

Aus dem Institut für Arbeits-, Sozial, und Umweltmedizin  
der Universitätsmedizin der Johannes Gutenberg-Universität Mainz

Cigarette Smoking, Risky Alcohol Consumption and Marijuana Smoking among University Students in Germany: Identification of Potential Sociodemographic and Study-Related Risk Groups and Predictors of Consumption

Zigarettenrauchen, Riskanter Alkoholkonsum und Marijuanarauchen unter Studierenden in Deutschland: Identifikation potenzieller soziodemographischer und studienbezogener Risikogruppen sowie Prädiktoren für Konsumverhalten

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# 1. Allgemeine Einleitung

## 1.1 Einordnung des Dissertationsprojekt in das Gesamtprojekt „Healthy Campus Mainz – gesund studieren“

Die vorliegende Promotionsarbeit wurde im Rahmen des Projektes *Healthy-Campus Mainz – gesund studieren* bearbeitet. Dieses Projekt wurde 2018 als Kooperation der Johannes-Gutenberg-Universität (JGU) Mainz und der BARMER Krankenkasse ins Leben gerufen, mit dem Ziel, ein evidenzbasiertes, nachhaltiges und ganzheitliches Programm zum Gesundheitsmanagement für die ca. 32000 Studierende an der JGU zu entwickeln, umzusetzen und zu evaluieren.

Das Projekt stützt sich auf die Empfehlungen aus der Okanagan-Charta von 2015. Hier wird die besondere Bedeutung von Gesundheitsförderung im Hochschulsetting hervorgehoben. Es wird gefordert, dass die kommenden Generationen an Führungskräften in guter Gesundheitsförderung ausgebildet werden sollten. So könne ein gesamtgesellschaftlichen Mehrwehrt entstehen, indem die Studierenden zu Multiplikatoren von Prävention und Gesundheit werden. Durch die Verabschiedung des Gesetzes zur Gesundheitsförderung und Prävention (Präventionsgesetz, § 20g SGB V) aus dem Jahr 2015 wurde dieses Vorhaben auch durch die deutsche Politik bestärkt. Daher startete im Sommer 2018 das Modellvorhaben *Healthy Campus Mainz – gesund studieren (HCM)* mit einer geplanten Laufzeit von 5 Jahren.

Um die verschiedenen Aspekte des Gesundheitsmanagements und Gesundheitsförderung adäquat abbilden zu können, wurde das Projekt interdisziplinär organisiert. So waren das Institut für Arbeits-Sozial und Umweltmedizin, das Institut für Psychologie, das Institut für Publizistik und Medienkonvergenz, das Institut für Sportwissenschaften sowie die Klinik und Poliklinik für Psychosomatische Medizin und Psychotherapie involviert.

Ein Teil des Projektes waren Studierendenbefragungen. Diese sollten als Grundlage für die die Entwicklung von zielgerichteten Maßnahmen dienen. Im Gesamtverlauf des Projektes wurden drei Onlinebefragungen durchgeführt. Die hier präsentierten Daten beziehen sich auf die erste Onlinebefragung aus dem Jahr 2019. In Zusammenarbeit mit allen Instituten wurde ein Fragebogen konzipiert. Dazu wurde basierend auf umfassenden Literaturrecherchen und Auswertung von vorangegangenen nationalen und internationalen Gesundheitsbefragungen an anderen Hochschulen eine Auswahl an Fragen zusammengestellt. Die ausgewählten Fragen gliederten sich in fünf inhaltliche Dimensionen: 1. Gesundheitszustand, 2. Gesundheitsverhalten, 3. assoziierte Faktoren

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von Gesundheit (wie z.B. die eigene Biografie oder soziale Faktoren), 4. Wissensstand sowie 5. Inanspruchnahme und Bedarf von Gesundheitsfaktoren. Ziel war es, ein möglichst breites und vollständiges Bild von studentischem Leben und ihrer Gesundheit zu erstellen. Insgesamt konnten bei vollständigem Ausfüllen des Fragebogens 270 Items erhoben werden. Die durchschnittliche Zeit zum Ausfüllen des Fragebogens sollte 45 Minuten betragen.

Zu Beginn des Fragebogens wurde für jeden Teilnehmenden ein individueller Code generiert, mit dem Ziel, bei einer Folgeumfrage einen Verlauf der Gesundheitsrelevanten Aspekte verfolgen zu können. Durch ein spezielles Verschlüsselungssystem war eine sichere Wiedererkennung des Teilnehmenden gewährleistet, jedoch ohne die Möglichkeit des Testauswerters Rückschlüsse auf die Identität der Teilnehmenden zu ziehen. Die Teilnehmenden der Umfrage blieben somit vollständig anonym. Die Umsetzung des Fragebogens erfolgte als Online-Fragebogen, da über dieses Medium die größte Reichweite und höchstmögliche Teilnehmerzahl erwartet wurde. Zeitraum der Umfrage war der 17.06.2019 bis zum 04.08.2019. Insgesamt wurden die Studenten mehrfach über E-Mails an ihrer Universität-Mailadresse über den Fragebogen benachrichtigt. Außerdem wurde Werbung über soziale Medien verbreitet.

Um die Teilnahmebereitschaft der Studierenden zu erhöhen, wurde eine Spende in Höhe von 1000 € bei 5000 Teilnehmenden an eine wohltätige Organisation, als auch ein Gewinnspiel mit Preisen im Wert von ca. 1250 €, verteilt auf 28 verschieden hoch dotierte Gutscheine, ausgelobt. Von den ca. 32000 Studenten der JGU öffneten 5006 Studierende den Link zum Fragebogen. Teilnehmende, die nicht ausreichend zu wenige Fragen beantwortet haben, als auch eine unglaublich kurze Zeit zum Beantworten der Fragen gebraucht haben, wurden ausgeschlossen. Nach diesem Ausschluss blieben noch 4351 Teilnehmer, damit 13,9% aller Studierenden der JGU als Testgruppe, übrig. 3914 Studierende beantworteten den gesamten Fragebogen. Aus dem erhobenen Datensatz wurden von den partizipierenden Instituten verschiedene Auswertungen erstellt. Eine Liste der Publikationen kann aus dem Abschlussbericht des Projektes entnommen werden.

Die nachfolgende Publikation bildet den Kern dieser Promotionsarbeit und beschäftigt sich mit den Prädiktoren für riskanten Konsum von Zigaretten, Alkohol und Marihuana unter Studierenden an der JGU in Mainz. Dabei wurde auf Grundlage des angegebenen Konsumverhaltens der Studierenden nach Korrelationen und damit indirekt nach möglichen Erklärungen für dieses Verhalten gesucht. Im medizinischen Kontext haben die drei untersuchten Substanzen insbesondere bei jungen Menschen einen erheblichen Einfluss auf die Entstehung von Krankheit. Über einen längeren Zeitraum führt

riskanter Konsum dieser Substanzen zu einer Reduktion von Lebenszeit. Umso wichtiger ist es, Konsummuster und auslösende Faktoren zu erkennen und gezielte Präventionsprogramme gegen riskanten Konsum zu etablieren. Ziel dieser Arbeit ist es, hier einen Beitrag zu leisten und so frühzeitig Gesundheitsschäden entgegenzuwirken. Der Artikel ist im Dezember 2023 in der Zeitschrift *Healthcare* publiziert worden.

## 1.2 Einordnung der Eigenleistung des Promovierenden zu dem publizierten Artikel

Leistung	Anteil
Konzeption des Fragebogens	Kein Anteil
Durchführung der Onlinebefragung	Kein Anteil
Erstellung des Datensatzes	Kein Anteil
Auswertung des Datensatzes	Hauptanteil, Unterstützung durch S. Heller, J. Reichel, P. Dietz
Statistische Auswertung	Hauptanteil, Unterstützung durch S. Heller
Konzeption des Artikels	Hauptanteil, Unterstützung durch S. Heller, J. Reichel, P. Dietz
Verfassung von Introduktion Materials and Methods Results Discussion	Komplett eigenständig Korrektur durch Co-Autoren
Erstellung der Grafiken	Komplett eigenständig Korrektur durch Co-Autoren
Überarbeitung der Sprache	P. Dietz, S. Heller

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## 2. Abstract in deutscher Sprache

Zigaretten, Alkohol und Marihuana unter Studierenden in Deutschland: Identifikation von potenziellen soziodemografischen und studienassoziierten Risikogruppen sowie Prädiktoren für riskanten Konsum:

(1) Einleitung: Zigaretten, Alkohol und Marihuana sind weltweit die am häufigsten konsumierten legalen sowie illegalen Drogen. Besonders unter Studierenden findet man häufig einen ausgeprägten Konsum. Um wirksame und evidenzbasierte Präventionsprogramme für riskanten Konsum zu entwickeln, wurde die „Healthy Campus“-Studie ins Leben gerufen. Sie zielte darauf ab, potenzielle soziodemographische und studienbezogene Risikogruppen zu finden sowie Prädiktoren für den riskanten Konsum von Zigaretten, Alkohol und Marihuana zu ermitteln.

(2) Methoden: Unter den Studierenden der Universität Mainz in Deutschland, wurde eine Online-Querschnittsbefragung mit rund 270 gesundheitsbezogenen Items durchgeführt. Als abhängige Variablen wurden Zigarettenrauchen, riskanter Alkoholkonsum (AUDIT-C-Score: weiblich  $\geq 4$ , männlich  $\geq 5$ ) und Marihuana Konsum gewählt. Von den 270 gesundheitsbezogenen Items wurden 56 als unabhängige Variablen ausgewählt und in fünf Gruppen zusammengefasst (soziodemografische, psychologische, studienbezogene-psychosoziale, allgemeine psychosoziale und Gesundheitsverhalten). Mittels etablierter und validierter Messinstrumente wurde die Prävalenz von Zigarettenrauchen, Alkoholkonsum und Marihuana Konsum ermittelt. Zur Analyse der Unterschiede in den Prävalenzen zwischen den soziodemografischen und studienbezogenen Gruppen wurde der Pearsons Chi-Quadrat-Test verwendet. Für die Analysen wurde eine binäre logistische Regression mit schrittweiser Inklusion der fünf Variablengruppen gerechnet.

(3) Ergebnisse: Von den 3991 Studierenden, die an der Analyse teilnahmen, gaben 14,9% an, Zigaretten zu rauchen, 38,6% berichteten über riskanten Alkoholkonsum und 10,9% gaben an, Marihuana zu konsumieren. Die Prävalenz dieser Angaben unterschied sich unter anderem nach Geschlecht, Studienfach und angestrebtem Abschluss. Durch eine binäre logistische Regressionsanalyse ergaben sich neun signifikante Prädiktoren ( $p \leq 0,05$ ) für Zigarettenrauchen (Nagelkerke  $R^2 = 0,314$ ), 18 signifikante Prädiktoren für riskanten Alkoholkonsum (Nagelkerke  $R^2 = 0,270$ ) und 16 signifikante Prädiktoren für den Konsum von Marihuana (Nagelkerke  $R^2 = 0,239$ ).

