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Electronic cigarette use was not associated with quitting of conventional cigarettes in youth smokers

Running title: E-cig use and quitting in youth smokers

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Declaration of Interests

None declared.

Category of study: Population study

1

Abstract

Background: To investigate the association between electronic cigarette (e-cig) use and smoking cessation among smokers who called the Youth Quitline in Hong Kong.

Methods: This longitudinal study collected data on youth smokers' (N=189) use and perception of e-cigs, conventional cigarette smoking behavior and socio-demographic characteristics at baseline. Self-reported past 7-day point prevalence of abstinence (PPA) was assessed at the 6-month telephone follow-up. Linear and logistic regressions were used to estimate the association of e-cig use with quitting cigarette and other cessation related outcomes.

Results: E-cig users were younger, more addicted to nicotine, and less ready to quit (all $p<0.05$) at baseline. The PPA rate was lower in e-cig users (13.4% vs. 20.8%) at follow-up. E-cig use was not associated with PPA at the 6-month follow-up (odds ratio: 0.56, 95% CI 0.24 to 1.35) but it was non-significantly related to more cessation attempts (raw coefficient: 1.26, 95% CI -0.13 to 2.66). Among those who still smoked, e-cig use was non-significantly associated with intention to quit smoking (odds ratio: 0.55, 0.15 to 2.05), nicotine dependence (Fagerström score, raw coefficient: 0.75, -0.39 to 1.90) and perceptions on quitting cigarette.

Conclusion: E-cig use was not associated with successful smoking cessation among Youth Quitline smokers.

Introduction

Electronic cigarettes (e-cigs) are popular worldwide, especially in the youth. A population survey in 2012 showed Europeans aged 15–24 years had 230% higher odds of having ever used e-cigs. (1) The prevalence of e-cig use even approached that of conventional cigarettes. A recent study among high school students in the US reported that the prevalence of e-cig use in the past 30 days increased from 1.7% in 2011 to 7.7% in 2013, while the proportion of current conventional cigarette smokers dropped from 15.1% to 13.1%. (2) E-cig use in Asian countries is emerging with 9.4% and 4.7% Korean adolescents ever tried and used it in the past 30 days, respectively. (3) In Hong Kong, the prevalence of past 30-day e-cig use in adolescents is relatively low (1.1% in 2012–2013) but it is gradually approaching that of conventional cigarette use (3.3%). (4)

E-cig use is more prevalent in current adolescent smokers. (1,3,4) Smoking cessation is one of the main reasons reported for the use of e-cigs. (5) The effects of e-cigs on smoking cessation among adolescents are uncertain because only 2 cross-sectional studies have reported results on successful abstinence. (3,6) Both ever and past 30-day e-cig use were associated with lower abstinence rate at 30-day, 6-month and 1-year follow-ups among ex-smokers from a representative sample of US secondary students. (6) Similar results were found in Korean adolescents using e-cigs in the past 30 days. (3) Prospective studies are needed to better assess the effects of e-cigs on quitting cigarette smoking among adolescents. Adult studies found inconclusive evidence on the effectiveness of e-cigs as a smoking cessation aid. (7) A recent meta-analysis concluded that e-cig users had 28% lower odds of quitting (8) but the designs of the studies included varied, which rendered this result less convincing. Meanwhile, positive associations were also reported by a paper

3

that included 3 cross-sectional studies among US young adult smokers (aged 18–25 years),

in which 1 study found that past-month e-cig use was positively related to past-year

quitting attempts and another found a positive association with the desire to quit. (9)

E-cig may affect the cessation of cigarette smoking differently between adolescents and

adults as similar phenomena were observed with reference to the use of medications for

smoking cessation (e.g. nicotine replacement therapy (NRT) and varenicline). A recent

systematic review failed to find the long-term beneficial effects of smoking medication use

among adolescents. (10) The e-cig was widely promoted as a smoking cessation tool

worldwide and in Hong Kong, and it is available on the internet and in some local shops.

