tests, respectively. Post-hoc Spearman's Rho correlations were used to assess within-group associations between autism-related difficulties (social communication difficulties and restricted, repetitive

behaviours) and frequency of cannabis/CBD use, using Bonferroni-adjusted alpha levels of 0.025 (0.05/2). Post-hoc Spearman's Rho correlations were also used to assess within-group associations between expectancies of cannabis/CBD use and frequency of cannabis/CBD use, using Bonferroni-adjusted alpha levels of 0.0125 (0.05/4). No adjustment was made for other analyses. Missing data were handled through pairwise deletion.

RESULTS

A total of 378 respondents accessed the survey. Thirty-two respondents were excluded due to non-UK residence, and 62 respondents did not provide consent to take part. Fifteen respondents indicated they did not have a formal ASD diagnosis but had related, subclinical issues. To ensure the group of autistic individuals was consistent, and to obtain a comparison between ASD diagnosed and non-ASD diagnosed groups, we excluded these respondents from analysis. Finally, propensity score matching to obtain a matched sample resulted in the exclusion of 103 participants. The final sample size was 166. Matched sample characteristics are seen in table 1, while full sample characteristics can be viewed in online supplemental table S1.

As shown in table 2, autistic participants were significantly less likely to have drank alcohol in the past 12 months compared with control participants, and this finding was supported by the full-sample analysis (online supplemental table S2). Groups were comparable in their use of tobacco in the past 12 months.

Autistic participants were significantly more likely to have used CBD in the past 12 months compared with control participants, and this finding was supported by the full-sample analysis (online supplemental table S2). Groups were similar in their use of cannabis in the past 12 months.

Autistic participants used CBD significantly more frequently compared with control participants, with a small-to-medium effect. This was supported by the full-sample analysis (online supplemental table S2). No differences in frequency of cannabis use between groups were found. Autism-related difficulties (social communication difficulties and restricted, repetitive behaviours) were not significantly correlated with frequency of cannabis or CBD use in the past 12 months, within either the autistic or control groups (all p values >0.05).

Both groups had comparable severity of dependence scores, for cannabis and for CBD.

In autistic participants, alcohol use was significantly associated with CBD use, while tobacco use was significantly associated with cannabis use in both autistic and control participants (online supplemental materials).

Table 3 shows between-group differences in cannabis use and CBD use expectancies. Groups were comparable on recreational drug use and autism-specific expectancies for cannabis use and whether they thought cannabis was safe and had medicinal properties. In the

Table 1 Demographic and clinical information for propensity score matched autistic and control participants

	ASD diagnosis n (%)	Control n (%)	Comparison test
Sample size	83	83	
Age			t(158)=0.01, p=0.993
N	83	83	
M	37.39	37.41	
SD	15.46	18.72	
Range	18–71	18–91	
Gender			p = 1.000†
Female	51 (61.4)	51 (61.4)	
Male	30 (36.1)	31 (37.3)	
Non-binary	2 (2.4)	1 (1.2)	
Ethnicity			p = 1.000†
White	78 (94.0)	79 (95.2)	
Asian or Asian British	1 (1.2)	1 (1.2)	
Mixed or Multiple Ethnic Groups	1 (1.2)	1 (1.2)	
Black, African, Caribbean or Black British	1 (1.2)	0 (0.0)	
Other Ethnic Group	1 (1.2)	0 (1.2)	
Omitted	1 (1.2)	2 (2.4)	
Highest education level			p = .294†
University degree	64 (77.1)	69 (83.1)	
A levels	14 (16.9)	7 (8.4)	
GCSEs	5 (6.0)	6 (7.2)	
Below GCSE	0 (0.0)	1 (1.2)	
Employment			χ²(2)=0.86, p=0.651
Full time	26 (31.3)	30 (36.1)	
Part time	16 (19.3)	12 (14.5)	
Unemployed	41 (49.4)	41 (49.5)	
Age of diagnosis			t(8.31)=−0.79, p=0.449
N	58	5	
M	30.47	27.40	
SD	16.40	7.16	
Range	3–63	19–36	
ASD			N/A
Diagnosis	83 (100.0)	0 (0.0)	
No diagnosis	0 (0.0)	83 (100.0)	
ADHD			p = .059†

