SPECIAL ISSUE - RESEARCH ARTICLE

WILEY

# Curiosity and intentions to use *my*blu e-cigarettes and an examination of the 'gateway' theory: Data from cross-sectional nationally representative surveys

Ian M. Fearon[1]  |  Ryan G. N. Seltzer[2]  |  Trisha L. Houser[3]  |  Andrew Tope[4]  |
Xavier Cahours[4]  |  Thomas Verron[4]  |  Layla Malt[4]  |  Thomas Nahde[5]  |
Grant O'Connell[4]  |  Mitchell Nides[6]

[1]whatIF? Consulting Ltd, Harwell, UK

[2]Safety in Numbers, LLC, Tucson, Arizona, USA

[3]Houser Clinical Research Writing and Consulting, LLC, Durham, North Carolina, USA

[4]Imperial Brands PLC, Bristol, UK

[5]Reemtsma Cigarettenfabriken GmbH, Hamburg, Germany

[6]LA Clinical Trials, LLC, Burbank, California, USA

**Correspondence**
Ian M. Fearon, whatIF? Consulting Ltd, The Crispin, Burr Street, Harwell, OX11 0DT UK.
Email: ian@whatifconsulting.net

**Funding information**
This work was funded by Fontem US LLC, a subsidiary of Imperial Brands PLC and manufacturer of the *my*blu™ products assessed in this study. This work was contracted by Imperial Brands PLC as a service provider on behalf of Fontem US LLC. Study design and data collection were performed independently of the study sponsor.

## Abstract

Encouraging adult smokers who are uninterested or unwilling to quit, and would otherwise continue to smoke, to transition to potentially less harmful nicotine products such as electronic nicotine delivery systems (ENDS) may positively impact population health. However, counterbalancing this benefit is the societal concern that ENDS may be used by never smokers and youth and serve as a 'gateway' into cigarette smoking. Data were analysed from two independent surveys of the prevalence and perceptions of *my*blu ENDS use in the United States. Total sample size was 22,232 young adults and 23,264 adults. Being curious to use *my*blu was 1.6–2.0 times more likely in young adult current smokers than young adult never smokers. This likelihood was 2.8 times greater for adult current smokers compared with adult never smokers in the perceptions survey, while in the prevalence survey, there was no difference between adult current and never smokers. Intentions to use *my*blu were significantly greater in young adult current smokers compared with young adult never smokers in both surveys and in adults in the prevalence survey. In all surveys and age cohorts, 124 of 45,496 participants (0.1% of the total survey population) reported first using *my*blu prior to smoking cigarettes and went on to become established smokers. Curiosity and intentions to use *my*blu were generally higher in current smokers compared with never smokers. There was minimal evidence to suggest the existence of a 'gateway' effect to established cigarette smoking among never-smoking *my*blu users.

**KEYWORDS**
cigarette smoking, curiosity, e-cigarettes, ENDS, intentions

## 1 | BACKGROUND

Cigarette smoking is a cause of human morbidity and mortality and is an established risk factor for a number of diseases, including lung cancer, heart disease and emphysema.[1-3] Smoking is reported to cause more than 7 million deaths per year globally,[4] and in the United States (US), almost 500,000 annual deaths are reported to be attributed to cigarette smoking.[5] Smoking-related diseases are primarily due to smokers' exposure to numerous and high levels of toxicants in cigarette smoke that are formed during the combustion of tobacco and

inhaled during smoking.[6–8] Approximately 6500 chemicals have been identified in cigarette smoke,[7] and a number of these are considered causes or potential causes of cancer, lung disease, heart disease and reproductive/developmental toxicity.[9] While quitting combustible cigarette smoking greatly reduces the disease risk[2] and despite large numbers of adult smokers reporting wanting to stop smoking,[10] less than 10% of adult smokers are reported to actually stop smoking each year.[10] In those adult smokers uninterested or unwilling to quit smoking and who would otherwise continue to smoke, a growing number of public health bodies such as Public Health England (now known as the Office for Health Improvement and Disparities) and the United Kingdom Royal College of Physicians have proposed that reduced exposure products such as electronic nicotine delivery systems (ENDS), which deliver nicotine but with fewer and lower levels of toxicants compared with cigarette smoke,[11] may provide a less harmful alternative to cigarette smoking and support tobacco harm reduction efforts.[12,13]

ENDS may provide an 'off-ramp' for adult smokers who want to move away from harmful combustible tobacco towards potentially less harmful means of nicotine use,[14] and data from both observational studies[15–23] and randomised controlled trials[22–25] support a link between ENDS use and quitting smoking. Therefore, reductions in smoking prevalence facilitated by the availability of ENDS may directly translate into significant improvements in population health by reducing smoking-related mortality.[26,27] However, it has been discussed that this public health potential may be diminished if there is significant use of ENDS by unintended populations such as never smokers, and particularly among youth,[28] thereby providing an 'on-ramp' to initiation of nicotine use that could potentially further lead to combustible cigarette smoking.[14] The proposition that ENDS use among never smokers may lead to the initiation of combustible cigarette smoking after ENDS use has been termed the 'gateway' effect. The 'gateway' hypothesis posits that the availability and use of ENDS may have a causal impact on smoking initiation in never smokers.[28–30] If the 'gateway' phenomenon exists in the real world, potential factors such as the appeal and availability of ENDS to never smokers, leading to curiosity and intentions to use ENDS products, have been cited.[31,32]

blu ENDS, including *my*blu, are marketed in the US and elsewhere as an alternative to smoking combustible cigarettes for adult smokers who are unwilling or uninterested in quitting and who would otherwise continue to smoke. *my*blu ENDS are commercially available in the US in two forms, each of which may contain different levels of nicotine either in its 'freebase' form (*my*blu) or in the form of a nicotine lactate salt formulation (*my*blu Intense).[33] In this paper, data from three waves of two independent cross-sectional surveys were assessed to examine the following: (i) the history of smoking and current cigarette smoking status among users of *my*blu ENDS and (ii) curiosity and intentions to use *my*blu ENDS in survey participants with differing smoking statuses. We further analysed data to investigate the prevalence of *my*blu ENDS use among young adult and adult never smokers and

assessed whether such use leads to transitioning to combustible cigarette smoking.

## 2 | METHODS

### 2.1 | Recruitment and participants

Data were obtained from two independent, cross-sectional, US nationally representative surveys; one study assessed prevalence of use of *my*blu ENDS, and the other study assessed perceptions of *my*blu ENDS use. Both surveys and all associated documentation were reviewed and approved by the Advarra Institutional Review Board (IRB; Columbia, MD, USA; reference numbers Pro00037377 and Pro00037947). Prior to entering either survey, all participants were required to read an on-screen informed consent form and provide electronic consent to participate. Both surveys took approximately 25 min to complete, and participants received an IRB-approved financial incentive (approximately $2 depending on the particular survey panel to which participants were registered) following survey completion.

The first study was a three-wave, cross-sectional 'prevalence' survey assessing the prevalence of use and intentions to use combustible cigarettes and *my*blu ENDS. The second study was a three-wave, cross-sectional 'perceptions' survey assessing perceptions of the risks, benefits, addictiveness and appeal of cigarettes and ENDS, including *my*blu. Data in each of these three-wave surveys were collected during periods of approximately 4 to 8 weeks beginning in August 2019, March 2020 and October 2020, respectively.

