MRC/CSO Social and Public Health Sciences Unit

Youth smoking: Towards a tobacco-free generation, but only for some?

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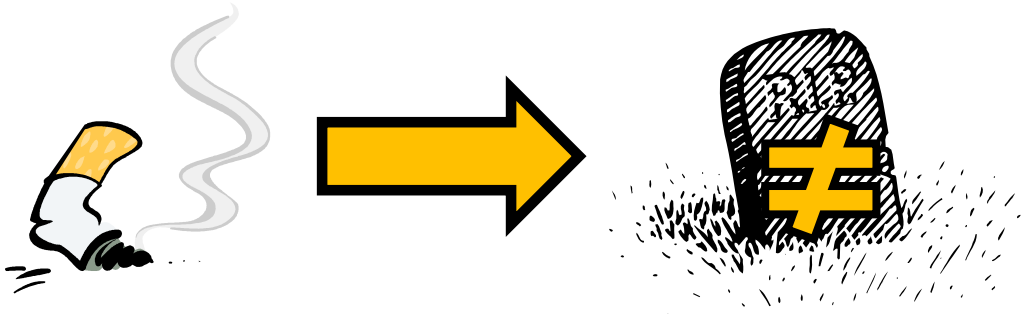
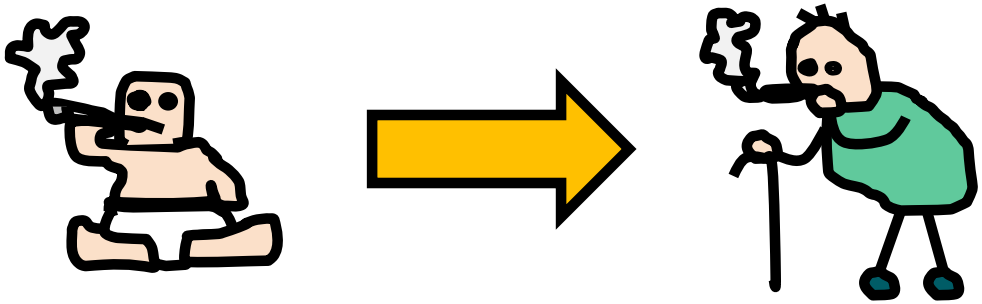
Why Look at Smoking in Youth?

- Smoking is a major health risk, often cited as one of the largest contributors to socioeconomic inequalities in health



- Onset is usually in adolescence, and earlier onset is associated with less chance of quitting



A Tobacco Free Generation

Source: Image tweeted by @ASHScotland.

A Tobacco Free Generation

- In 2013 Scotland set out an ambition to create a ‘tobacco-free generation’
- By the time children born in 2013 reached the age of 21 their generation would be tobacco-free
- I.e. smoking prevalence reduced to 5% by 2034
- Many countries setting similar targets, and/or have been implementing policies to reduce tobacco-use for many years

Progress towards Tobacco-Free in Scotland

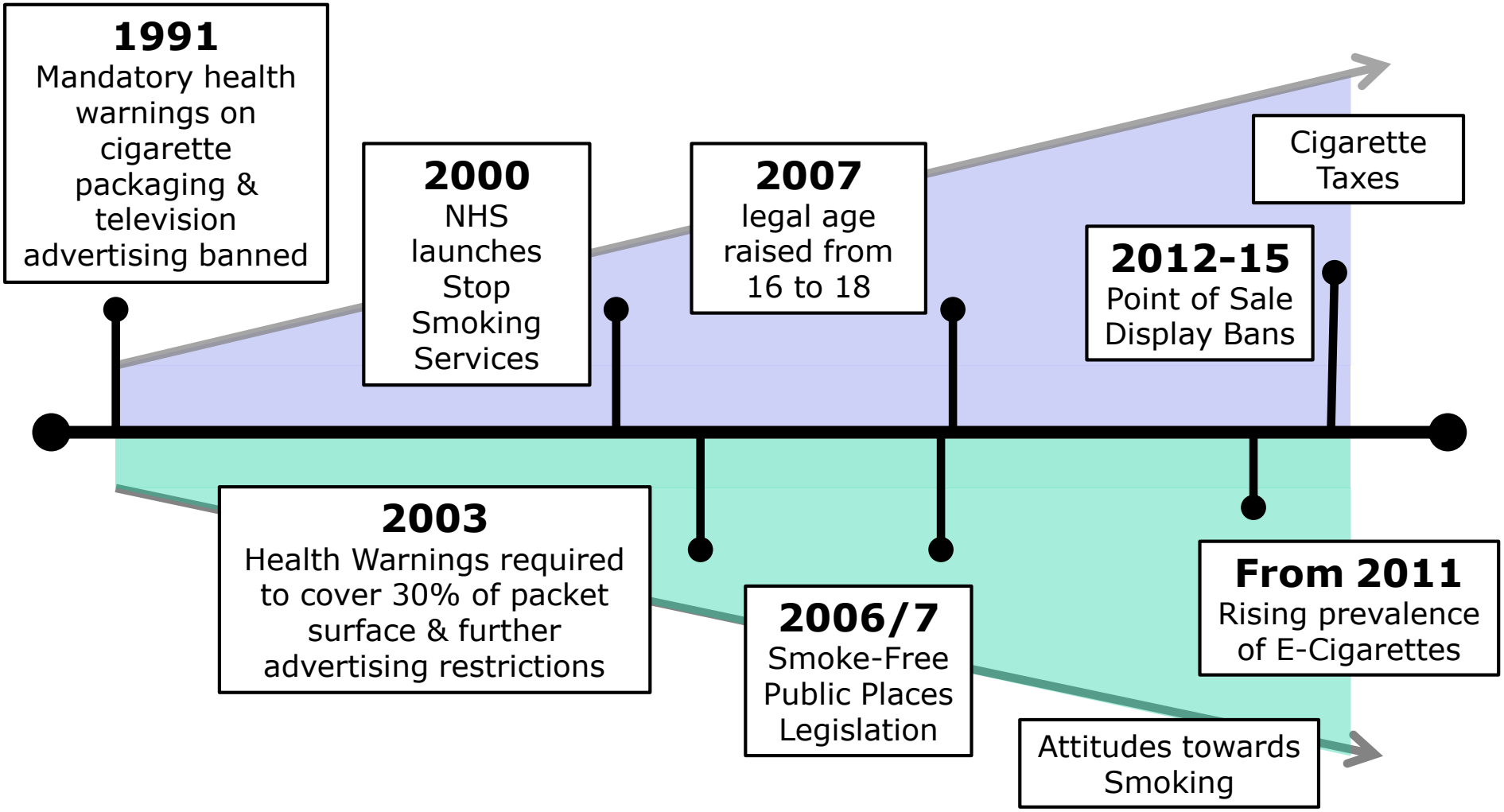
- A 2018 report describes progress:
  - Smoking rates and take-up continuing to fall
  - Smoking by school-age children at an all-time low
- BUT:
  - Smoking continues to be the greatest threat to public health in Scotland by some margin
  - Smoking not only creates health **inequality**, but the financial cost to smokers contributes to social and economic inequalities as well
- **Understanding equity impacts of policies to reduce tobacco use is critical, because smoking is strongly tied to inequalities in health**

Systematic Review on Equity impact of Tobacco Policies

Policy	# of studies	Equity Impact
Price increases	7	Positive
Smoke-free environments	13	Mixed
Mass media campaigns	1	Mixed
Advertising controls	4	Neutral/Negative
Controlling access to tobacco products	5	Mixed
Smoking cessation support	2	Positive/Neutral
Complex school-based/multi-policy interventions	8	Neutral/Negative

Source: Brown, et al. (2014). Equity impact of interventions and policies to reduce smoking in youth: systematic review. *Tobacco Control* 23: e98-e105.

UK: Smoking Policy Context



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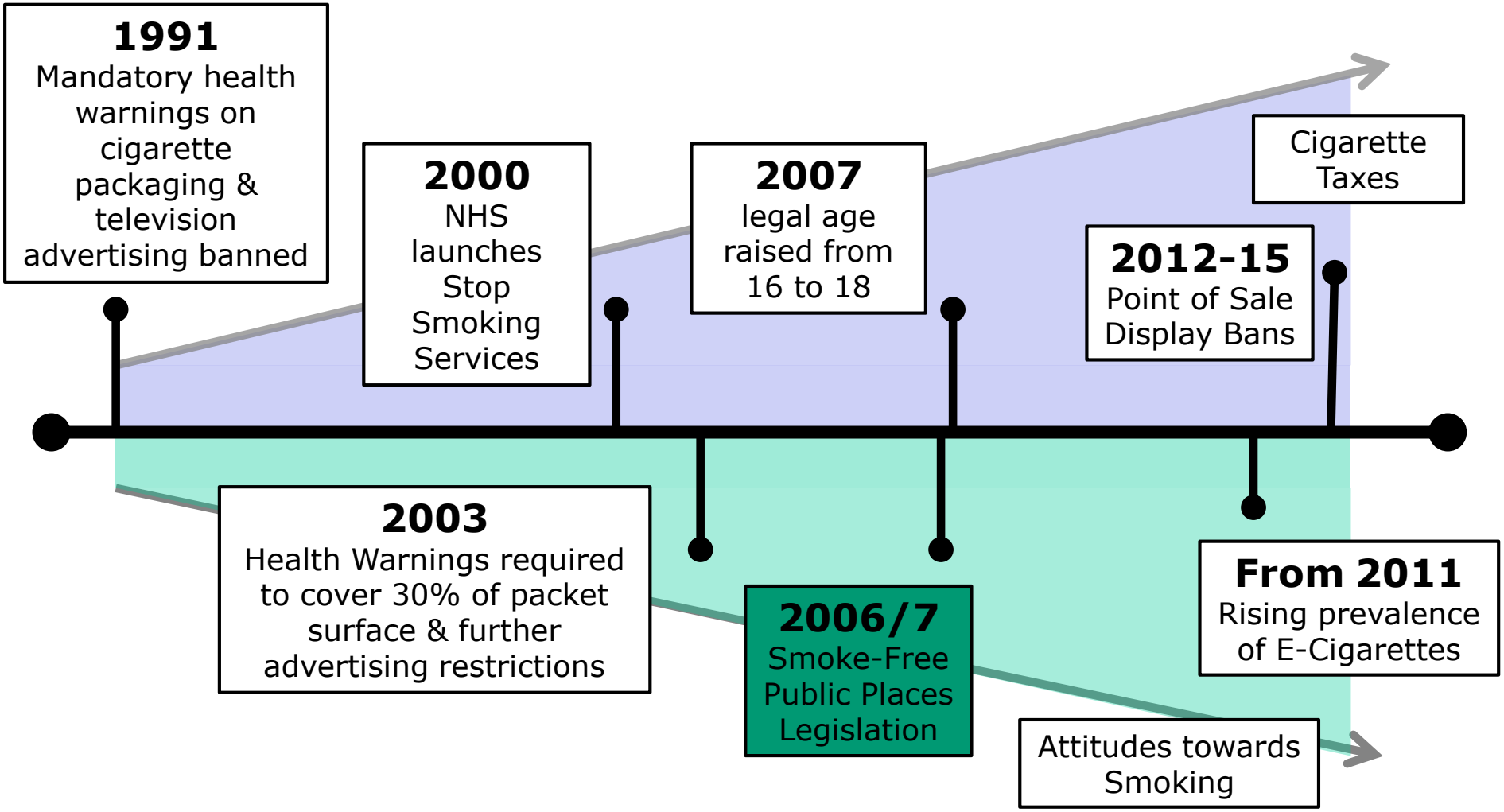

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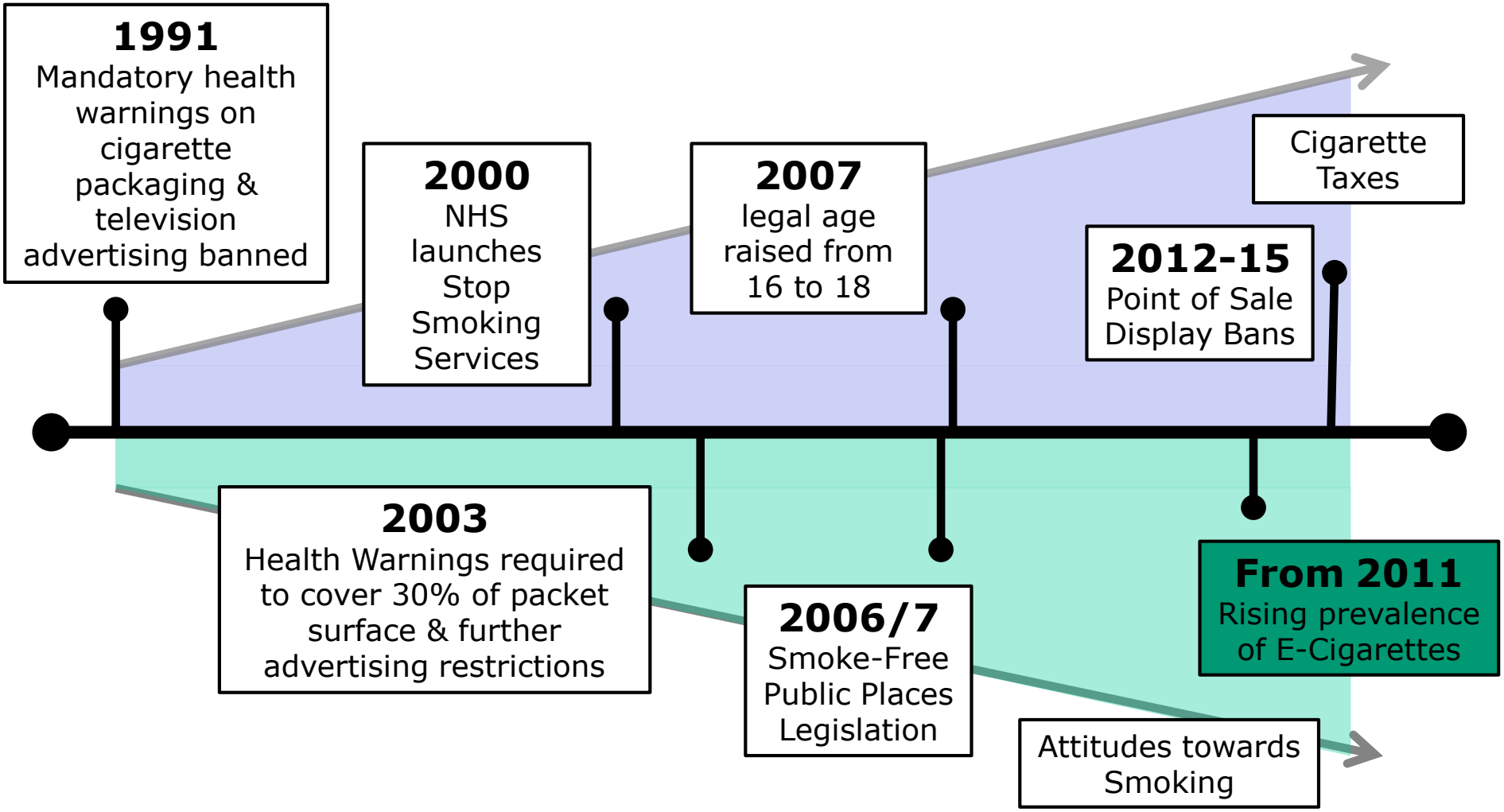


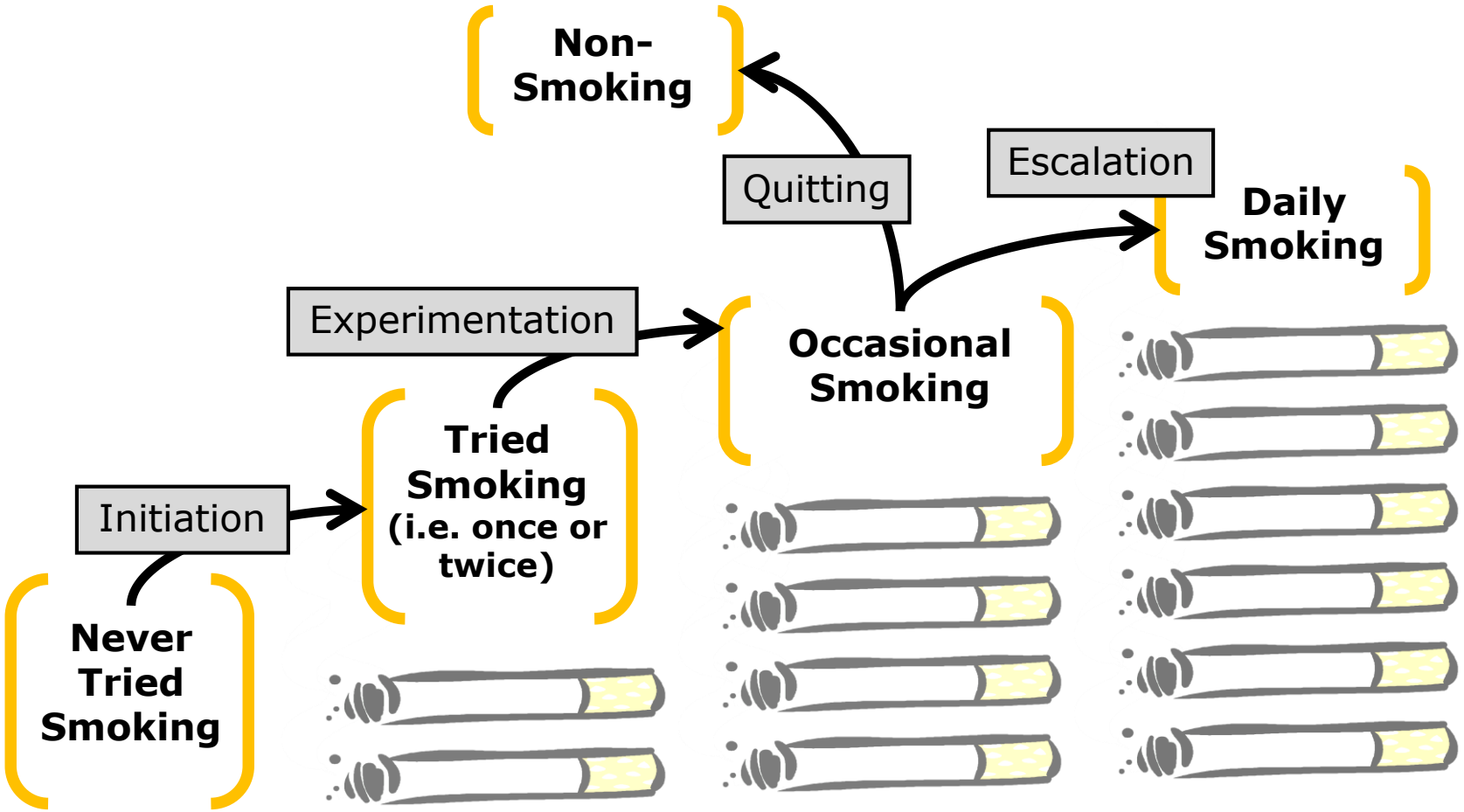
2006/7 Smoke-Free Public Places Legislation