(4) Schlussfolgerungen: Diese Studie konnte zeigen, dass Zigarettenrauchen, riskanter Alkoholkonsum und Marihuana Konsum unter deutschen Studierenden mit mehreren Faktoren, insbesondere mit dem Gesundheitsverhalten, in Verbindung stehen. Außerdem war jede der

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Substanzen in hohem Maße mit jeder der beiden anderen untersuchten Substanzen assoziiert. Andere Variablengruppen, wie psychologische oder psychosoziale Variablen, schienen eine eher untergeordnete Rolle zu spielen. Daher lautet unsere Empfehlung für künftige Präventionsprogramme bei Studierenden, dass der Substanzkonsum von den drei untersuchten Substanzen als Ganzes und nicht für jede Substanz einzeln vorgenommen werden sollte.

# 3. Dissertationsartikel

## Cigarette Smoking, Risky Alcohol Consumption, and Marijuana Smoking among University Students in Germany: Identification of Potential Sociodemographic and Study-Related Risk Groups and Predictors of Consumption

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**Abstract:** (1) Background: Cigarette smoking, risky alcohol consumption, and marijuana smoking are the most common behaviors of legal and illicit drug use worldwide, including among university students. To plan effective evidence-based programs to prevent the risky consumption of these substances among university students, the present study aimed to identify potential sociodemographic and study-related risk groups and predictors of consumption. (2) Methods: A cross-sectional online health survey with approximately 270 health-related items was conducted among students at the University of Mainz, Germany. Cigarette smoking, risky alcohol consumption (AUDIT-C score: female  $\geq 4$ , male  $\geq 5$ ), and marijuana smoking were chosen as dependent variables. Fifty-six of the 270 health-related items were chosen as independent variables and put together in five groups (sociodemographic, psychological, study-related psychosocial, general psychosocial and health behavior). The prevalence of cigarette smoking, risky alcohol consumption, and marijuana smoking was assessed using established and validated instruments. Pearson's chi-square test was used to analyze the differences in prevalence between the sociodemographic and study-related groups, and binary logistic regression was used for analyses with stepwise inclusion of the five variable groups. (3) Results: Of the 3991 university students who entered analyses, 14.9% reported smoking cigarettes, 38.6% risky alcohol consumption, and 10.9% smoking marijuana. The prevalence of these differed between genders, fields of study, and aspired degrees, among other factors. Binary logistic regression analyses revealed nine significant predictors ( $p \leq .05$ ) of cigarette smoking (Nagelkerke  $R^2 = 0.314$ ), 18 of risky alcohol consumption (Nagelkerke  $R^2 = 0.270$ ), and 16 of marijuana smoking (Nagelkerke  $R^2 = 0.239$ ). (4) Conclusions: This study showed cigarette smoking, risky alcohol consumption, and marijuana smoking among university students in Germany to be associated with multiple factors, especially health behaviors. Furthermore, each of the substances was highly associated with each of the two other substances we examined. Other variable groups, such as psychological or psychosocial variables, seemed to play a rather minor role. Therefore, our recommendation for future prevention programs is that substance use among university students should be addressed as a whole, not just in terms of specific substances.

**Keywords:** substance use; drugs, college; university; tertiary education

### 47 3.1 Introduction

48 Cigarette smoking, risky alcohol consumption, and marijuana smoking are known to be the  
49 most common behaviors of legal and illicit drug use worldwide [1]. Globally, 15.2% of all  
50 adults are daily smokers [2]. According to the latest wave of the Global Burden of Disease  
51 (GBD) study, in 2019, 32.7% of men and 6.6% of women were characterized as current cigarette  
52 smokers [3]. In Western Europe, the overall prevalence of current cigarette smoking is quite  
53 similar, but the difference between men and women is much smaller. For example, the GBD  
54 study reported the prevalence of current cigarette smoking as 28.8% for men and 22.7% for  
55 women in Western Europe and Lange et al. (2017) reported 28.7% for men and 19.5% for  
56 women in Germany. A particularly high prevalence of current cigarette smoking was reported  
57 among people living in Greece (32.2% women, 44.1% men), France (31.3% women, 36.9% men),  
58 and Austria (26.1% women, 36.1% men) [3]. In Germany, cigarette smoking still accounts for  
59 the majority of tobacco consumption [4–6]. Similar to the international figures presented  
60 above, recent data revealed that 23.0% of women and 29.9% of men in Germany are current  
61 cigarette smokers [3]. Furthermore, according to the 2018 Annual Survey of the Federal  
62 Government, 23.3% of all German adults reported smoking in the previous 30 days [4]. A  
63 closer look at the age distribution of cigarette smokers in Germany shows in 2017 that younger  
64 people smoke at a significantly higher rate than the population as a whole. For example, a  
65 study of 24,016 adults from Germany showed that 35.1% of men and 28.4% of women aged  
66 18–29 years were smokers, compared to only 9.2% of men and 6.8% of women aged 64 years  
67 and older [7]. In the younger age group, university students are no exception [8]. According  
68 to a recent survey among 7394 university students in Germany, 18.5% of the participants  
69 reported smoking cigarettes [9]. These figures are very similar to those reported by Velten et  
70 al., who surveyed a sample of 2991 university students and identified 20.8% as cigarette  
71 smokers [10]. Although the number of smokers declined slightly in the years up to the  
72 pandemic, most smoking usually starts in the age range between 15 and 24 years [11].

73 There are different definitions of risky alcohol consumption [12]. In the US, it is defined as  
74 having more than seven alcoholic drinks per week for women (or >3 drinks per occasion) and  
75 more than 14 for men (or >4 drinks per occasion) [13]. In German-speaking countries, it is  
76 defined by drinking more than 12 grams of alcohol per day for women and 24 for men [14,15].  
77 Globally, 32.5% of people are classified as current drinkers, defined as having at least one

78 standard drink of 10 grams of pure ethanol per day [16]. Prevalence is higher in Western  
79 countries. For example, a recent review of 4,152,000 participants reported a prevalence of  
80 30.5% for risky alcohol consumption within the previous year [2]. In Germany, 16% of the  
81 general population regularly consume risky amounts of alcohol [17]. University students  
82 appear to be a particularly vulnerable population for risky alcohol consumption [18,19]. For  
83 example, in the US, Slutske et al. [20] and others identified increased risk specifically in the  
84 college student group, compared to non-college students of the same age and the general  
85 population [20,21]. Their results support several other international studies conducted within  
86 the college and university student populations [19,22–25]. Looking more closely at German  
87 university students, the prevalence of risky alcohol consumption is at a very high level [9,26].  
88 For example, Grützmacher et al. [9] reported a prevalence of 40.6% for risky alcohol  
89 consumption in a sample of 6198 university students.

90 According to the World Drug Report 2021, marijuana is the most commonly used illicit drug  
91 in the world, and its global prevalence was estimated to be around 4% in 2019 [27].  
92 Significantly higher rates have been reported for North America and Western Europe. For  
93 example, the SAMSHA study, a national survey of drug use and health in the US, showed that  
94 18.0% of 44,958 participants aged 18 years and older had used marijuana within the previous  
95 year [28]. In addition, the United Nations has reported that 14.5% of adults in North America  
96 and 7.8% in Western Europe consume marijuana [29]. Looking at younger age groups, 15% of  
97 Europeans aged 15–34 years reported using cannabis in the previous year. In Germany, the  
98 prevalence in this age group was quite comparable, at 16.9% [30]. In addition, the 18–24-year  
99 age group showed an even higher prevalence, of 22.0%. Marijuana is the most commonly used  
100 drug among university students [31]. Among all graduated US college students, more than  
101 50% have used marijuana at least once in their lifetime, 15.8% within the previous year [28]. In  
102 addition, other studies have reported a prevalence of 29.1% in the past year [32]. Among  
103 university students in Germany, a lifetime prevalence of marijuana use of 45.6% and a 12-  
104 month prevalence of 20.6% were reported. Furthermore, the 12-month prevalence of  
105 marijuana use in Germany approximately doubled between 1990 and 2018 [4,33,34], indicating  
106 an increase in marijuana consumption in recent decades [9,23,35].

107 From a public health perspective, the prevalence of cigarette smoking, risky alcohol  
108 consumption, and marijuana smoking, especially among university students, is alarming,  
109 since the use of these substances is associated with various physiological and psychological

110 side effects, can lead to addiction, and increases mortality. Specifically, cigarette smoking is  
111 one of the leading factors for premature mortality and years of life lost due to disease and  
112 disability [1,36]. It is associated with an increased risk of coronary heart disease and  
113 atherosclerosis [37,38], pulmonary disease such as COPD [39,40], multiple types of cancer  
114 [41,42], and many other diseases [1,5,43,44]. There is no risk-free level of exposure to tobacco  
115 smoke, and even occasional tobacco smoking (e.g. light smoking) is sufficient to increase  
116 mortality and morbidity [45,46]. In 2010, alcohol use was ranked third in the global burden of  
117 disease [1]. Risky alcohol consumption can lead to liver cirrhosis or injury [47] and is  
118 associated with cardiovascular diseases such as hypertension, hypercholesterolemia, and type  
119 2 diabetes [48]. It is also one of the leading risk-factors for cancer [1,36,49,50]. Smoking  
120 marijuana can lead to respiratory disease and, especially in adolescents, psychotic disorders  
121 [51]. For example, a systematic review of longitudinal studies reported increased rates of  
122 mental health problems after marijuana consumption [52]. In addition, according to Manthey  
123 et al. [53], smoking marijuana leads to higher risk for psychotic disorders, acute cognitive  
124 impairment, traffic injuries, respiratory problems, and poorer pregnancy outcomes [53,54].  
125 Studies suggest that in Germany, marijuana is mostly (87.2%) consumed in the form of  
126 cigarettes (also known as “joints”) with tobacco [55]. Therefore, an adjustment for the adverse  
127 health effects of tobacco must be considered when scoping smoking marijuana. In addition,  
128 cigarette smoking, risky alcohol consumption, and marijuana smoking can lead to addiction.  
129 Withdrawal of cigarette smoking and the nicotine contained in joints for marijuana smoking  
130 can lead, among others, to frustration, anger, depressed mood, and insomnia [56]. Alcohol  
131 consumption results in the suppression of nervous system excitability and rebounds during  
132 withdrawal [47]. It can lead to craving, depressed mood, increased agitation, and seizures [57].  
133 Another aspect that is discussed in the literature is the gateway theory, or drug gateway  
134 hypothesis [58]. It states that alcohol consumption promotes the use of tobacco and vice versa  
135 and that both drugs promote the use of marijuana. In turn, marijuana is discussed as  
136 promoting the use of other illicit drugs, such as opioids and amphetamines [59–63]. Although  
137 the different patterns of use are not yet fully understood, a link between these substances is  
138 likely. In addition to adverse health effects, cigarette smoking, risky alcohol consumption, and  
139 marijuana smoking generate high socioeconomic costs each year [64–67].  
140 To plan evidence-based and effective programs to prevent cigarette smoking, risky alcohol  
141 consumption, and marijuana smoking among university students, it is important to

142 understand the conditions and factors that predict the use of these substances among this  
143 target group. Therefore, potential correlates (associated factors) or determinants (factors with  
144 a causal relationship) need to be explored for each substance. In this context, several studies  
145 have examined the relationship between sociodemographic, study-related, or psychosocial  
146 factors and cigarette smoking, risky alcohol consumption, or marijuana smoking [10,20,24–  
147 26,43,68–82]. For example, Skidmore et al. [81] identified study-related variables and specific  
148 peer-groups associated with substance use among university students. Van Hooijdonk et al.  
149 [82] identified an association between study-related characteristics and smoking, drinking  
150 alcohol, and consuming marijuana in the Netherlands. Others have shown associations  
151 between psychosocial factors [10,24,25] or health behaviors [26,68] and substance use.  
152 However, to the best of our knowledge, no study has examined sociodemographic,  
153 psychological, study-related, and general psychosocial as well as health behavior variables  
154 simultaneously in one regression model for each of the investigated substances. By doing so,  
155 researchers may be able to paint a more comprehensive picture of the predictors of cigarette  
156 smoking, risky alcohol consumption, and marijuana smoking among university students. In  
157 summary, empirical studies of cigarette smoking, risky alcohol consumption, and marijuana  
158 smoking among university students are heterogeneous in their methodology (e.g., definition  
159 of consumption, surveyed groups) and results [10,20,24–26,43,68–80]. Furthermore, there is a  
160 significant lack of knowledge about potential factors that may predict cigarette smoking, risky  
161 alcohol consumption, and marijuana smoking among university students. Therefore, the  
162 present study aims to address this gap by i) assessing the prevalence of cigarette smoking,  
163 risky alcohol consumption, and marijuana smoking among university students at a large  
164 university in Rhineland-Palatinate, Germany; ii) identifying potential sociodemographic and  
165 study-related risk groups for substance use, especially with regard to age, gender, field of  
166 study, semester, and aspired degree; iii) examining for the first time in a single regression  
167 model the predictors of substance use, including sociodemographic and study-related  
168 variables, psychological variables, general and study-related psychological variables, and  
169 health behavior, simultaneously. These results may contribute to the discussion on developing  
170 and implementing prevention strategies that target cigarette smoking, risky alcohol  
171 consumption, and marijuana smoking among university students.

