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Electronic cigarettes use among the adult population: a cross-sectional study in Barcelona, Spain (2013-14)

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Abstract

Objective: This study seeks to analyze the prevalence and correlates of e-cigarette use in a sample of the general population of the city of Barcelona, Spain.

Design, setting, and participants: We used the follow-up data of a longitudinal study of a representative sample of the adult (≥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 (OR), and their corresponding 95% confidence interval (CI).

Results: The prevalence of ever e-cigarettes use was 6.5% (95%CI: 4.7-8.3): 1.6% current, 2.2% past, and 2.7% only trial. 75% (95%CI: 62.8-87.3) of ever e-cigarettes users were current smokers at the moment of the interview. E-cigarette use was more likely among current smokers (OR: 13.19; 95%CI: 1.68-103.82) and highly dependent cigarette smokers (OR: 3.96; 95%CI: 1.60-9.82). 62.5% of the ever users charged their e-cigarettes with nicotine with 70% of them obtaining the liquids with nicotine in a specialized shop. 18.8% of ever e-cigarette users were totally or quite satisfied with their use, with current smokers expressing less satisfaction (13.9%) and smokers with high cigarette dependence having the lowest rate of satisfaction with e-cigarettes (7.7%).

Conclusions: E-cigarette use is strongly associated with current smoking (dual use) and most users continue to be addicted to nicotine. 6 out of 10 e-cigarette users used devices that deliver nicotine. Moreover, the satisfaction with e-cigarette use is very low.

Key words: electronic cigarettes; e-cigarettes; electronic nicotine delivery system (ENDS); prevalence study; dual use

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 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 in the follow-up. Also, this is a cross-sectional study and it is only possible to assess associations, but no 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.

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. Regardless of their shape, they are designed to vaporizes a mixture of nicotine, propylene glycol and other chemicals that heats the vapor via a battery activated by puffing, but contain no actual tobacco.[1, 2] The device can also vaporize a mixture that does not contain nicotine. Interest in e-cigarettes has been growing recently among smokers, manufacturers, including leading cigarette companies, and also among tobacco control researchers who are concerned with their potential benefits for harm reduction as well as their various risks.[2] Interest in e-cigarettes, as measured by internet searches, exceeded that of snus or nicotine replacement therapies.[3]

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 one year.[4] However, scientific evidence concerning e-cigarettes is still very limited, including valid estimates of the prevalence of e-cigarette use among the general population, particularly in Europe.

The objective of this study is to estimate the prevalence and analyze the correlates of current and ever-use of e-cigarettes 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 (≥16 years old) non-institutionalized population of the city of Barcelona (Spain) (n=1245, 694 women and 551 men). The baseline survey was conducted in 2004-2005 and its detailed design has been provided elsewhere.[5, 6] We followed-up all the adult participants who responded to a face-to-face questionnaire in 2004-2005 and agreed to participate in a future study. The research and ethics committee of the Bellvitge University Hospital provided ethical approval for the study protocol. At the beginning of 2013, we did a linkage with the Insured Central Registry of Catalonia (Registro Central de Asegurados, RCA) in order to update the vital status and contact information (address and telephone number) 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 1,010 people out of the 1,245 participants in the baseline study using the RCA (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 2004-05 study and informed all participants 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. 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 analyzed was 736 individuals (336 men and 400 women). Although there were not statistically significant differences between the followed-up

sample and the participants lost according to sex, level of education, and smoking status, the final sample overestimated the older people (data not shown).

Current use, ever-use, and trial use of e-cigarette data was 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 tested e-cigarettes”, and “I have never used e-cigarettes”. We also included two questions about the use of e-cigarettes with or without nicotine and the places where the nicotine was obtained (internet, specialized 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” (dichotomized as “totally and quite satisfied” and “somewhat and not satisfied”). We calculated the prevalence and the adjusted odds ratios (OR) by sex, age, and level of education with 95% confidence intervals (CI). All analyses were stratified by sex, group of age (≤44 years old, 45-64 years old, and ≥65 years old), level of education -categorized as low (no qualification up to middle school diploma), intermediate (high school), and high (university degree)-, cigarette smoking status (current smokers, former smokers, and never smokers), and level of nicotine dependence measured with the Fagerström test for cigarette dependence (FTND)[7] for current cigarette smokers, and categorized into low-medium dependence for scores between 0 and 5 and high dependence for scores between 6 and 10.

