

A row of blue dominoes is shown in the background, with the first four standing upright and the remaining ones falling in a chain reaction from left to right.

Applied Causal Inference

Using Bradford Hill Criteria

by

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Causal Inference: What are We Doing?

- In epidemiology, we have an **exposure**: Something we think causes (or prevents) an **outcome**.
 - Exposure = lack of exercise, outcome = heart attack
- **Confounders** are associated with the exposure and the outcome, and not on the causal pathway between the exposure and outcome. (Example = low income)
- ***A priori* Hypothesis**: My **exposure** is associated with (or causes, or prevents) my **outcome** after controlling for **confounders**.



Causal Inference: What are We Doing?

- In a statistical model
 - You make your **outcome** the dependent variable (DV)
 - You make the **exposure** an independent variable (IV) you leave in through the entire modeling process
 - And then you fit the model using your **confounders**.
- You can choose whatever modeling process you want, but in the end, you have a model with a bunch of slopes in it (for **exposure** and **confounders**)
 - **Is the slope for the exposure statistically significant?** If no, sorry! You were wrong about your hypothesis.
 - **But if yes, you interpret the slope for the exposure.**
 - You can always interpret the other slopes for fun.



Bradford Hill Criteria: Monika's Top 5 in Order of Application

Order	Criterion	Application
1	Temporality	Most study designs won't allow for this, but you can make inferences about it.
2	Dose-response gradient	If the exposure is measured this way, you can look at this.
3	Strength of association	This is very important, and important to assess relative to sample size and the slopes for the confounders.
4	Consistency	It's important to look at the slope in the context of other slopes in the literature.
5	Coherence	If it sounds stupid, it probably is.



Subpopulation:

Study design: Community-dwelling
Cross-sectional Hispanics in Puerto Rico

Exposure: Marijuana use
Outcomes: 1. Oral HPV infection
2. Severe Periodontitis

Confounders:
Model 1: Sex, age, healthcare coverage, oral sex partners, periodontal disease.

Model 2: Sex, age, healthcare coverage, current smoker, binge drinking, oral sex partners, oral HPV infection, an dental visit (past 3 years).

Marijuana use [±]	Oral HPV Infection [*]		Severe periodontitis [†]	
	OR _{crude} (95% CI)	OR _{adjusted} (95% CI)	OR _{crude} (95% CI)	OR _{adjusted} (95% CI)
No use	Reference	Reference	Reference	Reference
Occasional	2.70 (1.41–5.16) [‡]	1.61 (0.78–3.34)	1.69 (1.12–2.53) [‡]	1.06 (0.66–1.70)
Frequent	2.62 (0.57–11.98)	0.93 (0.18–4.73)	5.95 (2.40–14.77) [‡]	2.90 (1.06–7.93) [‡]

From article, “Association of marijuana use with oral HPV infection and periodontitis among Hispanic adults: Implications for oral cancer prevention” by Ortiz, et al, 2018.



Study design:
Cohort
(longitudinal)

Exposure:
Having chronic
kidney disease
(CKD)

Outcomes:
Having at least one
dental visit during the
study period

Confounders:
Age, gender,
race/ethnicity,
language,
insurance, monthly
income

Subpopulation:

San Francisco
Department of Public
Health Community
Health
Network clinical
databases

Table 2 Hazard ratios for having a dental visit by CKD status among entire cohort (reference = no CKD)

	Hazard Ratio	95% CI	P-value
unadjusted	0.60	0.52, 0.69	< 0.001
+ age	0.73	0.63, 0.85	< 0.001
+ gender, race/ethnicity, language	0.76	0.65, 0.88	< 0.001
+ insurance, monthly income	0.75	0.64, 0.88	< 0.001

From article, “Chronic kidney disease and use of dental services in a United States public healthcare system: a retrospective cohort study” by Grubbs, et al, 2012.