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New vs. old – use of nicotine delivery products by adult residents of Poland

Natalia Miller[1,C-D] ✉, Piotr Samel-Kowalik[1,C-D], Edyta Krzych-Fałta[2,D-E], Agata Zadrożna[3,A-B], Bolesław Samoliński[1,A,E-F]

[1] *Department of Prevention of Environmental Hazards, Allergology and Immunology, Medical University, Warsaw, Poland*
[2] *Department of Basic of Nursing, Medical University, Warsaw, Poland*
[3] *Social research expert, Opinia24 Sp. z o.o., Radom, Poland*
A – Research concept and design, B – Collection and/or assembly of data, C – Data analysis and interpretation, D – Writing the article, E – Critical revision of the article, F – Final approval of the article

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Abstract

Introduction and Objective. The global tobacco smoking prevalence is estimated at 22.3% of the adult population. In Poland, nearly 1/4 of all adults smoke cigarettes (TC). The aim of this study was to determine the percentage of adult Poles using traditional and novel nicotine-containing products, as well as to determine factors linked with choosing e-cigarettes and heated tobacco products (HTP).

Materials and Method. A representative cross-sectional study was conducted (CATI technique, data collected March-May 2022) with a random sample of 5,000 inhabitants of Poland aged 18+.

Results. The total current prevalence of use of one or more of the analyzed products (TC, e-cigarettes, HTP) was 24.4% (95%CI:23.2–25.6%). Current users of TC amounted to 21.1% (95%CI:20.0–22.2). The prevalence of everyday users of TC was 16.5% (95%CI:15.5–17.5%) with another 4.6% (95%CI:4.0–5.2%) smoking TC occasionally. The total current prevalence of use of e-cigarettes was 3.2%, where current everyday prevalence was 1.9% (95%CI:1.6–2.4) and 1.3% (95%CI:1.0–1.7) occasional. The total current prevalence of use of HTP was 3.4% where current everyday prevalence was 1.8% (95%CI:1.5–2.2) and 1.6% (95%CI:1.3–2.0) occasional.

Conclusions. In 2022, the current use prevalence of HTP (every day or occasional) is similar to the use prevalence of e-cigarettes among adults living in Poland. In 2022, the current smoking prevalence of TC in Poland was 6–7 times higher than the current use prevalence of HTP or e-cigarettes. Although the smoking prevalence of TC has decreased in the last 10 years, it remains higher in Poland when compared to the average in the European Union.

Key words

epidemiology, prevalence, nicotine, cigarettes, e-cigarettes, heated tobacco products

INTRODUCTION

In view of its documented toxicity, the smoking of tobacco-containing products is considered one of the main risk factors for mortality worldwide [1, 2]. It is recognised as one of several causes of cancer, cardiovascular disease, and respiratory disease, including chronic obstructive pulmonary disease (COPD) [3]. According to data from the World Health Organisation (WHO), tobacco is responsible for over 8 million deaths annually, with 7 million of these attributable to cigarette smoking, and nearly 1.3 million to passive smoking. The global prevalence of smoking is estimated at 22.3% of the population, with a predominance of male smokers [4]. In Poland alone, approximately one-in-four adults smoke cigarettes. In 2019, an estimated 26.0% of the adult Polish population were cigarette users, of whom 21.0% were regular users and 5.0% occasional users. There were 3.0% e-cigarette users, of whom 2.0% were regular and 1.0% occasional. The prevalence of using heated tobacco products (HTPs) was not assessed [5]. The highest documented toxicity has been attributed to traditional cigarettes, while e-cigarettes and HTPs, both relatively recent additions to the tobacco market, are perceived to be less harmful [6]. E-cigarettes are equipped with an electronic system for dosing nicotine in the form of an aerosol [7], while heat-not-burn (HnB) tobacco products use disposable tobacco sticks [8] that are heated to a temperature of 330–349°C, but do not result in no combustion. In comparison, traditional cigarettes are heated to 600°C and the tobacco is actually burned in the combustion process [8, 9].

The first references to e-cigarettes in Poland date back to 2006; however, it was not until 2008–2009 that there was a significant expansion of these products on the Polish market. A ban on smoking in public places in Poland was introduced by Parliament in the Act of 15 November 2010 (amending the Act of 9 November 1995 on the Protection of Health from the Consequences of Use of Tobacco and Tobacco), which specifies the regulations on the sale of tobacco products and places where smoking is prohibited [10]. Heated tobacco products were first introduced to the Polish market in 2017, exempt from excise tax. In 2018, a 0% excise tax was implemented for the initial two years and in October 2020 it was adjusted to 1/5 of the rate applied to traditional cigarettes. Effective from 1 March 2025, excise duty rates on tobacco products, novelty products and e-liquid will increase, which will range from 25% to as much as 75%, depending on the specific tobacco product. Heated tobacco

✉ Address for correspondence: Natalia Miller, Department of Prevention of Environmental Hazards, Allergology and Immunology, Medical University, Warsaw, Poland
E-mail: natalia.miller@wum.edu.pl

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products will face a 50% increase in 2025, followed by 20% in 2026 and 15% in 2027 [11].

Tobacco use represents a significant threat to public health due to its direct impact on premature mortality, and it remains a major public health concern in Poland. Updating the state of knowledge on changes in the prevalence of tobacco use is crucial for supporting informed public health decisions. The primary aim of this study was to determine the percentage of adult Poles using traditional and novel nicotine-containing products. A secondary objective was to identify the socio-demographic factors that influence the preference for e-cigarettes and heated tobacco products.

MATERIALS AND MEHOD

Study design. A representative cross-sectional study was conducted bythe structured telephone survey method CATI (Computer-Assisted Telephone Interviewing) in which interviewers followed a customized script provided by a software application. The survey involved a random sample of 5,000 inhabitants of Poland aged 18 years and over. The primary data was collected between March – May 2022 by the research company Kantar in cooperation with the Medical University of Warsaw. The average duration of the telephone interview was 10.6 minutes.

Participation in this study was voluntary and anonymous. All participants declared informed consent. The study protocol was approved by the Ethical Committee at the Medical University of Warsaw (Decision No. KB/193/2021 as of 8th November 2021).

