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“Do-it-yourself” (DIY) e-liquid mixing: users’ motivations and awareness of associated dangers – analysis of social media and online content

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Introduction: Electronic cigarettes (e-cigarettes) produce an aerosol by heating a liquid. Users can buy ready-made electronic liquids (e-liquids) or make some on their own by mixing together appropriate proportions of ingredients. The aim of this study was to determine users’ motivations for manufacturing e-liquids on their own and their awareness of the associated dangers among participants in online forums concerned with e-liquids.

Material and methods: We conducted a quantitative and qualitative analysis of online forums and portals related to e-cigarettes. The data was acquired with SentiOne monitoring of respective sites. For the detailed analysis, 200 comments were used, all of them written in Polish, between 1 January 2020 and 30 June 2020. The comments were classified into three categories: advice, safety, and motivation for producing Do-It-Yourself (DIY) e-liquids.

Results: Most of comment (56%) contained request for advice and respective recommendation on production of e-liquids. We identified four main motivations for producing e-liquids on one’s own: obtaining a particular flavour, aroma, cutting down on e-liquid costs and desire to quit traditional cigarettes. Safety-related issues were discussed in 34% of the postings. Most of them showed an awareness of certain dangers arising from the use of e-cigarettes and DIY production of e-liquids.

Conclusions: While choosing the ingredients and/or their proportions for the individual e-cigarettes’ production, users were relating to another users’ experience or e-liquid calculators, which correctness is not subject to control. Ingredients required for producing e-liquids are purchased from physical shops and the online platform allegro.pl. The main motivations for producing e-liquids at home comprised cost and flavour. The intended introduction of additional taxation by Polish government may induce e-cigarette users to consider switching to cheaper alternative – DIY e-liquid production.

KEY WORDS: nicotine, e-cigarette, vaping, e-liquid, vapers, DIY liquids.

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INTRODUCTION

In 2006, an alternative to traditional cigarettes became available in Poland in the form of electronic cigarettes (e-cigarettes), or electronic nicotine delivery systems [1]. They have become popular mainly owing to their low price, a variety of flavours and the belief that e-smoking makes it possible to cut down on conventional smoking [2, 3].

E-cigarettes produce an aerosol by heating a liquid (containing nicotine, flavours and solvents such as glycol and glycerin) to a temperature at which the liquid becomes volatile, without burning the tobacco [4, 5]. Users can buy ready-made electronic liquids (e-liquids) or make some on their own by mixing together appropriate proportions of ingredients. The lack of quality control measures or appropriate supervision over the

production of Do-It-Yourself (DIY) e-liquids may pose a threat to users' health.

Motivations for DIY manufacturing e-liquids include a need to cut down on the cost of using e-cigarettes. In 2017-2020 the Polish government made attempts to levy an excise tax on liquids for electronic cigarettes. On 21 November 2019, the Polish Parliament passed an amendment to the Excise Tax Act stating that the excise on e-liquid would be 0.55 zł/ml (0.13 €/ml, 0.14 \$/ml) [6, 7]. The explanatory memorandum published by the Parliament, the introduction of excise tax was postponed to 1 July 2020 [8]. The government has once again abandoned excise tax on liquid for electronic cigarettes in the ordinance of 30 June 2020. The ordinance was issued in connection with the COVID-19 pandemic [9]. Issues related to e-cigarettes have also been regulated since 2016 by the European Tobacco Products Directive (TPD) [10]. Its aim is to reduce tobacco-related morbidity and mortality in the European Union [11]. TPD prohibits advertising and promotion of e-cigarettes in media that have cross-border effects, i.e. the Internet, television, radio, the press and other printed publications [12]. Users of online forums are exposed to both commercial and other user generated advertising.

As e-cigarettes have been available on the market for just a decade, the long-term effects of e-cigarette use have not been fully determined [13, 14]. Research has shown that e-liquids contain a range of chemical compounds and contaminants, such as metals or formaldehyde, that can have deleterious effects on health [15-17]. The dangers associated with e-cigarettes are not only related to using them but also to the DIY manufacturing of e-liquids. Less quality control and incorrect mixing can lead to higher exposure to nicotine or other ingredients [18].

The use of e-cigarettes is becoming more and more popular, especially among young people [19]. About one fifth of Polish youth has tried e-cigarettes; most of them had smoked before [20]. The main reasons for using e-cigarettes in Poland are: low cost, willingness to quit smoking and the belief that they are less harmful than traditional cigarettes [21]. Young users buy e-cigarettes in vape shops or in online shops [22]. Age-limited access to e-cigarettes may encourage home production of e-liquids.

