Microsimulation Modeling

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Outline

- Definition
- Key properties
- Main uses
- Strengths and limitations
- Case examples
- Lab

Definition

Definition

- Microsimulation
  - Simulation: imitation of a situation or process
  - Micro = Individual-level
  - Sometimes referred to as
    - Agent-based model
    - Mathematical model
    - Dynamic model
    - General microsimulation
- Simulates individuals over time (discrete or continuous) by incorporating individual characteristics (e.g. age, sex, etc.)

Definition

- MSM are individual-based simulation models that simulate individuals over time by incorporating individual characteristics.

Definition

- Simulation modeling of complex systems at the **Individual level**
- Typically takes into account
  - Heterogeneity within a population
  - Unique individual characteristics of individuals and the correlations between these characteristics
- Individuals are typically independent of one another and the interaction among them are not considered

Key properties

Key properties

- Simulated Individual—agent. MSM takes into account the unique attributes of each individual. In other words, MSM allows for the incorporation of heterogeneity as well as the correlation between individual characteristics. Individuals are typically independent of one another and the interaction among them are not considered. These agents can be people, organizations, etc…

- Individual characteristics. When agents are people, the characteristics can include socio-demographics, social factors, lifestyle factors, metabolic factors or disease outcome variables.

Key properties

- Decision rule. In MSM, regression models are typically used for predicting individual future behavior and outcomes using the previous time step characteristics. Of particular relevance to MSM, are copulas which are functions that help incorporate correlation between individual characteristics. In fact, copulas allow one to create a multivariate distribution by joining univariate marginal distributions.
- Aggregate vs individual. MSM are *individual-based* simulation models.
- Dynamic/Time. MSM can be static or dynamic. When modeled dynamically, time is generally modeled discretely.

Main uses

Main uses

- MSM are useful especially when we need to consider heterogeneity within population

Strengths and limitations

Strengths

- Unlike other population-level simulation models, in MSM, each individual has its own sets of characteristics and individual events can be recorded

Limitations

- One limitation of a typical MSM is that it does not incorporate interactions between individuals.

Assumptions

- It assumes no interactions among individuals
- Time is usually discrete

Case example

Case example

- *Basu S et al. Implications of scaling up cardiovascular disease treatment in South Africa: a microsimulation and cost-effectiveness analysis. Lancet Glob Health. 2019*

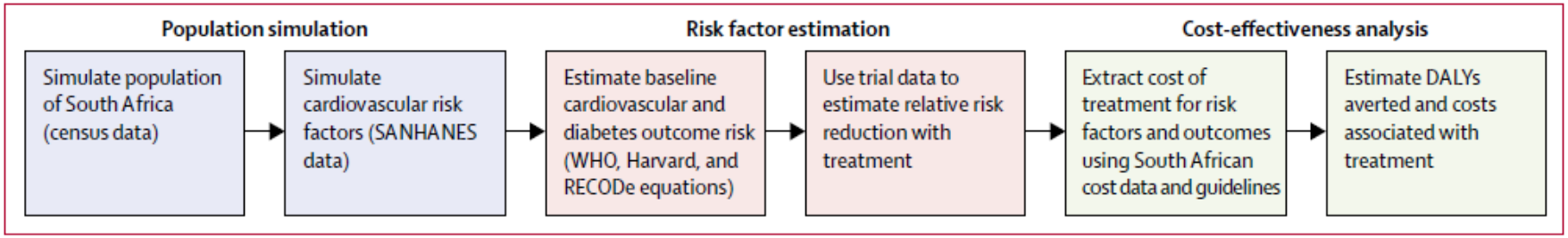

Figure 1: **Modelling approach**
DALYs=disability-adjusted life-years. RECODe=risk equations for complications of type 2 diabetes. SANHANES=South African National Health and Nutrition Examination Survey.

