Innovative Methods for Controlling Contamination Bias in Child Maltreatment Research

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CHILD MALTREATMENT SOLUTIONS NETWORK

Center for Healthy Children

PennState College of Health and Human Development

RESEARCH ARTICLE SUMMARY

PSYCHOLOGY

Estimating the reproducibility of psychological science

Open Science Collaboration*

Is Psychology Suffering From a Replication Crisis?

What Does "Failure to Replicate" Really Mean?

Scott E. Maxwell — *University of Notre Dame*
Michael Y. Lau — *Teachers College, Columbia University*
George S. Howard — *University of Notre Dame*

Sloppy Science

Are sketchy practices in the lab to blame for the replication crisis in psychology research?

By Daniel Engber

SCIENCE

Psychology's Replication Crisis Can't Be Wished Away

It has a real and heartbreaking cost.

ED YONG MAR 4, 2016

Replication Is About Effect Size: Comment on Maxwell, Lau, and Howard (2015)

Warren W. Tryon
Fordham University

	Prospective studies*	Retrospective studies*
Education and employment		
Low educational achievement	Moderate	Weak
Low skilled employment	Moderate	Lacking
Mental health		
Behaviour problems as child/adolescent	Strong	Strong
Post-traumatic stress disorder	Strong	Strong
Depression	Moderate	Strong
Attempted suicide	Moderate	Strong
Self-injurious behaviour	Weak	Weak
Alcohol problems	Moderate	Strong
Drug misuse/dependence	Weak	Strong
Physical health and sexual behaviour		
Prostitution/sex trading	Moderate	Strong
Teenage pregnancy	Inconsistent	Strong
Promiscuity	No effect	Strong
General adult health	Lacking	Moderate
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Obesity	Strong	Weak
Health-care use/costs	Lacking	Moderate
Quality of life	Lacking	Lacking
Aggression, violence, criminality		
Criminal behaviour	Strong	Strong

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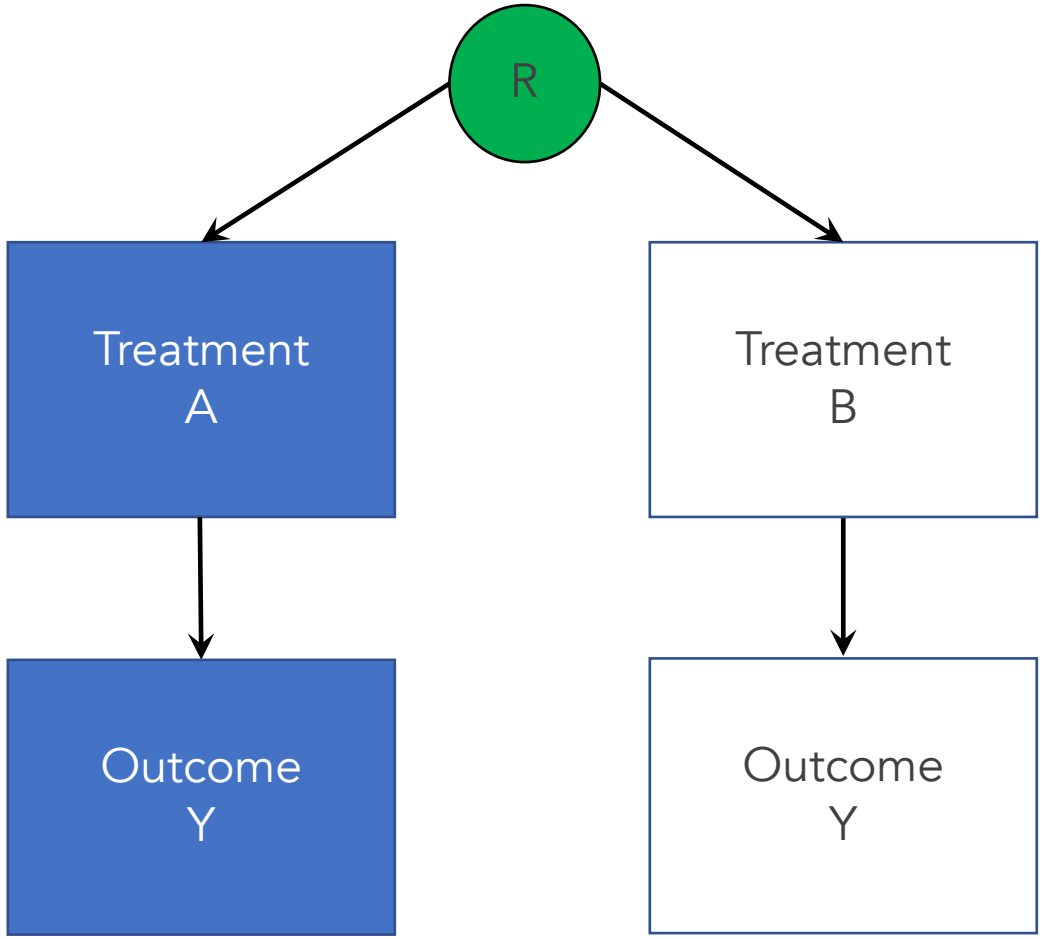
***Table 2:* Summary of review findings on consequences of child maltreatment—evidence for an association in prospective and retrospective studies**

Gilbert et al. (2009), *Lancet*

What is Contamination?