Nowadays, the Internet is one of the most popular sources of information. According to a poll by the CBOS Public Opinion Research Centre, 69% of Polish adults used the Internet at least once a week in 2019. Every third user reported that they placed comments on discussion forums or social network sites [23]. An online forum is a platform for exchanging opinions and experiences, and e-cigarette users are not an exception.

The aim of this study was to determine users' motivations for manufacturing e-liquids on their own and their awareness of the associated dangers among participants in online forums concerned with e-liquids.

MATERIAL AND METHODS

We conducted a quantitative and qualitative analysis of online content related to e-cigarettes. The necessary data and information was acquired with SentiOne (SentiOne, Gdańsk, Poland), a professional tool for monitoring the Internet. The tool collects all kinds of statements, comments and articles that have been published on the Internet, including: social networks (e.g. Facebook, Instagram, Twitter, YouTube), blogs, forums and news portals [24, 25].

Relevant data were identified on the basis of the presence of the following keywords: 'liquid' AND 'własnej' (own) AND 'produkcji' (production)/'zrobić' (make) AND 'liquid' AND 'sam' (on my own)/'mieszanie' (mixing) AND 'liquid'/'samoróbka' (self-made) AND 'liquid', where AND means that both search terms must be present in the text. The search terms were in Polish and relevant inflectional variants were accounted for.

A comment was defined as one reply from one user in an internet forum. Multiple responses by the same user on the same topic be considered separate comments.

Comments on online forums, blogs and portals concerned with e-cigarettes were included if they contained the key words in Polish and had been added between 1 January 2018 and 30 June 2020.

The exclusion criteria comprised comments including shops' promotional materials and unrelated to the topic of interest.

The exclusion was done manually. Unfortunately, we do not have access to data such as the number of comments without the exclusion words to Microsoft Excel. Records included basic information, i.e. content of the comment, username, thread posting date and access path. Comments were categorized. Any double entries were identified and removed.

The quantitative analysis was based on the analysis of the dynamics of the number of comments published on the Internet over time. Two analyzes were carried out in which the daily and monthly perspective were taken into account. A total of 6,651 comments were extracted that were subsequently used in a quantitative analysis.

A qualitative analysis was conducted on 1229 comments made between 1 January 2020 and 30 June 2020. A random sample of 200 comments was used for a detailed analysis, in proportion to the overall number of comments in a given month. The comments were classified into three main categories: advice, safety, and motivation for producing DIY e-liquids. If a comment pertained to more than one category, it was classified under every category it belonged to. The classification was based on the assessment of one author and was carried out deductively.

Each category was divided into specific subcategories (Fig. 1). Specific subcategories were separated due to the highest percentage of comments on this issue. Advice comments were thus classified separately into