The nicotine containing e-cig is required to register according to the Pharmacy and Poisons

Ordinance, but none has done so as of December 2016. Additionally, the use of e-cigs,

irrespective of whether it contains nicotine, is prohibited in smokefree areas under the

comprehensive smokefree legislation. We investigated the prospective associations of e-cig

use with smoking cessation behaviors, level of nicotine dependence, and perceived self-

efficacy on quitting cigarette smoking in youth smokers in Hong Kong.

Methods

Design

We analyzed the longitudinal data from the Youth Quitline (YQL), which provides a free

smoking cessation service (counseling without pharmacological intervention) for 6 months.

This quitline is funded by the Tobacco Control Office, Department of Health, Government

of Hong Kong SAR and is operated by the School of Nursing, University of Hong Kong.

4

Details of this quitline have been reported elsewhere. (11) Smokers who initiated a call to

the YQL were screened, and those who could speak Cantonese, smoked at least 1 cigarette

in the past 30 days, and were aged ≤ 25 years were eligible to receive the service. Those

unable to communicate or those who were undergoing other smoking cessation programs

were excluded. Smokers completed the assessment questionnaire on the phone at baseline,

and at the 3-day, 1-week, 2-week and 1-month follow-ups. Counseling was provided after

each assessment, based on the smoker's smoking behaviors, using the "five A's" strategy

(ask about smoking status, advise to quit, assess readiness to quit, assist to quit, and

arrange follow-up contact). (12) Smoking cessation outcomes were assessed at the 6-month

follow-up using self-reported abstinence, which was also validated by a salivary cotinine

level of < 10 ng/ml as an indicator of successful cessation. (13) Ethical approval was

obtained from the Institutional Review Board of the University of Hong Kong/Hospital

Authority West Cluster. Oral informed consent was obtained from all participants.

During 2014–15, a baseline questionnaire with added questions on e-cig were administered

among 224 smokers and 190 replied to the question on e-cig use (27 had never heard of e-

cig and 7 did not answer the questions on e-cig). Follow-up were successfully conducted

with 189 smokers, who were included in the current study. The smokers were asked

whether they had ever tried e-cig even a single puff, and whether they perceived that an e-

cig could help them quit smoking. Those who had ever used an e-cig further reported

details about its taste (e.g. menthol, fruit, and coffee) and the nicotine concentration of the

e-cigs. Socio-demographic characteristics, including age, sex, education, and employment

5

were recorded. The smoking behaviors assessed included number of smoking friends,

smokers lived with, and number of quitting attempts in one's lifetime, whether the smokers

wanted to quit (measuring intention to quit, yes/no), planned method, and day determined

for quitting cigarette smoking. The Fagerström score, including number of cigarettes

consumed per day (weekday and weekend) and time to first cigarette after waking (14) was

calculated. Perceived importance, confidence, and difficulties in successfully quitting

cigarette smoking were measured as they predicted abstinence of cigarette use. (15)

Similar questions on smoking and cessation behaviors were measured at the 6-month

follow-up, except the question on e-cig use.

Measures

Smokers who had tried the e-cig at least once were classified as "ever user". Participants

rated the perceived effectiveness of an e-cig as a smoking cessation aid on a 5-point scale

ranging from strongly agree to strongly disagree. Readiness to quit was classified into the

following stages with reference to when the respondent planned to quit: action/preparation

(already started to quit or planned to quit within 1 month, which indicated a higher

readiness to quit) and contemplation/pre-contemplation (planning to quit since longer than

1 month or not yet decided, which indicated a lower readiness to quit), based on the

Transtheoretical Model of change. (16) Level of nicotine dependence was assessed by the

Fagerström test and the number of cigarettes consumed per day on weekends because the

most of the participants were students, who spent most of the weekdays at school, and thus

could not smoke *ad libitum*. Perceived importance, confidence and difficulties in

6

successfully quitting cigarette smoking were measured on a scale of 0–10, (15,17)

indicating self-efficacy on quitting (higher scores indicated better perceived self-efficacy).

