Purchase Intent and Appeal of ENDS Products among Current, Former and Never Ever Users of Tobacco Products in the U.S.*

by

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SUMMARY

Background and objectives: The last decade has seen extensive research into electronic nicotine delivery systems (ENDS) such as e-cigarettes. Although some studies assess ENDS’ potential benefits, there is a paucity of studies that provide population-level estimates of purchase intent or product appeal among various tobacco user groups, or that have examined the impact of different product characteristics on those variables.

Methods: Purchase intent and product appeal ratings were analyzed from six online studies for multiple sub-brands of Vuse vapor products (including different flavors, nicotine levels, and device styles). The sample in each study was weighted to represent the adult U.S. population of current established, former established, and never established cigarette smokers on five key demographics; providing population-level estimates.

Results: Results for purchase intent and appeal are remarkably consistent. Ratings of purchase intent and appeal are higher for current tobacco users (current established cigarette smokers, current established non-cigarette tobacco users, and current tobacco experimenters) than for former and never ever tobacco users.

Conclusions and scientific significance: These findings show that varying sub-brands of an e-cigarette has little or no impact on population level purchase intent and appeal ratings across tobacco user groups. Additionally, greater variability in ratings among current tobacco experimenters than other tobacco user groups is discussed as well as correlations between measures. This paper provides the first population estimates of both purchase intent and product appeal for various ENDS products among adult tobacco users and nonusers; information that is critical for evaluating the impact on public health. [Contrib. Tob. Nicotine Res. 32 (2023) 34–42]

KEYWORDS

Behavior; e-cigarette; ENDS; electronic nicotine delivery system; nicotine; PMTA; regulatory;

ZUSAMMENFASSUNG

Hintergrund und Ziele: In den letzten zehn Jahren wurden umfangreiche wissenschaftliche Arbeiten über Geräte zur elektronischen Nikotinabgabe (ENDS) wie z. B. E-Zigaretten veröffentlicht. In einigen dieser Arbeiten wurden zwar die potenziellen Vorteile von ENDS untersucht, es gibt jedoch wenige Studien, die Schätzungen auf Bevölkerungsebene zur Kaufabsicht oder Produktattraktivität bei unterschiedlichen Gruppen von Tabakkonsumenten zum
BACKGROUND AND OBJECTIVES

Cigarette smoking is the leading cause of preventable premature mortality in the United States, with combustion identified as the primary source of carcinogens associated with tobacco use (1). Therefore, non-combustible tobacco and nicotine products like e-cigarettes are associated with less harm than cigarettes (2, 3). E-cigarettes have been developed to encourage adult smokers to use less harmful products, reduce overall cigarette consumption, and to address important Healthy People public health goals (4, 5).

At the same time, public health is also concerned with preventing smoking initiation and sustaining long-term smoking cessation to reduce smoking-related morbidity and mortality (6, 7). To meet these objectives, it is important for non-combustible tobacco and nicotine products to appeal to current smokers and not to nonusers of tobacco products, including both former and never users of tobacco.

The last decade bore witness to dramatically increased awareness, trial, and use of e-cigarettes among both the intended users (i.e., adult smokers) and unintended populations (i.e., nonsmokers, including youth and young adults) (8) before the U.S. Food and Drug Administration (FDA) began reviewing premarket applications for e-cigarettes in September 2020. FDA guidance (9, 10) states that to receive market authorization, a new tobacco product must be appropriate for the protection of public health by considering the extent to which it decreases use of combustible products among current smokers relative to the extent to which it leads to any increase in use among nonusers. As part of its guidance, FDA recommends that ENDS manufacturers provide population-level estimates of behavioral intentions and product appeal of their products among both tobacco users and nonusers. Although there are several
published reports in the tobacco literature about behavioral intentions (11–17) and product appeal (18–24), those reports do not provide population-level estimates that are critical to evaluating the impact of products on public health. The present work addresses this data gap.

This analysis provides population estimates of both purchase intent and product appeal among adult tobacco users (current established cigarette smokers, current established non-cigarette tobacco users, current cigarette experimenters) and nonusers (former tobacco users, and never ever tobacco users) from a series of conducted studies with three goals in mind. First, to provide population-level estimates of purchase intent and product appeal across tobacco user groups. Second, to describe how patterns of mean ratings of purchase intent and product appeal across tobacco user groups change when different products, or features within a particular product, are presented. Third, to examine the relationship between behavioral intentions and product appeal within tobacco user groups via correlational analyses.