- Comprehensive Smoke-Free legislation introduced in 2006 in Scotland and 2007 in the rest of the UK
- 10+ years on seen as a very successful policy eg leading to reductions in:
  - Second-hand smoke exposure
  - Hospital admissions
- Evidence less clear on how it's impacted on smoking rates & inequalities, especially for young people

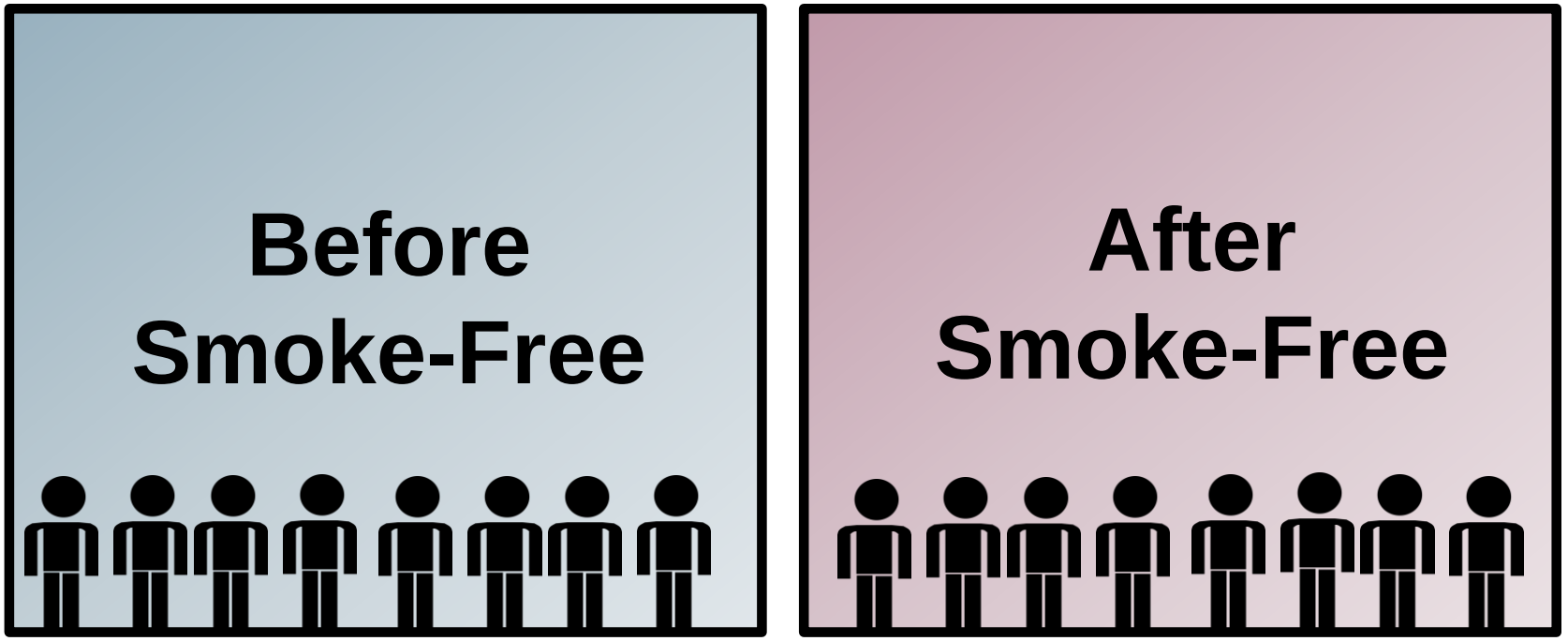
Data

- Longitudinal data from the British Household Panel Survey and Understanding Society study (1994-2016).
- Each youth contributed five years of data (74,960 person-years) representing **ages 11-15** years
- Missing data handled with multiple imputation (20 data sets)
- Inequalities by Parental Education (ref: degree vs other or no qualifications)
- Discrete time event-history analyses with key smoking transitions as outcomes

Smoking Development – Stages of Change



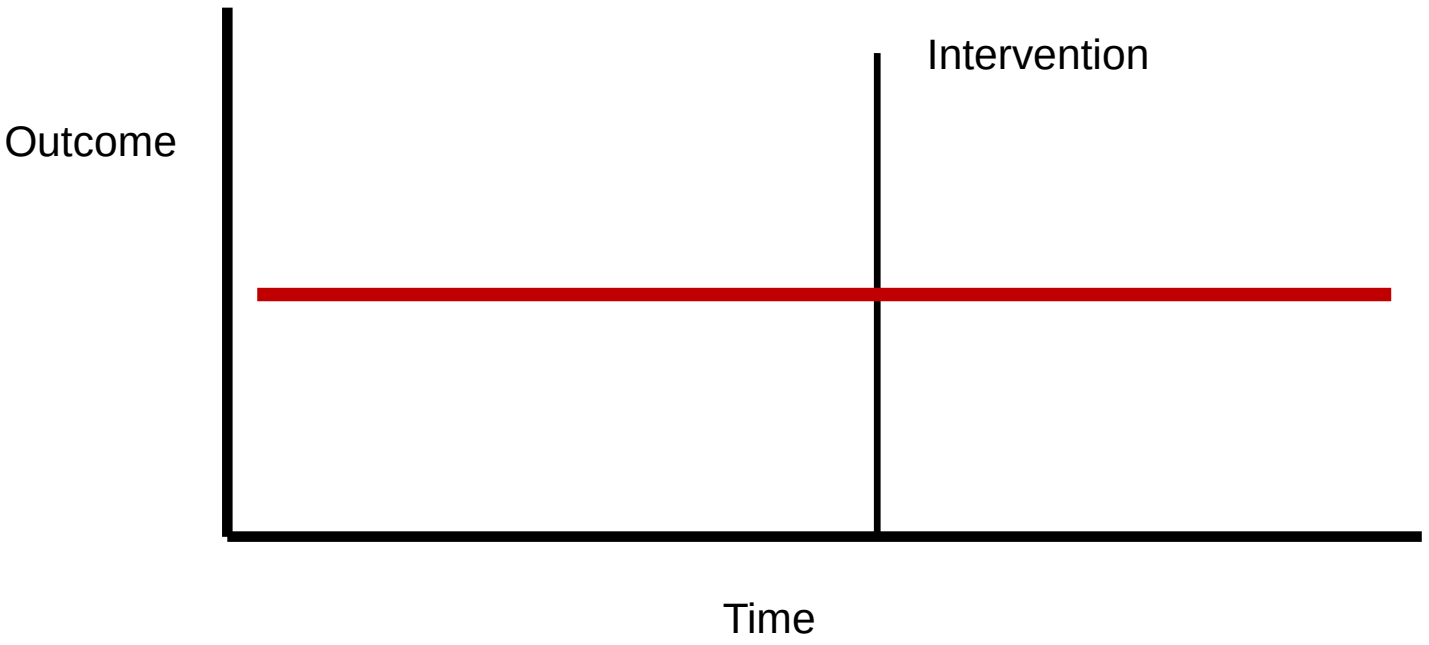
A Natural Experiment



- *If* we can assume the only difference between before and after is the smoke-free legislation being implemented…
- *Then* differences in a before/after comparison must be due to the smoke-free legislation

Design

- An interrupted time series design
- Outcome = Time + Intervention + Post-Intervention Time



Design

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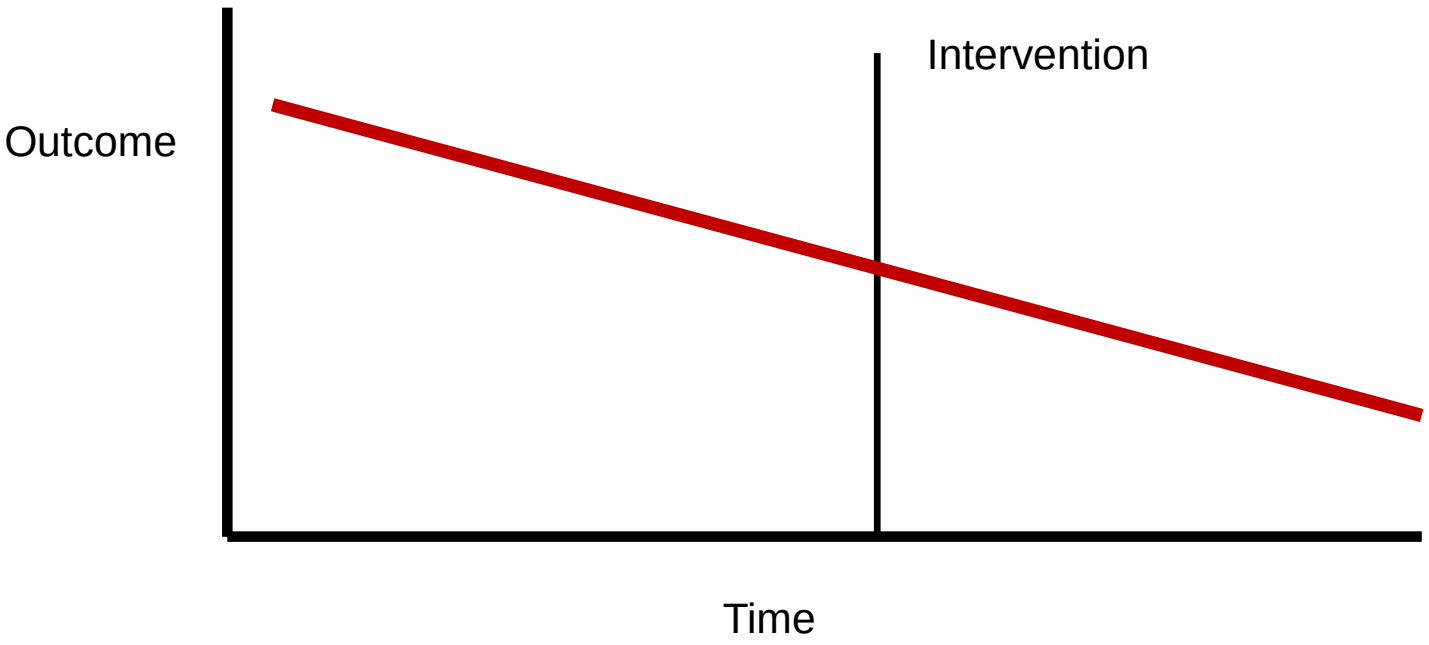

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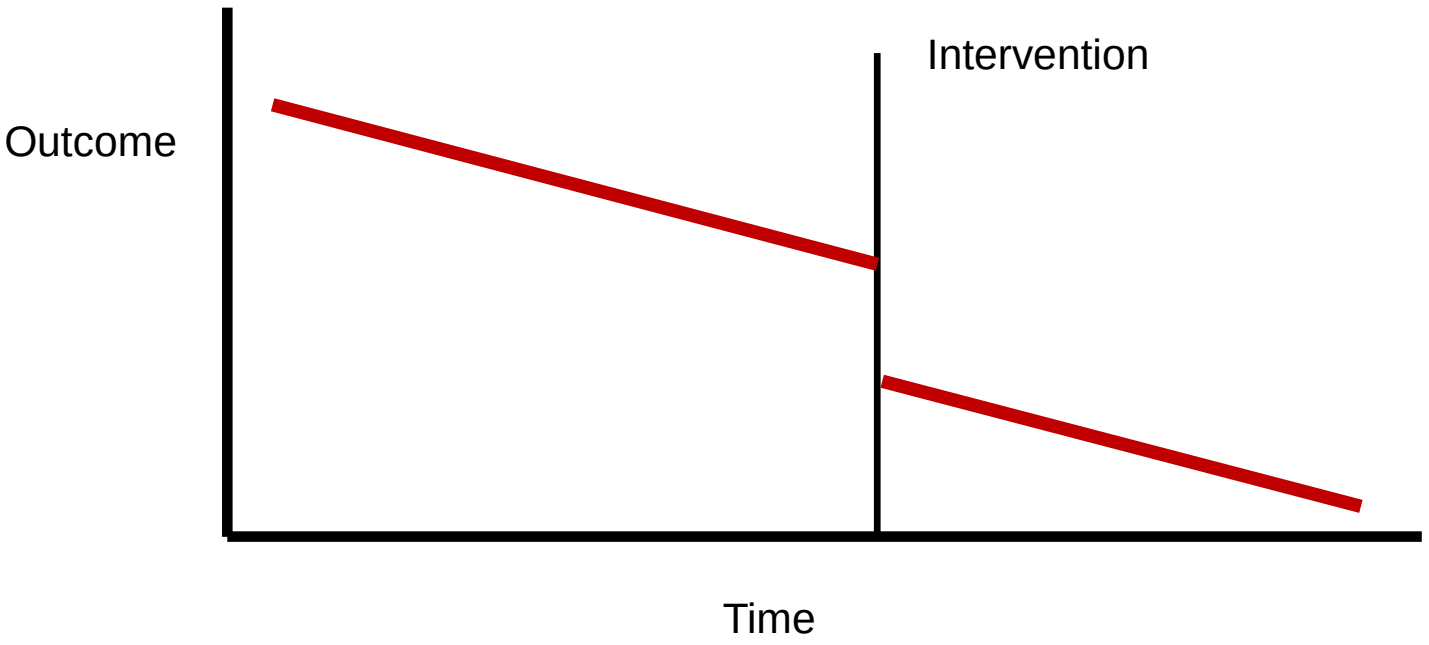

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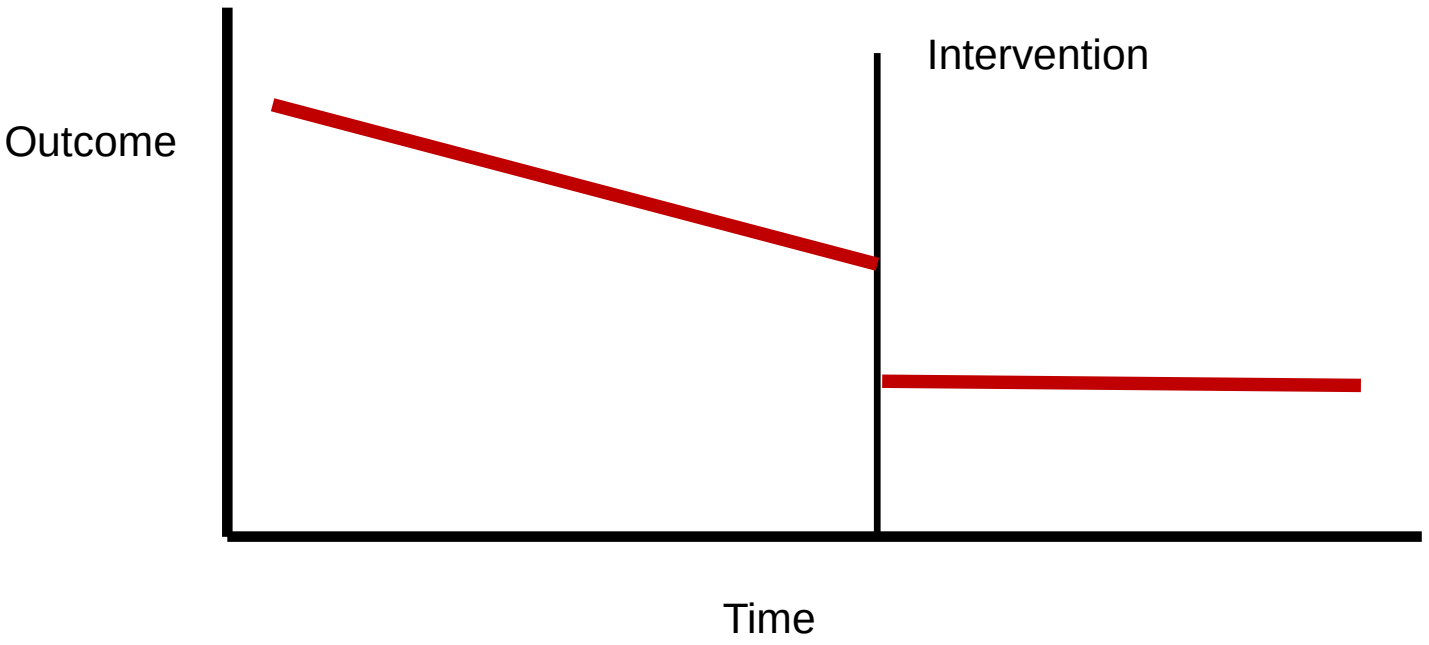

