Behavior Change for Pediatric Obesity Prevention: What’s the Evidence?

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Obesity Prevention Interventions

- Most have not worked (hundreds of studies)
- When worked, very small changes
- When worked once, didn’t work again
- Not clear what intervention components change
  - Obesity prevention – children
  - Obesity prevention – adults
  - Family based obesity prevention
HEALTHY Trial

- $38 million
- Did everything said should be done
  - Changed school food services – no vending
  - Enhanced PE
  - Classroom behavior change program
  - Social marketing program
- Treatment & Control lowered >85th %tile BMI by 4%

(HEALTHY, NEJM 2010)
To Tweak or Transform?

- Choice: Minor changes “to get it right”
  /OR/Foundational changes “to make it right”

- Analysis of current situation

- Outline of three alternatives
Mediating-Moderating Variable Model (MMVM) Offers a Framework To Understand Why We Are Here

This is the simplest single MV model
Assumptions of the MMVM

- Interventions must be adequately implemented according to theory based protocol
- Interventions impact mediating variable(s)
  - Influences on behavior (personal, social, ecological, biological)
- Changes in mediating variables change behaviors
- Changes in behavior change adiposity
- Relationships are strong and causal
- Moderators: Variables accounting for differences
  - Dilute broad program effectiveness
- Benefit – MMVM is pan-theoretical
Implications of the MMVM

Need to:

- Select and target for change the behaviors that are strongest and causally related to adiposity change
- Select and target for change the mediating variables that are strongest and causally related to targeted behavior change
- Employ behavior change procedures that are proven effective at changing targeted mediators
- Make selections that minimize range of moderators

Measurement is a problem at all steps
General Concerns About Measurement Have Become Prominent in Epidemiology

- Could exposure measurement problems give us wrong answers...?
  - (A Schatzkin, V Kipnis, J Natl Cancer Inst, 2004 Nov 3;96(21):1564-5)

- Poor measures
  - May not detect true effects/relationships?
  - May misidentify effects/relationships?

- Concern about measurement quality needs to increase in behavioral research
Measurement Accuracy

- Validity correlations of 0.9 or higher needed to minimize misclassification error

1. Have we targeted the right indicators of adiposity that are related to the important health outcomes?

- Different program outcomes from different indicators
  - (J Stevens, et al, Obesity, Sep 2007;15(9):2163-2170)
- Indicator and adiposity may not be related as expected
  - (AM Prentice, SA Jebb, Obes Rev, Aug 2001;2(3):141-147)
- Different relationships in different demographic groups
- BMI is most commonly used indicator of adiposity
BMI Is Not Highly Related to % Body Fat (DEXA) in Girls 3-18 yo

Relation between percentage of body fat and body mass index for females aged 3-18 years living in the Houston, Texas, metropolitan area from 1994 to 1998.

(K Ellis, et al, Am J Epidemiol, 1999 Nov 1;150(9):939-46)
It’s Even Worse in Boys 3-18 yo

Relation between percentage of body fat and body mass index for males aged 3-18 years living in the Houston, Texas, metropolitan area from 1994-1998

(K Ellis, et al, Am J Epidemiol, 1999 Nov 1;150(9):939-46)
Many studies → severe limitation of BMI

Some alternatives:

- A simple composite (e.g., BMI, WC, TSF)
- A population specific regression equation predicting DXA, BodPod (T. Lohman)
- Use DXA, BodPod in the field?
- Remember we are striving for $r_{\text{validity}} > 0.9$
- While these procedures may be expensive, not detecting a true relationship because of error can be very expensive
2a. Behaviors most strongly & causally related to adiposity?

- Targeted behaviors not related to adiposity, e.g. sweetened beverages, fruit & vegetables
  - (T. Ledoux, et al, Obesity Rev, in press)

- Hard to find patterns over time

- Relationships of behaviors to adiposity changed with age?
2b. How complex are these relationships?

- Perhaps intakes of foods or food groups are parts of larger patterns, i.e. dietary intake patterns, e.g. Mediterranean diet

- Do these complex eating patterns inhibit change?
  - Hard enough with just fruit and vegetables
2c. When do participants compensate for changes in behavior, and thereby minimize its effect on adiposity?

- Compensation across days?
  - How compensate?
  - How check compensation?
  

- No compensation in TAAG?
  
(CD Baggett, et al, IJO, 2010)
• 3a. Are we using measures of these behaviors with acceptable metrics (validity, reliability, sensitivity to meaningful change)?

