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Original investigation

E-cigarettes: Comparing the Possible Risks of Increasing Smoking Initiation with the Potential Benefits of Increasing Smoking Cessation

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Abstract

Introduction: The public health community is divided regarding electronic cigarettes. Skeptics emphasize potential vaping-induced increases in smoking among children and possible health hazards for adults. Enthusiasts consider e-cigarettes much less dangerous than smoking and believe they increase adult smoking cessation. We compare potential health benefits and costs to put these two perspectives in context.

Methods: Using a dynamic model that tracks the US adult population's smoking status and smoking-related deaths over time, we simulate the effects of vaping-induced smoking initiation and cessation on life-years saved or lost to the year 2070. The base case assumes that vaping annually increases smoking initiation by 2% and smoking cessation by 10%. Sensitivity analyses raise the initiation rate increase to 6% while decreasing the cessation rate increase to 5%. Sensitivity analyses also test vaping's reducing the health benefits of quitting smoking by 10%.

Results: With base-case assumptions, the population gains almost 3.3 million life-years by 2070. If all people who quit smoking by vaping lose 10% of the benefit of quitting smoking, the net life-year gain falls to 2.4 million. Under worst-case assumptions, in which vaping increases smoking initiation by 6% and cessation by 5%, and vaping-induced quitters lose 10% of the health benefits, the population gains over 580 000 life-years.

Conclusion: Potential life-years gained as a result of vaping-induced smoking cessation are projected to exceed potential life-years lost due to vaping-induced smoking initiation. These results hold over a wide range of plausible parameters.

Implications: Our analysis strongly suggests that the upside health benefit associated with e-cigarettes, in terms of their potential to increase adult smoking cessation, exceeds their downside risk to health as a result of their possibly increasing the number of youthful smoking initiators. Public messaging and policy should continue to strive to reduce young people's exposure to all nicotine and tobacco products. But, they should not do so at the expense of limiting such products' potential to help adult smokers to quit.

Introduction

The notion that novel alternative nicotine delivery systems (ANDS) might one day provide otherwise confirmed cigarette smokers with a less hazardous alternative has been discussed for two decades.[1,2] However, with the exception of the experience with snus in Sweden,[3,4] the idea was more theoretical than practical. The emergence of electronic cigarettes (e-cigarettes) has brought the idea to life.

Enthusiasm about the potential of e-cigarettes and future generations of ANDS to greatly reduce the toll of combusted tobacco products[5] has been met by an equally passionate wariness.[6]

Governmental[7,8] and non-governmental health organizations[9] fear that the popularity of e-cigarettes among young people might "renormalize" smoking. They worry that e-cigarettes might induce otherwise never-smoking adolescents to begin smoking[10] and subject young people's developing brains to risks posed by exposure to nicotine.[8] The two polar opposite positions—that e-cigarettes might benefit or damage public health—have ignited an intense, occasionally emotional debate between e-cigarette enthusiasts and skeptics.

In the United States in 2015, 3.5% of American adults vaped every day or some days.[11] Among them, 58.8% were current cigarette smokers, 29.8% former smokers, and 11.4% never smokers. Never-smoker use of e-cigarettes varied greatly by age, comprising 40% of the youngest adults (ages 18–24) but only 1.3% of adults ≥45 years. In the United Kingdom, an estimated 6% of adults used e-cigarettes in 2017. That year, for the first time, the majority (52%) were former smokers. Although there are many reasons for vaping, it is noteworthy that e-cigarettes are now the most commonly used aid in smoking cessation attempts in the United States.[12] In Great Britain, more than a third of former smokers said that, though they no longer vaped, they used e-cigarettes in their quit attempt.[13] The role of e-cigarettes in smoking cessation is controversial, although the bulk of the evidence, noted below, indicates that vaping likely increases smoking cessation.[14–22]