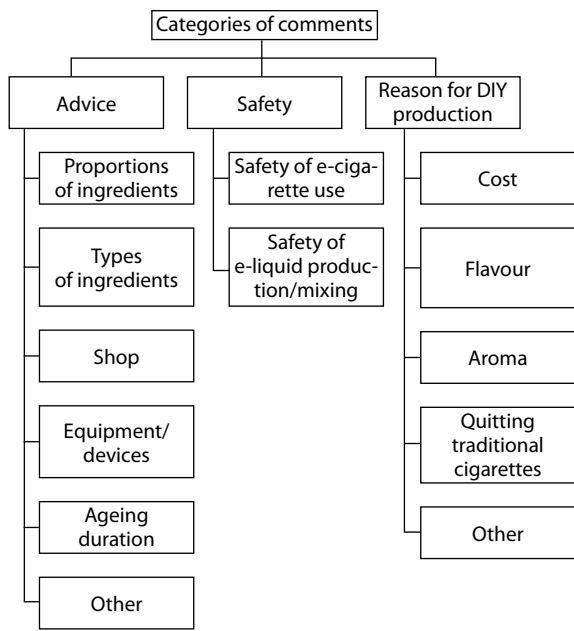


FIGURE 1. Categories of e-liquid-related comments

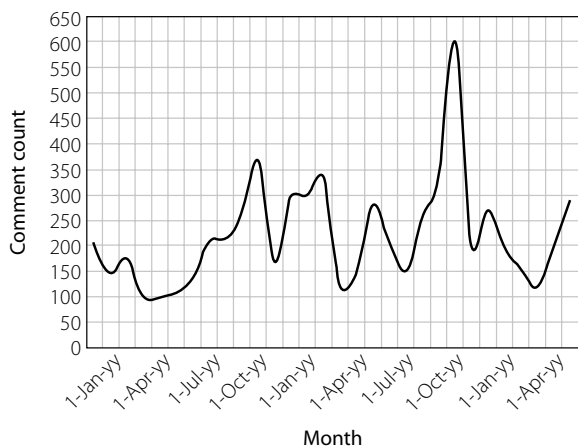


FIGURE 2. Monthly distribution of comment count between 1 January 2018 and 30 June 2020

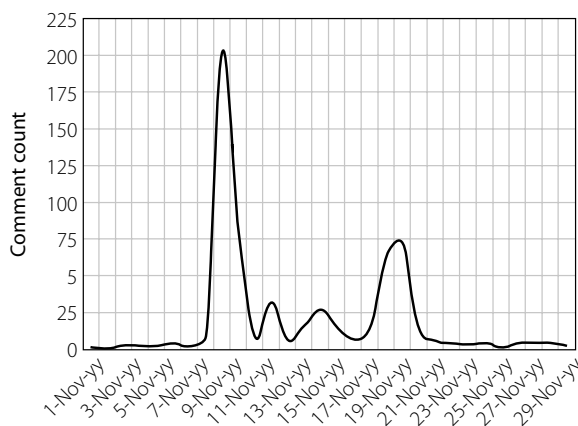


FIGURE 3. Daily distribution of comment count between 1 November 2019 and 30 November 2019

those referring to proportions of ingredients, type of ingredients, recommended shops, equipment used for DIY e-liquid production and duration of e-liquid ageing.

Safety-related comments were classified as referring to the safety of e-cigarette use or safety of DIY e-liquid production. They were tagged as indicating no harm, indicating harm and ambiguous. No-harm comments were those expressing the belief that e-cigarette use is safe for the body, does not cause disease and DIY e-liquid production is risk-free. Comments indicating harm were those stating that e-cigarette use is harmful to health, has a negative effect on the body, causes disease and untoward symptoms or addiction as well as those stating that user-performed mixing of e-liquid ingredients is associated with errors in calculating ingredient ratios, the ingredients being of unknown quality and the danger of an explosion, noxious vapours and a deleterious effect on health.

The category of motivation for undertaking DIY production of e-liquids was divided into cost, flavour, aroma and an intention to quit smoking traditional cigarettes.

RESULTS

The counts of comments included in the quantitative analysis are summarised in a linear graph (Fig. 2). Between 1 Jan 2018 and 30 Jun 2020, the highest count of online comments about DIY production of e-liquids was noted in November 2019 (603 posts). The count began to rise gradually from August 2019 (152 posts). It later fell to 198 in December 2019. The most popular sources of comments were the websites salonrozchmurzonych.pl, Money.pl and wykop.pl.

The month with the highest comment count was analysed (Fig. 3). The highest increase was noted on Nov 8, persisting on Nov 9 and falling from Nov 10 onwards. Another surge was seen on Nov 19, 2019. It persisted on the following day until Nov 20, 2019.

The results of classification of comments are presented in Figure 4. Most posters used the online forums to give or ask for advice regarding DIY production of e-liquids, with 112 of the 200 posts analysed (56%) pertaining to these topics. Safety-related issues regarding e-liquid use and/or production were discussed in 34% of the postings (68 comments). Motivations for producing e-liquids were revealed in 23% of the comments (45 postings).

Advice posts were most frequently concerned with proportions of the ingredients for DIY production of e-liquids, with 59 comments (30%) discussing this topic. Ten users (5%) based on their own recipe created their own experience when preparing e-liquids, while 5 declared that they used a ready-made e-liquid calculator to determine the proportion of ingredients (3%). A typical example of subcategory “proportion of ingredients” (translated from Polish):

I'm going to mix: 7.2 ml VPG – Power Smoke 18 mg/ml, 0.2 ml PG, 2 ml Glycerin, 0.5 ml distilled water and a few drops of aroma.

Postings about the type of ingredients added to the mix (foundations, aromas) accounted for 23% of the comments (45 postings).

I have been mixing the liquids for several months, first on the basis of Dirty Neutral, and from yesterday on the basis of Power Shot.

