New Zealand

# Developing a policy tool for the early life course

Simulation using data from NZ longitudinal studies

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THE UNIVERSITY OF AUCKLAND

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## Adding Value to Publicly Funded Data

*Colloquium*

*22 July 2011*

Roy Lay-Yee, Barry Milne
COMPASS Research Centre
www.compass.auckland.ac.nz

ministry of science + innovation
TE PŪNAHA HIRINGA WHAKAEA

# Modelling the early life course (MEL-C)

## Presentation outline

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

**Part 1**

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

*Questions*

**Part 2**

- Application
- Conclusion

*Questions*

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# Purpose

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- 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



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# Modelling the early life course (MEL-C)

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

# Framework: Life course

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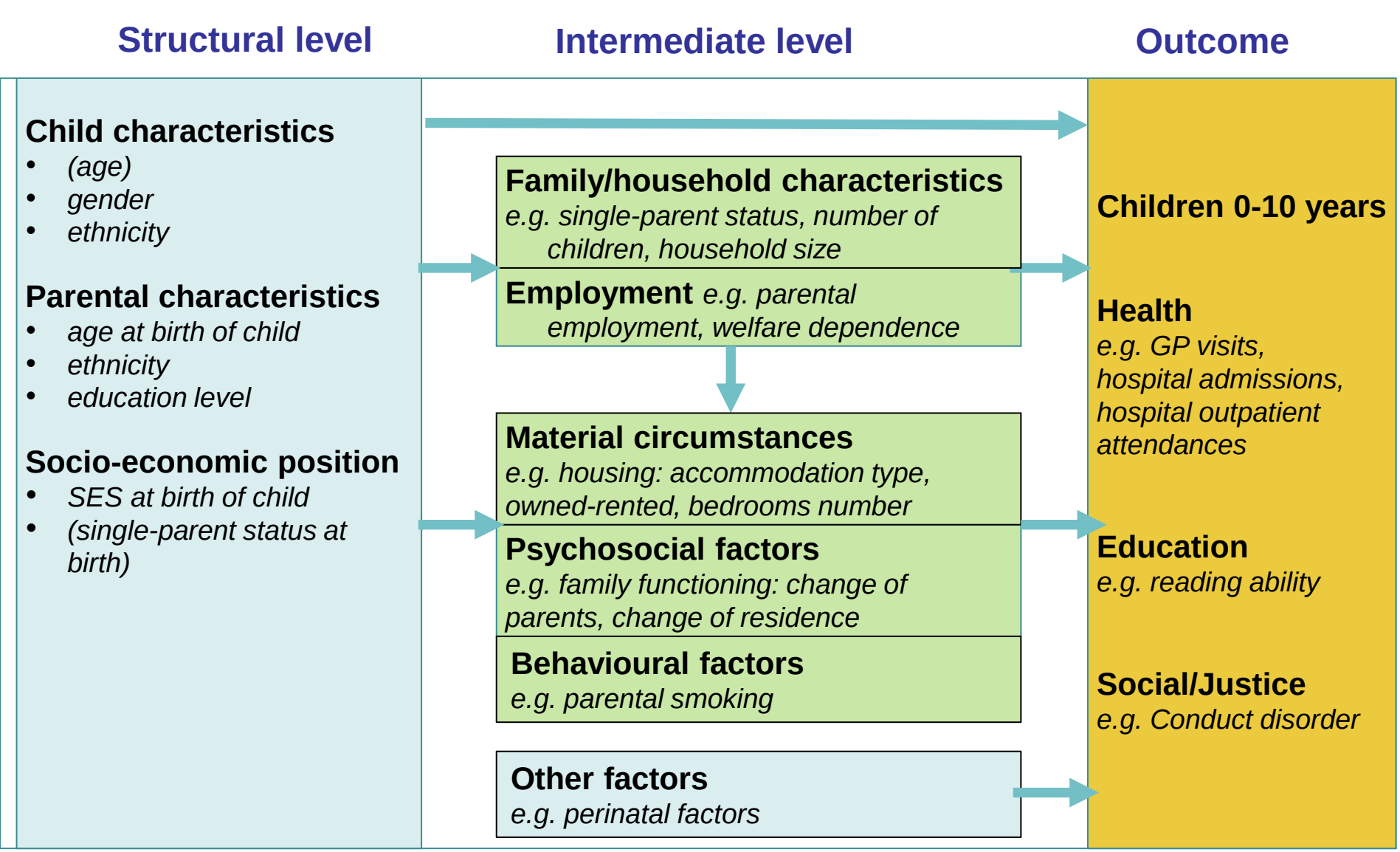
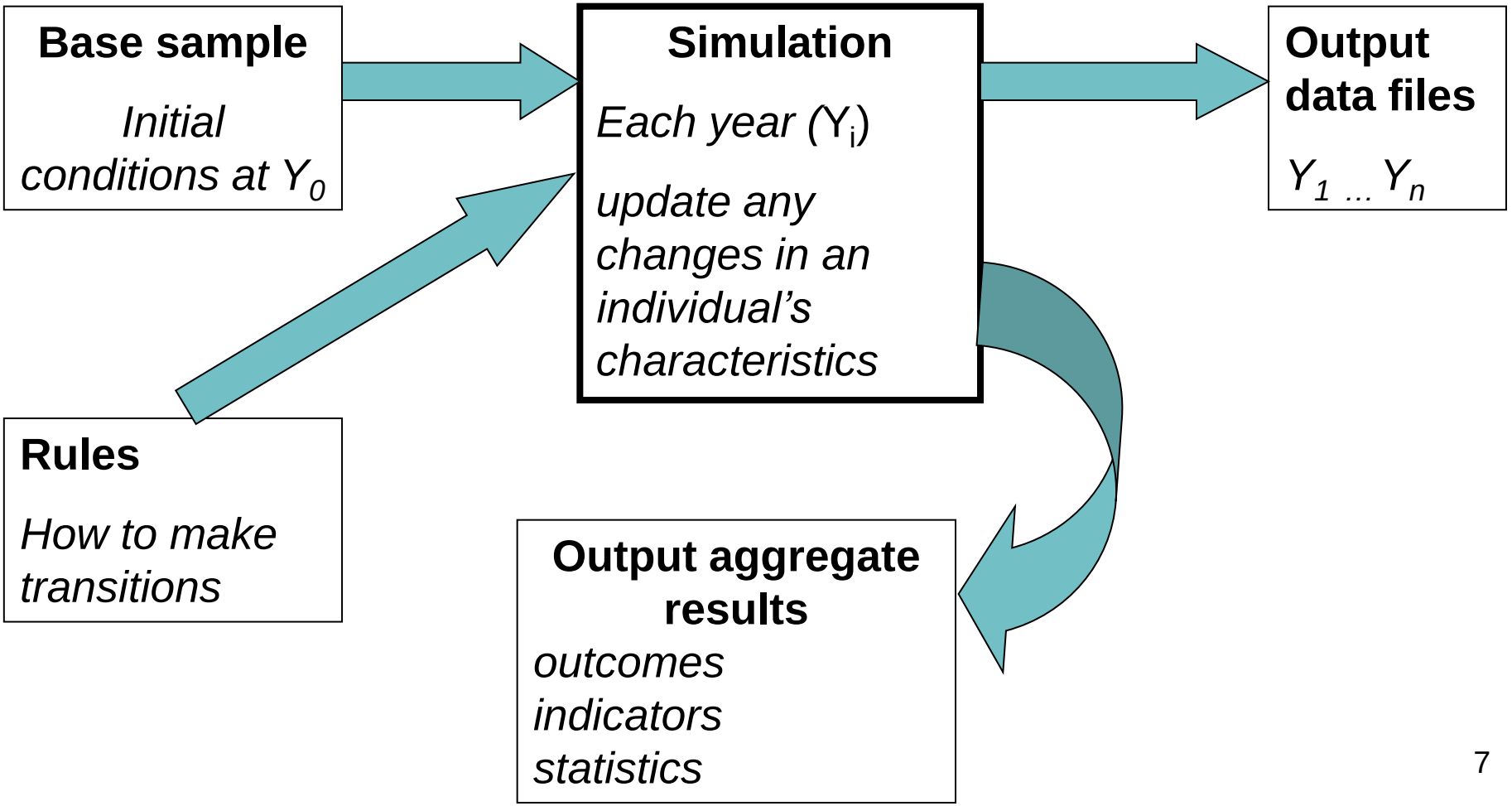
- Life course perspective
- Influence of social and family factors on early childhood outcomes
- Importance of early childhood for later life
- Policy relevance and utility

# Early life course, family & well being



# Framework: dynamic micro simulation



# Modelling the early life course (MEL-C)

## Presentation outline

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- 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)



