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Use of electronic cigarettes and alternative tobacco products among Romanian adolescents

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Abstract

Objectives—To assess socio-demographic and smoking-related correlates of e-cigarette and alternative tobacco products (ATPs) use in a multi-ethnic group of adolescents in Tîrgu Mures, Romania.

Methods—The cross-sectional study included 1835 high school students from Tirgu Mures, Romania. Socio-demographic variables and data about smoking and e-cigarettes and ATP use were collected using an online questionnaire. Chi-square tests or one-way ANOVA were applied to compare never smokers, non-current smokers, and current smokers. Multiple logistic regression was conducted to determine the correlates of e-cigarettes and ATP use.

Results—The most frequently tried non-cigarette nicotine and tobacco products were e-cigarette (38.5 %), cigar (31.4 %) and waterpipe (21.1 %). Ever trying and current use of cigarettes were the most important correlates of e-cigarette and ATPs use. Sex, ethnicity, sensation seeking and perceived peer smoking were correlates of several ATPs use.

Conclusions—The results of this study may inform the development of tailored tobacco control programs.

Keywords

Electronic cigarette; Alternative tobacco products; Correlates; Adolescents; Romania

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Introduction

Increasing use of electronic cigarettes (e-cigarettes) and alternative tobacco products (ATPs) among adolescents has become a major health concern worldwide (Durmowicz 2014; Agaku et al. 2014). E-cigarettes are the most commonly used non-tobacco nicotine delivery devices (Grana et al. 2014). ATPs, which include non-cigarette tobacco products (e.g., pipes, waterpipe, cigars) and smokeless tobacco products (e.g., chewing tobacco, dry and moist snuff, snus), deliver nicotine via oral or nasal routes and include traditional and novel products (O'Connor 2012; Reddy et al. 2014). Prevalence estimates of e-cigarette use among adolescents age 13–19 years vary worldwide, from 9.4 to 23.5 % (Durmowicz 2014) and the prevalence of smokeless tobacco use ranges from 1.1 to 14.4 % (Agaku et al. 2014). Although trying cigarette smoking declined from 70.4 % in 1999 to 41.1 % in 2013 among youth in the USA (Kann et al. 2014; CDC 2010), the prevalence of smoked or smokeless tobacco use has increased (Chapman and Wu 2014; Wang et al. 2014; Durmowicz 2014). Ever use of e-cigarettes among US middle and high school students doubled from 3.3 % in 2011 to 6.8 % in 2012 (CDC 2013).

A nationally representative study of adolescents in the US showed that ever smoking a cigarette and current smoking are associated with a sixfold increase in e-cigarette ever use (Dutra and Glantz 2014). Current and former smokers were almost ten times more likely to have tried e-cigarettes compared to non-smokers in Canada (Czoli et al. 2014). Global studies are consistent with US results. Among Finnish adolescents, the odds of trying e-cigarettes were 40 times higher in current cigarette smokers, and 2–3 times higher in snus and waterpipe users (Kinnunen et al. 2014); moreover, vocational education and poor school performance were associated with e-cigarette use (Kinnunen et al. 2014). E-cigarette use was higher among regular (33.4 %) and occasional smokers (16.4 %) than in non-smokers (4.4 %) in a representative sample of schoolchildren age 12–19 years in Paris (Dautzenberg et al. 2013). In a sample of grade 8 students in a low socio-economic status region in Argentina, having five or more friends who smoke, a thrill-seeking orientation, reporting depressive symptoms, and living with an adult smoker were associated with ATP use (Alderete et al. 2010).

While numerous studies describe e-cigarette and ATP use among adolescents in the Americas (Saunders and Geletko 2012; Nasim et al. 2012, 2013; Elfassy et al. 2015) and Western Europe (Raisamo 2011; Jensen et al. 2010; Jawad et al. 2013), few examine e-cigarette and ATP use among adolescents in Central and Eastern Europe (CEE) (Goniewicz and Zielinska-Danch 2012; Pärna et al. 2008). Regional, national and local data on e-cigarettes and ATPs in CEE countries could provide evidence to inform optimally tailored policies and interventions for smoking and ATP use prevention. The objectives of this study were to (1) describe use of e-cigarettes and ATPs among multiethnic high school students in central Romania, and (2) identify socio-demographic and smoking-related correlates of e-cigarette and ATP use.

