Electronic Cigarette Use Among Teenagers and Young Adults in Poland

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**KEY WORDS** adolescents, electronic cigarettes, e-cigarettes, nicotine, smoking, students

**ABBREVIATIONS**
CI—confidence interval
e-cigarette—electronic cigarette

Dr Goniewicz designed the study, analyzed and interpreted the data, and drafted the article. Dr Zielinska-Danch acquired and analyzed the data. Both authors approved the final version of this article.

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WHAT’S KNOWN ON THIS SUBJECT: Electronic cigarettes are battery-powered devices that simulate tobacco cigarettes by vaporizing nicotine and other chemicals into an inhalable mist. They have gained popularity around the world, but little is known about their safety and addictive properties.

WHAT THIS STUDY ADDS: Among Polish youth, electronic cigarettes are the fourth most common source of nicotine after cigarettes, waterpipes, and snuff. For those aged between 15 and 24 years, ever use of an electronic cigarette was 20.9%, and 30-day use was 6.9%.

**abstract**

**BACKGROUND:** Electronic cigarettes (e-cigarettes) are battery-powered devices developed with the goal of mimicking the action of smoking, including nicotine delivery, without the toxic effects of tobacco smoke. Little is known about the uptake of e-cigarettes among young people.

**METHODS:** A survey was conducted with a cluster sample of 20 240 students enrolled at 176 nationally representative Polish high schools and universities between September 2010 and June 2011. We estimated national e-cigarette prevalence among various demographic groups by using population weights. Multiple logistic regression was used to evaluate which demographic factors were independent predictors of 2 outcomes: ever use of e-cigarettes and use in the previous 30 days.

**RESULTS:** Among high school students, aged 15 to 19 years, 23.5% had ever used e-cigarettes and 8.2% had done so within the previous 30 days. Among those in universities, aged 20 to 24 years, 19.0% had ever used an e-cigarette and 5.9% had done so in the previous 30 days. In multivariate analyses that controlled for covariates, smoking cigarettes, male gender, living in an urban area, and having parents who smoke were associated with ever use of e-cigarettes. Overall, 3.2% of never smoking students reported ever use of e-cigarettes.

**CONCLUSIONS:** About one-fifth of Polish youth have tried e-cigarettes; most of them had previously smoked cigarettes. It is unclear whether e-cigarettes are just a novelty that young people try only once or whether they have potential to compete in the marketplace with conventional cigarettes. *Pediatrics* 2012;130:e879–e885
Electronic cigarettes (e-cigarettes, also known as electronic nicotine delivery systems) are battery-powered devices that deliver vaporized nicotine. The e-cigarette was developed with the goal of mimicking the action of smoking, including nicotine delivery, without the toxic effects of tobacco smoke. When a user inhales through the device, airflow is detected by a sensor, which activates a heating element that vaporizes a nicotine solution contained in a cartridge.\(^1,2\)

There is growing interest and concern about e-cigarettes in many countries because there is very limited scientific evidence about their safety and efficacy. According to the Electronic Cigarette Association (industry association), sales of these products reached an estimated $100 million worldwide in 2009.\(^3\) This is a negligible fraction of the sales of conventional cigarettes, but there are signs that e-cigarettes are becoming more popular. One study found that awareness of e-cigarettes among adults (age ≥18 years) in the United States doubled from 2009 to 2010, reaching 32%, while the estimated ever use of the products was 2.7%.\(^4\) E-cigarettes have been widely advertised in many countries in the past few years, mostly through the Internet.\(^5\) A study monitoring Google search queries from January 2008 to September 2010 reported that online interest in e-cigarettes has surpassed that of snus and nicotine replacement treatments.\(^6\) The products are also promoted in entertainment, including movies and television shows.\(^7\)

One potential public health concern is that they might have an impact on initiation of tobacco use, especially among youth, as a product which might cause nicotine addiction. Because e-cigarettes are mostly sold through the Internet, they might be easily purchased by young clients. Results of a study by Regan et al\(^8\) found that young adults in the United States were more aware of e-cigarettes than older adults. A study by Cho et al\(^9\) indicated that awareness of the products in a sample of Korean adolescents was 11%. In the United States, only 5 states (New Hampshire, Arizona, Oregon, Minnesota, and New Jersey) currently ban the sale of electronic nicotine delivery systems to minors (age <18 years).\(^4,9\)

E-cigarettes have been available on the Polish market since early 2008. Poland allows marketing of e-cigarettes within its current regulatory framework, although it bans the sale of tobacco products to minors (age <18 years). Because the popularity of these products on the Internet and other media has increased over the last few years, we investigated whether current awareness and use of them among students in Poland has reached a significant level. To the best of our knowledge, there has been no European or US study to investigate the usage and popularity of the products among children, adolescents, or young adults. The aims of this study were to assess the awareness, ever and current use of e-cigarettes, and perception of their safety among high school and university students in Poland.

