Childhood obesity – modelling the solutions?

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Obesity is a classic case of:

‘a mismatch between the magnitude of the public health problem and the adequacy of the evidence on potential interventions to address the problem’

Rychetnik et al J Epidemiol Comm Health 2004
IOTF framework for evidence-based obesity prevention

Questions | Evidence needed | Issue | Outputs
--- | --- | --- | ---
Should we do something? | Prevalence, trends, health impacts | 1. Burden of obesity | Burden estimates using costs, YLL, DALYs, or QALYs
What & who should we target? | Modifiable determinants of obesity | 2. Determinants, potential targets | Modifiable behaviours & environments, pop goals, target groups
How & where should we do intervene? | Relevant opportunities for action | 3. Framework for action | Strategies for settings, sectors, & support actions
Specifically, what could we do? | Potential specific actions & their likely impact & cost-effectiveness | 4. Potential interventions | Estimated effectiveness & population impact of potential interventions
Specifically, what should we do? | Implementation implications | 5. Portfolio of interventions | Agreed ‘best set’ of interventions & support actions

Contextual relevance – health, social, cultural, political

IOTF framework for evidence-based obesity prevention

Questions

- Should we do something?
- What & who should we target?
- How & where should we do intervene?

Evidence needed

- Prevalence, trends, health impacts
- Modifiable determinants of obesity
- Relevant opportunities for action
- Potential specific actions & their likely impact & cost-effectiveness
- Implementation implications

Issue

1. Burden of obesity
2. Determinants, potential targets
3. Framework for action
4. Potential interventions
5. Portfolio of interventions

Outputs

- Burden estimates using costs, YLL, DALYs, or QALYs
- Modifiable behaviours & environments, pop goals, target groups
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Contextual relevance – health, social, cultural, political

Latest Cochrane Review on Interventions for Preventing Obesity in Children

- 22 studies selected
  - Most less than 1 year in duration
  - Most in schools (primary)

- Conclusions unchanged from previous reviews
  - Diet and exercise interventions are NOT effective in preventing unhealthy weight gain but can be effective in promoting a healthy diet and increased PA levels

Summerbell et al 2005
Practice-based evidence
(Green L, Am J Health Behav 2001; Marmot M, BMJ 2004)

• More appropriate for public health interventions
  – More complex, may not be susceptible to RCTs
  – Need to incorporate implementation factors
  – Need engagement of key stakeholders

• Start with what could be done

• Keep evidence definition wide + include modelling

• End products
  – May have many assumptions, but can be comprehensive and relevant to decision-makers
Aims of intervention selection

To agree upon a balanced portfolio of specific, promising interventions to reduce the burden of obesity and improve health and quality of life.
ACE Obesity Project
(Assessing Cost-Effectiveness)

• 2y, DHS-funded project (Michelle Haby, Alison Markwick, Anne Magnus, Rob Carter, Marj Moodie)

• Based on previous ACE projects (cancer, heart disease, mental health) but obesity poses significant further challenges

• Aim
  – What are the best options towards which state and national resources should be directed to reduce overweight and obesity in children and adolescents?
ACE process

• Establish technical group & stakeholder working group
• Define interventions
  – From literature, current activities, possible actions
  – Very specifically defined
• Technical analyses
  – Population health gain, costs, cost effectiveness, cost utility, uncertainty/sensitivity analyses (simulations)
• Stage 2 ‘implementation’ filters
  – Strength of evidence, feasibility, sustainability, equity, other + or – effects, acceptability to stakeholders
Interventions being modelled

- Active transport
- Multi-faceted school program
- Soft drinks
- After school PA
- TV viewing
- School program for overweight children
- GP program for o/w & obese children
- Primary care for obese children
- Ban on TV food ads
- ? Fast food outlets
- ? Gastric banding
- ? Vacation camps for overweight children
- ? Taxes & subsidies
### ‘Promise’ Table

