



Knowledge Laboratory of the Early Life Course



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THE UNIVERSITY OF AUCKLAND

Whare Wānanga o Tāmaki Makaurau

COMPASS Seminar Series
21 September 2015

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MINISTRY OF BUSINESS,
INNOVATION & EMPLOYMENT
HIKINA WHAKATUTUKI



▣ Background: MEL-C project (2009-2013)

- What, why, how
- Insights
- Observations

▣ Knowledge Lab project (2013-2016)

- Plan
- Progress
- Next Steps
- Conclusion

Funded by MBIE

MEL-C (Modelling the Early Life Course) - What? Why? How?



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Whare Wānanga o Tāmaki Makaurau

1. Goals ... what are we trying to do?

- Develop a software application as a decision-support tool for policy-making

2. Rationale ... why are we doing it?

- To improve policymakers' ability to respond to issues concerning children and young people

3. Means ... how are we doing it?

- By building a computer simulation model with data from existing longitudinal studies to quantify the underlying determinants of progress in the early life course

MEL-C

- Conceptual framework



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Whare Wānanga o Tāmaki Makaurau

Structural level

Child characteristics

- *gender*
- *ethnicity*

Parental characteristics

- *age at birth of child*
- *ethnicity*
- *education level*

Socio-economic position

- *SES at birth of child*

Perinatal and early life factors

- *birth weight*
- *multiple birth*
- *gestational age*
- *birth order*
- *smoking during pregnancy*
- *drinking during pregnancy*
- *breastfeeding*

Intermediate level

Family characteristics / employment

- *single-parent status*
- *number of children*
- *number of household members*
- *employment status*
- *welfare dependent*

Psychosocial factors / housing

- *change of parents*
- *change of residence*
- *parental smoking*
- *accommodation type*
- *housing tenure (owned/rented)*
- *overcrowding*
- *maternal responsiveness*
- *maternal punitiveness*
- *early childhood education*

Outcome

Health service use

- *GP visits*
- *hospital admissions*
- *hospital outpatient attendances*

Education

- *Reading ability*

Social/Justice

- *Conduct problems*

MEL-C

How? *Microsimulation*



- ❑ We start with a sample of individuals
 - Synthetic (derived from Census 2006), n=5,000
- ❑ We derive statistical rules to create a 'virtual cohort' through to age 13
 - Analyse combined data from 3 longitudinal studies (Christchurch HDS, Dunedin MHDS, Pacific Islands FS)
 - Produces a sample of children with typical biographies over the life-course, allowing for variation
- ❑ We then simulate what might happen if policy were to change, by altering parameters
 - Using software application

MEL-C - Insights



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Whare Wānanga o Tāmaki Makaurau

- Able to model early life-course very well (against external benchmarks)
- Changing (single) factors in children's lives often had weak effects on child outcomes
 - Is that just the reality of policy impact?
 - Does it indicate that estimates based on observational analysis do not reflect causal effect of interventions?
- Policy relevance increased by increasing range of outcomes and factors
- Childhood factors have impacts into adulthood

MEL-C - Observations



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- ❑ There are many well-established estimates for factors that impact the lives of children, but these exist in isolation; micro-simulation offers a way to bring these together.
 - John Lynch, Professor of Public Health, University of Adelaide

- ❑ ‘Best’ estimates are thought to be derived from systematic reviews/meta analyses, but it is difficult to test their validity.
 - David Gough, Professor of Evidence Informed Policy and Practice, Institute of Education

➤ Background: MEL-C project

- What, why, how
- Insights
- Observations

➤ Knowledge Lab project

- What, why, how – extension
- Plan
- Progress: 1. End-users, 2. Software , 3. Literature search, 4. Some simulation results
- Next Steps: 1. Model building, 2. Scenario testing & deployment
- Conclusion

Knowledge Lab - What? Why? How?



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- Develop a software application as a decision-support tool for policy-making

2. Rationale ... why are we doing it?

- To improve policymakers' ability to respond to issues concerning children and young people

3. Means ... how are we doing it?

- By building a computer simulation model with data from the **international evidence base** to quantify the underlying determinants of progress in the early life course



- ❑ Identify key determinants of child and adolescent outcomes
- ❑ Integrate estimates from systematic reviews/meta analyses into working model of early life course
 - Developed from MEL-C; extended in breadth (more determinants and outcomes), and length (to age 21)
- ❑ Use as knowledge laboratory (microsimulation)
 - Test the validity of 'best' estimates
 - Test policy scenarios using validated model
 - Deploy in policy agencies

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Knowledge Lab – Progress:

1. End User Advisory Group



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- End User Advisory Group (EUAG)
 - Model is (ultimately) for policy makers, so we want to involve them in its development
 - Precedent from MEL-C
 - 4 Government Ministries – Health, Education, Social Development, Justice
 - Regular meetings to discuss progress & next steps
 - Deployment of tool with these ministries
 - Augmented for Knowledge Lab
 - 4 additional agencies: Te Puni Kōkiri, SUPERU, Children’s Commission, Pacific Islands Families Study
 - Same format

Improving the model for policy: Recent EUAG suggestions



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- Validation is important in convincing end users it is worthwhile tool to use
- Testing a scenario with a known outcome would help bolster validity (to show that the modelling matches what actually happened)
- It is important to create familiarity with the model among end users (web deployment will help)
- It is important to demonstrate both population gains (likely small) but also equity gains (likely larger)
- Showing geographic variation may help with some end user ministries, for example by weighting results to the characteristics of regions
- Adding costs (of policies and outcomes) would add value to the tool
- Getting ministries to work together by, for instance hosting this in the IDI (Statistics NZ's 'Integrated Data Infrastructure')
- Involving Treasury as part of the EUAG will help
- Knowing the policy work that is happening within ministries will help so that Knowledge Lab can be reactive to their needs