Another topic in this category was that of recommended equipment for DIY e-liquid production: scoops, bottles, stirrers and syringes were discussed in 18% of the comments (35 postings).

For this recipe, you will also need a syringe and a needle to measure the aroma.

Shops selling ingredients for e-liquids were mentioned in 9% of the online comments (17 postings), with 5 comments (3%) about distributors from the allegro.pl website, the largest on-line trading platform in Poland, and 10 (5%) recommending physical shops.

Ingredients such as glycol, linalool and many more are available on website allegro. The aromas most frequently buys in ivape.pl.

The duration of ageing, or the time the e-liquid has to be allowed to stand after it has been mixed so that the ingredients combine, was mentioned in 8 comments (4%). A representative comment follows:

You have to make a base and set it aside for about 2 weeks. After this time, you pour it into small bottles and you have the liquid ready.

The category "Other" contains 3 comments (2%), of which 2 concerned recommended temperatures for ageing (1%), and one concerned atomisers (1%).

Categories for classifying safety-related comments are shown in Table 1. The safety of using e-cigarettes was discussed in 28% of the comments (56 posts). The opinion that using e-cigarettes is harmful was expressed by 34 users (17%), while 21 users (11%) believed it was harmless. A representative comment from category safety related with use e-cigarette follows:

Electronic cigarette should be completely banned for sale. Still we hear that his smoking causes lung cancer.

Fewer comments were concerned with safe related the DIY production of e-liquids. Mixing e-liquid ingredients on one's own was considered harmless by 3% of the users (6 comments), while 7% of the users (13 comments) regarded DIY production of e-liquids as dangerous. Safety-related comments appeared most often under articles on online portals concerned with the introduction of an excise tax on e-liquids. Comment included to category safety of e-liquid mixing:

By the way, I want to make a reservation once again that mixing liquids is dangerous. Nicotine is toxic, and the effects of other ingredients during inhalation have not been fully researched.

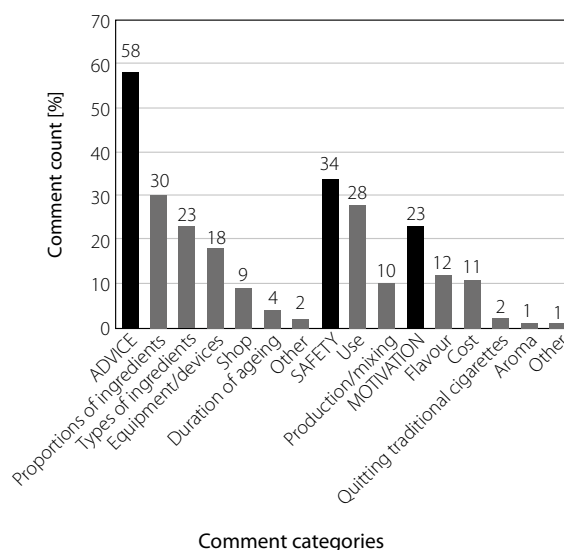


FIGURE 4. Classification of comments (the values do not add up 100%)

TABLE 1. Categories for classifying safety-related comments

Safety	Not harmful	Harmful	Ambiguous	Total
Use	21	34	1	56
Production/mixing	6	13	0	19

The most commonly declared motivation of the users of online forums, blogs and portals to produce e-liquids was the intention to obtain a sought-for flavour that was not available commercially (12% of posts).

I prefer to do at home. I choose the flavor I want. I've been making pinacolada all the time lately.

A desire to cut down costs was the reason for undertaking DIY production of e-liquids in the case of 21 users (11% of the comments). Users perceived, that home-made e-liquids are a cheaper alternative to commercially available e-liquids.

Mixing your own will always be cheaper than ready-made liquids. That's why I mix it myself.

Fewer posters declared an intention to quit smoking traditional cigarettes (2% of posts), or to obtain a particular aroma (1% of posts) or smoke of particular density (1% of posts).

DISCUSSION

A correlation was observed between activities of the Polish government regarding the introduction of an excise tax on e-liquid and the increase in the dynamics of the number of comments on self-prepared liquids. We can assume that the observed increase in the dynamics of discussions on the Internet is a reaction to the actions

of the Polish authorities. This hypothesis requires further verification using other research methods. The intended introduction of additional taxation is prompting e-cigarette users to look for cheaper solutions. In our study, the most popular topic on online forums concerned with e-cigarettes was advice about the proportions and types of ingredients for DIY production of e-liquids. We found that most posters were aware of the dangers associated both with using e-cigarettes and with DIY production of e-liquids. The main motivations for producing e-liquids on one's own were a desire to obtain a particular flavour and cutting down on e-liquid costs.