Methods

This research used the baseline data from the ASPIRE-Romania study, a cluster randomized trial of an intervention to prevent smoking initiation and promote cessation among adolescents in Romania (Ábrám et al. 2015). The study was launched in November 2014 in Tirgu Mures, Romania, with a population of 145,000, nearly half of whom are of Hungarian ethnicity. The sampling frame included all grade 9 students in the 16 high schools in the city. Three classes from one school declined participation. The remaining sample included 79 classes from 16 schools, including 2002 students. The study was approved by the Institutional Review Board of University of Medicine and Pharmacy of Tirgu Mures. Parents were informed about the purpose, benefits and risks of the study and all parents provided active written consent.

Trained data collectors informed participants about the study, explained that their participation was voluntary and asked them to complete an online questionnaire in the computer lab at school during one teaching hour. A total of 151 participants were absent on the day of questionnaire administration and 16 had missing or invalid responses to key study variables. The analytical sample included 1835 participants, with a response proportion of 91.7 %.

Measures

Socio-demographic data were collected on age, sex, school grades (8–10, 7–9, 6–8, 5–7, or <6 in most classes; 5 is the minimum required for passing), type of school (general, vocational), family size (≤4, >4 family members living together) and ethnicity (Romanian, Hungarian, Roma, German or other). For analysis, ethnicity was coded Romanian or non-Romanian.

E-cigarettes and ATP use was assessed by: “Which of the following products have you ever tried?” Response options included “Yes” or “No” for each of e-cigarettes, cigar, pipe, waterpipe, chewing tobacco, snus (or other oral tobacco products), and snuff (or other nasal tobacco products). ATPs with low prevalence were aggregated into “smokeless tobacco products”.

Cigarette smoking was measured in two questions: (1) “Have you ever tried smoking (even one or two puffs)?” (yes, no); and (2) “On how many of the last 30 days have you smoked cigarettes?” (seven categories from none to daily). Participants were categorized as: (a) never smokers (“No” on first question and “Not smoked in the last 30 days” on second question); (b) non-current smokers (“Yes” on first question and “Not smoked in the last 30 days” on second question); or (c) current smokers (“Yes” on first question and any response other than “Not smoked in the last 30 days” to the second question). Age at first cigarette was measured by: “How old were you when trying the first cigarette?” (≤7, 8–9, 10–11, 12–13, 14–15, ≥16 years, I have never smoked cigarettes. For analysis, responses were coded <12 or ≥12 years).

Social influences were measured by household smoking (“Does your father, step-father or other male guardian smoke?”, “Does your mother, step-mother or other female guardian

smoke?", "Do any of your brothers or sisters smoke?") and perceived peer smoking ("How many of your friends smoke cigarettes?" Response options ranging from "none" to "all of them" were collapsed for analysis into more than half or less than half).

Psychosocial measures included the 8-item brief sensation seeking scale (Sargent et al. 2010) (range 8–40; Cronbach's α = 0.78 in this sample); the 20-item Center for Epidemiological Studies Depression Scale (Stevens et al. 2013) which assesses frequency of depressive symptoms and has been validated in Romania, (range 0–60 with higher scores indicating more frequent symptoms; Cronbach's α = 0.87); and the decisional balance scale (Plummer et al. 2001). This scale consists of three subscales: coping pros of smoking, including items referring to perceived emotional regulatory effects of smoking (e.g., smoking cigarettes relieves tension); social pros of smoking, referring to perceived social advantages of smoking (e.g., kids who smoke have more friends); and the cons of smoking subscale, with items about the negative health impact of smoking (Sargent et al. 2010). Cronbach's α was 0.77, 0.68 and 0.85, respectively.

