

# Developing a policy tool for the early life course

Simulation using data from NZ longitudinal studies



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## Adding Value to Publicly Funded Data

*Colloquium*

*22 July 2011*

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ministry of  
**science + innovation**  
TE PŪNAHA HIRINGA WHAKAĒA



### *The MEL-C tool (work in progress)*

#### **Part 1**

- **Purpose**
- Frameworks
- Construction
- Validation

#### *Questions*

#### **Part 2**

- Application
- Conclusion

#### *Questions*

# Purpose



- The tool is information-based
- Use data from existing NZ longitudinal studies (adding value to publicly funded data)
- Construct a dynamic micro simulation model of early childhood outcomes
- Test policy scenarios
- Enable users to simulate the impacts of policy changes via a friendly tool
- Add to the decision-making tool-kit



- Purpose
- **Frameworks**
  - Life course
  - Dynamic micro simulation
- Construction
- Validation
- Application
- Conclusion

# Framework: Life course



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- Life course perspective
- Influence of social and family factors on early childhood outcomes
- Importance of early childhood for later life
- Policy relevance and utility

# Early life course, family & well being

## Structural level

## Intermediate level

## Outcome

### Child characteristics

- *(age)*
- *gender*
- *ethnicity*

### Parental characteristics

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

### Socio-economic position

- *SES at birth of child*
- *(single-parent status at birth)*

### Family/household characteristics

*e.g. single-parent status, number of children, household size*

**Employment** *e.g. parental employment, welfare dependence*

### Material circumstances

*e.g. housing: accommodation type, owned-rented, bedrooms number*

### Psychosocial factors

*e.g. family functioning: change of parents, change of residence*

### Behavioural factors

*e.g. parental smoking*

### Other factors

*e.g. perinatal factors*

## Children 0-10 years

### Health

*e.g. GP visits, hospital admissions, hospital outpatient attendances*

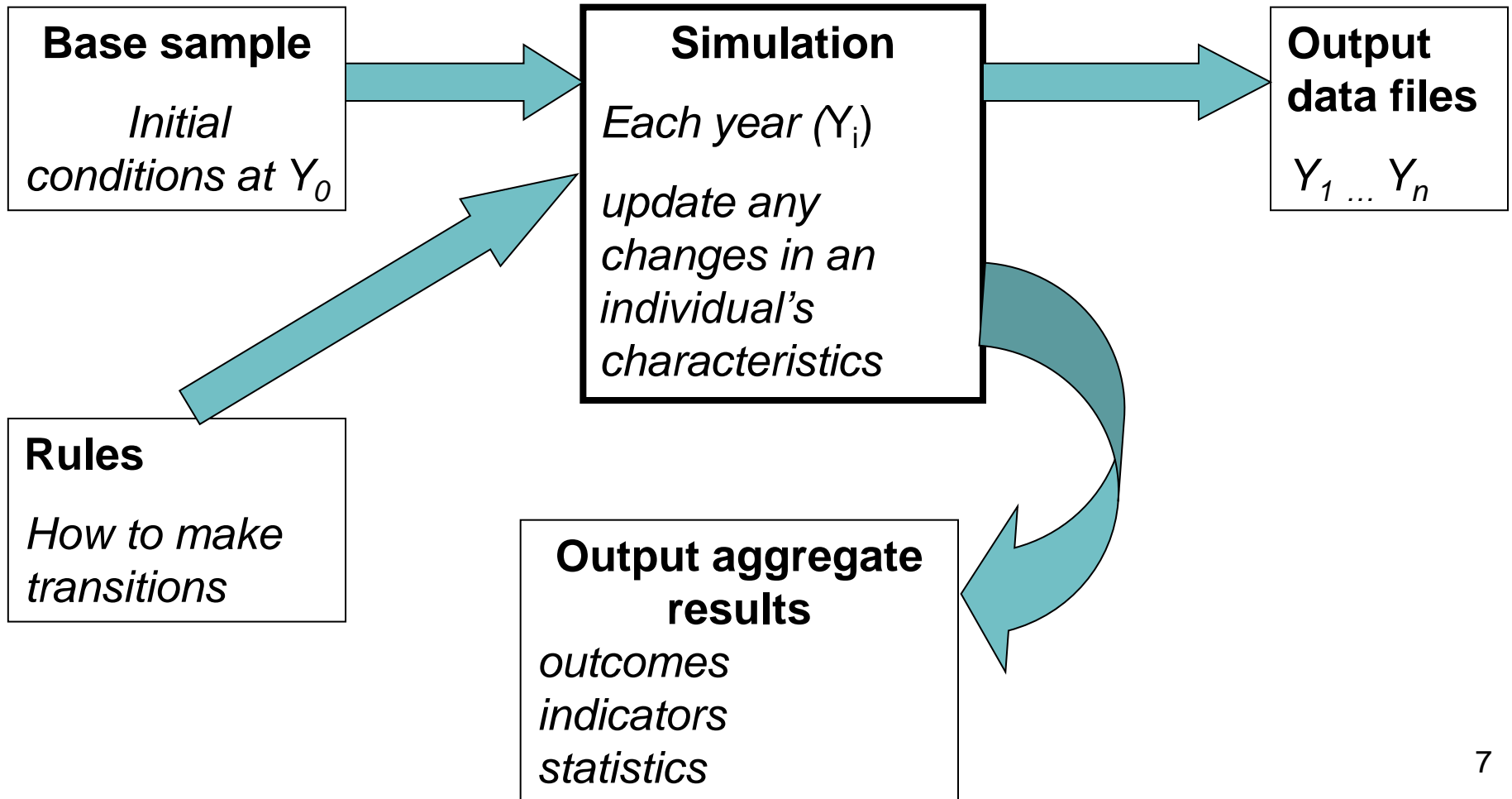
### Education

*e.g. reading ability*

### Social/Justice

*e.g. Conduct disorder*

# Framework: dynamic micro simulation





- Purpose
- Frameworks
- **Construction**
  - Creating a 'virtual cohort'
  - Data sources and use
  - Simulation process
- Validation
- Application
- Conclusion



