Title: E-cigarette (EC) and heated tobacco product (HTP) use in the United Arab Emirates, an emerging EC and HTP market: A cross-sectional analysis of the International Tobacco Control (ITC) UAE Survey

Short running title: E-cigarette and heated tobacco product use in the UAE

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Abstract (250 words)

Introduction: E-cigarettes (ECs) and heated tobacco products (HTPs) are recent arrivals to the nicotine product market in the Middle East, which are rapidly growing in popularity in the region. There is a lack of surveillance data at the country-level on use of these products and factors associated with their use.

Methods: This study analyzed a subset of data from the UAE Healthy Future Study, a population-based cohort study of the Emirati population, to determine the factors associated with EC and HTP use among a sample of Emirati adults (≥ 18 years). The baseline assessment and supplementary questionnaires, conducted from 2016 to 2023, included data on combustible tobacco use, EC, and HTP use and sociodemographic characteristics.

Results: Of the 2,041 individuals who answered questions on EC use, 32% reported ever using them. Of 521 people providing data on HTP, 30% reported ever using them. After adjusting for age, sex, education, perceived harms and perceived addictiveness of EC, current EC use was associated with baseline combustible tobacco smoking (aOR = 27.63, 95% confidence interval [CI] 14.39, 53.06), users of a younger age (aOR=0.91, 95%CI 0.88, 0.95), and users of male sex (OR = 2.15, 95% CI 1.21, 3.81). Current HTP use was less common, but was also associated with baseline combustible tobacco use.

Conclusions: Use of ECs and HTPs was more common among those who used combustible tobacco. Future research should examine use trajectories among those who do and do not smoke, as well as uptake of these products among youth.

Implications: Non-combustible nicotine products are growing in popularity in the Middle East Region. Our study found that EC and HTP use is associated with baseline combustible tobacco

use and that concurrent users may use them to cut down on their combustible tobacco use. Continued comprehensive population-based monitoring of all tobacco and nicotine products, especially EC and HTP use, will provide current data to aid in appropriately informing public health and harm reduction messages and programming.

Introduction

Non-combustible nicotine products (NCNPs) are a class of nicotine delivery devices that include e-cigarettes (ECs), also known as vapes, heated tobacco products (HTPs), and non-combustible tobacco and nicotine products, such as snus. NCNPs have become the focus of tobacco company development and marketing over the past several years, and use is increasingly seen as a popular alternative to combustible tobacco use.[1] Combustible tobacco use is decreasing in many parts of the world, but in the Eastern Mediterranean region (EMR) the number of people smoking is increasing.[1] In the United Arab Emirates (UAE), current estimates of tobacco use range from 13% to approximately 30%.[1,2] There are multiple forms of combustible tobacco available in the EMR.[3-5] In the UAE, in addition to cigarettes, other forms of combustible tobacco include shisha (waterpipe), and midwakh, which is a small pipe used to smoke loose tobacco (dokha).[6] While the number of people in the EMR who smoke has steadily been increasing, so has the popularity of NCNPs; ECs in particular.[7-9]

While some other countries in the EMR still restrict the sale of ECs, in April 2019 the UAE permitted the sale of these products.[10] Since ECs came to the Middle East market, there have been few studies conducted about their use, with most focusing on awareness, beliefs and attitudes towards ECs.[11-13] A recent study on EC use in the UAE found that most people using ECs were under 40 years old and were current or former combustible tobacco users.[9] The high percentage of those who use ECs who also currently or formerly smoked is consistent with use patterns in other countries, including the US, Canada, England, Australia, and Malaysia.[14,15] Additional studies in the Middle East region similarly found that people who currently or formerly smoked used ECs more commonly and younger people were more knowledgeable

about them.[7,8] However, surveillance data on their use in the general population is still lacking in many countries. Few studies have been conducted investigating HTP use. One cross-sectional survey of people who currently smoked in Saudi Arabia, Yemen, and Kuwait showed that about 5% used HTPs regularly, with half stating they used them to help them quit smoking.[16] Studies on HTP use and its correlates from other regions such as Mexico and Europe showed similar results.[17-19] Additional studies are needed to understand the relationship between current combustible tobacco, EC, and HTP use to evaluate the potential for these products to either impose or reduce harm and ultimately assess the public health impact of these new and emerging products in the region.

This study analyzed data from the UAE Healthy Future study (UAEHFS) baseline assessment and a supplemental EC and HTP questionnaire to explore associations between EC or HTP use, current at baseline smoking status and other sociodemographic characteristics. We also sought to understand patterns of use and reasons for this. We specifically examined associations between EC and HTP use and perceptions of harm and addictiveness of these products since perceiving they are harmful or addictive have been shown to be associated with use in other studies.[9,13,17] Understanding the use patterns of these relatively new products may help in appropriately targeting public health and harm reduction messaging, and informing future regulation.

Methods

Study Design/Sample: The protocol was pre-registered on the Open Science Framework (DOI: 10.17605/OSF.IO/J7ZST). We analyzed data from the UAE Healthy Future Study (UAEHFS) baseline assessment survey and the supplemental e-cigarette survey. The UAEHFS is

a population-based cohort study of Emiratis aimed at understanding factors that contribute to diabetes, heart disease, and obesity.[20] The baseline assessment survey for the UAEHFS began in 2016 and concluded in 2023. Participants were recruited from a community-based convenience sample stratified by age group and gender, with physical recruitment centers located throughout the country in an effort to recruit a geographically diverse sample. Eligible participants were Emirati nationals, 18 years or older, and currently residing in the UAE. All participants provided written consent to participate in the study procedures. The full study procedures are described elsewhere.[20]

Ethical approval: The UAEHFS received ethical approval from the Institutional Review Board at New York University Abu Dhabi, Dubai Health Authority, Ministry of Health and Prevention in the UAE, and the Abu Dhabi Health Research and Technology Committee, reference number DOH/ HQD/2020/516.

