UNIVERSITY OF LINCOLN

Experimental Methods in Health Research

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Introduction

- What is an experiment?
- Components of an experiment
- Classification of experimental designs
- Types of non-randomised design
- Reasons for adopting non-randomised experimental designs
- Disadvantages of non-randomised designs
- Case studies

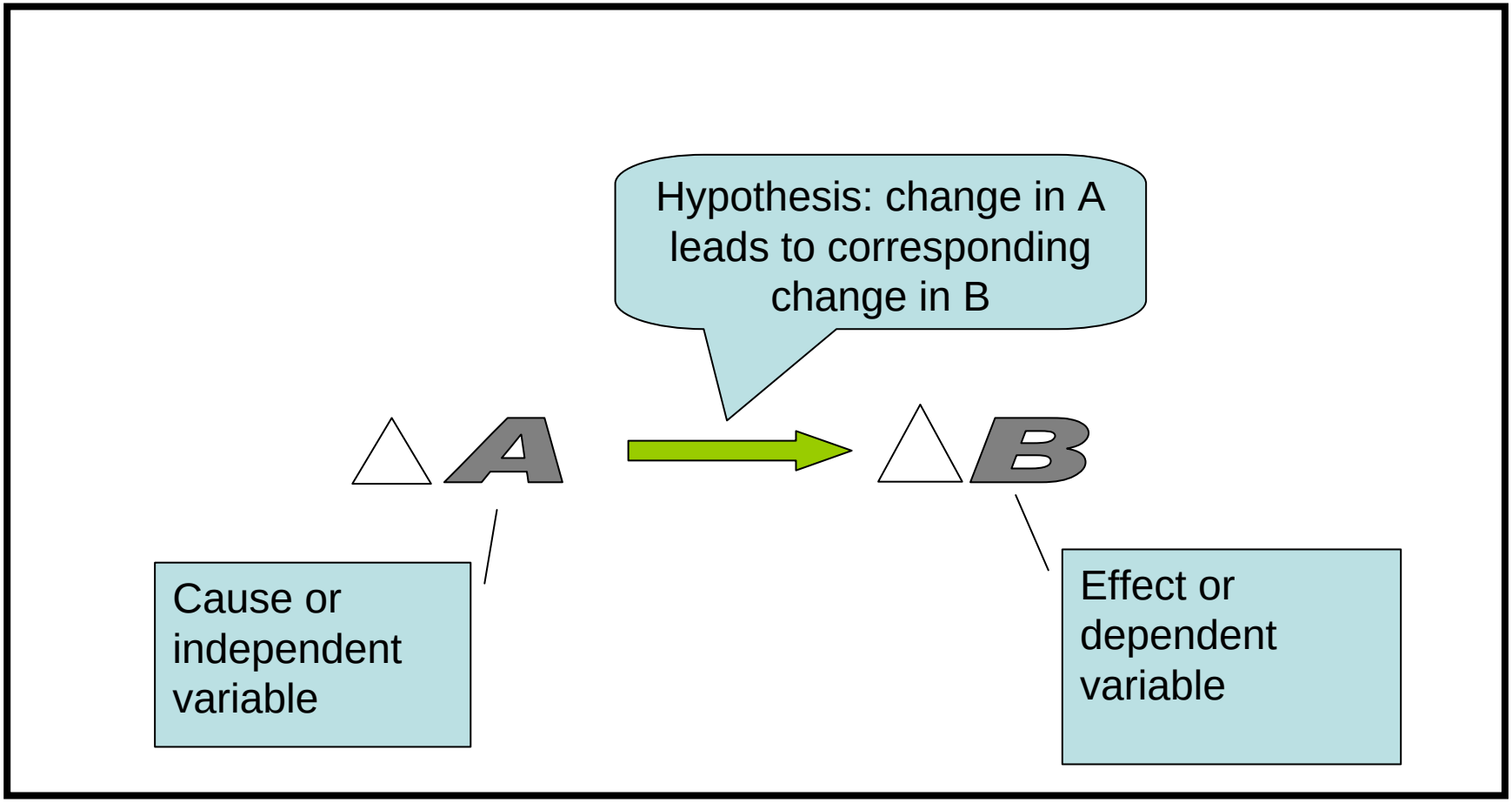
What is an experiment?