Continued

Table 1 Continued

	ASD diagnosis n (%)	Control n (%)	Comparison test
Diagnosis	5 (6.0)	0 (0.0)	
No diagnosis	78 (94.0)	83 (100.0)	
OCD			$\chi^2(1)=6.81$, p=0.009*
Diagnosis	9 (10.8)	1 (1.2)	
No diagnosis	74 (89.2)	82 (98.8)	
Anxiety			$\chi^2(1)=40.44$, p<0.001*
Diagnosis	45 (54.2)	7 (8.4)	
No diagnosis	38 (45.8)	76 (91.6)	
Depression			$\chi^2(1)=27.14$, p<0.001*
Diagnosis	45 (54.2)	13 (15.7)	
No diagnosis	38 (45.8)	70 (84.3)	
Panic			$\chi^2(1)=7.80$, p=0.005*
Diagnosis	12 (14.5)	2 (2.4)	
No diagnosis	71 (85.5)	81 (97.6)	
PTSD			$\chi^2(1)=7.89$, p=0.005*
Diagnosis	10 (12.0)	1 (0.6)	
No diagnosis	73 (88.0)	82 (99.4)	
Intellectual disability			p = .682†
Diagnosis	5 (6.0)	2 (2.4)	
No diagnosis	78 (94.0)	81 (97.6)	
Psychosis			N/A
Diagnosis	0 (0.0)	0 (0.0)	
No diagnosis	83 (100)	83 (100.0)	
Other			$\chi^2(1)=14.55$, p<0.001*
Diagnosis	18 (21.7)	2 (2.4)	
No diagnosis	65 (78.3)	81 (97.6)	

*p < 0.05.
†Fisher's exact test used due to low expected cell count.
ADHD, attention deficit hyperactivity disorder; A levels, advanced levels (further education qualification); ASD, autism spectrum disorder; GCSE, general certificate of secondary education (further education qualification); N/A, not applicable; OCD, obsessive compulsive disorder; PTSD, post-traumatic stress disorder.

control group, frequency of cannabis use in the past 12 months was significantly positively correlated with recreational drug use expectancies, $r_s=0.356$, p=0.001, N=80, the expectancy that cannabis is safe, $r_s=0.563$, p<0.001, N=81 and the expectancy that cannabis has medicinal properties, $r_s=0.284$, p=0.010, N=81. In the autistic group, frequency of cannabis use in the past 12 months was significantly positively correlated with recreational drug use expectancies, $r_s=0.348$, p=0.001, N=82, and the expectancy that cannabis is safe, $r_s=0.424$, p<0.001, N=83. All other correlations were non-significant. Differences in non-grouped cannabis expectancies between autistic and non-autistic individuals are shown in online supplemental table S3.

Control participants endorsed recreational drug use expectancies of CBD use to a significantly greater extent compared with autistic participants, with a small-to-medium effect that was also supported by the full-sample analysis (online supplemental table S4). Groups were comparable on the extent they endorsed autism-specific expectancies of CBD use, whether CBD was safe and whether it had medicinal properties. In the control group, frequency of CBD use in the past 12 months was significantly positively correlated with the expectancy that CBD has medicinal properties, $r_s=0.345$, p=0.002, N=77, and the expectancy that CBD is safe, $r_s=0.343$, p=0.002, N=77. In the autistic group, frequency of CBD use in the past 12 months was significantly positively correlated with the expectancy that CBD is safe, $r_s=0.321$, p=0.003, N=82. Differences in non-grouped CBD expectancies between groups are shown in online supplemental table S5.

Autistic and non-autistic participants were comparable in how they perceived the accuracy of information conveyed to them about cannabis and CBD (online supplemental table S6).

Table 4 displays autistic and non-autistic participants' ratings of trust for various sources of information regarding cannabinoids. Autistic participants trusted 'News' less than controls, with a small-to-medium effect size. Similarly, the autistic group reported less trust for doctors compared with controls, with a small-to-medium effect. Both of these group differences were replicated within the full-sample analysis (online supplemental table S7). All other sources of information were perceived to be equally trustworthy by autistic and non-autistic participants.

No significant differences were found between autistic and non-autistic participants for who they stated they would seek support for reducing cannabis/CBD use from. Searching online for information and going to the doctor/GP were the two most popular sources of support for autistic participants, both endorsed by 56.6% of autistic participants. See online supplemental table S8 for full details.