**METHODS**

**Design and Settings**

Recent data show that 30.3% (9.8 million) of the Polish population who are aged ≥15 years currently smoke cigarettes, including 36.9% of men and 24.4% of women.\(^10\) Results from the Global Youth Tobacco Survey found that in 2003, smoking prevalence among Polish students aged 13 to 15 years was 18.6% and was higher among boys than girls (19.6% vs 17.1%, respectively).\(^11\)

Data on e-cigarette use were collected during a national survey on waterpipe smoking among teenagers and young adults in Poland. The questionnaire was developed in Polish and finalized in August 2010 on the basis of results of a small pilot study conducted between February and April 2010. The survey was pretested in the Silesia region for clarity, sequencing of questions, time required to complete, data collection, management procedures, and other issues. The final survey was conducted between September 2010 and June 2011. The project was supported by the Ministry of Science and Higher Education of Poland.

The questionnaire was reviewed by the Committee for Human Research, and the survey was conducted in compliance with the requirements of the Medical University of Silesia. The survey was voluntary, anonymous, and confidential. No reimbursements or prizes were offered to the students. Verbal consent was obtained from eligible respondents. They could withdraw from the study at anytime and had the right to refuse to answer any question without providing a reason.

**Sampling and Data Collection**

The study involved a 3-staged stratified cluster sample of students in Poland where schools and universities were treated as the primary sample unit. In the first stage of sample selection, a total of 176 schools and universities were chosen. They were equally allocated across all 16 provinces; thus, there were 11 schools and universities in each province. In the second stage of sample selection, 3 regions (2 urban and 1 rural) in each province were selected, resulting in a total of 48 regions (32 urban and 16 rural). Rural regions with a population of <20 000 were excluded from the study to ensure availability of schools for the second stage of sample selection and survey completion. Excluded regions were primarily in remote and difficult to reach areas of Poland. Allocation of schools and universities to rural and
urban regions within each province was at a ratio of 2:1 for schools and 1:1 for universities, respectively. As a result, a total of 144 schools (96 in urban and 48 in rural regions) and 32 universities (16 in urban and 16 in rural regions) were selected. Finally, 115 students were randomly chosen from each school and invited to participate in the study. The sample size was 20,240 students allocated as follows: (1) 11,040 school students in urban areas; (2) 5,520 school students in rural areas; (3) 1,840 university school students in urban areas; and (4) 1,840 university school students in rural areas. The introductory letters and letters requesting permission to participate in the study were sent directly to school directors, principals, or deans. After each school and university agreed to participate, we contacted a designated person in each school and selected classes and students to be surveyed. Two protocols were used for delivering questionnaires to schools and collecting data. In the first protocol, questionnaires were mailed to 10,235 randomly selected students across 89 schools and universities. After completion of the survey by students, questionnaires were sent back to the study center. In the second protocol, questionnaires were delivered to 10,005 randomly selected students in 87 schools and universities, and these were collected after students had completed them on site. The average response rate was 78% (n = 15,875) and was higher for the second than for the first protocol (87.0% vs 70.1%, respectively).

**Questionnaire and Measures**

The survey consisted of 90 closed questions about demographic and background characteristics (age, gender, place of living, level of education, family status, and physical activities), current and previous use of waterpipe, cigarettes, snuff, snus, and e-cigarettes, nicotine product availability, alcohol and other substance use, knowledge about nicotine addiction and the health consequences of smoking, attitudes toward tobacco product regulation and smoking bans in public places, family and peers’ smoking history, attempts to quit smoking, and social life. Because white (Caucasian) race is predominant in Poland, the survey did not include the question about race. For the purpose of the study, we only used data pertaining to demographic characteristics, cigarette smoking, and e-cigarette use.

To assess smoking status, respondents were asked whether they had smoked a single cigarette in their life, had smoked at least 100 cigarettes in their life, and had smoked any cigarettes in the past 30 days. Students who had smoked >100 cigarettes in their lifetime and who had smoked at least once in the past 30 days were considered to be current smokers. Respondents were also asked about the smoking status of their parents and, if applicable, their partner.