Results

The prevalence of ever e-cigarette use was 6.5% (95%CI: 4.7-8.3). 75% of e-cigarettes 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 (8.0%; OR: 1.44, 95%CI: 0.78 – 2.66), younger people (≤44 years old, 13.1%; OR: 13.22, 95%CI: 4.18 – 41.81), and people with intermediate educational level (9.8%, OR: 1.42, 95%CI: 0.50 – 4.04). There was a statistically significant association between ever e-cigarette use and current smoking (OR=13.19, 95%CI: 1.68-103.82). Also, the highest prevalence (46.4%) of ever e-cigarette users was among current smokers with a high cigarette dependence score (table 1).

62.5% of the ever-users (95%CI: 48.8-76.2) used e-cigarettes with nicotine and 70% of them (95%CI: 53.6-86.4) indicated that they obtained the liquid with nicotine in a specialty shop, while 3.3% (95%CI: 0.6-16.7) indicated that they obtained it on the Internet. There were not statistically significant differences according to sex, age, level of education, 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 the ever e-cigarette users, 18.8% (95%CI: 7.7-29.9) were totally or quite satisfied with their use. The lowest percentages of satisfaction were found among current smokers (13.9%) and smokers with a high cigarette dependence score (7.7%) (table 1).

Table 2 shows the prevalence of current, past, and only trial e-cigarettes users. 1.6% were current users, 2.2% past users, and 2.7% had only tried it. There were no statistically significant differences among current e-cigarette users according to sex, age, and educational level. Finally, the prevalence of current users was higher among current smokers (dual users) and among current smokers with a 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-cigarettes use was 6.5% (1.6% current use, 2.2% past use, and 2.7% only trial use) and the predominantly ever and current e-cigarette users were among current smokers (75% of ever e-cigarette users were current smokers). Similar results were found in Europe according to Eurobarometer survey (7%)[8] and in the United States (6.2%)[9] according to a study conducted in general population. We also found that 62.5% of the ever e-cigarette users use the device with nicotine and specialty shops are where they most frequently buy the nicotine mixture (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%).[10] A study conducted among teenagers from Poland (between 15-24 years old) showed that 6.9% of them used e-cigarettes in the previous 30 days[11] while we found 13.1% of ever e-cigarettes users among young people (≤44 years old). Another study conducted in the United Kingdom using telephone interviews among current and former smokers, [12] showed that 4% were current e-cigarettes users and, among those 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 users make comparing the 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.[13-21] The only clinical trial published to date[22] showed that 7.3% of those who used e-cigarettes with nicotine to quit smoking were still abstinent at 6 months, compared to 5.8% who used nicotine patches and to 4.1%

who used e-cigarettes without nicotine, although no statistically significant differences were found. However, other studies[4, 9, 23] suggest that there is high percentage of e-cigarette users concurrently using conventional tobacco. 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 e-cigarette use (18.8%), particularly among current smokers and smokers with a high score in the FTND (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 continued smoking or relapsed in a short time. 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,[24, 25] particularly among young people, who may graduate to conventional tobacco products over time. The results of our study show that 62.5% of e-cigarette ever-users consumed nicotine e-cigarettes 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 attrition of the cohort in the follow-up. Although there are not statistically significant differences between the people who followed-up and those lost from the original study according to sex, educational level, and smoking status, our final sample overestimated the older people compared with the distribution of population in Barcelona. For this reason, the prevalence of e-cigarette users might be underestimated in our study because young people, particularly younger smokers, are those who most used e-cigarette devices. 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. Also, this is a cross-sectional study and it is only possible to assess associations, but no causal relationships.

In conclusion, 6.5% of the adult general populations in Barcelona (Spain) are ever e-cigarettes users and 6 out of 10 of them used devices that deliver nicotine. According to some studies conducted in United States, this figure could double in the coming years among the general population,[9] as well as the adolescent and student populations.[24, 26] Furthermore, our results show that current and ever e-cigarette use was predominantly among current smokers, indicating dual use behaviors, and that users indicated a very low level of satisfaction with e-cigarettes. More investigation is needed on dual use (e-cigarettes and conventional tobacco) and the users' satisfaction with e-cigarette devices as well as the effectiveness of e-cigarettes for smoking cessation and their risk-benefit balance.