Barriers to seeking support for cannabis/CBD use are shown in table 5. Autistic participants, compared with control participants, were significantly more likely to endorse the following as barriers: worrying they would not be understood, going somewhere unfamiliar and being in a crowded or chaotic place. All of these group differences were supported by the full-sample analysis (online supplemental table S9).

Table 2 Prevalence and frequency of substance use and severity of dependence, among autistic and control participants

	ASD diagnosis	Control	Comparison test
	Number of participants endorsing substance use in past 12 months (%)		
Alcohol	63 (75.9)	77 (92.8)	$\chi^2(1)=8.94$, p=0.003* $n_1=83$, $n_2=83$ OR=0.25 (0.09 to 0.65)
Tobacco	26 (31.3)	25 (30.1)	$\chi^2(1)=0.03$, p=0.866 $n_1=83$, $n_2=83$ OR=1.06 (0.55 to 2.05)
Cannabis	21 (25.3)	30 (36.1)	$\chi^2(1)=2.29$, p=0.130 $n_1=83$, $n_2=83$ OR=0.60 (0.31 to 1.17)
CBD	27 (32.5)	10 (12.0)	$\chi^2(1)=10.05$, p=0.002* $n_1=83$, $n_2=83$ OR=3.52 (1.57 to 7.87)
	Mean number of days used in last 12 months (*SD*)		
Cannabis	43.48 (105.86)	31.31 (88.26)	U=3149.50, p=0.313 $n_1=83$, $n_2=82$ r=−0.08
CBD	34.30 (93.16)	17.01 (68.97)	U=2716.00, p=0.002* $n_1=83$, $n_2=82$ r=−0.24
	Mean score (*SD*)		
Severity of cannabis dependence	3.00 (3.30)	1.57 (2.50)	U=217.50, p=0.147 $n_1=19$, $n_2=30$ r=−0.21
Severity of CBD dependence	0.92 (2.50)	0.40 (0.70)	U=123.50, p=0.943 $n_1=25$, $n_2=10$ r=−0.01

Only those using cannabis/CBD in the past 12 months were given Severity of Dependence scales for cannabis/CBD, respectively. ORs are presented followed by 95% CIs in parentheses.
*p < 0.05.
ASD, autism-spectrum disorder; CBD, cannabidiol; n_1, sample size of autistic participants; n_2, sample size of control participants.

DISCUSSION
Principal findings
To our knowledge, this is the first study to compare autistic and non-autistic individuals on their use of cannabis and CBD. Autistic participants were found to use CBD more and cannabis to a similar extent compared with non-autistic participants. However, autism-related difficulties (social communication difficulties and restricted, repetitive behaviours) were not correlated with frequency of cannabis or CBD use in the past 12 months, for both autistic and non-autistic participants. Cannabis and CBD use expectancies were similar between autistic and non-autistic participants, except recreational drug use expectancies for CBD which were lower for autistic participants. Recreational drug use expectancies for cannabis were positively correlated with frequency of cannabis use in the past 12 months, for both autistic and non-autistic groups. Medical expectancies regarding safety and medicinal properties were also positively correlated with frequency of cannabis and CBD use in both groups. Perceptions

of accuracy for cannabinoid-related information were similar for autistic and non-autistic participants, though autistic participants were found to trust the news and doctors less as sources of information regarding cannabinoids. Potential barriers to cannabinoid-related support seeking that autistic participants endorsed more than non-autistic participants included not being understood, and going somewhere unfamiliar, crowded and chaotic.

Strengths and limitations
Strengths of this study include the use of propensity score matching and triangulation with full-sample analysis, to ensure that findings were robust to different analytical approaches. Thus, by limiting our interpretation of group differences to those where both matched and full samples produced corroborating results, our findings can be considered more robust.[42] Limitations of this study include a lack of correction for multiple comparisons in the majority of analysis. This was chosen given the novel and exploratory nature of this research, though findings

Table 3 Expectancies of cannabis and CBD use among autistic and control participants