"In an experiment, one investigates the relationship between two (or more) things by deliberately producing a change in one of them and looking at, observing, the change in the other."

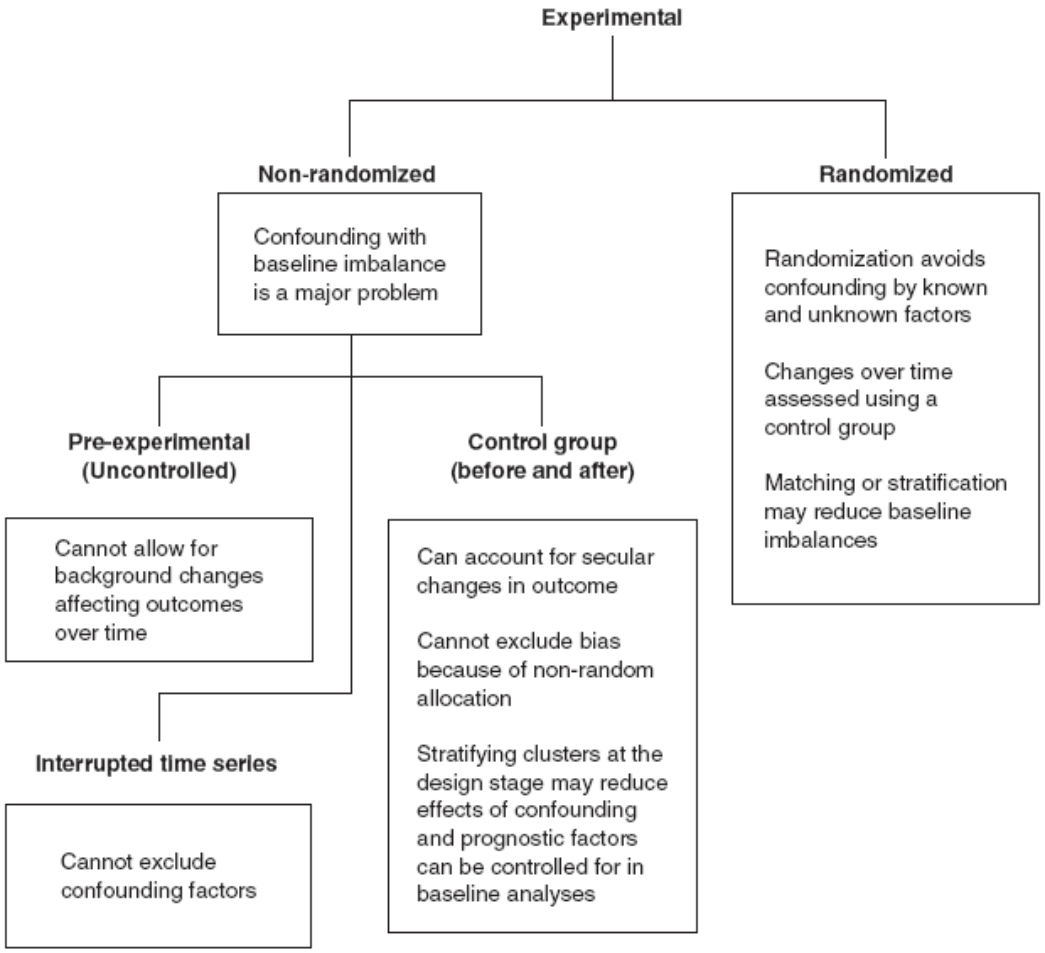
Robson C (1973), *Design and statistics in psychology*, Penguin, Harmondsworth

Components of the experiment

Experiments attempt to test causation rather than association



Classification of experimental designs



Ukoumunne OC et al (1999) Methods for evaluating area-wide and organisation-based interventions in health and healthcare: a systematic review, *Health Technol.Assess.* 3

Non-randomised experimental designs

- Pre-experimental designs:

  non-randomized experiments where a particular outcome of interest is measured only in the intervention group:-

  – single group post-intervention design
  – single group pre- and post-intervention design