The most concerning aspect of vaping has been its uptake by youth. In the United States in 2016, 11.3% of high school students and 4.3% of middle school students reported using e-cigarettes in the past 30 days. Prevalence of e-cigarette use rose rapidly from 2011 to 2014 and then dropped by 29% in 2016.[23] Most youth use of e-cigarettes is infrequent, with frequent use concentrated among current smokers.[24,25]

The vast majority of scientists agree that vaping per se is significantly less hazardous than cigarette smoking.[22,26–28] How much remains a subject of debate, however. Leading health organizations in England have concluded that vaping is no more than 5% as dangerous as smoking.[29,30] At the other extreme, opponents of e-cigarettes suggest the figure could be closer to a third to a half.[6] The specifics of the risks associated with vaping and the extent of the overall risk relative to smoking are critically important areas for further study.

Although research on e-cigarette issues has proliferated,[22,26,27] determination of vaping's ultimate impacts will take decades, if indeed those impacts will ever be clearly discerned from the multiplicity of patterns of conventional and novel nicotine and tobacco product use. Focusing on specific issues, while controlling for the vagaries of "the real world," simulation models offer potential to develop near-term insights regarding important likely effects, while helping to identify the most important questions warranting further study.

Several published models do just that,[31–41] most finding net benefits from the use of e-cigarettes. For example, using agent-based modeling, Cherng et al.[34] concluded that the potential benefits of e-cigarettes, in terms of reducing smoking, dramatically outweigh potential increases in smoking initiation. Levy et al.[35] also found strong support for the notion that e-cigarettes can benefit public health in their analysis of the effects of e-cigarettes on a cohort born in 1997. In another paper, Levy and colleagues[40] estimated that if vaping largely replaced smoking within a decade, the smoking-related loss of 20.8–86.7 million life-years would be avoided by the year 2100. In contrast, varying the possible risk of e-cigarettes up to half that of smoking, Kalkhoran and Glantz[31] identified the need for caution about the spread of e-cigarettes. Soneji and colleagues[41] recently concluded that e-cigarettes are more likely to create public health harm than benefit. Vugrin et al.[33] demonstrated that variations in assumptions about the risks of a generic novel product and rates of initiation, switching, and dual use could shift findings from reductions in deaths over time to increases. Variations that produced increases included extreme assumptions, however, such as the product being 50% as risky as cigarettes, with 50% of never smokers initiating use of the new product. A recent National Academies of Sciences, Engineering, and Medicine (NASEM) report also demonstrated that varying assumptions about the effects of vaping on smoking initiation and cessation could result in net benefits or costs to public health.[22] The committee concluded, however, that under likely scenarios, e-cigarettes will result in net benefits.[42]

Several contributions to this literature emanate from the tobacco industry.[32,36,37,39] Their work is motivated in part by the US Food and Drug Administration requirement that companies demonstrate a public health benefit in submissions to have reduced-risk products accepted as Modified Risk Tobacco Products. FDA approval of such applications is necessary to market novel products.[43] Simulation in this area is thus more than an academic exercise, potentially having important policy and public health implications.

Employing a model with which we have worked since 1995,[44–50,51] the present study compares the effects of vaping on both cessation and initiation in the United States in terms of the number of life-years saved or lost. Unlike Levy and colleagues' assessment of the potential of e-cigarettes,[40] with vaping to nearly completely replace smoking, we examine plausible marginal effects on cessation and initiation, assuming that vaping will increase both. Specifically, the study addresses whether, compared with the potential smoking cessation benefits of e-cigarettes, concerns about their increasing smoking initiation warrant significant caution about the availability and marketing of the products.

Methods

Background Simulation Model

We use a dynamic simulation model that tracks the US adult population (ages ≥18 years) over time, following numbers of cigarette smokers, former smokers, and never smokers. Annually smokers are subject to a quit rate and each year's new cohort of 18 year-olds enters with a smoking initiation rate. All individuals in the model are subject to age- and smoking-status-specific death rates.