Data analysis

Differences in e-cigarette and ATP use among never cigarette smokers, non-current smokers, and current smokers were assessed in Chi-square or one-way ANOVAs using SPSS version 22.0. Correlates of trying e-cigarettes, cigars, pipes, waterpipe, and smokeless tobacco were identified in multiple logistic regression analyses accounting for cluster effects of classes and schools using Mplus 7.0 (Muthén and Muthén 1998–2012). A latent class analysis (LCA) was performed to identify subgroups sharing similar patterns of tobacco use. LCA (Collins and Lanza 2010) is a latent variable analysis with categorical latent and indicator variables. LCA was performed on binary indicators of e-cigarette and ATP use. One- to five-class solutions were estimated. Bayesian information criteria parsimony index, the minimization of cross-classification probabilities, entropy, and the interpretability of clusters were used to determine the number of latent classes. In the final determination, the likelihood ratio difference test (Lo–Mendell–Rubin adjusted LRT test), which compares the estimated model with a model with one less class than the estimated model (Muthén and Muthén 1998–2012) was also used. A low probability value ($p < 0.05$) indicates that the model with one less class is rejected in favor of the estimated model. To better understand the nature of each class, we performed a series of omnibus and pairwise comparisons across latent classes. These analyses used posterior probability-based multiple imputation.

Results

Descriptive characteristics of the sample are presented in Table 1. Half of participants (53.2 %) had smoked cigarettes, 24.1 % had smoked cigarettes during the last 30 days, and 4.6 % had smoked cigarettes daily in the past month. Only 1.7 % had quit smoking. Almost 60 % reported at least one smoker in the household. The most frequently used alternative products were e-cigarettes (38.5 %), cigars (31.4 %) and waterpipe (21.1 %); fewer participants (5.4 %) had used smokeless tobacco products.

Relative to never smokers and non-current smokers, current cigarette smokers were older, more likely to attend vocational school, report at least one smoker in the household and have

friends who smoke. They had significantly higher sensation-seeking and depressive symptom scores, reported fewer negative consequences of smoking and more coping–reinforcement and social benefits of smoking. There were no differences by sex or family size across the three groups.

Never, non-current, and current cigarette smokers differed in ATP use. Few never smokers had tried e-cigarettes (8 %) or waterpipe (7.7 %), and even fewer had tried cigars (1.2 %), pipes (0.9 %) or smokeless tobacco (0.5 %). Among non-current smokers, 57.7 % had used e-cigarettes, 51.4 % had used cigars, 24.9 % had used waterpipe, 6.9 % had used smokeless tobacco, and 6.7 % had used pipes. Finally among current smokers, 74.4 % had use e-cigarettes, 66.1 % had used cigars, 42.8 % had used waterpipes, 18.1 % had used pipes and 13.3 % had used smokeless tobacco.

Correlates of e-cigarette and ATP use

Male sex, non-current and current smoking and higher sensation-seeking were significantly associated with e-cigarette use (Table 2). Independent correlates of cigar use included non-Romanian ethnic identity, non-current and current smoking and higher sensation-seeking. Being non-Romanian, having friends who smoke, non-current and current smoking, higher sensation-seeking and lower depressive symptoms were correlated with waterpipe use. Statistically significant correlates of pipe use included male sex, older age, being non-Romanian, living in a non-smoking household, having friends who smoke, non-current and current smoking, and believing that smoking can help in coping. Finally, use of smokeless tobacco was correlated with being Romanian, attending a general high school, having good school grades and non-current smoking.

Latent class analysis

Table 3 presents the information-based criteria and entropy for each latent class solution. The Akaike Information Criteria, Bayesian Information Criteria (BIC), and sample-size adjusted BIC continued to decrease as the number of latent classes increased until we reached the 3-class solution. However, Lo–Mendell–Rubin adjusted likelihood ratio test became non-significant at the 5-class solution, suggesting a 4-class model. Therefore, we accepted the 4-class solution. Patterns of use are presented in Fig. 1. Class 4 represents 56.3 % of the sample and includes participants who tried any product other than cigars. Class 3 represents 22.3 % of the sample and includes participants more likely to be e-cigarette or waterpipe users. Class 1 represents 17.5 % of the sample and includes participants who tried e-cigarettes, cigars or waterpipe. Finally, class 2 represents 3.9 % of the sample and includes participants who tried almost all products.

The Class 2 group is characterized by the highest proportion of cigarette use and current smoking, high levels of perceived peer smoking, the highest mean score for sensation-seeking, and the highest mean score for coping–reinforcement and social motives for smoking (Table 4). Class 2 also had the lowest mean score for beliefs about the negative consequences of smoking. The distribution by sex reflected a higher proportion of males. Class 1 was characterized by high levels of ATP use, high levels of cigarette smoking and perceived peer smoking, but a moderate proportion of current smoking. Compared to Class 3

and 4, Class 1 had higher mean scores for sensation-seeking, coping–reinforcement, and social motives for smoking, and a lower mean score for beliefs about the negative consequences of smoking. Class 3 is characterized by low-intensity cigarette use, and Class 4 may be viewed as non-users. Class 3 and 4 were distinct from Class 1 and 2 because the prevalence of non-current and current smoking was lower, perceived peer smoking was lower and the mean sensation-seeking score was lower.