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# Additional data sources

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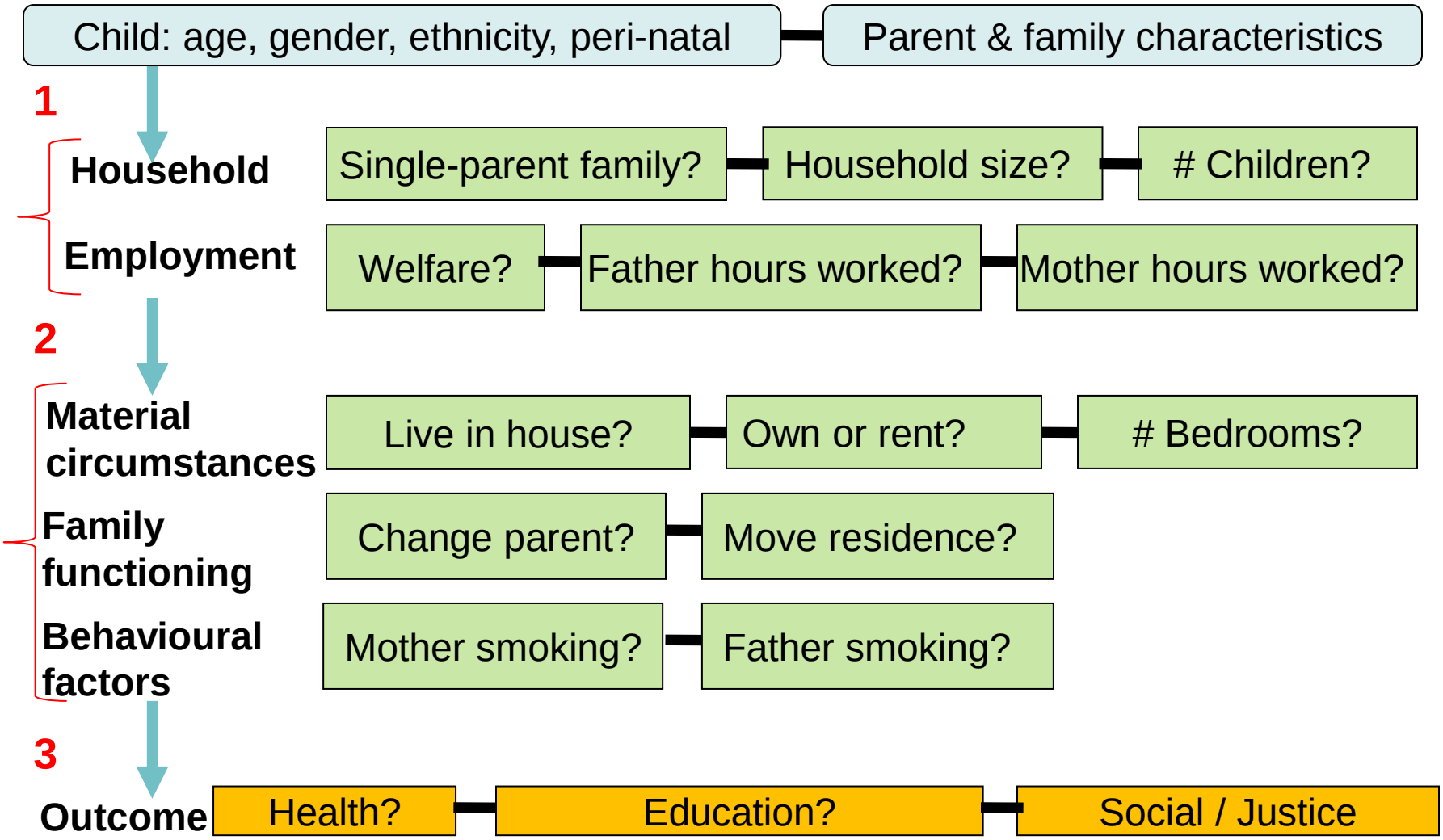
- Incorporate additional longitudinal data sets
  - Ensure better representation of contemporary diverse NZ society
  - Extend to other social domains
  - Extend to older age groups
- Other longitudinal data sources
  - Dunedin Multidisciplinary Health and Development Study (Otago)
  - Pacific Islands 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"



# Modelling the early life course (MEL-C)

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- **Validation**
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# Validation

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- 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



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# 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

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| | 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 |



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# Validation: hospital outpatient attendances



| | 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***



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# ANY QUESTIONS?

# Presentation outline

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

# Scenario testing



- 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

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- 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



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# 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

# Software development

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- 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

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- **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

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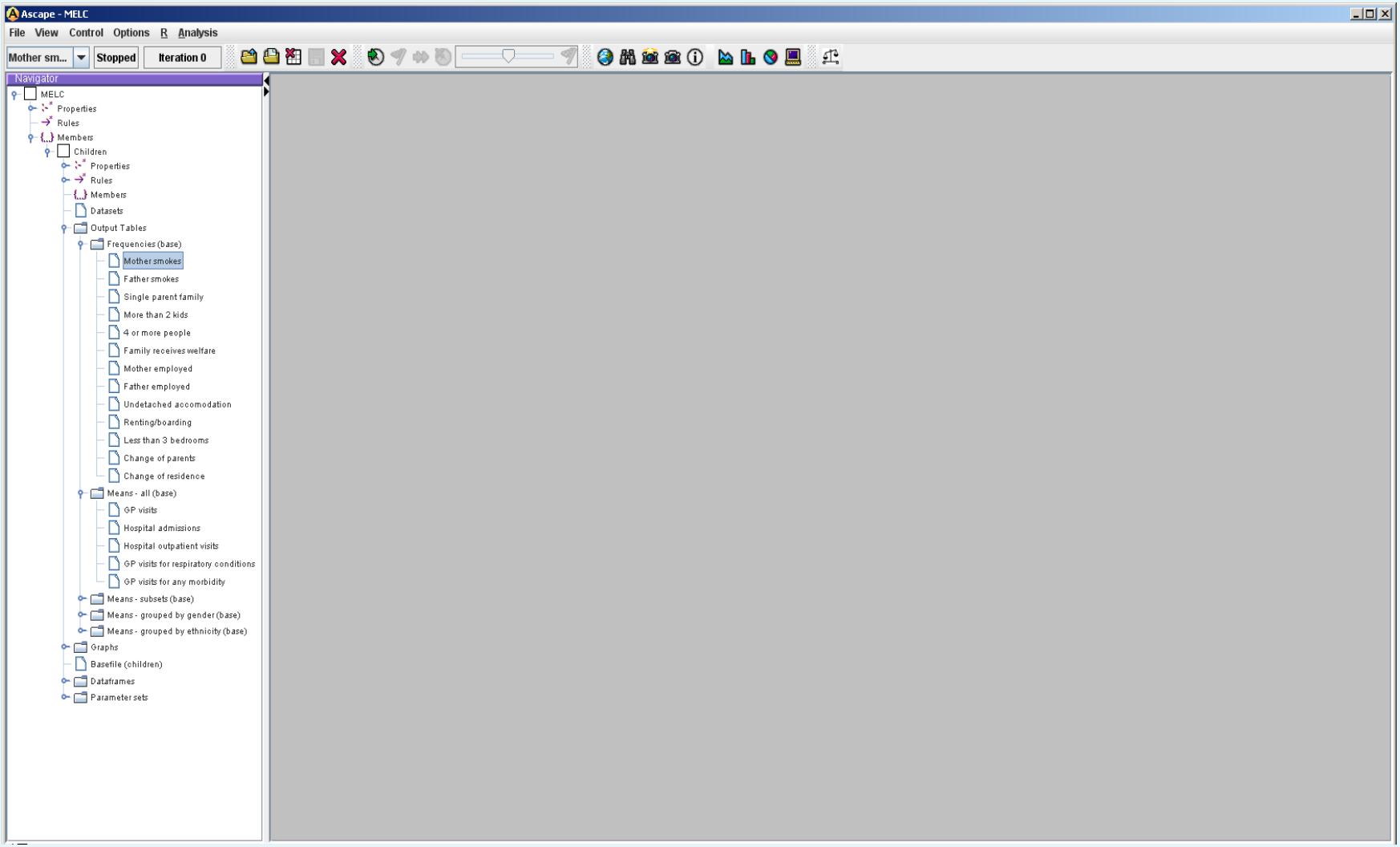


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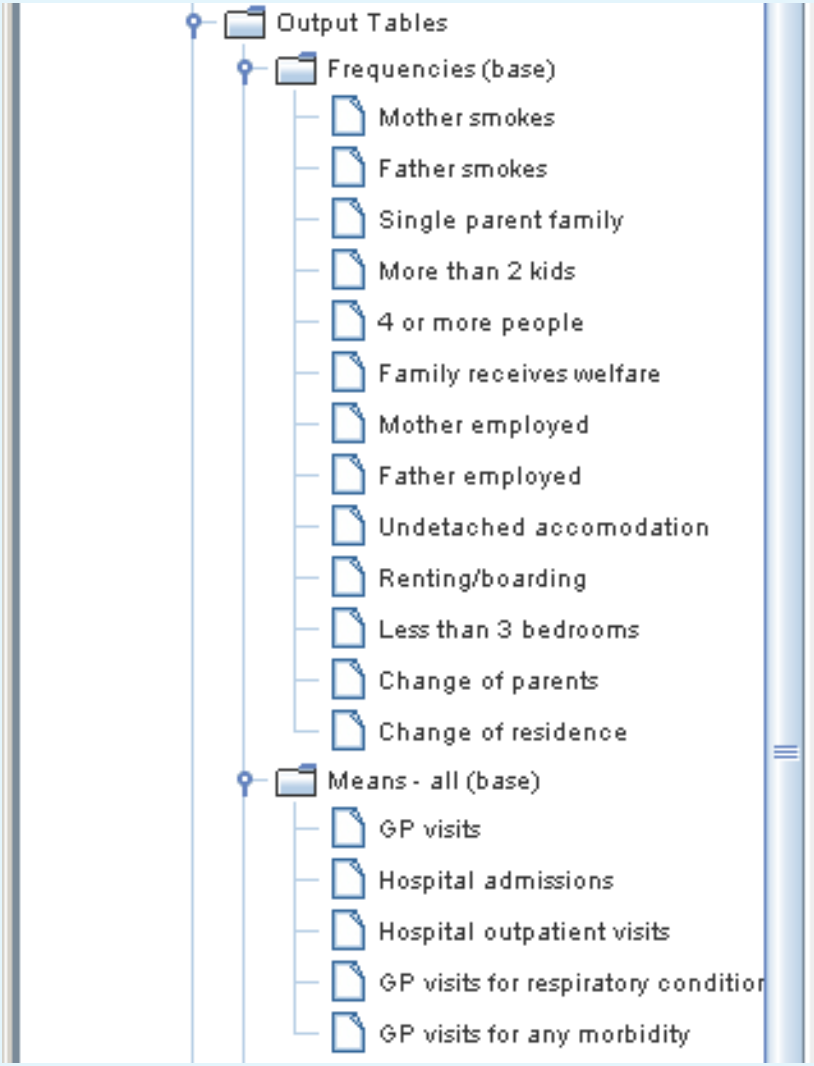

