



# E-cigarette use among Serbian adults: prevalence and user characteristics

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Received: 30 June 2015 / Revised: 5 January 2016 / Accepted: 10 January 2016 / Published online: 29 January 2016  
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## Abstract

**Objectives** The objective was to report the prevalence and characteristics of electronic cigarette (e-cigarette) users in order to inform an appropriate response to this emerging challenge in tobacco control.

**Methods** Data were drawn from a cross-sectional survey conducted in 2014 that used computer-assisted interviewing in a representative sample of 5385 Serbian adults age 18–64 years.

**Results** Lifetime e-cigarette use and current use was reported by 9.6 and 2 % of adults, respectively. Younger adults had a higher prevalence of both lifetime and current use. Females were more likely to be current e-cigarette users than males. The majority of ever and current

e-cigarette users were current or past cigarette smokers, but lifetime use was reported by non-smokers as well.

**Conclusions** Electronic cigarettes are popular in Serbia; one in ten adults had tried them at least once. Because females and young adults were more likely to use e-cigarettes, a targeted response in these specific groups is needed. A standardised methodology for monitoring e-cigarette use should be established and surveys exploring motives for and attitudes towards e-cigarettes use should be conducted.

**Keywords** Electronic cigarette · E-cigarette · Prevalence · Socio-demographic correlates

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This article is part of the special issue “Electronic Cigarettes and Public Health”

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## Introduction

Use of electronic nicotine delivery systems (ENDS) is increasing in many countries, with electronic cigarettes (e-cigarettes) being the most commonly used ENDS (WHO Study group on Tobacco Product Regulation 2014). E-cigarettes are battery-operated devices which resemble regular cigarettes. They have a liquid filled cartridge which can contain nicotine and are often flavoured (e.g., fruit, mint, branded cigarette taste). There is growing public health interest as well as concern about e-cigarettes because these products present both promise and threats to tobacco control (Pallazolo 2013; WHO Study group on Tobacco Product Regulation 2014).

Although limited, published research on the safety, efficacy, long-term effects and public health impact of e-cigarette use raises concerns. The nicotine content in e-cigarette products does not always match the advertised or labelled content. Products labelled “nicotine-free” have been found to contain nicotine and sometimes the amount

of nicotine is higher or lower than the labelled amount (Hadwiger et al. 2010; Goniewicz et al. 2013). An important issue that raises concern among tobacco control experts is that e-cigarette products are often designed and advertised in a way that appeals to youth. Use of these products, which may result in nicotine addiction, can lead to non-smokers initiating tobacco use (Nathan et al. 2011; Grana 2013). Surveys in the US show that in 2013, more than a quarter of a million youth who had never smoked tobacco were using ENDS (Bunnell et al. 2015). Even though ENDS have been on the market for less than 10 years (Noel et al. 2011), the lack of data on long-term effects is a source of serious concern (Trtchounian and Talbot 2011).

On the other hand, there are arguments that ENDS are a safer alternative to cigarettes, and that they help smokers cut-down or stop smoking cigarettes. The Royal College of Physicians in the UK recently recommended ENDS as “valuable harm reduction and cessation products” which are much safer than tobacco (Royal College of Physicians 2014). However, in his review, Pallazolo (2013) concludes that “less evidence exists to suggest that e-cigarettes are effective in recovery from nicotine dependence” (pp. 17). There is also little evidence to suggest that the use of ENDS is associated with increased health risk, but this finding is limited due to the short time period since ENDS became available (McRobbie et al. 2014).

Because of these challenges, many countries have to consider specific regulations related to quality control, manufacturing, advertising and use of e-cigarettes. In the European Union (EU), the New Tobacco Product Directive sets rules for e-cigarettes aimed at harmonising the quality and safety requirements of these products with regard to packaging and labelling (Official Journal of the European Union 2014).

In order to learn more about the characteristics of ENDS users, the number of targeted surveys among e-cigarette users has increased globally in the last few years. However, data on the prevalence and patterns of e-cigarette use e-cigarette users are still not available in many countries. In their review on the key issues related to e-cigarette use, Rahman et al. (2014) searched Pubmed, Scopus and the “Web of Science” and found fewer than 40 relevant articles published from January 2009 to January 2014.

In Serbia, adult cigarette smoking was 34.7 % in 2013 (Institute of Public Health of Serbia 2014). Current legislation does not regulate important aspects relevant to e-cigarettes such as use in public places or quality control in manufacturing and advertising. In the current Tobacco Law (Official Gazette of the Republic of Serbia, No. 101/05, 90/07, 95/10, 36/11, 93/12, 8/13 и 108/13), e-cigarettes are not recognised as a tobacco product and consequently not regulated by the Law on Protection of

Citizens of Exposure to Tobacco Smoke (Official Gazette RS 30/2010). This law stipulates a ban on use of tobacco product in enclosed spaces and on public transportation. The law on the health safety of objects of common use (Official Gazette RS 92/2011) regulates the quality of objects which come into contact with the skin and with mucous membranes. Although e-cigarettes are not specifically mentioned, control of the composition and characteristics of e-cigarettes comes under this legislation. Due to the lack of regulation on e-cigarette advertising, e-cigarettes are sometimes promoted as a cessation aid, and as “cigarettes” that can be used in places where smoking is not permitted. In Serbia, e-cigarettes are commonly sold in pharmacies, in specialised shops in shopping malls, in other public places and on the internet.

