Original Article

Use of Electronic Cigarettes among Secondary School Students and their Association with Depressive Symptoms: Findings from a National Secondary School Survey in Thailand

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Abstract

Objective: to describe: 1) the prevalence of electronic cigarette use among Thai secondary school students, stratified by grade levels and sex; 2) the extent that depressive symptoms were associated with former and current use of electronic cigarette.

Material and Methods: We conducted a cross-sectional study from secondary school students in Thailand in years 7, 9, and 11 of the 12-years educational system. We randomly sampled 113 schools in 21 provinces and Bangkok, randomly sampled classrooms in the school, and invited all students present in the sampled classrooms to participate in the study. All data were collected using self-administered questionnaires. We measured depressive symptoms using the Patient Health Questionnaire-2 (PHQ-2) instrument, and measured electronic cigarette use with adapted versions of existing instruments. Data analyses included descriptive statistics and logistic regression analyses with adjustment for sampling weights.

Results: A total of 23,659 students responded and provided adequately completed questionnaires. Approximately 12.3% of the participants reported a lifetime history of using electronic cigarette. Electronic cigarette use was more common among males and older students. There seemed to be a threshold in the association between the level of depressive symptoms and ever vs. never use of electronic cigarette, and the association was strongest at a PHQ-2 score of 6 vs.

0 (adjusted odd ratio (OR)=1.72; 95% confidence interval (CI)=0.98, 3.03). A similar association was found between current vs. former or never use of electronic cigarette and having a PHQ-2 score of 6 vs. 0 (adjusted OR=1.84; 95% CI=0.96, 3.52).

Conclusion: We found associations between depressive symptoms and electronic cigarette use. However, limitations with regard to the lack of temporality, measurement issues, and lack of generalizability should be considered as caveats in the interpretation of the study findings.

Keywords: adolescents, depression, electronic cigarette, Thailand, survey

Introduction

The use of electronic cigarette has risen among youths in the past decade[1], partly due to availability in a wide variety of sweet flavors and the perception of being free from negative health effects[2]. However, electronic cigarette use has been found to be associated with lung diseases in a similar manner to conventional cigarettes[3]. Electronic cigarette use, or "vaping," has the direct effect of electronic cigarette/vaping-associated lung injury (EVALI)[4], and the indirect effects of oxidative stress, impaired endothelial function, vascular stiffness, and increased blood pressure, as well as immunologic and neuro-developmental effects[4,5]. Vaping has also been found to increase the risk of using cannabis and other substances[6-8]. Thus, electronic cigarette use should be monitored in an effort to protect the public's health.

Thailand is a middle-income country that is an emerging market for electronic cigarette among young consumers[9]. Despite the existence of a complete ban on electronic cigarette use and distribution, electronic cigarette are widely available in the underground and online market[10]. Previous studies on electronic cigarette use prevalence at the national level have been conducted in Western countries[11-15], but data are scarce with regard to the prevalence of electronic cigarette use in low and middle-income countries such as Thailand. Such data can serve as empirical evidence for relevant stakeholders to monitor this emerging risky behavior.

Electronic cigarette use has been found to be associated with sex, age, socioeconomic status, and use of conventional cigarettes in previous studies[1,9,16-18]. Furthermore, a previous study found a strong association between alcohol use and depression among Thai youths[19]. Depression is a relatively common mental health condition among adolescents[20]. As nicotine has psychoactive properties[21], it is possible that adolescents with depressive symptoms use electronic cigarette as a method to intake nicotine, similar to the pattern in conventional cigarette use, or vice versa[22]. Previous studies and reviews[13,22-25] have reported that depression was associated with electronic cigarette use. However, as depression occurs in a gradient rather than as a binary, the pattern of associations between levels of depression and electronic cigarette use has not been fully explored. Such information would allow for a greater depth of understanding of the nature of depression and substance use, which would be of relevance to stakeholders in mental health treatment and substance use among youths.