<table>
<thead>
<tr>
<th>Increasing evidence certainty</th>
<th>Increasing population impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increasing</td>
<td>Promising</td>
</tr>
<tr>
<td>Less promising</td>
<td>Promising</td>
</tr>
<tr>
<td>Least promising</td>
<td>Less promising</td>
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</tbody>
</table>
Logic pathway for modelling the effect of interventions

 изменение 

△ Захраняване (g) на храна/напитка
△ Енергийна густина храна
△ Енергийна густина на напитка
△ Седенина
△ Физическа активност

△ Изменение енергийен баланс

△ Вес
△ BMI

△ DALYs

△ Честота срещу болести и връзка с ожирението

△ Частичен/популационен моделиране

△ Обективно идентифициране на взаимодействия

△ TEE – Вт връзка

△ Енергетика
Including efficacy studies

Studies on sugar drinks and obesity

Studies on TV viewing and obesity

Δ Amount (g) of food/beverages
Δ Food energy density
Δ Beverage energy density
Δ Sedentariness
Δ Physical activity
Δ Energy intake
Δ Energy balance
Δ Energy output
Δ Weight
Δ BMI
Δ Prevalence o/w & obesity
Example 1: Active school transport

- Real data as far as possible
  - Existing AT patterns and mean distances
  - Existing programs (Walking School Bus, Travel Smart) and their reach and adoption
- Modelled energetic costs
  - Individual to go from car transport to active transport (METS, weight, duration)
- Extrapolate to population level (Australia)
- Assumed no compensation (EI or EE)
AT as a stimulus to be active at other times

Example 2: Change from non-core to core foods/beverage

- Interventions like promotion of core foods or reduced marketing of non-core foods
- Uses changes in energy density based on National Nutrition Survey data
- Assumptions are needed for changes in total weight of food, eg:
  - Add $\frac{1}{2}$ piece of fruit, displaces other food ($x\%$)
  - Subtract 1 glass of cordial, replaced by water or core beverages (100%)
Australian Guide to Healthy Eating
### 1995 NNS data 2-18 y/o

<table>
<thead>
<tr>
<th></th>
<th>Foods</th>
<th>Beverages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Core</td>
<td>N-Core</td>
</tr>
<tr>
<td>Energy density (kJ/g)</td>
<td>6.5</td>
<td>13.8</td>
</tr>
<tr>
<td>% by weight</td>
<td>72</td>
<td>28</td>
</tr>
<tr>
<td>% by energy</td>
<td>56</td>
<td>44</td>
</tr>
</tbody>
</table>

*Not including water

Colin Bell, personal communication
Changes from non-core to core foods/beverages

- Assumption of constant weight (g/day) of food and beverages
- Every 1 %-point change in non-core to core food (8.4g/d) reduces EI by 61 kJ/d
- Every 1 %-point change in non-core to core beverages (13.8 g/d) reduces EI by 24 kJ/d (water excluded)
- Total 1 %-point shift is 85 kJ/d
Change in amount of food & energy density of food (1985-95)
Logic pathway for modelling the effect of interventions

- **Δ Amount (g) of food/beverages**
- **Δ Food energy density**
- **Δ Beverage energy density**
- **Δ Sedentariness**
- **Δ Physical activity**

Energetics

Δ Energy intake → Δ Energy output → Δ Energy balance → Δ Weight Δ BMI

**Existing BoD modelling**

Δ DALYs → Δ Prevalence o/w & obesity

**TEE – Wt relationship**

Individual or Pop modelling

?Interactions
Modelling energy balance to changes in weight in children

• 963 children with energy expenditure data (7 study centres internationally)

• Use the cross-sectional relationship between logWeight and LogTEE (LogTEI) to determine relationship for changes

• Assumptions
  • TEE=TEI when in energy balance
  • Move from one equilibrium (settling point) to another

Swinburn, Jolley, Kremer, Salbe, Ravussin AJCN submitted
Cross-sectional relationship

