Use of graphical approaches to understand poverty and health

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Structure of the talk

1. use of health to evaluate policy
2. causal diagrams
3. diagrams and policy

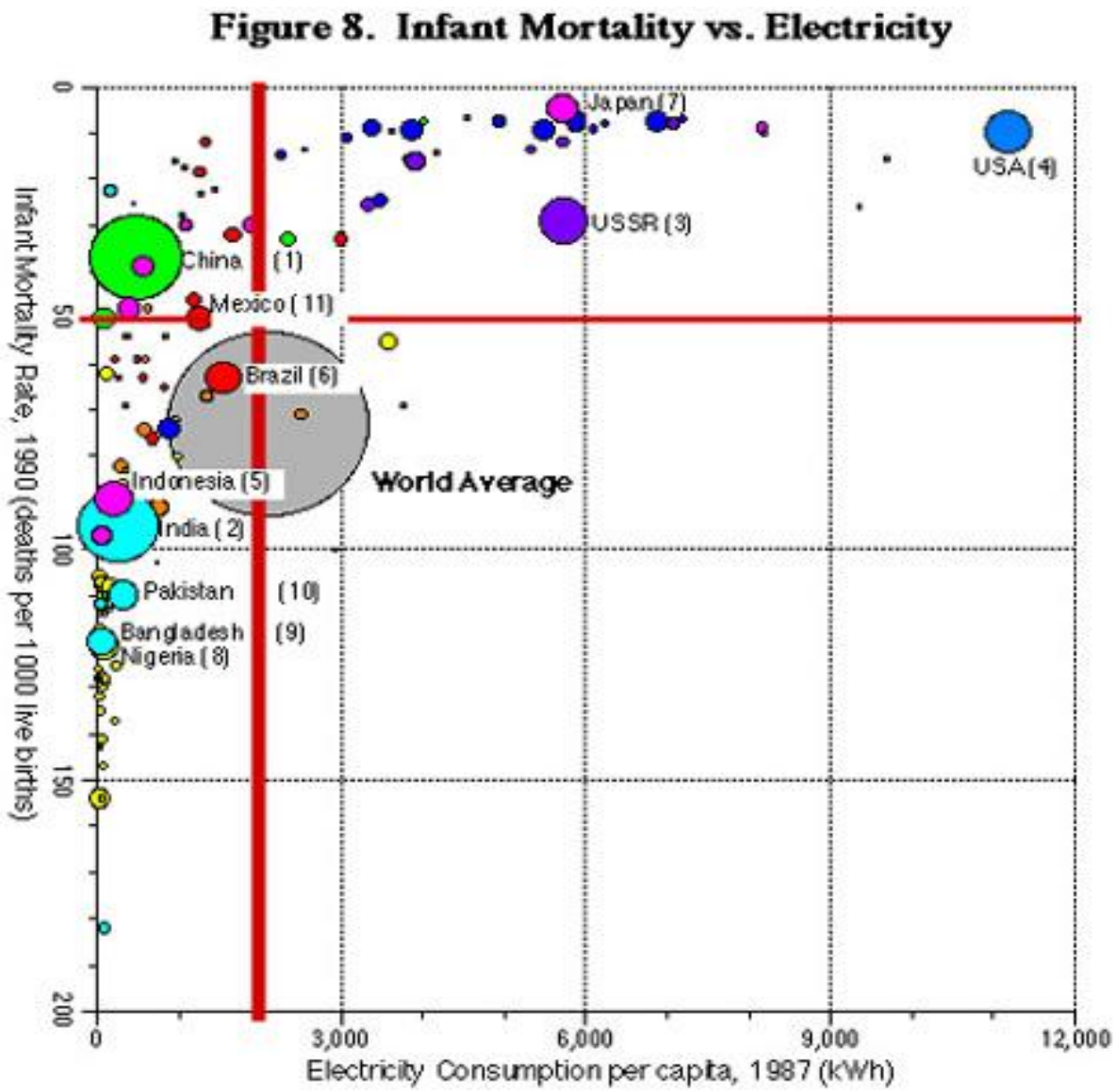
Health and major policy issues

1. specifically health crises:
   - HIV/AIDS epidemic; also TB, malaria, etc
   - obesity and related conditions
2. in reactive mode to the world's severe crises:
   - global climate change
   - resource depletion, e.g. fresh water
   - rapid mass extinction
   - absolute poverty and hunger ("the bottom billion")
3. health as a measure of basic human needs

Health and basic human needs

- food, energy, water, shelter, clothing,...
- health is important in assessing the effects:
  - of the need not being met – or positively: ***access***
  - insecurity
  - how they're met
- health benefits of access – diminishing returns

  => health-oriented action most affects those with the least resources; those with high resources need no more – and could do with less from a health viewpoint

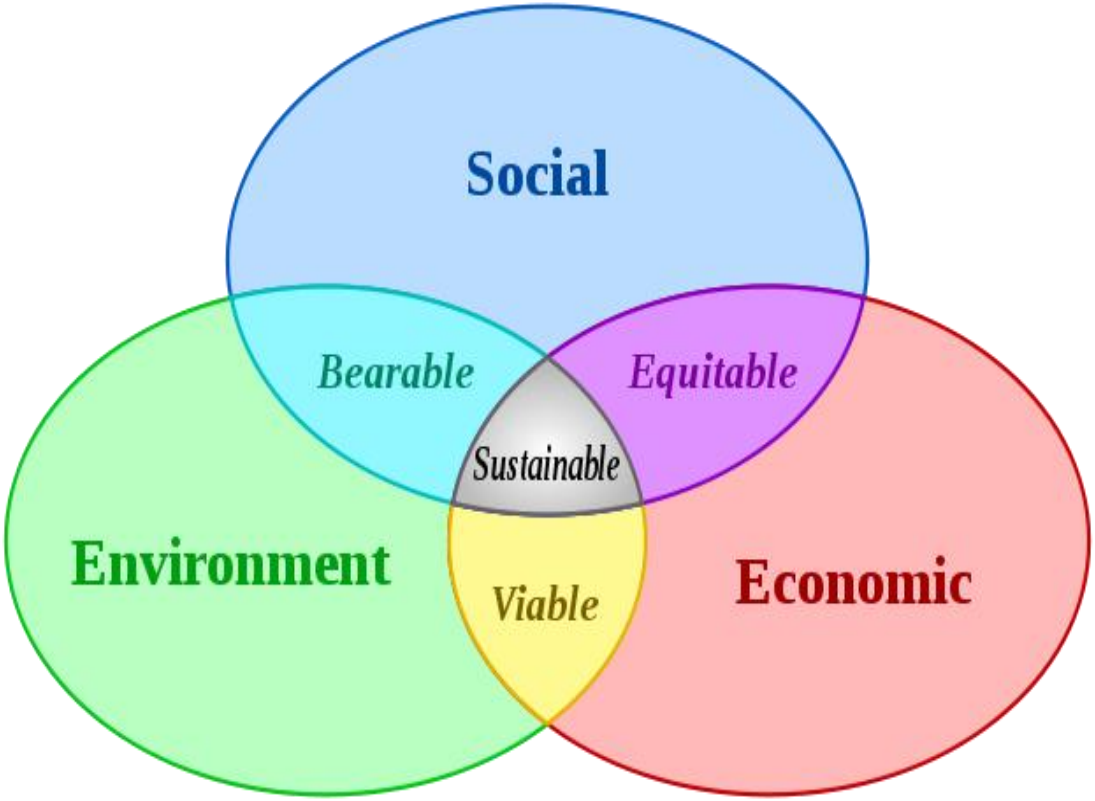


From GENI (Global Energy Network Institute):

http://www.geni.org/energy/assets/jpg/InfantMortalityRateVsElec.jpg

Health and sustainable development

health is an outcome of all three major aspects:

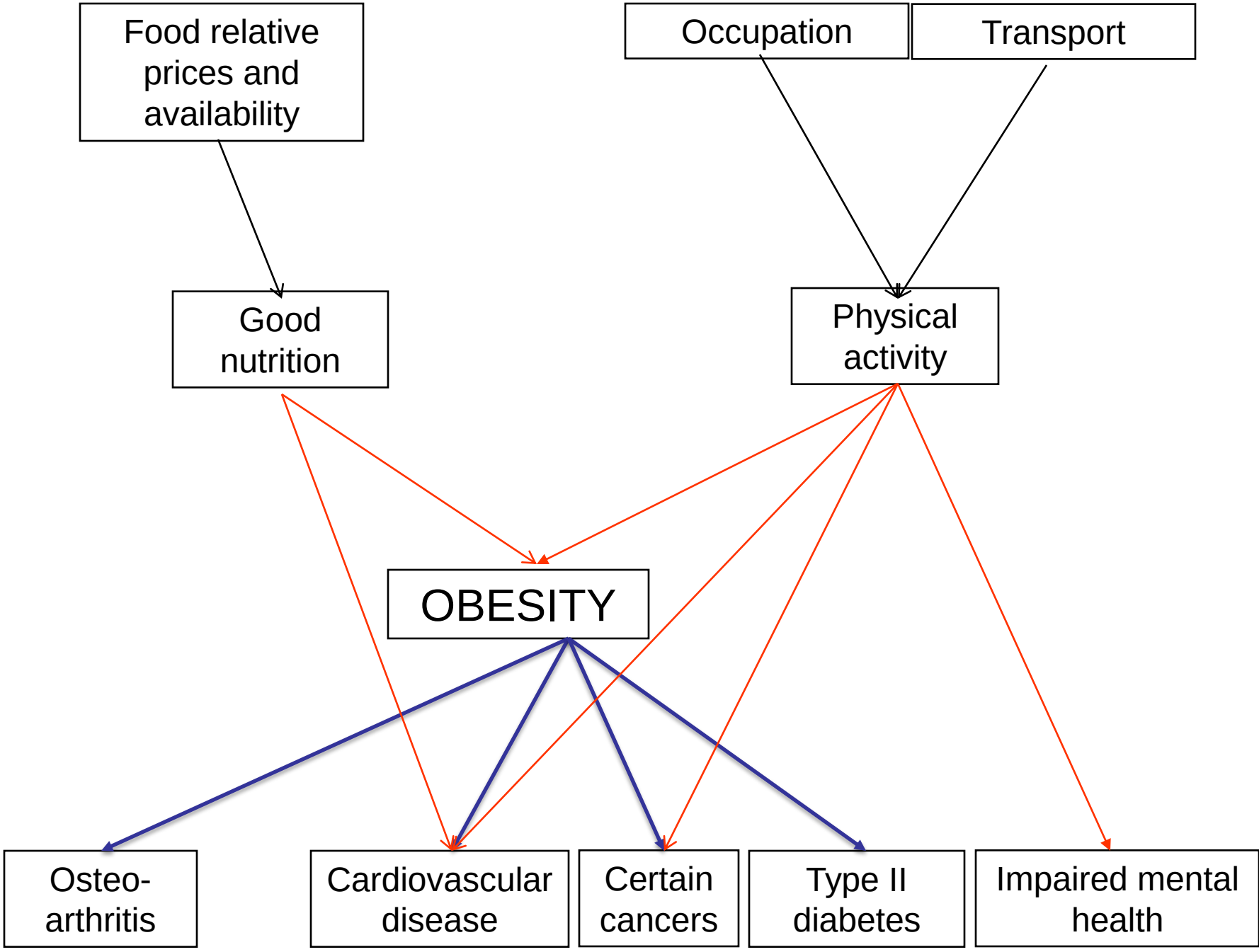


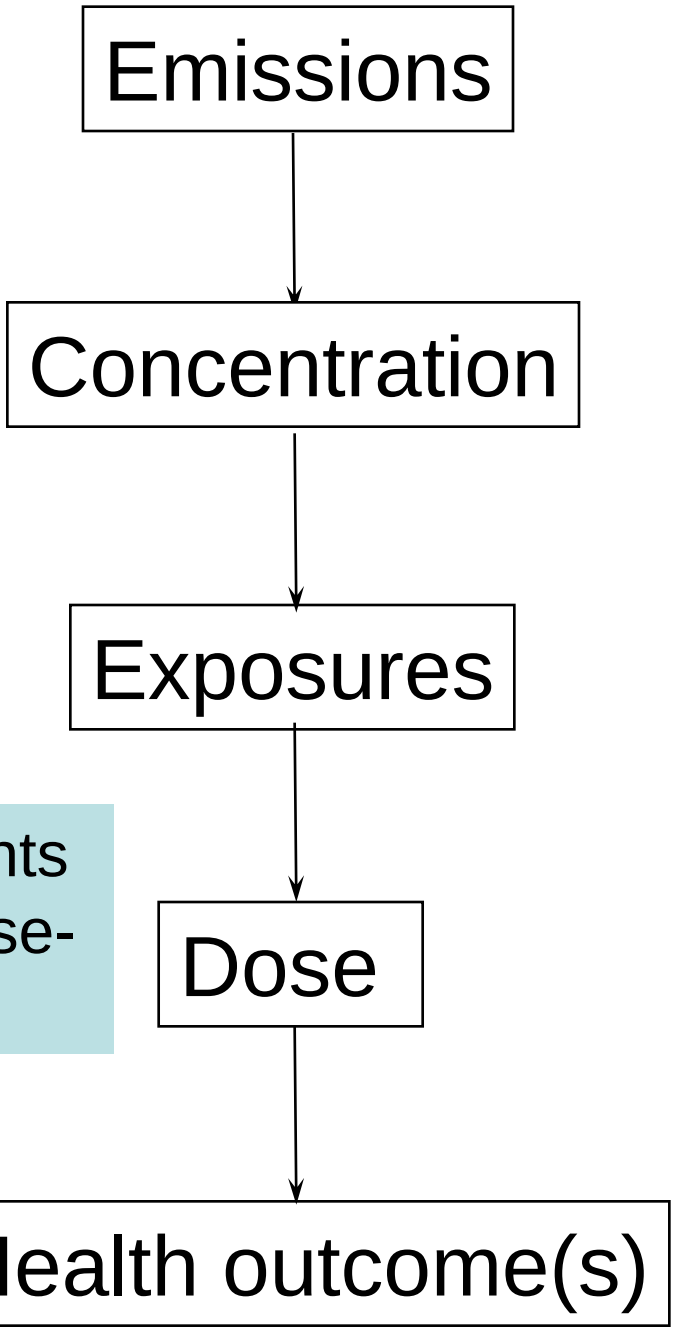
Health as a major policy criterion I

- mainstream economics tends to use GDP
- heterodox economists argue for an alternative measure, e.g. the Human Development Index
- this includes health, e.g. life expectancy – crude
- health is a major ***component*** of wellbeing and is indispensable for evaluating effects ***on humans*** – ***including future generations***
- health relates to ***basic needs***: the relationship with e.g. income is strong under conditions of poverty – unlike willingness to pay, health-based analyses are ***inherently equitable***

Health as a major policy criterion II

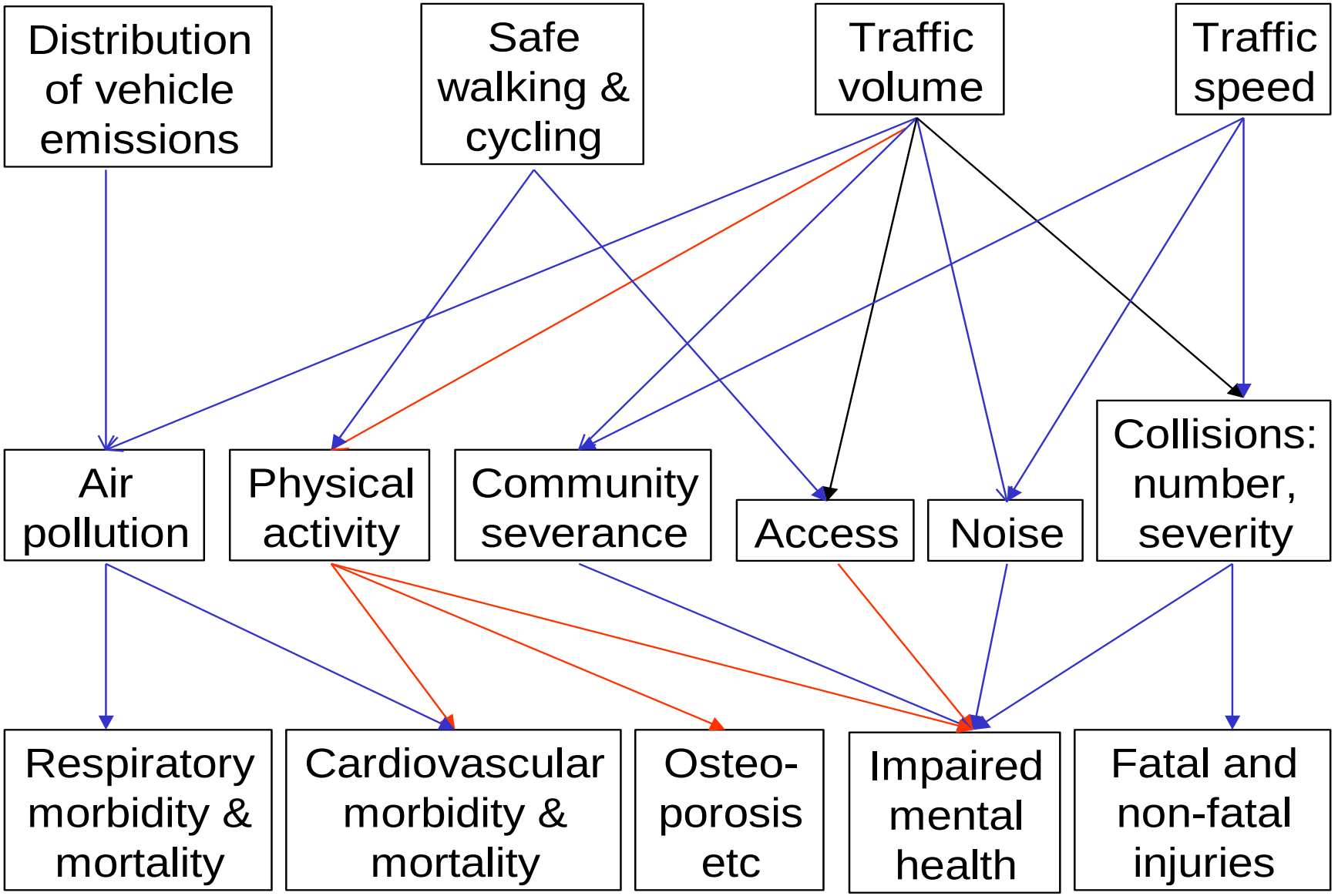
- it is proving difficult to achieve integration of health into mainstream policy – even where health damage or potential health gain are large
  - McMichael: health “late at the table” in relation to GCC
- conversely, starting from health: the “obesogenic environment” – governments are increasingly worried about increasing obesity, but fail to engage with its root causes (e.g. transport policy) – despite co-benefits for sustainable development, e.g. GHG/GCC
- hence the need for “Strategic Health Assessment”
- it has to include “determinants of determinants”


Food relative prices and availability
Occupation
Transport
Good nutrition
Physical activity
OBESITY
Osteo-arthritis
Cardiovascular disease
Certain cancers
Type II diabetes
Impaired mental health



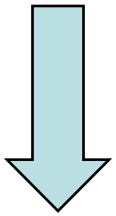
each arrow represents a process, e.g. a dose-response function

Transport-related health problems

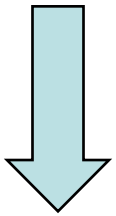


Determinants of the determinants of health

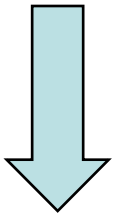
Underlying causes e.g. socioeconomic factors



Determinants (risk factors)



Health status (diseases etc)