Randomized controlled trial



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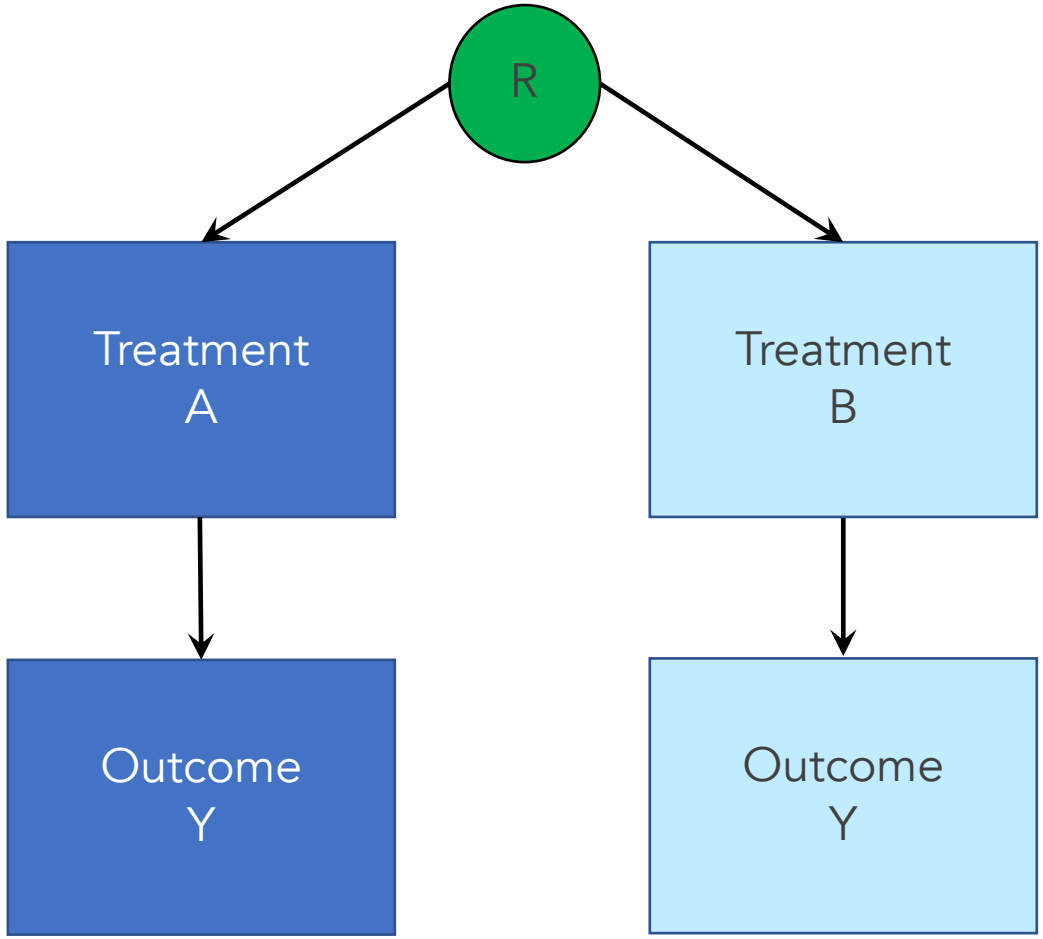

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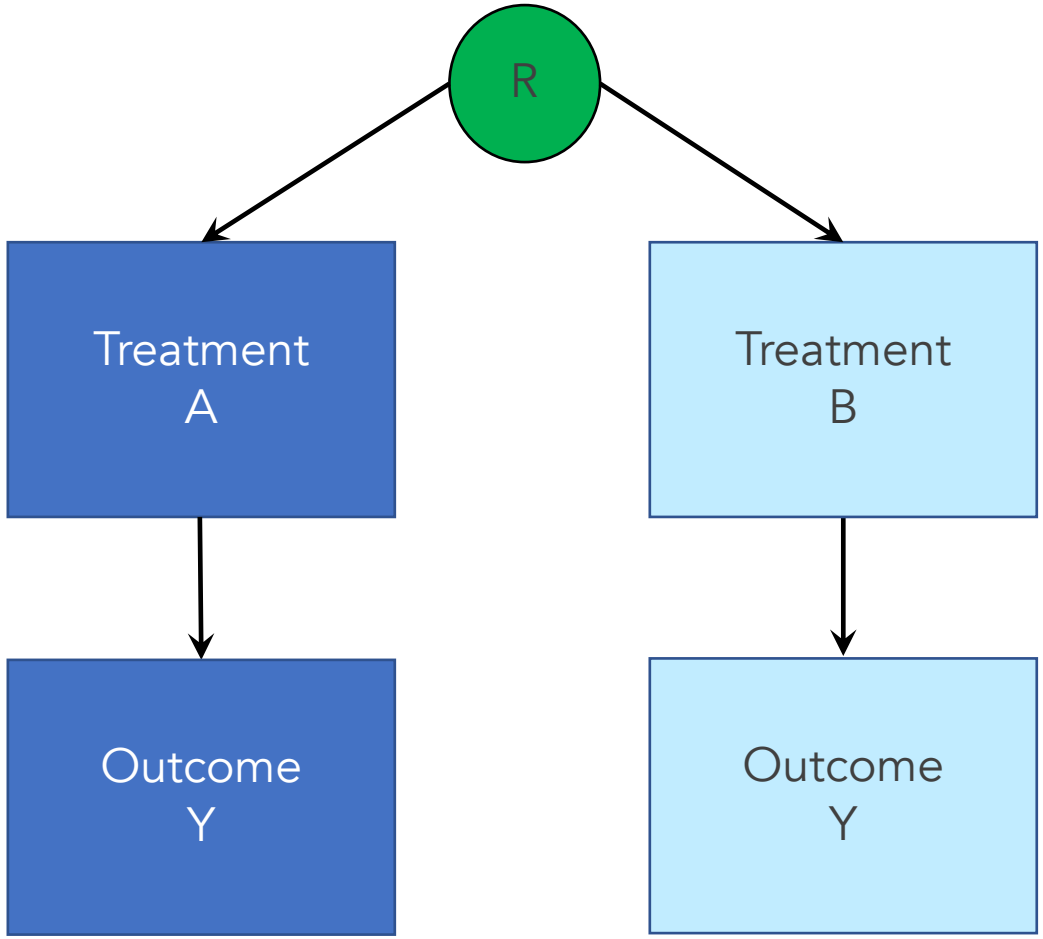


