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ORIGINAL RECHERCHE

Self-reported long-term impact of the COVID-19 pandemic on digital behaviours: A Latent Class Analysis of French-speaking students

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Résumé : Contexte : Les données actuelles indiquent une tendance à la hausse de « l'addiction numérique » au cours des deux dernières décennies, tendance qui s'est accentuée pendant la pandémie de COVID-19. **Objectifs** : Cette étude visait à évaluer l'impact de la pandémie sur différents comportements en ligne chez des étudiants français, un an après son début. Elle avait également pour objectif d'identifier des sous-groupes d'étudiants selon l'évolution de leurs comportements en ligne et de déterminer leurs profils cliniques. **Méthodes** : Un questionnaire en ligne a été diffusé auprès d'étudiants francophones, recueillant des données sur des comportements en ligne potentiellement excessifs (achats, jeux vidéo, jeux d'argent, visionnage de pornographie, séries TV), ainsi que sur la consommation de substances, la psychopathologie, les dimensions de personnalité et la satisfaction de vie. Une analyse de classes latentes a été réalisée en se basant sur l'évolution des comportements en ligne. **Résultats** : L'échantillon comprenait 460 participants, à partir desquels quatre clusters ont été identifiés. Les comportements en ligne sont restés relativement stables dans un seul cluster, dont les participants présentaient une santé mentale satisfaisante. Un autre cluster présentait également une santé mentale satisfaisante, mais affichait une augmentation significative des jeux en ligne. Les participants des deux autres clusters présentaient des niveaux élevés d'impulsivité et une santé mentale altérée, avec une augmentation observée dans des comportements en ligne spécifiques : achats et visionnage de séries TV pour un cluster, achats et visionnage de pornographie pour l'autre **Conclusions** : Les résultats de cette étude suggèrent que la crise sanitaire a durablement modifié les comportements en ligne de certains étudiants. Cette augmentation de l'usage numérique pourrait être interprétée comme un mécanisme d'adaptation efficace au stress lié à la pandémie chez les étudiants dont la santé mentale semble intacte, ou comme un indicateur de détresse psychologique chez les étudiants à risque de comportements excessifs.
Mots clés : étudiant ; comportement en ligne ; santé mentale ; addiction ; COVID-19

Abstract : Background: Current data indicates a rising trend of "digital addiction" over the past two decades, and digital use exacerbated during the COVID-19 pandemic. Objectives: We aimed to assess the pandemic's impact on various online behaviours in French students one year after its onset. Additionnaly, it aimed to identify student subgroups based on of the evolution of their online behaviours and determine their clinical profiles.
Methods: An online questionnaire was distributed to French-speaking students, gathering data on potentially excessive online behaviours (shopping, gaming, gambling, pornography viewing, TV-series watching), substances use, psychopathology, personality dimensions, and satisfaction with life. A latent class analysis was conducted based on the evolution of online behaviours. **Results**: The sample comprised 460 subjects, from which four clusters were identified. Online behaviours remained relatively stable in only one cluster, whose participants exhibited satisfactory mental health. Another cluster showed satisfactory mental health but displayed a significant increase in online gaming. Participants in the remaining two clusters demonstrated high levels of impulsivity and poor mental health, with increases observed in specific online behaviours: shopping and TV-series watching for one cluster, and shopping and pornography viewing for the other. **Conclusions**: The findings of this study suggest that the health crisis has enduringy altered the online behaviours of certain students. This escalation in digital use could be interpreted as an effective coping mechanism for stress related to the pandemic among students whose mental health appears to be intact, or as an indicator of psychological distress among students at risk of engaging in excessive behaviours.
Key-words: Student, online behaviour, mental health, addiction, COVID-19

1.INTRODUCTION

To mitigate the spread of the COVID-19 pandemic, many states enforced restrictions, including mobility limitations, spatial distancing, and reduced face-to-face interactions. In France, a strict lockdown from March to May 2020 was followed by two partial lockdowns (October to December 2020 and April to May 2021) with eased measures, prompting a gradual shift in communication modes. Virtual interactions, such as telecommuting, online learning, and video family gatherings, surged, alongside a transition to online cultural activities and gaming (1). Studies indicate that the pandemic and societal adjustments have impacted mental health, with increased stress, anxiety, depressive symptoms, and sleep disturbances during initial lockdowns (2). However, the global impact remains heterogeneous and modest in magnitude (3). Recent data shows a concerning change in substance use among young adults during the COVID-19 crisis. With increased isolation and stress, the consumption of alcohol, tobacco, and other drugs has seen notable changes and several studies have reported a rise in alcohol, tobacco and cannabis use as coping mechanisms for pandemic-related stress and anxiety (4,5). Additionally, a meta-analysis reveals a growing trend of excessive digital behaviours over the last two decades, exacerbated during the COVID-19 crisis (6). During the pandemic, there was a notable increase in online pornography use and video gaming (7,8). Similarly, online gambling rose while offline gambling declined, particularly among those with pre-existing issues (9,10). Binge-watching also surged during

the pandemic, particularly among those reporting higher levels of COVID-related stress (11). Moreover, students, already vulnerable to mental health issues (12), experienced further deterioration during the pandemic (13). The crisis exacerbated well-documented risk factors for depression, such as female gender, low socioeconomic status, and living in densely populated areas, while highlighting new risks specific to the pandemic context (14). Despite numerous short-term studies, few have explored the long-term impacts of the pandemic on students' quality of life, mental health, substance use and digital behaviours, which may persist due to factors like ongoing depressive symptoms, anxiety, and financial challenges. In particular, we hypothesized that the health crisis and successive lockdowns negatively influenced online behaviours, promoting their increase. Our study aimed to evaluate their prevalence over the past year among all students and to determine whether these behaviours remained stable, increased, or decreased during the previous 12 months, starting from the end of the first strict lockdown in France. Additionally, it sought to identify student subgroups based on the evolution of their online behaviours and to determine their clinical profiles.

2.MATERIELS ET METHODES

2.1. Design

This observational study was cross-sectional and retrospective.

2.2. Procedure

Data were collected through an online survey distributed to a French-speaking student population in France, Belgium, Luxembourg, and Switzerland. Participants were recruited via student networks, student associations, professional networks, and the press. The survey was available online from May, 18 to July, 26, 2021.

2.3. Participants

To participate in the study, individuals had to be enrolled in an initial degree course at least since the 2019-2020 academic year, to be sure that they had lived the "student life" experience for at least one year since the start of the pandemic in March 2020. There were no criteria for age, course of study or level of study. Non-inclusion criteria were as follows: non-students, students in continuing education, non-French speakers, people with difficulty reading or writing French, people under court protection, guardianship or curatorship, and pregnant people.

2.4. Measures

The online survey had four parts: the first gathered socio-demographic data, the second clinical characteristics, the third certain aspects of online behaviours, and the fourth substance use characteristics.

2.4.1. Sociodemographic characteristics

We collected the following variables: gender, age, type of accommodation and level of education.

