





Evaluating Natural Experiments to Prevent and Control Obesity

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Obesity: "Complex but Conquerable"

- Drivers of obesity are complex
- To conquer obesity, effective solutions need to extend beyond the individual to address
 - Neighborhood context
 - Social/cultural/political context
- The Institute of Medicine recommended a "systems approach" targeting changes in 5 critical environments:
 - 1) physical activity
 - 2) foods/beverages
 - 3) messages
 - 4) health care and work
 - 5) schools

IOM Accelerating Progress in Obesity Prevention, 2013



Policies, programs, built environment changes amendable to evaluations

- Population-level policies include sugar-sweetened beverage taxes, calorie-labeling regulations and zoning laws to encourage building supermarkets in low-income neighborhoods.
- Numerous school systems have implemented programs to increase children's fruit and vegetable consumption, and outdoor time



What are natural experiment studies?

- <u>Natural experiment</u> = intervention or policies not under the control of researchers, but amenable to research that takes advantage of the variation in exposure to assess impact.
- <u>Natural experiment studies</u> = methodological approaches to evaluating the impact on health or other outcomes of such events.
- <u>Key features</u>:
 - 1) Intervention not undertaken for the purposes of research
 - 2) Variation in exposure and outcomes is analyzed using methods that attempt to make causal inferences

UK Medical Research Council, 2010, www.mrc.ac.uk/naturalexperimentsguidance

Examples natural experiments

The effect of daylight saving on road traffic accidents in the U.S. – 28 years of traffic data showed that daylight saving decreased accidents

The effect of needle-exchange program for HIV prevention —showed decreasing HIV seroprevalence in cities w/ needle exchange and increasing prevalence in cities w/o needle exchange

Growing interest in natural experiment studies for obesity

- RCTs not feasible or appropriate
- NIH has several RFA's
 - Evaluating Natural Experiments in Healthcare to Improve Diabetes Prevention and Treatment (R18)
 - Time-Sensitive Obesity Policy and Program Evaluation (R01)

A NATURAL EXPERIMENT EVALUATING THE EFFECT OF A MINIMUM WAGE INCREASE ON OBESITY AND DIET-RELATED OUTCOME

Advantages and challenges of natural experiment studies

- Advantages
 - Cost effective if data are readily available
 - May not be able to answer question in any other way
 - May identify effective, scalable solutions
- Challenges
 - Observational
 - Potential for confounding due to baseline differences, and selection bias – non-random assignment of exposure
 - Difficult to draw causal inferences
 - Lack methodological standards for evaluating quality of study
 - Limited data sources

Study designs to consider for natural experiment studies

- Pre-Post study
- Cross sectional design
- Regression discontinuity
 - Use a cut-off/ rule- compare those just above and below cutoff to estimate effect of the policy
- Propensity score methods
- Interrupted time series

 Methods for evaluating natural experiments in obesity workshop, December 5-6, 2017

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REVIEW

Methods for Evaluating Natural Experiments in Obesity A Systematic Review

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Background: Given the obesity pandemic, rigorous methodological approaches, including natural experiments, are needed.

Purpose: To identify studies that report effects of programs, policies, or built environment changes on obesity prevention and control and to describe their methods.

Data Sources: PubMed, CINAHL, PsycINFO, and EconLit (January 2000 to August 2017).

had physical activity and 148 had dietary measures. For analysis, natural experiments most commonly used cross-sectional comparisons of exposed and unexposed groups (n = 55 [35%]). Most natural experiments had a high risk of bias, and 63% had weak handling of withdrawals and dropouts.

Limitation: Outcomes restricted to obesity measures and health behaviors; inconsistent or unclear descriptions of natural experiment designs; and imperfect methods for assessing risk of bias in natural experimente.

Goals of the Review

To identify studies that report effects of programs, policies or built environment changes on obesity prevention and control, and describe their methods.

- Focus on describing the methods
 - KQ1: Population-based data sources
 - KQ2: Use of data linkages
 - KQ3: Measures reported
 - KQ4: Study designs & analytic approaches
 - KQ5: Risks of bias
- To identify methodological advances to strengthen research that evaluates the effectiveness of programs & policies to prevent & control obesity

Review Inclusion Criteria

PICOTS	Inclusion Criteria for Studies
P opulations	 All ages, general population; sub-populations of obese & overweight
<u>I</u> nterventions, <u>S</u> etting <u>T</u> iming	 US & non-US policies, programs & built environment changes targeting a population; implemented 2000 or later
<u>C</u> omparisons	 Concurrent or non-concurrent comparison group or unexposed group
<u>O</u> utcomes	Body weight & body mass indexPhysical activity and dietary behaviors