The ready availability of e-cigarette products results in high population exposure. Data from the Global Youth Tobacco Survey in Serbia show that in 2013, 81.3 % of 13- to 15-year-old students had heard about e-cigarettes and 57.6 % had seen or heard advertisements or promotions of e-cigarettes on TV, radio, the internet or in a pharmacy during the past 30 days (Krstev 2014). Intense advertising and lack of regulation, in combination with a high smoking prevalence necessitates increased understanding of this new product in Serbia and in other similar countries.

Herein, we describe the characteristics of e-cigarette users in Serbia, data which are needed for evidence-based planning of a response to this challenge. Identification of population subgroups that use e-cigarettes will permit targeting awareness campaigns to enable users to make informed decisions on ENDS use. The specific objectives of this paper are to report the prevalence of e-cigarette use in Serbia and to describe the socio-demographic characteristics and cigarette smoking status of users.

## Methods

### Sampling and design

Data from the 2014 National Survey on the Lifestyle of Citizens of Serbia were used in this analysis. This cross-sectional survey, which comprises a representative sample of 5385 Serbians age 18–64 years, collected data on the prevalence and patterns of tobacco, e-cigarette, alcohol, pharmaceutical and illegal drug use using computer-assisted personal interviewing. The field work was conducted from January to March 2014 by trained interviewers. The sampling was designed to achieve a representative sample at the national level as well as in four administrative regions and in urban/rural areas. First stage units were enumeration areas selected based on the probability proportional to their size. Second stage units were households,

which were selected in each area by systematic sampling with random start and equal step without replacement of ineligible households. Third stage units were household members selected randomly using the Kish grid (Kish, 1949). The final response proportion represents 66.7 % of eligible households who were successfully contacted face-to-face, and 63.5 % of all eligible households, including those that could not be contacted. The final sample was weighted according to sex, age and distribution of regions according to the 2011 Serbian Population Census.

#### Instrument and study variables

The questionnaire was based on the European Model Questionnaire developed by the European Monitoring Centre for Drugs and Drug Addiction for use in general population surveys on drugs (EMCDDA 2002). It was modified to include modules on alcohol consumption, cannabis use, gambling and screening for mental health. Results based on the data collected in these modules have been published (Kilibarda et al. 2014). Data on use of e-cigarettes were collected by: “Have you ever used electronic cigarettes?” Response options included: (1) no, I have never used electronic cigarettes; (2) yes, I tried electronic cigarettes but I have never used them occasionally or regularly; (3) yes, I have previously used electronic cigarettes, but not on a daily basis and now I don’t use them anymore; (4) yes, I have previously used electronic cigarettes on a daily basis, but now I don’t use them anymore; (5) yes, I currently use electronic cigarettes, but not on a daily basis, and (6) yes, I currently use electronic cigarettes on a daily basis. Data were collected on socio-demographic variables including age, sex, living in an urban or rural area, education and occupation. Participants’ educational status was categorised into three groups: elementary school or less (obligatory 8 years of elementary school completed or not completed, secondary school not completed), completed secondary school (minimum of 3–4 years of secondary school, not completed college or university) and completed college or university. Occupational status was categorised into six groups: non-active (unemployed, temporarily not working, responsible for bringing up children, retired, unable to work due to illness); students; manual labourers (unskilled, semiskilled or skilled (e.g., craftsmen, farmers)); administrative workers (service and sales, administrative officers); businessmen (e.g., owners or co-owners of a company, owners of a shop, restaurant); professionals (teachers, nurses, highly qualified professionals (e.g., lawyers, doctors, architects, senior officials, legislators). Other covariates included: lifetime and current smoking status, with “current smoker” defined as a person who smoked at least one cigarette in the last 30 days.

#### Statistical analysis

Prevalence rates of smoking and e-cigarette use were calculated with 95 % confidence intervals. Associations between e-cigarette use and socio-demographic variables and tobacco smoking were examined using Chi-square tests. *T* tests were used to assess mean number of cigarettes daily among smokers, by e-cigarette status. In addition, associations were analysed using univariate and forward stepwise binary logistic regression with a probability of entry of 0.05 and removal of 0.1. Data were analysed using IBM SPSS Statistics, version 22.0.0.1.

#### Results

More than 40 % of the sample were current smokers and approximately one in ten had tried e-cigarettes at least once. Current e-cigarette use remained relatively uncommon, with an overall prevalence of 2, and 3 % among adults age 25–44 years (Table 1).

There were statistically significant differences in tobacco smoking status among ever and current e-cigarette users ( $p < 0.001$ ). Daily smokers had the highest prevalence of lifetime e-cigarette use. The proportion of ever e-cigarette users among never smokers was statistically significantly different from all other smoking categories. Among current daily cigarette smokers, it was significantly different from other smoking categories except current occasional smokers. The percentage of ever e-cigarette users among former smokers (daily or not daily) and current occasional smokers was similar.