## 172 **3.2 Materials and methods**

### 173 *3.2.1 Study design and survey procedure*

174 As part of the Healthy Campus Mainz project, a cross-sectional online health survey was  
175 conducted during the 2019 summer term (June and July). All registered students of the  
176 University of Mainz (approximately 31,000) were invited to participate via the central mailing  
177 list of the university. An email was sent to all students enrolled at the university at that time.  
178 The students received this email in their official mailing account, were the university also  
179 sends important information about grades. Monetary and nonmonetary incentives and four  
180 reminder-emails were used to increase participation. Participants had to be enrolled in at least  
181 one subject of study at the university. Answering demographic variables and at least one  
182 question on health topics was a prerequisite for inclusion. A full version of the survey  
183 (including the variables that were not used in this study) and a detailed reflection of the survey  
184 procedure can be found in Reichel et al. [83]. An introduction at the beginning of the online  
185 questionnaire briefly explained the background and purpose of the study, which was followed  
186 by a statement that participation would be anonymous and voluntary. Informed consent was  
187 obtained at the beginning of the survey. Ethical approval to conduct the study was obtained  
188 from the Ethics Committee of the Medical Association of Rhineland-Palatinate (No. 2019-  
189 14336).

190

### 191 *3.2.2 Measures*

192 The online questionnaire covered a wide range of health-related aspects and included  
193 approximately 270 items. We used established and validated instruments when available and  
194 self-developed scales as little as possible. For the present study, we selected 56 variables as  
195 independent variables and summarized them in five groups. Further, we selected three  
196 variables (cigarette smoking, alcohol consumption, and marijuana smoking) as dependent  
197 variables. A list of all surveyed topics and specific items covered can be found in Reichel et al.  
198 [83].

199 The three dependent variables in the present survey are highlighted here in more detail. To  
200 assess the prevalence of cigarette smoking, we asked about the frequency of consumption. The  
201 question (translated) was “Do you smoke cigarettes?” The following answers could be chosen:  
202 “never,” “formerly occasionally,” “formerly regularly,” “currently occasionally,” and

203 “currently regularly.” We defined “currently occasionally” and “currently regularly” as  
204 “cigarette smoking.” The prevalence of risky alcohol consumption was assessed using the  
205 AUDIT-C questionnaire. “AUDIT-C” stands for “Alcohol Use Disorder Identification Test—  
206 Consumption.” It is the short version of the original 10-item questionnaire published by the  
207 World Health Organization [84] and includes the first three questions of the AUDIT  
208 questionnaire. It assesses the frequency of alcohol consumption, the amount of alcohol  
209 consumption, and the frequency of excessive alcohol consumption (more than five drinks in  
210 one sitting). Scores range from zero to 12. The established cut-off of more than 4 points for  
211 women and more than 5 points for men was used to categorize the variable as risky alcohol  
212 consumption. The AUDIT-C has been shown in many publications to be a simple instrument  
213 for measuring risky alcohol consumption. It can be used to select individuals at high risk for  
214 alcohol use disorder or dependence [85–89]. The first question (translated) was: 1. “How often  
215 do you have a drink containing alcohol?” The answer could be one of the following five  
216 choices: “never” (0 points), “monthly or less” (1 point), “2–4 times a month” (2 points), “2–3  
217 times a week” (3 points), or “4 or more times a week” (4 points). The second question was  
218 “How many standard drinks containing alcohol do you have in a typical day?” The answer  
219 could be one of the following five choices: “1 or 2” (0 points), “3 or 4” (1 point), “5 or 6” (2  
220 points), “7 to 9” (3 points), or “10 or more” (4 points). The third question was: “How often do  
221 you have six or more drinks on one occasion?” As response options, one of the following five  
222 items could be selected: “Never” (0 points), “less than monthly” (1 point), “monthly” (2  
223 points), “weekly” (3 points), or “daily or almost daily” (4 points). To assess the prevalence of  
224 marijuana smoking, we evaluated the frequency of smoking. The question (translated) was  
225 “Do you smoke marijuana?” The following answers could be chosen: “never,” “formerly  
226 occasionally,” “formerly regularly,” “currently occasionally” or “currently regularly.” We  
227 defined “currently occasionally” and “currently regularly” as “marijuana smoking.”  
228 To predict cigarette smoking, risky alcohol consumption, and marijuana smoking, 56  
229 independent variables related to the research questions were selected from the questionnaire.  
230 A list of the specific variables, scales, and items used in the present study, as well as their  
231 references and specific questions with response options (for self-constructed items), is  
232 provided in Supplementary Table 1. These 56 variables were classified into five different  
233 groups according to the factor groups of the current research, as described in the introduction  
234 [90]. These were sociodemographic variables (16 variables, e.g., gender, age, semester, field of

235 study), psychological variables (six variables, e.g., depressive symptoms, loneliness), study-  
 236 related psychosocial variables (18 variables, e.g., social support from fellow students,  
 237 competence for self-motivation), general psychosocial variables (five variables, e.g., self-  
 238 criticism, impulsiveness), and health behavior variables (11 variables, e.g., healthy diet, fruit  
 239 and vegetable consumption, physical activity, use of neuroenhancement). Regarding the  
 240 independent variable “use of pharmacological neuroenhancement” (including substances  
 241 such as methylphenidate, amphetamines, atomoxetine, modafinil, ecstasy, ephedrine,  
 242 marijuana, cocaine, or crystal meth), an analysis of Heller et al. (2022) [90], from our dataset,  
 243 showed marijuana to be the most commonly used pharmacological neuroenhancer. Therefore,  
 244 in the present study, we excluded marijuana as a form of pharmacological neuroenhancement  
 245 to avoid confounding with the dependent variable marijuana smoking. The term  
 246 “pharmacological neuroenhancement” (PN) is generally defined as the use of illicit or  
 247 prescription drugs by healthy individuals for cognitive-enhancing purposes [91,92] such as  
 248 enhancing alertness, attention, concentration, memory, or mood [93,94]. According to this  
 249 definition, the so-called soft neuroenhancers (e.g., energy drinks, caffeine tablets) were not  
 250 included. There are many inconsistencies and differences in the definition of  
 251 neuroenhancement [95,96], but a full discussion of these would go beyond the scope of this  
 252 research.

253 **Table 1.** Basic and study-related characteristics of the participants.

<b>Variable</b>	<b>Value</b>
<b>Gender (n = 3991)</b>	
Female	71.4% (n = 2848)
Male	27.8% (n = 1111)
Diverse	0.8% (n = 32)
<b>Age, range (mean ± SD) (n = 3987)</b>	16–73 (23.8 ± 4.3)
<b>Semester, range (mean ± SD) (n = 3975)</b>	1–45 (7.2 ± 4.8)
<b>First year (n = 3884)</b>	
No	83.2% (n = 3233)
Yes	16.8% (n = 651)
<b>Aspired degree (n = 3991)</b>	
Bachelor’s	52.3% (n = 2088)
Master’s	21.2% (n = 847)
“Staatsexamen”	22.0% (n = 878)
Doctoral degree	3.5% (n = 139)
Other	1.0% (n = 39)
<b>Field of study (n = 3982)</b>	
STEM	18.1% (n = 720)
Social sciences, media, and sports	18.1% (n = 719)

Linguistics, humanities, and cultural studies	20.2% ( <i>n</i> = 804)
Medicine	13.3% ( <i>n</i> = 530)
Law and economics	12.9% ( <i>n</i> = 512)
Education (aspiring teachers)	15.5% ( <i>n</i> = 616)
Other	2.0% ( <i>n</i> = 81)

254 3.2.3 *Data analysis*

255 Descriptive statistics are presented as means with standard deviations (SD) for continuous  
 256 scaled variables and as percentages and numbers for noncontinuous scaled variables. To  
 257 analyze differences in prevalence between sociodemographic and study-related groups,  
 258 contingency analyses of categorical variables were performed using Pearson’s chi-square ( $\chi^2$ )  
 259 test. Multicollinearity of the 56 independent variables (Supplementary Table 1) was assessed  
 260 using a collinearity matrix and the variance inflation factor. Correlations greater than 0.75  
 261 were excluded. In the next step, pretests were performed to assess the association of each  
 262 independent variable with the three dependent variables. The dependent variables *cigarette*  
 263 *smoking*, *risky alcohol consumption*, and *marijuana smoking* were dichotomized (yes/no). ANOVA  
 264 was used for linear scaled variables, Pearson’s chi-square test for ordinal scaled variables, and  
 265 Cramer’s V-test for nominal scaled variables (Supplementary Tables 2–4). To predict the three  
 266 dependent variables cigarette smoking, risky alcohol consumption, and marijuana smoking,  
 267 all variables with a significant association ( $p \leq .001$ ) at pretest were included into a binary  
 268 logistic regression with stepwise inclusion of the five variable groups. In the binary logistic  
 269 regression models, variables with significant associations at a level of  $p \leq .05$  were classified as  
 270 possible predictors. Nagelkerke’s  $R^2$  was calculated to check the strength of each regression  
 271 model. Data were analyzed using IBM SPSS 23.