AUTHOR CONTRIBUTIONS

JMMS and EF conceived the study. MB, MF, EF, ES and JMMS contributed in the design and coordination of the study. JCMS analyzed the data. JMMS drafted the first manuscript. All authors contributed substantially to the interpretation of the data and the successive versions of the manuscript. All authors contributed to the manuscript and approved its final version. JMMS is the principal investigator of the project.

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COMPETING INTERESTS

None declared.

ETHICAL APPROVAL

The research and ethics committee of the Bellvitge University Hospital provided ethical approval for the study protocol.

DATA SHARING

No additional data are available.

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Table 1. Prevalence of ever e-cigarette users and percentage of users with cotinine and their satisfaction according to sex, age, educational level, smoking status, and FTND. Barcelona, Spain (2013-14).

	Ever e-cigarette users			Ever e-cigarette use with nicotine			Satisfaction with the usage of e-cigarettes (totally and quite satisfied)	
	N	%	OR* (95%CI)	n	%**	OR* (95%CI)	%**	OR* (95%CI)
Overall	736	6.5		48	62.5		18.8	
Sex								
Men	336	8.0	1.44 (0.78 - 2.66)	27	51.9	1	14.8	1
Women	400	5.3	1	21	76.2	2.66 (0.62 - 11.32)	23.8	3.01 (0.55 - 16.57)
Age								
≤44 years old	198	13.1	13.22 (4.18 - 41.81)	26	73.1	3.09 (0.78 - 12.17)	19.2	1.54 (0.28 - 8.39)
45-64 years old	267	6.7	5.12 (1.64 - 16.00)	18	44.4	1	16.7	1
≥ 65 years old	271	1.5	1	4	75.0	4.59 (0.37 - 57.49)	25.0	2.50 (0.15 - 40.23)
Educational level								
Low	161	3.1	1	5	60.0	0.64 (0.08 - 5.39)	20.0	1.71 (0.10 - 28.09)
Intermediate	287	9.8	1.42 (0.50 - 4.04)	28	53.6	1	21.4	3.45 (0.44 - 26.77)
High	288	5.2	0.49 (0.16 - 1.53)	15	80.0	1.70 (0.31 - 9.13)	13.3	1
Smoking status								
never smoker	298	0.3	1	1	0.0	-	0.0	-
former smoker	267	4.1	54.57 (7.33 - 406.38)	11	54.5	1	36.4	10.65 (0.95 - 119.69)
current smoker	171	21.1	13.19 (1.68 - 103.82)	36	66.7	1.22 (0.21 - 6.92)	13.9	1
FTND								
Low-Medium (0-5)	143	16.1	1	23	60.9	1	17.4	2.23 (0.14 - 34.59)
High (6-10)	28	46.4	3.96 (1.60 - 9.82)	13	76.9	5.86 (0.73 - 46.77)	7.7	1

* Adjusted OR for sex, age, and educational level. **Prevalence among ever e-cigarette users.

FTND: Fagerström test for cigarette dependence. OR: Odd Ratio; CI: confidence intervals

Table 2. Prevalence of current, past and trial e-cigarette users according to sex, age, educational level, smoking status, and FTND. Barcelona, Spain (2013-14).

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

FTND: Fagerström test for cigarette dependence. CI: confidence intervals

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	#2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	#2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	#4
Objectives	3	State specific objectives, including any prespecified hypotheses	#4
Methods			
Study design	4	Present key elements of study design early in the paper	#5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	#5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	#5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	#5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	#6
Bias	9	Describe any efforts to address potential sources of bias	#6
Study size	10	Explain how the study size was arrived at	#5-6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	#6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	#6
		(*b*) Describe any methods used to examine subgroups and interactions	#6
		(*c*) Explain how missing data were addressed	#6
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Not applicable
		(*e*) Describe any sensitivity analyses	Not applicable
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	#5-6
		(b) Give reasons for non-participation at each stage	#5-6
		(c) Consider use of a flow diagram	No diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	#6-7
		(b) Indicate number of participants with missing data for each variable of interest	#6-7
Outcome data	15*	Report numbers of outcome events or summary measures	#6-7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	#6-7 & #16-17
		(*b*) Report category boundaries when continuous variables were categorized	#6
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Not applicable
Discussion			
Key results	18	Summarise key results with reference to study objectives	#8-10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	#8-10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	#8-10
Generalisability	21	Discuss the generalisability (external validity) of the study results	#8-10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	#9-11

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Electronic cigarettes use among adult population: a cross-sectional study in Barcelona, Spain (2013-14)

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Key words: electronic cigarettes; e-cigarettes; electronic nicotine delivery system (ENDS); prevalence study; cross-sectional study; dual use; nicotine; dependence

Abstract

Objective: This study seeks to analyze the prevalence and correlates of 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 (≥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 (OR), and their corresponding 95% confidence interval (CI).

