Using natural experiments to evaluate population health interventions

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MRC Population Health Sciences Research Network

• Group of MRC Units and Centres, established in 2005 to
   Add value to the MRC’s existing core investment in population health sciences
   Provide a co-ordinated voice on research and policy issues relating to population health
   Develop capacity in the population health sciences

• Main aims 2010-15
   Collaborate with other groups to deliver a programme of ‘methodological knowledge transfer’, i.e. to identify, refine and translate best practice in the population health sciences
   www.populationhealthsciences.org
Methodological knowledge transfer

Developing and evaluating complex interventions: new guidance

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www.mrc.ac.uk/complexinterventionsguidance
Natural experiments – the early days

‘It was obvious that no experiment could have been devised which would more thoroughly test the effect of water supply on the progress of cholera than this’.

Can ‘natural experiments’ solve all our evaluation problems in public health?

The major constraint to further progress on the implementation of public health interventions is the weakness of the evidence base regarding their effectiveness and cost-effectiveness. Current public health policy and practice, which includes a multitude of promising initiatives, should be evaluated as a series of natural experiments.
The Foresight obesity systems map provides a tool for research funders to identify priority areas. Broadly, areas requiring increased support include:

Long term interventions

Studies focused on prevention

Research targeting large population groups

Evaluation of ‘natural experiments’ (rather than highly controlled experimental paradigms)
Happiness index to gauge Britain's national mood

If you want to know things – Should I live in Exeter rather than London? What will it do to my quality of life? – you need a large enough sample size and if you have a big sample, and have more than one a year, then people can make proper analysis on what to do with their life. And next time we have a comprehensive spending review, let's not just guess what effect various policies will have on people's wellbeing. Let's actually know.

Government source, quoted in the Guardian, 15 November 2010.
What constitutes a natural experiment?

• An act of nature or other unplanned perturbation of an existing system?

• A situation in which ‘naturally occurring’ variation in exposure can be exploited for the purposes of causal inference?

• A situation in which a ‘naturally occurring’ control group is identified for comparison in a study of the effect of a policy measure?

• A situation in which people or groups are allocated to treatment groups ‘as if’ they had been randomised?
A working definition

• A ‘natural experiment’ is a characteristic of an intervention and the way it is implemented, not a type of study design

• The key characteristics are

  • the allocation of people or groups to treatment condition is outside the control of the researcher
  
  • the introduction of the intervention is not motivated by research purposes

• A variety of (observational or quasi-experimental) study designs may be used to evaluate such interventions
How are they used?

- To identify causes of disease and of changes in population health
  - Famine, migration, economic crisis

- To evaluate impact of public health interventions
  - Air pollution control, smoking bans, regulation of poisons

- To evaluate health impact of non-health interventions
  - Changes in domestic gas supply, control of alcohol imports

- And in many other ways
Does a mention in *The New York Times* increase citations of a research paper?

Yes – papers mentioned in NYT are cited 73% more than comparable papers.

But is this just because they are better?

No – papers mentioned in articles included in facsimile editions, prepared but not published, during a strike were cited no more often than control papers.

The strike provides an almost perfect natural experiment, breaking the link between the quality of a paper and being mentioned in the NYT.

When should we use natural experiments?

- Whenever experimental manipulation of exposure to an intervention is unethical or impractical?
- Whenever an intervention is implemented in such a way that a planned experiment is not feasible?
- Whenever the (expected) effect size is so large that no credible alternative causal hypothesis is plausible?
- Whenever a planned experiment is impossible but there is an intervention and a source of data available for analysis?
When can we use them to best effect?

- When there is scientific uncertainty about the size or nature of the effects of the type of intervention

and

- it is impractical, unethical or politically unwelcome for the intervention to be introduced as a true experiment

and

- it is possible to obtain the relevant data from an appropriate study population

and

- the intervention or the principles behind it have the potential for replication, scalability or generalisability
Identifying candidates for natural experimental studies

- Size and nature of effects
  - How large are the effects
  - How rapidly do they follow change in exposure?

- Source of variation in exposure
  - How large is the change?
  - Is it abrupt or gradual?
  - How large is the population affected?
  - Does it affect a whole population or a subset?
  - How readily can individuals manipulate their own exposure?

➢ Rapid large effects are more readily detectable, but natural experiments can be used to detect more subtle effects so long as there is a suitable source of variation in exposure.
Improving the design of natural experimental studies

‘Calling a source of variation a natural experiment does not make that variation exogenous. But the natural experiment approach emphasises the importance of understanding the source of variation used to estimate key parameters. This is the primary lesson of recent work in the natural experiment mould. If one cannot experimentally control the variation one is using, one should understand its source.’


- For large and/or rapid effects, simple approaches may be adequate
- Natural experiments are not restricted to such cases, but more complicated designs will usually be needed
Using natural experiments to detect small effects

- Does ‘fundholding’ by family doctors influence referral rates?*
  - Source of variation: withdrawal of fundholding
  - Identification strategy: difference in differences
  - Testing: non-equivalent dependent variables


- Did Headstart reduce childhood mortality?**
  - Source of variation: targeting of help by poverty rates
  - Identification strategy: regression discontinuity
  - Testing: non-equivalent dependent variables

Choosing the right methods

- Size and type of effects
- Availability of routine data
- Minimising bias
  - By design
    - Multiple pre-post measures
    - Multiple exposed/unexposed groups
  - In analysis
    - Selection on ‘observables’
      - Matching
      - Propensity scores
    - Selection on unobservables
      - Difference in differences
      - Instrumental variables
      - Regression discontinuity
  - Testing
    - Mediators of change
    - Non-equivalent dependent variables
    - Sensitivity analysis
    - Combining methods and comparing results
Recommendations

- Natural experiments are valuable, but are not a panacea for all evaluation problems
- Natural experiments can be used to study subtle as well as rapid/large effects, but a rigorous approach to dealing with bias is essential
- Good research infrastructure is needed to exploit available opportunities:
  - links with policy
  - flexible funding
  - good routine data, etc.
- Single natural experimental studies are unlikely to be conclusive – replication is vital
- Transparent reporting is also essential – a prospective register would help
The new MRC guidance

- Great interest among researchers and policy-makers

- Lack of general guidance for producers and users of natural experimental evidence

- Experience suggests that new guidance would be useful
  - When to use natural experiments
  - Natural and planned experiments
  - Economic considerations
  - Choice of methods
  - Reporting and evidence synthesis

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