Risk factor modelling with the Proportional Multi-State Life Table model

Lennert Veerman
The University of Queensland
School of Public Health

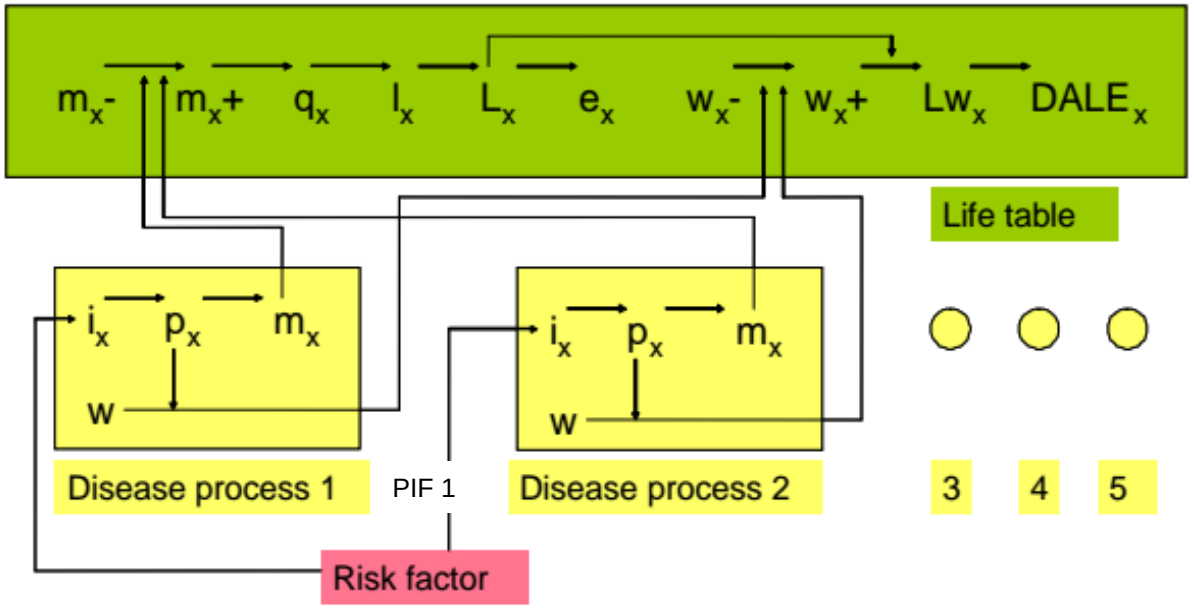
The University Of Queensland
AUSTRALIA

Overview

- The proportional multi-state life table model (MSLT)
- Exposure distributions
- Potential impact fractions
- Past and present projects
- Example: taxing sugary drinks in South Africa
- Strengths and weaknesses

A/Prof Jan Barendregt
Director at Epigear International Pty Ltd

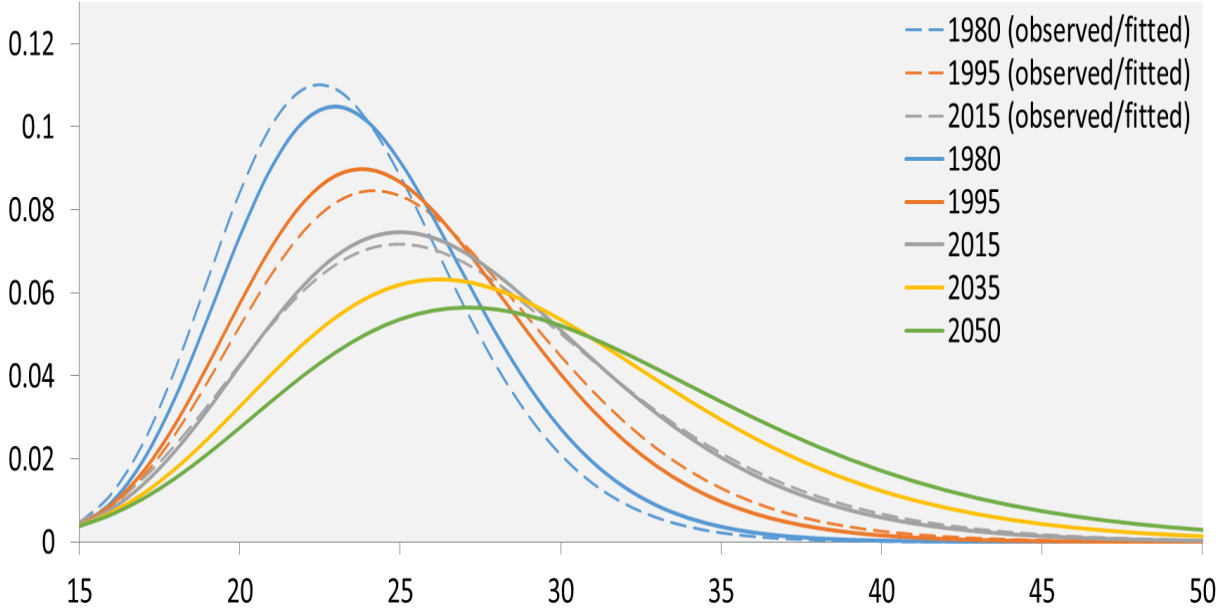
Proportional Multi-State Life table Markov Model