- Quasi-experimental designs:

  non-randomized experiments where a particular outcome of interest is measured in intervention and control group (or period):-

  – non-randomized control group before and after study
  – interrupted time series design

Reasons for non-randomised experimental designs (1)

- Such strong evidence for an intervention that a placebo group may be unethical
- Strong preference for intervention prevents control
- Educational or other interventions when active participation required
- Less costly than RCTs
- Feasibility studies including Phase II of MRC framework for evaluation of complex interventions

Reasons for non-randomised experimental designs (2)

New service or health technology already introduced

- Intrinsic
  - area-wide change
  - organization-based intervention
- External constraint
  - policy decision to introduce a new service
  - imposed or natural change across a geographical region.

Disadvantages of non-randomised designs

- Confounding (pre-experimental, interrupted time series without control): alternative explanation for change in outcome of interest
  - Secular change (pre-experimental): background change in outcome of interest due to increased awareness of new technologies or processes, local and national influences or demographic factors
  - Hawthorne effect
  - Regression to the mean
- Bias
  - E.g. Volunteer bias

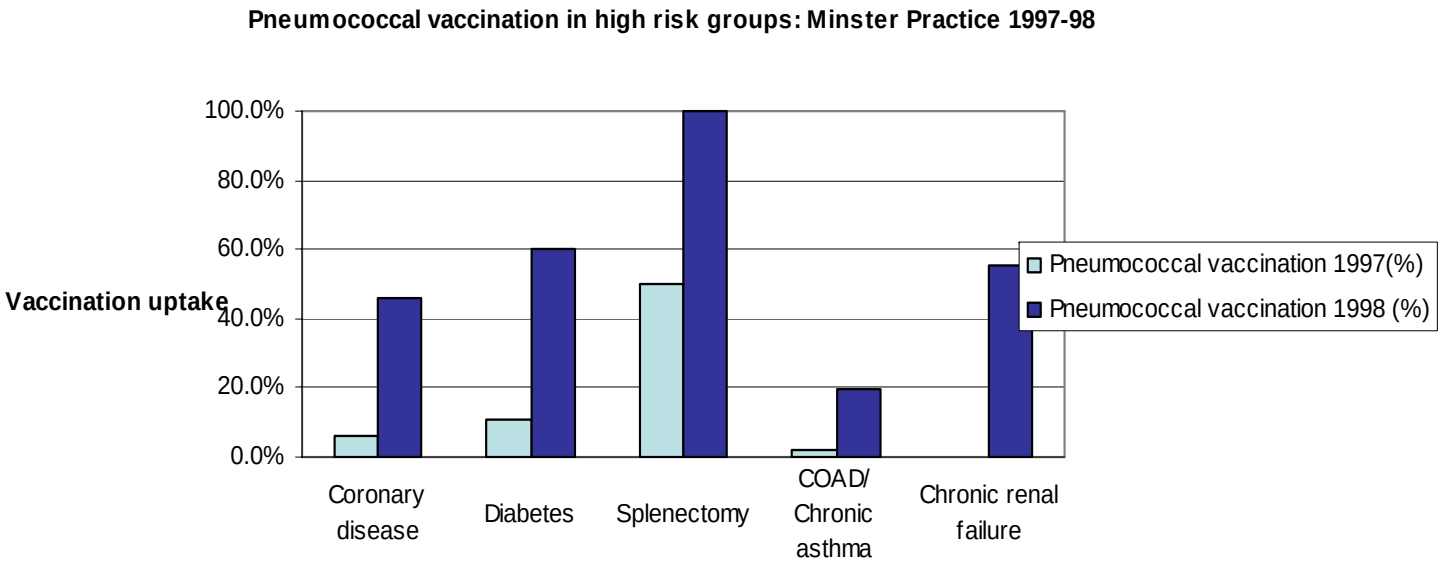
Threats to internal validity

- History
- Maturation (secular trends)
- Testing/Hawthorne effects
- Instrumentation
- Regression to the mean
- Selection bias
- Differential attrition
- Selection maturation interaction