For assessing awareness about e-cigarettes, prevalence of use, and attitude toward their safety, 4 questions were asked: (1) “Have you ever heard about electronic cigarettes (e-cigarettes)?”; (2) “Have you ever used an e-cigarette?”; (3) “Have you used an e-cigarette at least once in the previous 30 days?”; and (4) “Do you think e-cigarettes are less harmful than regular cigarettes?”. Students who answered that they had used the device in the last 30 days were classified as current e-cigarette users.

**Statistical Analysis**

Statistical analyses were conducted with Statistica version 10 (StatSoft, Tulsa, OK) by using weighted data corrected for nonrespondents. Due to nonproportional allocation of the sample to the different strata, sampling weights were required to ensure the actual representativeness of the sample at the national level as well as the stratum level (provinces, urban/rural regions, schools/universities). Weights were constructed by using the most recent Demographic Yearbook of Poland 2010 published by the Central Statistical Office. Among the 15,875 received questionnaires, 13,787 (86.8%) students were identified who completed the survey and provided evaluable data. Descriptive statistics were provided to assess the demographic characteristics of respondents, history of smoking, rates of the awareness, ever and current use of e-cigarettes, and perception of their safety. Multiple logistic regression analysis was performed to determine which factors had independent relationships with outcomes. To improve clarity, predicted probabilities were estimated for 5 measured factors: age, gender, area of living, current smoking status, and having a smoking parent and/or partner. Because only 3.9% of our sample had missing data on e-cigarette use, we excluded records of these students from regression analyses. For all analyses, values of P ≤ .05 were considered statistically significant. We ranked predicted probabilities and identified groups of young people who are at the highest and the lowest risk of e-cigarette use.

**RESULTS**

**Characteristics of the Sample**

Evaluable data were received from 13,787 students, representing a population of 3,426,897 persons aged 15 to 24 years living in Poland. Mean age of the sample was 17.9 years (96% confidence interval [CI]: 16.7–19.3). Survey weights were used to account and adjust for uneven representation. To assess the representativeness of the sample, the demographic profiles of the unweighted
sample were compared with the profiles of the national statistics used for calculating the weights. Differences in the demographic profiles between the survey and national statistics were modest.

**Awareness and Use of E-Cigarettes**

A total of 13,250 students responded to questions about e-cigarette awareness and use. Accounting for survey weights, 86.4% (95% CI: 85.8–87.0) of Polish students had ever heard about e-cigarettes. Awareness of e-cigarettes was high among all studied groups. Table 1 presents the demographic characteristics of ever and current (last 30 days) users of electronic cigarettes. We estimated that 20.9% (95% CI: 20.1–21.6) of Polish students aged 15 to 24 years had ever tried an e-cigarette, and 6.9% (95% CI: 6.4–7.4) had used it in the 30 days before completing the survey. Significantly higher rates of e-cigarette use were found among boys, school students, those living in urban areas, those who smoked cigarettes, and for those who had a parent or partner who smoked. Among surveyed Polish youths, e-cigarettes were the fourth most common source of nicotine after tobacco cigarettes (37.1%; 95% CI: 36.2–37.9), waterpipes (22.2%; 95% CI: 21.5–23.0), and snuff (16.9%; 95% CI: 16.2–17.5) (Fig 1).

Predicted probabilities of e-cigarette ever use and past 30 days’ use are presented in Fig 2. All analyzed factors were strong predictors of e-cigarette ever use except for age/school level. Boys were more likely than girls to try e-cigarettes (26.9% vs 13.9%). Students who had experienced smoking a cigarette were more likely to experience e-cigarettes than those who had never smoked (38.2% vs 8.8%). Current smokers were more likely to have used an e-cigarette in the last 30 days than nonsmokers (11.3% vs 0.8%). Having a parent or partner who smoked were significant predictors of both ever and current use of e-cigarettes (23.6% vs 16.1% and 6.8% vs 1.5%, respectively). Cigarette smoking boys, regardless of their age and place of living, who had a parent or partner who also smoked were at the highest risk of ever and current use of e-cigarettes (>50% and >25%, respectively). Nonsmoking girls, regardless of their age, who lived in rural areas and had nonsmoking parents and partners were at the lowest risk of ever and current use of e-cigarettes (<4% and <1%, respectively). More than one-half of Polish students (54.8%; 95% CI: 53.9–55.6) believed that e-cigarettes were safer than regular cigarettes.