Results: The prevalence of ever e-cigarette use was 6.5% (95%CI: 4.7-8.3): 1.6% current use, 2.2% past use, and 2.7% only e-cigarette experimentation. 75% (95%CI: 62.8-87.3) 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 – 406.38) and highly dependent cigarette smokers (OR: 3.96; 95%CI: 1.60-9.82). 62.5% of the ever users charged their e-cigarettes with nicotine with 70% of them obtaining the liquids with nicotine in a specialized shop. 39.6% of ever e-cigarette users were not satisfied with their use, 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. 6 out of 10 e-cigarette users preferred devices that deliver nicotine. The satisfaction with e-cigarette use is very low.

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, that could lead to a possible no participation bias.
- This is a cross-sectional study and it is only possible to assess associations, but no 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.

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. Regardless of their shape, they are designed to vaporizes a mixture of nicotine, propylene glycol and other chemicals that heats the vapor via a battery activated by puffing, but contain no actual tobacco[1, 2]. The device can also vaporize 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 public health community in general, who are concerned with their potential risks and cautiously optimistic about their potential benefits [2]. Interest in e-cigarettes, as measured by internet searches, exceeded that of snus or nicotine replacement therapies[3].

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 one year in US[4]. However, scientific evidence concerning 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 characterize the use of this new product in order to implement future regulations.

The objective of this study is to estimate the prevalence and analyze 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 (≥16 years old) non-institutionalized 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[5, 6]. 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. The Research and Ethics Committee of the Bellvitge University Hospital provided ethical approval for the study protocol. 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 1,010 people out of the 1,245 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 2004-05 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. 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 analyzed was 736 individuals (336 men and 400 women). Although there were not 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 was 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, specialized 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 (OR) with 95% confidence intervals (CI) by sex, age, and educational level. All analyses were stratified by sex, groups of age (≤44 years old, 45-64 years old, and ≥65 years old), educational level -categorized 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)[7] for current cigarette smokers, and categorized 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: 20.2-26.3) and the prevalence of ever e-cigarette use was 6.5% (95%CI: 4.7-8.3). 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. 75% of e-cigarettes 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 (8.0%), younger people (≤44 years old, 13.1%), and people with intermediate educational level (9.8%, OR: 1.42, 95%CI: 0.50 – 4.04). There was a statistically significant association between ever e-cigarette use and current smoking (OR=54.57, 95%CI: 7.33 - 406.38). Also, the highest prevalence (46.4%) of ever e-cigarette use was among current smokers with high cigarette dependence score (table 1). 62.5% of ever e-cigarettes users (95%CI: 48.8-76.2) used them with nicotine and 70% (95%CI: 53.6-86.4) indicated they obtained the liquid with nicotine in a specialty shop, while 3.3% (95%CI: 0.6-16.7) 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: 7.7-29.9) were totally or quite satisfied with their use and 39.6% (95%CI: 25.8-53.4) 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: 40.0% *vs.* 38.9%; OR=0.53, 95%CI: 0.11-2.49).

Table 2 shows the prevalence rates of current use, past use, and only experimentation with e-cigarettes. 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 were among current smokers (75% of ever e-cigarette users were current smokers). Similar results were found for general population in Europe according to the Eurobarometer survey conducted in 2012 [8] and also in the United States [9] 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 to other countries, as well as the quick reaction of the tobacco control community and public health authorities to apply the precautionary principle in Spain [10]. 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%)[11]. A study conducted among teenagers from Poland (between 15-24 years old) showed that 6.9% of them reported experimenting with e-cigarettes in the previous 30 days[12] while we found 13.1% of ever e-cigarette use among young people (≤44 years old). Another study conducted in the United Kingdom using telephone interviews among current and former smokers[13], 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 difficult the comparison among studies. 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[14-22]. The only clinical trial published to date[23] showed that 7.3% of those who used e-cigarettes with nicotine to quit smoking were still abstinent at 6 months, compared to 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[24, 25] also found that e-cigarettes may contribute to prevent relapse in former smokers and to promote smoking cessation in