Survey measures: The baseline assessment survey included questions on demographic characteristics, general health status, physical activity, mental health, and combustible tobacco use. The supplemental EC survey was originally intended to be part of the baseline assessment. However, ECs and HTPs were not legally available in UAE smoke shops until 2019 and therefore, the EC and HTP questions were deployed as a supplemental survey in 2021. The supplement was sent via email to all participants enrolled prior to 2021, and subsequently added to the baseline assessment as of 2021. Participants who enrolled before 2021 were invited to participate in the supplementary survey and sent the survey link via email reminders for a period of 2 months. The time between baseline assessment and supplementary survey completion for

those enrolled before 2021 ranged from 1 month – 6 years. The supplement on EC and HTP use included questions about current use, awareness, and perceptions about the safety of these products. Additional information on survey measures can be found in the supplemental materials and the pre-registered protocol (DOI: 10.17605/OSF.IO/J7ZST). The questions assessing use of combustible tobacco products, ECs, and HTPs were adapted from the International Tobacco Control Policy and Evaluation Project (ITC) surveys (https://itcproject.org/surveys/).[21] The text of specific questions on EC and HTP use are included in the supplementary information. Participants could choose to answer the survey in either English or Arabic.

Baseline tobacco use was determined by responses to three questions: "On average, how often do you smoke cigarettes?" with the same question being asked about midwakh and about shisha. Individuals were considered to be non-tobacco users if they responded "not at all" to all of these questions. If the participant then provided "yes" responses to the questions: "did you ever smoke cigarettes, [midwakh], [shisha]?" and "have you smoked 100+ cigarettes, midwakh, or shisha?", they were then classified as a former smoker. All others were classified as people who used tobacco at the time of the baseline assessment. EC and HTP use were determined by two questions: "have you ever used a(n) e-cigarette [heated tobacco product], even one time?" with those responding "yes" being considered a user of that product.

Statistical analysis: We analyzed data using STATA version 17.0 (STATA Corp, TX, USA). We estimated the prevalence of EC and HTP use by calculating the point prevalence and 95%CI for EC and HTP use among people who smoked combustible tobacco at baseline and people who did not, and compared their associated demographic characteristics. Study participant

characteristics are reported as frequencies and percentages (N, %) for categorical variables or mean and standard deviation (mean ± SD) for normally distributed continuous variables or median and interquartile range (median, IQR) for not normally distributed continuous variables. We presented reasons for EC or HTP use and perceptions of harm and addictiveness of ECs and HTPs descriptively. We also examined the rates of combustible tobacco use by type and compared them with EC and HTP use using Chi square tests or Fisher's exact tests for comparisons with few observations.

We examined the factors associated with EC and HTP use using logistic regression to estimate the association between a) ever use of EC and b) HTP use with current smoking status and sociodemographic factors including age, sex, education (less than college vs. college+), perceived harm of these products compared to combustible tobacco (less harmful vs. as harmful or more harmful), and perceived addictiveness of these products compared with combustible tobacco (less addictive vs. as addictive or more addictive), with and without adjustment for the other product. We initially planned to conduct an analysis on the combined use of EC and HTP, but due to low rates of HTP use, there was very little overlap between users and so we present the analyses of the products separately. We reported the odds ratio (OR) and 95% confidence interval (CI) to examine the association between these factors and ever use of EC and HTP products. When we fit the model adjusting for the other product, the number of observations decreased and we did not observe an improved model fit, and so the results presented here are for the adjusted model without adjustment for the other product. Models with adjustment for the other product are presented in the supplementary material.

We initially conducted complete case analyses. We evaluated the dataset for missingness and summarized the proportion of missing values for the outcome variables and covariates. We conducted sensitivity analyses to determine the level of bias introduced by missing data. We performed multiple imputation using chained equations (MICE) with 100 iterations to impute missing covariates for EC or HTP use (model 1).[22] We also fit a model to predict the outcome variable (EC or HTP use) and missing co-variates (model 2) for all participants who provided tobacco use data.

All applied tests were two-sided and a p-value <0.05 was the level of statistical significance. No p-value adjustment was performed for multiple comparisons.[23,24]

Results

Sample characteristics

A total of 14,294 participants enrolled in the UAEHFS baseline assessment with 14,008 providing questionnaire data. Of these, 7,535 (52.3%) completed the tobacco use survey questions. Just over 2,041 (14.1%) participants completed the supplemental questions on ECs and HTPs (**Figure 1**). Nearly half of the EC/HTP survey responses came from participants who were recruited before 2021 and therefore responded to the supplemental version of the survey (55%). Roughly one-third of the sample self-reported current combustible tobacco use (30.5%). The majority of tobacco users were men (91%). Individuals who reported completely quitting using combustible tobacco comprised 2% of the sample. Table 1 describes additional demographic characteristics of the study sample.

Of the participants who reported combustible tobacco use, cigarette, midwakh, and shisha were equally commonly used (62%, 61%, and 64% respectively). Over half of the combustible tobacco users reported concurrent use of 2 or more tobacco products (53%). Seventy four percent of tobacco users reported ever using ECs compared to 14% of people who did not use tobacco. Similarly, 51% of tobacco users reported ever using HTPs compared with only 7% of people who did not use tobacco (**Table 1**).