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Knowledge Lab - Progress:

2. Software



We need software that is:

- ❑ Flexible
 - To develop existing models further
 - To handle whatever microsimulation models we undertake in future
- ❑ Open source
 - In the spirit of open science – sharing tools
- ❑ Web deployable
 - To allow for a greater number of end-users
 - To allow for the model to be updated seamlessly
 - No software or security requirements for users – they only need internet access
 - Processing speed
- ❑ Speedy - currently around 2 minutes for each run (results based on average of 10 runs)

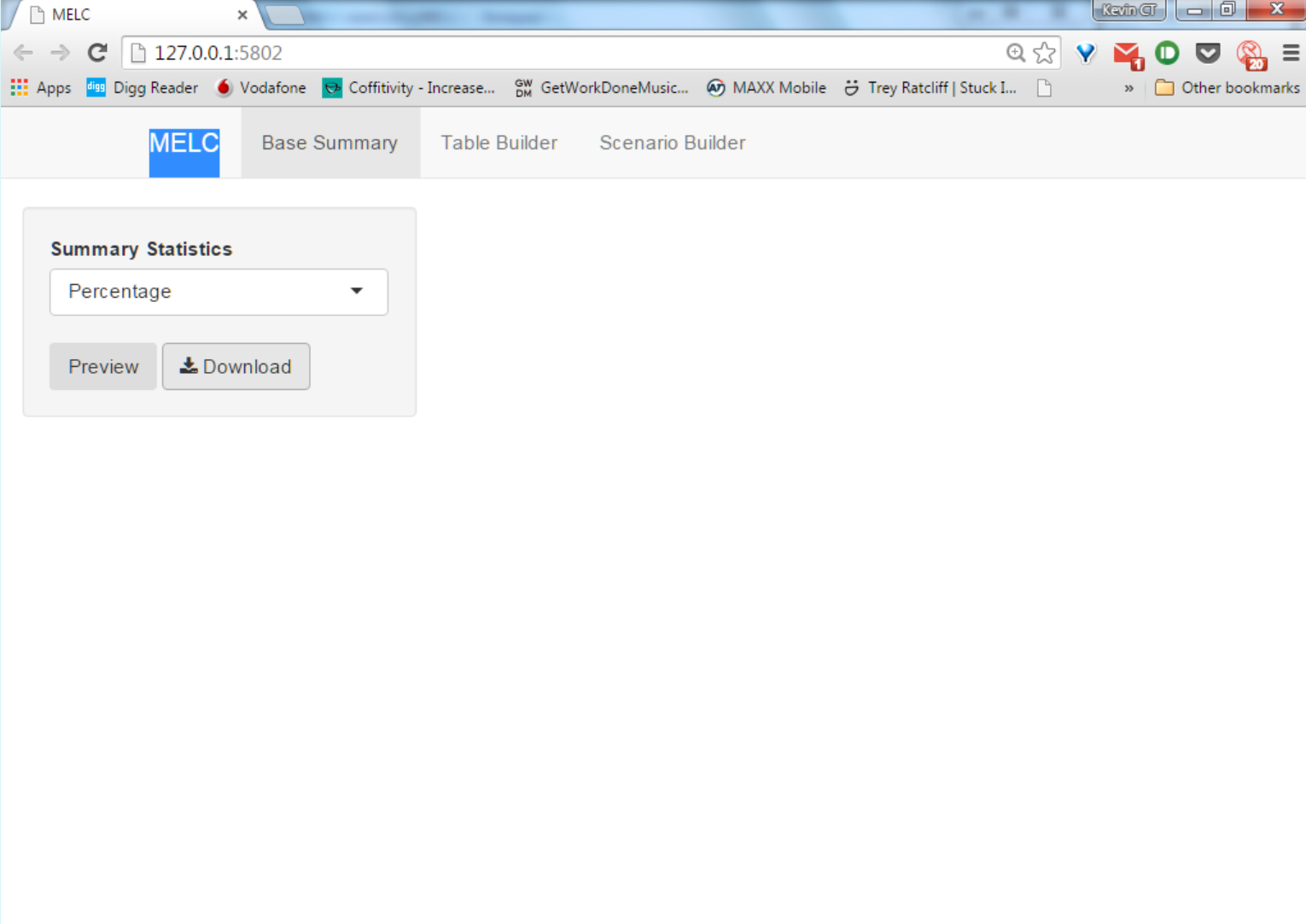
Knowledge Lab - Progress:

2. Software



Characteristic	JAMSIM-SIMARIO
Software	JAVA, R
Developer	COMPASS (in-house)
Tested and used	MEL-C project
Support & further development	COMPASS (in-house)
Expertise	COMPASS (in-house)
Control	In-house autonomy & direction
Learning (development)	Already in place
End-user friendly	Customised GUI
Web deployable	Rstudio's SHINY web application framework
Open source	GoogleCode, GitHub, R.org
Parallel processing	R Snowfall library