# Creating a ‘virtual cohort’ – using micro simulation



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## 1. We start with a “real” sample of people

- A birth cohort of children (Christchurch Health & Development Study)
- With individual attributes at the start

## 2. We then apply statistically-derived rules that allow us to create a synthetic data set (a ‘virtual cohort’)

- A sample of children with typical biographies over the life-course
- With allowance for variation around the average (via random allocation)

## 3. We then can simulate what might happen if policy were to change

- Impact on outcomes when we alter features within our synthetic data set

# First data source

## Christchurch Health & Development Study



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- Longitudinal data - cohort born 1977
  - 1,265 children, 0–10 years
  - will be weighted to NZ Census 2006 to be more current and representative (+ additional data sources)
- Used to create “virtual cohort”
  - provides “real data”, dynamic data (change over time)
    1. for statistical analysis (years 0-10)
    2. as initial conditions for simulation (birth & year 1)
    3. as benchmarks for simulated results (years 2-9)

# Additional data sources



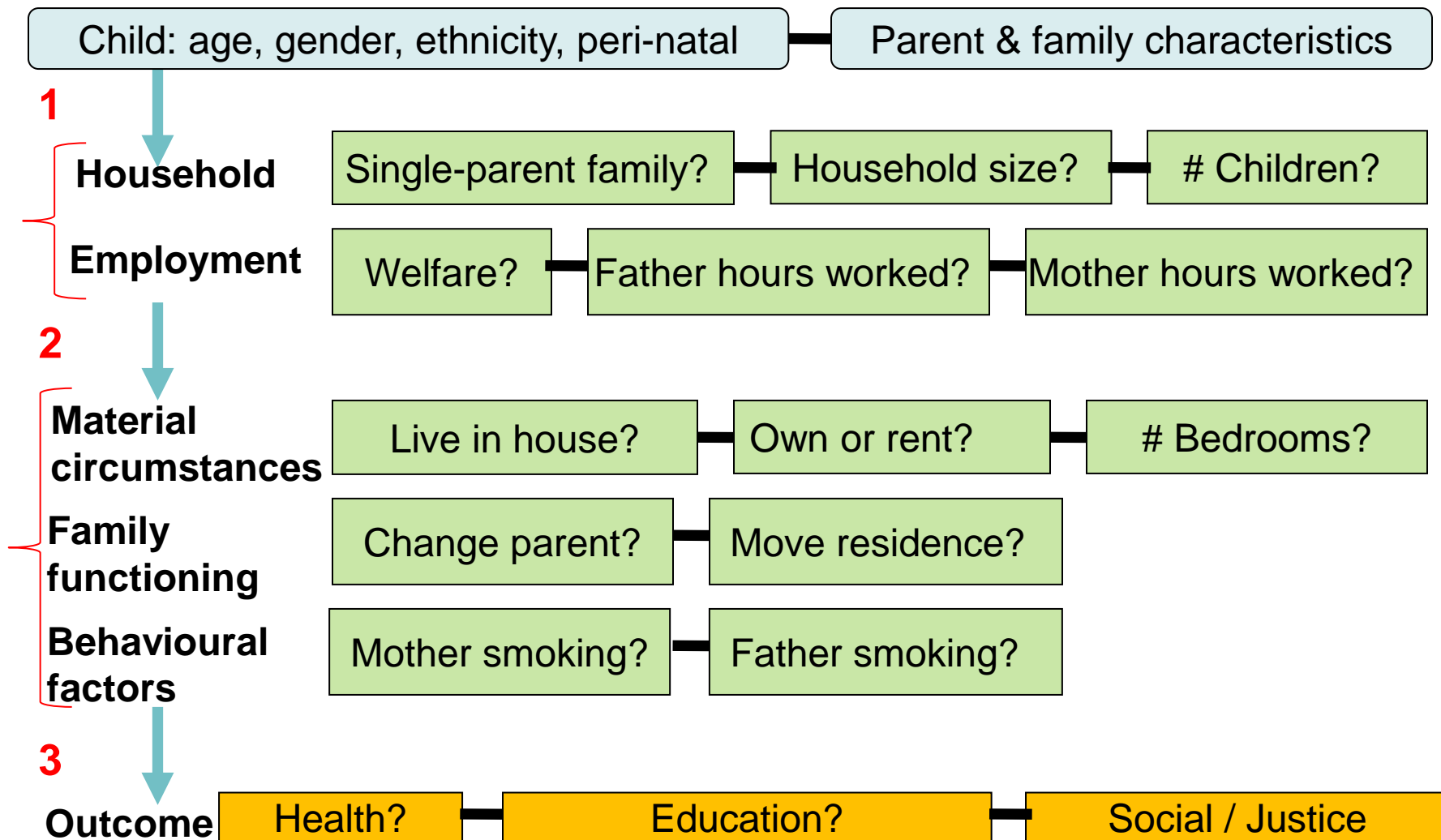
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- Incorporate additional longitudinal data sets
  - Ensure better representation of contemporary diverse NZ society
  - Extend to other social domains
  - Extend to older age groups
- Other longitudinal data sources
  - Dunedin Multidisciplinary Health and Development Study (Otago)
  - Pacific Islands Families (PIF) Study (AUT)
  - Te Hoe Nuku Roa – Best Outcomes for Māori Study (Massey)
- Methods to synthesise a more representative “virtual cohort”
- Adding value to publicly funded data

# Simulation process – how the data are used: Biography repeated each year to create a “virtual cohort”





- Purpose
- Frameworks
- Construction
- **Validation**
- Application
- Conclusion