Target population. The target population comprised all adult inhabitants of Poland (31.1 million). The inclusion criteria were as follows: age 18 years and above, consent to participate in the survey, ability to speak Polish, Polish residency. The exclusion criteria involved no telephone and pregnancy (when the female respondent answered positively to a question about pregnancy, the survey was discontinued).

Sample selection. The study was carried out on a quota-representative sample of 5,000 inhabitants of Poland aged 18 years and over. The sample was stratified by age (5 layers: 18–29 years, 30–39 years, 40–49 years, 50–59 years, 60 years, and over), gender (2 layers) of respondents, province (administrative region, 16 layers) and place of residence (5 layers). The sample structure based on current population data is presented in the online supplement (Tab. S1).

The telephone numbers used in the study were randomly generated based on the prefixes of mobile phones (the first 3–4 digits) registered in the Office of Electronic Communications (UKE). According to data from the UKE, over 90.0% of Poles use mobile phones, while approximately 10.0% use landlines. The study was conducted using mobile numbers, with survey respondents comprising individuals who answered the phone. The respondents were classified into layers based on their answers to the questions regarding their age, gender, and geographical location.

Variables. An ever smoker of cigarettes was defined as a person who had responded in the affirmative to the question 'Have you smoked at least 100 traditional cigarettes during your lifetime?' Current smokers were identified based on their responses to the question 'Do you currently smoke traditional cigarettes?' An ever-user of e-cigarettes was defined as a person who had responded affirmatively to the question 'Have you ever had your own e-cigarette?' Current e-cigarette users were identified based on their responses to the question 'Do you currently use e-cigarettes?' An ever-user of HTPs was defined as a person who responded affirmatively to the question 'Have you used at least 100 HTPs tobacco refills during your lifetime?' Current users of HTPs were identified based on their responses to the question 'Do you currently use a heated tobacco product?' To avoid misidentification of products, respondents were read descriptions of e-cigarettes and heated tobacco products.

Statistical analysis. Basic statistical analyses utilized descriptive statistics. Differences regarding selected socio-demographic factors were assessed using cross-tabulation and a chi-squared test. A p-value of less than 0.05 was used as the statistical significance threshold. Multivariate analyses were based on a logistic regression model, with all ordinal variables converted into a series of dichotomous variables. Nominal variables were converted into a set of dichotomous variables and included in the model. A full model and a reduced model were developed. The reduced model (with a reduced number of variables) was developed to mitigate the risk of overfitting. Data analysis was conducted utilising SPSS version 28 (IBM, Armonk, NY, USA).

RESULTS

Study group characteristics. Of the 5,000 participants included in the study, 52.0% were female (95%CI: 50.6–53.4%); mean age – 48.5 years (SE=0.24); median age – 47 years. A total of 61.0% (95%CI: 59.6–62.3%) of all respondents resided in urban areas. 33.3% (95%CI: 32.0–34.6%) of respondents reported having children under the age of 18 living in the same household (Tab. 1).

Use of traditional cigarettes and novel tobacco delivery products. Of the total number of participants (n=5,000), 46.7% had smoked at least 100 traditional cigarettes in their lifetime (ever-users) (95%CI: 45.4–48.1). A significant gender disparity was observed in these results ($p<0.001$), with the prevalence of ever-use of traditional cigarettes being higher among males, at 55.4% (95%CI: 53.4–57.4), compared to 38.7% (95%CI: 36.9 – 40.6) among females. The percentage of current users of traditional cigarettes at the time of the study was 21.1% of all participants (95%CI: 20.0–22.2), with 25.5% (23.7 – 27.2) of the males and 17.0% (15.6–18.5) of the females self-reporting as current smokers. The gender-related differences were statistically significant ($p<0.001$) for both ever-use and current use of traditional cigarettes. The percentage of ever-users of e-cigarettes was 12.8% of all participants (95%CI: 11.9–13.7), 15.6% (95%CI: 14.2–17.1) of the males, and 10.2% (95%CI: 9.0–11.4) of the females, at $p<0.001$. The prevalence of ever-use of HTPs was 4.0% (95%CI: 3.5–4.6) of all participants. In the case of HTPs, there were no statistically significant differences observed between male and female respondents ($p=0.281$). The prevalence of current use of e-cigarettes at the time of the study was 3.3% (95%CI: 2.8–3.8), while current use of HTPs accounted for 3.5% (95%CI: 3.0 – 4.0). Gender was not a discriminating

Table 1. Study group characteristics

	n	% (95%CI)
Gender		
Male	2400	48.0 (46.6–49.4)
Female	2600	52.0 (50.6–53.4)
Age		
18–24	402	8.0 (7.3–8.8)
25–29	398	8.0 (7.2–8.7)
30–39	1000	20.0 (18.9–21.1)
40–49	900	18.0 (17.0–19.1)
50–59	750	15.0 (14.0–16.0)
60+	1550	31.0 (29.7–32.3)
Place of residence		
Rural area	1950	39.0 (37.7–40.4)
Town with less than 20,000 population	650	13.0 (12.1–14.0)
Town with population between 20,000–100,000	950	19.0 (17.9–20.1)
Town with population between 100,000–500,000	850	17.0 (16.0–18.1)
Town with more than 500,000 population	600	12.0 (11.1–12.9)
Marital status		
single	1365	27.3 (26.1–28.5)
married	2744	54.9 (53.5–56.3)
divorced	428	8.6 (7.8–9.4)
widowed	463	9.3 (8.5–10.1)
Children below 18 years of age in the household		
No	3335	66.7 (65.4–68)
Yes	1665	33.3 (32.0–34.6)
Education		
Primary or did not complete primary school	197	3.9 (3.4–4.5)
Junior secondary (gimnazjum)	61	1.2 (0.9–1.6)
Vocational	886	17.7 (16.7–18.8)
Secondary (general or technical)	1598	32 (30.7–33.3)
Post-secondary	323	6.5 (5.8–7.2)
Bachelor-level (first-cycle) studies	450	9.0 (8.2–9.8)
Master-level studies, post-graduate studies, PhD	1485	29.7 (28.4–31.0)
Self-declared financial status		
We can afford to buy everything we need and still can make savings for the future	1288	25.8 (24.6–27.0)
We can afford to buy everything we need without limiting ourselves, but we don't make savings for the future	1149	23.0 (21.8–24.2)
We live economically and thus can afford to buy everything we need	1501	30.0 (28.8–31.3)
We live very economically to make savings for the most important purchases	347	6.9 (6.3–7.7)
We only have enough money to satisfy our basic needs	522	10.4 (9.6–11.3)
We cannot afford even the cheapest food	92	1.8 (1.5–2.2)
Refused to answer	101	2.0 (1.7–2.4)

Table 2. Prevalence of ever-users and current users of traditional cigarettes, e-cigarettes and HTP.