current smokers. Other studies[4, 9, 26] suggest that there is high percentage of e-cigarette users concurrently using conventional tobacco. However, the evidence is still scarce according to recent reviews of the scientific literature[27, 28]. According to our data, we likewise found high percentage (75%) of current e-cigarette users exhibiting dual use patterns with conventional tobacco. Moreover, we surprisingly found very low percentage of ever e-cigarette users quite or totally satisfied with their use (18.8%), particularly among current smokers and smokers with 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[29, 30], 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 young and middle aged population[31-33] 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 no 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[5, 6] 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 [8, 9]. 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 to Internet and other self-administered surveys[9, 26]. 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 scanty 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 the coming years among the general population[9], as well as in the adolescent and student populations[29, 34]. Furthermore, our results show that current and ever e-cigarette use were predominant among current smokers, indicating dual use pattern, and that there were very low level of satisfaction with e-cigarettes. More investigation is needed on dual use (e-cigarettes and conventional tobacco) and on the users' satisfaction with e-cigarette devices, as well as on the effectiveness of e-cigarettes for smoking cessation and their benefit-risk balance.

AUTHOR CONTRIBUTIONS

JMMS and EF conceived the study. MB, MF, EF, ES and JMMS contributed in the design and coordination of the study. JCMS analyzed the data. JMMS drafted the first manuscript. All authors contributed substantially to the interpretation of the data and the successive versions of the manuscript. All authors contributed to the manuscript and approved its final version. JMMS is the principal investigator of the project.

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COMPETING INTERESTS

None declared.

ETHICAL APPROVAL

The research and ethics committee of the Bellvitge University Hospital provided ethical approval for the study protocol.

DATA SHARING

No additional data are available.

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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. Barcelona, Spain (2013-14).

	Ever e-cigarette users			Ever use of e-cigarettes with nicotine			Satisfaction with the usage of e-cigarettes (not satisfied)	
	N	%	OR* (95%CI)	n	%**	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 – 1.27)	21	76.2	2.66 (0.62 - 11.32)	33.3	0.49 (0.11 – 2.26)
Age								
≤44 years old	198	13.1	1	26	73.1	1	30.8	1
45-64 years old	267	6.7	0.39 (0.20 – 0.75)	18	44.4	0.32 (0.08 – 1.28)	55.6	3.21 (0.78 – 13.13)
≥ 65 years old	271	1.5	0.08 (0.02 – 0.24)	4	75.0	1.49 (0.13 – 17.48)	25.0	0.73 (0.05 – 10.84)
Educational level								
Low	161	3.1	1	5	60.0	1	0.0	-
Intermediate	287	9.8	1.42 (0.50 - 4.04)	28	53.6	1.56 (0.18 – 13.05)	42.9	1
High	288	5.2	0.49 (0.16 - 1.53)	15	80.0	2.64 (0.27 – 26.15)	46.7	2.41 (0.48 – 12.15)
Smoking status								
never smoker	298	0.3	1	1	0.0	-	0.0	-
former smoker	267	4.1	13.19 (1.68 – 103.82)	11	54.5	1	45.5	1
current smoker	171	21.1	54.57 (7.33 – 406.38)	36	66.7	1.22 (0.21 - 6.92)	38.9	1.30 (0.28 – 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 - 9.82)	13	76.9	5.86 (0.73 - 46.77)	30.8	0.14 (0.01 – 1.42)

* Adjusted ORs for sex, age, and educational level. **Prevalence among ever e-cigarette users.

FTCD: Fagerström test for cigarette dependence. OR: Odd 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. Barcelona, Spain (2013-14).

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

FTCD: Fagerström test for cigarette dependence. CI: confidence intervals

Electronic cigarettes use among adult population: a cross-sectional study in Barcelona, Spain (2013-14)

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Abstract

Objective: This study seeks to analyze the prevalence and correlates of 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 (≥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 (OR), and their corresponding 95% confidence interval (CI).

Results: The prevalence of ever e-cigarette use was 6.5% (95%CI: 4.7-8.3): 1.6% current use, 2.2% past use, and 2.7% only e-cigarette experimentation. 75% (95%CI: 62.8-87.3) 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 – 406.38) and highly dependent cigarette smokers (OR: 3.96; 95%CI: 1.60-9.82). 62.5% of the ever users charged their e-cigarettes with nicotine with 70% of them obtaining the liquids with nicotine in a specialized shop. 39.6% of ever e-cigarette users were not satisfied with their use, 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. 6 out of 10 e-cigarette users preferred devices that deliver nicotine. The satisfaction with e-cigarette use is very low.

