Effects of stunting on body composition, biological age, and muscle strength of Maya and Ladino children in Guatemala

Maria Inés Varela-Silva¹; Mustafa Sogut¹;²; Liña Mansukoski¹; Lidia Millan-Fernandez¹;³; Susana Monserrat-Revillo¹; Hugo Azcorra⁴; Federico Dickinson⁴; Samantha Sanchez⁴; Barry Bogin¹

¹Loughborough University, SSEHS, UK ²Kirikkale University, Turkey ³Universidad Autónoma de Madrid ⁴CINVESTAV, Ecología Humana, Mérida, México

Background

• Stunting is an indicator of chronic malnutrition and its nefarious effects linger for life.
• The Maya people from Guatemala show the shortest average height of any non-pygmy human population. This has not changed in the last 100 years.
• In Guatemala, data from 2010, showed that 50% of infants and children were stunted, some rural Maya regions had 70% children stunted, and 38% of Maya in rural Guatemala were stunted at birth.
• Guatemala went through 36 years of civil war (1960-1996) and its devastating effects are still in place, disproportionately burdening the Maya people from Guatemala show the shortest average height of any non-pygmy human population. This has not changed in the last 100 years.
• The prevalence of stunting is very high in both groups. However, Maya boys and girls show a significantly higher prevalence of stunting than the Ladino.
• The Maya are indigenous inhabitants of what is now the southeastern part of Mexico, Guatemala, Belize, San Salvador and Honduras. In Guatemala, the Maya speak >30 Mayan languages and Spanish, and practice a mixture of pre-Columbian and Christian traditions.
• The Ladinos are Spanish descendants, speak Spanish, practice Christianity and typically deny Maya ancestry.

(Varela-Silva et al 2016)

Aim

To assess the effects of stunting on body composition, biological age and muscle strength on a cross-sectional sample of Ladino and Maya children measured during the Civil War in Guatemala.

Hypotheses

1. Stunted children have less muscle mass, delayed biological age, and lower values of muscle strength than non-stunted children;
2. The year of birth impacts on stunting. Children born between 1971 and 1985 (Guatemalan Civil War at its peak of violence) have more negative growth outcomes than the children who were born after 1985; and
3. Being Maya exacerbates the negative effects of stunting.

Methods

Sample

N=1520, 436 Ladino and 1084 Maya, 838 boys & 682 girls, 6-16 years (Mean ± SD= 11.90±2.72), measured 1979-1999.

Measures

• Height (cm), weight (kg), arm circumference (cm), and triceps skinfold (mm) (Lohman et al 1988).
• Z-scores for anthropometry and upper index (Silva et al, 2016)
• Bone age (Bone Expert® http://www.bonexpert.com)
• Z-scores handgrip strength (McQuiddy 2015).
• Stunting: height-for-age < 5th percentile (NCHS), by age and gender.

Results | Descriptive Statistics

• Average Z-scores for height-for-age, in both Ladino and Maya groups, are significantly lower than the references (p<.000), but the Maya are significantly shorter than the Ladino (p<.000) (Fig 1-2).
• The prevalence of stunting is very high in both groups. However, Maya boys and girls show a significantly higher prevalence of stunting than the Ladino (Fig 3).

Results | Hypothesis testing

• Hypothesis 1 is fully accepted (Table 1).
• Hypothesis 2 is fully accepted (Table 2).
• Hypothesis 3 is fully accepted (Table 2 and 3).

Table 1: Linear regression. Predictors of UMA, Arm Age and Handgrip

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B</th>
<th>S.E.</th>
<th>Exp(B)</th>
<th>95% C.I. for EXP(B)</th>
<th>Lower</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.099</td>
<td>0.000</td>
<td>4.984</td>
<td>0.000</td>
<td>1.047</td>
<td>3.169</td>
</tr>
<tr>
<td>Group: 0=ladino, 1=Maya</td>
<td>-0.139</td>
<td>0.046</td>
<td>0.869</td>
<td>0.000</td>
<td>0.006</td>
<td>4.067</td>
</tr>
<tr>
<td>Gender: 0=male, 1=female</td>
<td>0.159</td>
<td>0.047</td>
<td>4.098</td>
<td>0.000</td>
<td>0.017</td>
<td>0.247</td>
</tr>
<tr>
<td>Age (dec years)</td>
<td>-0.045</td>
<td>0.008</td>
<td>0.500</td>
<td>0.000</td>
<td>0.028</td>
<td>0.002</td>
</tr>
<tr>
<td>Stunting: 0=No, 1=Yes</td>
<td>-0.284</td>
<td>0.043</td>
<td>0.761</td>
<td>0.000</td>
<td>0.175</td>
<td>0.008</td>
</tr>
</tbody>
</table>

Table 2: Logistic regression. Predictors of stunting (Nagelkerke R Squares 0.083)

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B</th>
<th>S.E.</th>
<th>Exp(B)</th>
<th>95% C.I. for EXP(B)</th>
<th>Lower</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group: 0=ladino, 1=Maya</td>
<td>0.094</td>
<td>0.012</td>
<td>2.949</td>
<td>0.924</td>
<td>3.589</td>
<td>1.69</td>
</tr>
<tr>
<td>Gender: 0=male, 1=female</td>
<td>0.293</td>
<td>0.109</td>
<td>1.344</td>
<td>1.081</td>
<td>1.661</td>
<td>1.09</td>
</tr>
<tr>
<td>Year of birth (1960-1970)</td>
<td>0.032</td>
<td>0.001</td>
<td>2.547</td>
<td>1.711</td>
<td>3.703</td>
<td>2.434</td>
</tr>
<tr>
<td>Year of birth (1971-85)</td>
<td>0.589</td>
<td>0.161</td>
<td>1.800</td>
<td>1.102</td>
<td>3.342</td>
<td>2.434</td>
</tr>
<tr>
<td>Constant</td>
<td>-1.425</td>
<td>0.282</td>
<td>0.000</td>
<td>0.024</td>
<td>1.000</td>
<td>0.24</td>
</tr>
</tbody>
</table>

Summary of Results

• Stunting is the strongest negative predictor of muscle mass, strength and biological maturation.
• Being Maya (especially male Maya) exacerbates the negative effects of stunting.
• Children born between 1960-70 were almost 2.5 times more likely of being stunted in childhood (adjusted for age and gender), and children born between 1971-1985 were almost 2 times more likely of being stunted when compared to children born after 1985.
• Being Maya doubled the odds of being stunted, when compared to being Ladino.

References