From the above table: x is age; i is incidence; p is prevalence; m is mortality; w is disability-adjustment; q is probability of dying; l is number of survivors; L is life years; Lw is disability-adjusted life years; e is life expectancy and DALE is disability-adjusted life expectancy, and where '-' denotes a parameter that specifically excludes modelled diseases, and '+' denotes a parameter for all diseases (i.e. including modelled diseases).

Vos et al. ACE Prevention Final Report, 2010
Barendregt et al. *Math Popul Stud* 1998;7:29–49

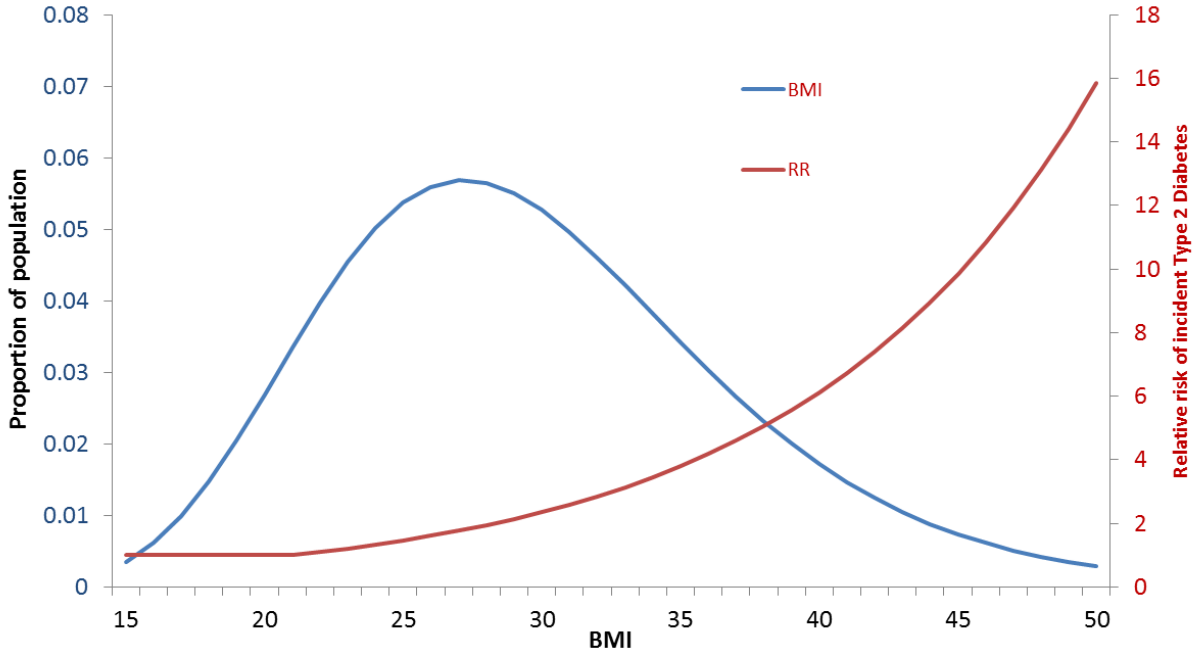
The shifting population distribution of BMI



