Are psychotic-like experiences related to a discontinuation of cannabis consumption in young adults?

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Are psychotic-like experiences related to a discontinuation of cannabis consumption in young adults?


Objective: To assess changes in cannabis use in young adults as a function of psychotic-like experiences.

Method: Participants were initially recruited at age 14 in high schools for the longitudinal IMAGEN study. All measures presented here were assessed at follow-ups at age 19 and at age 22, respectively. Perceived stress was only significantly related to cannabis use and psychotic-like experiences using the Community Assessment of Psychic Experiences (CAPE). Of those, nearly all (n = 549) reported to have experienced at least one psychotic experience of any form at age 19.

Results: Mean cannabis use increased from age 19 to 22 and age of first use of cannabis was positively associated with a change in cannabis use at the two time points. Cannabis use was not significantly related to cannabis use and psychotic-like experiences using the Community Assessment of Psychic Experiences (CAPE).
1. Introduction

Cannabis is the most used illicit drug in Europe, with estimates that 24.7 million adults have used the drug in the last year (EMCDDA, 2019). Cannabis use across adolescence is reported to increase and reach its peak in young adulthood (Patton et al., 2007; Tucker et al., 2019). Herbal cannabis and its extracts contain numerous cannabinoids, most notably tetrahydrocannabinol (THC) and cannabidiol (CBD). Evidence has linked cannabis consumption to psychosis (Moore et al., 2007), specifically THC, which is known for its psychoactive effect and can cause intoxicating effects (Morgan and Curran, 2008). The potency of THC in cannabis has risen in herbal and in resin cannabis (EMCDDA, 2019). The increased levels of THC may put users at a higher risk for developing psychosis (Di Forti et al., 2019).

Longitudinal studies show that regular cannabis use is associated with an increased risk for schizophrenia and for reporting psychotic symptoms (Hall and Degenhardt, 2008). More frequent cannabis use is independently associated with more frequent or intense symptoms on three psychotic dimensions: positive, negative and depressive (Bernardini et al., 2018; Schubart et al., 2011a; Skinner et al., 2011; Verdoux et al., 2003). The negative dimension refers to one of the key symptom domains of schizophrenia, with negative symptoms including anhedonia or apathy (Setlen et al., 1998), whereas the depressive dimension partly overlaps with negative symptoms, but additionally covers more cognitive symptoms of depression (e.g. sadness, pessimism, feeling guilty) that discriminate between depression and negative symptoms (Kibel et al., 1993; Stefanis et al., 2002; Stefanis et al., 2004). According to meta-analyses, psychotic experiences and cannabis intake show a dose-response relationship (Marconi et al., 2016; Ragazzi et al., 2018), which suggests that psychosis and psychotic-like experiences (PLEs) share the same risk factors, thus supporting an association between cannabis use and PLEs.

Not only is continuous cannabis consumption related to psychosis, but also the age of first use is predictive of frequency and intensity of psychotic symptoms (Konings et al., 2008; Ragazzi et al., 2018; Schubart et al., 2011b; Skinner et al., 2011). Such an association is also reported for negative psychotic symptoms, but to a lesser degree (Schubart et al., 2011b). Together, these findings support the hypothesis that the impact of cannabis use is age dependent and stronger for positive psychotic symptoms.

Although the association between cannabis consumption and PLEs is well documented, its causality and directionality are still intensely debated (Degenhardt et al., 2018; DeVylder et al., 2018; Hall and Degenhardt, 2008; Murray and Hall, 2020). Different theories are discussed: First, the psychosis risk might be primarily caused by familial and genetic risk factors including stress exposure could contribute to both cannabis use and PLEs in adolescents (Shakoor et al., 2015; Arranz et al., 2018). Thirdly, cannabis use disorder also could directly affect the risk for PLEs (Nesvag et al., 2017). Fourthly, cannabis could be used as self-medication in face of subclinical symptoms of psychosis to reduce distress (Mané et al., 2015).

