National SCIENCE Challenges

A BETTER START

E Tipu e Rea

Testing the impact of policy using microsimulation

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COMPASS Seminar, 27 February 2024

A Better Start is funded by the Ministry of Business, Innovation and Employment

Host Institution

Acknowledgements

- Work undertaken as part of the ‘A Better Start’ National Science Challenge
  - Successful Learning: Gail Gillon, Brigid O’Neill, Megan Gath
  - Health Weight: Rachael Taylor, Wayne Cutfield, Sarah Maessen
  - Resilient Teens: Karolina Stasiak, Sarah Hetrick, Ruth Williams
  - Modelling: Kevin Chang, Eileen Li, Chris Ball, Oliver Mannion, Jessica McLay, Nichola Shackleton, Steph D’Souza, Roy Lay-Yee, Janet Pearson, Peter Davis, Martin von Randow

Background

- Need to evaluate the impact of a policy change or intervention
- Expensive to try out and see
- Simulation offers possibility to model interventions on a virtual world
  - Can model the complexity of multiple associations and pathways

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/realistic (synthetic) sample of people
- Apply statistically-derived rules to reproduce patterns via a stochastic process
- 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 ← **transition probability**

- And that those who **do attend** have the probability of leaving school with qualifications (SCQUAL):
- p = 0.80 ← **transition probability**

- And that those who **don't attend** have the probability of leaving school with qualifications:
- p = 0.50 ← **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

	Run1				Run2			
	p(ECE)	**ECE?**	**p(ScQ)**	**ScQ?**	**p(ECE)**	**ECE?**	**p(ScQ)**	**ScQ?**
Abby	0.5	Yes	0.8	Yes	0.5	No	0.5	No
Brian	0.5	No	0.5	No	0.5	No	0.5	Yes

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…
- <u>For 5 runs & 20 units</u>
- 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 percentage point 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

International models (Int J Microsimulation)

The Cost of Basic Income in the United Kingdom: A Microsimulation Analysis

Karl Widerquist, Georg Arndt

A Dynamic Microsimulation Model for Ageing and Health in England: The English Future Elderly Model

Luke Archer, Nik Lomax, Bryan Tysinger

Simulations of Policy Responses During the COVID-19 Crisis in Argentina: Effects on Socioeconomic Indicators

Julian Martinez-Correa, Guillermo Cruces, Juan Menduiña, Jorge Puig

Aotearoa-New Zealand models

Tax and Welfare Analysis TAWA (The Treasury) is a model of the New Zealand personal tax and transfer system, based on the Household Economic Survey.
TAWA is used to monitor the effects of potential policy changes on individuals, scaling up and aggregating the results so that they are representative of the New Zealand population.

MSIM (Ministry of Social Development) applies the rules of the benefit system to simulate benefit eligibility and payments, for past and current MSD clients.
The model runs several different scenarios including identifying the winners/losers resulting from specific policy changes and modelling fiscal costs.

Pinto Sarah A and Warn Verity (February 2024). Microsimulation models. Current state and future potential in New Zealand Government agencies. (Working Paper). Social Wellbeing Agency.

Aotearoa-New Zealand models

Monty (Ministry of Transport) models the travel movements of a representative sample of 10 percent of the NZ population across a 24-hour period.
The model aims to answer how a policy change (e.g. road pricing) is expected to affect travel behaviour – and the social and environmental impacts of such a change.

He Ara Poutama mō te Reo Māori (Te Mātāwai, Te Taura Whiri i te Reo Māori, and the Ministry of Education) forecasts the number of te reo Māori speakers from now until 2040. It is used to understand who is speaking te reo Māori and where, as well as how changes to certain revitalisation initiatives may affect future numbers of te reo Māori speakers.

Pinto Sarah A and Warn Verity (February 2024). Microsimulation models. Current state and future potential in New Zealand Government agencies. (Working Paper). Social Wellbeing Agency.

COMPASS Models

- **2005-2008** Primary Care in an Aging Society (PCASO)
  - HRC
- **2009-2012** Balance of Care in an Aging Society (BCASO)
  - HRC
- **2009-2013** Modelling the Early Life Course (MELC)
  - Foundation for Research Science and Technology (FRST)
- **2013-2016** Knowledge Laboratory of the Early Life Course
  - MBIE; https://compassnz.shinyapps.io/knowlabshiny/
- **2015-2017** New Zealand as a Social Laboratory
  - RSNZ; https://compassnz.shinyapps.io/SociaLabShiny/
- **2022-2024** Better Start National Science Challenge
  - MBIE; https://compassnz.shinyapps.io/BetterStartModelShiny/

Better Start Simulation Model

- Successful Learning
  - Better Start Literacy Approach
    → Literacy Yr 1 School → Reading Yr 5 School
- Healthy weight
  - Smoking in pregnancy → obesity
  - POI Sleep Intervention → obesity
- Resilient Teens
  - ‘Stress Less’ Intervention → Wellbeing

Better Start Model ☰

- First Page
- Model input
- Model Builder
- Scenario Builder
- Table Builder

Project upload

Choose Project File

Browse... No

Scenarios Run

Select Scenario for comparison:

Name the Project:

Better Start Model (Simulation Modelling for A Better Start)

Health and wellbeing in childhood and adolescence lays the foundation for a successful transition to a successful adulthood. Evaluating the early-life interventions that have the greatest impact – and also result in more equitable outcomes – is therefore of considerable importance. One way to assess both the impact and equitability of interventions across the life-course is to model the long-term consequences through simulation.

The Better Start Model uses simulation to assess the long-term impact of interventions undertaken as part of the 'A Better Start' National Science Challenge (ABS). These interventions target literacy, early growth, and mental wellbeing. Using effect sizes derived from interventions, the Better Start Model simulates the impact of:

1. The Better Start Literacy Approach on literacy in early childhood.
2. Smoking in pregnancy on obesity.
3. A sleep intervention on obesity.
4. 'Stress Less' intervention on wellbeing in early adulthood.