272 **3.3 Results**

273 A total number of 4351 university students participated in the survey, of whom  $N = 3991$   
 274 answered the questions with regard to the dependent variables (alcohol consumption,  
 275 cigarette smoking, and marijuana smoking) and were included in the analyses. The mean age  
 276 of the sample was 23.8 ( $\pm 4.3$ ) years, and 71.4% ( $n = 2848$ ) of participants were female. The mean  
 277 semester was 7.2 ( $\pm 4.8$ ), and 16.8% ( $n = 651$ ) of the students reported being in their first year  
 278 (first or second semester). Regarding the degree aspired to, 52.3% ( $n = 2088$ ) were aiming for a  
 279 bachelor’s degree, 21.2% ( $n = 847$ ) for a master’s degree, 22% ( $n = 878$ ) for a state examination  
 280 (a special program that is specific to German students studying e.g., law or medicine), for and

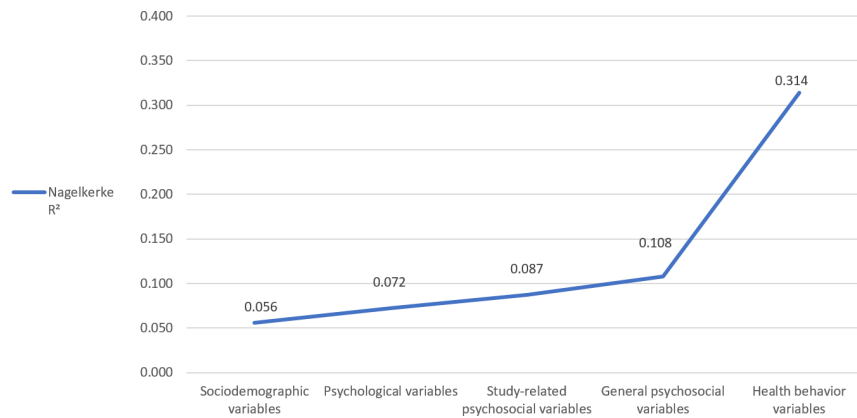
281 3.5% (n = 139) a doctoral degree. Regarding the field of study, 18.1% (n = 720) indicated STEM  
282 (science, technology, engineering, and mathematics); 18.1% (n = 719) social science, media, and  
283 sports; 20.2% (n = 804) linguistics, humanities, and cultural science; 13.3% (n = 530) medicine;  
284 12.9% (n = 512) law and economics; and 15.5% (n = 616) education (aspiring teachers). All of  
285 the participant's sociodemographic and study-related characteristics of the participants are  
286 presented in Table 1.

287

### 288 3.3.1 Prevalence, risk groups, and predictors of cigarette smoking

289 As shown in Table 2, 14.9% (n = 592) of all students smoked cigarettes. Regarding potential  
290 risk groups for cigarette smoking, women (13.4%) smoked significantly ( $p \leq .001$ ) less than men  
291 (18.0%) or diverse (34.4%) participants. Concerning the field of study, we assessed a  
292 significantly ( $p \leq .001$ ) lower prevalence in students from the field of education (9.8%)  
293 compared those from social science, media, and sports (16.7%); linguistics, humanities, and  
294 cultural sciences (18.3%); and law and economics (16.4%). Furthermore, the prevalence  
295 differed significantly ( $p \leq .001$ ) between students of medicine (11.2%) and of linguistics,  
296 humanities, and cultural sciences (18.3%).

297 Of the 56 independent variables that were previously selected for this study, 24 were  
298 significantly associated with cigarette smoking in the pretests, and these were included in the  
299 binary logistic regression analysis (Supplementary Table 2). Binary logistic regression revealed  
300 nine significant predictors ( $p \leq .05$ ), including 3448 (86.4%) students, for the final regression  
301 (Table 3). Negatively related variables were migrant background (OR = .585), use of soft  
302 neuroenhancement within the past 12 months (OR = .593), and former occasional marijuana  
303 smoking (OR = .790). Positively associated variables were impulsiveness (OR = 1.106), general  
304 anxiety (OR = 1.114), risky alcohol consumption (OR = 1.336), current occasional marijuana  
305 smoking (OR = 1.488), first study (OR = 2.413), and current regular marijuana smoking (OR =  
306 2.971). The Hosmer-Lemeshow goodness of fit test revealed a chi-square of 2.835 with a  
307 significance of 0.944. The stepwise inclusion of the five variable groups revealed a Nagelkerke  
308  $R^2$  of 0.056 after inclusion of the sociodemographic variables, 0.072 (+0.016) after inclusion of  
309 the psychological variables, 0.087 (+0.015) after inclusion of the study-related psychosocial  
310 variables, 0.108 (+0.021) after inclusion of the general psychosocial variables, and 0.314 (+0.206)  
311 after inclusion of the health behavior variables (Figure 1). Thus, our final model explains 31.4%  
312 of the variance in cigarette smoking.



313  
 314 **Figure 1.** Regression model for cigarette smoking. Changes in Nagelkerke R<sup>2</sup> by stepwise inclusion of the  
 315 different variable groups.

316 **Table 2.** Prevalence of cigarette smoking distributed for the different basic and study-related characteristics.

Variable	Risky consumption		p-value
	"Yes"	"No"	
<b>All students (n = 3984)</b>	14.9% (n = 592)	85.1% (n = 2984)	
<b>Gender (n = 3984)</b>			
<sup>a</sup> Female	13.4% (n = 381)	86.6% (n = 2463)	<.001 <sup>a-b; a-c</sup>
<sup>b</sup> Male	18% (n = 200)	82% (n = 910)	
<sup>c</sup> Diverse	34.4% (n = 11)	65.6% (n = 21)	
<b>Age, median split (n= 3982)</b>			
<sup>a</sup> Between 16 and 23	14.5% (n = 326)	85.5% (n = 1919)	.486
<sup>b</sup> Older than 24	15.3% (n = 266)	84.7% (n = 1,471)	
<b>First year (n = 3879)</b>			
<sup>a</sup> No	14.8% (n = 479)	85.2% (n = 2750)	.516
<sup>b</sup> Yes	13.8% (n = 90)	86.2% (n = 560)	
<b>Aspired degree (n = 3986)</b>			
<sup>a</sup> Bachelor's	16.1% (n = 335)	83.9% (n = 1752)	.239
<sup>b</sup> Master's	14.1% (n = 119)	85.9% (n = 726)	
<sup>c</sup> "Staatsexamen"	13.8% (n = 121)	86.2% (n = 755)	
<sup>d</sup> Doctoral degree	8.6% (n = 12)	91.4% (n = 127)	
<sup>e</sup> Other	12.8% (n = 5)	87.2% (n = 34)	
<b>Field of study (n = 3977)</b>			
<sup>a</sup> STEM	14.6% (n = 105)	85.4% (n = 615)	<.001 <sup>b-f; c-d; c-f; e-f</sup>
<sup>b</sup> Social sciences, media, and sports	16.7% (n = 120)	83.3% (n = 598)	
<sup>c</sup> Linguistics, humanities, and cultural sciences	18.3% (n = 147)	81.7% (n = 656)	
<sup>d</sup> Medicine	11.2% (n = 59)	88.8% (n = 469)	
<sup>e</sup> Law and economics	16.4% (n = 84)	83.6% (n = 428)	
<sup>f</sup> Education (aspiring teachers)	9.8% (n = 60)	90.2% (n = 555)	
<sup>g</sup> Other	18.5% (n = 15)	81.5% (n = 66)	

317 *p*-value by Pearson's chi-square test  
 318 <sup>a-b</sup> significant difference between a and b  
 319

**Table 3.** Odds ratios (OR) and 95% confidence intervals (CI) for the dependent variable smoking cigarettes and each predictor variable ( $p \leq .05$ )

Variable	OR (95% CI)	<i>p</i> -value	Wald chi-square
Migrant background (yes)	0.585 (0.444–0.772)	<.001	14.354
Use of soft neuroenhancement (within the last 12 months)	0.593 (0.428–0.823)	.002	9.795
Marijuana consumption (formerly occasionally)	0.790 (0.629–0.990)	.041	4.178
Impulsiveness	1.106 (1.049–1.166)	<.001	13.797
Anxiety symptoms	1.114 (1.014–1.224)	.028	5.066
AUDIT-C-score	1.336 (1.262–1.415)	<.001	99.144
Marijuana consumption (currently occasionally)	1.488 (1.153–1.919)	.002	9.354
First study (did other studies before, but did not graduate)	2.413 (1.099–5.298)	.028	4.817
Marijuana consumption (currently regularly)	2.971 (1.896–4.655)	<.001	22.591

321

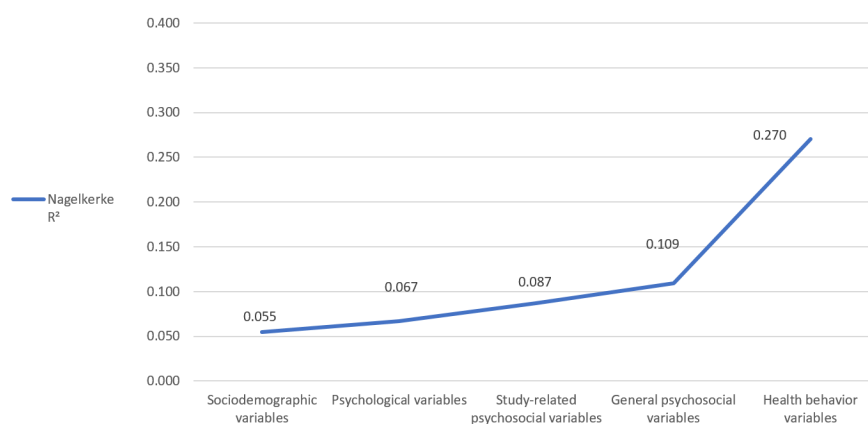
### 322 3.3.2 Prevalence, risk groups, and predictors of risky alcohol consumption

323 In our sample, 38.6% ( $n = 1537$ ) of all students demonstrated a risky alcohol consumption  
 324 pattern. With regard to potential sociodemographic and the study-related risk groups (Table  
 325 4), students younger than or equal to 23 years of age had a significantly higher prevalence  
 326 (40.8%,  $p = .001$ ) than those aged 24 years and older (35.7%). Furthermore, the prevalence was  
 327 significantly higher among first year students (42.3%,  $p = .030$ ) compared to students of higher  
 328 semesters (37.8%). Regarding the field of study, the prevalence was significantly higher ( $p =$   
 329 .001) among students in the fields of social science, media, and sport (43.2%) and law and  
 330 economics (43.0%) compared to those in linguistics, humanities, and cultural science (33.5%).  
 331 Of the 56 selected independent variables, 24 were significantly associated with risky alcohol  
 332 consumption in the pretest, and these were included in the binary logistic regression analysis  
 333 (Supplementary Table 3).

334 The binary logistic regression analysis revealed 18 significant predictors ( $p \leq .05$ ), including  
 335 2908 (72.9%) students, for the final regression (Table 5). The negatively related variables were  
 336 use of pharmacological neuroenhancement within the past 12 months (OR = .625), first study  
 337 (OR = .693), relationship status (joint household) (OR = .736), first study (no, graduated before)

338 (OR = .745), use of soft neuroenhancement within the past 12 months (OR = .799), fruit  
 339 consumption per day (OR = .822), and loneliness (OR = .931). Positive associations were  
 340 detected for procrastination (OR = 1.017), impulsiveness (OR = 1.100), social support by fellow  
 341 students (OR = 1.205), physical activity (active, beneficial to health) (OR = 1.303), social media  
 342 use (OR = 1.323), employment (yes, marginally employed) (OR = 1.381), currently regularly  
 343 cigarette smoking (OR = 1.426), migrant background (OR = 1.523), part-time employment (OR  
 344 = 1.527), currently occasionally marijuana smoking (OR = 1.600), and currently occasionally  
 345 cigarette smoking (OR = 1.691). The Hosmer-Lemeshow goodness of fit test revealed a chi-  
 346 square of 7.430 with a significance of 0.491.