It has been reported that a decrease in cannabis use in n = 705 young adults aged 18–27 years was associated with a decrease in psychotic-like experiences, while increased consumption was linked to positive symptoms at follow-up (Van Gastel et al., 2014). This association between changes in cannabis use and changes in the frequency of PLEs does not prove a causal relationship, but strongly suggests a bidirectional association and a reduction of PLEs after the cessation of cannabis use. Interestingly, the “cannabis discontinuation hypothesis” suggests that in young adolescents, aversive effects of cannabis use including the manifestation of psychotic symptoms may trigger a reduction in cannabis consumption by self-selection, i.e. a self-imposed protection from the risk of developing enduring psychotic disorders (Sami et al., 2019; Van Gastel et al., 2012). Moreover, cessation of cannabis consumption was predicted by more aversive subjective experiences with cannabis and by no increase in the first three years after first use (Seidel et al., 2019), which could partly be mediated by aversive psychotic experiences. Hence, in the present study we sought to investigate the association of change in cannabis use over a period of 3 years with the occurrence of PLEs in a non-clinical sample of young adults, controlling for potentially confounding factors including age of first use of cannabis, other illicit drug use and socio-economic status.

1.1. Anecdotal evidence from qualitative interviews for hypothesis generation

Qualitative interviews in our study were conducted within the scope of the interdisciplinary research project ERANID, which focuses on use of illicit drugs including cannabis (ERANID, 2015). For the purpose of hypothesis generation, interviews were conducted additionally to quantitative data using a mixed-method approach. Detailed information on the ethnographic methods can be found in Section 2.1. One topic that emerged in several interviews was the cessation of cannabis consumption after the experience of psychotic experiences, as suggested by the so-called cannabis discontinuation hypothesis (Sami et al., 2019). For exemplification, we here provide a quote of one participant (age 22):

“I think that definitely a motivation for stopping was every time I got reasonably high, I would start to have paranoid thoughts, not in a psychotic way like, people were watching me or whatever [...]. So, yeah, I kind of had enough of that. Taking a break has stopped that so I think that was a good decision.”

1.2. Hypotheses

We tested the hypothesis that (1) cannabis use at age 19 is predictive of cannabis use at age 22; (2) early age of first use of cannabis is predictive of increase in cannabis use from 19 to 22; (3) total occurrence of distressful PLEs at age 19 as well as frequency and distress of positive PLEs are associated with reductions in cannabis use between age 19 and 22; and (4) current cannabis use at age 19 or 22 is associated with current PLEs at these time points. Furthermore, we explored the association of stress effects at age 22 with PLEs and cannabis use.

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2. Methods

2.1. Sample

The sample was drawn from the longitudinal European IMAGEN cohort (Schumann et al., 2010). The IMAGEN study consists of a community sample recruited at the age of 14 (N = 2214) from 8 sites across Europe. Follow-up 1 (FU1) was conducted at age 16 (N = 1700). Here we used data from the second follow-up at age 19 (FU2; N = 1515) and the third follow-up (FU3; N = 1360) at age 22. In the current study, we included all participants who had reported to have used cannabis at least once in their life at the age of 19 (for assessment see 2.2.2.). Recruitment strategies and inclusion criteria can be found elsewhere (Schumann et al., 2010). The anecdotal evidence provided above was obtained in a subsample (N = 42) of the IMAGEN cohort within the scope of the research project Imagen Pathways funded by ERANID (ERANID, 2015). Here, ethnographic interviews on the experience of illicit drug use were conducted at age 22, transcribed by independent assistants, and reoccurring topics in relation to cannabis use were extracted by ethnographic researchers.

All study participants were provided with a description of the study and written informed consent was obtained before participation. The research protocol was approved by local Ethics Committees and adhered to the Declaration of Helsinki.

