Relationship between weight and length in early childhood

William Checkley, MD, PhD
Stephanie Richard, PhD
Johns Hopkins University
wcheckl1@jhmi.edu
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Objectives

• Describe the longitudinal experience of wasting in childhood

• Examine the relationships between early childhood wasting and variability in weight-for-length and:
  • Linear growth faltering
  • Risk of stunting
Public health significance

- Malnutrition is a leading cause of illness and death in developing countries.
- Stunting, severe wasting, and IUGR are responsible for 2.2 million child deaths.
- 178 million children under five in developing countries are stunted.

Causes of undernutrition

Relationship of weight to height

• Inconsistent relationship between weight and length in cross-sectional studies
• Length decreases throughout first 2 y of life
• Weight-for-length falters early but levels
• Precise timing of weight-for-height faltering varies by weaning and region
• Cross-sectional data may misrepresent relationships?
Relationship of weight to height

- Single-center longitudinal studies found small but measurable relationships between weight and height growth
- Changes in weight may have a lagged effect on height
- Weight is maintained or regained under periods of nutritional stress at the expense of height
Relationship of weight to height

Costello AM. Arch Dis Child 1979; 64:1478-1482
Estimates of components of variances for the prevalences of stunting and wasting for 237 provinces from 45 nations

<table>
<thead>
<tr>
<th></th>
<th>Stunting</th>
<th>Wasting</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variances (square of prevalence as percentage)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Among nations</td>
<td>141.0</td>
<td>18.0</td>
</tr>
<tr>
<td>Among provinces within nations</td>
<td>102.6</td>
<td>7.3</td>
</tr>
<tr>
<td>Among individuals within provinces</td>
<td>21.0</td>
<td>5.6</td>
</tr>
<tr>
<td><strong>Ratios</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Among nations/Among individuals</td>
<td>6.7</td>
<td>3.2</td>
</tr>
<tr>
<td>Among provinces/Among individuals</td>
<td>4.9</td>
<td>1.3</td>
</tr>
<tr>
<td>Among nations/Among provinces</td>
<td>1.4</td>
<td>2.5</td>
</tr>
</tbody>
</table>

1 The variances shown for among individuals within provinces refer to the sampling variability expected for a hypothetical sample of 100 individuals.
Relationship of weight to height

Data

• 8 cohort studies (Childhood Malnutrition and Infection Network)

• At least one anthropometry measure in each of 4 six month periods (0-5, 6-11, 12-17, 18-23)

• 27,062 anthropometric measurements for 1,599 children
<table>
<thead>
<tr>
<th>Dates</th>
<th>Setting</th>
<th>Design</th>
<th>Purpose</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985-1987</td>
<td>Lima, Peru (urban)</td>
<td>Observational</td>
<td>Effects of diarrhea on growth</td>
<td>118</td>
</tr>
<tr>
<td>1989-1991</td>
<td>Lima, Peru (urban)</td>
<td>Observational</td>
<td>Effects of diarrhea on growth</td>
<td>84</td>
</tr>
<tr>
<td>1995-1998</td>
<td>Lima, Peru (urban)</td>
<td>Observational</td>
<td>Effects of diarrhea on growth</td>
<td>159</td>
</tr>
<tr>
<td>1989-2000</td>
<td>Goncalves, Brazil (urban)</td>
<td>Observational</td>
<td>Effects of diarrhea on growth</td>
<td>99</td>
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<tr>
<td>1987-1990</td>
<td>Bandim, Guinea-Bissau (urban)</td>
<td>Observational</td>
<td>Identify risk factors for diarrhea in Africa</td>
<td>90</td>
</tr>
<tr>
<td>1994-1997</td>
<td>Bandim, Guinea-Bissau (urban)</td>
<td>Randomized trial</td>
<td>Effects of dietary management of diarrhea on growth</td>
<td>434</td>
</tr>
<tr>
<td>2002-2006</td>
<td>Vellore, India (urban)</td>
<td>Observational</td>
<td>Comparative study of rotavirus epidemiology</td>
<td>246</td>
</tr>
<tr>
<td>1993-1996</td>
<td>Mirzapur, Bangladesh (rural)</td>
<td>Observational</td>
<td>Identify risk factors for diarrhea</td>
<td>369</td>
</tr>
</tbody>
</table>
Data

Keep only those with age <24 months

Keep only those with anthropometry in 0.2-5, 6-11, 12-17, and 18-23 periods

N=1,599
27,062 anthropometric measures
Acute or chronic

Stunting

- 29% stunted in >50% of measurements
- 80% of children stunted at 3, 6, or 9 months were stunted at 12 months

Wasting

- 1% wasted in >50% of measurements
- 30% of children wasted at 3, 6, or 9 months were wasted at 12 months
Cross-sectional relationship

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Correlation Coefficient (r)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5 mo</td>
<td>r = -0.04, P = 0.0017</td>
<td></td>
</tr>
<tr>
<td>6-11 mo</td>
<td>r = 0.18, P &lt; 0.000</td>
<td></td>
</tr>
<tr>
<td>12-17 mo</td>
<td>r = 0.33, P &lt; 0.000</td>
<td></td>
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<tr>
<td>18-23 mo</td>
<td>r = 0.42, P &lt; 0.000</td>
<td></td>
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</tbody>
</table>

The scatter plots show the relationship between LAZ (Length-for-Age Z-Score) and WLZ (Weight-for-Length Z-Score) for different age groups. The correlation coefficients and p-values indicate the strength and significance of the relationships.
% wasted on stunting by country

- Bangladesh 1993 (24)
- India 2005 (23)
- Guinea-Bissau 1987 (22)
- Peru 1985 (19)
- Guinea-Bissau 1996 (18)
- Peru 1989 (20)
- Brazil 1989 (17)
- Peru 1995 (21)
% wasting by age and region
Methods

• Predictors: Wasting in 0-5, 6-11, 12-17 month age groups, gender

• Length-for-age Z-score (continuous)
  • Random effects with robust variance

• Stunting (dichotomous)
  • GEE logistic regression with robust variance
Wasting and length-for-age
Mean LAZ difference by geographic region

- ■ Latin America
- ● Africa
- ▲ Asia

Wasted in period

- 12–17 months
- 6–11 months
- 0–5 months
Wasting and odds of stunting

Odds of stunting at 18–24 months

- - - - - - + + + + +

Wasted in period
12–17 months
6–11 months
0–5 months
Weight-for-length variability

SD=0.25

SD=0.5

SD=0.75

SD=1

SD=2

SD=3

Weight-for-length variability for different SD values.
## Weight-for-length variability

<table>
<thead>
<tr>
<th>WLZ variability in first 18 months (&gt; 0.5 SDs)</th>
<th>Mean effect LAZ (95% CI)</th>
<th>OR of stunting (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.51 (-0.67 to -0.36)</td>
<td>2.51 (1.23 to 5.09)</td>
</tr>
</tbody>
</table>
LAZ difference associated with higher WLZ variability
Conclusions

• Periods of wasting predict shortfalls in length-for-age and increase the risk of stunting

• Variability in weight-for-length is associated with lower length-for-age and higher risk of stunting and will be explored further

• Interventions to reduce wasting in early childhood will have benefits on linear growth retardation
Limitations

• Little wasting in Latin America and Africa

• Confounding factors not available

• Long-term effects of intrauterine growth restriction
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