2.4.2. Clinical characteristics

Several self-reported questionnaires were used to explore psychopathology, personality dimensions and satisfaction with life. Their choice was based, on the one hand, on the variables we aimed to explore, and on the other hand, on a compromise between their brevity (necessary to ensure the completion of the online survey) and their strong psychometric properties.

- Brief Symptoms Inventory 18 (BSI-18) (15)

The BSI-18 assesses general psychological distress by describing 18 physical and emotional complaints covering three dimensions: depression, anxiety and somatization. Participants are asked to indicate on a scale of 0 to 4 the extent to which they were troubled by such experiences. A total score between 0 and 24 is calculated for each of the three subscales.

- Short version of the UPPS-P Impulsive Behavior Scale (UPPS-P) (16)

The UPPS-P short version is a 20-item scale that has the advantage of measuring impulsivity in a fine-grained way by exploring 5 dimensions: positive urgency, negative urgency, lack of premeditation, lack of perseverance and sensation seeking. In this questionnaire, "urgency" refers to rash actions taken in response to emotional states. Each item is scored on a 4-point Likert scale ranging from 1 to 4. A total score is calculated for each of the subscales.

- Emotion Regulation Questionnaire (ERQ) (17)

The ERQ is composed of 10 items presented on a likert scale ranging from 1 to 7, and divided into two subscales corresponding to two emotion regulation strategies (6 items for the cognitive reappraisal strategy and 4 items for the expressive suppression strategy). A total score is calculated for each subscale. The higher the score, the greater the use of that particular emotion regulation strategy.

- Brief Coping Orientation to Problems Experienced Inventory (Brief-COPE) (18,19)

The Brief-COPE is a 28 items questionnaire used to assess coping skills, i.e. the ability to deal with a situation. The respondent uses a 4-point scale to provide a response to each statement. The tool offers 14 scales assessing distinct dimensions of coping (active coping, planning, instrumental support, emotional support, venting, behavioral disengagement, self-distraction, self-blaming, positive

reframing, humor, denial, acceptance, religion and substance use). Subsequent analyses suggested a three-factor structure, with three overarching coping styles, each represented by a set of coping facets: Problem-Focused Coping (Active coping, Instrumental support, positive reframing, Planning); Emotion-Focused Coping (emotional support, venting, humor, acceptance, religion, self-blaming); Avoidant Coping (self-distraction, denial, substance use, behavioral disengagement). The score of each coping styles corresponds to the sum of item scores that comprise it, divided by the number of items (20,21). High score on a coping style indicates great use of it.

- Satisfaction With Life Scale (SWLS) (22)

This scale provides a global assessment of satisfaction with one's life. It consists of 5 items exploring the general satisfaction the subject has with his or her life, each of them being rated on a scale ranging from 1 to 7. A total score between 5 and 35 is calculated for all items. A score of 20 represents the neutral point on the scale, a score of 5 to 9 indicates extreme dissatisfaction with life, a score of 10 to 14 indicates dissatisfaction, a score of 15 to 19 indicates mild dissatisfaction, a score of 20 to 24 indicates mild satisfaction, a score of 25 to 29 indicates high satisfaction, and a score of over 30 indicates extreme satisfaction.

2.4.3. Online behaviours characteristics

For each online behaviour (shopping, gaming, gambling, pornography viewing, TV-series watching), the frequency of the behaviour was explored retrospectively in the current period (i.e. over the last 12 months), as well as before the start of the health crisis. Participants were asked to rate the impact of the pandemic on each behaviour (no use, decreasing, stable, or increasing use).

In addition, a problematic practice of each behaviour was screened only for those who reported a use, by the following questionnaires:

- Compulsive Buying Scale (CBS): screening for compulsive buying disorder with a cut-off score of less than -1.34 indicating a likely compulsive buyer (23).
- The Ten-Item Internet Gaming Disorder Test (IGDT-10): screening for Internet Gaming Disorder according to the DSM-5 definition, with a cut-off score greater than or equal to 5 indicating probable Internet gaming disorder (24).
- Problem Gambling Severity Index (PGSI): screening for problem gambling with a cut-off score greater than or equal to 5 indicating moderate-risk (25,26).
- The Short Internet Addiction Test adapted to online sexual activities (s-IAT-sex): screening for sexual addiction related to online sexual activities. There is no threshold score (27).
- Binge-Watching Engagement and Symptoms Questionnaire (BWESQ): screening for compulsive TV series viewing. This questionnaire includes 7 scales: engagement, positive emotions, pleasure preservation, desire/savouring, binge-watching, dependency, and loss of control. There is no threshold score (28).

2.4.4. Substances use characteristics

For each psychoactive substance (tobacco, alcohol, cannabis, cannabidiol, heroin, cocaine and other psychostimulants, LSD and other synthetic hallucinogens, prescribed opioids / psychostimulants / sedative hypnotics), the frequency of use was explored retrospectively in the current period (i.e. over the last 12 months), as well as before the start of the health crisis. Participants were asked to rate the impact of the pandemic on each consumption (no use, decreasing, stable, increasing).

2.5. Ethical aspects

The survey began with clear information about the study, its objectives and how to participate. Students were then free to choose whether or not to participate, and the consent of their legal guardians was requested for students under 18. The non-interventional design of this online survey made approval by an ethics committee unnecessary, according to the legislation in force in France at the time of the study (Jardé Law).

2.6. Statistical analysis

A descriptive statistical analysis was first conducted on all the variables collected. Means and standard deviations, or medians and minimum/maximum were calculated for continuous variables, and numbers and percentages were calculated for categorical variables.

A Latent class analysis (LCA) was then performed to identify a typology of students according to the evolution of their online behaviours before and after the pandemic. To choose the optimal number of clusters, models composed of 1 to 6 clusters were compared. The selection of the best model was based on a trade-off between the Bayesian Information Criterion (BIC) (the lower the BIC, the better the fit of the model), the classification error rate (the closer it is to 0, the better the accuracy of the individual classification), the entropy (the closer it is to 1, the better the distinction between classes), the log likelihood (the higher it is, the better the model fits the data), and the relevance of the clusters' interpretation.

Once the model was chosen, the clusters were described and compared according to their socio-demographic, clinical, and substances use characteristics, as well as their problematic online behaviours. The chi-square test of independence was applied to compare the proportions of categorical variables

between classes. One-way factor analysis (ANOVAs) was used to compare the means of quantitative variables between clusters. In case of significant p-values, pairwise comparisons between all possible pairs of clusters were tested using Tukey tests. The Benjamini-Hochberg correction method was applied to the p-values to overcome the alpha inflation risk due to multiple comparisons. We named the four clusters a posteriori, based on the observed characteristics of digital use and questionnaire results.