Abstaining from smoking for more than 24 hours (18) (yes/no) was considered a serious

quit attempt and the main outcome used was self-reported point prevalence of abstinence

(PPA) (19) for the past 7-days at the 6-month follow-up.

Analysis

Stata (Release 13, College Station, TX: StataCorp LP) was used for the analyses. We

adopted a pairwise deletion approach and used a 2-tailed $\alpha = 0.05$ as the significance level.

The relationship of socio-demographic characteristics with smoking behaviors and e-cig

use were examined. Adjusted odds ratios (AORs) for self-reported past 7-day PPA and

intention to quit, and raw coefficients (b) from a linear regression for quit attempts, level of

nicotine dependence, number of cigarettes consumed per day, and perceived self-efficacy

on quitting cigarette smoking in relation to e-cig use were calculated, adjusting for baseline

respective levels of smoking behaviors and socio-demographic characteristics, when

applicable. The effect size was measured by the Cohen's d and Cohen's w.

Results

The participants included in the study shared similar socio-demographic characteristics

with excluded smokers, except that they were younger (18.1 years vs. 19.6 years, p < 0.01)

(data not shown in the tables). Most participants (82.0%) were male, with a mean age of

7

18.1 (± 2.7) years, and 75.7% had an education level of high school or above (Table 1).

The average number of cigarettes consumed per day on weekends was 11.5 (± 9.6) and

level of nicotine dependence was mild (Fagerström score: 2.8 ± 2.4). As expected, nearly

all smokers (94.7%) had an intention to quit and over half of the smokers (51.4%) were

more ready to abstain from smoking. Smokers generally perceived successful quitting as

important (7.3 ± 2.2), not difficult (3.6 ± 2.3), and they were confident in their ability to

quit (6.1 ± 2.3). A total of 112 smokers (59.3%, 95% CI 51.9% to 66.3%) had ever tried ab

e-cig and they were younger (17.5 years vs. 18.9 years), more addicted to nicotine

(Fagerström score: 3.3 vs. 2.2), less ready to quit (44.8% vs. 60.8%) and consumed more

cigarettes daily on weekend (12.9 vs. 9.4), compared with non-users (all p < 0.05).

Table 2 shows that 31 (16.4%, 95% CI 11.1% to 21.7%) participants reported abstinence at

the 6-month follow-up with a lower PPA for the past 7 days for e-cig users than that for

non-users (13.4% vs. 20.8%). E-cig users had non-significant lower odds of quitting (AOR:

0.56, 95% CI 0.24 to 1.35), although they appeared to have tried quitting more frequently

(b: 1.26, 95% CI -0.13 to 2.66). Among those who remained smokers at the 6-month

follow-up, ever e-cig use was non-significantly associated with lower intention to quit

(AOR: 0.55, 95% CI 0.15 to 2.05) (Table 3); higher level of nicotine dependence (b: 0.75,

95% CI -0.39 to 1.90); more cigarette consumption (b: 1.47, 95% CI -2.21 to 5.15): and

lower perceived importance (b: -0.76, 95% CI -2.01 to 0.49), confidence (b: -0.13, 95% CI

-1.80 to 1.54), and difficulties (b: -0.75, 95% CI -2.38 to 0.88) pertaining to quitting

cigarette smoking.

8

Discussion

To the best of our knowledge, this is the first report on prospective associations of e-cig

use on quitting cigarette smoking in youth quitline smokers. Among these motivated youth

smokers, ever e-cig use did not predict abstinence from cigarette smoking. However, the

finding of non-significant negative associations with nicotine dependence, intention to quit,

number of cigarettes consumed per day, and perceived self-efficacy among non-quitters

were consistent with those on quitting cigarette smoking. The result on quitting cigarette

smoking was consistent with that reported in American and Korean cross-sectional

adolescent studies. (3,6) Such negative or null associations between e-cig use and intention

to quit were also reported by cross-sectional studies among US and Hong Kong

adolescents. (2,4,20,21) E-cig users appeared to have more quit attempts than non-users

did in our study, which was similar to the positive association between e-cig use and quit

attempts in a convenient sample of US young adults (9) and a representative sample of

Korean adolescents. (3)

The lack of prospective association between e-cig use and smoking cessation may be

explained by the fact that only a few smokers (15.5%) used nicotine containing e-cigs in

our study. Although e-cig use can mimic smoking behaviors, the effect of nicotine-free e-

cigs on quitting cigarette is weaker than that of e-cigs containing nicotine in adults. (22–24)

9

New generation e-cigs, which have improved nicotine delivery systems, (25) have been

found to be more effective in relieving cravings (26) and promoting cessation (27) in adults.