- Compare simulated results to key benchmarks
- Improve the model to better approximate the benchmarks
- Align simulated results to benchmarks if necessary
- Example: health service use, 0-5 years

# Validation: GP visits - preventive

	Number of preventive GP visits (mean)	
Year	Real cohort (CHDS)	Virtual cohort (simulated)
1	2.50	2.50
2	1.77	1.84
3	0.04	0.04
4	0.24	0.23
5	0.38	0.38

# Validation: hospital admissions

	Total number of hospital admissions (mean)	
Year	Real cohort (CHDS)	Virtual cohort (simulated)
1	0.23	0.23
2	0.11	0.12
3	0.11	0.09
4	0.08	0.09
5	0.11	0.10



# Validation: hospital outpatient attendances



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	Total number of hospital outpatient attendances (mean)	
Year	Real cohort (CHDS)	Virtual cohort (simulated)
1	0.48	0.48
2	0.57	0.56
3	0.52	0.56
4	0.57	0.57
5	0.60	0.56

# Summary so far



- **Purpose of the tool**
  - *Test policy scenarios – ask “what if” questions*
- **Construction and use of the tool**
  - *Start with a sample of real children*
  - *Follow that sample through the life-course*
  - *Derive statistical models that best reproduce what really happened*
  - *Use those statistical models to create a virtual cohort*
  - ***Test scenarios on the virtual cohort by modifying key variables ... coming up***



ANY QUESTIONS?



- Purpose
- Frameworks
- Construction
- Validation
- **Application**
  - **Development and requirements**
  - **Demonstration**
  - **Future Directions**
- Conclusion



- ❑ Test “what if” scenarios
  - Projection into the future; alternative settings
  - Simulate impact of policy change
- ❑ Important role of end users
  - Engage key people from government agencies
  - Adopt a partnership approach, participatory modelling
  - Use their expertise to get better model & policy-relevant scenarios
- ❑ How do we test scenarios?
  - Change initial conditions or original settings, simulate & determine impact on outcome
- ❑ Possible scenarios?
  - Range of policy questions related to various life stages & domains

# Simulation tool - Development



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## End Users Group:

### Ministry of Science and Innovation

- Pereri Hathaway

### Ministry of Health

- Pat Tuohy
- Martin Tobias

### Ministry of Justice

- Donna Provoost
- Robert Lynn

### Ministry of Social Development

- Dorothy Adams
- Jenni Nana (CYF)

### Ministry of Education

- Lynne Whitney
- Ann Armstrong

# Simulation tool - Requirements

- ❑ Models should advise both the policies that should and should not be implemented
- ❑ Important factors should be modelled even if it is unclear how these might be affected by policy
- ❑ Risk factor interplay should be explored
  - Combinations and interactions of factors
  - Mediation and moderation of factors
- ❑ Simulate a wide range of scenarios covering health, education, social and justice outcomes through childhood

# Simulation tool - Requirements

- ❑ Inputs modifiable in ways that mimic how policy may affect them. E.g.,
  - By shifting people from one part of a distribution to another
  - By shifting people from one group to another
  - Allow changes to inputs that do not change over time ('static') and to inputs that do ('time dynamic'); and to allow time-dynamic inputs to be changed in a time-dynamic way
- ❑ Can test effects of inputs independent of other inputs





- Designed to be an end user tool for microsimulation and scenario testing
  - Can be run on a desktop PC by non-technical users
- Uses open source software
- User interface developed via JAVA in collaboration with international software developers (ASCAPE)
- Simulation programmed in JAVA and R.
- R provides in-built analysis functionality
- Output can be exported to external packages (Excel, SAS, SPSS, etc.)

# Simulation tool - Demonstration



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- ❑ Demonstrate modelling the effect of various socioeconomic inputs on health service outcomes for the child across ages 0-5, based on CHDS data
  - ❑ Interrogate system to check base rates of various inputs and outputs
  - ❑ Show how inputs can be flexibly changed
  - ❑ Show the effect of changing inputs on outputs.