R SHINY interface - MELC



MELC

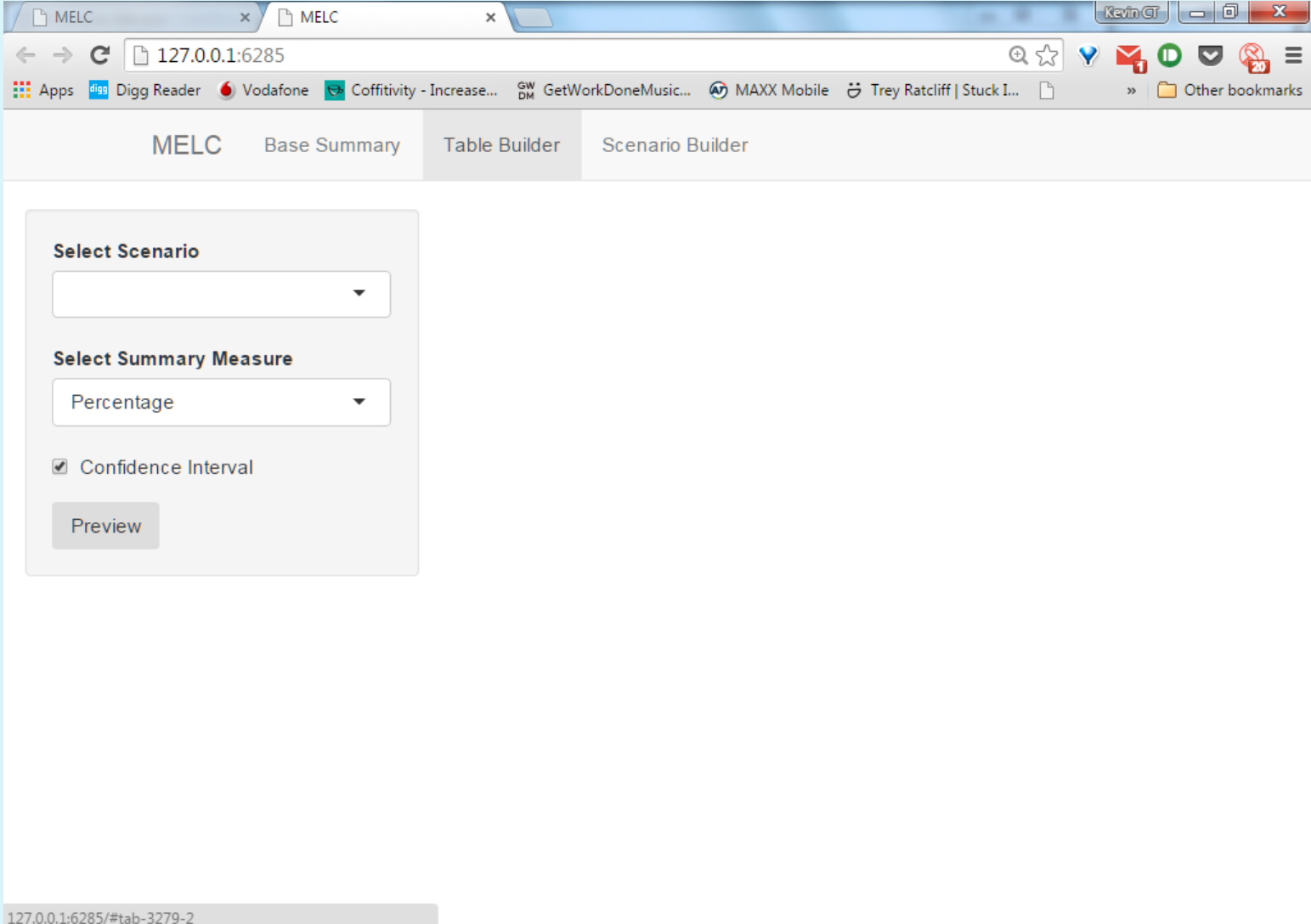
Base Summary Table Builder Scenario Builder