<u>Impact:</u>

Loss of statistical power

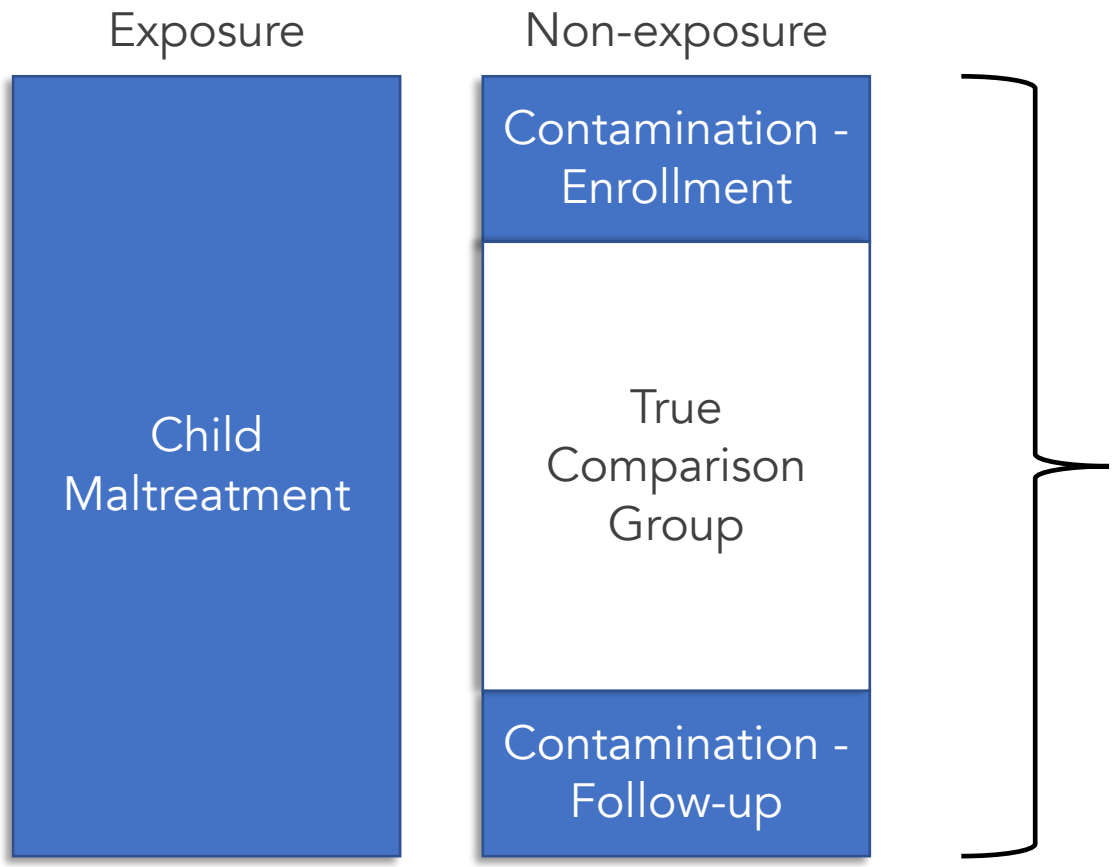
Increased probability of Type II errors

Bias in effect size estimates

Jo (2002), *Psychological Methods*; Cuzick, Roberts, & Segnan (1997), *Statistics in Medicine*

What is Contamination?

Prospective cohort study



Traditional Design and Data Analytic Methods Include Contamination

Adapted from Cuzick et al. (1997), *Statistics in Medicine*

How Does Contamination Occur?

Lack of randomization requires additional control

- Demographic matching of comparison subjects
- Statistical adjustment of confounders

What variables do we use for demographic matching?

- Age, race, income, sex, caregiver marital status
- All hallmark risk factors for child maltreatment

Comparison subjects exposed to or at risk for maltreatment

Rubin (1973a, 1973b), *Biometrics*; Widom (1988), *American Journal of Orthopsychiatry*; Institute of Medicine (2011)

Detecting Contamination

Method 1 - Self-report

- More likely to detect cases of maltreatment
- 152 per 1000 vs. 9.2 per 1000

Method 2 - Official government records

- More objective method of determination
- 40%-50% fail to self-report confirmed maltreatment

Multi-method approach provides most accurate risk estimation

Finkelhor et al (2015), *JAMA Pediatrics*; U.S. Department of Health and Human Services (2020); Baldwin et al (2019), *JAMA Psychiatry*; Shaffer et al (2008), *Child Abuse & Neglect*

Prevalence of Contamination

Widom's Longitudinal Cohort:	45%
Rochester Youth Development Study:	18%
Female Adolescent Development Study:	45%
Scott's Longitudinal Cohort:	15%

Widom & Morris (1997), *Psychological Assessment*; Smith et al (2008), *American Journal of Orthopsychiatry*; Shenk et al (2016), *Journal of Pediatric Psychology*; Scott et al (2010), *Archives of General Psychiatry*

Prospectively Ascertained Child Maltreatment and Its Association With *DSM-IV* Mental Disorders in Young Adults

Kate M. Scott, PhD, MA Appl(Clin Psych); Don R. Smith, MA; Pete M. Ellis, PhD, BMBCh

Table 6. *DSM-IV* Disorder Groups Among Young Adults With Child Protection Agency History Compared With Those Without[a]

