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Oral Health Problems Perceived: Electronic Cigarettes versus Conventional Smokers

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ABSTRACT

Electronic cigarettes are currently becoming a new trend for smokers, particularly among youth and young adults. Oral health problems related to their use are still not fully understood compared to the adverse effects of conventional cigarettes that are widely recognized. Therefore, this study aimed to compare oral health problems perceived between electronic cigarette users and conventional smokers. The method used was an observational cross-sectional design comprising 100 enrolled college students at Universitas Sumatera Utara. Electronic cigarette users and conventional smokers were invited to participate in the study and data collection was carried out using a questionnaire. Frequencies and percentages were obtained for socio-demographic, Cigarette Dependence Index, and self-perceived oral health problems due to smoking according to their status. A Chi-square test was used to assess the variation between the study groups with the different factors. The result showed that there was no statistical difference in oral health problems perceived between electronic cigarettes and conventional smokers (p = 0.648). Irritation of the mouth, cracked or broken tooth, and dry mouth were more prevalent in electronic cigarettes at 24%, 36%, and 64%, compared to conventional smokers at 14%, 28%, and 56%, respectively. In conclusion, this study observed no difference in oral health problems perceived between electronic cigarette users and conventional smokers.

Keywords: Electronic Cigarettes, Smokers, Oral Health Problems Perceived

ABSTRAK

Rokok elektronik saat ini sedang menjadi tren baru bagi perokok, terutama di kalangan remaja dan dewasa muda. Masalah kesehatan mulut terkait penggunaannya masih belum sepenuhnya dipahami, berbeda halnya dengan efek buruk dari penggunaan rokok konvensional yang telah diketahui sejak lama. Penelitian ini bertujuan untuk membandingkan masalah kesehatan mulut yang dialami oleh pengguna rokok elektronik dan perokok konvensional. Penelitian observasional dengan desain *cross sectional* ini dilakukan pada seratus orang mahasiswa di Universitas Sumatera Utara secara *consecutive sampling*. Penelitian ini melibatkan pengguna rokok elektronik dan perokok konvensional. Seluruh data dikumpulkan menggunakan kuesioner. Data sosiodemografi, *Cigarette Dependence Index* dan pengalaman masalah kesehatan mulut dihitung dalam frekuensi dan persentase berdasarkan status merokok. Uji *Chi-square* digunakan untuk menganalisis perbedaan antara kedua kelompok dengan faktor risiko berbeda. Hasil penelitian ini menunjukkan bahwa secara statistik tidak terdapat perbedaan pengalaman masalah kesehatan mulut di antara pengguna rokok elektronik dan perokok konvensional ((p = 0,648). Iritasi mulut, gigi fraktur atau pecah, dan mulut kering, lebih banyak ditemukan pada pengguna rokok elektronik (24%, 36%, dan 64%, secara berurutan) dibandingkan perokok konvensional (14%, 28%, dan 56%, secara berurutan). Sebagai kesimpulan, penelitian ini menunjukkan tidak terdapat perbedaan pengalaman masalah kesehatan mulut di antara pengguna rokok elektronik dan perokok konvensional.

Keyword: Rokok Elektronik, Perokok, Pengalaman Masalah Kesehatan Mulut

1. Introduction

Smoking is still health issue globally, with Indonesia ranking as the third largest trend of increasing smokers, after China and India [1]. According to *Riset Kesehatan Dasar* (RISKESDAS), the proportion of smoking in the population aged 10 years and older was 28.9% in 2018. Based on the type of cigarettes, 2.8% of smokers use electronic cigarettes [2].

Electronic cigarettes are battery-powered devices that work by heating and converting a liquid mixture, called e-liquid into an inhalable aerosol and delivering nicotine to the user without the combustion of tobacco [3–5]. The basic structure consists of three main elements, namely the battery, a metal heater (atomizer), and a cartridge filled with chemical liquid [1]. Furthermore, electronic cigarettes or nicotine delivery systems are currently becoming a new trend for smokers as smoking cessation aids, particularly among youth and young adults [1,5,6]. Due to their potential to reduce the harmful effects, electronic cigarettes have been considered as an alternative product for conventional types. However, this alternative could act as a gateway product to smoking and promote dual use with other forms of tobacco [1,4]. In 2017 *Badan Pengawas Obat dan Makanan* (BPOM) in Indonesia proposed a ban on the commercial distribution of electronic cigarettes because of the uncertain benefits and potential adverse effects on society. According to the BPOM, smoking in any form is considered to be an addiction with detrimental effects on health [1].