Discussion

This study adds insight into the patterns of e-cigarette and ATP use among multi-ethnic adolescents in Eastern Europe. More than one-third of grade 9 students had used e-cigarettes or cigars, and more than 20 % had used waterpipe. The prevalence of ever using these products was consistently higher among participants who were currently using or had ever tried conventional cigarettes. Importantly, some non-smokers also reported e-cigarette and waterpipe use. Non-current and current cigarette use were the most consistent and strongest correlates of e-cigarette and ATP use. Sex, ethnicity, sensation-seeking and perceived peer smoking were also independent correlates of ATP use. We identified four distinct patterns of ATP use.

Our findings on the smoking behaviors of grade 9 students in Tîrgu Mures are consistent with global youth tobacco survey (GYTS) data obtained in 2009 in a nationally representative sample of Romanian students in grades 7–10 (49.9 % ever smoked; 17.2 % current smokers; 3.3 % current daily smokers). Our findings are also consistent with recent GYTS data reported by several CEE countries (ever smoked: Hungary 57.9 %; Bulgaria 58.8 %, Republic of Moldova 41.7 %; current smokers: Hungary 23.2 %, Bulgaria 28.2 %, Republic of Moldova 13.7 %; current daily smokers: Hungary 5.9 %, Republic of Moldova 3.9 %) (CDC 2004–2008; Agaku et al. 2014).

The prevalence of e-cigarette and ATP use in our sample (38.5 %) was higher than reported in other European countries (i.e., 23.5 % in Poland (Goniewicz and Zielinska-Danch 2012), 23.8 % in Ireland (Babineau et al. 2015), 17.4 % in Finland (Kinnunen et al. 2014), 12.3 % in Wales (Moore et al. 2015) and 11.8 % in France (Dautzenberg et al. 2013). This might relate to the higher prevalence of conventional cigarette use in Eastern European countries (Bogdanovica et al. 2011) or possibly to ineffective or poorly implemented tobacco control programs (Joossens and Raw 2014; Kuipers et al. 2015).

Because few European studies are currently available, comparison of our findings on cigar, pipe, waterpipe, snuff, and chewing tobacco use with findings in other European countries was not possible. The prevalence of cigar and pipe ever use in our sample (31.1 and 6.8 %, respectively) was higher than that observed in Argentina (12.4 and 2.6 %, respectively) (Alderete et al. 2010). In contrast, waterpipe ever use among high school students in Tirgu Mures (21.1 %) was lower than that reported among Estonian boys (38.1 %) and girls (31.4 %) (Pärna et al. 2008). Smokeless tobacco use in our study was moderate in the European context, falling between countries with the lowest prevalence of ever use (5.4 vs 1.6 % in Serbia, 1.7 % in Hungary, 1.9 % in Croatia, 2.0 % in Slovenia) and those with the highest prevalence (6.9 % in Estonia and 10.9 % in Latvia) (Agaku et al. 2014).

Our results on the association between conventional and e-cigarettes are consistent with findings from the US, Canada, France, and Finland, (Dutra and Glantz 2014; Czoli et al. 2014; Kinnunen et al. 2014; Dautzenberg et al. 2013). Although the strength of this association varies across countries, cigarette smoking appear to be centrally important to e-cigarette use in adolescents worldwide, including Romania. While cigarette use was correlated with most ATPs, these associations were less consistent for cigars, smokeless tobacco and waterpipe in other studies (Nasim et al. 2013; Reddy et al. 2014; Pärna et al. 2008).

Similarly to studies in the US (Barnett et al. 2015; Krishnan-Sarin et al. 2015), South Korea (Lee et al. 2014), New Zealand (White et al. 2015) and Poland (Goniewicz and Zielinska-Danch 2012), we found that males were more likely to try e-cigarettes than females. Similarly, the higher level of pipe use among males in our sample is consistent with findings from Argentina (Alderete et al. 2010) and among current adolescent smokers in the US (Saunders and Geletko 2012). Other studies, however, have reported no association between sex and e-cigarette or ATP use (Czoli et al. 2014; Dautzenberg et al. 2013; Jawad et al. 2013). These discrepancies might relate to the interplay between sex and cultural patterns of cigarette consumption (Tyas and Pederson 1998).