METHOD

Samples

This data analysis focused on study samples from six separate online studies conducted between July 2019 and January 2021 that varied with respect to Vuse vapor sub-brand (Ciro, Vibe, and Alto), nicotine levels (from 1.5% to 5%), available flavors (one to eight tobacco and non-tobacco flavors), and device types (power units with corresponding non-refillable cartridges, tanks, and pods) and power unit colors (Vuse Alto). Those six studies included a total of 34,615 respondents across 10 separate analytic samples that ranged in size from approximately 2,250 to approximately 4,600 depending on specific study objectives. The samples came from three different internet panel providers. The first four samples came from Dynata (Shelton, CT, USA), the next four samples came from Precision Sample (Denver, CO, USA), and the last two samples came from EMI (Cincinnati, OH, USA). All respondents were U.S. adults of legal age to purchase tobacco products (based on the jurisdiction in which they resided at the start of the data collection period) up to age 75, were not current or former users of the test products, and had not participated in tobacco research in the three months prior to data collection.

Each sample was stratified by three groups based on cigarette smoking status: (1) current established cigarette smokers (smoked at least 100 cigarettes in their lifetime and smoked in the last 30 days); (2) former established cigarette smokers (smoked at least 100 cigarettes in their lifetime and did not smoke in the last 30 days); and (3) never established cigarette smokers (never smoked at least 100 cigarettes).

To ensure representativeness, participants were quota-sampled by five key demographic characteristics (age, sex, race/ethnicity, education, and geographic region) within each of the three cigarette user groups, and the data were then weighted to the U.S. population using data from the U.S. Census, the Annual Social and Economic Supplement to the Current Population Survey, and the Tobacco Use Supplement to the Current Population Survey (25–27). When multiple samples were collected within a single study, respondents were assigned to a sample using an adaptive allocation minimization algorithm to ensure demographic variable balance across samples (e.g., 28, 29). This type of randomization procedure produces unbiased estimates of treatment effects with increased power relative to simple randomization (29). Differences between weighted demographics and actual population counts were less than 1%. Although sampling was based on cigarette user status (to align with Current Population Survey data that were used as weighting targets), analyses were based on tobacco use status that included the full range of tobacco products, not only cigarettes. Tobacco use status was not used for sampling or weighting purposes because there are no population targets available at that level of granularity.

Five tobacco user groups based on the following mutually exclusive categories were used as the unit of analysis: (a) current established cigarette smokers (smoked at least 100 cigarettes in their lifetime and smoked in the last 30 days), (b) current established non-cigarette tobacco users (used tobacco products other than cigarettes at least 100 times in their lifetime and used those products in the last 30 days but are not a current established cigarette smoker), (c) current tobacco experimenters (used one or more tobacco products in the last 30 days but have not reached lifetime criterion of 100 uses for any product), (d) former tobacco users (used one or more tobacco products but have not used any tobacco product in the last 30 days), and (e) never ever tobacco users (no use of any tobacco product even once). Based on this hierarchy, current established cigarette smokers could include current users, experimenters, or former users of other tobacco products.

PROCEDURES, MEASURES, AND ANALYSES

Studies were conducted in accordance with International Organization for Standardization (ISO 20252:2019) guidelines. The Western Institutional Review Board reviewed each of the six study protocols before the start of the study. All studies were approved or received an exempt determination, and statistical analysis plans were developed prior to data collection.

Panel members who received an invitation and consented to participate answered screening questions to determine eligibility and to assess demographic characteristics and tobacco use history. Participants were presented with high-resolution color digital images prior to collection of purchase intent and appeal ratings.

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1 The studies on which these analyses are based were conducted to support regulatory submissions for three products under the Vuse brand (sub-brands included Ciro, Vibe, and Alto).


