Causal diagrams for evaluation of public health interventions

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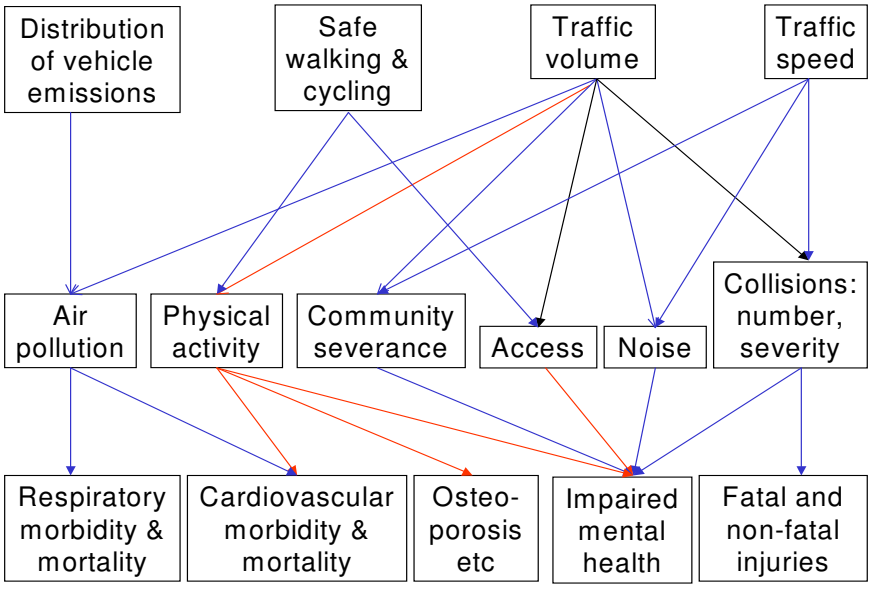
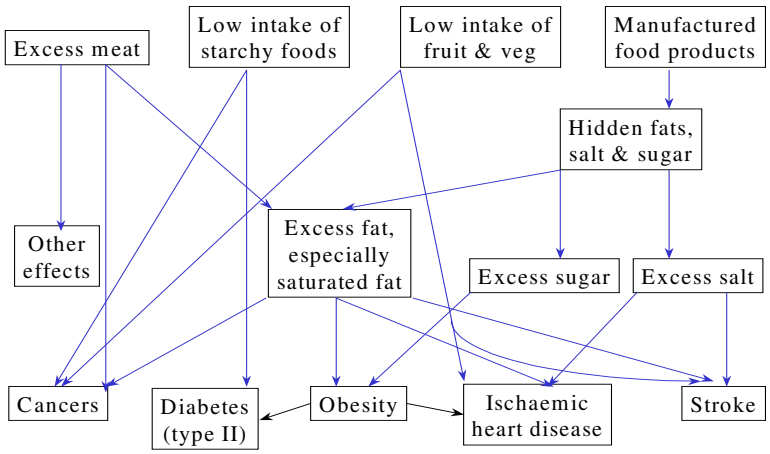
Transport-related health problems



Diet-related health problems



Determinants of the determinants of health

Underlying causes e.g. socioeconomic factors

↓

Determinants (risk factors)

↓

Health status (diseases etc)

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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”

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- flow charts are used for modelling in infectious disease epidemiology, based on differential equations (Anderson & May)
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- 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

Causal diagrams

- typically “causation” here means that one variable affects the magnitude, 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

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

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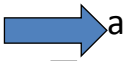
Altering the determinants of the health determinants

Policy options  alterable causes

Changes in alterable risk factors

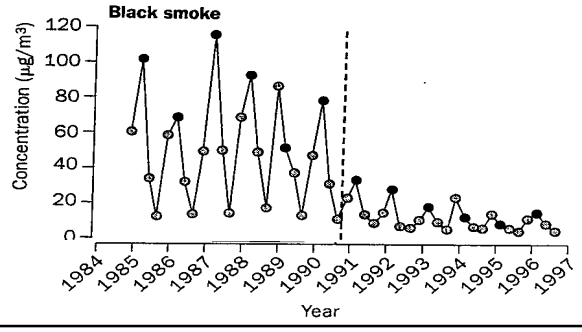
Changes in health status

"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".

