Forecasting the Burden of Diabetes in Singapore using a Demographic Epidemiological Model of Singapore*

By Foo Jie Min

Singapore is a microcosm of Asia as a whole, and its rapidly ageing, increasingly sedentary population heralds the chronic health problems other Asian countries are starting to face and will likely face in the decades ahead. One of the many competing public health issues is type 2 diabetes mellitus (T2DM), as reflected in the doubling of prevalence from 5% in 1980s to 11% in 2010. As the age-specific prevalence of obesity and overweightness -- a risk factor of T2DM -- has risen substantially in most demographic segments over time, it foreshadows an increase in the age-specific prevalence of T2DM. Therefore, predictions should incorporate ageing and secular trends in obesity, reflecting changes in diet and physical activity, as well as genetic contributions from familial aggregation.

This paper describes a demographic, epidemiological model of Singapore and its use in forecasting the total prevalence of T2DM to 2050. It is an individual-based model which represents each resident in the city-state, past and future, thereby facilitating the incorporation of obesity trends, both secular and over and individual's life span. The model incorporates sub-models for mortality, fertility, migration, body mass index trajectories, genetics and workforce participation, parameterized using Markov chain Monte Carlo methods, and permits forecasts by ethnicity and employment status. BMI trajectories, demographics, and genetic risk are used together within the T2DM onset model. Evidence synthesis comes from multiple data streams -- national statistics, national health surveys, four cohort studies, and known risk factors such as aging, obesity, ethnicity, and genetics.
The results show that incident rates of T2DM are expected to double over the period 1990-2050 for all demographic groupings. The total prevalence of T2DM is projected to rise from 7.3% in 1990 to 15% in 2050.

This is driven by two factors: the modelled ageing and evolving obesity. The proportion of the population over age 60 is predicted to increase from 13.3% in 2010 to 31.9% in 2050 while the proportion of the population under age 20 is falling from 25.2% in 2010 to 15.9% in 2050. We forecast that obesity prevalence will quadruple from 4.3% in 1990 to 15.9% in 2050, while the proportion of overweight people is projected to expand from 24.6% in 1990 to 38.6% by 2050. The lifetime risk for T2DM for Singaporean adults aged 18-69 is projected to rise from 34.5% in 1990 to 43.8% in 2050. Ethnic Indians and Malays will bear a disproportionate burden compared with the Chinese majority, and the number of patients with diabetes in the workforce will grow markedly.

If the recent rise in obesity prevalence continues, there will be concomitant implications for greater healthcare expenditure, productivity losses, and the targeting of health promotion programmes. Forecasting the changing burden of T2DM in Singapore which will accompany the aging population is vital to plan the resources needed and motivate preventive efforts. Going forward, the long term goal is to bring together three models: the present one, which projects prevalence of T2DM in subpopulations; a model of outcomes; and a model of interventions. These will allow the assessing of effectiveness and the cost effectiveness of different health promotion interventions by determining how much of a reduction to levels of overweightness and obesity would be needed to substantially reduce the burden of T2DM, and how much can realistically be achieved by health promotion campaigns.

* Based on Phan TP, Alkema L, Tai ES, et al. "Forecasting the burden of type 2 diabetes in Singapore using a demographic epidemiological model of Singapore". *BMJ Open Diabetes Research and Care* 2014;2:e000012. doi: 10.1136/bmjdrc-2013-000012