3. RESULTATS

3.1. Description of the sample

Figure 1. Flow chart of the study

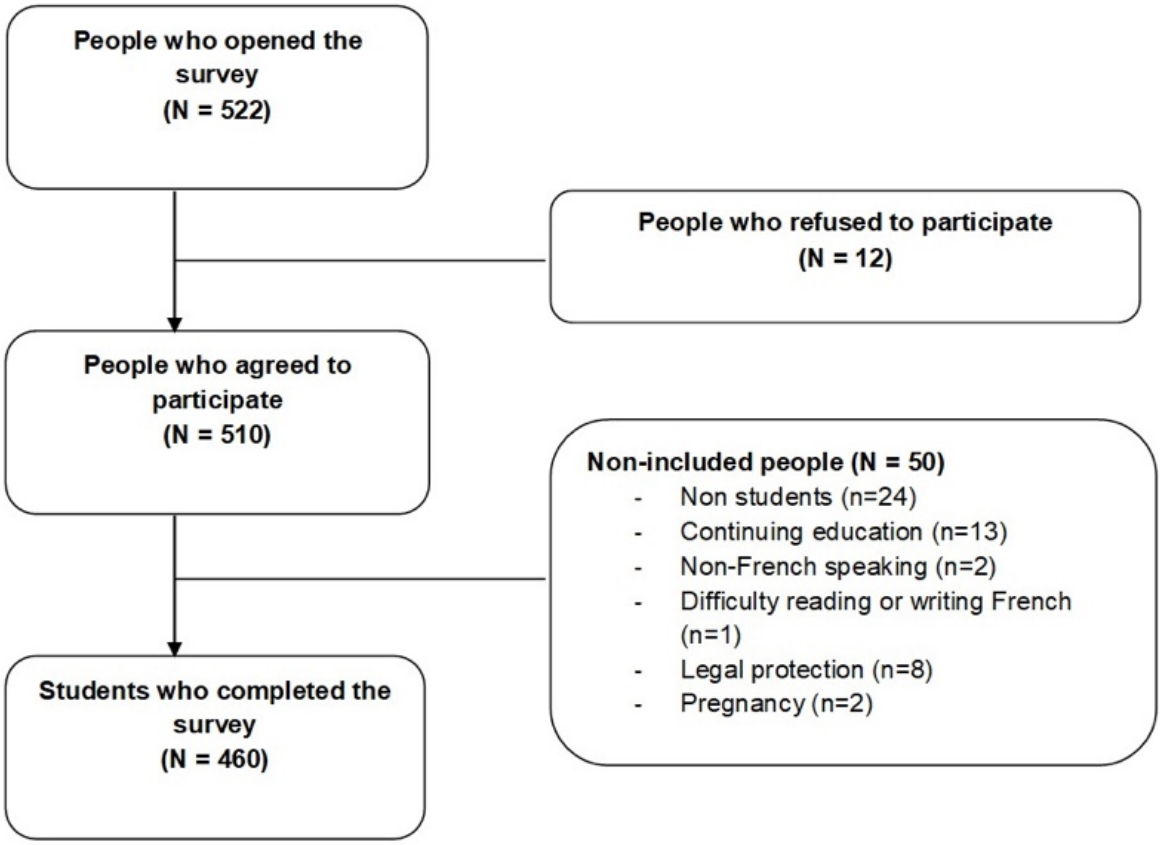

Figure 1. Flow chart of the study

As shown in Figure 1, 522 people clicked on the link to access the survey, and finally, 460 students completed it entirely. All of their characteristics are presented in Table 1. The vast majority of participants reported an absence of online gaming and gambling, and almost half reported an absence of online pornography viewing. Conversely, a majority of them reported online shopping and TV-series watching, these two behaviours tending to increase during the period. In addition, only a few participants were identified with excessive behaviour in one of the assessed activities, mainly shopping (shopping: 19 participants; gaming: 2 participants; gambling: 1 participant).

3.3. Identification of latent profiles of online behaviours

3.2.1. Choice of the best model

The fit indices of the 1- to 6- cluster solutions tested in the LCA are provided in Table 2. The four-cluster solution was selected as it offered the most balanced combination of statistical fit and clinical interpretability. This model achieved the highest entropy (0.77), indicating well-separated latent classes, and a low classification error rate (8.5%), suggesting accurate prediction of class membership. The BIC reached its lowest value with the 2-cluster model but increased with models containing more clusters. However, the 4-cluster solution represented an acceptable trade-off, providing a good fit while enabling clearer distinctions between students' behaviours.

Thus, from an interpretive perspective, the 4-cluster model identified distinct groups of students with meaningful behavioural profiles that aligned with observed trends and clinical relevance. In contrast, models with fewer clusters failed to capture sufficient behavioral diversity, whereas those with more clusters resulted in less interpretable groups, diminishing both theoretical and practical coherence.

	median [min-max]/ number [%]
SOCIO-DEMOGRAPHIC CHARACTERISTICS	
Age	22 [18-44]
Gender	
Male	91 [19.2]
Female	369 [80.2]
Educational level (number of years after baccalaureat)	4 [1-12]
Housing	
Alone	107 [23.3]
With the family (parents or grand-parents, siblings)	188 [40.9]
With a partner	87 [18.9]
Sharing a common space with other people (shared accommodation, student residence)	75 [16.3]
Other situations	3 [0.7]
CLINICAL CHARACTERISTICS	
BSI-18	
Depression *[0-24]*	3 [0-21]
Anxiety *[0-24]*	9 [0-24]
Somatization *[0-24]*	5 [0-24]
UPPS-P	
Negative urgency *[4-16]*	9 [4-16]
Positive urgency *[4-16]*	10 [4-16]
(lack of) premeditation *[4-16]*	7 [4-14]
(lack of) perseverance *[4-16]*	7 [4-15]
Sensation seeking *[4-16]*	10 [4-16]
ERQ	
Cognitive reappraisal strategy *[6-42]*	4.17 [1-7]
Expressive suppression strategy *[4-28]*	4 [1-7]
Brief-COPE	
Problem-focused coping *[1-4]*	2.5 [1.6-3.2]
Emotion-focused coping *[1-4]*	2.1 [1.3-3.1]
Avoidant coping *[1-4]*	2.1 [1.4-2.9]
SWLS *[5-35, with 20=neutral point]*	25 [5-35]

Table 1. Characteristics of the sample (N=460)

ONLINE BEHAVIORS CHARACTERISTICS					
Category	No use	Decreasing use	Stable use	Increasing use	Score (Median [Range])
Pornography viewing	225 [48.91]	27 [5.87]	167 [36.30]	41 [8.91]	
Gaming	323 [70.22]	11 [2.39]	62 [13.48]	64 [13.91]	
Gambling	439 [95.43]	2 [0.43]	14 [3.04]	5 [1.09]	
Shopping	141 [30.65]	8 [1.74]	149 [32.39]	162 [35.22]	
TV-series watching	45 [9.78]	23 [5.00]	211 [45.87]	181 [39.35]	
s-IAT-sex (n=235)					16 [12–36]
IGDT-10 (n=137)					0 [0–6]
PGSI (n=21)					0 [0–19]
CBS (n=319)					2.14 [–4.37–3.61]
BWESQ – Engagement (n=415)					2 [1–3.62]
BWESQ – Positive emotions (n=415)					2.80 [1–4]
BWESQ – Desire/savouring (n=415)					2.67 [1–4]
BWESQ – Pleasure preservation (n=415)					2 [1–4]
BWESQ – Binge-watching (n=415)					2.17 [1–4]
BWESQ – Dependency (n=415)					1.20 [1–3.40]
BWESQ – Loss of control (n=415)					1.17 [1–3.86]

