Advancing Research Methods for Evaluation of Natural Experiments in Obesity Prevention

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Background

- Obesity is an enormous public health problem with adverse health consequences for adults & children.
- Drivers of obesity epidemic are complex:
  - Food systems, physical activity environments, health care systems & other community, family & individual-level factors.
- Policies & population-based programs targeting obesity include economic approaches, urban planning & school-based programs to:
  - Improve fruit/vegetable consumption
  - Increase physical activity
  - Reduce body weight or prevent future obesity
Why conduct natural experiment studies?

• Often not feasible to conduct controlled trials of obesity programs & policies
  • Expensive, take long time, & intervention out of control of researchers

• Natural experiment studies used to evaluate programs, policies & built environment changes when
  • Intervention not designed for research
  • Variation in exposure & outcomes analyzed using methods that seek to make causal inferences
    • (U.K. Medical Research Council 2013)
Goals of the Systematic Review

• To systematically review studies, including natural experiments, evaluating programs & policies addressing obesity prevention & control in terms of their methods:
  • KQ1: Population-based data sources
  • KQ2: Use of data linkages
  • KQ3: Measures reported
  • KQ4: Study designs & analytic approaches
  • KQ5: Risks of bias
  • KQ6: Identify future research needs

• To identify methodological advances that could strengthen research that uses natural experiments to evaluate the effectiveness of programs & policies to prevent & control obesity.
Key Questions

1) What population-based data sources have been used in studies of how programs, policies, or built environment changes affect or are associated with obesity prevention & control outcomes?

2) What methods have been used to link different population-based data sources?

3) What obesity measures, dietary physical behaviors & other outcomes have been assessed in studies of how programs, policies, or built environment changes affect or are associated with obesity prevention & control?
Key Questions (continued)

4) Which experimental & non-experimental methods have been used in studies of how programs, policies or built environment changes affect or are associated with obesity prevention & control outcomes?

5) What are the risks of bias in studies of how programs, policies, or built environment changes affect or are associated with obesity prevention & control outcomes?

6) What methodological/analytic advances (e.g., data system features, approaches to linking data sources, or analytic methods) would help to strengthen efforts to estimate the effect of programs, policies, or built environment changes on obesity prevention & control?
## Scope of the Review

<table>
<thead>
<tr>
<th>PICOTS</th>
<th>Inclusion Criteria for Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population(s)</td>
<td>• All ages, general population; sub-populations of obese &amp; overweight</td>
</tr>
<tr>
<td>Intervention(s)</td>
<td>• US &amp; non-US policies, programs &amp; built environment changes targeting a population</td>
</tr>
<tr>
<td>Comparison(s)</td>
<td>• Studies with a clearly defined concurrent or non-concurrent comparison group (which could be prior to or without exposure to the policy or program)</td>
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<td>• Observational or cohort studies that use regression models to assess association of a policy or program with outcomes in an exposed vs unexposed group</td>
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## Scope of the Review: Outcomes of Interest

<table>
<thead>
<tr>
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| **Outcome(s)** | • Body weight & body mass index  
• Individual physical activity behavior assessed using validated questionnaire that assesses quantity & type of activity, or measures physical activity objectively (e.g., step counts).  
• Individual dietary behavior assessed using validated questionnaire, measuring one or more of the following:  
  o Total daily caloric intake  
  o Macronutrients related to obesity: vegetable, fruit or fiber  
  o Eating behaviors associated with obesity: sugar sweetened beverage intake, or fast food frequency  
**Co-outcomes:**  
• Described when studies had at least one “outcome of interest”  
• Categories included: food-environment (e.g. access to fruits), physical activity environment (e.g. walkability, observed physical activity at a park), commuting behavior, purchasing behavior |
## Scope of the Review: Timing & Setting

<table>
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</table>
| **Timing** | • Programs & policies enacted or implemented in 2000 or later  
  • The *US Surgeon General's Call To Action To Prevent and Decrease Overweight and Obesity* was published in 2001, marking a turning point to raise public health awareness about obesity. |
| **Setting** | • US & non-US settings at all levels (national, state, community/neighborhood) |
Analytic Framework