However, nicotine-containing e-cigs may not be effective in adolescents even if such

products could indeed help adults quit cigarette smoking, as corroborated by NRT studies.

(10,28) However, no study has investigated the cessation effect of nicotine-containing e-

cigs in adolescents. In this regard, a subgroup analysis on nicotine e-cig use is not feasible

in the present study because few smokers used such e-cigs.

Another explanation may be that the participants did not engage in e-cig use for aiding

smoking cessation because 55.9% of the smokers in this study planned to quit smoking just

by themselves or without a specific method, and only 6 planned to use e-cigs for quitting

cigarette. Many smokers (67.8%) did not perceive e-cigs as an effective tool for smoking

cessation. Other studies found that non-cessation-oriented e-cig users usually stopped

using e-cigs after trying them or used them infrequently. (5,29) Cessation-oriented users

may be more willing to practice e-cig use for a longer period, which may facilitate learning

on how to inhale a satisfactory level of nicotine,(30) and may lead to a higher chance of

quitting cigarette smoking.

This study has several limitations. More in depth analysis was restricted by the lack of

detailed use pattern (e.g. number of use days in the past 30 days, number of puffs/sessions

per day, reason for use). Due to the small sample size, a post priori analysis showed that

the statistical power was 0.27 for the detection of a significant association, if the true effect

10

of ever e-cig use on quitting conventional cigarette was assumed to be OR = 0.59, as found

in this study. Smoking abstinence was self-reported because biochemical validation of

quitting cigarette smoking remained low (58.1% of all quit), mostly due to participants'

busy schedule. As an observational study, unmeasured confounders could not be

eliminated, which preclude drawing a causal inference.

Our findings showed that e-cig use was not associated with successful abstinence and it

appeared to increase difficulties in quitting cigarette smoking in Youth Quitline smokers.

Given the prevalent e-cig use in the youth and other evidence on the adverse effects on

smoking initiation and respiratory health, (31,32) further public health action should be

taken against the promotion, sales and use of e-cigs.

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Declaration of Interests

None declared.

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11

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Table 1. Baseline socio-demographic characteristics and smoking behaviors by ever e-cig use in all participants (N=189)

	All (%)	E-cig use		
		Non-user (%)	User (%)	P value
Male	82.0	79.2	83.9	0.41
Age (mean ± SD), years	18.1 ± 2.7	18.9 ± 2.7	17.5 ± 2.6	<0.001
Highest education				<0.01
Junior second or below	24.3	12.5	32.7	
Senior second or diploma	57.2	59.7	55.5	
Sub-degree/higher diploma or above	18.5	27.8	11.9	
Work/study status				0.49
Full-time student	74.6	69.3	78.3	
Employed of self-employed	16.6	18.7	15.1	
Unemployed	1.7	2.7	0.9	
Others	7.2	9.3	5.7	
Number of cigarettes consumed per day [a] (mean ± SD)	11.5 ± 9.6	9.4±8.1	12.9±10.3	0.02
Nicotine dependence [b] (mean ± SD)	2.8 ± 2.4	2.2 ± 2.2	3.3 ± 2.4	<0.01
Readiness to quit smoking				0.03
Action/preparation	51.4	60.8	44.8	
Contemplation/pre-contemplation	48.6	39.2	55.2	
Intention to quit	94.7	96.1	93.8	0.48
Lifetime quit attempts (mean ± SD)	3.3 ± 5.3	3.2 ± 5.3	3.3 ± 5.3	0.91
Perceived self-efficacy in quitting smoking [c] (mean ± SD)				
Importance in successfully quitting cigarette smoking	7.3 ± 2.2	7.6 ± 2.2	7.2 ± 2.3	0.25
Confidence in successfully quitting cigarette smoking	6.1 ± 2.3	6.2 ± 2.4	6.0 ± 2.2	0.56
Difficulties in successfully quitting cigarette smoking	3.6 ± 2.3	3.6 ± 2.6	3.5 ± 2.1	0.72

[a] Cigarettes consumed per day on weekends.