DSM-IV Mental Disorder Group	Child Protection Agency Group		Comparison Group Including Retrospectively Reported Childhood Maltreatment[b]		Comparison Group: Including Retrospectively Reported Childhood Maltreatment[b]		Comparison Group: Excluding Retrospectively Reported Childhood Maltreatment[b]	
	No. (%)	SE	No. (%)	SE	Unadjusted OR (95% CI)	Adjusted OR (95% CI)[c]	Unadjusted OR (95% CI)	Adjusted OR (95% CI)[c]
12-Month Disorders								
Any mood disorder	44 (20.94)	3.80	227 (11.90)	1.10	1.96 (1.19-3.23)[d]	1.86 (1.12-3.08)[d]	2.47 (1.47-4.13)[d]	2.38 (1.37-4.14)[d]
Any anxiety disorder	80 (35.74)	5.02	345 (17.92)	1.26	2.55 (1.62-4.00)[d]	2.41 (1.47-3.97)[d]	2.96 (1.87-4.69)[d]	2.92 (1.73-4.91)[d]
Any substance use disorder	38 (16.98)	3.13	186 (8.70)	0.88	2.15 (1.32-3.49)[d]	1.71 (1.01-2.88)[d]	2.55 (1.55-4.21)[d]	2.29 (1.31-4.01)[d]
Any disorder	103 (50.54)	5.03	540 (29.02)	1.81	2.55 (1.62-4.00)[d]	2.32 (1.39-3.85)[d]	2.96 (1.87-4.69)[d]	2.83 (1.68-4.80)[d]
Any 2 disorders	28 (12.13)	3.13	130 (6.11)	0.68	2.12 (1.15-3.92)[d]	1.40 (0.72-2.73)	2.54 (1.35-4.76)[d]	1.55 (0.75-3.21)
Any ≥3 disorders	28 (13.27)	3.03	110 (5.44)	0.68	2.66 (1.49-4.75)[d]	2.67 (1.47-4.87)[d]	3.71 (2.00-6.89)[d]	4.47 (2.29-8.75)[d]
Lifetime Disorders								
Any mood disorder	75 (32.91)	3.95	399 (20.23)	1.25	1.93 (1.31-2.85)[d]	1.80 (1.21-2.68)[d]	2.50 (1.67-3.74)[d]	2.31 (1.52-3.50)[d]
Any anxiety disorder	99 (43.72)	5.22	498 (25.47)	1.46	2.27 (1.47-3.52)[d]	2.04 (1.24-3.33)[d]	2.84 (1.82-2.44)[d]	2.68 (1.61-4.46)[d]
Any substance use disorder	93 (39.68)	4.32	389 (18.15)	1.12	2.97 (2.02-4.37)[d]	2.38 (1.55-3.65)[d]	3.73 (2.51-5.55)[d]	3.11 (1.97-4.91)[d]
Any disorder	136 (64.66)	5.99	795 (43.83)	2.05	2.34 (1.37-4.01)[d]	2.12 (1.20-3.75)[d]	2.91 (1.69-5.00)[d]	2.80 (1.58-4.97)[d]
Any 2 disorders	36 (17.68)	4.04	214 (10.43)	0.88	1.84 (1.05-3.25)[d]	1.30 (0.67-2.53)	2.28 (1.28-4.04)[d]	1.54 (0.77-3.08)
Any ≥3 disorders	67 (28.77)	4.13	247 (11.35)	0.94	3.16 (2.03-4.90)[d]	2.86 (1.79-4.56)[d]	4.19 (2.64-6.66)[d]	3.80 (2.29-6.33)[d]

Scott, Smith, & Ellis (2010), *Archives of General Psychiatry*

Increase in Effect Size Magnitude:

Past Year Disorder - 22%

Lifetime Disorder - 32%

Contamination in the Prospective Study of Child Maltreatment and Female Adolescent Health

Chad E. Shenk,[1,2] PhD, Jennie G. Noll,[1] PhD, James L. Peugh,[3,4] PhD, Amanda M. Griffin,[1] MS, and Heather E. Bensman,[3] PsyD

Table III. The Relative Risk of Child Maltreatment on Female Adolescent Health

	No control of contamination-baseline model ($N = 498$)		Contamination controlled-multimethod strategy ($N = 394$)	
Outcome	RR	95% CI	RR	95% CI
Teenage births				
Unadjusted	1.80**	1.17–2.78	2.89**	1.47–5.66
Adjusted[a]	1.66*	1.06–2.61	2.21*	1.06–4.63
Obesity				
Unadjusted	1.16	0.88–1.52	1.51*	1.04–2.21
Adjusted[b]	1.16	0.90–1.50	1.47*	1.03–2.08
Major depression				
Unadjusted	1.59	0.99–2.57	4.04**	1.64–9.97
Adjusted[b]	1.28	0.79–2.08	2.95*	1.22–7.16
Past-month cigarette use				
Unadjusted	2.01***	1.51–2.66	2.64***	1.74–3.99
Adjusted[b]	1.36*	1.06–1.74	1.68**	1.21–2.35

Shenk et al. (2016), *Journal of Pediatric Psychology*

Increase in Effect Size Magnitude:

Teenage Births - 33%

Obesity - 27%

Major Depression - 130%

Cigarette Use - 24%

Multi-method Detection Approach

	No Detection	Self-report Only	CPS Records Only	Multi-method Detection
Teen Births	**1.66** (1.06-2.61)	1.27 (0.93-1.74)	1.29 (0.96-1.72)	**2.21** (1.06-4.63)
Obesity	1.16 (0.90-1.50)	**2.84** (1.24-6.51)	1.22 (0.72-2.05)	**1.47** (1.03-2.08)
Major Depression	1.28 (0.79-2.08)	1.70 (0.94-3.08)	**1.79** (1.05-3.02)	**2.95** (1.22-7.16)
Cigarette Use	**1.36** (1.06-1.74)	**1.56** (1.14-2.14)	**1.46** (1.13-1.87)	**1.68** (1.21-2.35)