The model tracks individuals to a maximum age of 110. For each simulation year and every year of age, the model updates its population-group count in the following way: The number of people of age a in year t is computed by multiplying the number of people of age $a - 1$ in year $t - 1$ by the appropriate survival rate (1 - *death rate*). Current smokers are estimated as the number of smokers in the previous year who survived to the current year and did not quit smoking. Former smokers are the previous year's former smokers who did not die, plus the previous year's current smokers who did not die but did quit smoking. Initiation and cessation rates are supplied exogenously to the model and used as controllable values.

Census data provide the initial population distribution.[52] Initial age-specific smoking rates come from the National Health Interview Survey (NHIS)[53] (see Supplementary Table A1). Age-specific death rates come from the Statistical Abstracts of the United States.[54] We differentiate death rates by smoking status using findings from Cancer Prevention Study II.[55] We define the adult smoking initiation

rate as the smoking prevalence rate for 18 year-olds. No initiation after age 18 is considered. The annual cessation rate was estimated from a recent application of this model.[45] We have used the model frequently in previous research.[45–50,51] The model has proven quite accurate in predicting future US smoking prevalence.[46,50]

Status Quo Assumptions

In the complete absence of e-cigarettes, the background initiation rate falls from 20% in 2010 to 10% in 2028 and remains at 10% thereafter. This reflects actual experience 2005–2014, when the initiation rate fell from 24.4% to 16.7%, projected to 10% in 2028. We treat initiation as a constant rate thereafter. The background cessation rate, again with no e-cigarettes, increases from 4.18% in 2010 to 6% in 2028. We estimated cessation rates for 1990–2014[45] and then projected to the assumed constant rate of 6% in 2028.

E-cigarette Effects: Base-Case Model Assumptions

For our base-case simulation, we assume that vaping by previously never-smoking adolescents increases the overall smoking initiation rate by 2%. This increase is applied every year to the status quo rate of initiation described above (ie, the smoking initiation rate in the complete absence of e-cigarettes). Soneji et al.[10] concluded that vaping by previously never-smoking young people increased their odds of trying cigarettes by 3.50. Employing this odds ratio and data from Monitoring the Future (MTF) and the Population Assessment of Tobacco and Health (PATH) survey, we estimate that e-cigarettes increased any subsequent cigarette use (by all members of the age group) by 3.35%. Most youthful cigarette users do not become regular smokers. Although no study gives a precise estimate of transitions to regular smoking, recent papers provide guidance.[56–59] See the supplementary material for the specific calculations producing the 2% increase in the initiation rate.

For the base-case simulation, we assume that vaping increases adult smoking cessation by 10%. As with the smoking initiation increase, the vaping-induced cessation increase is applied every year to the background rate of smoking cessation described above (ie, the smoking cessation rate in the complete absence of e-cigarettes). 10% falls midway between the minimum impacts of vaping on cessation estimated by Beard et al.[17] and West et al.[18] for England (8%) and Zhu et al.[19] for the United States (12%). (These percentages derive from the authors' estimates of the number of quitters compared to base rates of quitting. The percentage estimates have been confirmed with West and Zhu.) Dual use of cigarettes and e-cigarettes is not an issue for this study, as we examine the *net* addition to the ranks of quitters. Implicitly, any remaining dual users are individuals who would not otherwise have quit smoking.

The base case treats vaping as harmless, which is not likely. However, if the use of e-cigarettes is short-term only, brief exposure to a substantially reduced-risk product is not likely to constitute a significant health risk. (In the United Kingdom, many individuals who quit smoking by vaping stop vaping within a year or two.[13]) In two of the sensitivity analyses described below, we adopt a conservative assumption about the risk of vaping that we believe exaggerates the likely risk.

For the base case, we estimate the impact on life-years lost of the 2% initiation rate increase alone, ie, with no cessation increase (scenario *a*, the worst case: no benefit from vaping; all cost); on life-years gained for the 10% cessation rate increase alone, ie, with no initiation increase (scenario *b*, the best case: all benefit, no cost); and on life-years gained or lost for both effects occurring simultaneously, ie, vaping increasing both smoking initiation and cessation (scenario *c*, reflecting both the desired and undesired effects of vaping).

E-cigarette Effects: Sensitivity Analyses

We also run three simulations that vary assumptions about the vaping-induced initiation and cessation rate increases and the health benefit derived from quitting smoking with vaping. In all three sensitivity analyses, the assumptions are intentionally highly conservative—biased against finding a net benefit from vaping—to test the robustness of base-case findings.

Sensitivity analysis 1 employs the base case initiation and cessation rate assumptions but assumes that every smoker who quits smoking as a result of vaping loses 10% of the mortality reduction associated with quitting smoking outright. This is the equivalent of assuming that life-long vapers lose 20% of the mortality reduction, with half of all vaping-induced quitters continuing to vape until they die.

Sensitivity analysis 2 assumes a vaping-induced initiation rate increase of 6%, three times our estimate of the most likely effect (see the Supplementary Material). The cessation rate increase is 5%, half that of the midpoint of the lower estimates for the United Kingdom and the United States.[17–19]

Sensitivity analysis 3 combines the 6% initiation rate increase and 5% cessation rate increase with a loss of 10% of the mortality reduction associated with quitting smoking without vaping.

Results

Table 1 presents cumulative life-years gained or lost as a result of vaping under the base-case assumptions for each decade 2020–2070. The table shows how the impacts of vaping-induced initiation and cessation unfold over time, if e-cigarettes increased smoking

Table 1. Cumulative Life-years Saved (or Lost) Under Base-case Assumptions

Year (1)	Scenario *a*: vaping-induced initiation only (2)	Scenario *b*: vaping-induced cessation only (3)	Scenario *c*: vaping-induced initiation and cessation** (4)
2020	0*	29 147	29 147
2030	0*	360 123	360 123
2040	(3679)	1 131 525	1 127 943
2050	(27 790)	2 084 227	2 057 156
2060	(99 007)	2 913 920	2 817 291
2070	(258 359)	3 526 607	3 273 771

*We assume no smoking-related deaths occur before the age of 35. The first cohort of vaping-induced initiators reaches age 35 in 2031.

**Column (4) is not the difference between columns (3) and (2) because the dynamics of cessation and initiation interact when both are considered together.

initiation but did not affect cessation (scenario *a*, column 2); if e-cigarettes increased smoking cessation but did not increase initiation (scenario *b*, column 3); and if e-cigarettes increased both initiation and cessation (scenario *c*, column 4). In all years, the hypothesized vaping-induced increase in cessation produces many more life-years gained than are lost due to the assumed vaping-induced initiation. No life-years are lost due to vaping-induced initiation in 2020 and 2030 because we assume that no smoking-related deaths occur before age 35. The first cohort of vaping-induced initiators reaches age 35 in 2031. The adverse impact of vaping-induced initiation does not reach large numbers until the last two decades, when the early vaping-induced initiators are in their 60s and 70s. Life-years gained due to vaping-induced cessation grow throughout the period.

Table 2 presents cumulative life-years gained or lost under the three scenarios by the year 2070 as a result of vaping, for the base case simulation and the three sensitivity analyses. For all simulations, the life-year gains from vaping-induced cessation substantially outweigh the life-years lost from vaping-induced initiation. Net life-years gained range from a high of nearly 3.3 million under the base case to a low of 583 000 under sensitivity analysis 3, which incorporates all of the most conservative assumptions. Under scenario *a*, presenting only the impact of increased initiation, life-years lost are either 258 000 (base case and sensitivity analysis 1, with 2% initiation rate increase), or 775 000 (sensitivity analyses 2 and 3, with 6% initiation increase). Under scenario *b*, showing the impact of vaping-induced cessation alone, benefits range from 1.35 million life-years gained to 3.5 million. The largest negative impact on net life-years gained results from tripling the vaping-induced initiation rate from 2% to 6% in sensitivity analyses 2 and 3.

Complete results of the simulations are presented in Supplementary Material. Supplementary Table A2 compares annual smoking prevalence for all three scenarios for the base case analysis with status quo prevalence (no effects of vaping).

Discussion

In all our simulations, the positive contribution of smoking cessation outweighs the negative impact of smoking initiation. In the most conservative sensitivity analysis (#3), life-years saved by additional vaping-induced smoking cessation exceed life-years lost by vaping-induced smoking initiation by three-quarters. In the base case simulation, utilizing what we consider the most plausible assumptions, life-year gains exceed losses by a factor of 13.7.

Our critical finding is not specific numbers, however. Rather it is a qualitative conclusion based on the quantitative findings: If e-cigarettes help a modest number of smokers to quit smoking, even at the risk of additional young people becoming smokers, the benefits to the public's health will exceed the potential costs to vaping-induced new smokers. The risk to young people should not be ignored. Public messaging and policy should strive to reduce their exposure to all nicotine and tobacco products. But, they should not do so at the expense of limiting such products' potential to help adult smokers to quit. As this study shows, that cost is too high. A more positive approach to e-cigarettes—encouraging their use to aid in smoking cessation, especially by inveterate adult smokers—likely would pay handsome public health dividends.

Our essential qualitative conclusion—that e-cigarettes have substantial potential to improve public health—is consistent with that of most of the published simulation studies.[34–40] Only one study has produced an unequivocal finding that e-cigarettes are likely to produce net harm.[41] Even the most publicly skeptical of the simulation study authors found a positive outcome over a range of plausible assumptions.[31] Their skepticism reflects results from simulations that include assumptions that have not materialized (eg, vaping "renormalizing" smoking) or represent outlier estimates of the relative risk of vaping compared to smoking.[60]

That the different studies produce a range of positive outcomes is not surprising. For example, although Levy et al.[40] found a potential gain of 20.8–86.7 million life-years by 2100, our base case indicates a net gain of 3.3 million life-years by 2070. The difference reflects the fact that Levy and colleagues assessed the *potential* of e-cigarettes if vaping replaced smoking entirely within 10 years. We examined the consequences of evidence-based *marginal* vaping-induced changes in initiation and cessation. Precisely because we examine marginal changes, and consistent with the NASEM findings,[22] the net benefits we estimate represent a small fraction of the life-years lost due to smoking. Because the life-years lost due to smoking are enormous, however, this fraction still represents a significant contribution to public health.

Conservative Assumptions

This study employs conservative (anti-e-cigarette) assumptions. The first, in all of the simulations, is that vaping by never-smoking young people will later result in significant numbers of additional adult smokers and that this effect will persist every year into the future. The "gateway" effect is e-cigarette skeptics' greatest fear, supported by prospective studies that have identified a correlation between

Table 2. Life-years Gained (or Lost) as a Result of Vaping by 2070, Base Case and Sensitivity Analyses

Model	Change in life-years		
I = initiation rate increase C = cessation rate increase (1)	Scenario *a*: vaping-induced initiation only (2)	Scenario *b*: vaping-induced cessation only (3)	Scenario *c*: vaping-induced initiation and cessation* (4)
Base case			
I = 2%, C = 10%	(258 359)	3 526 607	3 273 771
Sensitivity analyses:			
1. Base case with 10% mortality risk from continued e-cig use	(258 359)	2 616 298	2 361 786
2. Pessimistic case I = 6%, C = 5%	(775 078)	1 820 108	1 053 680
3. Pessimistic case with 10% mortality risk	(775 078)	1 352 421	583 398

*Column (4) is not the difference between columns (3) and (2) because the dynamics of cessation and initiation interact when both are considered together.

never-smoking youths' vaping and subsequent cigarette smoking.[10,22] These studies have many limitations.[61] Further, data from two major national surveys (National Youth Tobacco Survey, NYTS,[23] and Monitoring the Future, MTF[62]) demonstrate that during the years of rapid growth in e-cigarette use, US students' cigarette smoking fell at an unprecedented rate, while other tobacco product use rates also fell. In 2016, high school students' 30-day e-cigarette use dropped 23% (MTF, Table 1) to 29% (NYTS), ***while*** cigarette smoking fell an additional 14% (NYTS) to 15% (MTF, Table 2). From 2011 to 2015, the adult initiation rate (ie, 18 year-olds' smoking prevalence) fell from 18.9% to 13%, a 31% reduction. Thus, even if e-cigarette use by never-smoking young people increases their propensity to smoke, that effect is swamped by other forces rapidly driving youth smoking down.

