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Clustering of substance use and its association with adolescents' health and well-being: evidence from the Health Behaviour in School-Aged Children (HBSC) Luxembourg study

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Abstract

Introduction: Substance use during adolescence often persists into adulthood, with alcohol, tobacco, and cannabis use frequently clustering. These behaviors are associated with negative outcomes for self-rated health and well-being. **Objectives:** This study analyzes the clustering of substance use (alcohol, cigarettes, e-cigarettes, and cannabis) among adolescents in Luxembourg and examines their association with sociodemographic factors, self-rated health, and well-being. **Methods:** Data were drawn from 5, 543 adolescents (50.7% boys; ages 13–18, secondary schools) who participated in the 2022 Health Behaviour in School-aged Children (HBSC) survey in Luxembourg. Substance use was assessed based on consumption in the past 30 days. Health outcomes included the WHO-5 Well-being Index and self-rated excellent health. A two-step cluster analysis identified substance use patterns. Binomial logistic regression and ANCOVA adjusted by sociodemographic variables examined associations with health outcomes. **Results:** Three substance use clusters emerged: “No substance use” (56.4%), “Alcohol only” (18.8%), and “Other substance use” (24.8%; including cannabis, cigarettes, e-cigarettes, or multiple substances). Age, family structure, migration background, and perceived wealth were significantly associated with cluster membership. The “Other substance use” cluster reported the lowest well-being ($M = 11.87$) compared with the other 2 clusters. In addition, this cluster presented lower odds of excellent health ($OR = 0.50$), compared to “No substance use”. **Conclusions:** Substance use is negatively associated with adolescent health and well-being in Luxembourg. Distinct usage patterns suggest the need for tailored prevention strategies targeting specific risk groups to promote healthier lifestyles among youth.

Keywords: alcohol; cigarette; e-cigarette; cannabis; cluster analysis; mental health

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BACKGROUND

Adolescence is a critical developmental period, characterized by rapid physical, emotional, and social changes, which can influence decision-making and risk-taking [1-3]. Behaviors established during this period, such as substance use, often persist into adulthood, influencing long-term health trajectories [4-6].

Substance use among adolescents is a significant public health concern, as it is associated with a range of adverse health outcomes and risk behaviors [7], such as mental health problems [5, 8]. In recent years, there has been growing interest in understanding how the use of single or multiple substances, including alcohol, tobacco, and cannabis tend to cluster among young people [9], as research has shown that substance use behaviors frequently co-occur [8, 10-12]. In particular, the co-use of tobacco and cannabis [13-15] has been well documented, as has the co-use of alcohol and cannabis [16], and tobacco and alcohol [15, 17], while the combination of alcohol, tobacco and cannabis represents the most common polysubstance use [18].

In addition, distinct clusters could be associated with sociodemographic factors, such as sex, socioeconomic status, migration background and family structure [19-23]. For instance, boys [24] and adolescents from lower sociodemographic background [25] are more likely to engage in multiple substance use, particularly involving alcohol, tobacco and cannabis with or without other drugs [8]. Evidence indicates that adolescents in different

substance-use patterns show distinct impacts on health and mental health, with polysubstance users generally reporting poorer well-being and health outcomes, highlighting the importance of these indicators in characterizing clusters [8, 10-12, 26].

The clustering of substance use not only reflects the complexity of adolescent behavior but also highlights the importance of early intervention to prevent escalation and related harms [24, 27]. Cluster-based approaches, such as person-centered methods, identify qualitatively distinct patterns of co-occurring substance use rather than relying on simple prevalence estimates or predefined categories [28]. By identifying these distinct profiles, clustering analyses help detect high-risk subgroups and tailor prevention strategies to specific combinations of behaviors and sociodemographic characteristics, thereby informing more targeted and effective public health interventions and policy planning [9, 29].