SUBSTANCE USE CHARACTERISTICS				
Substance	No use	Decreasing use	Stable use	Increasing use
Tobacco	321 [69.78]	32 [6.96]	50 [10.87]	57 [12.39]
Alcohol	261 [56.74]	62 [13.48]	92 [20.00]	45 [9.78]
Cannabis and/or synthetic cannabinoid	370 [80.43]	12 [2.61]	48 [10.43]	30 [6.52]
Cannabidiol (CBD)	414 [90.00]	3 [0.65]	26 [5.65]	17 [3.70]
Heroin	460 [100.00]	0 [0.00]	0 [0.00]	0 [0.00]
Cocaine, amphetamines, and/or synthetic cathinones	441 [95.87]	3 [0.65]	9 [1.96]	7 [1.52]
LSD and/or other synthetic hallucinogens	454 [98.70]	0 [0.00]	3 [0.65]	3 [0.65]
Prescription opioids (nonmedical use)	448 [97.39]	0 [0.00]	4 [0.87]	8 [1.74]
Prescription psychostimulants (nonmedical use)	460 [100.00]	0 [0.00]	0 [0.00]	0 [0.00]
Prescription sedative hypnotics (nonmedical use)	446 [96.96]	0 [0.00]	3 [0.65]	11 [2.39]

Table 1. Characteristics of the sample (N=460). Brief-COPE: Brief Coping Orientation to Problems Experienced Inventory; BSI-18: Brief Symptoms Inventory; BWESQ: Binge-Watching Engagement and Symptoms Questionnaire; CBS: Compulsive Buying Scale; ERQ: Emotion Regulation Questionnaire; IGDT-10: Ten-Item Internet Gaming Disorder Test; PGSI: Problem Gambling Severity Index; s-IAT-sex: Short Internet Addiction Test adapted to online sexual activities; SWLS: Satisfaction With Life Scale; UPPS-P: Short version of the UPPS-P Impulsive Behavior Scale;

	Log-likelihood	**BIC**	**Entropy**	**Classification error rate**
1 cluster	-3659.7029	7503.3426	1.0000	0.0000
2 clusters	**-3488.8689**	**7351.7426**	**0.7489**	**0.0622**
3 clusters	**-3443.9593**	**7451.9915**	**0.7557**	**0.0748**
4 clusters	**-3410.2047**	**7574.5503**	**0.7660**	**0.0851**
5 clusters	-3379.0421	7702.2930	0.7335	0.1416
6 clusters	-3349.9776	7834.2322	0.7160	01876

Table 2. Fit indices for 1- to 6- cluster solutions (N=460). BIC: Bayesian Information Criterion

3.2.2. Description of the 4-class model

The distribution of the different online behaviours between the 4 clusters is provided in Figure 2. The profiles of the four clusters are depicted in Figure 3.