The adverse health effects of electronic cigarettes are currently under study [4] E-liquid in electronic cigarettes contains nicotine that can cause vascular disorders due to long-term consumption such as vasoconstrictions, increased heart rate, high blood pressure, urine production, and risk of thrombosis. Furthermore, aerosols consist of adverse chemicals, including potential carcinogens (formaldehyde, acetaldehyde, and acrolein), metals, tobacco-specific nitrosamines or TSNAs, and other adverse chemical constituents [1,3,7]. Several studies have shown the deleterious impact of electronic cigarettes on oral health [4,5,8]. Because of the increasing use particularly among youth and young adults, oral health problems related to electronic cigarettes are still not fully understood compared to conventional smokers that are widely recognized [8]. Therefore, this study aimed to compare oral health problems perceived between electronic cigarette users and conventional smokers.

2. Materials and Methods

Ethical approval for this study was provided by Health Research Ethics Commission at the Universitas Sumatera Utara (No: 696/KEP/USU/2020) on November 13th, 2020. All participants provided informed written consent to the study. This observational cross-sectional study was conducted on consecutively enrolled college students who smoke at Universitas Sumatera Utara, Medan, Indonesia. Electronic cigarette users and conventional smokers were invited to participate in the study. Specifically, electronic cigarette users were defined as daily smokers who engaged in the activity for at least 6 months. This also included smokers who had quit using combustible tobacco and switched completely to electronic cigarettes for at least 6 months before the study. Conventional smokers included individuals using combustible tobacco cigarettes for at least 6 months. However, participants drinking alcohol and receiving treatment for systemic diseases were excluded.

Data collection was carried out using a questionnaire, which consisted of three parts, namely socio-demographic data, cigarette dependence index, and self-perceived oral health problems due to smoking. Socio-demographic data were collected on age, gender, address, telephone number, religion, and race. Cigarette dependence index for electronic and conventional cigarettes use variables was assessed by a questionnaire comprising 10 items, adapted from Foulds et.al. Specifically, two items were asked about the actual numbers, five items on difficulty quitting, the experience of craving, and withdrawal symptoms. There were also two items that asked about assessing waking at night to use and one item evaluated the recent strength of urges to use. Response options for each question were collected and the total scoring of all questions was classified into four categories. These included high dependence (score >13), medium dependence (score 9-12), low dependence (score 4-8), and not dependent (score 0-3) [9].

The self-perceived oral health problems variable was assessed in a question where participants could show yes or no response option when experienced oral health problems due to smoking during the last month before the study. Oral health problems adopted [5,10,11] were bleeding gums, black tongue, irritation of the mouth, cracked or broken tooth, bad breath, and dry mouth. Variables were computed based on the response option to each oral health problems listed. The participants were allowed to select one or more response options

from the list.

All study data were computerized and a normality test was performed using the Kolmogorov-Smirnov test. Descriptive statistics in terms of frequencies and percentages were obtained for the study variables according to smoking status, namely electronic cigarettes and conventional smokers. The difference between the outcome and explanatory variables was assessed with the Chi-square test. The statistical significance level used in the study was less than 0.05.

3. Results

A total of 100 college students were included in this study, comprising 50 electronic cigarette users and 50 conventional smokers. The demographic data of participants based on their status of smoking is presented in Figure 1. All participants were male and the majority were 21-25 years of age, both electronic cigarette users (76%, n = 38) and conventional smokers (60%, n = 30).

