Commentary on:

Taxation of electronic nicotine and non-nicotine delivery systems

A Discussion Paper, December 2021

By the National Treasury, Republic of South Africa

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Summary – recognise ENDS benefits and beware unintended consequences

We are pleased to offer comments on the National Treasury discussion paper: *Taxation of electronic nicotine and non-nicotine delivery systems* (December 2021).[1] The discussion paper does not recognise the most important characteristics of electronic nicotine delivery systems (ENDS). It does not, therefore, take sufficient account of the likely perverse effects of applying taxes to these products. Any policymaking in this area should recognise three fundamental characteristics of ENDS:

1. While not necessarily without risks, it is clear beyond reasonable doubt that ENDS are much less harmful to health than cigarettes. See Section1.
2. ENDS contribute to smoking cessation or displace cigarettes among people who would otherwise take up smoking. See Section 2.
3. ENDS are economic substitutes for cigarettes. Increases in the relative price of ENDS are likely to decrease demand for ENDS but increase demand for cigarettes. See Section 3.

Because cigarettes are much more harmful than ENDS, it will only take a slight rise in smoking to offset any public health benefit from reduced ENDS use arising from ENDS taxation. The critical issue is the interaction of demand for ENDS with demand for much more harmful cigarettes. This is not a new idea: the Royal College of Physicians (London) expressed this clearly in its 2016 report:[2]

> … if [a risk-averse, precautionary] approach also makes e-cigarettes less easily accessible, less palatable or acceptable, more expensive, less consumer-friendly or pharmacologically less effective, or inhibits innovation and development of new and improved products, then it causes harm by perpetuating smoking. Getting this balance right is difficult.

The discussion paper does not try to "get this balance right" or even recognise that a balance is necessary. The discussion paper does identify that ENDS and cigarettes are economic substitutes (at paragraph 3.6), but it does not draw the obvious conclusion: *increases in ENDS taxes will increase demand for cigarettes*. Applying taxes to ENDS without considering the effects on smoking could easily lead to a net increase in harm to public health by "perpetuating smoking" or stimulating black market activity. To serve policymakers, the discussion paper should provide an estimate of the likely impact of an ENDS tax on smoking and, therefore, its negative public health impact.

Evidence for the three characteristics listed above is described briefly in the following three sections of this response to the discussion paper and supported by a scientific discussion paper included at Appendix 1. We provide an example of an estimate of the range of impacts of an ENDS tax presented to the US Congress at Appendix 2.

Finally, we briefly consider policy implications in Section 4, calling for a risk-proportionate approach to taxation and use of ENDS to fight illicit trade in cigarettes. In practice this would mean a very low tax, or, given deadweight of tax administration, no tax on ENDS. ENDS should be used to drive down smoking, the dominant form of tobacco use in South Africa. Once the problem of smoking has been substantially addressed ENDS tax policy could be revisited – otherwise it will maintain the dominance of the cigarette, quite probably the illicit cigarette.

In 2018, we submitted commentary on South Africa's proposed regulation of ENDS.[3] [4] We have made other contributions on South Africa's tobacco policy.[5] [6] [7] Our views on tax policy should be seen in the context of wishing for the best public health outcomes for the people of South Africa.

1 ENDS are much less harmful than cigarettes

The discussion paper refers to the harms arising from *tobacco* or *nicotine* use at several points. But more precisely, *smoking* is the problem. Smoking accounts for 98 per cent of the global burden of tobacco-related mortality.[8 9] Inhalation of products of combustion – the toxic tar and gases created in the burning tip of a cigarette – is the primary cause of harm, not nicotine itself. As Professor Michael Russell famously explained in 1976:[10]

> But smokers cannot easily stop smoking because they are addicted to nicotine … People smoke for nicotine, but they die from the tar. Their risk of lung cancer and bronchitis might be more quickly and effectively reduced if attention were focused on how to reduce their tar intake, irrespective of nicotine intake.

In this statement, Russell lays the ground for *tobacco harm reduction*: reducing exposure to the toxic tar from cigarette smoke without quitting nicotine as well. This allows smokers an easier path to smoke-free status and therefore means more will be able and willing to take it. Forty-six years later, ENDS make this possible in a format that works for consumers through a compact, efficient device that operates below the temperature at which combustion can occur but delivers a satisfactory nicotine dose through an inhaled aerosol ("vapour").

There is no real doubt that ENDS are much less risky than cigarettes. Many of the toxicants in tobacco smoke are either not present at detectable levels or present at much lower levels than in cigarette smoke. The most convincing evidence comes from biomarker data (measurement of toxicants in the blood, saliva or urine of users and non-users). In 2018, independent experts for Public Health England reviewed the biomarker data and concluded:[11]

> Vaping poses only a small fraction of the risks of smoking, and switching completely from smoking to vaping conveys substantial health benefits over continued smoking. Based on current knowledge, stating that vaping is at least 95% less harmful than smoking remains a good way to communicate the large difference in relative risk unambiguously so that more smokers are encouraged to make the switch from smoking to vaping. It should be noted that this does not mean e-cigarettes are safe.

The United States National Academies of Science, Engineering and Medicine concluded:[12]

> Laboratory tests of e-cigarette ingredients, in vitro toxicological tests, and short-term human studies suggest that e-cigarettes are likely to be far less harmful than combustible tobacco cigarettes.

A more detailed discussion of the health impacts of e-cigarettes compared to cigarettes forms part of a recent paper by fifteen past presidents of the independent Society of Research on Nicotine and Tobacco (SRNT).[13] These authors, some of the world's leading authorities, summarise the safety case as follows:

> *Many scientists have concluded that vaping is likely substantially less dangerous than smoking because of the following:*
>
> - *The number of chemicals in cigarette smoke, greater than 7000, exceeds that of e-cigarette aerosol by 2 orders of magnitude.*

- *Among potentially toxic substances common to both products, cigarette smoke generally contains substantially larger quantities than e-cigarette aerosol. However, e-cigarette aerosol contains some substances not found in cigarette smoke.*
- *Biomarkers reflecting exposure to toxic substances are present at much higher levels in exclusive cigarette smokers than in exclusive vapers, and studies of smokers who switch to e-cigarettes find decreases in toxicant exposures.*
- *Tests of lung and vascular function indicate improvement in cigarette smokers who switch to e-cigarettes. Exclusive users of e-cigarettes (most being former smokers) report fewer respiratory symptoms than do cigarette smokers and dual users.*

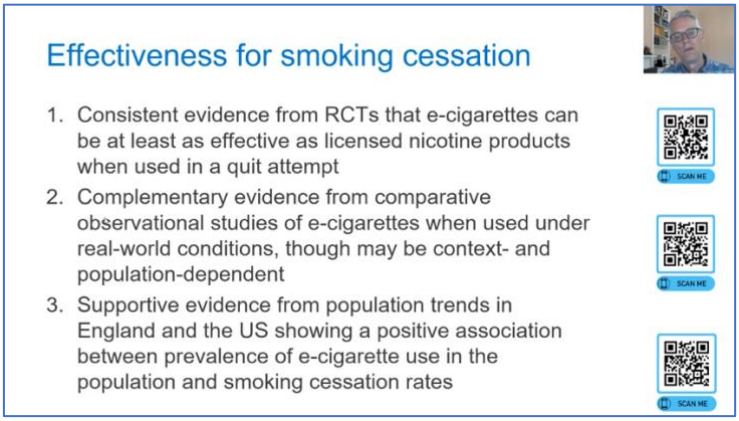
The SRNT past presidents' paper was published in the American Journal of Public Health and is appended as Appendix 1. Citations for the statements above can be accessed via the paper.