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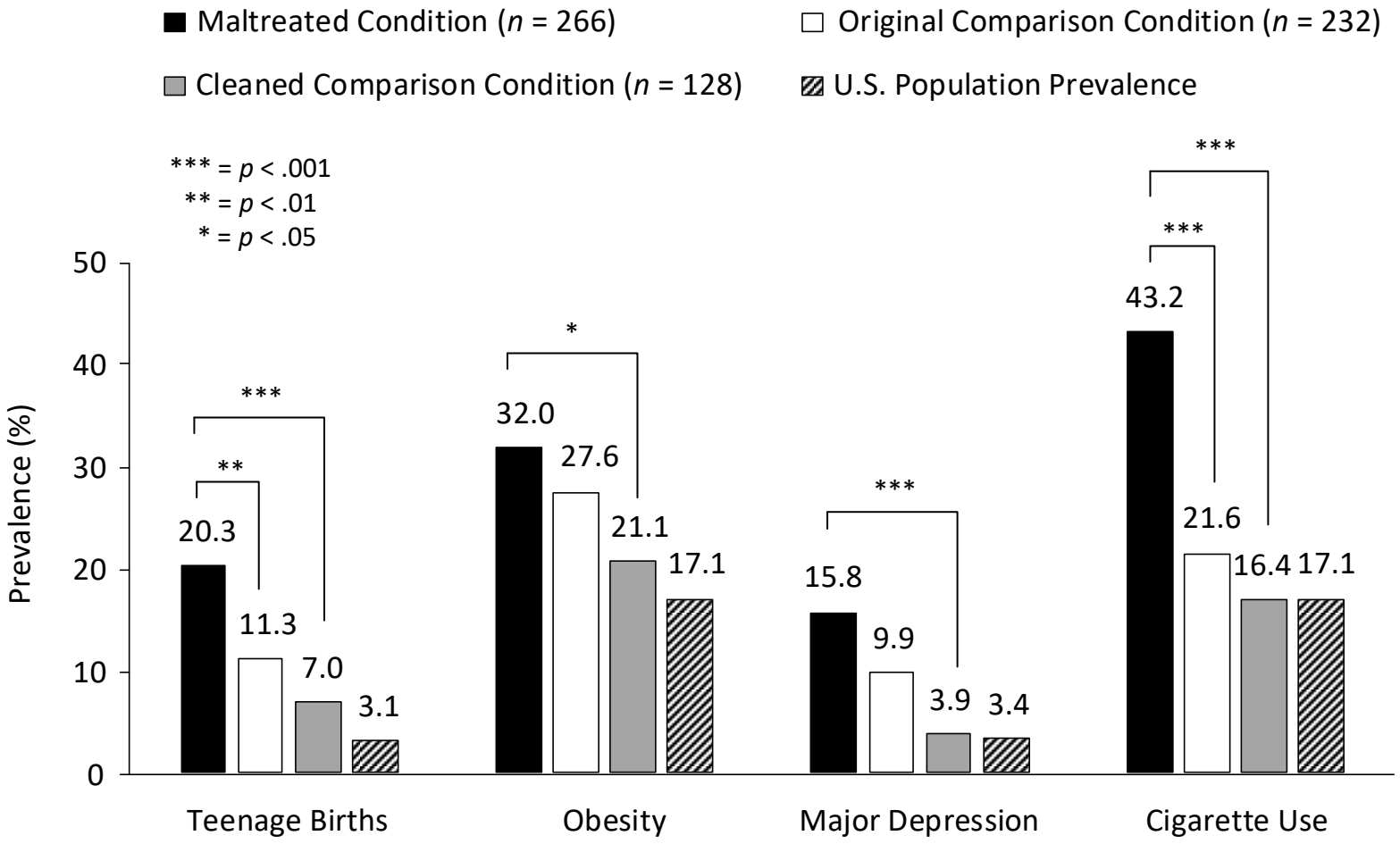
Representativeness



Shenk et al. (2016), *Journal of Pediatric Psychology*

Limitations of Current Research

Both of these prior studies:

Removed subjects to control contamination

- Fails to characterize risks for the “contaminated” group
- Fails to illustrate how contamination biases estimates

Outcomes measured at one or two time points only

What about demographic matching or propensity scores??

Replicating and Improving Prior Research

Longitudinal Studies of Child Abuse and Neglect (LONGSCAN)

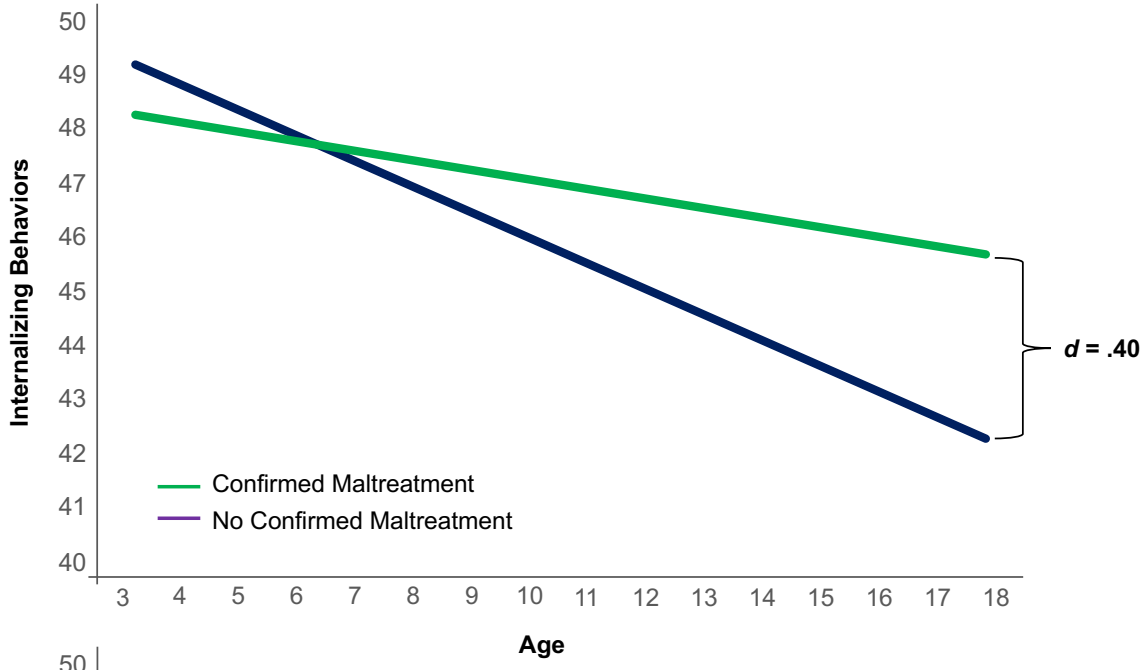
- Confirmed child maltreatment (n = 657)
- Unconfirmed child maltreatment (n = 697)