347 Stepwise inclusion of the five groups of variables revealed a Nagelkerke R<sup>2</sup> of 0.055 after  
 348 inclusion of the sociodemographic variables, 0.067 (+0.012) after inclusion of the psychological  
 349 variables, 0.087 (+0.020) after inclusion of the study-related psychosocial variables, 0.109  
 350 (+0.022) after inclusion of the general psychosocial variables, and 0.270 (+0.161) after inclusion  
 351 of the health behavior variables (Figure 2). Thus, our final model explains 27% of the variance  
 352 of risky alcohol consumption.



353  
 354 **Figure 2.** Regression model for alcohol consumption (AUDIT-C score: female  $\geq 4$ , male  $\geq 5$ ). Changes in  
 355 Nagelkerke R<sup>2</sup> by stepwise inclusion of the different variable groups.

356 **Table 4.** Prevalence of risky alcohol consumption (AUDIT-C score: female  $\geq 4$ , male  $\geq 5$ ) distributed for the different  
 357 basic and study-related characteristics (n = 3984).

Variable	Risky consumption		p-value
	"Yes"	"No"	
<b>All Students (n = 3984)</b>	38.6% (n = 1537)	61.4% (n = 2447)	
<b>Gender (n = 3984)</b>			
<sup>a</sup> Female	37.9% (n = 1076)	62.1% (n = 1766)	.120
<sup>b</sup> Male	40.7% (n = 452)	59.3% (n = 658)	
<sup>c</sup> Diverse	28.1% (n = 9)	71.9% (n = 23)	
<b>Age, median split (n = 3981)</b>			
<sup>a</sup> Between 16 and 23	40.8% (n = 917)	59.2% (n = 1328)	<.001 <sup>a-b</sup>

<sup>b</sup> Older than 24	35.7% ( <i>n</i> = 620)	64.3% ( <i>n</i> = 1116)	
<b>First Year (<i>n</i> = 3878)</b>			
<sup>a</sup> No	37.8% ( <i>n</i> = 1219)	62.2% ( <i>n</i> = 2009)	.030 <sup>a-b</sup>
<sup>b</sup> Yes	42.3% ( <i>n</i> = 275)	57.7% ( <i>n</i> = 375)	
<b>Aspired degree (<i>n</i> = 3984)</b>			
<sup>a</sup> Bachelor's	40% ( <i>n</i> = 835)	60% ( <i>n</i> = 1251)	.143
<sup>b</sup> Master's	36.7% ( <i>n</i> = 310)	63.3% ( <i>n</i> = 535)	
<sup>c</sup> "Staatsexamen"	38.7% ( <i>n</i> = 339)	61.3% ( <i>n</i> = 537)	
<sup>d</sup> Doctoral degree	27.3% ( <i>n</i> = 38)	72.7% ( <i>n</i> = 101)	
<sup>e</sup> Other	39.5% ( <i>n</i> = 15)	60.5% ( <i>n</i> = 23)	
<b>Field of Study (<i>n</i> = 3975)</b>			
<sup>a</sup> STEM	36.4% ( <i>n</i> = 262)	63.6% ( <i>n</i> = 457)	.001 <sup>b-c; c-e</sup>
<sup>b</sup> Social sciences, media, and sports	43.2% ( <i>n</i> = 310)	56.8% ( <i>n</i> = 407)	
<sup>c</sup> Linguistics, humanities, and cultural sciences	33.5% ( <i>n</i> = 269)	66.5% ( <i>n</i> = 534)	
<sup>d</sup> Medicine	37.5% ( <i>n</i> = 198)	62.5% ( <i>n</i> = 330)	
<sup>e</sup> Law and economics	43% ( <i>n</i> = 220)	57% ( <i>n</i> = 292)	
<sup>f</sup> Education (aspiring teachers)	38.6% ( <i>n</i> = 238)	61.4% ( <i>n</i> = 378)	
<sup>g</sup> Other	46.3% ( <i>n</i> = 37)	53.8% ( <i>n</i> = 43)	

*p*-value by Pearson's chi-square test

<sup>a-b</sup> Significant difference between a and b

358  
359  
360

**Table 5.** Odds ratios (OR) and 95% confidence intervals (CI) for the dependent variable risky alcohol consumption (AUDIT-C score: female  $\geq 4$ , male  $\geq 5$ ) and each predictor variable ( $p \leq .05$ )

Variable	OR (95% CI)	<i>p</i> -value	Wald chi-square
Use of pharmacological neuroenhancement (within the last 12 months)	0.625 (0.423–0.924)	.019	5.542
First study (did other studies before, but changed the field of study)	0.693 (0.549–0.875)	.002	9.525
Relationship status (joint household)	0.736 (0.580–0.933)	.011	6.420
First study (no, graduated before)	0.745 (0.563–0.985)	.039	4.276
Use of soft neuroenhancement (within the last 12 months)	0.799 (0.647–0.988)	.038	4.287
Fruit consumption	0.822 (0.753–0.898)	<.001	18.905
Loneliness	0.931 (0.892–0.972)	.001	10.749
Procrastination	1.017 (1.001–1.032)	.038	4.311
Impulsiveness	1.100 (1.052–1.150)	<.001	17.436
Social support by students	1.205 (1.079–1.345)	.001	10.989
WHO scale for physical activity (active, beneficial to health)	1.303 (1.053–1.613)	.015	5.915
Use of social media	1.323 (1.242–1.411)	<.001	74.190

Employment			
(yes, marginally employed)	1.381 (1.137–1.678)	.001	10.595
Cigarette smoking			
(currently regularly)	1.426 (1.030–1.974)	.033	4.570
Migrant background (yes)	1.523 (1.226–1.893)	<.001	14.394
Employment (yes, part-time)	1.527 (1.164–2.001)	.002	9.374
Marijuana consumption			
(currently occasionally)	1.600 (1.194–2.143)	.002	9.908
Cigarette smoking			
(currently occasionally)	1.691 (1.297–2.203)	<.001	15.113

361

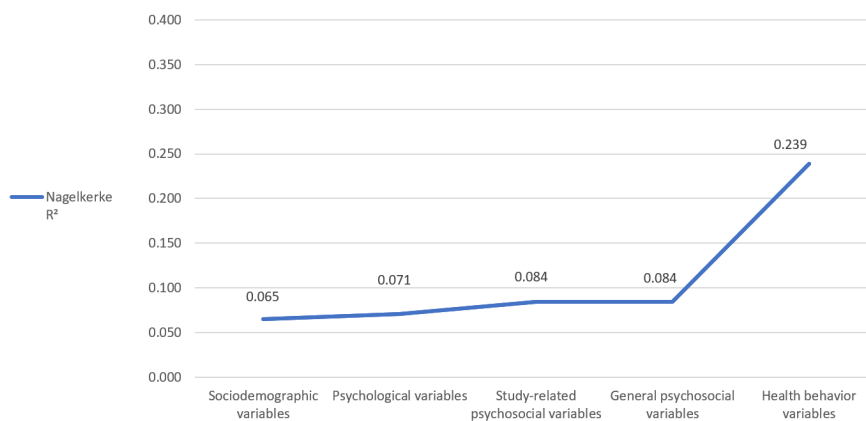
### 362 3.3.3 Prevalence, risk groups, and predictors of marijuana smoking

363 In our sample, 10.9% ( $n = 435$ ) of all students smoked marijuana as defined above (currently  
364 occasionally or currently regularly). With regard to potential sociodemographic and study-  
365 related risk groups (Table 6), women (9.0%) smoked significantly ( $p \leq .001$ ) less marijuana than  
366 men (15.4%) or diverse students (25.0%). Students aged 23 years or younger had a significantly  
367 higher prevalence (11.8%,  $p = .034$ ) of marijuana smoking compared with those aged 24 years  
368 or older (9.7%). With regard to aspired degree, bachelor's students (13.0%) had a significantly  
369 higher prevalence ( $p \leq .001$ ) of marijuana smoking than aspirants of state examination (8.7%)  
370 or doctoral aspirants (3.6%). Regarding field of study, we detected a significantly ( $p \leq .001$ )  
371 higher prevalence among students in the field of social science, media, and sports (15.7%) than  
372 those in STEM (9.3%), medicine (8.3%), and education (9.1%).

373 Of the 56 selected independent variables, 16 were significantly associated with marijuana  
374 smoking in the pretest, and these were included in the binary logistic regression analysis  
375 (Supplementary Table 4), which yielded 12 predictors ( $p \leq .05$ ), including 3435 (86.1%) students,  
376 for the final regression (Table 7). Negatively related variables were aspired degree (doctoral  
377 degree) (OR = .169), pharmacological neuroenhancement within the past 12 months (OR =  
378 .646), soft neuroenhancement within the past 12 months (OR = .691), self-endangering  
379 behavior (OR = .827), and semester hours per week (OR = .977).

380 Positive associations were detected with risky alcohol consumption (OR = 1.209), gender  
381 (male) (OR = 1.314), first study (OR = 1.398), physical activity (moderately active) (OR = 1.451),  
382 physical activity (active, beneficial to health) (OR = 1.641), currently regularly cigarette

383 smoking (OR = 1.959), and currently occasionally cigarette smoking (OR = 2.007). The Hosmer-  
 384 Lemmshow goodness of fit test revealed a chi-square of 11.281 with a significance of  
 385 0.186. Stepwise inclusion of the five groups of variables revealed a Nagelkerke R<sup>2</sup> of 0.065 after  
 386 inclusion of the sociodemographic variables, 0.071 (+0.006) after inclusion of the psychological  
 387 variables, 0.084 (+0.013) after inclusion of the study-related psychosocial variables and general  
 388 psychosocial variables, and 0.239 (+0.15.1) after inclusion of the health behavior variables  
 389 (Figure 3). Thus, our final model explains 23.9% of the variance in risky alcohol consumption.



390  
 391 **Figure 3.** Regression model for marijuana smoking. Changes in Nagelkerke R<sup>2</sup> by stepwise  
 392 inclusion of the different variable groups.

393 **Table 6.** Prevalence of marijuana smoking distributed for the different basic and study-related  
 394 characteristics (n = 3,985).