2.2. Measures

2.2.1. Psychotic-like experiences (PLEs)

2.2.1.1. Community Assessment of Psychotic Experiences (CAPE). PLEs were assessed using the CAPE (Stefanis et al., 2002), a self-report questionnaire consisting of 42 items, which has been found to be a reliable and valid instrument for evaluating the presence of lifetime psychotic-like symptoms in the general population in various languages (Mark and Toulopoulou, 2016, 2017; Mossaheb et al., 2012; Schlier et al., 2015; Vermeiden et al., 2019). The CAPE measures (1) frequency and (2) associated distress of psychotic experiences on three symptom dimensions: positive (Pos), negative (Neg) and depressive (Dep) (Konings et al., 2006; Stefanis et al., 2002). PLEs were not queried explicitly in relation to cannabis consumption, hence the CAPE score reflects PLEs induced by cannabis use as well as non-cannabis related PLEs across lifespan. The frequency scale answers comprise the options: never (0); sometimes (1); often (2); and nearly always (3); whereas the distress scale answer options are: not distressed (0); sometimes (1); often (2); and nearly always (3). Items scores were re-coded (range: 1 to 4) and added up to a total score (CAPETotal) and to the sum scores for the positive dimension, i.e. the frequency of positive symptoms and the distress associated with them (CAPE - positive frequency: CAPEPosFreq; CAPE - positive distress: CAPEPosDis). Sum scores were weighted with number of answered items to account for partial non-responders resulting in a value ranging from 1 to 4. In our analysis, the total score and the weighted sum scores were used as continuous measures.

2.2.2. Cannabis use

2.2.2.1. European School Survey Project on Alcohol and Drugs (ESPAD). The ESPAD (Hibell et al., 1997) was used to measure the frequency of cannabis use in the past year at age 19 and age 22 respectively in an online design by asking the question: "On how many occasions OVER THE LAST 12 MONTHS have you used marijuana (grass, pot) or hashish (hash, hash oil)?”. Answers were scored between 0 and 6 according to their use frequencies: never (0); once or twice (1); 3–5 times (2); 6–9 times (3); 10–19 times (4); 20–39 times (5); 40 times or more (6). Additionally, age of first use of cannabis was asked at age 19 using the question: “When did you first try marijuana (grass, pot) or hashish (hash, hash oil)?”

The difference in frequency of cannabis use assessed at FU2 versus FU3 was calculated by subtracting frequency at age 22 from frequency at age 19. The difference in frequency of cannabis use was used as main outcome variables in our analysis.

2.2.3. Stress measures

2.2.3.1. Perceived Stress Scale. The Perceived Stress Scale (PSS) is a self-report scale measuring perceived stress with 10 items (Cohen et al., 1994). The degree to which situations are perceived as unpredictable, uncontrollable and overloaded is assessed using a 5-point Likert scale ranging from never (0), almost never (1), sometimes (2), fairly often (3), very often (4). Total scores range from 0 to 40, with higher scores indicating greater perceived stress.

2.2.4. Covariates

Additional parameters of drug use were assessed at FU2 and FU3 and used as covariates. Apart from gender, age of first use of cannabis (if applicable), the use of other illicit drugs (ever vs. never), nicotine dependence, parental socio-economic status (SES) and psychiatric disorders were introduced as covariate in our analysis (for details of assessment see supplements). Additionally, recruitment site was introduced as covariate in our analysis. As number of inhabitants is related to urbanicity, which has been associated with psychotic-like experiences in children (Karcher et al., 2020) and considered to be a general risk factor for psychosis in adults in developed countries (Heinz et al., 2013), we ranked the recruitment sites in the order of inhabitants of the respective city to account for possible differences in urbanicity.

2.3. Data analysis

The analyses were carried out with the statistical package for the social sciences (SPSS 20.0). Descriptive statistics for the predictor (CAPETotal, CAPEPosFreq and CAPEPosDis), main outcome variables (cannabis use, change in cannabis use) and all covariates (gender identification, recruitment site, age of first use, other illicit drug use, nicotine dependence, SES, and diagnosis of any psychiatric disorders) were estimated as means and standard deviations (SD) for continuous variables and as frequencies for all other variables (Table 1). Listwise exclusion was applied for missing values and a quality check was applied for cannabis use: participants who stated never to have used at age 22, while they indicated cannabis use at age 19, were removed from the original sample of 562 participants (N = 10). First exploratory analyses including t-tests for continuous variables and χ² test for categorical variables were conducted to compare the 3 groups of change in use (decrease, unchanged, increase) (Table 2).