	Mean score (SD)		Comparison test
	ASD diagnosis	Control	
Recreational drug use expectancies for cannabis	2.75 (0.85)	2.54 (0.70)	U=2788.00, p=0.098 n_1=82, n_2=80 r=−0.13
Autism-specific expectancies for cannabis	2.41 (0.95)	2.10 (0.77)	U=2704.00, p=0.053 n_1=82, n_2=80 r=−0.15
Cannabis is safe	2.92 (1.31)	2.93 (1.25)	U=3343.00, p=0.950 n_1=83, n_2=81 r=−0.00
Cannabis has medicinal properties	3.36 (1.16)	3.23 (1.18)	U=3157.00, p=0.489 n_1=83, n_2=81 r=−0.05
Recreational drug use expectancies for CBD	2.28 (1.00)	2.59 (0.90)	U=2495.00, p=0.030* n_1=82, n_2=76 r=−0.17
Autism-specific expectancies for CBD	2.09 (1.00)	2.36 (0.98)	U=2577.00, p=0.060 n_1=82, n_2=76 r=−0.15
CBD is safe	3.73 (1.27)	3.49 (1.30)	U=2832.00, p=0.245 n_1=82, n_2=77 r=−0.09
CBD has medicinal properties	3.30 (1.33)	3.57 (1.25)	*U*=2757.50, p=0.197 n_1=81, n_2=77 *r*=−0.10

Recreational drug use expectancies (eg, 'cannabis/CBD generally has positive effects on people') were grouped and the average score for each participant was calculated. Autism-specific expectancies (eg, 'cannabis/CBD makes social relationships easier') were also grouped and the average score per participant was calculated. Scores represent the following: 1=almost never/never, 2=some of the time, 3=about half of the time, 4=most of the time, 5=almost always/always.
*p < 0.05.
ASD, autism spectrum disorder; n_1, sample size of ASD diagnosis group; n_2, sample size of control group.

should, therefore, be interpreted cautiously and require further replication. Additionally, this study was restricted to UK residents and failed to capture cross-national differences in cannabinoid usage rates as well as cultural and policy views regarding cannabinoids.[43] This study's sampling methods may also limit the generalisability of findings. Given the technological abilities required to access the online survey and the high proportion of university-educated participants, findings may not be representative of autistic individuals with co-occurring learning disability. Generalisation across ethnicities may also be limited given the high proportion of the sample

Table 4 Perceived trustworthiness of sources for cannabis/CBD information, among autistic and control participants

	Median score		Comparison test
	ASD diagnosis	Control	
Parents	20.0	25.5	U=2289.50, p=0.346 n_1=72, n_2=70 r=−0.08
Friends	30.0	42.0	U=2522.00, p=0.141 n_1=78, n_2=75 r=−0.12
News	24.0	35.0	U=2277.50, p=0.024* n_1=77, n_2=75 r=−0.18
Doctor	70.0	80.0	U=2242.00, p=0.003* n_1=79, n_2=78 r=−0.24
Scientific journals	80.0	83.5	U=3020.50, p=0.384 n_1=82, n_2=80 r=−0.07
Police	40.0	45.5	U=2354.50, p=0.279 n_1=73, n_2=72 r=−0.09
National Institute of Health and Care Excellence	72.0	79.0	U=2562.00, p=0.070 n_1=81, n_2=76 r=−0.14

Scores range from 0 being 'least trust' to 100 being 'most trust'.
*p < 0.05.
ASD, autism spectrum disorder; CBD, cannabidiol; n_1, sample size of ASD diagnosis group; n_2, sample size of control group.

Table 5 Barriers to seeking support for cannabis/CBD use among autistic and control participants

	ASD diagnosis	Control	
	n (%)	*n* (%)	Comparison test
Fear of being judged for taking cannabis/CBD	44 (53.7)	51 (64.6)	$\chi^2(1)=1.98$, p=0.160 n_1=82, n_2=79 OR=0.64 (0.34 to 1.20)
Fear of legal consequences	50 (61.0)	57 (72.2)	$\chi^2(1)=2.26$, p=0.133 n_1=82, n_2=79 OR=0.60 (0.31 to 1.17)
Worrying they would not understand me	43 (52.4)	20 (25.3)	$\chi^2(1)=12.43$, p<0.001* n_1 = 82, n_2=79 OR=3.25 (1.67 to 6.33)
Going somewhere unfamiliar	47 (57.3)	16 (20.3)	$\chi^2(1)=23.21$, p<0.001* n_1 = 82, n_2=79 OR=5.29 (2.62 to 10.67)
Being in a crowded or chaotic place	43 (52.4)	8 (10.1)	$\chi^2(1)=33.28$, p<0.001* n_1 = 82, n_2=79 OR=9.79 (4.18 to 22.89)
Other	10 (12.2)	8 (10.1)	$\chi^2(1)=0.17$, p=0.677 n_1=82, n_2=79 OR=1.23 (0.46 to 3.30)