The largest number of posts about DIY mixing of e-liquids were written in November 2019. That was the month when, on 21 November 2019, the Parliament passed an amendment to the Excise Tax Act [6]. On November 8 and 9, the portal money.pl published two articles about the intended introduction of an excise tax. Supposedly, that had direct influence on the increased activity of online forum users. The two articles alone gathered 629 comments. In the postings, vapers, or e-cigarette users, expressed their discontent with the price rise. The planned rise prompted them to look for new solutions. The production of e-liquids from semi-finished products, not infrequently manufactured by unknown entities, was to protect users against the expected increase in prices related to excise tax. It is probable that the problem mainly affected younger users with limited budgets. A unit (10 ml) of commercially available ready-made e-liquid cost approximately 9 zł (2.10 €; 2.35 \$), while the cost of the same volume of home-made e-liquid amounts to 1.80 zł (0.42 €; 0.47 \$) [7]. Currently, no data are available on the effect of an excise tax on the use of electronic cigarettes, but valuable insights may be gained from data on the use of traditional cigarettes. A study by Schaffer *et al.* (2018) simulated the introduction of an excise tax on traditional cigarettes to reveal a fall of 18.43% in legal consumption and a rise in illegal cigarette consumption of 10.99% [26]. A study by Chaloupka (2014), based on data from the GATS (Global Adult Tobacco Survey) and NATS (National Adult Tobacco Survey) studies, showed that a country's global taxation scheme influenced the efficacy of controlling traditional cigarette smoking, with greater effectiveness shown by increases in additional taxation of cigarettes in countries with simpler global taxation schemes. In countries where the tax system is more complicated, there are more opportunities for finding cheaper solutions or substitutes [27].

Online forums on e-cigarettes were the place that users would most often go to in order to share opinions and experiences [28]. Despite the introduction of TPD in 2016, which bans e-cigarette advertising in media that have cross-border effects, including the internet, they are still visible in user comments. Exposure to each type of e-cigarette marketing may be associated with increased likelihood of ever and current use of

e-cigarettes among middle and high school students. Exposure also may be associated with susceptibility to use of e-cigarettes among current nonusers [29]. Advice on the proportions of the ingredients, as identified by our analysis, was based on users' personal experiences or consisted of recommending calculators. A calculator is a website or application that allows one to calculate the quantities of ingredients for producing e-liquids. Calculators take into account of the quantity and cost of ingredients possessed by the user to minimize the cost of e-liquid. The authors of such calculators emphasise that they do not take responsibility for any harm ensuing from the use of their results. E-cigarette users reported on testing such calculated proportions on themselves. Comments were also concerned with recommending particular ingredients, equipment, duration of ageing of the liquid, or shops. Posters recommended buying ingredients from physical shops selling e-liquid raw materials more often than from the website allegro.pl, considering physical shops a safer source. An earlier study by Chen *et al.* (2015) demonstrated that equipment for using e-cigarettes was the most popular topic on online forums discussing e-cigarettes, with a significant proportion of posts being concerned with describing users' vaping experiences [30]. It needs to be noted that Chen *et al.*'s study was carried out in the United States of America and investigated online forums popular among American users.

As demonstrated by our study, flavour and aroma were the main reasons underlying the decision to produce e-liquids on one's own. The mixing of e-liquids allows for obtaining a diversity of flavours that are not commercially available from shops. Online comments contained advice regarding proportions of ingredients necessary for obtaining a specific flavour. In a study by Schneller *et al.* (2018), 22% of adult participants and 40% of adolescent participants mixed e-liquids on their own in order to obtain a particular combination of flavours [31]. DIY production is a cheaper solution than buying e-liquid from a shop [32]. According to online forum users, the cost of a DIY e-liquid may be even five times less compared to the cost of ready-made e-liquid. Fewer users pointed to a need to quit smoking traditional cigarettes or to obtain a particular aroma of the smoke as their reason for undertaking DIY e-liquid production. Cox *et al.* (2018) identified four main motivations for producing e-liquids on one's own: cost reduction, fun, higher nicotine levels, and control over the production process. These results are similar to ours despite differences in research techniques [32].