Ethnicity was significantly correlated with using several ATPs but not e-cigarettes. Non-Romanian participants had a higher odds of cigar, pipe and waterpipe use, while Romanians were more likely to use smokeless tobacco products. Ethnicity has been identified as a correlate by others, including of ATP use in general (Saunders and Geletko 2012) or of individual ATPs such as smokeless tobacco products, cigars, waterpipe and pipes (Nasim et al. 2012; Reddy et al. 2014; Jawad et al. 2013; Alderete et al. 2010; Agaku et al. 2014). ATP use in ethnic minorities originating in Eastern Mediterranean and African countries may be viewed of as cultural or traditional (Agaku et al. 2014; Jawad et al. 2013), while reasons for use in other ethnicities are not clear (Tyas and Pederson 1998).

Grade 9 students with friends who smoke were more likely than those without, to try pipe and waterpipe. Peer smoking has been associated with pipe and waterpipe use in London (Jawad et al. 2013), e-cigarette use in New Zealand (White et al. 2015) and cigars in Argentina (Alderete et al. 2010) and the US (Nasim et al. 2013). Studies on conventional cigarette smoking suggest that the relationship between peer smoking and ATPs is bidirectional—peer smoking can lead to ATP use, but ATP use may also encourage users to seek out smokers as a peer group (Tyas and Pederson 1998).

Among psychosocial characteristics, sensation-seeking was consistently associated with e-cigarette, cigar and waterpipe use, although not with pipe use. Alderete (2010) also found higher levels of cigar and pipe use among adolescents with a thrill-seeking orientation.

We hypothesized that individuals who try one ATP may also try other ATPs. Therefore, we analyzed patterns of use and identified four subgroups including intense users with a high probability of trying all ATPs; selective users who used e-cigarettes, cigars and waterpipe; e-cigarette users; and a nonuser group with a low level of ATP use. Most persons in the intense and selective user groups had tried cigarette smoking, were current smokers, and

sensation-seekers who underestimated the negative consequences of cigarette smoking and overestimated the coping and social benefits of smoking. Increased understanding of differences across groups may help target students who require tailored prevention strategies that do not focus solely on cigarette smoking but also incorporate e-cigarettes and other ATPs.

This study has at least three limitations. First, the cross-sectional design of the study limits causal inference. Second, the sample was drawn from one city in central Romania possibly limiting the generalizability of the findings. Third, self-report data are subject to recall and social desirability bias, as well as misclassification.

Conclusions

This is the first study to report the prevalence, correlates and patterns of e-cigarette and ATP use of among multi-ethnic high school students in central Romania. The results may inform the development of tailored tobacco control programs. For example, content delivered to young persons who use multiple products (classes 1 and 2) should cover the spectrum of nicotine and tobacco products, while messages targeting class 3 should focus on e-cigarettes and waterpipe. Non-tailored, generic interventions should not focus on a single product since use of multiple products is more prevalent. Future research should monitor changes in the prevalence of e-cigarette and ATP use among high school students, and enhance understanding of the determinants of use.