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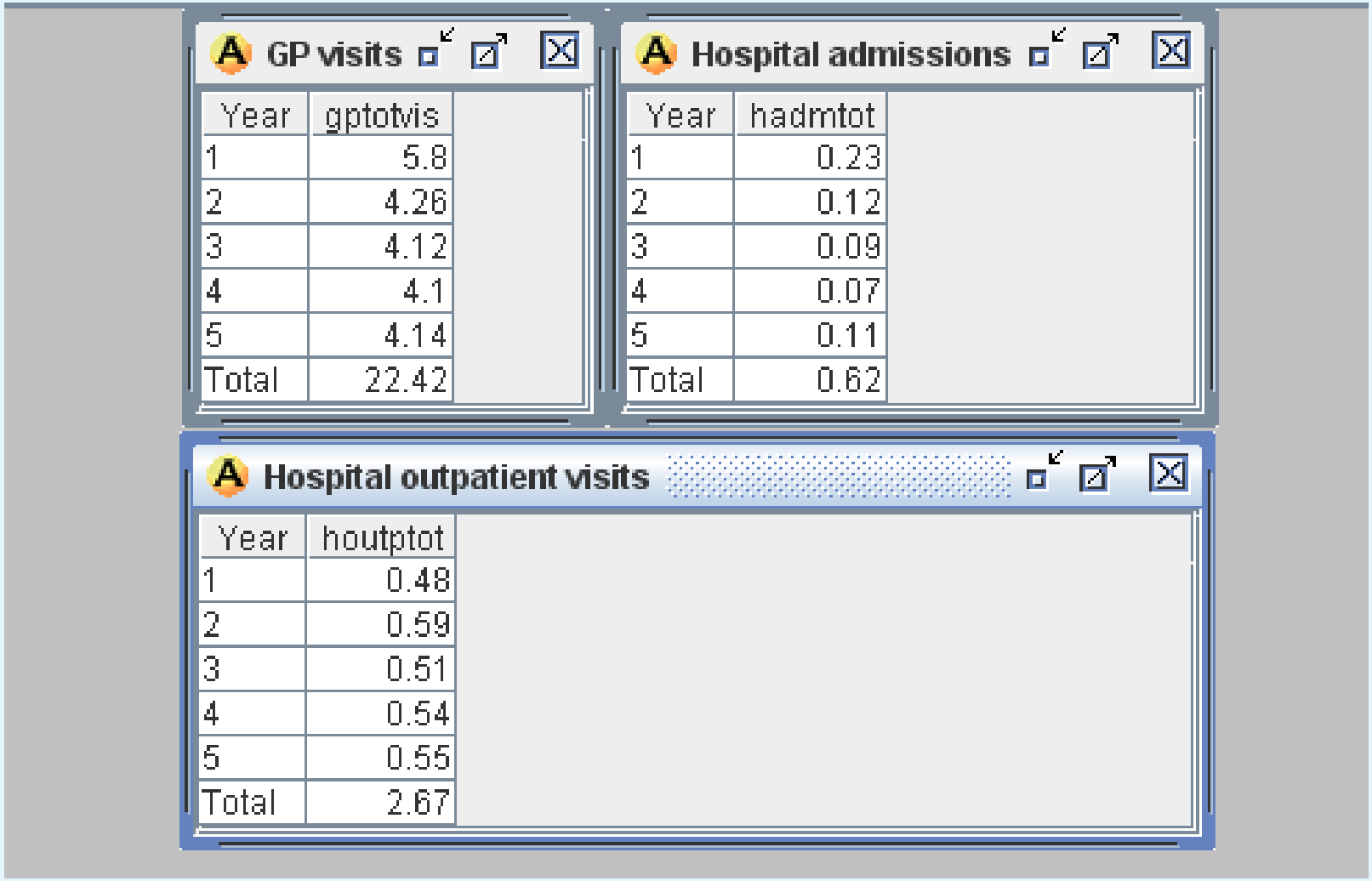

GP visits

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

Hospital admissions

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

Hospital outpatient visits

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

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**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 |

**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 |

**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 |

**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 |

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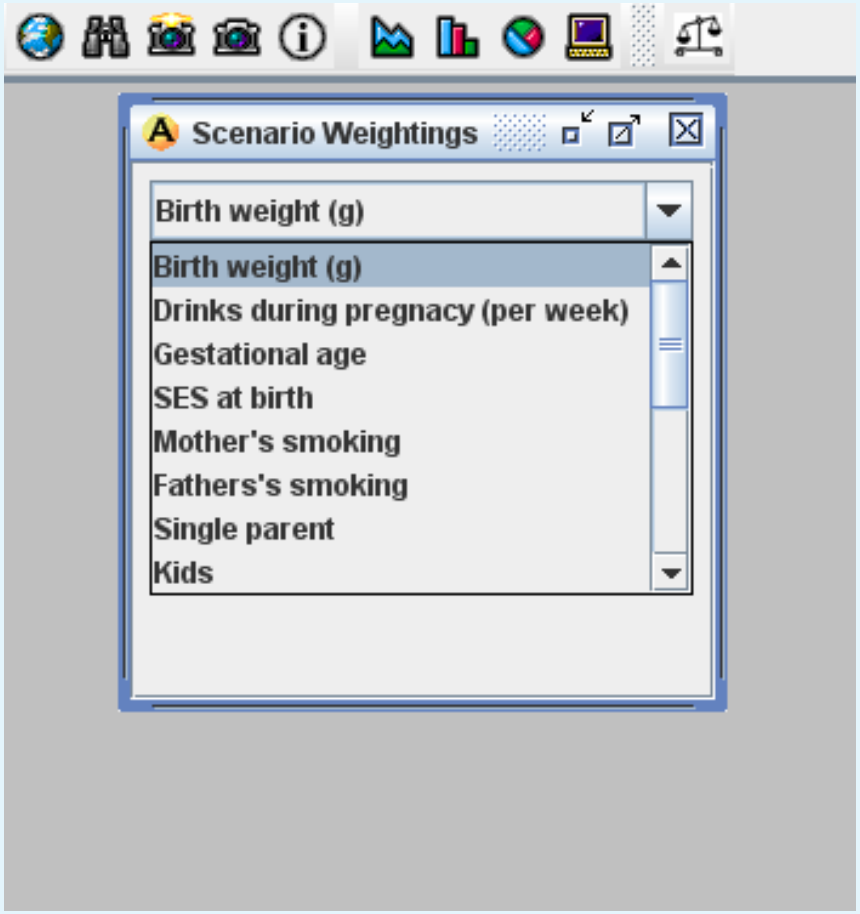
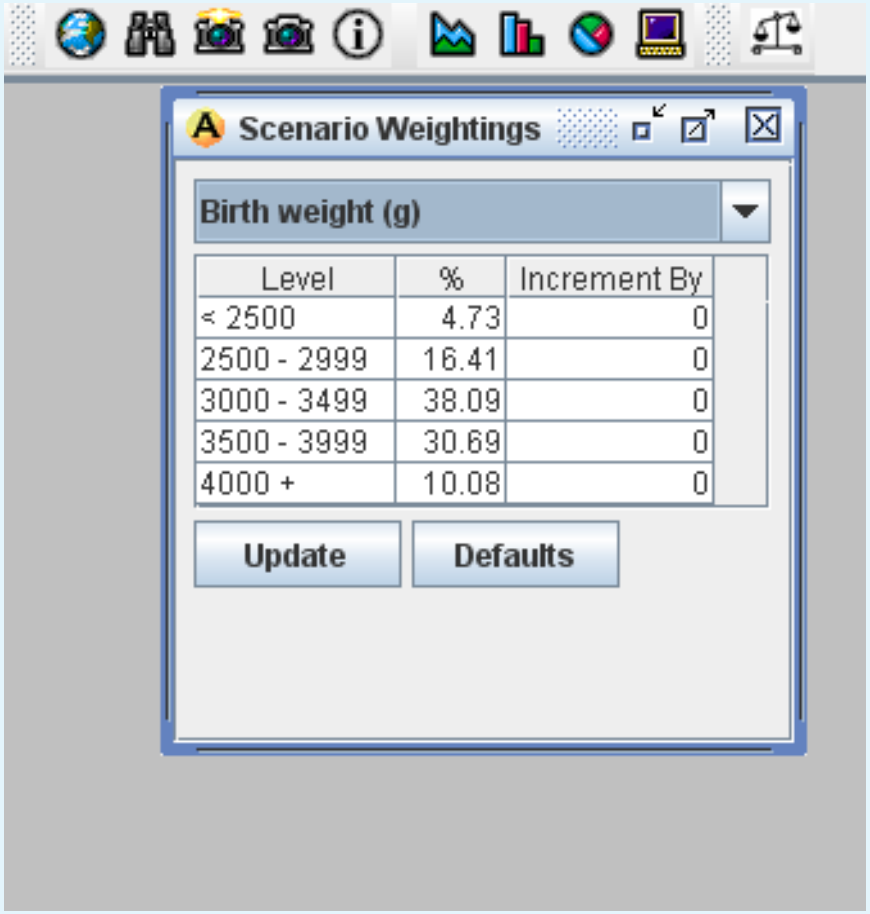
# Simulation tool - Demonstration