2 ENDS help smokers quit and displace smoking

2.1 Adult smoking cessation

There is considerable converging evidence from multiple sources, including randomised controlled trials, observational studies, population trends, and market data, that people use ENDS to quit smoking, cut down, transition to smoke-free status over time, or as a diversion from smoking in the first place.

The evidence for ENDS as a substitute for cigarettes and a driver of smoking cessation comes from multiple sources, each with its strengths and weaknesses, but taken together make a strong case – and *more* robust than the conventional smoking cessation treatments. The British smoking cessation expert, Professor Robert West, summarised the state of evidence in a 2019 presentation.[14] The slide from Professor West's presentation above summarises his view of the evidence, and a link to the whole presentation is provided in the endnote.



The following provides an overview of studies that support the evidence framework articulated in Professor West's presentation.

- *Randomised controlled trials.* Several recent trials show positive results.[15] [16] The most substantial clinical trial to date showed e-cigarettes with approximately twice the smoking cessation efficacy of NRT[17]. There is an accumulating evidence base: the Cochrane Review, which provides a world-renowned synthesis of clinical trial evidence, concluded in September 2021.[18]

> Nicotine e-cigarettes probably do help people to stop smoking for at least six months. They probably work better than nicotine replacement therapy and nicotine-free e-cigarettes. They may work better than no support, or behavioural support alone, and they may not be associated with serious unwanted effects

The Cochrane Review restricts its evidence reviews to clinical trial evidence. But a range of evidence from other sources strengthens the support for ENDS for smoking cessation.

- *Observational data*. There is evidence that smokers who use e-cigarettes are more likely to quit smoking than those who do not.[19] [20]
- *Population trends*. There is evidence that smoking cessation activity also increases as the prevalence of e-cigarette use increases in a population.[21] [22] [23] [24]
- *Modelling studies*. Modelling studies based on the experience show substantial public health potential even when parameterised with sceptical assumptions.[25] [26]
- *Testimonials*. Thousands of users provide compelling reports of quitting smoking with ENDS.[27]

The evidence also suggests that vaping encourages smoking cessation in smokers who were not otherwise interested in quitting smoking. These smokers become what is known as "accidental quitters".[28] The reason is that it does not require them to quit nicotine, the most important reason for smoking, but does allow them to eliminate the smoke inhalation that causes nearly all the harm.

2.2 Diversion of young people from smoking

Again, the evidence points to interactions between ENDS use and cigarettes among adolescents, with ENDS functioning *as a diversion* from smoking for adolescents.[29] [30] [31] This is consistent with observed US adolescent population trends, which have seen a sharp decline in smoking as ENDS use has risen.[32] [33] US and UK data show that the most intensive adolescent use of ENDS is among those most likely to smoke.[34] [35] [36] There is little evidence of dependence in ENDS users who are never-smokers, and these users generally use ENDS infrequently.[37] The US high school past-30-day vaping rate fell from 27.5% of in 2019[38] to just 11.3% in 2021.[39] This rapid change suggests there is a core of more intense users who would otherwise be smoking (and who likely benefit from vaping) and a broader group of experimental or frivolous 'party' users that warrant less public health concern.

2.3 Looking at all the evidence

Taken as a whole, the evidence makes a compelling case that smoke-free alternatives to cigarettes displace smoking. The Tobacco Treatment Network of the SRNT recently argued:[40]

> Strategies used for combustible product cessation may be adapted for novel products, and treatment recommendations for tobacco use disorder should be made within the context of a harm reduction framework wherein alternative product use may be the desired outcome.

A further discussion of the smoking cessation evidence is summarised in the letter from fifteen past presidents of SRNT,[13] which is also appended at Appendix 1. The authors conclude:

> Although not the final word, the totality of the evidence indicates that frequent vaping increases adult smoking cessation. Smokers unable to quit smoking with evidence-based cessation methods should be well informed about the relative risks of vaping and smoking and vaping's potential to help them quit smoking.

3 ENDS function as economic substitutes for cigarettes

3.1 Evidence of economic substitution between ENDS and cigarettes

It is not uncommon for two goods to function as economic substitutes if they represent different forms of similar consumption in competition: tea and coffee, beef and lamb, or rice and pasta. This means that the price of one good affects the demand for the other through a positive 'cross-elasticity'.[i] Evidence is emerging that ENDS use displaces smoking and promotes smoking cessation (see section 2 above). Further evidence for substitution comes from analyses of the effects of measures to control ENDS use. Evidence suggests e-liquid flavour bans,[41] e-cigarette advertising bans,[42] and access restrictions[43] may *increase* cigarette smoking.

However, the most direct and relevant evidence comes from studies of the demand response to ENDS taxes that have been imposed. In section 3.6, the discussion paper acknowledges the linkage between ENDS and cigarettes:

> WHO also argues that: "*ENDS/ENNDS and cigarettes are substitutes – higher cigarette prices are associated with increased ENDS/ENNDS sales*"[25]. A review of more recent literature[26-31] largely supports WHO's assertion.

However, the discussion paper does not draw the obvious corollary from this observation: *higher ENDS/ENNDS prices will increase cigarette sales*. The references cited in the discussion paper at 25-31 are included in this submission as endnotes.[44 45 46 47 48 49 50] However, these are not the most recent or most relevant sources. More recent sources are discussed below.

Abouk and colleagues (2021) studied the impact of ENDS taxes on youth tobacco use, concluding:[51]

> … we estimate sizable positive cigarette cross-tax elasticities, suggesting economic substitution between cigarettes and e-cigarettes for youth. These substitution effects are particularly large for frequent cigarette smoking. We conclude that the unintended effects of ENDS taxation may considerably undercut or even outweigh any public health gains.

The authors modelled a proposed US Federal e-liquid tax of $2.87 per fluid millilitre and estimated that it would cause a decrease in ENDS use but an *increase* in youth cigarette use of 2.3-3.7 percentage points depending on which tobacco use survey is used.

Pesko and Warman (2017) studied the effects of prices on youth transitions in the US National Youth Tobacco Use Survey from 2011 to 2015 and concluded:[49]

> We find that higher e-cigarette cartridge prices reduce e-cigarette use and increase current cigarette consumption, especially for males and for older teenagers. Our results suggest that on average e-cigarettes reduce youth smoking.