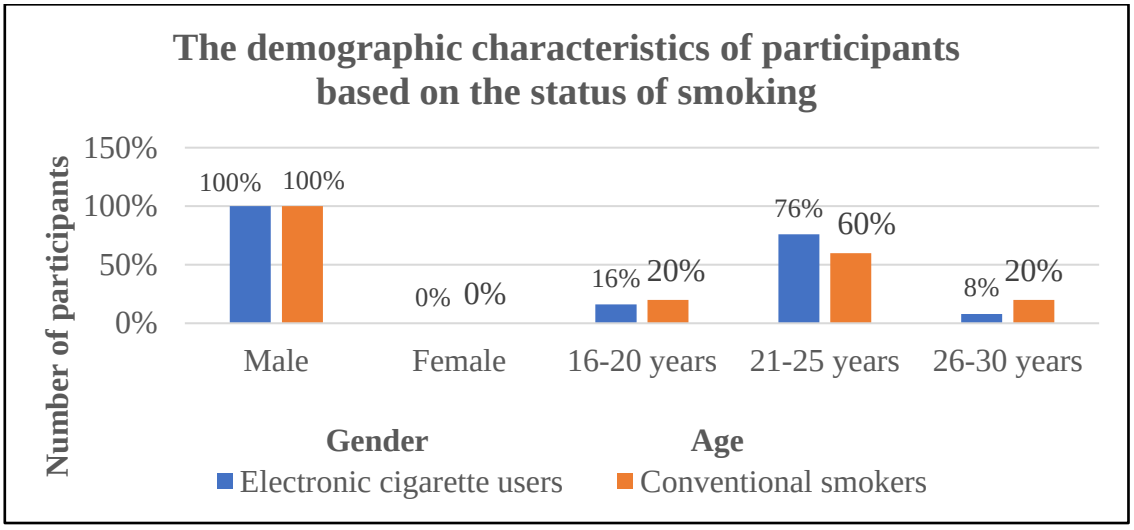

Figure 1. The demographic data of electronic cigarette users (n = 50) and conventional smokers (n = 50).

Based on the duration for smoking as shown in Figure 2, most electronic cigarette users had smoked for less than 5 years (68%, n = 50). Meanwhile, the majority of conventional smokers had smoked for more than 5 years (60%, n = 50). Based on the frequency of smoking, most of participants often smoked less than 10 times per day, both electronic cigarette users (56%, n = 50) and conventional smokers (56%, n = 50).

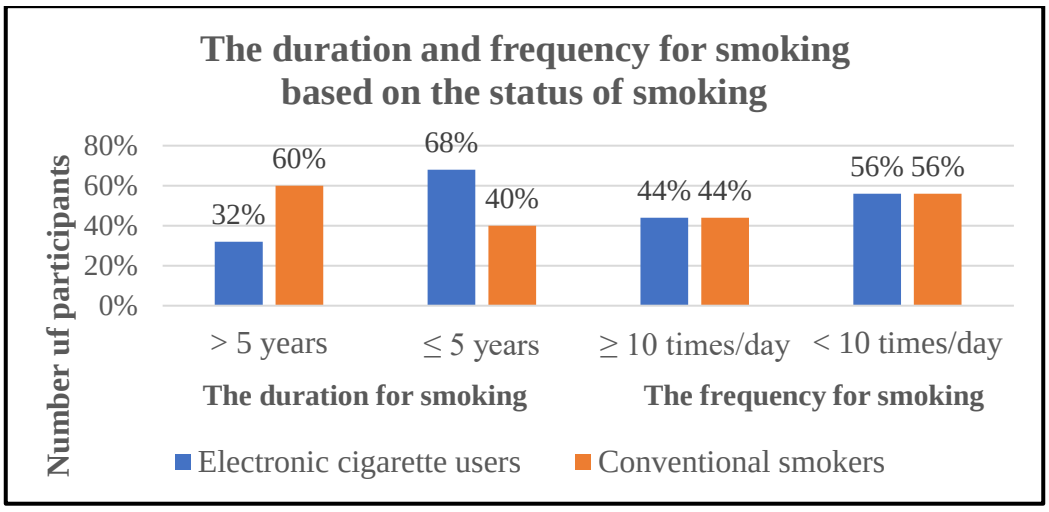

Figure 2. The duration and frequency of smoking of electronic cigarette users (n = 50) and conventional smokers (n = 50).

Based on cigarette dependence index in Figure 3, most electronic cigarette users had low dependence (64%, n = 32), followed by medium dependence (24%, n = 12), and not dependent (12%, n = 6). Meanwhile, most conventional smokers had medium dependence (52%, n = 26), followed by low (44%, n = 22), and high (4%, n = 2).