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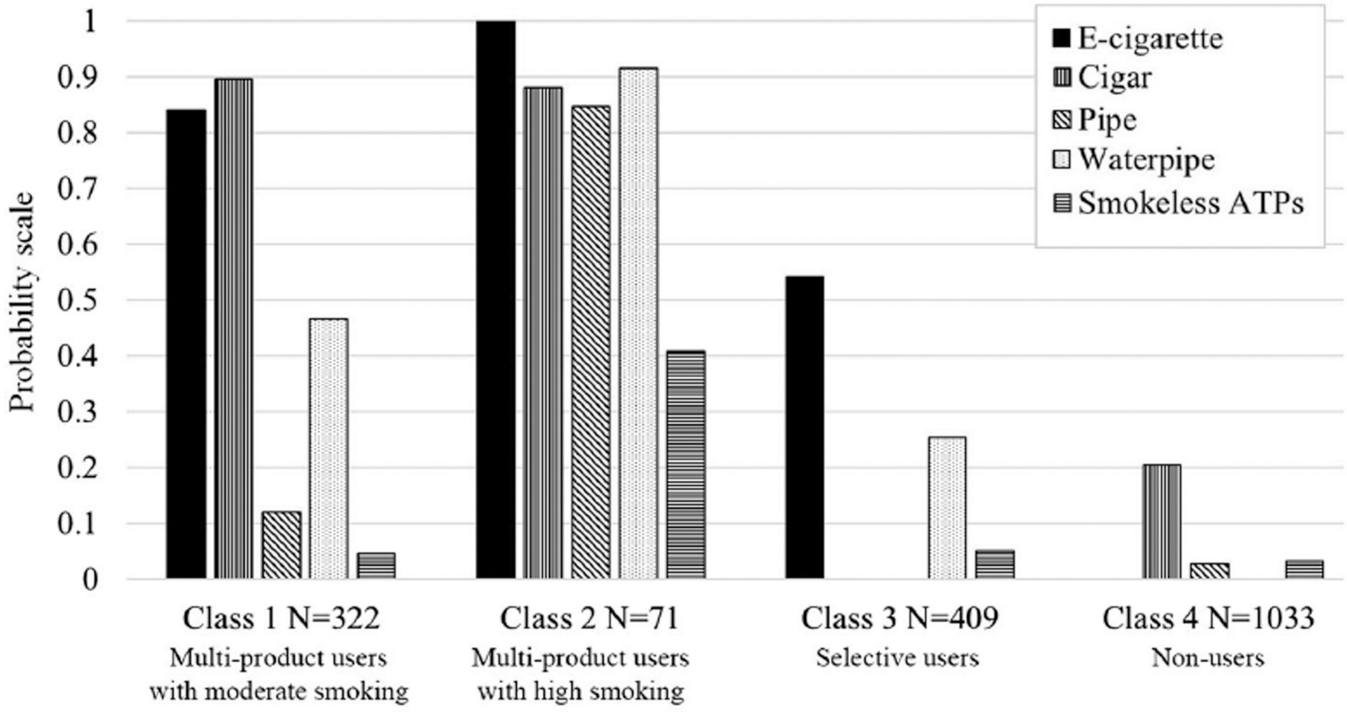

Fig. 1.

Latent classes of e-cigarette and alternative tobacco products patterns of use among grade 9 high school students, Tirgu Mures, Romania, 2014

Note: Estimated N is based on the most likelihood latent class membership.

Table 1

Socio-demographic and other characteristics according to cigarette smoking status among grade 9 high school students, Tirgu Mures, Romania, 2014

	Total *n* = 1835	**Never smokers *n* = 859**	**Non-current smokers *n* = 534**	**Current smokers *n* = 442**	***p***
Age, years, mean (SD)	14.9 (0.5)	14.9 (0.5)	14.9 (0.5)	15.0 (0.6)	0.003
Male (%)	46.5	45.9	49.8	43.9	0.157
Family size ≤4 (%)	78.1	77.9	77.0	79.9	0.541
Ethnicity (%)					
Romanian	55.1	56.0	53.9	55.0	0.845
Hungarian	42.1	41.4	43.4	41.6	
Other	2.8	2.6	2.7	3.4	
General high school (%)	30.0	36.4	29.6	18.1	<0.001
Household smoking (%)	59.9	49.4	63.7	75.8	<0.001
≥50 % of friends smoke (%)	32.3	15.0	33.7	64.3	<0.001
At least one close friend smokes[#] (%)	58.6	39.6	64.4	88.5	<0.001
E-cigarette (%)	38.5	8.0	57.7	74.4	<0.001
Cigar (%)	31.4	1.2	51.4	66.1	<0.001
Pipe (%)	6.8	0.9	6.7	18.1	<0.001
Waterpipe (%)	21.1	7.7	24.9	42.8	<0.001
Chewing tobacco (%)	1.6	0.1	1.9	4.1	<0.001
Snus/other oral tobacco product (%)	3.9	0.1	4.7	10.4	<0.001
Snuff (%)	1.1	0.2	0.6	3.6	<0.001
Any smokeless tobacco product (%)	5.4	0.5	6.9	13.3	<0.001
Sensation-seeking, mean (SD)	26.3 (6.47)	24.3*a* (6.12)	27.2*b* (6.10)	29.0*c* (6.34)	<0.001
Depressive symptoms, mean (SD)	15.04 (9.78)	13.2*a* (8.75)	15.2*b* (9.80)	18.3*c* (10.72)	<0.001
Decisional balance[##]					
Negative consequences, mean (SD)	3.93 (0.97)	4.11*a* (0.91)	3.98*b* (0.96)	3.54*c* (0.99)	<0.001
Coping–reinforcement, mean (SD)	1.83 (0.88)	1.55*a* (0.71)	1.75*a* (0.81)	2.46*a* (0.95)	<0.001
Social benefits, mean (SD)	1.55 (0.64)	1.45*a* (0.57)	1.51*a* (0.58)	1.79*b* (0.74)	<0.001