KQ=Key Question

Population
- All ages
- General population
- Subgroups
  - Gender
  - Age
  - Race/ethnicity
  - Socioeconomic status
  - Urban/rural residency
  - Type 2 diabetes mellitus
  - Pre-diabetes
  - Elevated cardiovascular risk

Interventions
- Policies, programs, and built environmental changes

KQ4 and 5
- Experimental and non-experimental methods and risk of bias

KQ1 and 2
- Data sources and linkage methods

KQ6
- Gaps

KQ3 Outcomes
- Obesity-related health behaviors*
  - Individual dietary and physical activity behaviors
- Obesity measures
  - Body weight
  - Body mass index
- Co-outcomes
  - e.g., purchases, commuting behavior
Methods: Study selection

• Searched PubMed, CINAHL, PsycINFO, & EconLit
  • 2000 to November 4, 2016
  • Update will be thru August 21, 2017
• Independent screening of abstracts & full-text articles
• Included if evaluated a program, policy or built environment change, with a defined comparison group, 100 or more study subjects, & written in English
Methods: Data extraction

- 2 reviewers serially extracted:
  - Study population & intervention characteristics
  - Data sources & their detailed characterization
  - Outcome measures
  - Study design & analytic approaches
Results of Literature Search

PubMed: 13,985
CINAHL and PsycINFO: 4718
EconLit: 538
Hand search: 2327

Total: 21568

DUPLICATES
2531

EXCLUDED
18007

EXCLUDED
754

INCLUDED STUDIES
261
(Reported in 276 articles)
**KQ1: Characterization of data sources**

- Assessed whether sources met criteria for a data system
  - Beyond collecting & managing data, contains some information technology infrastructure to maintain & operate the system

<table>
<thead>
<tr>
<th>Criteria for data system for obesity research</th>
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KQ2: Assessment of data linkages

- Used study reports & other publicly available information to assess types of data linkages
- Applied coding schema to identify methods for how studies linked data sources together
KQ3: Obesity measures

• Assessed which obesity measures were reported, how they were measured & what data sources included them
  • Weight & BMI - z-score & percentile
  • Individual dietary behaviors - total daily caloric intake, macronutrients related to obesity, & eating behaviors
  • Individual physical activity behaviors - activity type & quantity
  • Co-outcomes - food environment, physical activity environment, commuting behavior, purchasing behavior
KQ4: Study design & analytic approaches

• Abstracted details of natural experiment studies, experimental studies, & other study designs using classifications:
  • Experimental - RCT, controlled clinical trial
  • Non-experimental - cohort, case-control, interrupted time series, cross-sectional, other

• Analytic approaches characterized, including regression model, pre/post comparison, difference in differences, & others
KQ5: Risk of bias assessment

- Risk of bias evaluated independently by 2 reviewers using the Effective Public Health Practice Project (EPHPP) quality assessment tool.
- Domains: study design, selection bias, confounders, blinding, data collection, withdrawals/drop-outs.
- Using EPHPP algorithm, studies received domain-specific & global risk of bias ratings - strong, moderate, weak.
- Developed additional study-design specific questions for non-experimental designs.
KQ6: Methodological & analytic advances

- Developed & administered a feedback form to query our research team, internal advisors & external experts about what is needed to advance research methods & analytic approaches, aligned with each KQ
Key Question 1

What population-based data sources have been used in studies of how programs, policies, or built environment changes affect or are associated with obesity prevention and control outcomes?
Background

• Challenges in identifying population-based data sources & data systems
  o Not all natural experiments use data systems that can be shared with other researchers
  o Natural experiments often require population-level health survey data (e.g., NHANES, BRFSS)
  o Inconsistent use of terminology across sources
  o Inconsistent use or availability of data dictionaries
Methods

• Assessed whether sources met criteria for a data system
  o Beyond collecting & managing data, contains some information technology infrastructure to maintain & operate the system

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Key Findings (1)

• 294 studies reported one or more population-based data sources

• 93 US & non-US studies included secondary and/or sharable primary data sources.

