Childhood Obesity: Implications for Future Health

Peter T. Katzmarzyk, PhD

Outline

1) Identifying overweight and obese children
2) Factors associated with childhood obesity
3) Obesity and health in childhood
4) Childhood obesity and future health
5) Clinical implications

An overarching model

Adulthood

Obesity

Health

Childhood

Obesity

Health
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Identifying overweight and obese children

CDC Growth Charts: United States
body mass index-for-age percentiles

International obesity task force classification
of overweight and obesity in children
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International obesity task force classification of overweight and obesity in children

Prevalence of obesity United States, 1971-2008

The Pediatric Obesity Epidemic Continues Unabated in Bogalusa, Louisiana
Stephanie Broyles, Peter T. Katzmarzyk, Sathanur R. Srinivasan, Wei Chen, Claude Bouchard, David S. Freedman, and Gerald S. Berenson

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Global prevalence of childhood overweight and obesity, 2001-02

Factors associated with childhood obesity

Parent and child factors associated with youth obesity

Odds ratios for obesity in 3,796 girls and 3,942 boys 12-19 y of age in the 2000/01 Canadian Community Health Survey, adjusted for age, parent and youth smoking status, and household income

Carriere; Health Reports 2003 14; 20-29

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Overweight and obesity in Canadian adolescents and their associations with dietary habits and physical activity patterns

Girls

Boys

Is the Canadian obesity epidemic related to physical inactivity?

Diet, physical activity and sedentary behaviors as risk factors for overweight in adolescence

- Patrick et al., Arch Pediatr Adolesc Med 2004; 158: 385-90
- Percentage of 878 adolescent boys and girls 11-15 y of age meeting various guidelines as a function of their weight status
- Normal weight vs. overweight (≥ "at risk plus overweight" in reference paper; children which exceed the 85th percentile for their BMI)
- Different guidelines include:
  - <2hr/d of weekend television
  - 60 min of physical activity
  - ≤30% of calories from total fat
  - <10% of calories from saturated fat
  - Fiber grams per day ≥ age +5
- Overweight children are less apt to meet the guidelines than normal weight children, while more normal weight children meet these guidelines than overweight children
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Obesity and health in childhood

The independent influence of physical inactivity and obesity on health complaints in 6th to 10th grade Canadian youth
Psychological health scores across physical activity and BMI categories in 2,792 girls and 2,602 boys 11-16 y of age in the 2000/01 Health Behavior in School-Aged Children Survey (Canadian Component)

![Graphs showing the relationship between physical activity, BMI, and psychological health scores for boys and girls.](image)

**Boys**
- Low activity: Normal psychological health score
- Moderate activity: Slightly elevated psychological health score
- High activity: Significantly elevated psychological health score

**Girls**
- Low activity: Normal psychological health score
- Moderate activity: Normal psychological health score
- High activity: Significantly elevated psychological health score

(p < 0.05)


The independent influence of physical inactivity and obesity on health complaints in 6th to 10th grade Canadian youth
Somatic health scores across physical activity and BMI categories in 2,792 girls and 2,602 boys 11-16 y of age in the 2000/01 Health Behavior in School-Aged Children Survey (Canadian Component)

![Graphs showing the relationship between physical activity, BMI, and somatic health scores for boys and girls.](image)

**Boys**
- Low activity: Normal somatic health score
- Moderate activity: Slightly elevated somatic health score
- High activity: Significantly elevated somatic health score

**Girls**
- Low activity: Normal somatic health score
- Moderate activity: Normal somatic health score
- High activity: Significantly elevated somatic health score

(p < 0.05)

(p > 0.05)


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The utility of the international BMI overweight guidelines for children and adolescents for predicting CHD risk factors


Odds of being in the high risk category (top 10%) of CVD risk factors in overweight vs. normal weight adolescents: 410 boys and 337 girls 9-18 y of age from the Quebec Family Study


The utility of the international BMI overweight guidelines for children and adolescents for predicting CHD risk factors


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Pediatric obesity and vascular health

**Flow mediated vasodilation at baseline of the intervention and obese control groups and lean control subjects and data after 6-month Intervention or non-intervention. Comparison of baseline in obese vs lean control subjects by 1-way ANOVA. Comparison of data at baseline vs after 6-months by paired t-test.**

Adapted from Meyer et al. J Am Coll Cardiol 2006;48:1865-70

**Pediatric obesity and vascular health**

Carotid IMT at baseline and after intervention in lean, intervention and obese control subjects