[#]The range of number of closest friends is between 0 and 3

[##]Based on a three-factor model (Plummer et al. 2001), and the means of items are provided here

[a, b, c, d]Means sharing a common superscript are not statistically different at $p < 0.05$ according to Games–Howell post hoc test

Table 2

Correlates of e-cigarettes and alternative tobacco products use among grade 9 high school students, Tirgu Mures, Romania, 2014: multiple logistic regression models

	Electronic cigarette		Cigar		Pipe		Waterpipe		Any smokeless tobacco product	
	OR	**95 % CI**	**OR**	**95 % CI**	**OR**	**95 % CI**	**OR**	**95 % CI**	**OR**	**95 % CI**
Sex										
Females	0.47*	0.34–0.67	0.90	0.62–1.32	0.58*	0.41–0.82	0.75	0.54–1.04	0.83	0.58–1.19
Males	Ref.		Ref.		Ref.		Ref.		Ref.	
Age	0.90	0.75–1.07	0.95	0.69–1.29	1.35*	1.01–1.79	0.89	0.75–1.06	1.25	0.84–1.87
Ethnicity										
Romanian	0.89	0.70–1.12	0.20*	0.14–0.28	0.46*	0.30–0.71	0.60*	0.47–0.76	2.35*	1.67–3.29
Non-Romanian	Ref.		Ref.		Ref.		Ref.		Ref.	
School type										
General high school	0.79	0.61–1.01	0.73	0.48–1.09	0.79	0.45–1.37	0.70	0.42–1.15	2.04*	1.45–2.86
Technical vocational school	Ref.		Ref.		Ref.		Ref.		Ref.	
School grade	0.95	0.82–1.10	1.05	0.87–1.25	1.07	0.88–1.29	1.16	0.98–1.37	1.23*	1.00–1.51
Household smoking										
Smokers in the household	1.01	0.82–1.25	0.89	0.67–1.18	0.64*	0.47–0.86	1.03	0.83–1.26	1.29	0.89–1.87
Non-smokers in the household	Ref.		Ref.		Ref.		Ref.		Ref.	
Perceived peer smoking										
≥50 % friends smoke cigarette	1.31	0.97–1.76	1.18	0.80–1.73	2.24*	1.54–3.26	1.34*	1.07–1.66	1.31	0.95–1.81
<50 % smoke	Ref.		Ref.		Ref.		Ref.		Ref.	
Tried cigarette smoking										
Yes	15.64*	10.73–22.81	110.08*	42.46–285.36	6.13*	2.20–17.13	3.21*	2.09–4.94	13.22*	4.04–43.26
No	Ref.		Ref.		Ref.		Ref.		Ref.	
Smoked cigarette in the past 30 days										
Yes	2.21*	1.78–2.75	1.63*	1.16–2.29	2.10*	1.47–3.01	2.05*	1.43–2.93	1.36	0.70–2.63
No	Ref.		Ref.		Ref.		Ref.		Ref.	
Sensation seeking (BSSS)	1.05*	1.02–1.07	1.07*	1.05–1.09	1.01	0.97–1.05	1.09*	1.06–1.12	1.01	0.96–1.05