Both surveys collected data in nonprobabilistic representative samples of the US population. Prior to survey conduct and to assure national representation of collected data, quotas were set based on US Census information for age, sex, education level and region. Eligible individuals for each survey were young adults (aged 18–24 years) and adults (aged 25+ years) who were enrolled members of an online research panel maintained by Qualtrics, LLC (Provo, UT, USA). Young adults' data were analysed independently since this cohort may have increased susceptibility to initiating tobacco product use,[34] and this group is also considered by the US Food and Drug Administration as a surrogate for individuals below the minimum age of sale (i.e. youth).[35]

An invitation email to take part in the surveys was sent to potentially eligible participants. In states in which the age of majority is greater than 18 years, recruitment of participants was restricted to those at or above the age of majority. Thus, in Alabama and Nebraska, participants were 19 years of age or older, and in Mississippi, subjects were aged 21 or older. Individuals who participated in the survey did not have to be ever users of combustible cigarettes or ENDS. For the perceptions survey, only those who had seen or heard of ENDS in general and of blu or *my*blu ENDS specifically were allowed to participate. This measure ensured that survey participation was not a means

to inappropriately raise awareness of these products among unintended audiences.

## 2.2 | Survey procedures

In both surveys, participants who clicked on the link provided in the invitation email were routed to an informed consent form that provided information about the purpose of the study, who was sponsoring and conducting the study, contact information for the investigator and IRB, who was eligible to take part and how individuals' survey answers would be used, and the steps taken to protect individuals' confidentiality and privacy.

Participants were informed that they were being invited to take part in a single online survey about their views of, and experiences with, tobacco products, like combustible cigarettes and ENDS. Individuals who satisfied eligibility criteria, including the age requirement, and gave informed consent to participate were then able to begin the survey.

Based on programmed survey logic, participants were routed to applicable questions on the basis of their responses to previous questions. The survey instrument was designed with the assumption that all respondents to a question would be asked the next question, unless there were specific instructions routing a subgroup of respondents to a different question. For example, only participants who were current or ever smokers were asked about their experiences of smoking combustible cigarettes. Participants answered survey questions at their own pace. If a participant did not complete the survey, all data provided up to the point of exit from the survey were deleted.

## 2.3 | Data quality checks

Manual and automated checks were implemented by Qualtrics to ensure participants who gave low quality or invalid responses were excluded from the dataset. Checks were conducted for straight lining (responses to radio button questions for which responses down one side of the options were selected), geolocation (duplicate surveys completed from the same physical place), inattentiveness (participants who left long pauses between answering questions), speeding (participants who completed the survey in a time more than two standard deviations from the median duration), duplicates (more than one survey completed based on, e.g., email address or IP address) and bots (automated survey responses). These checks were performed by Qualtrics independently of the study investigators.

## 2.4 | Survey measures

Survey questions were developed based on those of the US Population Assessment of Tobacco and Health (PATH)[36] and the National Youth Tobacco Survey (NYTS).[37]

## 2.5 | Demographics

Questions assessed age, sex, state of residence (from which the US region was derived) and race/ethnicity of participants. Questions assessing race and ethnicity were identical to those used in the PATH Wave 1 survey instrument (questions RO1_AM0005_01 and RO1_AM0006_01).

## 2.6 | Combustible cigarette smoking

A series of questions assessed participants' combustible cigarette smoking status; responses to these questions were used to categorise participants into one of four smoking statuses. Established (current) smokers were classified as those who had 'Ever smoked a cigarette, even one or two puffs?,' who had ever smoked '100 or more cigarettes' in their entire life, had smoked in the past 30 days and who now reported smoking 'every day' or 'some days.' Experimental smokers were classified as those who had ever smoked a cigarette but had not smoked more than 100 cigarettes in their entire life. Former smokers were those participants who reported ever smoking, who reported having smoked '100 or more cigarettes' in their entire life and who had not smoked a cigarette in the past 30 days. An additional item of reporting smoking now 'not at all' was used to categorise former smokers in the prevalence survey only (this question was not asked in the perceptions survey). Finally, never smokers were classified as those who reported having never smoked a cigarette, even one or two puffs.

## 2.7 | Awareness and use of *my*blu ENDS

As stated above, in the perceptions survey, awareness of *my*blu ENDS was an eligibility criterion for survey participation. This criterion was not applied to the prevalence study; however, at the start of the survey section on *my*blu use, participants were asked 'Have you ever seen or heard of a brand of e-cigarette called "*my*blu" before this study?' Further questions concerning the use of *my*blu were only asked to those who responded affirmatively to this question. Similar to combustible cigarette smoking, participants had their *my*blu ENDS use categorised into one of four statuses based on a series of questions regarding past and current *my*blu ENDS use. Established (current) *my*blu users were classified as those who had 'Ever used a *my*blu e-cigarette, even once or twice?,' who had ever used *my*blu on 'Over 100 days' in their entire life and had used *my*blu in the past 30 days. Experimental *my*blu users were classified as those who had ever used *my*blu but had used *my*blu on less than 100 days in their entire life. Former *my*blu users were those participants who reported having used *my*blu on more than 100 days in their entire life but who had not used *my*blu in the past 30 days. An additional item of reporting using *my*blu now 'not at all' was used to categorise former *my*blu users in the prevalence survey only (this question was not asked in the

perceptions survey). Finally, never *my*blu users were classified as having never used *my*blu, even once or twice.

## 2.8 | Curiosity and intentions to use *my*blu ENDS

Curiosity and intentions to use *my*blu ENDS were assessed using questions that were adapted from questions on cigarette smoking curiosity in the US PATH survey[36] (PATH Wave 2 adult instrument questions R02_AC1103, R02_AC1206 and R02_AC1104), but using language specific for *my*blu ENDS. For example, the PATH question 'Have you ever been curious about smoking a cigarette?' was modified to 'Have you ever been curious about using a *my*blu e-cigarette?'. Response options and skip logic were also the same as those found in the PATH survey questionnaire. In both surveys, participants who reported that they had never used *my*blu ENDS were asked if they had ever been curious about using one. Those whose response indicated any level of curiosity ('A little curious,' 'Somewhat curious,' or 'Very curious') were then asked, 'Do you think that you will try using a *my*blu e-cigarette in the next year?' Those who answered 'Definitely yes' or 'Probably yes' were then asked if they thought they would try using a *my*blu e-cigarette soon (possible responses were 'Definitely yes,' 'Probably yes,' 'Probably not' or 'Definitely not').

For analysis purposes, curiosity to use *my*blu was categorised into two groups: a 'More Curiosity' group comprising the 'Somewhat curious' and 'Very curious' responses and a 'Less Curious' group comprising the 'Not at all curious' and 'A little curious' responses.[38] Intentions to use *my*blu in the next year and to use soon were categorised into a 'Yes group' ('Definitely yes' and 'Probably yes') and a 'No group' ('Definitely not' and 'Probably not').

## 2.9 | *my*blu ENDS use to combustible cigarette smoking transitions

Participants who reported ever use of combustible cigarettes and/or *my*blu were asked to report how old they were the first time they smoked part or all of a cigarette, as well as how old they were when they first used *my*blu ENDS, even once or twice. Any participants who reported the same age for both questions were then asked which they did first: smoked a cigarette or used *my*blu ENDS. Answers to these questions were combined to create a variable of whether or not the participant used *my*blu before smoking a cigarette.

## 2.10 | Data analysis

To assure national representation, in addition to quotas employed during the time of data collection, data collected in the surveys were weighted following completion based on US Census data for age, sex, education level, region, race and smoking status.[39] Young adult and adult datasets were weighted independently. Weighting procedures were carried out by Strop Insights (Dallas, TX, USA) using a Random

Iterative Method (RIM; raking) weighting procedure[40,41] implemented with WinCross software (The Analytical Group, Inc., Scottsdale, AZ, USA).

Descriptive statistics for variables such as awareness and use of *my*blu were broken out by age and survey type, as well as crossed by smoking status. These descriptive statistics are reported as raw sample sizes and weighted means, weighted standard error of the mean (SEM) and weighted percentages. Hypothesis tests were performed on weighted data and comprised logistic regressions to test the relationship between smoking status and ever use of *my*blu ENDS, as well as smoking status and curiosity and intentions to use *my*blu ENDS. These logistic regressions were performed using sex, race and age as covariates. The covariate-adjusted odds ratios (aORs) are presented with 95% confidence intervals (CIs). Statistical significance was determined when 95% CIs did not cross 1. All analyses were conducted using SAS 9.4 (Cary, NC, USA).