Online forum users tended to perceive e-cigarettes as a harmful. Safety related comments were more focused on absolute risk of e-liquids. Relevant research has shown that e-liquids do not contain carcinogens present in tobacco smoke. At the same time, however, they contain a number of other harmful constituents, such as solvents,

aromas, or contaminations [33, 34]. The relative risk of using e-cigarettes compared to traditional cigarettes was presented in their study by Gravely *et al.* (2020). They proved that respondents in six European Union countries perceived e-cigarettes to be equally or more harmful than combustible cigarettes [35]. Safety was a frequent topic of online discussions. Forum users were generally aware of dangers associated with using e-cigarettes. Comments contained references to possible health consequences of e-smoking in the form of untoward symptoms, diseases or even death. In a study of Twitter posts, Allem *et al.* (2019) concluded that online users were concerned about the health consequences of e-cigarettes [36], while Hua (2013) revealed that online forums were also used for describing symptoms associated with smoking e-cigarettes [37]. DIY production was also considered harmful by forum users, who warned against possible dangers of using poor-quality ingredients or miscalculating the proportions. These errors may lead to explosions, the generation of noxious vapours or the production of an e-liquid that is harmful to health. The nicotine delivered by e-cigarettes is also a threat. A 2018 study demonstrated that e-liquid components can contribute significantly to nicotine exposure [18]. Cox (2018) investigated 33 DIY e-liquids. A chemical analysis in her study revealed the presence of several harmful substances and airway irritants [32]. Another aspect to consider is discrepancies in reported versus actual content of nicotine in e-liquids that have been found in study carried out by Girvalaki *et al.* (2020). They indicated that there were wide inconsistencies between the labelled and the actual nicotine concentration of the products, with production impurities commonly noted [38].

There are certain limitations to our study. The analysis of comments was conducted by one of the authors. The evaluation of the comments was subjective. The analysis concerned only those e-cigarette users who were active on online forums. Information on the study population's demographics could not be acquired. We do not know the age of forum users, their place of residence, education, etc. The qualitative analysis covered comments made between 1 January 2020 and 30 June 2020. That period was marked by the outbreak of the COVID-19 pandemic, which may have influenced the results. The comments necessary to conduct the study were obtained in Polish from Polish internet forums. This limits the generalization of the results to other countries. Keyword ambiguity was a limiting factor. The word "liquid" in Polish is also used in the context of travel, cosmetics or medicines. Even despite including "exclusion keywords" in the search, comments unrelated to the subject of the study were not completely eliminated.

It is a study analyzing numerous forums and internet portals regarding the self-production of liquids. Thanks to the SentiOne program, it was possible to search the space of the Internet, which is one of the ways in which

users of electronic cigarettes communicate. The research allowed to obtain information on the motivation and awareness of the risks associated with the independent production of liquids. The results of this study may identify ways to prevent this practice. This is a relatively new practice, so further research in this area may broaden our knowledge in this field. Further research is needed in which it would be possible to determine the demographic data of the studied population. It is also essential to research the health effects of such e-cigarette trends. Comparing the content of online e-cigarette forums in different countries could also provide additional information on the results presented in the study.

CONCLUSIONS

Our study, which was conducted using analysis of social media and online content, proved that the main motivations for producing e-liquids at home comprised a wish to obtain a desired flavour and to cut down the cost of e-liquids. Ingredients required for producing e-liquids are purchased from physical shops and the online platform *allegro.pl*. The selection of proportions or types of ingredients was based on other users' experience or e-liquid calculators. A majority of the respondents were aware of certain dangers arising from the use of e-cigarettes and DIY production of e-liquids. A governmental attempt to introduce an excise tax on e-liquids may prompted users to consider DIY e-liquid production. Semi-finished products used to make e-liquids should be included in future excise tax regulations on e-liquids.

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DISCLOSURE

Authors report no conflict of interest.

References

1. Stępniewska A, Kowalczyk M, Cholewińska E, Ognik K. E-cigarettes – an aid in quitting smoking or a threat? *Hygeia Public Health* 2017; 52 (2): 86-95.
2. Yamin C K, Bitton A, Bates DW. E-cigarettes: a rapidly growing Internet phenomenon. *Ann Intern Med* 2010; 153 (9): 607-609.
3. Konsumpcja nikotyny. Raport z badań ilościowych dla biura do spraw substancji chemicznych. CBOS, Warszawa 2019 [Nicotine consumption. Quantitative test report for offices for chemical substances. Public Opinion Research Center, Warsaw 2019]. Available from: <https://www.gov.pl/attachment/b1667fe1-5689-42cd-ba9f-ba2123935a93> (accessed: 10 March 2021).
4. Etter J P, Bullen C. Electronic cigarette: users profile, utilization, satisfaction and perceived efficacy. *Addiction* 2011; 106 (11): 2017-2028.