The effect of simulations can be programmed and visualised using an interactive web application using the Shiny R package and R programming language. This Shiny app can be shared as a web page, which allows the user to run across a number of different platforms, and does not require any specialist software to be installed.

To cite this application, please use the following,

The source code is stored in three places:

- Simario R package is at: https://github.com/kcha193/simarioV2 .
- Models of Better Start is at: under construction.
- Shiny application is at: under construction.

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https://compassnz.shinyapps.io/BetterStartModelShiny

Better Start Model

- First Page
- Model input
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- Scenario Builder
- Table Builder

Project upload

Choose Project File

Browse... No

Scenarios Run

Select Scenario for comparison:

bsla_50

Name the Project:

Instruction

HOVER OVER an arrow to see the effect sizes and citation for that path.

CLICK ON an arrow to link to the paper(s) the effect sizes come from.

HOVER OVER a bubble to see the levels of that variable.

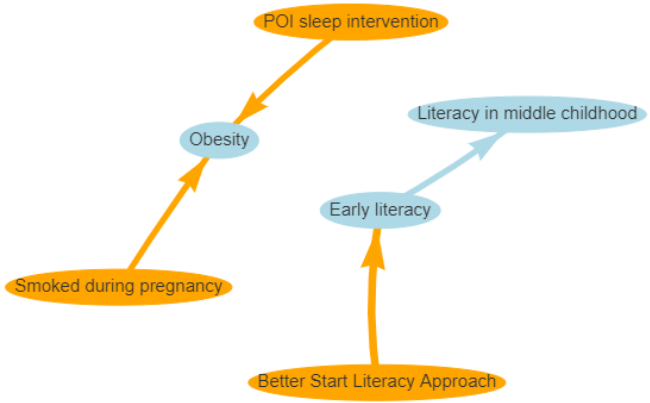
Comments and Suggestions

We encourage users to provide comments and suggestions about the conceptual framework and estimates. In particular, we welcome suggestions for changes and additions where supporting evidence from the literature can be provided.

Contact email:

Barry Milne
Eileen Li
Kevin Chang

Conceptual Framework



Better Start Literacy Approach

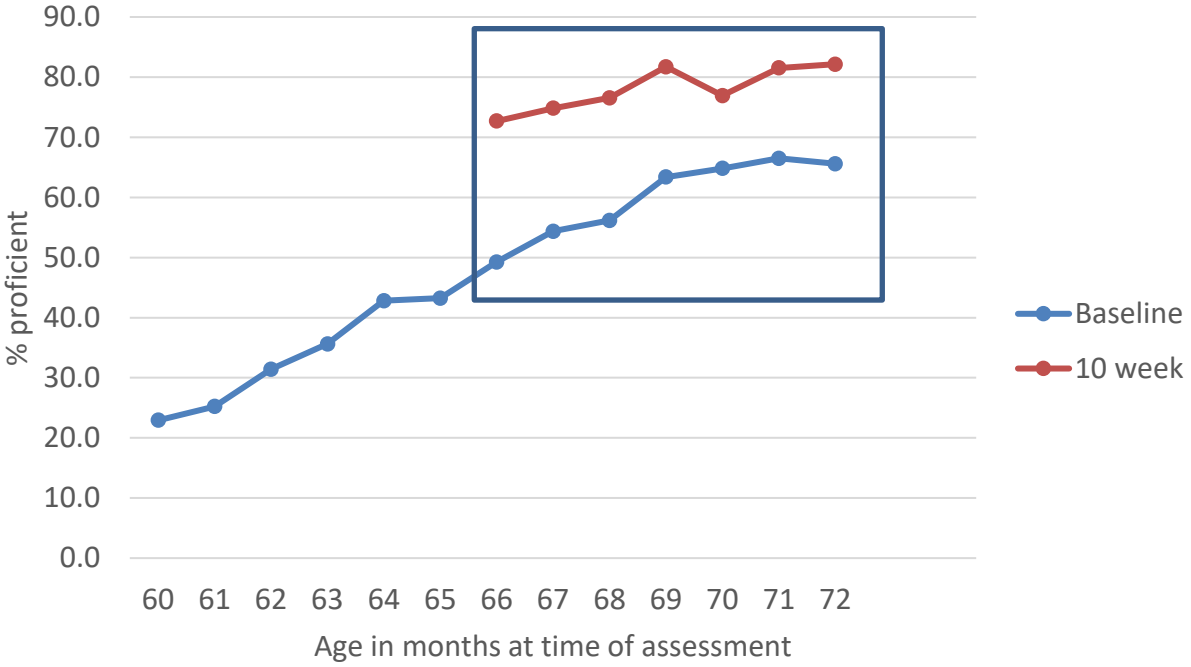
EVIDENCE-BASED LITERACY TEACHING

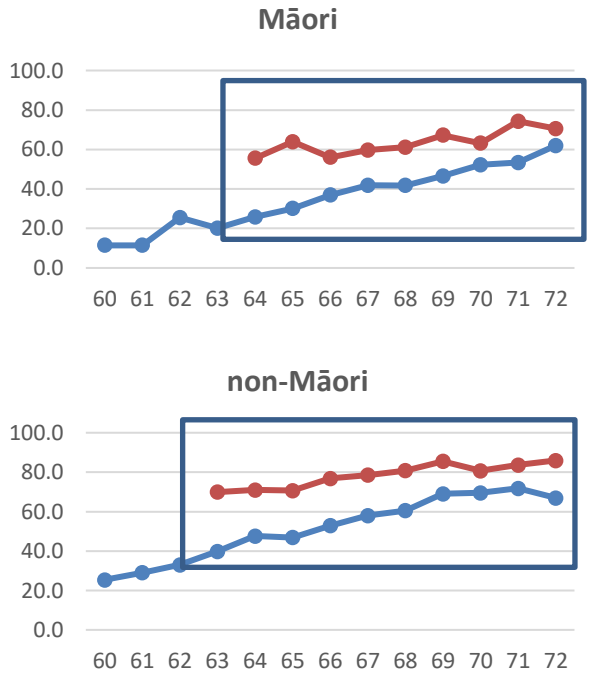
The Better Start Literacy Approach is a structured approach to literacy instruction for Year 0 to Year 2 classrooms, to support children's early reading, writing and oral language success. It has been developed by our team specifically for our New Zealand educational and cultural context and controlled research trials have proven its effectiveness. It includes the systematic teaching of critical phonological awareness skills and letter sound knowledge skills through fun, games-based activities, activities making explicit links to the reading and spelling context, and structured small group reading sessions using the new Ready to Read - Phonics Plus early readers series. In addition, the approach includes explicit teaching in vocabulary skills and in building children's oral narrative and listening comprehension skills through quality children's story books. The Better Start Literacy Approach follows a structured phonics scope and sequence that is used in the class and small group reading teaching.

