The cost-effectiveness of raising the legal smoking age in California

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Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology
The policy of raising the legal smoking age in California from the current age of 18 to 21 was evaluated. Alternative scenarios of raising the age to 19 or 20 were also contemplated.

Type of intervention
Primary prevention, Other (legislation).

Economic study type
Cost-effectiveness analysis.

Study population
The target population comprised a dynamic hypothetical cohort of California's general population, which was classified according to age, gender and smoking status.

Setting
The setting was the community. The economic study was performed in the USA.

Dates to which data relate
Epidemiologic evidence dated from 1992 to 2003. The resource use and cost data were obtained from references dating from 1992 to 2004. The prices used were for 2003.

Source of effectiveness data
The effectiveness data were derived from a review of completed studies.

Modelling
A dynamic computer simulation model using Vensim 5.1 software (Ventana Systems Inc.) was developed to simulate the effects of the policy change. Briefly, the population was divided into hypothetical cohorts according to age, gender and smoking status. Then, annual transitions such as birth, death, aging, net migration, and changes in smoking behaviour in the California population over 50 years were simulated. As there is no direct evidence of the impact of changing the law on patterns of tobacco use, two series of scenarios with different assumptions about the impacts on smoking initiation rates in youth were considered. The model was described in further detail in Tengs et al. 2004 and 2005 (see 'Other Publications of Related Interest' below for bibliographic details).

Outcomes assessed in the review
The parameters incorporated in the model included:
California population characteristics, divided into cohorts according to age, gender and smoking status; and annual transitions such as birth, death, aging, net migration, and changes in smoking behaviour (initiation, cessation and relapse, which varies by age and gender).

**Study designs and other criteria for inclusion in the review**
The study designs and other criteria for inclusion in the review were not reported. The author referred the interested reader to Tengs et al. 2004 and 2005.

**Sources searched to identify primary studies**
Not reported.

**Criteria used to ensure the validity of primary studies**
Not reported.

**Methods used to judge relevance and validity, and for extracting data**
Not reported.

**Number of primary studies included**
Twelve references were provided.

**Methods of combining primary studies**
Not reported.

**Investigation of differences between primary studies**
The author does not appear to have investigated differences between the primary studies.

**Results of the review**
The author reported a selection of the parameters used for the model.

In the status quo scenario, the initiation probability distribution varied by age and was presented graphically, ranging from near 0 at age 6 to around 0.10 at age 18.

Assuming a 3-year shift after increasing the legal smoking age from 18 to 21, the initiation probability distribution varied by age and was presented graphically, ranging from near 0 at age 9 to around 0.06 at age 19.

In the status quo scenario, the initial smoking prevalence (2003) was 15.4% at ages 14 - 17, 16.8% at ages 18 - 20 and 16.7% at age 21 or older.

If the legal smoking age was increased to 21, and if that resulted in a 3-year shift in the probability of initiation, smoking prevalence was expected to decrease dramatically in all age groups. The smoking prevalence at ages 14 - 17 was likely to decrease to 2.4% in 50 years, a substantial drop of 82%. The smoking prevalence at ages 18 - 20 would decrease to 7.9% in 50 years, while that at age 21 or older would drop to 12.6%.

A 30% decline in the probability of initiation in youths under age 21 resulted in a decrease in smoking prevalence from status quo levels of 13.3% to 5.2% among those in the 14 - 17 age group, and from 17.3% to 12.7% among those in the 18 - 20 age group.
A 30% decline in the probability of initiation in youth under age 19 resulted in a decrease in smoking prevalence from status quo levels of 13.3% to 5.2% among those in the 14-17 age group, from 17.3% to 13.4% among those in the 18-20 age group, and from 17% to 15.3% among those aged 21 or older.

Methods used to derive estimates of effectiveness
The author made some assumptions to derive estimates of effectiveness.

Estimates of effectiveness and key assumptions
As no direct data of effectiveness was available, two possible series of scenarios were considered.

In the first series, the assumption was that increasing the legal smoking age from 18 to 21 would have the effect of rendering underage youth three additional years from being legally able to smoke, and thus “shifted” the initiation distribution accordingly, and that adults aged 21 and older would maintain their current initiation rates. This allowed the study to test the effects of raising the age limit to 19 or to 20 years.

In a second group of scenarios, the author assumed that the age- and gender-specific probability of smoking initiation would decrease by some percentage (from 10 to 50%) for those under the age of 21. Another assumption was that smoking prevalence would remain stable during the horizon of the study.

Measure of benefits used in the economic analysis
The measure of benefits used was the quality-adjusted life-years (QALYs). Data obtained from the Quality of Well Being scale for populations of different age, gender and smoking status were used. The quality of life weights ranged from 0.94 to 0.66 for never, current and former smokers. An annual discount rate of 3% was appropriately used for the benefits, owing to the long-term horizon of the study.

Direct costs
Three cost categories were incorporated. More specifically, the costs of enforcement, checking purchaser identification (ID) and medical care. The costs of enforcement included salaries for inspectors, underage shoppers and supervisors, as well as the expense of tracking inspection results, administering civil fines, handling legal challenges in court, liability insurance, transportation, and the maintenance of office space, equipment and supplies. The additional costs to retailers of checking purchaser ID was incorporated through a formula that considered the average time to do an ID check, the average hourly wage for cashiers in California, and the number of purchases that entail an additional ID check under a mandated legal smoking age of 21. The latter was derived using, among other inputs, the packs per year consumed by each adult smoker, California smoking prevalence, assumptions about cigarette consumption among youth smokers per year, the percentage of store purchases for underage smokers, and assumptions about compliance with the enforcement. Finally, medical care costs were also considered according to age group, gender and smoking status. These comprised the sum of the categories Medicare, Medicaid, out-of-pocket (direct costs) and other private cost (insurance).