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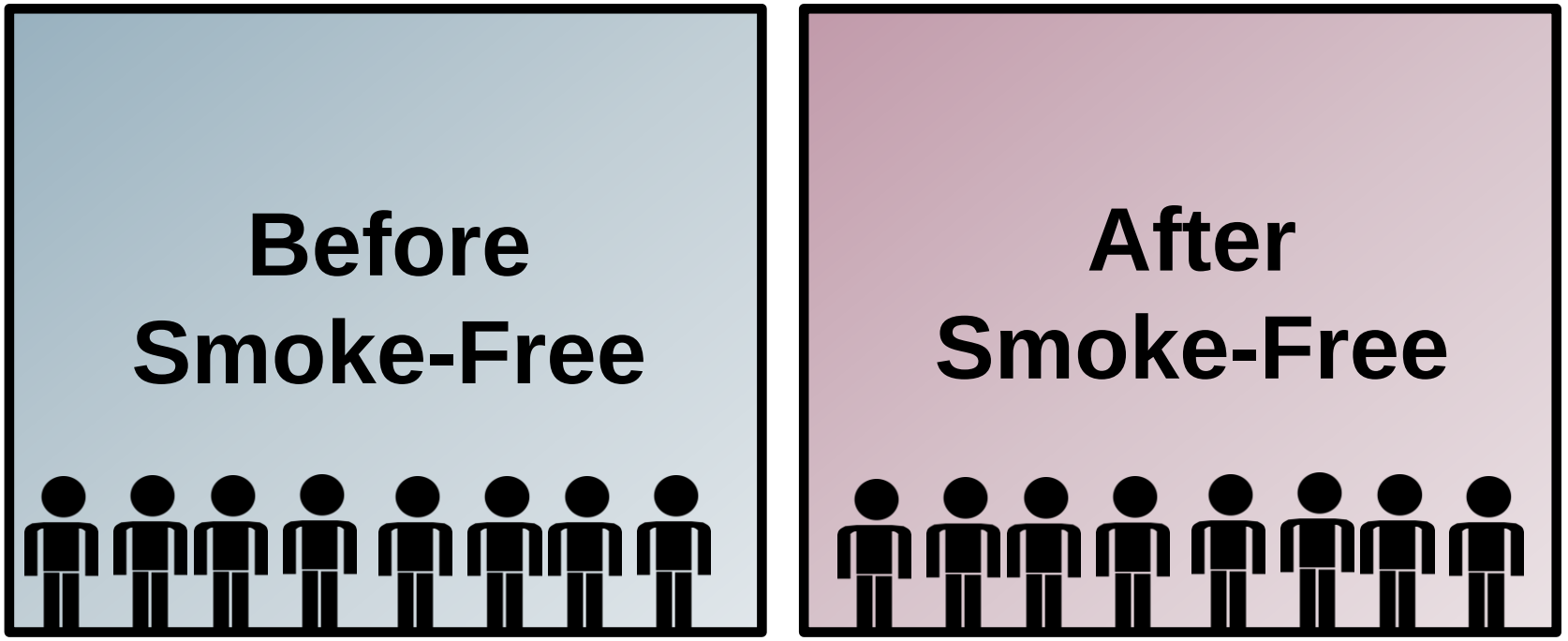

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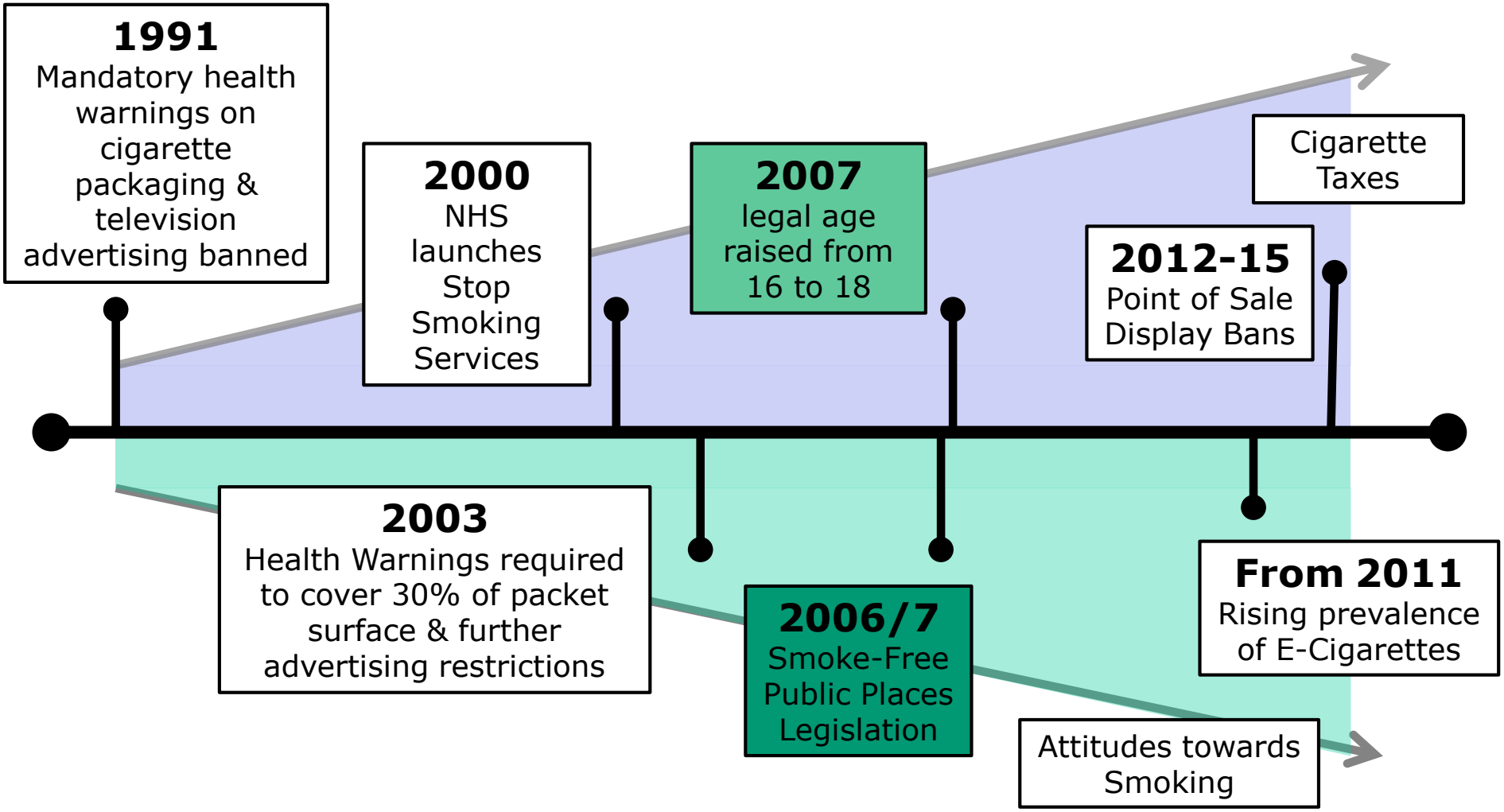
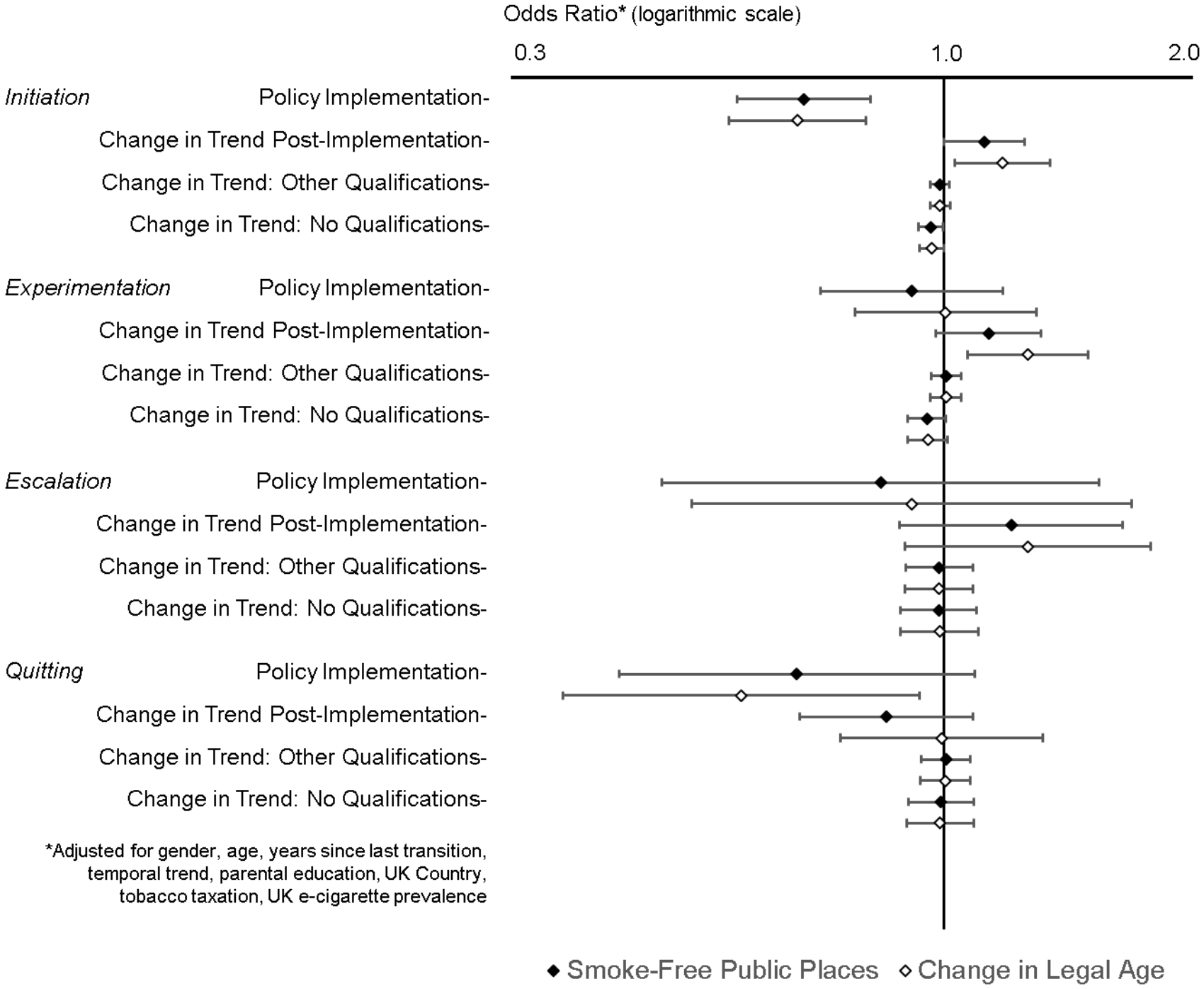


Differences in policy coverage

- Only in Scotland/Northern Ireland and only a 1 year difference out of 22 years (1994-2016)
- Only 698 person-years (<1%) where coverage differed, so high collinearity
- Decided to perform parallel analyses of:
  - Smoke-free legislation
  - Change in legal age


Odds Ratio* (logarithmic scale)
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1.0
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Initiation
Policy Implementation-
Change in Trend Post-Implementation-
Change in Trend: Other Qualifications-
Change in Trend: No Qualifications-
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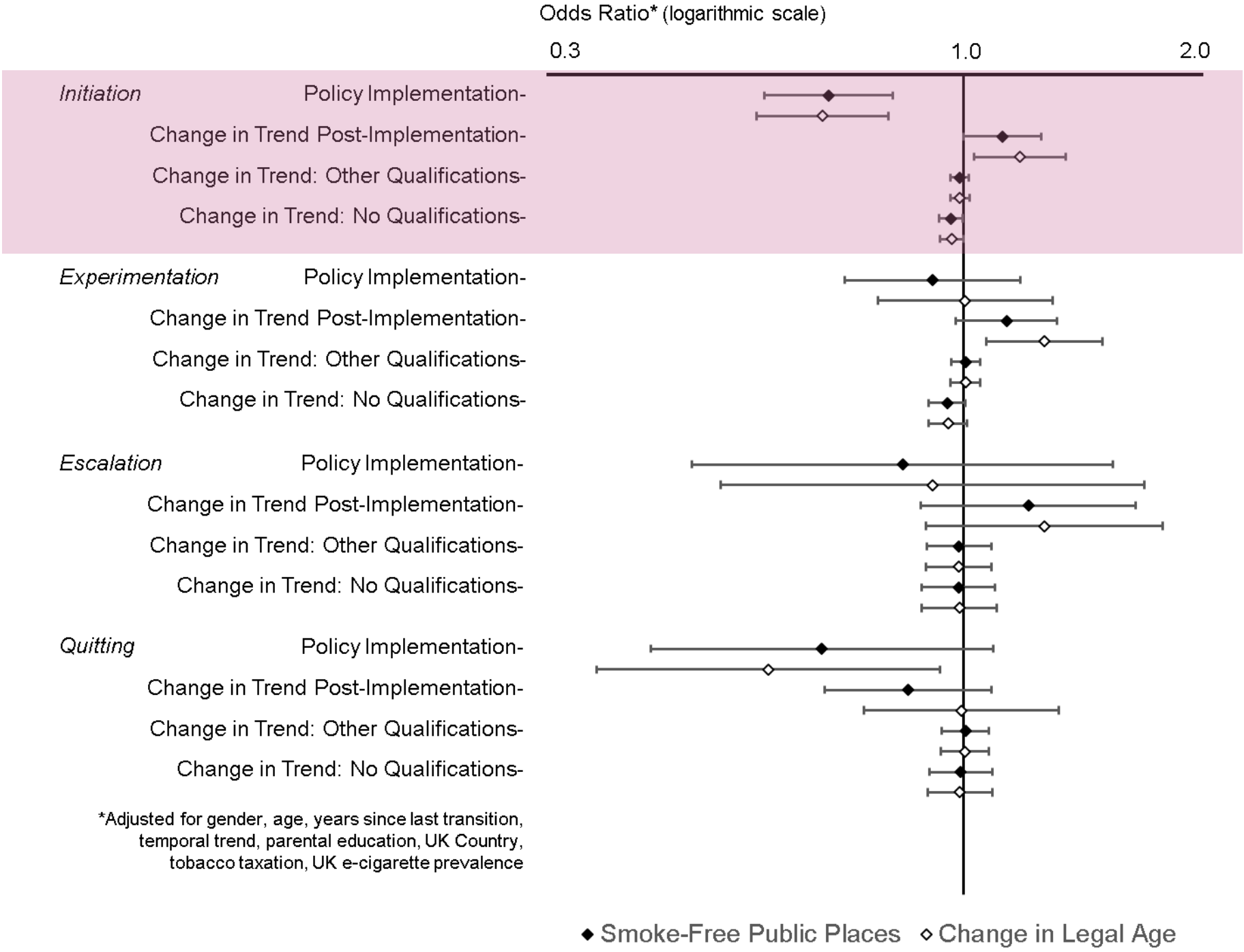
Smoke-Free Public Places
Change in Legal Age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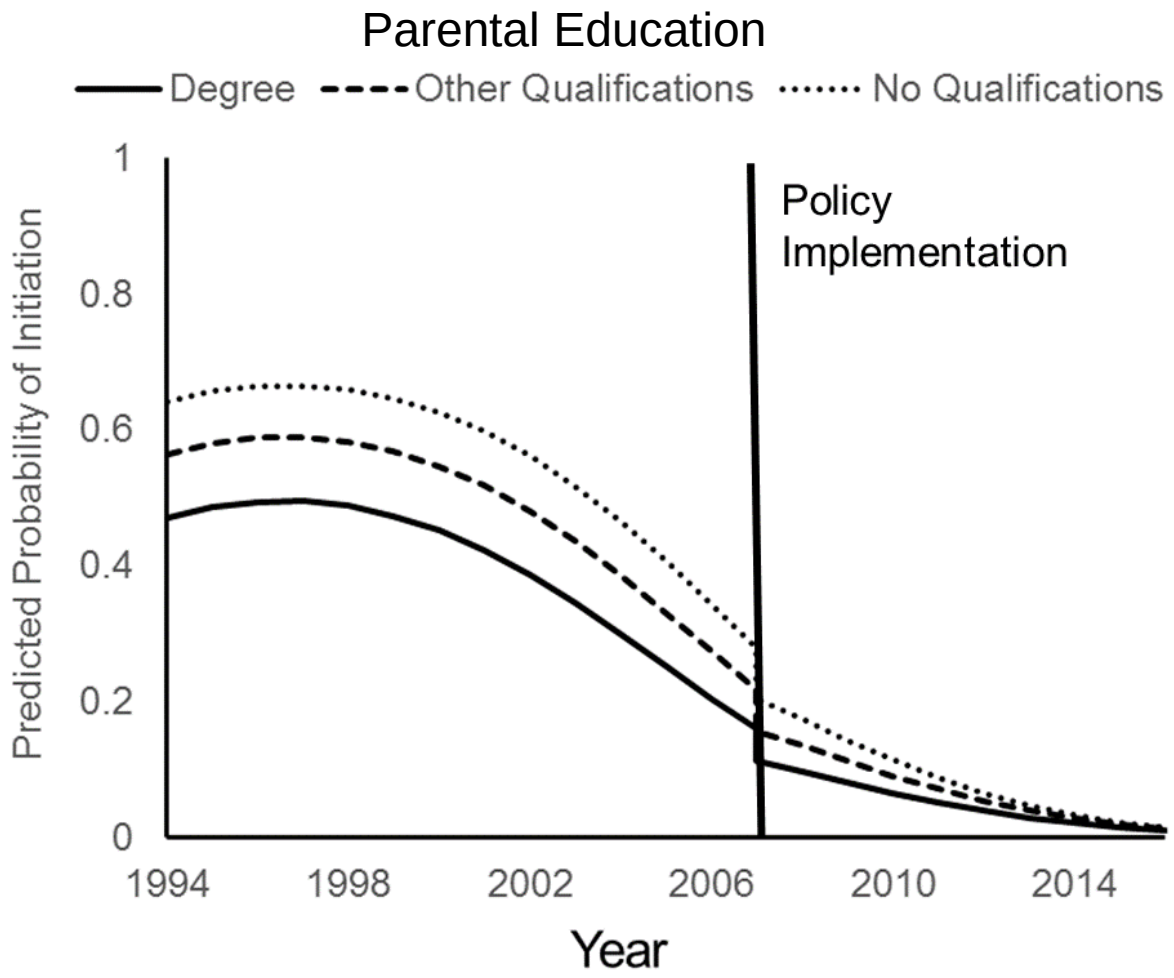
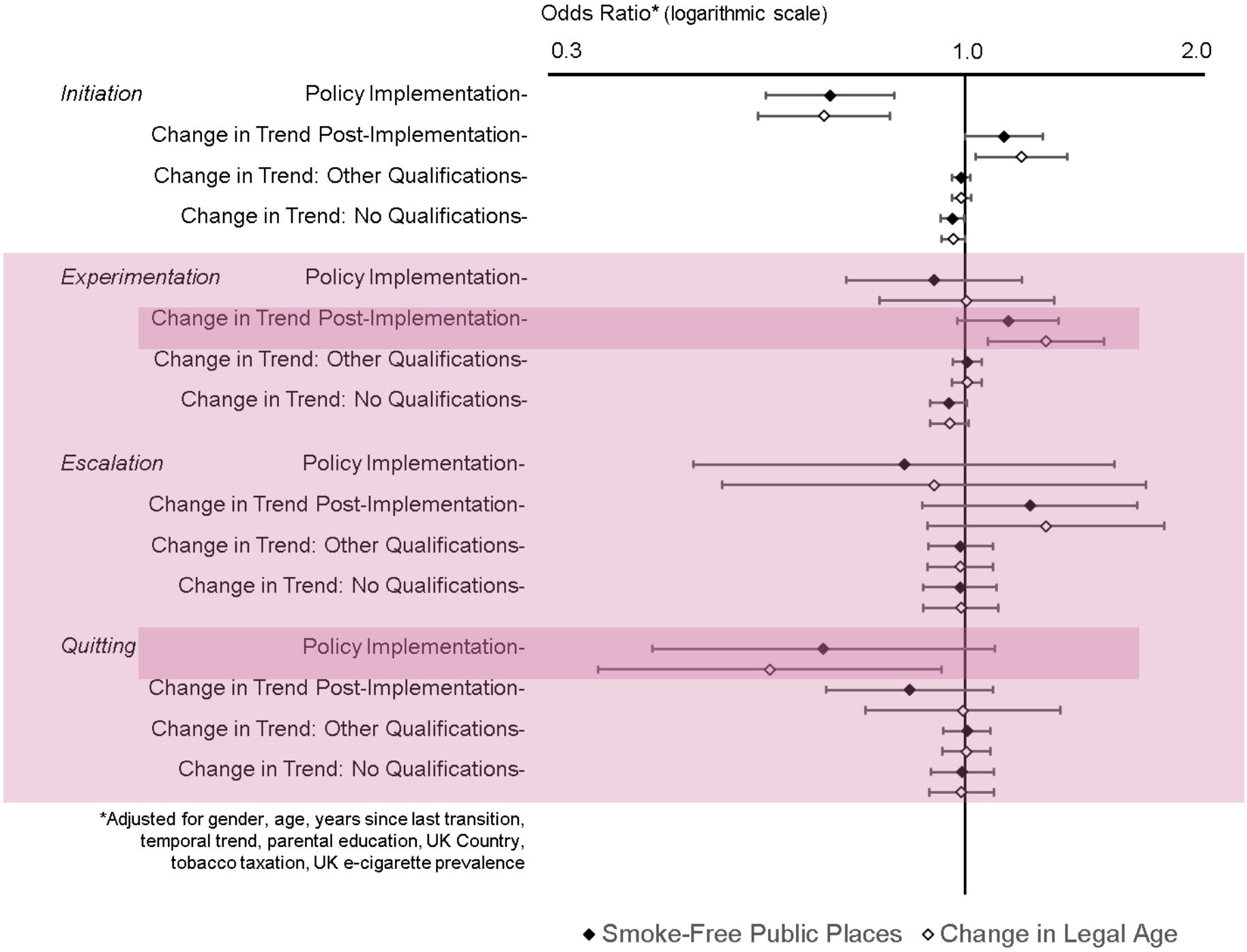
◆ Smoke-Free Public Places ◇ Change in Legal Age