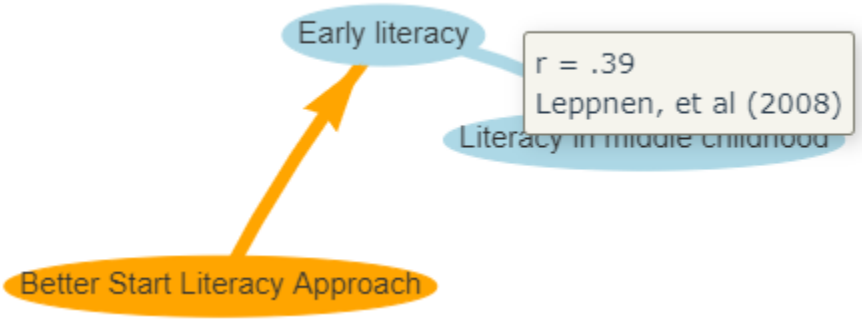
- “teachers monitor children’s response to the BSLA teaching and then scaffold, adapt activities, or increase teaching intensity as necessary to ensure all children progress towards their next steps for learning.”(Gillon et al., 2022)

https://www.betterstartapproach.com

Proficiency in the phoneme identity task






Early literacy
r = .39
Leppnen, et al (2008)
Literacy in middle childhood
Better Start Literacy Approach

Variable

Select Models for simulation:

base_model

STEP 1: Name your scenario

bsla_50

STEP 2: Select Variable to Examine

Better Start Literacy Approach

STEP 4 (optional): Select Subgroup for subgroup formula:

None

Insert | (|) | And | Or | Reset

Subgroup formula:

STEP 5: Click after every variable adjustment

Add Scenario

STEP 6 (optional): Choose number of Runs:

10

Scenario simulation log:

Step 7:

Run Scenario

Setting the Scenario

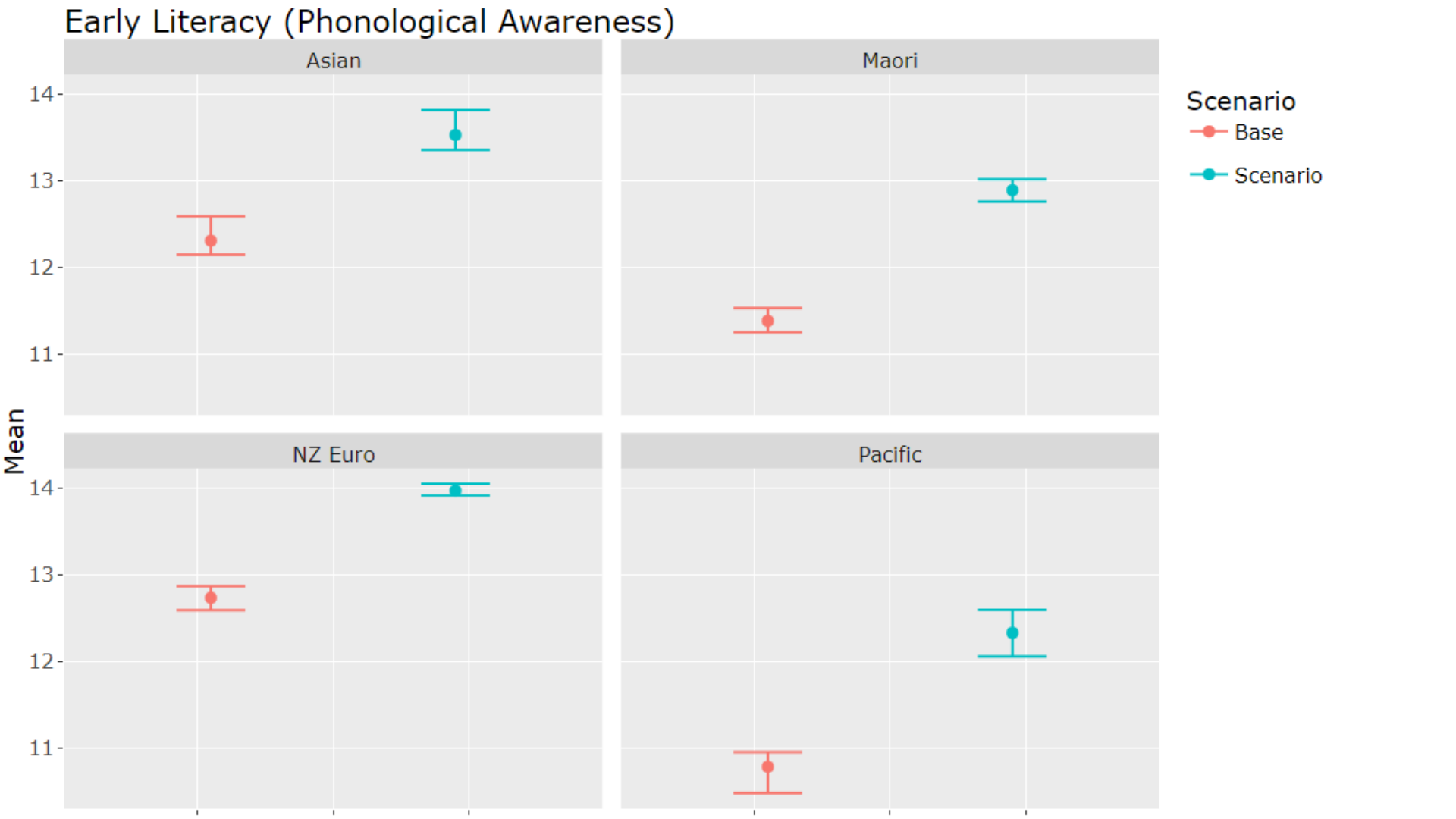
STEP 3: Variable Adjustment

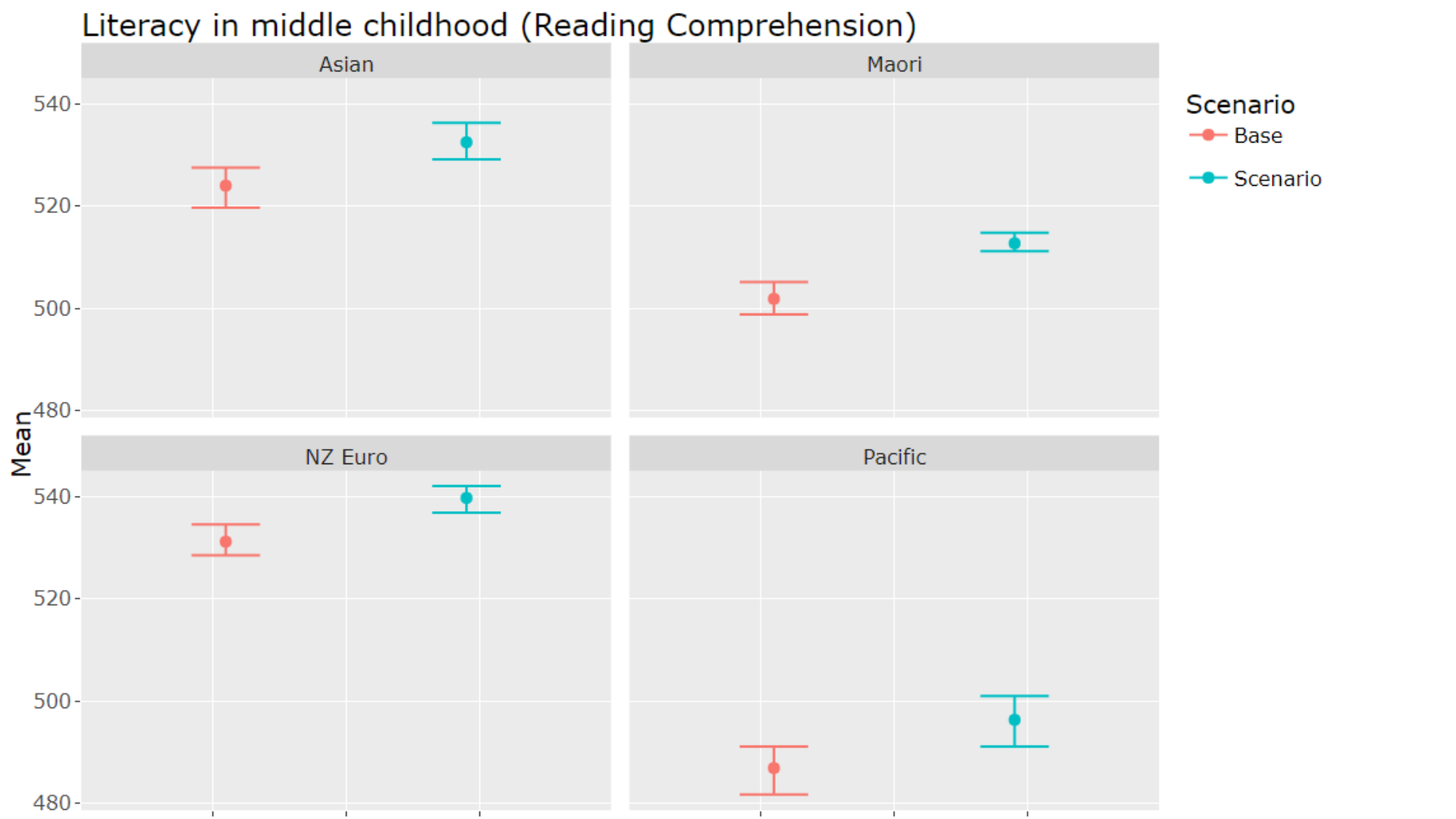
Level	Better Start Literacy Approach
No (%)	50.00
Yes (%)	50.00

Base value for the Variable:

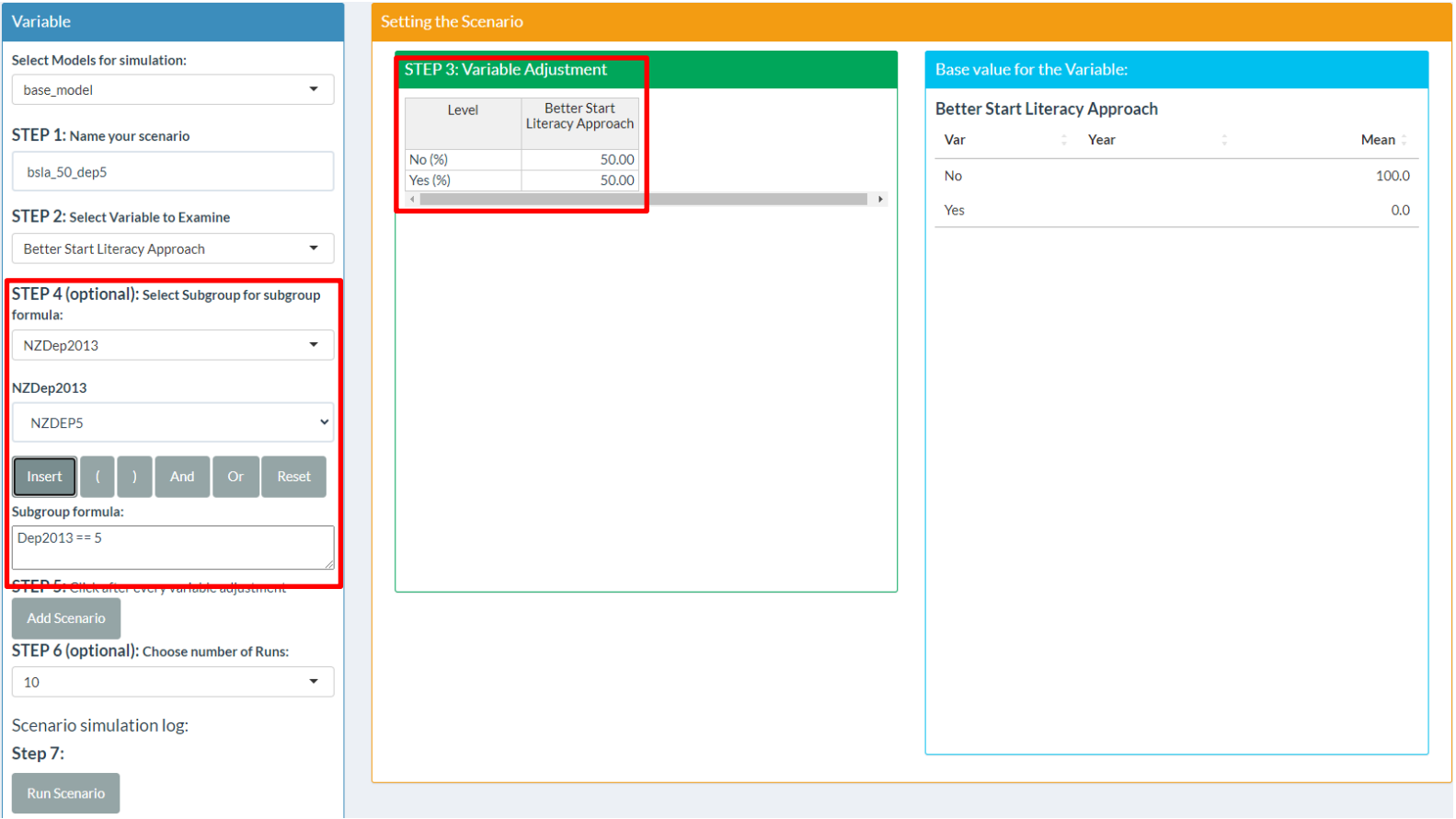
Better Start Literacy Approach

Var	Year	Mean
No		100.0
		0.0


Early Literacy (Phonological Awareness)
Asian
Maori
NZ Euro
Pacific
Mean
14
13
12
11
Scenario
Base
Scenario

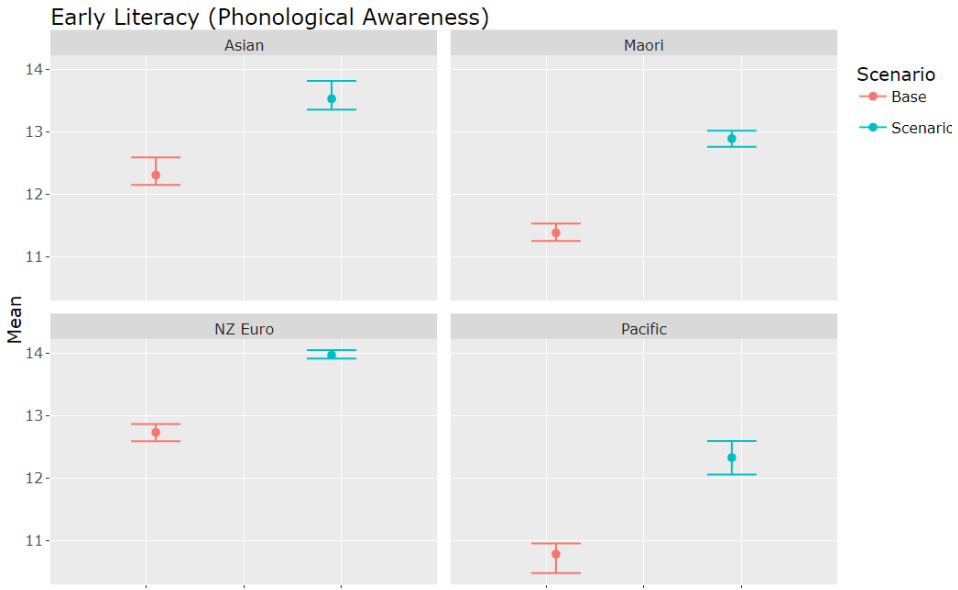

Literacy in middle childhood (Reading Comprehension)
Asian
Maori
NZ Euro
Pacific
Mean
540
520
500
480
Scenario
Base
Scenario

What about a targeted intervention?

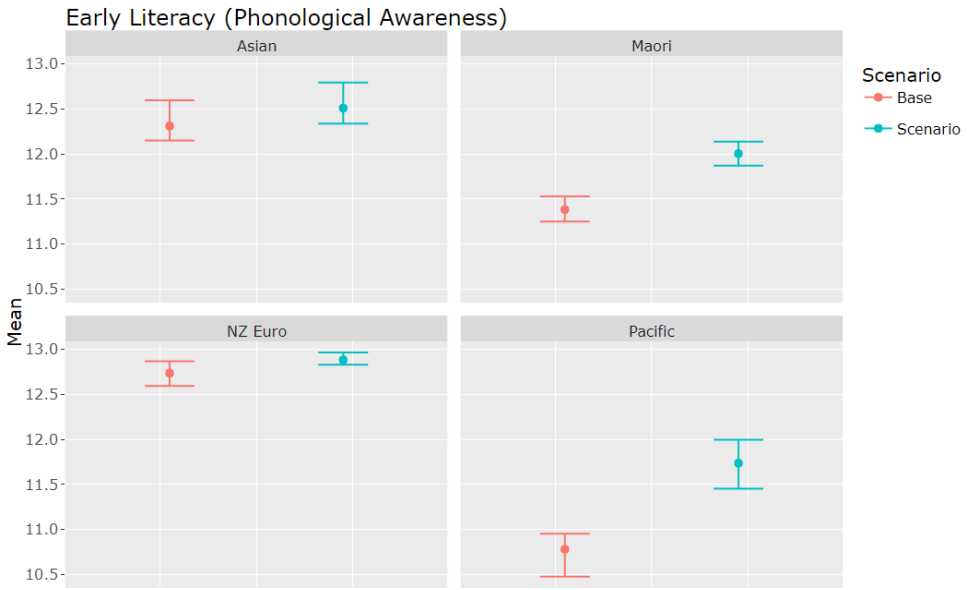


What about a targeted intervention?