Key words: electronic cigarettes; e-cigarettes; electronic nicotine delivery system (ENDS); prevalence study; cross-sectional study; dual use; nicotine; dependence

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, that could lead to a possible no participation bias.
- This is a cross-sectional study and it is only possible to assess associations, but no 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.

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. Regardless of their shape, they are designed to vaporizes a mixture of nicotine, propylene glycol and other chemicals that heats the vapor via a battery activated by puffing, but contain no actual tobacco[1, 2]. The device can also vaporize 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 public health community in general, who are concerned with their potential risks and cautiously optimistic about their potential benefits [2]. Interest in e-cigarettes, as measured by internet searches, exceeded that of snus or nicotine replacement therapies[3].

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 one year in US[4]. However, scientific evidence concerning 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 characterize the use of this new product in order to implement future regulations.

The objective of this study is to estimate the prevalence and analyze 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 (≥16 years old) non-institutionalized 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[5, 6]. 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. The Research and Ethics Committee of the Bellvitge University Hospital provided ethical approval for the study protocol. 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 1,010 people out of the 1,245 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 2004-05 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. 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 analyzed was 736 individuals (336 men and 400 women). Although there were not 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 was 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, specialized 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 (OR) with 95% confidence intervals (CI) by sex, age, and educational level. All analyses were stratified by sex, groups of age (≤44 years old, 45-64 years old, and ≥65 years old), educational level -categorized 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)[7] for current cigarette smokers, and categorized 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: 20.2-26.3) and the prevalence of ever e-cigarette use was 6.5% (95%CI: 4.7-8.3). 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. 75% of e-cigarettes 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 (8.0%), younger people (≤44 years old, 13.1%), and people with intermediate educational level (9.8%, OR: 1.42, 95%CI: 0.50 – 4.04). There was a statistically significant association between ever e-cigarette use and current smoking (OR=54.57, 95%CI: 7.33 - 406.38). Also, the highest prevalence (46.4%) of ever e-cigarette use was among current smokers with high cigarette dependence score (table 1). 62.5% of ever e-cigarettes users (95%CI: 48.8-76.2) used them with nicotine and 70% (95%CI: 53.6-86.4) indicated they obtained the liquid with nicotine in a specialty shop, while 3.3% (95%CI: 0.6-16.7) 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: 7.7-29.9) were totally or quite satisfied with their use and 39.6% (95%CI: 25.8-53.4) 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: 40.0% *vs.* 38.9%; OR=0.53, 95%CI: 0.11-2.49).

Table 2 shows the prevalence rates of current use, past use, and only experimentation with e-cigarettes. 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 were among current smokers (75% of ever e-cigarette users were current smokers). Similar results were found for general population in Europe according to the Eurobarometer survey conducted in 2012 [8] and also in the United States [9] 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 to other countries, as well as the quick reaction of the tobacco control community and public health authorities to apply the precautionary principle in Spain [10]. 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%)[11]. A study conducted among teenagers from Poland (between 15-24 years old) showed that 6.9% of them reported experimenting with e-cigarettes in the previous 30 days[12] while we found 13.1% of ever e-cigarette use among young people (≤44 years old). Another study conducted in the United Kingdom using telephone interviews among current and former smokers[13], 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 difficult the comparison among studies. 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[14-22]. The only clinical trial published to date[23] showed that 7.3% of those who used e-cigarettes with nicotine to quit smoking were still abstinent at 6 months, compared to 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[24, 25] also found that e-cigarettes may contribute to prevent relapse in former smokers and to promote smoking cessation in

current smokers. Other studies[4, 9, 26] suggest that there is high percentage of e-cigarette users concurrently using conventional tobacco. However, the evidence is still scarce according to recent reviews of the scientific literature[27, 28]. According to our data, we likewise found high percentage (75%) of current e-cigarette users exhibiting dual use patterns with conventional tobacco. Moreover, we surprisingly found very low percentage of ever e-cigarette users quite or totally satisfied with their use (18.8%), particularly among current smokers and smokers with 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[29, 30], 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 young and middle aged population[31-33] 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 no 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[5, 6] 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 [8, 9]. 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 to Internet and other self-administered surveys[9, 26]. 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 scanty 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 the coming years among the general population[9], as well as in the adolescent and student populations[29, 34]. Furthermore, our results show that current and ever e-cigarette use were predominant among current smokers, indicating dual use pattern, and that there were very low level of satisfaction with e-cigarettes. More investigation is needed on dual use (e-cigarettes and conventional tobacco) and on the users' satisfaction with e-cigarette devices, as well as on the effectiveness of e-cigarettes for smoking cessation and their benefit-risk balance.