Regressions (ordinal and linear) were carried out according to our hypotheses with either cannabis use or the change in cannabis use as the outcome measure and, respectively, cannabis use, age of first use, CAPETotal, CAPEPosFreq and CAPEPosDis score as predictors. The predictor variables were tested a priori to verify there was no violation of the assumption of no multicollinearity (see T1 in supplements). We first investigated model (I) correcting for gender identification and site. In model (II), the other covariates were additionally included. Post-hoc analyses were performed with the changes in cannabis use and the frequency and distress scores of the positive subscales as outcome variables.

3. Results

3.1. Sample characteristics

Of the 1434 subjects who participated in FU2 and FU3 the IMAGEN study, 562 subjects indicated ever use of cannabis at age 19 and
Table 1
Sample characteristics of total study sample (n = 552) by gender identification at age 19 and age 22.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Total sample</th>
<th>N available for analyses</th>
<th>p-Value&lt;sup&gt;ab&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>552</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender identification</td>
<td>Female 258, Male 294</td>
<td>Female/male</td>
<td></td>
</tr>
<tr>
<td>Parental socio-economic status (SES) (M ± SD)</td>
<td>5.94 ± 0.90</td>
<td>215/244</td>
<td>.382</td>
</tr>
<tr>
<td>Ethnicity*</td>
<td>Central European 236, Black or mixed Black 8, Asian or mixed Asian 7, Other or mixed other 7</td>
<td>258/294</td>
<td>.351</td>
</tr>
<tr>
<td>Age of onset of cannabis use (M ± SD)</td>
<td>15.94 ± 1.59</td>
<td>143/217</td>
<td>.583</td>
</tr>
</tbody>
</table>

Total frequency of PLEs (CAPETotal)
| Age 19 (M ± SD) | 64.83 ± 12.41 | 258/294 |
| Age 22 (M ± SD) | 62.26 ± 11.03 | 254/289 |

Frequency of positive PLEs (CAPEPosFreq)
| Age 19 (M ± SD) | 1.32 ± 0.24 | 258/294 |
| Age 22 (M ± SD) | 1.25 ± 0.22 | 254/289 |

Distress of positive PLEs (CAPEPosDis)
| Age 19 (M ± SD) | 1.79 ± 0.48 | 246/286 |
| Age 22 (M ± SD) | 2.13 ± 0.50 | 230/272 |

Cannabis use within last 12 month*
| Age 19 (yes/no) | 192/66 | 258/294 |
| Age 22 (yes/no) | 153/105 | 258/294 |

Other illicit drug use ever*
| Age 19 (yes/no) | 89/169 | 258/294 |
| Age 22 (yes/no) | 140/118 | 258/294 |

Nicotine dependence*
| Age 19 (M ± SD) | 0.57 ± 1.38 | 258/294 |
| Age 22 (M ± SD) | 0.39 ± 1.13 | 258/294 |

Any disorder (clinical rating, DSM-IV)*
| Age 19 (yes/no) | 68/175 | 241/275 |
| Age 22 (yes/no) | 61/134 | 195/203 |

<sup>a</sup> refers to gender, as males were used as the reference category. <sup>b</sup> Chi-square test. <sup>c</sup> Wald statistic. <sup>d</sup> Alternating logistic regression. <sup>e</sup> Not applicable. <sup>f</sup> signs refer to gender, as males were used as the reference category. <sup>g</sup> Wald statistic. <sup>h</sup> Not applicable. <sup>i</sup> signs refer to gender, as males were used as the reference category. <sup>j</sup> Wald statistic. <sup>k</sup> Not applicable. <sup>l</sup> signs refer to gender, as males were used as the reference category. <sup>m</sup> Wald statistic. <sup>n</sup> Not applicable. <sup>o</sup> signs refer to gender, as males were used as the reference category. <sup>p</sup> Wald statistic. <sup>q</sup> Not applicable. <sup>r</sup> signs refer to gender, as males were used as the reference category. <sup>s</sup> Wald statistic. <sup>t</sup> Not applicable. <sup>u</sup> signs refer to gender, as males were used as the reference category. <sup>v</sup> Wald statistic. <sup>w</sup> Not applicable. <sup>x</sup> signs refer to gender, as males were used as the reference category. <sup>y</sup> Wald statistic. <sup>z</sup> Not applicable.
In exploratory analyses, we observed a positive correlation for perceived stress at age 22 and the CAPETotal score ($r(539) = 0.48$, $p < .001$), the CAPEPosFreq scale ($r(539) = 0.305$, $p < .001$) and the CAPEPosDis scale ($r(539) = 0.308$, $p < .001$), respectively (Fig. 3). For perceived stress and current cannabis use at age 22, no significant association was found ($r = -0.026$, $p = .428$).