3 Data for each study were taken from the version of these surveys that were the most recently available at the time of the study.
These product images included product packaging, label, content, as well as available flavors and power units. The group of high resolution color images was presented on one to two pages and included all text information in a legible format (front, back, side panels, and top/bottom, if information was presented). Zooming in was enabled if participants wanted to see a magnified image. Brand names were visible on the packs, and for each product, the specific flavor varieties and power unit options (if any) were presented. After viewing the images of the test, participants were asked to rate: (a) their purchase intent on a 10-point scale ranging from 1 (definitely would not purchase it to use) to 10 (definitely would purchase it to use), and (b) product appeal on a 7-point scale ranging from 1 (not at all appealing) to 7 (extremely appealing).

Descriptive statistics (i.e., weighted means, with unweighted sample sizes, and weighted 95% confidence intervals, CIs) are presented for product appeal and purchase intent for the five tobacco user groups in each of the samples, as well as aggregated across the samples. In addition, weighted correlational analyses (Pearson’s R) between purchase intent ratings and product appeal ratings are presented for each tobacco user group within each sample. Data processing and analyses were conducted using SAS version 9.4 (30).

RESULTS

Purchase intent ratings

Figure 1 provides the mean purchase intent ratings and 95% CIs for each of the five tobacco user groups aggregated across all 10 of the samples and shows that purchase intent ratings are higher among the three groups of current tobacco users (current tobacco experimenters: 5.6, current established cigarette smokers: 4.2, and current established non-cigarette tobacco users: 3.9) than among the two groups who are not currently using tobacco (former tobacco users: 2.1, and never ever tobacco users: 1.7). Absence of overlap in CIs for any of the groups indicates that all of the group means differ from each other.

Table 1 presents mean purchase intent ratings and 95% CIs for each tobacco user group and shows that means are higher for current tobacco users than nonusers in every sample. Notably, in every sample, the lowest mean for any group of current tobacco users is at least 1.5 higher (on a 10-point scale) than the highest mean for either of the groups of nonusers of tobacco. Thus, variability in the product features across the 10 samples (i.e., changes in sub-brand, device style, nicotine strength, and flavors and number of flavors per sample) has little to no impact on ratings of product appeal across the tobacco user groups: Mean product appeal ratings are always higher among current tobacco users than nonusers of tobacco products.

Product appeal ratings

Figure 2 provides the mean appeal ratings and 95% CIs for each of the five tobacco user groups aggregated across all 10 of the samples and shows a similar pattern of results to purchase intent ratings; that is, appeal ratings are higher among the three groups of current tobacco users (current tobacco experimenters: 4.4, current established cigarette smokers: 3.8, and current established non-cigarette tobacco users: 3.7) than among the two groups who are not currently using tobacco (former tobacco users: 2.3, and never ever tobacco users: 2.1).

Table 1 presents mean appeal ratings and 95% CIs of each sample for each tobacco user group. Similar to the aggregated mean appeal ratings, means are higher for current tobacco users than nonusers in every sample. Notably, within every sample, the lowest mean for any group of current tobacco users is at least 0.9 higher (on a 7-point scale) than the highest mean for either of the groups of non-users of tobacco. Thus, variability in the product features across the 10 samples (i.e., changes in sub-brand, device style, nicotine strength, and flavors and number of flavors per sample) has little to no impact on ratings of product appeal across the tobacco user groups: Mean product appeal ratings are always higher among current tobacco users than nonusers of tobacco products.

Relationship between the purchase intent and appeal ratings

To examine the relationship between purchase intent and product appeal, Table 2 provides the correlations between the two metrics for each of the five tobacco user groups across each of the 10 samples. The ranges of the correlations between purchase intent and appeal vary systematically across tobacco user groups: they are highest for the two groups of established tobacco users (current established smokers: 0.62–0.71 and current established non-cigarette tobacco users: 0.55–0.75), next highest for current tobacco experimenters (0.48–0.65), followed by former tobacco users (0.38–0.63), and lowest for never ever tobacco users (0.24–0.45). These results indicate a stronger relationship between the metrics among current tobacco users than nonusers.