# Possible policy scenarios



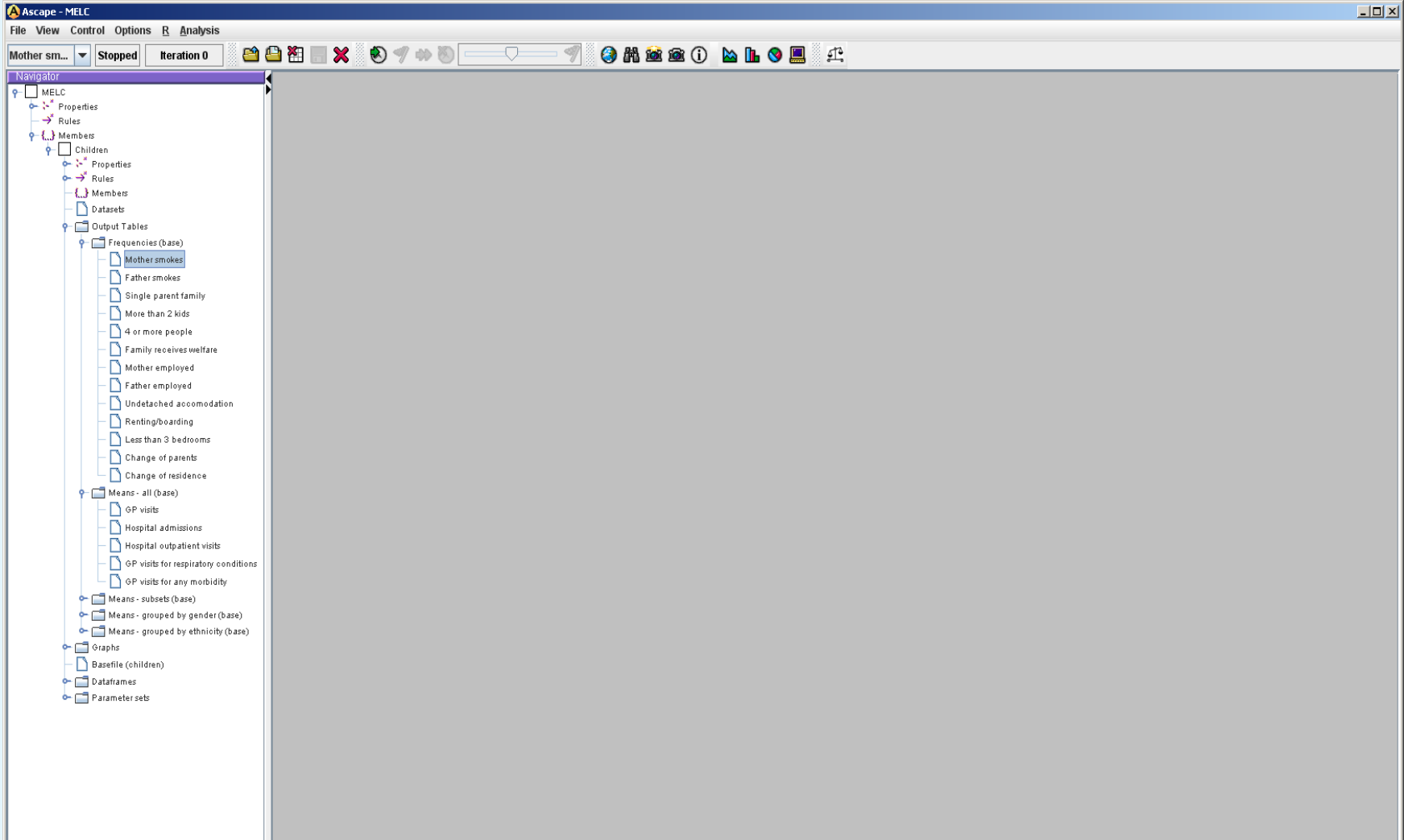
## Outcomes

- GP visits: total (= preventive + total morbidity); preventive; total morbidity; respiratory
- hospital admissions: total
- hospital outpatient attendances (incl. acute and arranged): total

## Policy levers (*P=Perinatal, S=Structural, I=Intermediate*)

- P reduce smoking in pregnancy (smoking or number of cigarettes)
- P reduce drinking in pregnancy (drinking or number of drinks)
- P prevent low birth weight
- P promote breast-feeding
- s improve family socio-economic status (SES at birth of child)
- s improve parental educational level (at birth of child)
- s reduce proportion of (very young) single mothers (at birth of child)
- I increase support for single parents (given single-parent status of family impacts on health)
- I reduce level of unemployment
- I increase proportion of working mothers or hours worked (mother's hours worked)
- I improve home ownership level (home owned/rented)
- I reduce overcrowding (ratio of number of bedrooms to household size)
- I reduce parental smoking (especially mother's smoking)