Variable	Risky consumption		p-value
	"Yes"	"No"	
<b>All students (n = 3985)</b>	10.9% (n = 435)	89.1% (n = 3550)	
<b>Gender (n = 3985)</b>			
<sup>a</sup> Female	9.0% (n = 256)	91.0% (n = 2587)	<.001 <sup>a-b; a-c</sup>
<sup>b</sup> Male	15.4% (n = 171)	84.6% (n = 939)	
<sup>c</sup> Diverse	25.0% (n = 8)	75.0% (n = 24)	
<b>Age, median split (n = 3981)</b>			
<sup>a</sup> Between 16 and 23	11.8% (n = 266)	88.2% (n = 1979)	.034 <sup>a-b</sup>
<sup>b</sup> Older than 24	9.7% (n = 169)	90.3% (n = 1567)	
<b>First year (n = 3878)</b>			
<sup>a</sup> No	10.8% (n = 348)	89.2% (n = 2881)	.725
<sup>b</sup> Yes	11.2% (n = 73)	88.8% (n = 576)	
<b>Aspired degree (n = 3985)</b>			
<sup>a</sup> Bachelor's	13.0% (n = 272)	87.0% (n = 1815)	<.001 <sup>a-c; a-d</sup>
<sup>b</sup> Master's	9.6% (n = 81)	90.4% (n = 764)	
<sup>c</sup> "Staatsexamen"	8.7% (n = 76)	91.3% (n = 800)	
<sup>d</sup> Doctoral degree	3.6% (n = 5)	96.4% (n = 134)	
<sup>e</sup> Other	2.6% (n = 1)	97.4% (n = 37)	
<b>Field of study (n = 3977)</b>			
<sup>a</sup> STEM	9.3% (n = 67)	90.7% (n = 653)	<.001 <sup>a-b; b-d; b-f</sup>

<sup>b</sup> Social sciences, media, and sports	15.7% ( <i>n</i> = 113)	84.3% ( <i>n</i> = 605)
<sup>c</sup> Linguistics, humanities, and cultural sciences	10.8% ( <i>n</i> = 87)	89.2% ( <i>n</i> = 716)
<sup>d</sup> Medicine	8.3% ( <i>n</i> = 44)	91.7% ( <i>n</i> = 484)
<sup>e</sup> Law and economics	10.7% ( <i>n</i> = 55)	89.3% ( <i>n</i> = 457)
<sup>f</sup> Education (aspiring teachers)	9.1% ( <i>n</i> = 56)	90.9% ( <i>n</i> = 559)
<sup>g</sup> Other	16.0% ( <i>n</i> = 13)	84.0% ( <i>n</i> = 68)

*p*-value by Pearson's chi-square test

<sup>a-b</sup> Significant difference between a and b

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**Table 7.** Odds ratios (OR) and 95% confidence intervals (CI) for the dependent variable smoking marijuana and each independent variable (*p* ≤ .05)

Variable	OR (95% CI)	<i>p</i> -value	Wald chi-square
Aspired degree (Ph.D)	0.169 (0.038–0.744)	.019	5.452
Use of pharmacological neuroenhancement (within the last 12 months)	0.646 (0.437–0.954)	.028	4.861
Use of soft neuroenhancement (within the last 12 months)	0.691 (0.488–0.978)	.037	4.329
Self-harm	0.827 (0.699–0.978)	.027	5.117
Semester hours per week	0.977 (0.963–0.990)	.001	11.023
AUDIT-C score	1.209 (1.140–1.282)	<.001	39.911
Gender (male)	1.314 (1.008–1.713)	.043	4.466
First study (did other studies before, but changed the field of study)	1.398 (1.052–1.858)	.021	4.910
WHO scale for physical activity (moderate active)	1.451 (1.008–2.089)	.045	3.967
WHO scale for physical activity (active, beneficial to health)	1.641 (1.200–2.245)	.002	9.411
Cigarette smoking (currently regularly)	1.959 (1.476–2.599)	<.001	30.126
Cigarette smoking (currently occasionally)	2.007 (1.568–2.568)	<.001	21.728

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### 3.4 Discussion

400 The aims of the present study were to i) assess the prevalence of cigarette smoking, risky  
401 alcohol consumption, and marijuana smoking among university students at a large university

402 in Rhineland-Palatinate, Germany; ii) identify potential sociodemographic and study-related  
403 risk groups for substance use, especially with regard to age, gender, field of study, semester,  
404 and aspired degree; and iii) examine predictors of substance consumption, including  
405 sociodemographic and study-related variables, psychological variables, general and study-  
406 related psychosocial variables, and health behavior variables in a regression model. The results  
407 showed that models with groups of sociodemographic and study related variables,  
408 psychological variables, general and study related psychosocial variables, and health behavior  
409 related variables as predictors are suitable for explaining the prevalence of cigarette smoking,  
410 risky alcohol consumption, and smoking marijuana among university students. In each of  
411 these three models, the group of health behavior variables specifically showed the highest  
412 impact on consumption patterns. In particular, the consumption of each substance studied  
413 was predicted by the consumption of each of the other substances studied. With regard to the  
414 first aim, our results are in line with the current literature, which reports particularly high  
415 prevalence rates for the three types of substance use [20].

416

#### 417 3.4.1 *Cigarette smoking*

418 With regard to cigarette smoking, we detected significantly more users in the group of male  
419 and diverse students compared to female students, and significantly fewer cigarette smokers  
420 in the group of aspiring teachers compared to other fields of study. In particular, the observed  
421 gender difference to be consistent with global trends [97] and previous studies from Germany  
422 [4]. One reason for this may be that women are more engaged in seeking health information  
423 and take fewer risks than their male peers [98]. Regarding the field of study, there are no recent  
424 data available comparing different groups of students in Germany with regard to their  
425 smoking behavior.

426 Among the sociodemographic variables, migrant background and having dropped out of  
427 studies in the past emerged as strong predictors of cigarette smoking. Interestingly, migrant  
428 background was negatively associated with cigarette smoking in our sample, which is  
429 contrary to previous studies [73,99]. One possible reason for this could be an  
430 overrepresentation of female participants in the subgroup of students with an immigrant  
431 background, with the consequence that the female characteristic is more likely to be  
432 represented here than the specified migrant background. Another reason could be the  
433 "healthy migrant" paradox, which describes that people with migrant background have better

434 health behaviors than natives [100] and, in particular, are less likely to smoke cigarettes  
435 [100,101]. This effect is particularly evident in the first years of migration—for example, young  
436 people who leave their home country to study abroad. As the length of stay increases, health  
437 behaviors become more similar to the host country population. Another negatively associated  
438 point is former occasional marijuana smoking. Data from the SAMHSA study showed a  
439 noticeable gap between lifetime prevalence and use within the last year [28]. This gap can  
440 similarly be observed for cigarette smoking. Our hypotheses is that these differences can be  
441 explained by a group of students that tried marijuana consumption for a period of time but  
442 then ceased consumption. Thus, a negative correlation can be found in our data. Furthermore,  
443 impulsiveness and general anxiety emerged as positive predictors of cigarette smoking.  
444 Consistent with our results, numerous previous studies have shown an association among  
445 impulsiveness [102], general anxiety [103], and cigarette smoking. The strongest predictors of  
446 cigarette smoking were occasional or regular marijuana smoking and risky alcohol  
447 consumption. Comparable to our results regarding risky alcohol consumption and marijuana  
448 smoking, the group of health behavior variables also had the largest influence on the explained  
449 variance in the cigarette smoking regression model. Therefore, there turned out to be a strong  
450 association between cigarette smoking and health behavior variables.

451

#### 452 3.4.2 *Risky alcohol consumption*

453 Regarding potential risk groups for risky alcohol consumption, surprisingly, there was no  
454 significant association between gender and risky alcohol consumption in our study, contrary  
455 to what has often been reported in the literature [72,104]. However, a few studies have shown  
456 results consistent with ours. For example, Santangelo et al. [24,25] reported that 37.9% of  
457 female and 40.7% of male students in Palermo, Italy, showed risky alcohol consumption  
458 behavior [25]. Significant differences were detected in age and study progress. In particular,  
459 younger students and students in their first year of study were significantly more likely to  
460 engage in risky alcohol consumption than older students who had enrolled for longer (>1 year)  
461 —as also shown by other studies [76].

462 Sociodemographic factors had a strong influence on risky alcohol consumption in our model.  
463 Marginal or part-time employment were associated with risky alcohol consumption. Since  
464 socioeconomic status is associated with alcohol consumption, it may be that students who  
465 need to earn money in addition to their studies come from families with lower socioeconomic

466 backgrounds [74,105]. Another sociodemographic factor correlated with risky alcohol  
467 consumption was migrant background. This factor could have potentially been influenced by  
468 students participating in an exchange program [106].

469 We detected only a small additional influence of psychological (physical and mental health)  
470 and psychosocial factors. There were negative associations with loneliness and positive  
471 relations with social support from fellow students, procrastination, and impulsiveness.  
472 However, these factors explained only a small proportion of the variance in our model. With  
473 regard to psychological variables, research results have been heterogeneous. Some previous  
474 studies have associated psychological symptoms such as anxiety, loneliness, depression, and  
475 illness with increased alcohol consumption [78,80,107,108], although other studies have shown  
476 no clear association [10,24,77].

477 Health behavior variables had the largest impact on risky alcohol consumption in our model.  
478 Consistent with previous studies, we observed risky alcohol consumption primarily among  
479 students who were physically active [71], heavy social media users [70,75], soft  
480 neuroenhancement users [90], and smokers [69]. Elevated scores were measured for occasional  
481 and regular cigarette smokers and occasional marijuana smokers. Thus, we can conclude that  
482 low health awareness and lifestyle are associated with risky alcohol consumption. When  
483 factors were added groupwise, our model was mainly explained by sociodemographic and  
484 health behavior variables. Psychological and psychosocial variables only had a small  
485 association with the explained variance in risky consumption, despite the large number of  
486 variables tested.

487

### 488 3.4.3 *Marijuana smoking*

489 As with cigarette smoking, female students in our sample were significantly less likely to  
490 smoke marijuana than male or diverse students. In addition, our results showed higher rates  
491 among students pursuing bachelor's degrees compared to doctoral candidates and those  
492 pursuing the German "Staatsexamen" (studies at university with a final examination  
493 administrated by the state—e.g., medicine, pharmacology, law). Regarding the field of study,  
494 students of social science, media, and sports smoked marijuana significantly more often than  
495 students of STEM, medicine, or education (aspiring teachers). Binary logistic regression  
496 analysis revealed that sociodemographic and study-related characteristics such as aspiring to  
497 a doctoral degree and having a higher number of semester hours per week were negative

498 predictors of marijuana smoking. In addition to sociodemographic variables, health behavior  
499 variables again had the largest impact on marijuana smoking in our model, as we have already  
500 seen for cigarette smoking and risky alcohol consumption. Surprisingly, the use of  
501 pharmacological and soft neuroenhancement within the previous 12 months were strongly  
502 negatively associated with marijuana smoking. Therefore, to avoid confounding with  
503 marijuana smoking, the results of our study refer to pharmacological neuroenhancement as  
504 excluding smoking marijuana for the purposes of neuroenhancement, as described in the  
505 methods section. Positively associated variables were a high AUDIT-C score (indicating riskier  
506 alcohol consumption), medium or high physical activity score, and occasional or regular  
507 cigarette smoking. Psychological, study-related, and general psychosocial variables had a  
508 small impact in our model. In the context of marijuana smoking, the picture emerged that time-  
509 consuming, advanced studies (doctoral degrees), as well as trying to improve oneself with  
510 neuroenhancement, are not compatible with marijuana smoking. On the other hand,  
511 physically active men who also consume more alcohol and cigarettes, are clearly more  
512 amenable to marijuana. Nevertheless, the use of marijuana as a neuroenhancer should be  
513 investigated further.

514

#### 515 3.4.4 *Limitations*

516 Comparing the groups of students that answered the questionnaire with regard to cigarette  
517 smoking, alcohol consumption, and marijuana smoking (3991 students) with the group of  
518 students who did not (360 students; exclusion criterion), we found higher rates of male  
519 students (+9.8%) and first-year students (+4.3%). Both groups are often associated in the  
520 literature with increased rates of risky consumption. Therefore, as a limitation, it should be  
521 considered that the prevalence of risky use in our sample may have been underestimated.  
522 Tables with full descriptive statistics of excluded participants can be found in the  
523 supplemental material.