As for the current e-cigarette use, the highest rate was found in former daily and current tobacco smokers without any statistically significant difference between smoking categories. There were no e-cigarette users among never-smokers (i.e., never smoked, only tried) (Table 2).

Table 3 shows that current smokers who use e-cigarettes consume marginally fewer cigarettes than do smokers who do not use e-cigarettes. However, the difference was statistically significant among males only.

The multivariate analysis showed that sex, age, residential area, occupation and smoking status were significantly associated with ever-use of e-cigarettes, while education was not. Females had a higher odds of being e-cigarette users, while a 1-year increase in age was associated with a 4 % reduction in the odds of ever having used e-cigarettes. Urban dwellers were 53 % more likely than their rural counterparts to have ever used e-cigarettes. Students and manual labourers had a lower (although not statistically significant so) odds of e-cigarette use. Compared to persons not actively engaged in an occupation, professionals were 49 % more likely to have ever used

**Table 1** Prevalence of tobacco and e-cigarette use among adult population according to socio-demographic characteristics in Serbia, 2014

	<i>n</i>	Current tobacco smoking ( <i>n</i> = 2164) % yes (95 % CI)	Ever e-cigarette use ( <i>n</i> = 517) % yes (95 % CI)	Current use of e-cigarette, ( <i>n</i> = 106) % yes (95 % CI)
Total	5385	40.2 (38.8–41.3)	9.6 (8.8–10.4)	2.0 (1.6–2.3)
Sex				
Male	2676	44.3 (42.1–45.7)	9.5 (8.4–10.6)	1.6 (1.1–2.1)
Female	2709	36.2 (34.4–38.0]	9.7 (8.6–10.8]	2.3 (1.8–2.9)
<i>p</i> *		<0.001	0.805	0.03
Age group, years				
18–24	693	34.7 (31.1–38.2)	12.3 (9.9–14.8)	1.6 (0.7–2.5)
25–34	1126	42.5 (39.6–45.4)	13.7 (11.7–15.7)	3.0 (2.0–4.0)
35–44	1111	44.7 (41.7–47.6)	12.3 (10.4–14.2)	3.0 (2.0–4.0)
45–54	1158	45.1 (42.2–48.0)	6.9 (5.8–8.4)	1.2 (0.5–1.8)
55–64	1297	32.9 (30.4– 35.5)	4.6 (3.5–5.6)	1.1 (0.6–1.7)
<i>p</i> *		<0.001	<0.001	<0.001
Education				
≤Elementary	1419	40.4 (37.5–43.2)	6.0 (4.8–7.3)	1.2 (0.6–1.8)
Secondary	2942	42.5 (40.8–44.2)	10.9 (9.8–12.0)	2.2 (1.7–2.7)
Post-secondary	1024	33.4 (30.5–36.3)	10.8 (8.9–12.7)	2.4 (1.4–3.3)
<i>p</i> *		<0.001	<0.001	0.018
Residential area				
Urban	3281	41.3 (39.6–43.0)	11.4 (10.3–12.5)	2.2 (1.7–2.7)
Rural	2105	38.4 (36.4–40.5)	6.8 (5.7–7.9)	1.6 (1.0–2.1)
<i>p</i> *		0.027	<0.001	.0177
Occupation				
Non-active	2321	38.7 (36.8–40.7)	7.8 (6.7–8.9)	1.7 (1.2–2.2)
Student	449	26.7 (22.6–30.8)	10.1 (7.3–12.9)	0.9 (0.4–1.8)
Manual labourer	1125	50.2 (47.2–53.1)	9.2 (7.5–10.9)	1.7 (0.9–2.4)
Administrative worker	679	39.0 (35.3–42.6)	13.2 (10.6–15.7)	2.7 (1.5–3.9)
Businessman	167	40.4 (32.9–48.0)	13.1 (7.9–18.3)	2.7 (0.2–5.2)
Intellectual	582	37.9 (34.0–42.0)	11.9 (9.3–14.5)	3.4 (1.9–3.9)
<i>p</i> *		<0.001	<0.001	0.008

Because respondents may be both tobacco smokers and e-cigarette users, they may be enumerated in multiple columns

\* All *p* values are from Chi-square tests

**Table 2** E-cigarette use according to tobacco smoking status among adults in Serbia, 2014

Smoking status	<i>n</i>	Ever e-cigarette use (%)	Current e-cigarette use (%)
Never-smoker	1914	0.3 <sub>a</sub>	0.0 <sup>A</sup>
Tried smoking but never smoked	338	2.9 <sub>b</sub>	0.0 <sup>A</sup>
Previously smoked but not on daily basis	231	5.1 <sub>b,c</sub>	1.3 <sub>a</sub>
Previously smoked on daily basis	762	9.4 <sub>c</sub>	3.9 <sub>a</sub>
Currently smoking occasionally	214	12.8 <sub>c,d,e</sub>	3.3 <sub>a</sub>
Currently smoking daily	1926	20.2 <sub>e</sub>	3.4 <sub>a</sub>
Chi-square tests		$\chi^2 = 467.38$ ; <i>df</i> = 5; <i>p</i> = 0.000	$\chi^2 = 84.23$ ; <i>df</i> = 5; <i>p</i> = 0.000

For each pair of smoking categories, proportions (for each row) are compared using a *z* test with significance level at 0.05, both for ever and current e-cigarette use. If a pair of values is significantly different, the values have different subscript letters assigned to them. Tests are adjusted for all pairwise comparisons within a column of each innermost subtable using the Bonferroni correction

<sup>A</sup> This category is not used in comparisons because its proportion is equal to zero or one

**Table 3** Mean (SD) number of cigarettes smoked daily among adult smokers according to current e-cigarette use in Serbia, 2014

	Current e-cigarette user		<i>M</i> diff (95 % CI)	<i>t</i>	<i>p</i>
	Yes	No			
Total	15.78 (7.33)	17.96 (9.82)	2.17 (0.2,4.4)	1.94	0.05
Male	16.41 (8.01)	20.37 (9.99)	3.96 (0.4,7.5)	2.20	0.03
Female	15.37 (6.90)	14.98 (8.74)	−0.39 (−2.9,2.2)	−0.30	0.77

**Table 4** Association of socio-demographic variables and smoking status with ever e-cigarette use among adults in Serbia, 2014

Correlate	<i>n</i>	Univariate analysis		Stepwise selection	
		OR <sub>crude</sub> (95 % CI)	<i>p</i> value	OR <sub>adj</sub> (95 % CI)	<i>p</i> value
<b>Sex</b>					
Male	2626	Ref		Ref	
Female	2758	1.02 (0.85–1.22)	0.829	1.25 (1.02–1.52)	0.032
Age	5384	0.97 (0.97–0.98)	0.001	0.96 (0.96–0.97)	<0.001
<b>Education</b>					
≤Elementary	735	Ref		dropped	
Secondary	3627	1.90 (1.49–2.44)	<0.001		
Post-secondary	1001	1.89 (1.41–2.54)	<0.001		
<b>Residential area</b>					
Rural	2111	Ref		Ref	
Urban	3273	1.75 (1.43–2.14)	<0.001	1.53 (1.23–1.91)	<0.001
<b>Occupation</b>					
Non-active	2163	Ref		Ref	
Student	652	1.33 (0.94–1.87)	0.104	0.84 (0.56–1.27)	0.417
Manual labourer	1066	1.20 (0.93–1.54)	0.163	0.95 (0.73–1.25)	0.729
Administrative worker	735	1.79 (1.37–2.34)	<0.001	1.43 (1.06–1.91)	0.018
Businessman	161	1.78 (1.11–2.86)	0.017	1.69 (1.01–2.84)	0.045
Professional	547	1.60 (1.19–2.14)	0.002	1.49 (1.08–2.05)	0.014
<b>Ever smoking status</b>					
Never	1971	Ref		Ref	
Ever	3413	52.89 (23.94–116.85)	<0.001	24.45 (10.77–55.49)	<0.001
<b>Current smoking status</b>					
Non-smoker <sup>a</sup>	3235	Ref		Ref	
Current smoker <sup>b</sup>	2149	8.39 (6.64–10.59)	<0.001	3.38 (2.63–4.34)	<0.001

<sup>a</sup> Did not smoke in the last 30 days

<sup>b</sup> Smoked occasionally or daily in the last 30 days

e-cigarettes. Smoking experience and smoking status were significantly associated with lifetime e-cigarette use, with smokers being three times more likely to be ever e-cigarette users (Table 4).

In the multivariate analysis, sex, age, occupation, and current smoking status were significantly associated with current e-cigarette use, while education, residential area and ever-smoking status were not (all current e-cigarette users were also ever-smokers). Females were 77 % more likely to be current e-cigarette smokers, and the association between current e-cigarette use and age was similar to the

finding for ever e-cigarette use. Professionals were twice as likely to be current e-cigarette users as non-active individuals. Current smokers were 60 % more likely to be current e-cigarette users than non-smokers (Table 5).

## Discussion

Since becoming available for purchase, e-cigarette use has increased considerably across countries (Etter and Bullen 2014). According to at least one author (Adkison et al.

**Table 5** Associations among socio-demographic characteristics, smoking status and current e-cigarette use among adults in Serbia, 2014

Correlate	<i>n</i>	Univariate OR <sub>crude</sub> (95 % CI)	Multivariate		
			<i>p</i> value	OR <sub>adj</sub> (95 % CI)	<i>p</i> value
Sex					
Male	2626	Ref		Ref	
Female	2758	1.46 (0.98–2.16)	0.058	1.77 (1.17–2.67)	0.007
Age	5384	0.98 (0.96–0.99)	0.008	0.97 (0.95–0.99)	<0.001
Education					
≤Elementary	735	Ref		Dropped	
Secondary	3627	1.85 (1.08–3.17)	0.022		
Post-secondary	1001	2.02 (1.08–3.77)	0.021		
Residential area					
Rural	3273	1		Dropped	
Urban	2111	1.44 (0.95–2.18)	0.087		
Occupation					
Non-active	2163	Ref		Ref	
Student	652	0.54 (0.20–1.50)	0.239	0.39 (0.14–1.15)	0.087
Manual labourer	1066	0.98 (0.56–1.71)	0.949	0.91 (0.51–1.61)	0.737
Administrative worker	735	1.59 (0.90, 2.79)	0.107	1.34 (0.76–2.38)	0.315
Businessman	161	1.61 (0.60–4.32)	0.346	1.71 (0.63–4.66)	0.297
Professional	547	2.05 (1.19–3.54)	0.010	2.03 (1.17–3.54)	0.012
Ever smoking status <sup>a</sup>					
Never	1971				
Ever	3413				
Current smoking status					
Non-smoker	3235	Ref		Ref	
Current smoker	2149	4.34 (2.80–6.72)	0.000	1.60 (1.03–2.50)	0.038

<sup>a</sup> All 106 current e-cigarette smokers were ever-smokers

2013), e-cigarettes are more common in countries where there are fewer or no restrictions. Early data on e-cigarette use originate from probability samples of adults in the Netherlands, Brazil, Mexico, China, Republic of Korea and Malaysia (Gravelly et al. 2014). Although relatively few countries have data on e-cigarette use in the general population, some comparisons are possible. In Serbia, the lifetime prevalence of e-cigarette use is lower than in the EU (9.6 % compared to 12 %). However, lifetime use of e-cigarettes in EU countries in 2015 varied from 8 % in Portugal to 21 % in Bulgaria. Countries with a prevalence of lifetime e-cigarette use similar to Serbia (approximately 9–10 %) include: Germany, Estonia, Hungary, Italy, Belgium, Lithuania, Netherlands, and Austria. The prevalence of current e-cigarette use in Serbia (2 %) is the same as the average among the 28 member states of the EU (EU28). The highest prevalence, 4 %, was reported in France and the United Kingdom (UK) (Special Eurobarometer 2015).

Due to the rapid increase in ENDS use, it is difficult to compare the prevalence across different countries across time. In a 2010 survey, lifetime e-cigarette use in the US

adult population was 3.4 % (Pearson et al. 2012), whereas in 2013 it was 8.5 % (King et al. 2015). Similarly, in the EU lifetime e-cigarette use increased from 7 % in 2012 (Special Eurobarometer 2012) to 12 % in 2015 (Special Eurobarometer 2015).

Similar to a 2012 survey conducted in the US (Zhu et al. 2013), females in this current study had a slightly higher prevalence of lifetime and current e-cigarette use than males. Suggestive that there may be local and regional differences in the sex distribution of e-cigarette use, other studies report that males were more likely than females to use e-cigarettes (Cho et al. 2011; Sutfin et al. 2013; Rahman et al. 2014).

Similar to the USA (Choi and Forster 2013), e-cigarette use was more prevalent at younger ages in Serbia. Shawna et al. (2014) also reported that in 2011, lifetime use was highest among adults age 20–28 years in the USA. These authors also reported an increase in the prevalence of e-cigarette use among adolescents in 2012 (Shawna et al. 2014). In a recent review, Rahman et al. (2014) reported that prevalence rates “increased significantly during the

third to fifth decades of life, and then declined” (pp. 3). In Europe the percentage of those who tried e-cigarettes, but did not use them anymore, was four times higher among 15–24 year-olds, compared to adults older than age 55 years (i.e., 13 % compared to 3 %).

In contrast to studies in the USA (McMillen et al. (2012) and elsewhere (Adkison et al. 2013; Pearson et al. 2012) educational status was not associated with lifetime or current e-cigarette use in this current study. However, in Serbia occupational status was an independent correlate, such that professionals were more likely to be ever and current e-cigarette users than those not currently employed.

Similar to Poland (Goniewicz and Zielinska-Danch 2012), people living in urban areas in this study had a higher prevalence of ever e-cigarette use, although the difference across residential area was not statistically significant. In contrast, Canadian students in rural areas had greater odds of e-cigarette use (Hamilton et al. 2015). Because there are few reports exploring urban versus rural differences, the association between e-cigarette use and residential area remains unclear.

Smoking status is related to e-cigarette use (Rahman et al. 2014), a finding that has been replicated across countries [i.e., in Canada (Czoli et al. 2014), the UK (ASH 2015), the USA (Pearson et al. 2012) and EU countries (Vardavas 2014)] including in this current study. Pearson et al. (2012) reported higher rates of e-cigarette use among current smokers than in the total population (11.4 % compared to 3.4 %) with 2.0 % of former smokers and 0.8 % of never-smokers ever using e-cigarettes. Moreover, the number of e-cigarette users is increasing among smokers. In 2010 in the UK, 8.2 % of current smokers had tried e-cigarettes. However, by 2014 this had risen to 50.6 %, while in the same year 1.1 % of never-smokers had tried e-cigarettes (ASH 2015). A recent study in England reported that the prevalence of current e-cigarette use among smokers is currently 18 % and has not increased since the third quarter of 2013 (West et al. 2014). Hajek et al. (2014) reviewed available research on e-cigarette use and also concluded that e-cigarette use is increasingly popular among smokers. They did not find any evidence of regular use among never-smokers (Hajek et al. 2014). This was supported by Rahman et al. (2014) who reported that in six of seven studies, e-cigarette use was more prevalent among smokers and former smokers.

An association between e-cigarette use and smoking status was reported in the EU (Vardavas 2014) where 20.3 % of current smokers, 4.7 % of ex-smokers, and 1.2 % of never cigarette smokers had ever used e-cigarettes. Ever e-cigarette use is more likely among smokers who smoke 6–10 or 11–20 cigarettes per day (in comparison to very light smokers who smoke less than five cigarettes per day).

Recent data from the EU (Special Eurobarometer 2015) show that in 2015, more current smokers than ex-smokers use ENDS (4 and 3 %, respectively). In our study, the highest percentage of current e-cigarette users was observed among people who have previously smoked daily, but are not current smokers. According to the Special Eurobarometer survey, as in Serbia, no current e-cigarette users could be found among adults who have never smoked in EU. However, evidence of ENDS use among non-smokers observed in Serbia, is also reported in the UK in 2012 (Dockrell et al. 2013) and in Canada (Czoli et al. 2014).

While a study in Great Britain reported that e-cigarette use was associated with number of cigarettes smoked (Brown et al. 2014), the current results do not support such a conclusion. Also, according to the current results, difference in cigarettes smoked per day among males who currently use e-cigarettes and males who do not, was not detected among female cigarette smokers. Future research should address motives for and patterns of use among females.

Limitations of this study include that its cross-sectional design limits causal inference. The low number of current e-cigarette users limited power and the absence of data on the frequency of e-cigarette use limited the interpretation of the data. Nevertheless, the current study is the first in Serbia to provide data on the prevalence and correlates of e-cigarette use. Further, this survey provides data prior to implementation of regulations or legislative measures pertaining to e-cigarettes, data which may be useful for researchers examining the impact of such regulations.

## Conclusion

Results from the current study suggest that the prevalence of current e-cigarette use in Serbia is comparable to that in other EU countries. Females, young adults and professionals were more likely to use e-cigarettes. E-cigarette use was more prevalent among ex- and current tobacco smokers, but it was rare among non-smokers. Because e-cigarette regulations do not yet exist and because of pervasive advertising, we expect that e-cigarette use will increase in Serbia. Strict regulation of the promotion and supply of e-cigarettes is needed. Standardised methodology for monitoring e-cigarette use in population surveys should be developed and the prevalence, patterns of use, motives for use and attitudes toward e-cigarette use should be monitored.

**Acknowledgments** The authors acknowledge Mr Harald Oechsler, researcher at the Centre for Interdisciplinary Addiction Research, University of Hamburg (ZIS) and Ms Minja Milovanovic, research psychologist at the Perinatal HIV research Unit, Faculty of Health Science in the University of the Witwatersrand, Johannesburg, South

Africa, for proof reading the manuscript. Data used for the analysis are from the National Survey on Lifestyles of Citizens of Serbia in 2014. The authors acknowledge the Institute of Public Health of Serbia which carried out the survey with the support of the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA)—within its European Union financed IPA project 2011/280 - 057 “Preparation of IPA Beneficiaries for their participation with the EMCDDA” and the Twinning project SR 10 IB JH 02 “Implementation of Strategy to Fight Against Drugs (supply and demand reduction components)”. This publication was supported by institutional support program of Charles University in Prague No. PRVOUK-P03/LF1/9 and the project “National Institute of Mental Health (NIMH-CZ) “Grant Number CZ.1.05/2.1.00/03.0078, and the European Regional Development Fund.