Summary Statistics

Percentage

Preview Download

R SHINY interface – Table Builder

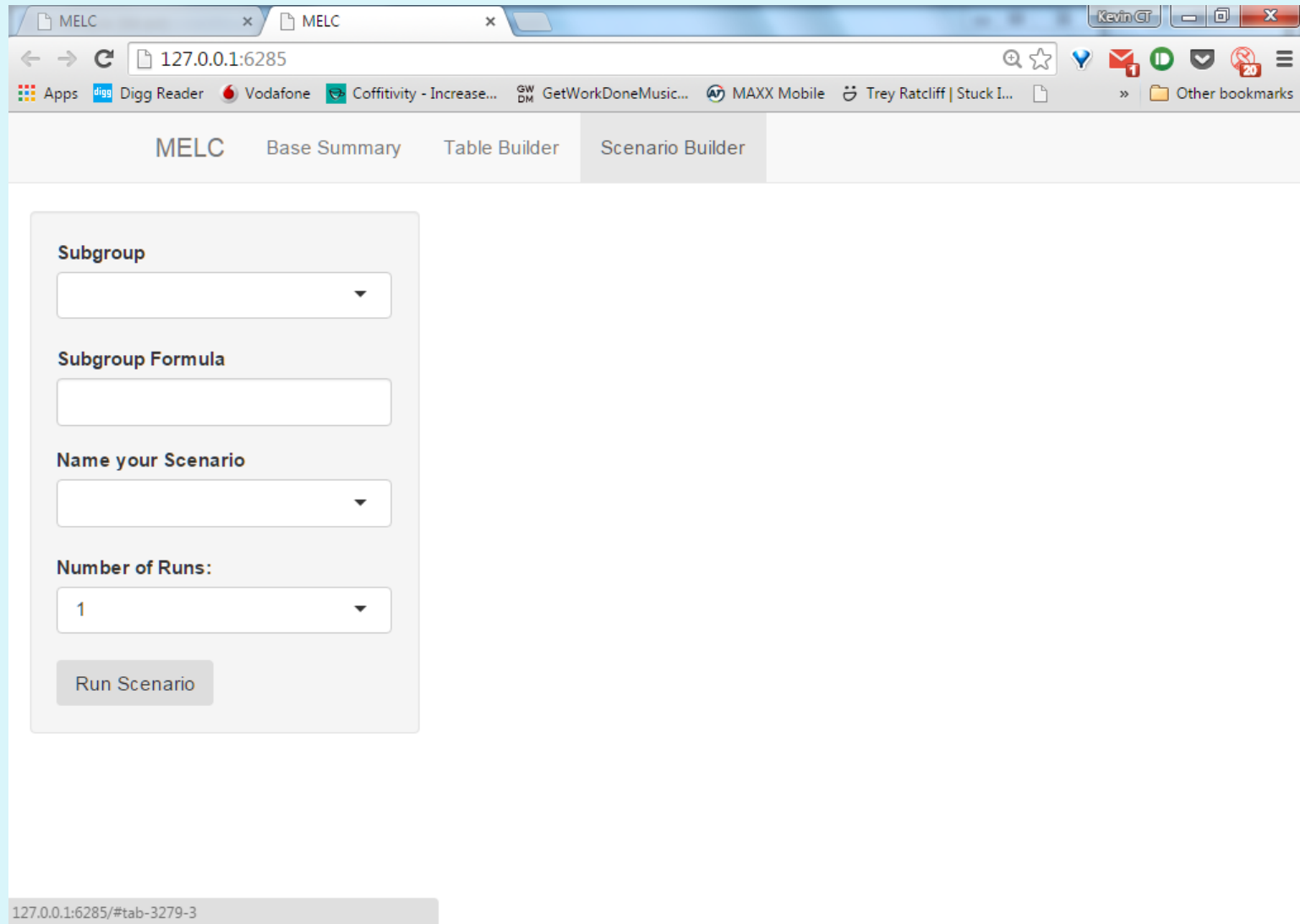


The screenshot shows a web browser window with two tabs labeled 'MELC'. The address bar shows '127.0.0.1:6285'. The browser's bookmark bar includes 'Apps', 'Digg Reader', 'Vodafone', 'Coffitivity - Increase...', 'GetWorkDoneMusic...', 'MAXX Mobile', and 'Trey Ratcliff | Stuck I...'. The page has a navigation menu with 'MELC', 'Base Summary', 'Table Builder' (selected), and 'Scenario Builder'. The main content area contains a form with the following elements:

- Select Scenario**: A dropdown menu.
- Select Summary Measure**: A dropdown menu with 'Percentage' selected.
- Confidence Interval**
- Preview**: A button.

The status bar at the bottom of the browser window shows '127.0.0.1:6285/#tab-3279-2'.

R SHINY interface – Scenario builder



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- Subgroup**: A dropdown menu.
- Subgroup Formula**: A text input field.
- Name your Scenario**: A dropdown menu.
- Number of Runs:** A dropdown menu with the value '1' selected.
- Run Scenario**: A button.

The URL bar at the bottom of the browser shows '127.0.0.1:6285/#tab-3279-3'.

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Knowledge Lab – Progress:

2. Literature search



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Whare Wānanga o Tāmaki Makaurau

- ❑ Determine search strategy
 - ❑ ARTICLE TYPE: Systematic Review OR Meta Analysis
 - ❑ AGES: Birth-24
- ❑ Databases: PubMed, Cochrane Reviews, ERIC, PsycInfo, etc
- ❑ Search results: 10,000 papers found
- ❑ Determine important factors - identify estimates that can be used from the literature
- ❑ Input from end-users on relevance (via EUAG)

Knowledge Lab – Progress:

2. Literature search



Search	Search terms	Result
Alcohol	“alcohol” or “alcoholism” or “drinking”	726
Ambulatory sensitive hospitalizations	“ambulatory sensitive hospitalizations” or “avoidable hospitalizations”	0
Asthma	“asthma”	552
Birth weight/ gestational age	“birth weight” or “gestational age”	848
Books in home	“books” or “literacy”	202
Breastfeeding	“breastfeeding”	285
Child health groups	“health group”	51
Drug abuse	“drug abuse” or “drug dependence” or “cannabis” or “methamphetamine” or “cocaine” or “heroin”	76
Early childhood education	“early childhood education”	39
Early parenting	“teen parents” or “teen pregnancy” or “early pregnancy”	21

Knowledge Lab – Progress:

2. Literature search



Search	Search terms	Result
Mental health		
ADHD	“attention deficit”	188
Anxiety	“anxiety” or “anxious” or “panic” or “phobia” or “agoraphobia” or “obsessive compulsive disorder”	505
Conduct disorder	“conduct disorder” or “conduct problem” or “antisocial”	66
Depression	“depression” or “depressive”	371
Eating	“eating disorder” or “bulimia” or “anorexia”	42
Psychosis	“manic” or “mania” or “bipolar” or “psychosis” or “schizophrenia” or “schizophreniform” or “schizotypy”	181
Nutrition	“nutrition”	393
Obesity	“obesity”	370
Otitis media	“otitis media” or “hearing”	264
Parental involvement in schools	“parent” & “schools” & “involvement”; yielded some references but not along lines hoped for	7