524 To measure risky alcohol consumption, we chose the AUDIT-C questionnaire, the short form  
525 of the AUDIT questionnaire. We used the short form to keep the entire questionnaire, which  
526 already contained about 270 questions, as short as possible. However, the applicability of the  
527 AUDIT-C for the detection of risky alcohol consumption is well established [86–88].  
528 Furthermore, there are inconsistent data regarding the cut-off of the AUDIT-C to measure  
529 risky alcohol consumption. Several studies have presented samples from a clinical setting

530 where a cut-off of  $\geq 3$  has been shown to be useful [89,109]. Rumpf et al. [87] showed that in a  
531 German nonclinical sample, a cut-off of  $\geq 5$  achieved the highest specificity with good  
532 sensitivity, which has been confirmed by other studies [88]. Therefore, we decided to use a  
533 cut-off of  $\geq 5$  for risky alcohol consumption. AUDIT-C scores  $\leq 4$  were classified as “non-risky  
534 consumption.”

535 To define cigarette smoking and marijuana smoking, we chose to define “current use” as risky,  
536 regardless of quantity or frequency (“occasionally” or “regularly”). This decision was based  
537 on the works of Inoue-Choi and colleagues [45,46], who were able to show that even occasional  
538 cigarette smoking and small amounts of marijuana can be harmful to health. Since 2017,  
539 medical marijuana has been approved in Germany for serious or incurable diseases. As a  
540 tested medical product, it contains significantly less harmful substances than nonmedical  
541 marijuana [110]. Since we did not have any data on medical marijuana in our student  
542 collective, we assumed the use of illegal marijuana. This aspect also argues for classifying even  
543 small amounts of marijuana as dangerous. Further research on the prevalence of medical  
544 cannabis among students would be helpful.

545 The sample we studied was 70.5% female. Compared to the number of female students  
546 enrolled at the Johannes-Gutenberg-University in Mainz (59.5%) [111], we had an 11%  
547 overrepresentation of women in our sample. By adjusting the cut-off values for risky  
548 consumption according to gender, we compensated for this limitation as best as possible, but  
549 a slight overrepresentation of women must be considered when using our results.

550

### 551 **3.5 Conclusions and practical recommendations**

552 The present study shows that cigarette smoking, risky alcohol consumption, and marijuana  
553 smoking among university students in Germany are associated with multiple factors,  
554 especially with health behaviors. Looking more closely at the predictors of the three substances  
555 studied, two aspects in particular stand out. First, consumption is predicted mainly by  
556 sociodemographic and health behavior variables. Psychological and psychosocial variables  
557 play a rather minor role. Second, the consumption behavior of each substance is to a large  
558 extent associated with the other two substances we examined. For example, people who drink  
559 more alcohol are more likely to smoke cigarettes or marijuana. Those who smoke cigarettes  
560 are more likely to consume alcohol or marijuana. This leads us to the point that the  
561 consumption of each of the three substances analyzed increases according to the higher risk of

562 consuming the other substances. Conversely, low consumption of one substance is also  
563 associated with lower consumption of the other substances (see Table 3, 5, and 7). This  
564 suggests that the substances cannot be considered in isolation from each other, with their  
565 consumption being largely interrelated. Based on this association, we conclude that  
566 prevention programs could be more effective if they address substance use as a whole and not  
567 individual substances (e.g., cigarette smoking, alcohol consumption, marijuana smoking). The  
568 second point is that all three substances were very strongly associated with the health behavior  
569 variables, as this group had the biggest impact on our regression model. By having one group  
570 of variables that have a strong lever to “risky use,” this could also be a good starting point for  
571 prevention programs, as it is possible to effectively influence all three substances. For  
572 prevention, it might be more a question of “general substance use” than one of specific  
573 substance use. This could lead to synergistic effects and make prevention programs more  
574 effective.

### 575 **3.6 Patents**

576 **Supplementary materials:** Supplemental Tables 1–6

577 **Author contributions:** Conceptualization: TAH, SH, JLR, AMW, MS, ANT, PS, MB, SL, TR and PD. Formal analysis,  
578 methodology, and software: TAH, SH, AMW, ANT, and PD. Data curation: SH, JLR, AMW, MS, ANT, TR, and PD.  
579 Funding acquisition: SL. Investigation: TAH, SH, AMW, ANT, and PD. Project administration and resources: SL  
580 and PD. Supervision: PD. Validation of manuscript content: SH, TR, and PD. Writing—original draft: TAH. The  
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585 by the Ethical Committee of the Medical Association of Rhineland-Palatinate, Germany (No. 2019-14336).

586 **Informed consent statement:** The participants provided their written informed consent online to participate in this  
587 study.

588 **Data availability statement:** The raw data supporting the conclusions of this article will be made available by the  
589 corresponding author, without undue reservation.

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591 **Conflicts of interest:** The authors declare that the research was conducted in the absence of any commercial or  
592 financial relationships that could be construed as a potential conflict of interest.

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## 5. Supplementary Material

### Article Title: Cigarette smoking, risky alcohol consumption, and marijuana smoking among university students in Germany: identification of potential sociodemographic and study-related risk groups and predictors of consumption

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932 **Supplementary Table 1. List of all 56 variables used in the present study and their**  
 933 **characteristics**

Dimension	Variable (count)	Scale	Reference	Item	"Question for the self-constructed item," answering options
Sociodemographic variables	Gender (1)	Self-constructed items		1	"Your gender": male (1) / female (2) / diverse (3)
	Age (1)	Self-constructed items		1	"Your age in years"
	Relationship status (1)	Self-constructed items		1	"What is your relationship status?" Single (1) / Partnership in one household (2) / Partnership with separate living conditions (3)
	Employment (1)	Self-constructed items		1	"Are you currently employed?" No (1) / Yes, full-time (2) / Yes, regularly part-time (3) / Yes, marginally or irregularly employed (4)
	Financial situation	Self-constructed items		1	"How much money do you have at your disposal on average each month?"
	Parental support	Self-constructed items		1	"How do you finance your studies?" Support by parents or relatives: Yes / No
	Parents' educational background	Self-constructed items		1	"Please select the highest educational attainment of your mother or your father (the highest of both)": List of attainments, also including "other attainment"
	Migrant background	Self-constructed items		1	"Were both of your parents born within the current

				geography of Germany?" <i>Yes (1) / No (2) / Don't know (3) / No information (4)</i>
	Personal migration experience (1)	Self-constructed items	1	"Were you born in the current geography of Germany?" <i>Yes (1) / No (2) / Don't know (3) / No information (4)</i>
	Degree (1)	Self-constructed items	1	"Which degree are you pursuing in your current studies?" <i>Drop-down list of all degrees at the University of Mainz</i>
	Field of study (1)	Self-constructed items	1	Grouped variable created for "What is your current study subject or special subject?" <i>Drop-down list of all subjects of the University of Mainz</i>
	First year (Semester / study progress) (1)	Self-constructed items	1	"What is the number of your current university semester?"
	First study	Self-constructed items	1	"Have you started or completed another degree program before your current one?" <i>No (1) / Yes, graduate before (2) / Yes, but changed the field of study (3) / Yes, but did not graduate (4)</i>
	Semester hours and semester hours with mandatory attendance (2)	Self-constructed items	2	"How many hours per week are you taking this semester?" and "Of these, how many require your attendance?"
Psychological variables	Somatic symptoms	SSS8	Gierk et al. (2014)	8
	Depression symptoms	PHQ-9	Kroenke et al. (2001)	9
	General anxiety	GAS-2	Döring & Bortz (1993)	2
	Social anxiety	Mini-SPIN	Wiltink et al. (2017)	3
	Loneliness	UCLA	Döring & Bortz (1993)	3
	Emotional exhaustion	MBI-SS	Gumz et al. (2013)	5
Study-related psychosocial variables	Presenteeism		Töpitz et al. (2016)	1
	Absenteeism		Töpitz et al. (2016)	1

	Perceived employability	Self-constructed items		1	“How do you estimate your chances on the job market?” Very Bad (1) to Very Good (7)
	Autonomy	BARI-S	Gusy & Lohmann (2014)	6	
	Coping through the use of structural resources and social support (2)		Daniels et al. (2008)	4	
	Self-endangering behavior		Krause et al. (2015)		
	Planning competency		Dettmers & Clauß (2018)	8	
	Work complexity		Gusy et al. (2016)		
	Competition		Fend (1997)	4	
	Performance pressure		Fend (1997)	5	
	Cognitive irritation		Mohr et al. (2005)		
	Social support by teachers	SALSA	Rimann & Udris (1997)	3	
	Social support by fellow students	SALSA	Rimann & Udris (1997)	3	
	Competence for self-motivation		Dettmers & Clauß (2018)	8	
	Self-efficacy		Self-Efficacy Scale, adapted from Rigotti et al. (2008)	6	
	Procrastination	GPS-K	Klingsieck & Fries (2012)	9	
General psychosocial variables	Self-criticism	DEQ-SC4	Rudich et al. (2008)	4	
	Self-acceptance		Ryff & Keyes (1995); Ryff (1989)	3	
	Emotion regulation	ERQ	Abler & Kessler (2011)	4	

	Emotion suppression	ERQ		Abler & Kessler (2011)	4	
	Impulsiveness	ERQ		Abler & Kessler (2011)	4	
Health behavior variables	Healthy diet	Self-constructed items			1	“A healthy diet consists of eating a large quantity of whole grains, potatoes, fruit, and vegetables several times a day and food low in trans fats as well as a small quantity of red meat and sausages, fast-food (e.g., burger, fries), and sugar-rich food (e.g., lemonade, soft drinks, candy, cake). To what extent have you study to a healthy diet in the last month?” Not at all (1) to Very strong (5)
	Fruit consumption			European Comission (2013); Fehr et al. (2018)	4	
	Vegetable consumption			European Comission (2013); Fehr et al. (2018)	4	
	Physical activity	IPAQ version	Short	Craig et al. (2003); International Physical Activity Questionnaire		
	Sedentary behavior	IPAQ version	Short	Craig et al. (2003); International Physical Activity Questionnaire	7	
	Smoking cigarettes			Töpritz et al. (2016)	1	
	Risky alcohol consumption	AUDIT-C		Bush et al. (1998)	1	
	Marijuana smoking	Self-constructed items				“Do you smoke marijuana?” <i>never (1) / formerly occasionally (2) / formerly regularly (3) / currently occasionally (4) / currently regularly (5)</i>

Use of  
neuroenhance-  
ment (2)

Dietz et al. 2  
(2016)

Use of social-  
media

Adapted 6  
from Stark  
et al. (2017)

935 **Supplementary Table 2. Association between the dependent variable cigarette smoking and each independent**  
 936 **variable (pretest for regression)**