Threats to internal validity

Number of groups	Observation period	Potential major sources of bias
Intervention group only	After	Selection, attrition, maturation, external influences
	Before and after	maturation, external influences, testing
	Time series	External influences, testing effect on outcomes
Intervention and non-equivalent control group	After	Maturation, selection, attrition
	Before and after	Residual selection, selection-maturation, regression to mean
	Time series	Residual selection, selection-maturation, regression to mean

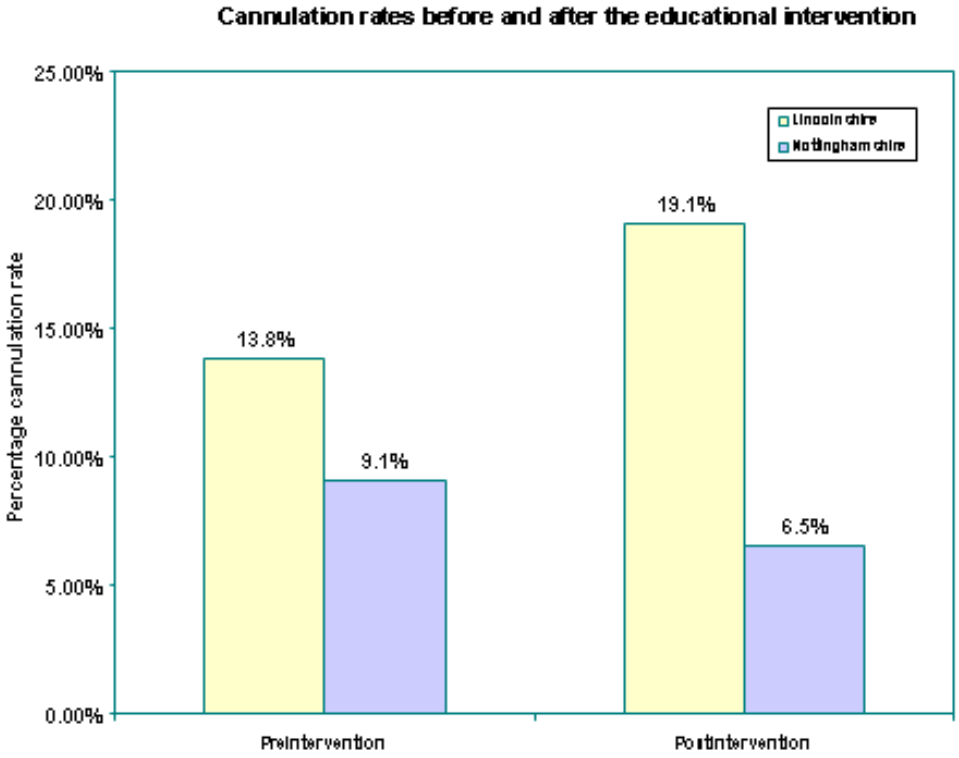
Example 1: Pre-experimental



	Coronary disease	Diabetes	Splenectomy	COAD/ Chronic asthma	Chronic renal failure
Pneumococcal vaccination 1997(%)	5.8%	10.5%	50.0%	2.0%	0.0%
Pneumococcal vaccination 1998 (%)	46.2%	59.8%	100.0%	19.3%	55.6%

Siriwardena AN. Targeting pneumococcal vaccination to high-risk groups: a feasibility study in one general practice. *Postgrad Med J* 1999; **75**: 208-212.

Example 2: Non-randomised control group design



Significant reduction in cannulation rates intervention vs control area ($p<0.001$)