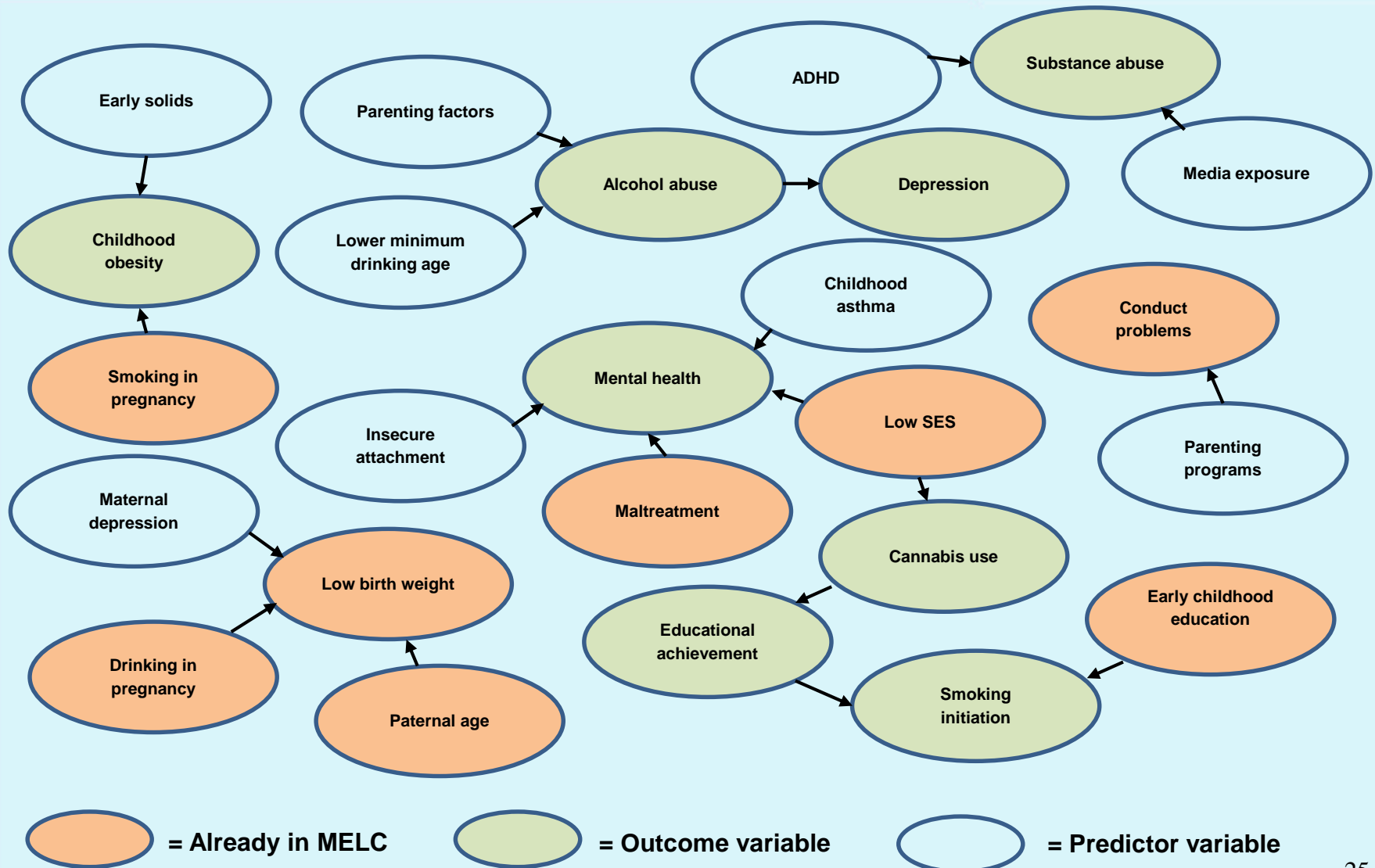
Knowledge Lab – Progress:

2. Literature search



Search	Search terms	Result
Physical activity	“physical activity” or “exercise”	298
Respiratory health	“respiratory”	423
School type (single-sex/co-ed)	school & (single-sex or co-educational)	0
Smoking	“smoking” or “tobacco”	127
Socioeconomic measures	“income” or socioeconomic” or “deprivation”	351
Suicide	“self harm” or “suicide”	41
Teacher quality	(teacher or teaching) & quality	5
Transfer payments	“transfer payments”; a few different combinations	0
Transitions to employment	“employment”	60
Violence in families	“violence”	51
Welfare dependence	“welfare” or “poverty”	116
Total		9852

Initial organisation of concepts



New Zealand

The University of Auckland

Important factors (in consultation with EUAG)



Focus on 6 factors

Alcohol and drug use	Ethnicity	Justice contacts	Physical activity
Ambulatory Sensitive Hospitalisations	Family transitions – formation/disintegration	Lead Maternity Carer enrolment	School type (single sex/co-ed)
Asthma/respiratory health	Food in schools	Maltreatment	Smoking
Birth weight/gestational age	Health visits	Mental Health	Poverty
Books in home	Home visiting	Nutrition	Suicide
Breastfeeding	Housing quality	Obesity	Teaching quality
Conduct disorder	Immunisation	Otitis Media	Transfer payments
Early Childcare education (amount, quality, type)	Injuries	Parental and intergenerational welfare dependence	Transition to employment
Early parenting	Involvement in Child Health groups (e.g., plunket)	Parental involvement in schools	Violence in families
Education		Parental mental health	

Finding literature for Māori – Lucy Cowie



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Whare Wānanga o Tāmaki Makaurau

- Catalogue all publications on health, social, behavioural, and educational outcomes for Māori children & youth
- A search in PubMed, Scopus, PsycInfo, ERIC and NZResearch databases was conducted
- A search of government websites and research groups was undertaken
- Google Scholar used to check

Catalogue of Māori research: Health – top 10 ICD chapters



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ICD-10 Chapter	Subject	Overall	Prevalence	Risk Factors
21. Factors influencing health status and contact with health services	Alcohol and drugs	18	12	3
	Immunisation	9	9	1
	Primary Healthcare Use and Access	20	17	1
	Smoking	41	30	14
	Other	11	9	2
		(99)	(77)	(21)
4. Endocrine, nutritional and metabolic diseases	Diabetes	19	17	1
	Diet, Nutrition, Weight and Physical Activity, Vitamin D, Cystic Fibrosis	49	40	5
		(68)	(57)	(6)
10. Diseases of the respiratory system	Asthma	24	22	3
	Other including pneumococcal, pneumonia, bronchiectasis and influenza	22	20	1
		(46)	(42)	(4)
1. Certain Infectious and Parasitic Diseases	Whooping cough, TB, Staphylococcus, Streptococcal, Hepatitis, H pylori, Measles	32	30	3
19. Injury, poisoning and certain other consequences of external causes	Other including injury	32	29	2
5. Mental and behavioural disorders	Mental Health	19	19	
	Antisocial	8	7	1
	Others including snoring, ADHD, amnesia	4	4	
		(31)	(30)	(1)
20. External causes of morbidity and mortality	Mortality	10	10	
	Suicide and Self Harm	14	12	
	Other including violence	6	3	
		(30)	(25)	
11. Diseases of the digestive system	Oral health	23	20	2
	Other	6	6	
		(29)	(26)	(2)
9. Diseases of the circulatory system	Rheumatic Fever and Heart Disease	16	15	
	Other including cardiovascular disease and blood pressure	12	11	
		(28)	(26)	
22. Codes for special purposes	Health Status	8	7	
	Health Status Overview Paper	11	11	2
	Other	6	5	
				28