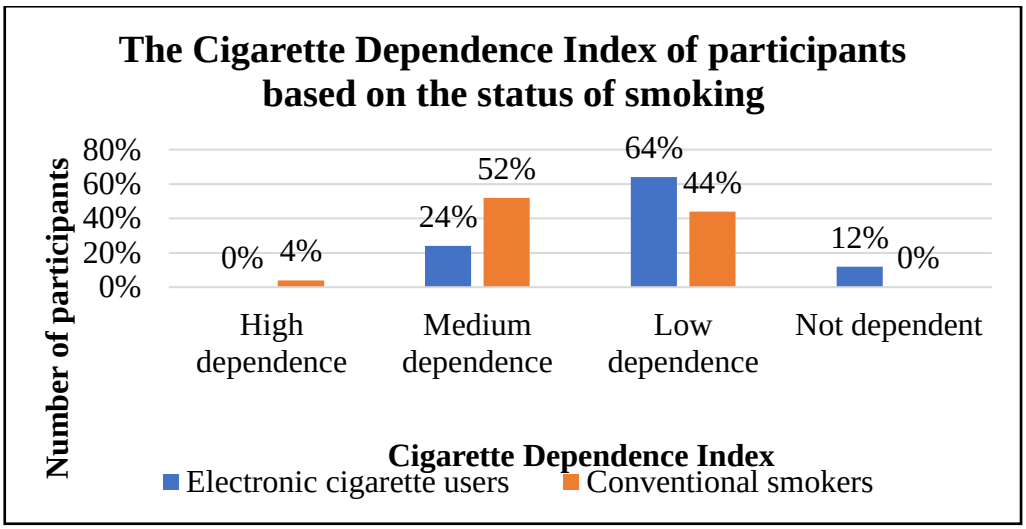

Figure 3. Cigarette Dependence Index of electronic cigarette users (n = 50) and conventional smokers (n = 50).

As presented in Figure 4, most electronic cigarette users experienced oral health problems for at least or more than one (72%, n = 36). In conventional smokers group, most participants also experienced any oral health problems for at least or more than one (76%, n = 38). The Chi-square test analysis showed there was statistically no difference in oral health problems perceived between electronic cigarettes and conventional smokers (*P* = 0.648).

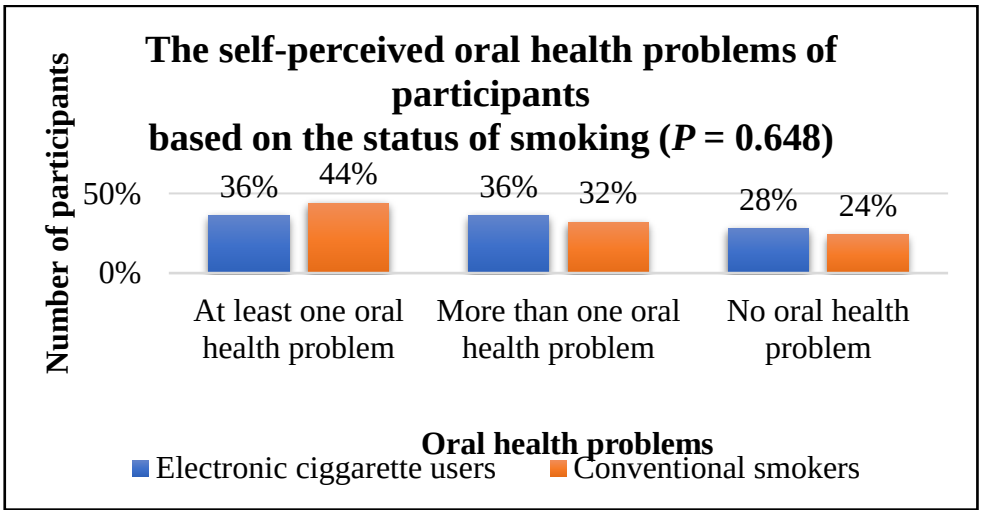

Figure 4. The self-perceived oral health problems of electronic cigarette users (n = 50) versus conventional smokers (n = 50), *P* = 0.648.

