A socio-ecological model of the double burden of malnutrition

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Looking backwards ...

Under-nutrition
- Low-income countries
- Poverty
- Food insecurity
- Infectious disease

Obesity
- High-income countries
- Affluence
- Food security
- ‘Modern’ lifestyles
Evolving concept

• Obesity and under-nutrition co-occur:
  - within the same country
  - within the same community
  - within the same family (mothers, children)
  - with the same person (stunted, overweight)

Speed of ‘nutrition transition’
This shifts explanatory framework from epidemiology to biology
New scientific approach

Socio-ecological model

Life-course development
Critical windows

Growth trait

Fetal life, Infancy

Age

Emergence of overweight

Early emergence of under-nutrition

Wells, J Theor Biol 2003
Critical windows

Emergence of overweight
Marked by BMI

Marked by wasting or stunting

Early emergence of under-nutrition

Growth trait

Fetal life  Infancy  Adolescence

Critical windows

Wells, J Theor Biol 2003
Critical windows

Growth trait

Maternal physiology

Emergence of overweight

Marked by BMI

Marked by wasting or stunting

Early emergence of under-nutrition

Fetal life  Infancy  Adolescence

Wells, J Theor Biol 2003
Maternal somatic phenotype

Ozaltin et al., JAMA 2010
Maternal epigenetic effects

Peri-conceptional exposure to maternal famine and IGF2 gene methylation in Dutch famine

Heijmans et al., PNAS 2008
Kwashiorkor and gut biota

Functional development of biome

Smith et al., Sci 2013
Obesity and gut biota

Ley et al., Nature 2006
Maternal obesity and co-morbidities

Maternal Obesity
Diabetes
Hypertension

Anemia
Inflammation
Perturbed metabolism
Impaired lactation

LBW
Preterm birth
Poor growth
Macrosomia
Socio-ecological model

Are there common factors?
# Food insecurity and child under-nutrition

## TABLE 3 Prevalence of child undernutrition, infant and young child feeding practices, and child morbidity by HFI category

<table>
<thead>
<tr>
<th></th>
<th>Bangladesh</th>
<th></th>
<th></th>
<th></th>
<th>Ethiopia</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Vietnam</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Food-secure</td>
<td>Mild HFI</td>
<td>Moderate HFI</td>
<td>Severe HFI</td>
<td>Food-secure</td>
<td>Mild HFI</td>
<td>Moderate HFI</td>
<td>Severe HFI</td>
<td>Food-secure</td>
<td>Mild HFI</td>
<td>Moderate HFI</td>
<td>Severe HFI</td>
<td>Food-secure</td>
<td>Mild HFI</td>
</tr>
<tr>
<td>Stunting</td>
<td>41.7***</td>
<td>54.5</td>
<td>55.2</td>
<td>62.8</td>
<td>45.5***</td>
<td>49.6</td>
<td>53.6</td>
<td>56.9</td>
<td>17.3***</td>
<td>23.2</td>
<td>27.8</td>
<td>25.6</td>
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<tr>
<td>Underweight</td>
<td>39.6***</td>
<td>49.5</td>
<td>48.2</td>
<td>56.9</td>
<td>22.4***</td>
<td>27.9</td>
<td>28.6</td>
<td>30.6</td>
<td>12.1***</td>
<td>19.8</td>
<td>22.7</td>
<td>19.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wasting</td>
<td>17.7***</td>
<td>20.4</td>
<td>18.7</td>
<td>25.4</td>
<td>5.3</td>
<td>6.4</td>
<td>5.9</td>
<td>6.4</td>
<td>4.5</td>
<td>4.6</td>
<td>7.1</td>
<td>5.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum DD</td>
<td>53.4***</td>
<td>41.2</td>
<td>41.5</td>
<td>33.0</td>
<td>9.1***</td>
<td>10.1</td>
<td>7.3</td>
<td>3.3</td>
<td>87.1***</td>
<td>81.0</td>
<td>75.1</td>
<td>73.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diarrhea</td>
<td>6.8***</td>
<td>9.4</td>
<td>9.9</td>
<td>11.7</td>
<td>13.4***</td>
<td>13.7</td>
<td>16.7</td>
<td>24.4</td>
<td>7.2***</td>
<td>12.1</td>
<td>11.2</td>
<td>12.6</td>
<td></td>
<td></td>
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<tr>
<td>ARI</td>
<td>30.3***</td>
<td>29.6</td>
<td>40.6</td>
<td>41.1</td>
<td>15.1***</td>
<td>15.1</td>
<td>22.3</td>
<td>30.3</td>
<td>14.1***</td>
<td>18.8</td>
<td>23.9</td>
<td>29.4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Values are percentages. The prevalence of various categories of HFI was compared by using chi-square test. Different from food-insecure households: **P < 0.01, ***P < 0.001. ARI, acute respiratory illness; DD, dietary diversity; HFI, household food insecurity.

Ali et al., J Nutr 2013
SES and fast food intake, Johannesburg

<table>
<thead>
<tr>
<th>Demographic variables</th>
<th>Frequency of fast food intake</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Seldom (less than twice per month)</td>
</tr>
<tr>
<td><strong>TOTAL SAMPLE (n = 341) (%)</strong></td>
<td>13 (3.8)</td>
</tr>
<tr>
<td><strong>SEG; n (%)^A</strong></td>
<td></td>
</tr>
<tr>
<td>LSEG (n = 117)</td>
<td>1 (0.9)</td>
</tr>
<tr>
<td>MSEG (n = 106)</td>
<td>7 (6.6)</td>
</tr>
<tr>
<td>HSEG (n = 118)</td>
<td>5 (4.2)</td>
</tr>
</tbody>
</table>

Van Zyl et al., S Afr J Clin Nutr 2010
Food insecurity and overweight

Figure 2. Kernel density and contour plots of school point pattern overlayed on vendor and sugar-sweetened beverage point patterns, Soweto, South Africa, 2013. [A text description of this figure (14_0559a.html#2) is also available.]

Moodley et al., Prev Chronic Dis 2015
Gender inequality and under-nutrition

Marphatia et al., Global Health Epidemiol Genom 2016
Gender inequality and ‘excess’ female obesity

Gender inequality and ‘excess’ female obesity

Vulnerable groups – migrants

Environment 1
- Poverty
- Food insecurity

Rural-urban
- Ethnic minorities in high-income countries

Environment 2
- Poverty
- Food insecurity

Under-nutrition

Obesity
Vulnerable groups - Refugees

- Poverty
- Food aid
- Restricted physical activity

Grijalva-Eternod et al., PlosMed 2012
Multi-level connections

- Macro-level and public policy
- Social environment
  - Family
  - Physical environment
  - Inter-generational
  - Individual
- Community
- Trade Policies
- Personal agency
- Food Insecurity
- Gender Equality
- Gut biota
- Maternal metabolism
Thank you for your attention