EC users were asked about the device they most commonly used. At the time of the survey, most EC users preferred to use the disposable non-rechargeable EC device (66%) followed by the tank type of device that uses refillable liquids (22%). Most EC users preferred fruit flavored liquids (57%). People who used ECs were asked about their reasons for using ECs. (**Figure 2**) The most prevalent reasons were because ECs tasted good (83%), they enjoyed using them (59%), they could be used in places where traditional cigarettes were not allowed (53%), and they were less harmful than traditional cigarettes (50%). The least prevalent reasons were looking cool (7%), health provider advice (7%), and attractive packaging (21%).

We examined the reasons for using ECs for those who also smoked and those who did not smoke. Both people who smoked and those who did not had a high level of agreement with the statement “they taste good” as one of the reasons they used ECs (81% people who do not smoke and 83% people who smoke agree). Curiosity and the perception that ECs were less harmful than regular cigarettes were reasons given for EC use (56% of people who did not smoke for both reasons, 38% and 48% of people who smoked, respectively). Over half of people who smoked agreed that a reason for using ECs was that they would help them either cut down or quit smoking cigarettes (54% and 56%, respectively). Nearly 20% of people had heard about HTPs,

and of the people who had heard of them, 30% reported using HTPs. Reasons for HTP use among people who smoked included curiosity (71%), that they perceived them as less harmful than traditional cigarettes (54%) and that they might help them quit smoking traditional cigarettes (50%).

Associations with EC and HTP use

First, we examined unadjusted associations between EC or HTP use and baseline combustible tobacco use. Those who smoked were much more likely to have ever used ECs (74%) than were those who did not smoke (14%) (OR=18.16, 95%CI 14.27, 23.12). The same was true for HTPs, with those who smoked being much more likely to ever used HTPs (51% vs. 7%) (OR=14.57, 95%CI 8.34, 25.43).

In the multivariate analysis of complete cases, EC use was even more strongly associated with tobacco use at baseline (OR=27.63, 95%CI 14.39, 53.06). (**Table 2**) EC use was also associated with being male, at least college educated, and perceiving the products as being less harmful than combustible tobacco. The median age of the study participant sample was 25 years (range = 18 – 71). Younger respondents were more likely to use ECs, with decreased odds for respondent age (OR=0.91, 95%CI 0.88, 0.95). The multivariate analysis also showed a stronger association between HTP use and baseline tobacco use (OR=51.23, 95%CI 8.82, 297.41).

Sensitivity analysis

Approximately half of the study participants completed the tobacco use questionnaire (47% missing). Fewer participants completed the questions on EC and HTP use (86% and 96% missing, respectively). (**Supplementary figure 1**) In our sensitivity analysis, we imputed

missing covariates, with 100 iterations, in the adjusted model for 1) the EC use outcome and 2) the HTP use outcome. Our effect estimates maintained a strong significant association between EC or HTP use and combustible tobacco use when we imputed missing covariates for both outcomes, and the confidence intervals were tighter around the effect estimates. In the models with imputed data for all covariates (model 1), EC and HTP use were still significantly associated with current tobacco use (OR_{EC} = 17.69, 95%CI 13.01, 24.05 and OR_{HTP} = 12.31, 95%CI 6.04, 25.10). Imputation models with 100 iterations, that included imputing the outcomes (EC and HTP use) for all participants who provided tobacco use data (model 2) showed similar results (OR_{EC} = 17.43, 95%CI 13.02, 23.33 and OR_{HTP} = 11.70, 95%CI 5.42, 25.26). (**Supplementary table 1**) Additional information on the missing data analysis and imputed models can be found in the supplementary data. (**Supplementary figures 1 - 3**)

Discussion

We sought to understand the current patterns of EC and HTP use among a sample of Emiratis residing in the UAE. We found that EC use was most common among those who reported at baseline they smoked combustible tobacco, who were younger adults, and who had at least a college education. Women were less likely to smoke combustible tobacco or use EC or HTP. HTP use was less common overall, but showed similar associations with baseline combustible tobacco use. People who used HTP were more likely to be current at baseline combustible tobacco users, men, and at least college educated. We did not see significant associations in the adjusted model, but this is likely due to the small sample size. Additional data may affect these results.

Previous studies conducted in the US and England that characterize the use of EC and HTP among people who currently smoke and people who do not smoke have shown that most NCNP use is among younger adults who also use some form of combustible tobacco.[25-27] A study in England showed EC use, independent of other forms of non-combustible nicotine products, was significantly associated with either currently or formerly smoking (aOR = 23.53, 95%CI 14.31, 38.69 and aOR=11.25, 95%CI 6.71, 18.86, respectively).[25] Additionally, in this study, whilst not statistically significant, younger adults were more likely to use EC than adults older than 25 (aOR = 1.22, 95%CI 0.79, 2.03).[25] Results from a four-country ITC Project survey on tobacco use and vaping show similar results to ours. In an ITC study of HTP awareness and use, in countries where HTP were available, (Canada, USA, Australia, and England) awareness and use were significantly associated with concurrent smoking and vaping (OR=1.42, 95%CI 1.13, 1.79; OR=1.68, 95%CI 1.12, 2.53, respectively).[26] In the same four country survey, they also found that men were more likely to use EC than women, and they stated similar reasons for using EC as our sample.[28]