ORs are presented followed by 95% CIs in parentheses.
*p < 0.05.
ASD, autism spectrum disorder.; CBD, cannabidiol; n_1, sample size of ASD diagnosis group; n_2, sample size of control group.

that were White. Sampling limitations, such as these have been previously discussed within cannabis and autism-related research,[44 45] and future studies may wish to consider targeted recruitment towards hard-to-reach autistic populations. It is also important to note that a proportion of autistic and non-autistic participants had psychiatric comorbidities, which have been demonstrated to affect substance use and self-medication attitudes.[46–48] Finally, ASD diagnoses were self-reported and not verified by a trained clinician.

Relationship to previous literature
In this study, autistic participants were more likely to have tried CBD in the past 12 months and used it more frequently, compared with non-autistic participants. However, frequency of CBD use in the past 12 months was not correlated with autism-related difficulties, which does not support the notion that autistic individuals self-medicate using CBD in response to particular aspects of ASD. In understanding the reasons why autistic individuals may use CBD, it is notable that diagnosis rates for anxiety and depression were higher in the autistic versus control group, which is in line with previous findings.[49] Anxiety and depression have been previously found to be common reasons for CBD use,[50] and it may be that autistic individuals are choosing to use CBD to self-medicate anxiety or depression rather than autism per se. However, current findings are unable to confirm the reasons autistic participants used CBD, and this may represent an area for further inquiry.

Previous studies have found ASD diagnoses and autistic traits to be associated with cannabis use and increased risk of drug use disorder, supporting the notion of self-medication.[5 6] In contrast, this study did not find cannabis use nor severity of cannabis dependence to be elevated in autistic participants. Given contradictory findings, further research may be warranted.

Expectancy theory proposes that expectancies motivate substance-using behaviours,[8] and our results provide partial support for this proposition. Recreational drug use expectancies were associated with frequency of cannabis use for both autistic and non-autistic participants. Medical expectancies were also associated with frequency of cannabis and CBD use in both groups. However, autism-specific expectancies were not associated with frequency of cannabis or CBD use, and recreational drug use expectancies were not associated with frequency of CBD use. This contrasts a previous study, which found autism-specific expectancies to be associated with more frequent alcohol use among autistic individuals.[9] Since alcohol is readily available for purchase by adults, expectancies may be the dominant factor determining alcohol use, while cannabis and CBD use may be determined by additional factors such as illegality and high prices.[21 51]

Implications
These findings indicate appropriate avenues to disseminate cannabinoid-related information and support to autistic individuals. Compared with non-autistic participants, autistic participants trusted the news and doctors less as sources of information regarding cannabinoids. Scientific journals and National Institute of Health and Care Excellence (NICE) were rated as the most trusted sources by autistic individuals. Current NICE guidelines on medicinal cannabinoids do not mention its relevance to ASD,[52] although these findings indicate this information could positively inform cannabinoid use for autistic individuals. Additionally, our findings corroborate previous work[9] that the internet is among the most popular sources for substance-related support, reiterating

the importance of high-quality, accessible guidance online.

Finally, this study highlights the benefits of autism-relevant adjustments within substance use services. Autistic participants endorsed that not being understood, being somewhere unfamiliar and going to a crowded, chaotic place were potential barriers to cannabinoid-related support seeking, more so than non-autistic participants. These potential barriers were also identified by previous work[9] as highly prevalent for autistic individuals in relation to alcohol-related support seeking and together suggests targets to improve accessibility of care. Notably, a transition to remote services due to the SARS-CoV-19 pandemic may lessen these barriers, and it will be pertinent to investigate how these changing services are experienced by autistic individuals.[53] Furthermore, future research may wish to assess how autistic individuals access cannabis, as these barriers may potentially suggest a preference away from approaching cannabis dealers in-person if this involves unfamiliar or chaotic environments.

CONCLUSION

This study used propensity score matching and triangulation to examine differences between autistic and non-autistic participants in their cannabinoid use and related beliefs. Our findings indicate a higher prevalence and frequency of CBD use, but not cannabis use, among autistic individuals compared with non-autistic individuals. Findings also suggest appropriate methods to disseminate cannabinoid-related support and guidance to autistic people and highlight potential barriers to target in improving access to cannabinoid-related support.

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