



## Gender differences influence overweight smokers' experimentation with electronic nicotine delivery systems



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### HIGHLIGHTS

- We observed a large increase in reported experimentation with ENDS from 2011 to 2012.
- Overweight or obese smokers were more likely to report experimentation with ENDS.
- Experimentation with ENDS was not associated with a reduction in use of cigarettes or a decrease in cigarette dependence.

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### ABSTRACT

**Introduction:** Overweight and obese tobacco users possess increased risk of cancer, diabetes, heart disease and chronic tobacco-related disease. Efforts to prevent tobacco-related health risk in this comorbid population would be informed by better understanding and monitoring of trends in the concurrent use of electronic nicotine delivery systems (ENDS) among smokers in the US marketplace.

**Method:** The California Longitudinal Smokers Study (CLSS) established a cohort of current cigarette smokers in 2011 who were surveyed for tobacco use and health behavior at baseline and again in 2012 at follow-up.

**Results:** We observed a large increase in reported experimentation with ENDS. As hypothesized, overweight or obese smokers were more likely to report experimentation with ENDS, an increase that was also observed among women. Experimentation with ENDS was not associated with a reduction in use of cigarettes or a decrease in cigarette dependence in this high risk population of smokers.

**Conclusions:** Continued surveillance of this vulnerable population is needed to better understand how experimentation with new ENDS products may impact health, facilitate switching to non-combustible tobacco or facilitate persistent cigarette dependence.

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### 1. Introduction

Tobacco use and obesity are the leading causes of morbidity and mortality worldwide (Haslam & James, 2005; Mokdad et al., 2003). Rates of obesity are particularly high among heavier smokers (Chiolero, Faeh, Paccaud, & Cornuz, 2008) and 37–65% of smokers seeking cessation treatment are overweight or obese (Bush et al., 2008). Weight loss and tobacco cessation have been a focus of public health efforts to decrease risk for diabetes, heart disease, lung disease, cancer, and chronic illness in vulnerable populations of overweight or obese

smokers. As new nicotine and tobacco products enter the marketplace, attention to products that may appeal to this high risk population is heightened. Electronic nicotine delivery devices (ENDS) have seen a dramatic increase in the US (Kasza et al., 2011; Yamin, Bitton, & Bates, 2010), have rapidly captured consumer interest since 2008 (Ayers, Ribisl, & Brownstein, 2011; King, Alam, Promoff, Arrazola, & Dube, 2013; Zhu et al., 2013) and have generated a multibillion dollar industry. Among smokers in the US, estimates of experimentation with ENDS range from 11.4% in 2010 (Pearson, Richardson, Niaura, Vallone, & Abrams, 2012), 21.2% in 2011 (Kasza et al., 2011), and 32.18% in 2012 (Zhu et al., 2013). Experimentation among smokers has been concentrated among youth and non-Hispanic whites (Kasza et al., 2011; Pearson et al., 2012; Zhu et al., 2013) though aggressive marketing efforts seek to expand markets (de Andrade, Hastings, Angus, Dixon, & Purves, 2013). While the significance of ENDS in supporting cessation

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and serious concerns about ENDS sustaining nicotine dependence continue to be debated (Etter, 2012; Henningfield & Zaatari, 2010; IOM, 2012) attention to trends in product use in vulnerable populations of overweight or obese smokers is needed to better understand the potential impact in populations with disproportionate tobacco-related disease.

ENDS may have a particular appeal to overweight or obese smokers seeking alternative means of nicotine self-administration to manage appetite and weight concerns that may interfere with cessation (French & Jeffery, 1995). Nicotine intake has been associated with decreased appetite (Jessen, Buemann, Toubro, Skovgaard, & Astrup, 2005; Mineur et al., 2011), increased metabolic expenditure (Chiolerio et al., 2008; Collins, Cornelius, Vogel, Walker, & Stamford, 1994; Hofstetter, Schutz, Jequier, & Wahren, 1986; Perkins et al., 1991) and decreased body weight (Bamia, Trichopoulou, Lenas, & Trichopoulos, 2004). Many tobacco users endorse the belief that nicotine is effective in weight control (Potter, Pederson, Chan, Aubut, & Koval, 2004). However, the potential acute weight-regulating effects of nicotine may not be available to chronic tobacco users. Among regular smokers, acute nicotine intake has been associated with increased hunger and increased caloric intake during meals (Perkins et al., 1992). In several population studies, heavier smoking has been positively associated with higher Body Mass Index (BMI) (Chiolerio et al., 2008; John, Hanke, Rumpf, & Thyrian, 2005; Mackay, Gray, & Pell, 2013; Rasky, Stronegger, & Freidl, 1996). Although there has been mixed objective support for tobacco use in managing weight, concerns about weight remain a powerful motive predictive of tobacco use initiation (Potter et al., 2004), persistent nicotine dependence and a barrier to cessation (Jeffery, Hennrikus, Lando, Murray, & Liu, 2000; Meyers et al., 1997; Ockene et al., 2000).