Study Search & Identification

- Searched PubMed, CINAHL, PsycINFO, & EconLit
 - January 2000 to August 2017
- Independent screening of abstracts & full-text articles
 - 30,548 search results \rightarrow 294 studies (312 articles)
- 2 reviewers extracted:
 - Study population & intervention characteristics
 - Data sources & their detailed characterization
 - Outcome measures
 - Study design & analytic approaches
 - Classified studies into natural experiments vs. experimental
 - Classified data sources as data systems

Classification of data sources as data systems for obesity research

- Data source is still in existence (e.g., information about the data system can be found on the web)
- Data are available and accessible in digital format (e.g., datasets are downloadable from a current website)
- Data are sharable and can be acquired by others for research purposes (e.g., has a public or transferable license that allows the data to be used for research purposes)
- Data system collects/contains at least one of the outcomes of interest (e.g., primary outcomes, such as weight and height, or secondary outcomes, such as policy and built environment)

Risk of Bias Assessment

- Effective Public Health Practice Project (EPHPP) quality assessment tool
- Domain-specific & global risk of bias ratings: strong, moderate, weak

Domain	Summary of Items		
Selection bias	Representativeness Participation rate		
Study design	Type of study design For RCTs, randomization		
Confounders	Baseline differences between groups Control for confounding		
Blinding	Blinding of outcome assessor Blinding of study participants		
Data Collection Methods	Validity of data collection tools Reliability of data collection tools		
Withdrawals and dropouts	Count &reasons for dropouts % completing study		
Global Bias Rating	Strong if 0 weak domains; Weak if 2+ weak		

Overview of Results, 294 studies

- Majority were studies in US, 188 of 294 (64%)
 - Canada, UK, & Italy most common after US
- 86 of 294 (29%) reported multiple (food, physical activity) policy, program or environmental targets
- Most studies were conducted in schools, 237 (80%)
- Natural experiment studies most commonly evaluated national, state, & local policies - e.g. UK's provision of free local bus passes to retirees, menus labeling with calories.
 - Others included local built environment changes e.g. addition of new supermarkets in food deserts or new transportation systems

Natural experiment vs. experimental studies

20 Other Study Designs (7%)

118 Experimental Studies (40%) 156 Natural Experiment Studies (53%)

Key Questions #1 and #2 POPULATION DATA SOURCES AND LINKAGES

Population data sources

 From the 294 studies → 169 primary and secondary data sources → 116 unique data sources after duplicates removed

 Identified 71 data systems in the U.S. that were further classified

Original Purpose for Data Use & Function for 71 US Data Systems

Examples of data systems

- CDC/NCHS
 - National Youth Physical Activity and Nutrition Study (NYPANS), Youth Risk Behavior Survey Surveillance, BRFSS, NHANES
- RWJF
 - Bridging the Gap Community Obesity Measures Project
- State-level data e.g. Minnesota Student Survey
- School data e.g. Anchorage School District

Demographic coverage of US data systems (N=71)

* Values in each group are not mutually exclusive & don't sum to 100%.

Linkages between data sources

- 26 of 188 US studies (23%) performed or used data linkages
 - All 26 studies with data linkages were natural experiments
- 10 used an individual-level key, e.g., patient identifiers, to link survey data with another data source
- 16 used a geographic allocation, e.g., patient resides in a specific county thus mapping county specifications extracted from other sources for that individual

Example of individual-level linkage

The Effect of State Competitive Food and Beverage Regulations on Childhood Overweight and Obesity

- Linked Data Sources
 - Children's survey data from the Military Teenagers Environment Exercise and Nutrition Study (M-TEENS), from 12 army installations in the US
 - State-level Competitive Food & Beverage policies from Bridging the Gap State Wellness Policy data
- Assessed the effect of food policies on BMI z-score & dietary behaviors
- Showed Competitive food policies significantly associated with lower BMI z-scores and better dietary outcomes, relative to no policy.

Datar A and Nicosia N. J. Adol Health. 2017

Example of geographic-level linkage

A Difference-in-Differences Analysis of Health, Safety, and Greening Vacant Urban Space

- Linked Data Sources
 - <u>Vacant lots in Philadelphia</u> assembled from the Philadelphia Bureau of Revision of Taxes, the Philadelphia Department of Licenses and Inspections, & US Postal Service record
 - <u>Philadelphia Police Department's</u> longitude-latitude coordinates for crimes & arrests
 - <u>Philadelphia Health Management Corporation</u> provided census tract level data from the Southeastern Pennsylvania Household Health Survey, administered via random digit dialing every 2 years to ~5,000 Philadelphians.
- Assessed the impact of a vacant lot greening program in Philadelphia on exercise, stress level and safety outcomes
- In regression models, vacant lot greening was associated with less perceived stress and more exercise.