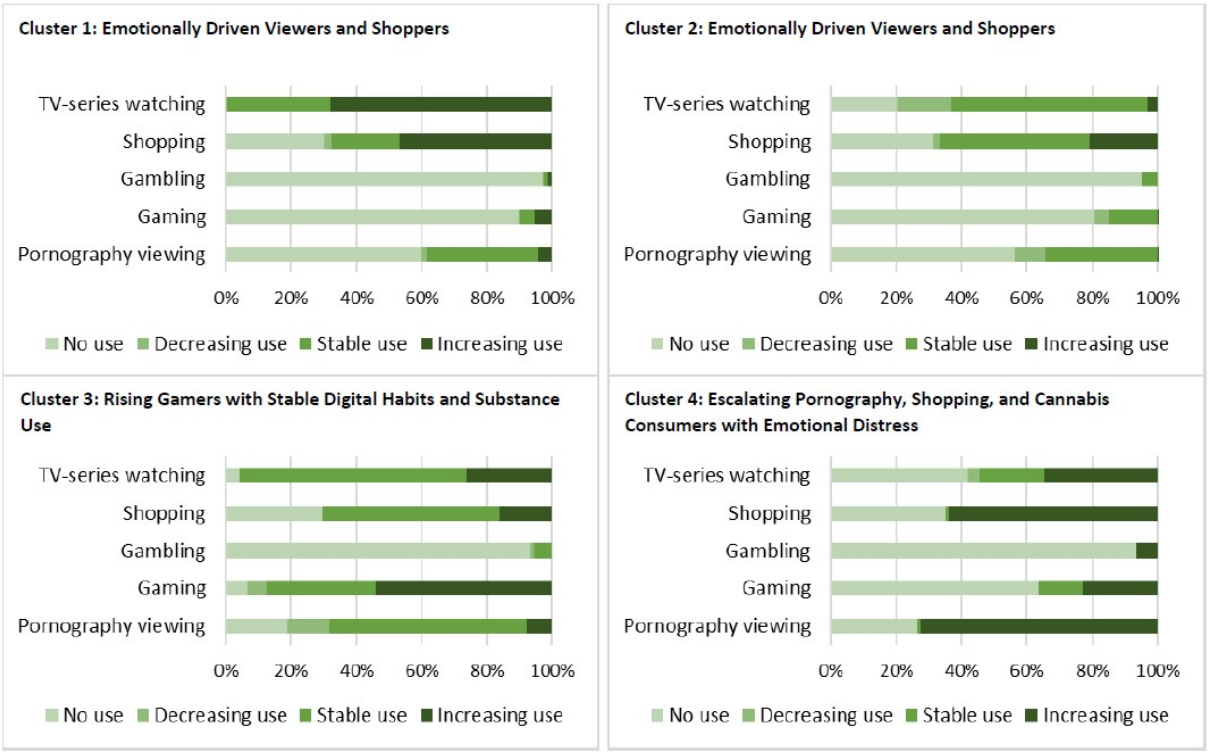

Figure 2. The distribution of the different online behaviours

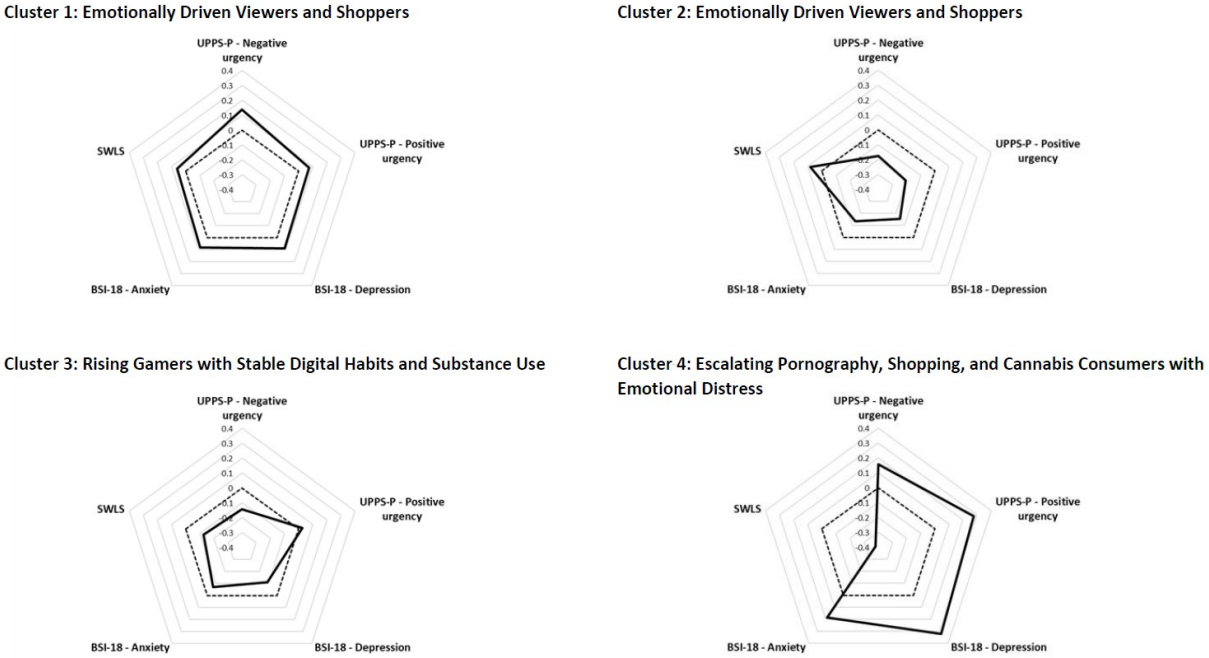

Figure 3. The profiles of the four clusters

Cluster 1 (45% probability of belonging): participants from this cluster, the vast majority of whom were women living with their family, tended to increase their time spent watching series and shopping online, while video games, gambling and pornography viewing behaviours were stable or absent. Apart from alcohol and tobacco use, which remained stable, they used very few other substances. The results of the screening questionnaires did not reveal any problematic online behaviour.

Cluster 2 (29% probability of belonging): participants from this cluster, also mostly women living with their family, tended to be stable in watching series and shopping online. On the other hand, a majority of them did not use online pornography viewing, gaming or gambling. Similarly, a majority did not use any susbtance.

Cluster 3 (18% probability of belonging): participants from this cluster, with an equal number between men and women, living mostly alone or with their family, tended to increase their online gaming, while their online pornography viewing, gambling, shopping and TV-series watching were stable or absent. Apart from alcohol and cannabis use, most of them didn't use any substance. The results of the screening questionnaires did not reveal any problematic online behaviour.
Cluster 4 (8% probability of belonging): participants from this cluster, composed of two thirds of women living alone or with their familiy, had an increasing trend in their online pornography viewing and shopping, and a decreasing trend in their online gaming, gambling and TV-series watching. Their tobacco and cannabis use tended to increase and their alcohol use was stable or increasing. The results of the screening questionnaires did not reveal any problematic online behaviour.

3.2.3. Clusters comparison

The results of the comparisons are presented in Table 3. Among the characteristics that contribute to the clustering, the four clusters differed significantly regarding all the online behaviours considered, with the exception of gambling. Apart from gender, the clusters did not differ in their socio-demographic characteristics. Overall, the clusters included mainly females, except for clusters 3 and 4, where the distribution was more balanced.
Cluster 1 was characterized by a significant increase in TV-series watching compared to the other clusters. Compared to cluster 2, participants from cluster 1 had higher scores on different dimensions of the BWESQ (loss of control, engagement, dependence, desire, binge watching and positive emotions) which suggests that they were at greater risk of problematic TV-series watching. Furthermore, participants from this cluster were those who increased the most their online shopping, just after the participants from cluster 4. Participants from this cluster had used less cannabis and CBD than participants from clusters 3 and 4. Their UPPS-P negative urgency score was higher than that of participants from clusters 2 and 3, and their UPPS-P positive urgency score was higher than that of participants from cluster 2, indicating that they had a greater tendency to act rashly in the presence of emotions, be they negative or positive, than participants from the two other clusters cited. Their BSI-18 depression score was higher than that of participants from clusters 2 and 4, and their BSI-18 anxiety score was higher than that of participants from cluster 2, indicating that this cluster had stronger clinical features of depression or anxiety than in the other clusters mentioned. We named this cluster "Emotionally Driven Viewers and Shoppers".
Cluster 2 was characterized by a higher proportion of non-users of online pornography viewing and gaming, compared to clusters 3 and 4 (those with the most stable or increased use). It differed from cluster 1, with a stable consumption of online shopping and TV-series watching. Participants from this cluster had used less cannabis than participants from clusters 3 and 4. Their BSI-18 depression score was lower than that of participants from clusters 1 and 4, and the BSI-18 anxiety score was lower than that of participants from cluster 1, indicating that participants from cluster 2 had better psychological health than those from clusters 1 and 4. Participants from cluster 2 had lower UPPS-P negative and positive scores compared to those of participants from clusters 1 and 4, meaning that they were less likely to act rashly in emotional contexts. Finally, this cluster was marked by a higher SWLS score than clusters 1 and 4, indicating a higher perceived life satisfaction. We named this cluster "Stable Non-Users with High Life Satisfaction".
Cluster 3 was characterized by a significant increase in online gaming compared to the other clusters. However, the IGDT-10 score was below the cut-off score, excluding a problem gaming. It was also the cluster with the most stable number of participants regarding online pornography viewing and TV-series watching, as well as cannabis use. There were more cocaine users in this cluster than in cluster 2. We named this cluster "Rising Gamers with Stable Digital Habits and Substance Use".
Cluster 4 was characterized by a significant increase in online pornography viewing compared to the other clusters. Participants from this cluster had the highest score on the s-IAT-sex, reflecting a higher risk of excessive behaviour regarding pornography viewing. Participants from this cluster also had the highest increase in online shopping, just after those from cluster 1, with a higher risk of excessive behaviour according to their CBS score. Participants from this cluster had the most increased cannabis use compared to those from clusters 1 and 2. They had higher UPPS-P negative and positive scores than that of participants from cluster 2. Finally, they had the lowest SWLS score and the highest BSI-18 depression score compared to those of participants from clusters 1 and 2, reflecting a poorer quality of life and increased depressivity. We named this cluster "Escalating Pornography, Shopping, and Cannabis Consumers with Emotional Distress".

