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Last update: 2025/06/15 11:10

Causal Inference

'Causal inference' is the process of determining whether a specific factor (exposure, variable, or intervention) directly causes a change in an outcome, rather than merely being associated with it.

Key distinction

Association ≠ Causation

A variable may correlate with an outcome without causing it.

Methods for causal inference

- Randomized controlled trials (RCTs) gold standard for establishing causality.
- Quasi-experimental designs such as difference-in-differences, instrumental variables.
- Causal modeling e.g., directed acyclic graphs (DAGs), structural equation models.
- Counterfactual reasoning comparing observed outcomes with hypothetical alternatives.

In observational studies

Causal inference requires:

- Control of confounders
- Attention to bias (selection, measurement, etc.)
- Proper temporal sequence (cause precedes effect)

Clinical importance

Causal inference underpins:

- Treatment effect estimation
- Policy decisions
- Guideline development

'In summary: 'causal inference seeks to answer the question: "Does X cause Y?", not just "Is X related to Y?"