People in our study were more familiar with EC than HTP, but we found similar patterns of HTP and EC use. This would suggest that perhaps as people become more familiar with HTP, use may increase. Analysis of 2 waves of the EUREST-PLUS ITC surveys in several European countries showed that as awareness of HTP increased between waves so did their use (1.1% to 1.9%).[18] In a study conducted in Mexico, HTP use was around 1.1% after being introduced to the market and was more common among people who already smoked combustible tobacco (ARRR=1.57 95%CI: 0.69, 3.54) and who perceived them as less harmful than combustible tobacco (ARRR = 1.13, 95%CI 0.62, 2.08).[17] Although these results were not statistically significant, they represent

data from a new HTP market that should be monitored. Alternatively, a study of HTP users in the UK, a market where HTP have been available longer, found that despite greater awareness of the product, daily use was only around 3%.[29] There are several studies that found an association between current EC use and HTP use suggesting poly use of non-combustible nicotine products is a concern.[26,27,29-31] Studies have also show that perceptions that the products, either ECs or HTPs, are less harmful than combustible tobacco, namely cigarettes, also predicts future use of those products among people regardless of their current tobacco use status.[32,33]

The NCNP market is relatively new in the Middle East; however, in a short time it has seen rapid growth. Current data on use patterns from the region has been drawn from convenience samples, primarily university-based, and they suggest NCNP use may be high among young adults.[12,34,35] This growth may be driven by their wide availability and popularity. Both people who currently or never smoked in this study who had tried ECs agreed that they used them because they tasted good and that they were more acceptable to use than combustible cigarettes. Responses from people who smoke suggest that they use ECs to replace regular cigarettes and so there is the potential for these products to assist in cutting down on combustible tobacco consumption. Reasons for HTP use included curiosity and the perception they are less harmful than combustible tobacco. The number of responses to these questions was low and so these results should be interpreted with caution.

ECs have been shown to be effective in helping people quit using combustible tobacco.[36] However, as people transition from combustible to non-combustible tobacco there may be a period of dual use. Long-term dual use does not convey as many health benefits as a complete

transition or cessation of all nicotine products.[37,38] A smoking cessation trial that followed transitions from combustible cigarette use to ECs showed that while combustible cigarette use decreased, their total nicotine consumption and dependence actually increased.[39] There needs to be a concerted effort to completely transition from combustible cigarettes to ECs and then, when risk of smoking relapse is deemed very low, transition to complete cessation of all nicotine products. Evidence from the most recent updated Cochrane review on ECs for smoking cessation now has high certainty evidence that nicotine-containing ECs do help people successfully quit smoking combustible tobacco for 6 months or longer.[36] The evidence for HTPs is less clear, and would suggest they may not be as effective in helping people quit and may expose users to more harmful chemicals than ECs.[40,41]

Strengths and Limitations

This is one of the largest studies of dual combustible tobacco and NCNP use in the region. In our study we sampled Emirati adults from all seven Emirates in an attempt to reach a wide distribution of individuals across the country. Additionally, participants were drawn from a variety of community-based settings. We were also able to begin collecting data on EC and HTP use shortly after they were legally available in the UAE.

This study has several limitations. Tobacco and NCNP use is based on self-report data. It is possible that some individuals who reported never smoking did smoke in reality. In a previous study, we found that self-report underestimated actual smoking status by 6% for both men and women after smoking status was biochemically verified via urinary cotinine.[2] If self-reported smoking status was underreported in this study, that would suggest that there were more

individuals potentially dual using ECs or HTPs and combustible tobacco. Future research to biochemically verify combustible tobacco use and NCNP use is warranted.

Second, our smoking classification in the models distinguished between people who were currently smoking at baseline and those who were not. There were very few people who quit using all forms of combustible tobacco in this sample (N=166, 2%) and so we limited our analysis to examine differences between people who were currently smoking at baseline compared to those who were not. Additional studies should follow smoker trajectories as people may use EC or HTP to transition from combustible tobacco and ultimately quit.

Data collection for the baseline assessment of the UAEHFS lasted 6 years, and the follow up NCNP questionnaire may have been answered years after the initial assessment. It is possible that people who indicated in the initial questionnaire that they were smoking had quit smoking at the time they answered the questions on EC and HTP use. This does not necessarily change our conclusions that individuals with any experience using combustible tobacco, either current or former, were more likely to use EC or HTP than those who never used combustible tobacco. Further follow-up studies should ask about both combustible tobacco use and any NCNP use within the same time period.

We chose to define EC/HTP use as “even one time” for the purposes of this study. We were limited by sample size and chose to have a broader inclusion criterion in this study. Previously, the Centers for Disease Control (CDC) has defined EC use as ever, even one time, use.[42] Future studies should use a stricter definition to better distinguish people who try ECs/HTPs from those who regularly use them.

Another limitation of this study is the relatively small sample size. The UAEHFS is a population-based cohort study that has enrolled nearly 15,000 participants. Half of the study participants

provided tobacco use data. We were able to analyze available data on 2,041 individuals who provided information on EC use and just over 500 individuals who provided HTP use data. The number of observations in the complete case analysis of HTP use was small and there was a very high level of uncertainty around the estimate and so this should be interpreted with caution. Additionally, this was a convenience sample of participants and the data were not weighted to account for potential differences in the sample and population structure, which could introduce some bias into the estimates. The associations we observed may change with more available data.

Conclusions

NCNPs such as ECs and HTPs are likely to increase in popularity in the Emirati population as the regulatory environment allows for their marketing and sale. This is the largest study, to date, in the region that examines the factors associated with EC and HTP use among a community-based sample of adults. Our current study shows that NCNP use is associated with ~~current~~ baseline combustible tobacco use among young Emirati adults. There is still little research available on the long-term health effects of concurrent combustible and non-combustible tobacco use. As the market for these products continues to expand in region, the types of products people use may change. In order to understand the impact on population health, future efforts should include monitoring of population trends in use of these products in addition to combustible tobacco. Future research should also consider monitoring product type, nicotine concentration, and dual and poly use patterns to understand the effect on human health.