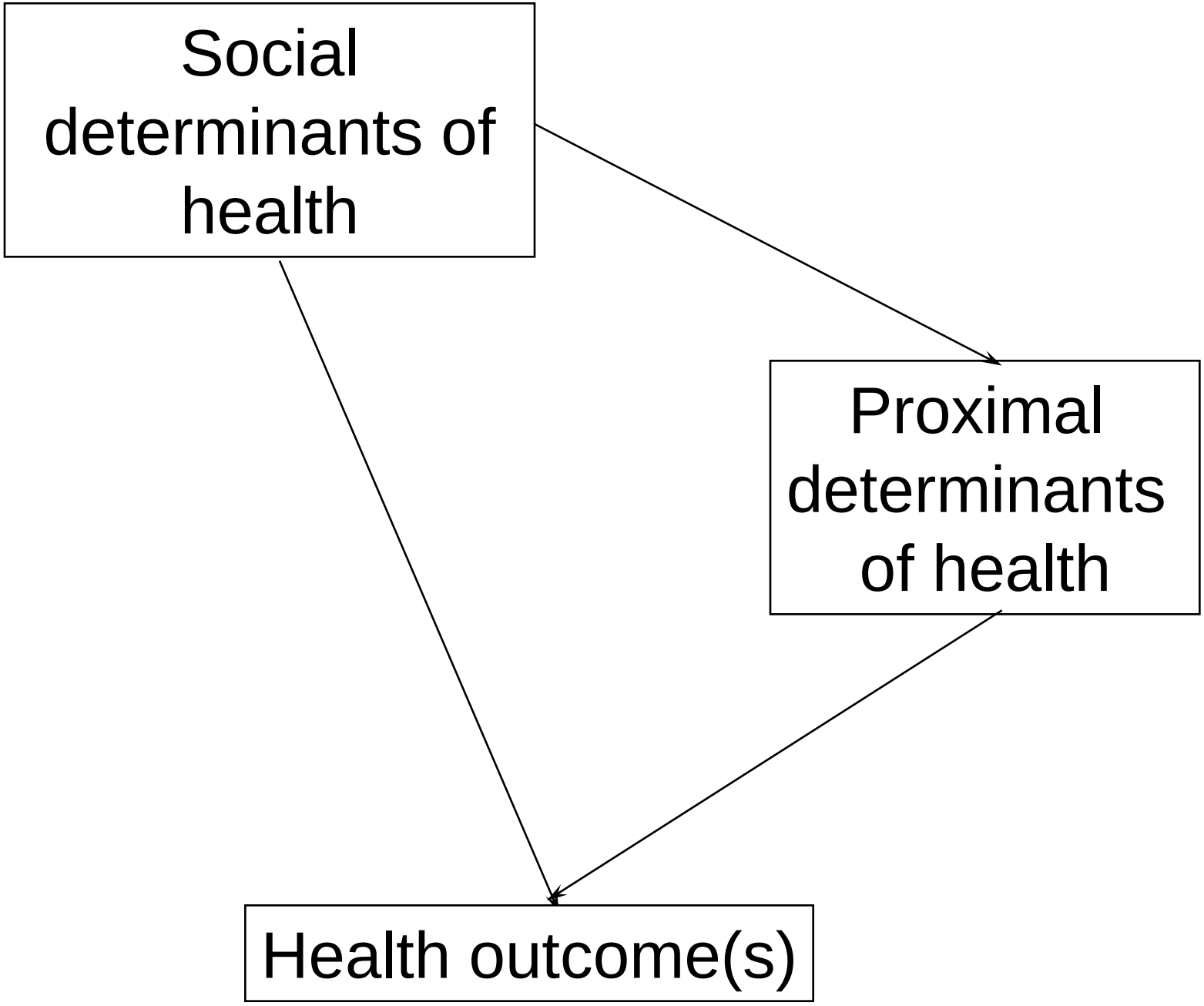
DALYs and/or Economic valuation

Basic characteristics of diagram

- chains of causation, not just one link
- multiple chains – assumption of independence
  - combination of chains in policy e.g. stick & carrot
- multidisciplinary
- individual & group levels (as is routine in infectious disease epidemiology)
- organised by economic/policy sector
- health determines the content of the diagram – “driven by the bottom line”

Use of diagrams

- flow charts are used for modelling in infectious disease epidemiology, based on differential equations (Anderson & May)
- diagrams in statistics – graphical models
- these are not necessarily explicitly “causal”
- the theory of Directed Acyclic Graphs (DAGs) has developed formal rules for controlling confounding, as rigorous as algebraic formulations, and less error-prone in complicated situations
  - in epidemiology, this has so far used mainly for inferring causation for a single link, but this approach can be expanded to diagrams of larger causal systems


Social determinants of health
Proximal determinants of health
Health outcome(s)

Causal diagrams

- typically “causation” here means that one variable affects the magnitude, timing, probability and/or severity of the next variable
- start simple; build up
  - reduction and expansion – pragmatic
- diagrams are suitable for both qualitative and quantitative analysis
- a diagram is not like a single study, it’s more like a synthesis, => the issue of generalisability
- diagrams evolve from conjectural to well-supported, as evidence is accumulated

Functions of diagrams: scientific

- a framework for analysis, e.g. statistical modelling
- to make assumptions and hypotheses explicit for discussion, and for planning data collection and analysis
- to place hypotheses in the public domain prior to testing – a conjecture that is open to refutation
- to identify evidence gaps
- to generate a research agenda

Empirical aspects

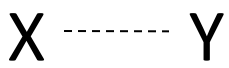
- default: “all arrows” (saturated) – omission is a stronger statement than inclusion
- corollary: ***deletion*** following statistical analysis is the strong step
- quantification of the links that remain
- a single diagram can be used to integrate multiple datasets
  - the question of generalisability

Causal aspects (Pearl)

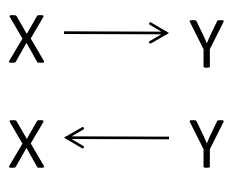
- causal knowledge is essential – e.g. in multivariate statistical analysis, the rule of thumb is not to adjust for a covariate that is on the causal pathway
- DAGs can be used to formalise this
  - they are more rigorous and more general
- if an association exists, e.g. between a suggested causal variable X and a suggested effect Y, the number of ways that this can be brought about is limited

Causal diagrams

Given: X is associated with Y, and this is not due to random error:

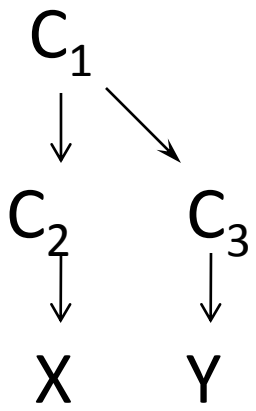


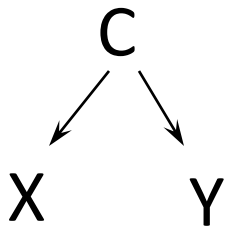
This could be due to:



causation

reverse causation





confounding
(common ancestor)

Pearl: causal & statistical languages

associational concept:
can be defined as a joint distribution of observed variables

- correlation
- regression
- risk ratio
- dependence
- likelihood
- conditionalization
- “controlling for”

causal concept:

- influence
- effect
- confounding
- explanation
- intervention
- randomization
- instrumental variables
- attribution
- “holding constant”

