Evaluating nicotine dependence levels in e-cigarette users

Evaluación de los niveles de dependencia de la nicotina en usuarios de cigarrillos electrónicos

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Electronic cigarettes (e-cigarettes) are non-combustible electronic nicotine delivery systems (ENDS) that mimic the experience of smoking tobacco (Harrell, Simmons, Correa, Padhya, & Brandon, 2014). They consist of three main elements: a rechargeable battery, an atomizer, and a tank.

Since the e-cigarette entered the market in 2003, its prominence and use has greatly increased worldwide (Martínez-Sánchez et al., 2014). Recent data on e-cigarette prevalence in both European and American samples indicates that nearly 6.8% of adults are e-cigarette users to date (McMillen, Gottlieb, Shaefer, Winickoff, & Klein, 2015). Nevertheless, this growing popularity has raised several public health issues regarding its safety and effectiveness as an alternative for smoking cessation (Yu et al., 2016). Research focused on e-cigarettes and smoking cessation has provided mixed results. While several internet surveys and uncontrolled designs suggest e-cigarettes may be effective in promoting tobacco abstinence, others have not found such results. To date, recommendations of the World Health Organization points out that the effectiveness of e-cigarettes as a method for quitting is limited and requires more research (World Health Organization, 2014).

A further concern involves abuse liability in current e-cigarette users (Cobb, Hendricks, & Eissenberg, 2015). Recent evidence has shown that nicotine levels as measured through plasma and saliva are similar to those seen in smokers, and even higher than observed levels in nicotine replacement therapy users (Marsot & Simon, 2015). On the other hand, low levels of self-reported nicotine dependence when vaping and a greater number of minutes between waking up and first use have been found among vapers, thereby accounting for lower nicotine dependence levels among this former group when compared to tobacco cigarette smokers (Foulds et al., 2015). This study aimed to explore nicotine dependence levels in a sample of experienced e-cigarette users (n=39; males=77%) and to compare them with current tobacco cigarette smokers (n=42; males=57%). Among e-cigarette users 20.5% were using second generation devices, while 79.5% were using third generation ones. We conducted several face-to-face interviews in order to assess sociodemographic and dependence related characteristics in both e-cigarette users and in smokers. Adapted versions of both the Fagerström test for nicotine dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991) and the nicotine dependence syndrome scale (NDSS; Shiffman, Waters, & Hickcox, 2004) were used to analyze nicotine dependence in each of the groups. Biochemical markers of carbon monoxide and urinary cotinine analysis were also collected. Our findings extend previous research on e-cigarette use and nicotine addiction. Two main findings can be drawn from this work: (1) e-cigarette users were dependent on e-liquids containing nicotine, (2) e-cigarette users were found to be less ni-

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cotine dependent than current tobacco cigarette smokers (see table 1).

Several mechanisms may explain these results. First, because nicotine dependence and abuse liability are influenced by nicotine bioavailability, the oral route of e-liquid administration might have strongly influenced rates of both nicotine absorption and exposure, therefore accounting for self-reported nicotine dependence levels among e-cigarette users. Second, in addition to the nicotine itself, using e-cigarettes has been shown to involve other psychosocial components which could explain addictiveness among e-cigarette users. For instance, the use of e-cigarettes enables the user to replace most of the sensorial-motor and social components associated with smoking such as the hand to mouth ritual or the visualization of exhaled vapor. Third, due to the fact that the sample of e-cigarette users were former smokers or current tobacco cigarette smokers, it might be that when they first used e-cigarettes, they were already nicotine dependent on tobacco cigarettes. Thus, nicotine delivered by means of e-cigarette use might lead to the maintenance of nicotine dependence.

This study is not exempt of limitations. First, we did not employ validated versions of the dependence scales we used. However, the validation test could not be performed because during the recruitment process we were not able to obtain enough sample size of e-cigarette users. Nonewithstanding, data suggest that e-cigarette use in Spain probably is not as prevalent as other European and U.S. countries. Second, the fact that a 35.9% of e-cigarette users were also smoking at the time of the interview preclude us to yield firm conclusions on nicotine dependence levels.

Despite these limitations, these findings add substantially to our understanding of e-cigarette abuse liability. Although e-cigarette users were found to be nicotine dependent, biochemical measures of carbon monoxide and self-reported questionnaires found nicotine dependence on e-cigarettes to be lower than was observed in tobacco cigarette smokers. Considerably more longitudinal research is needed in order to better ascertain addictiveness levels among e-cigarette users. Further research should therefore focus on properly exploring the levels of nicotine dependence in e-cigarette users as measured by adapted and validated questionnaires.

Conflict of interest

No conflict declared.

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Table 1. *Dependence levels among e-cigarette users and smokers*

	E-cigarette users (n = 39)	Smokers (n = 42)	t	p	r
CO (ppm)	8±6.77	15.24±7.18	-4.657	‹.001	0.49
Cotinine (ng/ml)	1891.26±1452.11	2383.51±1129.07	-1.710	.091	0.16
FTND (tobacco/e-cigarette)[a]	4.38±1.93	5.57±1.48	-3.118	.003	.74
NDSS-T (tobacco/e-cigarette)[a]	26.26±5.29	40.50±8.14	-9.405	‹.001	.75
NDSS-Impulsivity (tobacco/e-cigarette)[a]	10.46±4.72	19.98±5.14	-8.659	‹.001	.70
NDSS-Priority (tobacco/e-cigarette)[a]	4.82±1.57	7.81±3.07	-5.452	‹.001	.52
NDSS-Tolerance (tobacco/e-cigarette)[a]	14±3.41	22.19±3.93	-9.987	‹.001	.75
NDSS-Continuity (tobacco/e-cigarette)[a]	23.13±3.91	25.90±4.86	-2.819	.006	.30
NDSS-Stereotypy (tobacco/e-cigarette)[a]	11.64±2.95	13.21±3.47	-2.191	.031	.24

Note. Nicotine dependence among e-cigarette dual users was assessed using scores on questionnaires evaluating dependence on e-cigarette use; CO = carbon monoxide; ppm = parts per million; ng/ml = nanogram/milliliter. [a] = Means ± SD; t= Student´s t test; r= Cohen's d effect size; FTND; Fagerström Test for Nicotine Dependence; NDSS; The Nicotine dependence syndrome scale.

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