4. Discussion

In this longitudinal study in 552 subjects from the general population, we investigated whether cannabis use and its change between age 19 and 22 are associated with PLEs, and we explored whether perceived stress is associated with cannabis use or PLEs. We observed that cannabis use at age 19 was positively associated with cannabis use three years later (age 22). Surprisingly, later first use of cannabis was associated with an increase in cannabis use between age 19 and 22. Regarding the "cannabis discontinuation hypothesis" (Sami et al., 2019; van Gastel et al., 2014), we could not confirm that (distressful) PLEs predict subsequent reductions in cannabis use. Instead, we observed that frequency of cannabis use was positively associated with PLEs at age 22, however, this finding was no longer significant after including presence of psychiatric diagnoses as a covariate. In our exploratory analysis, we observed perceived stress to be associated with PLEs at age 22, but not with cannabis use.

Regarding our first results, observing that cannabis use at age 19 is associated with cannabis use 3 years later is a plausible finding, which confirms previous study results (Chen et al., 1997; Jones et al., 2016; Patton et al., 2007). The frequency of cannabis use tends to increase in puberty, and on average still continues increasing between age 19 and 22 (Melchior et al., 2008), which was also found in our sample. From age 19 on, different trajectories can be observed in our data, including no change of use as well as increases or decreases in cannabis use. Surprisingly, in our sample the age of first use of cannabis was positively correlated with change in cannabis use from age 19 to 22, indicating that those who initiated use at age 15 and later were more likely to increase their use between age 19 and 22 than those who started earlier. While we hypothesized a straightforward association of early first use with higher frequency in cannabis use, some studies indeed suggest more complex trajectories of cannabis use across adolescence and...
early adulthood (Scholes-Balog et al., 2016; Taylor et al., 2017). According to Scholes-Balog et al. (2016), early-onset cannabis users often start before the age of 15 and usually show persistent use throughout adolescence (1/month), whereas late-onset users usually start after age 15 and tend to use cannabis less often (3–5/year). In our sample, first users at age 15 decreased their use between 19 and 22, which does not support the hypothesis of a rather persistent use of “early-onset” users. Late-onset users in our study increased their use during early adulthood, which raises the concern of persisting harmful use. Given that our sample was followed up 3 times since the age of 14 (Schumann et al., 2010), it is possible that our results partly reflect a selection bias inherent to the longitudinal study design. Dropouts in longitudinal studies are more likely to use substances and tend to report higher mean use of substances at baseline than non-dropouts (Snow et al., 1992), which could affect our final sample at age 22 and contribute to an underestimation of use. Unlike hypothesized (Mullin et al., 2012; Van Gastel et al., 2014), we did not find an association between PLEs at age 19 (or 22) and the change in cannabis use during this observation period. Therefore, the “cannabis discontinuation hypothesis” (Sami et al., 2019; Van Gastel et al., 2012) was not confirmed.

Regarding current cannabis use predicting PLEs at the same time point, the occurrence of other psychiatric diagnoses explained the

![Fig. 2. Boxplot for changes in cannabis use within past year and age of first use of cannabis.](image)

### Table 3

<table>
<thead>
<tr>
<th>Model</th>
<th>Variable</th>
<th>Association with changes in cannabis use</th>
<th>β</th>
<th>p-Value</th>
</tr>
</thead>
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<td>Model (I)</td>
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<td>.002</td>
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<tr>
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<td>Male gender identification</td>
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<td>.165</td>
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<td>Model (I)</td>
<td>Recruitment site</td>
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<td>.05 to .93</td>
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<td>Model (II)</td>
<td>Age of first use of cannabis</td>
<td>0.195</td>
<td>.011</td>
<td></td>
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<tr>
<td>Model (II)</td>
<td>Male gender identification</td>
<td>0.254</td>
<td>.323</td>
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<tr>
<td>Model (II)</td>
<td>Recruitment site</td>
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<td>.179 to .684</td>
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<td>Model (II)</td>
<td>Other illicit drug use ever</td>
<td>0.719</td>
<td>.23</td>
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<tr>
<td>Model (II)</td>
<td>Nicotine dependence</td>
<td>−0.073</td>
<td>.400</td>
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<td>Model (II)</td>
<td>Socio-economic status</td>
<td>−0.159</td>
<td>.207</td>
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<td>Model (II)</td>
<td>Any disorder (clinical rating, DSM-IV)</td>
<td>0.290</td>
<td>.309</td>
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</table>

