Prevent v 3.0:

Work in Progress

Esther de Vries
Jan Barendregt

Erasmus MC
University Medical Center Rotterdam

SCHOOL OF POPULATION HEALTH
THE UNIVERSITY OF QUEENSLAND

Overview

- What is Prevent?
- Some history
- Current version (3.0)
- Technical issues
- Inputs and outputs
- Limitations
- Demonstration
- Conclusion

What is Prevent? (1)

- Prevent is a Public Health model that links changes in risk factor exposure to changes in risk factor related disease specific outcomes and to changes in generic health outcomes
- Prevent handles multiple risk factors and diseases simultaneously
- A risk factor can be related to many diseases, and a disease can have many risk factors
- Lag times can exist between a change in a risk factor and changes in the risk of related diseases

What is Prevent? (2)

- Diseases and risk factors are embedded in a dynamic population model
  - Intervention effects are calculated over ‘real’ time
  - Population projections, ageing, migration
- It calculates two scenarios (called ‘reference’ and ‘intervention’), that are the same in all respects, except for the intervention(s) to be evaluated
  - Therefore the difference between the two is due to the intervention(s)

Some history (1)

- Work on the first version started in 1986
  - At first in-house use only (PhD Louise Gunning-Schepers 1988), first semi-publicly available version (2.0) in 1989
- Features:
  - Model is an empty shell: input files determine risk factors, diseases, and relationships
  - Health outcomes only disease specific and total mortality, and mortality based outcomes such as YLL
- Usage:
  - Intended to be used by policy makers, but that never happened
  - Interest more from public health researchers

Some history (2)

- Version 2.9 (~1997) features:
  - Windows version
  - Simple disease model added: incidence, prevalence, mortality
  - Morbidity based outcomes added, including disability and costs
  - Various limits lifted (numbers of risk factors and diseases, length of time lags)
- Usage:
  - Mostly for teaching
  - Some own research

Current version (3.0) features:

- Both categorical and continuous risk factor prevalences
  - Can be mixed in a single model
- The distinction between ‘risk factors’ and ‘diseases’ has largely been dropped
  - Risk factors can be risk factors for other risk factors
  - Diseases can be risk factors for other diseases and risk factors
- Population projections can be imported (instead of calculated)
- Autonomous (ie not risk factor related) trends in disease variables possible

- And: a special Eurocadet facility

Eurocadet facility

- Eurocadet looks at outcomes in cancer incidence only
  - Setting the ‘incidenceonly’ switch in the ‘generaltab’ table of the dataset achieves this
  - It implies that all outcomes based on disease prevalence and mortality are not available:
    - Prevalence, life expectancy, disability, costs, etc
  - And many inputs are not needed:
    - Case fatality, disability weights, costs, etc
- The Eurocadet facility makes Prevent a less complex and data demanding, but also more limited model

Technical issues (1)

- Prevent expects an intervention to affect risk factor prevalence
  - The change in risk factor prevalence is expressed as a change in disease risk using a relative risk (RR) to calculate a potential impact fraction (PIF)
- For a dichotomous risk factor the PIF equation is:

$$PIF = \frac{\left(p - p^{*}\right)\left(RR - 1\right)}{p\left(RR - 1\right) + 1}$$

- With p^* the risk factor prevalence after intervention
- When $p^* = 0$ the PIF reduces to the population attributable fraction (PAF):

$$PAF = \frac{p\left(RR - 1\right)}{p\left(RR - 1\right) + 1}$$

Technical issues (2)

- For multiple exposure categories *c* this equation applies:

$$PIF = \frac{\sum_c p_c RR_c - \sum_c p_c^* RR_c}{\sum_c p_c RR_c}$$

- For continuous risk factor distributions the following equation applies:

$$PIF = \frac{\int_a^b RR(x)P(x)dx - \int_a^b RR(x)P^*(x)dx}{\int_a^b RR(x)P(x)dx}$$