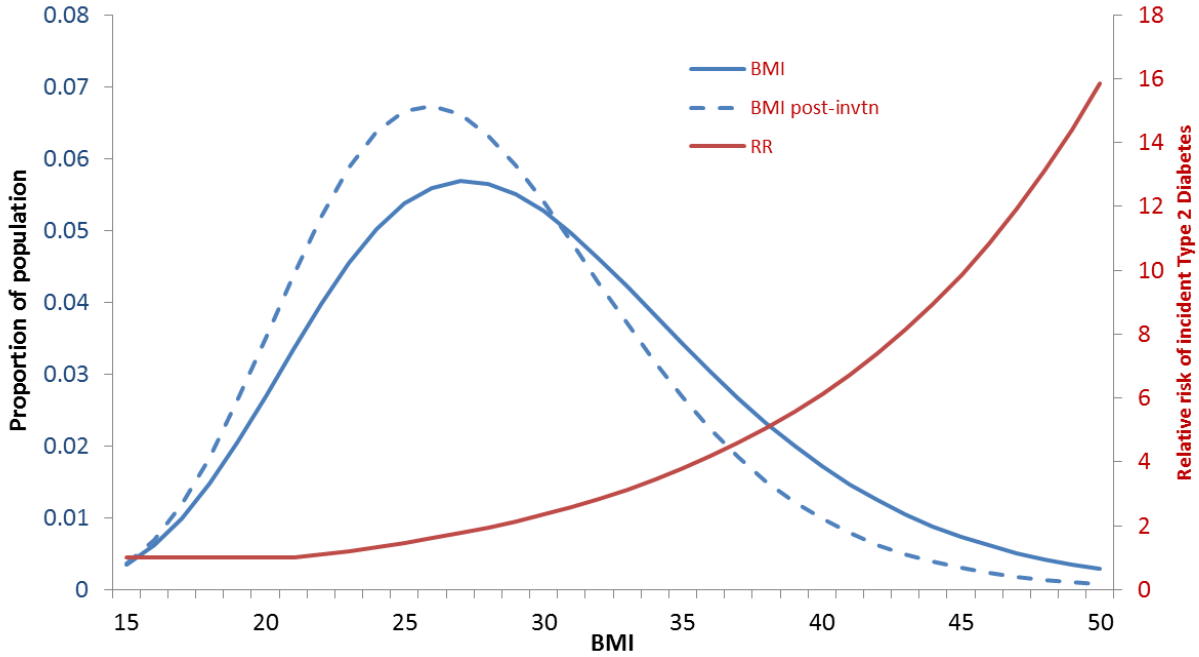
Australia, women

ANZOS 2016 Poster - King Wa Tam

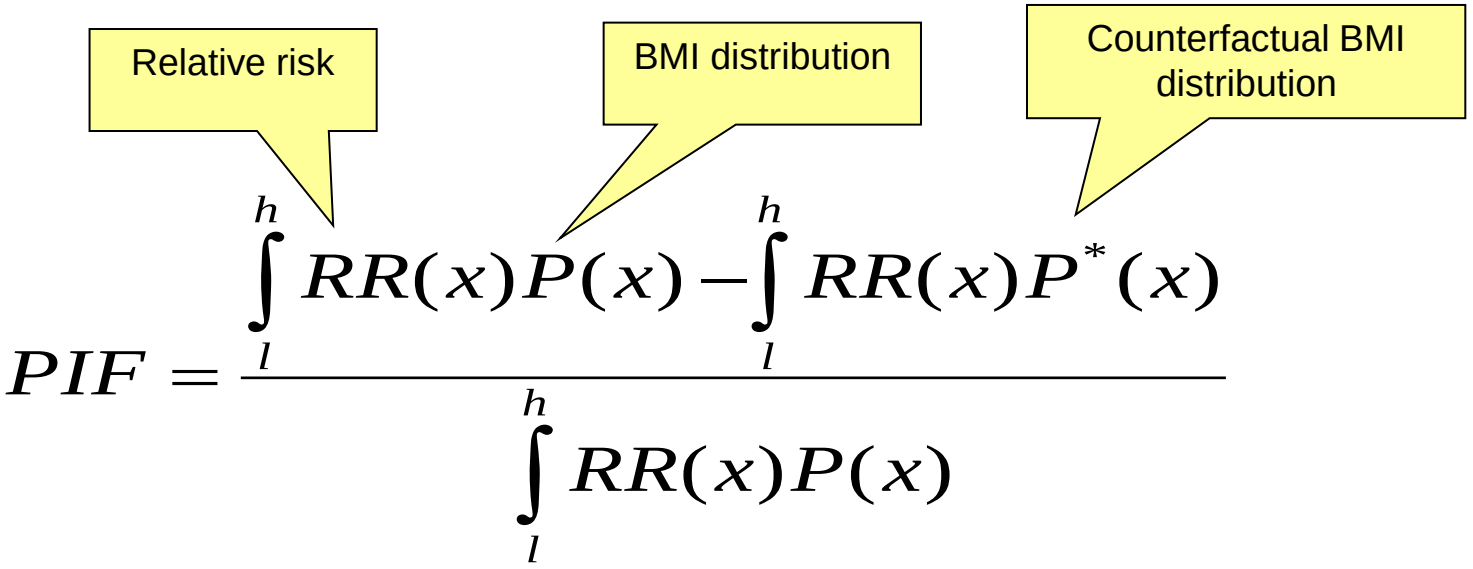
Intervention effects



Intervention effects



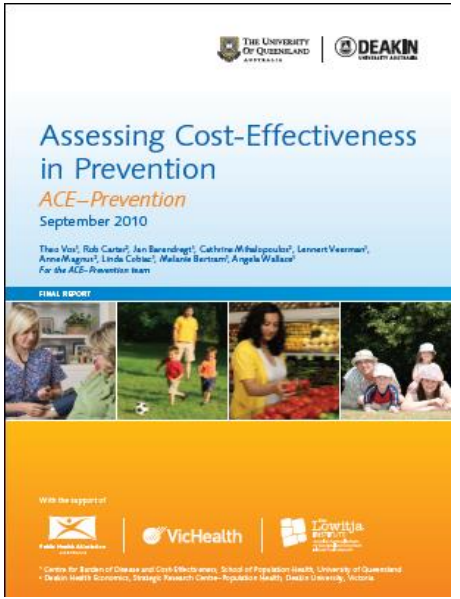
Intervention effects – Potential Impact Fractions



Barendregt JJ, Veerman JL. Categorical versus continuous risk factors, and the calculation of potential impact fractions. JECH. 2010;64:209-12.

ACE Prevention

- 5-year study concluded in 2011
- 150 interventions, 123 in prevention
- Modelled population of Australia, 2003, followed lifetime