**DISCUSSION**

**Principal Findings**

Using data from a large sample of students in Poland, we found that 1 in 5 Polish students had ever tried an e-cigarette and ~7% had used it during the 30 days before they took the survey. Among surveyed Polish youth, e-cigarettes were the fourth most common source of nicotine after cigarettes, waterpipes, and snuff. We also showed that more than half of Polish students believed that e-cigarettes are safer than regular cigarettes. The results indicated that some demographic factors were independent predictors of e-cigarette use among students.

**Strengths and Weaknesses of Our Study**

To our knowledge, this is the first nationally representative study of e-cigarette awareness and use among students aged 15 to 24 years. Our study had some limitations that should be noted when considering the results. First, we excluded students from rural regions with a population of <20,000; thus, groups of students who live in rural areas might be underrepresented. Because we found that students living in urban areas were more likely to use e-cigarettes than students from rural...
areas, it is very likely that the national prevalence of e-cigarette use might be overestimated. Second, all estimates in our study were based on self-reported use of e-cigarettes and might be affected by reporting bias. Third, we did not investigate whether students were currently using e-cigarettes on a periodic basis but rather if they had ever used them. Students did not report how many times they used e-cigarettes, and we are not able to assess how many students use them continuously or occasionally. Finally, the survey used was limited to state-run public schools. Therefore, generalizations to students in private schools cannot be made. In addition, the low response rate of 78% could have biased our results. Despite these limitations, estimates obtained in our survey on smoking prevalence are consistent with those of a national survey conducted in 2010 among students aged 18 to 19 years (38% vs 40%), suggesting reliability of the current results.14

Strengths and Weaknesses in Relation to Other Studies

We found that 20.9% of Polish students had ever tried an e-cigarette and ∼7% had used it during the 30 days before they took the survey. Those numbers are higher than statistics reported by Cho et al8 who surveyed a random sample of Korean students. They found that only 0.5% of students reported having ever used an e-cigarette. However, their study differs from ours. First, we had access to more recent data (2010–2011 vs 2008), which is important because the popularity of e-cigarettes has increased rapidly.4–6 Regan et al4 collected data from US adults (age >18 years) using a consumer-based mail-in survey and found that ever use of e-cigarettes in the United States more than quadrupled from 2009 to 2010. Secondly, we surveyed a large sample of students from different regions of the country, which might have contributed to higher variability among respondents. Finally, we had a larger sample size and estimated national prevalence of e-cigarettes among students. To our knowledge, no other studies of the
We found a higher prevalence of e-cigarettes in this population of Polish students than previously reported among adults in other countries. A study in the United Kingdom found that 9% of adult smokers had ever used e-cigarettes.\(^4\) A study by Regan et al\(^4\) showed that in 2010, 2.7% of US adults had tried e-cigarettes. Moreover, the same study found that young adults were more aware of e-cigarettes than older adults. Because e-cigarettes are mostly advertised through the Internet, younger people might be more aware of them.

We found that boys and students living in urban areas were more likely to have used e-cigarettes than girls and those living in rural areas, respectively. The gender effect is consistent with the findings of Cho et al,\(^8\) and surveys among adult users of e-cigarettes showed that they are more popular among men than women.\(^16\)–\(^18\) The effect of living area might be explained by easier access to the Internet from urbanized parts of the country, as web sites remain the main source of information and channel of distribution of the products.

We also found that students who had a parent or partner who smoked were more likely to use e-cigarettes than students with no smoking person in their family or in a close relationship. This phenomenon has been previously reported among students who smoked waterpipes: prevalence of these products was higher among students who had family members or friends who smoked than among those without such contacts.\(^19\) The smoking behavior of partners has been shown to be associated with higher odds of weekly and occasional smoking.\(^20\)

### Unanswered Questions and Future Research

Because of the high levels of e-cigarette use reported among these Polish students, there is a need for education programs as well as further investigation of national prevalence rates, population health risk/benefits, and effect on tobacco product use. Future research is needed to determine prevalence rates among various demographic groups, as well as to compare prevalence across various countries. The impact of e-cigarette promotion and advertising on e-cigarette use among youths needs to be evaluated.

One of the public concerns about e-cigarettes is that they might initiate tobacco use. In our study, only a small fraction (3.2%) of never-smoking students reported ever use of e-cigarettes and 1.4% had used it in the last 30 days. However, we were unable to examine patterns of their e-cigarette use and if they had later initiated tobacco use. Future studies should consider monitoring e-cigarette use among adolescents and their effect on concurrent use of other nicotine products.

### CONCLUSIONS

We concluded that e-cigarette use was widespread in a population of Polish students and is not a fad. There is a need for further research on the use of e-cigarettes and their effect on public health.

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