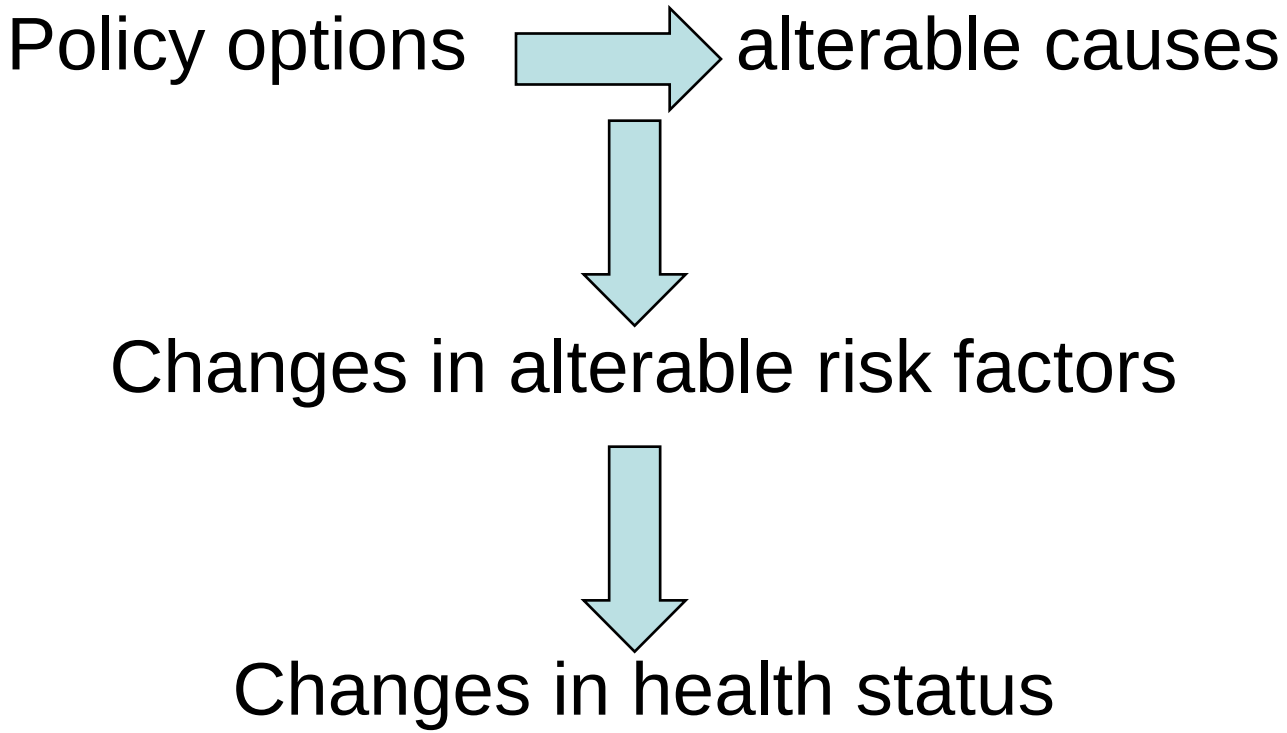
Functions of diagrams: use for policy

- means of communicating among stakeholders
- to express the connections between policy options and health outcomes, ***positive and negative***; ***unintended as well as intended***:
  - to facilitate discussions between experts in different fields, e.g. transport, health; policy areas such as land use, road planning, charging
  - to make judgements explicit
  - to simplify but not over-simplify
  - a check-list, to ensure inclusion of all key items
  - broader than e.g. “evaluation” (1-chain focus)

Relationship to the policy process

- there are various possible models
- the best is ***a division of labour*** between the technical assessment and the policy process: for all the possible ***policy options*** – including those not currently seen as feasible – ***a list of the health impacts***, including the numbers affected and the severity of effects (economic valuation can be added), information on special risk groups/equity, on reversibility and on possibilities (and costs) for remediation
  - plus the degree of certainty of each component

Altering the determinants of the health determinants

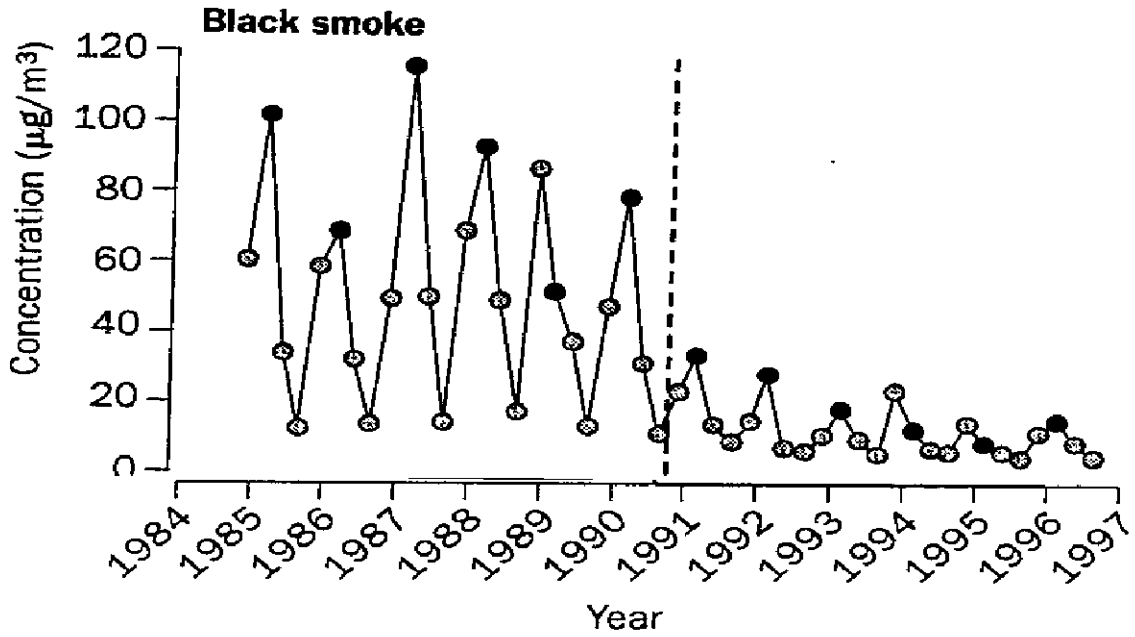


“Change” models: advantages

- *Pragmatism*: changes in the determinants of health determinants link naturally to policy options (cf Wanless: “natural experiments”);
- *Parsimony*: the immense complexity of the pathways can be greatly reduced by focusing on changes, especially in the absence of effect modification;
- *Philosophy*: causality is more readily grasped when something is altered, e.g. a particular road layout rather than “roads” as a necessary condition of “road deaths”.

