Prevent v 3.0:

Work in Progress

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Barcelona, March 2009
Overview

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

- Work on the first version started in 1986. Features:
  - Health outcomes only disease specific and total mortality, and mortality based outcomes
- Version 2.9 (~1997) features:
  - Windows version
  - Simple disease model added: incidence, prevalence, mortality
  - Morbidity based outcomes added, including disability and costs
Current version (3.0) features:

- Eurocadet project: Cancer in Europe
- Categorical and continuous risk factors in 1 model
- Population projections can be imported from Statistics Offices (instead of calculated)
- Autonomous (ie not risk factor related) trends in disease variables
What is Prevent?

(1) Risk factor(s)

(2) Population
What is Prevent? (1)

- Links changes in risk factor exposure to changes in related disease outcomes
  - Prevent is not a cancer model, but a model to evaluate risk factor interventions
  - Prevent is NOT a PREDICTION model!
- It handles multiple risk factors and diseases simultaneously
What is Prevent? (2)

- Diseases and risk factors are in a dynamic population model
  - Population projections, ageing, migration
  - Intervention effects are calculated over ‘real’ time
- Latency and Lag times:
  Time between a change in a risk factor and changes in the risk of related diseases
Technical issues (1)

- Basic: Population attributable fraction*

\[ PAF = \frac{p(RR - 1)}{p(RR - 1) + 1} \]

- Example:

<table>
<thead>
<tr>
<th>Smoking %</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>30%</td>
<td>5%</td>
<td></td>
</tr>
</tbody>
</table>

| RR cancer (smokers vs. ns) | 1.9 | 4 |
| Attributable risk           | 21%** | 13% |

**\((0.9 \times 0.3)/(0.3 \times 0.9 + 1)\)**

*The reduction in a disease that would be observed if the population were entirely unexposed*
Technical issues (2)

- Basic: **Potential Impact Fraction (PIF)**

\[
PIF = \frac{(p - p^*)(RR - 1)}{p(RR - 1) + 1}
\]

- With \(p^*\) the risk factor prevalence after intervention

*How much would population disease estimate change for any given change in exposure?
Technical issues (3)

- PIF and PAF

\[ PAF = \frac{p(RR - 1)}{p(RR - 1) + 1} \]

\[ PIF = \frac{(p - p^*)(RR - 1)}{p(RR - 1) + 1} \]

- With \( p^* \) the risk factor prevalence after intervention
- When \( p^* = 0 \) the PIF reduces to the population attributable fraction (PAF)
Technical issues (4)

- 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)
Technical issues (5)

- For multiple exposure categories \( c \) this equation applies:

\[
P_IF = \frac{\sum_c p_c \cdot RR_c - \sum_c p_c^* \cdot RR_c}{\sum_c p_c \cdot RR_c}
\]

\( \rightarrow \) PIF is age, sex and period specific

\( \rightarrow \) This is a multiplicative model, assuming that each risk factor is independent (in real life often not the case!)
Technical issues (6)

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 (7)

Continuous risk factor, an example:

**Body Mass Index (BMI) among men, 2006**

- Normal weight (BMI < 25)
- Prev overweight (BMI 25-29.9)
- Prev obesity (BMI 30+)

**Probability distribution BMI, men**

- Current
- Intervention
Technical issues (8)

- Prevent has two sets of PIFs
  - TIF: trend impact fraction
  - PIF: potential impact fraction

![Diagram showing Prevent Method]

- Baseline disease data
- Risk factors (past)
- TIF (Reference population)
- Intervention +
- TIF + PIF (Intervention population)
Technical issues (9)

- TIF: effects of autonomous trends in risk factor exposure on related diseases
- PIF: effects of risk factor interventions on related diseases
- Reference group: TIF
- Intervention group: TIF + PIF
- The difference between the reference and intervention scenarios \( \rightarrow \text{attributable to the interventions only} \)
Technical issues (10)

- Formula’s

Reference group:

\[ I_{t}^{\text{ref}} = I_0 \left( 1 - \prod_{r} (1 - TIF_r) \right) \]

Intervention group: TIF + PIF

\[ I_{t}^{\text{int}} = I_0 \left( 1 - \prod_{r} (1 - TIF_r)(1 - PIF_r) \right) \]
Technical issue (11)

- Full model → Proportional multi state life table
  → Forecast adjusted population

- Eurocadet modus
  → Use population prediction
  → TIF/PIF are applied to incidence rates
Technical issues (12)

- Prevent can model a “causal web” of risk factors
- For example:
  - Cancer has many risk factors
    - Some of these risk factors are diseases themselves
    - Some of these risk factors have risk factors themselves
What is Prevent?

(1) **Risk factor(s)**

(2) **Population**
**Extra features:**

- **Autonomous (i.e. not risk factor related) trends in disease variables possible**

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoking %</td>
<td>24%</td>
</tr>
<tr>
<td>RR oesophageal cancer (smokers vs. ns)</td>
<td>1.9</td>
</tr>
<tr>
<td>Attributable risk (or PIF, int: 100%)</td>
<td>18%*</td>
</tr>
<tr>
<td>Total cases without disease trend</td>
<td>1000</td>
</tr>
<tr>
<td>Total cases with disease trend</td>
<td>900</td>
</tr>
</tbody>
</table>

Saved cases: 180

160
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
Limitations (3)

- Prevent uses an average population perspective
  - Despite the risk factors there is no heterogeneity
    - Example: SES groups with different exposure and cancer incidence patterns
  - No selective mortality for exposed
  - No strongly competing risks (but there is substitution → if full model is chosen)
Limitations (4)

- 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
Limitations (5)

- Prevent makes independence assumptions
- Risk factors are independent

Joint effect of smoking and alcohol on oesophageal cancer

Smoking

Alcohol

Never

Ever

Never

Ever

Nev er

Ev er

Never

Ever

0

5

10

15

20
Conclusions

- Prevent is (and probably always will be) a work in progress
- It could be better, but it is usable
- Prevent clearly has methodological limitations
  - No heterogeneity
  - Independence assumptions
Relevant literature

The future is made of the same stuff as the present.  

Simon Weil

www.eurocadet.org