# Simulation tool - Demonstration



Ascape - MELC

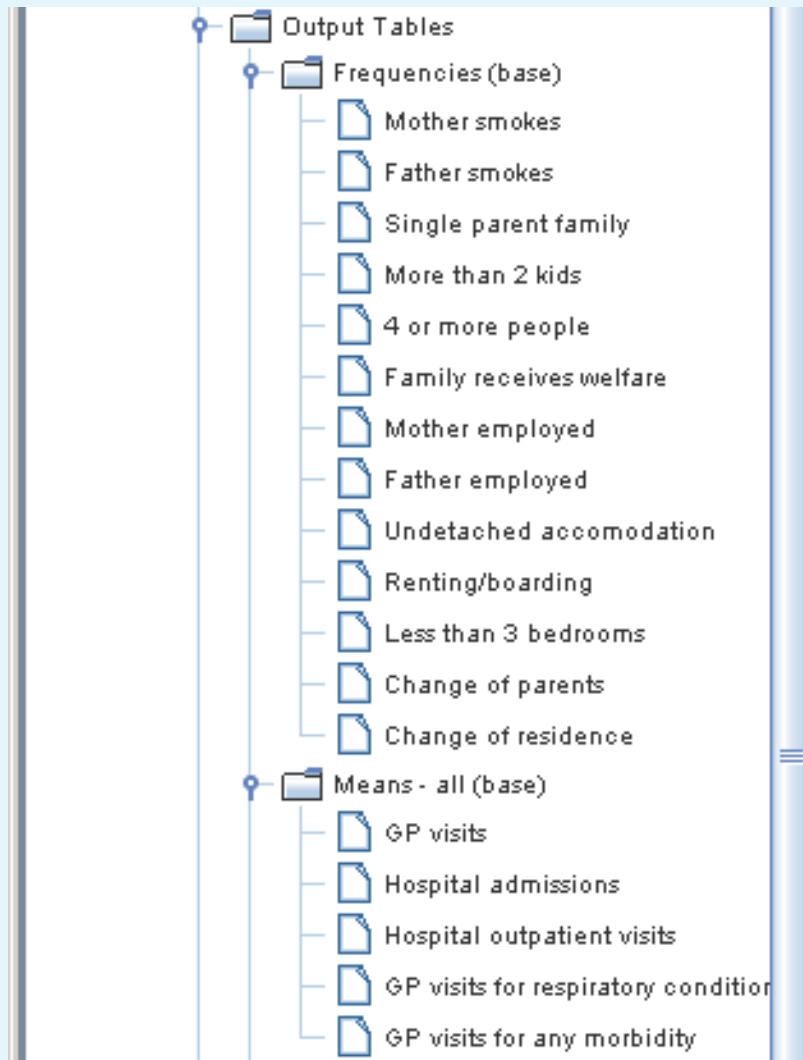
File View Control Options Analysis

Mother sm... Stopped Iteration 0

Navigator

- MELC
  - Properties
  - Rules
  - Members
    - Children
      - Properties
      - Rules
      - Members
    - Datasets
    - Output Tables
      - Frequencies (base)
        - Mother smokes
        - Father smokes
        - Single parent family
        - More than 2 kids
        - 4 or more people
        - Family receives welfare
        - Mother employed
        - Father employed
        - Undetached accomodation
        - Renting/boarding
        - Less than 3 bedrooms
        - Change of parents
        - Change of residence
      - Means - all (base)
        - GP visits
        - Hospital admissions
        - Hospital outpatient visits
        - GP visits for respiratory conditions
        - GP visits for any morbidity
      - Means - subsets (base)
      - Means - grouped by gender (base)
      - Means - grouped by ethnicity (base)
    - Graphs
    - Basefile (children)
    - Dataframes
    - Parameter sets

# Simulation tool - Demonstration



# Simulation tool - Demonstration



**A** GP visits

Year	gptotvis
1	5.8
2	4.26
3	4.12
4	4.1
5	4.14
Total	22.42

**A** Hospital admissions

Year	hadmtot
1	0.23
2	0.12
3	0.09
4	0.07
5	0.11
Total	0.62

**A** Hospital outpatient visits

Year	houtptot
1	0.48
2	0.59
3	0.51
4	0.54
5	0.55
Total	2.67

# Simulation tool - Demonstration



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## A Mother smokes

Year/msmoke	Non-smoker (%)	Smoker (%)
1	67.26	32.74
2	69.45	30.55
3	70.61	29.39
4	70.7	29.3
5	68.6	31.4

## A Family receives welfare

Year/welfare	No benefit (%)	Receiving benefit (%)
1	90.63	9.37
2	89.25	10.75
3	87.91	12.09
4	87.24	12.76
5	86.57	13.43

## A Single parent family

Year/single	Two parents (%)	Single parent (%)
1	92.6	7.4
2	91.48	8.52
3	91.17	8.83
4	89.61	10.39
5	89.52	10.48

## A Renting/boarding

Year/homeown	Own home (%)	Not owned (%)
1	67.17	32.83
2	70.96	29.04
3	73.24	26.76
4	74.98	25.02
5	76.23	23.77

# Simulation tool - Demonstration



**A Scenario Weightings**

Birth weight (g) ▼

Birth weight (g) ▲

Drinks during pregnancy (per week)

Gestational age

SES at birth

Mother's smoking

Fathers's smoking

Single parent

Kids ▼



**A Scenario Weightings**

Birth weight (g) ▼

Level	%	Increment By
< 2500	4.73	0
2500 - 2999	16.41	0
3000 - 3499	38.09	0
3500 - 3999	30.69	0
4000 +	10.08	0

Update Defaults



# Simulation tool - Demonstration



**A Scenario Weightings**

Birth weight (g) ▼

Birth weight (g) ▲

Drinks during pregnancy (per week)

Gestational age

SES at birth

Mother's smoking

Fathers's smoking

Single parent

Kids



**A Scenario Weightings**

Birth weight (g) ▼

Level	%	Increment By
< 2500	4.73	<input type="text" value="350"/>
2500 - 2999	16.41	<input type="text" value="0"/>
3000 - 3499	38.09	<input type="text" value="0"/>
3500 - 3999	30.69	<input type="text" value="0"/>
4000 +	10.08	<input type="text" value="0"/>

# Simulation tool - Demonstration



**A Scenario Weightings**

Birth weight (g) ▼

Birth weight (g) ▲

Drinks during pregnancy (per week)

Gestational age

SES at birth

Mother's smoking

Fathers's smoking

Single parent

Kids ▼



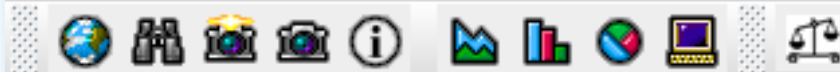
**A Scenario Weightings**

Birth weight (g) ▼

Level	%	Increment By
< 2500	1.87	0
2500 - 2999	19.27	0
3000 - 3499	38.09	0
3500 - 3999	30.69	0
4000 +	10.08	0

Update Defaults

# Simulation tool - Demonstration



**A Scenario Weightings**

SES at birth

Birth weight (g)

Drinks during pregnancy (per week)

Gestational age

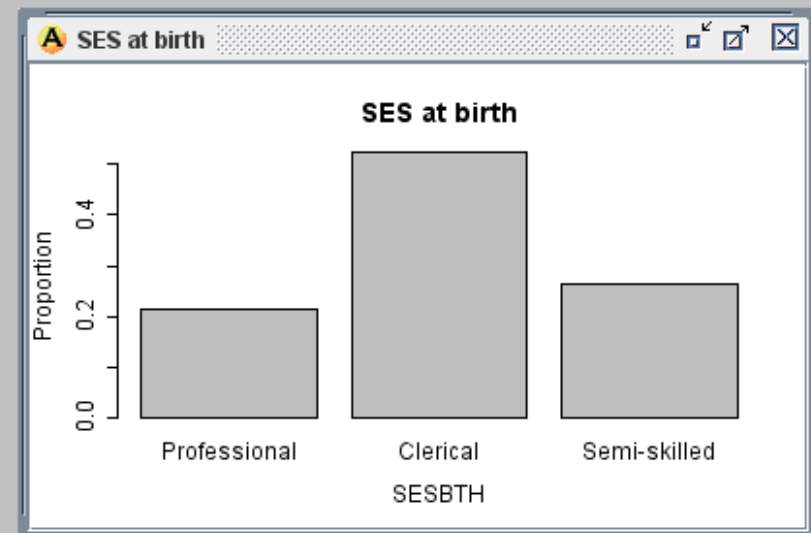
**SES at birth**

Mother's smoking

Fathers's smoking

Single parent

Kids



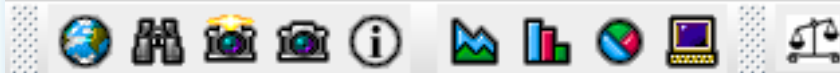
**A Scenario Weightings**

SES at birth

	Professional (%)	Clerical (%)	Semi-skilled (%)
At Birth			

**Update** **Defaults**

# Simulation tool - Demonstration



**A Scenario Weightings**

SES at birth

Birth weight (g)