Effect of the coal ban, Dublin, 1990

- before-after comparison of pollution concentration, adjusted for weather etc
- 72 months before and after the ban
- also controls for influenza and age structure
- all-Ireland controls for secular changes

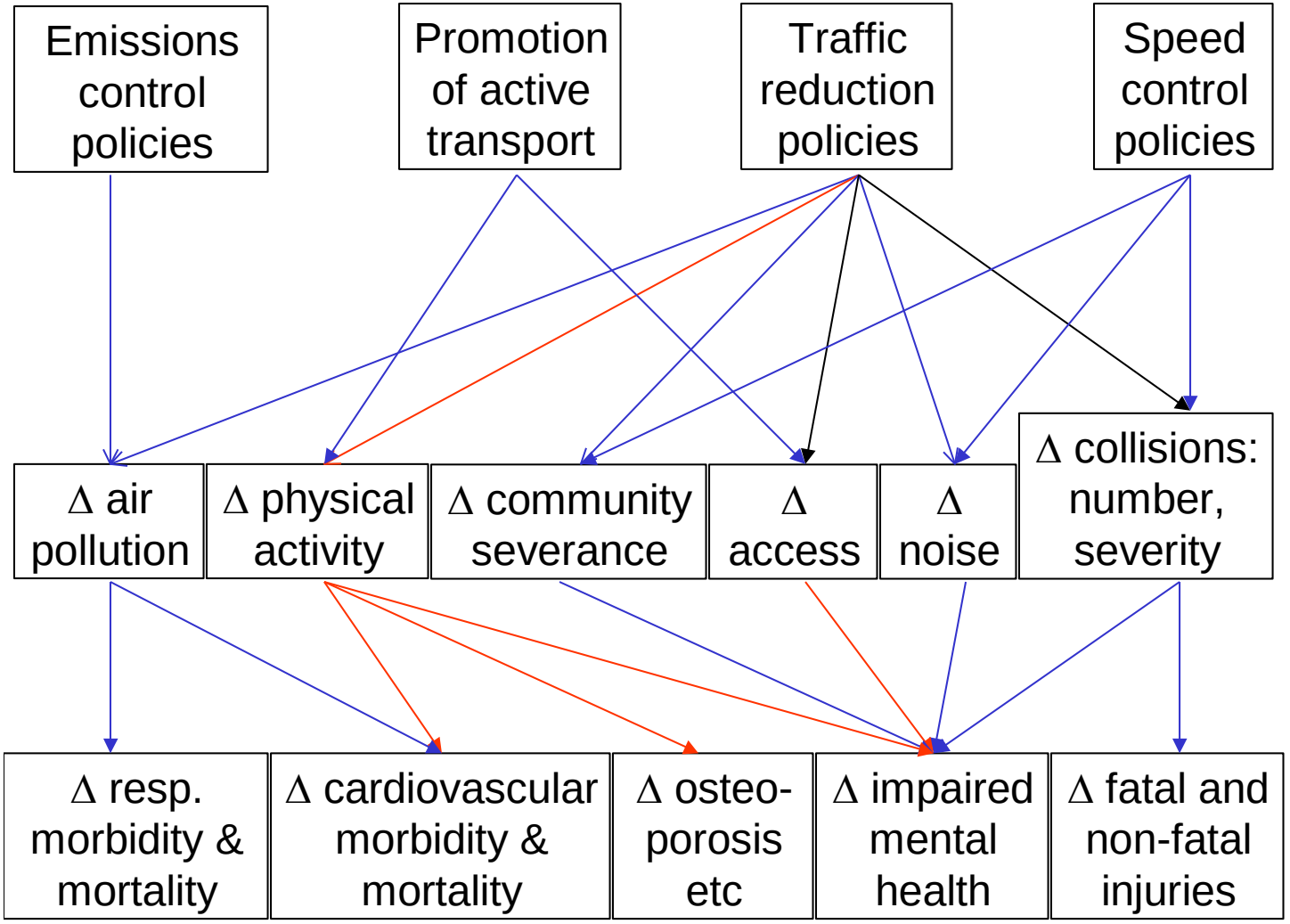


	1984–90	1990–96	Change	p
Deaths per 1000 person-years				
Non-trauma				
Autumn	8·73	8·54	–0·19	<0·0001
Winter	11·03	9·88	–1·15	<0·0001
Spring	9·49	8·66	–0·83	<0·0001
Summer	8·40	7·56	–0·85	<0·0001
Total	9·41	8·65	–0·75	<0·0001
Cardiovascular				
Autumn	4·01	3·67	–0·34	<0·0001
Winter	5·18	4·47	–0·71	<0·0001
Spring	4·41	3·71	–0·69	<0·0001
Summer	3·89	3·29	–0·59	<0·0001
Total	4·37	3·78	–0·58	<0·0001
Respiratory				
Autumn	1·11	1·09	–0·02	0·51
Winter	2·00	1·55	–0·44	<0·0001
Spring	1·49	1·16	–0·33	<0·0001
Summer	0·93	0·83	–0·10	0·049
Total	1·38	1·16	–0·22	<0·0001

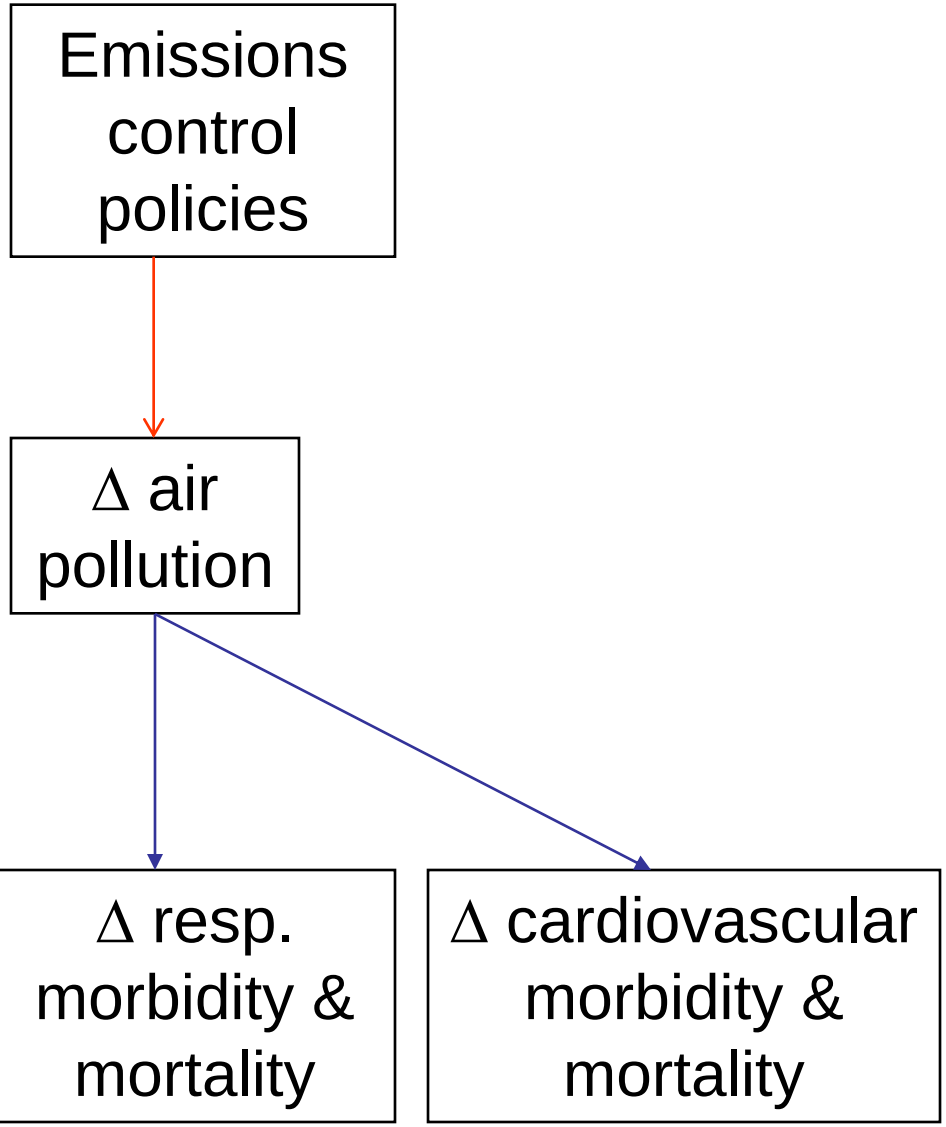
Traffic law enforcement: case-crossover study of road deaths