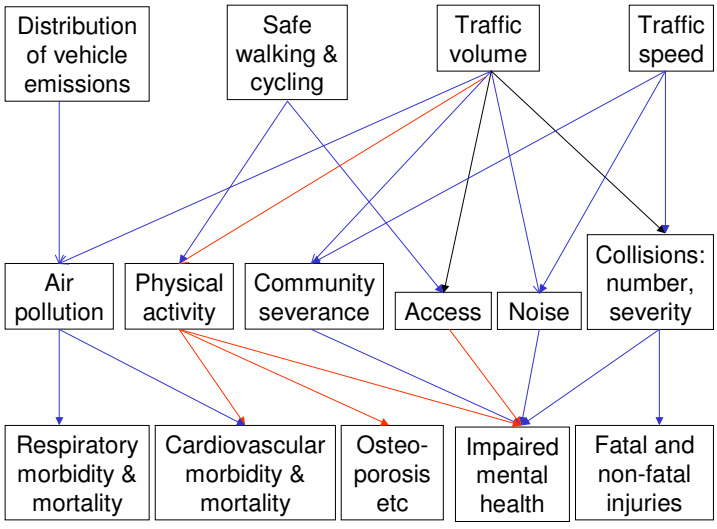
Effect of the coal ban, Dublin, 1990

- 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

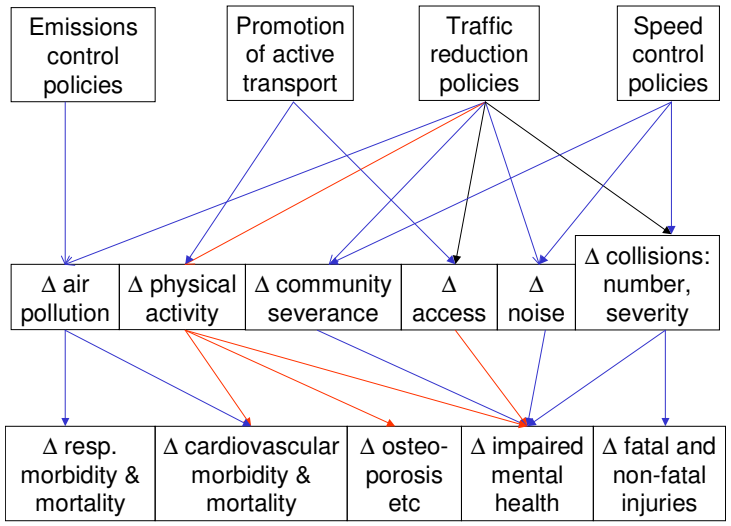


	1984–90	1990–96	Change	p
Deaths per 1000 person-years				
Non-trauma				
Autumn	8·73	8·54	–0·19	<0·0001
Winter	11·03	9·88	–1·15	<0·0001
Spring	9·49	8·66	–0·83	<0·0001
Summer	8·40	7·56	–0·85	<0·0001
Total	9·41	8·65	–0·75	<0·0001
Cardiovascular				
Autumn	4·01	3·67	–0·34	<0·0001
Winter	5·18	4·47	–0·71	<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