Inequalities in Initiation

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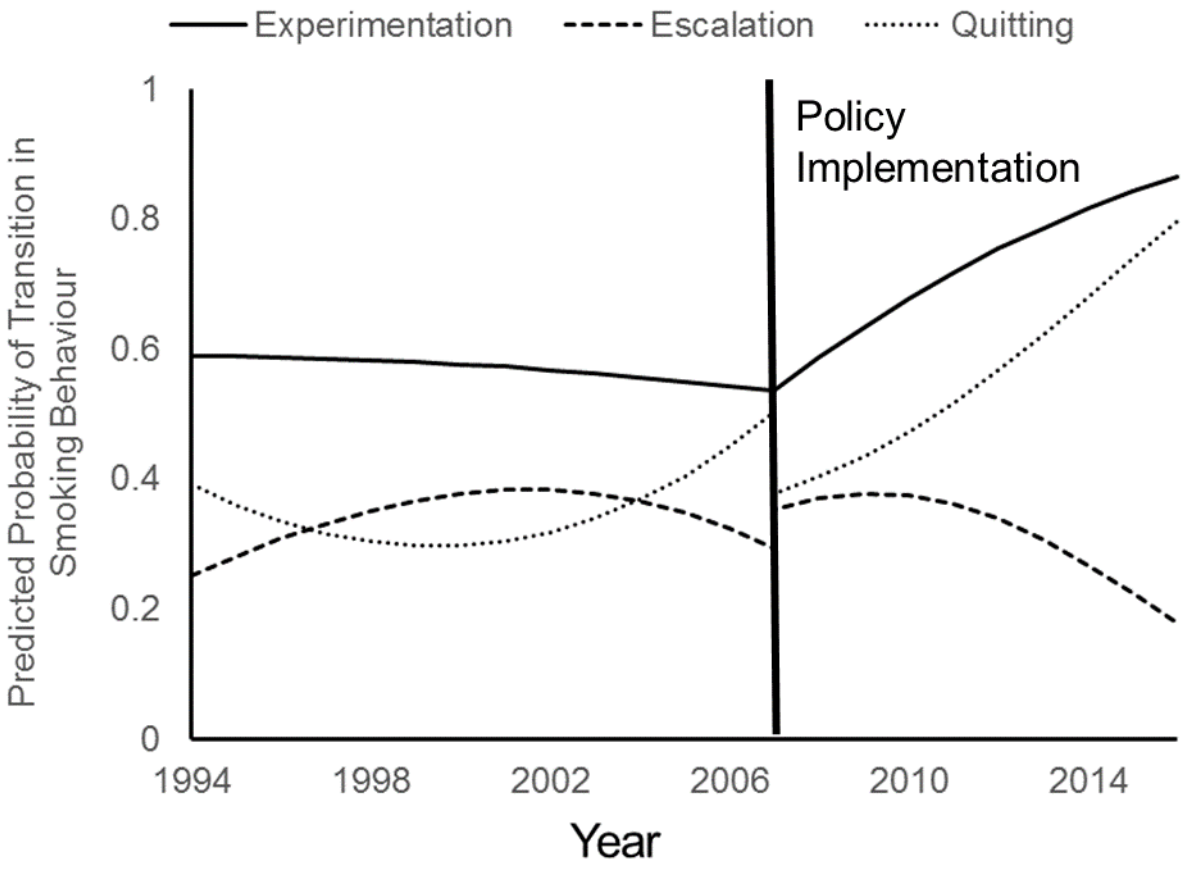
Impacts on other smoking transitions

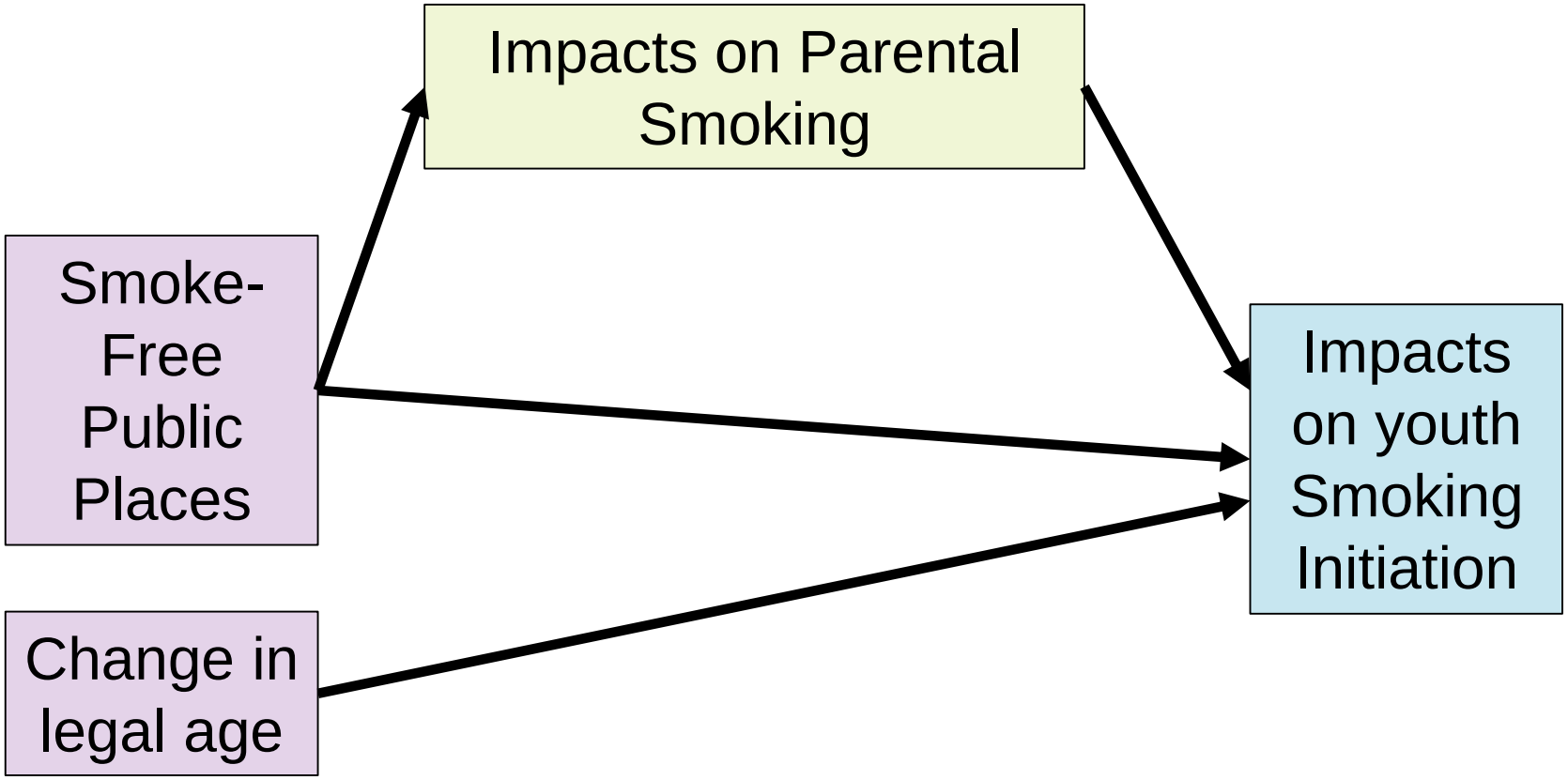


Impact of 2006/7 Legislation – Key Findings

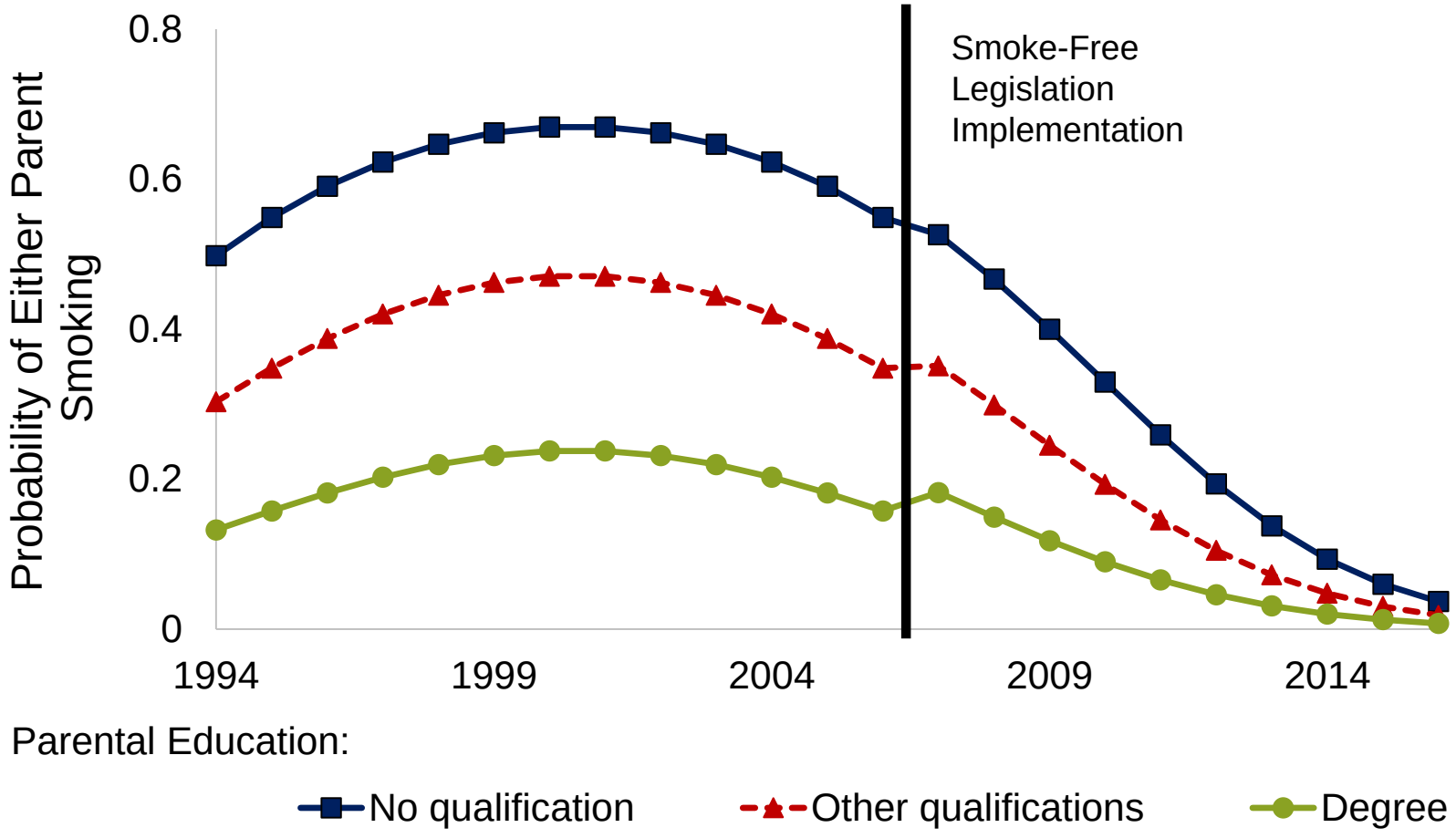
- Immediate drop in Initiation followed by narrowing of inequalities in initiation, but:
  - Equity impact only apparent by following up for some years after implementation
  - It is important to allow sufficient time for impacts to emerge
- Some evidence for increases in experimentation and reductions in quitting
  - Perhaps suggests selection in terms of who still initiates smoking?
- Very difficult to attribute effects to one policy vs. the other when implemented so closely together
  - Effects might best be interpreted as the combined effect of both policies

Why did this happen?