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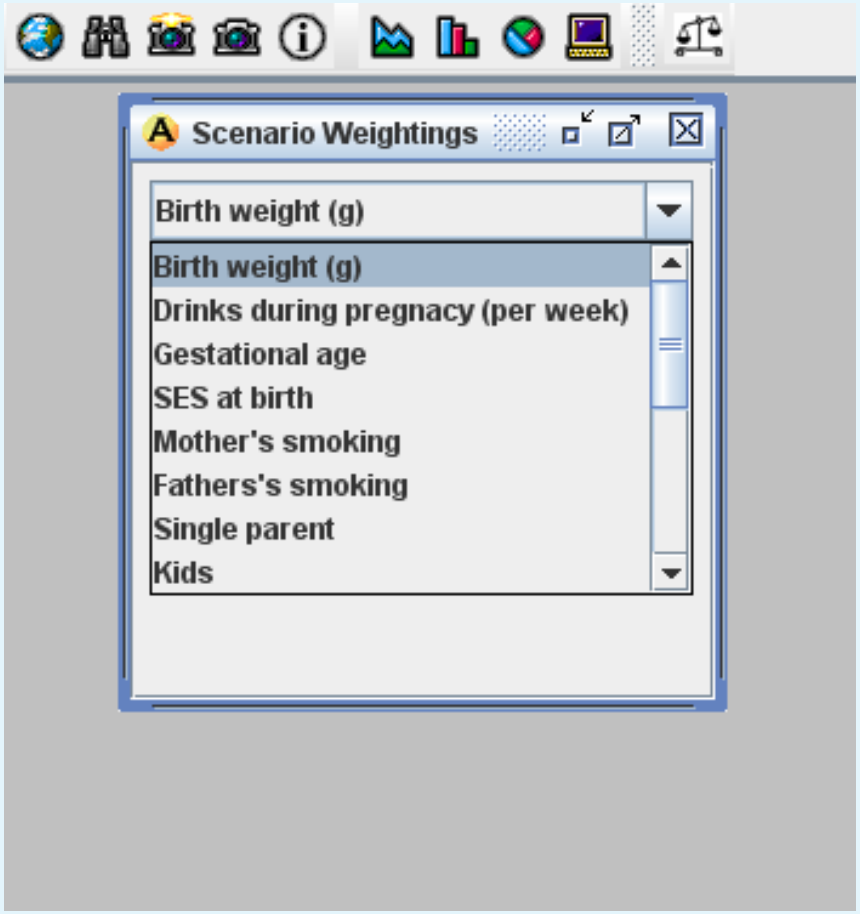


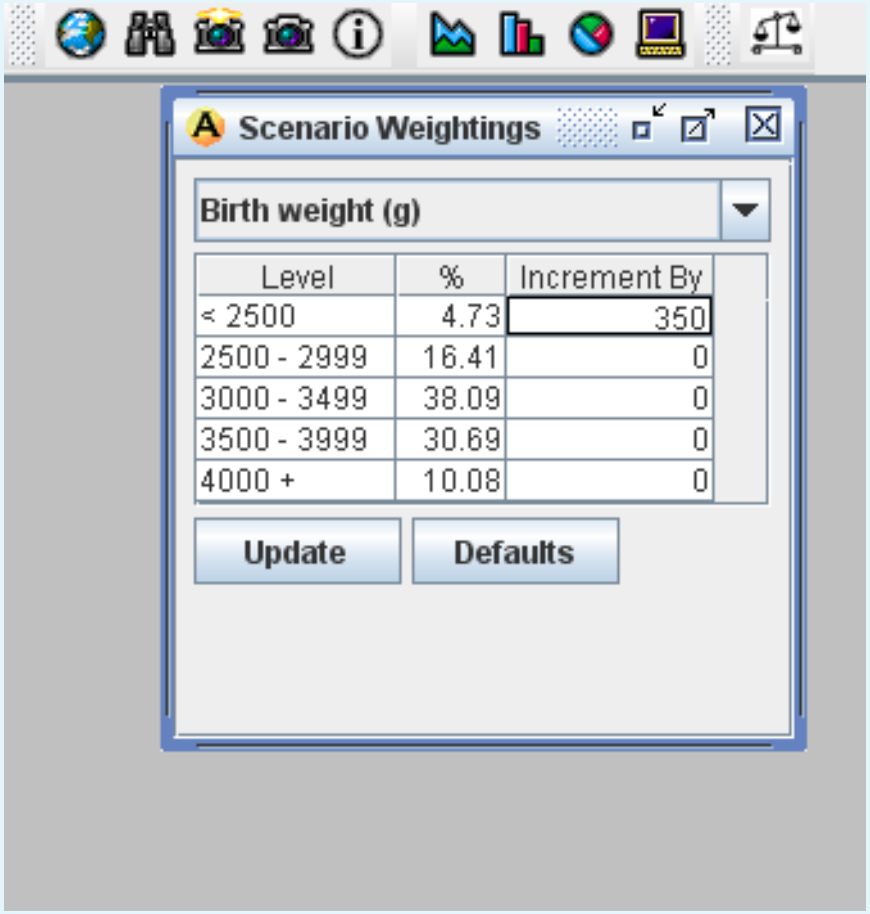

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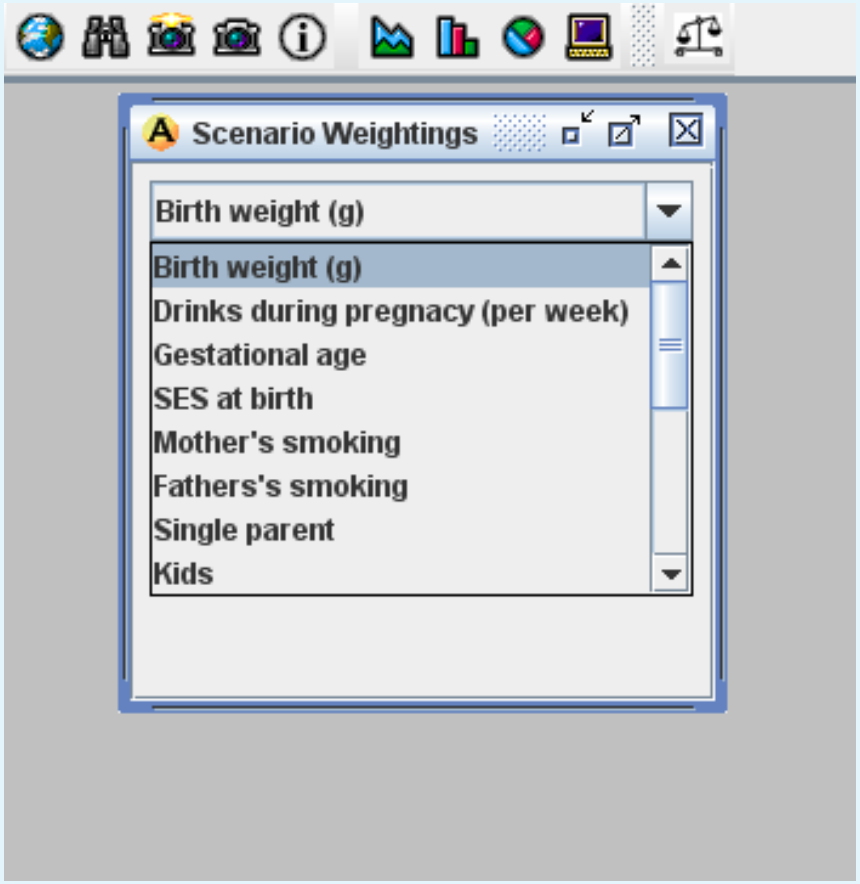