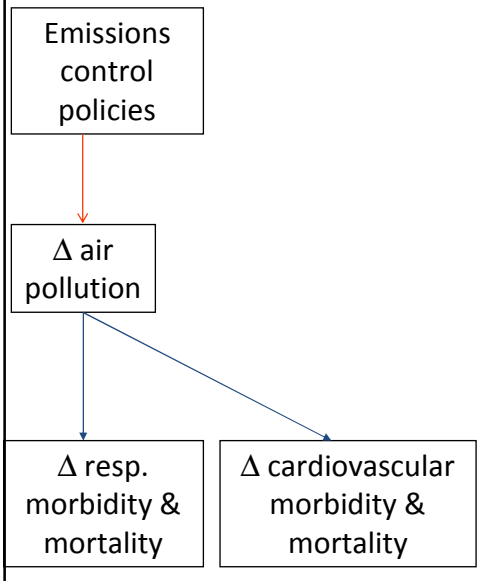
Transport-related health problems

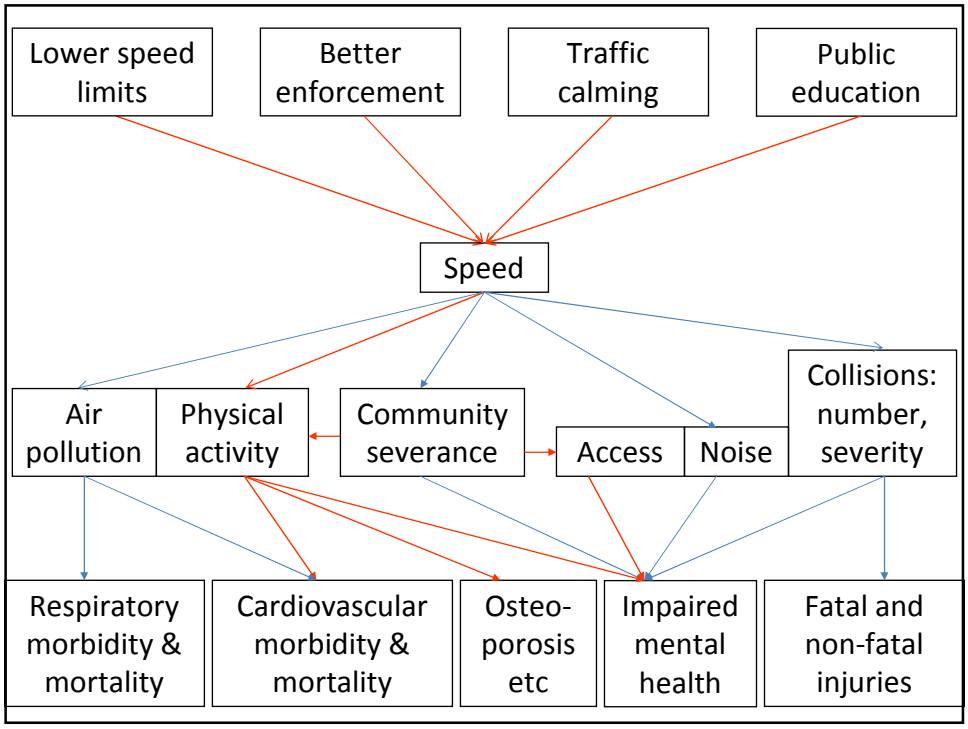


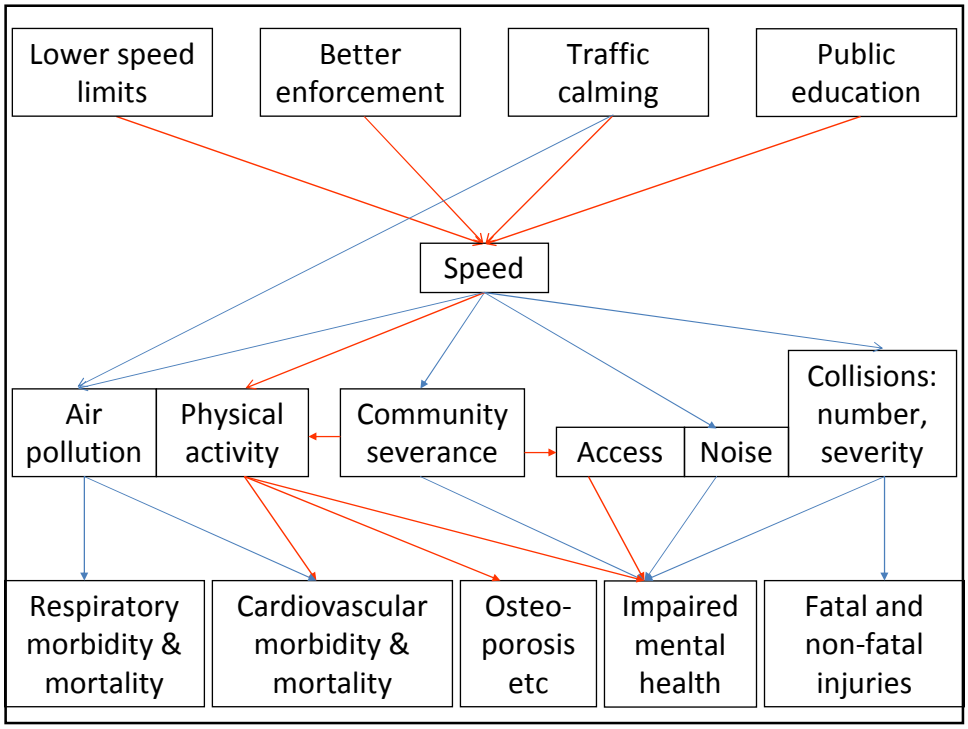
Health impact of transport policies



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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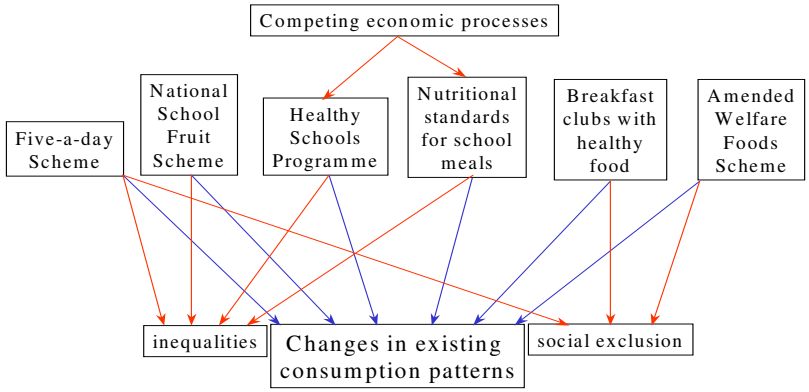
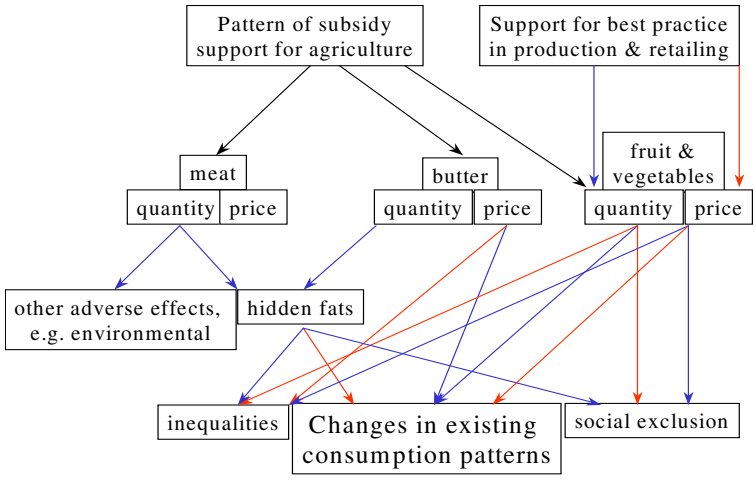
Health promotion initiatives



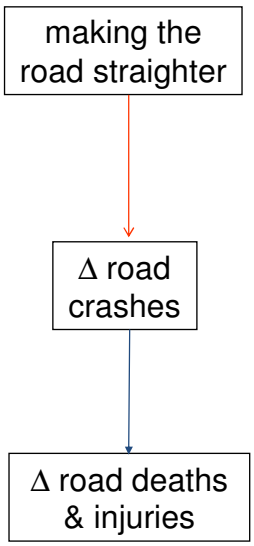
Agricultural policy