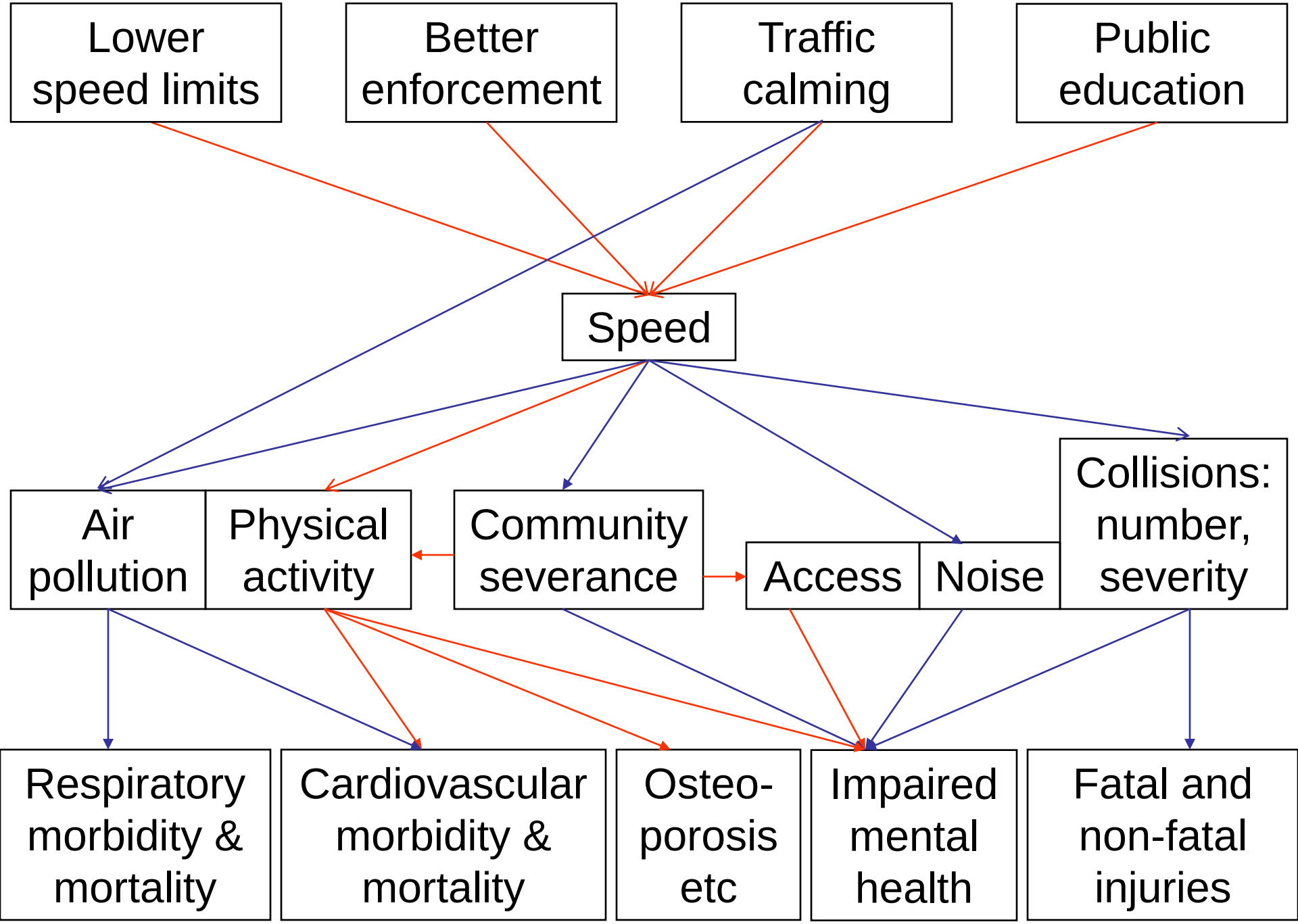
- fatal crashes identified (‘88-’98), Ontario
- “exposure” is motoring conviction
  - additional information e.g. penalty points
- comparison is a period just before the crash with a period e.g. a year earlier
- 35% reduction in RR of a crash, lasting for a few months
  - especially if penalty points were received
- individual level, each case his/her own control