In Luxembourg, as in many European countries, the landscape of adolescent substance use is rapidly evolving [30-32]. The prevalence of alcohol and tobacco use among adolescents remains concerning, despite public health efforts to reduce consumption [24, 33, 34]. The emergence of e-cigarettes, often perceived as a less-harmful alternative to traditional smoking [35], and their quickly increasing prevalence among adolescents has sparked debate about whether their use serves as a gateway to traditional cigarette smoking or reflects a common liability to substance use [36, 37]. In relation to cannabis, many countries have regulated its use, including Luxembourg,

where regulatory measures have arisen since 2018, including legal access to cannabis for medical purposes and gradual steps toward controlled cultivation and use for non-medical purposes [38]. These changes may shift consumption patterns, underscoring the need to better understand how substances are used together among adolescents. This is crucial for tailoring effective national prevention and intervention strategies aimed at mitigating both immediate and long-term health risks.

Therefore, this study examines clustering of substance use, more specifically, the use of alcohol, cigarettes, e-cigarettes, and cannabis, among adolescents in Luxembourg. Using Health Behaviour in School-aged Children (HBSC) data, it also investigates how these clusters relate to sociodemographic characteristics—including migration background and socioeconomic status—and to well-being and self-rated health. Nationally representative analyses of polysubstance-use profiles in small but highly diverse European contexts such as Luxembourg remain limited. By identifying these profiles, this study contributes to understanding how substance-use patterns relate to social inequalities and health and provides evidence to inform targeted prevention strategies for adolescent subgroups in Luxembourg.

METHODOLOGY

Study Design and Sample

This cross-sectional study utilized data from the 2022 Health Behaviors in School-aged Children (HBSC) Luxembourg survey. HBSC is an international

study in collaboration with the World Health organization (WHO) using a standardized questionnaire, following an international research protocol to ensure consistency in the data collection and processing every four years with national representative samples [39, 40].

In Luxembourg, the study included students enrolled from cycle 4 to the upper grades of general secondary or vocational education in both public and private schools, to have a representative sample of adolescents aged 11 to 18. The sampling strategy involved a two-stage cluster sample, randomly selecting school classes from the national register. A total of 9,432 adolescents from 152 schools participated in the HBSC 2022 survey, completing a paper-pencil questionnaire during school hours.

Due to the sensitivity of questions related to drug consumption, only secondary school students were invited to respond to cannabis related questions. Consequently, students from Primary School (cycle 4) and those that did not report their age were excluded from the present study. A total of 6,364 students aged 13 to 18 (49.3% girls, mean age = 15.57 ± 1.71 years) from 46 secondary schools were included in the analysis. Ethical approval was granted by the Ethics Review Panel of the University of Luxembourg (ERP 21-013 HBSC 2022), the parents/guardians of the adolescents were informed about the study through the school management and could refuse/consent their child's participation.

Measurements

Substance use

We evaluated the consumption of alcohol, cigarettes, e-cigarettes and cannabis with four questions ["On how many days (if any) have you (drunk alcohol/smoked cigarettes/used electronic cigarettes/taken cannabis) in the last 30 days?"] with a seven-point-scale from "never" to "30 days (or more)" [41, 42].

Health outcomes

Two variables were used to measure well-being and self-rated health. The WHO-5 Well-being Index is a brief instrument used to assess emotional well-being during the previous two weeks [43]. Using a 6-point Likert scale ranging from 0 (at no time) to 5 (all the time), the responses to the items are added together to create a well-being score ranging from 0 to 25. A higher score indicates better well-being [44]. WHO-5 has been validated regarding to both clinical and psychometric validity [43]. Internal consistency reliability was assessed using Cronbach's alpha. The WHO-5 demonstrated good reliability in our sample ($\alpha = 0.84$), consistent with previous studies reporting in adolescent populations [44].

Additionally, participants' self-rated health was assessed by a single question: "In general, how do you rate your health?". Responses were given on a scale ranging from 1 (poor) to 4 (excellent). We dichotomized this variable into 1 ("excellent" health) and 0 ("good/average/poor" health). This measure was previously validated against objective health indicators [45]. We

dichotomized self-rated health into “excellent” versus all other categories to identify adolescents reporting optimal health and to ensure comparability with prior epidemiological study using self-rated health as a global health indicator [46].