Drinks during pregnancy (per week)

Gestational age

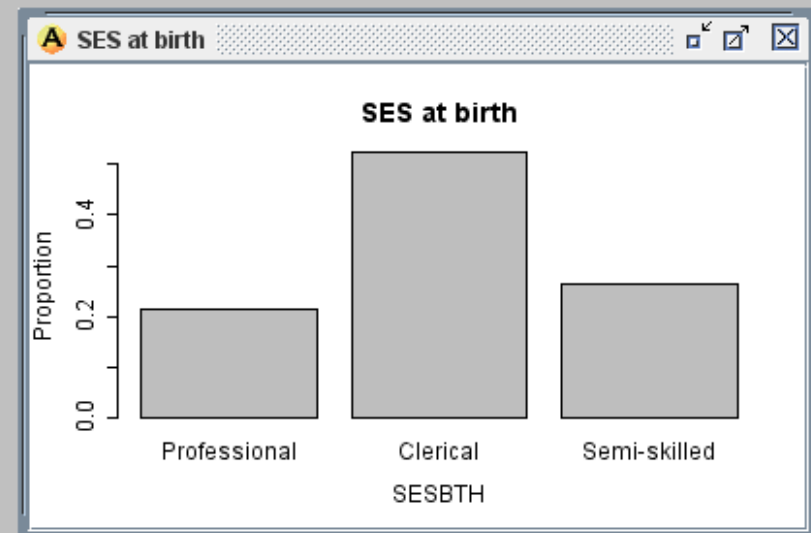
**SES at birth**

Mother's smoking

Fathers's smoking

Single parent

Kids



**A Scenario Weightings**

SES at birth

	Professional (%)	Clerical (%)	Semi-skilled (%)
At Birth	35	50	15

**Update** **Defaults**

# Simulation tool - Demonstration

The screenshot shows the main interface of the simulation tool. At the top is a toolbar with various icons for navigation and analysis. Below the toolbar is a window titled 'Scenario Weightings'. This window contains a list of variables that can be selected for weighting. The variables listed are: Single parent, Birth weight (g), Drinks during pregnancy (per week), Gestational age, SES at birth, Mother's smoking, Fathers's smoking, Single parent, and Kids. The 'Single parent' option is currently selected.

**A Single parent family**

Year/single	Two parents (%)	Single parent (%)
1	92.6	7.4
2	91.53	8.47
3	90.95	9.05
4	90.72	9.28
5	89.7	10.3

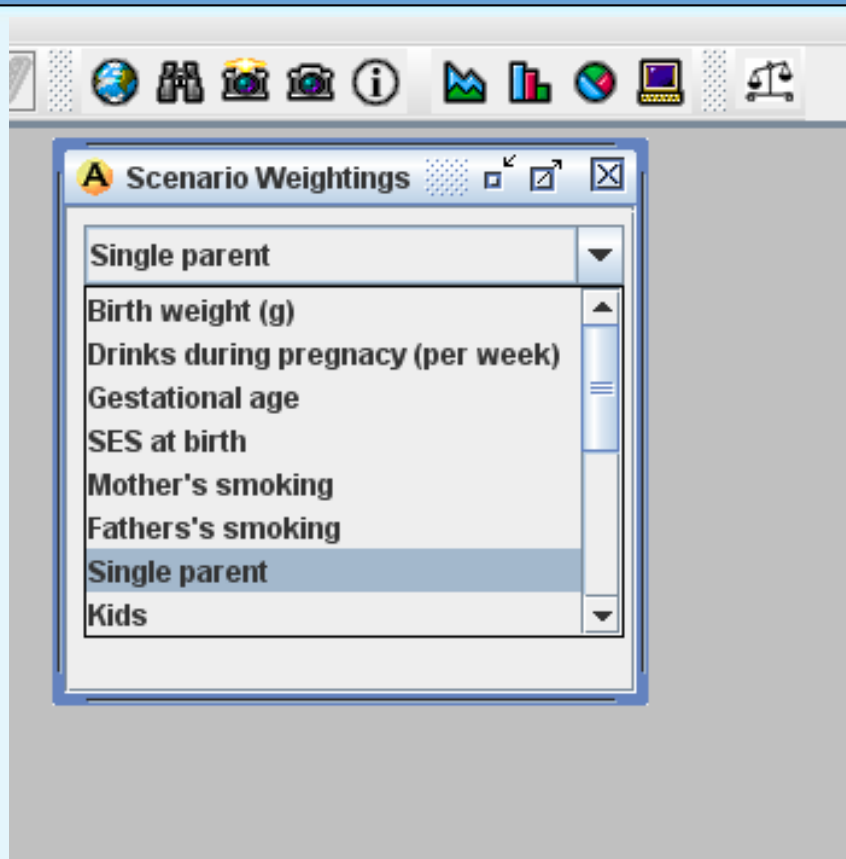
**A Scenario Weightings**

Single parent

	Two parents (%)	Single parent (%)
Year 1		
Year 2		
Year 3		
Year 4		
Year 5		

Update Defaults

# Simulation tool - Demonstration



The screenshot shows the main interface of the simulation tool. At the top is a toolbar with icons for various functions like home, search, and data visualization. Below the toolbar is a window titled 'Scenario Weightings' with a dropdown menu. The dropdown menu is open, showing a list of factors: 'Single parent', 'Birth weight (g)', 'Drinks during pregnancy (per week)', 'Gestational age', 'SES at birth', 'Mother's smoking', 'Fathers's smoking', 'Single parent', and 'Kids'. The 'Single parent' option is currently selected.

