A Shiny new app for policy makers: Using simulation to test which factors most improve child well-being

Barry Milne and COMPASS team

COMPASS Seminar Series
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Outline

- **Background**
  - Knowledge translation
  - Knowledge Lab of the early life-course
    - Model development

- **What is microsimulation?**
  - A simple example

- **A Shiny app for policy**
  - Demonstration
  - Policy scenarios: Obesity, Education, Mental health
Background
- Knowledge translation

Knowledge translation: How to do?
- ‘Push system’
  Researchers create knowledge; policy makers use it (or not)
- ‘Pull system’
  Policy makers seek out or request information to fit their purpose
- Emphasises divide between researches and policy makers, across which knowledge is pushed and pulled
  • Knowledge brokers may be employed to ‘translate’
- Co-production of knowledge through policy-research partnerships
  • Shown to improve knowledge translation
Background - Goal

Our goal:
- Collaborate with policy makers to produce a policy tool in which knowledge is embedded, but which can be interrogated by policy makers, and can be updated as per the needs of policy makers

Knowledge Laboratory of the early life course
- Identify key determinants of child and adolescent outcomes (to age 21)
- Integrate estimates from systematic reviews/meta analyses into working microsimulation model of early life course (built upon earlier MELC model)
- Make available for use by policy makers (and others) as a ‘knowledge laboratory’ to test policy scenarios
- Web deployment to aid uptake (https://compassnz.shinyapps.io/knowledg_labshiny)
Knowledge Lab
- End user engagement

- Important role of policy reference “End User” group
  • Use their expertise to determine what they’d like modelled policy-relevant scenarios

- Seven agencies involved
  • Health
  • Education
  • Social Development
  • Justice
  • Te Puni Kōkiri
  • Children’s Commission
  • SuPERU
Focus on three outcomes
- Obesity
- Education
- Mental Health

For each outcome
- Determine conceptual framework
- Get NZ prevalences and inter-relations for each predictor in the conceptual framework
- Get meta-analytic estimates for each path in the conceptual framework
- Build (upon) a computer simulation model to quantify the underlying determinants of obesity, education and mental health
Obesity - Conceptual framework

Prenatal | Birth | Postnatal | Infancy | Childhood/Adolescence

SES

- Maternal smoking
- Birth weight
- Breast feeding
- Quality of sleep

Maternal BMI

- Caesarean
- Early solid foods
- Rapid weight gain
- Energy balance

Preterm birth

- Parental BMI
- Overweight/Obesity
Mental health - Conceptual framework

- **Prenatal/Birth**
- **Infancy**
- **Childhood**
- **Adolescence**
- **Young adulthood**

**Socioeconomic Status of parents**

- Stressful life events/adversity
  - Parental attachment/warmth
  - Maltreatment

- Gender
- Parental substance abuse
- Parental depression

- ADHD
- School attainment
- Smoking

- Obesity
- Peer relations

- Substance Abuse (Alcohol/Drug)

- Depression
Knowledge Lab - Conceptual framework(s)
Literature comparing effect sizes for Māori vs non-Māori

- Getting meta-analytic estimates from literature all very well
  - …But will they accurately represent estimates for Māori? (or Pacific, etc…)

- Searched the literature for papers looking at health, education, psychosocial functioning for Māori youth, and found...
  - Most in health area, e.g. smoking (n=49), asthma (n=30)

- Few papers looked at risk factors (n=68; 10%)
  - Largely found in the smoking literature (n=14; 20%)
  - 38/68 reported whether magnitude of risk factor estimates differed for Māori vs non-Māori
Literature comparing effect sizes for Māori vs non-Māori

- 103 interactions reported (from the 38 papers)
- 63 reported that associations differed between Māori and non-Māori
  - Involving obesity (deprivation, rurality) – accounted for
  - Involving depression (family dysfunction) – not included
  - Involving alcohol (proximity to outlets) – not included

- 40 reported that associations did not differ between Māori and non-Māori
What is Microsimulation?

- Simulates plausible data for micro-level units (i.e., people, businesses, …)

- It (typically) uses empirical data as a basis to simulate real or alternative worlds, and their futures

- It enables experimentation in a virtual lab
Microsimulation: A virtual world

- Start with a real (or realistic synthetic) sample of people
- Apply statistically-derived rules to reproduce patterns via a stochastic process
- In so doing, create a virtual world (our simulation model)
- Predict what might happen if conditions were to change (i.e., by altering parameters)
A simple worked example
(made up)

• Suppose every child born has the same probability of attending early childhood education (ECE)
  • $p = 0.50 \leftarrow \text{transition probability}$

• And that those who **do attend** have the probability of leaving school with qualifications (SCQUAL):
  • $p = 0.80 \leftarrow \text{transition probability}$

• And that those who **don’t attend** have the probability of leaving school with qualifications:
  • $p = 0.50 \leftarrow \text{transition probability}$
A simple worked example

