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

Maria Inês Varela-Silva[1]; Mustafa Sogut[1,2]; Liina Mansukoski[1]; Lídia Millan-Fernandez[1,3]; Susana Monserrat-Revillo[1]; Hugo Azcorra[4]; Federico Dickinson[4]; Samantha Sanchez[4]; Barry Bogin[1]

[1]Loughborough University, SSEHS, UK I [2]Kirikkale University, Turkey I [3]Universidad Autónoma de Madrid I [4]CINVESTAV, Ecologia 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 poorest segments of the population, such as the Maya and some *Ladino* groups.
- 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-arm indexes (Frisancho 2008).
- 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 I 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<.00) (Fig 1-2).

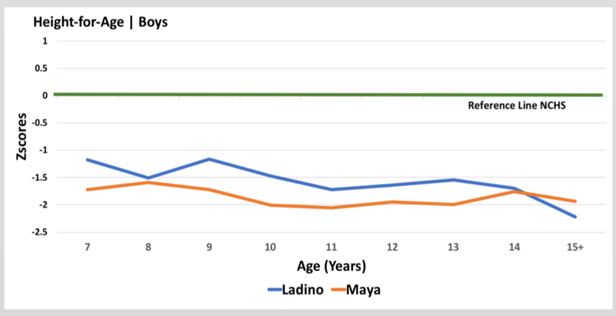

Fig 1. Z-scores height-for-age (boys)

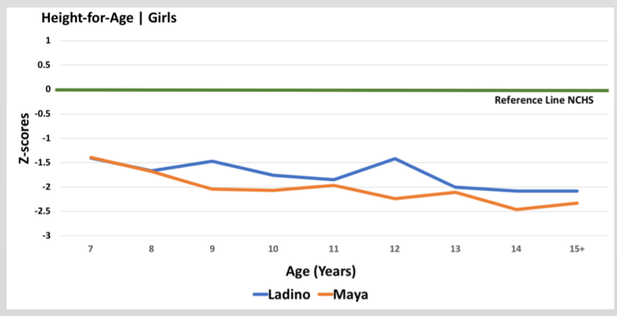

Fig 2. Z-scores height-for-age (girls)

- 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).

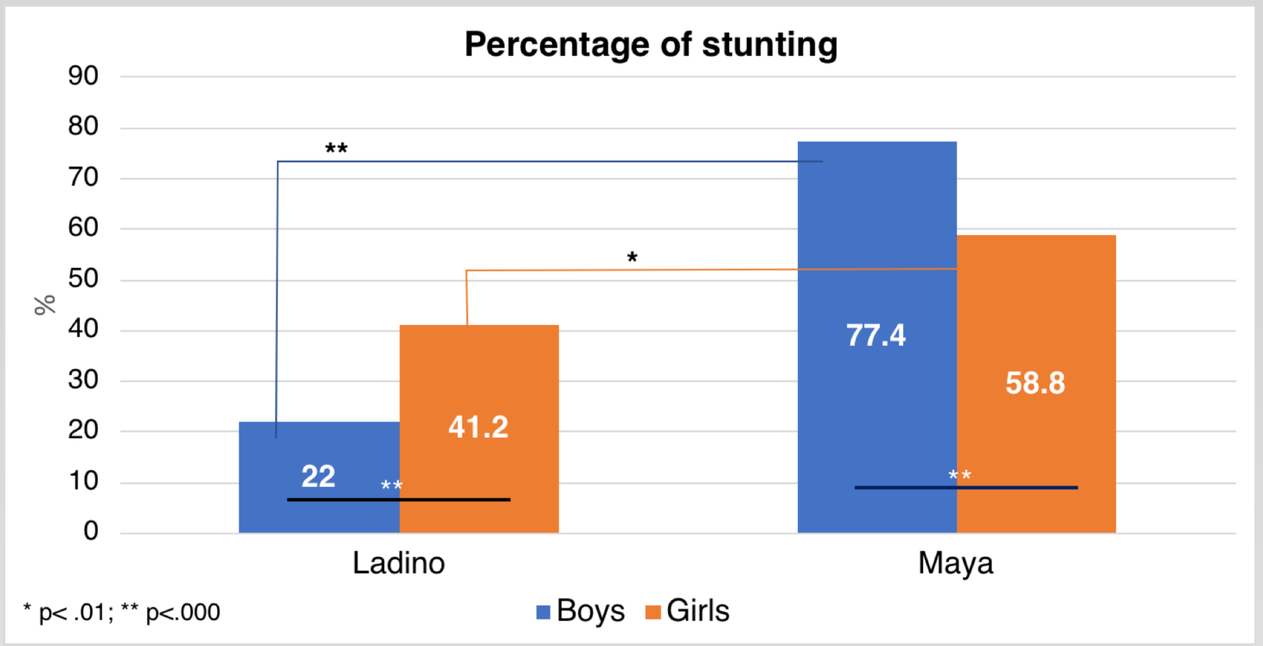

Fig 3. Prevalence of stunting by group and gender

Results I Hypothesis testing

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

	Upper Arm Muscle Area (R Sq Adj=0144)				Biological Age (R Sq Adj=0.175)				Handgrip (R Sq Adj=0.23)			
	Std Beta	Coeff SE	t	Sig	Std Beta	Coeff SE	t	Sig	Std Beta	Coeff SE	t	Sig
(Constant)		0.099	-8.494	**0.000**		0.148	-6.552	**0.000**		0.097	-12.368	**0.000**
Group: 0=Ladino, 1=Maya	-0.139	0.046	-5.694	**0.000**	0.006	0.07	0.262	0.794	0.066	0.045	2.84	**0.005**
Gender: 0=boy, 1=girl	0.159	0.042	6.596	**0.000**	0.113	0.062	4.788	**0.000**	-0.028	0.041	-1.247	0.213
Age (dec years)	-0.045	0.008	-1.822	0.069	0.085	0.012	3.548	**0.000**	0.175	0.008	7.541	**0.000**
Stunting: 0=No, 1=Yes	-0.284	0.043	-11.612	**0.000**	-0.418	0.064	-17.485	**0.000**	-0.468	0.042	-20.219	**0.000**

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

	B	S.E.	Sig.	Exp(B)	95% C.I.for EXP(B)	
					Lower	Upper
Group: 0= Ladino, 1= Maya	0.904	0.127	**0.000**	**2.469**	1.924	3.169
Gender: 0= Boys, 1= Girls	0.293	0.109	**0.008**	**1.34**	1.081	1.661
Age (dec years)	0.04	0.023	0.085	1.041	0.994	1.089
Year of birth (1960-1970)	0.935	0.203	**0.000**	**2.547**	1.711	3.793
Year of birth (1971-85)	0.589	0.153	**0.000**	**1.802**	1.334	2.434
Constant	-1.425	0.262	**0.000**	**0.24**		

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

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

Frisancho AR (2008). Anthropometric Standards. University of Michigan Press, Ann Arbor. _ **Lohman TG et al (1988**) Anthropometric Standardization Reference Manual. Human Kinetics, Champaign, Illinois. _ **McQuiddy VA et al (2015).** Normative Values for Grip and Pinch Strength for 6- to 19-Year-Olds. Arch Phys Med Rehab, 96: 1627-1633 _ **Varela-Silva MI et al (2016)** Deep data science to prevent and treat growth faltering in Maya children. Eur J Clin Nutr, 70: 679-680.