Case example

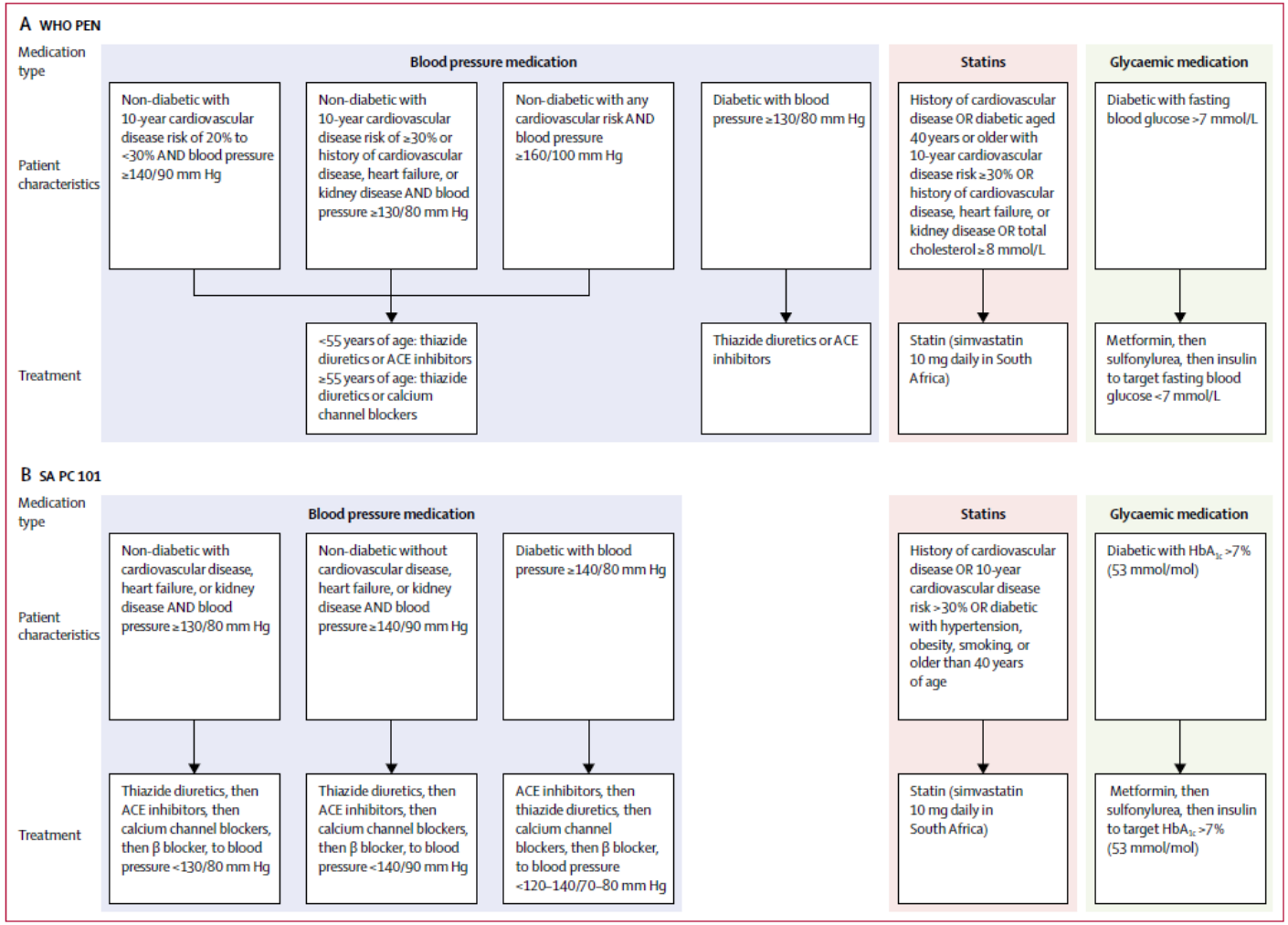

***Figure 2*: Alternative guidelines for management of elevated blood pressure, dyslipidaemia, and type 2 diabetes for South African providers**
The management flow is shown according to the WHO PEN (A) and SA PC 101 (B) guidelines. ACE=angiotensin-converting enzyme. SA PC 101=South Africa's Primary Care 101. PEN=package of essential non-communicable disease interventions.

Case example

- Under both guidelines, there were increases in blood pressure treatment (4·2 percentage points under WHO PEN vs 12·6 percentage points under SA PC 101), lipid treatment (16·0 vs 14·9), and glucose control medications (1·2 vs 0·6).

- The incremental cost-effectiveness of implementing SA PC 101 over current treatment would be a saving of US$24 902 (95% CI 14 666-62 579) per DALY averted compared with a saving of $17 587 (1840-42 589) under WHO PEN guidelines.

Lab

Lab exercise

- 1) Modify the code to change the effective contact rate to 2 and then 0.5. What do you observe? Could you quantify observed difference?
- 2) Change the time to adoption to 42 days. What do you observe?
- 3) How many people would have reduced their weight by day 100 if you changed the time to adoption to 42?

References

- Book: Basu S. Modeling Public Health and Healthcare Systems. Oxford; New York: Oxford University Press, 2018. Chap 8. Microsimulation
- Krijkamp. Microsimulation Modeling for Health Decision Sciences Using R. A tutorial. Med Dec Making 2018