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References

1. Drope J HS, Chaloupka F, Guerrero C, Lee HM, Mirza M, Mouton A, Murukutla N, Ngo A, Perl R, Rodriguez-Iglesias G, Schluger N, Siu E, Vulovic V. . The Tobacco Atlas. Vital Strategies and Tobacconomics. Accessed May 15, 2023,
2. Al-Houqani M, Leinberger-Jabari A, Al Naeemi A, et al. Patterns of tobacco use in the United Arab Emirates Healthy Future (UAEHFS) pilot study. *PLoS One*. 2018;13(5):e0198119. doi:10.1371/journal.pone.0198119
3. Afifi R, Ghandour L, El Salibi N, Nakkash R, Rady A, Sherman S. Prevalence of Midwakh tobacco smoking in trend-setting Lebanon: an indicator of potential spread across the Arab world? journal article. *Tobacco Induced Diseases*. 2018;16(1)doi:10.18332/tid/84722
4. Jawad M, Al-Houqani M, Ali R, et al. Prevalence, attitudes, behaviours and policy evaluation of midwakh smoking among young people in the United Arab Emirates: Cross-sectional analysis of the Global Youth Tobacco Survey. *PLOS ONE*. 2019;14(4):e0215899. doi:10.1371/journal.pone.0215899
5. Maziak W, Nakkash R, Bahelah R, Husseini A, Fanous N, Eissenberg T. Tobacco in the Arab world: old and new epidemics amidst policy paralysis. *Health Policy and Planning*. 2013;29(6):784-794. doi:10.1093/heapol/czt055
6. Sherman S, El-Shahawy O, Leinberger-Jabari A, Shearston J, Weitzman M. Smoking Dokha Tobacco Through a Midwakh Pipe: An Alternative Tobacco Product Endemic to the Arabian/Persian Gulf. In: Laher I, ed. *Handbook of Healthcare in the Arab World*. Springer International Publishing; 2021:2743-2753.
7. Al-Sawalha NA, Almomani BA, Mokhemer E, Al-Shatnawi SF, Bdeir R. E-cigarettes use among university students in Jordan: Perception and related knowledge. Observational Study Research Support, Non-U.S. Gov't. *PLoS ONE [Electronic Resource]*. 2021;16(12):e0262090.
8. Abo-Elkheir OI, Sobh E. Knowledge about electronic cigarettes and its perception: a community survey, Egypt. Observational Study. *Respiratory Research*. 2016;17(1):58.
9. Barakat M, Jirjees F, Al-Tammemi AaB, et al. The Era of E-Cigarettes: A Cross-Sectional Study of Vaping Preferences, Reasons for Use and Withdrawal Symptoms Among Current E-Cigarette Users in the United Arab Emirates. *J Community Health*. 2021;46(5):876-886. doi:10.1007/s10900-021-00967-4
10. (ESMA) EAfSaM. Electronic Nicotine Products (Equivalents of Traditional Tobacco Products). In: ESMA, editor. UAES5030:2018. UAE2019.
11. Abdel-Qader DH, Al Meslamani AZ. Knowledge and Beliefs of Jordanian Community Toward E-cigarettes: A National Survey. *J Community Health*. 2021/06/01 2021;46(3):577-586. doi:10.1007/s10900-020-00896-8
12. Abbasi Y, Hout M-CV, Faragalla M, Itani L. Knowledge and Use of Electronic Cigarettes in Young Adults in the United Arab Emirates, Particularly during the COVID-19 Pandemic. *International Journal of Environmental Research and Public Health*. 2022;19(13):7828.
13. Aqeeli AA, Makeen AM, Al Bahhawi T, et al. Awareness, knowledge and perception of electronic cigarettes among undergraduate students in Jazan Region, Saudi Arabia. *Health & Social Care in the Community*. 2022;30(2):706-713. doi:https://doi.org/10.1111/hsc.13184
14. Yong H-H, Borland R, Cummings KM, et al. Reasons for regular vaping and for its discontinuation among smokers and recent ex-smokers: findings from the 2016 ITC Four