Catalogue of Māori research: Health – bottom 12 ICD chapters



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<i>ICD-10 Chapter</i>	<i>Subject</i>	<i>Overall</i>	<i>Prevalence</i>	<i>Risk Factors</i>
18. Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	Sudden Infant Death Syndrome	13	11	2
	Other including psychological testing	7 (20)	4 (15)	1 (3)
15. Pregnancy, childbirth and the puerperium	Contraception	5	4	2
	Pregnancy	7	5	
	Other	7 (17)	6 (15)	(2)
2. Neoplasms	Leukaemia, HPV, others	15	12	3
13. Diseases of the musculoskeletal system and connective tissue	Other including Gout and Bones	12	11	1
6. Diseases of the nervous system	Meningococcal and others including orbital infection, meningitis and growth hormone treatments	11	10	1
12. Diseases of the skin and subcutaneous tissue	Skin Infection and Acne	9	9	1
8. Diseases of the ear and mastoid process	Hearing	9	8	2
14. Diseases of the genitourinary system	Other including kidney disease	8	7	
3. Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism	Anaemia and Iron Deficiency	7	5	3
16. Certain conditions originating in the perinatal period	Birthweight and Others	5	5	
17. Congenital malformations, deformations and chromosomal abnormalities	Club Foot and Spina Bifida	3	3	1
7. Diseases of the eye and adnexa	Sight	3	3	29

Summary of Findings



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Whare Wānanga o Tāmaki Makaurau

- ❑ Of 1,904 papers retrieved, 656 papers are in frame, 539 in health (80%)
- ❑ Health
 - Most papers relate to prevalence
 - Very few papers (10%) found which give estimates of the effect of risk factors on outcomes for Māori
 - The most researched category was smoking, with 49 papers (35 prevalence, 14 risk factors)
 - The least researched category was “Congenital malformations, deformations and chromosomal abnormalities” (3 O, 3 P, 1 RF)
 - Suggests a large gap in the literature

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Knowledge Lab – Progress: 4. Simulation results example



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- ▣ Adding new paths to the Knowledge Lab model, from the meta-analysis literature
- ▣ Example – Overweight - as a function of smoking in pregnancy and breastfeeding

Literature estimates A

Source (DOI)	Outcome	Model-type	Predictor	OR (or RR)	CL-lower	CL-upper
10.1136/archdischild-2012-302263 Weng et al, 2012	childhood overweight (variously defined)	logistic	breastfed (y/n)	0.85	0.74	0.99
		logistic	smoking in pregnancy (y/n)	1.47	1.26	1.73
10.4088/JCP.12r07968 Grigoriadis et al, 2013	premature delivery (<37 weeks)	logistic	maternal depression	1.37	1.04	1.81
	breastfeeding initiation	logistic	maternal depression	0.68	0.61	0.76
10.1111/j.1467-789X.2012.01055.x Chen et al, 2012	incident asthma	logistic	childhood overweight (BMI >=85th pctile)	1.19	1.03	1.37
	incident asthma (in boys)	logistic	childhood overweight	1.57	1.23	2
	incident asthma (in girls)	logistic	childhood overweight	0.85	0.4	1.78
	incident asthma	logistic	childhood obesity (BMI >=95th pctile)	2.02	1.16	3.5
	incident asthma (in boys)	logistic	childhood obesity	2.47	1.57	3.87
	incident asthma (in girls)	logistic	childhood obesity	1.25	0.51	3.03
10.1017/s0033291712000360 van Dam et al, 2012	psychosis	logistic	childhood bullying (y/n)	2.25	1.49	3.4
10.1111/j.1469-8749.2012.04407.x Somhovd et al, 2012	anxiety	logistic	preterm (<32 weeks) and/or low birth weight (<1500g)	2.27	1.15	4.47

Literature estimates B



Source (DOI)	Outcome	Model-type	Predictor	OR (or RR)	CL-lower	CL-upper
10.1371/journal.pmed.1001349 Norman et al, 2012	depression	logistic	physical abuse	1.54	1.16	2.04
			emotional abuse	3.06	2.43	3.85
			neglect	2.11	1.61	2.77
	drug use (excl. alcohol)	logistic	physical abuse	1.92	1.67	2.2
			emotional abuse	1.41	1.11	1.79
			neglect	1.36	1.21	1.54
	suicide attempts	logistic	physical abuse	3.4	2.17	5.32
			emotional abuse	3.37	2.44	4.67
			neglect	1.95	1.13	3.37
STIs & risky sexual behaviour	logistic	physical abuse	1.78	1.5	2.1	
		emotional abuse	1.75	1.49	2.04	
		neglect	1.57	1.39	1.78	
10.1111/j.1467-789X.2011.00867.x Yu et al, 2011	obesity (BMI \geq 95th pctile, or weight/ideal weight $>$ 1.2)	logistic	high birth weight ($>$ 4000g compared to \leq 4000g)	2.04	1.87	2.21
			high birth weight ($>$ 4000g) compared to normal weight (2500-4000g)	2.1	1.93	2.28
	obesity	logistic	low birth weight ($<$ 2500g compared to \geq 2500g)	0.61	0.43	0.88
			low birth weight ($<$ 2500g compared to \geq 2500g)	0.54	0.32	0.9
	obesity	logistic	birth weight 3500-4000g (cf. $<$ 2500g)	1.65	1.08	2.52
			birth weight $>$ 4000g (cf $<$ 2500g)	2.23	1.46	3.41
	obesity (in boys)		high birth weight ($>$ 4000g compared to \leq 4000g)	2.03	1.78	2.32
	obesity (in girls)		high birth weight ($>$ 4000g compared to \leq 4000g)	2.33	1.92	2.83
	obesity (in girls)	logistic	low birth weight ($<$ 2500g compared to \geq 2500g)	0.46	0.23	0.93