• Within the 93 studies, we found 143 secondary data sources & 26 sharable primary data sources.
  
  o Total of 169 data sources $\rightarrow$ 116 data sources after duplicates removed
Key Findings (2)

• 96 data systems were used in natural experiment studies
• 71 were in US & met the 4 criteria for a data system.
• Of 71 US data systems, 39% were originally designed for an admin purpose & 31% for public health operations, & 57% had national coverage.
• 62% of the US data systems contained at least one of the main outcomes of weight, BMI, dietary, or physical activity behaviors.
• 53% included at least one of the co-outcomes or exposures such as information about the policy, program, built environment, or other geographical information.
Identification & Classification of Data Sources & Systems (1)

studies reviewed
n = 294

studies with non-sharable primary data source
n = 216

- non-sharable primary data sources
  n = 221 (not reviewed)

studies with sharable primary or secondary data source
n = 93

- sharable primary (26) or secondary (143) data sources
  n = 169
  
  - duplicates removed
    n = 53
    
    - data source did not fit data system definition
      n = 10

- sharable primary (21) or secondary (95) data sources
  n = 116

- sharable primary (20) or secondary (86) data sources
  n = 106
Identification & Classification of Data Sources & Systems (2)

- sharable primary (20) or secondary (86) data sources
  - n = 106

  - International Non-US data systems (primary 6; secondary 29)
    - n = 35 (33.0%)
    - US data systems (primary 14; secondary 57)
      - n = 71 (67.0%)

    - US data systems linked to other data sources
      - n = 26 (37.0%)
      - US data systems not linked to other data sources
        - n = 45 (63.0%)

    - US data systems linked to other data sources on an individual level
      - n = 10 (38.0%)
    - US data systems linked to other data sources using geography
      - n = 16 (62.0%)
Level of Information Available for US Data Systems (N=71)*

Values in each group, depicted by the lighter color, are mutually exclusive.
Original Purpose for Data Use & Function for US Data Systems (N=71)

- Public Health, 31.0%
- Research, 29.6%
- Clinical, 1.6%
- Administrative, 39.4%
Demographic Coverage of US Data Systems (N=71)*

Population Denominator
- General Population
- Community level
- Schools
- Programs
- Households
- Other

Age Coverage
- Infant
- Preschool
- Elementary School
- Middle School
- High School
- Teen/Adolescent/Youth
- Adult

Other Demographics
- Socio-economic Status
- Ethnicity
- Race

* Values in each group are not mutually exclusive & don't sum to 100%.
Obesity-Related Outcomes & Exposures in US Data Systems (N=71)*

* Values in each group are not mutually exclusive and do not sum to 100%.
Conclusions

• Only 1 in 5 of the US data systems were shared primary data collection efforts to be used by other researchers.

• Most data systems had information about their data on the web (70%) but only 15% had a formal/detailed data dictionary.

• Most US data systems were statewide or nationally representative (57% & 51%).

• Most US data systems had a focus on schools or communities (37% & 23%), respectively.
Key Recommendations for KQ1

• Need an obesity database catalogue/registry focusing on adults (NCCOR is mainly focused on children)
• Need to promote sharing of primary data collections
• Need to promote sharing of data dictionaries of available data sources
• Need to collate community-based data sets that capture objective measures (i.e., going beyond self-reported methods; e.g., population-level EHR data)
Key Question 2

What methods have been used to link different population-based data sources in studies evaluating programs & policies addressing obesity prevention & control?
Background for KQ2

- Natural experiment studies addressing obesity prevention & control need to use multiple data sources:
  - At all levels — e.g., national, state, & regional/small area/community data systems
  - Contain policy or program information — e.g., park density, transit maps, states where policies were implemented
  - Contain outcomes of interest — e.g., obesity-related measures from electronic health or school health records, national surveys & cohort studies
  - Follow populations over time to assess change — e.g., repeated, standard measures of same population
Background, continued

- Linking multiple data sources expands our ability to evaluate programs & policies to reduce obesity.
- Little data is available about the state of data linkages & methods in natural experiment studies on obesity.
Methods used for KQ2