Second, our sensitivity analyses employ highly conservative assumptions. Sensitivity analyses #2 and 3 triple what we believe to be the likely initiation rate increase, assuming that vaping does increase smoking initiation, and halve what we consider a plausible impact of vaping on cessation.

Third, sensitivity analyses #1 and 3 assume that all people who successfully quit smoking with vaping lose 10% of the mortality reduction experienced by smokers who quit without vaping. This is equivalent to assuming that half of vaping-induced quitters will continue to vape for their remaining lives, losing 20% of that mortality reduction, whereas the remaining half will quit soon enough after stopping smoking to avoid any serious vaping-related health consequences. In the United Kingdom, already a third of former smokers who used vaping to quit have stopped vaping as well.[13]

We have not presented sensitivity analyses employing more optimistic assumptions. For example, under optimal conditions (better e-cigarette technology, better understanding of how to use e-cigarettes to quit smoking, and better communications to encourage their use) the vaping-induced increase in smoking cessation might be 15% or more. More optimistic assumptions produce correspondingly higher estimates of net life-years gained.

Limitations

Our base-case cessation parameter—a 10% vaping-induced increase in cessation—derives from limited evidence, much of it cross-sectional in nature with the inherent limitations. We need longitudinal studies with large samples, if not randomized controlled trials.[16] Although a wide range of impacts on cessation produce a positive finding regarding vaping, clearly the results would be negative if e-cigarettes *reduce* quitting among smokers. A meta-analysis[63] derived that conclusion, but the paper's measurement of e-cigarette use and associated selection of studies have been criticized as faulty.[16] The one simulation that concluded that vaping poses more risk than benefit relied on that analysis.[41] The bulk of the evidence, including recent studies,[17–21] strongly indicates that e-cigarettes do help a subset of smokers to quit.[16,26] Still, more research on the relationship between vaping and smoking cessation is essential to determine not only whether e-cigarettes aid in cessation but also how and how much. Evidence suggests that intensive e-cigarette use is associated with quitting, whereas low levels are not.[20,21] Dissemination of research-based knowledge of how former smokers quit with e-cigarettes could increase vaping-associated quit rates well above our base-case assumption.

Our analysis does not consider the negative implications of vaping by former smokers and never-smoking adults. Public health could be harmed if nonsmoking adults use e-cigarettes, other than experimentally, especially if some resumed or started smoking as a result. There is little evidence of this occurring, however. The vast majority of adult e-cigarette use is by current smokers and recent former smokers, many of whom claim to have used e-cigarettes to quit smoking.[13,64]

We have measured vaping-induced cessation benefits solely in terms of reduced mortality (gained life-years). The inclusion of smoking's large morbidity and disability burdens[65] would have indicated a significantly greater health benefit. Future studies might evaluate the consequences of e-cigarettes or other novel products using measures like DALYs (disability-adjusted life-years) that incorporate health benefits other than just avoiding premature death.

We do not consider the effects of vaping-induced initiation and cessation on second-hand exposure to either cigarette smoke or e-cigarette vapor. If vaping reduces the numbers of smokers (and their smoking frequency), second-hand smoke exposure will decrease and net health benefits in our simulations would increase. While the health effects of second-hand vapor exposure are unknown, the vastly reduced toxins in vapor compared to cigarette smoke suggest that adverse consequences of second-hand vapor exposure, if any, must be substantially less than those of second-hand smoke.[66]

Our assumed time paths, in the absence of e-cigarettes, of the smoking initiation rate (decreasing through 2028) and the cessation rate (increasing through 2028) could affect our findings. In other simulations, not presented, we adopted a constant (unchanging) initiation rate of 15%, slightly lower than that achieved in 2014 (16.7%), and a constant cessation rate of 4.35% (the average of our estimates of cessation in 2014 using NHIS (4.50%) and NSDUH (4.20%) data).[45] The resulting net life-years saved were modestly higher than in the simulations we report. For example, in the base case simulation the estimated number of life-years saved was 8.6% higher with the simpler constant assumptions than with the declining initiation and increasing cessation rates we report. We consider the latter likely more realistic, if a bit more complicated, and the associated results are more conservative.