The objectives of this study were to describe: 1) the prevalence of electronic cigarette use among Thai secondary students at various grade levels and sexes, and 2) the extent which depressive symptoms were associated with former and current use of electronic cigarette.

Material and Methods

Study design and setting

This study was a nationally-representative cross-sectional study titled the 5th National School Survey on Alcohol Consumption, Substance Use and Other Health-Risk Behaviors (henceforward "the survey"). The aim of the survey was to provide information about the magnitude and trend of health risk behaviors among secondary school students in Thailand's formal education system. The Survey was conducted from November 2020 to March 2021 at 113 schools in 21 (out of 77) provinces of Thailand and 1 district of Bangkok, the capital of Thailand.

Study participants and samples selection

We used a spreadsheet-based random number generator to select the 21 study provinces from the 12 education regions (plus one district in the capital of Bangkok), then stratified the schools in each province by type and randomly selected the participant schools. The Survey participants were drawn from students in Year 7 (Matthayom 1), Year 9 (Matthayom 3), and Year 11 (Matthayom 5) in the general education system Matthayom 5) and the vocational education system (Vocational Certificate Year 2) studying at the selected schools. We then selected 5 schools per study province (1 public general education school in an urban area, 1 public general education school in a rural area, 1 private school in an urban area, 1 business vocational school, and 1 technical vocational school). There were few to no rural private schools. In schools that had more than 5 classrooms per year level, we would randomly select 3 classrooms from each year level. In smaller schools with fewer than 5 classrooms per year level, we collected data from students in all classrooms in each target year level.

Exposure variable: depressive experience

We measured depressive symptoms at the time of the study using the Thai version of the Patient Health Questionnaire-2 (PHQ-2) questionnaire[26]. We modified the questions and answer choices to suit the self-administered format of the Survey. We used the same scoring criteria from 0 to 6 points in our analyses.

Outcome variable: electronic cigarette usage

Our questions regarding the use of electronic cigarette included lifetime history of electronic cigarette use, method of obtaining electronic cigarette, frequency and number of times of electronic cigarette use within 30 days prior to the Survey, and intention and history of quitting using electronic cigarette within the past 12 months. The questions were adapted from the questions regarding conventional cigarette use in the previous version of the questionnaire[19,27]. We adapted the definition of one time (session) of electronic cigarette use being equal to 15 puffs or 10 minutes of use from a survey of electronic cigarette use among students aged 18 years or older at a university in the United States[28].

Other characteristics of the study participants

Other sections of the study instrument also included self-reported demographic and socioeconomic information, alcohol use, and conventional cigarette smoking status. Our methods of measurement in this survey were similar to the methods previously described in the literature[27]. We classified our participants as never vs. former vs. current smokers based on the self-reported histories of lifetime and past-12-months smoking.

Data collection and data management

We then contacted the school administrators to ask for permission to conduct the Survey. We asked for a list of the classrooms within the school and sampled the classrooms according to the above-mentioned sampling procedure. Our trained study enumerators then visited the sampled classrooms at a time arranged with the school

administrators. The enumerators requested the teacher or other school staff with disciplinary authority to leave the classroom, introduced themselves to the students, provided information about the Survey, provided the students with the information sheet and the questionnaire, and asked the students for their verbal consent to participate in the study. The students then completed the questionnaires and placed the filled questionnaires in opaque envelopes. The enumerators then collected the envelopes and sent them to the data entry team, who performed data entry using the EpiData Entry software. Participants who answered less than 70 percent of the questions in which skip patterns did not apply were considered to have submitted incomplete responses and were excluded from the analyses.