Simulation of overweight, by age: Validation against NZ Health Survey



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Base simulation

Year	Overweight (%)	Mean	Overweight (%)	Lower	Overweight (%)	Upper
1		NA		NA		NA
2		27.352		26.6670		28.1130
3		27.388		26.5875		28.3345
4		27.986		26.9170		29.0320
5		28.700		27.7035		29.2775
6		29.600		28.8250		30.3110
7		30.506		28.9895		32.1455
8		30.954		30.1355		31.7310
9		31.784		30.5620		32.9175
10		32.808		32.1025		33.4530
11		34.030		33.2340		34.5465
12		35.020		34.0420		35.7155
13		36.024		35.2585		37.1450
14		36.876		35.7060		37.6400
15		38.020		37.1490		39.5005
16		39.400		38.7045		40.5260
17		40.888		39.5145		42.8495
18		42.230		41.2025		43.2640
19		43.780		42.5925		44.8375
20		44.844		44.1650		45.6420
21		46.838		45.7905		48.2485

NZHS 2013/4

Mean (95% CI)

2-4 years
28.7 (24.7-33.1)

5-9 years
30.1 (27.0-33.7)

10-14 years
37.5 (33.9-41.3)

15-21 years
46.4 (42.4-48.5)

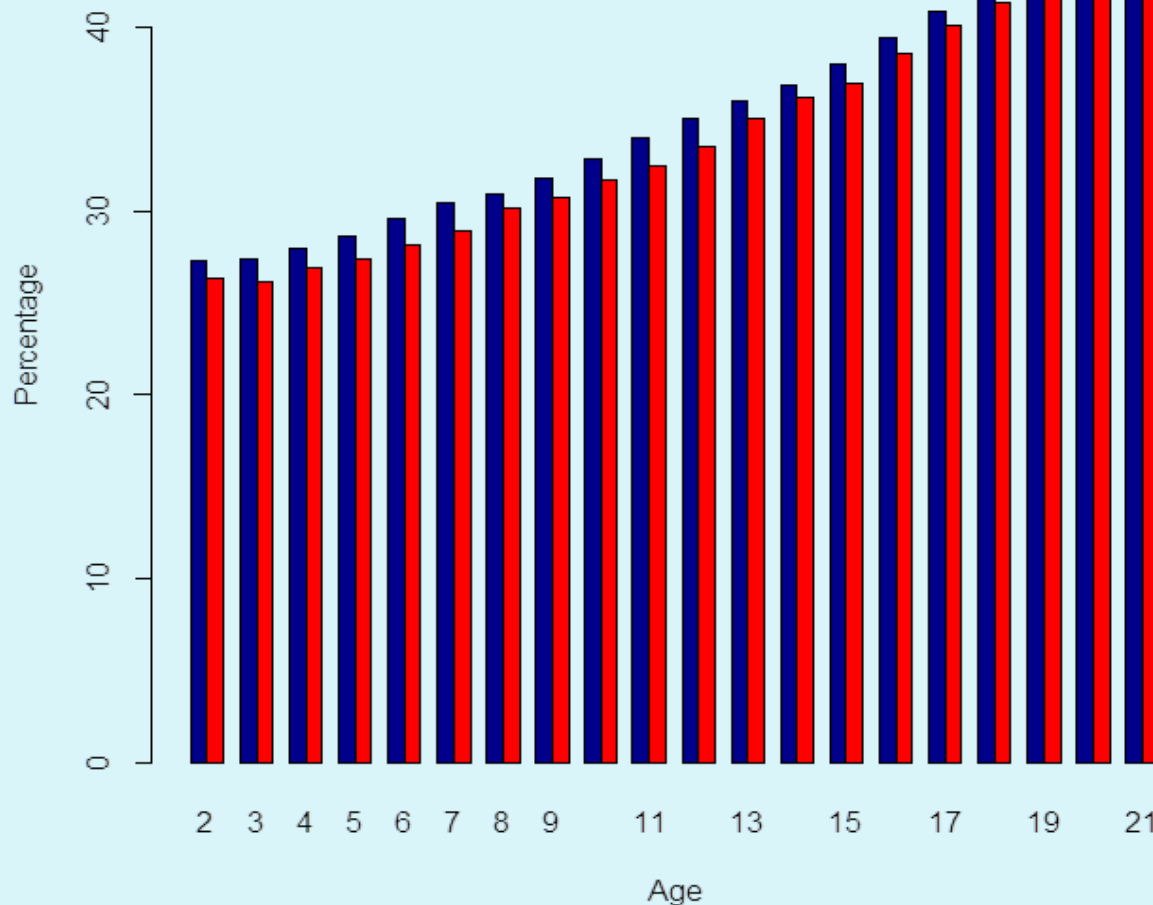
New Zealand

The University of Auckland

Impact of reducing smoking-in-pregnancy on being overweight, by age



Overweight scenario1



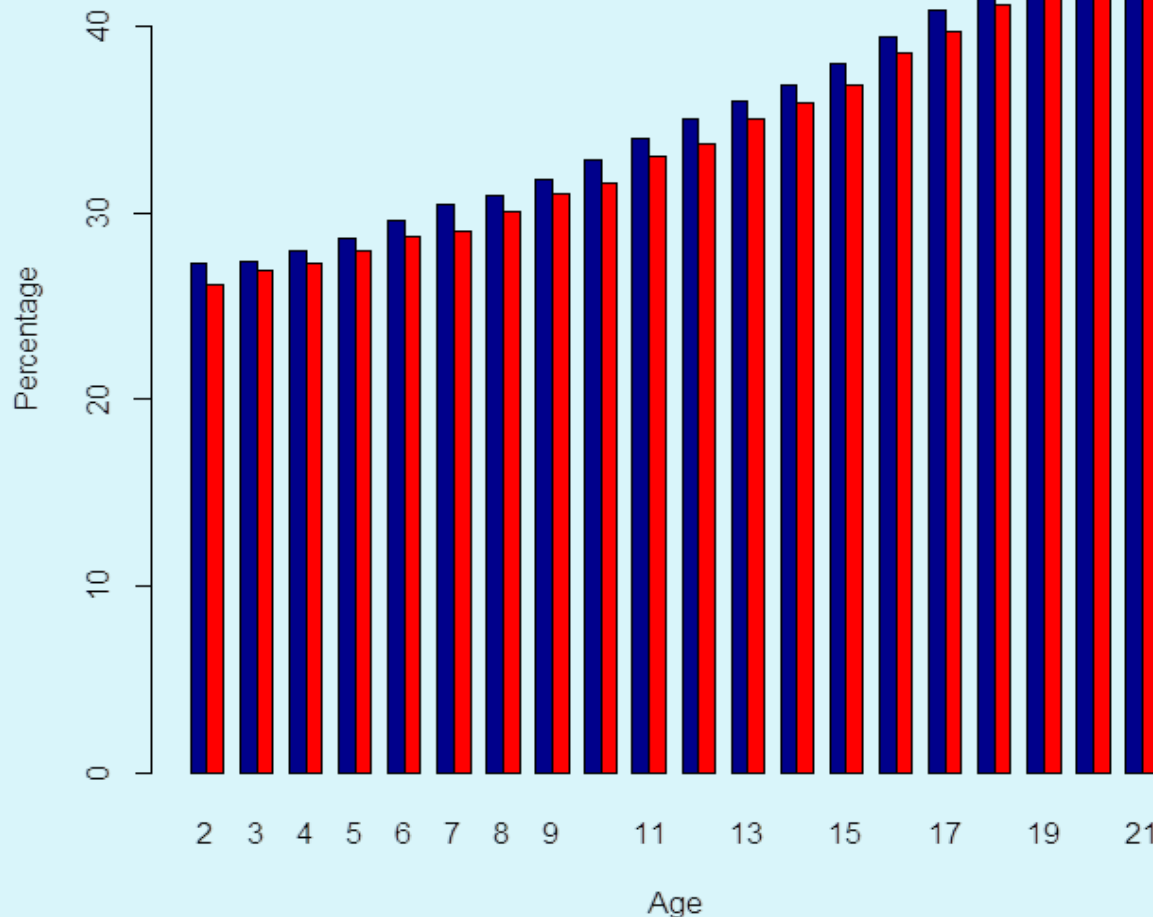
Base simulation

Scenario

Halving
smoking-in-pregnancy
(from 22% to 10%)

Impact of increasing breastfeeding on being overweight, by age

Overweight scenario2



Base simulation

Scenario

40% increase in
breastfeeding
(from 64% to 90%)

➤ Background: MEL-C project

- What, why, how
- Insights
- Observations

➤ Knowledge Lab project

- What, why, how – extension
- Plan
- Progress: 1. End-users, 2. Software , 3. Literature search, 4. Some simulation results
- Next Steps: 1. Model building, 2. Scenario testing & deployment
- Conclusion

Knowledge Lab - Next Steps:

1. Model building



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Whare Wānanga o Tāmaki Makaurau

- ❑ Complete extraction from literature
- ❑ Update conceptual model
- ❑ Apply estimates derived from literature to the microsimulation model
 - ❑ Program estimates into the decision-support tool, in the order specified by the conceptual model
- ❑ Validate model, as per MEL-C
 - ❑ Check it is reproducing NZ rates
 - ❑ This is a test of the 'best' estimates

Knowledge Lab – Next steps:

2. Scenario testing & deployment



- Test scenarios using model
 - Guided by EUAG
 - Wider range of outcomes should make model more policy relevant
- Deploy model in policy agencies
 - Previously loaded on dedicated computers – now web-accessible platform

Plan: Recap & Conclusion



- Identify key determinants of child and adolescent outcomes
- Integrate estimates from systematic reviews/meta- analyses into working model of early life course
 - Developed from MEL-C; extended in breadth (more determinants and outcomes), and length (to age 21)
- Use as knowledge laboratory
 - Test the validity of 'best' estimates
 - Test policy scenarios using validated model
 - Deploy in policy agencies

- Significant progress on various fronts
- Our methodology is working
- On track to achieve objectives – useful tool for policymakers



▣ Acknowledgements

- ▣ COMPASS team: Barry Milne, Peter Davis, Jessica McLay, Martin von Randow, Kevin Chang
- ▣ EUAG: Ann Armstrong (MinEdu), Alex Collier (SuPERU), Christina Connolly (MSD), Jackie Fawcett (MOH), Kathleen Logan (Children's Commission), Robert Lynn (MOJ), Nathaniel Pihama (TPK), Jeremy Robertson (SuPERU), Dan Tautolo (PIFS), Evan Thompson (MSD), Martin Tobias (MoH)

QUESTIONS?