- Health sector perspective incl. costs to patients/participants
- Standardised methods
- Acknowledging other criteria in decision making

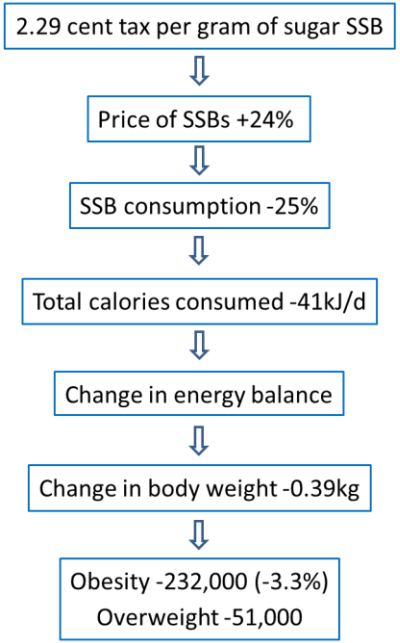


https://public-health.uq.edu.au/assessing-cost-effectiveness-ace-prevention-study

Further work

- Australia (obesity)
- South Africa (obesity)
- NZ (tobacco, salt)
- USA (childhood obesity, e.g. Am J Prev Med. 2015 Jul;49:102-159)
- World Bank (SSB tax in China, Indonesia, Philippines, Fiji)
- Canada (obesity)
- Estonia (obesity)