<b>Variable</b>	<b><i>p</i>-value</b>
<b>1) Sociodemographic variables</b>	
Gender	<sup>c</sup> <.001
Age, median split	<sup>b</sup> .486
Relationship status	<sup>c</sup> .430
Employment	<sup>c</sup> <.001
Financial situation	<sup>a</sup> <.001
Parental support	<sup>c</sup> .159
Parents' educational background	<sup>c</sup> .278
Migrant background	<sup>c</sup> <.001
Personal migrant experience	<sup>c</sup> .001
Aspired degree	<sup>c</sup> .095
Field of study	<sup>c</sup> <.001
Semester	<sup>a</sup> .921
First study	<sup>c</sup> .001
First year	<sup>c</sup> .516
Semester hours per week	<sup>a</sup> .005
Semester hours per week with mandatory attendance	<sup>a</sup> .001
<b>2) Psychological variables</b>	
Somatic symptoms	<sup>a</sup> <.001
Depression symptoms	<sup>a</sup> <.001
General anxiety	<sup>a</sup> <.001
Social anxiety	<sup>a</sup> .663
Loneliness	<sup>a</sup> .374
Emotional exhaustion	<sup>a</sup> .002
<b>3) Study-related psychosocial variables</b>	
Presenteeism	<sup>a</sup> .428
Absenteeism	<sup>a</sup> .001
Perceived employability	<sup>a</sup> .002
Autonomy	<sup>a</sup> .990
Autonomy exams	<sup>a</sup> .123
Coping via use of structural resources	<sup>a</sup> .188
Coping via use of social resources	<sup>a</sup> .198

Self-endangering behavior	a .813
Planning competency	a <.001
Work complexity	a .603
Competition	a .421
Performance pressure	a .064
Cognitive irritation	a .064
Social support from teachers	a .294
Social support from fellow students	a .401
Competence for self-motivation	a <.001
Self-efficacy	a .001
Procrastination	a <.001

**4) General psychosocial variables**

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Self-criticism	a .059
Self-acceptance	a <.001
Emotion regulation	a .209
Emotion suppression	a .316
Impulsiveness	a <.001

**5) Health behavior variables**

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Healthy diet	b <.001
Fruit consumption	a .010
Vegetable consumption	a .377
Physical activity	b .347
Sedentary behavior	a .101
AUDIT-C score	a <.001
Marijuana smoking	c <.001
Use of soft neuroenhancement	c <.001
Use of pharmacological neuroenhancement	c <.001
Use of social media	a <.001

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a		ANOVA		test.
b	Pearson's		chi-square	test.
c	Cramer's V-test.			

**Supplementary Table 3. Association between the dependent variable risky alcohol consumption and each independent variable (pretest for regression)**

<b>Variable</b>	<b><i>p</i>-value</b>
<b>1) Sociodemographic variables</b>	
Gender	<sup>c</sup> .120
Age, median split	<sup>b</sup> .001
Relationship status	<sup>c</sup> <.001
Employment	<sup>c</sup> <.001
Financial situation	<sup>a</sup> .007
Parental support	<sup>c</sup> <.001
Parents' educational background	<sup>c</sup> .118
Migrant background	<sup>c</sup> <.001
Personal migrant experience	<sup>c</sup> .002
Aspired degree	<sup>c</sup> .032
Field of study	<sup>c</sup> .001
Semester	<sup>a</sup> <.001
First study	<sup>c</sup> .001
First year	<sup>c</sup> .030
Semester hours per week	<sup>a</sup> .418
Semester hours per week with mandatory attendance	<sup>a</sup> .206
<b>2) Psychological variables</b>	
Somatic symptoms	<sup>a</sup> .767
Depression symptoms	<sup>a</sup> .339
General anxiety	<sup>a</sup> <.001
Social anxiety	<sup>a</sup> <.001
Loneliness	<sup>a</sup> <.001
Emotional exhaustion	<sup>a</sup> .089
<b>3) Study-related psychosocial variables</b>	
Presenteeism	<sup>a</sup> .020
Absenteeism	<sup>a</sup> .616
Perceived employability	<sup>a</sup> .839
Autonomy	<sup>a</sup> .318
Autonomy exams	<sup>a</sup> .608
Coping via use of structural resources	<sup>a</sup> .372

Coping via use of social resources	a .949
Self-endangering behavior	a .011
Planning competency	a .432
Work complexity	a .930
Competition	a .089
Performance pressure	a .010
Cognitive irritation	a <.001
Social support by teachers	a .590
Social support by fellow students	a <.001
Competence for self-motivation	a .447
Self-efficacy	a .149
Procrastination	a <.001

#### 4) General psychosocial variables

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Self-criticism	a .239
Self-acceptance	a <.001
Emotion regulation	a .762
Emotion suppression	a <.001
Impulsiveness	a <.001

#### 5) Health behavior variables

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Healthy diet	b .004
Fruit consumption	a <.001
Vegetable consumption	a .326
Physical activity	b <.001
Sedentary behavior	a .006
Cigarette smoking	c <.001
Marijuana smoking	c <.001
Use of soft neuroenhancement	c <.001
Use of pharmacological neuroenhancement	c <.001
Use of social media	a <.001

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a ANOVA test.  
b Pearson's chi-square test.  
c Cramer's V-test.

**Supplemental Table 4. Association between the dependent variable marijuana smoking and each independent variable (pretest for regression)**

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<i>Variable</i>	<i>p-value</i>
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<b>1) Sociodemographic variables</b>	
Gender	c <.001
Age, median split	b .034
Relationship status	c .014
Employment	c .012
Finances	a .193
Parental support	c .028
Parents' education	c .189
Parents' migration	c .479
Own migration	c .727
Aspired degree	c <.001
Field of study	c <.001
Semester	a .028
First study	c <.001
First year	c .725
Semester hours per week	a <.001
Semester hours per week in attendance	a .007
<b>2) Psychological variables</b>	
Physical complaints	a .380
Depression symptoms	a <.001
Anxiety symptoms	a .355
Social anxiety	a .535
Loneliness	a .235
Emotional exhaustion	a .851
<b>3) Study-related psychosocial variables</b>	
Presenteeism	a .070
Absenteeism	a .279
Perceived employability	a .659
Autonomy	a .231
Autonomy exams	a .650
Coping via use of structural resources	a .297
Coping via use of social resources	a .239
Self-endangering behavior	a <.001
Planning competency	a <.001
Work complexity	a .249
Competition	a .335
Performance pressure	a <.001
Cognitive irritation	a .201
Social support from teachers	a .423
Social support from fellow students	a .906
Competence for self-motivation	a <.001
Self-efficacy	a .401
Procrastination	a <.001
<b>4) General psychosocial variables</b>	

Self-criticism	a	.541
Self-acceptance	a	.279
Emotion regulation	a	.365
Emotion suppression	a	.867
Impulsiveness	a	.002
<b>5) Health behavior variables</b>		
Healthy diet	b	.249
Fruit consumption	a	.990
Vegetable consumption	a	.241
Physical activity	b	<.001
Sedentary behavior	a	.091
AUDIT-C score	a	<.001
Cigarette smoking	c	<.001
Use of soft neuroenhancement	c	<.001
Use of pharmacological Neuroenhancement	c	<.001
Use of social media	a	.011
a		ANOVA
b	Pearson's	chi-square
c	Cramer's V-test.	
		test.
		test.

**Supplemental Table 5. Answering rate for each independent variable (included group, N = 3991)**

Variable	Answering	Percentage
<b>1) Sociodemographic variables</b>		
Gender	3991	100.0%
Age	3987	99.9%
Relationship status	3987	99.9%
Employment	3991	100.0%
Financial situation	3911	98.0%
Parental support	3968	99.4%
Parents' educational background	3989	99.9%
Migrant background	3990	100.0%
Personal migration experience	3990	100.0%
Aspired degree	3991	100.0%
Field of study	3982	99.8%
Semester	3975	99.6%
First study	3989	99.9%
First year	3884	97.3%
Semester hours per week	3867	96.9%
Semester hours per week with mandatory attendance	3873	97.0%
<b>2) Psychological variables</b>		
Physical complaints	3988	99.9%

Depression symptoms	3987	99.9%
Anxiety symptoms	3990	100.0%
Social anxiety	3617	90.6%
Loneliness	3991	100.0%
Emotional exhaustion	3909	97.9%

### 3) Study-related psychosocial variables

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Presenteeism	3897	97.6%
Absenteeism	3898	97.7%
Perceived employability	3892	97.5%
Autonomy	3949	98.9%
Autonomy exams	3943	98.8%
Coping via use of structural resources	3937	98.6%
Coping via use of social resources	3941	98.7%
Self-endangering behavior	3935	98.6%
Planning competency	3935	98.6%
Work complexity	3922	98.3%
Competition	3921	98.2%
Performance pressure	3920	98.2%
Cognitive irritation	3909	97.9%
Social support by teachers	3892	97.5%
Social support by fellow students	3900	97.7%
Competence for self-motivation	3891	97.5%
Self-efficacy	3890	97.5%
Procrastination	3932	98.5%

### 4) General psychosocial variables

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Self-criticism	3881	97.2%
Self-acceptance	3880	97.2%
Emotion regulation	3879	97.2%
Emotion suppression	3880	97.2%
Impulsiveness	3874	97.1%

### 5) Health behavior variables

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Healthy diet	3991	100.0%
Fruit consumption	3649	91.4%
Vegetable consumption	3806	95.4%
Physical activity	3899	97.7%
Sedentary behavior	3899	97.7%
Use of soft neuroenhancement	3984	99.8%
Use of pharmacological neuroenhancement	3984	99.8%
Use of social media	3987	99.9%
Average	3923	<u>98.3%</u>

**Supplemental Table 6. Answering rate for each independent variable (non-included group, N = 360)**

Variable	<i>answering</i>	percent
<b>1) Sociodemographic variables</b>		
Gender	359	99.7%
Age	360	100.0%
Relationship status	360	100.0%
Employment	95	26.4%
Financial situation	0	0.0%
Parental support	0	0.0%
Parents' educational background	360	100.0%
Migrant background	360	100.0%
Personal migration experience	360	100.0%
Aspired degree	360	100.0%
Field of study	360	100.0%
Semester	358	99.4%
First study	360	100.0%
First year	342	95.0%
Semester hours per week	0	0.0%
Semester hours per week with mandatory attendance	0	0.0%
<b>2) Psychological variables</b>		
Physical complaints	340	94.4%
Depression symptoms	320	88.9%
Anxiety symptoms	297	82.5%
Social anxiety	267	74.2%
Loneliness	297	82.5%
Emotional exhaustion	0	0.0%
<b>3) Study-related psychosocial variables</b>		
Presenteeism	0	0.0%
Absenteeism	0	0.0%
Perceived employability	0	0.0%
Autonomy	0	0.0%
Autonomy exams	0	0.0%
Coping via use of structural resources	0	0.0%
Coping via use of social resources	0	0.0%
Self-endangering behavior	0	0.0%
Planning competency	0	0.0%
Work complexity	0	0.0%
Competition	0	0.0%
Performance pressure	0	0.0%
Cognitive irritation	0	0.0%
Social support by teachers	0	0.0%
Social support by fellow students	0	0.0%

Competence for self-motivation	0	0.0%
Self-efficacy	0	0.0%
Procrastination	0	0.0%
<b>4) General psychosocial variables</b>		
Self-criticism	0	0.0%
Self-acceptance	0	0.0%
Emotion regulation	0	0.0%
Emotion suppression	0	0.0%
Impulsiveness	0	0.0%
<b>5) Health behavior variables</b>		
Healthy diet	153	42.5%
Fruit consumption	124	34.4%
Vegetable consumption	100	27.8%
Physical activity	29	8.1%
Sedentary behavior	29	8.1%
Use of soft neuroenhancement	0	0.0%
Use of pharmacological neuroenhancement	0	0.0%
Use of social media	224	62.2%
Average	117	32.6%

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