(LnWt, height, age, gender r²=0.86)
Equations

1. \( \ln(wt) = 0.45 \ln(TEI) + 0.018 \times Ht - 0.012 \times \text{Age} + 0.022 \times \text{Gender} - 2.838 \)

2. \( Wt = (TEE)^{0.45} \times e^{\text{constants}} \)

3. \( \frac{Wt_2}{Wt_1} = \frac{(TEE_2)^{0.45} \times e^{\text{constants}}}{(TEE_1)^{0.45} \times e^{\text{constants}}} \)

4. \( \frac{Wt_2}{Wt_1} = \left( \frac{TEE_2}{TEE_1} \right)^{0.45} \)
Features of the relationship

- Residual relationship between TEE or TEI and weight is POSITIVE (adj height, age, gender)
  - EI-driven (high EI, high wt), not EE-driven (high EE, low wt)
  - Use TEI as the independent variable

- The use of a ratio relationship (eg 10% TEI  4.5% weight) sidesteps the spread of absolute values in childhood
Longitudinal relationship

Slope ≈ 0.45
Near linear within these limits

% change in weight

% change in energy balance

A = current population of children
Longitudinal relationship

C = population of children in 10 years time with 10% TEI (ED or 10%) or 10% TEE (exercise ~30-40% more)

B = population of children in 10 years time with 10% TEI (ED or 10%) or 10% TEE (exercise ~30-40% less)

Slope ~0.45
Features

• Thinking ‘populations’ not ‘individuals’ sidesteps issues of:
  – Efficiency of costs of storage versus costs of release of energy
  – Metabolic compensatory changes
  – Individual variability

• Big changes in AEE needed to change TEE
• Changing TEI (ED and g) seems more feasible
Validation

• Repeat TEE measurements 2-5 years
• Three datasets
  – N=111, 2y f/u, weight change 41.4 to 52.3kg (95% CI 49.7-55.0); predicted final weight 51.7kg
  – N=24, 5y f/u, weight change 33.7 to 58.4kg (95% CI 55.5-61.3); predicted final weight 56.9kg
  – N=77, 5y f/u, weight change 23.7 to 53.5kg (95% CI 50.0-57.0); predicted final weight 54.3kg
• Predict final weight to within 250g
Couple of preliminary findings

- **Active transport (Walking Bus + TravelSmart)**
  - Save ~XX BMI units
  - Cost ~$XX/m/y
  - Cost-effectiveness: ??
  - 2nd Stage filters: ??

- **Ban on junk food ads on TV**
  - Save ~XX BMI units
  - Cost ~$XX/y
  - Cost-effectiveness: ??
  - 2nd stage filters: ??
Couple of preliminary findings

- Active transport (Walking Bus + TravelSmart)
  - Save ~500 BMI units
  - Cost ~$38m/y
  - Cost-effectiveness – very low
  - 2nd Stage filters - Very popular, other positive effects

- Ban on junk food ads on TV
  - Save ~500,000 BMI units
  - Cost ~$100k/y
  - Cost-effectiveness - ‘Dominant’ ie cost saving
  - 2nd stage filters - Key stakeholder (Federal Govt) opposed
Reality check

• Ideal situation
  – Process driven by good data and modelling, explicit judgements, & transparent process
  – Outcome is a balanced portfolio of ‘best investments’

• Reality
  – Process driven by vested interest lobbying and political mileage
  – Outcome is a selection of ‘announceables’ or nothing (‘get it out of existing budgets’)

WHO Collaborating Centre for Obesity Prevention
Conclusions

• Shortage of proven interventions demands modelling for promising interventions
• Practice-based evidence approach
  – Engagement of stakeholders
  – Technical analyses
• Illuminates the ‘barn door’ issues
  – EI vs EE as determinants and interventions
  – Small changes, wide reach, high volume, policy
  – Clashes between technical & political rationales