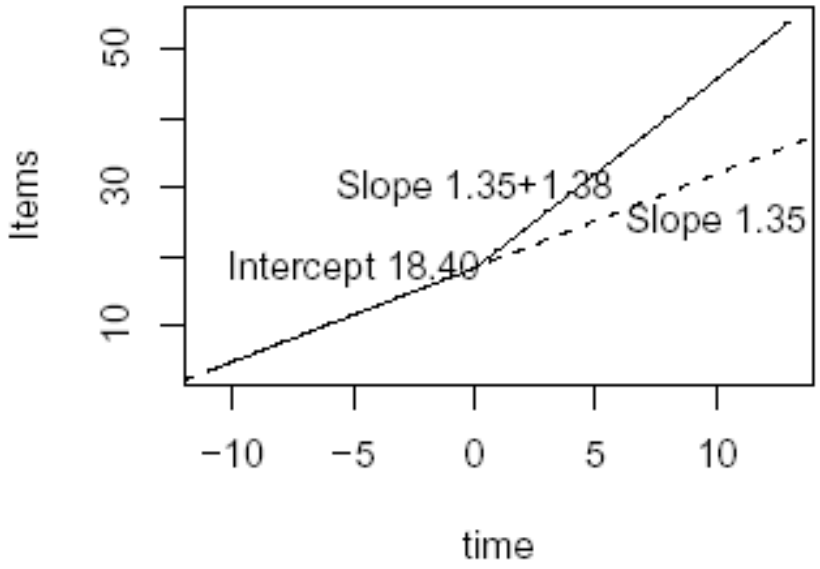
Reduction in cannulation-intervention area from 9.1% to 6.5% (OR 0.7, 95% CI 1.15 to 1.90, $p<0.01$)

Increase in cannulation - control area from 13.8 to 19.1% (OR 1.47, 95% CI 1.15 to 1.90, $p<0.01$)

Siriwardena AN, Banerjee S, Iqbal M et al. An evaluation of an educational intervention to reduce inappropriate cannulation and improve cannulation technique by paramedics. *Emerg Med J* 2009;**26**;831-836