The frequency distributions of self-perceived oral health problems of participants ranged from 14% in conventional smokers who experienced irritation of the mouth as well as cracked or broken tooth. There was 18% of electronic cigarette users group who experienced crack or broken tooth, while 74% of conventional smokers had bad breath. The results showed that 64% of electronic cigarette users experienced dry mouth and bad breath, as presented in Figure 5. Irritation of the mouth, cracked or broken tooth, and dry mouth were more prevalent in electronic cigarette users (24%, n = 12; 36%, n = 18; and 64%, n = 32; respectively) compared to conventional smokers (14%, n= 7; 28%, n= 14; and 56%, n= 28; respectively). Meanwhile, the frequency distributions of bleeding gum among electronic cigarette users were the same as conventional smokers (46%, n = 23, equally). Black tongue and bad breath were more prevalent in conventional smokers (58%, n = 29 and

74%, n = 37, respectively) compared to electronic cigarette users ((38%, n = 19 and 63%, n = 32, respectively).

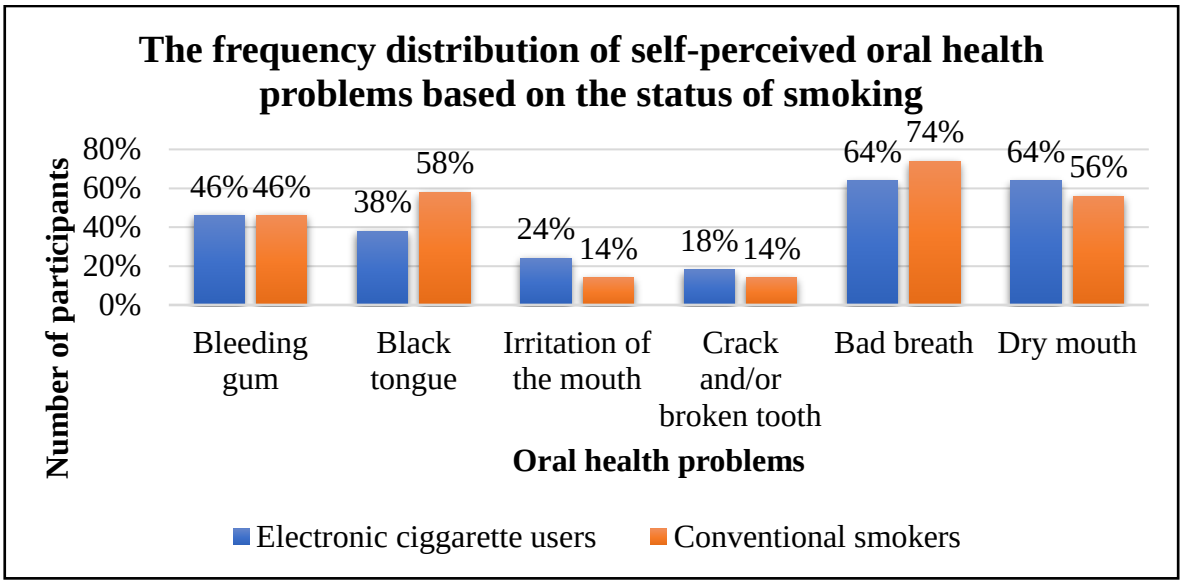

Figure 5. The frequency distributions of self-perceived oral health problems among electronic cigarette users (n= 50) and conventional smokers (n= 50).

4. Discussion

This study was conducted on college students with a history of smoking. RISKESDAS 2018 reported that the proportion of smokers in Indonesia among the population currently attending school was 8.6%. [2] All college students who participated in this present study were male. Currently, male smokers continue to outnumber females, with Indonesia ranking first globally in terms of male smokers [1,2].

The majority of participants in this study were at 21-25 years of age predominantly consisting of electronic cigarette users than conventional smokers. RISKESDAS 2018 reported that the use of electronic cigarettes in the 10-14 years age group was higher compared to 15-19 years, 20-24 years, and 25-29 years at 10.6%, 10.5%, 7%, and 4.3%, respectively [2]. Elsa et. al. conducted a study using SUSENAS (National Social Economic Survey) data in 2017 and showed different results that electronic cigarettes in Indonesia were mostly used by more than 24 years age group compared to the youth (15-24 years) [12]. This showed that the use of electronic cigarettes was becoming increasingly popular among youth and young adults as a safer alternative to smoking tobacco products [1,12]. Abadi et al. reported that there was a perception of less harm among California college students. Furthermore, enjoying sampling different e-juice flavors with friends and watching the exhaled vapor, were the major contributing factors [4].