Branas CC and colleagues. Am J. Epi. 2011

Key Question #3 MEASURES AND OUTCOMES

Child & Adult Weight Measures in Natural Experiment Studies

		Measure n					
Method and Population	Outcome	Measured by trained staff	EHR	Self- reported	Other		
Natural Experiment							
Children, N=50	Change in BMI z- score	14	1	3	5		
	Change in BMI percentile	15	0	6	6		
	Change in weight	7	0	0	1		
Adult, N=17	Change in body weight	0	0	1	0		
	Change in BMI	6	0	10	0		

BMI=Body Mass Index; EHR=electronic health record; n=number of measures reported; N=number of studies *Studies may have captured more than one outcome so counts may not match total N

Example of a natural experiment assessing weight

Free bus passes, use of public transport and obesity among older people in England

Observational Cohort Study –

- English Longitudinal Study of Aging (ELSA)
- 8,309 -11,305 older people in England
- Exposure New policy providing free local bus travel pass for people >= age 60
- Outcomes Weight & height measured during nurse visits as part of cohort study

Webb E, Netuveli G, Millett C. Free bus passes, use of public transport and obesity among older adults. J Epidemiol Community Health 2012.

Diet Measures – reported in 148 out of 294 studies

77 natural experiments (children N=52, adult N=30) reported diet measures

- Fruit and vegetable intake (n=75)
- Sugar-sweetened beverage intake (n=31)
- Total daily caloric intake (n=10)
- Fast food intake (n=11)
- Fiber intake (n=6)

Physical Activity Measures reported in 152 out of 294 studies

71 natural experiments (children N=43, adult N=32) reported physical activity

- Most commonly measured using questionnaire
- Wearables used in 17 out of 43 studies in children, 6 out of 32 studies in adults

Key Question #4 STUDY DESIGN AND ANALYTIC APPROACHES

Study Designs for Natural Experiments

	Number	Percent
Natural experiment studies	156	
Cross-sectional	55	35%
Pre/Post	48	31%
Difference-in-differences	45	29%
Regression Discontinuity	1	1%
Interrupted Time Series	4	3%
Instrumental Variables	4	3%
Other	1	1%

Natural Experiment Study using difference in difference analysis

New neighborhood grocery store increased awareness of food access but did not alter dietary habits or obesity

- The Pennsylvania Fresh Food Financing Initiative provided incentives to built new grocery stores in underserved communities
- Compared random samples (n=1440 at baseline, 47% response rate at 6 m follow-up) residents in neighborhood w/ new supermarket, with race/income/demographic-matched control neighborhood
- Self-reported outcomes BMI, Fruit + Vegetable intake measured pre- & post- supermarket construction
- Difference in difference analysis no difference in BMI or F/V intake

Cummins S and colleagues. Health Aff (Millwood). 2014

Confounding in Natural Experiment Studies (N=156)

- Baseline comparison of exposed & unexposed groups missing in 33%
- Methods to control confounding
 - Regression adjustment (73%)
 - Direct covariate matching/stratification (13%)
 - Propensity score (3%)
- Few sensitivity analyses to assess robustness to unobserved confounders (3%)
- Few studies adjusted for clustering

Key Question #5 **RISK OF BIAS**

Risk of bias for natural experiment studies (N=156)

Limitations of the evidence

- Majority of studies in children and schools; fewer in adults in community or workplaces
- Few local/neighborhood level data sources utilized; few studies linked multiple data sources together
- Most studies were cross-sectional (35%), pre/post (31%) with single time pre/post points, or used a differences-in-differences (29%) design
- Natural experiment studies had high risk of bias due to confounding and high rates of withdrawals/ losses to followup

Improving methods for evaluating natural experiments in obesity

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POSITION PAPERS | 1 MAY 2018

National Institutes of Health Pathways to Prevention Workshop: Methods for Evaluating Natural Experiments in Obesity

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Panel's Recommendations

- Improve researchers' ability to use and link data
 - Promote data sharing of existing surveillance and research data – including EHR data—including common language, data dictionaries and tips on linking
 - Promote public-private partnerships especially around wearable technology
- Develop & validate new measures for assessing diet e.g. plate waste measures, ecologic momentary assessment of diet
 - Need to measure unintended consequences as well
- Promote collaborations to enhance methods beyond the simple pre-post design –
 - e.g. regression discontinuity approach, uses a threshold below or above which an intervention is assigned and examines causal effects of interventions by observing either side of the threshold.

Researchers' toolkit for natural experiments

- Keep finger on pulse for policy initiatives, especially local or regional policies and programs
- Maintain stakeholder engagement with community members to develop study designs and data collection for both intended and unintended consequences
- Consider longitudinal data sources e.g. occupational health, EHR data, school data.
- Consider non-experimental designs like instrumental variable approaches or experimental designs like staged roll-out's of programs.

WARNING: Drinking beverages with added sugar(s) contributes to obesity, diabetes, and tooth decay.

Thank You to our Team!

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