- Systematic review identified 294 studies addressing population-based policies or programs on obesity prevention or control
- Abstracted all data sources from 294 studies
  - Considered “sharable” primary (collected for the purpose of the study only) or secondary data sources for assessment of linkages
  - Applied 4 criteria to assess if data source was a data system:
    - Data source can be located (e.g., on the web)
    - Data available & accessible digitally
    - Data are sharable & can be acquired for research (e.g., has public or transferable license)
    - Contains ≥1 obesity-related outcomes of interest
Methods: Data Synthesis

• For all U.S. Data Systems
  • We used published studies & other publicly available information to assess types of data linkages
  • Applied coding schema to identify methods for linkage of sources
    • What data sources were linked?
    • What was the linkage level?
    • What method was used to link?
Results: Identification of Linkages

Sharable primary or secondary data sources
N=106 out of 294 (36%)

U.S. Data Systems
N=71 (67%)

U.S. Data Systems linked to other sources
N=26 (37%)

Linkage at individual level
N=10

Linkage at geographic level
N=16

International sharable data sources
N=35 (33%)

U.S. data systems not linked
N=45 (63%)
Results: Linkage methods

• 26 of 188 US studies (23%) performed or used data linkages
  • All 26 studies with data linkages were natural experiments
  • 10 US studies (5%) used an individual-level key, e.g., patient identifiers, to perform linkages
  • 16 US studies used a geographic allocation, e.g., patient resides in a specific county thus mapping county specifications extracted from other sources for that individual
• 2 studies used statistical models to link primary data sources with external data sources & adjust for potential covariates.
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.

Datar A and Nicosia N. J. Adol Health. 2017
Geographic-level linkage

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

- Linked Data Sources
  - Vacant lots in Philadelphia assembled from the Philadelphia Bureau of Revision of Taxes, the Philadelphia Department of Licenses and Inspections, & US Postal Service record
  - Philadelphia Police Department’s longitude-latitude coordinates for crimes & arrests
  - Philadelphia Health Management Corporation 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 health and safety outcomes

Branas CC and colleagues. Am J. Epi. 2011
Conclusions

• Data system linkage is underutilized in natural experiments & other study designs addressing obesity prevention & control
  • Only 26 of 71 US (37%) data systems were linked with another data source.
Recommendations for KQ2

- Increase awareness among researchers & evaluators about availability of & methods for linking data systems

- Provide data dictionaries/codebooks for data systems, with standard formats & information about performing data linkages

- Address ethical/legal/privacy barriers to performing individual-level linkages – e.g., de-identified data in networks such as PCORNet

- Data with spatial/geographical attributes should contain consistent units of analysis to improve linking — e.g., census data & traffic data report different spatial units.
Key Question 3

What obesity measures, dietary & physical activity behaviors, & other outcomes have been assessed in studies of how programs, policies, or built environment changes affect or are associated with obesity prevention and control?
Background for KQ3

Standard measures for obesity-related outcomes:

- Weight: measured by trained staff
- Diet: 24-hour recall
- Physical activity: questionnaire
  - increased use of pedometers & accelerometers

Growing interest in measuring physical activity environment (e.g., walkability, park density) & food environment (e.g., number of fast food restaurants)
Methods used for KQ3

- Assessed which obesity measures were reported, how they were measured & what data sources reported them
  - Adult weight & BMI; Child BMI z-score & percentile
  - Individual dietary behaviors - total daily calories, fruit & vegetable, fiber, sugar sweetened beverage, and fast food intake
  - Individual physical activity behaviors - activity type & quantity
  - Co-outcomes including food environment, physical activity environment, commuting behavior, purchasing behavior
Child & Adult Weight Measures

• Child Weight Measures (BMI z-score or percentile), 95 of 294 studies
  • 46 studies were natural experiments
  • Most studies conducted in school setting

• Adult Weight Measures (Weight or BMI change), 32 of 294 studies
  • 17 studies were natural experiments
  • Most studies conducted in community or workplace settings
# Child & Adult Weight Measures in Natural Experiment Studies