- Simulation is a **stochastic** process, so you get different results each time
  - On each simulation run, different units may be simulated as
    (i) attended ECE
    (ii) left school with qualifications

Imagine 2 individuals

<table>
<thead>
<tr>
<th></th>
<th>p(ECE)</th>
<th>ECE?</th>
<th>p(ScQ)</th>
<th>ScQ?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abby</td>
<td>0.5</td>
<td>Yes</td>
<td>0.8</td>
<td>Yes</td>
</tr>
<tr>
<td>Brian</td>
<td>0.5</td>
<td>No</td>
<td>0.5</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>p(ECE)</th>
<th>ECE?</th>
<th>p(ScQ)</th>
<th>ScQ?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run1</td>
<td>0.5</td>
<td>Yes</td>
<td>0.8</td>
<td>Yes</td>
</tr>
<tr>
<td>Run2</td>
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<td>0.5</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>No</td>
<td>0.5</td>
<td>Yes</td>
</tr>
</tbody>
</table>
A simple worked example

- Simulation is a **stochastic** process, so you get different results each time
  - On each simulation run, different units may be simulated as
    (i) attended ECE
    (ii) left school with qualifications

- Best to take a number of runs and average…

- For 5 runs & 20 units
  - Av=10.2/20 attended ECE
  - Av=13.2/20 left school with qualifications
A simple worked example

- Suppose an intervention is suspected to increase the probability of children attending ECE to
- $p = 0.80$

- But the probability of leaving school with qualifications remains the same
  ($p=0.80$ for attenders; $p=0.50$ for non-attenders)

- What would happen??
A simple worked example

- For 5 runs & 20 units,
- Av=16/20 attended ECE
- Av=14.8/20 left school with qualifications, an increase from 13.2/20 (8% increase)

- A very simple model for which simulation probably not needed…
  …But if lots of factors affect ECE attendance, and its association with school qualifications (through potentially multiple pathways)

Microsimulation can capture this in one model, and allows counterfactuals to be tested
SHINY - Data visualisation using R
Demonstration - Model inputs
Demonstration - Model inputs
Demonstration - Model inputs

OR = 0.47 (Maternal emotional responsiveness vs None) Age 12 to 18
Yap et al, 2014
Demonstration - Model inputs
Demonstration - Scenario builder

Variable

STEP 1: Name your scenario
Scenario1

STEP 2: Select Variable to Examine
ADHD

STEP 4 (optional): Select Subgroup for subgroup formula:
None

STEP 5: Click after every variable adjustment
Add Scenario

STEP 6 (optional): Choose number of Runs:
10

Scenario simulation log:
Step 7:

Setting the Scenario

STEP 3: Variable Adjustment

<table>
<thead>
<tr>
<th>Level</th>
<th>ADHD</th>
</tr>
</thead>
<tbody>
<tr>
<td>No (%)</td>
<td></td>
</tr>
<tr>
<td>Yes (%)</td>
<td></td>
</tr>
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</table>

Base value for the Variable:

<table>
<thead>
<tr>
<th>ADHD</th>
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<tbody>
<tr>
<td>Var</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>
Demonstration - Scenario builder

Variable

STEP 1: Name your scenario
Obesity

STEP 2: Select Variable to Examine
Breakfast consumption

STEP 4 (optional): Select Subgroup for subgroup formula:
None

STEP 5: Click after every variable adjustment
Add Scenario

STEP 6 (optional): Choose number of Runs:
10

Scenario simulation log:
Breastfeeding (months) has been added inserted in the scenario.
Breakfast consumption has been added inserted in the scenario.

STEP 3: Variable Adjustment

<table>
<thead>
<tr>
<th>Level</th>
<th>Breakfast consumption</th>
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<tbody>
<tr>
<td>No (%)</td>
<td>9.00</td>
</tr>
<tr>
<td>Yes (%)</td>
<td>91.00</td>
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</table>

Base value for the Variable:

<table>
<thead>
<tr>
<th>Var</th>
<th>Year</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>Childhood</td>
<td>18.2</td>
</tr>
<tr>
<td>Yes</td>
<td>Childhood</td>
<td>81.8</td>
</tr>
</tbody>
</table>
Demonstration
- Table builder

Variable

STEP 1: Select Summary Measure
Percentage

STEP 2: Choose variable:
Overweight

Select a level to compare in plot:
Overweight

STEP 3 (optional): Select ByGroup:
None

STEP 4 (optional): Select Subgroup for subgroup formula:
None

Subgroup formula:

STEP 5 (optional): Apply subgroup to:
Scenario population (After scenario testing)

STEP 6 (optional):
- Confidence Interval

STEP 7 (optional):

Graph:
- Overweight
- Year
- Percentage
- Line plot (Percentage and Mean only)
- Box plot (Quantile only)
THANK YOU!!

https://compassnz.shinyapps.io/knowlabshiny