Sociodemographic variables

Sex and age

Respondents answered if they were a boy or a girl and their month and year of birth. They were categorized into “13-14 years old”, “15-16 years old” or “17-18 years old”.

Migration background.

Adolescents informed their own and their parents’ country of birth. Three categories are then created: (a) ‘no migration background’; (b) ‘second generation’ (parents migrated) and; (c) ‘first generation’ (pupil migrated). They were afterwards categorized as “Native”, “First generation” or “Second generation” [40].

Family structure.

Respondents informed who they were living with. They were afterwards categorized as living with “Both parents” or “Other” family constellations. The category “Both parents” refers to adolescents who had both parents

living in the household (mother and father). The “other family structure” consists of adolescents who lives with a single parent or one parent and his/her partner or other families’ constellations.

Perceived wealth.

Respondents answered on a five-point scale on how they perceived their own family’s socioeconomic circumstances (i.e. How well off do you think your family is?). The answers were categorized as “Well off”, “Average” or “Not well off”.

Statistical analysis

In the descriptive analysis, we used both absolute (n) and relative (%) values for categorical, and reported means, standard deviations (SD) and 95% confidence intervals (95% CI) for numerical variables.

The Two-Step Cluster Analysis was conducted with categorical of alcohol, cigarettes, e-cigarettes, and cannabis use frequency. Each variable was entered in the two-step cluster analysis using the original 7-point frequency scale (“never” to “30 days or more”) and treated as categorical, following recommendations for Two-Step Cluster Analysis [47]. This method determines automatically the cluster selection based on the log-likelihood as the distance measure (to account for the congruency between clusters), the low Schwarz’s Bayesian Criterion (BIC), the high ratio of distance measures, and the high ratio of BIC changes. Cases with missing values on clustering

variables were excluded ($n = 821$), representing 5.2–8.7% missingness across variables. Included and excluded participants were compared on the sociodemographic characteristics on the supplementary material (S2).

Based on the results of the cluster analyses, we conducted chi-square tests to examine the associations between substance use clusters and the sociodemographic characteristics of adolescents in Luxembourg.

For the second part of the analysis, we investigated the relationship between substance use clusters and health outcome. We tested the association between substance use clusters and self-rated health, using the binomial logistic regression model, adjusted by sex, age group, family structure, migration background, and perceived wealth. The results of the model were expressed in odds ratios (OR) and the respective 95% confidence intervals (95% CI). The “No substance use” cluster was the reference category in the regression models.

Additionally, to compare the well-being of adolescents across different substance use clusters, we used Analysis of Covariance (ANCOVA) with Bonferroni post hoc. This analysis compared the mean of well-being scores across clusters controlling for by sex, age group, family structure, migration background, and perceived wealth.

In all inferential statistical procedures (chi-squared, ANCOVA and binomial logistic regression), were conducted using the complex sample methodology incorporating the educational tracks and grade, the clustering by school classes (primary sampling units) and the sampling weight. This approach

ensuring that the sample distribution corresponds to the population and reducing possible bias from differences in participation rates [40]. All statistical analyses were performed using SPSS version 28, with a significance level set at 0.05.

RESULTS

Using the Two-Step cluster analysis, three subgroups of risk behaviors were identified among a sample of 5,543 adolescents in Luxembourg, supplementary table with information about the cluster analysis is available as supplementary material (S1) and the silhouette coefficient was good (0.7). Most participants (Cluster 1, $n = 3,129$; 56.4%) reported no substance use, a smaller proportion (Cluster 2, $n = 1040$; 18.8%) reported alcohol consumption only, while the remaining (Cluster 3, $n = 1,374$; 24.8%) reported the consumption of one other substance (cannabis, cigarette and e-cigarette) or a combination of consumption (polysubstance use, that may or may not include alcohol). Clusters were labelled according to the most accentuated behaviors as cluster 1: “No substance use”; cluster 2: “Alcohol consumption only”; and cluster 3: “Other substance use”. The clusters’ description is shown in Table 1.