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Total	ANOVAs/Chi²/Fisher exact	Post hoc tests
Average cluster size[a]	0.45	0.29	0.18	0.08			
	Mean (standard deviations) or percentage					Adjusted p-values	Adjusted p-values
Online behaviours frequency (contributive to the clustering)							
Pornography viewing							1-2 : 0.735
No use	59.69	56.46	18.91	26.42	48.91		**1-3 : <0.001**
Decreasing use	1.98	9.20	12.91	0.08	5.87		**1-4 : <0.001**
Stable use	34.07	34.30	60.28	0.83	36.30	**<0.001**	**2-3 : <0.001**
Increasing use	4.25	0.04	7.91	72.67	8.9		**2-4 : <0.001**
							3-4 : <0.001
Gaming							1-2 : 0.798
No use	89.78	80.60	6.52	63.62	70.22		**1-3 : <0.001**
Decreasing use	0.05	4.58	5.85	0.02	2.39		**1-4 : <0.001**
Stable use	4.81	14.73	33.50	13.68	13.48	**<0.001**	**2-3 : <0.001**
Increasing use	5.36	0.09	54.13	22.69	13.91		**2-4 : 0.004**
							3-4 : <0.001
Gambling							-
No use	96.86	95.09	93.19	93.48	95.43		
Decreasing use	0.50	0.00	1.14	0.00	0.43	0.567	
Stable use	1.35	4.90	5.67	0.02	3.04		
Increasing use	1.29	0.00	0.00	6.49	1.09		
Shopping							**1-2 : <0.001**
No use	30.16	31.21	29.59	34.02	30.65		**1-3 : 0.004**
Decreasing use	2.32	2.35	0.01	0.01	1.74		**1-4 : <0.001**
Stable use	20.76	45.69	54.10	1.03	32.39	**<0.001**	2-3 : 0.784
Increasing use	46.76	20.75	16.30	63.93	35.22		2-4 : 0.971
							3-4 : 0.168
TV-series watching							**1-2 : <0.001**
No use	0.09	20.37	3.97	41.76	9.78		**1-3 : <0.001**
Decreasing use	0.06	16.32	0.04	3.69	5.00		**1-4 : <0.001**
Stable use	31.78	60.24	69.90	19.77	45.87	**<0.001**	**2-3 : <0.001**
Increasing use	68.09	3.07	26.09	34.78	39.35		2-4 : 0.347
							3-4 : 0.001
Covariates (not contributive to the clustering)							
Socio-demographic characteristics							
Age	21.96 (2.26)	22.32 (3.71)	21.77 (2.40)	22.17 (3.22)	22.04 (2.93)	0.241	-
Sex							**1-2 : 0.032**
Male							**1-3 : <0.001**
Female	7.86	18.05	46.95	34.14	19.78	**<0.001**	**1-4 : <0.001**
	92.14	81.95	53.05	65.86	80.22		**2-3 : <0.001**
							2-4 : <0.001

							3-4 : 0.665
Educational level (number of years after baccalaureat)	3.59 (1.72)	3.77 (1.88)	3.62 (1.94)	3.75 (2.55)	3.66 (1.88)	0.501	-
Housing							**-**
Alone	25.02	19.63	21.34	30.91	23.26	0.101	
With the family (parents or grand-parents, siblings)	41.12	41.75	38.99	40.49	40.87		
With a partner	18.37	22.50	19.97	6.13	18.91		
Sharing a common space with other people	15.16	14.51	19.52	22.41	16.30		
Other situations	0.34	1.61	0.17	0.07	0.65		
Clinical characteristics							
BSI-18							
Depression *[0-24]*	10.00 (6.09)	8.49 (5.98)	8.77 (6.22)	11.46 (7.51)	9.45 (6.26)	**0.005**	**1-2 : 0.027** 1-3 : 0.109 1-4 : 0.666 2-3 : 0.959 **2-4 : 0.038** 3-4 : 0.064
Anxiety *[0-24]*	6.92 (5.70)	5.73 (5.10)	6.09 (5.25)	7.48 (5.30)	6.47 (5.43)	**0.022**	**1-2 : 0.014** 1-3 : 0.242 1-4 : 0.993 2-3 : 0.934 2-4 : 0.487 3-4 : 0.785
Somatization *[0-24]*	4.69 (4.47)	3.95 (4.17)	4.17 (4.05)	4.10 (3.53)	4.34 (4.25)	0.085	-
UPPS-P							
Negative urgency *[4-16]*	9.70 (3.04)	8.75 (2.92)	8.85 (2.61)	9.76 (3.67)	9.28 (3.02)	**0.003**	**1-2 : 0.003** **1-3 : 0.024** 1-4 :0.959 2-3 : 0.978 **2-4 : 0.032** 3-4 : 0.108
Positive urgency *[4-16]*	10.52 (2.48)	9.81 (2.51)	10.40 (2.34)	11.03 (2.34)	10.33 (2.54)	**0.003**	**1-2 : 0.013** 1-3 : 0.974 1-4 : 0.287 2-3 : 0.183 **2-4 : 0.003** 3-4 : 0.229
(lack of) premeditation *[4-16]*	7.39 (2.20)	7.08 (2.07)	7.44 (2.00)	7.75 (2.54)	7.33 (2.15)	0.161	-
(lack of) perseverance *[4-16]*	7.17 (2.48)	7.33 (2.53)	7.96 (2.43)	8.00 (3.03)	7.42 (2.54)	0.125	-
Sensation seeking *[4-16]*	9.45 (2.90)	9.61 (2.90)	10.02 (2.42)	9.82 (3.66)	9.62 (2.89)	0.069	-
ERQ							
Cognitive reappraisal strategy *[6-42]*	4.10 (1.17	4.29 (1.16)	4.15 (1.15)	3.92 (1.47)	4.15 (1.19)	0.854	-
Expressive suppression strategy *[4-28]*	3.84 (1.40)	3.79 (1.48)	3.91 (1.42)	3.95 (1.40)	3.85 (1.43)	0.513	-
Brief-COPE							
Problem-focused coping *[1-4]*	2.48 (0.33)	2.48 (0.32)	2.40 (0.30)	2.51 (0.36)	2.47 (0.33)	0.098	**-**