AUTHOR CONTRIBUTIONS

JMMS and EF conceived the study. MB, MF, EF, ES and JMMS contributed in the design and coordination of the study. JCMS analyzed the data. JMMS drafted the first manuscript. All authors contributed substantially to the interpretation of the data and the successive versions of the manuscript. All authors contributed to the manuscript and approved its final version. JMMS is the principal investigator of the project.

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data collection and analysis, interpretation, writing the report or the decision to submit it for publication. Authors declare that they have no conflicts of interest.

COMPETING INTERESTS

None declared.

ETHICAL APPROVAL

The research and ethics committee of the Bellvitge University Hospital provided ethical approval for the study protocol.

DATA SHARING

No additional data are available.

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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. Barcelona, Spain (2013-14).

	Ever e-cigarette users			Ever use of e-cigarettes with nicotine			Satisfaction with the usage of e-cigarettes (not satisfied)	
	N	%	OR* (95%CI)	n	%**	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 – 1.27)	21	76.2	2.66 (0.62 - 11.32)	33.3	0.49 (0.11 – 2.26)
Age								
≤44 years old	198	13.1	1	26	73.1	1	30.8	1
45-64 years old	267	6.7	0.39 (0.20 – 0.75)	18	44.4	0.32 (0.08 – 1.28)	55.6	3.21 (0.78 – 13.13)
≥ 65 years old	271	1.5	0.08 (0.02 – 0.24)	4	75.0	1.49 (0.13 – 17.48)	25.0	0.73 (0.05 – 10.84)
Educational level								
Low	161	3.1	1	5	60.0	1	0.0	-
Intermediate	287	9.8	1.42 (0.50 - 4.04)	28	53.6	1.56 (0.18 – 13.05)	42.9	1
High	288	5.2	0.49 (0.16 - 1.53)	15	80.0	2.64 (0.27 – 26.15)	46.7	2.41 (0.48 – 12.15)
Smoking status								
never smoker	298	0.3	1	1	0.0	-	0.0	-
former smoker	267	4.1	13.19 (1.68 – 103.82)	11	54.5	1	45.5	1
current smoker	171	21.1	54.57 (7.33 – 406.38)	36	66.7	1.22 (0.21 - 6.92)	38.9	1.30 (0.28 – 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 - 9.82)	13	76.9	5.86 (0.73 - 46.77)	30.8	0.14 (0.01 – 1.42)

* Adjusted ORs for sex, age, and educational level. **Prevalence among ever e-cigarette users.

FTCD: Fagerström test for cigarette dependence. OR: Odd 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. Barcelona, Spain (2013-14).

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

FTCD: Fagerström test for cigarette dependence. CI: confidence intervals

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	#2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	#2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	#4
Objectives	3	State specific objectives, including any prespecified hypotheses	#4
Methods			
Study design	4	Present key elements of study design early in the paper	#5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	#5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	#5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	#5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	#6
Bias	9	Describe any efforts to address potential sources of bias	#6
Study size	10	Explain how the study size was arrived at	#5-6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	#6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	#6
		(*b*) Describe any methods used to examine subgroups and interactions	#6
		(*c*) Explain how missing data were addressed	#6
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Not applicable
		(*e*) Describe any sensitivity analyses	Not applicable
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	#5-6
		(b) Give reasons for non-participation at each stage	#5-6
		(c) Consider use of a flow diagram	No diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	#6-7
		(b) Indicate number of participants with missing data for each variable of interest	#6-7
Outcome data	15*	Report numbers of outcome events or summary measures	#6-7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	#6-7 & #16-17
		(*b*) Report category boundaries when continuous variables were categorized	#6
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Not applicable
Discussion			
Key results	18	Summarise key results with reference to study objectives	#8-10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	#8-10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	#8-10
Generalisability	21	Discuss the generalisability (external validity) of the study results	#8-10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	#9-11

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.