	Total (n=5,000)	Male (n=2,400)	Female (n=2,600)	p-value
	% (95%CI)	% (95%CI)	% (95%CI)	
Ever-user				
traditional cigarettes	46.7 (45.4–48.1)	55.4 (53.4–57.4)	38.7 (36.9–40.6)	<0.001
e-cigarettes	12.8 (11.9–13.7)	15.6 (14.2–17.1)	10.2 (9.0–11.4)	<0.001
HTP	4.0 (3.5–4.6)	4.4 (3.6–5.2)	3.7 (3.1–4.5)	0.281
Current user				
traditional cigarettes	21.1 (20–22.2)	25.5 (23.7–27.2)	17.0 (15.6–18.5)	<0.001
e-cigarettes	3.3 (2.8–3.8)	3.7 (3.0–4.5)	2.9 (2.3–3.6)	0.112
HTP	3.5 (3.0–4.0)	3.5 (2.8–4.2)	3.4 (2.8–4.2)	1.000

factor in the prevalence of current use of either e-cigarette or HTPs (Tab. 2).

Everyday vs. occasional use of traditional cigarettes. The prevalence of everyday users of traditional cigarettes at the time of the study was 16.5% (95%CI: 15.5–17.5%) of the sample, with another 4.6% (95%CI: 4.0–5.2%) smoking traditional cigarettes occasionally. The gender-related differences were statistically significant (p<0.001), with 20.1% (95%CI: 18.5–21.7%) of male participants self-identifying as everyday smokers of traditional cigarettes, compared to 13.1% (95%CI: 11.9 – 14.5%) of female participants. Occasional smokers of traditional cigarettes constituted 5.4% (95%CI: 4.5–6.3%) of the males and 3.9% (95%CI: 3.2 – 4.7%) of the females.

Statistically significant differences were found with regard to marital status (p<0.001), with the highest prevalence of current everyday use of traditional cigarettes observed among divorced participants, at 29.0% (95%CI: 24.8–33.4%). Additionally, 6.1% (95%CI: 4.1–8.6) of divorced participants smoked traditional cigarettes occasionally. These figures are in contrast to a prevalence of 13.3% (95%CI 12.1–14.6%) and 3.4% (95%CI: 2.8–4.2%), respectively, observed among married participants.

The proportion of everyday users of traditional cigarettes differed according to the level of education (p<0.001). The highest prevalence was observed among the least educated respondents: 26.9% (95%CI: 21.1–33.4%) of respondents who had only completed primary school or had no formal education; 24.6% (95%CI: 15.1–36.4%) of those who had completed lower secondary school, and 26.1% (95%CI: 23.3–29.0%) of those who had completed vocational school, while the lowest prevalence of 9.2% (95%CI: 7.8 – 10.8%) was seen among those with an MA (master's degree), post-graduate diploma or a PhD.

Self-reported financial status was found to have a significant impact on the prevalence of smoking traditional cigarettes (p<0.001), with the highest prevalence of everyday smokers observed among those least well-off, at 33.6% (95%CI: 24.7 – 43.7%), and the lowest, at 14.0% (95%CI: 12.2 – 15.9%), among those who rated their financial status the highest. Factors such as age group (p=0.064), population at the place of residence (p=0.235), and the presence of children under 18 years of age in the household (p=0.385), did not have a significant impact on the prevalence of smoking traditional cigarettes (Fig. 1).

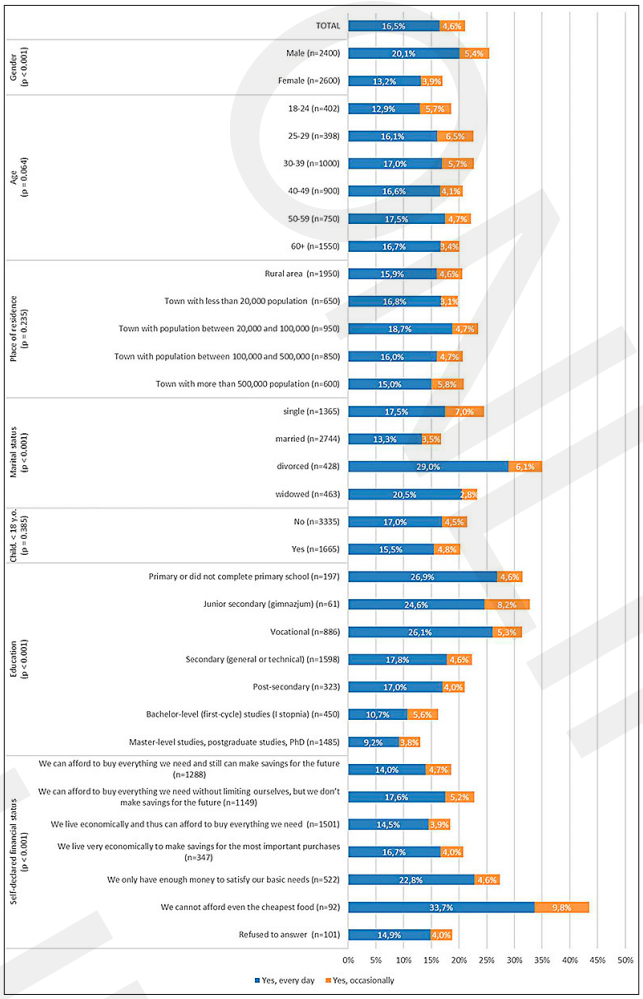

Figure 1. Everyday and occasional smoking of traditional cigarettes vs. socio-demographic variables