In an updated analysis of this data, Pesko and Warman (2021) conclude:[52]

> We find evidence that e-cigarettes and cigarettes are same-period economic substitutes. Coefficient estimates (while imprecisely estimated) also suggest potentially large positive

[i] The cross elasticity of demand measures the responsiveness of the demand for one good (A) in response to price changes of another (B). The cross elasticity is the change in demand for good A (%) divided by the change in price of good B (%). Substitute good have a positive cross-elasticity.

> effects of past e-cigarette prices on current cigarette use, indicating intertemporal economic substitution.

Pesko and colleagues (2020) examined adult tobacco use and price data and concluded:[53]

> Similarly, we find that higher e-cigarette tax rates increase traditional cigarette use and reduce e-cigarette use. Cross-tax effects imply that the products are economic substitutes. Our results suggest that a proposed national e-cigarette tax of $1.65 per millilitre of vaping liquid would raise the proportion of adults who smoke cigarettes daily by approximately one percentage point, translating to 2.5 million extra adult daily smokers compared to the counterfactual of not having the tax.

Cotti and colleagues (2020) examined US retail scanner data from 2011 to 2017 and concluded:[54]

> Our results suggest that e-cigarettes are elastic goods and their use substantially reduces cigarette sales. […] Policymakers should consider unintended costs when setting e-cigarette policy.

Abouk and colleagues (2019) used birth records in the United States from 2013 to 2018 to examine the effect of e-cigarette tax rates on pre-pregnancy smoking and prenatal smoking and concluded:[55]

> We show that e-cigarette taxes increase pre-pregnancy smoking, increase prenatal smoking, and lower smoking cessation during pregnancy. These findings imply that e-cigarettes and traditional cigarettes are substitutes among pregnant women.

Though this evidence does not use data from South Africa, a good starting place for analysis would be to assume the substitution interactions between ENDS and cigarettes would be similar unless there are more specific local data available. *There is no reason to assume no substitution effects*.

The fact that ENDS and cigarettes are economic substitutes should be a central consideration in ENDS tax policy because this is the mechanism by which ENDS taxation is likely to do more harm than good. In an excellent example of a synthesis of the literature for decision-makers, Associate Professor Michael Pesko of Georgia State University and colleagues wrote to members of the US Congress setting out evidence-based concerns about the likely perverse consequences of ENDS taxation – i.e., more smoking. The letter summarised the evidence by estimating the effect of the proposed Federal ENDS tax, which would approximately equate taxes on cigarettes and ENDS, as follows[56]

- *Simulating the current bill's e-cigarette tax on teen tobacco use indicates that this policy would reduce teen e-cigarette use by 2.7 percentage points, but that 2 in 3 teens who do not use e-cigarettes due to the tax would smoke cigarettes instead (study A). This would result in approximately a half-million extra teenage smokers overall. This finding that teens substitute to cigarettes in response to e-cigarette taxes has also been documented using National Youth Tobacco Survey data (study B).*
- *The tax would raise the number of daily adult cigarette smokers by 2.5 million nationally and reduce adult e-cigarette users by a similar number (study C).*
- *For every e-cigarette pod eliminated by an e-cigarette tax, more than 5.5 extra packs of cigarettes are sold instead (study D).*

- *For every three pregnant women that do not use e-cigarettes due to an e-cigarette tax, one smokes cigarettes instead (study E).*

Dr Pesko's letter is appended in full at Appendix 2. Ideally, the discussion paper on ENDS tax policy should contain an equivalent analysis making whatever assumptions are necessary to illustrate potential perverse consequences of an ENDS tax in South Africa alongside any benefits.

4 Consequences for policy

4.1 Risk proportionate taxation

The analysis in the discussion paper acknowledges the substitution interaction between ENDS and cigarettes (section 3.6). However, it does not incorporate this into the discussion of policy options in Section 7 of the paper. Yet, these effects give rise to the most significant health effect of an ENDS tax. Given that the proposed tax policy is predicated on protecting health, any analysis should include the negative health consequences of additional cigarette smoking induced by ENDS taxation.

Chaloupka, Sweanor, and Warner (2015) set out a reasonable approach in the New England Journal of Medicine:[57]

> We believe that implementing differential taxes on nicotine-yielding products on the basis of degree of risk could substantially expedite the move away from cigarette smoking that has occurred during the past half-century, especially now that there are nicotine-yielding products that pose dramatically less danger than combustible tobacco products

The challenge here is whether a tax level based on ENDS risk compared to be smoking risk would be so low that it would not justify the deadweight of tax administration costs. The approximate but efficient implementation of this risk-proportionate approach would set excise duties at zero and rely on general sales taxes or VAT. One approach would change the tax philosophy over time. ENDS taxes would be kept low or zero while they are the challenger technology to the incumbent cigarette trade. Then policymakers should consider raising ENDS taxes once cigarette use has been driven down to much lower levels through sustained substitution.

4.2 Illicit trade

The discussion paper does not discuss the interaction of tax policy with illicit trade, in which tax is largely or entirely avoided. The tax differential suggested by Chaloupka et al. makes sense only if cigarettes, in practice, command a high level of taxation. However, there are signs that a growing black market in cigarettes in South Africa is undermining this tax base and may create downward pressure on cigarette prices. This process intensified during the ban on tobacco sales during the COVID lockdown in 2020.[58] [59]

A further consideration, which is not discussed in the discussion paper, is the possible behavioural responses to a high level of taxation on ENDS. This could take the form of illicit manufacture and sale of ENDS in South Africa, cross-border trade by which foreign producers undermine law-abiding South African producers, an increase in DIY home mixing or formation of informal supply chains, and various possible workarounds. Criminal suppliers of illicit cigarettes may recognise an additional opportunity for illegal trade in ENDS and undermine the tax base for both cigarettes and ENDS. A better strategy would be to have relatively inexpensive but legal ENDS products compete with fully taxed and cheap illicit cigarettes *and* illicit ENDS.

About the authors

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Clive D. Bates MSc is Director of Counterfactual, a consulting and advocacy practise focussed on a pragmatic approach to sustainability and public health. He has had a diverse career in the public, private and not-for-profit sectors. After an early career in the private sector and environmental campaigning, he joined the tobacco control movement. From 1997-2003 he was Director of Action on Smoking and Health (UK), campaigning to reduce the harms caused by tobacco. From 2000, he was closely involved in the development of the Framework Convention on Tobacco Control as head of a leading non-profit tobacco control organisation. In 2003, he joined Prime Minister Blair's Strategy Unit and worked in senior roles in government and regulators, and for the United Nations in Sudan. He started Counterfactual in 2013. He lives in Nigeria.

Raymond S. Niaura PhD is Professor of Social and Behavioral Sciences and Epidemiology at the School of Global Public Health, New York University. From 2009-2017, he was Director of Research at the Schroeder Institute, Truth Initiative (formerly the American Legacy Foundation). He has extensive expertise in tobacco dependence and treatment, and he has published over 400 peer-reviewed articles and several book chapters in this area. His interests include studying the biobehavioral substrates of tobacco dependence; evaluating behavioral and pharmacological treatments for cessation; and understanding and addressing public health disparities in tobacco-related burdens of illness and disability. He has been Principal Investigator or co-Investigator of over 30 NIH-funded grants. He is a former President of the Society for Research on Nicotine and Tobacco. He also has a background in factors that influence adolescent/early adult tobacco use trajectories.

David T. Sweanor JD is Adjunct Professor of Law and Chair of the Advisory Board of the Centre for Health Law, Policy and Ethics at the University of Ottawa. He was the first lawyer in the world to work full time on policies to reduce cigarette smoking. He has worked on Canadian and global tobacco and health issues for over 40 years, helping set many global precedents, including in shaping tobacco tax policy, and drafting tobacco control legislation, in South Africa. He has worked on tobacco issues with the WHO, PAHO, World Bank and many other bodies, worked on successful litigation against cigarette companies, and spoken and published widely. He was recognised as Ottawa's outstanding individual philanthropist in 2016. In 1993, Derek Yach invited David Sweanor to visit South Africa as Trevor Manuel (then Minister of Finance) was considering increases in tobacco excise taxes. That visit had a galvanising impact on tobacco policy in South Africa.

Derek Yach MPH DSc has spent 4 decades addressing various aspects of tobacco control and other major global health issues. With Tim Stamps (then Minister of Health of Zimbabwe) he convened the first All African meeting on tobacco control in Harare in 1993. He led research and advocacy in South Africa through the 1980s and 1990s that underpinned the strong tobacco control elements of the Mandela government, including increases in excise taxes above inflation for a decade, and the leadership role South Africa played in the FCTC negotiations. Yach was the first South African to be asked to serve at WHO post the 1994 election and went on to lead the work on the WHO FCTC within the secretariat. From 2005, as the evidence of benefit increased, he started to advocate for urgent government support for tobacco harm reduction as a means of accelerating future deaths and disease from tobacco, and in 2017 founded the Foundation for a Smoke Free World to support science and advocacy for this purpose. He is now an independent consultant in global health.

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Appendix 1

Communication to the American Journal of Public Health by fifteen past presidents of the Society for Research on Nicotine and Tobacco (SRNT)

August 2021

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Balfour, D. J. K.et al. (2021). Balancing Consideration of the Risks and Benefits of E-Cigarettes. *American Journal of Public Health*, *111*(9), 1661–1672. 10.2105/AJPH.2021.306416

Balancing Consideration of the Risks and Benefits of E-Cigarettes

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The topic of e-cigarettes is controversial. Opponents focus on e-cigarettes' risks for young people, while supporters emphasize the potential for e-cigarettes to assist smokers in quitting smoking. Most US health organizations, media coverage, and policymakers have focused primarily on risks to youths. Because of their messaging, much of the public—including most smokers—now consider e-cigarette use as dangerous as or more dangerous than smoking. By contrast, the National Academies of Science, Engineering, and Medicine concluded that e-cigarette use is likely far less hazardous than smoking. Policies intended to reduce adolescent vaping may also reduce adult smokers' use of e-cigarettes in quit attempts.

Because evidence indicates that e-cigarette use can increase the odds of quitting smoking, many scientists, including this essay's authors, encourage the health community, media, and policymakers to more carefully weigh vaping's potential to reduce adult smoking-attributable mortality.

We review the health risks of e-cigarette use, the likelihood that vaping increases smoking cessation, concerns about youth vaping, and the need to balance valid concerns about risks to youths with the potential benefits of increasing adult smoking cessation. (*Am J Public Health*. Published online ahead of print August 19, 2021:e1–e12. https://doi.org/10.2105/AJPH.2021.306416)

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The use of nicotine-containing electronic- or e-cigarettes has divided the tobacco control community along a spectrum from fervent opponents to enthusiastic supporters. Opponents emphasize that vaping can cause nicotine addiction among young people and could lead some to become dependent cigarette smokers, possibly "renormalizing" smoking. They cite research indicating that nicotine may harm adolescents' developing brains. Some consider vaping's health risks substantial, and some question whether vaping decreases smoking cessation.[1] By contrast, proponents present evidence that vaping assists smokers in quitting smoking and believe that vaping poses far less risk to users' health than does smoking. Smoking among youths, they observe, has declined rapidly during vaping's ascendancy.[2]

Many US governmental health agencies[3–6] and nongovernmental medical[7,8] and health organizations[9–12] focus primarily on vaping's risks for young people. These organizations' pronouncements and their influence on policymakers and the media have had a profound impact on the public's understanding of vaping. A study of US news articles on e-cigarettes found that, from 2015 to 2018, 70% of articles mentioned vaping's risks for youths, while only 37.3% noted potential benefits for adult smokers.[13] Of respondents to a 2019 national survey, nearly half considered vaping nicotine just as harmful as or more harmful than cigarette smoking. Only 1 in 8 considered vaping less harmful. (The rest responded "I don't know."[14]) By contrast, the US National Academies of Sciences, Engineering, and Medicine[15] and the British Royal College of Physicians[16] have concluded that vaping is likely far less hazardous than smoking cigarettes.

The public's inaccurate perception worsened following a 2019 vaping-associated acute pulmonary disease outbreak (named "e-cigarette or vaping use-associated lung injury" [EVALI]) that caused 68 fatalities.[17] Media coverage was extensive. Several states and cities promptly banned retail and online sale of flavored e-cigarettes.[18] In early 2020, however, research attributed the illness to vitamin E acetate, an adulterant in illicit tetrahydrocannabinol (THC) vaping devices shown to produce pulmonary injury in animals.[19–21] A small percentage

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of patients with EVALI reported vaping only nicotine, but they were primarily in states where THC was illegal, and most had no toxicology testing.[22] Once the potential harm of vitamin E acetate was publicized and adulterated THC removed from the market, the incidence of new cases fell precipitously.[19] Yet, after the outbreak, two thirds of respondents to a poll related the lung disease deaths to use of "e-cigarettes such as JUUL." Only 28% related the deaths to use of "marijuana or THC e-cigarettes."[23]

Scientists differ in their views of the relative risks and benefits of vaping nicotine, and of their implications.[1,2,24,25] Many, including this article's authors, believe that vaping can benefit public health, given substantial evidence supporting the potential of vaping to reduce smoking's toll. Our objective is to encourage more balanced consideration of vaping within public health and in the media and policy circles.

In the following pages we address:

- the health risks of vaping,
- the likelihood that vaping increases smoking cessation,
- the principal concerns about youth vaping, and
- balancing concerns about risks to youths with potential benefits for adult smokers.

THE HEALTH RISKS OF VAPING

According to the National Academies of Sciences, Engineering, and Medicine, "Laboratory tests of e-cigarette ingredients, in vitro toxicological tests, and short-term human studies suggest that e-cigarettes are likely to be far less harmful than combustible tobacco cigarettes."[15(p1)] The British Royal College of Physicians similarly concluded that "vaping isn't completely risk-free but is far less harmful than smoking tobacco."[16]

High-quality clinical and epidemiological data on vaping's health effects are relatively sparse. There are no data on long-term health effects, reflecting the relative novelty of vaping and the rapid evolution of vaping products. Determining even short-term health effects in adults is difficult because most adult vapers are former or current smokers.

Some studies find that vaping may worsen asthma, bronchitis, and cough, including among nonsmoking young people.[26,27] By contrast, a few studies found that smokers with asthma or chronic obstructive lung disease see symptoms improve after switching to e-cigarettes.[28,29] Randomized switching trials (cigarettes to e-cigarettes) document improvements in respiratory symptoms.[30,31]

Laboratory studies have reported potentially adverse effects of e-cigarette aerosol in cells and animals.[26,32] It is difficult, however, to extrapolate from exposure conditions in cells and animals to humans.[26] Human experimental studies have focused on acute effects,[33] which may not predict future disease. For example, e-cigarettes acutely impair tests of endothelial function, a common feature of cardiovascular disease, but when smokers switch from cigarettes to e-cigarettes, endothelial function normalizes.[34,35] A recent study detected no difference in biomarkers of inflammatory and oxidative stress in exclusive e-cigarette users and nonusers of either cigarettes or e-cigarettes.[36]

There is little evidence that e-cigarettes pose significant cancer risk.[15] However, some studies raise concerns that warrant long-term follow-up of vapers.[37,38]

Many scientists have concluded that vaping is likely substantially less dangerous than smoking because of the following[15,16]:

- The number of chemicals in cigarette smoke, greater than 7000,[39] exceeds that of e-cigarette aerosol by 2 orders of magnitude.[40,41]
- Among potentially toxic substances common to both products, cigarette smoke generally contains substantially larger quantities than e-cigarette aerosol.[42–44] However, e-cigarette aerosol contains some substances not found in cigarette smoke.[45]
- Biomarkers reflecting exposure to toxic substances are present at much higher levels in exclusive cigarette smokers than in exclusive vapers, and studies of smokers who switch to e-cigarettes find decreases in toxicant exposures.[31,46–50]
- Tests of lung and vascular function indicate improvement in cigarette smokers who switch to e-cigarettes.[28,29,34] Exclusive users of e-cigarettes (most being former smokers) report fewer respiratory symptoms than do cigarette smokers and dual users.[51]

However, questions remain.[52] Ongoing research will lend further insight into the products' absolute and relative dangers.

THE LIKELIHOOD THAT VAPING INCREASES SMOKING CESSATION

A growing body of evidence indicates that vaping can foster smoking cessation, although the evidence is not definitive.[53,54]

Randomized Trials

In an English smoking cessation randomized controlled trial,[55] smokers assigned to e-cigarettes achieved nearly twice the rate of biochemically confirmed smoking cessation at 1 year (18%) than smokers assigned to nicotine replacement therapy (9.9%); all received identical behavioral counseling. While 80% of those who quit with e-cigarettes were still vaping, they were no longer exposed to smoking's substantially higher risk.

A New Zealand trial found that at 6 months, nicotine patch with nicotine e-cigarettes outperformed patch with nicotine-free e-cigarettes and patch alone. Thus, in addition to aiding quitting when used alone, nicotine e-cigarettes may increase the effectiveness of existing cessation aids.[56]

Examining 26 randomized controlled trials, a recent Cochrane Review concluded that "There is moderate-certainty evidence that ECs [electronic cigarettes] with nicotine increase quit rates compared to ECs without nicotine and compared to nicotine replacement therapy."[53] Another meta-analysis drew similar conclusions, albeit with less certainty.[57] However, the US Preventive Services Task Force's smoking cessation practice guideline did not find the evidence convincing.[58] As such, and for reasons the Cochrane Review describes, more well-designed clinical trials are needed.

Noteworthy is the lack of trials by e-cigarette manufacturers in pursuit of regulatory agency approval to use e-cigarettes for smoking cessation, likely reflecting the profitability of selling e-cigarettes as consumer products, rather than medicinal devices.

Population Studies

Collectively, population studies' findings are consistent with a near doubling of quit attempt success, found in the randomized controlled trials, and the fact that e-cigarettes are smokers' most used aid in quit attempts.[59] Four studies[60–63] found significant increases in smoking cessation (10%–15%) that the authors associated with vaping. A Centers for Disease Control and Prevention study reported that, in 2018, 15.1% of smokers had quit smoking for 6 months or longer using e-cigarettes, compared with 3.3% using other noncigarette tobacco products and 6.6% using no tobacco products.[64] Another study identified a near doubling of self-reported cessation among users of e-cigarettes or varenicline compared with smokers not using these products.[65] Consistent with these population studies, simulation analyses have generally found that vaping increases smoking cessation, avoiding large numbers of premature deaths.[66–69]

Other researchers have found regular and frequent e-cigarette use to be associated with increased smoking cessation, while infrequent use was not.[70–75] This could reflect self-selection, with frequent vapers possibly liking vaping more and being more motivated to quit smoking. Infrequent vapers might use vaping as a temporary nicotine source where smoking is prohibited.[73,76]

Other researchers have reported reduced cessation rates among smokers who vape.[77,78] However, many failed to distinguish frequency of vaping, introducing the risk of the selection biases just noted. Other studies included only current vapers who also smoke, systematically excluding vapers who had successfully quit smoking.[53,78]

An often-cited meta-analysis found vapers' odds of quitting smoking 28% lower than for nonvaping smokers.[77] This analysis combined clinical trials, cohort studies, and cross-sectional analyses, an inappropriate practice for meta-analyses.[79] Furthermore, the individual studies' sources of bias could be compounded in a meta-analysis, possibly producing an incorrect result.[76]

Cigarette Sales

For years, US cigarette sales declined 2% to 3% annually. More recently, as vaping product sales increased, cigarette sales decreased much more rapidly. Conversely, following the EVALI outbreak and e-cigarette sales restrictions, sales of e-cigarettes fell and sales of cigarettes resumed their prevaping pattern.[80] Studies finding a positive cross-price elasticity of demand between cigarettes and e-cigarettes support the conclusion that the products are substitutes.[81,82]

Support for the plausibility of an inverse causal relationship between vaping and smoking comes from countries in which startling decreases in cigarette sales have accompanied rising sales of another novel nicotine product, heated tobacco products (HTPs). Like e-cigarettes, HTPs expose users to lower levels of toxicants than do cigarettes.[83] In Japan, HTP adoption from 2015 to 2019 was accompanied by cigarette sales declining by a third.[84] In both cases—HTPs in Japan and e-cigarettes in the United States—as sales of reduced-risk products rose, cigarette sales fell.

Unintended Consequences of Policies Restricting Vaping

Studies have found that policies intended to restrict e-cigarette use may

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have unintentionally increased cigarette smoking. One study associated a Minnesota e-cigarette tax with increased adult smoking and reduced cessation, estimating that taxing e-cigarettes at the same rate as cigarettes nationwide could deter 2.75 million smokers from quitting smoking over a decade.[85] Two other studies found state restrictions on minors' access to e-cigarettes associated with higher adolescent cigarette smoking.[86,87]

Implications

Although not the final word, the totality of the evidence indicates that frequent vaping increases adult smoking cessation. Smokers unable to quit smoking with evidence-based cessation methods[88] should be well informed about the relative risks of vaping and smoking and vaping's potential to help them quit smoking. They should understand that, while the long-term health consequences are unknown, completely substituting vaping for smoking likely reduces health risks, possibly substantially.[15] Dual use of cigarettes and e-cigarettes will not have a comparable beneficial effect.[88] However, a period of dual use may be necessary for some smokers to transition from smoking. Because vaping itself poses some risk, the best advice is to eventually stop vaping as well.

THE PRINCIPAL CONCERNS ABOUT YOUTH VAPING

The principal objections to vaping regard 3 potential effects on youths:

- Vaping can cause nicotine addiction among young people who never would have tried smoking.
- Vaping by never-smoking youths may cause some to try smoking, risking "renormalizing" smoking among young people.
- Nicotine can harm developing brains, and vaping nicotine may have other adverse health effects.

Vaping as a Cause of Nicotine Addiction

Vaping likely addicts some young people to nicotine. However, the evidence does not suggest it is addicting very large numbers.[89] Jarvis et al. concluded that "Data . . . do not provide support for claims of a new epidemic of nicotine addiction stemming from use of e-cigarettes."[90] Jackson et al. recently reported that the e-cigarette–driven increase in nicotine product use among high-school students is not associated with an increase in population-level dependence.[89] Among tobacco-naïve youths, in addition to low vaping prevalence (9.1% in the past 30 days in 2020) and frequency (2.3% vaping ≥ 20 days in the past 30 days),[91] small percentages exhibited signs of nicotine dependence.[90]

Frequent use is much more common among current or former smoking youths than among never-smokers.[90] Many former smokers were already addicted to nicotine before initiating vaping. With high-school students' smoking declining at an increasing rate since youths began using e-cigarettes,[92,93] some may vape to reduce or quit smoking.

Nonetheless, to the extent that vaping creates nicotine addiction among otherwise tobacco-naïve youths, concerted efforts are needed to reduce youth vaping. The new minimum age of 21 years for purchasing tobacco products should help.[94] Governmental agencies[3,95] and voluntary organizations[12,96] disseminate vaping's risks to youths through Web sites, social media, and television campaigns. Voluntary organizations lobby Congress and state governments to adopt policies restricting youth access to e-cigarettes.

Recent policy attention has focused on restricting the availability of e-cigarettes with flavors,[97] a principal attraction for youths.[98–101] While flavor bans could reduce youth interest in e-cigarettes, they could also reduce adult smokers' vaping to quit smoking.[102–104] Like youths, adults prefer nontobacco flavors,[105] both groups favoring fruit and sweet flavors.[106,107]

Policies regarding flavors reflect the more general issue considered in this article: the need to create a balance between the sometimes-conflicting goals of preventing youth vaping and supporting adults' smoking cessation attempts, particularly for smokers unable or unwilling to quit otherwise.[108]

Vaping Causing Smoking Initiation

Prospective studies have found that young people who had vaped but never smoked cigarettes were more likely to have tried cigarettes several months to 2 years later than contemporaries who had neither smoked nor vaped.[15,109–113] Some commentators thus consider vaping a "gateway" into smoking.[114,115]

Other observers believe the relationship reflects a "common liability"[116]: young people who vape are generally more prone to risky behavior[117]; hence, they might be more likely to try smoking even without vaping.[118–121] Three recent studies have concluded that vaping likely diverts more young people from smoking than encourages them to

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smoke.[122–124] Conversely, some prospective studies have found the vaping–smoking relationship strongest in youths at low risk of smoking.[125–127]

Obvious plausible correlates are often not considered, however.[128] Importantly, few studies include youths' use of other psychoactive substances, including marijuana and alcohol. In 1 study, inclusion of marijuana and 3 other variables eliminated the otherwise statistically significant link between vaping and subsequent smoking.[126,127] Most studies do not even consider previous use of tobacco products other than cigarettes. Adjustment for confounders substantially reduces the relationship between vaping and subsequently trying cigarettes.[129]

Numbers of cigarettes smoked at follow-up are frequently very low, only 1 or 2 in the past 12 months in one study.[130] Furthermore, the prospective studies generally have not examined progression to regular dependent smoking, with 1 recent exception.[131] Only a small proportion of youths who experiment with smoking become regular smokers. Kim and Selya found that while e-cigarette use was associated with ever trying smoking, it was not associated with current continued smoking.[119] Pierce et al. recently concluded the opposite.[131] Shahab et al. reported that less than 1% of US students who initiated nicotine or tobacco use with e-cigarettes were established cigarette smokers.[132]

If vaping causes some young people to try cigarettes, the aggregate impact must be small. A recent study[68] estimated that if vaping increases nonsmoking youths' odds of trying cigarettes by 3.5 (as reported by Soneji et al.[109]), smoking initiation among young adults would increase less than 1 percentage point. Furthermore, US survey data demonstrate that smoking among young people has declined at its fastest rate ever during vaping's ascendancy.[92,93,133] If vaping increases smoking initiation, other unknown factors more than compensate.

Nicotine Harming Developing Brains

Animal model studies have found that nicotine can affect maturation of brain parts associated with executive function and decision-making, potentially leading to more impulsive behavior, cognitive deficits, and greater likelihood to self-administer other drugs.[134,135] In addition, there is evidence in humans of neurological changes attributed to nicotine in the brains of adolescent smokers, interpreted by some as reflecting similar harmful effects to those in the animal models.[136,137]

These studies lead some researchers to suspect that adolescent nicotine use in any form may lead to long-term structural and functional brain changes with associated negative implications for cognition or impulse control.[138] However, given species differences and questions about the relevance of experimental animal nicotine dosing paradigms to human use patterns, the validity of extrapolation to humans is speculative. Whether impaired brain development with behavioral consequences occurs in young nicotine consumers is difficult to determine because of potential confounding of genetic and socioeconomic factors, the influence of other substance abuse, and the role of preexisting neuropsychiatric problems associated with youth smoking. Research has yet to isolate nicotine use in the adolescent years and then examine later sequelae. Still, concerns about brain function effects of nicotine exposure through vaping deserve serious examination.[98]

Concerns About Youth Vaping in Context

Several considerations raise the question of whether, for youth as a whole, vaping creates dangerous levels of nicotine exposure that would not have occurred in the absence of vaping.

- The large majority of nontobacco product–using young people do not vape and, thus, have no nicotine exposure.[90]
- Among those who vape, most do so infrequently; many are short-term experimenters.[90]
- Frequent vaping is most common among current or former smokers, individuals already exposed to nicotine.[91]
- The most dangerous form of youth exposure to nicotine, cigarette smoking, has declined at an unprecedented rate during the era of youth vaping.[92,93,133] Use of other tobacco products has declined as well.[139]

Still, concerns emanating from substantial increases in youth vaping in 2018 and 2019 are readily understandable and important to address. A sizable decline in 2020 is encouraging.[139] We must continue monitoring youth vaping, learning more about potential harms and identifying effective prevention strategies. However, as public health groups, the media, policymakers, and the general public focus on youth vaping, vaping's potential to help adults quit smoking too often gets lost. That may come at a significant public health cost. Fourteen percent of US adults smoke; smoking annually causes nearly half a

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million deaths. Anything that can reduce that toll deserves serious attention.

With the focus on youths creating an environment in which smokers believe that vaping is as dangerous as or more dangerous than smoking,[14] many smokers struggling to quit may be unwilling to try vaping as an alternative. This likely translates into less smoking cessation than if smokers correctly understood the relative risks of vaping and smoking.

BALANCING CONCERNS ABOUT RISKS AND POTENTIAL BENEFITS

Research comparing vaping's risks for youths with potential benefits for adult smokers has found the latter to dominate,[66] potentially avoiding the smoking-produced loss of tens of millions of life-years.[67,68] Vaping cannot end cigarette smoking. But vaping can complement tried-and-true methods of reducing smoking, including taxes on combustible tobacco products, smoke-free workplace laws, marketing restrictions, plain packaging with graphic warning labels, antismoking media campaigns, tobacco-21 laws,[94] and evidence-based smoking cessation treatment.[88]

We believe the potential lifesaving benefits of e-cigarettes for adult smokers deserve attention equal to the risks to youths.[140] Millions of middle-aged and older smokers are at high risk of near-future disease and death. Quitting reduces risk.[88] Young people will not experience smoking-related (and conceivably vaping-related) chronic diseases for 3 decades, and likely not at all if they quit within a decade or 2. Social pressures to quit smoking will probably remain strong, and quitting aids may improve. Furthermore, as noted previously, the rate of smoking among young people has declined while vaping has increased.[92,93,133] Vaping may addict some youths to nicotine, but many fewer than popularly believed.[89,90]

Seeking a Sensible Mix of Policies

To date, the singular focus of US policies on decreasing youth vaping may well have reduced vaping's potential contribution to reducing adult smoking. Those policies include taxing e-cigarettes at rates comparable to cigarette taxes,[141] decreasing adult access to flavored e-cigarettes that may facilitate smoking cessation,[103] and convincing the public—including smokers—that vaping is as dangerous as smoking.[14]

The public health objective should be to develop policies and interventions that both reduce youth vaping and increase adult smoking cessation.[97,120,140,142] While an in-depth discussion of an optimal policy mix exceeds the scope of this article, we here present illustrative policies that would serve this objective. These are all in addition to conventional evidence-based prevention and cessation measures.

- Tax cigarettes and other combustible tobacco products heavily; impose a more modest tax on e-cigarettes. Taxes should be proportionate to risk. A much higher tax on combustibles will encourage adult smokers to quit smoking or to switch to less expensive e-cigarettes. By raising the price of e-cigarettes, a modest tax will discourage their use by price-sensitive youths.[141]
- Because both youth and adult smokers find e-cigarette flavors attractive,[98–107] banning all (or most) flavors risks reducing smokers' use of e-cigarettes to quit smoking[102–104] at the same time that it reduces youth vaping.[99,101] An alternative would be to limit the retail sale of flavored e-cigarettes to adult-only outlets such as vape shops. An imperfect policy for either goal, this approach could benefit both.
- Government agencies and health organizations should develop nuanced, targeted communications that emphasize the realistic concerns about youth vaping and, separately, the potential benefits of e-cigarettes as less-risky (but not risk-free) alternatives for adult smokers otherwise unable or unwilling to quit smoking.
- The US Food and Drug Administration (FDA) should strictly regulate e-cigarette advertising and marketing, prohibiting all marketing directed at, or attractive to, youths and young adults, including all "lifestyle" advertising. They should limit advertising to a "switch" theme directed clearly, and exclusively, to adult smokers otherwise unable to quit smoking.
- FDA should implement its thoughtful comprehensive 2017 plan,[143] mandating reduction of nicotine in cigarettes to levels incapable of sustaining addiction, while ensuring the availability of consumer-acceptable reduced-risk nicotine products. To achieve the latter, the agency should develop product standards for products like e-cigarettes, ensuring minimization of risk associated with the product class while maintaining consumer acceptability.

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The Role of Nicotine in Tobacco-Produced Disease

FDA predicated its comprehensive plan on recognition of the continuum of risk in nicotine products.[143] Nicotine is the chemical in tobacco that fosters addiction. However, toxic constituents other than nicotine, predominantly in smoked tobacco, produce the disease resulting from chronic tobacco use.[143,144] Nicotine-yielding products vary in risk from FDA-approved nicotine replacement therapy products at the lowest end of the risk continuum to combustible cigarettes at the highest.

Unfortunately, the public has a distorted view of the dangers associated with nicotine per se. In a recent survey, 57% of respondents incorrectly agreed that "nicotine in cigarettes is the substance that causes most of the cancer caused by smoking." Only 18.9% disagreed. (The rest answered "Don't know.")[14] In a recent survey of physicians, 80% strongly, but incorrectly, agreed that nicotine causes cancer, cardiovascular disease, and chronic obstructive pulmonary disease.[145]

CONCLUSIONS

We share the very legitimate concerns about youth vaping with the entire field of public health. Our goal is to put those concerns in perspective. We agree with former Surgeon General C. Everett Koop who, in 1998, urged that "[A]s we take every action to save our children from the ravages of tobacco, we should demonstrate that our commitment to those who are already addicted . . . will never expire."[146] The latter appears at risk today.

While evidence suggests that vaping is currently increasing smoking cessation, the impact could be much larger if the public health community paid serious attention to vaping's potential to help adult smokers, smokers received accurate information about the relative risks of vaping and smoking, and policies were designed with the potential effects on smokers in mind. That is not happening.

The need to pay attention to adult smokers is particularly important from a social justice perspective. African Americans suffer disproportionately from smoking-related deaths, a disparity that, a new clinical trial shows, vaping could reduce.[31] Today's smokers come disproportionately from lower education and income groups, the LGBTQ (lesbian, gay, bisexual, transgender, and queer or questioning) community,[147] and populations suffering from mental health conditions[148] and from other drug addictions.[149] Smoking accounts for a significant proportion of the large life expectancy difference between affluent and poorer Americans.[150,151] For smokers with serious psychological distress, two thirds of their 15-year loss of life expectancy compared with nonsmokers without serious psychological distress may be attributable to their smoking.[152] Vaping might assist more of these smokers to quit.[148,153]

To the more privileged members of society, today's smokers may be nearly invisible. Indeed, many affluent, educated US persons may believe the problem of smoking has been largely "solved." They do not smoke. Their friends and colleagues do not smoke. There is no smoking in their workplaces, nor in the restaurants and bars they frequent. Yet 1 of every 7 US adults remains a smoker today.

Smoking will claim the lives of 480 000 of our fellow citizens this year alone. AJPH

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K. E. Warner wrote much of the original draft of the article and supervised revisions. N. L. Benowitz, S. M. Colby, D. K. Hatsukami, R. Niaura, N. A. Rigotti, and R. West drafted specific sections of the article or played lead roles in reviewing and revising article drafts. All authors reviewed all drafts critically,

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The authors are former presidents of the Society for Research on Nicotine and Tobacco (SRNT), the world's leading professional organization dedicated to the subject. They are listed in alphabetical order. All 26 of the then–past presidents were invited to participate as co-authors of this article. (A 27th past president was the active president at the time of preparation of the article.) We were unable to reach one of them. Three were not included because of institutional commitments that they felt might be interpreted as conflicts of interest. The remaining 7 declined to co-author.