[Insert Table 1 Here]

Table 2 presents the association between sociodemographic characteristics, and the identified clusters of substances use. Age group, family structure, migration background and perceive wealth demonstrated significant associations with the clusters. While sex did not have an association with the clusters.

[Insert Table 2 Here]

Health outcomes

Table 3 presents the adjusted means and 95% CI for well-being scores across the substance use clusters.

[Insert Table 3 Here]

The analysis showed significant differences in mean well-being scores across the three substance use clusters ($p < .001$, $\eta^2 = 0.138$). Adolescents in the “No substance use” cluster had the highest mean well-being score (13.83, 95% CI 13.65–14.02), followed by those in the “Alcohol consumption” cluster (13.40, 95% CI 13.09–13.71). Although this difference was statistically significant (post hoc $p = .015$), its magnitude was small, as indicated by overlapping confidence intervals. Adolescents in the “Other substance use” cluster reported the lowest well-being scores (11.87, 95% CI 11.61–12.13), with significantly lower scores compared with both the “No substance use” and “Alcohol consumption” clusters ($p < .001$). The overall effect size was

moderate ($\eta^2 = 0.138$), largely driven by the lower well-being observed in the “Other substance use” cluster.

Table 4 presents the results of the association between self-rated health, and the clusters of substances use.

[Insert Table 4 Here]

Regression analysis showed that adolescents in the “Other substance use” cluster had lower odds of reporting excellent health compared with those in the “No substance use” cluster (OR = 0.50, 95% CI 0.42–0.59). No significant differences in self-rated health were observed between the “Alcohol consumption” and “No substance use” clusters.

DISCUSSION

The primary objective of this study was to analyze the clustering of substance use, more specifically, the use of alcohol, cigarettes, e-cigarettes, and cannabis, among adolescents in Luxembourg, to describe these clusters in relation to sociodemographic characteristics and to examine their association with well-being and self-rated health. By employing a cluster analysis, three distinct subgroups of adolescents were identified based on substance use patterns. Over half of the adolescents reported no substance use. Approximately one fourth engaged in the use of other substances or polysubstance use (regardless of alcohol consumption), while the smallest

group reported using alcohol only. In addition, adolescents in the “Other substance use” cluster reported lower well-being scores and lower odds of reporting excellent self-rated health compared with the no users cluster.

This is the first study with a representative sample of adolescents in Luxembourg examining substance use profiles. Our findings were mostly similar to previous research with representative samples of adolescents in other countries. A systematic review [18] with 17 studies about polysubstance use among adolescents aged 10 to 19 found three to four latent classes with “no use” or “low use” classes being the largest, “polysubstance use” being the smallest and the intermediate classes including extensive single substance use, such as “alcohol only” classes. Similarly, a study with 33,566 adolescents aged 12 to 16 from 25 European countries applying latent cluster analyses found nonusers (68%), low-alcohol users (16.1%), alcohol users (11.2%), and polysubstance users (recent use of alcohol, marijuana, and other illicit drugs; 4.7%) [11]. Other study discovered additional classes like Marijuana/nicotine co-users and polysubstance/e-cigarette users in a sample of 15,607 adolescents of CDC’s Youth Risk Behaviors Surveillance System [48]. These consistent patterns show that substance use among adolescents can follow similar profiles in diverse contexts and corroborate the validity of the groups identified in Luxembourg.