Health impact of transport policies



Emissions control as a technical fix

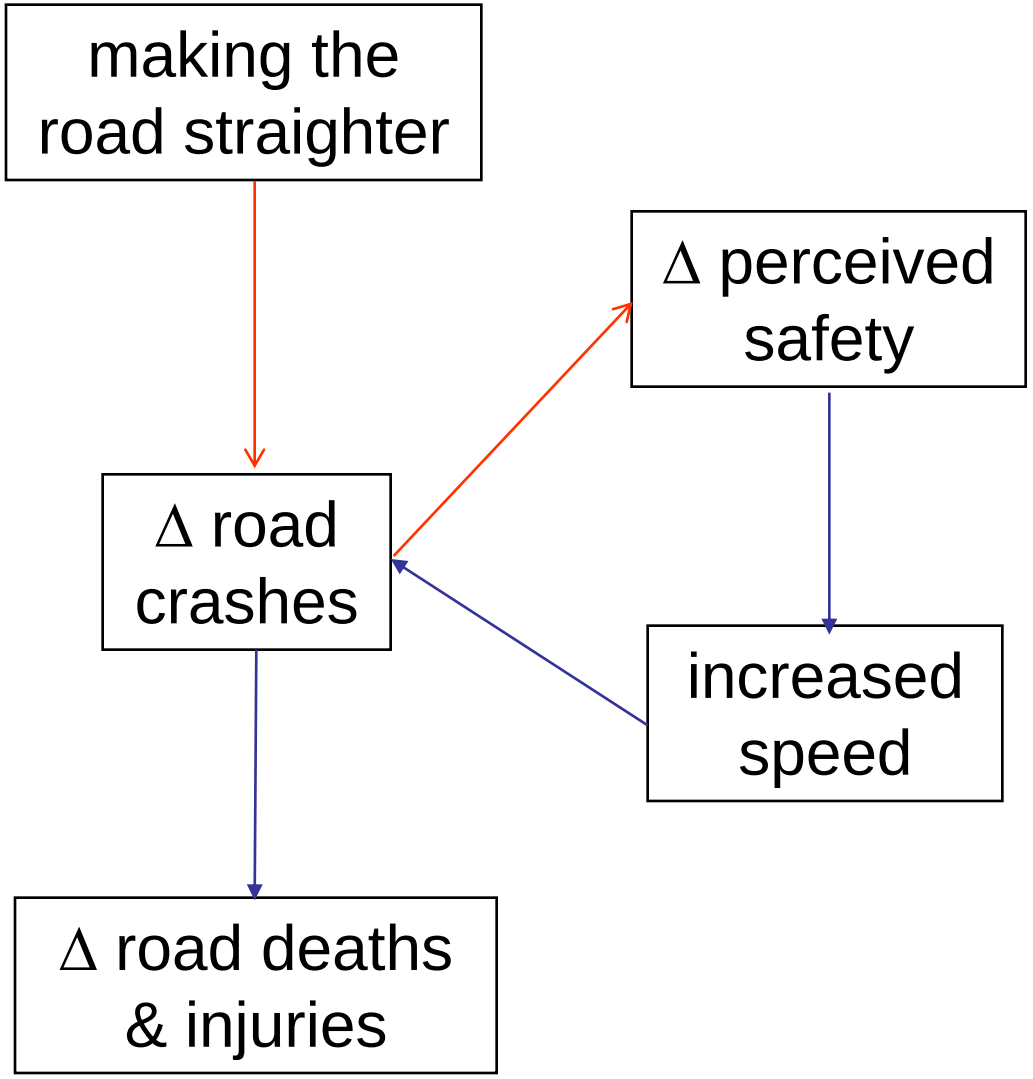



Lower speed limits
Better enforcement
Traffic calming
Public education
Speed
Air pollution
Physical activity
Community severance
Access
Noise
Collisions: number, severity
Respiratory morbidity & mortality
Cardiovascular morbidity & mortality
Osteo-porosis etc
Impaired mental health
Fatal and non-fatal injuries

Methodological issues

- need for sensitivity analyses
- combining individual and group (e.g. spatial) levels of analysis
- combining static and “change” evidence
- feedback

A dangerous bend: risk compensation

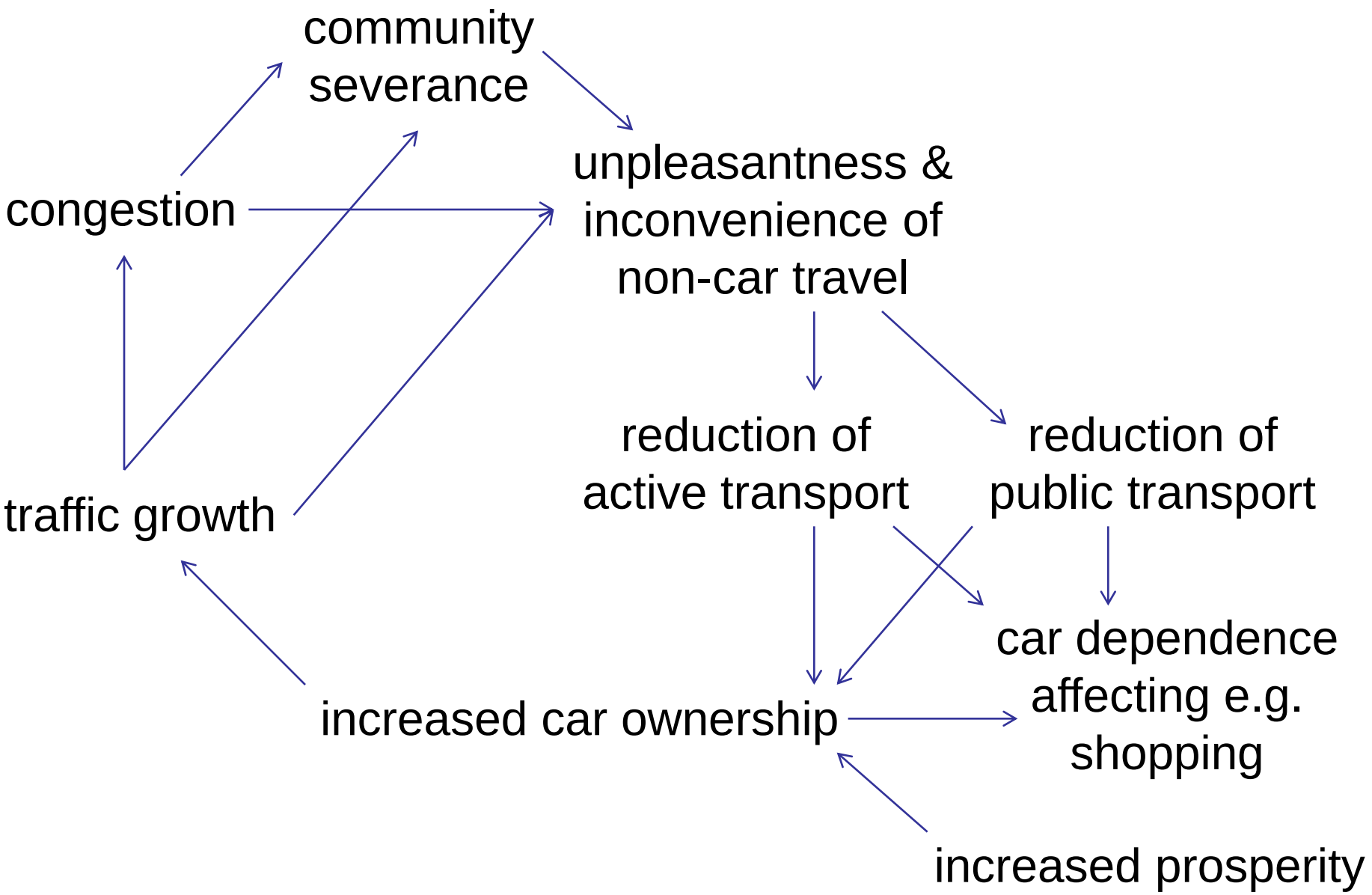


John Adams: *Risk*

Feedback

- negative feedback
  - adaptive responses like risk compensation
- positive feedback
  - amplifies the effect
- feedback is especially likely
  - (a) with issues that have a substantial behavioural element e.g. drug abuse, violence, obesity;
  - (b) if the policy decision is itself included in the model – analysis ***of*** policy – we have been more concerned with health impacts of policy options, i.e. analysis ***for*** policy

Car dependence



Conclusion

- health is one important way of assessing how issues outside the healthcare sector affect humans
- health assessment can be used to inform policy – but there is a problem with silo thinking
- scientists need to develop better methods of health assessment in the context of complex inter-related systems; including assessing effects of intervention