Based on cigarette dependence index, the majority of electronic cigarette users were categorized as having low dependence, while conventional smokers were in the medium category. Similarly, Foulds et al. found that electronic cigarette users who had quit using conventional method during data collection reported significantly lower levels of smoking dependence ($P < 0.0001$) [9]. This suggested that electronic cigarette users were generally less dependent on nicotine due to significantly low peak levels. Furthermore, there was a gradual delivery of nicotine, leading to lower levels of addiction than conventional smokers [3,9].

Since the majority of participants (29%) were former conventional smokers, electronic cigarette users had a strong motivation to quit smoking. There were also presumptions regarding the motivation for individuals to use electronic cigarettes as a method of quitting smoking [13]. Baweja et al. stated that the majority of users (73.5%) reported starting electronic cigarettes to quit tobacco and 93.5% applied the method as cessation aid [14]. Adriaens et al. stated that in a series of controlled lab sessions with electronic versus tobacco smokers, second-generation electronic cigarettes were shown to be immediately and highly effective in reducing abstinence-induced cigarette craving and withdrawal symptoms ($p < 0.001$). This was because of the ability to suppress the desire to smoke along with a significant reduction in cravings [15]. Damayanti et al. conducted a similar study in Surabaya's personal vaporizer community. The results showed that participants used electronic cigarettes most commonly to quit smoking (80.6%) compared to trying something new (12.9%)

and lifestyle (6.5%). The majority of participants considered electronic cigarettes to be safer alternative to quitting smoking [13].

Several studies have addressed the direct health effects of using electronic cigarettes, particularly with regard to oral health [5,8,10,16]. In this study, there was statistically no difference in oral health problems perceived between electronic cigarettes and conventional smokers. However, Adriaens et al. found that electronic cigarette users had significantly fewer adverse complaints and more positive symptoms compared to conventional smokers ($P < 0.001$) [15]. The variation in results could be attributed to different methods used during the experiment. The previous study investigated the efficacy of electronic cigarettes in an eight-month Randomized Controlled Trial (RCT). The investigation included electronic cigarette users as the experimental group and conventional smokers as the control group, who were exposed to the same interventions and questionnaires [15].

Participants in this study obtained their electronic cigarettes for free due to the lack of governing regulations in Indonesia. This has led to a significant development with a wide variety of brands and models, thereby allowing users to fill and change product fluids extremely easily. The development has raised concerns about the opening of opportunities for users to inject excessive nicotine or other substances, including drugs illegally [1]. Moreover, it was recently proposed that electronic cigarettes could also be a gateway as an intermediary product to start smoking or promote dual users with other forms of tobacco products [1,4]. Regulatory policy toward tobacco significantly affects oral health due to the substantial contribution to diseases that manifest in oral cavity [16].

Regarding the distribution of oral health problems perceived in this study, irritation of the mouth, cracked or broken tooth, and dryness were more prevalent among electronic cigarette users compared to conventional smokers. This was similar to previous reports [5,10,11,17], although there were variations in results. Moreover, there was no uniform definition of smokers or assessment of oral health problems perceived in all of the literature. All included studies defined oral health problems perceived as subjective patient-reported oral symptoms. This led to differences in the prevalence of oral health problems perceived among smokers.