Annotations: For model (II), associations between all factors and change in cannabis use are also displayed. βs with a p-value below 0.05 are shown in italic.

### Table 4

<table>
<thead>
<tr>
<th>Predictor: CAPETotal</th>
<th>Model (I)</th>
<th>Variable</th>
<th>β</th>
<th>p-Value</th>
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<td>.038 to .664</td>
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<td>Age of first use of cannabis</td>
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<td>Other illicit drug use ever</td>
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<td>Any disorder (clinical rating, DSM-IV)</td>
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<td>Recruitment site</td>
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<td>.203 to .737</td>
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<td>Model (II)</td>
<td>CAPEPosFreq</td>
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<td>.039 to .682</td>
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<td>Nicotine dependence</td>
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<td>Any disorder (clinical rating, DSM-IV)</td>
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<td>.968</td>
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<th>Variable</th>
<th>β</th>
<th>p-Value</th>
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<tbody>
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<td>Model (I)</td>
<td>CAPEPosDis</td>
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<td></td>
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<tr>
<td>Male gender identification</td>
<td>0.173</td>
<td>.275</td>
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<tr>
<td>Recruitment site</td>
<td>−0.410 to 0.343</td>
<td>.153 to .269</td>
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<tr>
<td>Model (II)</td>
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<td>Male gender identification</td>
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<td>Recruitment site</td>
<td>−0.841 to 0.141</td>
<td>.049 to .747</td>
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<tr>
<td>Age of first use of cannabis</td>
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<td>.059</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other illicit drug use ever</td>
<td>−0.546</td>
<td>.032</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nicotine dependence</td>
<td>0.029</td>
<td>.691</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Socio-economic status</td>
<td>−0.129</td>
<td>.267</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any disorder (clinical rating, DSM-IV)</td>
<td>−0.045</td>
<td>.881</td>
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</tr>
</tbody>
</table>

Annotations: For model (II), associations between all factors and change in cannabis use are also displayed. βs with a p-value below 0.05 are shown in italic.
occurrence of PLEs better than cannabis use (or male gender) at both time points. This may reflect the genetic overlap between several mental disorders (Witt et al., 2017) or common environmental factors contributing to both cannabis use disorder and other mental disorders (Heinz et al., 2013; Van Os et al., 2010). Also, the fact that we did not observe an association may be due to the rather low clinical load of our sample. Our PLE score was rather low compared with Barragan et al. (2011) (M = 68.3, SD = 13.4) and this restricted variance may limit significant associations with individual differences in cannabis use.

Finally, the frequency of PLEs was significantly and positively associated with perceived stress. It has been hypothesized that stress exposure contributes to the manifestation of psychotic experiences (Heinz et al., 2020) or that perceived stress levels indicate an increased vulnerability for severe mental disorders (Fusar-Poli et al., 2017). However, our data are only correlational, and the directionality of this interaction needs to be examined in longitudinal studies. On the other hand, we did not find a significant association between perceived stress and cannabis use, rendering it rather unlikely that cannabis was used as self-medication to reduce stress by a majority of the sample (Mané et al., 2015).

4.1. Limitations

The major limitation of this study is that selective drop-outs may have occurred during the observation period. This could reduce power to detect effect of increased cannabis use on PLEs. Also, the fact that consumption data were gathered by self-report via online assessment could possibly lead to either over- or underreporting of illegal drug consumption including cannabis use. However, recent studies have shown that web-based questionnaires are a suitable instrument for scientific research and potential biases regarding drug use are unlikely to be systematic (Martin-Willett et al., 2020; Meyerson and Tryon, 2003; Vleeschouwer et al., 2014). Another potential limitation is that the CAPE questionnaire assesses some PLEs that can be hard to distinguish from acute intoxication effects of cannabis. There is, however, some evidence that high CAPE scores associated with acute cannabis intoxication also reflect psychosis proneness (Genetic Risk and Outcome in Psychosis (GROUP) investigators, 2011).