Emotion-focused coping *[1-4]*	2.08 (0.32)	2.10 (0.29)	2.03 (0.31)	2.07 (0.33)	2.08 (0.31)	0.322	-
Avoidant coping *[1-4]*	2.09 (0.32)	2.16 (0.30)	2.06 (0.30)	2.03 (0.30)	2.10 (0.31)	0.067	-
SWLS *[5-35, with 20=neutral point]*	23.95 (6.47)	24.12 (7.00)	22.69 (6.52)	20.96 (7.58)	23.55 (6.80)	**0.022**	1-2 : 0.996 1-3 : 0.490 **1-4 : 0.017** 2-3 : 0.500 **2-4 : 0.018** 3-4 : 0.266
Problematic online behaviours							
s-IAT-sex	15.98 (2.90)	16.50 (5.77)	16.23 (4.19)	21.58 (7.25)	16.79 (5.30)	**<0.001**	**1-2 : <0.001** **1-3 : <0.001** **1-4 : <0.001** **2-3 : <0.001** **2-4 : <0.001** **3-4 : <0.001**
IGDT-10 *n=2 (1.46%) at-risk gamers (IGDT-10 ≥ 5)*	0.88 (1.45)	0.37 (1.01)	0.73 (1.19)	1.76 (1.83)	0.78 (1.29)	**0.008**	1-2 : 0.608 1-3 : 0.971 1-4 : 0.115 2-3 : 0.636 **2-4 : 0.004** **3-4 : 0.015**
PGSI *n=1 (4.76%) at-risk gambler (ICJE ≥ 5)*	3.12 (7.69)	0.65 (0.95)	0.85 (1.17)	0.58 (0.71)	1.48 (4.11)	0.674	-
CBS *n=19 (5.96%) compulsive buyers (CBS ≤-1.34)*	1.48 (1.64)	2.14 (1.33)	1.98 (1.23)	0.60 (2.38)	1.69 (1.62)	**<0.001**	**1-2 : 0.001** 1-3 : 0.111 **1-4 : 0.022** 2-3 : 0.754 **2-4 : <0.001** **3-4 : <0.001**
BWESQ							
Engagement	2.00 (0.51)	1.88 (0.52)	1.96 (0.54)	2.00 (0.81)	1.96 (0.54)	0.131	-
Positive emotions	2.78 (0.44)	2.61 (0.62)	2.73 (0.48)	2.81 (0.67)	2.73 (0.53)	**<0.001**	**1-2 : 0.004** 1-3 : 0.306 1-4 : 0.992 2-3 : 0.667 **2-4 : 0.002** 3-4 : 0.907
Desire/savouring	2.81 (2.86)	2.59 (0.65)	2.71 (0.69)	2.84 (0.91)	2.74 (0.68)	**0.005**	**1-2 : <0.001** 1-3 : 0.315 1-4 : 0.948 2-3 : 0.426 2-4 : 0.533 3-4 : 0.975
Pleasure preservation	1.99 (0.70)	1.88 (0.70)	2.06 (0.68)	2.22 (0.81)	1.99 (0.71)	**0.008**	1-2 : 0.096 1-3 : 0.835

							1-4 : 0.219 2-3 : 0.222 **2-4 : 0.042** 3-4 : 0.528
Binge-watching	2.31 (0.67)	2.04 (0.68)	2.21 (0.66)	2.41 (0.95)	2.23 (0.70)	**0.003**	**1-2 : <0.001** 1-3 : 0.411 1-4 : 0.951 2-3 : 0.302 2-4 : 0.071 3-4 : 0.538
Dependency	1.52 (0.57)	1.36 (0.43)	1.46 (0.44)	1.63 (0.83)	1.47 (0.53)	**0.008**	**1-2 : <0.001** 1-3 : 0.087 1-4 : 0.432 2-3 : 0.296 2-4 : 0.636 3-4 : 0.544
Loss of control	1.90 (0.69)	1.63 (0.58)	1.78 (0.57)	1.94 (0.82)	1.81 (0.66)	**0.003**	**1-2 : <0.001** 1-3 : 0.149 1-4 : 0.999 2-3 : 0.555 2-4 : 0.248 3-4 : 0.732
Substances use characteristics							
Tobacco						0.534	-
No use	68.28	71.70	72.9	62.50	69.78		
Decreasing use	6.99	7.55	6.02	6.25	6.96		
Stable use	10.75	12.58	9.64	6.25	10.87		
Increasing use	13.98	8.18	12.05	25.00	12.39		
Alcohol						0.133	-
No use	52.15	66.04	53.01	46.88	56.74		
Decreasing use	14.52	9.43	19.28	12.50	13.48		
Stable use	23.12	17.61	16.87	21.88	20.00		
Increasing use	10.22	6.92	10.84	18.75	9.78		
Cannabis and/or synthetic cannabinoid							1-2 : 0.295
No use	83.87	88.05	67.47	56.25	80.43		**1-3 : <0.001**
Decreasing use	2.15	1.26	3.61	9.38	2.61		**1-4 : 0.001**
Stable use	6.45	7.55	25.30	9.38	10.43	**<0.001**	**2-3 : 0.001**
Increasing use	7.53	3.14	3.61	25.00	6.52		**2-4 : <0.001** **3-4 : 0.001**
Cannabidiol (CBD)							1-2 : 0.440
No use	89.78	92.45	89.16	81.25	90.00		**1-3 : 0.039**
Decreasing use	0.00	0.00	3.61	0.00	0.65		**1-4 : 0.039**
Stable use	5.91	5.66	6.02	3.13	5.65	**0.008**	2-3 : 0.113
Increasing use	4.30	1.89	1.20	15.63	3.70		**2-4 : 0.002** 3-4 : 0.012

Heroin	//	//	//	//	//		
Cocaine, amphetamines, and/or synthetic cathinones							1-2 : 0.075
No use	94.62	99.37	91.57	96.88	95.87		1-3 : 0.160
Decreasing use	1.61	0.00	0.00	0.00	0.65		1-4 : 0.763
Stable use	1.61	0.63	6.02	0.00	1.96	**0.041**	**2-3 : 0.005**
Increasing use	2.15	0.00	2.41	3.13	1.52		2-4 : 0.075
							3-4 : 0.360
LSD and/or other synthetic hallucinogens							
No use	98.39	100.00	97.59	96.88	98.70		
Decreasing use	0.00	0.00	0.00	0.00	0.00	0.110	-
Stable use	0.54	0.00	2.41	0.00	0.65		
Increasing use	1.08	0.00	0.00	3.13	0.65		
Prescription opioids							
No use	97.31	97.48	98.80	93.74	97.39		
Decreasing use	0.00	0.00	0.00	0.00	0.00	0.655	-
Stable use	1.08	0.63	0.00	3.13	0.87		
Increasing use	1.61	1.89	1.20	3.13	1.74		
Prescription psychostimulants	//	//	//	//	//		
Prescription sedative hypnotics							
No use	96.77	97.48	97.59	93.75	96.96		
Decreasing use	0.00	0.00	0.00	0.00	0.00	0.233	-
Stable use	0.00	1.26	0.00	3.13	0.65		
Increasing use	3.23	1.26	2.41	3.13	3.39		