Country Smoking and Vaping Survey. *Addiction*. 2019;114(S1):35-48. doi:https://doi.org/10.1111/add.14593
15. Driezen P, Nordin ASA, Hairi FM, et al. E-cigarette prevalence among Malaysian adults and types and flavors of e-cigarette products used by cigarette smokers who vape: Findings from the 2020 ITC Malaysia Survey. *Tob Induc Dis*. 2022;20:32. doi:10.18332/tid/146363
16. Alanazi AM, Monshi SS, Aldawsari NS, et al. The associations between cigarette smoking behavior and the use of heated tobacco products among Arab cigarette smokers: Findings from Saudi Arabia, Egypt, Kuwait, and Yemen. *Journal of Ethnicity in Substance Abuse*.1-14. doi:10.1080/15332640.2023.2204075
17. Cruz-Jimenez L, Barrientos-Gutierrez I, Zavala-Arciniega L, et al. Heated tobacco product use, its correlates, and reasons for use among Mexican smokers. Research Support, N.I.H., Extramural. *Drug & Alcohol Dependence*. 2022;232:109283.
18. Maria Lotrean L, Trofor A, Radu-Loghin C, et al. Awareness and use of heated tobacco products among adult smokers in six European countries: findings from the EUREST-PLUS ITC Europe Surveys. Research Support, Non-U.S. Gov't. *European Journal of Public Health*. 2020;30(Suppl_3):iii78-iii83.
19. Majek P, Jankowski M, Nowak B, et al. The Frequency of Use and Harm Perception of Heated Tobacco Products (HTPs): The 2019 Cross-Sectional Survey among Medical Students from Poland. *International Journal of Environmental Research & Public Health [Electronic Resource]*. 2021;18(7):24.
20. Abdulle A, Alnaeemi A, Aljunaibi A, et al. The UAE healthy future study: a pilot for a prospective cohort study of 20,000 United Arab Emirates nationals. *BMC Public Health*. 2018/01/05 2018;18(1):101. doi:10.1186/s12889-017-5012-2
21. Fong GT, Cummings KM, Borland R, et al. The conceptual framework of the International Tobacco Control (ITC) Policy Evaluation Project. *Tobacco Control*. 2006;15(suppl 3):iii3-iii11. doi:10.1136/tc.2005.015438
22. von Hippel PT. How Many Imputations Do You Need? A Two-stage Calculation Using a Quadratic Rule. *Sociological Methods & Research*. 2020;49(3):699-718. doi:10.1177/0049124117747303
23. Rothman KJ. No adjustments are needed for multiple comparisons. *Epidemiology*. Jan 1990;1(1):43-6.
24. Gelman A, Hill J, Yajima M. Why We (Usually) Don't Have to Worry About Multiple Comparisons. *Journal of Research on Educational Effectiveness*. 2012/04/01 2012;5(2):189-211. doi:10.1080/19345747.2011.618213
25. Cox S, Brown J, Kock L, Shahab L. Prevalence and characteristics of ever regular use of non-combustible nicotine for 1 year or more: a population survey in England. Research Support, Non-U.S. Gov't. *Harm Reduction Journal*. 2021;18(1):114.
26. Miller CR, Sutanto E, Smith DM, et al. Awareness, trial and use of heated tobacco products among adult cigarette smokers and e-cigarette users: findings from the 2018 ITC Four Country Smoking and Vaping Survey. Research Support, N.I.H., Extramural Research Support, Non-U.S. Gov't. *Tobacco Control*. 2022;31(1):11-18.
27. Miller CR, Sutanto E, Smith DM, et al. Characterizing Heated Tobacco Product Use Among Adult Cigarette Smokers and Nicotine Vaping Product Users in the 2018 ITC Four Country Smoking & Vaping Survey. Research Support, N.I.H., Extramural Research Support, Non-U.S. Gov't. *Nicotine & Tobacco Research*. 2022;24(4):493-502.

28. Yimsaard P, McNeill A, Yong HH, et al. Gender Differences in Reasons for Using Electronic Cigarettes and Product Characteristics: Findings From the 2018 ITC Four Country Smoking and Vaping Survey. Research Support, N.I.H., Extramural Research Support, Non-U.S. Gov't. *Nicotine & Tobacco Research*. 2021;23(4):678-686.
29. Brose LS, McDermott MS, McNeill A. Heated Tobacco Products and Nicotine Pouches: A Survey of People with Experience of Smoking and/or Vaping in the UK. Research Support, Non-U.S. Gov't. *International Journal of Environmental Research & Public Health [Electronic Resource]*. 2021;18(16):22.
30. Berg CJ, Romm KF, Patterson B, Wysota CN. Heated Tobacco Product Awareness, Use, and Perceptions in a Sample of Young Adults in the United States. Research Support, N.I.H., Extramural. *Nicotine & Tobacco Research*. 2021;23(11):1967-1971.
31. Kim J, Lee S, Kimm H, Lee JA, Lee CM, Cho HJ. Heated tobacco product use and its relationship to quitting combustible cigarettes in Korean adults. Research Support, Non-U.S. Gov't. *PLoS ONE [Electronic Resource]*. 2021;16(5):e0251243.
32. Elton-Marshall T, Driezen P, Fong GT, et al. Adult perceptions of the relative harm of tobacco products and subsequent tobacco product use: Longitudinal findings from waves 1 and 2 of the population assessment of tobacco and health (PATH) study. *Addictive Behaviors*. 2020/07/01/ 2020;106:106337. doi:https://doi.org/10.1016/j.addbeh.2020.106337
33. Fong GT, Elton-Marshall T, Driezen P, et al. U.S. adult perceptions of the harmfulness of tobacco products: descriptive findings from the 2013-14 baseline wave 1 of the path study. *Addict Behav*. Apr 2019;91:180-187. doi:10.1016/j.addbeh.2018.11.023
34. Al-Hamdani M, Brett Hopkins D. E-cigarettes in the Middle East: The known, unknown, and what needs to be known next. *Preventive Medicine Reports*. 2023/02/01/ 2023;31:102089. doi:https://doi.org/10.1016/j.pmedr.2022.102089
35. Ahmed LA, Verlinden M, Alobeidli MA, et al. Patterns of tobacco smoking and nicotine vaping among university students in the United Arab Emirates: a cross-sectional study. *International journal of environmental research and public health*. 2021;18(14):7652.
36. Hartmann-Boyce J, McRobbie H, Butler AR, et al. Electronic cigarettes for smoking cessation. *Cochrane Database of Systematic Reviews*. 2021; (9)doi:10.1002/14651858.CD010216.pub6
37. Shahab L, Goniewicz ML, Blount BC, et al. Nicotine, Carcinogen, and Toxin Exposure in Long-Term E-Cigarette and Nicotine Replacement Therapy Users: A Cross-sectional Study. *Ann Intern Med*. Mar 21 2017;166(6):390-400. doi:10.7326/m16-1107
38. Pisinger C, Rasmussen SKB. The Health Effects of Real-World Dual Use of Electronic and Conventional Cigarettes versus the Health Effects of Exclusive Smoking of Conventional Cigarettes: A Systematic Review. *Int J Environ Res Public Health*. Oct 21 2022;19(20)doi:10.3390/ijerph192013687
39. Martinez U, Martinez-Loredo V, Simmons VN, et al. How Does Smoking and Nicotine Dependence Change After Onset of Vaping? A Retrospective Analysis of Dual Users. Research Support, N.I.H., Extramural. *Nicotine & Tobacco Research*. 2020;22(5):764-770.
40. Tattan-Birch H, Hartmann-Boyce J, Kock L, et al. Heated tobacco products for smoking cessation and reducing smoking prevalence. Meta-Analysis Research Support, Non-U.S. Gov't Review. *Cochrane Database of Systematic Reviews*. 2022;1:CD013790.

41. Kanai M, Kanai O, Tabuchi T, Mio T. Association of heated tobacco product use with tobacco use cessation in a Japanese workplace: a prospective study. Research Support, Non-U.S. Gov't. *Thorax*. 2021;76(6):615-617.
42. Syamlal G CK, Blackley DJ, King BA. Prevalence of Electronic Cigarette Use Among Adult Workers — United States, 2017–2018. . *MMWR Morb Mortal Wkly Rep*. 2021;70:297-303. doi:http://dx.doi.org/10.15585/mmwr.mm7009a1

Figures and Tables

Figure 1 UAE Healthy Future Study Participant Flow Diagram

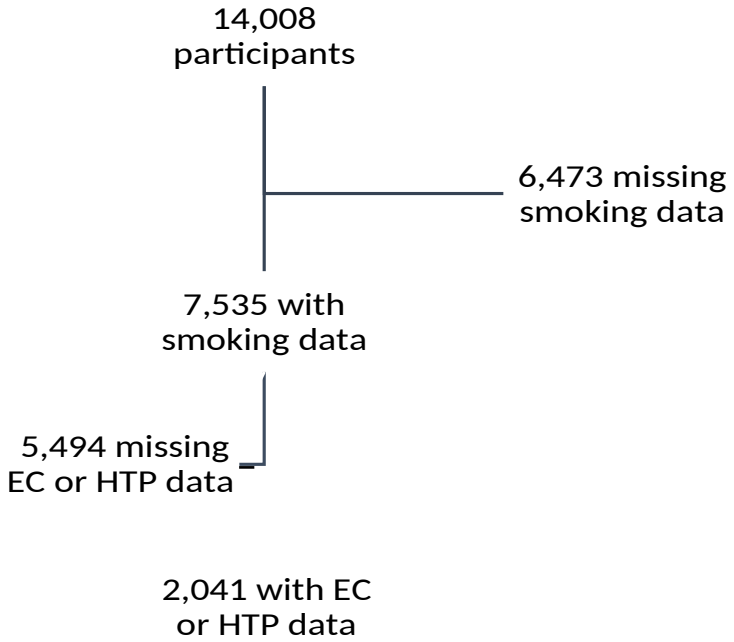
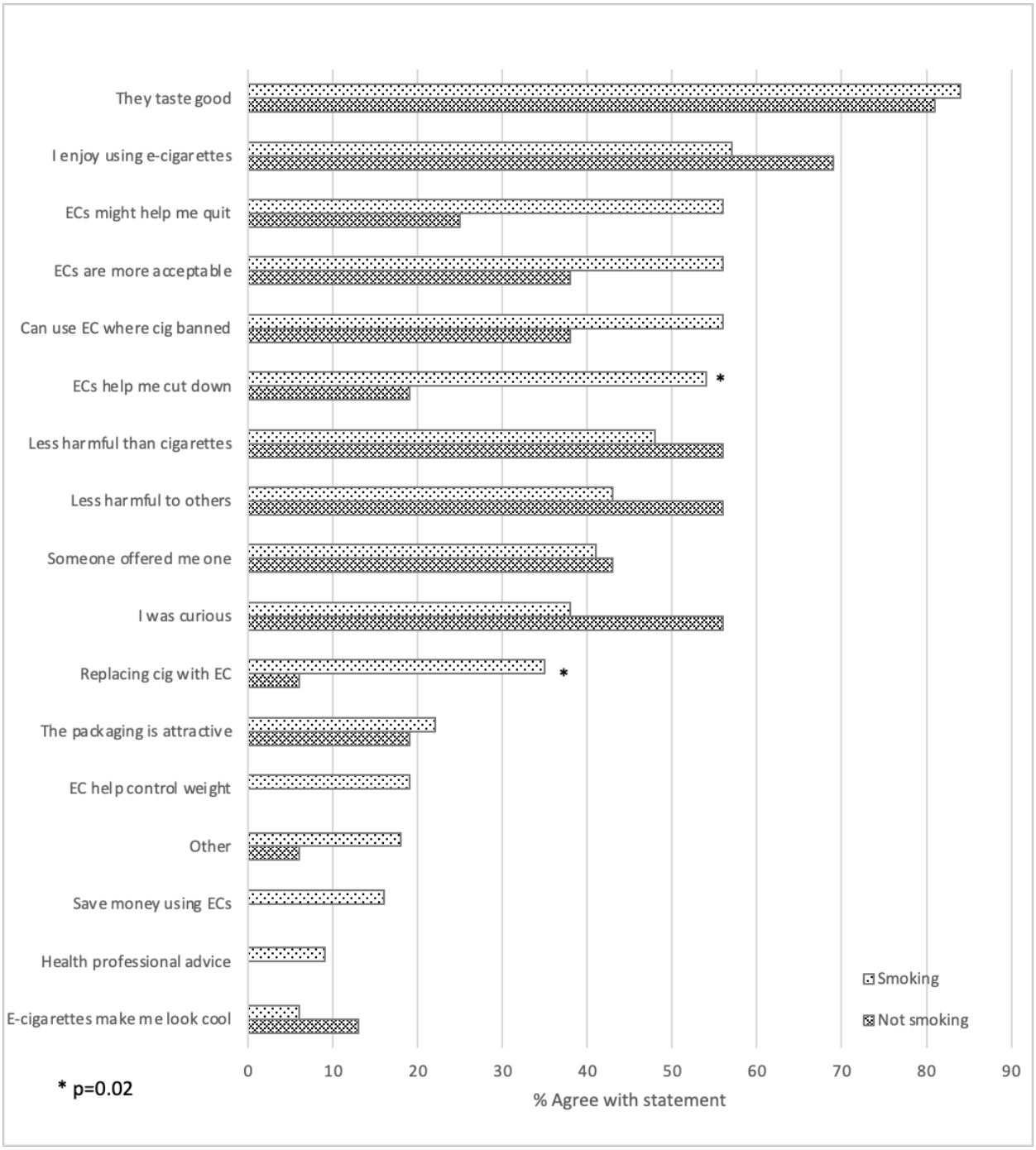


Figure 2 Reasons for EC use given by people who are currently and not currently smoking (N=84)



Full reasons for using ECs in order of agreement among people who smoke:

They taste good

I enjoy using e-cigarettes

They might help me quit smoking ordinary cigarettes

Using e-cigarettes is more acceptable than smoking ordinary cigarettes to people around me

I can use e-cigarettes in places where smoking ordinary cigarettes is banned
E-cigarettes help me cut down on the number of ordinary cigarettes I smoke
Less harmful than cigarettes
They are less harmful to the health of people around me than cigarettes are
Someone offered me one
I was curious
Replacing some of my ordinary cigarettes with e-cigarettes means I don't have to give up smoking ordinary cigarettes altogether
The packaging is attractive
E-cigarettes help me control my appetite and/or weight
Other
I save money by using e-cigarettes instead of smoking ordinary cigarettes
A health professional advised me to try them
E-cigarettes make me look cool

Table 1 UAE Healthy Future Study Sample Characteristics

Baseline characteristics	Not smoking (N=5,227)		Smoking (N=2,307)		p-value
Age (median, IQR)	24	(20 - 32)	27	(23 - 34)	p<0.000
Sex (N, %)					
Male	2,188	42%	2,098	91%	p<0.000
Female	3,039	58%	210	9%	
Education					
Less than college	2,404	48%	1,144	52%	p=0.002
College +	2,647	52%	1,077	48%	
Type of tobacco used (N, % of tobacco users)					
Cigarettes	-	-	1,339	62%	
CPD (mean, SD)	-	-	12.2	16.5%	
Midwakh	-	-	1,291	61%	
MPD (mean, SD)	-	-	12.5	10.3%	
Shisha	-	-	1,315	64%	
shisha per week (mean, SD)	-	-	5.7	15.4%	
Dual/poly use *(N, %)*	-	-	1,222	53%	
EC ever use *(N, %)**	185	14%	437	74%	p<0.000
HTP ever use *(N, %)**	16	7%	131	51%	p=0.000

** Figures are based on individuals with both smoking and NCN data (EC ever N=2,041 responses; HTP ever N=521 responses)*

Table 2 Estimated OR (95%CI) from complete case analysis of factors associated with EC or HTP use from univariate (unadjusted and multivariate (adjusted) models

	EC only		HTP only	
	Univariate OR, 95%CI (N=2,041)	Multivariate OR, 95% CI (N=532)	Univariate OR, 95% CI (N=521)	Multivariate OR, 95% CI (N=136)
Tobacco Use				
Non smoking	REF	REF	REF	REF
Smoking	**18.16 (14.27, 23.12)**	**27.63 (14.39, 53.06)**	**14.57 (8.34, 25.43)**	**51.23 (8.82, 297.41)**
Gender				
Female	REF	REF	REF	REF
Male	**4.79 (3.85, 5.97)**	**2.15 (1.21, 3.81)**	**5.26 (2.86, 9.67)**	1.15 (0.24, 5.56)
Age	**0.98 (0.97, 0.99)**	**0.91 (0.88, 0.95)**	**1.04 (1.01, 1.06)**	**1.07 (1.00, 1.14)**
Education				
Less than college	REF	REF		REF
College+	0.83 (0.68, 1.00)	**1.79 (1.06, 3.03)**	0.90 (0.61, 1.34)	1.65 (0.54, 4.99)
NCN Harmful				
Less harmful	REF	REF	REF	REF
Equally harmful	**0.44 (0.28, 0.70)**	0.70 (0.36, 1.38)	**0.30 (0.12, 0.75)**	0.65 (0.17, 2.49)
More harmful	**0.37 (0.22, 0.61)**	**0.38 (0.17, 0.83)**	**0.21 (0.07, 0.57)**	0.69 (0.15, 3.18)
Don't know/Prefer not to answer	**0.37 (0.23, 0.59)**	0.82 (0.38, 1.75)	**0.12 (0.04, 0.39)**	0.22 (0.04, 1.19)
NCN Addictive				
Less addictive	REF	REF	REF	REF
Equally addictive	**0.36 (0.22, 0.58)**	0.80 (0.41, 1.55)	**0.31 (0.13, 0.77)**	0.32 (0.08, 1.31)
More addictive	**0.43 (0.26, 0.70)**	0.69 (0.33, 1.47)	**0.25 (0.08, 0.76)**	1.26 (0.20, 7.81)
Don't know/Prefer not to answer	**0.22 (0.14, 0.36)**	**0.36 (0.17, 0.76)**	**0.19 (0.06, 0.57)**	0.44 (0.09, 2.26)

**Adjusted for sex, age, education, perceived harm, perceived addictiveness of the product*

Adjusting for use of the other product did not result in a change in the estimate, therefore the results presented here are without that adjustment

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