Getting the Most Bang for Your Buck in Public Health Policy: Using the CHOICES Model for Cost-Effectiveness Analysis of Childhood Physical Activity Interventions

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Active Living Research
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Why Cost Effectiveness?

When you talk to decision-makers about what can be done to improve childhood obesity, they want to know three things

- What is feasible (the intervention, program, policy)?
- How effective is it?
- What will it cost?
Your Survey Results

- How many people are impacted? (Reach)
- How effective is it? (Effectiveness)
- How large an impact it has on obesity or inactivity prevalence? (Population impact)
- How much does it cost? (Cost)
- How cost-effective is it? (Value for money)

CHOICES
Your Survey Results

- How does it affect people differently? (Equity) 7.0
- Do key people support it? (Acceptability) 6.0
- Is it easily or conveniently done? (Feasibility) 6.0
- Will it last? (Sustainability) 7.0
- Other positive or negative outcomes that may result (Unintended consequences) 5.0
- It is a new/novel idea (Innovation) 5.0
Why Use Cost Effectiveness Analysis

• Provides a strategy to compare competing policy options
  ▪ Cost
  ▪ Population impacted
  ▪ Likely outcomes
  ▪ Suggested implementation strategies
What is Cost Effectiveness?
Cost-effectiveness analysis can assess...
Cost-effectiveness analysis can assess affordability.

The diagram illustrates cost-effectiveness with different cost outcomes:

- **A** represents the baseline with zero cost.
- **B** is a point at $5K.
- **C** is a point at $12K, and
- **D** is a point at $15K, with a higher cost but more effective.

The diagram shows a cost-effectiveness analysis comparing various options (A, B, C, and D) with different costs ($5K, $9K, and $15K).
Cost-effectiveness analysis can assess...

Costs vs. Benefits diagram:

- A
- B
- C
- D

CHOICES
Cost-effectiveness analysis can assess value

**DEPENDS**
- What is ratio?
- Other factors

**BENEFITS**
- GREAT DEAL
- BAD DEAL

**COSTS**
Cost-Effectiveness Analysis: Outcomes

• The primary outcome of a CEA is the **incremental cost effectiveness ratio**

\[
\text{ICER} = \frac{\text{New Policy Cost} - \text{Usual Practice Cost}}{\text{New Policy Outcome} - \text{Usual Practice Outcome}}
\]

• ICERs are **comparative**

- Program costs
- Downstream Cost
- BMI reduction
- Cases of Disease
- Years of life
- QALYs, DALYs
Tradeoffs between Costs and Effectiveness

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Present Value of Program Cost</th>
<th>Present Value of Downstream Costs</th>
<th>Total Present Value Costs</th>
<th>Present Value of Lifetime Health Effects</th>
<th>ICER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usual Practice</td>
<td>0</td>
<td>$12K</td>
<td>$12K</td>
<td>30 LY</td>
<td>N/A</td>
</tr>
<tr>
<td>New Policy Intervention</td>
<td>$10K</td>
<td>$4000</td>
<td>$14K</td>
<td>32 LY</td>
<td>$2000/2 LY=$1000 per LY</td>
</tr>
</tbody>
</table>

CHOICES
CHOICES Study Goals

• To generate cost effectiveness estimates for 40 of the most relevant childhood obesity interventions in the United States;
• To engage policymakers and the general public in this issue, and provide guidance so the most cost effective strategies for action are identified and become a focus
Goals

• To move beyond “what is effective?” to:
  • Effectiveness
  • Population reach of interventions
  • Cost of interventions
  • Cost effectiveness

• Identify interventions providing “biggest bang for buck”
Cost Effectiveness Analysis: CHOICES

• Some interventions that can reduce BMI and obesity prevalence may save more money for society than they cost to implement.

• Other strategies may provide a relatively low cost option for reducing BMI and obesity rates compared to interventions that society is already willing to pay for (i.e. bariatric surgery).
CHOICES Outcomes

• CHOICES is concerned with ICERS related to BMI:
  ▪ cost per BMI unit
  ▪ cost per 1% reduction in obesity prevalence
  ▪ Shorter-term outcomes: cost per minute of MVPA achieved

• Independent physical activity pathway
• Interventions compared to a “natural history” scenario:
  ▪ what we would expect to happen to BMI levels, obesity rates and health outcomes if no interventions were conducted?
CHOICES Outcomes

• Same cost-effectiveness framework used for all interventions
• Can compare the cost and health outcomes for each intervention
ACTIVITIES to DATE

• Adapted framework from ACE/Australia
• Stakeholder group convened
• Interventions selected
  ▪ 75 interventions Considered
  ▪ 41 Currently in CHOICES Process
• Systematic reviews for intervention-specific evidence conducted
• Gathered reach/cost data
• Model intervention inputs (effectiveness, reach and cost)
• Markov cohort and Micro-simulation models developed
Microsimulation Overview