- Metrics often not reported in articles
- Validity of 0.9 necessary to minimize misclassification error
  - (C de Moore, et al, Pub Health Nutr, 2003;6:393-399)
  - We don’t usually get close
- PA ↔ adiposity?
- Severe under-reporting by the obese (10-20% kcal intake)
  - How to correct? Huang method? (lose half the sample)
3b. What measures of dietary intake should we use?

- New methods coming:
  - Computerized interviews (ASA24, FIRSSt)
  - Cell phone – verbal/text
  - Cell phone – images
  - Chest gadgets
  - Raman Spectroscopy (infrared)
4a. What mediating variable or combinations of mediating variables are necessary to change behavior?

- What are the best mediating variables?
  - Hypothesized mediating variables not related + suppressors
  - Outcome expectancies only consistent mediator in dietary change
    - (E. Cerin, JNEB, 2009)

- How do mediating variables change (process)?
Model of Goal Directed Physical Activity (PA) Effective Parenting Practices

Each color is from a different behavioral theory

(Adapted from SD Taylor, RP Bagozzi, et al, Br J Health Psych, 2005;10:505-530)
Models Linking Parenting To Child Behavior And Health Outcomes

Since links are multiplicative, weak effects at end
4b. How much change in each of how many mediating variables are necessary to change each behavior enough to influence adiposity?

- What mediating variables have been shown to predict and be causal of the behaviors of interest to you?
- What strength of relationships found?
5. Are we using measures of these mediating variables with acceptable metrics (validity, reliability, range, sensitivity to meaningful change?)

- **Self efficacy**
  - (R. Jago, et al, IJBNPA, 2009)
  - (T. Baranowski, et al, IJBNPA, 2009)

- **“Validated measure”**
  - (C deMoor, T Baranowski, Pub Health Nutr, 2003;6:393-399)
6a. What procedures have been validated as promoting meaningful change in the targeted mediating variables?

- **Self Efficacy for substance abuse**

- **Half the targeted mediators showed no change from intervention**
  - (T Baranowski, et al, Ann Epidemiol, 1997;7:S89-S95)
6b. How much intervention dose must be delivered to effect mediating variable change sufficient to influence behavior at necessary levels?

- Depends on intervention (intensity, quality, fidelity)
  - (T Baranowski, R Jago, Exercise Sport Sci Rev, 2005;33(4);163-168)

- Measures of implementation vary
7. Are there optimal circumstances for implementing these change procedures?
   • Have they been shown to work in this channel?
   • Have they been shown to work with this target group?
   • What procedures have been demonstrated to change the targeted mediators at a high enough level in your targeted population to expect enough change in the behavior to impact the indicator of adiposity?
8. Do the effectiveness of these procedures, or the nature of these relationships, vary by demographic, channel, location, or baseline characteristics?

- Eating in the absence of hunger is related to adiposity in boys, but not girls
  - (C Hill et al, IJO 2008; 32:1499-1505)
- Genes accounted for 63% variance in satiety responsiveness, 75% for food cue responsiveness
  - (S Carnell et al, IJO 2008;32:1468-1473)
Have assumed Simple Energy Balance (SEB)

- Energy intake
  - Food
  - Beverages

- Energy expenditure
  - Resting
    - Body composition
  - Post prandial
  - Growth

- Obesity has to be a result of energy imbalance (but not simple)
Have assumed Simple Energy Balance (SEB)

- Problems with SEB
  - Weight is not immediately and continually variable in response to energy imbalance
    - Plateaus, delays, limits
  - Ignores reasons why people might over eat, not exercise
Leptin Signaling Pathways

(Figure 1 - Han, Lawlor, Kimm. *Lancet* 2010, 375: 1737-48)
Emerging Picture of Causes of Obesity

- Genetic variation
- Epigenetics
- Endocrine irregularities
  - Appetite
  - Resting metabolism
  - Physical activity
- CNS pathology
- Intrauterine exposure to
  - Gestational diabetes
  - High maternal adiposity
Emerging Picture of Causes of Obesity

- Diet
- Energy expenditure
- TV viewing
- Sleep
- Microbial infection
- Iatrogenic
- Ethnic origin
- Socioeconomic position
- Neighborhood environment
- Etc.