**A Single parent family**

Year/single	Two parents (%)	Single parent (%)
1	92.6	7.4
2	91.53	8.47
3	90.95	9.05
4	90.72	9.28
5	89.7	10.3

**A Scenario Weightings**

Single parent

	Two parents (%)	Single parent (%)
Year 1	98	2
Year 2	97	3
Year 3	96	4
Year 4	95	5
Year 5	94	6

**Update** **Defaults**

# Simulation tool - Demonstration

The screenshot shows the main interface of the simulation tool. At the top is a toolbar with icons for various functions like home, search, and data visualization. Below the toolbar is a window titled 'Scenario Weightings'. This window contains a list of factors that can be selected for weighting, including 'Single parent', 'Birth weight (g)', 'Drinks during pregnancy (per week)', 'Gestational age', 'SES at birth', 'Mother's smoking', 'Fathers's smoking', 'Single parent', and 'Kids'. The 'Single parent' option is currently selected.

**A Single parent family**

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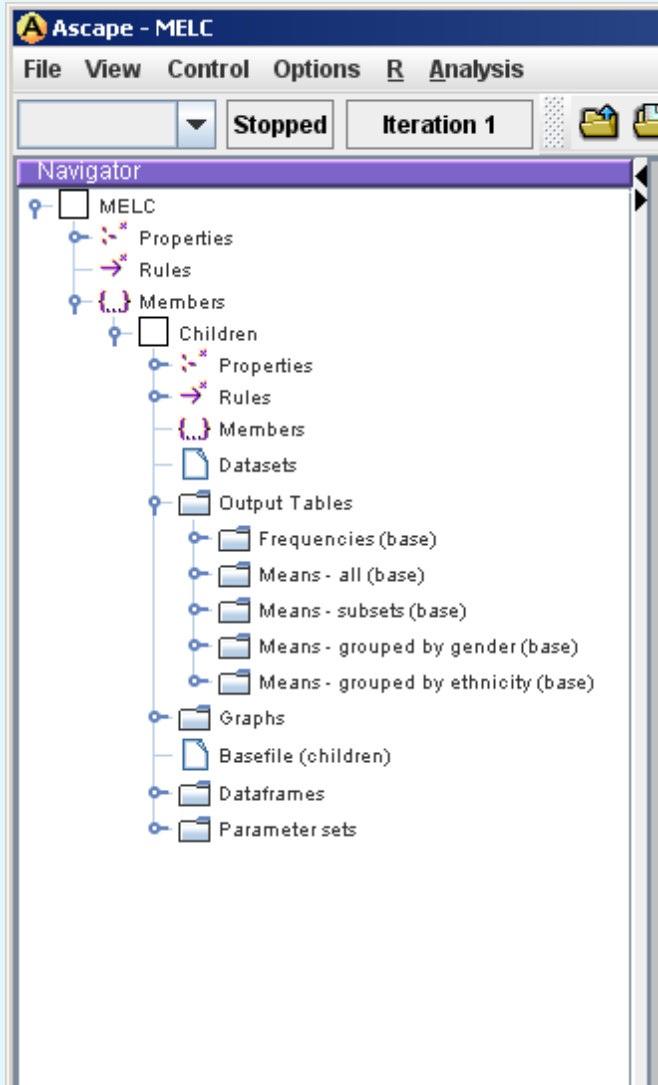
**A Scenario Weightings**