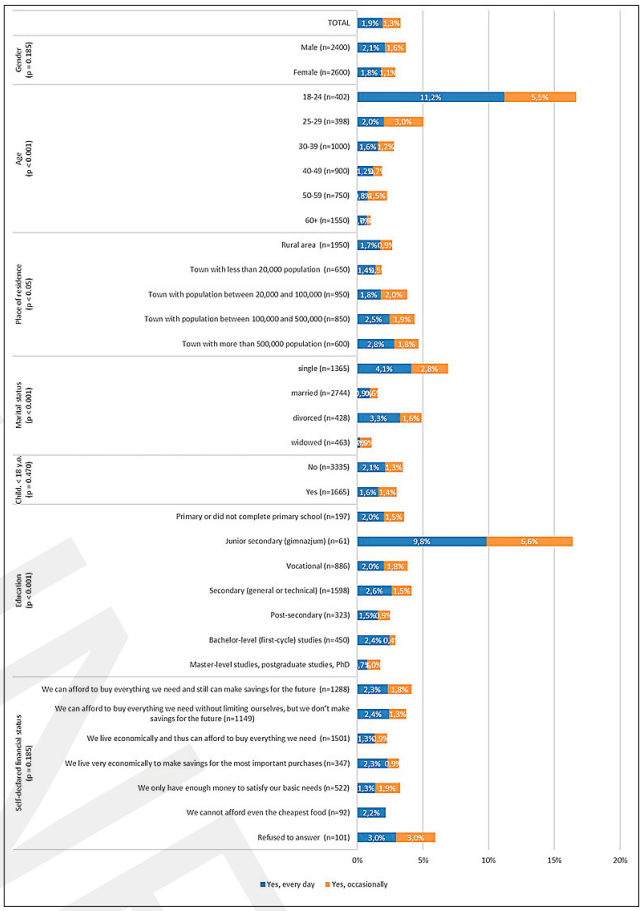

Figure 2. Everyday and occasional use of e-cigarettes vs. socio-demographic variables

Everyday vs occasional use of e-cigarettes. The percentage of current everyday users of e-cigarettes was 1.9% (95%CI: 1.6–2.4) of the sample, while 1.3% (95%CI: 1.0–1.7) were occasional users, with no significant gender differences (p=0.185). The highest prevalence of everyday and occasional use of e-cigarettes was observed in the 18–24 age group (p<0.001), at 11.2% (95%CI: 8.4–14.6) and 5.5% (95%CI: 3.6–8.0), respectively. In the other age groups, prevalence ranged between 0.7% – 2.0% for everyday use of e-cigarettes and from 0.3% – 3.0% for occasional use. There were statistically significant differences in relation to the place of residence (p<0.05), with prevalence ranging from 1.4% – 2.8% for everyday use and 0.5% – 2.0% for occasional use. With regard to the remaining variables investigated, statistically significant differences were revealed for marital status (p<0.001) and level of education (p<0.001). Never-married participants had a prevalence of 4.1% (95%CI: 3.1–5.3) for everyday use of e-cigarettes and 2.8% (95%CI: 2.0–3.8) for occasional use. A relatively higher prevalence was also observed among divorced respondents, at 3.3% (95%CI: 1.9–5.3) and 1.6% (95%CI: 0.7–3.2), respectively. With regard to the level of education, the highest percentages of e-cigarette users were found among respondents with lower secondary education, where everyday users of e-cigarettes accounted for 9.8% (95%CI: 4.2–19.2), and occasional users made up another 6.6% (95%CI: 2.3–14.8) of the population. The presence of children under 18 years of age in the household and self-reported financial status were not associated with statistically significant differences (p=0.470 and p=0.185, respectively) (Fig. 2).

Everyday vs occasional use of heated tobacco products. Everyday users of HTPs constituted 1.8% (95%CI: 1.5–2.2) of the total sample, with 1.6% (95%CI: 1.3–2.0) of the respondents reporting occasional use. While there were no statistically significant differences related to gender (p=0.298), a significant difference was observed when comparing by age (p<0.001), with the highest prevalence of HTPs users in the 18–24 age group, where 5.5% (95%CI: 2.6–8.0) of respondents reported everyday use and an additional 4.7% (95%CI: 3.0–7.1) reported occasional use.

The proportion of HTPs users varied according to the level of education (p<0.001). The highest proportion of users was observed among the least educated respondents. The highest prevalence of HTPs use was observed in cities with a population of more than 500,000, where everyday use of HTPs was reported by 3.5% (95%CI: 2.2–5.2) of respondents, and occasional use was reported by 2.2% (95%CI: 1.2–3.6). Respondents' marital status (p<0.001), level of education (p<0.01) and self-reported financial status, were all factors influencing the results. Among never-married respondents, everyday use of heated tobacco was reported by 3.4% (95%CI: 2.6–4.5) and occasional use by 3.7% (95%CI: 2.8–4.8). With regard to the level of education, the highest prevalence of HTPs use was observed among individuals who had

completed lower secondary education, with 4.9% (95%CI: 1.4–12.5) reporting everyday use of heated tobacco and 4.9% (95%CI: 1.4–12.5) declaring occasional use. Participants with higher financial status exhibited higher prevalence of HTPs usage, with 3.1% (95%CI: 2.3–4.2) of those who could afford to cover all expenses and also save for the future reporting everyday use of HTPs and 2.7% (95%CI: 1.9–3.7) reporting occasional use (Fig. 3). The presence of children under 18 years old in the household was not associated with statistically significant differences (p=0.122).

Concurrent use of different types of nicotine delivery products. The total current prevalence of traditional cigarettes, e-cigarettes, and HTPs use was 24.4% (95%CI: 23.2–25.6%). Users of only one type of product accounted for 21.4% (95%CI: 20.3–22.6), while concurrent users of two products reached 2.6% (95%CI: 2.2–3.0), and of three types of products made up 0.4% (95%CI: 0.3–0.6) of the respondents. When considering the prevalence of ever-use, the proportion of participants who reported using only one type of product was 35.9% (95%CI: 34.6–37.3), while concurrent users of two products accounted for 10.7% (95%CI: 9.8–11.5), and of three types of products for 2.1% (95%CI 1.7–2.5) of the respondents. Among current everyday users of e-cigarettes, 21.9% (95%CI: 14.2–30.3) also smoked traditional cigarettes on a daily basis, and 7.1% (95%CI: 3.3–13.5) did so occasionally. Among current occasional users of e-cigarettes, 48.4% (95%CI: 36.1–59.6) also smoked traditional cigarettes every day, and 16.4% (95%CI: 9.0–26.6) did so on an occasional basis. 23.9% (95%CI: 16.3–33.7) of current everyday users of HTPs, also smoked traditional cigarettes on a daily basis, and 9.7% (95%CI: 5.0–17.3) did so occasionally. Of those who currently used HTPs occasionally, 39.3% (95%CI: 29.0–49.8) also smoked traditional cigarettes every day, with 15.5% (95%CI: 9.2–24.9) doing so occasionally. Detailed data are shown in Table 3.

Patterns of current use of e-cigarettes and HTPs – multivariate analysis (logistic regression models). A simplified logistic regression model regarding the current use (everyday and occasional use) of e-cigarettes showed a Cox & Snell R Square goodness-of-fit value of 0.059 and a Nagelkerke R Square value of 0.233. The model revealed significant age-related differences, with respondents aged 18–24 years having nearly 30-fold higher odds (OR=29.74; 95%CI: 16.31–54.23) of being current e-cigarette users compared to those aged 60 years and over. For the 25–29 age group, the odds ratio was 5-fold higher (OR=5.14; 95%CI: 2.57–10.26). In subsequent age groups, the odds ratio (in relation to the 60+ age group) ranged from 2.02 – 3.06. With regard to the place of residence, statistically significant differences were found exclusively when comparing residents of rural areas with those residing in towns with a population of 100,000–500,000. For the latter group, the odds of being current users of e-cigarettes were 65.0% higher than in rural residents (OR=1.65; 95%CI: 1.04–2.62). Furthermore, having smoked at least 100 traditional cigarettes was found to increase the

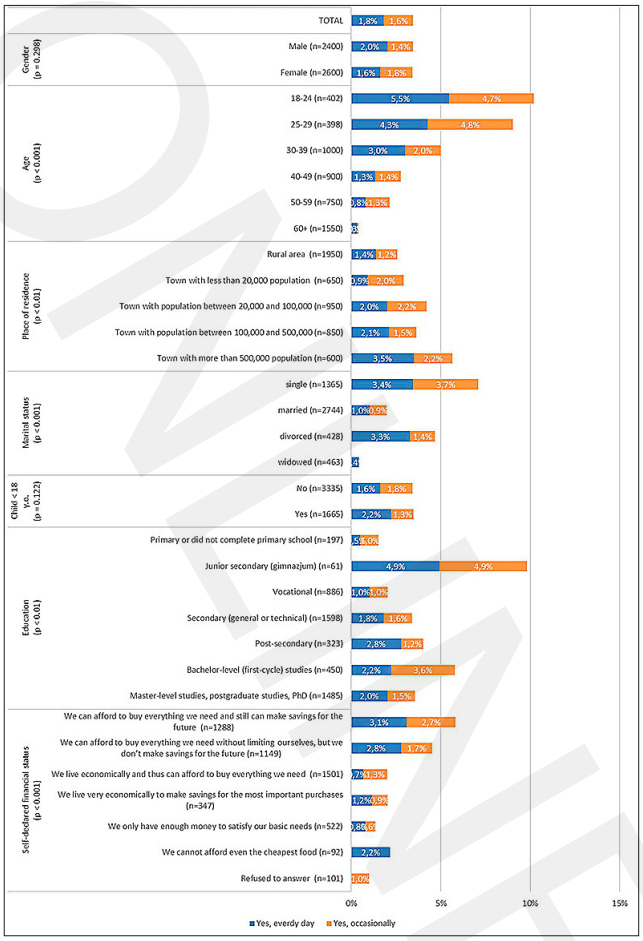

Figure 3. Everyday and occasional use of heated tobacco products vs. socio-demographic variables

Table 3. Percentages of concurrent traditional cigarette users among respondents using e-cigarettes and heated tobacco

		Traditional cigarettes				
		Yes, every day	Yes, occasionally	Not currently	Never used	Total
		Row % (95%CI)	Row % (95%CI)	Row % (95%CI)	Row % (95%CI)	%
e-cigarettes	Yes, every day (n = 98)	21.9 (14.2–30.3)	7.1 (3.3–13.5)	65.7 (55.5–74.2)	5.4 (2–10.8)	100
	Yes, occasionally (n = 67)	48.4 (36.1–59.6)	16.4 (9–26.6)	32.2 (21.2–43.1)	3.1 (0.6–9.2)	100
	Not currently (n = 904)	42 (38.7–45.2)	9.2 (7.4–11.2)	43.8 (40.6–47.1)	5 (3.7–6.5)	100
	Never used (n = 3932)	9.9 (9–10.9)	3.3 (2.8–3.9)	53.6 (52–55.1)	33.2 (31.7–34.7)	100
HTP	Yes, every day (n = 91)	23.9 (16.3–33.7)	9.7 (5–17.3)	64.2 (54.7–74.1)	2.1 (0.5–6.9)	100
	Yes, occasionally (n = 82)	39.3 (29–49.8)	15.5 (9.2–24.9)	38.8 (29–49.8)	6.4 (2.4–12.8)	100
	Not currently (n = 344)	43.8 (38.4–48.9)	12.4 (9.3–16.3)	40.7 (35.6–45.9)	3.1 (1.7–5.5)	100
	Never used (n = 4483)	13.8 (12.8–14.8)	3.7 (3.2–4.3)	52.6 (51.2–54.1)	29.9 (28.5–31.2)	100