Data analyses

We analyzed the data using descriptive statistics and logistic regression analyses, with adjustment for sampling weight using the epicalc[29] and Survey[30] packages in R. In bivariate and multivariate logistic regression analyses, we used dummy variables for PHQ-2 scores with 0 as the reference group. We assessed the extent that dose-response relationships existed between depressive symptoms and electronic cigarette use by using the numeric PHQ-2 score as the exposure variable and using the p-value as the p-for-trend. As per findings in the literature on determinants of electronic cigarette use,[1,9,16–19] we designated sex (gender assigned at birth), year of study (as proxy for age), weekly allowance (as proxy for socioeconomic status), conventional cigarette smoking status, and drinking status as confounders in our multivariate analyses and made adjustments accordingly.

Ethical considerations

The Survey was approved by the Human Research Ethics Committee of the Faculty of Medicine, Prince of Songkla University (approval number: REC.63-446-18-2).

Results

A total of 23,659 students responded and provided adequately completed questionnaires, the majority of whom were female and in the general education system (Table 1). The prevalence of lifetime and current uses of electronic cigarette (4.5% and 7.8%, respectively) was higher than that of conventional cigarette (3.8% and 5.5%, respectively). Current electronic cigarette users reported an average of slightly less than 2 times per day. The sources of electronic cigarette for the current users were heterogenous, but the most common source was having received the device from others. Approximately one-seventh of all participants had depressive symptoms above the screening cut-off point at the time of the Survey.

The use of electronic cigarette varied by year of study (a proxy for age) and sex (Table 2). The prevalence of lifetime and current use was highest among Vocational Certificate Year 2 (Year 11, vocational education) boys, followed by Matthayom 3 (Year 9) boys and Matthayom 5 (Year 11, general education) boys.

Detailed analyses of depressive symptoms scores and prevalence of electronic cigarette use showed an apparent threshold effect (Figure 1). The prevalence of lifetime use and current use were nearly identical among those with PHQ-2 scores between 0 and 2, then increased by about 1.5 times magnitude among those with PHQ-2 scores between 3 and 6. There seemed to be a linear-trend relationship between depression level (according to PHQ-2 score) and lifetime (ever) use of electronic cigarette (Table 3), with the strongest level among those with a PHQ-2 score of 6 (adjusted OR=1.72; 95% CI=0.98, 3.03). This relationship trend was statistically significant (p-for-trend=0.003). A similar linear-trend relationship was also present between depression level and current use of electronic cigarette (Table 4). The strongest level was among those with a PHQ-2 score of 6 (adjusted OR=1.84; 95% CI= 0.96, 3.52), although the trend was not statistically significant (p-for-trend=0.111).

Table 1 Characteristics of the study participants (n=23,659 students)

Characteristic	Weighted percent±SE or Weighted mean±SE
Birth gender: female (ref. male)	
Male	42.0%±2.1%
Female	58.0%±2.1%
Year of study	
Matthayom 1 (year 7)	35.3%±3.8%
Matthayom 3 (year 9)	35.5%±3.8%
Matthayom 5 (year 11)	26.1%±7.2%
Vocational certificate 2 (year 11)	3.0%±1.1%
Weekly allowance in THB	479.0±16.7 THB
Alcohol use	
Never (never drinkers	73.0%±1.9%
Former (former drinkers)	6.0%±0.4%
Current occasional (more than 30 days but within 12 months)	9.1%±0.7%
Current regular drinkers (within past 30 days)	11.8%±1.1%
Conventional cigarette use	
Never	90.7%±0.7%
Former	3.8%±0.3%
Current	5.5%±0.5%
Electronic cigarette use	
Never	87.7%±1.0%
Former	4.5%±0.0%
Current	7.8%±0.6%
Co-use of conventional and electronic cigarette	
Never used conventional cigarettes, never used electronic cigarette	85.2%±0.9%
Never used conventional cigarettes, former electronic cigarette user	2.4%±0.2%
Never used conventional cigarettes, current electronic cigarette user	3.1%±0.2%
Former conventional cigarette user, never used electronic cigarette	1.5%±0.2%
Former conventional cigarette user, former electronic cigarette user	1.3%±0.1%
Former conventional cigarette user, current electronic cigarette user	1.0%±0.1%
Current conventional cigarette user, never used electronic cigarette	1.1%±0.1%
Current conventional cigarette user, former electronic cigarette user	0.7%±0.1%
Current conventional cigarette user, current electronic cigarette user	3.6%±0.4%
Among current electronic cigarette users, source of electronic cigarette at the most recent use	(n=2,896 students)
Purchased by self (from store or stall ∕ online shop)	15.0%±1.1%
Straw purchase	6.1%±0.7%
Given by others	23.2%±2.2%
Stolen	0.6%±0.2%
By other means	20.9%±2.2%
No answer	34.3%±5.0%
Mean number of times per day of use (1 time=15 hits or 10 minutes) during past 30 days (n=907 students)	1.9±0.3 times
Depressive symptoms at time of survey (PHQ-2 ≥3 points)	
No	85.2%±0.9%
Yes	14.8%±0.9%