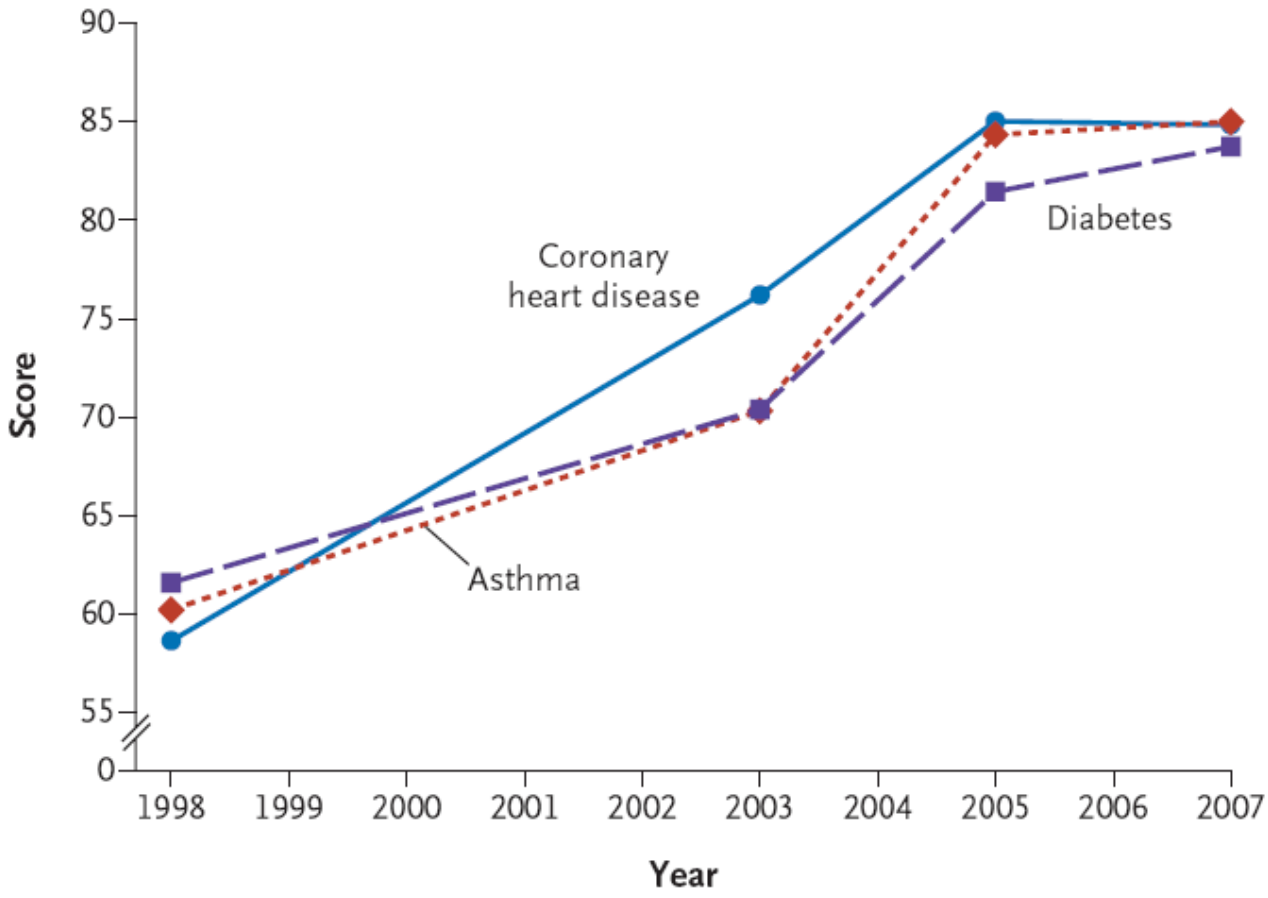
Example 3: Time series

Example of a simple model



Siriwardena AN et al. Investigation of the effect of a countywide protected learning time scheme on prescribing rates of ramipril: interrupted time series study. *Family Practice* 2006 (18 October 2006) doi: 10.1093/ fampra/cml051.

QOF: Interrupted time series



Campbell S. et al. Effects of Pay for Performance on the Quality of Primary Care in England N Engl J Med 2009;361:368-78.

TARGET: Time series

- To investigate the effect of a large scale educational intervention to primary health care teams to increase prescribing of angiotensin converting enzyme inhibitors for prevention of cardiovascular outcomes in patients with diabetes.

Siriwardena AN et al. Investigation of the effect of a countywide protected learning time scheme on prescribing rates of ramipril: interrupted time series study. *Family Practice* 2006 (18 October 2006) doi: 10.1093/ fampra/cml051.