- Note that in the continuous case the RR is replaced by a risk function *RR(x)*

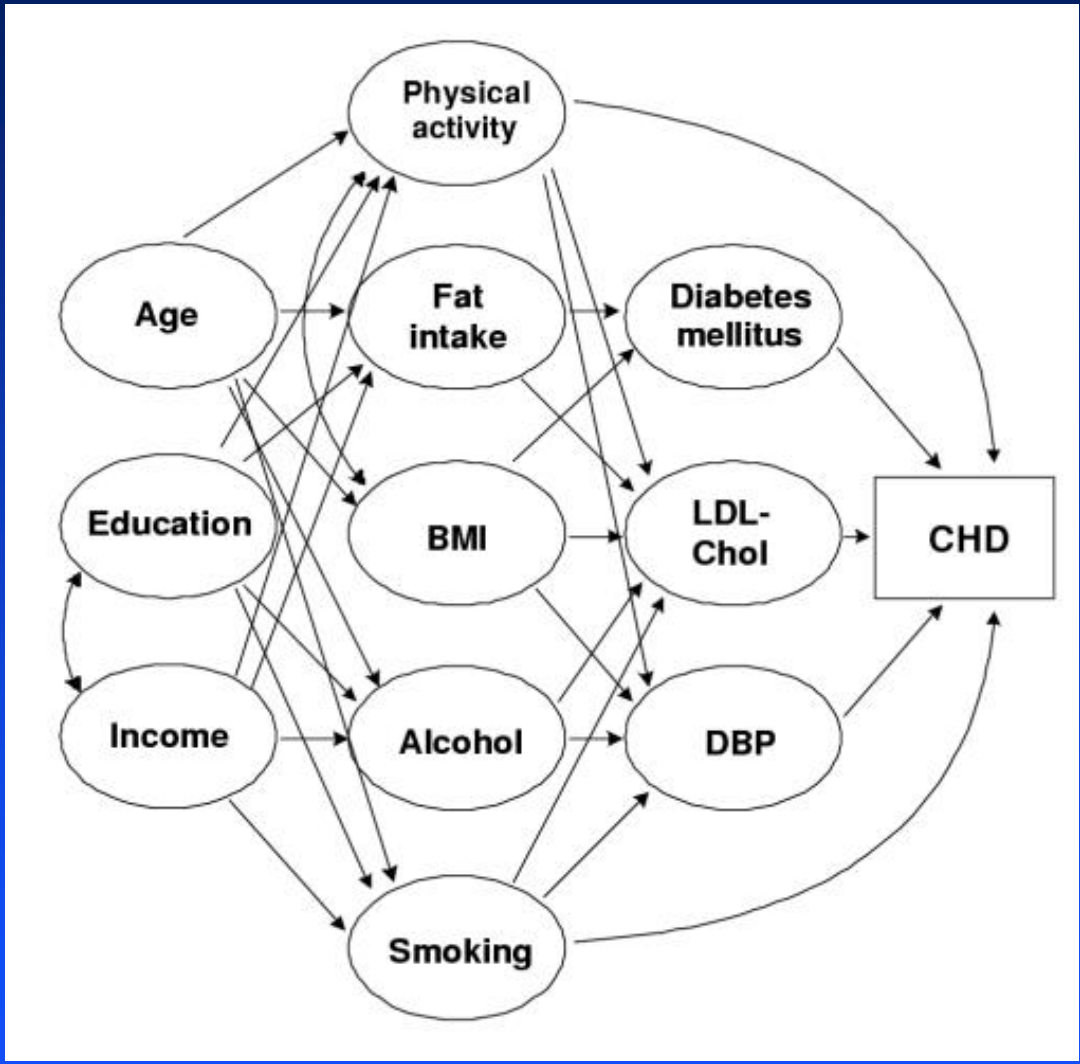
Technical issues (3)

- Prevent has two sets of PIFs
  - TIFs: trend impact fraction
  - PIFs: potential impact fraction
- The TIF calculates the effects of autonomous trends in risk factor exposure on related diseases
- The PIF calculates the effects of risk factor interventions on related diseases
- We want the difference between the reference and intervention scenarios to be attributable to the interventions only
  - In the reference scenario therefore only the TIF applies
  - In the intervention scenario both TIF and PIF apply

Technical issues (4)