In addition to the identified similar consumption profiles, our findings also highlight sociodemographic factors such as age, family structure, migration background, and perceived wealth associated with cluster profiles. Age

emerged as a strong association, with older adolescents (17-18 years old) being more likely to belong to the higher-risk clusters (“Alcohol consumption” and “Other substance use”). These age differences may arise from multiple peer-related processes, including socialization, selection into substance-using peer groups, normative beliefs, and increased access and opportunities through peer networks [49, 50]. Exposure to peer contexts also tends to increase with age due to greater autonomy, more time spent with friends, and reduced parental monitoring [22], which may amplify these mechanisms [51]. Family structure also played a crucial role, as adolescents who do not live with both parents were more likely to engage in substance use, similar to other studies [20-22]. For instance, adolescents in single-parent or reconstituted families may experience lower levels of parental monitoring and supervision, which has been identified as a protective factor against substance use [22, 52, 53]. The quality of communication with parents also tends to be lower in single families, limiting opportunities to discuss risk behaviors, including substance use [22]. In addition, parental substance use, more prevalent in single families context, could contribute to the normalization of substance use, elevating the likelihood of consumption [21]. Migration background was also associated with cluster membership. Native adolescents were overrepresented in the alcohol consumption cluster, while first-generation adolescents were underrepresented in this cluster, while the adolescents of first generation were underrepresented in the “alcohol consumption” cluster. A systematic review [23] examining substance use

among adolescents and young people aged 11 to 29 in Europe, found that adolescents with an immigrant background especially from non-European countries and/or Muslim background were less likely to consume alcohol than their non-immigrant peers. The same review reported inconsistent results regarding tobacco and drug use. Considering the high proportion of residents with a migrant background in Luxembourg [54], the association between substance use profiles and migration background might be partly explained by social and cultural norms regarding substance use and by peer network composition, such as co-ethnic density in school classes, which has been associated with lower smoking prevalence among immigrant adolescents [55]. For instance, the social composition of school classes, and more specifically, the proportion of immigrant peers in the class, could shape exposure to substance use, as evidence showed that co-ethnic density in school classes has been associated with lower smoking prevalence among immigrant adolescents. Furthermore, perceived wealth also contributed to cluster formation. Adolescents who perceived themselves as less well-off were associated with the engage in substance use, underscoring the importance of incorporating both socioeconomic and cultural dimensions into the design of effective prevention strategies programs [56].

Although previous researchers found sex was significantly associated with the substance use clusters [8, 19], the present study is in line with studies in Luxembourg when controlled by other sociodemographic variables [57]. This

finding might be explained by a narrowing gender gap and gender inequality decrease in substance use throughout the years [30, 34, 58-61].

Adolescents in the “no substance use” cluster serve as a benchmark, suggesting a protective effect on the mental health of those who refrain from substance use [8, 62-64]. Those who only consume alcohol displayed a moderate level of well-being, though their scores were still significantly lower than those of non-substance users; however, the magnitude of this difference was small, and the confidence intervals overlapped, suggesting limited practical significance. Finally, the most pronounced effect was observed among those in the “other substance use” cluster, who reported the lowest well-being scores. These findings are in line with studies with adolescents from other countries [65] and further corroborate the harmful effects of heavier or polysubstance use on adolescent well-being [8, 65] in adolescents in Luxembourg.

The regression analysis further examined the relationship between substance use clusters and self-rated health. No differences were observed in self-rated health between the “No substance use” and “Alcohol consumption” clusters. Adolescents in the alcohol consumption cluster did not exhibit a statistically significant difference in the likelihood of rating their health as excellent compared to the no substance use cluster. In contrast, adolescents who used other substances were significantly less likely to rate their health as excellent. This suggests that this cluster is strongly associated with a poorer perception of overall health, adding to the evidence that substance use

behaviors are linked to a negative impact on both mental and physical health [24, 65]. The absence of differences for alcohol use may reflect that adolescents' self-rated health is influenced by multiple behavioural and contextual factors, and not necessarily by alcohol use alone [66]. Furthermore, alcohol is deeply rooted in European society and widely accepted as a normal part of life, including celebrations, and peer dynamics, contributing to its perception as a normative and socially accepted behavior and leading to the associated health risks being underestimated [67]. These findings underline the importance of addressing substance use not only to improve well-being but also to enhance health [68].