Table 4. Logistic regression models for 1) current use of e-cigarettes and 2) current use of heated tobacco

	e-cigarettes		HTP	
	OR (95%CI)	p-value	OR (95%CI)	p-value
Gender				
Male	ref.	ref.	ref.	ref.
Female	1.02 (0.73–1.43)	0.914	1.4 (1.01–1.95)	
Age				
18–24	29.74 (16.31–54.23)	p<0.001	31.18 (12.53–77.62)	p<0.001
25–29	5.14 (2.57–10.26)	p<0.001	24.21 (9.79–59.89)	p<0.001
30–39	3.06 (1.63–5.75)	p<0.001	14.94 (6.23–35.8)	p<0.001
40–49	2.02 (1–4.05)	p<0.05	8.62 (3.45–21.53)	p<0.001
50–59	2.34 (1.16–4.72)	p<0.05	6.46 (2.47–16.9)	p<0.001
60+	ref.	ref.	ref.	ref.
Place of residence				
Rural area	ref.	ref.	ref.	ref.
Town with less than 20,000 population	0.76 (0.39–1.49)	0.424	1.55 (0.88–2.73)	0.133
Town with population between 20,000 – 100,000	1.52 (0.95–2.41)	0.079	1.77 (1.13–2.79)	p<0.05
Town with population between 100,000 – 500,000	1.65 (1.04–2.62)	p<0.05	1.46 (0.9–2.37)	0.128
Town with more than 500,000 population	1.66 (1–2.76)	0.051	2.07 (1.27–3.36)	p<0.01
Have you smoked at least 100 traditional cigarettes?				
No	ref.	ref.	ref.	ref.
Yes	5.62 (3.71–8.5)	p<0.001	4.99 (3.2–7.77)	p<0.001
Have you ever used at least 100 HTP refills or had your own e-cigarette?				
No	ref.	ref.	ref.	ref.
Yes	2.39 (1.5–3.79)	p<0.001	4.01 (2.8–5.73)	p<0.001

odds of being a current user of e-cigarettes by nearly 6-fold (OR=5.62; 95%CI: 3.71–8.50). Likewise, current or past HTPs use increased the odds of current e-cigarette use by more than 2-fold (OR=2.29; 95%CI 1.50–3.79). Gender was found to have no significant impact in this regard (p=0.914) (Tab. 4). A full model incorporating additional variables yielded a fit of 0.065 for Cox & Snell R Square and of 0.258 for Nagelkerke R Square, as presented in the online supplement (Tab. S2). The other simplified model focused on the current use of HTP devices, yielding a goodness of fit of 0.069 for Cox & Snell R Square and 0.266 for Nagelkerke R Square. It was found that females had 40.0% higher odds of being current users of such products compared to males (OR=1.40; 95%CI: 1.01–1.95). Furthermore, respondents aged 18–24 years exhibited over 31-fold higher odds of being current users of HTPs when compared to those aged 60 or more (OR=31.18; 95%CI: 12.53–77.62). The odds were 24-fold higher for those aged 25–29 years (OR=24.21; 95%CI: 9.79–59.89) and nearly 15-fold higher for those aged 30–39 years (OR=14.94; 95%CI: 6.23–35.8).

In the two remaining age groups, the odds ratios in comparison to those aged 60 or over were 8.62 and 6.46, respectively. In comparison with residents of rural areas, odds ratios for being current users of HTPs were significantly higher for residents of towns with a population between 20,000 and 100,000 (OR=1.77; 95%CI: 1.13–2.79) and those living in the largest cities with over 500,000 inhabitants (OR=2.07; 95%CI 1.27–3.36). It was also found that respondents who had smoked at least 100 traditional cigarettes in their lifetime had nearly 5-fold higher odds of being current users of HTPs (OR=4.99; 95%CI: 3.20–7.77), while having or having had one's own e-cigarette increased the odds by 4-fold (OR=4.01; 95%CI: 2.80–5.73) (Tab. 4). A full model with additional variables yielded a goodness of fit of 0.078 for Cox & Snell R Square and of 0.299 in terms of Nagelkerke R Square, as presented in the online supplement (Tab. S2).

Table S1. Assumed sample structure based on current CSO data

Criterion		Assumed structure
Gender	Male	48%
	Female	52%
Age	18–29	17%
	30–39	20%
	40–49	18%
	50–59	15%
	60+	31%
Province (administrative region)	dolnośląskie	8%
	kujawsko-pomorskie	6%
	lubelskie	6%
	lubuskie	3%
	łódzkie	7%
	małopolskie	9%
	mazowieckie	14%
	opolskie	3%
	podkarpackie	6%
	podlaskie	3%
	pomorskie	6%
	śląskie	12%
	świętokrzyskie	3%
	warmińsko-mazurskie	4%
	wielkopolskie	9%
	zachodniopomorskie	5%
Population of area of residence	Rural	39%
	Town with less than 20,000 population	13%
	Town with population between 20,000–100,000	19%
	Town with population between 100,000–500,000	17%
	town with population of more than 500,000	12%

Source: CSO data[*]
[*] https://stat.gov.pl/obszary-tematyczne/ludnosc/ludnosc/ludnosc-stan-i-struktura-w-przekroju-terytorialnym-stan-w-dniu-30-06-2019,6,26.html

DISCUSSION AND RESULTS

This study presents an updated survey on tobacco and nicotine use in Poland carried out by public health specialists. A previous study [12–14] was conducted in 2010, when alternative tobacco and nicotine products (TNPs) such as

Table S2. Logistic regression models for 1) current use of e-cigarettes and 2) current use of heated tobacco

	e-cigarettes		HTP	
	OR (95%CI)	p-value	OR (95%CI)	p-value
Gender				
Male	ref.	ref.	ref.	ref.
Female	1.15 (0.81 – 1.64)	0,431	1.45 (1.03 – 2.05)	p<0.05
Age				
18–24	39.61 (17.5 – 89.67)	**p<0.001**	23.33 (8.27 – 65.82)	**p<0.001**
25–29	7.26 (3.22 – 16.35)	**p<0.001**	16.4 (6.06 – 44.36)	**p<0.001**
30–39	4.43 (2.15 – 9.11)	**p<0.001**	12.17 (4.77 – 31.07)	**p<0.001**
40–49	2.47 (1.16 – 5.23)	**p<0.05**	7.16 (2.75 – 18.65)	**p<0.001**
50–59	2.37 (1.16 – 4.87)	**p<0.05**	5.92 (2.23 – 15.7)	**p<0.001**
60+	ref.	ref.	ref.	ref.
Place of residence				
Rural area	ref.	ref.	ref.	ref.
Town with less than 20,000 population	0.79 (0.4 – 1.55)	0,488	1.33 (0.74 – 2.38)	0,340
Town with population between 20,000 – 100,000	1.62 (1.01 – 2.6)	**p<0.05**	1.58 (0.99 – 2.52)	0,053
Town with population between 100,000 – 500,000	1.78 (1.1 – 2.88)	**p<0.05**	1.09 (0.66 – 1.8)	0,741
Town with population more than 500,000	1.93 (1.12 – 3.31)	**p<0.05**	1.39 (0.83 – 2.31)	0,210
Marital status				
Single	ref.	ref.	ref.	ref.
Married	1.15 (0.66 – 1.98)	0,625	0.68 (0.42 – 1.11)	0,124
Divorced	2.64 (1.38 – 5.04)	**p<0.01**	1.45 (0.79 – 2.69)	0,233
Widowed	0.99 (0.35 – 2.78)	0,979	0.41 (0.09 – 1.79)	0,237
Children in the household under 18 years of age				
No	ref.	ref.		
Yes	1.48 (0.98 – 2.23)	0,063	1.41 (0.94 – 2.12)	0,096
Education				
Primary, or did not complete primary school	ref.	ref.	ref.	ref.
Junior secondary (middle school)	1.34 (0.43 – 4.22)	0,612	1.44 (0.31 – 6.78)	0,646
Vocational	0.84 (0.34 – 2.11)	0,716	0.81 (0.21 – 3.1)	0,759
Secondary (general or technical)	0.56 (0.23 – 1.38)	0,209	1.02 (0.28 – 3.68)	0,976
Post-secondary	0.39 (0.12 – 1.2)	0,101	1.4 (0.34 – 5.67)	0,640
Bachelor-level (first-cycle) studies	0.31 (0.11 – 0.89)	**p<0.05**	1.82 (0.48 – 6.94)	0,378
Master-level studies, post-graduate studies, PhD	0.39 (0.15 – 1.02)	0,055	1.61 (0.44 – 5.92)	0,474
Self-declared financial status				
We can afford to buy everything we need and still can make savings for the future	ref.	ref.	ref.	ref.
We can afford to buy everything we need without limiting ourselves, but we don't make savings for the future	1.06 (0.67 – 1.67)	0,802	0.79 (0.53 – 1.18)	0,242
We live economically and thus can afford to buy everything we need	0.81 (0.5 – 1.32)	0,397	0.53 (0.33 – 0.85)	**p<0.01**
We live very economically to make savings for the most important purchases	1.28 (0.62 – 2.65)	0,507	0.49 (0.21 – 1.14)	0,098
We only have enough money to satisfy our basic needs	1.03 (0.55 – 1.94)	0,927	0.29 (0.13 – 0.69)	**p<0.01**
We cannot afford even the cheapest food	0.48 (0.1 – 2.26)	0,355	0.43 (0.09 – 2.07)	0,292
Refused to answer	1.8 (0.68 – 4.77)	0,236	0.15 (0.02 – 1.11)	0,064
Have you smoked at least 100 traditional cigarettes?				
No	ref.	ref.	ref.	ref.
Yes	5.65 (3.69 – 8.66)	**p<0.001**	5.27 (3.37 – 8.24)	**p<0.001**
Have you ever used at least 100 HTP refills or had your own e-cigarette?				
No	ref.	ref.	ref.	ref.
Yes	2.45 (1.53 – 3.92)	**p<0.001**	4.41 (3.05 – 6.38)	**p<0.001**

e-cigarettes and HTPs were not available. Given the evolving market landscape, it was imperative to conduct a repeat analysis to better understand the prevalence of use of specific products. The most important finding of the current study is that cigarettes, which carry the highest risks of morbidity and mortality from cancer and COPD, remain the most prevalent TNPs. This underscores the need for continued efforts to reduce the negative consequences of smoking. While quitting all tobacco and nicotine use is the best strategy, the majority of smokers persist in their habit. From the public health perspective, the most important observation from this study is that 'heavy smoking' remains by far the most prevalent form of TNPs use, despite the availability of less harmful alternatives such as e-cigarettes and HTPs.

Current users of traditional cigarettes, e-cigarettes or HTPs constitute 24.4% of the adult Polish population, with 21.1% of the respondents reporting smoking traditional cigarettes, 3.3% using e-cigarettes, and 3.5% using HTPs. Those using two or all three types of products concurrently constitute 3.0% of the sample. Current everyday users of traditional cigarettes made up 16.5% of the sample, and occasional users accounted for another 4.6%, yielding a total of 21.1%. The highest prevalence of current everyday smoking of traditional cigarettes was observed among individuals with the lowest financial status (33.7% of that subgroup) and among divorced respondents (29.0%). The percentage of adult Poles who had ever possessed their own e-cigarette was 12.8% (15.6% among male respondents and 10.2% among female respondents). Current everyday e-cigarette users accounted for 1.9% of the sample, and occasional users constituted 1.3% (differences between the genders were not statistically significant). The highest percentage of current everyday users of e-cigarettes was found in the 18–24 age group (11.2%). 29.0% of current everyday users of e-cigarettes also smoked traditional cigarettes, a percentage that increased to 64.8% among occasional e-cigarette users. For users of HTPs, the respective percentages were 33.6% and 54.8%. Ever users of HTPs accounted for 4.0% of the sample, with no statistically significant differences between the genders. Current everyday users of HTPs constituted 1.8% of the sample, while another 1.6% reported occasional use. The highest percentages of current everyday users of HTPs were recorded in the 18–24 (5.5%) and 25–29 (4.3%) age groups.

Interpretation. Nicotine dependence has been classified in the International Classification of Diseases and Related Health Problems as a chronic medical condition and is defined as both a physical and psychological addiction [15, 16]. The health consequences of cigarette combustion are far-reaching and result in decreased life expectancy. Despite the downward trend in the prevalence of cigarette smoking, the overall number of smokers has been increasing, currently at 1.14 billion worldwide, reflecting the global population growth. This issue is particularly salient in developing countries [17]. In Poland, nicotine dependence represents a very significant epidemiological and clinical problem. The current study investigates the patterns of use of three types of tobacco delivery products that are currently commercially available: traditional cigarettes, e-cigarettes and heated tobacco products.

In 2019, almost eight milion deaths were attributable to smoking. Furthermore, it is reported that more than 200 million smokers have died within the last 30 years [17]. In response to these data, the WHO, as part of the implementation process for the main UN Sustainable Development Goals, has initiated measures to reduce cigarette smoking by 2030, recognising it as the primary cause of non-infectious disease [18]. According to reports from the WHO, there has been a decline in the prevalence of smoking among adults and children over 15 years of age, with a decrease of 2.8 percentage points from 23.5% in 2007 to 20.7% in 2015 [17, 19]. Converging conclusions can be drawn from a recent meta-analysis, which found a decrease of nearly 27.5% in smoking prevalence in the 15–24 age group, with the largest declines observed in Brazil, Norway, Senegal, Iceland, Denmark, Australia, Costa Rica, Colombia and Canada, and the highest increases in Afghanistan, Saudi Arabia, Bosnia and Herzegovina, and several other countries. Based on their findings, the authors concluded that the absolute number of young smokers has been increasing, which can be attributed to population growth, globalization, and easy access to various nicotine delivery systems [17].

Globally, nineout of every 10 smokers initiate regular smoking before reaching the age of 25, with 32.7% in males and 6.6% in females. Of particular note is the low age of initiation to tobacco, with two out of every 10 smokers beginning to smoke regularly by as early as 15 years old [17]. Regional differences in smoking prevalence are attributable to cultural determinants and the availability of tobacco products. The countries with the highest smoking prevalence include, in descending order, China, India, Indonesia, the United States, Russia, Bangladesh, Japan, Turkey, Vietnam, and the Philippines [17]. The Global Adult Tobacco Survey (GATS) in Poland [13] revealed that the prevalence of everyday smokers in the population aged 15 and above was 33.5% in males and 21.0% in females, collectively accounting for 27.0% of the study population. The present study established a slightly lower, but nevertheless epidemiologically significant, smoking prevalence, with 24.4% of all respondents admitting to using traditional cigarettes, e-cigarettes or HTPs. Another Polish study conducted in 2022 yielded a figure of 28.8% for tobacco users. However, unlike this present study, it was conducted using a CAWI technique, which may explain the discrepancy in results obtained for the comparable time period [20]. As demonstrated by other studies, smoking prevalence varies significantly with regard to place of residence [13]. Smoking has been found to be more prevalent in urban areas, at 30.3% (35.4% of males and 25.8% of females) than in rural areas (5.4%). Moreover, the highest smoking prevalence was recorded in male and female respondents who had received vocational education [13]. It is also noteworthy that traditional cigarettes are more popular among individuals with a low socio-economic status, with 26.1% of those living below poverty level smoking compared to 13.9% of those at or above poverty level [21]. Interestingly, a 2022 study conducted in Poland, revealed that having children was an additional determinant of cigarette smoking, along with age and level of education [20]. In the present study, marital status emerged as another factor contributing to significant differences in smoking prevalence, with the highest prevalence observed among divorced respondents (28.9%).

In the context of studies examining the prevalence of nicotine use in the general population, the type of delivery system is an important factor. In the United States, the National Adult Tobacco Survey revealed that nearly 21.3%

of all adults aged 18 and over used various commercially available delivery systems, with 17.0% smoking traditional cigarettes, 1.8% smoking cigars/cigarillos, 0.6% using water pipes/shisha, 3.3% using e-cigarettes and 2.5% using HTPs [22]. Regardless of the delivery system, smoking prevalence continues to be higher among males than females. Significantly, the highest smoking prevalence is observed in the 25–44 age group (14.8%), and the lowest in individuals over 65 years of age [23]. Polish studies demonstrate that the percentage of e-cigarette users is highest among 18–24 year olds (14.0%). Furthermore, findings indicate that e-cigarettes are more prevalent among current smokers of traditional cigarettes than among past smokers and never-smokers [5]. Another study conducted in Poland reported the prevalence of everyday use of e-cigarettes at 4.8% (4.0% among females and 5.6% among males), while the prevalence of everyday HTPs use was established at 4.0% of all respondents (5.1% of females and 2.9% of males) [20]. The latest 2024 survey indicates that 24.5% of Polish adults smoked tobacco daily, 5.9% used e-cigarettes, and 4.9% used heated tobacco, making it possible to assess the dynamics of the phenomenon [24].

Limitations of the study. The distinct technological characteristics of e-cigarettes and the absence of a standardised packaging size of e-cigarette liquids precluded the use of a uniform question. This structural disparity between the questions constitutes a limitation to the study's comparative analysis. The study's reliance on self-reported measures also renders it susceptible to recall bias, and the use of telephone interviews might have led to respondents confusing HTPs with e-cigarettes. The cross-sectional nature of the study design, which did not involve prospective follow-up of participants, limited the ability to draw causal inferences from the reported data. Additional limitations of the study include the potential for sampling and selection bias, as well as all biases typically associated with self-reported measures and response bias.

CONCLUSIONS

In 2022, the prevalence of the current use of heated tobacco products (everyday or occasional) among adults residing in Poland was comparable to the prevalence of e-cigarette use. The substantial majority of current users of heated tobacco products and e-cigarettes were either current or former traditional cigarette smokers. Also in 2022, the prevalence of current smoking of traditional cigarettes in Poland was found to be 6–7 times higher than the prevalence of current use of heated tobacco or e-cigarettes. Despite a decrease in the smoking prevalence of traditional cigarettes over the last 10 years, Poland continues to exceed the European Union average.

As a group of public health experts, the authors of the current study monitor tobacco and nicotine prevalence to provide policymakers and public health authorities with essential information on the extent of the tobacco epidemic in Poland, subgroups in need of tailored policies or changes in tobacco use following implementation of policies/programmes. They believe that assessment of tobacco and nicotine use is critical to understand the background and create effective public health tools to reverse the tobacco epidemic.

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