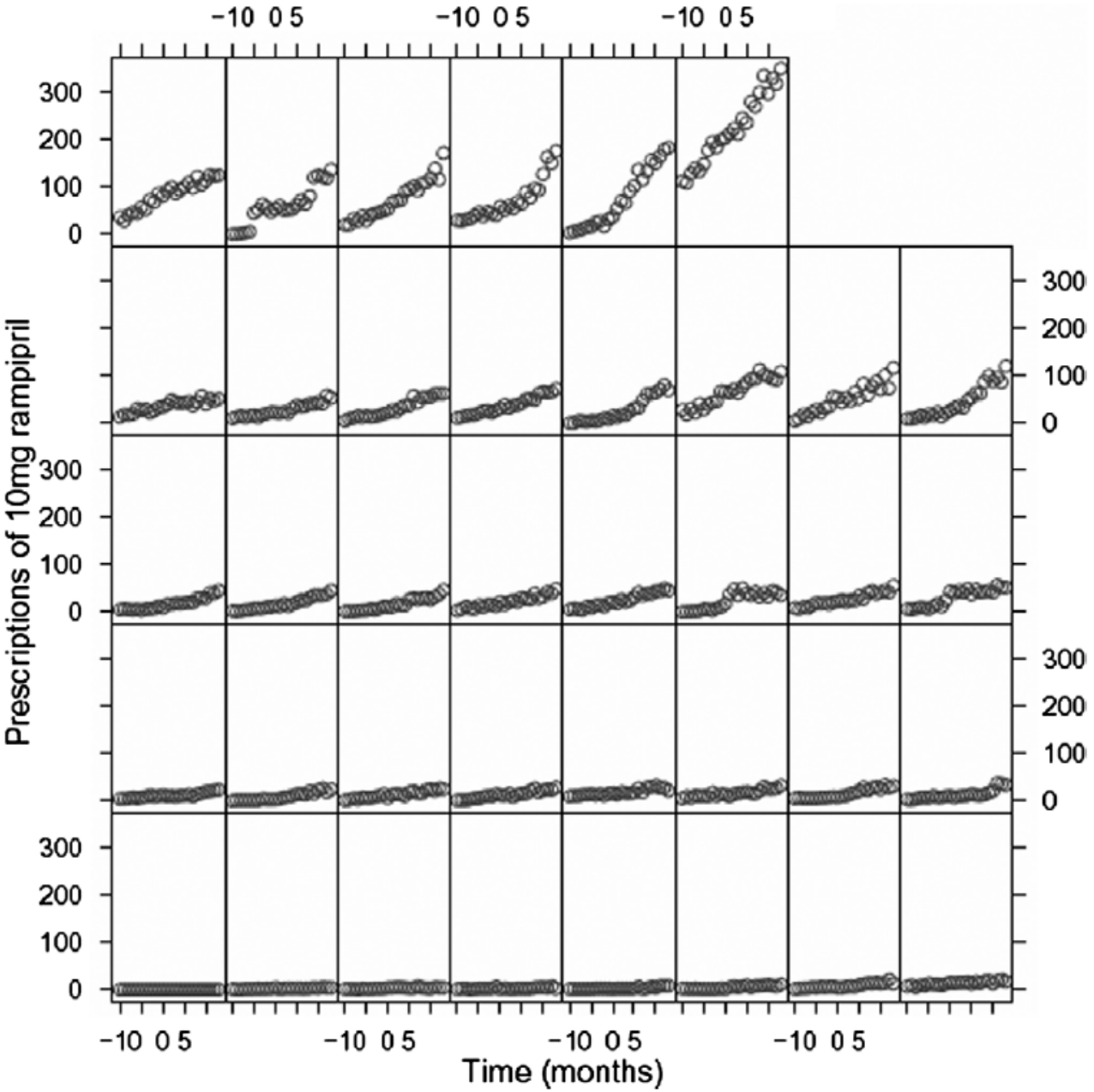
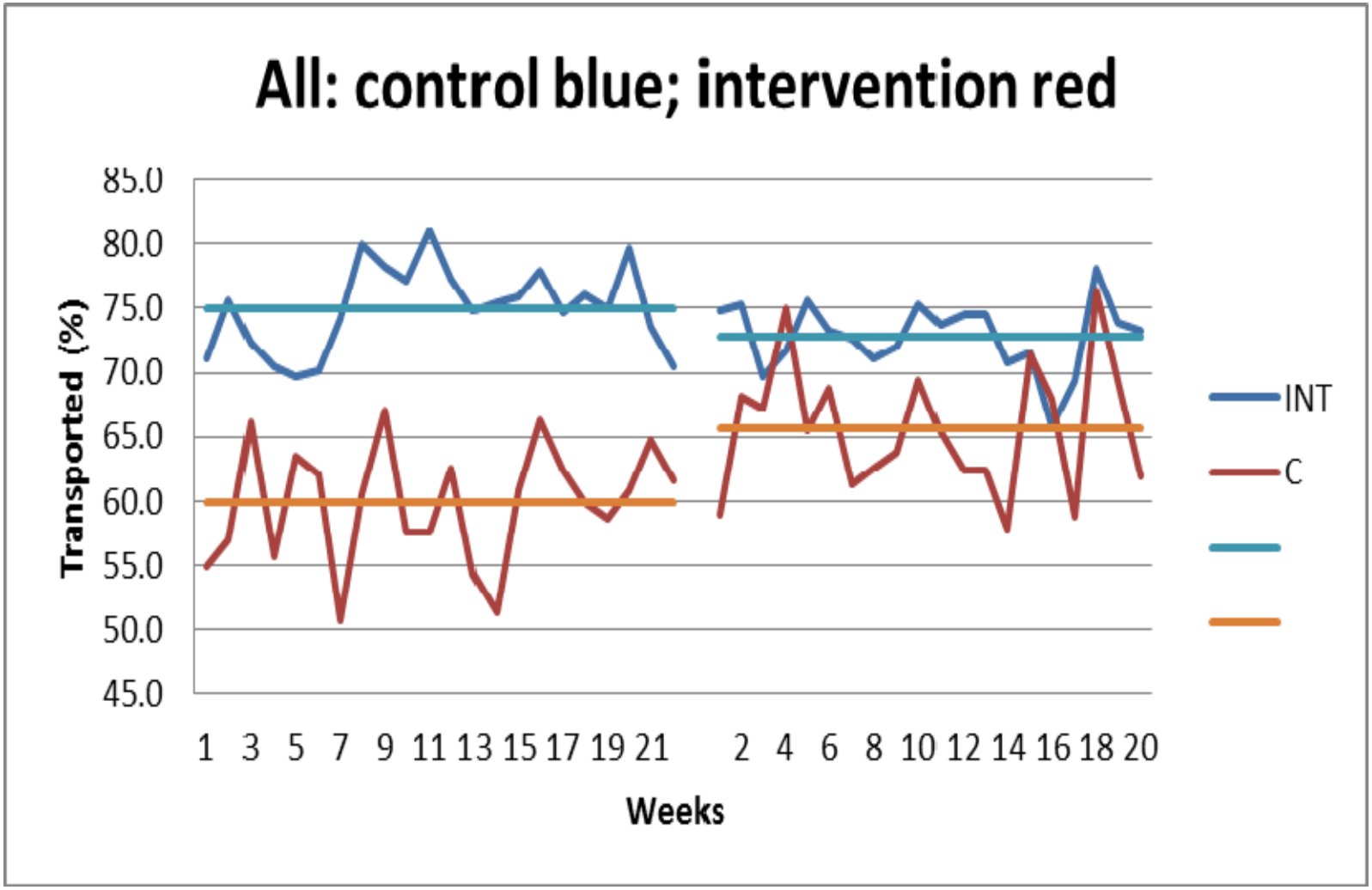