Example: taxing sugary drinks (SSBs) in South Africa



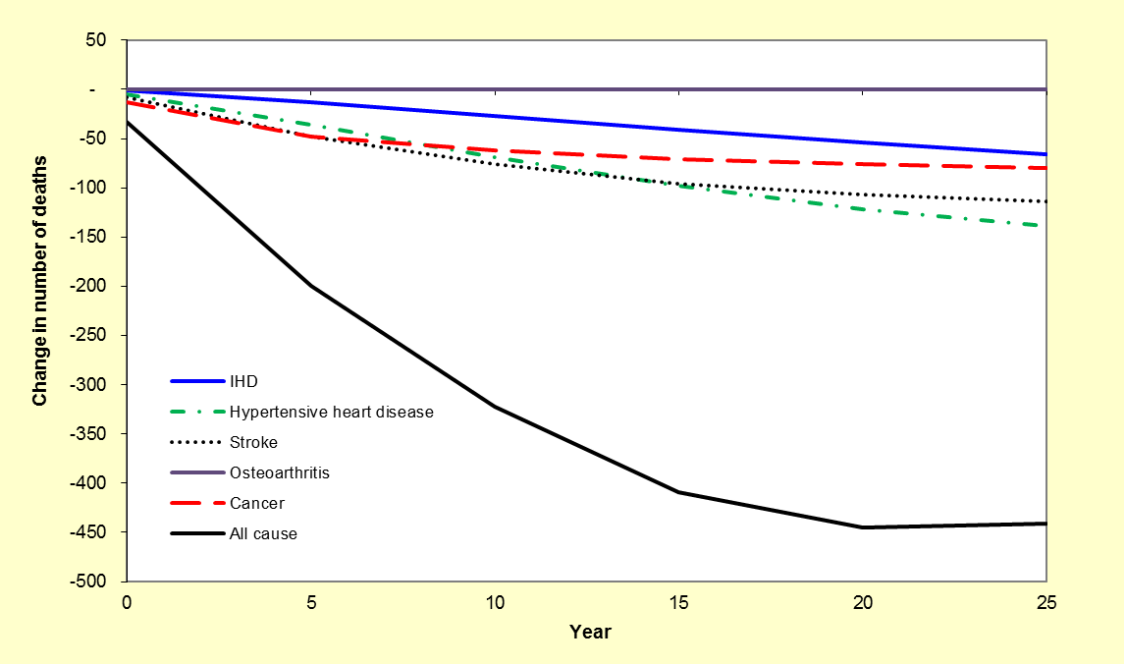
July 2016 South African Treasury proposal

Price elasticities Cabrera Escobar et al. (2013)

Based on observational study (Hall 2011)

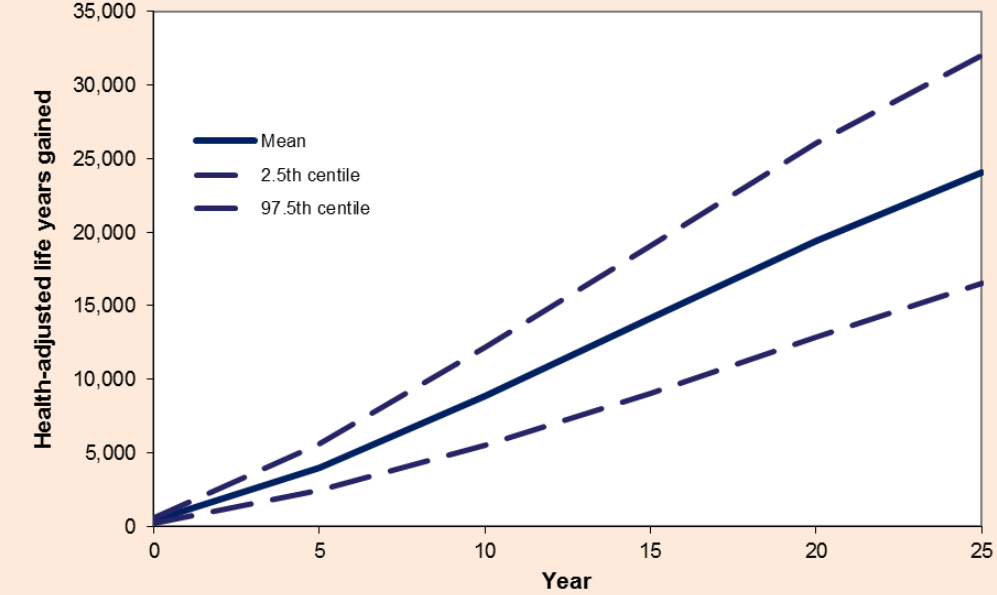
Preliminary results

SA SSB tax: Reduced mortality



Preliminary results

SA SSB tax: Healthy life years gained



Lifetime HALYs:
1.59 million
(1.13–2.01 m)

Preliminary results

SOWETAN (Late Final)
20 Aug 2014, p.6

CALL FOR 20% LEVY ON FIZZY DRINKS

South Africa becoming a obese natio

SUGAR TAX CAN FIGHT FAT – STUDY

A NEW research paper from the University of the Witwatersrand has added credence to Health Minister Aaron Motsoaledi's proposed sugar tax.