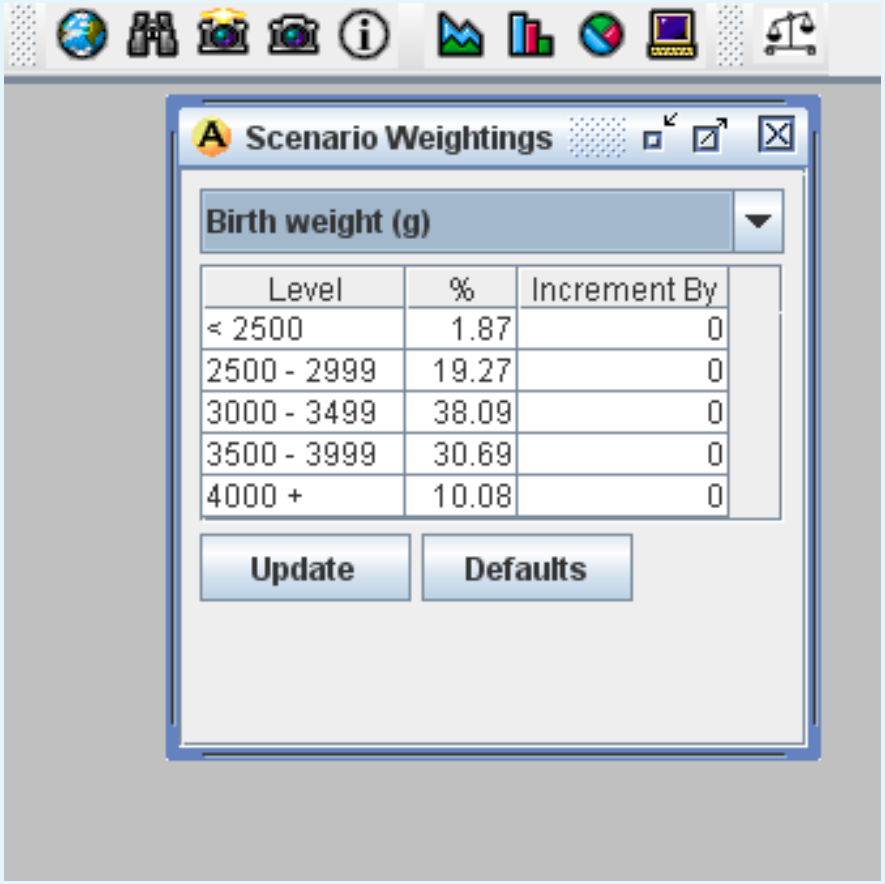

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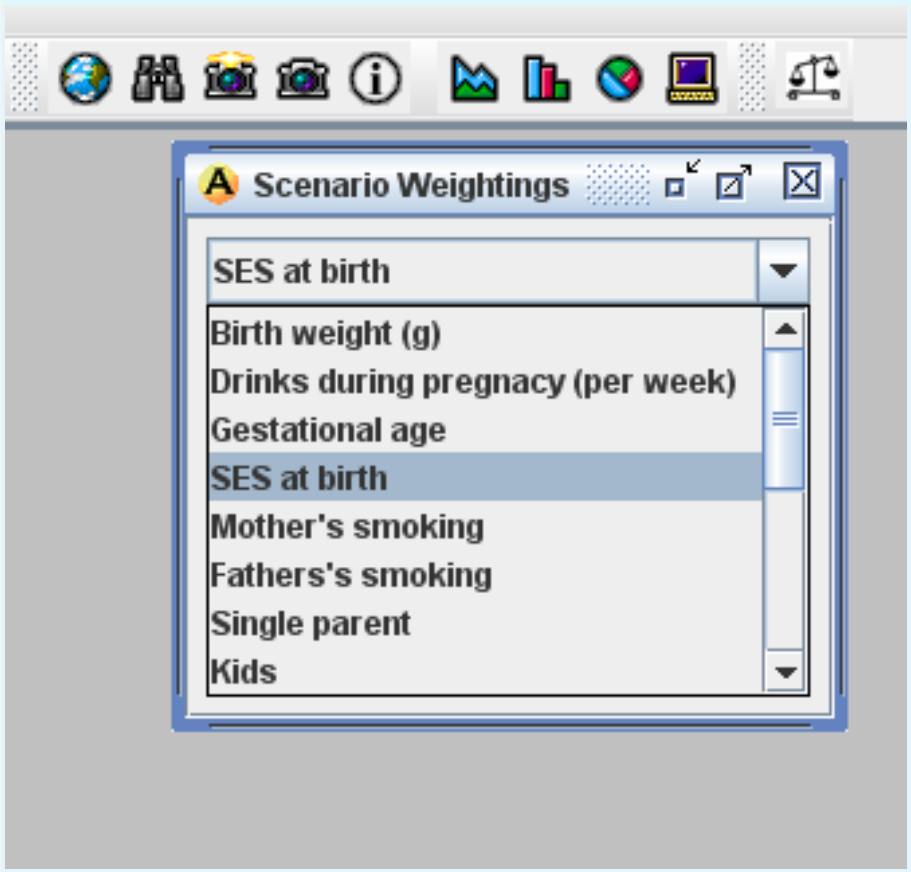


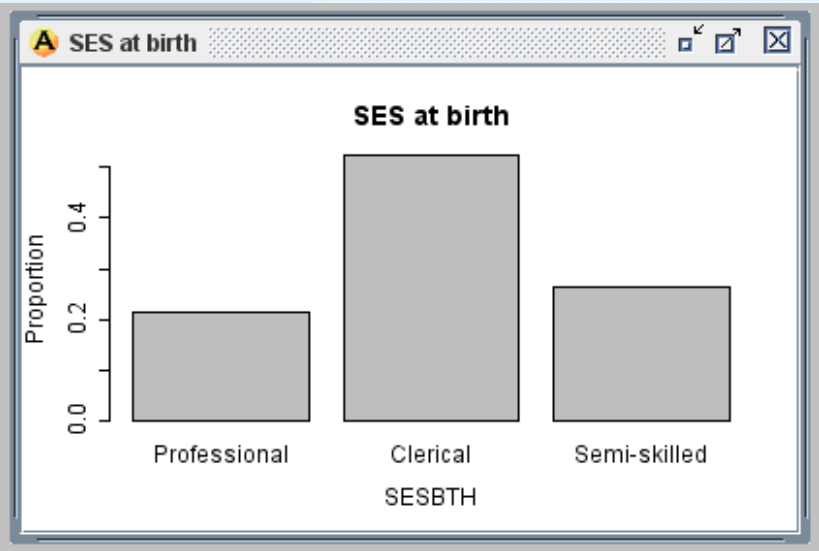


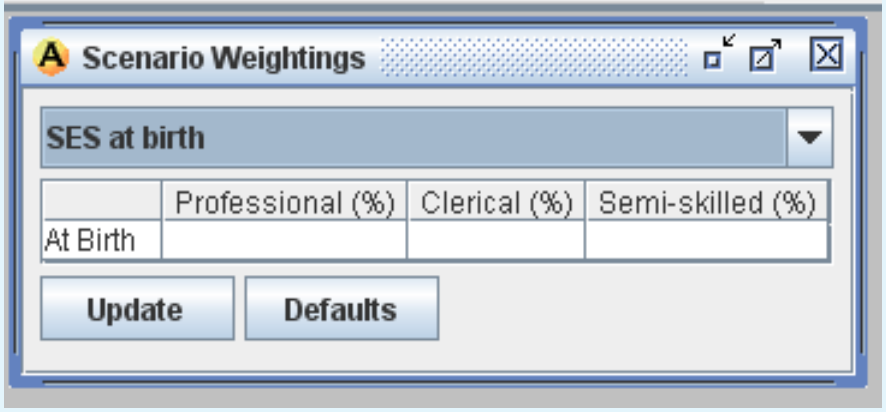


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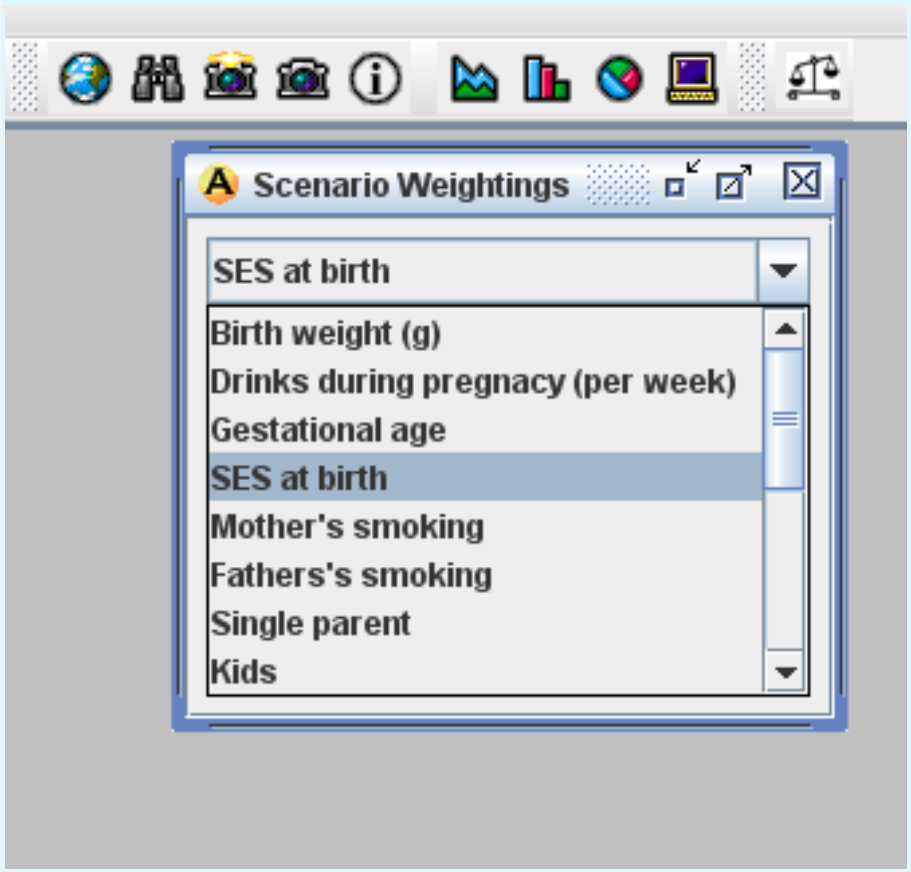