Finally, even if e-cigarettes aid smokers in quitting, that effect might wear off over time. We assume that it continues annually. From now until 2070, alternative nicotine delivery systems (ANDS) are almost certain to vary by type and generation. Novel heat-not-burn (HnB) products are now being marketed in several countries, with evidence of success in Japan.[67] If such ANDS have similar or even better disease risk profiles than e-cigarettes and produce a similar or better behavioral response (ie, encourage smoking cessation), they might join or replace e-cigarettes in the tobacco harm reduction marketplace. This suggests that this paper's terms "e-cigarettes" and "vaping" might best be interpreted as reflecting whatever ANDS are popular at any given time. This study's real question is thus whether substantially reduced-risk products that might aid in smoking cessation but also create uptake by adolescents would produce net public health benefits or costs. Of course, which novel products make it to market, and hence whether they will affect smoking at all, will depend on governmental regulatory agency decisions. In the United States, permission to market novel products rests with the Food and Drug Administration.[41]

Implications

Twenty years ago Henningfield and Slade emphasized the importance of focusing attention and resources on helping adult smokers to quit.[68] They observed that ensuring that no current child ever started smoking would fail to alter the smoking-produced mortality curve for 30 years. Only assisting adult smokers to quit could "bend the death curve" down starting immediately.

It is our responsibility as a public health community to bend that curve as much as possible, and as quickly as possible. Certainly, we have a moral obligation to discourage children from using tobacco and nicotine products. We also have a moral obligation to assist addicted adults who do not want to remain smokers. They represent previous generations of children whose youthful experimentation with and subsequent addiction to nicotine we failed to prevent.

Public communications and policy must be developed to address both obligations. This may entail media campaigns educating children about the dangers of nicotine and tobacco product use and, like the highly successful Truth campaign, intensifying their social unacceptability. Other media campaigns might educate adult smokers about the nicotine continuum of risk[69] and, in the process, provide honest information on the relative dangers of combusted and non-combusted nicotine and tobacco products, including e-cigarettes.[70] Professional education might encourage both individual health care practitioners and their professional organizations to seriously contemplate the potential role of ANDS for patients unable or unwilling to quit smoking through more conventional means.[71]

With regard to policies, minimum age of purchase and marketing restrictions can discourage adolescents' use of all nicotine and tobacco products, whereas regulatory agency approval of factual reduced-harm marketing of products like e-cigarettes, targeted to adult smokers, could enhance the potential of such products to diminish the horrific toll of smoking.

All such communications and policies will benefit from further research on the role of e-cigarettes in youthful smoking, whether and how vaping increases adult smoking cessation, and, of course, the health risks of vaping relative to smoking.

Communications and policies addressing the two fundamental goals—discouraging youth use of e-cigarettes and encouraging their consideration as a means of reducing adult smoking—may come into conflict. For example, publicity or policy that demonizes e-cigarettes to prevent their uptake by children may also inhibit their use by adult smokers whom they might help to quit. Negative public discussion in the United States about vaping's risks has worsened American adults' understanding of the actual risks of e-cigarettes relative to smoking.[72]

When the goals of protecting children and helping adult smokers conflict, public health professionals must carefully consider the practical implications in both directions. In the debate about e-cigarettes and tobacco harm reduction, more generally, this study suggests that we have to give a much higher priority than we have to date to helping adult smokers to quit.

Supplementary Material

Supplementary data is available at *Nicotine & Tobacco Research* online

Declaration of Interests

The authors declare that they have no conflicts of interest relevant to this study.

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