The quantities and the costs were occasionally reported separately. The estimation was derived from actual data, national sources and the author’s assumptions, using modelling. An annual discount rate of 3% was appropriately used for the costs, owing to the long-term horizon of the study. An adjustment for inflation was also made. In the case of medical care costs, the medical Consumer Price Index was used. In addition, an autoregressive moving average model was used to determine the increase in medical costs over the simulated period. The price year was 2003.

Statistical analysis of costs
The costs were included as parameters in the model. No statistical test was carried out on them.

Indirect Costs
The indirect costs were not reported.
Currency
US dollars ($).

Sensitivity analysis
The model was calibrated using reliable external data to test its accuracy. As data relating to the impact of this policy were unavailable, different scenarios investigating the impact of changing the legal age of smoking on smoking initiation rates were evaluated.

Estimated benefits used in the economic analysis
The total cumulative discounted QALYs for the entire California population (all reported in millions) accrued during 50 years for the status quo were 1,072.75. For the first series of scenarios (shift of initiation age), the incremental QALYs ranged from 1.47 (shifted by three years) to 0.56 (shifted by one year). For the second series of scenarios (initiation probability decrease) the incremental QALYs ranged from 1.36 (50% decrease) to 0.26 (10% decrease).

Cost results
The total discounted cumulative costs for the entire California population (all reported in millions) during 50 years for the status quo were $3,723,959 ($2 for enforcement; $17 for ID checking, and $3,723,940 for medical care). For the first series of scenarios (shift of initiation age), the incremental costs ranged from -$24,079 (shifted by three years) to -$8,786 (shifted by one year). For the second series of scenarios (initiation probability decrease), the incremental costs ranged from -$22,686 (50% decrease) to -$4,017 (10% decrease).

Synthesis of costs and benefits
As all policy interventions conferred additional health benefits and saved costs, the benefits and costs were not combined in a summary measure in the primary analysis.

Even if the author assumed that there were no medical cost-savings, the incremental cost per life-year was $686 and the incremental cost per QALY gained was $238.

Authors’ conclusions
Compared with the status quo, raising the smoking age to 21 would result in a large drop in teen smoking prevalence, a rise in life expectancy and quality of life, and cost-savings for the state of California and its inhabitants over 50 years. Although a lower increase in age might be easier to pass through legislation, increasing the legal smoking age to 21 clearly offers the largest gains in quality-adjusted life-years (QALYs) and most cost-savings.

CRD COMMENTARY - Selection of comparators
The author explicitly selected the relevant comparators for the setting (California) and explored other age limits as well. You should decide if these are relevant to your own setting.

Validity of estimate of measure of effectiveness
It was not stated that a systematic review of the literature was undertaken. Uncertainty remains around the literature search and possible omission of relevant studies, as the search strategy was not reported in the paper. Since there is no direct evidence of the potential effect of changing the law, the author estimated the potential effects through different assumed scenarios in order to evaluate the plausible results. In addition, since the only effect of the law modelled was to deter the initiation of smoking, the author stated that the estimates would be conservative because additional effects could be increased cessation and reduced relapse among smokers who would become underage under the new legislation. Different age limits were also evaluated. No additional sensitivity analysis was reported.
Validity of estimate of measure of benefit
The estimation of benefits was appropriately modelled using data on quality of life in different age, gender and smoking status sub-groups, as provided in a personal communication, and using the Quality of Well Being instrument.

Validity of estimate of costs
The author adopted a societal perspective and included the costs of medical care, law enforcement and checking ID. The indirect costs were not reported as is usual in a societal perspective, probably because of the "Washington Panel" recommendation of excluding them if benefits are measured in healthy years such as QALYs. All the relevant costs seem to have been considered for each cost category. The sources comprised published studies and the author's assumptions. Resource use was derived using modelling and was not reported in detail, a fact that may limit extrapolation exercises to other settings. The author reported the price year, which will facilitate any future inflation exercises. Discounting was adequately applied, as the study horizon was longer than 2 years, and the prices were reflated when necessary. No statistical or sensitivity analyses of the costs were performed.

Other issues
The strength of the model lay in its calibration, using external reliable data on sociodemographic and smoking, in which it performed well. The author reported some caveats. First, the use of national US mortality data instead of California's mortality, which could have led to a slight overestimation of the benefits. Second, the uncertainty surrounding net migration in 50 years. Finally, the exclusion of possible facts such as periodic access of underage smokers to cigarettes through social channels, or a black market (which could have led to a slight overestimation of the benefits). The author did not compare the results with those of other studies. The generalisability of the results cannot be guaranteed as the results are "California specific".

Implications of the study
This research should prove useful to California's policy makers regarding legislation to raise the state's legal smoking age, and may foster studies in other states or countries. Raising the legal smoking age to 21 may be among a few policy options that result in a gain in QALYs while saving costs. The decision to increase the legal smoking age to 21, compared with 19 or 20, dominated throughout the analysis. Even when considering medical care provided by California State (Medi-Cal), there would still be net savings.

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Other publications of related interest

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