All children



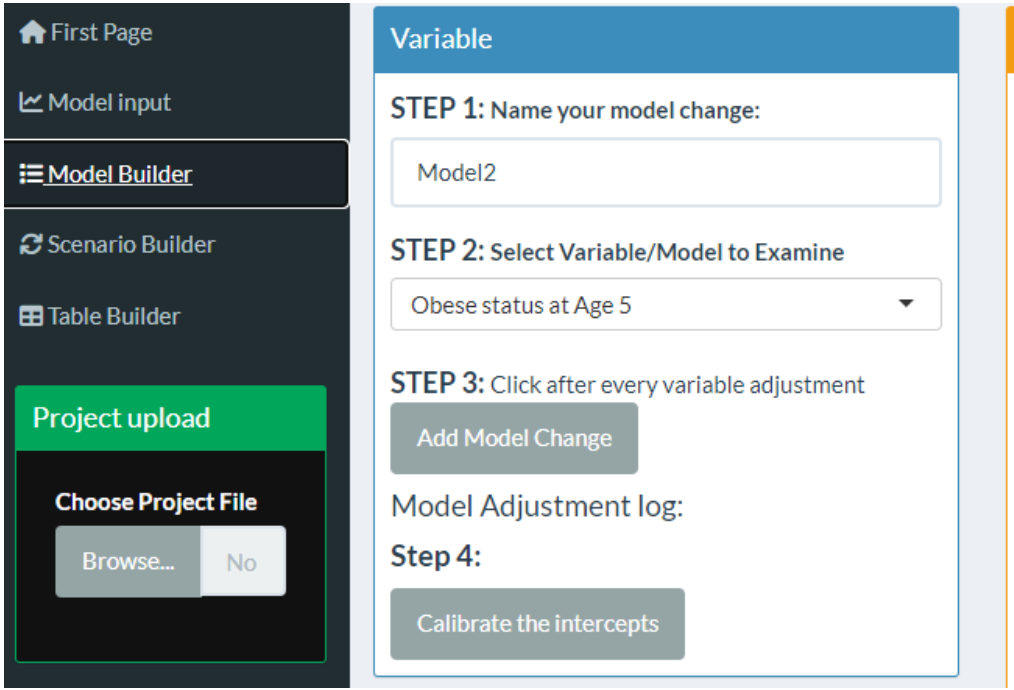
Children in lowest deprivation quintile



Prevention of Overweight in Infancy (POI) randomized controlled trial

- High prevalence of overweight in childhood (NZ & elsewhere)
- Long term health consequences (cardiovascular), hard to change once established
- Short sleep associated with increased weight
- Does a sleep intervention reduce overweight/obesity in childhood?
- Odds of obesity halved in those receiving the POI sleep intervention

Taylor et al., 2018; Am J Clin Nutr 2018;108:228–236



Changing the Coefficients

STEP 3: Coefficients Adjustment

Variable	ClassVal0	Estimate
Intercept		0.0780
z1Gender	1	1.2530
r1Ethn	2	2.2821
r1Ethn	3	3.8619
r1Ethn	4	0.6965
z1GenderLvl1r1Eth	2	1.0586
z1GenderLvl1r1Eth	3	1.1785
z1GenderLvl1r1Eth	4	1.0909
z1Smk	1	1.3207
z1Sleep	1	0.5086

Variable

Select Models for simulation:

base_model

STEP 1: Name your scenario

poi_50

STEP 2: Select Variable to Examine

POI Sleep Intervention

STEP 4 (optional): Select Subgroup for subgroup formula:

None

Insert | (|) | And | Or | Reset

Subgroup formula:

STEP 5: Click after every variable adjustment

Add Scenario

STEP 6 (optional): Choose number of Runs:

10

Scenario simulation log:

Step 7:

Run Scenario

Setting the Scenario

STEP 3: Variable Adjustment

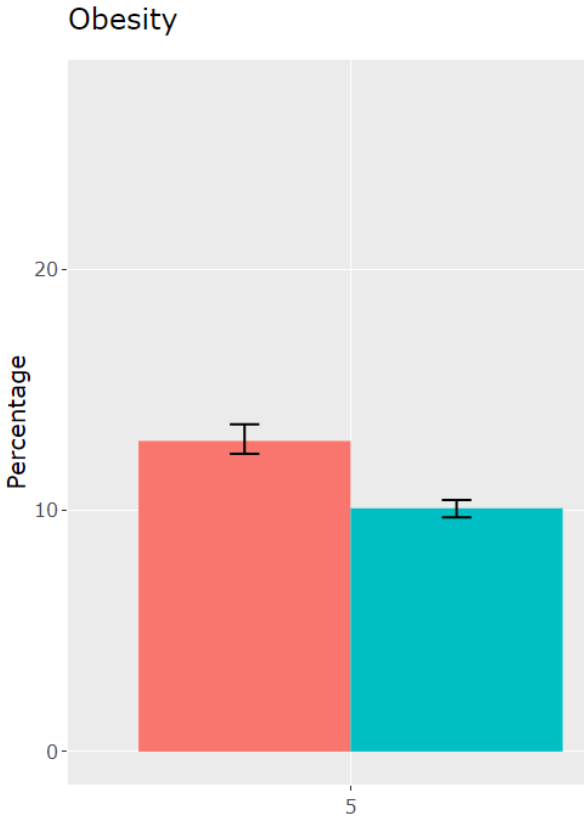
Level	POI Sleep Intervention
No (%)	50.00
Yes (%)	50.00

