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Maternal Education and Nutritional Status in Merida, Mexico

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Resumen

Analizamos la asociación entre nivel educativo materno (NEM) y estado nutricional (EN) de 835 individuos (443 niñas, 392 niños) de 9 a 17 años, residentes de Mérida, México, entre septiembre de 2008 y diciembre de 2009. Evaluamos EN mediante puntajes *z* de talla para la edad (T/E), de perímetro de cintura para la edad (PC/E) y de suma de pliegues tricipital y subescapular para la edad (SP/E) y obtuvimos datos sobre nem y otras variables socioeconómicas. Un ANOVA de una vía mostró que los promedios de los puntajes *z* de T/E aumentaron y de SP/E disminuyeron ($p < 0.001$ en ambos casos) conforme el nem aumentó. Un mayor nem disminuyó las probabilidades de PC/E excesivo ($OR = 0.534$, 95 % $IC = 0.294$-0.968, $p = 0.039$) y nem medios o altos hicieron lo propio para T/E baja ($OR = 0.289$, 95 % $IC = 0.145$-0.575, $p = 0.001$ y $OR = 0.221$, 95 % $IC = 0.111$-0.441, $p = 0.001$, respectivamente) y para SP/E excesiva ($OR = 0.487$, 95 % $IC = 0.278$-0.856, $p = 0.012$ y $OR = 0.406$, 95 % $IC = 0.235$-0.703, $p = 0.001$). El nem protege contra desmedro y excesiva adiposidad en un contexto en el cual las tasas de desmedro y sobrepeso de niños y adolescentes son alarmantes. Nuestros datos no permiten identificar las vías por las cuales el nem tiene esta función, pero los resultados sugieren que influye en la conducta materna y es indicador del nivel socioeconómico de la familia.

Palabras clave: México, Yucatán, crecimiento, estado nutricional, educación materna.

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Abstract

From September 2008 to December 2009, we analysed the association between maternal education (ME) level and nutritional status (NE) regarding to height, waist circumference (WC) and sum of triceps and subscapular skinfolds (SumSkfs) in 835 individuals (443 girls and 392 boys) 9-17 years old living in Merida, Mexico, whose NE was evaluated using *z* scores for height-for-age, WC-for-age and SumSkfs-for-age. A socioeconomic questionnaire was applied to collect data on ME and other socioeconomic variables. A one-way ANOVA indicated that the mean *z*-score values for height increased and those for SumSkfs decreased ($p < 0.001$ in both cases) as ME level increased. High ME level decreased odds for excessive WC ($OR = 0.534$, 95 % $CI = 0.294$-0.968, $p = 0.039$), and middle or high level decreased odds for stunting ($OR = 0.289$, 95 % $CI = 0.145$-0.575, $p = 0.001$, and $OR = 0.221$, 95 % $CI = 0.111$-0.441, $p = 0.001$, respectively) and excessive SumSkfs ($OR = 0.487$, 95 % $CI = 0.278$-0.856, $p = 0.012$, and $OR = 0.406$, 95 % $CI = 0.235$-0.703, $p = 0.001$). In the sample, ME protects against stunting and adiposity in a context where rates of stunting, overweight and obesity are alarming. The pathways by which ME plays this role cannot be identified with this data set, but it may be an indicator of the socioeconomic status of mother's family of origin and a factor that affects maternal behaviour.

Keywords: México, Yucatan, children, growth, nutritional status.

Introduction

Child and adolescent nutritional status in Mexico continues to be a pressing national concern, with a 37.9 % of weight excess (overweight + obesity) in children 5 to 11 years old and a 35.8 % of weight excess in the 12 to 19 years old group, according to an official survey carried out in 2018 (INEGI *et al.* 2018: 39); the Southern Mexico is the region where malnutrition (under and overnutrition) rates are alarmingly high. The state of Yucatan has had some of the highest rates of child and adolescent chronic undernutrition (stunting) and overweight/obesity (OW/OB) in said region. Data from the National Survey of Health and Nutrition applied in 2006 (Encuesta Nacional de Salud y Nutrición, Ensanut), show that in urban school-aged children (5-11 years old) prevalence of low height-for-age was 23 % and that for OW/OB was 28 %. In urban teenagers (12-19 years old), prevalence for low height-for-age was 38 % and for OW/OB was 40.5 % (INSP 2007). A recent study carried out with 3 243 children

6-12 year-old in Merida, the capital of Yucatan, found prevalence of 6.41 % for stunting and 51 % for OW/OB (Mendez *et al.* 2016).

Several biological and socioeconomic factors can explain variations in children's nutritional status. Biological factors can include birth weight (Herngreen *et al.* 1994; Ulijaszek *et al.* 1998), birth order and interval, as well as genetic group, that is, an individual's link to his ancestors, as a proxy for genetics (Chakraborty *et al.* 1989; Colantonio *et al.* 2003; Relethford 1995). Social and economic factors can include head of household employment status, household income, crowding and access to piped water and toilets (Bogin 1991, 1999; Bogin and Keep 1999; Frisancho *et al.* 2001; Siniarska and Wolanski 1999; Ulijaszek *et al.* 1998).

One factor known to significantly improve children's health status is parent education level, especially maternal education, since mothers normally assume a greater responsibility in childcare (Grossman 2006; IEGY 2011). Several studies have shown that maternal education level is positively associated with child growth and nutritional status (Aslam and Gandhi Kingdon 2012; Atanasio *et al.* 2004; Biehl *et al.* 2013; Bjelland *et al.* 2010; Boyle *et al.* 2006; Chen y Li 2009; Fedorov y Sahn 2005; Frost *et al.* 2005; Geale 2010; Schuch *et al.* 2013; Sereebutra *et al.* 2006). This is the case when controlling for potential confounding variables, such as child age and sex, maternal age, income, ethnicity and urban/rural residence (Urke *et al.* 2011; Semba *et al.* 2008; Victora *et al.* 1992).

Merida is the most important city in Southern Mexico in terms of commerce, education, health and financial services. It is a socioeconomically segregated city; the city's lowest income population lives in its southern neighbourhoods. This area also generally lacks proper infrastructure in terms of household, education, health and recreation services. Middle-class households are concentrated largely in the northwest, and the high-income population is in the north. Both the northwest and north have more developed infrastructure and services (Pérez-Medina 2012). This internal segregation provides an opportunity to study the relationship between maternal education and child nutritional status in a social and economic context in which socioeconomic differences influence the population's biological conditions. As far as we know, no study on the influence of maternal education on nutritional status of young Mexican population has been published. The present study's aim is to analyse the association between maternal education and the nutritional status categories of height, waist circumference and triceps and subscapular skinfolds in a sample of growing individuals residing in Merida, Yucatan, Mexico. 'Nutritional status' is a multidimensional concept, including both biochemical, physiological, body composition, and body morphology and proportions; on the field, nutritional status could be measured using anthropometric techniques and bioimpedance, as we did for this study.

Methods and materials

Sample selection

From September 2008 to December 2009, a cross-sectional study was undertaken on a sample of 835 individuals (443 girls) 9-17 years old and their biological mothers from the city of Merida, Mexico. School selection was based on location and the concentration of different income level groups in the city with the purpose of including individuals from different socioeconomic groups. A map was generated indicating income levels within Merida, and then data sets from the Ministry of Public Education (Secretaría de Educación del Gobierno del Estado de Yucatán) and the National Institute of Statistics and Geography (Instituto Nacional de Estadística y Geografía, INEGI) were used to plot the city's existing schools. The maps allowed the identification of the public and private schools from the north and south of the city and their selection according to their range of distribution of income. Authorization was then requested from the Ministry of Public Education to visit schools, and permission requested from school principals to collect data. Permission was granted by seven private schools and fourteen public schools. Within each school potential study participants were randomly selected.

Anthropometric measurements

Height, as an indicator of nutritional history, waist circumference (WC) to asses central adiposity, and triceps and subscapular skinfolds (SumSkfs) as an approximation to body fat distribution, were measured between 7 and 10 hours, following standardized procedures (Lohman *et al.* 1988) by trained research assistants. Height, WC and SumSkfs data were transformed to *z*-score values and percentiles using the Comprehensive References published by Frisancho (2001), based on the NHANES III, which included US subjects of Mexican ancestry.

The nutritional status categories used were:

Height: Low height-for-age was defined as when a participants' height *z*-score was below – 1.650 or < 5th percentile.

Waist circumference (WC): Excessive WC-for-age was defined as when a participants' WC *z*-score was above 1.030 or > 85th percentile.

Sum of skinfolds (triceps + subscapular skinfolds): Excessive SumSkfs-for-age was defined as when a participants' SumSkfs *z*-score was above 1.030 or > 85th percentile.

Socioeconomic data: During home visits, mothers of the participating children and teens were asked to answer a questionnaire to collect data on maternal education level, the variable of interest in this study, and other variables, such as frequency of Maya surnames, family size and crowding regarding family socioeconomic condition.

In Mexico, the formal education system is organized as follows: basic education consisting of 6 years of elementary education and 3 years of junior high education, 3 years of high school education, and professional studies (e.g. technical or short careers, generally 3 years) or university studies (generally 5 years). For this study, three categories were used to classify maternal education level: 1) None or Basic: no formal education or elementary or junior high studied or finished (46 %), 2) Middle: high school or technical degrees studied or finished (20 %), and 3) High: bachelors, masters or doctorate degree studied or finished (34 %).

Socioeconomic and biological data was collected via the questionnaire included family crowding index, participants' ethnicity, mother's age, number of offspring and participant's birth weight. The crowding index was calculated by dividing the number of household members by the number of rooms used for sleeping (Coneval 2012); overcrowding was defined as a value of ≥ 2.5. Maya ethnicity was identified by the presence or absence of Maya surnames. As is common throughout Latin America, people born in Mexico have a patronymic and matronymic surname. Surnames can be used as a genetic proxy and a tool for identifying ethnic groups (Chakraborty *et al.* 1989; Colantonio *et al.* 2003; Relethford 1995), and have been used previously in studies of human biology in Merida (Wolanski *et al.* 1993; Azcorra *et al.* 2013, 2015; Vázquez-Vázquez *et al.* 2013). Based on presence or absence of paternal and maternal Maya surnames in the participants, three ethnicity categories were used: 1) no Maya surname, 2) one Maya surname and 3) two Maya surnames. Mother's age and number of offspring in the family were used as categorical variables (mother's age: 26-36, 37-47 and > 48 years; number of offspring: 1-3, 4-6 and > 7). Participant birthweight was obtained from birth certificates and used as a continuous variable.

Statistical analysis

Descriptive statistics (mean and standard deviations) of the anthropometric measurements and derived variables were calculated by age group and maternal education level. A chi-square test was applied to analyse the differences in the proportion between boys and girls in the nutritional status categories, and a Mann-Whitney test applied to analyse the differences in the mean *z*-score values of triceps and subscapular skinfolds between boys and girls. Estimates of associations between the stunting, excessive WC and excessive SumSkfs categories, and the maternal education categories were calculated using the odds ratios in binomial logistic regression models for categorical outcomes. In all models, the effect of child age and sex, overcrowding, birth weight, Maya ancestry, number of children and mother's age was controlled. The WC model was adjusted for child height, transforming the measurement in centimetres to its natural logarithm. The models were validated by calculating the Hosmer-Lemeshow goodness-of-fit test. Statistical analyses were done using the Stata/IC 11.1 for Windows statistics package (StataCorp 2010). Significance level in all analyses was set at $\alpha = 0.05$.

Results

Participant age and sex distribution data exhibited no significant differences in proportions of boys and girls by age group ($\chi^2_{(8)} = 6.04$, $p = 0.64$) (table 1).

Socioeconomic characteristics

Mean mother's age was 39.6 years ($SD = 6.14$), the largest portion (90 %) being between 26 and 47 years old, this range is due to the age range of children and adolescents who participated in the study (9-17) and to the fact that the participation of both students and their mothers was voluntary.

Table 1. Age and sex distribution of participants.

Age (years)	Boys		Girls		Total
	n	%	n	%	
9	42	46.67	48	53.33	90
10	56	50.00	56	50.00	112
11	48	46.15	56	53.85	104
12	53	44.54	66	55.46	119
13	30	36.59	52	63.41	82
14	34	50.75	33	49.25	67
15	39	45.88	46	54.12	85
16	50	50.00	50	50.00	100
17	40	52.63	36	47.37	76
Total	392	46.95	443	53.05	835

Most mothers (46 %) reported being at the None or Basic education level, and 34 % reported being at the High level. Sample distribution by number of offspring indicated most participants (80 %) belonged to families with a mean of 4.7 persons (SD =1.40). Based on surnames, 25 % and 13 % of participants had one and two Maya surnames, respectively. Crowding was present in 22.63 % of the families. Mean participant birth weight was 3 200 g (SD = 0.54), and 7.15 % were classified as low birth weight (< 2 500 g).

Anthropometric characteristics and nutritional status

Three hundred and thirty eight boys (86.2 %) and 358 girls (80.8 %) had height above the 5th percentile; the proportion of stunting, i.e. a height below the 5th percentile, was significantly higher in girls (19.19 % vs. 13.78 %, $\chi^2_{(1)} = 4.39$, $p = 0.036$). Boys had a higher prevalence of both WC than girls (25 % vs. 15.80 %, $\chi^2_{(2)} = 11.08$, $p = 0.004$) (table 2). In the overall sample, the prevalence of stunting was 17 % (139 individuals) and that of excessive WC was 20 % (168 individuals).

No significant differences in mean z-score values of triceps and subscapular skinfolds were observed between boys and girls (triceps mean = 0.44, SD = 0.74; subscapular mean = 0.61, SD = 0.83). However, girls as a

Table 2. Stunting and nutritional status categories by excess in the overall sample (n = 825), by sex (boys: 392; girls: 443).

Category	Boys		Girls		Total#		Statistical tests
	n	%	*n*	%	*n*	%	
Stunting (< 5th)	54	13.78	85	19.19	139	16.65	$\chi^2_{(1)}=4.39$, $p = 0.036$
Excessive WC (> 85th)	98	25.00	70	15.80	168	20.12	$\chi^2_{(2)}=11.08$, $p = 0.004$
Excessive TS (> 85th)	89	22.70	97	21.95	186	22.30	$\chi^2_{(1)}=0.06$, $p = 0.793$
Excessive SbS (> 85th)	123	31.38	135	30.54	258	30.94	$\chi^2_{(1)}=0.06$, $p = 0.795$
Excessive SumSkfs (> 85th)	70	17.86	116	26.24	186	22.30	$\chi^2_{(1)}=8.43$, $p = 0.004$

[#] The sum of columns of ‘n’ is not equal to 825 because an individual could be at different categories of nutritional status; WC: waist circumference; TS: triceps skinfold; SbS: subscapular skinfold; SumSkfs: sum of triceps and skinfolds.

group did exhibit higher values for the SumSkfs (girls: mean = 0.50, SD = 0.82 vs. boys: mean = – 0.08, SD = 1), and a higher proportion of excessive SumSkfs (26.24 % vs. 17.86 %, $\chi^2_{(1)} = 8.43$, $p = 0.004$) (table 2) (descriptive tables for anthropometric data are available upon request from the corresponding author). It is important to note that a given individual could be classified in more than one nutritional category, i.e. for example a girl or boy could be, simultaneously stunted and have excessive sum of skinfolds.

Maternal education and nutritional status

A one-way ANOVA indicated that as maternal education level increased, mean z-score values for height increased ($p < 0.001$), and mean z-score values for subscapular skinfold and SumSkfs decreased ($p < 0.001$) (table 3). The Bonferroni multiple comparison tests identified significant differences in mean z-score values for height between the three maternal education categories, as well as differences in mean z-score values for subscapular skinfold and SumSkfs between the None or Basic and High categories.

Logistic regression models

The binomial regression models showed that girls had a greater probability of having an excessive SumSkfs (OR = 1.56, 95 % CI = 1.108-2.259, p

Table 3. Descriptive statistics (mean ± *SD*) of anthropometric and derived variables of the overall sample, by maternal education level.

	Maternal education*						
Variables	**None or Basic** $n = 382$		**Middle** $n = 169$		**High** $n = 284$		**ANOVA *p*-value**
	Mean	*SD*	Mean	*SD*	Mean	*SD*	
Height (cm)	146.32	11.37	153.68	13.69	152.76	13.56	
HAZ§	– 1.16	0.95	– 0.48	0.91	– 0.25	0.92	$F = 84.39$, $p < 0.001$
TS (mm)	17.08	6.72	15.79	6.38	15.62	5.83	
TSZ	0.49	0.74	0.36	0.73	0.42	0.74	$F = 2.21$, $p > 0.05$
SbS (mm)	15.77	7.87	14.32	6.77	13.48	6.59	
SbSZ#	0.73	0.80	0.51	0.82	0.52	0.86	$F = 7.16$, $p < 0.001$
SumSkfs (mm)	32.89	14.04	30.12	12.57	29.10	11.74	
SumSkfsZ&	0.37	0.96	0.08	0.98	0.12	0.99	$F = 7.33$, $p < 0.001$
WC (cm)	71.99	10.47	71.85	10.46	71.08	9.78	
WCZ	0.38	0.81	0.27	0.77	0.33	0.81	$F = 1.08$, $p > 0.05$

* Maternal education: None or Basic = no formal education, elementary or junior high complete or incomplete; Middle = high school or short vocational degrees complete or incomplete; High = bachelors, masters, doctorate, and technical degrees complete or incomplete. HAZ: height-for-age z-scores; TS: triceps skinfold; TSZ: triceps skinfold z-scores; SbS: subscapular skinfold; SbSZ: subscapular skinfold z-scores; SumSkfs: sum of triceps and subscapular skinfolds; SumSkfsZ: sum of triceps and subscapular skinfolds z-scores; WC: waist circumference; WCZ: waist circumference z-scores.

§ Level 3 > Level 2 > Level 1.

\# Level 1 > Level 2, Level 1 > Level 3.

& Level 1 > Level 2, Level 1 > Level 3.

= 0.018), and lower odds for excessive WC (*OR* = 0.647, 95 % *CI* = 0.432-0.971, *p* = 0.035) (tables 4-6). After controlling for all other predictors, a High maternal education level decreased the odds for excessive WC (*OR* = 0.534, 95 % *CI* = 0.294-0.968, *p* = 0.039) (table 4), while Middle and High education levels lowered the odds for stunting (*OR* = 0.289, 95 % *CI* = 0.145-0.575, *p* = 0.001 and *OR* = 0.221, 95 % *CI* = 0.111-0.441, *p* = 0.001, respectively) (table 5) and excessive SumSkfs (*OR* = 0.487, 95 % CI = 0.278-0.856, *p* = 0.012 and *OR* = 0.406, 95 % *CI* = 0.235-0.703, *p* = 0.001) (table 6).

Table 4. Logistic regression model for excessive waist circumference (WC).

Factors	***OR***	***SE***	***p***	**95 % *CI***
Normal WC	Base Outcome Odds Ratio = 1.00			
Child age (years)	0.484	0.043	**0.000**	0.407-0.577
Child sex (girls)	0.647	0.133	**0.035**	0.432-0.971
LogNat height	1.001	0.0002	**0.000**	1.001-1.002
Overcrowding	0.916	0.251	0.750	0.535-1.569
Low birth weight	0.809	0.365	0.639	0.334-1.959
Maya ancestry				
No Maya surname				
One Maya surname	1.313	0.362	0.322	0.765-2.254
Two Maya surnames	1.272	0.450	0.495	0.636-2.546
Number of children				
1-3 (reference)				
4-6	1.226	0.347	0.471	0.704-2.138
> 7	1.405	0.736	0.516	0.503-3.924
Maternal age (years)				
26-36 (reference)				
37-47	0.992	0.229	0.975	0.631-1.561
> 48	1.446	0.582	0.359	0.657-3.186
Maternal education				
None or Basic (reference)				
Middle	0.542	0.171	0.053	0.291-1.007
High	0.534	0.162	**0.039**	0.294-0.968

n = 724, *OR*: Odds ratio; *SE*: Standard error; *CI*: Confidence interval; LogNAT height: natural logarithm for height; Overcrowding: > 2.5 persons per room; Low birth weight: < 2 500 g; Maternal education: None or Basic = no formal education, elementary or junior high complete or incomplete; Middle = high school or short vocational degrees complete or incomplete; High = bachelors, masters, doctorate, and technical degrees complete or incomplete. Hosmer-Lemeshow $\chi^2 = 19.61$, $p = 0.051$.

Table 5. