

# BMJ Open Electronic cigarette use among adult population: a cross-sectional study in Barcelona, Spain (2013–2014)

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## ABSTRACT

**Objective:** This study seeks to analyse the prevalence and correlates of electronic cigarette (e-cigarette) use, purchase location and satisfaction with its use in a sample of the general population of the city of Barcelona, Spain.

**Design, setting and participants:** We used participants from a longitudinal study of a representative sample of the adult ( $\geq 16$  years old) population of Barcelona (336 men and 400 women). The field work was conducted between May 2013 and February 2014. We computed the prevalence, adjusted odds ratios (ORs) and their corresponding 95% confidence interval (CI).

**Results:** The prevalence of ever e-cigarette use was 6.5% (95% CI 4.7% to 8.3%): 1.6% current use, 2.2% past use and 2.7% only e-cigarette experimentation. 75% (95% CI 62.8% to 87.3%) of ever e-cigarette users were current cigarette smokers at the moment of the interview. E-cigarette use was more likely among current smokers (OR=54.57; 95% CI 7.33 to 406.38) and highly dependent cigarette smokers (OR=3.96; 95% CI 1.60 to 9.82). 62.5% of the ever users charged their e-cigarettes with nicotine with 70% of them obtaining the liquids with nicotine in a specialised shop. 39.6% of ever e-cigarette users were not satisfied with their use, a similar percentage of not satisfied expressing the smokers (38.9%) and there were no statistically significant differences in the satisfaction between the users of e-cigarettes with and without nicotine.

**Conclusions:** E-cigarette use is strongly associated with current smoking (dual use) and most users continue to be addicted to nicotine. Six out of 10 e-cigarette users preferred devices that deliver nicotine. The satisfaction with e-cigarette use is very low.

## INTRODUCTION

The electronic cigarette, also called ‘e-cigarette’ or electronic nicotine delivery system, is an electronic device commonly shaped like a cigarette. There are also devices resembling cigars or pipes.

## Strengths and limitations of this study

- Scientific evidence concerning e-cigarettes is still very limited, particularly in Europe.
- This is the first study to estimate the correlates of use of e-cigarettes in a representative sample of the general adult population in a Mediterranean city.
- The main limitation of our study is attrition of the cohort used, which could lead to a possible no participation bias.
- This is a cross-sectional study and it is only possible to assess associations, but not causal relationships.
- This is the first study that used a face-to-face questionnaire with trained interviewers to assess e-cigarette use in a representative sample of the general population, thus potentially increasing the internal validity of our results.

Regardless of their shape, they are designed to vapourise a mixture of nicotine, propylene glycol and other chemicals that heat the vapour via a battery activated by puffing, but contain no actual tobacco.<sup>1 2</sup> The device can also vapourise a mixture that does not contain nicotine. Interest in e-cigarettes has been growing recently among smokers, manufacturers, including leading tobacco companies, and also among tobacco control researchers and the public health community in general, who are concerned with their potential risks and cautiously optimistic about their potential benefits.<sup>2</sup> Interest in e-cigarettes, as measured by internet searches, exceeded that of snus or nicotine replacement therapies.<sup>3</sup>

Initially, e-cigarettes were primarily obtained through internet sources. Specialty shops and varieties of brands have grown rapidly in recent years in several developed countries. General awareness of e-cigarettes has doubled in just 1 year in the USA.<sup>4</sup> However, scientific evidence concerning



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e-cigarettes is still very limited, including valid estimates of the prevalence of e-cigarette use among the general population, particularly in Europe. Moreover, to our knowledge, there is a lack of information on specific characteristics of use, such as the location of purchase, use of liquids containing nicotine and the satisfaction with this product among users. These issues are especially relevant to characterise the use of this new product in order to implement future regulations.

The objective of this study is to estimate the prevalence and analyse the correlates of current and ever use of e-cigarettes, including purchase location and satisfaction with its use, in a sample of the general population of the city of Barcelona (Spain) in 2013 and 2014.

## METHODS

The Determinants of Cotinine phase 3 project (dCOT3, website: <http://bioinfo.iconcologia.net/es/content/estudio-dcot3>) is a longitudinal study of a representative sample of the adult ( $\geq 16$  years old) non-institutionalised population of the city of Barcelona (Spain;  $n=1245$ , 694 women and 551 men). The theoretical baseline sample size was 1291 individuals, assuming an expected smoking prevalence of 30% (with an  $\alpha$  error of 5% and a precision of 2.5%), which was the estimated percentage of smokers in Spain when the baseline survey was conducted. The baseline survey was conducted in 2004–2005 and its detailed design has been provided elsewhere.<sup>5 6</sup> We followed up all the adult participants who responded to a face-to-face questionnaire in 2004–2005 and agreed to participate in future studies. At the beginning of 2013, we did a linkage with the Insured Central Registry of Catalonia in order to update the vital status and contact information (addresses and telephone numbers) of all participants. We restricted the follow-up to the participants who continued to live in the city of Barcelona and their province.

We traced 1010 people out of the 1245 participants in the baseline study using the Insured Central Registry (101 have died, 49 migrated out of the province of Barcelona and 85 did not give consent to be followed or were  $< 18$  years old in 2004–2005). In February 2013, we sent them a letter stating the primary findings of the 2004–2005 study and informed them that an interviewer would go to their home to administer another face-to-face questionnaire. The follow-up survey was conducted between May 2013 and February of 2014. In total, 72.9% agreed to participate and responded to the questionnaire, 18.5% refused to participate in the follow-up, 7.2% had moved elsewhere and 1.3% had died. The final sample analysed was 736 individuals (336 men and 400 women). Although there were no statistically significant differences between the followed up sample and the participants lost according to age, sex, level of education and smoking status, the final sample skewed as slighter older (data not shown).

Data on current use, ever use and experimentation with e-cigarettes were obtained using the question (as translated from Spanish): “Have you ever used e-cigarettes?” The answers to this question were: “yes, currently”; “yes, in the past”; “I have only experimented with e-cigarettes”; and “I have never used e-cigarettes.” We also included two questions about the use of e-cigarettes with or without nicotine using the question: “Do/did you use the electronic cigarettes with nicotine?” (yes/no) and the places where the nicotine was obtained (internet, specialised shop or other countries). Finally, we asked ever e-cigarette users about their satisfaction with e-cigarettes using the question: “How satisfied are you with the use of the electronic cigarette?” The possible answers for this question were: “totally satisfied”; “quite satisfied”; “somewhat satisfied” and “not satisfied” (recoded as “totally and quite satisfied,” “somewhat” and “not satisfied”). We calculated the prevalence and the adjusted odds ratios (ORs) with 95% confidence intervals (CIs) by sex, age and educational level. All analyses were stratified by sex; groups of age ( $\leq 44$ , 45–64 and  $\geq 65$  years old); educational level—categorised as low (no qualification up to middle school diploma), intermediate (high school) and high (university degree); cigarette smoking status (current smokers as participants who smoked cigarettes either daily (at least one cigarette/day) or occasionally (less than one cigarette/day) at the moment of the survey, former smokers as participant who did not smoke cigarettes at the moment of the survey but had smoked cigarettes in the past and never-smokers as participants who have never smoked cigarettes); and level of nicotine dependence measured with the Fagerström test for cigarette dependence (FTCD)<sup>7</sup> for current cigarette smokers, and categorised into low-medium dependence for scores between 0 and 5 and high dependence for scores between 6 and 10.

## RESULTS

The prevalence of smokers of manufactured cigarettes was 23.3% (95% CI 20.2% to 26.3%) and the prevalence of ever e-cigarette use was 6.5% (95% CI 4.7% to 8.3%). Smokers of manufactured cigarettes had a mean age of 49.4 years, 53.8% were men and 47.9% had intermediate educational level. The e-cigarette users had a mean age of 45.1 years, 56.2% were men and 58.3% had intermediate educational level. There were no statistically significant differences according to demographic characteristics (sex, age, and level of education) between smokers of manufactured cigarettes and e-cigarette users. In total, 75% of e-cigarette users were smokers, 22.9% were former smokers and 2.1% were never-smokers at the time of the interview. The prevalence of ever e-cigarette use was higher among men (8%), younger people ( $\leq 44$  years old, 13.1%) and people with intermediate educational level (9.8%, OR=1.42, 95% CI 0.50 to 4.04). There was a statistically

significant association between ever e-cigarette use and current smoking (OR=54.57, 95% CI 7.33 to 406.38). Also, the highest prevalence (46.4%) of ever e-cigarette use was among current smokers with a high cigarette dependence score (table 1).

In total, 62.5% of ever e-cigarette users (95% CI 48.8% to 76.2%) used them with nicotine and 70% (95% CI 53.6% to 86.4%) indicated they obtained the liquid with nicotine in a specialty shop, while 3.3% (95% CI 0.6% to 16.7%) indicated that they obtained it on the internet. There were no statistically significant differences according to sex, age, educational level and smoking status regarding the use of e-cigarettes with nicotine or not (table 1), and the places where they obtained the liquid with nicotine (data not shown). Among ever e-cigarette users, 18.8% (95% CI 7.7% to 29.9%) were totally or quite satisfied with their use and 39.6% (95% CI 25.8% to 53.4%) were not satisfied. The percentage of not satisfied users was 38.9% among current smokers, 30.8% among smokers with high cigarette dependence score (table 1). There were no statistically significant differences in the satisfaction with e-cigarettes according to use of liquids with and without nicotine (not satisfied: 40% vs 38.9%; OR=0.53, 95% CI 0.11 to 2.49).

Table 2 shows the prevalence rates of current use, past use and only experimentation with e-cigarettes. In total,

1.6% were current users, 2.2% past users and 2.7% had only experimented with e-cigarettes. There were no statistically significant differences among current e-cigarette users according to sex, age and educational level. Finally, the prevalence of current use was higher among current smokers (dual users) and among current smokers with high cigarette dependence score (5.3% and 14.3%, respectively).

## DISCUSSION

This is the first study to estimate the use of e-cigarettes in a representative sample of the general adult population in a Mediterranean city. The prevalence of ever e-cigarette use was 6.5% (1.6% current use, 2.2% past use and 2.7% only e-cigarette experimentation) and the predominant ever and current e-cigarette use was among current smokers (75% of ever e-cigarette users were current smokers). Similar results were found for the general population in Europe according to the Eurobarometer survey conducted in 2012<sup>8</sup> and also in the USA<sup>9</sup> according to a study conducted in 2010–2011. Surprisingly, our prevalence of ever use is lower to what we would expect, considering the increase of marketing and popularity of e-cigarettes in recent years. This low prevalence could be due to a potential delay in the general marketing of e-cigarettes in Spain as compared

**Table 1** Prevalence of ever e-cigarette use, percentage of users of e-cigarettes with cotinine, and percentage of satisfaction with e-cigarettes according to sex, age, educational level, smoking status and FTCD in Barcelona, Spain (2013–14).

	n	Ever e-cigarette users		n	Ever use of e-cigarettes with nicotine		Satisfaction with the usage of e-cigarettes (not satisfied)	
		%	OR* (95% CI)		%†	OR* (95% CI)	%†	OR* (95% CI)
Overall	736	6.5		48	62.5		39.6	
Sex								
Men	336	8.0	1	27	51.9	1	44.4	1
Women	400	5.3	0.69 (0.38 to 1.27)	21	76.2	2.66 (0.62 to 11.32)	33.3	0.49 (0.11 to 2.26)
Age (years)								
≤44	198	13.1	1	26	73.1	1	30.8	1
45–64	267	6.7	0.39 (0.20 to 0.75)	18	44.4	0.32 (0.08 to 1.28)	55.6	3.21 (0.78 to 13.13)
≥65	271	1.5	0.08 (0.02 to 0.24)	4	75.0	1.49 (0.13 to 17.48)	25.0	0.73 (0.05 to 10.84)
Educational level								
Low	161	3.1	1	5	60.0	1	0.0	–
Intermediate	287	9.8	1.42 (0.50 to 4.04)	28	53.6	1.56 (0.18 to 13.05)	42.9	1
High	288	5.2	0.49 (0.16 to 1.53)	15	80.0	2.64 (0.27 to 26.15)	46.7	2.41 (0.48 to 12.15)
Smoking status								
Never-smoker	298	0.3	1	1	0.0	–	0.0	–
Former smoker	267	4.1	13.19 (1.68 to 103.82)	11	54.5	1	45.5	1
Current smoker	171	21.1	54.57 (7.33 to 406.38)	36	66.7	1.22 (0.21 to 6.92)	38.9	1.30 (0.28 to 5.96)
FTCD								
Low-Medium (0–5)	143	16.1	1	23	60.9	1	43.5	1
High (6–10)	28	46.4	3.96 (1.60 to 9.82)	13	76.9	5.86 (0.73 to 46.77)	30.8	0.14 (0.01 to 1.42)

\*Adjusted ORs for sex, age and educational level.

†Prevalence among ever e-cigarette users.

FTCD, Fagerström test for cigarette dependence.

OR, odds ratio; CI, confidence intervals.

**Table 2** Prevalence of current use, past use and experimentation with e-cigarettes according to sex, age, educational level, smoking status and FTCD in Barcelona, Spain (2013–14).

	n	Current e-cigarette use % (95% CI)	Past e-cigarette use % (95% CI)	Experimentation with e-cigarettes % (95% CI)
Overall	736	1.6 (0.7 to 2.5)	2.2 (1.1 to 3.3)	2.7 (1.5 to 3.9)
Sex				
Men	336	1.8 (0.4 to 3.2)	3.3 (1.4 to 5.2)	3.0 (1.2 to 4.8)
Women	400	1.5 (0.3 to 2.7)	1.3 (0.2 to 2.4)	2.5 (1.0 to 4.0)
Age (years)				
≤44	198	2.0 (0.0 to 4.0)	5.1 (2.0 to 8.2)	6.1 (2.8 to 9.4)
45–64	267	1.9 (0.3 to 3.5)	1.9 (0.3 to 3.5)	3.0 (1.0 to 5.0)
≥65	271	1.1 (0.4 to 3.2)	0.4 (0.1 to 2.1)	0.0 (0.0 to 1.4)
Educational level				
Low	161	1.2 (0.3 to 4.4)	0.0 (0.0 to 2.3)	1.9 (0.6 to 5.3)
Intermediate	287	2.4 (0.6 to 4.2)	4.5 (2.1 to 6.9)	2.8 (0.9 to 4.7)
High	288	1.0 (0.4 to 3.0)	1.0 (0.4 to 3.0)	3.1 (1.1 to 5.1)
Smoking status				
Never-smoker	298	0.3 (1.6 to 5.6)	0.0 (0.0 to 1.3)	0.0 (0.0 to 1.3)
Former smoker	267	0.7 (0.2 to 2.7)	1.1 (0.4 to 3.3)	2.2 (0.4 to 4.0)
Current smoker	171	5.3 (1.9 to 8.7)	7.6 (3.6 to 11.6)	8.2 (4.1 to 12.3)
FTCD				
Low-Medium (0–5)	143	3.5 (0.5 to 6.5)	5.6 (1.8 to 9.4)	7 (2.8 to 11.2)
High (6–10)	28	14.3 (1.3 to 27.3)	17.9 (3.7 to 32.1)	14.3 (1.3 to 27.3)

CI, confidence intervals; FTCD, Fagerström test for cigarette dependence.

with other countries, as well as the quick reaction of the tobacco control community and public health authorities to apply the precautionary principle in Spain.<sup>10</sup> We also found that 62.5% of the ever e-cigarette users preferred liquids with nicotine and specialty shops were the places where they most frequently bought these liquids (70%).

One study conducted among young Swiss men showed lower prevalence of ever e-cigarette use in the past 12 months than in our study (4.9%).<sup>11</sup> A study conducted among teenagers from Poland (between 15 and 24 years old) showed that 6.9% of them reported experimenting with e-cigarettes in the previous 30 days<sup>12</sup> while we found 13.1% of ever e-cigarette use among young people (≤44 years old). Another study conducted in the UK, using telephone interviews among current and former smokers,<sup>13</sup> showed that 4% were current e-cigarette users and, among those who were aware of e-cigarettes, 17.7% had tried e-cigarettes, which is slightly lower than in our study (5.3% and 21.1%, respectively). However, the differences in the questions used to measure the prevalence of e-cigarette use make the comparison among studies difficult.

Currently, there is an intense debate in the tobacco control community about the usefulness of e-cigarettes as a new strategy to quit or reduce tobacco consumption and its potential harmful health effects.<sup>14–22</sup> The only clinical trial published to date<sup>23</sup> showed that 7.3% of those who used e-cigarettes with nicotine to quit smoking were still abstinent at 6 months, compared with 5.8% who used nicotine patches and to 4.1% who used e-cigarettes

without nicotine, although no statistically significant differences were found. Two longitudinal studies<sup>24 25</sup> also found that e-cigarettes may contribute to preventing relapse in former smokers and to promote smoking cessation in current smokers. Other studies<sup>4 9 26</sup> suggest that there is a high percentage of e-cigarette users concurrently using conventional tobacco. However, the evidence is still scarce according to recent reviews of the scientific literature.<sup>27 28</sup> According to our data, we likewise found a high percentage (75%) of current e-cigarette users exhibiting dual use patterns with conventional tobacco. Moreover, we surprisingly found a very low percentage of ever e-cigarette users quite or totally satisfied with their use (18.8%), particularly among current smokers and smokers with a high score in the FTCD (13.9% and 7.7%, respectively). Our hypothesis is that these highly nicotine-dependent smokers tried e-cigarettes for smoking cessation or to reduce cigarette use, but they continued smoking or relapsed in a short time. In addition, we found no differences in the satisfaction according to the use of the e-cigarettes with or without nicotine. More longitudinal and qualitative studies are needed to confirm this hypothesis.

Some studies suggest that e-cigarettes could be another way to create new nicotine addicts,<sup>29 30</sup> particularly among young people, who may graduate to conventional tobacco products over time. Moreover, the current advertisements and messages about e-cigarettes in the media and the social networks, such as twitter, could increase the experimentation, particularly among the young and middle aged population.<sup>31–33</sup> The results of

our study show that 62.5% of ever e-cigarette users preferred e-cigarettes with nicotine, and a considerable percentage of them were young people. However, the percentage of never-smokers who had ever used the e-cigarettes is very low (0.3%) and its use was without nicotine. However, this result should be taken with caution because of the small sample size in this category.

The main limitation of our study is the potential of participation bias due to the attrition of the cohort of participants. Although there are no statistically significant differences between the people who were followed up and those lost from the original study according to sex, age and educational level, our final sample overestimated the older people compared with the distribution of population in Barcelona. For this reason, the prevalence of e-cigarette use might be underestimated in our study because young people, particularly younger smokers, are those who most used e-cigarettes. Moreover, we conducted the study only in the city of Barcelona and the validity to infer the results to the rest of Spain could be limited. Nevertheless, the baseline sample size was representative of the city of Barcelona<sup>5 6</sup> and the final sample size for this analysis was sufficient to estimate the prevalence of e-cigarette users, due to the relatively lower prevalence of ever e-cigarette use in the general population.<sup>8 9</sup> According to an expected prevalence of ever e-cigarette use of 10%, the sample size would be 554 individuals, with an  $\alpha$  error of 5% and a precision of 2.5%. Another potential limitation is the use of a questionnaire to collect self-reported information on e-cigarette use that could be an inherent source of bias. However, this is the first study, to our knowledge, that used a face-to-face questionnaire with trained interviewers to assess e-cigarette use in a representative sample of the general population, thus potentially increasing the internal validity of our results as compared with internet and other self-administered surveys.<sup>9 26</sup> Additionally, our results could slightly underestimate the real prevalence of use, because we only included the term 'e-cigarette' in the questionnaire, and there are other terms associated to new products in the market. However, this effect may be limited, because the term 'e-cigarettes' is the most popular in Spain, and products such as 'hookah pens' or 'vape pens' are scantily marketed. Finally, this is a cross-sectional study and it is only possible to assess associations and not causal relationships.

In conclusion, 6.5% of the adult general populations in Barcelona (Spain) are ever e-cigarette users, and 6 out of 10 of them used devices that deliver nicotine. According to evidence from other countries, this figure could double in coming years among the general population<sup>9</sup> as well as in the adolescent and student populations.<sup>29 34</sup> Furthermore, our results show that current and ever e-cigarette use was predominant among current smokers, indicating a dual use pattern, and that there were very low levels of satisfaction with e-cigarettes. More investigation is needed on dual use (e-cigarettes and conventional tobacco) and on users' satisfaction

with e-cigarette devices, as well as on the effectiveness of e-cigarettes for smoking cessation and their benefit–risk balance.

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