Possible explanations for the irritation of the mouth symptom are numerous [11]. Similar to conventional type, electronic cigarette aerosols contain many chemicals. These include the thermal degradation products of the e-liquid base compounds propylene glycol and vegetable glycerin, such as acrolein, formaldehyde, and acetaldehyde, which are known as toxicants [10,11,18]. There are also specific impacts of flavoring chemicals added in numerous mixtures of electronic cigarettes [18,19]. Menthol and cinnamon were associated with higher levels of irritation of the mouth. Nicotine increases short-term blood flow to mucosal tissues, with the ability to mask airway irritation [19]. Nickel from the nickel-chromium heating filaments of electronic cigarettes is capable of causing tongue or buccal pain. [10] A study by Cho found that electronic cigarettes were associated with a significantly increased chance of tongue or buccal pain among youths. The odds of tongue or buccal pain among daily electronic cigarette users were over 50% higher ($P = 0.028$) compared to non-users. Additionally, longer and harder puffing with a stronger vacuum was found to be essential for vaping than for conventional cigarette smoking to produce aerosol. Vacuum generation might include the tongue, the palate, and the buccal mucosa, causing direct exposure to the vapor [11].

The higher prevalence of dry mouth in electronic cigarette users compared to conventional smokers, was similar to the previous study by Guo et al., [20] but different from Hasan et al [21]. The study by Baweja et al. reported that most commonly participants experienced dry mouth as the negative effect associated with electronic cigarettes [14]. The harmful consequences of nicotine on oral tissues have been well established [3]. It could be suspected that nicotine circulating in the blood vessels affected blood vascularization in the salivary glands [22,23]. Furthermore, smoking increases the activity of salivary glands but decreases the flow rate due to long-term use [21]. Based the on self-report of dry mouth, no publication has addressed objectively whole or glandular-specific salivary hypofunction in electronic cigarette users [22].

A cracked or broken tooth is a dental symptom that can be found in electronic cigarette users, along with caries, tooth discoloration, tooth sensitivity, abscess/infection, and tooth loss/extraction [19]. A study by Ghazali et. al. about oral health of smokers and electronic cigarette users found the absence of significant differences in the occurrence of caries, between the control, cigarette, and electronic cigarette groups [24]. According to Cho, the use of electronic cigarettes increased the odds of cracked or broken tooth among

adolescents, which were over 60% higher (P = 0.003) than non-users. Nicotine can be a contributing factor in cases of cracked or broken teeth leading to functions of dentin matrix synthesis and mineralization decreasing in the dental pulp cells of smokers. An inflammatory response plays a role in pulpal inflammation onset and progresses to pulp necrosis, causing enhanced streptococcus mutans biofilm formation and biofilm metabolic activity to increase the development of caries [10,18]. The viscosity of electronic liquid might facilitate the adhesion of Streptococcus mutans to the tooth surface. Meanwhile, the flavors of electronic liquid contribute to the potentiation of cariogenic bacteria to increase biofilm formation [19].

The results showed a high prevalence of bleeding gum, black tongue, and bad breath in both electronic cigarette users and conventional smokers. These oral symptoms were experienced by the participants, as in previous studies [5,8,11,25]. Oral cavity being the first part of the body exposed to the constituents of any form of tobacco products, including electronic cigarettes, was at high risk of carcinogenic, immunologic, microbial, and clinical effects [5,8,18].

This study was the first to compare oral health problems perceived between electronic cigarette users and conventional smokers in college students at Universitas Sumatera Utara, Medan, Indonesia. The experiment was performed on subgroup analyses to discuss the prevalence of self-perceived oral health problems by smoking type. Despite the significant contributions, there were some limitations associated with the analysis conducted. Firstly, this study used an observational cross-sectional design, leading to the presence of some biases. Secondly, there might be a need to establish a clear distinction between the two subgroup analyses. Therefore, future studies should include electronic users who have not been conventional smokers in their lifetime. Additional characteristics should be such as the participants socioeconomic status, levels of chemical/toxicants due to smoking, and objective clinical validation to verify self-reported oral symptoms. Thirdly, the number of participants in the analyses was limited, requiring the inclusion of a larger population of high quality to offer evidence.

5. Conclusion

In conclusion, this study observed that there was no difference in oral health problems perceived between electronic cigarette users and conventional smokers. The result showed that electronic cigarette users reported lower levels of smoking dependence, and more self-perceived oral symptoms, particularly irritation of the mouth, crack or broken tooth, and dry mouth compared to conventional smokers. Meanwhile, a high prevalence of bleeding gum, black tongue, and bad breath were observed in the two groups of smokers.

6. Acknowledgments

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7. Conflict of Interest

All the authors report no conflicts of interest.

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