Table 3. Description and comparisons of the four clusters (n=460). [a]**:** The average cluster size represents the mean of the cluster membership probabilities of all the participants for each cluster; [b]**:** For each variable, p-values are reported for the comparisons of all possible pairs of means of the four clusters (1–2: cluster 1 vs cluster 2; 1–3: cluster 1 vs cluster 3; 1–4: cluster 1 vs cluster 4; 2–3: cluster 2 vs cluster 3; 2–4: cluster 2 vs cluster 4; 3–4: cluster 3 vs cluster 4); Significant adjusted p-values ($p < 0.05$) are indicated in bold. SD: Standard deviation.**Brief-COPE:** Brief Coping Orientation to Problems Experienced Inventory; **BSI-18:** Brief Symptoms Inventory; **BWESQ:** Binge-Watching Engagement and Symptoms Questionnaire; **CBS:** Compulsive Buying Scale**; PGSI:** Problem Gambling Severity Index; **ERQ:** Emotion Regulation Questionnaire; **IGDT-10:** Ten-Item Internet Gaming Disorder Test; **s-IAT-sex:** short Internet Addiction Test adapted to online sexual activities; **UPPS-P:** Short version of the UPPS-P Impulsive Behavior Scale. **Cluster 1:** "Emotionally Driven Viewers and Shoppers"; **Cluster 2:** "Stable Non-Users with High Life Satisfaction"; **Cluster 3:** "Rising Gamers with Stable Digital Habits and Substance Use"; **Cluster 4:** "Escalating Pornography, Shopping, and Cannabis Consumers with Emotional Distress

4. DISCUSSION

4.1. Main results

This observational study focused on the evolution of a set of online behaviours that could potentially become excessive, in a sample of students, assessed one year after the beginning of the COVID-19 crisis. Several key findings of this work should be highlighted.

First, the participants, predominantly female and residing with their families, extensively utilized digital technology in various ways during the pandemic. A large majority of the students reported watching online TV-series, with viewing time either stable or increased. This trend was observed in both European and Asian countries (29–31). Similarly, a majority of students engaged in online shopping, with the frequency of shopping either remaining stable or increasing. The majority of students also reported viewing pornography online, with the majority maintaining stable viewing habits, consistent with previous research indicating that pornography use tends to stabilize after initial lockdowns (32). A smaller proportion of students reported playing online video games, with usage either increasing or remaining stable, aligning partially with studies indicating a trend towards increased gaming activity (33,34). Furthermore, a minority of students reported gambling, with most maintaining stable activity levels. A recent Spanish study concluded that gambling levels decreased during the lockdown (35). However, in the French general population, there was an observed upward trend in online gambling during the health crisis (36). This contrast could be related to the sex ratio being heavily skewed in favor of women in our sample.

Our findings generally align with existing studies, albeit differing depending on the online behaviors examined (29–33). One explanation for these discrepancies could be that existing studies primarily focused on the general population, whereas ours targeted a student population, predominantly composed of females. Additionally, we conducted our interviews remotely, after the initial phases of the epidemic, while the studies cited were conducted during the first or subsequent waves of the epidemic and associated restrictions in their respective countries. Moreover, the majority of our students did not report substance use, and for those who did, there was no significant increase. This contrasts with observations in the general population, where there was a trend towards increased use of substances other than alcohol during the early stages of the COVID-19 pandemic (Roberts et al., 2021).

Contrary to our hypothesis, the health crisis seems to have had a limited impact on online behaviours in the student population. Only a few participants were identified as having a probable excessive online behaviours, suggesting that if online behaviours increased in frequency to the point of becoming excessive for some, it may have been only transiently during the successive lockdowns, returning to normal a year later when health restriction measures were lifted. It can also be assumed that the students were sufficiently informed about the risks and took steps to protect themselves, for example, by investing in their studies, diversifying their leisure activities, or spending time with others. This is consistent with the high satisfaction with life they globally reported. Another explanation is that the vast majority of them did not live alone. Being "under the watch" of others (parents, partners, friends, or roommates) could have acted as a form of limitation on their online behaviors.

Secondly, this study aimed to identify clusters of students based on the evolution of their online behaviours and to explore their clinical profiles. The LCA revealed four distinct clusters, each characterized by specific digital usage patterns. Clusters 1 and 4 were distinguished from the other two by the addictive potential of their participants. Participants in both clusters exhibited a psychopathological profile characterized by higher levels of negative and positive urgency and greater intensity of depression compared to participants in Cluster 2. Cluster 1 was composed of participants, mainly female, at higher risk of developing excessive behaviours regarding online shopping and TV-series watching, while participants from cluster 4 were at higher risk of developing excessive behaviours towards online shopping and pornography viewing. Unlike in cluster 1, the sex ratio in cluster 4 was more balanced. Previous research has established correlations between high levels of impulsivity and engagement in compulsive buying/shopping (37,38), binge watching (39), or sex addiction (40). Risk factors for compulsive buying/shopping and binge-watching include being female and having symptoms of depression or emotional reactivity (41,42), whereas for addictive cybersex, being male and having symptoms of depression were identified as risk factors (43,44). Additionally, participants in Cluster 4 reported higher cannabis use compared to the other clusters, with a considerable increase during the period considered. This finding can be attributed to the male predominance in Cluster 4, as studies have shown that young adult males consume higher quantities of cannabis than females (45). Cluster 2 had predominantly absent or stable online behaviours and lower substance use compared to other clusters. Clinically, this cluster appeared to be the most psychologically stable, with its digital use seemingly unaffected by the pandemic. Cluster 3 primarily consisted of male participants with good psychological well-being, and the increase in their gaming behavior could be interpreted as a coping strategy for the pandemic. Several studies have suggested that playing online video games may have helped reduce stress, feelings of loneliness and isolation caused by the pandemic and successive lockdowns, providing an escape from daily concerns (46–48).

4.2. Strengths and weaknesses

These results must be viewed within the context of several limitations. Firstly, although the survey was disseminated in various fields, we recruited primarily female students, resulting in an imbalance in the

sex ratio. The overrepresentation of female students in the sample may have influenced the patterns of substance use and online behaviours observed, as these behaviours can differ across genders. Our results cannot be extrapolated to the student population as a whole, and even less to the general population, where the sex distribution is more balanced. Secondly, most participants reported living with other people, which is considered a protective factor. Thirdly, the evolution of online behaviours and substance use was not observed at various measurement times but rather retrospectively self-reported at a single time, potentially leading to recall bias and over- or underestimation of their prevalence and patterns. A longitudinal collection of data would have been more appropriate. Finally, it would have been interesting to ask students about their use of digital tools for academic purposes before and after the pandemic. However, these limitations are balanced by the strengths of our study. With a large sample size and no missing data, we were able to derive conclusive results.

5.CONCLUSION

Our findings provide valuable insights into the diverse patterns of online behaviors and their psychological correlates. Thus, people who are not specialized in mental health and who are in contact with students (family, friends, teachers, supervisors) could detect signs of psychological suffering by observing or questioning online behaviours and direct students to appropriate support. The role of Preventive Medicine and Health Promotion services specifically dedicated to students is of primary importance. It is part of their missions to develop health promotion actions focused on specific issues, such as addressing risky behaviours related to excessive tobacco and alcohol consumption, substance misuse, mental health, sexuality, nutrition, and more (49). Further research remains to be carried out, further away from the pandemic (to explore long-term impacts on excessive behaviours in the student population, adopting a longitudinal design) and with samples that are more representative of the student population.

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