- Because of the diluted distinction between risk factors and diseases Prevent can model a “causal web” of risk factors
- For example:
  - Cardiovascular disease (CHD & stroke) has many risk factors
    - Some of these risk factors are diseases themselves
    - Some of these risk factors have risk factors themselves
  - The result is a tangle of risk factors, diseases, and relationships

A possible causal web



Source: Murray et al, 2003

Inputs (1)

- Definition tables
  - Base year, highest age group, and such
  - List of diseases and risk factors and their characteristics
  - List of risk factor and disease relations
- Population tables
  - Population numbers in base year
  - Total mortality
  - Population projections

Inputs (2)

- Categorical risk factors
  - List of categories
  - Prevalence by category and year
  - Relative risk by category
  - Interventions
- Continuous risk factors
  - Distribution type (choice of Normal, lognormal, Weibull)
  - Parameters by year
  - Parameters of the distribution with theoretical minimum risk
  - Risk functions (choice of linear, two-piece-linear, per unit, loglinear, and logit) and parameters
  - Interventions

Inputs (3)

- Disease inputs
  - Incidence in the base year
  - Disease trends and interventions, expressed as proportional changes by year

Outputs

- All outputs are by year and sex, many by age and available in rates and numbers
- Population outputs
  - Numbers by age
  - % age 60 and over
- Disease specific outputs
  - Incidence (all ages) in numbers, and by age in numbers and rates
- Risk factor outputs
  - Prevalences
  - TIFs and PIFs

Limitations (1)

- Prevent is about relations between risk factors and diseases
  - The valid domain is changes in risk factor exposure, that give rise to change in related disease incidence, but do not substantially change disease natural history
  - This generally excludes early detection, interventions that improve survival
  - Prevent uses an average population perspective
  - Despite the risk factors there is no heterogeneity
  - No selective mortality for exposed
  - No strongly competing risks (but there is substitution)
- Many of these limitations do not apply in the case of Eurocadet

Limitations (2)

- Prevent makes independence assumptions
  - Risk factors are independently distributed
  - Disease incidence rates are independent
  - All diseases specific cause of death rates are independent
  - Each disease incidence is independent of all disease specific causes of death except its own
- Note that the independence assumptions are not violated:
  - When diseases have a risk factor in common
  - When a disease is a risk factor for another disease

- Disease incidence independence assumption:

$$\Pr\left\{\bigcap_{i\in Z}\left\{A_{Ii}\le a\right\}\right\}=\prod_{i\in Z}\Pr\left\{A_{Ii}\le a\right\}$$

Limitations (3)

- Currently Prevent uses an age-perspective
  - Effects of interventions in a specific age-group are applied to that same age-group in the projection
  - For some interventions, however, effects are long-lasting and should be applied to older age-groups too as the population ages (cohort-perspective)
  - This is a problem only when
    - The intervention is applied to a specific age-group
    - The effect is long-lasting
  - Some childhood interventions may fit the bill
- This limitation is to be removed

Conclusions

- Prevent is (and probably always will be) a work in progress, and it shows
  - Things are planned, but not yet implemented, leading to unused fields in the database
  - Some times things could be more consistent
  - The output lags the implementation of new features
- It could be better, but it is usable
- Prevent clearly has methodological limitations
  - No heterogeneity
  - Independence assumptions
- But if these limitations are understood, it will do the job for Eurocadet

Relevant literature

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Demonstration of an application, predefined case

- New program on housing: increase proportion of barrier-free residences, should reduce number of falls.

Choices in Prevent, data needed:

- Risk factor: categorical (proportion living in barrier-free residence)
- OR/RR for health related outcomes in both exposed and unexposed (if needed by age and sex)
- Data on occurrence of health related outcomes in population, by age and sex
- Data on population structure as a whole
- Duration of building houses etc
- If wanted: other co-occurring risk factors
- Specified intervention: change in proportion of barrier free residences

Expected results

- Number of cases under both reference and intervention scenario by calendar year
- Rates under reference and intervention scenario
- If information on case-fatality and costs:
  - Prevalence
  - Mortality
  - Costs
  - etc