[b] Fagerström score: 0–3 mild, 4–5 moderate, 6–10 severe.

[c] Score: 0–10, higher scores indicate better perceived self-efficacy.

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Table 2. Association between ever e-cig use and quitting cigarette smoking and quit attempts in all participants at the 6-month follow-up

| | N | Outcome [a] | | Effect size [b] | Raw coefficient (95% CI) [c] | |
		No EC use	EC use		Model 1	Model 2 [d]
Quitting cigarette	189	20.8 %	13.4 %	0.10	0.59 (0.27 to 1.28)	0.56 (0.24 to 1.35) [e]
Quit attempts	89	2.1 ± 2.4	3.1 ± 3.2	0.35	1.32 (0.05 to 2.60) [f]	1.26 (-0.13 to 2.66)

[a] Percentage for quitting cigarette smoking and mean for quit attempts.

[b] Cohen's d/Cohen's w: 0.10, small; 0.30, medium; 0.50, large.

[c] Odds ratio for quitting cigarette smoking and raw coefficients from the linear regression for quit attempts.

[d] Model 2: Adjusting for Model 1 variables and sex, age, smoking friends, and smoking family members.

[e] Adjusting for Model 2 variables, and for baseline quit attempts and nicotine dependence level.

[f] Adjusting for lifetime quit attempts reported at baseline.

2

Table 3. Association between ever e-cig use and quitting related outcomes in non-quitters at the 6-month follow-up

	N	Outcome (mean ± SD) [a]		Effect size [b]	Raw coefficient (95% CI) [c]	
		No EC use	EC use		Model 1 [d]	Model 2 [e]
Intention to quit	61	80.8 %	68.6 %	0.14	0.51 (0.15 to 1.72)	0.55 (0.15 to 2.05)
Nicotine dependence [f]	57	1.5 ± 1.6	2.6 ± 2.1	0.61	1.02 (0.00 to 2.04)	0.75 (-0.39 to 1.90)
Number of cigarettes consumed per day [g]	65	7.2 ± 6.4	8.7 ± 6.9	0.22	1.38 (-1.98 to 4.73)	1.47 (-2.21 to 5.15)
Perceived self-efficacy in quitting smoking [h]						
Importance in successfully quitting cigarette smoking	56	7.9 ± 1.9	6.6 ± 2.3	0.59	-0.85 (-1.93 to 0.24)	-0.76 (-2.01 to 0.49)
Confidence in successfully quitting cigarette smoking	55	5.0 ± 2.8	5.3 ± 2.5	0.09	0.06 (-1.49 to 1.62)	-0.13 (-1.80 to 1.54)
Difficulties in successfully quitting cigarette smoking	50	3.8 ± 2.9	3.2 ± 2.5	0.25	-1.06 (-2.69 to 0.56)	-0.75 (-2.38 to 0.88)

[a] Mean of outcome for all variables except % for intention to quit.

[b] Cohen's d/Cohen's w: 0.10, small; 0.30, medium; 0.50, large.

[c] All are raw coefficients from the linear regression except for intention to quit, which are odds ratios.

[d] Model 1: Adjusting for baseline respective level.

[e] Model 2: Adjusting for Model 1 variables and for sex, age, smoking friends and smoking family members.

[f] Fagerström score: 0–3 mild, 4–5 moderate, 6–10 severe.

[g] Cigarettes consumed per day on weekends.

[h] Score: 0–10, higher scores indicate better perceived self-efficacy.

3