5. Vansickel AR, Eissenberg T. Electronic cigarettes: effective nicotine delivery after acute administration. *Nicotine Tob Res* 2013; 15 (1): 267-270.
6. Ustawa z dnia 21 listopada 2019 r. o zmianie ustawy o podatku akcyzowym Dz.U. 2019 poz. 2523 [Act of 21 November 2019 amending the Act on Excise Tax. *J Laws* 2019, item 2523]. Available from: <https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20190002523> (accessed: 20 January 2021).
7. National Bank of Poland. Warsaw: NBP; 2019 Value of EUR and USD based on the 2019 interim exchange rate of the National Bank of Poland. Available from: https://www.nbp.pl/kursy/Archiwum/publ_usdeur_m_2019.csv (accessed: 20 January 2021).
8. Rządowy projekt ustawy o zmianie ustawy o podatku akcyzowym. Druk nr 15, 2019 [Government bill amending the Act on Excise Tax. Paper No. 15, 2019]. Available from: <https://www.sejm.gov.pl/sejm9.nsf/PrzebiegProc.xsp?nr=15> (accessed: 20 January 2021).
9. Rozporządzenie Ministra Finansów z dnia 30 czerwca 2020 r. w sprawie zaniechania podatku akcyzowego od płyn do papierosów elektronicznych i wyrobów nowatorskich. Dz. U. 2020 poz. 1159 [Regulation of the Minister of Finance of 30 June 2020 on the abandoning the Excise Tax on liquid for electronic cigarettes and innovative products. *J Laws* 2020 items 1159]. Available from: <https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20200001159> (accessed: 20 January 2021).
10. Dyrektywa Parlamentu Europejskiego i Rady Unii Europejskiej 2014/40/UE [European Parliament and the Council of the European Union Directive 2014/40/EU]. Available from: <https://eur-lex.europa.eu/legal-content/PL/ALL/?uri=celex-3A32014L0040> (accessed: 20 January 2021).
11. Kyriakos CN, Filippidis FT, Hitchman S, et al. Characteristics and correlates of electronic cigarette product attributes and undesirable events during e-cigarette use in six countries of the EUREST-PLUS ITC Europe Surveys. *Tob Induc Dis* 2018; 16 (Suppl 2): A1.
12. Kahnert S, Driezen P, Balmford J, et al. Impact of the Tobacco Products Directive on self-reported exposure to e-cigarette advertising, promotion and sponsorship in smokers-findings from the EUREST-PLUS ITC Europe Surveys. *Eur J Public Health* 2020; 30 (Suppl_3): iii55-iii61.
13. Nagy LB. What we know from the harmful effects of e-cigarettes? *Orv Hetil* 2019; 160 (45): 1767-1773.
14. Helen GS, Eaton DL. Public Health Consequences of e-Cigarette Use. *JAMA Intern Med* 2018; 178 (7): 984-986.
15. Margham J, McAdam K, Foster M, et al. Chemical composition of aerosol from an e-cigarette: a quantitative comparison with cigarette smoke. *Chem Res Toxicol* 2016; 29 (10): 1662-1678.
16. Glantz SA, Bareham DW. E-cigarettes: use, effects on smoking, risks, and policy implications. *Annu Rev Public Health* 2018; 39: 215-235.
17. Hess CA, Olmedo P, Navas-Acien A, et al. E-cigarettes as a source of toxic and potentially carcinogenic metals. *Environ Res* 2017; 152: 221-225.
18. DeVito EE, Krishnan-Sarin S. E-cigarettes: impact of e-liquid components and device characteristics on nicotine exposure. *Curr Neuropharmacol* 2018; 16 (4): 438-459.
19. Jankowski M, Brożek G, Lawson J, Skoczyński S, Zejda JE. E-smoking: Emerging public health problem? *Int J Occup Med Environ Health* 2017; 30 (3): 329-344.
20. Goniewicz ML, Zielinska-Danch W. Electronic cigarette use among teenagers and young adults in Poland. *Pediatrics* 2012; 130 (4): e879-85.
21. Lewek P, Woźniak B, Maludzińska P, Smigielski J, Kardas P. E-cigarette use and its predictors: Results from an online cross-sectional survey in Poland. *Tob Induc Dis* 2019; 17: 79.
22. Balwicki L, Smith D, Balwicka-Szczybra, et al. Youth access to electronic cigarettes in an unrestricted market: a cross-sectional study from Poland. *Int J Environ Res Public Health* 2018; 15 (7): 1465.
23. Korzystanie z Internetu. CBOS, Warszawa 2019 [Use of the Internet. Public Opinion Research Center. Warsaw 2019]. Available from: https://cbos.pl/SPISKOM.POL/2019/K_095_19.PDF (accessed: 20 January 2021).
24. Burzyńska J, Bartosiewicz A, Rękas M. The social life of COVID-19: Early insights from social media monitoring data collected in Poland. *Health Informatics J* 2020; 26 (4): 3056-3065.
25. Nemeth R, Sik D, Katona E. The asymmetries of the biopsychosocial model of depression in lay discourses – Topic modelling online depression forums. *SSM – Population Health* 2021; 14 (3): 100785.
26. Schaffer C, Yeh CY, Chen SH, Lee JM, Hsieh CJ. A simulation impact evaluation of a cigarette excise tax increase on licit and illicit cigarette consumption and tax revenue in 36 European countries. *Public Health* 2018; 162: 48-57.
27. Chaloupka FJ, Kostova D, Shang C. Cigarette excise tax structure and cigarette prices: evidence from the global adult tobacco survey and the U.S. National Adult Tobacco Survey. *Nicotine Tob Res* 2014; 1 (16): S3-9.
28. Cole-Lewis H, Pugatch J, Sanders A, et al. Social listening: a content analysis of e-cigarette discussions on Twitter. *J Med Internet Res* 2015; 17 (10): e243.
29. Mantey D, Cooper MR, Clendennen SL, Pasch KE, Perry CL. E-cigarette marketing exposure is associated with e-cigarette use among US youth. *J Adolesc Health* 2016; 58 (6): 686-690.
30. Chen AT, Zhu SH, Conway M. What online communities can tell us about electronic cigarettes and hookah use: a study using text mining and visualization techniques. *J Med Internet Res* 2015; 17 (9): e220.
31. Schneller LM, Bansal-Travers M, Goniewicz ML, et al. Use of flavored electronic cigarette refill liquids among adults and youth in the US-Results from Wave 2 of the Population Assessment of Tobacco and Health Study (2014-2015). *PLoS One* 2018; 13 (8): e0202744.
32. Cox S, Leigh N, Vanderbush TS, et al. An exploration into “do-it-yourself” (DIY) e-liquid mixing: Users’ motivations, practices and product laboratory analysis. *Addict Behav Rep* 2018; 9: 100151.
33. Kavvalakis MP, Stivaktakis PD, Tzatzarakis MN, et al. Multi-component analysis of replacement liquids of electronic cigarettes using chromatographic techniques. *J Anal Toxicol* 2015; 39 (4): 262-269.