THB=Thai baht, SE=standard error

Table 2 Electronic cigarette use by sex and year of study (n=22,705 students)

Sex and year of study	Never users %	Former users %	Current users %
Matthayom 1 Boys (n=2,851 students)	90.5±1.7	4.5±1.0	5.0±0.9
Matthayom 1 Girls (n=3,710 students)	95.1±0.7	1.6±0.4	3.3±0.5
Matthayom 3 Boys (n=2,799 students)	76.7±2.8	7.6±0.7	15.7±2.2
Matthayom 3 Girls (n=3,702 students)	90.5±1.0	3.6±0.4	5.9±0.7
Matthayom 5 Boys (n=2,186 students)	78.9±3.4	7.3±1.1	13.8±2.6
Matthayom 5 Girls (n=2,809 students)	90.4±1.7	4.1±0.8	5.5±1.1
Vocational certificate 2 Boys (n=2,001 students)	69.4±3.8	8.7±1.0	21.9±3.2
Vocational certificate 2 Girls (n=1,647 students)	85.3±3.2	4.2±1.2	10.5±2.2

Table 3 Associations between depressive symptoms (PHQ-2) score and lifetime history of electronic cigarette use (n=21,953 students)

Depressive symptom (PHQ-2) score	Never users %	Lifetime (current or former) users %	Crude OR (95% CI)	Adjusted OR (95% CI)*
Score=0 (n=7,777)	88.3	11.7	1 (Reference)	1 (Reference)
Score=1 (n=4,094)	88.8	11.2	0.96 (0.72, 1.26)	1.16 (0.88, 1.54)
Score=2 (n=7,156)	88.5	11.5	0.98 (0.75, 1.28)	1.28 (1.00, 1.63)
Score=3 (n=1,039)	83.9	16.1	1.45 (1.00, 2.10)	1.69 (1.15, 2.48)
Score=4 (n=945)	83.6	16.4	1.48 (1.02, 2.16)	1.35 (0.91, 2.00)
Score=5 (n=382)	83.7	16.3	1.48 (0.93, 2.36)	1.36 (0.66, 2.79)
Score=6 (n=560)	82.7	17.3	1.58 (1.06, 2.37)	1.72 (0.98, 3.03)
P-for-trend	N/A	N/A	0.017	0.003

*Adjusted for sex, year of study, weekly allowance, alcohol use, and conventional cigarette smoking
PHQ-2=patient health questionnaire-2

Table 4 Associations between depressive symptoms (PHQ-2) score and current use of electronic cigarette (n=21,953 students)