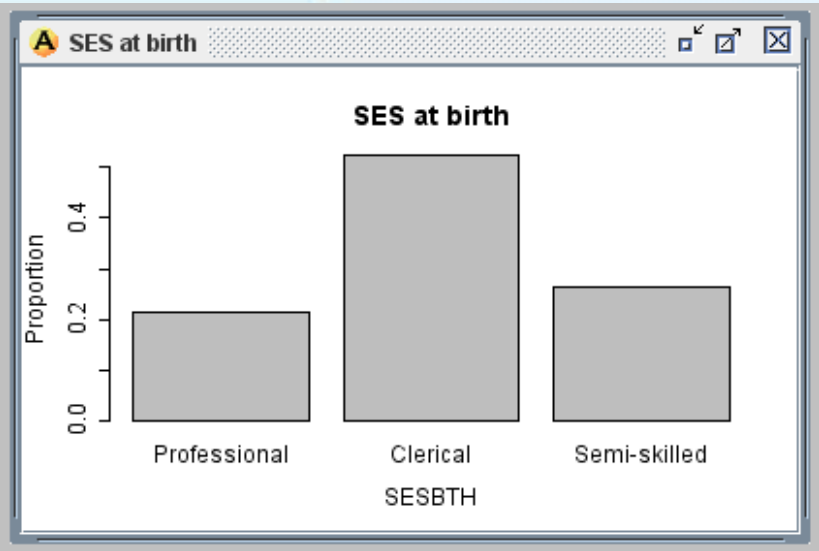


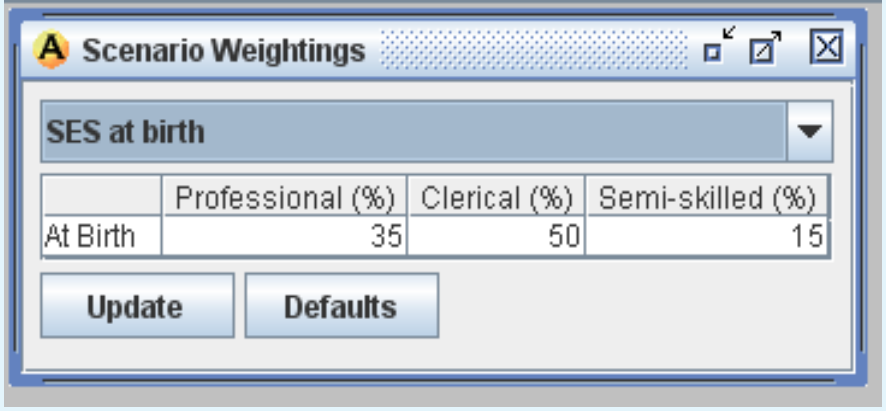

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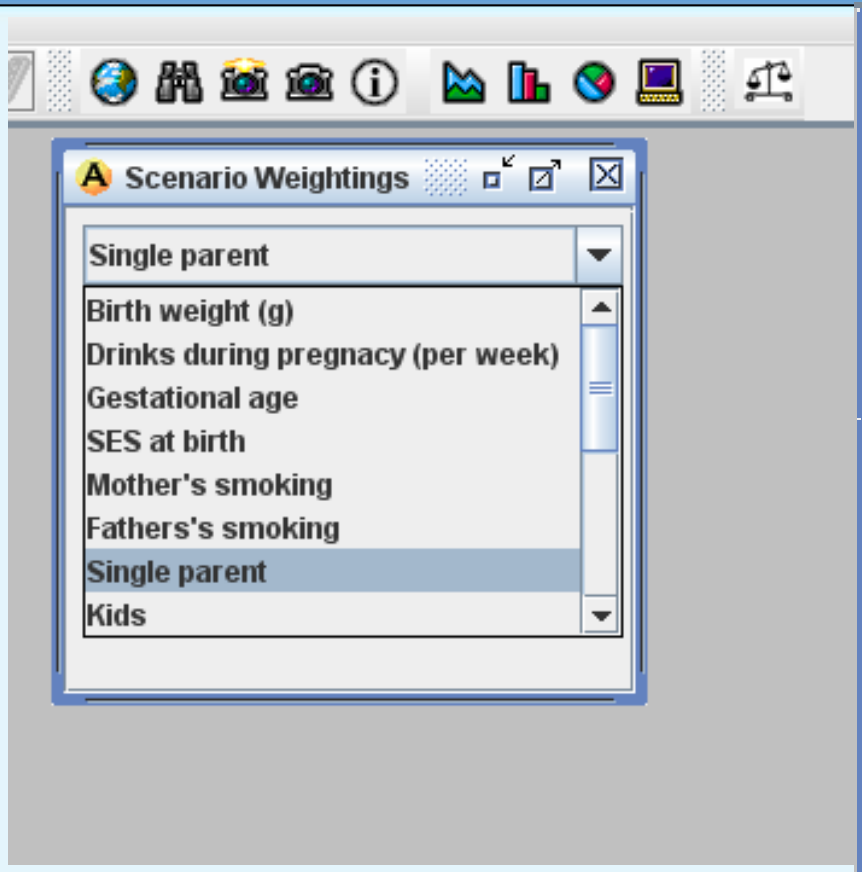


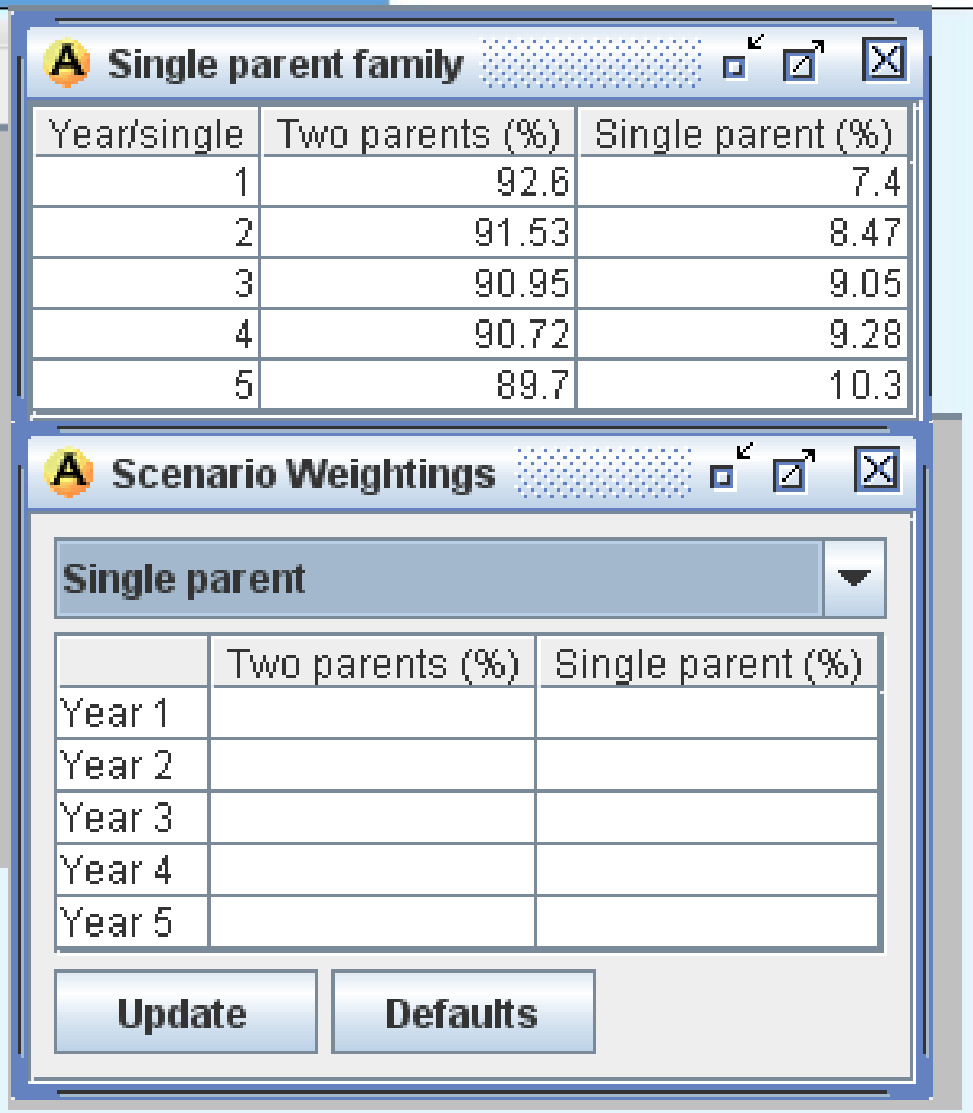


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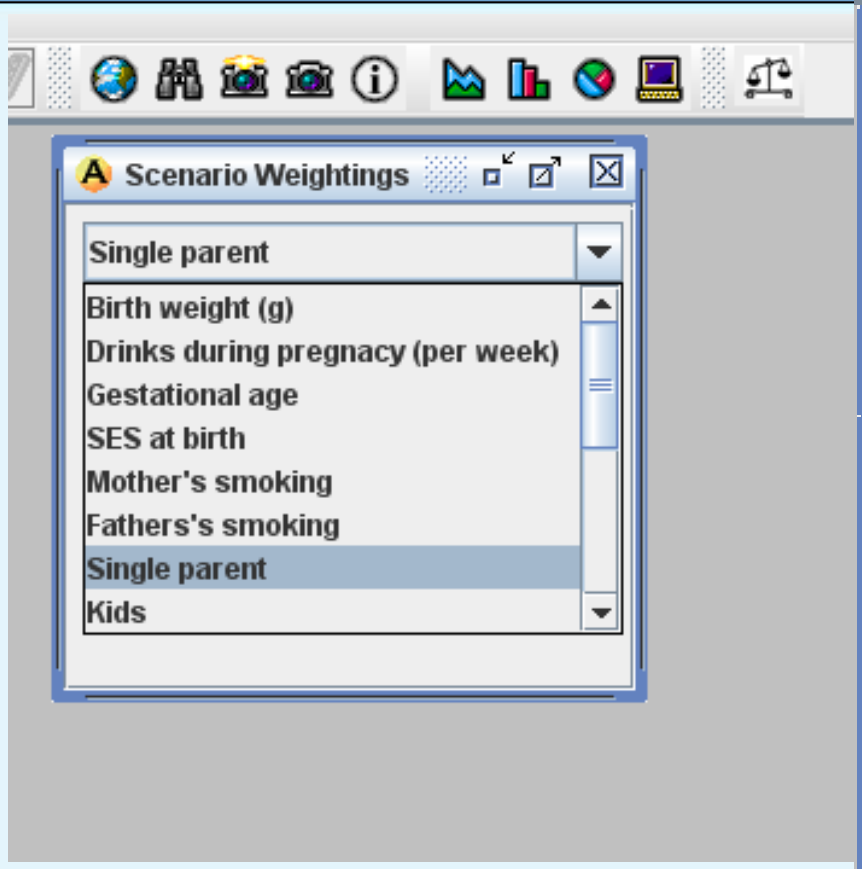