The clear distinctions between these clusters underscore the need for targeted prevention and intervention strategies. These should focus on adolescents at higher risk in this study, particularly older adolescents (17-18 years), those not living with both parents, adolescents reporting lower perceived wealth, and native adolescents who were overrepresented in the alcohol-use cluster. These interventions could address the varying levels of risk associated with each behavioral pattern and promote health and well-being among adolescents in Luxembourg. A systematic review and meta-analysis showed that certain school-based interventions were associated with improvements in knowledge, intentions and attitudes towards not only the substance targeted (e.g., e-cigarettes), but also other substance use (e.g., tobacco, alcohol, cannabis), as well as positive effects on mental health [69]. However, it is important that such programs include developmentally

appropriate information [70, 71] and if possible parental involvement [52, 69].

This study has limitations that should be acknowledged. First, the cross-sectional design limits the ability to draw causal inferences about the relationship between substance use and well-being. Second, the “Other substance use” cluster was heterogeneous, combining adolescents with different substance-use patterns, which may mask distinct behavioral profiles and limit interpretation. Future studies using more refined person-centered methods may better distinguish these patterns. Third, reliance on self-reported data may be subject to biases such as social desirability and recall errors, potentially affecting the accuracy of the findings. Furthermore, the study was conducted in Luxembourg, and while the findings may have broader implications, cultural and contextual factors should be considered when generalizing the results to other populations. Despite these limitations, studying has notable strengths. The use of a large, representative sample of adolescents enhances the generalizability of the findings. Moreover, the application of cluster analysis allowed for nuanced identification of behavioral subgroups, providing a more holistic and contextualized understanding of adolescent experiences than variable centered approaches could offer [72]. Finally, the findings have implications on public health policies and adolescent-focused interventions. In particular, the results regarding the sociodemographic characteristics and the substance use

profile are particularly in the context of Luxembourg, it can help tailor more effective interventions in the country.

FINAL CONSIDERATION

In summary, this study provides significant evidence of the negative impact of substance use on adolescent well-being and health. The association between sociodemographic factors (age, family structure, migration background and perceived wealth) and substance use highlights the necessity for targeted interventions that address the unique needs of these specific groups. Future research should focus on longitudinal studies to explore causal relationships and incorporate broader sociocultural contexts to gain a comprehensive understanding of the dynamics of adolescent substance use and their impact on health outcomes.

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Declarations

Statements of Ethics approval and consent to participate

The HBSC 2022 Luxembourg study was approved by the Ethics Review Panel of the University of Luxembourg (ERP 21-013 HBSC 2022) and in compliance with the Helsinki Declaration. Parents/guardians of these adolescents received an information letter about the survey as well as an informed consent form with the opportunity to refuse/consent their child. Informed consent was obtained from parents/guardians of all participants of the study.

Consent for publication

Not applicable.

Availability of data and materials

The datasets that were generated and analysed during the current study are not publicly available because of legal guidelines and ethical reasons but are available from the corresponding author FGM upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

F.G.M. and C.C. were responsible for the design of the study. F.G.M., K.S. and C.C. wrote the main manuscript text. F.M. and J.L.F. performed the analyses. All authors reviewed the manuscript.

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Table 2. Association between sociodemographic characteristics with substances use clusters.

	Total	No substance use (%)	Alcohol consumption (%)	Other substance use (%)	χ^2	p-value
Sex					2.837	.242
Boy	50.7	51.1	52.1	48.8		
Girl	49.3	48.9	47.9	51.2		
Age Group					698.027	<.001
13-14 yo	35.6	49.2	15.1	19.9		
15-16 yo	37.9	34.8	47.3	38.0		
17-18 yo	26.5	16.0	37.6	42.2		
Family Structure					90.921	<.001
Both parents	65.6	70.1	66.7	55.1		
Others family structure	34.4	29.9	33.3	44.9		
Migration Background					113.469	<.001
Native	25.8	22.1	38.9	24.5		
Second generation	48.3	49.5	41.7	50.3		
First generation	25.9	28.3	19.4	25.1		
Perceived Wealth					29.096	<.001
Well off	52.1	53.5	52.8	48.5		
Average	40.8	40.3	41.7	41.5		
Not well off	7.1	6.2	5.5	10.0		

Footnote: The methodology for weighting and complex sampling was considered. yo = years old.