<table>
<thead>
<tr>
<th>Method and Population</th>
<th>Outcome</th>
<th>Measure n</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Measured by trained staff</td>
<td></td>
<td>EHR</td>
<td>Self-reported</td>
</tr>
<tr>
<td>Children, N=50</td>
<td>Change in BMI z-score</td>
<td>14</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Change in BMI percentile</td>
<td>15</td>
<td>0</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Change in weight</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Adult, N=17</td>
<td>Change in body weight</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Change in BMI</td>
<td>6</td>
<td>0</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>

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
Natural experiment assessing weight

English Longitudinal Study of Aging (ELSA)

- Study design: observational study
- 8,309 - 11,305 older people in England
- Intervention: eligibility for free local bus travel
- Outcomes: self-reported public transport use, BMI
- Weight & height measured during nurse visits

## Child & Adult Weight Measures in Experimental Studies

<table>
<thead>
<tr>
<th>Measure, n</th>
<th>Method and population</th>
<th>Outcome</th>
<th>Measured by trained staff</th>
<th>EHR</th>
<th>Self-reported</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experimental studies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Children N=48 studies</strong></td>
<td></td>
<td>Change in BMI z-score</td>
<td>27</td>
<td>0</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Change in BMI percentile</td>
<td>13</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Change in weight</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td><strong>Adult N=13 studies</strong></td>
<td></td>
<td>Change in body weight</td>
<td>5</td>
<td>0</td>
<td>0</td>
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<td></td>
<td></td>
<td>Change in BMI</td>
<td>7</td>
<td>0</td>
<td>6</td>
<td>0</td>
</tr>
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BMI=Body Mass Index; EHR=electronic health records; n=number of measures reported; N=number of studies
*Studies may have captured more than one outcome so counts may not match total N
**Experimental study assessing weight**

**ATLAS cluster randomized controlled trial**

- Study design: cluster RCT in 14 secondary schools in low-income communities in New South Wales, Australia
- 361 adolescent boys (age 12-14 yrs) at risk of obesity
- Intervention: 20-week school-based intervention, including teacher training, fitness equipment, pedometers, parental strategies to reduce screen time
- Outcomes: BMI assessed using standard protocol for height & weight measurement

Child & Adult Diet Measures

Diet Measures, 148 of 294 studies

- 77 natural experiments (children N=52, adult N=30)
  - 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)
## Child & Adult Diet Measures in Natural Experiment Studies

<table>
<thead>
<tr>
<th>Measure n*</th>
<th>Outcome</th>
<th>24-recall</th>
<th>FFQ</th>
<th>Questionnaire</th>
<th>Record/log</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=52</td>
<td>Caloric intake</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Fast food</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sugar sweetened beverage</td>
<td>1</td>
<td>2</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Fruit/veg</td>
<td>5</td>
<td>6</td>
<td>29</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Fiber</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>N=30</td>
<td>Caloric intake</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Fast food</td>
<td>0</td>
<td>1</td>
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<tr>
<td></td>
<td>Fiber</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
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FFQ=food frequency questionnaire; Freq=frequency; Fruit/veg=fruit & vegetables; n=number of measures reported; N=number of studies; *Studies may have captured more than one outcome so counts may not match total N
Natural Experiment Assessing Diet

Pennsylvania Fresh Food Financing Initiative
- Study design: pre-post quasi-experimental longitudinal study
- 1,440 respondents
- Intervention: opening a new supermarket in a low-income, predominantly black community in Philadelphia
- Outcomes: BMI, daily fruit and vegetable intake, perceptions of food accessibility
- Mean fruit & vegetable intake assessed using Block Food Frequency Questionnaire

Cummins S, Flint E, Matthews SA. New neighborhood grocery store increased awareness of food access but did not alter dietary habits or obesity. Health Affairs 2014.
## Child & Adult Diet Measures in Experimental Studies