These are all somehow inter-related; Need Systems Model

(Han, Lawlor, Kimm. Lancet 2010. 375: 1737-48)
Optional Intervention Paths Forward

1. Assume Δ in small number of environments and behaviors ➔ O prevention most people
   - But behaviors vary by region/target group
   - This is extension of existing model

2. Assume Δ in critical points in systems model ➔ O prevention most people

3. Assume everyone has different causes
   - Solution will require systems model & influences and complex analysis to individualize prevention
   - This is the 400+ genes are related to obesity model
Pathway 1: small number environments and behaviors

Prior to studies:

- Select adiposity indicator
  - What influences your targeted health indicator most in your target group?
  - Conduct an adiposity measurement study?
- Select target population
  - Who needs most?
- Select channel for reaching target population
  - Under what circumstances should a channel be selected for intervention?
    - Schools may not always be best
    - Too many competing responsibilities?
Formative Study A:

- Document what behaviors in what combinations are causally related to the selected indicator(s) of adiposity in the targeted group and channel, and whether they are strongly enough related to expect behavior change to influence adiposity
- Document the metric characteristics of the behavior instruments in the targeted group and channel
- If we can’t measure behavior with enough precision in reasonably sized samples, then should find another set of behaviors to target
Formative Study B:

- Document what mediating variables are causally related to the selected behaviors in the targeted group and channel, and whether they are strongly enough related to expect mediating variable change to influence behavior change
- Document the metric characteristics of the mediating variable instruments in this target group and channel
- If we can’t measure mediating variables with enough precision in reasonably sized samples, or if they are not related as expected, then should not proceed
Formative Study C:

- Document what change procedures induce meaningful change in the selected mediating variables in the targeted group and channel, and whether the dose is strong enough to expect change in the mediating variables at levels high enough to influence behavior.
- Document the quality control of implementation and the metrics of measures of sufficient dose.
- If we can’t change the mediating variables enough to expect a resulting change in behavior enough to influence adiposity, then should not proceed.
Formative Study D:

- Implement a pilot study where the change procedures are combined to reach the targeted group in the selected channel, and demonstrate feasibility.
Pathway 3: assume everyone has different causes (1)

- Research needs to integrate genetic, biological, behavioral and environmental influences
  - Has only started
- Prevention will need multiple interventions
  - Environmental: minimize endocrine toxins
  - Behavioral: get more sleep
  - Biological: vaccines, pills
  - Genetic
- Will need complex algorithms
Recommended assessment of childhood-onset obesity

(Figure 2 - Han, Lawlor, Kimm. Lancet 2010, 375: 1737-48)
Pathway 3: assume everyone has different causes

- **Problems**
  - Each behavior has own influence
  - How learn to motivate so many different behaviors?
    - Need simple generic motivational procedures?
    - Motivational interviewing?
    - Goal setting/problem solving
  - Will take a long time
  - Will be very expensive
Pathway 2: assume $\Delta$ in critical points in system $\Rightarrow$ prevention most people

- Need integrative research
  - Need systems models
  - Need to prioritize few intervention points with broad effects
- Need developmental perspective
  - Need change
- Need comprehensive continuous programs
  - How can we pursue this without violating individual rights?
We Have A Lot Of Work To Do!
Thank You!

Dêkuji! (Czech)
DANKE! (German)
MUITO OBRIGADO! (Portuguese)
M GÒI! (Chinese, Cantonese)
ARIGATŌ! (Japanese)
MERCI BEAUCOUP! (French)
MUCHAS GRACIAS! (Spanish)
SERDECZNI E DZI ËKUJ Ë! (Polish)
SHUKRAN! (Arabic, Middle East)
TACK SÅMYCKET! (Swedish)
TÅKK! (Norwegian)
EFCHARISTO! (Greek)
Xie Xie! (Chinese, Mandarin)
Dank u wel (Dutch)
Khawp Khun maxh! (Thai)
Grazie! (Italian)
Bio-behavioral Model of Likely Influences on Diet, Physical Activity and Adiposity

**Contextual Factors:**
- Socioeconomic Status (income, education)
- Gender
- Ethnic Group
- Region

**Environmental Influences**
- Norms

**Home Environment**
- (Food, PA, Media)
- (Choices)

**Parenting**
- (Food, PA, Media)

**Anticipated Outcomes/Reinforcers**
- Behaviors:
  - Dietary Intake/
  - Physical Activity

**Expected Outcomes/Reinforcers**
- Adiposity
- Experienced Outcomes/Reinforcers/Fullness
- Sensitivity to Reward

**Possible Gene Influences**
- Intrinsic Motivation (Wanting)/Values/Preferences (Liking)
- Habit
- Sensitivity to Reward

**Self Control Practices**
- Self-control Skills
- Experienced Cravings/Hunger/Loss of Control

**Self Efficacy**

**Possible Gene Influences**

Bolded lines and words are hypothesized gene related influences; environmental influences; Non bolded items below dotted line are psychosocial influences.