Single parent

	Two parents (%)	Single parent (%)
Year 1	98	2
Year 2		
Year 3		
Year 4		
Year 5		

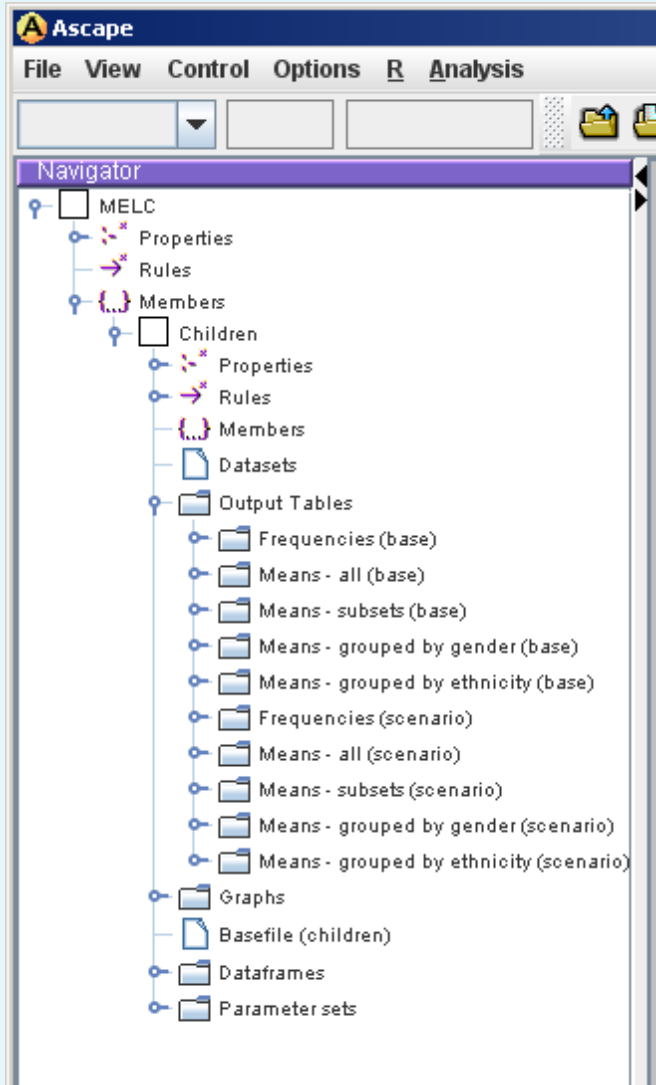
Update Defaults

# Simulation tool - Demonstration





# Simulation tool - Demonstration



# Simulation tool - Demonstration



The screenshot displays the Ascape software interface. On the left is a Navigator tree showing a project structure for 'MELC' with sub-items like Properties, Rules, Members, Children, Datasets, Output Tables, and various statistical outputs. On the right are four data tables:

Year	houptot
1	0.48
2	0.59
3	0.51
4	0.54
5	0.55
Total	2.67

Year	gptotvis
1	5.8
2	4.26
3	4.12
4	4.1
5	4.14
Total	22.42

Year	houptot
1	0.48
2	0.52
3	0.46
4	0.45
5	0.46
Total	2.36

Year	gptotvis
1	5.8
2	4.21
3	4.1
4	4.05
5	3.94
Total	22.1

# Simulation tool - Demonstration



The screenshot shows the Ascape software interface. On the left is a 'Navigator' pane with a tree structure for a project named 'MELC'. The tree includes folders for 'Properties', 'Rules', 'Members', 'Children', 'Datasets', 'Output Tables', 'Frequencies', 'Means', 'Graphs', 'Basefile', 'Dataframes', and 'Parameter sets'. The 'Output Tables' folder is expanded, showing various summary statistics like 'Means - all (base)', 'Means - subsets (base)', etc. On the right side of the interface, four data tables are displayed in a grid. The top-left table is 'Hospital outpatient visits', the top-right is 'GP visits', the bottom-left is 'Hospital outpatient visits scenario', and the bottom-right is 'GP visits scenario'. Each table shows data for years 1 through 5 and a 'Total' row.

Year	houpttot
1	0.48
2	0.59
3	0.51
4	0.54
5	0.55
Total	2.67

Year	gptotvis
1	5.8
2	4.26
3	4.12
4	4.1
5	4.14
Total	22.42

Year	houpttot
1	0.48
2	0.52
3	0.46
4	0.45
5	0.46
Total	2.36

Year	gptotvis
1	5.8
2	4.21
3	4.1
4	4.05
5	3.94
Total	22.1

**12% drop**

**1.4% drop**

# Simulation tool - Capabilities



- ❑ Can test the effect of one (or a combination) of inputs and one (or many) outputs
- ❑ Inputs modifiable in ways that mimic how policy may affect them. E.g.,
  - By shifting people from one part of a distribution to another (e.g., birth weight)
  - By shifting people from one group to another (e.g., SES)
  - Flexible to allow changes to inputs to be (i) constant over time; (ii) variable over time as determined by the user; (iii) variable over time as determined by the simulation
- ❑ Can test effects of inputs independent of other inputs

# Simulation tool – Future directions

- ❑ Framework in place to extend to other domains (e.g., education, social, justice), and to a wider range of inputs and outputs within domains
  - Education and conduct problems next!
- ❑ Allow comparisons of 2+ different simulations
- ❑ Allow user to see a list of inputs that are likely to affect outputs of interest
- ❑ Allow scenarios to be run on ‘subgroups’ (e.g., what would happen if the smoking in pregnancy rate of Māori was equal to that of Pakeha?)

# Simulation tool – Future directions



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- ❑ Allow ‘error’ around output values to be estimated and reported
- ❑ Update/weight base data to be more representative of the current population
  - ❑ Census data
  - ❑ Birth data from MOH datasets
- ❑ Use additional (longitudinal) sources to inform parameter estimates



- Purpose
- Frameworks
- Construction
- Validation
- Application
- **Conclusion**

# Conclusion



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- A dynamic simulation model of the early life course was constructed & applied (work in progress)
- With participation of data providers and end-users
- A useful tool for scenario testing
- Will contribute to better policy decision-making
- Using publicly-funded data from existing NZ longitudinal studies
- Adding value by employing advanced methods: data synthesis & dynamic simulation



# Acknowledgments



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- Funder: Ministry of Science and Innovation
- Research Team (COMPASS)  
*Peter Davis (Science Leader), Gerry Cotterell (Centre Manager), Roy Lay-Yee (Senior Research Fellow), Barry Milne (Research Fellow), Janet Pearson (Statistician), Martin von Randow (Data Manager), Oliver Mannion (Programmer), Jessica Thomas (Statistician)*
- International Advisory Group  
*Prof Laurie Brown (Canberra), Prof Nigel Gilbert (Surrey), Prof Klaus Troitzsch (Koblenz), Asst Prof Flaminio Squazzoni (Brescia), Dr. Martin Spielauer (Statistics Canada), Dr. Dimitris Ballas (Sheffield)*
- Māori Advisory Group  
*Chair: Dr. Marilyn Brewin (Nga Pae o te Maramatanga)*
- Academic Advisors  
*Dr Tracey McIntosh, Dr Louise Humpage, Prof Alastair Scott (Auckland)*
- End Users Advisory Group  
*Dorothy Adams (MSD), Ann Armstrong (MoE), Pereri Hathaway (MSI), Robert Lynn (MoJ), Jenni Nana (MSD), Donna Provoost (MoJ), Martin Tobias (MoH), Pat Tuohy (MoH), Lynne Whitney (MoE)*
- Christchurch Health & Development Study  
*Prof David Fergusson, Assoc Prof John Horwood*



ANY QUESTIONS?