- We tried investigating parental smoking as a mechanism…



Impact of Smoke-Free Legislation on Parental Smoking



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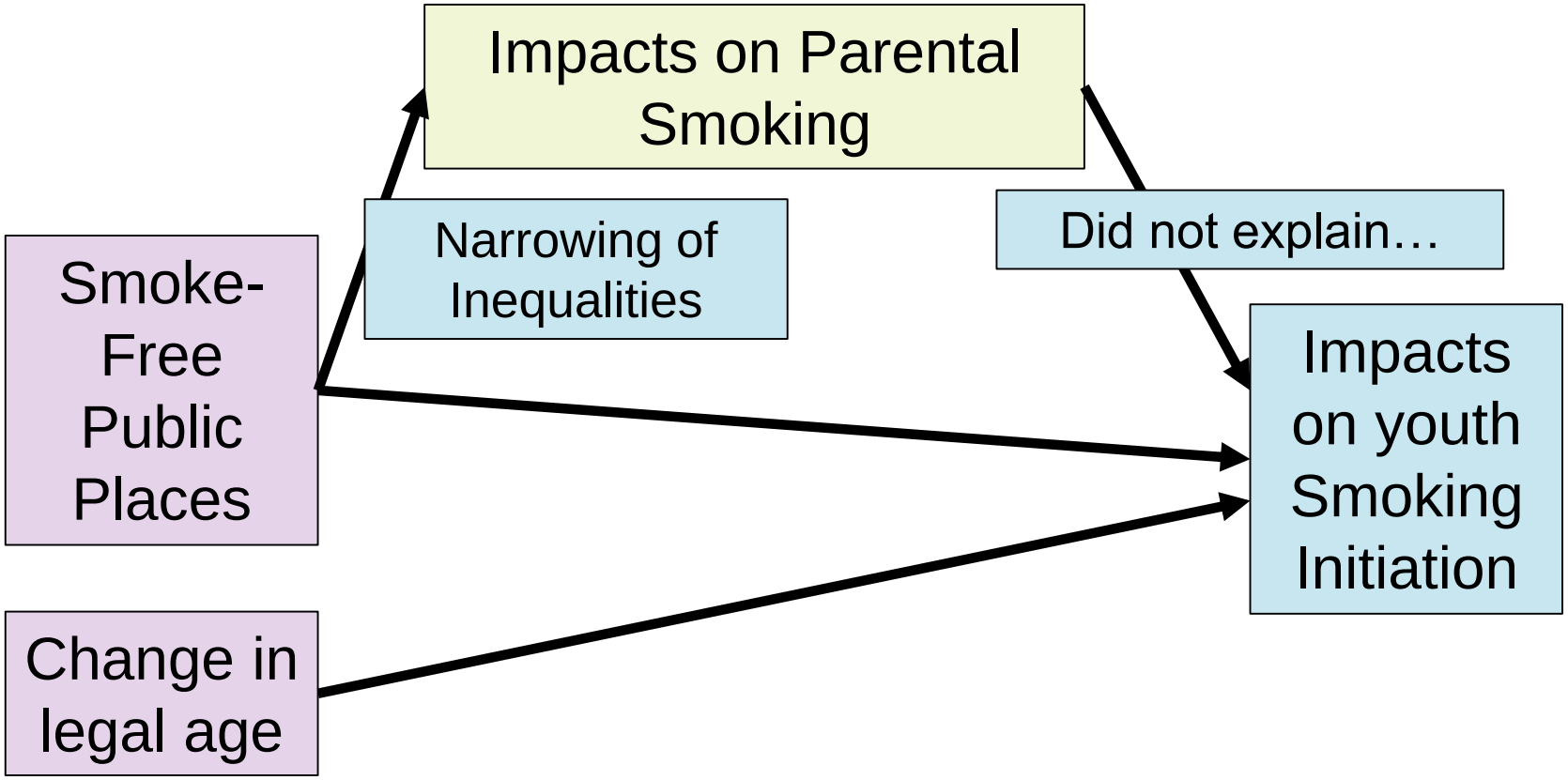

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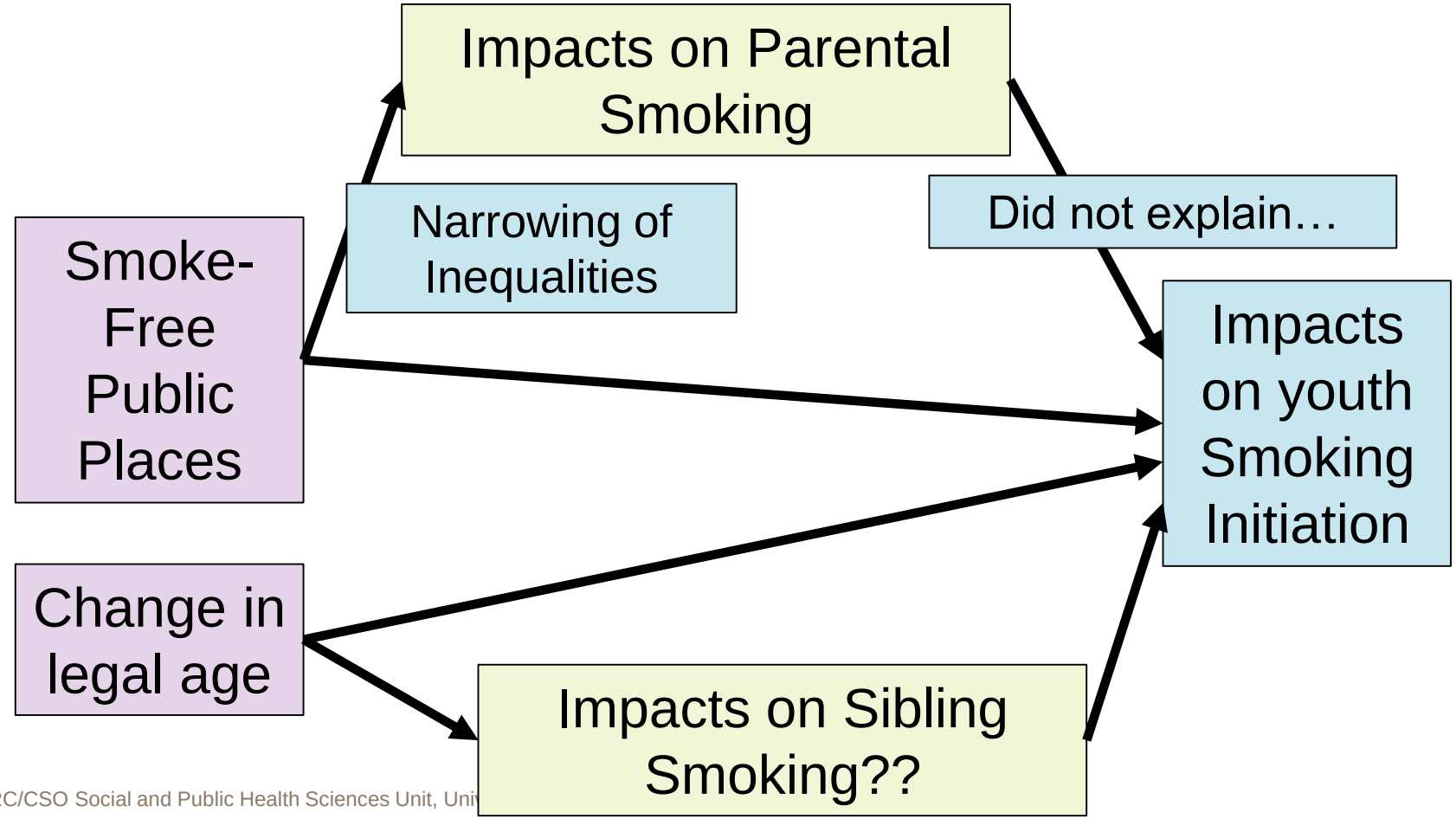

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- Very difficult to attribute effects to one policy vs. the other when implemented so closely together
  - Effects might best be interpreted as the combined effect of both policies
  - **Parental smoking does not seem to be a key mechanism**

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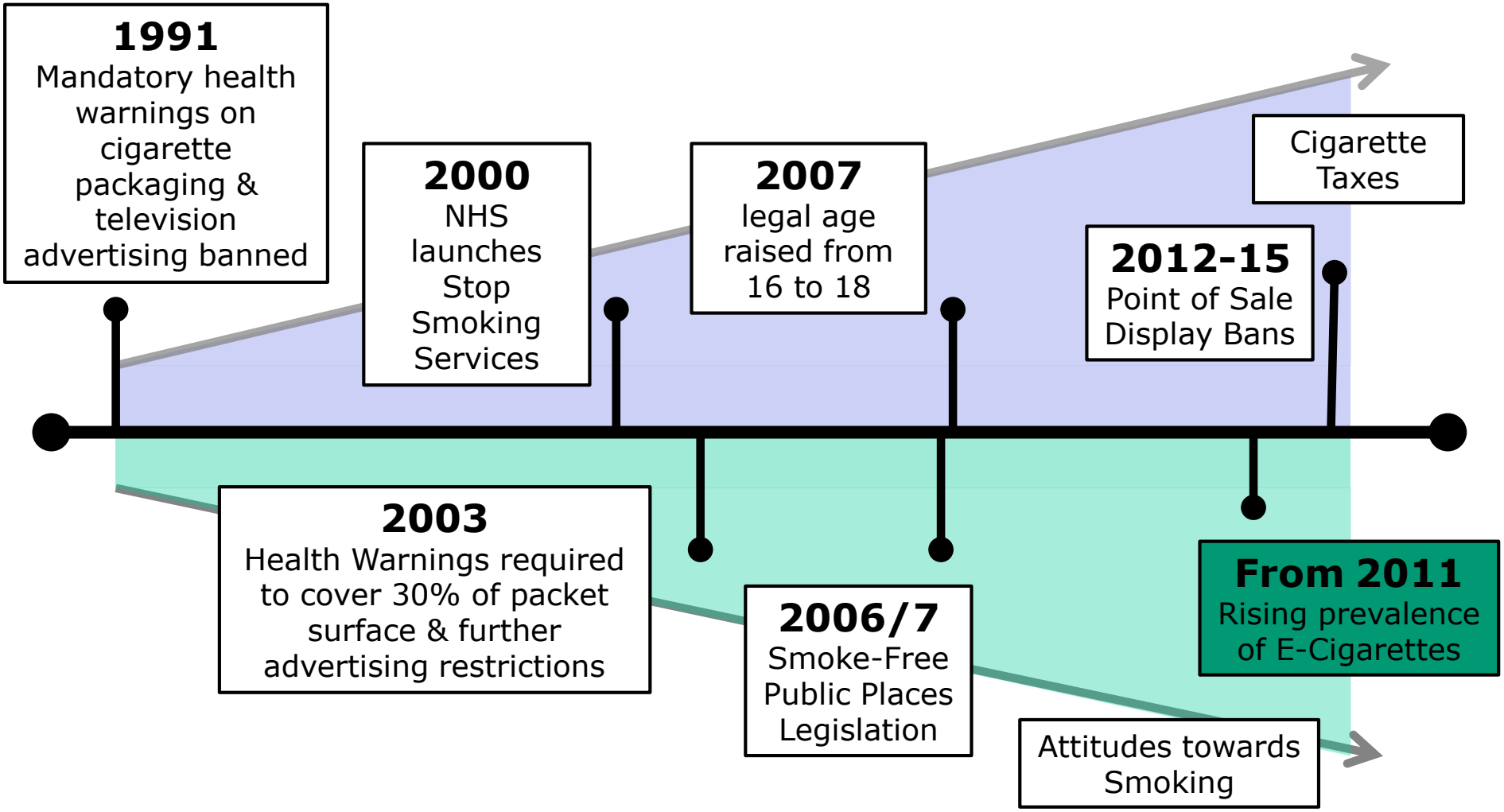
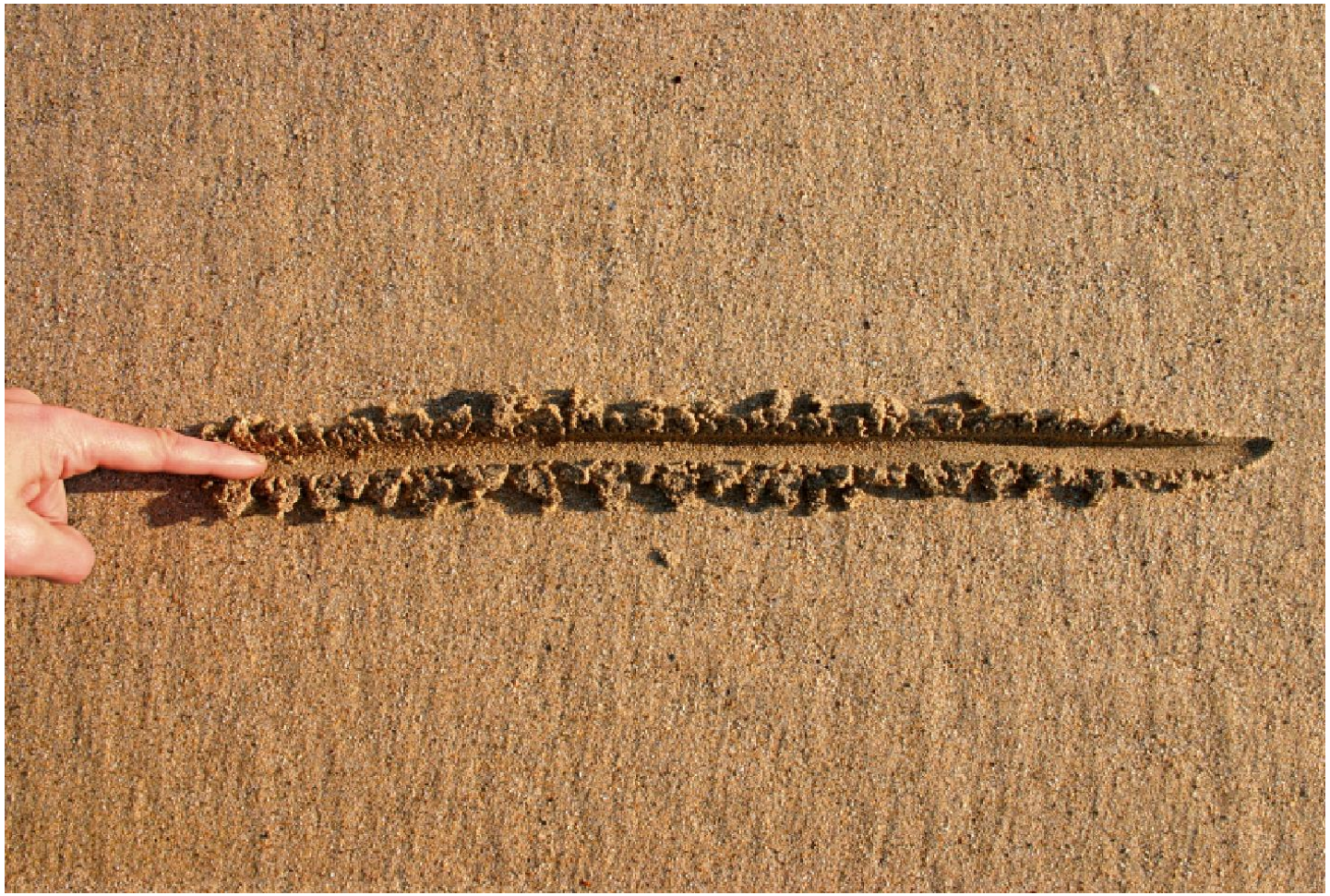


E-Cigarettes

- **E-Cigarettes:** electronic devices that deliver a dose of Nicotine without Tobacco Smoke
- Relatively new thing, with use in the UK rising since 2011
- Probably substantially less harmful than smoking

E-Cigarettes are controversial



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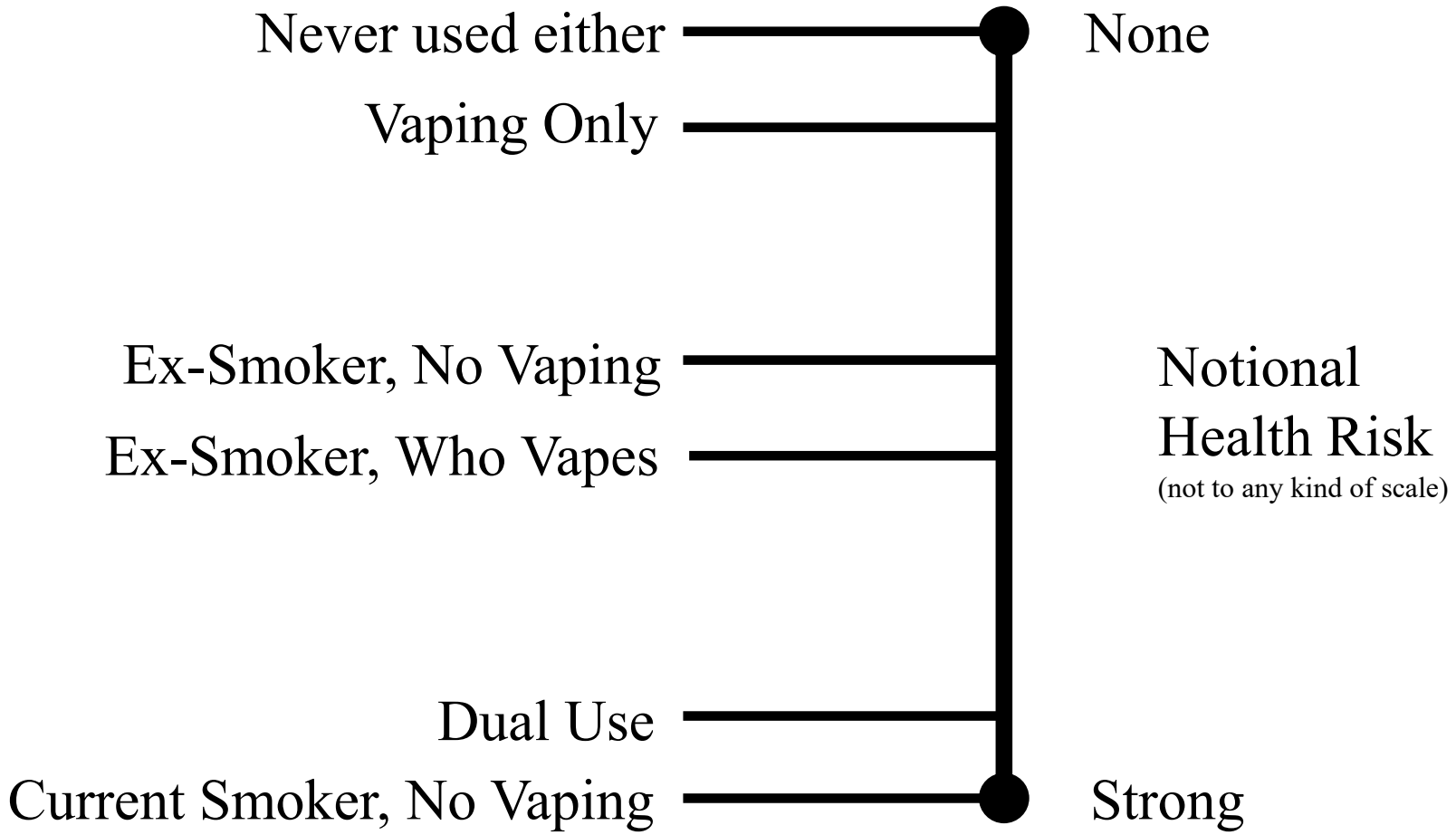
Less Harmful ≠ Harmless



What does it mean for health if youth vape?

	Does not vape	Does vape
Never smoked		 
Has ever smoked		 

- Interpretation depends on:
  - **Who is using them**
  - **Who you're comparing them to**

Comparing  with 

	Does not vape	Does vape
Never smoked		 
Has ever smoked		 

- **Vaping among ever smokers??**
- May be being used as a cessation aid/to reduce health risk?
- Lower cost/less regulated so more accessible?

Comparing  with 

	Does not vape	Does vape
Never smoked		 
Has ever smoked		 

- **Vaping among never smokers is concerning**
- Not harmless
- For youth there is evidence for damaging impacts of nicotine use
- Gateway?

Comparing with

	Does not vape	Does vape
Never smoked		 
Has ever smoked		 

- **Vaping vs smoking**
- What if youth vape instead of smoking?
- Probably substantially less harmful

Understanding Society (wave 7)

- Large annual survey of UK households
- Wave 7 (2015-2017) included this question on e-cigarette use:
  - *Do you ever use electronic cigarettes (e-cigarettes)?*
- Weighted to be representative of the UK general population:
  - **3,291** youth aged 10-15*

*All these respondents were included with multiple imputation of missing values.

Descriptive data: Vaping & Smoking

	Does Not Vape	Does Vape	Total
Never Smoker	3002 (98.6%)	42 (1.4%)	3044
Ever Smoker	177 (71.6%)	70 (28.4%)	247
Total	3179 (96.6%)	112 (3.4%)	3291

Descriptive data: Vaping & Smoking

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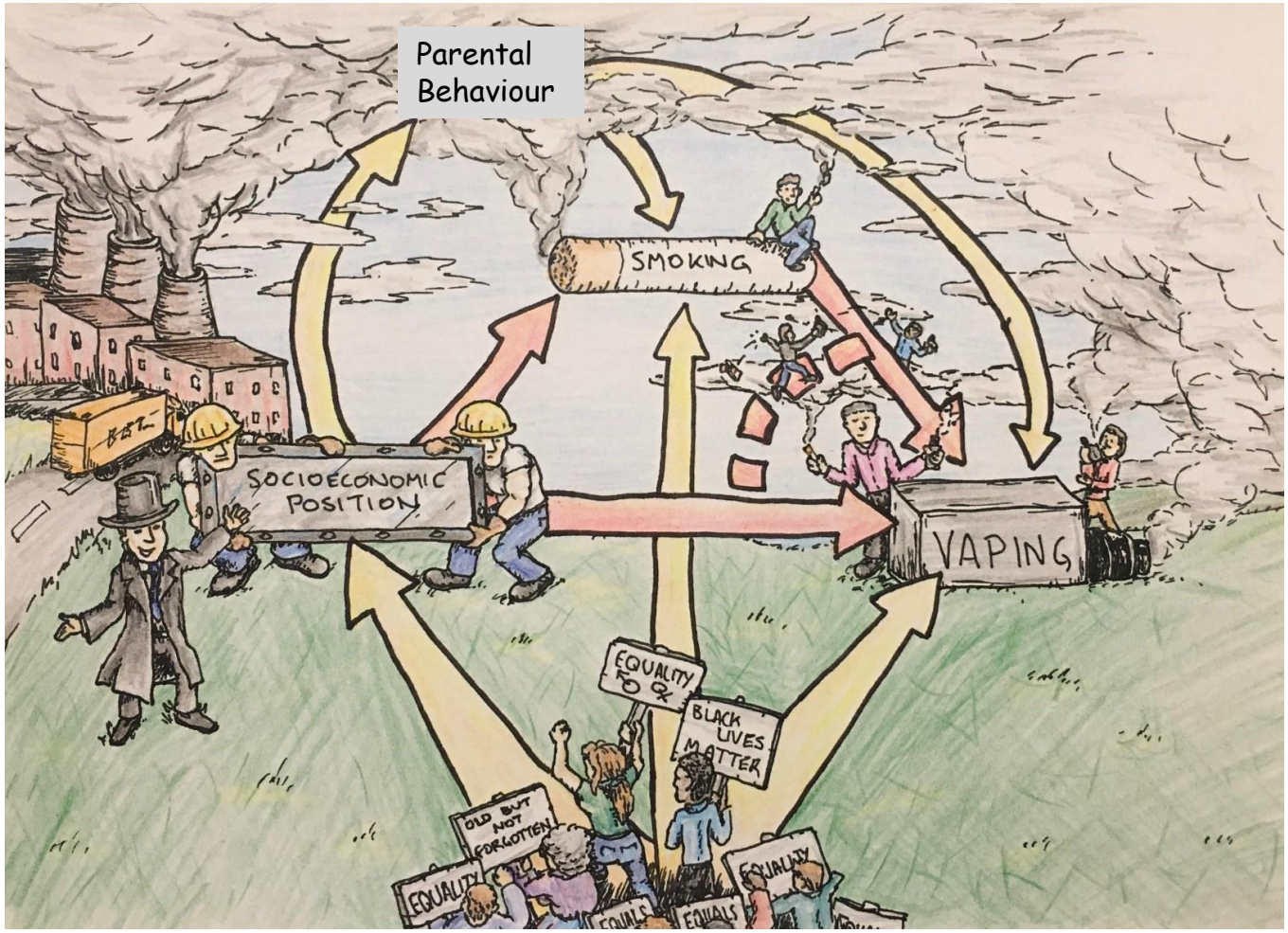
What do we want to estimate?



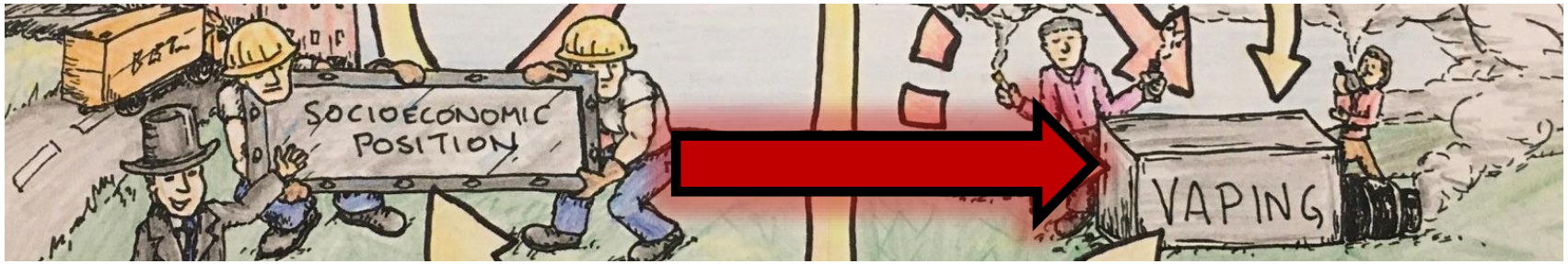
DAG=

Directed Acyclic Graph.

Causal Diagram.

Useful medium for encoding assumptions and identifying potential sources of bias.

What do we want to estimate?



Focal effect of interest is:

SEP → Vaping

SEP: Index of parental education, occupation & income

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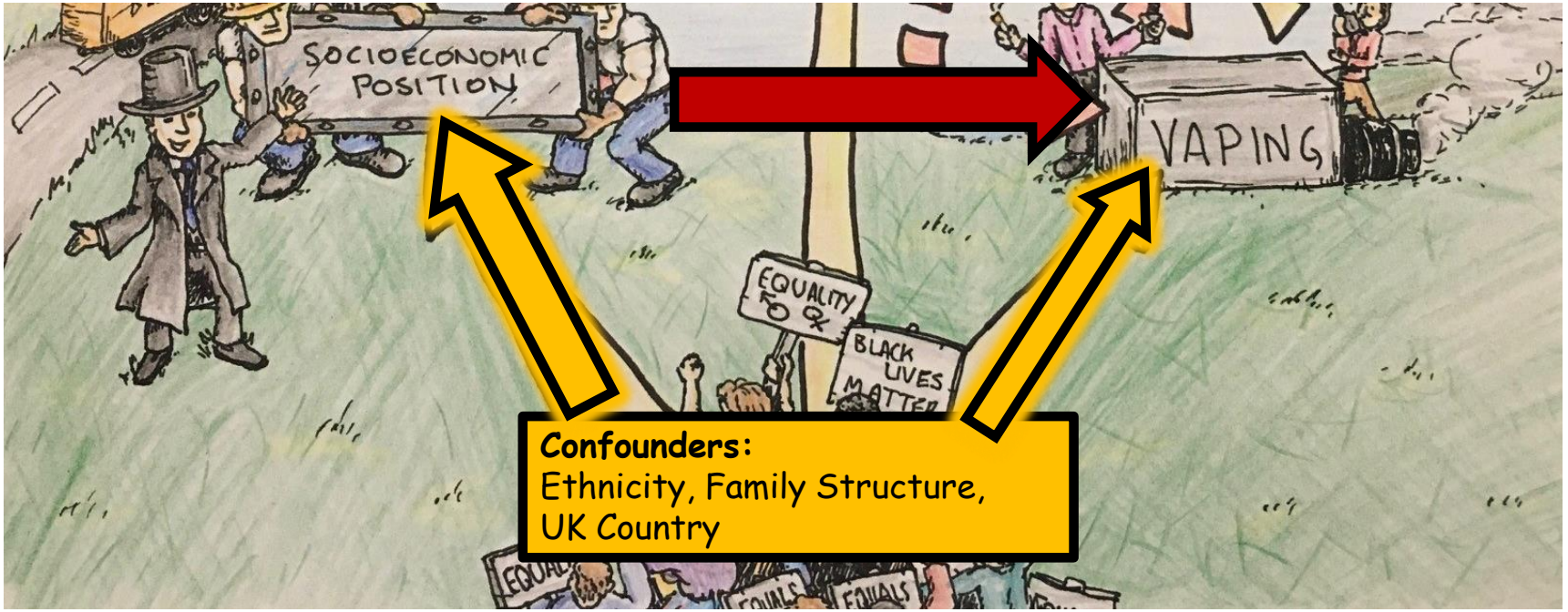
What do we want to estimate?



Need to adjust for confounders, i.e. factors that may determine both SEP and Vaping

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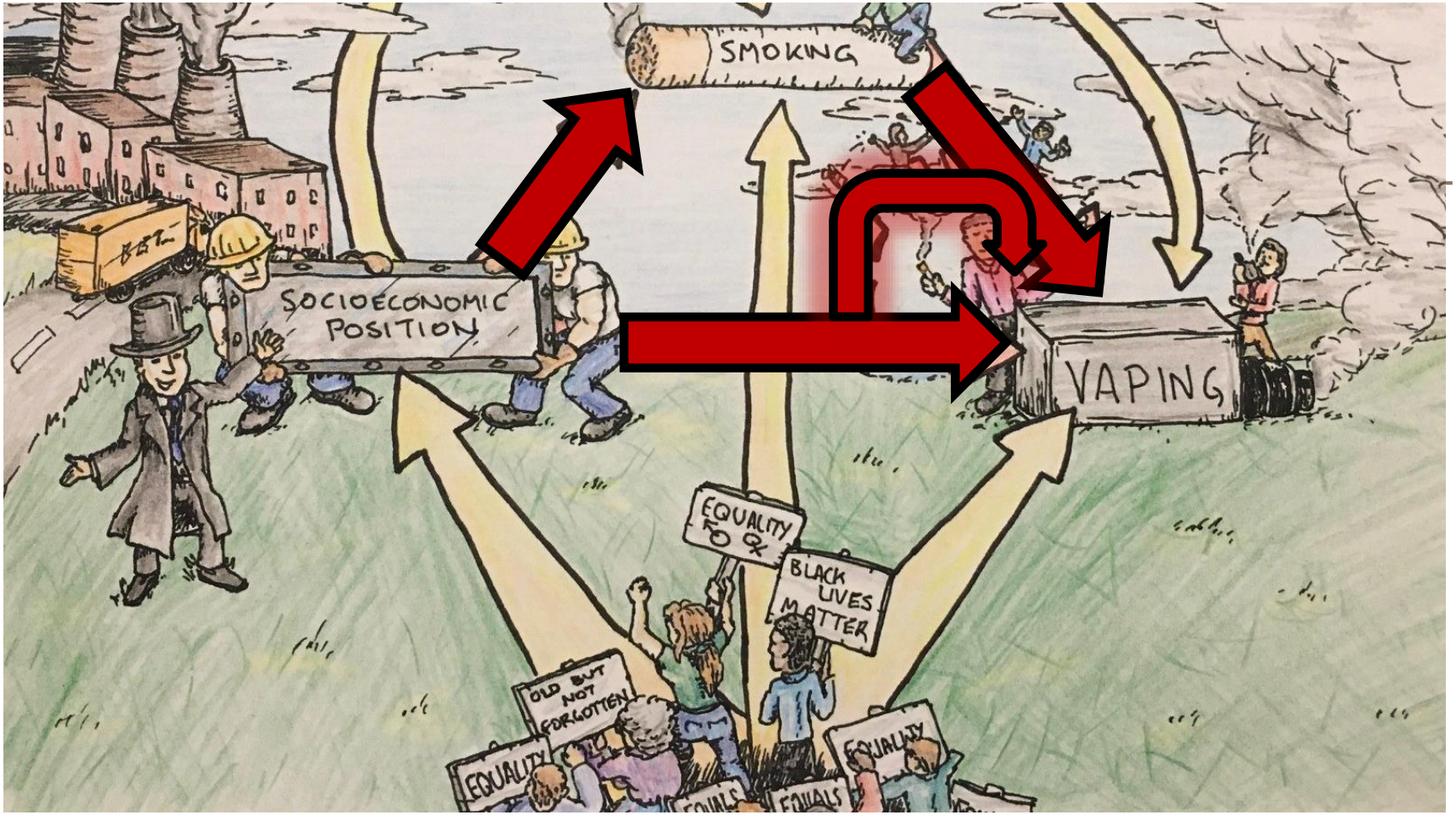

BUT we want to stratify by smoking (ever vs never)