<table>
<thead>
<tr>
<th>Variable</th>
<th>Baseline</th>
<th>After 6 Months</th>
<th>p Value</th>
<th>Intervention</th>
<th>Baseline</th>
<th>After 6 Months</th>
<th>p Value</th>
<th>Lean</th>
<th>Baseline</th>
<th>After 6 Months</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMD t/m</td>
<td>0.06 + 0.06</td>
<td>0.04 + 0.06</td>
<td>0.012</td>
<td>0.47 + 0.08</td>
<td>0.47 + 0.08</td>
<td>0.012</td>
<td>0.47 + 0.08</td>
<td>0.47 + 0.08</td>
<td>0.012</td>
<td>0.47 + 0.08</td>
<td>0.47 + 0.08</td>
</tr>
<tr>
<td>CCA max</td>
<td>0.37 + 0.06</td>
<td>0.34 + 0.06</td>
<td>0.032</td>
<td>0.55 + 0.06</td>
<td>0.57 + 0.06</td>
<td>0.032</td>
<td>0.55 + 0.06</td>
<td>0.57 + 0.06</td>
<td>0.032</td>
<td>0.55 + 0.06</td>
<td>0.57 + 0.06</td>
</tr>
<tr>
<td>CB max</td>
<td>0.35 + 0.06</td>
<td>0.34 + 0.06</td>
<td>0.032</td>
<td>0.55 + 0.06</td>
<td>0.57 + 0.06</td>
<td>0.032</td>
<td>0.55 + 0.06</td>
<td>0.57 + 0.06</td>
<td>0.032</td>
<td>0.55 + 0.06</td>
<td>0.57 + 0.06</td>
</tr>
</tbody>
</table>

Comparison of baseline data between obese groups and lean control subjects by 1-way ANOVA *p<0.001
Comparison of data at baseline and after 6 months by paired t-test. Data presented as mean +/- SD
CB=carotid bifurcation; CCA=common carotid artery; FMD=flow-mediated vasodilation; IMT=intima-media thickness; max=maximum measurement; mean=mean of 10 measurements of left and right side

Adapted from Meyer et al. J Am Coll Cardiol 2006;48:1865-70
### Predicting obesity in young adulthood from childhood and parental obesity

Odds (95% CI) of being obese in young adulthood based on childhood and parental obesity

<table>
<thead>
<tr>
<th>Age</th>
<th>Obese as a Child</th>
<th>No. of Obese Parents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>yes vs no</td>
<td>1 vs 0</td>
</tr>
<tr>
<td>1-2</td>
<td>1.3 (0.6-3.0)</td>
<td>3.2 (1.8-5.7)</td>
</tr>
<tr>
<td>3-5</td>
<td>4.7 (3.5-8.8)</td>
<td>3.0 (1.7-5.3)</td>
</tr>
<tr>
<td>6-9</td>
<td>8.8 (4.7-16.5)</td>
<td>2.6 (1.4-4.6)</td>
</tr>
<tr>
<td>10-14</td>
<td>22.3 (10.5-47.1)</td>
<td>2.2 (1.2-3.8)</td>
</tr>
<tr>
<td>15-17</td>
<td>17.5 (7.7-39.5)</td>
<td>2.2 (1.1-4.3)</td>
</tr>
</tbody>
</table>

Whitaker et al. *NEJM* 1997; 337: 869-73

### Stability of adiposity phenotypes from childhood and adolescence into young adulthood with contribution of parental measures

12-year partial inter-age correlations, controlling for age and length of follow-up

<table>
<thead>
<tr>
<th></th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>0.65</td>
<td>0.59</td>
</tr>
<tr>
<td>FM</td>
<td>0.59</td>
<td>0.64</td>
</tr>
<tr>
<td>FFM</td>
<td>0.65</td>
<td>0.57</td>
</tr>
<tr>
<td>%BF</td>
<td>0.50</td>
<td>0.57</td>
</tr>
<tr>
<td>SF6</td>
<td>0.66</td>
<td>0.44</td>
</tr>
<tr>
<td>TERadj</td>
<td>0.41</td>
<td>0.47</td>
</tr>
</tbody>
</table>

p<0.001

Campbell et al. *Obes Res* 2001; 9: 394-400

### Stability of adiposity phenotypes from childhood and adolescence into young adulthood with contribution of parental measures

Prediction of young adulthood body composition from childhood and parental measures (R² values)

<table>
<thead>
<tr>
<th></th>
<th>Paternal</th>
<th>Maternal</th>
<th>Baseline</th>
<th>p=0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>0.01</td>
<td>0.0001</td>
<td>0.36</td>
<td></td>
</tr>
<tr>
<td>FM</td>
<td>0.01</td>
<td>0.0</td>
<td>0.37</td>
<td></td>
</tr>
<tr>
<td>FFM</td>
<td>0.0</td>
<td>0.05</td>
<td>0.31</td>
<td></td>
</tr>
<tr>
<td>%BF</td>
<td>0.006</td>
<td>0.006</td>
<td>0.27</td>
<td></td>
</tr>
<tr>
<td>SF6</td>
<td>0.0</td>
<td>0.0002</td>
<td>0.35</td>
<td></td>
</tr>
<tr>
<td>TERadj</td>
<td>0.005</td>
<td>0.02</td>
<td>0.26</td>
<td></td>
</tr>
</tbody>
</table>