Base value for the Variable:

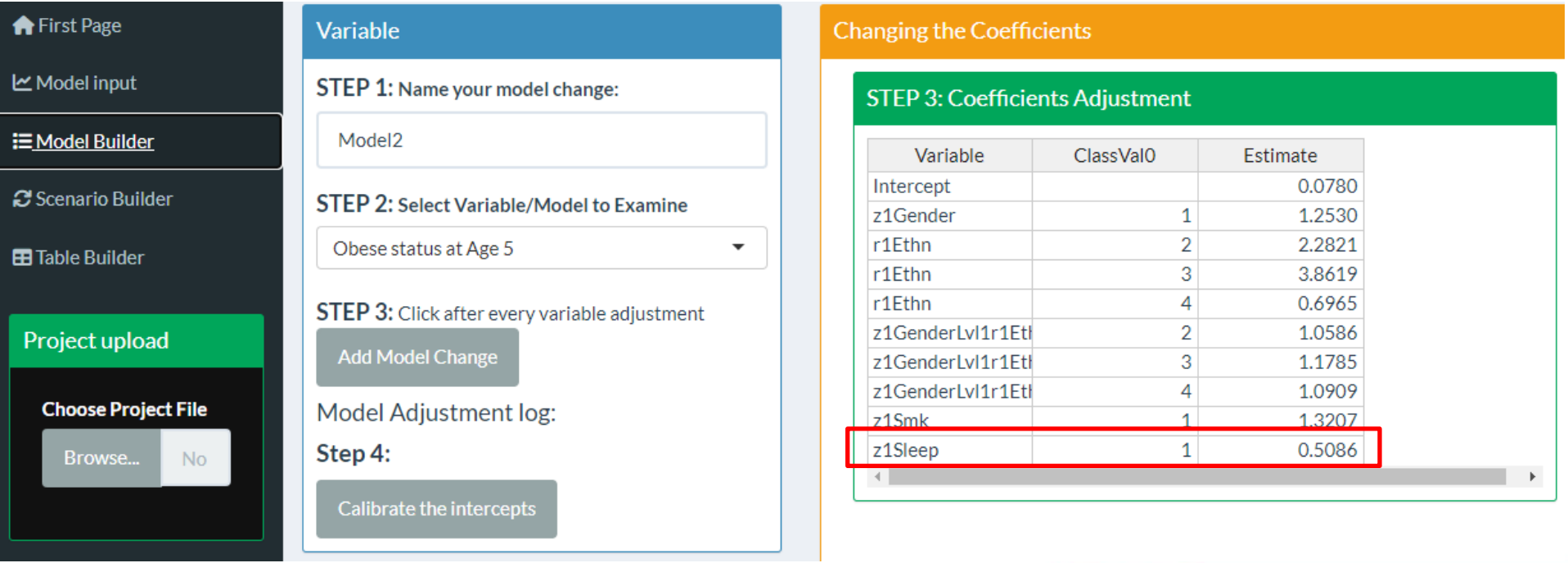
POI Sleep Intervention

Var	Year	Mean
No		100.0
		0.0

POI Sleep Intervention



What if we think effects may be smaller than the research indicates?