## References

- Adkison SE, O'Connor RJ, Bansal-Travers M, Hyland A, Borland R, Yong HH, Cummings KM, McNeill A, Thrasher JF, Hammond D, Fong GT (2013) Electronic nicotine delivery systems: international tobacco control four-country survey. *Am J Prev Med* 44(3):207–215. doi:10.1016/j.amepre.2012.10.018
- ASH (2015) Use of electronic cigarettes (vapourisers) among adults in Great Britain. [http://www.ash.org.uk/files/documents/ASH\\_891.pdf](http://www.ash.org.uk/files/documents/ASH_891.pdf). Accessed 26 Nov 2015
- Brown J, West R, Bread E, Michie S, Shahab L, McNeill A (2014) Prevalence and characteristics of e cigarette users in Great Britain: findings from a general population survey of smokers. *Addict Behav* 39(6):1120–1125. doi:10.1016/j.addbeh.2014.03.009
- Bunnell R, Agaku I, Arrazola RA, Apelberg BJ, Caraballo RS, Corey CG, Coleman BN, Dube SR, Kin BA (2015) Intentions to smoke cigarettes among never smoking US middle and high school electronic cigarette users: national youth tobacco survey, 2011–2013. *Nicotine Tob Res* 17(2):228–235. doi:10.1093/ntr/ntu166
- Cho HJ, Shin E, Moon SS (2011) Electronic cigarette smoking experience among adolescents. *J Adolesc Health* 49(5):542–546. doi:10.1016/j.jadohealth.2011.08.001
- Choi K, Forster J (2013) Characteristics associated with awareness, perceptions, and use of electronic nicotine delivery systems among young US midwestern adults. *Am J Prev Med* 103(3):556–561. doi:10.2105/AJPH.2012.300947
- Czoli CD, Hammond D, White CM (2014) Electronic cigarettes in Canada: prevalence of use and perceptions. *Can J Public Health* 105(2):97–102
- Dockrell M, Morison R, Bauld LL, McNeill A (2013) E-cigarettes: prevalence and attitudes in Great Britain. *Nicotine Tob Res* 15(10):1737–1744. doi:10.1093/ntr/ntt057
- EMCDDA (2002) Handbook for surveys on drug use among general population. [http://www.emcdda.europa.eu/attachements.cfm/att\\_58103\\_EN\\_Handbook%20for%20surveys%20on%20drug%20use%20among%20the%20general%20population%20-%202002.pdf](http://www.emcdda.europa.eu/attachements.cfm/att_58103_EN_Handbook%20for%20surveys%20on%20drug%20use%20among%20the%20general%20population%20-%202002.pdf). Accessed 1 Oct 2015
- Etter JF, Bullen C (2014) A longitudinal study of e cigarette users. *Addict Behav* 39(2):491–494. doi:10.1016/j.addbeh.2013.10.028
- Goniewicz M, Zielinska-Danch W (2012) Electronic cigarette use among teenagers and young adults in Poland. *Pediatrics* 130(4):4879–4885. doi:10.1542/peds.2011-3448
- Goniewicz M, Kuma T, Gawron M, Knysak J, Kosmider L (2013) Nicotine levels in electronic cigarettes. *Nicotine Tob Res* 15(1):158–166. doi:10.1093/ntr/nts103
- Grana RA (2013) Electronic cigarettes: a new nicotine gateway? *J Adolesc Health* 52(2):135–136. doi:10.1016/j.jadohealth.2012.11.007
- Gravelly S, Fong GT, Cummings MK et al (2014) Awareness, trial, and current use of electronic cigarettes in 10 countries: findings from the ITC project. *Int J Environ Heal R* 11(11):11691–11704. doi:10.3390/ijerph111111691
- Hadwiger ME, Trehy ML, Ye W, Moore T, Aligire J, Westenbergen B (2010) Identification of amino-tadalafil and rimonabant in electronic cigarette products using high pressure liquid chromatography with diode array and tandem mass spectrometric detection. *J Chromatogr A* 1217(48):7547–7555. doi:10.1016/j.chroma.2010.10.018
- Hajek P, Etter JF, Benowitz N, Eissenberg T, McRobbie H (2014) Electronic cigarettes: review of use, content, safety, effects on smokers and potential for harm and benefit. *Addiction* 109(11):1801–1810. doi:10.1111/add.12659
- Hamilton HA, Ferrence R, Boak A, Schwartz R, Mann RE, O'Connor S, Adlaf EM (2015) Ever use of nicotine and nonnicotine electronic cigarettes among high school students in Ontario, Canada. *Nicotine Tob Res* 17(10):1212–1218. doi:10.1093/ntr/ntu234 (Epub 2014 Oct 30)
- Institute of Public Health of Serbia (2014). Results of the national health survey of the Republic of Serbia 2013. <http://www.batut.org.rs/download/publikacije/2013SerbiaHealthSurvey.pdf>. Accessed 2 Oct 2015
- Kilibarda B, Mravcik V, Sieroslowski J, Gudelj Rakic J, Martens MS (2014). National survey on life styles of citizens in Serbia 2014—substance use and gambling. Institute of Public Health of Serbia. <http://www.batut.org.rs/download/publikacije/Izvestaj%20engleski%20web.pdf>. Accessed 2 Oct 2015
- King BA, Patel R, Nguyen KH, Dube SR (2015) Trends in awareness and use of electronic cigarettes among US adults, 2010–2013. *Nicotine Tob Res* 17(2):219–227. doi:10.1093/ntr/ntu191
- Kish L (1949) A procedure for objective respondent selection within the household. *J Am Stat Assoc* 44(247):380–387. doi:10.1080/01621459.1949.10483314
- Krstev S (2014). Global Youth Tobacco Survey in Serbia 2013. Institute of Public Health of Serbia. <http://www.batut.org.rs/download/publikacije/2014gytsSerbiaReport.pdf>. Accessed 2 Oct 2015
- McMillen R, Maduka J and Winickoff J (2012). Use of emerging tobacco products in the United States. *J Environ Public Healthvol.* 2012, Article ID 989474. doi:10.1155/2012/989474
- McRobbie H, Bullen C, Hartmann-Boyce J, Hajek P (2014) Electronic cigarettes for smoking cessation and reduction. *Cochrane Database Syst Rev*. doi:10.1002/14651858.CD010216
- Nathan K, Cobb M, Abrams DB (2011) E-cigarette or drug-delivery device? Regulating novel nicotine products. *N Engl J Med* 365:193–195. doi:10.1056/NEJMp1105249
- Noel K, Rees VW, Connolly GN (2011) Electronic cigarettes: a new “tobacco” industry? *Tob Control* 20(1):81. doi:10.1136/tc.2010.038562
- Official Gazette of the Republic of Serbia No 30/2010 (2015) Law on protection of citizens of exposure to tobacco smoke. <http://data.euro.who.int/tobacco/Sites/Legislation.aspx?legislatureID=157>. Accessed 10 Oct 2015
- Official Gazette of the Republic of Serbia No 92/2011 (2015) Law on the health safety of objects of common use. [http://www.paragraf.rs/propisi/zakon\\_o\\_zdravstvenoj\\_ispravnosti\\_predmeta\\_opste\\_upotrebe.html](http://www.paragraf.rs/propisi/zakon_o_zdravstvenoj_ispravnosti_predmeta_opste_upotrebe.html). Accessed 2 Oct 2015
- Official Gazette of the Republic of Serbia, No. 101/05, 90/07, 95/10, 36/11, 93/12, 8/13 и 108/13 (2015) Tobacco law. [http://duvan.gov.rs/en/documents/regulations/law\\_on\\_tobacco](http://duvan.gov.rs/en/documents/regulations/law_on_tobacco). Accessed 10 October 2015