Depressive symptoms (PHQ-2) score	Non-current (never or former) users %	Current users %	Crude OR (95% CI)	Adjusted OR (95% CI)*
Score=0 (n=7,777)	92.5	7.5	1 (Reference)	1 (Reference)
Score=1 (n=4,094)	92.6	7.4	0.97 (0.73, 1.30)	1.19 (0.90, 1.56)
Score=2 (n=7,156)	93.0	7.0	0.93 (0.70, 1.23)	1.11 (0.88, 1.40)
Score=3 (n=1,039)	90.0	10.0	1.36 (0.95, 1.95)	**1.40 (1.01, 1.92)**
Score=4 (n=945)	90.2	9.8	1.33 (0.88, 2.01)	1.21 (0.87, 1.69)
Score=5 (n=382)	91.6	8.4	1.13 (0.56, 2.27)	0.82 (0.38, 1.79)
Score=6 (n=560)	87.8	12.2	**1.70 (1.08, 2.67)**	1.84 (0.96, 3.52)
P-for-trend	N/A	N/A	0.107	0.111

*Adjusted for sex, year of study, weekly allowance, alcohol use, and conventional cigarette smoking
PHQ-2=patient health questionnaire-2
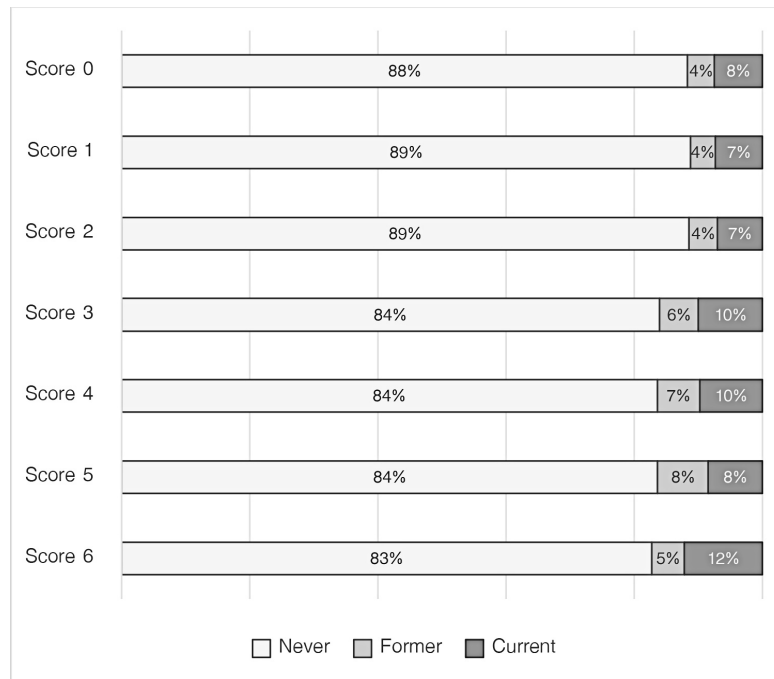
PHQ-2=Patient Health Questionnaire-2

Figure 1 Electronic cigarette current use by PHQ-2 score

Discussion

In this nationally representative school-based survey, we described the prevalence of electronic cigarette use among Thai secondary school students and their associations with depressive symptoms. We found variations in prevalences of former and current use by sex (gender assigned at birth) and year level. We also found that there appeared to be a threshold effect for level of depression (as measured by the PHQ-2 screening score) and former/current use of electronic cigarette, and that depressive symptoms were significantly associated with electronic cigarette use. The findings of our study have implications for those who work in tobacco control, as well as those who work on adolescent mental health.

We found that male students had a higher prevalence of current electronic cigarette use than female students, and vocational students had a higher prevalence than general education students. The higher prevalence of use among male compared to female adolescents was consistent with the literature from other settings[31]. On the other hand, the higher prevalence of use among vocational students compared to general education students could be a reflection of the broader disparities in deviant behaviors between students in different education tracks[32] that may be more specific to Thailand. Furthermore, it is possible that adolescent electronic cigarette users of different ages and genders may also have different perceptions pertaining to vaping, as well as different social aspects[33]. Future studies should investigate these issues in more detail to achieve a better understanding of the disparities in electronic cigarette use in adolescents.