<table>
<thead>
<tr>
<th>Measure</th>
<th>Child N=47 studies</th>
<th>Adult N=17 studies</th>
</tr>
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<tbody>
<tr>
<td>Calories</td>
<td>0 1 1 1 1 1</td>
<td>1 0 0 0 0 1</td>
</tr>
<tr>
<td>Fast food</td>
<td>1 0 3 0 0 0</td>
<td>0 1 0 0 0 0</td>
</tr>
<tr>
<td>SSB</td>
<td>4 7 9 0 1 1</td>
<td>0 1 0 0 0 0</td>
</tr>
<tr>
<td>Fruit/veg</td>
<td>12 15 14 1 5 5</td>
<td>0 7 5 1 0 2</td>
</tr>
<tr>
<td>Fiber</td>
<td>0 3 1 0 0 0</td>
<td>0 1 1 0 0 0</td>
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FFQ=food frequency questionnaire; Freq=frequency; Fruit/veg=fruit & vegetables; n=number of measures reported; N=number of studies

*Studies may include more than one outcome so counts may not match total N
Experimental study assessing diet

High 5 Project

- Study design: RCT of 28 elementary school randomized to immediate intervention vs. delayed intervention
- 1,698 families of fourth-grade children
- Intervention: classroom, parent and cafeteria
- Outcomes: diet, psychosocial variables
- Fruit & vegetable consumption assessed 7 days of the week through 24-hr recall interviews

Child & Adult Physical Activity Measures in Natural Experiments

Physical Activity Measures, 152 of 294 studies

- 71 natural experiments (children N=43, adult N=32)
- Most in school (N=89) or community (N=40) settings
Child & Adult Physical Activity Measures in Natural Experiments

<table>
<thead>
<tr>
<th>Measure n*</th>
<th>Electronic monitor</th>
<th>Questionnaire</th>
<th>Record/log</th>
<th>Observation</th>
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</table>

GIS=Geographic Information System; n=number of measures reported; N=number of studies
*Studies may have captured more than one outcome so counts may not match total N
Natural experiment assessing physical activity

Mebane on the Move

• Study design: Difference in difference
• Mebane, North Carolina
• Intervention: community intervention designed to promote active living and decrease obesity
• Outcomes: physical activity & weight
• Child physical activity measured using an accelerometer for 1 week

# Child & Adult Physical Activity Measures in Experimental Studies

<table>
<thead>
<tr>
<th>Measure n*</th>
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<th>Questionnaire</th>
<th>Record/log</th>
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</tr>
</tbody>
</table>

GIS=Geographic Information System; n=number of measures reported; N=number of studies
*Studies may include more than one outcome so counts may not match total N
Experimental study assessing physical activity

Lowering playground density to promote physical activity

- Study design: within-subject design
- 128 4-6 year-old children in 4 preschools in Ghent, Belgium
- Intervention: increasing playground area per child to improve activity during recess
- Outcomes: physical activity
- Assessed using accelerometry during one preschool week

## Co-outcomes Among Study Designs (N=37 studies)

<table>
<thead>
<tr>
<th>Co-outcome</th>
<th>N studies</th>
</tr>
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<tbody>
<tr>
<td><strong>Natural Experiment</strong></td>
<td></td>
</tr>
<tr>
<td>Commuting behavior</td>
<td>3</td>
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<tr>
<td>Food environment</td>
<td>3</td>
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<tr>
<td>Physical activity environment</td>
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<tr>
<td>Purchasing behavior</td>
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</tr>
<tr>
<td>Other</td>
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<tr>
<td><strong>Experimental studies</strong></td>
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<td>Commuting behavior</td>
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<td>Purchasing behavior</td>
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</tr>
<tr>
<td>Other</td>
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<tr>
<td><strong>Other study designs</strong></td>
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<td>Food environment</td>
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</tr>
<tr>
<td>Other</td>
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</table>
Examples of Data Sources Used for Measures

Commonly used secondary data sources for obesity-related outcomes included:

- Behavioral Risk Factor Surveillance System (BRFSS)
- School Nutrition Dietary Assessment Study-III (SNDA-III)
- Youth Risk Behavior Survey Surveillance – National
- Bridging the Gap Community Obesity Measures Project (BTG-COMP)
- California Health Interview Survey
Conclusions

- Weight & BMI were most commonly directly measured by trained staff
- Dietary outcomes were most commonly measured using questionnaires
- Physical activity behavior was most commonly measured using questionnaires & electronic monitoring (e.g., pedometers)
Key Recommendations for KQ3

A lack of standardized measures & methods for obesity-related outcomes across populations and studies is common to all study designs.