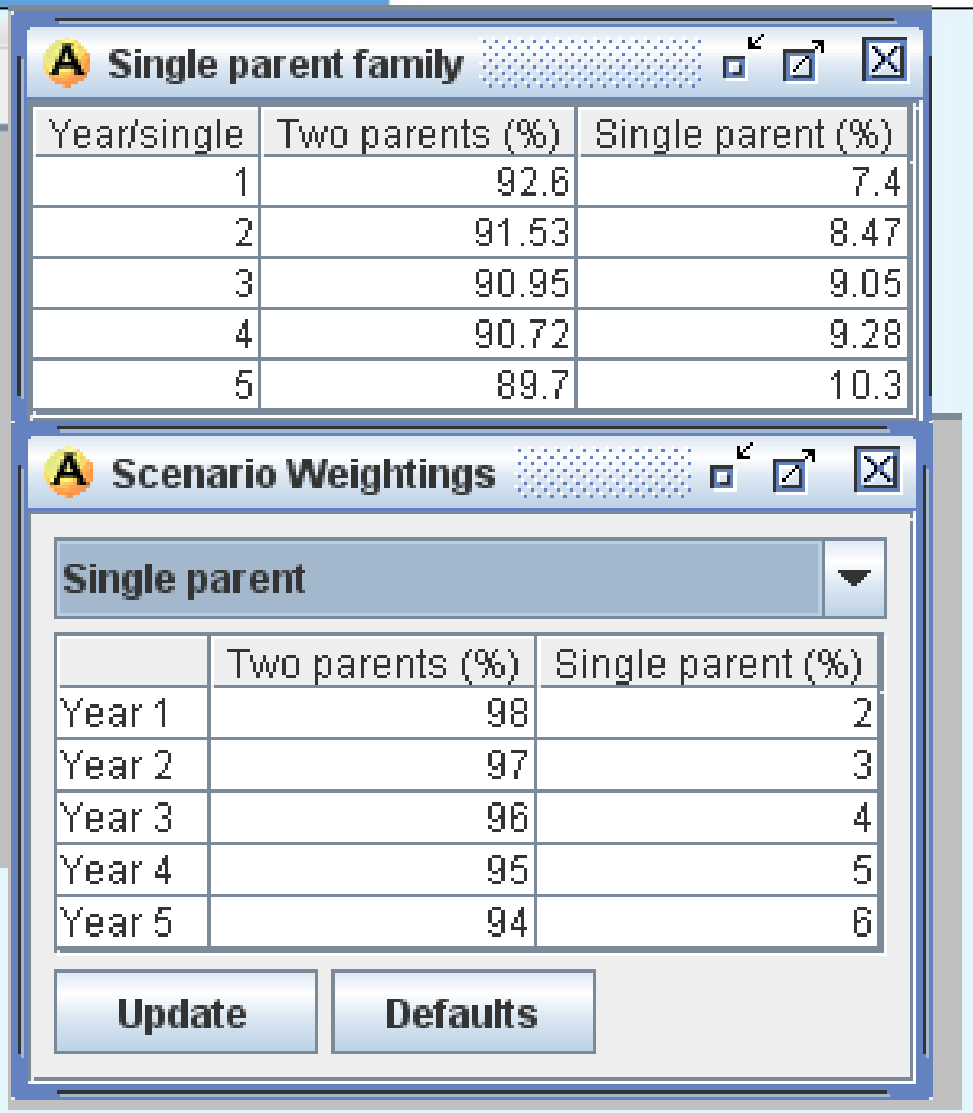


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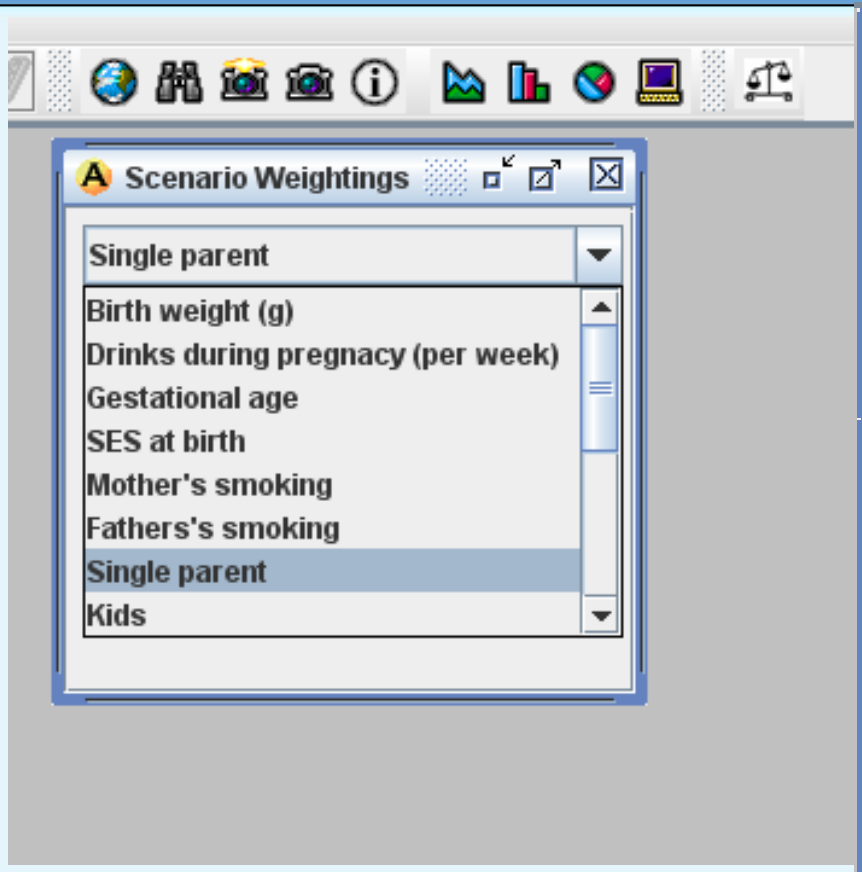