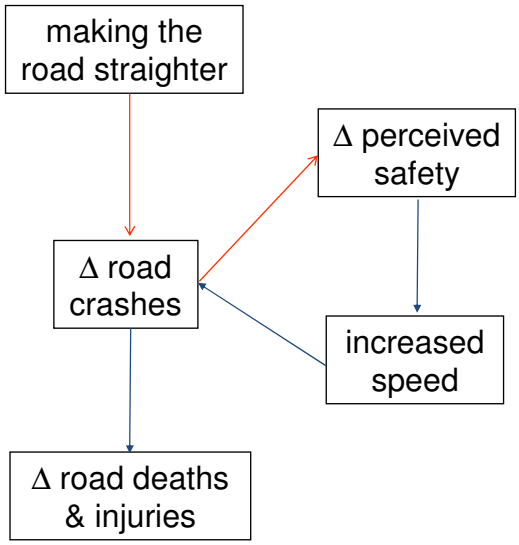
Methodological issues

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

A dangerous bend



A dangerous bend: risk compensation

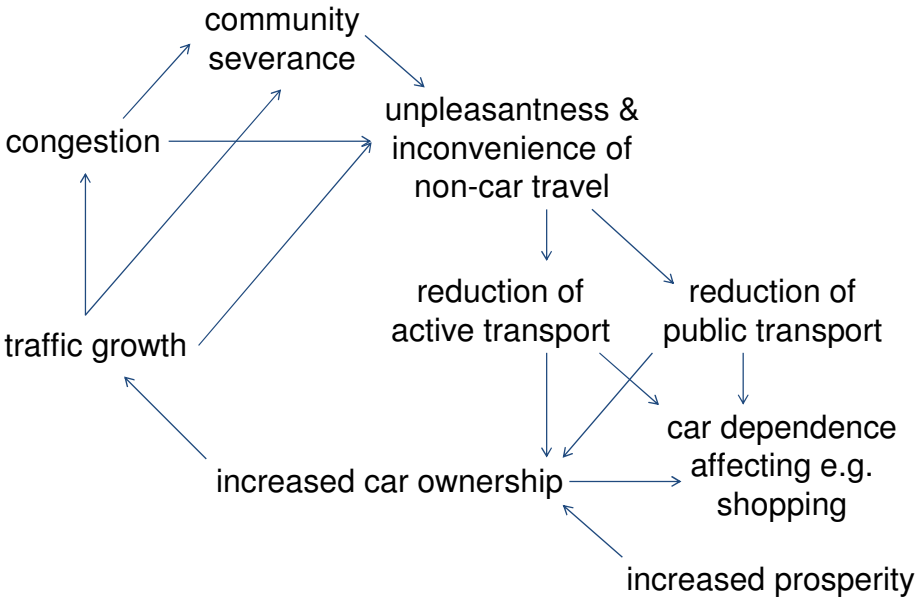


John Adams: *Risk*

Feedback

- negative feedback
  - adaptive responses like risk compensation
- positive feedback
  - amplifies the effect

Car dependence



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- 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

Thank you!