- Official Journal of the European Union (2014). Directive 2014/40/EU of the European Parliament and of the Council. <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2014:127:FULL&from=EN>. Accessed 2 Oct 2015
- Pallazolo DL (2013) Electronic cigarettes and vaping: a new challenge in clinical medicine and public health. A Literature Review. *Front Public Health* 1:56. doi:10.3389/fpubh.2013.00056
- Pearson JL, Richardson A, Niaura RS, Vallone DM, Abrams DB (2012) E-cigarette awareness, use, and harm perceptions in US adults. *Am J Public Health* 102(9):1758–1766. doi:10.2105/AJPH.2011.300526
- Rahman MA, Hann N, Wilson A, Carter LW (2014) Electronic cigarettes: patterns of use, health effects, use in smoking cessation and regulatory issues. *Tob Induc Dis* 12:21. doi:10.1186/1617-9625-12-21
- Royal College of Physicians. (2014). What you need to know about electronic cigarettes. <https://www.rcplondon.ac.uk/commentary/what-you-need-know-about-electronic-cigarettes>. Accessed 2 Oct 2015
- Shawna L, Chapman C, Wu LT (2014) E-cigarette prevalence and correlates of use among adolescents versus adults: a review and comparison. *J Psychiatr Res* 54:43–54. doi:10.1016/j.jpsychires.2014.03.005
- Special Eurobarometer 385 (2012). Attitudes of Europeans towards tobacco. European Union. [http://ec.europa.eu/health/tobacco/docs/eurobaro\\_attitudes\\_towards\\_tobacco\\_2012\\_en.pdf](http://ec.europa.eu/health/tobacco/docs/eurobaro_attitudes_towards_tobacco_2012_en.pdf). Accessed 2 Oct 2015
- Special Eurobarometer 429 (2015). Attitudes of Europeans towards tobacco and electronic cigarettes. European Union. [http://ec.europa.eu/public\\_opinion/archives/ebs/ebs\\_429\\_en.pdf](http://ec.europa.eu/public_opinion/archives/ebs/ebs_429_en.pdf). Accessed 2 Oct 2015
- Sutfin LE, McCoy TP, Morrell HER, Hoepfner BB, Wolfson M (2013) Electronic cigarette use by college students. *Drug Alcohol Depend* 131(3):214–221. doi:10.1016/j.drugalcdep.2013.05.001
- Trtchounian A, Talbot P (2011) Electronic nicotine delivery systems: is there a need for regulation? *Tob Control* 20:47–52. doi:10.1136/tc.2010.037259
- Vardavas, CI, Fillipidis F, Agaku IT (2014) Determinants and prevalence of e-cigarette use throughout the European Union: a secondary analysis of 26 566 youth and adults from 27 countries. *Tob Control tobaccocontrol-2013-051394*, Published Online. doi: 10.1136/tobaccocontrol-2013-051394
- West R, Hajek P, McNeill A. (2014). Electronic cigarettes: what we know so far. A report to UK all party parliamentary groups
- WHO Study Group on Tobacco Product Regulation (2014). Report on e-cigarettes to WHO Framework Convention on Tobacco Control. [http://apps.who.int/gb/fctc/PDF/cop6/FCTC\\_COP6\\_10-en.pdf?ua=1](http://apps.who.int/gb/fctc/PDF/cop6/FCTC_COP6_10-en.pdf?ua=1). Accessed 2 Oct 2015
- Zhu SH, Gamst A, Lee M, Sharon C, Yin L, Zoref L (2013) The use and perception of electronic cigarettes and snus among the US population. *PLoS One* 8(10):e79332. doi:10.1371/journal.pone.0079332