- Microsimulation – individual people are modeled
- Population heterogeneity can be represented
  - Geographic location (state-specific model estimates)
  - Evaluate intervention effects on disparities
  - Individual-level body measures and behaviors
Virtual U.S. Population

Each Individual has their own:

- **Demographics**
  - Location
  - Age
  - Sex
  - Income
  - Poverty Level
  - Race/Ethnicity

- **Body Measures**
  - Height
  - Weight
  - BMI

- **Behaviors**
  - Dietary intake
  - School Lunch, Fast Food Frequencies, etc.
Simulating Changes Over Time

• Model timeframe: 10-years

• Individual Level
  ▪ Use longitudinal trajectories to project growth (height and weight) for each individual
  ▪ Adjust for cohort effects

• Population Level
  ▪ “Open” population – Incoming children are “born” into the model
Intervention Description

• Who does what to whom?

• Logic model
  ▪ Impact of policy and/or program activities on behavior
  ▪ Impact of behavior on BMI
  ▪ Impact of BMI on health care outcomes and costs
Intervention Logic Models, Effect and Costing

- Intervention reach
- Intervention Implementation
  - Costs of
    - intervention
    - current practice
- BMI and Obesity
  - Short term outcomes: $cost/BMI
- 10 year BMI, Obesity, Health Care Costs Averted
  - 10 year outcomes: health care costs, $cost/BMI, obese year and prevalence
Implementation and Equity Considerations

• Equity and impact on disparities
• Level of evidence (e.g. pathway to BMI)
• Acceptability to stakeholders
• Feasibility
• Impact on social and policy norms
• Sustainability
• Side effects
CHOICES Example: Active PE Intervention

• Jessica L. Barrett, MPH
• Steven L. Gortmaker, PhD
• Michael W. Long, ScD
• Zachary J. Ward, MPH
• Stephen C. Resch, PhD
• Marj L. Moodie, DrPH
• Rob Carter, PhD
• Gary Sacks, PhD
• Boyd A. Swinburn, MD
• Y. Claire Wang, MD, ScD
• Angie L. Cradock, ScD

“Cost-effectiveness of an elementary school active physical education policy”

Active PE Intervention

How will the intervention be carried out?
Policy or program: Policy
Level of implementation: State
Sector: School
Age level: School age

Implementation of a state policy directing the U.S. state boards of education to include a requirement for **50% of PE time** to be devoted to **MVPA** in the state PE curriculum for the elementary school level

- Based on policies passed by state legislatures in Texas (SB 891, 2009) & Oklahoma (SB 1876, 2010)
- Implemented within **existing** PE time provided

Group Activity

• Describe your intervention using worksheet
What is the best available evidence linking the steps in the pathway?

Active PE Policy Implementation

- Modeled after SPARK and CATCH PE programs
  - PE curricula, portable equipment, & teacher training designed to increase student activity levels
    - Sallis et al. 1997; McKenzie et al. 1996

- All teachers at schools providing PE would be trained

- 73% (95% UI 58-90%) of trained teachers would implement, based on studies of ongoing maintenance of CATCH PE
  - Hoelscher et al. 2004; McKenzie et al. 2003

Evidence from a meta-analysis of active PE trials
- Lonsdale et al. 2013

Active PE would increase MVPA by 1.87 minutes (95% UI 1.23-2.51) during a 30-minute PE class

16% increase over existing MVPA levels during PE

Physical Activity and BMI

1 minute/day increase in MVPA on school days

0.023 decrease in BMI (95% UI 0.010-0.039)

Source:
- Kriemler et al. BMJ 2010: 9-month randomized controlled trial of a school-based physical activity intervention
- Mitchell et al. Obesity 2013: 6-year longitudinal observational study estimating change in BMI from change in MVPA

INTERVENTION REACH
INTERVENTION REACH

• How many children (and potentially adults) can we estimate would be effected by the intervention as specified?
  ▪ What age groups?
  ▪ What settings?
  ▪ What parameters?
  ▪ What assumptions?
# Reach of Active PE Policy