Contamination

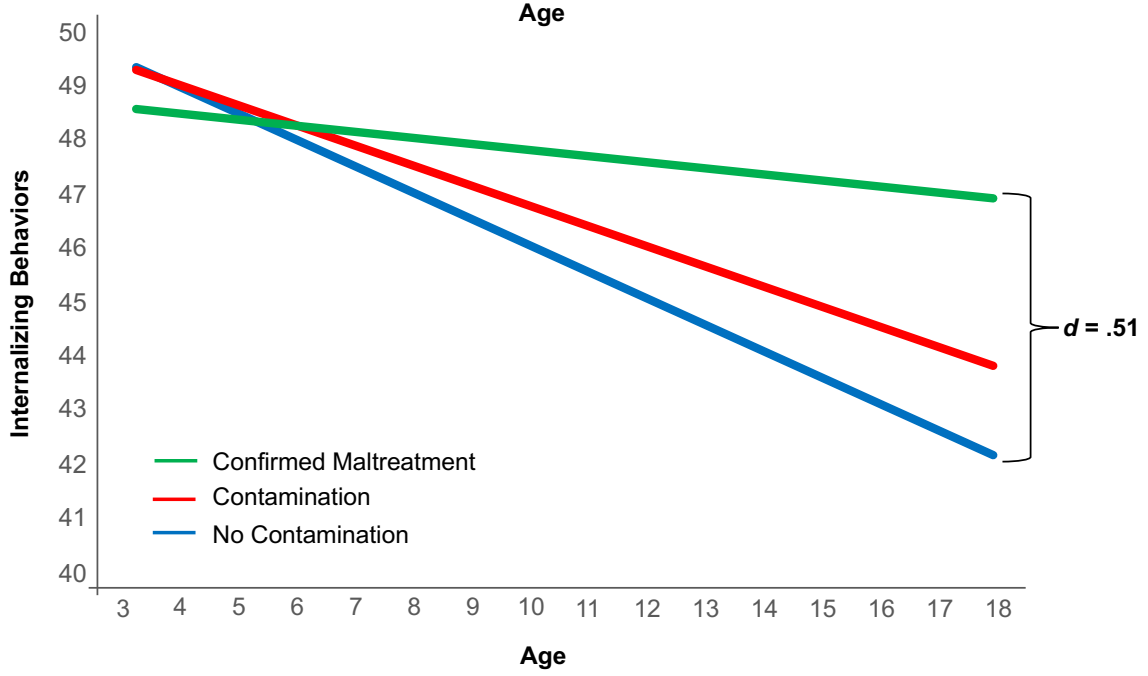
- Self-report of maltreatment in unconfirmed condition
- Measured repeatedly beginning at age 12

Trajectories of child behavior problems (ages 3-18)

- T-scores for both internalizing and externalizing behaviors



Before Controlling Contamination

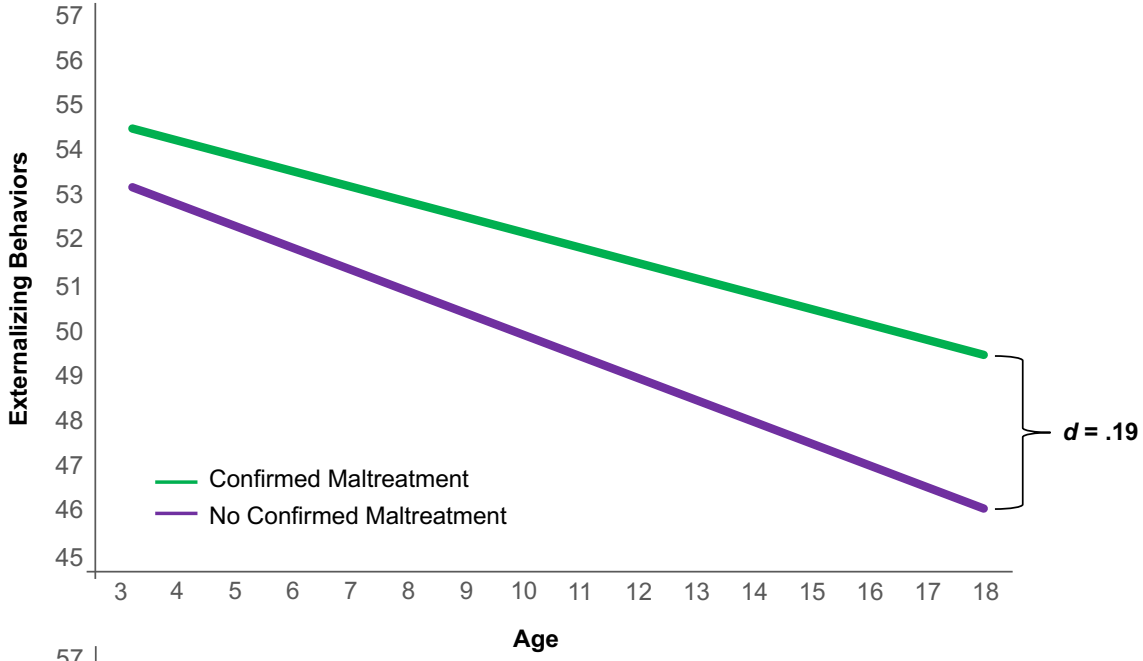


After Controlling Contamination

27.5%

increase in effect size magnitude

Shenk et al. (2021), *Development and Psychopathology*



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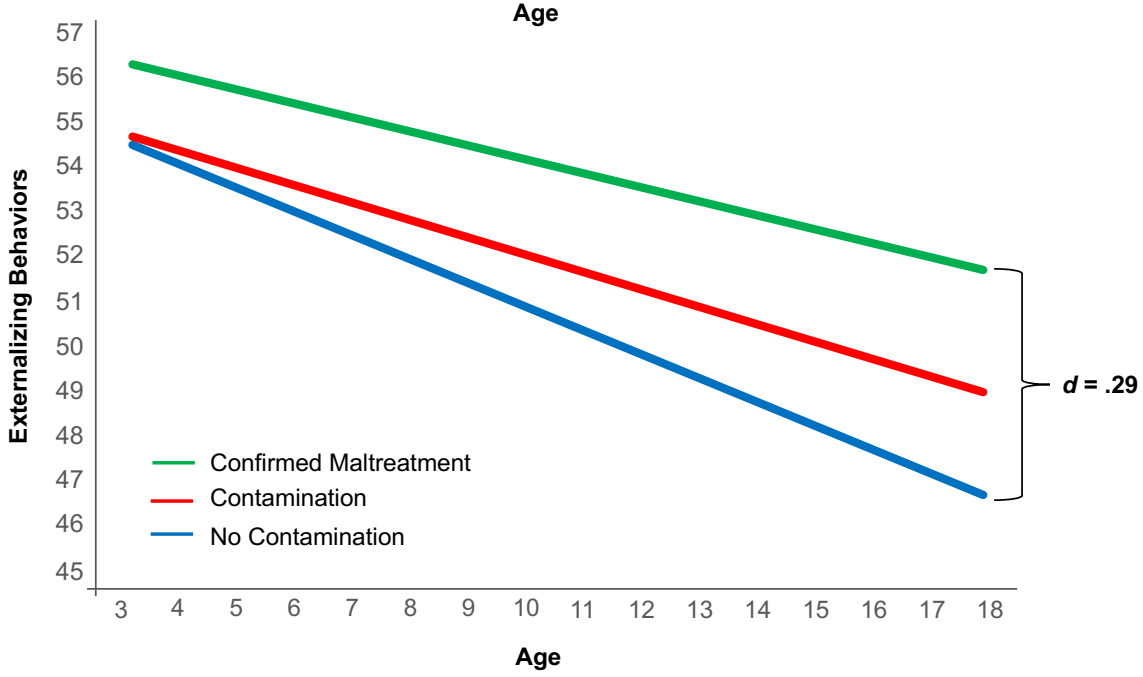