−10 0 5
300
200
100
0
Prescriptions of 10mg rampipril
Time (months)

TABLE 2 *Model for number of prescriptions of 10 mg of ramipril including predictors*

Effect	Estimate	95% Confidence interval	
(Intercept)	17.53	7.91	27.15
GP attended	–1.63	–6.93	3.67
Time	1.27	0.93	1.61
Timepost	1.50	1.07	1.93
Total patient list	0.0000629	–0.000658	0.000784
Training	–0.24	–7.12	6.63
Single handed	0.83	–5.89	7.54
Dispensing	0.85	–4.43	6.13
Lincolnshire South West	6.08	0.08	12.08
West Lincolnshire	9.78	3.89	15.68
Nurse attended (Warwick) diabetes course	9.61	3.11	16.12

Siriwardena AN et al. Investigation of the effect of a countywide protected learning time scheme on prescribing rates of ramipril: interrupted time series study. *Family Practice* 2006 (18 October 2006) doi: 10.1093/ fampra/cml051.


All: control blue; intervention red
85.0
80.0
75.0
70.0
65.0
60.0
55.0
50.0
45.0
Transported (%)
1 3 5 7 9 11 13 15 17 19 21 2 4 6 8 10 12 14 16 18 20
Weeks
INT
C

Key issues

- Pre-experimental and quasi-experimental vs. RCT designs
- Importance as potential applications for assessing and evaluating health technologies, interventions and services
- Modelling prior to RCTs, particularly of complex interventions.

Summary

- Experiments in health research
- Non-randomised experimental designs
- Applications, advantages and disadvantages of non-randomised designs

Reading

- Siriwardena AN. (2012) Experimental methods in health research [book chapter], in Saks, M & Allsop J (eds.), Researching Health: qualitative, quantitative and mixed methods 2nd edition. Sage, London.
- Shadish WR, Cook TD, Campbell DT (2002), *Experimental and quasi-experimental designs for generalized causal inference*, Houghton-Mifflin, Boston.
- Trochim, William M. The research methods knowledge base, 2nd edition. Internet page at http://www.socialresearchmethods.net/kb/
- Ukoumunne OC, Gulliford MC, Chinn S, Sterne JAC, Burney PGJ (1999), Methods for evaluating area-wide and organisation-based interventions in health and healthcare: a systematic review, *Health Technol.Assess* 3(5).
- Britton A, McKee M, Black N, McPherson K, Sanderson C, Bain C (2006), Choosing between randomised and non-randomised studies: a systematic review, *Health Technol. Assess* 2(13).

Thank you