## Description Population # Source

<table>
<thead>
<tr>
<th>Description</th>
<th>Population #</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>All children under age 18 in U.S. population</td>
<td>73.6 million</td>
<td>U.S. Census, 2015 population estimates</td>
</tr>
<tr>
<td>All children ages 6-11 attending public elementary schools</td>
<td>24.6 million</td>
<td>99% of elementary schools offer any PE (Turner et al. 2012)</td>
</tr>
<tr>
<td>All states without a current policy</td>
<td>(47 states)</td>
<td>TX, OK, AZ, &amp; DC excluded (Carlson et al. 2013)</td>
</tr>
<tr>
<td>All children ages 5-11 attending public elementary schools in states without a current policy</td>
<td>18.5 million</td>
<td>U.S. Census, 2015 population estimates; U.S. DOE (NCES CCD; Digest of Education Statistics)</td>
</tr>
<tr>
<td>Eligible children attending PE</td>
<td>17.6 million</td>
<td>96% of elementary school children participate in PE (Office of the New York State Comptroller 2008; UCLA School of Public Health 2007)</td>
</tr>
<tr>
<td>Children among ITT population attending schools implementing the policy</td>
<td>12.6 million</td>
<td>72% of trained PE teachers implement (Hoelscher et al. 2004; McKenzie et al. 2003)</td>
</tr>
</tbody>
</table>

INTERVENTION COST
CHOICE Costing Methodology

Three steps:

1. **Resource Identification**
   - Identify incremental resources need to implement the intervention.

2. **Resource Measurement**
   - Quantify the amount of each resource needed to deliver the intervention (per person or per state).

3. **Resource Valuation**
   - Assign a monetary value to each identified resource.
Key Principles of the CHOICES Costing Process

• Modified Societal Perspective
  ▪ All resources included in cost, irrespective of who pays, except participant time.

• Opportunity Costs
  ▪ Resources valued according to their societal opportunity cost.
    • E.g., Teacher training

• Transfer Payments
  ▪ Not included as costs.
  ▪ Money is exchanged; no resource is consumed; no societal opportunity is lost.
    • E.g., tax revenue transferred from consumers to government.

• Incremental Costs
  ▪ Resources only included if different from natural history comparator.
## Cost of Implementing Active PE Policy

<table>
<thead>
<tr>
<th>Activity</th>
<th>Resource</th>
<th>Payer</th>
<th>Population</th>
<th>Source/Notes</th>
<th># Units</th>
<th>Unit Cost</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training for elementary school PE teachers through professional organizations &amp; state trainings</td>
<td>PE teacher training facilitator FTE</td>
<td>State government</td>
<td>ITT</td>
<td>Trainer salary taken from the US Bureau of Labor Statistics (Occupation 25-9031) and 45.6% fringe was added per June 2014 US BLS report of Employer Costs for Employee Compensation.</td>
<td>3.1</td>
<td>$93,900</td>
<td>$294,500</td>
</tr>
<tr>
<td>Training for elementary school PE teachers through professional organizations &amp; state trainings</td>
<td>Training paper copies</td>
<td>State government</td>
<td>ITT</td>
<td>Based on reasonable assumption given the average weekly number of PE minutes offered per school., and per SPARK model.</td>
<td>591,400</td>
<td>$0.15</td>
<td>$88,700</td>
</tr>
<tr>
<td>Replacement of PE curricula &amp; equipment for increasing MVPA</td>
<td>Curriculum and equipment set for PE class</td>
<td>Schools</td>
<td>ITT</td>
<td>Frequency of equipment replacement based on personal communication with expert stakeholders. Cost per set derived from SPARK and CATCH product websites.</td>
<td>9,900</td>
<td>$6,900</td>
<td>$68,000,000</td>
</tr>
<tr>
<td>Oversight of training and implementation</td>
<td>State PE coordinator FTE</td>
<td>State government</td>
<td>Eligible</td>
<td>Labor time needed based on reasonable assumption. Salary for state health coordinators based on personal communication with CDC, and 45.6% fringe was added.</td>
<td>3.3</td>
<td>$100,700</td>
<td>$331,000</td>
</tr>
<tr>
<td>Training for principals for assess MVPA in PE as part of annual evaluation of PE teachers</td>
<td>School principal FTE</td>
<td>Schools</td>
<td>ITT</td>
<td>Training time for principals based on consultation with school district stakeholders. School principal salary taken from the US Bureau of Labor Statistics (Occupation 11-9032) and 45.6% fringe was added.</td>
<td>10.8</td>
<td>$135,000</td>
<td>$1,460,000</td>
</tr>
<tr>
<td>Training for principals for assess MVPA in PE as part of annual evaluation of PE teachers</td>
<td>Principal training facilitator FTE</td>
<td>State government</td>
<td>ITT</td>
<td>Trainer salary taken from the US Bureau of Labor Statistics (Occupation 25-9031) and 45.6% fringe was added.</td>
<td>0.2</td>
<td>$93,900</td>
<td>$20,200</td>
</tr>
<tr>
<td>Oversight of monitoring</td>
<td>State PE coordinator FTE</td>
<td>State government</td>
<td>Eligible</td>
<td>Salary for state health coordinators based on personal communication with CDC, and 45.6% fringe was added.</td>
<td>1.4</td>
<td>$100,700</td>
<td>$142,000</td>
</tr>
</tbody>
</table>