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	Electronic cigarette		Cigar		Pipe		Waterpipe		Any smokeless tobacco product	
	OR	**95 % CI**	**OR**	**95 % CI**	**OR**	**95 % CI**	**OR**	**95 % CI**	**OR**	**95 % CI**
Depressive symptoms (CES-D)	0.99	0.98–1.00	1.00	0.98–1.01	1.01	0.99–1.03	0.98*	0.97–1.00	1.01	0.99–1.04
Negative consequences (Cons)	1.11	0.90–1.36	1.00	0.85–1.17	0.88	0.71–1.08	0.98	0.85–1.12	0.86	0.71–1.05
Coping–reinforcement	0.97	0.86–1.10	1.20	1.03–1.40	1.35*	1.17–1.57	1.24	0.99–1.56	1.21	0.91–1.62
Social benefits	1.02	0.81–1.27	1.14	0.91–1.42	0.85	0.52–1.38	0.90	0.67–1.20	1.20	0.95–1.52
R^2 (%)	48		70.7		41.6		31.8		47.1	

OR odds ratio, *CI* confidence interval, *Ref.* reference group, R^2 explained variance

*Significant (at $p < 0.05$)

Table 3

Fit indices for the latent profile analysis of e-cigarette and alternative tobacco products use among grade 9 high school students, Tirgu Mures, Romania, 2014

Number of latent classes	AIC	BIC	SSABIC	Entropy	L-M-R test	*P* value
2 classes	7643.8	7704.4	7669.5	0.749	674.0	$p < 0.0001$
3 classes	7604.3	7698.1	7644.0	0.770	50.3	$p = 0.0461$
4 classes	7602.2	7729.0	7656.0	0.708	13.8	$p = 0.0362$*
5 classes	7630.8	7790.8	7698.7	0.677	4.94	$p = 0.5144$

AIC Akaike information criteria, *BIC* Bayesian information criteria, *SSABIC* sample-size adjusted Bayesian information criteria, *L-M-R test* Lo–Mendell–Rubin adjusted likelihood ratio test value, *p p* value associated with L-M-R test

*Statistically significant

Table 4

Comparison of selected characteristics across latent classes of e-cigarette and alternative tobacco products use among grade 9 high school students, Tirgu Mures, Romania, 2014

	Class 1 MPU-MS *n* = 322	**Class 2 MPU-HS *n* = 71**	**Class 3 SU *n* = 409**	**Class 4 NU *n* = 1033**	***p***
Female (%)	51.4*a*	31.6*b*	50.6*a*	58.2*c*	<0.001*
Age [mean (SE)]	14.9 (0.03)	15.0 (0.06)	14.9 (0.02)	14.9 (0.02)	0.201
Romanian (%)	44.2*a*	44.6*ac*	64.0*b*	55.5*c*	<0.001*
Vocational school (%)	71.4	70.4	71.6	68.1	0.771
Grades [mean (SE)]	3.8 (0.06)	3.7 (0.13)	3.9 (0.05)	4.0 (0.04)	0.026
Household smoking (% yes)	69.1	60.8	61.1	54.5	0.08
≥50 % friends smoke (%)	51.4*a*	76.8*b*	29.5*c*	21.4*d*	<0.001*
Tried smoking (%)	95.9*a*	98.1*a*	53.0*b*	28.8*c*	<0.001*
Current smokers (%)	51.5*a*	77.5*b*	19.9*c*	9.4*d*	<0.001*
Sensation-seeking [mean (SE)]	29.3*a* (0.32)	31.0*a* (0.91)	26.0*b* (0.31)	24.6*c* (0.25)	<0.001*
Depressive symptoms [mean (SE)]	16.2 (0.55)	17.8 (1.63)	14.3 (0.46)	14.8 (0.38)	0.005
Negative consequences (Cons) [mean (SE)]	3.8*a* (0.06)	3.4*b* (0.13)	4.0*c* (0.05)	4.0*c* (0.04)	<0.001*
Coping–reinforcement [mean (SE)]	2.2*a* (0.05)	2.7*b* (0.14)	1.7*c* (0.04)	1.7*c* (0.03)	<0.001*
Social benefits [mean (SE)]	1.7*a* (0.04)	1.8*a* (0.10)	1.5*b* (0.03)	1.5*b* (0.02)	<0.001*

Calculation across classes is based on using posterior probability-based multiple imputations

MPU-MS multi-product users with moderate smoking, *MPU-HS* multi-product users with high smoking, *SU* selective users, *NU* non-users

*Omnibus test was statistically significant after the Bonferroni correction ($p < 0.004$)

*a, b, c, d*Means or proportions sharing a common superscript are not statistically different at $p < 0.05$ according to pairwise comparisons using Wald χ^2 test