## 3 | RESULTS

### 3.1 | Demographics

Across the three waves of both surveys, invites were sent out to 166,223 potential participants who were registered members of Qualtrics' panels. Survey completion rate was, on average, approximately 52% following nonresponses to survey invites. For the perceptions survey, across the three waves, 36,710 of 71,570 potential participants who received email invites to participate were screened out due to nonawareness of *my*blu. Following the data quality checks performed by Qualtrics independently of the investigators, approximately 15% of completed surveys were removed. Participant demographic and smoking status data for the 45,496 participants across all three waves of both the prevalence and perceptions surveys and whose data were analysed in this study are presented in Table 1. Of the 22,232 young adults, the average age was approximately 21 years and 50.1% were male. For the 23,264 adults, average age was approximately 50 years and just under half (48.1%) of participants were male. In both age cohorts, participants were predominantly white. The largest proportion of young adult participants was classified as experimental smokers (42.8%); a similar proportion (39.6%) were classified as never smokers. Smaller proportions were established (10.5%) or former (7.2%) smokers. Similarly, the largest proportion of adult participants was classified as experimental smokers (35.4%), followed by former (27.6%), never (22.9%) and established (14.1%) smokers.

### 3.2 | Prevalence survey

#### 3.2.1 | Young adults' *my*blu use and cigarette smoking

Prevalence survey data were collected from 14,804 young adults, and awareness of *my*blu ENDS was reported in 7495 (57.9%) of these

**TABLE 1** Participant demographics and smoking status.

| Variable | Response | N (%) Young adults | Mean | SEM | N (%) Adults | Mean | SEM |
|---|---|---|---|---|---|---|---|
| Age | Years | 22,232[a] | 21.50 | 0.01 | 23,264[b] | 50.05 | 0.10 |
| Sex | Male | 10,077 (50.1) | . | . | 11,215 (48.1) | . | . |
| | Female | 11,798 (48.3) | . | . | 11,955 (51.5) | . | . |
| | Transgender | 357 (1.6) | . | . | 94 (0.4) | . | . |
| Region | Northeast | 3858 (19.1) | . | . | 4471 (19.8) | . | . |
| | South | 9654 (39.1) | . | . | 8376 (38.8) | . | . |
| | Midwest | 4175 (21.0) | . | . | 5781 (21.0) | . | . |
| | West | 4542 (20.8) | . | . | 4635 (20.5) | . | . |
| Hispanic, Latino/Latina, or Spanish origin? | Not of Hispanic, Latino/Latina, or Spanish origin | 17,257 (78.6) | . | . | 21,297 (91.5) | . | . |
| | Mexican, Mexican American, or Chicano | 2702 (11.9) | . | . | 969 (4.2) | . | . |
| | Puerto Rican | 736 (3.0) | . | . | 343 (1.5) | . | . |
| | Cuban | 253 (1.1) | . | . | 151 (0.7) | . | . |
| | Multiple Hispanic ethnicities | 1284 (5.5) | . | . | 504 (2.2) | . | . |
| Race | White | 13,675 (73.3) | . | . | 19,103 (78.6) | . | . |
| | Black or African American | 4693 (15.0) | . | . | 2160 (12.3) | . | . |
| | American Indian or Alaska Native | 502 (1.3) | . | . | 272 (0.7) | . | . |
| | Asian | 985 (3.7) | . | . | 726 (5.2) | . | . |
| | Multiracial | 2377 (6.7) | . | . | 1003 (3.2) | . | . |
| Smoking status | Established smoker | 3359 (10.5) | . | . | 7182 (14.1) | . | . |
| | Experimental smoker | 8920 (42.8) | . | . | 6657 (35.4) | . | . |
| | Former smoker | 1246 (7.2) | . | . | 5095 (27.6) | . | . |
| | Never smoker | 8707 (39.6) | . | . | 4330 (22.9) | . | . |

*Note*: Data presented are combined from both the prevalence and perceptions surveys in three waves. Percentages are population weighted.
Abbreviation: SEM, standard error of the mean.
[a]Population composed of 4970, 5188 and 4646 participants from Waves 1 to 3 of the prevalence survey and 2500, 2612 and 2316 participants from Waves 1 to 3 of the perceptions survey.
[b]Population composed of 5011, 5260 and 5182 participants from Waves 1 to 3 of the prevalence survey and 2500, 2769 and 2542 participants from Waves 1 to 3 of the perceptions survey.

**TABLE 2** Awareness of *my*blu and *my*blu ENDS use status among young adults in the prevalence survey by smoking category.

| | | Established smoker N (%) | Experimental smoker N (%) | Former smoker N (%) | Never smoker N (%) |
|---|---|---|---|---|---|
| Awareness of the *my*blu ENDS brand | Yes | 1428 (67.8) | 3335 (63.1) | 532 (67.9) | 2200 (47.0) |
| *my*blu ENDS ever user | Yes | 610 (19.4) | 1285 (60.4) | 177 (11.5) | 164 (8.8) |
| *my*blu ENDS use status | Established *my*blu user | 30 (44.6) | 17 (35.5) | 4 (16.7) | 1 (3.1) |
| | Experimental *my*blu user | 565 (18.7) | 1250 (61.1) | 170 (11.4) | 159 (8.9) |
| | Former *my*blu user | 15 (37.9) | 18 (44.0) | 3 (10.8) | 4 (7.4) |

*Note*: Data are presented as N (weighted %). Awareness values are expressed as those participants in each smoking category who reported awareness.

participants (Table 2). Ever use of *my*blu ENDS was reported by 2236 (41.2%) young adult participants who were aware of *my*blu and had reported having used an e-cigarette in their lifetime (*N* = 5091), which was 14.2% of the overall young adult survey population (i.e. independent of *my*blu awareness). When categorising these 2236 participants by *my*blu ENDS use status, 52 (0.6%) participants were

classed as established *my*blu users, 2144 (40.0%) as experimental *my*blu users and 40 (0.6%) as former *my*blu users. In the young adult cohort, however, the greatest proportion was never *my*blu users (2855 participants, 58.8%).

Of those 2236 young adult participants reporting ever *my*blu ENDS use, 19.4% (N = 610) were established smokers, 60.4% (N = 1,285) were experimental smokers, 11.5% (N = 177) were former smokers and 8.8% (N = 164) were never smokers. Logistic regression showed that current smokers were significantly more likely to have used *my*blu ENDS compared with never smokers (aOR = 2.57, 95% CI [1.92, 3.43]) and with former smokers (aOR = 1.39, 95% CI [1.06, 1.83]). Established use (i.e. having used *my*blu both >100 days in their entire life and during the past 30 days) of *my*blu was highest among established smokers and very low among never smokers, with only one never smoker reporting established *my*blu use (Table 2). Experimental *my*blu use was most prominently reported among experimental smokers.

### 3.2.2 | Young adults' curiosity/intentions to use *my*blu ENDS

Curiosity/intentions to use *my*blu ENDS data are presented in Table 3. Overall, being more curious to use *my*blu and thinking they would use *my*blu in the next year or soon were seen in greater proportions of current smokers than among former smokers or never smokers. Logistic regression analysis showed that being a young adult current smoker was associated with being more curious to use *my*blu ENDS compared with both former smokers (aOR = 1.57, 95% CI [1.00, 2.45]) and never smokers (aOR = 1.58, 95% CI [1.03, 2.42]). Current smokers also reported a greater likelihood of thinking that they would try *my*blu ENDS in the next year than never smokers (aOR = 4.37, 95% CI [2.65, 7.22]) and former smokers (aOR = 2.26, 95% CI [1.35, 3.78]) and were more likely to think that they would use *my*blu ENDS soon compared with both never smokers (aOR = 4.28, 95% CI [2.54, 7.21]) and former smokers (aOR = 1.97, 95% CI [1.16, 3.33]).

### 3.2.3 | Adults' *my*blu use and cigarette smoking

Prevalence survey data were collected from 15,453 adults. Among these adults, awareness of the *my*blu ENDS brand was reported in 6892 (47.3%) participants (Table 4). Awareness was highest among participants with a smoking history, particularly established smokers and lowest among never smokers. Ever use of *my*blu ENDS was reported by 45.6% (N = 1912) of adult participants who were aware of *my*blu and had reported ever having used an e-cigarette (N = 4205). These *my*blu ever-users were 10.2% of the overall survey population. Of the participants who reported both ever having used an ENDS and awareness of *my*blu, 134 (2.7%) were classed as established *my*blu users, 1694 (40.9%) as experimental *my*blu users and 84 (2.1%) as former *my*blu users. In the adult cohort, however, the greatest proportion was never users (2293 participants, 54.4%).

Overall, ever use of *my*blu ENDS in adult never smokers and former smokers was low compared with smokers. Of those reporting ever *my*blu use, 26.1% (N = 953) were established smokers, 54.2% (N = 710) were experimental smokers, 16.3% (N = 210) were former smokers and 3.3% (N = 39) were never smokers. Logistic regression showed that current smokers were significantly more likely to have used *my*blu ENDS compared with former smokers (aOR = 1.50, 95% CI [1.22, 1.84]) but not compared with never smokers (aOR = 1.32, 95% CI [0.83, 2.11]). Established use of *my*blu ENDS was highest among participants with a past history of smoking or current smoking status and nonexistent among never smokers (Table 4), while experimental *my*blu ENDS use was most prominently reported among experimental smokers.

### 3.2.4 | Adults' curiosity/intentions to use *my*blu ENDS

Curiosity/intentions to use *my*blu ENDS data for adults are presented in Table 5. Overall, being more curious to use *my*blu and thinking they would use *my*blu in the next year or soon were seen in greater proportions of current smokers than among former smokers or never

**TABLE 3** Curiosity and intentions to use *my*blu ENDS among young adults in the prevalence survey by smoking category.

| Question | Response | Current smoker N (%) | Former smoker N (%) | Never smoker N (%) |
|---|---|---|---|---|
| Have you ever been curious about using a *my*blu e-cigarette? | More curious | 173 (24.0) | 53 (16.6) | 86 (16.6) |
| | Less curious | 506 (76.0) | 263 (83.4) | 419 (83.4) |
| Do you think that you will try using a *my*blu e-cigarette in the next year? | Yes | 205 (52.3) | 48 (32.9) | 58 (23.0) |
| | No | 189 (47.7) | 100 (67.1) | 166 (77.0) |
| Do you think you will use a *my*blu e-cigarette soon? | Yes | 181 (45.9) | 43 (30.7) | 52 (18.8) |
| | No | 213 (54.1) | 105 (69.3) | 172 (81.2) |

*Note*: Data are presented as N (weighted %). The more curious category comprises the 'Somewhat curious' and 'Very curious' responses, while the less curious category comprises the 'Not at all curious' and 'A little curious' responses. The intentions to use in the next year and to use soon are grouped into a yes category ('Definitely yes' and 'Probably yes') and a no category ('Definitely no' and 'Probably no').

**TABLE 4** Awareness of *my*blu and *my*blu ENDS use status among adults in the prevalence survey by smoking category.

| | | Established smoker N (%) | Experimental smoker N (%) | Former smoker N (%) | Never smoker N (%) |
|---|---|---|---|---|---|
| Awareness of the *my*blu ENDS brand | Yes | 2834 (64.0) | 1986 (52.8) | 1292 (41.2) | 780 (34.8) |
| *my*blu ENDS ever user | Yes | 953 (26.1) | 710 (54.2) | 210 (16.3) | 39 (3.3) |
| *my*blu ENDS use status | Established *my*blu user | 85 (34.8) | 32 (43.1) | 17 (22.1) | 0 (0.0) |
| | Experimental *my*blu user | 825 (25.5) | 664 (56.6) | 167 (14.4) | 38 (3.5) |
| | Former *my*blu user | 43 (28.7) | 14 (21.5) | 26 (47.0) | 1 (2.9) |

*Note*: Data are presented as N (weighted %). Awareness percentages are expressed as those participants in each smoking category who reported awareness.

**TABLE 5** Curiosity and intentions to use *my*blu ENDS among adults in the prevalence survey by smoking category.

| Question | Response | Current smoker N (%) | Former smoker N (%) | Never smoker N (%) |
|---|---|---|---|---|
| Have you ever been curious about using a *my*blu e-cigarette? | More curious | 418 (30.7) | 84 (19.1) | 19 (29.1) |
| | Less curious | 893 (69.3) | 385 (80.9) | 49 (70.9) |
| Do you think that you will try using a *my*blu e-cigarette in the next year? | Yes | 476 (55.4) | 62 (27.7) | 14 (33.0) |
| | No | 357 (44.6) | 161 (72.3) | 30 (67.0) |
| Do you think you will use a *my*blu e-cigarette soon? | Yes | 452 (53.0) | 52 (24.0) | 13 (32.7) |
| | No | 381 (47.0) | 171 (76.0) | 31 (67.3) |

*Note*: Data are presented as N (weighted %). The more curious category comprises the 'Somewhat curious' and 'Very curious' responses, while the less curious category comprises the 'Not at all curious' and 'A little curious' responses. The intentions to use in the next year and to use soon are grouped into a yes category ('Definitely yes' and 'Probably yes') and a no category ('Definitely no' and 'Probably no').

smokers, although the difference in curiosity was very small between the current smoker and never smoker groups. This was confirmed by the logistic regressions, which showed that being a current smoker was associated with being more curious to use *my*blu ENDS compared with former smokers (OR = 1.97, 95% CI [1.47, 2.64]) but not compared with never smokers (OR = 0.99, 95% CI [0.51, 1.92]). Current smokers also reported thinking that they were more likely to try *my*blu ENDS in the next year than both never smokers (aOR = 2.96, 95% CI [1.32, 6.65]) and former smokers (aOR = 3.22, 95% CI [2.23, 4.65]). Current smokers were more likely to think that they would use *my*blu ENDS soon compared with both never smokers (aOR = 2.81, 95% CI [1.24, 6.38]) and former smokers (aOR = 3.50, 95% CI [2.38, 5.13]).

## 3.3 | Perceptions survey

### 3.3.1 | Young adults' *my*blu awareness, use and cigarette smoking

Survey data were collected from 7428 young adults. These participants were asked about their level of awareness of *my*blu; of the 7428 survey participants, 2902 (40.2%) responded 'Just a little,' 3286

(44.2%) responded 'Some,' while 1240 (15.6%) responded 'A lot.' Overall, ever use of *my*blu ENDS in never smokers and former smokers was low compared with established or experimental smokers. Of those reporting ever *my*blu use (N = 1672), 19.3% (N = 456) were established smokers, 62.2% (N = 953) were experimental smokers, 11.7% (N = 148) were former smokers and 6.7% (N = 115) were never smokers. Logistic regression analysis showed that current smokers were significantly more likely to have ever used *my*blu ENDS compared with never smokers (aOR = 4.53, 95% CI [3.42, 6.00]) but not compared with former smokers (aOR = 1.27, 95% CI [0.98, 1.66]).

When categorising young adult perceptions survey participants by *my*blu ENDS use status, 42 (0.8%) participants were classed as established *my*blu users, 1594 (35.09%) as experimental *my*blu users and 36 (0.8%) as former *my*blu users (Table 6). In this young adult cohort, however, the greatest proportion was never users (2796 participants, 63.3%). When cross-tabulating *my*blu use with cigarette smoking status, established *my*blu use was primarily observed in those who were established or experimental smokers, with very few former smokers and no never smokers reporting established *my*blu use. A similar pattern was seen for experimental *my*blu use, though the numbers of former (137, 21.4%) and never smokers (113, 6.9%) were higher for experimental than for established use.

**TABLE 6** *my*blu ENDS use status among young adults in the perceptions survey by smoking category.

| | Established smoker N (%) | Experimental smoker N (%) | Former smoker N (%) | Never smoker N (%) |
|---|---|---|---|---|
| Established *my*blu user 42 (0.8%) | 19 (37.8) | 19 (51.0) | 4 (11.2) | 0 (0.0) |
| Experimental *my*blu user 1594 (35.0%) | 422 (18.6) | 922 (63.1) | 137 (11.4) | 113 (6.9) |
| Former *my*blu user 36 (0.8%) | 15 (30.2) | 12 (36.5) | 7 (27.8) | 2 (5.5) |
| Never *my*blu user 2796 (63.3%) | 586 (13.8) | 1372 (54.5) | 254 (10.9) | 584 (20.8) |

*Note*: Data are presented as N (weighted %).

**TABLE 7** Curiosity and intentions to use *my*blu ENDS among young adults in the perceptions survey by smoking category.

| Question | Response | Current smoker N (%) | Former smoker N (%) | Never smoker N (%) |
|---|---|---|---|---|
| Have you ever been curious about using a *my*blu e-cigarette? | More Curious | 117 (18.3) | 45 (18.2) | 71 (12.1) |
| | Less Curious | 469 (81.7) | 209 (81.8) | 513 (87.9) |
| Do you think that you will try using a *my*blu e-cigarette in the next year? | Yes | 164 (55.4) | 41 (40.7) | 45 (21.5) |
| | No | 132 (44.6) | 69 (59.3) | 172 (78.5) |
| Do you think you will use a *my*blu e-cigarette soon? | Yes | 160 (52.1) | 37 (35.8) | 34 (15.1) |
| | No | 136 (47.9) | 73 (64.2) | 183 (84.9) |

*Note*: Data are presented as N (weighted %). The more curious category comprises the 'Somewhat curious' and 'Very curious' responses, and the less curious category comprises the 'Not at all curious' and 'A little curious' responses. The intentions to use in the next year and to use soon are grouped into a yes category ('Definitely yes' and 'Probably yes') and a no category ('Definitely no' and 'probably no').

### 3.3.2 | Young adults' curiosity/intentions to use *my*blu ENDS

Curiosity/intentions to use *my*blu ENDS data for young adults are presented in Table 7. Overall, being more curious to use *my*blu was seen in greater proportions of current smokers than never smokers but was similar between current smokers and former smokers. Regarding survey participants reporting thoughts about trying *my*blu ENDS in the next year or soon, affirmative responses were seen in greater proportions of current smokers than either former smokers or never smokers. Logistic regression showed that being a current smoker was associated with being more curious to use *my*blu ENDS compared with never smokers (aOR = 2.01, 95% CI [1.38, 2.92]) but not compared with former smokers (aOR = 0.97, 95% CI [0.62, 1.50]). Current smokers also reported thinking that they would try *my*blu ENDS in the next year more than both never smokers (aOR = 5.02, 95% CI [3.06, 8.24]) and former smokers (aOR = 1.84, 95% CI [1.11, 3.05]). Current smokers were more likely to think that they would try using *my*blu ENDS soon compared with never smokers (aOR = 6.58, 95% CI [3.96, 10.95]) and former smokers (aOR = 1.97, 95% CI [1.18, 3.30]).

### 3.3.3 | Adults' *my*blu awareness, use and cigarette smoking

Survey data were collected from 7811 adults. Regarding awareness of *my*blu, 3472 (45.8%) responded 'Just a little,' 3240 (41.2%) responded 'Some,' while 1099 (13.1%) responded 'A lot.' Ever use of *my*blu ENDS was reported by 46.0% (N = 1,786) of adults. Overall, ever use of *my*blu ENDS in never smokers and former smokers was low compared with established or experimental smokers. Of those reporting ever use, 23.0% (N = 807) were established smokers, 53.9% (N = 713) were experimental smokers, 20.9% (N = 241) were former smokers and 2.2% (N = 25) were never smokers (Table 8). Logistic regression showed that adult current smokers were significantly more likely to have used *my*blu ENDS compared with both never smokers (aOR = 1.93, 95% CI [1.16, 3.19]) and former smokers (aOR = 1.27, 95% CI [1.04, 1.55]).

When categorising perceptions survey participants by *my*blu ENDS use status, 152 (2.8% of ever users) participants were classified as established *my*blu users, 1556 (41.2%) as experimental *my*blu users and 78 (2.0%) as former *my*blu users (Table 8). In this adult cohort, however, the greatest proportion was never users (2066 participants,

**TABLE 8**  *my*blu ENDS use status among adults in the perceptions survey by smoking category.

| | Established smoker N (%) | Experimental smoker N (%) | Former smoker N (%) | Never smoker N (%) |
|---|---|---|---|---|
| Established *my*blu user 152 (2.8%) | 107 (45.8) | 31 (32.8) | 13 (18.1) | 1 (3.4) |
| Experimental *my*blu user 1556 (41.2%) | 661 (21.1) | 664 (56.5) | 207 (20.1) | 24 (2.2) |
| Former *my*blu user 78 (2.0%) | 39 (29.4) | 18 (29.4) | 21 (41.2) | 0 (0.0) |
| Never *my*blu user 2066 (54.0%) | 1107 (29.1) | 402 (29.2) | 490 (37.1) | 67 (4.5) |

*Note*: Data are presented as N (weighted %).

**TABLE 9**  Curiosity and intentions to use *my*blu ENDS among adults in the perceptions survey by smoking category.

| Question | Response | Current smoker N (%) | Former smoker N (%) | Never smoker N (%) |
|---|---|---|---|---|
| Have you ever been curious about using a *my*blu e-cigarette? | More curious | 321 (27.5) | 85 (16.6) | 8 (12.9) |
| | Less curious | 786 (72.5) | 405 (83.4) | 59 (87.1) |
| Do you think that you will try using a *my*blu e-cigarette in the next year? | Yes | 472 (63.8) | 73 (32.4) | 15 (69.2) |
| | No | 262 (36.2) | 155 (67.6) | 10 (30.8) |
| Do you think you will use a *my*blu e-cigarette soon? | Yes | 432 (58.9) | 63 (28.0) | 15 (67.6) |
| | No | 302 (41.1) | 165 (72.0) | 10 (32.4) |

*Note*: Data are presented as N (weighted %). The more curious category comprises the 'Somewhat curious' and 'Very curious' responses, and the less curious category comprises the 'Not at all curious' and 'A little curious' responses. The intentions to use in the next year and to use soon are grouped into a yes category ('Definitely yes' and 'Probably yes') and a no category ('Definitely no' and 'Probably no').

**TABLE 10**  Smoking transitions in never-smoking *my*blu users.

| | | | Smoking status | | |
|---|---|---|---|---|---|
| Survey | Cohort | *my*blu use prior to cigarette smoking N (%) | Established smoker N (%) | Experimental smoker N (%) | Former smoker N (%) |
| Prevalence | Young adults | 459 (2.6) | 57 (1.8) | 389 (5.3) | 13 (1.9) |
| | Adults | 133 (0.8) | 18 (0.3) | 114 (2.3) | 1 (0.1) |
| Perceptions | Young adults | 303 (4.2) | 30 (2.5) | 269 (8.6) | 4 (1.1) |
| | Adults | 193 (2.4) | 19 (0.6) | 171 (6.1) | 3 (0.2) |

*Note*: Data are from participants who first used *my*blu ENDS as a never smoker and reported subsequent cigarette smoking and are presented as N (weighted %) with percentages expressed as those of each survey population. Analysis based on 14,804 young adult and 15,453 adult participants in the prevalence survey and 7428 young adult and 7811 adult participants in the perceptions survey.

54.0%). When cross-tabulating *my*blu use with cigarette smoking status, established *my*blu use was largely restricted to those who were established smokers, although there was some evidence of established *my*blu use among experimental smokers, with few former smokers and only a single never smoker reporting established *my*blu use. Experimental *my*blu use was predominant in experimental smokers, with almost two-thirds of experimental *my*blu users also reporting being experimental smokers. As with established *my*blu use, experimental use was seen infrequently in former and never smokers.

### 3.3.4 | Adults' curiosity/intentions to use *my*blu ENDS

Curiosity/intentions to use *my*blu ENDS data for adults are presented in Table 9. Overall, being more curious to use *my*blu and thinking of using *my*blu in the next year or soon were seen in greater proportions of current smokers than among former smokers or never smokers. Logistic regression showed that current smokers were more curious to use *my*blu ENDS compared with both former smokers (aOR = 1.80,

95% CI [1.34, 2.41]) and never smokers (aOR = 2.84, 95% CI [1.27, 6.37]). Current smokers also reported thinking that they were more likely to try *my*blu ENDS in the next year compared with former smokers (aOR = 3.61, 95% CI [2.54, 5.14]) but not with never smokers (aOR = 1.00, 95% CI [0.41, 2.42]). Current smokers were more likely to think that they would use *my*blu ENDS soon compared with former smokers (aOR = 3.62, 95% CI [2.52, 5.21]) but not with never smokers (aOR = 0.92, 95% CI [0.38, 2.22]).

### 3.3.5 | Transition from *my*blu use to cigarette smoking in never smokers

As described above, very low proportions of ever *my*blu users in the surveys were never smokers, with the reported incidence consistent between the two different survey types. To further assess whether ever *my*blu use in never smokers led to transitioning to cigarette smoking, data from all waves of both surveys were examined (Table 10). In either survey and in both the young adult and adult cohorts, the prevalence of *my*blu use among never smokers prior to subsequent cigarette smoking was low (≤4.2%). The greater behavioural pattern was *my*blu use in never smokers leading to experimental smoking, which was seen in 2.3% to 8.6% of never-smoker participants. Transitioning from never smoking to established smoking following *my*blu use was infrequent, observed in ≤2.5% of participants in any survey/cohort. Overall, in all surveys and age cohorts combined, 124 participants (representing 0.1% of the total survey population) reported using *my*blu ENDS for the first time prior to smoking cigarettes and went on to become established smokers.

## 4 | DISCUSSION

Overall, the findings from our analyses of survey data from US nationally representative samples of young adults and older adults, obtained in two independent surveys each conducted over three waves, demonstrate that curiosity and intentions to use *my*blu ENDS were generally higher among current smokers than former and never smokers. We also further found only minimal evidence of a 'gateway' from initiation of *my*blu use among never smokers and subsequently to established cigarette smoking. Given the criticality of the debate regarding whether ENDS support or erode tobacco control efforts, these findings provide important insight into the relative lack of use of *my*blu ENDS by unintended populations. A key finding from the prevalence study was that ever-use of *my*blu ENDS was significantly more likely in young adult current smokers than in both young adult former smokers and young adult never smokers. While ever *my*blu use in adult never smokers was no less likely than in adult current smokers in the prevalence survey, this effect was likely due to the large CIs and the substantially lower number of never smokers in the adult population dataset. However, it is notable that awareness of *my*blu was lower in both young adult and adult never smokers. These findings regarding *my*blu use in the prevalence survey were similar in the

perceptions survey in which, regardless of age cohort, *my*blu use was more likely in current compared with former or never smokers.

These findings regarding *my*blu use being more common in the intended user population (adult current smokers) and less common in those who do not have a history of combustible cigarette smoking are important to developing an overall assessment of the potential impact of *my*blu on both individual and population health. Even under a pessimistic scenario in which the potential for ENDS causing harm is greater than that which the scientific literature estimates but still substantially reduced compared with combustible cigarettes, population health modelling has projected that ENDS availability in the US would result in 1.6 million fewer premature deaths and 20.8 million fewer life-years lost over a 10-year period.[26] In more recent dynamic population simulation modelling, the substantial harm reduction potential of ENDS has been corroborated.[27,30] Thus, *my*blu ENDS use predominantly among current smokers could have a positive population health impact. This potential may be diminished if there is evidence of use of *my*blu ENDS by significant numbers of individuals for whom the product is not intended. Such unintended populations include those who have never smoked or are not currently smoking (i.e. former smokers),[28] especially youth and young adults who have never smoked. The potential may be further diminished if *my*blu ENDS use among never smokers led to initiation of cigarette smoking, the 'gateway' hypothesis.[28–30] We did not find substantial evidence of such a 'gateway' effect for *my*blu ENDS. Overall, in totality, our findings point to a positive population health impact of *my*blu, since they demonstrate a positive balance between current smokers using *my*blu as an 'off-ramp' from combustible cigarette smoking and minimal use of *my*blu as an 'on-ramp' to nicotine use among never users and nonsmokers.

A number of studies have reported that ENDS use among non-smokers is associated with a risk of future cigarette smoking,[29,42] leading to the advancement of the hypothesis that the 'gateway' effect, particularly among youth, may erode the harm reduction potential of ENDS. However, the methodological limitations of those studies have caused difficulty in interpretation.[29,42] Some of the difficulties in interpretation are due to the complexity of the relationships between ENDS use, cigarette smoking and other behaviours and the potential for the existence of common risk factors,[43] as well as study design issues and difficulty in drawing conclusions regarding causality correlations from cross-sectional or even longitudinal study designs given the presence of confounding factors.[44] Our findings inject necessary information into the debate. The data presented here demonstrate that the prevalence of established *my*blu ENDS use among both young adult and adult never smokers was low. Although data for ENDS use prevalence among never smokers are widely variable, our findings are in accordance with those of other studies. For example, studies have reported the prevalence of ever and current ENDS use in 1.6% and 0.7% of never smokers, respectively.[45] More recent analyses have reported current ENDS use in 3.3% of never-smoking young adults[46] and 2.8% of adults,[47] though in the latter study approximately 10% of young adult current ENDS users were never smokers.[47] Importantly though, in the data from studies presented

here, the use of *my*blu ENDS in never smokers was not associated with the development, to any great degree, of established smoking in that population, which is in direct contrast to the 'gateway' hypothesis. This contrasts with the findings of a recent meta-analysis that reported an association between ENDS use among nonsmokers and later smoking[48] though this finding was subject to a high degree of heterogeneity between individual studies. Our findings are, however, in accordance with recent analyses of data from the 2014–2017 NYTS surveys[49] that found very low proportions (0.7%) of US adolescents who used ENDS prior to first smoking cigarettes went on to become established cigarette smokers. Furthermore, a putative 'gateway' effect would lead to rises in cigarette smoking as ENDS use increases; however, data from both the US and Canada show that cigarette smoking prevalence has not increased following increases in ENDS use prevalence[43,50] and in fact may have decreased.[51,52]

Findings across the studies presented here also point to a greater degree of experimental, rather than established, cigarette smoking among the population that had used *my*blu prior to smoking a cigarette. In addition, experimental *my*blu use was generally associated with experimental cigarette smoking, which is suggestive of individuals trying either type of product but without continuing to established use. While this study cannot determine the reasons for these findings, it may be explained by the 'common liability' principle, which postulates that any observed relationships between ENDS use and cigarette smoking may be attributed to the 'liability' of individuals to experiment and use tobacco products[53] rather than any direct causal use link between ENDS use and cigarette smoking. It should also be noted that we have only assessed a single aspect of the 'gateway' effect, that of the development of established smoking in participants who first used *my*blu as never smokers. We have made no assessment of other potential 'gateway' aspects, such as relapse back into cigarette smoking in smokers who had quit smoking prior to initiating *my*blu use, since it was not possible to assess this in our cross-sectional survey data. However, in such cases, it would also be important to ascertain the extent to which ENDS may actually serve as a 'roadblock' back to combustible cigarettes for smokers that may otherwise relapse. That said, the greater public health and societal focus appears to be that of smoking initiation among never smokers. Our analyses have also not examined progression to the use of other potentially less harmful tobacco products, such as smokeless tobacco among never users of those products, though the health impact of such products has been shown to be substantially lower than that of cigarette smoking.[54]

The findings presented from these studies must be interpreted in the context of some limitations. Firstly, our survey studies only assessed a single type of closed-system ENDS product, and as such, our findings may not be generalisable to other closed-system ENDS products or to other types of ENDS products such as open systems. Many factors may be involved in an individual's choice to begin using either ENDS products or combustible cigarettes, and therefore, data reported here for *my*blu ENDS products may not necessarily be extrapolated to other ENDS products. Secondly, data were only collected from participants residing in the US, and therefore, the findings

may not be generalisable to other countries where a different regulatory environment and legislative framework is in place. Thirdly, survey studies inherently rely on participants self-reporting both *my*blu use and cigarette smoking. However, in online studies of tobacco and nicotine product use, behaviours cannot be verified using, for example, biochemical verification. Finally, the ENDS product marketplace and regulatory environment are continually evolving, and our findings from online surveys completed in late 2019 and early 2020 could become outdated.

## 5 | CONCLUSIONS

In conclusion, our analyses of large-scale nationally representative datasets suggest that use of closed-system *my*blu ENDS was predominant in survey participants with a smoking history and particularly in current smokers. Curiosity and intentions to use *my*blu ENDS were also generally more common among current smokers than former and never smokers. Finally, our analyses did not find significant levels of *my*blu use prior to ever smoking leading to established smoking. Overall, these data suggest that *my*blu ENDS use is more commonly found in the intended population; that is, those who are either current smokers or who have a history of cigarette smoking and who may thus benefit the most from using ENDS as a potentially less harmful alternative to continued cigarette smoking. Furthermore, the public health potential of *my*blu ENDS is not mitigated to any concerning degree by unintended use, curiosity/intentions to use or by the generation of a 'gateway' effect among never smokers between ENDS use and subsequent initiation of established cigarette smoking.

employee of LACT at the time of survey conduct and analyses. TLH is an independent consultant contracted to LACT to provide analytical and writing support for clinical and behavioural studies. AT, TV, XC, LM, TN and GO'C were employees of Imperial Brands PLC, a company of which Fontem US LLC is a subsidiary, at the time of the study. MN is the president of LACT, which was contracted by Imperial Brands PLC to perform behavioural survey and clinical studies. MN has also contracted to consult with, and conducted behavioural and clinical studies for, other ENDS and smoking cessation medication manufacturers.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## ORCID

*Ian M. Fearon* https://orcid.org/0000-0003-1038-4346

## REFERENCES

1. World Health Organization. *WHO Report on the Global Tobacco Epidemic: Warning About the Dangers of Tobacco*. World Health Organization; 2011.
2. US Department of Health and Human Services. *The Health Consequences of Smoking: 50 Years of Progress: A Report of the Surgeon General*. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2014.
3. International Agency for Research on Cancer. IARC handbooks of cancer prevention. In: *Reversal of Risk After Quitting Smoking*. Vol.11. IARC; 2007.
4. World Health Organization. Tobacco. Accessed 3rd November 2020, https://www.who.int/news-room/fact-sheets/detail/tobacco
5. Gallucci G, Tartarone A, Lerose R, Lalinga AV, Capobianco AM. Cardiovascular risk of smoking and benefits of smoking cessation. *J Thorac Dis*. 2020;12(7):3866-3876. doi:10.21037/jtd.2020.02.47
6. Institute of Medicine. *Clearing the Smoke—Assessing the Science Base for Tobacco Harm Reduction*. The National Academies Press; 2001.
7. Perfetti T, Rodgman A. The complexity of tobacco and tobacco smoke. *Beitr Tab Int*. 2011;24(5):17-232. doi:10.2478/cttr-2013-0902
8. Stratton K, Shetty P, Wallace R, Bondurant S. Clearing the smoke: the science base for tobacco harm reduction—executive summary. *Tob Control*. 2001;10(2):189-195. doi:10.1136/tc.10.2.189
9. Food and Drug Administration. Harmful and potentially harmful constituents in tobacco products and tobacco smoke; established list. Docket no. FDA–2012–N–0143. *Federal Register*. 2012;77(64): 20034-20037.
10. Babb S, Malarcher A, Schauer G, Asman K, Jamal A. Quitting smoking among adults—United States, 2000-2015. *MMWR Morb Mortal Wkly Rep*. 2017;65(52):1457-1464. doi:10.15585/mmwr.mm6552a1
11. Eaton DL, Kwan LY, Stratton K (Eds). National academies of sciences engineering and medicine. In: *Public Health Consequences of E-cigarettes*. National Academies Press; 2018.
12. Public Health England. *Evidence Review of e-Cigarettes and Heated Tobacco Products 2018. A Report Commissioned by Public Health England*. PHE Publications; 2018.
13. Royal College of Physicians. *Nicotine Without Smoke. Tobacco Harm Reduction. A Report by the Tobacco Advisory Group of the Royal College of Physicians*. Royal College of Physicians; 2016.
14. Gottlieb S. *Statement From FDA Commissioner Scott Gottlieb, M.D., on New Steps to Address Epidemic of Youth E-cigarette Use*. Food and Drug Administration. Accessed Dec 1st 2018. https://www.fda.gov/news-events/press-announcements/statement-fda-commissioner-scott-gottlieb-md-new-steps-address-epidemic-youth-e-cigarette-use
15. Beard E, West R, Michie S, Brown J. Association between electronic cigarette use and changes in quit attempts, success of quit attempts, use of smoking cessation pharmacotherapy, and use of stop smoking services in England: time series analysis of population trends. *Brit Med J*. 2016;354:i4645.
16. Beard E, West R, Michie S, Brown J. Association of prevalence of electronic cigarette use with smoking cessation and cigarette consumption in England: a time-series analysis between 2006 and 2017. *Addiction*. 2020;115(5):961-974. doi:10.1111/add.14851
17. Berry KM, Reynolds LM, Collins JM, et al. E-cigarette initiation and associated changes in smoking cessation and reduction: the population assessment of tobacco and health study, 2013-2015. *Tob Control*. 2019;28(1):42-49. doi:10.1136/tobaccocontrol-2017-054108
18. Giovenco DP, Delnevo CD. Prevalence of population smoking cessation by electronic cigarette use status in a national sample of recent smokers. *Addict Behav*. 2018;76:129-134. doi:10.1016/j.addbeh.2017.08.002
19. Levy DT, Yuan Z, Luo Y, Abrams DB. The relationship of E-cigarette use to cigarette quit attempts and cessation: insights from a large, nationally representative U.S. survey. *Nicotine Tob Res*. 2018;20(8): 931-939. doi:10.1093/ntr/ntx166
20. Pierce JP, Benmarhnia T, Chen R, et al. Role of e-cigarettes and pharmacotherapy during attempts to quit cigarette smoking: the PATH study 2013-16. *PLoS One*. 2020;15(9):e0237938. doi:10.1371/journal.pone.0237938
21. Zhu SH, Zhuang YL, Wong S, Cummins SE, Tedeschi GJ. E-cigarette use and associated changes in population smoking cessation: evidence from US current population surveys. *Brit Med J*. 2017;358: j3262. doi:10.1136/bmj.j3262
22. Hartmann-Boyce J, McRobbie H, Butler AR, et al. Electronic cigarettes for smoking cessation. *Cochrane Database Syst Rev*. 2021;9(9): Cd010216. doi:10.1002/14651858.CD010216.pub5
23. Hartmann-Boyce J, McRobbie H, Lindson N, et al. Electronic cigarettes for smoking cessation. *Cochrane Database Syst Rev*. 2020;10: CD010216. doi:10.1002/14651858.CD010216.pub
24. Hajek P, Phillips-Waller A, Przulj D, et al. A randomized trial of E-cigarettes versus nicotine-replacement therapy. *N Engl J Med*. 2019; 380(7):629-637. doi:10.1056/NEJMoa1808779
25. Hajek P, Phillips-Waller A, Przulj D, et al. E-cigarettes compared with nicotine replacement therapy within the UK stop smoking services: the TEC RCT. *Health Technol Assess*. 2019;23(43):1-82. doi:10.3310/hta23430
26. Levy DT, Borland R, Lindblom EN, et al. Potential deaths averted in USA by replacing cigarettes with e-cigarettes. *Tob Control*. 2018; 27(1):18-25. doi:10.1136/tobaccocontrol-2017-053759
27. Mendez D, Warner KE. A magic bullet? The potential impact of e-cigarettes on the toll of cigarette smoking. *Nicotine Tob Res*. 2020; 23(4):654-661. doi:10.1093/ntr/ntaa160
28. Cahn Z, Drope J, Douglas CE, et al. Applying the population health standard to the regulation of electronic nicotine delivery systems. *Nicotine Tob Res*. 2021;23(5):780-789. doi:10.1093/ntr/ntaa190
29. Chan GCK, Stjepanović D, Lim C, et al. Gateway or common liability? A systematic review and meta-analysis of studies of adolescent e-cigarette use and future smoking initiation. *Addiction*. 2020;116(4): 743-756. doi:10.1111/add.15246
30. Warner KE, Mendez D. E-cigarettes: comparing the possible risks of increasing smoking initiation with the potential benefits of increasing smoking cessation. *Nicotine Tob Res*. 2019;21(1):41-47. doi:10.1093/ntr/nty062

