Health Based Population Forecasting: Analysis of The Effects of Smoking, Obesity and Alcohol Consumption.

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Background: The growth of the Social Security and Medicare eligible population is currently projected without using information on the health traits of that population. Estimates are made of the rate of increase, or decrease, in mortality rates for specific causes of death using expert judgment (SSA, 2001, 2002). Procedures are only now being evaluated which take advantage of time series models to statistically evaluate empirical trends in mortality rates (e.g. Lee and Carter, 1992). What such procedures cannot do is to anticipate turning points, such as, for cancer in 1990, which are due to changes in risk factors and medical treatments affecting health substantially prior to death. For example, for males we know that cohort patterns of smoking changed direction in 1995 when the males who were in their teenage years and mid-twenties just after the first Surgeon General's report started reaching the age of Medicare eligibility. Current Medicare projections, based on mortality trends, do not directly reflect this underlying cohort change.

Smoking, alcohol consumption and obesity are the most important factors influencing the U.S. population qualitative and quantitative health characteristics such as life expectancy, morbidity, mortality, medical loses and disability. According to the official reports of Center for Disease Control and Prevention (Morbidity and Mortality Weekly Report), National Vital Statistics Reports, U.S. Department of Health and Human Services and U.S. Environmental Protection Agency, these factors are the leading causes of mortality and morbidity. Smoking is the No. 1 cause of deaths in the U.S.: 430,000 deaths per year vs. 81,000 deaths from No. 2 cause – alcohol (National, 2003). Medical and social factors directed to reducing the prevalence of these factors can significantly improve the socio-economics situation in U.S. and population health.

Data and research methods: Micromodeling and microsimulation technologies in social sciences allow us to forecast the future U.S. population taking into account these risk factors.

This can be done by constructing an individual's life model and simulating projection on an 'year by year' and 'individual by individual' basis. The basic events of the individual life model including birth, pregnancy, disease and death occur stochastically and are characterized by age, sex and race specific rates, extracted from the Health, United States, 2002 (Health, 2002), National Vital Statistics Reports and Morbidity and Mortality Weekly Reports.

An important feature of the microsimulation algorithm is the straightforward analysis of interventions. Interventions can be implemented in the algorithm by recalculating prevalence rates. This recalculation is based on epiemiological information on relative risk of specific disease (e.g. MMWR, 1994) and infertility for women due to smoking, obesity and alcohol consumption. Comparison of projections done with different prevalence rates allows us to make conclusions about effects of these risk factors on U.S. population.

We include in our model data on mortality in different age groups attributable to smoking, alcohol consumption and obesity diseases: neoplasms (lip, oral cavity, pharynx, esophagus, pancreas, liver, larynx, trachea, lung, urinary bladder and other), cardio- and cerebrovascular and heart diseases (hypertensive disease, ischemic heart disease, atherosclerosis, aortic aneurism and other), diseases of respiratory tract (pneumonia, bronchitis and emphysema, chronic airway obstruction), metabolic diseases(diabetes mellitus), infant diseases (respiratory distress syndrome, sudden infant death syndrome). We also took into account the influence of these risk factors on female and male reproductive function, precisely on fertility rate.

Results: Microsimulation was applied to projecting the age distribution of U.S. white population for 1, 20, 50 and 100 years. Characteristics of the projected population (i.e. age and sex distributions) were predicted. Explicit formulae for rates as a function of smoking rates are obtained, that allows us to consider the effect of smoking on characteristics of the projected U.S. population. One half and double the smoking prevalences were considered and results are compared with predictions for the current smoking rate. According to our calculations, the total number of people of working age (19 – 67 years old) are: in the current smoking population – 139,588,000; with 50% smoking prevalence – 142,777,000 and in the doubled smoking prevalence – 133,503,000 individuals. So, the difference between the extreme smoking prevalence levels are 9.3 millions individuals (~7%). For young (0-18 yr. old) and the oldest (68+ yr. old) smokers relative losses are larger (8.7% and 16.9%, respectively). Medical losses

due to smoking-attributable diseases and impairment of females fertility increase over time and will exceed (doubled smoking prevalence vs. 50% smoking prevalence) 4.8 millions (8.7%) at ages 0-18 yrs., 8.9 millions (8.7%) – at ages 19-67 yrs. and 6.5 millions – at ages 68+ yrs.

The main consequences of smoking for the U.S. white population will be: 1) reduced life expectancy at birth (-2.6 and –1.8 year) for males and females comparing 200% and 50% smoking prevalence 2) reduced mean age at death (-2.3 and –1.7 years for males and females, respectively, in 100 year projection comparing 200% and 50% smoking prevalence), 3). a deceleration of population aging for constant mortality and fertility rates, 4). stable sex ratio of population over time not dependent on smoking prevalence.

The influence of alcohol and obesity on U.S. population (including white, black, Hispanic and Asian) life expectancy, mean age at death, process of population aging, mortality and fertility rates may be as significant, as for smoking, and combined effect of all these factors will be reported.

Implementation of this approach will produce new results practical use in medical, social and actuary sciences, as well as allow us to estimate socio-economic effect of new medical technology application.

REFERENCES

Health, United States. 2002. National Center for Health Statistics, http://www.cdc.gov/nchs/products/pubs/pubd/hus/02hustop.htm

Lee, R. and L. Carter (1992). "Modeling and forecasting U.S. mortality." Journal of the American Statistical Association 87(419): 659-671.

Morbidity and Mortality Weekly Report, June 10, 1994; Vol.43(SS-1): 3-6. Centers for Disease Controle and Prevention. CDC Surveillance Summaries. D.E. Nelson, R.S. Kirkendall, R.L. Lawton, J.H. Chrismon, R.K. Merritt, D.A. Arday, G.A. Giovino. “Surveillance for Smoking-Attributable Mortality and Years of Potential Life Lost, by State – United States, 1990.

National Center for Chronic Diseases Prevention and Health Promotion, 2003. *Comparative Causes of Annual Deaths in the United States: Tobacco Information and Prevention Source;* http://www.cdc.gov/tobacco/research_data/health_consequences/andths.htm

Social Security Administration, 2001, Short-Range Actuarial Projections of the Old-Age, Survivors, and Disabilty Insurance Program, .Actuarial Study No. 115. : Baltimore, MD, 2001.

Social Security Administration, 2002, Life Tables for the United States Social Security Area 1900-2100; Actuarial Study No. 116 *by : Felicitie C. Bell and Michael L. Miller*