Modeling cigarette smoking exposure in subsets of the population

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Understanding and acknowledging various factors that impact cigarette smoking and exposure is critical when creating public health interventions to curb tobacco use. Here, Theodore R. Holford from Yale University discusses the impact of different approaches to tobacco control

The harmful effects of cigarette smoking have been widely recognized for more than 50 years [1], and the huge toll that it has taken in shortening lives has led to the recognition of an urgent need to reduce associated exposure. Because cigarette smoking is an addictive behavior, it has been a public health challenge to reduce the level of exposure in the population, even though alternative approaches have been used. These approaches include the introduction of taxes that increase cost to users, changing the legal age at which cigarettes can be purchased, introducing clean air laws that limit locations where individuals are allowed to smoke, and establishing resources that will assist those who wish to quit smoking. These efforts can be undertaken on a national level, but more often, such efforts are implemented at different times and in different ways in different regions. In the US, these laws are more commonly introduced by a state, county, or city. [2] This introduces geographic disparities in cigarette smoking exposure, and it is important to understand these differences when planning approaches to protect public health.

An earlier article described an approach for characterizing smoking behavior in a population using a smoking history generator, which has been used by the Cancer Intervention and Surveillance Modelling Network (CISNET). [3] This approach estimated state-specific trends in smoking initiation, cessation, and intensity for birth cohorts using data from the National Health Interview Survey (NHIS) and the Tobacco Use Supplement to the Current Population Survey (TUS-CPS). This presentation describes how these smoking history details can be used to assess the impact of different approaches to tobacco control.

State-specific smoking trends in the US

To illustrate differences in cigarette smoking in US states, consider California and Kentucky; the latter state is a tobacco producer, so a large part of its economy is driven by tobacco farming, as well as the production of tobacco products, including cigarettes. There is considerable resistance in Kentucky to reducing the market for cigarettes because of the impact this would have on large numbers of individuals living in the state. Hence, little legislative action has been taken to reduce the manufacture or sale of

cigarettes. On the other hand, tobacco is not a major contributor to California's economy, and it tends to be at the forefront of societal trends, including the latest in styles and factors affecting health.

Figure 1 illustrates how these differences have affected current smoking prevalence in different birth cohorts. In general, smoking rates in males are higher than in females. In both states, the rates have been declining as knowledge of the danger associated with cigarette smoking became more widely accepted. In earlier cohorts, there is little difference between these states in females, but for more recent cohorts, the prevalence changed little in Kentucky but much more in California. For males, the pattern is similar, although the prevalences were much higher than females in the earlier cohort. Currently, the sexes are more similar.

To better understand what happened in these two states, it is essential to consider the drivers of smoking prevalence, i.e., initiation and cessation. Figure 2 shows initiation probabilities for each birth cohort. Individuals who smoke tend to start in the late teens or early twenties, and these tend to decline, i.e., lower for the more recent birth cohorts. However, there is a sizable difference between these states in recent cohorts, so any public health measures directed at initiation will be introduced into populations that are quite different. Yearly cessation probabilities are shown in Figure 3, and these tend to rise with age throughout a lifetime. There are differences between these states in that California shows cessation probabilities that are somewhat higher than Kentucky, reflecting perhaps the more aggressive public health efforts to control smoking. When assessing the impact of a particular intervention, this level of detail is important because the history will have affected the distribution of individuals influenced by the proposed approach.

Quantifying the impact of an intervention

To quantitatively assess the impact of a public health intervention on exposure to a population, it depends on who will be impacted. Promoting smoking cessation would primarily affect current smokers, but it would have little effect on initiation. Kentucky would have a higher proportion of smokers and lower cessation probabilities, giving greater possibility for change.

An Institute of Medicine report considered a limitation of the legal age for purchasing cigarettes to those 21 and over. It concluded that the effect would be medium (15%) for those under 15 years, large (25%) for those 15-17 years, medium (15%) for those 18-21 years, and no effect thereafter (p. 206). [4] There would be little or no effect of this policy on cessation. Using the estimated initiation probabilities displayed in Figure 2, one can estimate what the expected probabilities would be following the date when the new law was put into effect in each state. In this way, one would have a new set of initiation probabilities to go with the cessation probabilities that were previously estimated. With these, one can estimate the smoking prevalence that would be expected following the change in the minimum legal age for purchasing cigarettes.

Other public health policies could have even more complex effects on a population, affecting both initiation and cessation probabilities. For example, the effect of clean air laws could encourage current smokers to quit, thus changing the cessation probabilities. But these laws could also discourage individuals who currently do not smoke from starting, affecting the initiation probabilities.

Assessing the impact of change in cigarette smoking exposure

A smoking history generator provides details that allow one to characterize more carefully the effects that might be expected by the introduction of policy changes that could affect behavior. This would enable one to assess the magnitude of the effect that could result from the change by providing estimates of the changed distribution of exposures. While this would provide a framework for assessing policy, there remain limitations and uncertainty in those quantitative estimates. For example, one cannot be certain as to the magnitude of the effect of a particular in the real world. However, this approach would provide a framework for determining the sensitivity of the estimates that might be expected under a range of possible effects. By carefully constructing models for the impact of public health policies, one can develop cost-effective approaches.

References

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