31. Ashley DL, Spears CA, Weaver SR, Huang J, Eriksen MP. E-cigarettes: how can they help smokers quit without addicting a new generation? *Prev Med*. 2020;140:106145. doi:10.1016/j.ypmed.2020.106145

32. Sapru S, Vardhan M, Li Q, Guo Y, Li X, Saxena D. E-cigarettes use in the United States: reasons for use, perceptions, and effects on health. *BMC Public Health*. 2020;20(1):1518. doi:10.1186/s12889-020-09572-x

33. O'Connell G, Pritchard JD, Prue C, et al. A randomised, open-label, cross-over clinical study to evaluate the pharmacokinetic profiles of cigarettes and e-cigarettes with nicotine salt formulations in US adult smokers. *Intern Emerg Med*. 2019;14(6):853-861. doi:10.1007/s11739-019-02025-3

34. Hammond D. Smoking behaviour among young adults: beyond youth prevention. *Tob Control*. 2005;14(3):181-185. doi:10.1136/tc.2004.009621

35. Food and Drug Administration. (Ed). *Premarket Tobacco Product Applications and Recordkeeping Requirements. Final Rule*. Maryland, USA: Food and Drug Administration, editor; 2021.

36. Hyland A, Ambrose BK, Conway KP, et al. Design and methods of the population assessment of tobacco and health (PATH) study. *Tob Control*. 2017;26(4):371-378. doi:10.1136/tobaccocontrol-2016-052934

37. Office on Smoking and Health. National youth tobacco survey: methodology report. 2020 https://www.cdc.gov/tobacco/data_statistics/surveys/nyts/pdfs/2020/2020-NYTS-Methodology-Report-508.pdf

38. Agaku IT, Odani S, Homa D, Armour B, Glover-Kudon R. Discordance between perceived and actual tobacco product use prevalence among US youth: a comparative analysis of electronic and regular cigarettes. *Tob Control*. 2019;28(2):212-219. doi:10.1136/tobaccocontrol-2017-054113

39. Jones DM, Majeed BA, Weaver SR, Sterling K, Pechacek TF, Eriksen MP. Prevalence and factors associated with smokeless tobacco use, 2014-2016. *Am J Health Behav*. 2017;41(5):608-617. doi:10.5993/AJHB.41.5.10

40. Sharot T. Weighting survey results. *J Market Res Soc*. 1986;28: 269-284.

41. Deming WE, Stephan FF. On a least squares adjustment of a sampled frequency table when the expected marginal totals are known. *Ann Math Stat*. 1940;11(4):427-444, 18. doi:10.1214/aoms/1177731829

42. Glasser A, Abudayyeh H, Cantrell J, Niaura R. Patterns of E-cigarette use among youth and young adults: review of the impact of E-cigarettes on cigarette smoking. *Nicotine Tob Res*. 2019;21(10):1320-1330. doi:10.1093/ntr/nty103

43. Hammond D, Reid JL, Rynard VL, et al. Prevalence of vaping and smoking among adolescents in Canada, England, and the United States: repeat national cross sectional surveys. *Br Med J*. 2019;365:l2219.

44. Shahab L, Brown J, Boelen L, Beard E, West R, Munafò MR. Unpacking the gateway hypothesis of e-cigarette use: the need for triangulation of individual- and population-level data. *Nicotine Tob Res*. 2022; 24(8):1315-1318. doi:10.1093/ntr/ntac035

45. Dutra LM, Glantz SA. High international electronic cigarette use among never smoker adolescents. *J Adolesc Health*. 2014;55(5):595-597. doi:10.1016/j.jadohealth.2014.08.010

46. Bandi P, Cahn Z, Goding Sauer A, et al. Trends in E-cigarette use by age group and combustible cigarette smoking histories, U.S. adults, 2014-2018. *Am J Prev Med*. 2020;60(2):151-158. doi:10.1016/j.amepre.2020.07.026

47. Boyle RG, Richter S, Helgertz S. Who is using and why: prevalence and perceptions of using and not using electronic cigarettes in a statewide survey of adults. *Addict Behav Rep*. 2019;10:100227. doi:10.1016/j.abrep.2019.100227

48. Khouja JN, Suddell SF, Peters SE, Taylor AE, Munafò MR. Is e-cigarette use in non-smoking young adults associated with later smoking? A systematic review and meta-analysis. *Tob Control*. 2020; 30(1):8-15. doi:10.1136/tobaccocontrol-2019-055433

49. Shahab L, Beard E, Brown J. Association of initial e-cigarette and other tobacco product use with subsequent cigarette smoking in adolescents: a cross-sectional, matched control study. *Tob Control*. 2021; 30(2):212-220. doi:10.1136/tobaccocontrol-2019-055283

50. Hammond D, Reid JL, Rynard VL, et al. Erratum to: prevalence of vaping and smoking among adolescents in Canada, England, and the United States: repeat national cross sectional surveys. *Br Med J*. 2020;370:m2579.

51. Meza R, Jimenez-Mendoza E, Levy DT. Trends in tobacco use among adolescents by grade, sex, and race, 1991-2019. *JAMA Netw Open*. 2020;3(12):e2027465. doi:10.1001/jamanetworkopen.2020.27465

52. Sun T, Lim CCW, Stjepanović D, et al. Has increased youth e-cigarette use in the USA, between 2014 and 2020, changed conventional smoking behaviors, future intentions to smoke and perceived smoking harms? *Addict Behav*. 2021;123:107073. doi:10.1016/j.addbeh.2021.107073

53. Cheng HG, Largo EG, Gogova M. E-cigarette use and onset of first cigarette smoking among adolescents: an empirical test of the 'common liability' theory. *F1000Res*. 2019;8:2099. doi:10.12688/f1000research.21377.1

54. Clarke E, Thompson K, Weaver S, Thompson J, O'Connell G. Snus: a compelling harm reduction alternative to cigarettes. *Harm Reduct J*. 2019;16(1):62. doi:10.1186/s12954-019-0335-1