Dynamic Population Modeling indicates that a flavored EVP ban in the UK market may negatively impact population health

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INTRODUCTION

The regulation of electronic vaping products (EVP) continues to be a topic of intense debate among public health authorities, policymakers, and researchers. While EVP have been widely recognized as a potentially reduced risk alternative to smoking cigarettes, regulatory measures, including bans on specific e-liquid formulations, may influence consumer behavior and, consequently, public health outcomes. Understanding these potential impacts is essential for developing evidence-based policies that balance harm reduction with potential unintended consequences.

To address this issue, we have developed a dynamic population model that allows us to predict the smoking and vaping prevalence and population health impact over time. Our model captures the transitions between different nicotine-use states, incorporating real-world behavioral data and population health metrics. By applying different scenarios reflecting potential EVP user responses to a flavored EVP ban we can project changes in prevalence and population health. This approach enables us to assess the potential public health impact of such a regulatory measure and provide insights into the possible benefits and risks associated with its implementation.

Here, we present the structure of our model, describe the key assumptions and data sources, as well as explore the projected outcomes under different regulatory scenarios.

DATA and METHODS

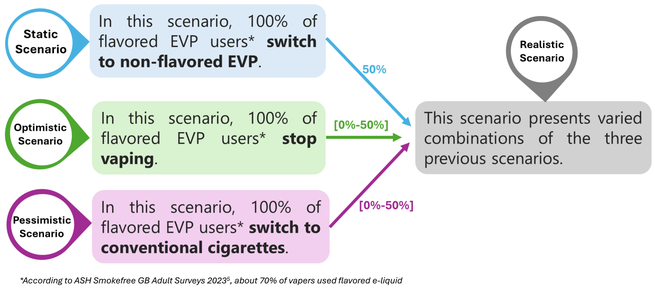
Understanding how changes in tobacco and nicotine product availability affect population health requires robust modeling of user behavior over time. The gold standard for simulating consumption trajectories involves transition matrices that account for initiation, cessation, and switching between smoking and next generation product (NGP) use, stratified by age, sex, and other factors.

However, this approach relies on longitudinal data that are often scarce or costly to obtain. As an alternative to overcome these challenges, we apply time series models to historical prevalence data derived from repeated cross-sectional surveys. These models can capture behavioral trends and forecast future prevalence without requiring extensive longitudinal inputs.

We developed a Dynamic Population Model (DPM) using UK smoking and vaping prevalence data from 2014–2022 (ONS)[1], applying statistical approaches such as ARIMA and Prophet[2] to project trends over 30 years. These projected trajectories were combined with mortality[3] and disease risk[4] models to assess the potential long-term health effects of a ban on flavored electronic vapor products. Our analysis compares a baseline (no-ban) scenario with four alternative scenarios reflecting possible consumer responses, including vaping cessation, smoking relapse, and product switching (**Figure 1**).

Scenarios reflecting potential EVP user responses to a flavored EVP ban

Figure 1



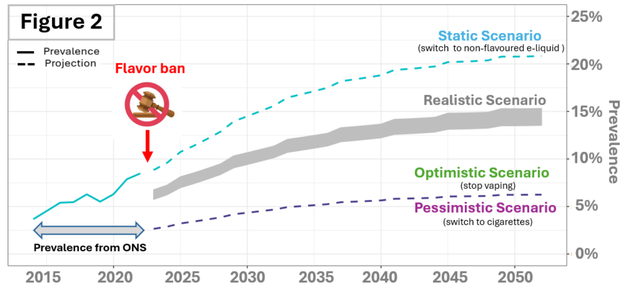
*According to ASH Smokefree GB Adult Surveys 2023[5], about 70% of vapers used flavored e-liquid

By comparing these scenarios to the status quo (flavored EVP available), we evaluate the potential impact of a flavored EVP ban on smoking and vaping prevalence, as well as the associated population health impact.