**TOTAL COST:** $70.7 million

Group Activity

• Use Reach worksheet to define your populations and potential sources for finding data
• Use Resources worksheet to list your resources used and potential sources for finding data
  ▪ List your top 4 resources that will be biggest expense

<table>
<thead>
<tr>
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<th># Units</th>
<th>Unit Cost</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex: Training for PE teachers through professional organizations &amp; state trainings</td>
<td>PE teacher training facilitator FTE</td>
<td>State government</td>
<td>ITT</td>
<td>Trainer salary from the US Bureau of Labor Statistics</td>
<td>3 FTE</td>
<td>$100,000</td>
<td>$300,000</td>
</tr>
</tbody>
</table>
Group Activity

• Use your effect estimate and best guess for cost to come up with a Cost Effectiveness Ratio:
  ▪ Cost per increased minute of MVPA achieved
## Your Cost Effectiveness Guesstimates

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Effect (Minutes MVPA)</th>
<th>Reach</th>
<th>Cost</th>
<th>Cost per Minute MVPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity in the Classroom</td>
<td>10</td>
<td>3.37 million</td>
<td>30 million</td>
<td>1</td>
</tr>
<tr>
<td>Afterschool Physical Activity and Nutrition</td>
<td>1</td>
<td>3.78 million</td>
<td>141.75 million</td>
<td>37.50</td>
</tr>
<tr>
<td>Early Child Care Center Space</td>
<td>1</td>
<td>2 million</td>
<td>65 million</td>
<td>32.50</td>
</tr>
<tr>
<td>Active Travel to School</td>
<td>10</td>
<td>150 million</td>
<td>1.5 billion</td>
<td>100</td>
</tr>
</tbody>
</table>
### Results of Active PE Policy

<table>
<thead>
<tr>
<th></th>
<th>Mean (95% Uncertainty Interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in MVPA minutes/day per person</td>
<td>0.87 (0.14–1.86)</td>
</tr>
<tr>
<td>BMI unit (kg/m²) reduction per person</td>
<td>0.020 (0.003–0.050)</td>
</tr>
<tr>
<td>Cost per MVPA minute</td>
<td>0.026 (0.011–0.161)</td>
</tr>
<tr>
<td>Cost per MET-hour gained per person</td>
<td>0.34 (0.15–2.15)</td>
</tr>
<tr>
<td>Cost per BMI unit reduced ($)</td>
<td>401 (148–3,100)</td>
</tr>
</tbody>
</table>

Benchmark for Physical Activity Cost Effectiveness

  - If the cost of sedentary behavior accounts for 2.4-5% of annual healthcare costs (Colditz 1999; Roux et al. 2008)
  - And spending for healthcare in 2008 was $7681 per person (CMS)
    - Inflated to 2014: $8446
  - Then the cost of sedentary behavior was $203-$422 per person in 2014
  - National PA recommendations for youth translate to 1095 MET-hours
  - So for youth who are sedentary, a benchmark of cost effectiveness could be $0.19-$0.39 per MET-hour in 2014.
    - Or $0.014-$0.029 per MVPA minute

CMS. National health expenditure data. www.cms.hhs.gov/NationalHealthExpendData/02_NationalHealthAccountsHistorical.asp.
Active PE Conclusions

- Implementation of an Active PE policy among elementary schools could:
  - Result in a small increase in MVPA
  - Potentially reduce BMI
  - Have additional positive impacts related directly to physical activity increases
    - Improvements in cognitive function, fitness, and mood
    - Future reductions in risk of heart disease, diabetes mellitus, osteoporosis, and high blood pressure

Discussion

• How do we communicate cost effectiveness?
  ▪ How to report to different audiences/stakeholders?
  ▪ How to order results?
  ▪ What language to use?
Implementation and Equity Considerations

- Equity and impact on disparities
- Level of evidence (e.g. pathway to BMI)
- Acceptability to stakeholders
- Feasibility
- Impact on social and policy norms
- Sustainability
- Side effects
CHOICES Conclusions

• To make better choices, we need better information
• We need to move beyond just “what is effective” to:
  • Effectiveness
  • Population reach of interventions
  • Cost of interventions
  • Cost effectiveness
• Small differences in effectiveness are magnified by reach and cost => large differences in cost effectiveness
• Many childhood obesity preventive interventions are more cost effective than some obesity treatments
RESOURCES

- HSPH Center for Health Decision Science: [http://chds.hsph.harvard.edu](http://chds.hsph.harvard.edu)
- CEA registry: [https://research.tufts-nemc.org/cear/](https://research.tufts-nemc.org/cear/)
- Society for Medical Decision Making (SMDM)
- ISPOR Good Research Practices & Issues: [http://www.ispor.org/workpaper/practices_index.asp](http://www.ispor.org/workpaper/practices_index.asp)
- US Public Health Service Panel Recommendations