34. Hutzler C, Paschke M, Kruschinski S, et al. Chemical hazards present in liquids and vapors of electronic cigarettes. *Arch Toxicol* 2014; 88 (7): 1295-1308.
35. Gravely S, Driezen P, Kyriakos CN, et al. European adult smokers' perceptions of the harmfulness of e-cigarettes relative to combustible cigarettes: cohort findings from the 2016 and 2018 EUREST-PLUS ITC Europe Surveys. *Eur J Public Health* 2020; 30 (Suppl 3): iii38-iii45.
36. Allem JB, Majmundar A, Dharmapuri L, Cruz TB, Unger JB. E-liquid-related posts to Twitter in 2018: Thematic analysis. *Addict Behav Rep* 2019; 10: 100196.
37. Hua M, Alfi M, Talbot P. Health-related effects reported by electronic cigarette users in online forums. *J Med Internet Res* 2013; 15 (4): e59.
38. Girvalaki C, Tzatzarakis M, Vardavas A, et al. Discrepancies in reported versus measured nicotine content of e-cigarette refill liquids across nine European countries before and after the implementation of the EU Tobacco Products Directive. *Eur Respir J* 2020; 55 (2): 1900941.

AUTHORS' CONTRIBUTIONS

FR prepared research concept and design of the publication, critically revised it. AB collected data, analysed them and wrote the article. FE, AB contributed to preparing the final publication.