Using microsimulation modelling to analyse early life health interventions

Chris Schilling, Peter O'Connor and Chris Nixon, NZIER

Introduction

Policy analysis of early life health interventions is difficult. Epidemiology suggests that early life actions can have lasting benefits into old-age, and indeed extend into subsequent generations (Morton 2004). Impacts of interventions vary across ethnicities, ages, incomes, and behaviours. Life and health care costs can be difficult to value. Choosing an appropriate discount rate is typically controversial.

We investigate the use of microsimulation modelling to analyse the effectiveness of policy interventions that help reduce smoking during pregnancy.

Microsimulation methodology

Microsimulation is a 'bottom up' modelling technique that models agents (and their responses and behaviours) individually. In the context of health, the agent represents a person. This means we analyse over 4 million agents and their varying characteristics that represent the New Zealand population.

The model simulates the life path of each agent. Each life event, for example pregnancy, birth, smoking initiation and cessation, has a probability distribution. These are compared to random numbers between zero and one to determine the life course of each agent. The agents in the model are initialised to match the age, gender, ethnicity and income socio-demographics of the current New Zealand population. We project forward trends in demography using birth, mortality and migration rates from Statistics New Zealand demographic data.

The health module

The basic demographic model is augmented with health outcomes and risk factors. Smoking initiation and cessation events are incorporated in the model. Data from the New Zealand College of Midwives (2008) was used to calibrate smoking during pregnancy prevalence across the population by age, income and ethnicity. Nation-wide, 15.5 per cent of women in New Zealand smoke during pregnancy. That prevalence increases to 37 per cent for Maori women.

The negative health impacts of smoking during pregnancy are then modelled. A broad review of the scientific literature identified the relative risk ratios for infant mortality, small for gestational age, and asthma are 1.6, 2.5 and 1.4 respectively (adapted from the British Medical Association 2004). This means, for example, that children born from mothers who smoked during pregnancy are 2.5 times more likely to be born small than children from mothers who did not smoke during pregnancy.

Simulating the policy intervention and valuing the health outcomes

We consider a low intensity intervention. This includes services such as leaflets, self-help materials, advice and strategies to help quit smoking. We apply the intervention to 40 per cent of the population of women who smoke during pregnancy, and assume an effectiveness of 3 per cent based on the latest scientific evidence (Lumley et al, 2009 and McRobbie 2010). We simulate the population out to 2061, and compare against a baseline scenario.

To value health outcomes, we consider health care costs for smokers versus non-smokers and for children born from mothers who smoked during pregnancy versus children born from mothers who did not smoke during pregnancy. We match ethnicities, ages and genders to account for these differences in health care costs.

To discount health care costs and benefits we assume a discount rate of 3.5 per cent, as per PHARMAC (Grocott et al 2007) and UK's National Institute for Health and Clinical Excellence (NICE, 2009). We compare the results for discount rate of 8 per cent as per Treasury's usual standard.

Results and discussion

We find that a low intensity intervention that is applied to 40 per cent of women who smoke during pregnancy, and has a success rate of 3 per cent, reduces the number of births to women who smoke during pregnancy by 131. This reduces the number of children born small for gestational age by 12 and with asthma by 11. Life time health care costs are reduced by a present value of $500,000, resulting in a benefit-cost ratio of 2.

The results indicate that early life health interventions can have lasting health benefits and be cost-effective. Microsimulation modelling can capture the long term costs and benefits of early life health interventions, and account for the heterogeneous nature of the wider population.

However the results are sensitive to the discount rate selected. At a discount rate of 8 per cent, life time health care savings fall to around $250,000 and a benefit-cost ratio of 1.

Contact Author

Chris Schilling

chris.schilling@nzier.org.nz

DDI: 04 494 7967

References

British Medical Association (BMA) (2004), Smoking and reproductive life: The impact of smoking on sexual, reproductive and child health. London. BMA

Grocott, R. Metcalfe, S. PHARMAC's updated guidelines for cost-effectiveness analyses, with new discount rate. Journal of New Zealand Medical Association, 20-July-2007, Vol 120 No 1258.

Lumley J, Chamberlain C, Dowswell T, Oliver S, Oakley L, Watson, L. (2009) Interventions for promoting smoking cessation during pregnancy (Review). The Cochrane Collaboration, The Cochrane Library 2009, Issue 3.

Macklin MT, Macklin CC. (1940), Does chronic irritation cause primary carcinoma of the human lung? Archives of Pathology 1940;30:924–55.

McCowan LME, GA Dekker, E Chan, A Stewart, LC Chappell, M Hunter, & RA North (2009) , Spontaneous preterm birth and small for gestational age infants in women who stop smoking early in pregnancy: prospective cohort study. British Medical Journal. doi:10.1136/bmj. b1081 2009;338;b1081 BMJ.

McRobbie, Hayden. (2010), Interventions to help pregnant women stop smoking. Personal correspondence, December 9th, 2010.

Morton, SMB (2004). Invited Commentary: The child is the mother of the woman: intergenerational associations in maternal anthropometry. International Journal of Epidemiology 2004: 33; 1249-51

National Institute for Health and Clinical Excellence (2009). The guidelines manual. London. Available from www.nice.org.uk

New Zealand College of Midwives (2008), Smoke free Outcomes with Midwife Lead Maternity Carers. An analysis of smoking during pregnancy from the New Zealand College of Midwives, Midwifery Database Information 2004-2007. Report prepared for The Ministry of Health. November 2008