The research paper says

BUSINESS DAY (Late Final)
20 Aug 2014, p.1

Sugar tax mooted to save lives and money

Nomaswazi Nkosi
Health Reporter

SUGAR may become the new sweet and sour of t food industry.

And soon consumers m have to pay a tax on nature's sweet temptatio

A recent study conduct by the University of the W watersrand shows that a sugar tax, as suggested b the department of health, sugar-sweetened beverag (SSBs) could reduce obes in adults.

Sugar-sweetened bever ges include fizzy drinks (cold drinks) and sweeter juices.

According to the resea paper, in South Africa 7% all deaths were attributal to excess body weight in 2000. Obesity related dis eases are among the top causes of death and their prevalence rates rival the of HIV/Aids.

The World Health Orga sation estimates that wor wide, obesity-related dise ses account for more tha 2.8 million deaths annual

Being overweight or obese increases the risk contracting diabetes, hea disease, high blood pres sure, stroke and cancer b four to eight times.

According to Professor Karen Hofman, one of the authors of the research paper (The Potential Imp

TAMAR KAHN
Science and Health Writer

CAPE TOWN — A 20% tax on sugar-sweetened drinks could cut the number of obese South Africans by almost a quarter of a million, saving lives and money, local research has found.

The study is important, because it adds to the limited research available to low- and middle-income countries on this contentious issue. Only a few countries have introduced taxes on sugared drinks and they have all encountered strong opposition from the soft-drink industry.

Mexico imposed a sugar tax in January. At the end of February, Coca-Cola reported a 5% drop in sales in Mexico.

"It is the responsibility of the government to protec of its population. One so is through nudgin make healthier and m able choices," said U the Witwatersrand Mercy Manyema, the of the study, publishe by the Public Library

Obesity rates h

Coca-C report drop ir Mexic of Feb year a tax wa there.

ANDRE

STAR
20 Aug 2014, p.4

Wits study supports 20% sugar tax proposal

VUYO MKIZE
vuyo.mkhize@inl.co.za

A NEW study on the suggested tax on sugar-sweetened beverages (SSBs) has added weight to the effect such taxes may have on the country's high obesity levels.

A team of researchers from the University of Witwatersrand have authored a paper entitled "The potential impact of a 20 percent tax on sugar-sweetened beverages on obesity in South African adults: A mathematical model".

The paper was published in the prestigious open-access journal PLOS ONE yesterday. It found that the prevalence of obesity and the consumption of SSBs in South Africa had risen sharply.

"Research shows that consumption of SSBs leads to weight gain in both adults and children, and reducing SSBs will significantly impact the prevalence of obesity and its related diseases," the study said.

The lead authors are Dr Lennert Veerman, Dr Lumbwe Chola, Professor Benn Sartorius, Mercy Manyema, Professor Demetre Labadarios, Aviva Tugendhaft and Professor Karen Hofman.

The paper draws reference to the 2003 SA Demographic and Health Survey as well as the 2012 National Health and Nutrition Examination Survey, which showed that in less than a decade, obesity prevalence had risen from 8.8 percent to 10.6 percent in men.

In women, levels increased from 27.4 percent to 39.2 percent.

The researchers conducted a mathematical simulation model to estimate the effect of a 20 percent SSB tax on the prevalence of obesity, using 2012 as the baseline year.

They found that by instituting a 20 percent tax, in other words, a 20 percent price increase per unit of SSBs,

These fizzy drinks do not contain any essential nutrients

n to consumers and reduce emand. The average daily energy ntake per person would fall by 36 ilojoules, which would translate nto 222,669 fewer obese adults.

"The cost of obesity and the omplications caused by obesity-elated diseases have a very erious financial impact on the amily, caregivers and bread-winners," study co-author Karen Hofman said. A sugar tax would ot necessarily harm the eco-omy, she said, as beverage com-anies could promote alternative roducts such as bottled water.

The Beverage Association of SA said a "discriminatory" tax was ot an "effective measure because vidence shows consumers switch o different alternatives of the ame or similar foods instead".

ahnt@bdfm.co.za

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Building the case for a sugar tax in South Africa

PRICELESS SA
Priority Cost Effective Lessons for System Strengthening

Nov 2013: Evidence that a tax on sugar sweetened beverages reduces the obesity rate: a meta-analysis. *BMC Public Health*

Aug 2014: The potential impact of a 20% tax on sugar-sweetened beverages on obesity in South African adults: a mathematical model. *PLoS One*

Oct 2015: Cost of inaction on sugar-sweetened beverage consumption: implications for obesity in South Africa. *Public Health Nutr*

Nov 2015: Decreasing the Burden of Type 2 Diabetes in South Africa: The Impact of Taxing Sugar-Sweetened Beverages. *PLoS One*

May 2016: Modelling the potential impact of a sugar-sweetened beverage tax on stroke mortality, costs and health-adjusted life years in South Africa. *BMC Public Health*

2013

2014

2015

2016

2017

Professor Karen Hofman,
Director of PRICELESS SA
Wits University

Aug 2014: Media storm

Feb 2016: Finance Minister Pravin Gordhan announces 'sugar tax'

Jul 2016: South African Treasury proposes tax of 2.29 cent tax per gram of sugar per litre of SSB.

The University Of Queensland
AUSTRALIA

Strengths

- Multiple diseases and causes of death
- Accounts for replacing mortality and morbidity by integrating the impact of specific diseases in a life table
- Include impact on health-related quality of life at every age
- Implementation in MS Excel makes it flexible and accessible to researchers without programming skills (but also makes it somewhat error-prone)
- Basic structure is easily adaptable, and the use of data from e.g. the Global Burden of Disease enables to produce outcomes for any desired country, and a wide range of risk factors and diseases.
- Trends can be incorporated (but this increases complexity and runtime).

Limitations

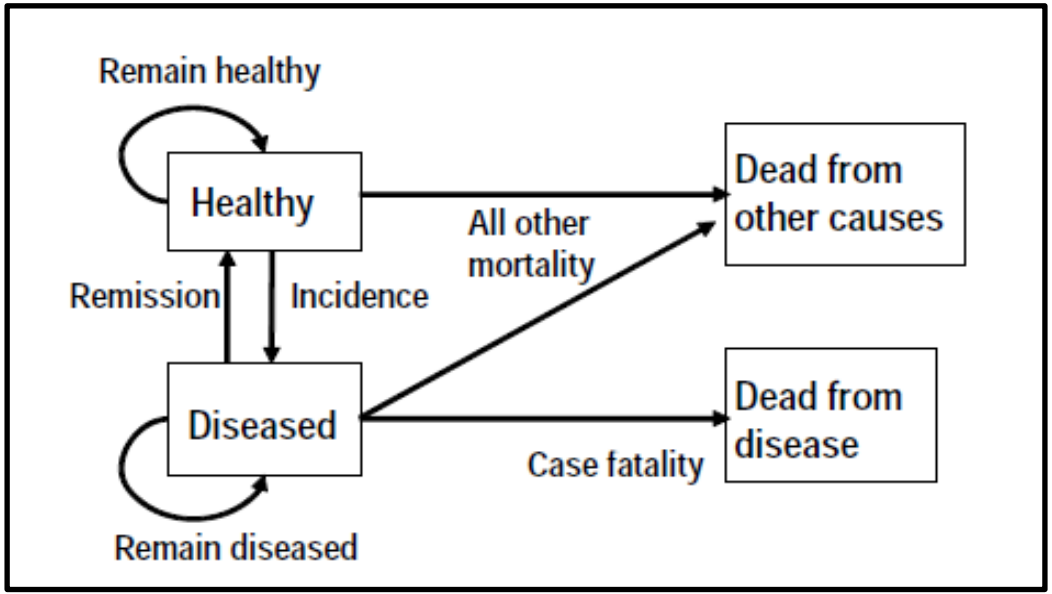
- requires add-in software for the Monte Carlo simulation (we use Epigear's Ersatz)
- Provide results at the aggregate level; estimating the impact on socio-economic differences in health requires modelling each population subgroup separately
- Clustering of diseases or risk factors not modelled

Thank you

With thanks to Rainer Fehr, Johan Mackenbach, Fintan Hurley and Odile Mekel for organizing this workshop and for their kind invitation, and to Universität Bielefeld for the financial support that enabled me to attend this conference.

The Crystal Ball 1902 by John William Waterhouse

DISMOD II



Source: Barendregt et al, Population Metrics, 2003