Recommendations:

• Use consistent obesity-related measures across studies
• Increase use of standard objective measures of weight, diet & physical activity
• Increase reporting of food & physical activity environment changes in studies that report weight/diet/physical activity
• Develop a registry of standard measures that include adult obesity, diet & physical activity outcomes
Key Question 4

Which experimental & non-experimental methods have been used in studies of how programs, policies or built environment changes affect or are associated with obesity prevention & control outcomes?
KQ4 Background

• Challenges in evaluating programs, policies, & built environment changes aimed at obesity prevention & control
  • Need for population-based interventions
  • RCTs provide strong evidence, but not well suited to many interventions

• Increasing interest in using natural experiment studies
Natural Experiment Studies

• Natural experiment studies
  • Intervention implementation not for research
  • Variation in exposure & outcomes analyzed using methods that seek to make causal inferences (U.K. Medical Research Council 2013)

• Why natural experiment studies?
  • Population-level approach
  • Take advantage of existing variation & data sources
  • RCTs not feasible for some interventions

• Challenges
  • Observational (potential for confounding)
  • Lack methodological standards
  • Limited data sources
KQ 4 Methods: Study Design

• Natural experiment vs. experimental design vs. other
  • Was intervention under control of the investigator?

• Study designs & analytic approaches:
  • Natural experiment studies
    o Cross-sectional
    o Pre/post comparison
    o Difference-in-differences
    o Instrumental variable
    o Regression discontinuity
    o Interrupted time series
  • Experimental studies
    o Randomized or non-randomized controlled trial
KQ4 Results, 294 studies

156 Natural Experiment Studies (53%)

118 Experimental Studies (40%)

20 Other Study Designs (7%)
## Study Designs for Natural Experiments

<table>
<thead>
<tr>
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<tr>
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</table>
A Natural Experiment Study

Pennsylvania Healthy Food Financing Initiative

- Natural experiment study
- Difference-in-differences approach
- Random sample of residents in 2 neighborhoods:
  - One neighborhood with new supermarket
  - Race/income/demographic-matched control neighborhood
- BMI, Fruit + Vegetable intake measured pre- & post-supermarket construction

## Experimental Study Designs

<table>
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<td>Pre/Post</td>
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</table>
School Nutrition Policy Intervention to Prevent Overweight and Obesity

- Randomized controlled trial
- 10 low-SES schools in Philadelphia, PA
- Intervention: 1) school self-assessment; 2) nutrition education; 3) nutrition policy; 4) social marketing; 5) parent outreach over 2 years
- 1349 4th-6th graders
- Outcomes: BMI-z, diet

KQ4 Conclusions

• Natural experiment studies
  • Common: cross sectional (35%), pre/post (31%), differences-in differences (29%)
  • Uncommon: instrumental variables (3%), regression discontinuity (1%), interrupted time series (3%)

• Experimental studies
  • RCTs most common (67%)

• Challenges in classification
  • 7% not classified
KQ4 Key Recommendations

1) Consider longitudinal designs to strengthen inferences
2) Standardize terminology related to natural experiment designs & methods
3) Provide guidance on conduct, reporting, & evaluation of natural experiments
Key Question 5

What are the risks of bias in studies of how programs, policies, or built environment changes affect or are associated with obesity prevention & control outcomes?
KQ5 Background

- Evaluate the risks of bias in order to identify methodological advances to strengthen studies
- Lack of risk of bias assessments for natural experiment studies
- Risk of bias tool
  - For experimental & natural experiment studies
  - Include risks of bias important to natural experiment studies
  - Easy to apply
## KQ5 Methods

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

<table>
<thead>
<tr>
<th>Domain</th>
<th>Summary of Items</th>
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<td>Selection bias</td>
<td>Representativeness</td>
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<tr>
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<td>Participation rate</td>
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<td>For RCTs, randomization</td>
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<td>Withdrawals and dropouts</td>
<td>Count &amp; reasons for dropouts</td>
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<td>% completing study</td>
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<tr>
<td>Global Bias Rating</td>
<td>Strong if 0 weak domains; Weak if 2+ weak</td>
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</table>
Risk of bias for natural experiment studies (N=156)
Risk of bias for experimental studies (N=118)
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%)