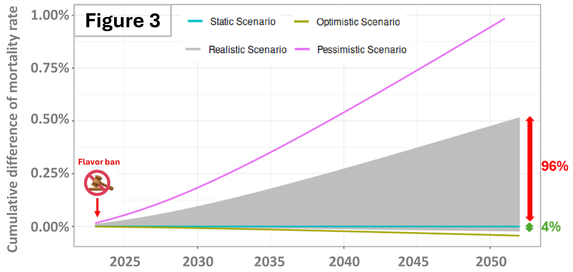
RESULTS

Prevalence and projection of current EVP consumers of four scenarios on vapers' behavior in response to flavor ban in the UK

- Our DPM was used to extrapolate potential EVP consumer responses to a flavored EVP ban, forecasting shifts in prevalence across current, former and never vaper/smoker categories.
- As an example, **Figure 2** illustrates the prevalence and projections of the current vapers for the four scenarios in the UK market.
- Under the realistic flavor ban scenario, the prevalence of current vapers is projected to fall between 13.5% and 15.3% by 2052. Compared to the status quo, this represents a reduction of 5.5% to 7.3% in current e-vapor product (EVP) use. Similar analyses were conducted for all other vaper and smoker categories.



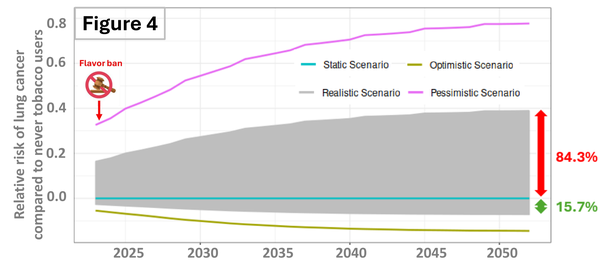
Cumulative difference of mortality rate for the four scenarios normalized to the status quo, over the 30-year follow-up period in the UK



- Applying the mortality model to the prevalence projections and the representative population trajectories, we estimated the mortality impact of each scenario. Comparing these mortality trends to the status quo enables us to assess the health impact of a flavor ban for EVP (**Figure 3**).
- When comparing realistic scenarios to the status quo, 96% of projections indicated that flavor ban would have a negative impact on mortality.

Relative risk of lung cancer compared to never tobacco users of four scenarios on vapers' behavior in response to flavor ban in the UK

- Using the disease risk estimation models, we can also predict the relative incidence of smoking-related diseases, for each scenario compared to the status quo.
- As an example, **Figure 4** shows the predictions of the relative risk of lung cancer for the four scenarios. When comparing realistic scenarios to the status quo, 84.3% of projections indicated that flavor ban would have a negative impact on lung cancer risk.
- Similar outcomes have been predicted by our model for other important smoking-related diseases.



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CONCLUSIONS

Our dynamic population model demonstrates that flavor bans on EVP could unintentionally hinder tobacco harm reduction efforts by limiting smokers' transitions to less harmful alternatives. Most scenarios modeled indicate that such bans may lead to increased mortality and higher risks of smoking-related diseases, reinforcing the important role that flavors play in supporting adult smokers to switch away from combustible products and reduced relapse rate.

Restricting the flavors available to vapers is likely to reduce their effectiveness as tobacco harm reduction tools.

The model's strength lies in its ability to generate robust population health projections using historical prevalence data and time series forecasting, without requiring complex and resource-intensive longitudinal datasets. This makes it especially suited for post-market assessments and multi-scenario regulatory analyses. Compared to other published models, our approach offers similar insights with significantly lower computational burden, enhancing both efficiency and scalability.

However, the model has some limitations. It focuses exclusively on the adult population, omitting youth dynamics, and is currently applicable only in markets where prevalence data are available over several years. Additionally, it is based on UK-specific data, and results may not generalize to other regions with different user behaviors or regulatory contexts. The analysis isolates the impact of a potential flavor ban, assuming all other factors remain unchanged over time

Despite these limitations, this approach shows strong potential as a regulatory support tool, helping decision-makers evaluate whether new policy could contribute to public health goals.

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