After Controlling Contamination

52.6%

increase in effect size magnitude

Shenk et al. (2021), *Development and Psychopathology*

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Mental health		
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Alcohol problems	Moderate	Strong
Drug misuse/dependence	Weak	Strong
Physical health and sexual behaviour		
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Teenage pregnancy	Inconsistent	Strong
Promiscuity	No effect	Strong
General adult health	Lacking	Moderate
Chronic pain in adulthood	No effect	Weak
Obesity	Strong	Weak
Health-care use/costs	Lacking	Moderate
Quality of life	Lacking	Lacking
Aggression, violence, criminality		
Criminal behaviour	Strong	Strong

*Refers to ascertainment of maltreatment. The classification indicates consensus about the findings from included studies and are broadly consistent with the following criteria: strong=evidence of a significant effect after adjustment for confounders; moderate=evidence of a significant but small effect, or of a stronger effect that is reduced after adjustment for confounders or highly likely to be confounded; weak=evidence of an effect based on methodologically problematic studies or associations that do not persist after adjustment, but consistently favour a positive effect; inconsistent=effect qualitatively different across studies (ie, positive and negative or no associations); lacking=no studies addressing this question.

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Even if risks are "significant", effect sizes will vary across studies depending on different rates of contamination and whether contamination is controlled

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Future Research

<u>Detecting and Controlling Contamination Bias Project (DCCB)</u>

Aims and Objectives:

1. Establish the prevalence of contamination in national cohorts

2. Test statistical methods for optimal control of contamination
    - Five approaches to controlling contamination
    - Data simulations to extend model results

Shenk, PI (R03HD104739); Shenk, PI (NSF - BCS2041333)

Detecting Contamination

Prevalence of contamination in national cohorts

- LONGSCAN (N=1354)
- NSCAW-II (N=5873)

Types of prevalence:

- Standard
- Time varying
- Multiple event and competing risk survival models

Prevalence determined via self and caregiver report

Shenk, PI (R03HD104739); Shenk, PI (NSF - BCS2041333)

Controlling Contamination

Statistical efficiency of five bias-control methods:

- No control of contamination
- Remove subjects
- Treat contamination as a moderator, covariate
- Propensity score matching (baseline)
- Augmented synthetic controls (follow-up)

Shenk, PI (R03HD104739); Shenk, PI (NSF - BCS2041333)

Controlling Contamination

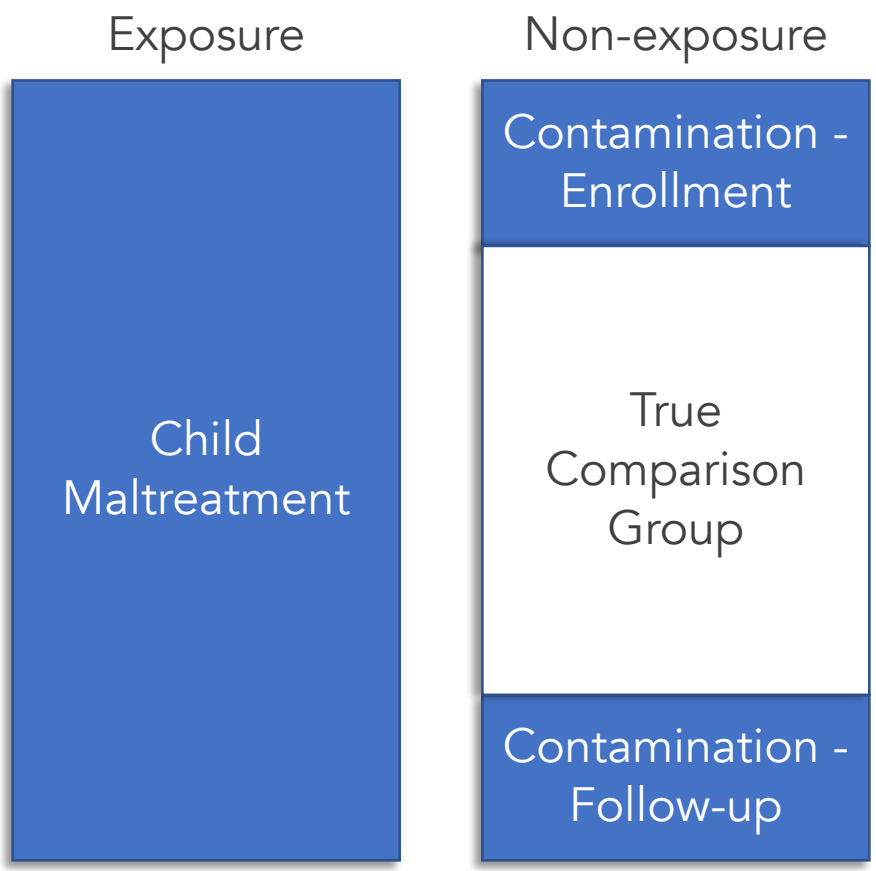
Data simulations to model variation in:

- Contamination prevalence
- Statistical power
- Effect sizes
- Sample size
- Missing data