Among our study participants, lifetime history and current use of electronic cigarette were more common than with their conventional cigarette counterparts. This difference reflected a similar trend among adolescents and young adults in other countries[34]. However, considering that conventional

and electronic cigarette use heavily overlap[35] and that both products function as nicotine self-administration devices, it is unlikely that conventional cigarettes will be completely replaced with electronic cigarette. In addition, the average use of 2 times per day should also be carefully considered. We defined one occasion (time) of using an electronic cigarette as "15 puffs or 10 minutes"[28], and translated this definition to our study questionnaire. This definition was likely prone to error. Users who took more than 15 puffs during a span of 10 minutes but were unaware of their actual puff numbers might have under-reported the number of times of use, thus biasing the estimated number of times downward. A previous study on nicotine equivalence in electronic cigarette only measured the number of puffs[36], thus future studies should consider removing the 10-minute limit. One additional major limitation of our study is that we did not capture the normal frequency of electronic cigarette use among ever users. Daily users of electronic cigarette may have a different distribution of depressive experiences compared to non-daily users. Our frequency measurement question was "D15. In the past 30 days, how many days did you use electronic cigarettes?" with the answer choices of: "0) None; 1) 1-2 days; 2) 3-5 days; 3) 6-9 days; 4) 10-19 days; 5) 20 days or more". Thus, it was not possible for us to distinguish whether participants who answered "20 days or more" were non-daily or daily users. Furthermore, the number of days of use during the 30 days prior to the survey also might not have reflected the usual frequency. Future studies should consider adopting standard questions such as those used by the Global Adult Tobacco Survey[37] in order to obtain this important measurement.

PHQ-2 scores had a more pronounced positive association with lifetime use of electronic cigarette than current use of electronic cigarette, although there were statistically significant positive trends for both outcomes. The findings of our study have the potential to complement existing findings which investigated the association between electronic cigarette use (as the exposure) and depressive experience (as the outcome)[9,13]. Our study used depressive symptoms as the exposure and electronic cigarette use as the outcome, which was the inverse of other studies. The p-for-trend values suggested that there was a possible dose-response relationship between depressive symptoms and use of electronic cigarette. The use of electronic cigarette could have been a coping behavior for depression, similar to the use of conventional cigarettes[22]. However, considering that depression can either be chronic or episodic[38], that the PHQ-2 questions only pertained to depressive symptoms within the 2 weeks prior to the survey, and that we did not ask about the specific date of the first and last electronic cigarette use, a caveat is advised with regard to the temporality of the association. The adolescent brain is more sensitive to the effect of toxic substances, including nicotine, on neurobiological functions and development[39]. Thus, electronic cigarette use could have preceded and induced depression, rather than vice versa. Furthermore, the PHQ-2 is a screening instrument and is not intended for diagnostic purposes, and the findings of this study should be accordingly considered as preliminary.

The strength of this study is in the large sample size, which allows for assessment of the associations between depressive symptoms and electronic cigarette use even among the small minority who scored very high on the PHQ-2 questionnaire. However, a number of limitations should be considered in the interpretation of the study findings. Firstly, the cross-sectional study design did not allow for ensuring the temporality of the association. Secondly, there are a number of measurement issues: depressive symptoms were measured on the day of the survey and electronic cigarette use was measured with regard to status (as never vs. former vs. current users) rather than pattern of use. Future studies should consider more relevant and thorough measurements. Thirdly, this study was conducted only in school-going adolescents. The findings of this study may not be generalizable to non-school-attending adolescents.

Conclusion

We found variations in lifetime and current use of electronic cigarette by year level and sex. We also found that depressive symptoms were associated with both lifetime and current use of electronic cigarette, although the association was clearer for the former than the latter. Our findings contribute basic information for public health, and have implications for stakeholders in tobacco control and adolescent mental health issues. However, limitations with regard to the lack of temporality, measurement issues, and lack of generalizability should be considered as caveats in the interpretation of the study findings.

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