Note. The opinions expressed in this article are solely those of the authors. They do not represent those of SRNT, which has taken no organizational position on the issues discussed in this article and had no involvement in the preparation of this article.

CONFLICTS OF INTEREST

N. L. Benowitz is a consultant to Pfizer and Achieve Life Sciences, companies that market or are developing smoking cessation medications, and has been an expert witness in litigation against tobacco companies. S. J. Leischow is conducting a clinical trial supported by Achieve Life Sciences, which is developing a nonnicotine medication for smoking cessation, and has consulted with them. He also consulted more than 1 year ago for GSK, which is working to bring a new nicotine-replacement product to market, and he receives medication for a National Institutes of Health–funded smoking-cessation study from Pfizer. N. A. Rigotti receives royalties from UpToDate Inc for writing about smoking cessation and e-cigarettes and is a consultant for Achieve Life Sciences for an investigational smoking-cessation medication. R. West has undertaken research and consultancy for Pfizer and GSK, companies that manufacture smoking-cessation medications.

HUMAN PARTICIPANT PROTECTION

There were no human participants involved.

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Appendix 2
Letter to US Congress from health economists concerning proposed taxes on e-cigarettes

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Georgia State University | ANDREW YOUNG SCHOOL OF POLICY STUDIES

November 8, 2021

Dear Members of Congress:

My name is Michael Pesko and I am an Associate Professor in the Department of Economics at Georgia State University (website). I have a $1.4 million dollar grant from the National Institutes of Health to conduct e-cigarette policy evaluation research, including evaluation of e-cigarette taxes. I do ***not*** receive funding from the tobacco industry, or related groups.

I write to share what I have learned about e-cigarette taxes from my NIH-funded research. These scientific opinions are co-signed by other highly-regarded health economists that I have co-authored this research with.

The version of the Build Back Better (BBB) Act released on Nov. 3 (link, see section 138520) and currently under consideration by the House of Representatives would raise e-cigarette taxes to a level comparable to cigarette taxes, and exceeding cigarette taxes for some e-cigarette products. The Act does not change the cigarette tax rate.

My NIH-funded research spanning ten peer-reviewed published papers evaluating e-cigarette policies, and complementary work from other researchers, shows that across an array of analytic approaches, e-cigarettes and other nicotine vaping products function as what economists call 'substitutes' for conventional cigarettes. In practical terms, if e-cigarettes and cigarettes are substitutes, then raising the price of one on average leads people to increase use of the other. Given extensive peer-reviewed evidence indicating that these products are substitutes, an unintended but inevitable effect of increasing taxes on e-cigarettes is to increase cigarette use. Given that cigarettes are believed to be substantially more harmful than e-cigarettes, this effect on cigarette use is concerning.

Our economic evaluations of existing state and county e-cigarettes taxes find that increasing e-cigarette taxes to parity with the cigarette tax rate will sizably increase cigarette use across teens, adults, and pregnant women, compared to taxing tobacco products differentially in proportion to their health risk. Across various papers, we find several concerning consequences of large e-cigarette tax increases:

- Simulating the current bill's e-cigarette tax on teen tobacco use indicates that this policy would reduce teen e-cigarette use by 2.7 percentage points, but that 2 in 3 teens who do not use e-cigarettes due to the tax would smoke cigarettes instead (study A). This would result in approximately a half million extra teenage smokers overall. This finding that teens substitute to cigarettes in response to e-cigarette taxes has also been documented using National Youth Tobacco Survey data (study B).
- The tax would raise the number of daily adult cigarette smokers by 2.5 million nationally and reduce adult e-cigarette users by a similar number (study C).
- For every e-cigarette pod eliminated by an e-cigarette tax, more than 5.5 extra packs of cigarettes are sold instead (study D).

- For every three pregnant women that do not use e-cigarettes due to an e-cigarette tax, one smokes cigarettes instead (study E).

A wide array of research suggests that this boost in cigarette use as a result of large e-cigarette tax increases would significantly increase overall tobacco-related death and disease.

E-cigarettes have now been available in the U.S. marketplace for over a decade, and much is known about their danger relative to cigarettes. A National Academies of Sciences, Engineering, and Medicine report says that e-cigarettes are not without risk, but they are likely to be far less harmful than cigarettes. Despite a common misconception to the contrary, nicotine alone (such as in nicotine gum and e-cigarettes) is not carcinogenic. While high nicotine exposures have been found to harm the developing brain of rodents, this has not been documented in human brains, nor has the harmful effect been compared to other substances such as caffeine, alcohol, or Tetrahydrocannabinol (THC). A recent Cochrane systematic review—such reviews are regarded as among the best in the world— finds that e-cigarettes are more effective than nicotine replacement therapy in helping adults to quit smoking.

Despite their potential for harm reduction, e-cigarettes have been met with significant skepticism. In part this skepticism is driven by the substantial and worrying increase in underage e-cigarette use. Fortunately, concerns that e-cigarettes may act as a `gateway' to cigarettes have not materialized: youth cigarette use is at historic lows. In 2009, 19.5% of youth used cigarettes and a Healthy People 2020 goal of a 16.0% youth cigarette use rate was announced by government scientists and public health officials. By 2019, youth cigarette use was at 6%, surpassing the 2020 goal by 386%, likely in large part due to e-cigarettes.

While not the topic of our research in particular, smokeless tobacco products are also substantially safer than combustible tobacco products. Given this risk differential, we suggest that smokeless tobacco products should similarly be taxed at lower rates than more lethal combustible products, to incentivize switching to safer forms of tobacco. The current version of the BBB imposes a high tax on smokeless nicotine pouch products that is opposite of this goal.

Policymakers are understandably worried about youth e-cigarette use. Yet over-regulating e-cigarettes could cause substantial harm. One option for Congress to consider that could reduce youth e-cigarette use (and other tobacco product use), without discouraging use of a potential life-saving product for adult smokers, is improving underage undercover buyer inspection programs of retailers. Retailers are a major source of e-cigarettes for minors today. I have found in prior work that the Food and Drug Administration's (FDA) current underage undercover buyer inspection program is inadequate. In particular, youth decoys are prohibited from mis-stating their age and using false identification – two tactics commonly used by actual underage youth attempting to buy tobacco products. Hence, targeted retailers can easily evade FDA underage inspectors. If Congress improved the youth inspection program by requiring use of these methods, it could significantly reduce youth access to all tobacco products (including e-cigarettes), hence yielding significant public health benefit.

Scientific evidence supports e-cigarettes providing immediate benefits as a harm reduction product. Overall, my scientific opinion is that raising taxes on e-cigarettes and smokeless tobacco products to levels equivalent to cigarettes will increase cigarette use across all populations and cause significant public health harm.

Please let me know if you have any questions.

Sincerely,

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