-smoking is a potential mediator

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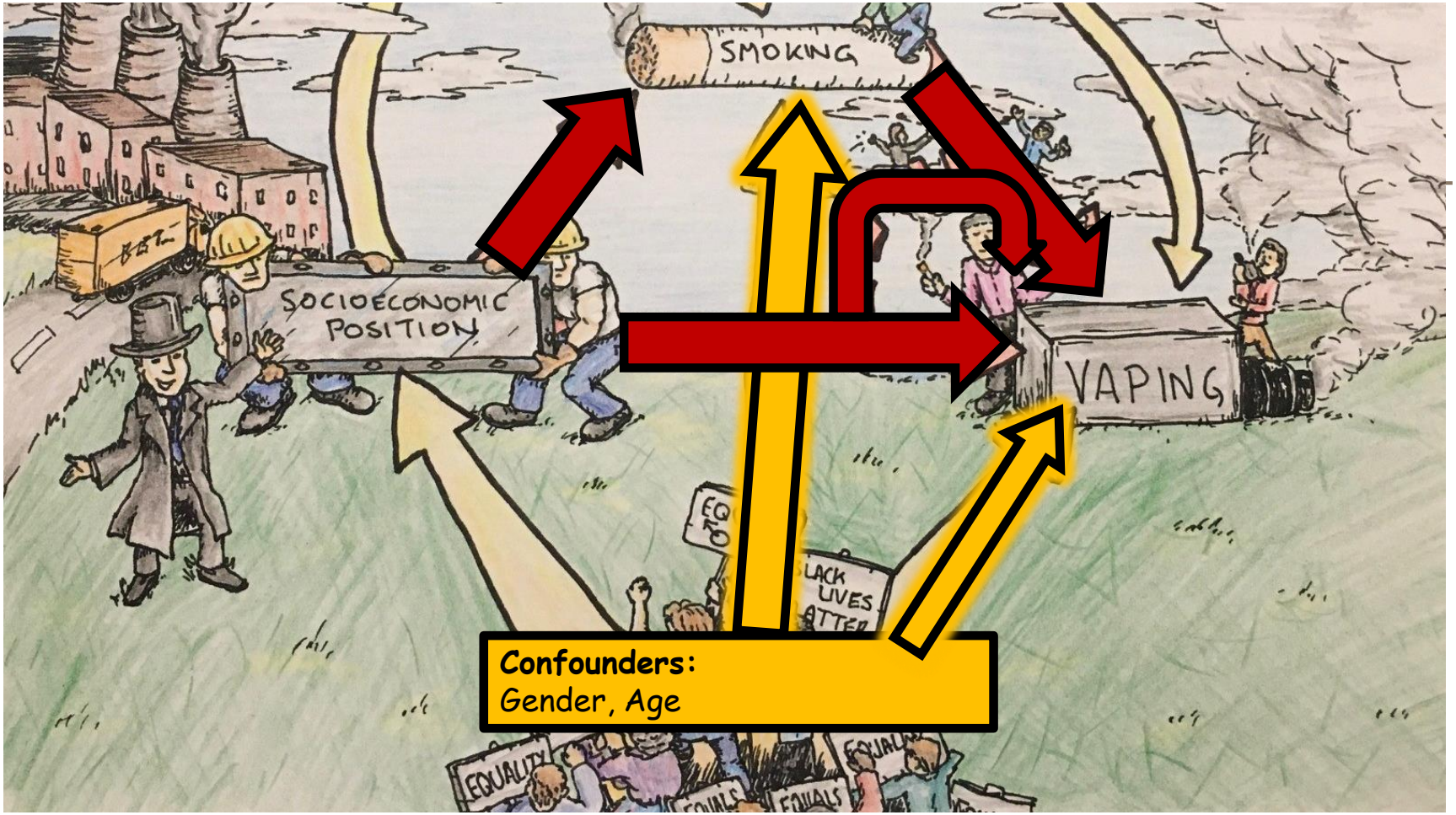
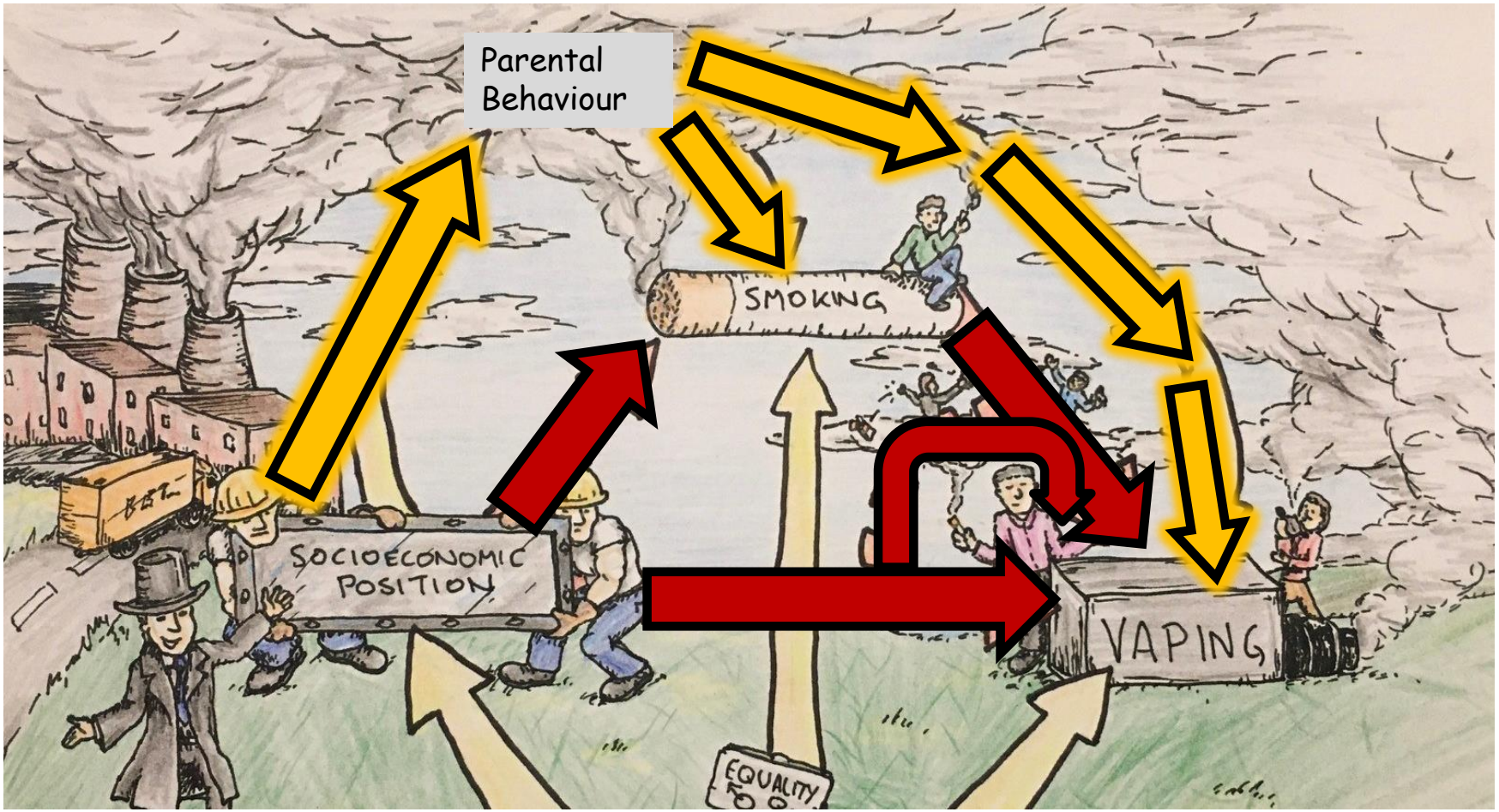


This means we also need to consider potential confounders of the smoking/vaping relationship



BUT some confounders of smoking/vaping, may be caused by SEP

- Pathway from **SEP-> Parental Behaviour -> Vaping** is part of the effect we want to estimate, we don't want to adjust this out.
- However, if we don't adjust for it, we can induce **collider bias**

Estimating CDEs via MSMs

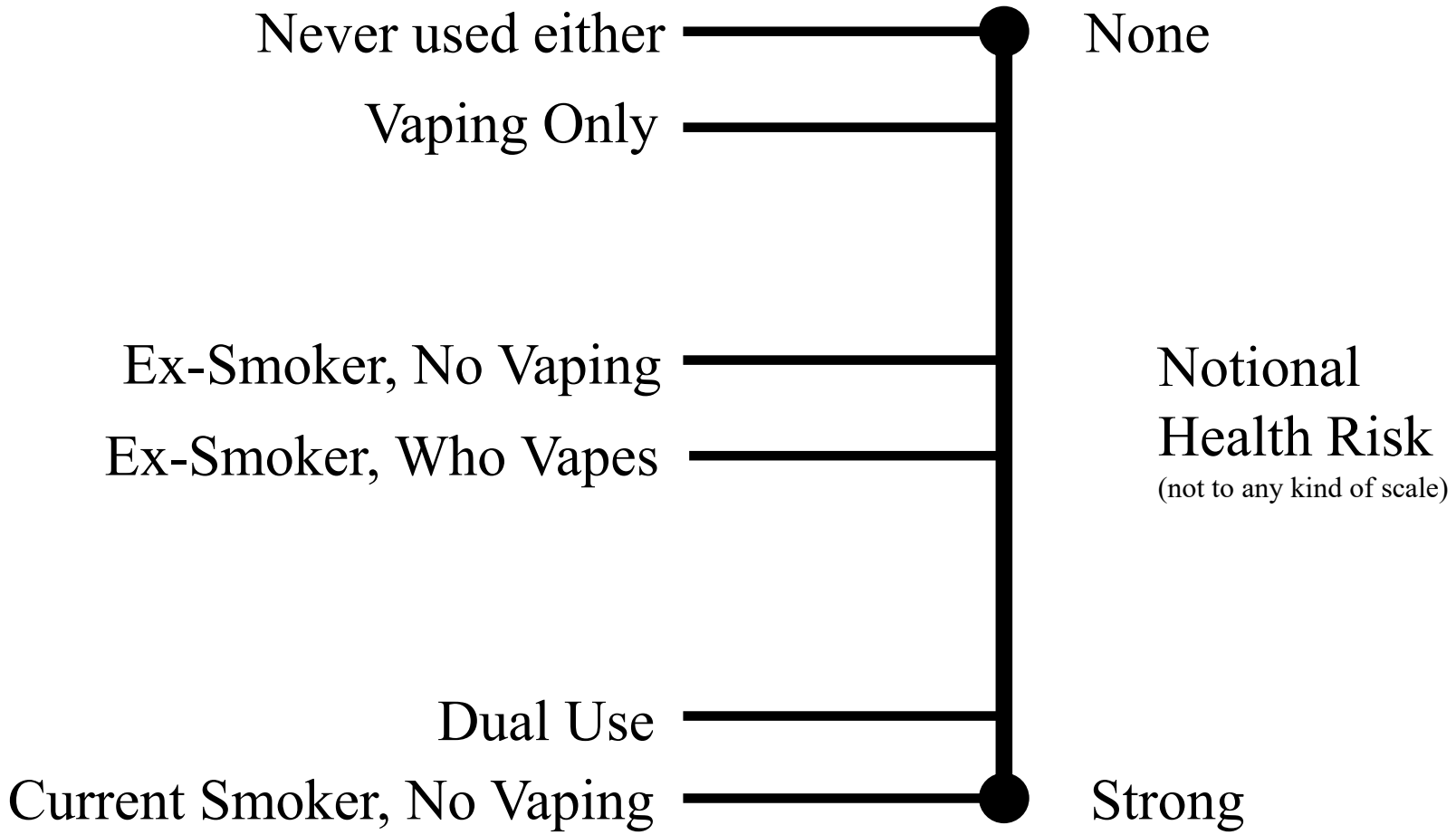
- CDE=**Controlled Direct Effect**, i.e. effect of SEP when everyone has the same smoking status (e.g. never or ever)
- Can be estimated via a **Marginal Structural Model** (MSM)
- Exposure weight = P(x)/P(x|a)
- Intermediate weight = P(z|x)/P(z|x,a,b)
  - *x = Observed SEP (Index of Parental Education, Occupation & Income)*
  - *z = Observed Smoking Status*
  - *a = Confounders (UK Country, Ethnicity, Family Structure)*
  - *b = Intermediate Confounders (Parental Smoking & Vaping, Gender, Age)*
- Aims to balance all confounders, **except to the extent that they are caused by the exposure**

Inequalities in youth vaping - Results

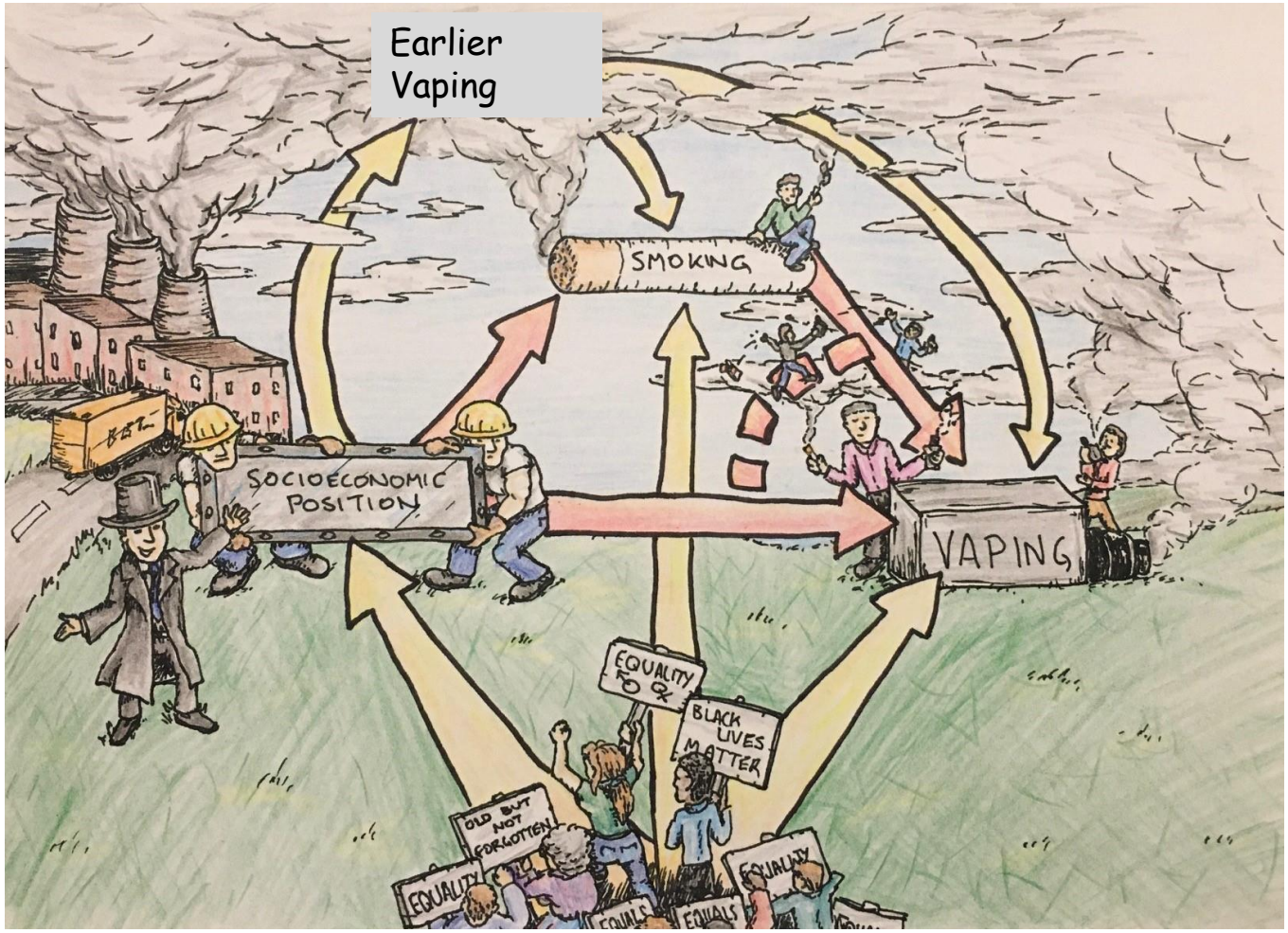
	Unadjusted Association between SEP and vaping			CDE estimates of SEP on vaping		
	OR	95% CI	P-value for difference from association among never smokers	OR	95% CI	P-value for difference from effect among never smokers
Youth (aged 10-15)						
Never Smokers	1.18	1.06-1.32	-	1.17	1.03-1.34	-
Ever Smokers	1.08	0.90-1.29	0.380	1.03	0.82-1.29	0.309
All	1.16	1.06-1.28	-	1.14	1.01-1.29	-

- Suggests **inequalities in youth vaping** that are particularly clear among youth who have never smoked (where vaping would be most concerning).
- BUT, remember prevalence is still very low and we **assumed no unmeasured confounding**.

Less Harmful ≠ Harmless



Potential unmeasured confounders



Our measure of vaping was cross-sectional.

If earlier unmeasured vaping led to ever smoking,

this could have biased our estimates.

E-Cigarettes are controversial

Gateway Effects

Two reasons to be interested:

- We found inequalities in vaping among never smokers, if vaping increases risk for smoking, could exacerbate inequalities
- BUT if so, could also mean our estimates of inequalities in vaping are biased

Gateway effects are often contrasted against the notion of **common liability.**

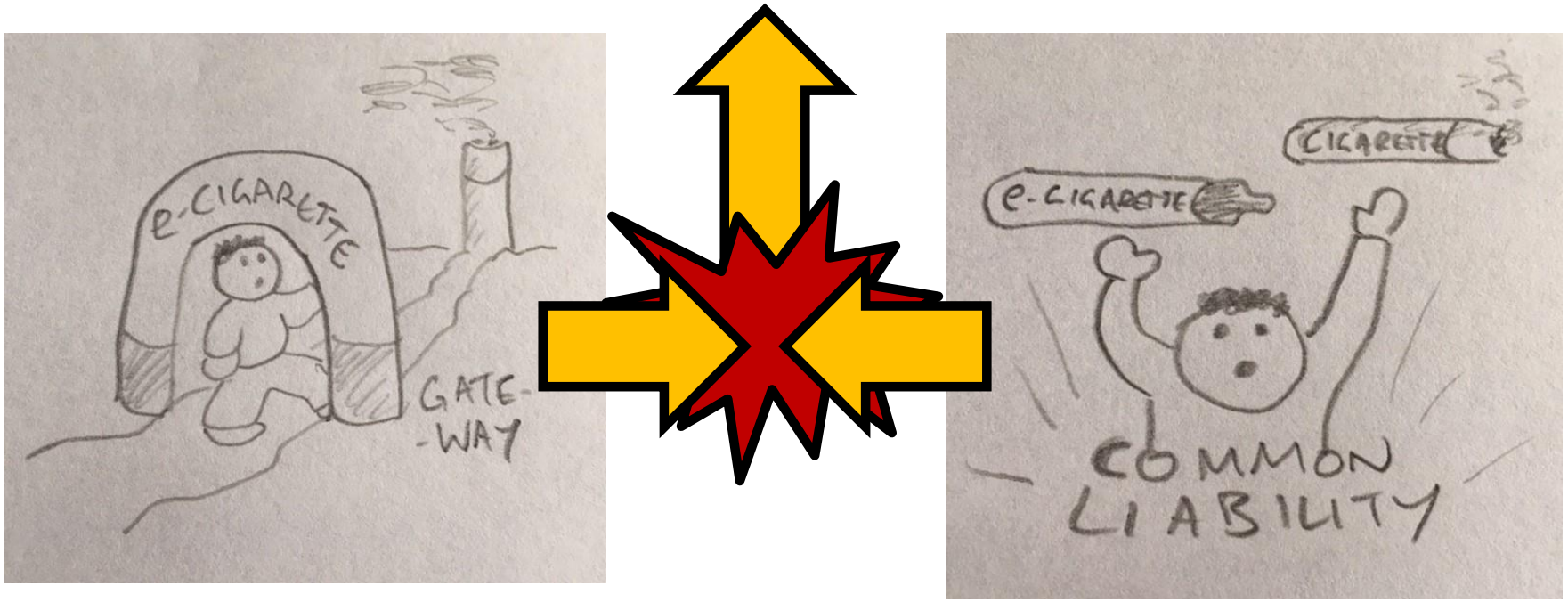
Gateway Effects vs Common Liability

- Most studies show strong associations between youth vaping and smoking
- Longitudinal data tends to indicate higher chances of later smoking for youth who vape

vs

Gateway Effects vs Common Liability

- The two ideas are not mutually exclusive
  - What proportion of associations due to each?
- The two may interact



Why might gateway effects be heterogeneous?

- One possible mechanism for vaping to lead to smoking is that it could provide experience in the social performance of similar behaviour

- Consider how that mechanism might be more or less salient if the young person:
  - Has rarely ever seen anyone smoke
  - Has frequently and regularly seen others smoking

- If the background propensity for smoking is high, vaping may have little additional impact, but could have more of an impact where such background propensities are low

Hypothetical Trials

Consider two hypothetical (unethical) trials, with smoking as the outcome:

- **Trial 1:** A sample of youth *from the general population* are randomised to either vape or not
- **Trial 2:** A sample of youth *who do vape* are randomised to either vape or not

- If the effects of vaping on smoking are homogeneous, then effects from these trials would be identical.
- They will differ if the effect of vaping varies with the background factors that predict vaping.

Emulating a Target Trial

Propensity weighting:

- Predict exposure using observed confounders
- Use predicted probabilities of exposure to re-weight exposure groups
- Creates a pseudo-control group, where observed confounders are balanced across levels of exposure
- **Assumes no unmeasured confounding**

Defining Causal Effects with Propensity Weighting

	Youth who do not vape re-weighted to resemble…	**Youth who do vape** re-weighted to resemble…	**Target Trial:**
Average Treatment Effect (ATE)	All youth	All youth	Trial 1: General population
Average Treatment Effect among the Treated (ATT)	Youth who do vape	Youth who do vape (ie no re-weighting)	Trial 2: Youth who do vape

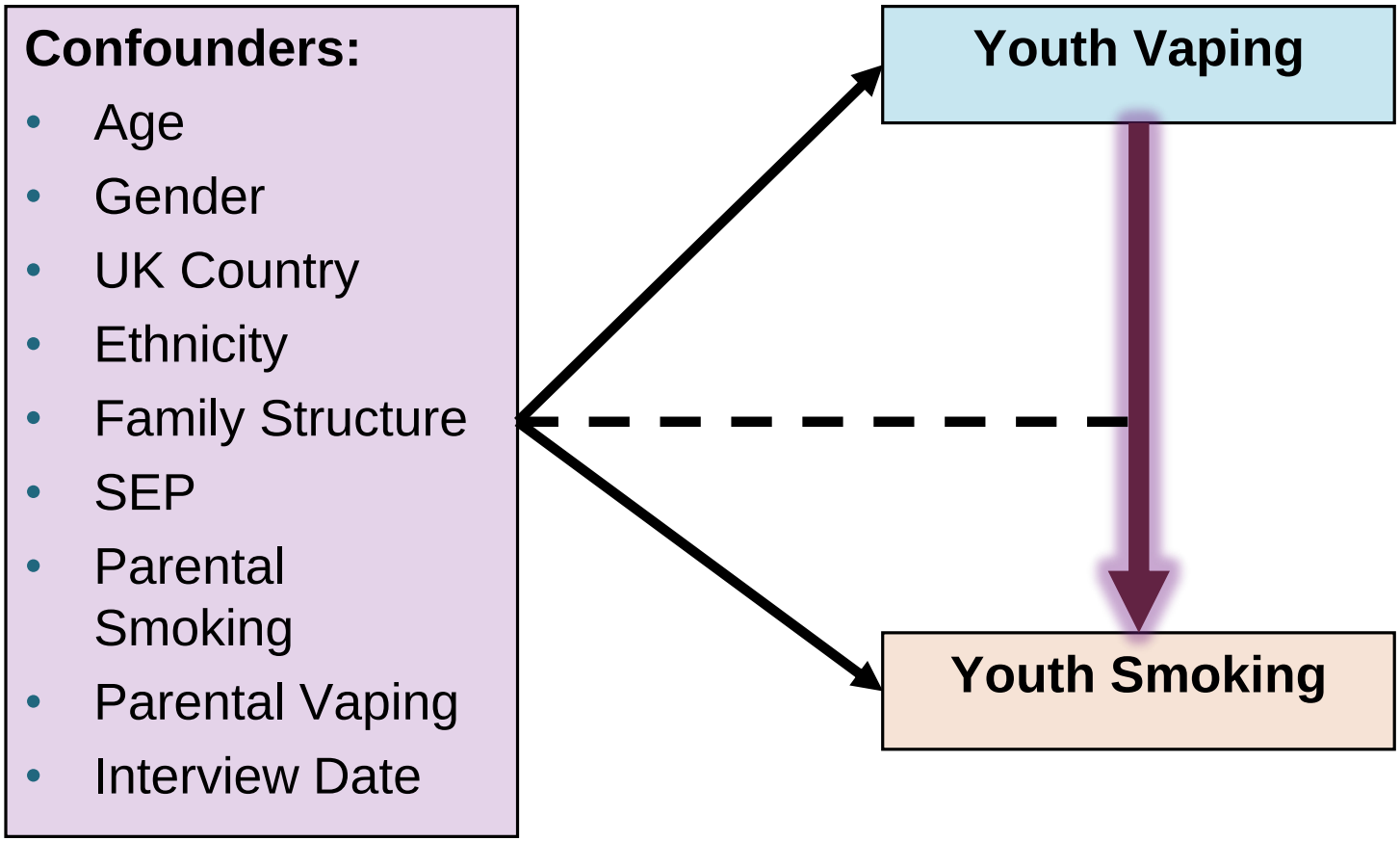
Interpretation of estimates

Considering low prevalence of vaping among youth:

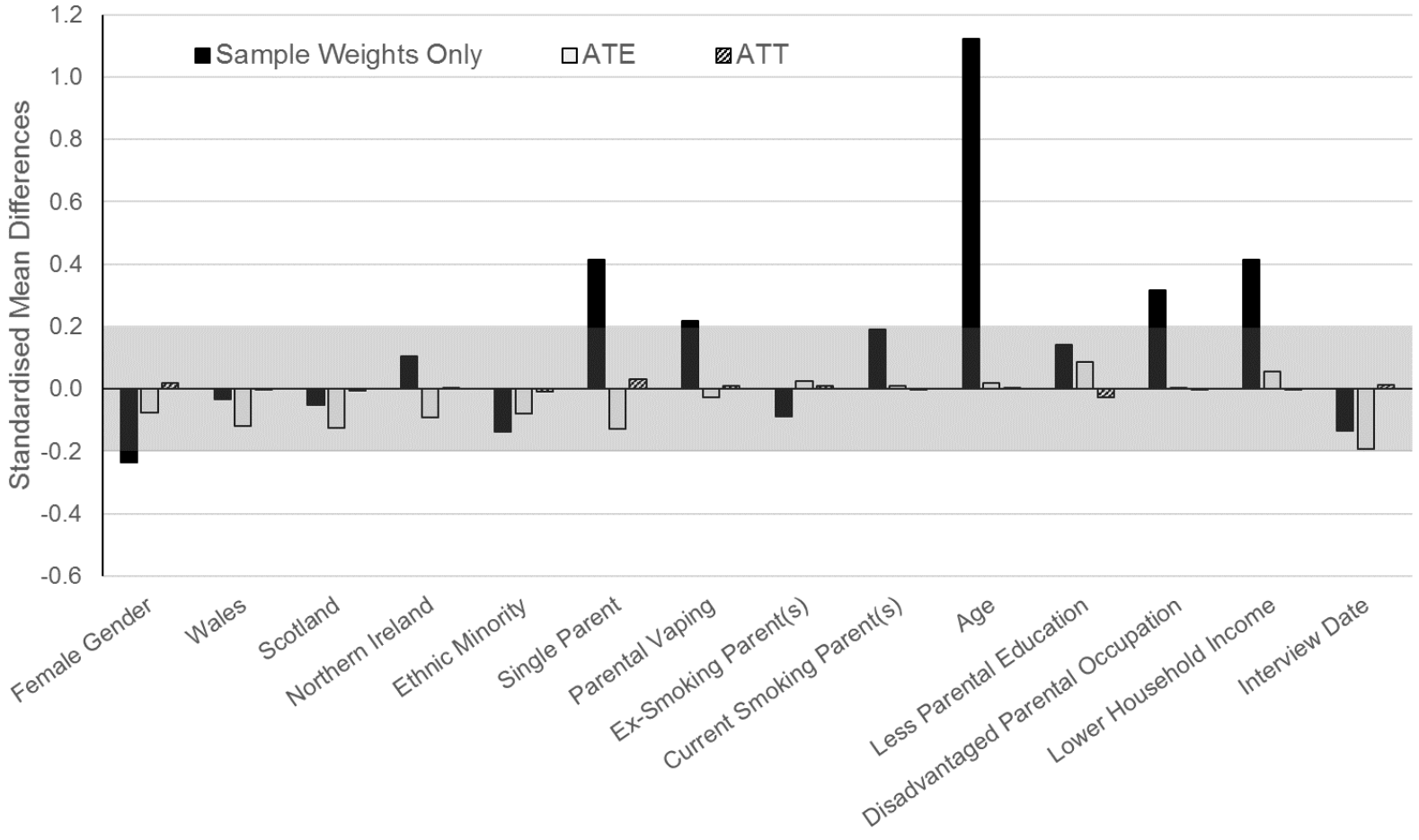
- **ATE/Trial 1:** insights into potential risk if vaping were adopted much more widely by youth

- **ATT/Trial 2:** insights into risk that could be averted by preventing/stopping current levels of youth vaping

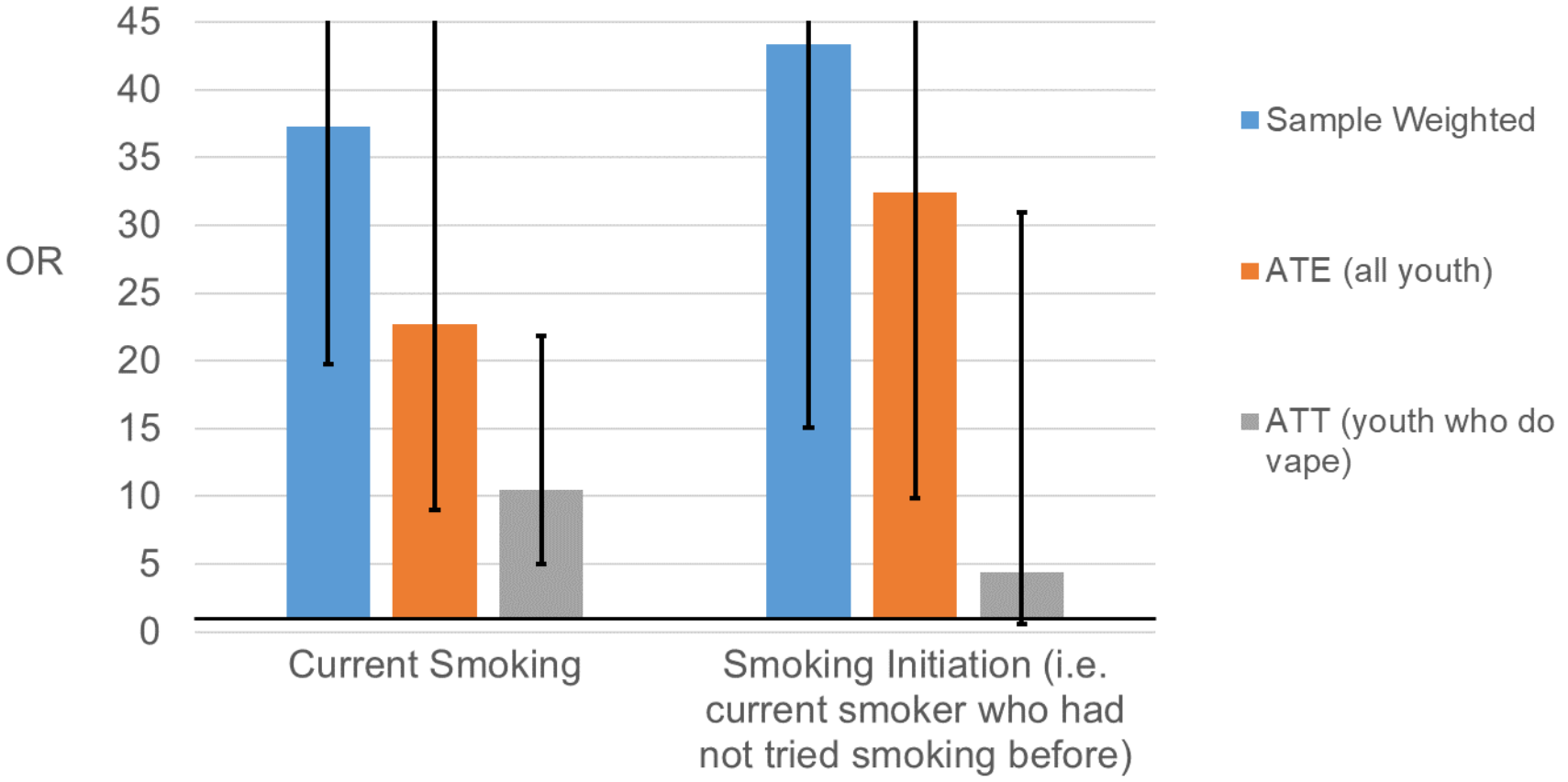
New question, New DAG



Results: Balancing Confounding of Youth Vaping



Results: Effect Estimates for Youth Vaping -> Youth Smoking



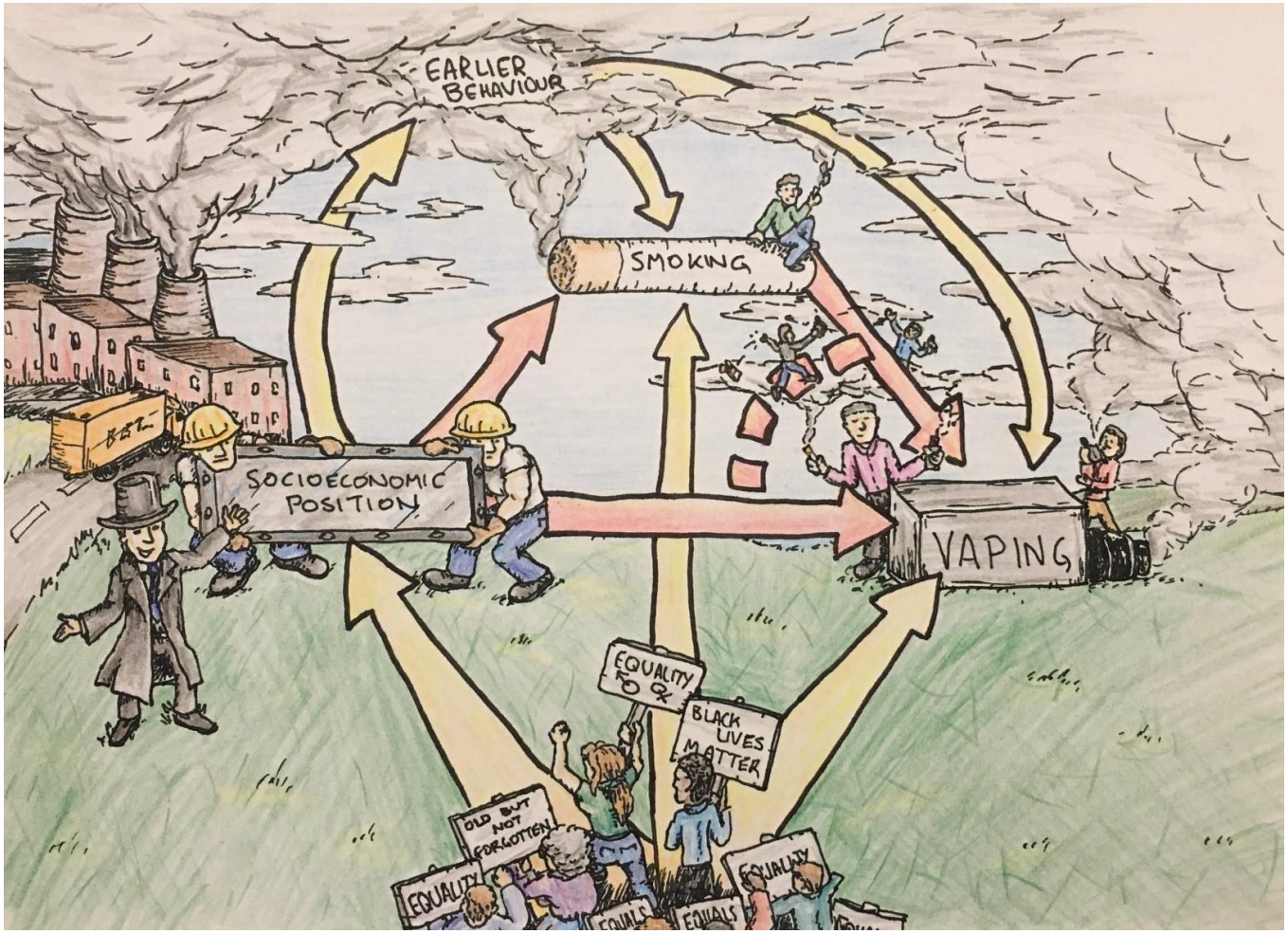
Gateway Effects: Interpretation

- Common liabilities make strong contributions to associations between smoking and vaping among youth, **but also seemed to interact with possible gateway effects**
- Estimates for gateway effects were considerably weaker among youth who do vape (trial 2) than in the general population (trial 1)
  - **Good News:** current levels of youth vaping probably not increasing risk for smoking
  - **Warning:** vaping could increase risk for smoking if adopted much more widely
- **Strong caveat:** depends on assumption of direction of effect from vaping to smoking (and no unmeasured confounding)
  - Further planned analyses of longitudinal data will hopefully make these issues much clearer

Towards a tobacco-free generation, but only for some?

- Something to keep an eye on:
  - Inequalities in youth vaping, especially among never smokers
- BUT lots of reasons to be optimistic:
  - Inequalities in youth smoking take-up have narrowed since introduction of major legislation in 2006/7
  - Prevalence of youth vaping is low, and little evidence that current levels are raising risk for smoking

Thanks for listening!



Any questions?