5. Conclusion

Altogether, we observed a general increase in cannabis use across early adulthood and a positive correlation with (late) age of first use, supporting the notion of diverse trajectories in cannabis use in the general population (Bourque et al., 2017; Patton et al., 2007). We did not find an association between PLEs and subsequent cannabis use, thus not confirming the hypothesis that distressful or other PLEs induce a decline in cannabis use (Van Gastel et al., 2014). Interestingly, perceived stress at age 22 was associated with PLEs (but not with cannabis consumption), emphasizing the importance of perceived stress for psychosis risk (Fusar-Poli et al., 2017). These findings suggest to further explore stress effects on the manifestation of PLEs and vice versa.

CRediT authorship contribution statement

Laura S. Daedelow was involved in the conceptualization of the study, collecting and analyzing the data, interpreting the data and drafting the paper.

Table 5

<table>
<thead>
<tr>
<th>Model</th>
<th>Predictor: cannabis use at age 19</th>
<th>Association with CAPETotal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model (I)</td>
<td>Cannabis use at age 19</td>
<td>0.422 .079</td>
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<tr>
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<td>Male gender identification</td>
<td>-3.133 .002</td>
</tr>
<tr>
<td></td>
<td>Recruitment site</td>
<td>-0.2.490 to .231 to .820</td>
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<tr>
<td></td>
<td>Model (II)</td>
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<tr>
<td></td>
<td>Male gender identification</td>
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<tr>
<td></td>
<td>Recruitment site</td>
<td>-4.467 to 0.342 to .011 to .951</td>
</tr>
<tr>
<td></td>
<td>Age of first use of cannabis</td>
<td>-0.503 .256</td>
</tr>
<tr>
<td></td>
<td>Other illicit drug use ever</td>
<td>1.040 .501</td>
</tr>
<tr>
<td></td>
<td>Nicotine dependence</td>
<td>0.351 .426</td>
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<td></td>
<td>Socio-economic status</td>
<td>0.467 .509</td>
</tr>
<tr>
<td></td>
<td>Any disorder (clinical rating, DSM-IV)</td>
<td>13.931 .000</td>
</tr>
</tbody>
</table>

| Model (I)   | Cannabis use at age 22            | 0.700 .001                |
|             | Male gender identification       | -2.728 .006               |
|             | Recruitment site                 | 0.226-5.241 .009 to .910  |
|             | Model (II)                       | 0.092 .774                |
|             | Male gender identification       | -1.085 .439               |
|             | Recruitment site                 | -3.013 to 4.781 .042 to .267 |
|             | Age of first use of cannabis     | -0.275 .502               |
|             | Other illicit drug use ever       | 2.248 .194                |
|             | Nicotine dependence              | 0.968 .047                |
|             | Socio-economic status            | -1.383 .048               |
|             | Any disorder (clinical rating, DSM-IV) | 13.237 .000        |

Annotations: For model (II), associations between all factors and change is cannabis use are also displayed. βs with a p-value below 0.05 are shown in italic.

Fig. 3. Scatterplot for association of perceived stress (assessed by PSS) and PLEs at age 22 respectively: A) CAPETotal Score B) CAPEPosFreq: Frequency of positive dimension C) CAPEPosDis: Distress of positive dimension.
Andreas Heinz was involved in the design of the study, interpretation of the data, revision of the draft and supervision of the project.

Annika Rosenthal, Moritz Berning and Hayley Murray were involved in collecting the data and in a critical revision after the draft.

Anita Hardon, Nicole Y.L. Oei and Reinout W. Wiers were involved in the conceptualization of the study, in the supervision of the ERANID project and in a critical revision after the draft.


Hall, W., Degenhardt, L., 2008. Cannabis use and the risk of developing a psychotic disorder. World Psychiatry 7, 68.


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