Tobacco industry has long promoted products associated with themes targeting weight control, including suggestions for substitution of tobacco for sweets, and use of packaging (Pierce et al., 2010) to appeal to weight-concerned women (USDHS, 2001). Themes of weight control are readily apparent in marketing materials for ENDS products. Emerging products highlight effective delivery of nicotine with hundreds of flavors including many sweets that may appeal to broad tastes (de Andrade et al., 2013; Grana & Ling, 2014) or directly include descriptions of appetite control and weight loss. Concerns about gaining weight when quitting smoking are common, particularly among women (Klesges & Klesges, 1988; Pirie, Murray, & Luepker, 1991). The potential inclusion of weight control messages and broadened flavorings may make these ENDS products particularly appealing to women and overweight or obese smokers interested in cessation or reduction in their tobacco use.

We hypothesize that experimentation with ENDS will be more common among overweight or obese smokers than their normal weight counterparts. We also hypothesized that given more frequent weight concerns among women when considering making changes in tobacco use, the effect of weight status on the likelihood of experimenting with ENDS would be stronger among women than men. Hypotheses were tested within the California Longitudinal Smokers Study (CLSS) that assessed tobacco and ENDS use in a cohort assessed in 2011 and again in 2012. Primary hypotheses will be followed by exploration of whether a relationship between levels of weight concerns at the initial assessment and ENDS experimentation over time differed by weight status. Finally, we examined whether experimentation with ENDS was consistent with concurrent patterns of reduction in cigarette consumption or cigarette dependence with consideration for demographic characteristics and mental health concerns associated with weight status and known to influence both experimentation with ENDS and tobacco use.

## 2. Method

### 2.1. California Longitudinal Smokers Study

The data used in the present study are from the 2011 California Longitudinal Smokers Survey (CLSS). The CLSS is a follow-back survey of

smokers who participated in the 2009 California Health Interview Survey (CHIS 2009), a population-based random sample of California residents. CHIS 2009 data collection spanned from December 27th, 2009, through May 26th, 2010 (Edwards, et al., 2011). The CLSS re-contact began in July 2011 and concluded in April 2012 and smokers were contacted again during a follow-up period that lasted from November 6, 2012 and January 16, 2013. Of the 1745 eligible smokers from the 2010–11 survey cohort, responders to CLSS included 1000 adults aged 18 years or older who reported current cigarette smoking in 2010–11 and completed a follow-up survey in 2012–13. Analyses in the current study were limited to the 1000 current smokers from this sample who were identified and agreed to be followed in the longitudinal component of the study.

### 2.2. Measures

#### 2.2.1. Demographic characteristics

Survey questions included age of the respondent, coded 18–24, 25–44, and 45–59. Ethnic/racial status was coded for Non-Hispanic white or other ethnicity/racial group. Smokers provided self-reported height and weight which were used to compute Body Mass Index, acknowledging that self-reported weight may result in overestimation of height, underestimation of weight, and thereby result in an underestimation of BMI in population surveys (Gorber, Tremblay, Moher, & Gorber, 2007). Smokers were classified as normal weight when BMI was <25 or overweight or obese when BMI was ≥25.

#### 2.2.2. Smoking characteristics

The survey instrument for the CLSS included detailed information on the frequency and quantity of cigarette smoking. Frequency was assessed with the question “On how many of the past 30 days did you smoke cigarettes?” Quantity was assessed with the question “During the past 30 days, on the days that you *did* smoke, about how many cigarettes did you usually smoke?”. Cigarette dependence was assessed using the Heaviness of Smoking Index (HSI) which sums categories of current cigarettes per day (0 = 0–10; 1 = 11–20; 2 = 20–30; 3 = 31+) and the “time to first cigarette” (TTFC) question “How soon after you awake in the morning do you usually smoke your first cigarette?” (0 for ‘> 60 min’, 1 for ‘31–60 min’, 2 for ‘6–30 min’, and 3 for ‘≤ 5 min’). The HSI is a reliable index of cigarette dependence over time (Borland, Yong, O’Connor, Hyland, & Thompson, 2010) and was scaled among current smokers and quitters with higher scores reflecting more dependence.

#### 2.2.3. Anxiety and depression symptoms

Patient Health Questionnaire for Depression and Anxiety (PHQ-4; (Kroenke, Spitzer, Williams, & Lowe, 2009). The survey poses the overall question: “Over the past 2 weeks have you been bothered by these problems?” The two clusters of anxiety symptoms it assesses are: 1) feeling nervous, anxious, or on edge; and 2) not being able to stop or control worrying. The two clusters of depression symptoms it assesses are: 1) feeling down, depressed, or hopeless; and 2) little interest or pleasure in doing things. Participants chose between the following four options for each of the four items: 1) not at all; 2) several days; 3) more days than not; and 4) nearly every day. Total scores on the PHQ-4 were used to elaborate on combined risks associated with symptoms of these disorders.

#### 2.2.4. Weight concerns

The survey included two tobacco-related weight concern questions to examine. Respondents were asked: “How concerned are you that you may gain weight if you quit smoking?” Response options ranged from ‘not at all concerned’, ‘somewhat concerned’, or ‘very concerned’ and were scaled from 0 to 2. Respondents were also asked: “Please tell me if any of these reasons are true for you...you’re still smoking because

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