Campbell et al. *Obes Res* 2001; 9: 394-400
Adolescent overweight is associated with adult overweight and related multiple cardiovascular risk factors: *the Bogalusa heart study*

![Graph showing data](image)

Srinivasan et al. Metabolism 1996 45:235-40

Change in BMI from adolescence to young adulthood and increased carotid intima-media thickness at 28 years of age: *the atherosclerosis risk in young adults study*

<table>
<thead>
<tr>
<th>Regression Coefficient (95% CI)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1: reader, adolescent age and gender</td>
<td>3.1 (2.1, 4.0)</td>
</tr>
<tr>
<td>Model 2: Model 1 + lumen diameter + adolescent BP and puberty status + adult BP and LDL</td>
<td>2.1 (1.0, 3.1)</td>
</tr>
<tr>
<td>Model 3: Model 2 + adult BMI</td>
<td>0.9 (-0.3, 2.2)</td>
</tr>
</tbody>
</table>


Long-term morbidity and mortality of overweight adolescents; *A follow-up of the Harvard growth study of 1922 to 1935*

![Graph showing data](image)


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Body Mass Index in adolescence in relation to total mortality: 32-year follow-up of 227,000 Norwegian boys and girls

Obesity in adolescence and adulthood and the risk of adult mortality

Stability of indicators of the metabolic syndrome from childhood and adolescence to young adulthood: the Québec family study
12-year partial inter-age correlations, controlling for age and length of follow-up

<table>
<thead>
<tr>
<th></th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF3</td>
<td>0.70</td>
<td>0.50</td>
</tr>
<tr>
<td>MBP</td>
<td>0.40</td>
<td>0.54</td>
</tr>
<tr>
<td>HDL-C</td>
<td>0.58</td>
<td>0.56</td>
</tr>
<tr>
<td>TG</td>
<td>0.37</td>
<td>0.20</td>
</tr>
<tr>
<td>CHOL/HDL-C</td>
<td>0.51</td>
<td>0.57</td>
</tr>
<tr>
<td>GLY</td>
<td>0.30</td>
<td>0.14</td>
</tr>
<tr>
<td>Risk Factor Index</td>
<td>0.51</td>
<td>0.46</td>
</tr>
</tbody>
</table>

k of death


Adolescent BMI percentile

Men

Women

Unadjusted

Adjusted for adult BMI

Men

Women

Engeland et al. Epidemiology 2004 15:79-85

<25th 25-74th 75-84th >84th

Adolescent BMI percentile

SF3 0.70 0.50
MBP 0.40 0.54
HDL-C 0.58 0.56
TG 0.37 0.20
CHOL/HDL-C 0.51 0.57
GLY 0.30 0.14
Risk Factor Index 0.51 0.46

p<0.05

Clinical implications

Pediatric weight management and treatment

<table>
<thead>
<tr>
<th>BMI Status</th>
<th>Treatment Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 85th percentile</td>
<td>Maintain BMI percentile to prevent obesity</td>
</tr>
<tr>
<td>85th – 95th percentile</td>
<td>Maintain BMI with age to reduce BMI percentile</td>
</tr>
<tr>
<td>≥ 95th percentile</td>
<td>Maintain BMI with age (younger children) or gradual weight loss (adolescents) to reduce BMI percentile</td>
</tr>
<tr>
<td>≥ 95th percentile with co-morbidities</td>
<td>Gradual weight loss to reduce BMI percentile</td>
</tr>
</tbody>
</table>

Adapted from Daniels et al. Circulation 2005; 111:1999-2012

Conclusions

1) There are several behavioral correlates of obesity in children, including physical inactivity and sedentary behavior

2) Obesity in children and youth is associated with both psychological and physical health problems, including an elevated risk of having high levels of cardiometabolic risk factors

3) Obesity in childhood is related to obesity in adulthood, as well as elevated CVD risk factors, other health measures and premature mortality in adulthood
### Acknowledgements

- **Québec Family Study**
  - Claude Bouchard
  - Robert Malina
  - Louis Pérusse
  - Angelo Tremblay
  - Jean-Pierre Després
  - Peter Campbell

- **Bogalusa Heart Study**
  - Gerald Berenson
  - Sathanur Srinivasan
  - Wei Chen
  - Claude Bouchard
  - Robert Malina

- **Health Behaviour in School-Aged Children Survey**
  - Ian Janssen
  - William Pickett
  - William Boyce