• Sensitivity analyses to assess robustness to unobserved confounders (3%)
Categories of confounders accounted for in natural experiment studies (n=156)

- Community Factors
- School factors
- Household SES
- Baseline outcome
- Sex
- Race/ethnicity
- Age
KQ5 Conclusions

• Overall, natural experiment studies were rated “weak” (high risk of bias)
  • Room for improvement: Withdrawals/dropouts, confounding, study design

• Lack of methodological standards for the range of natural experiment studies
  • Challenging to assess and conduct natural experiment studies without standards
1) Provide guidance on conducting, reporting, & evaluating natural experiment studies that should include:
   • Emphasis on assessment & control of confounding
   • Domains of confounding variables specific to topic area
   • Best practices regarding selection of appropriate comparison groups
   • Catalog of obesity-related surveillance & data systems

2) Create “clearinghouse” of obesity prevention & control policies/programs that showcases highest quality evidence & provides “best practices” for researchers, policy-makers, & practitioners
Key Question 6

What methodological/analytic advances (e.g., data system features, approaches to linking data sources, or analytic methods) would help to strengthen efforts to estimate the effect of programs, policies, or built environment changes on obesity prevention & control?
Background for KQ6

• Policy makers need better estimates of the effects of programs, policies, or built environment changes on obesity prevention & control.

• Investigators need to use stronger methods to provide better estimates of the effects of programs, policies & built environment changes.
Methods for KQ6

• Developed & administered a feedback form to query our research team, internal advisors & external experts about what is needed to advance research methods & analytic approaches, aligned with each KQ
Expert Opinions on KQ6

What features or types of data sources could help researchers advance methods…?

- Process that encourages & facilitates dissemination of publicly available information about existence & location of data sources that include information about obesity-related outcomes or programs, policies, or built environment changes that could affect obesity prevention & control
- Consistent use of standard terminology, data dictionaries, & standard format describing how data were collected & validated (including data quality control processes)
- Description of the timing of interventions
- Coverage of small geographic areas in data sources.
Expert Opinions on KQ6

What methodological advances would help to facilitate better or more frequent linkage of population-based data sources for studies?

- Development & use of new & standardized methods for linking data, & development of reporting standards
- Adoption of standard policies & procedures for exchanging/sharing data
Expert Opinions on KQ6

What methodological advances (e.g. measures & data collection procedures) would help strengthen assessment of obesity-related outcomes, including dietary & physical activity behaviors?

- Longer-term surveillance of measures
- Standardized measures & methods for outcomes, e.g., park & transportation studies beyond only observing use
- Studies of purchasing behavior correlated to behavioral & health outcomes
- Establishing standards for collection of obesity-related outcomes in adults & children
- Consistent use of validated measures & terminology of obesity-related outcomes across studies
Expert Opinions on KQ 6

What study design & analytic approaches would help to strengthen methods & reduce the risk of bias encountered in studies?

- Consistent use of standards for terms & reporting in studies of obesity using natural experiments
- Design-specific reporting standards for observational study methods used in natural experiments
- Use of time-series designs vs simple pre-post comparisons
- Use of stronger natural experiment designs such as instrumental variables & regression discontinuity
- Use of validated instruments for measuring “exposures”
- Development & use of specific practical & validated tools for assessing risk of bias in observational studies
Key Recommendations

• Standardization of terminology, coding, reporting, & methods for linking & sharing data
  o Need more objective (beyond self-reported) population data
• Use longer-term observations of outcomes
• To reduce high risk of bias:
  o Standardize conduct & reporting of studies
  o More use of measures at multiple time points, rather than simple pre-post comparisons
  o Greater use of stronger natural experiment designs such as propensity scores, instrumental variables & regression discontinuity
Conclusions for KQ6

- Numerous methodological/analytic advances are needed to address the gaps & weaknesses identified in our systematic review of studies designed to estimate the effect of programs, policies, or built environment changes on obesity prevention & control.

- Such advances would help to give policy makers better estimates of the effectiveness of programs, policies & built environment changes on obesity prevention & control.