Table 1. Weighted proportions of characteristics of substances use clusters by each behaviour. (n = 5543)

	No substance use n (%)	Alcohol consumption n (%)	Other substance use n (%)
<i>Smoked cigarettes</i>			
Never	3,129 (100.0)	1040 (100.0)	582 (42.4)
1-2 days	0	0	224 (16.3)
3-5 days	0	0	95 (6.9)
6-9 days	0	0	77 (5.6)
10-19 days	0	0	87 (6.4)
20-29 days	0	0	86 (6.3)
30 days (or more)	0	0	223 (16.2)
<i>Total</i>	3,129 (100.0)	1040 (100.0)	1,374 (100.0)
<i>Smoked e-cigarettes</i>			
Never	3,129 (100.0)	1040 (100.0)	458 (33.3)
1-2 days	0	0	364 (26.5)
3-5 days	0	0	174 (12.7)
6-9 days	0	0	123 (9.0)
10-19 days	0	0	119 (8.7)
20-29 days	0	0	63 (4.6)
30 days (or more)	0	0	73 (5.3)
<i>Total</i>	3,129 (100.0)	1040 (100.0)	1,374 (100.0)
<i>Cannabis used</i>			
Never	3,129 (100.0)	1040 (100.0)	784 (57.1)
1-2 days	0	0	272 (19.8)
3-5 days	0	0	95 (6.9)
6-9 days	0	0	57 (4.1)
10-19 days	0	0	54 (3.9)
20-29 days	0	0	43 (3.1)
30 days (or more)	0	0	69 (5.0)
<i>Total</i>	3,129 (100.0)	1040 (100.0)	1,374 (100.0)
<i>Alcohol Consumption</i>			
Never	3,129 (100.0)	0	415 (30.2)
1-2 days	0	620 (59.6)	371 (27.0)
3-5 days	0	255 (24.5)	247 (18.0)
6-9 days	0	97 (9.3)	165 (12.0)
10-19 days	0	44 (4.2)	117 (8.5)
20-29 days	0	10 (1.0)	24 (1.7)
30 days (or more)	0	14 (1.3)	35 (2.5)
<i>Total</i>	3,129 (100.0)	1040 (100.0)	1,374 (100.0)

Footnote: "No substance use" cluster reported no substance use, "Alcohol consumption" cluster reported only the alcohol consumption and, "Other substance use" reported the consumption of one other substance (cannabis, cigarette and e-cigarette) or a combination of consumption (polysubstance use, that may or may not include alcohol).

Table 3. Adjusted means and 95% CI for well-being scores across the substance use clusters among adolescents in Luxembourg in 2022, controlling by sex, age, migration background, family structure and perceived wealth.

	WHO 5 index (95% CI)	η^2
<i>Substance Use clusters</i>		.138
No substance use	13.83 (13.65- 14.02)	
Alcohol consumption	13.40 (13.09- 13.71) ^a	
Other substance use	11.87 (11.61- 12.13) a, b	

Footnote: results of the post hoc test ^a $p \leq .05$ compared to category “no substance use”; ^b $p \leq .05$ compared to category “Alcohol consumption”; bold: $p < .001$. The methodology for weighting and complex sampling was considered. CI: Confidence Interval.

Table 4. Association between self-rated health and substance use clusters of adolescents in Luxembourg in 2022, controlling by sex, age, migration background, family structure and perceived wealth.

	Odds ratio (95% CI)	p-value
<i>Substance Use clusters</i>		
No substance use	1	
Alcohol consumption	0.88 (0.74-1.04)	.125
Other substance use	0.50 (0.42-0.59)	<.001

Footnote: The methodology for weighting and complex sampling was considered. CI: confidence Interval