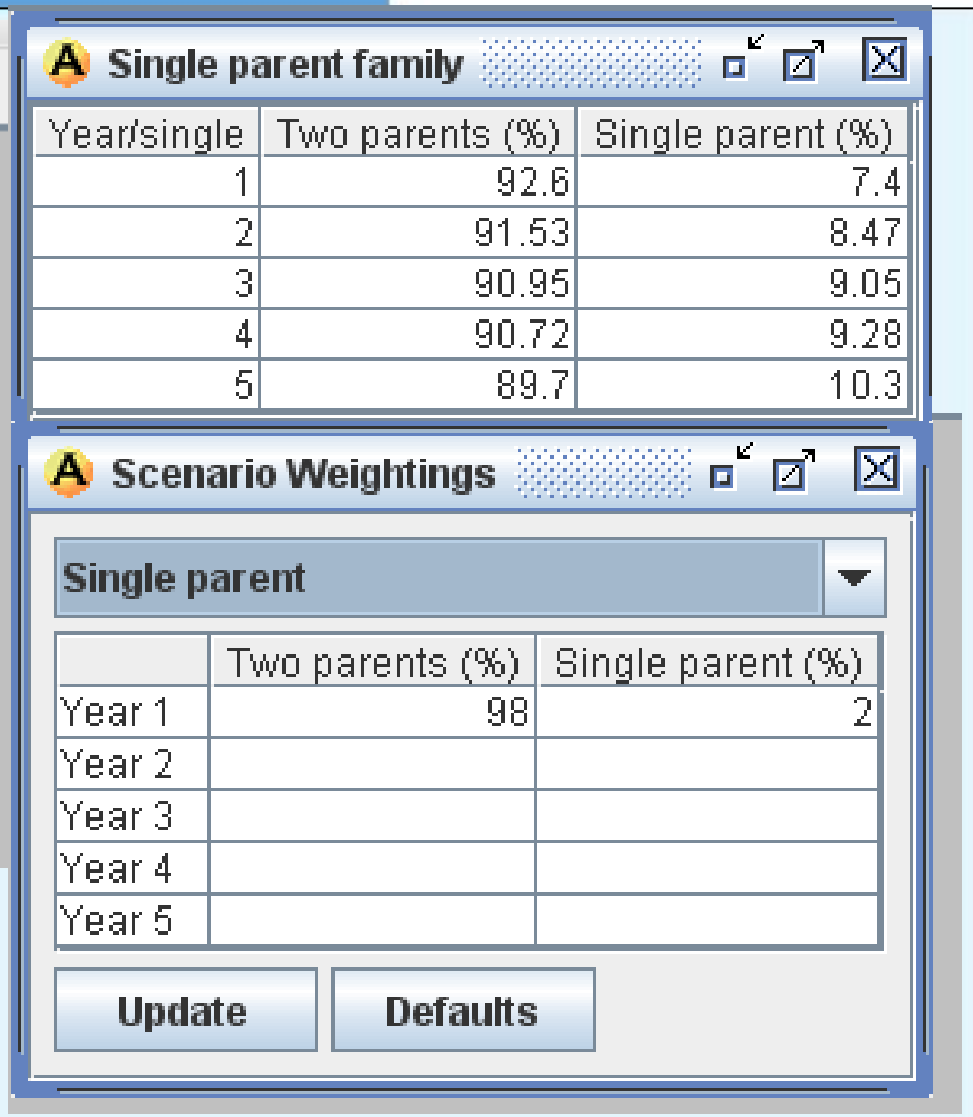


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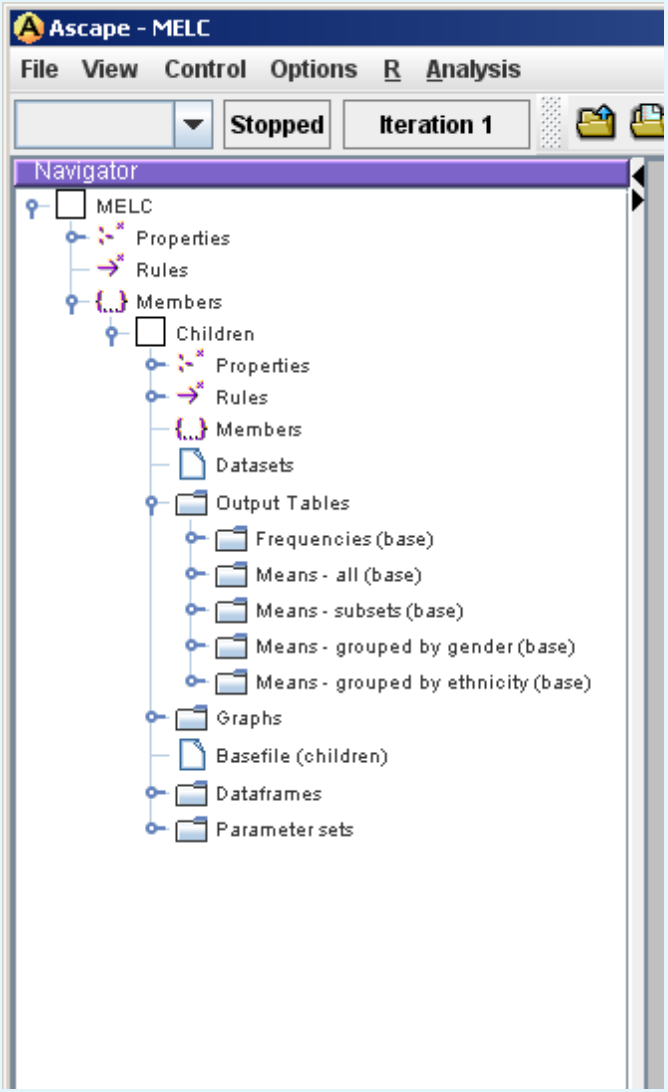

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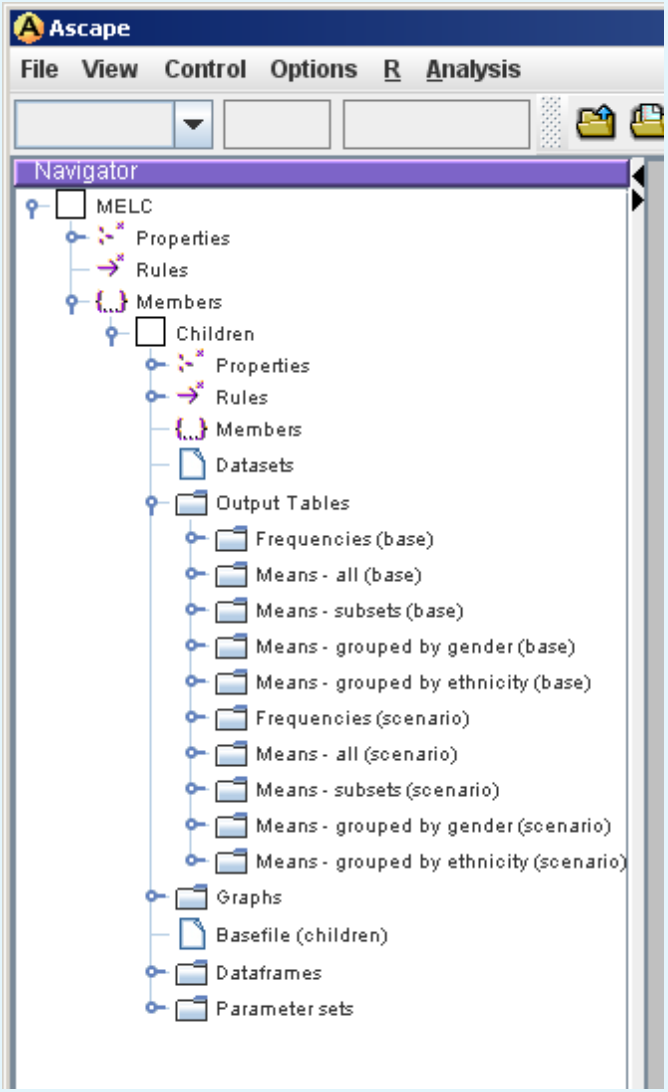


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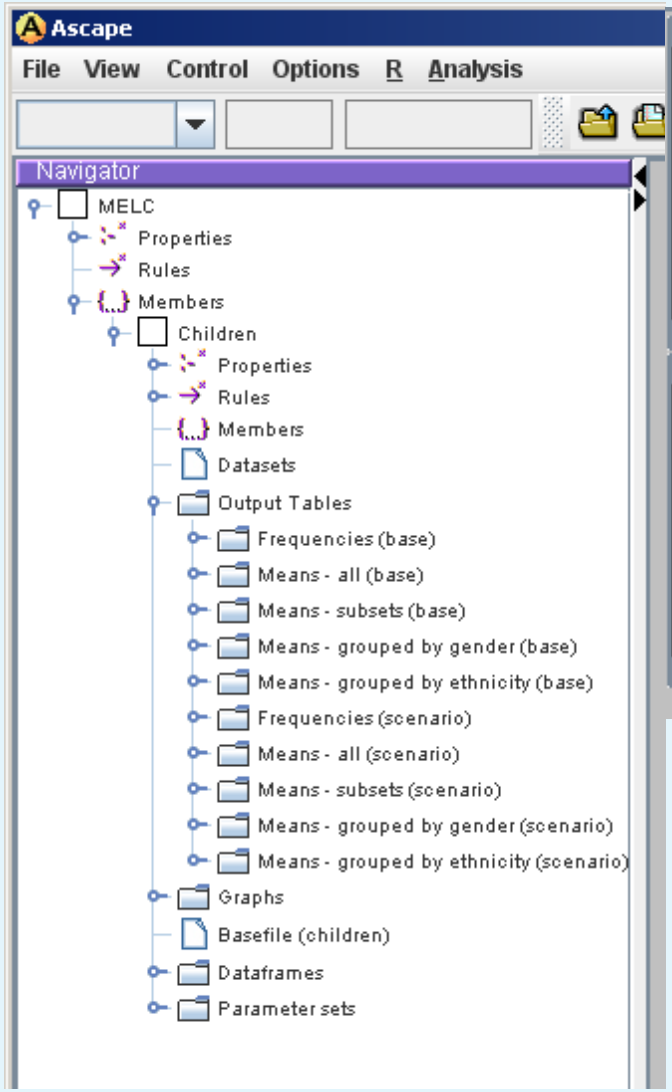


**Hospital outpatient visits**

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

**GP visits**

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

**Hospital outpatient visits scenario**

| Year | houtptot |
|---|---|
| 1 | 0.48 |
| 2 | 0.52 |
| 3 | 0.46 |
| 4 | 0.45 |
| 5 | 0.46 |
| Total | 2.36 |

**GP visits scenario**

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

# Simulation tool - Demonstration

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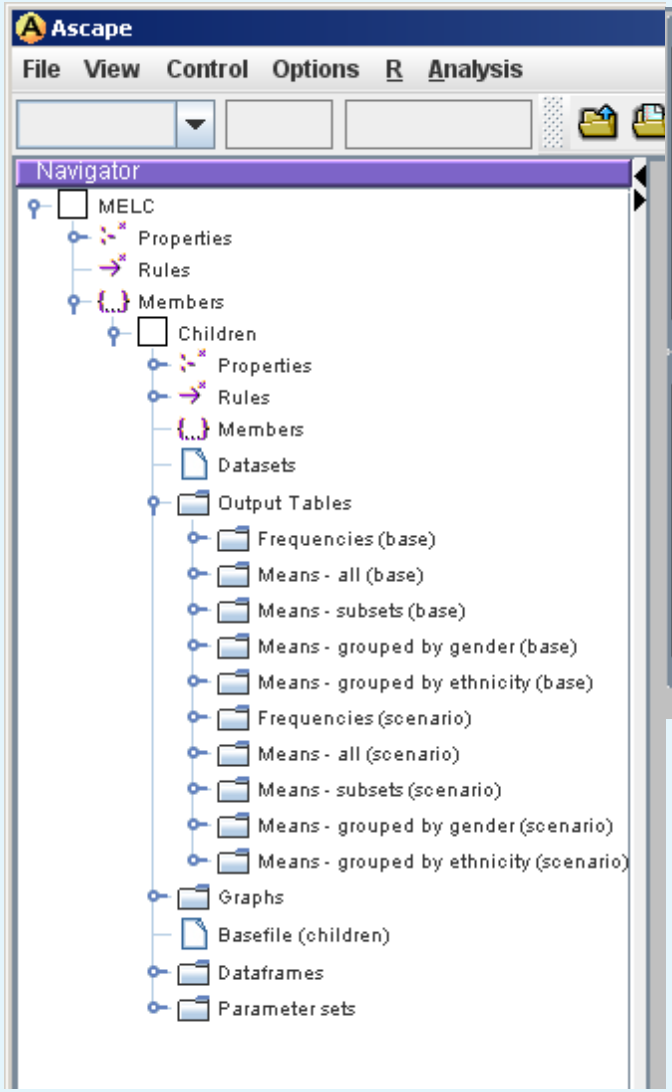


**Hospital outpatient visits**

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

**GP visits**

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

**Hospital outpatient visits scenario**

| Year | houtptot |
|---|---|
| 1 | 0.48 |
| 2 | 0.52 |
| 3 | 0.46 |
| 4 | 0.45 |
| 5 | 0.46 |
| Total | 2.36 |

**GP visits scenario**

| 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

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- 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?)



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# 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

# Modelling the early life course (MEL-C)

## Presentation outline

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

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# 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



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  *Chair: Dr. Marilyn Brewin (Nga Pae o te Maramatanga)*
- Academic Advisors

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- End Users Advisory Group

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# ANY QUESTIONS?