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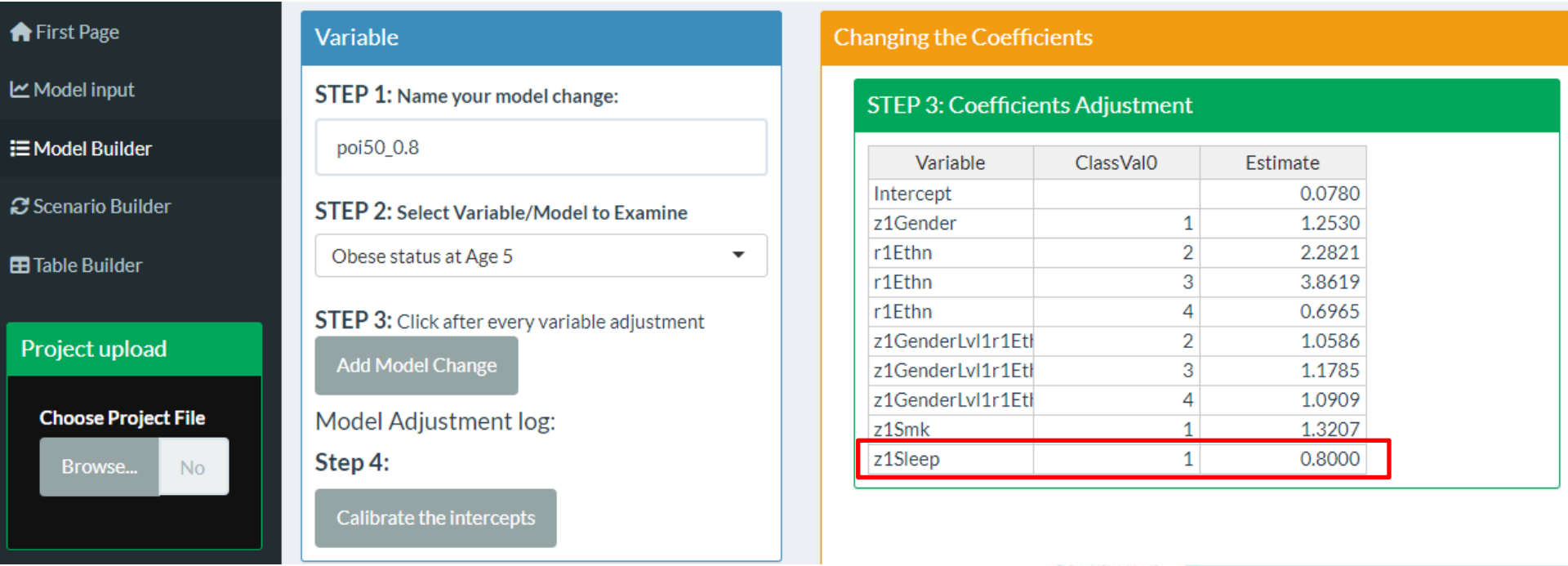
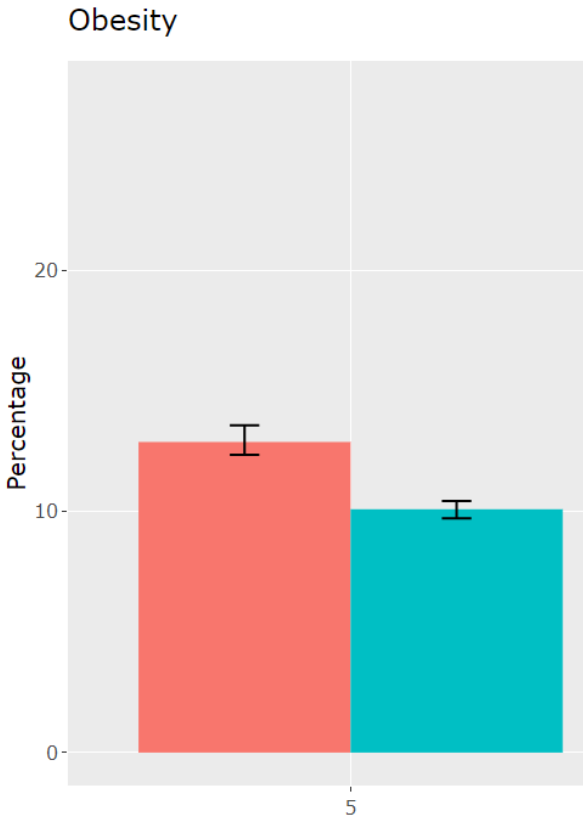
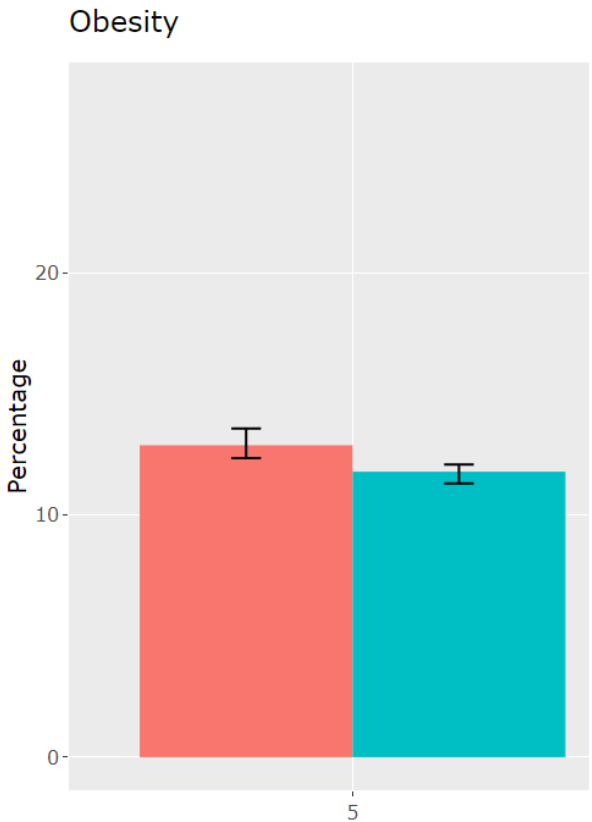


What if we think effects may be smaller than the research indicates?

OR = 0.5





OR = 0.8

‘Stress Less’ Intervention

- ‘Stress Less’ (formerly ‘Stress Detox’) is a Chatbot on the HABITs (Health Advances Through Behaviour Intervention Technologies) platform
  - 21-day programme, based on CBT and positive psychology.
  - The chatbot messages the user via Facebook Messenger once a day and guides them through a brief (about 3–5 min) daily activity.
- Improved wellbeing in 18–24 year-old students

Williams et al., 2021. Social Sciences 10: 416.

Week 1: Physiological sensations associated with stress and anxiety

Week 2: Cognitive appraisal of stress and anxiety

Week 3: Behavioural response

Table 1. Summary of content of the 21-Day Stress Detox Chatbot.

Focus	Day	Module
Week 1: Feelings	1	Onboarding ('meet & greet') SMART Goal Gratitude Journal introduced
	2	Subjective Stress Rating Breathe Taster Goal Setting
	3	Stress Sensations Calm Breathing
	4	Stress Psychoeducation Focusing Game
	5	Cognitive Triad Progressive Muscle Relaxation (PMR)
	6	Sleep Psychoeducation Self-Care Psychoeducation
	7	Know Your Anxiety Meditation Gratitude Journal Review
Week 2: Thinking	8	Downloading the Positives
	9	Stink Thoughts
	10	Reality Check
	11	Challenging Thoughts
	12	Brainstorming
	13	Perspective
	14	Recap
Week 3: Actions	15	STEPS
	16	Stairwell of Stress
	17	Assertiveness
	18	Conflict Resolution
	19	Pleasant Activity Part1
	20	Pleasant Activity Part 2 Communication Skills
	21	Recap of modules Gratitude Journal Review
	22	Outboarding

Williams et al., 2021. Social Sciences 10: 416.

Summary

- Microsimulation is a flexible way to test the impact of policies and interventions
- The Better Start Model tests interventions developed as part of the Better Start National Science Challenge
  - Better Start Literacy Approach
  - POI Sleep Intervention; Impact of smoking in pregnancy
  - To do: ‘Stress Less’ Digital Intervention
  - Targeted Interventions; Modifiable effect sizes
    - https://compassnz.shinyapps.io/BetterStartModelShiny (Still under development)

THANK YOU!

QUESTIONS??