Extend to research on misclassification bias

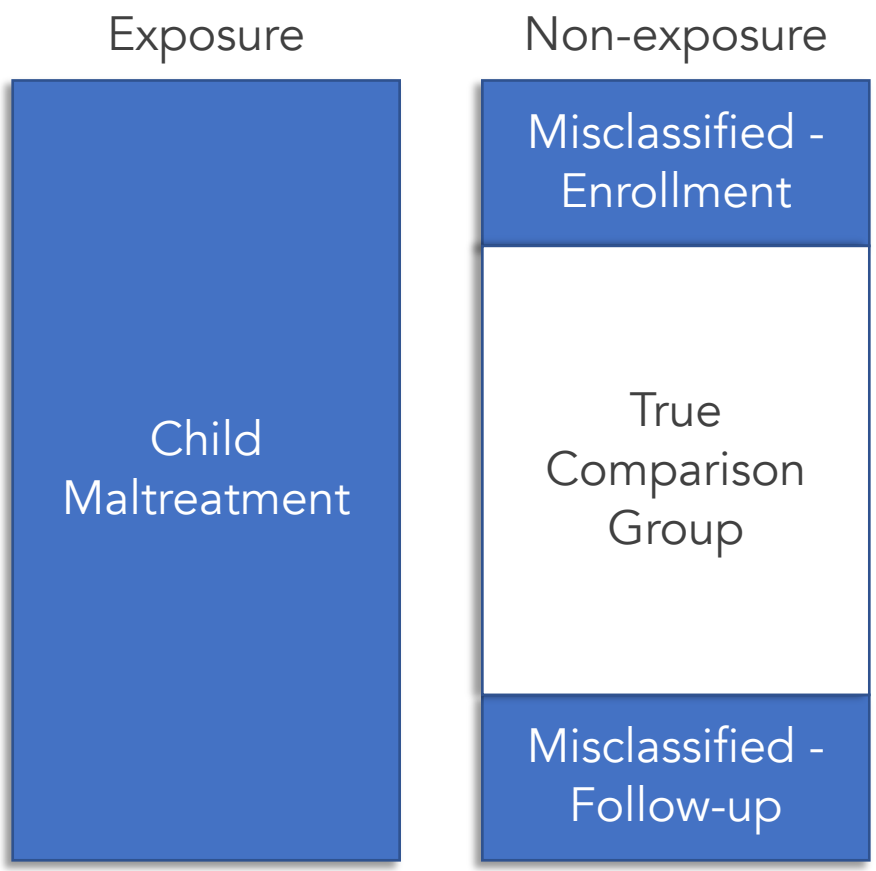
Shenk, PI (R03HD104739); Shenk, PI (NSF - BCS2041333)

Misclassification Bias



Adapted from Cuzick et al. (1997), *Statistics in Medicine*

Misclassification Bias



Misclassified =

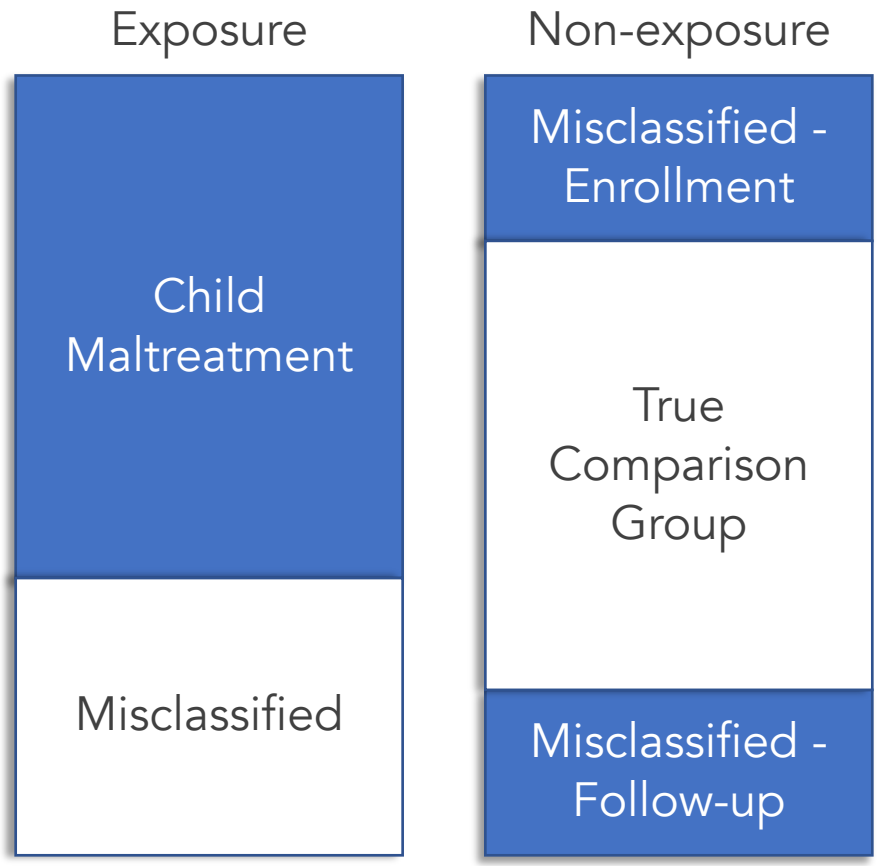
Self-reported maltreatment in comparison condition

Adapted from Cuzick et al. (1997), *Statistics in Medicine*

Misclassification Bias

Misclassified =

No self-reported maltreatment in maltreatment condition



Misclassified =

Self-reported maltreatment in comparison condition

Adapted from Cuzick et al. (1997), *Statistics in Medicine*

Misclassification Bias

Sensitivity and specificity of exposure variables

Non-differential misclassification

- Influenced by specificity (e.g. CPS records)
- Biases risk estimates toward zero

Differential misclassification

- Influenced by sensitivity (e.g. self-reports)
- Biases risk estimates away from zero

Copeland et al (1977), *American Journal of Epidemiology;* Höfler (2005), *International Journal of Methods in Psychiatric Research*

Conclusions

<u>Contamination:</u>

Is a feature, not a bug, of child maltreatment research

Truncates the significance and magnitude of risk estimates

Can be detected and controlled readily

More results to come!

Thank you!

Contact information:

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