DISCUSSION

This analysis provides population-level estimates of purchase intent and appeal ratings for e-cigarettes across five tobacco user groups from 10 separate samples in which each set of respondents viewed different Vuse e-cigarettes that varied with respect to sub-brand, device style, nicotine strength, and different flavors and number of flavors. For both dependent variables – purchase intent and product appeal – mean ratings were consistently highest among current cigarette smokers, followed by current established non-cigarette tobacco users, and current tobacco experimenters among the two groups of nonusers (former tobacco users and never ever tobacco users). The consistency in the pattern of results across the tobacco user groups suggests that the types of product variations across the e-cigarettes presented are unlikely to have differential effects on public health (i.e., purchase intent and appeal among tobacco users and nonusers).
Table 1. Weighted mean purchase intent ratings and mean product appeal ratings (and 95% Confidence Intervals) for each sample by tobacco user group.

<table>
<thead>
<tr>
<th>Sample # and provider</th>
<th>Product</th>
<th>Current established cigarette smokers</th>
<th>Current established non-cigarette tobacco users</th>
<th>Current tobacco experimenters</th>
<th>Former tobacco users</th>
<th>Never ever tobacco users</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Dynata</td>
<td>Vuse Ciro with 1.5% nicotine cartridges in 7 flavors</td>
<td>4.8 (4.6–5.1) n = 1,022</td>
<td>4.2 (3.7–4.6) n = 266</td>
<td>6.0 (5.7–6.4) n = 417</td>
<td>2.2 (2.1–2.4) n = 1,385</td>
<td>1.8 (1.7–1.9) n = 981</td>
</tr>
<tr>
<td>2 Dynata</td>
<td>Vuse Vibe with 3.0% nicotine tanks in 8 flavors</td>
<td>4.5 (4.3–4.7) n = 1,017</td>
<td>4.2 (3.7–4.6) n = 289</td>
<td>5.9 (5.5–6.3) n = 361</td>
<td>2.0 (1.9–2.2) n = 1,494</td>
<td>1.8 (1.6–1.9) n = 1,026</td>
</tr>
<tr>
<td>3 Dynata</td>
<td>Vuse Alto with 2.4% and 5.0% nicotine pods in 4 flavors</td>
<td>3.9 (3.7–4.1) n = 1,007</td>
<td>3.4 (2.9–3.8) n = 238</td>
<td>4.6 (4.3–4.9) n = 357</td>
<td>1.9 (1.8–2.0) n = 1,482</td>
<td>1.7 (1.6–1.8) n = 970</td>
</tr>
<tr>
<td>4 Dynata</td>
<td>Vuse Alto with 2.4% and 5.0% nicotine pods in 4 flavors; different packaging</td>
<td>3.7 (3.5–3.9) n = 1,007</td>
<td>3.6 (3.2–4.0) n = 250</td>
<td>4.8 (4.4–5.2) n = 359</td>
<td>1.9 (1.6–2.0) n = 1,449</td>
<td>1.7 (1.5–1.8) n = 989</td>
</tr>
<tr>
<td>5 Precision sample</td>
<td>Vuse Alto with 2.4% nicotine pods in 1 flavor</td>
<td>3.8 (3.5–4.1) n = 524</td>
<td>3.4 (2.9–3.9) n = 177</td>
<td>5.1 (4.5–5.7) n = 127</td>
<td>1.7 (1.6–1.8) n = 920</td>
<td>1.5 (1.4–1.7) n = 505</td>
</tr>
<tr>
<td>6 Precision sample</td>
<td>Vuse Alto with 2.4% nicotine pods in 1 flavor</td>
<td>4.3 (4.0–4.6) n = 523</td>
<td>3.5 (3.0–4.0) n = 178</td>
<td>4.8 (4.2–5.4) n = 128</td>
<td>1.8 (1.6–1.9) n = 918</td>
<td>1.5 (1.4–1.7) n = 506</td>
</tr>
<tr>
<td>7 Precision sample</td>
<td>Vuse Alto with 1.8% nicotine pods in 4 flavors</td>
<td>4.4 (4.2–4.6) n = 1,047</td>
<td>7.1 (6.5–7.7) n = 357</td>
<td>5.1 (4.6–5.5) n = 277</td>
<td>1.9 (1.8–2.1) n = 1,814</td>
<td>1.6 (1.5–1.8) n = 1,019</td>
</tr>
<tr>
<td>8 Precision sample</td>
<td>Vuse Alto with 1.5% nicotine pods in 4 flavors</td>
<td>4.3 (4.1–4.6) n = 1,039</td>
<td>4.3 (3.9–4.8) n = 286</td>
<td>6.9 (6.6–7.2) n = 484</td>
<td>2.4 (2.2–2.5) n = 1,374</td>
<td>1.9 (1.8–2.1) n = 885</td>
</tr>
<tr>
<td>9 EMI</td>
<td>Vuse Alto in 4 flavors and 7 power unit colors</td>
<td>4.2 (4.0–4.5) n = 661</td>
<td>4.2 (3.7–4.8) n = 232</td>
<td>6.5 (6.1–6.8) n = 363</td>
<td>2.5 (2.3–2.7) n = 781</td>
<td>1.9 (1.7–2.1) n = 545</td>
</tr>
<tr>
<td>10 EMI</td>
<td>Vuse Alto in 4 flavors and 7 additional power unit colors</td>
<td>4.2 (3.9–4.5) n = 656</td>
<td>4.5 (3.9–5.0) n = 216</td>
<td>6.5 (6.2–6.9) n = 384</td>
<td>2.5 (2.3–2.7) n = 799</td>
<td>1.8 (1.6–1.9) n = 544</td>
</tr>
</tbody>
</table>

Weighted mean product appeal ratings and 95% CI
Figure 1. Mean purchase intent ratings and 95% CIs aggregated across samples by tobacco user group.

Figure 2. Mean appeal ratings and 95% CIs aggregated across samples by tobacco user group.
In contrast to the consistency in the pattern of results across tobacco user groups, there appears to be variability in purchase intent ratings within tobacco user groups across the samples, particularly among current tobacco experimenters (see Figure 2). That variability may reflect differential interest in the products presented to each sample or the impact of broader environmental variables associated with the timing of the various studies. This report cannot distinguish between those possibilities because the product presented to each sample and the timing of studies are confounded. However, the timing of those lower ratings corresponds to intense negative media coverage in 2019 associated with E-cigarette, or Vaping, Product Use Associated Lung Injury (EVALI; 31, 32). Observing lower ratings after EVALI made headlines is consistent with the samples, particularly among current tobacco experimenters (19) and a study that reports on less interests in using e-cigarettes among smokers who had heard about EVALI (33). Ratings across the studies appear to have rebounded after it was demonstrated that EVALI was primarily linked to vitamin E acetate added to certain THC containing vapor products rather than to nicotine ENDS products (34). That time-based decrease then rebound suggests that the effect is likely attributable to the broader environment rather than product differences. The observation that it appears to be largest among current tobacco experimenters suggests that they may be a more sensitive barometer to change than other tobacco user groups who are more set in their behaviors of either using, or not using, tobacco products. Despite strong correlations between the purchase intent and appeal metrics, there may be value in retaining both measures in future research.

The primary strength of this article is that the studies in it were conducted with a high degree of methodological rigor. All of the studies included large samples, employed quotas to allow for samples sizes for meaningful tobacco user group analyses, and used multi-step statistical weighting processes to yield weighted estimates that closely match the U.S. population, resulting in generalizable population-based estimates.

Limitations include that the samples were drawn from internet panels and would not include respondents who do not have access to the internet or those who choose not to join the panel. Panel surveys have, however, become widely used in population research. Another potential limitation, which is inherent in virtually all tobacco-related surveys, is that respondents are categorized based on self-reported tobacco use behavior. It is possible that respondents misrepresent their actual tobacco use behavior; however, the confidential nature of the data collection methodology ensures there is no incentive for respondents to provide inaccurate data regarding use behavior.
CONCLUSIONS AND SCIENTIFIC SIGNIFICANCE

Mean purchase intent ratings and ratings of appeal are higher for current tobacco users (current established cigarette smokers, current established non-cigarette tobacco users, and current tobacco experimenters) than for former and never ever tobacco users. This pattern, which was observed across three different sub-brands/device types, from one to eight flavors, single or multiple nicotine levels (from 1.5% to 5.0%), and power unit colors, suggests that these vapor products do not differ with respect to their potential impact on public health insofar as these product design characteristics may influence product appeal and purchase intent.

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CONFLICTS OF INTEREST

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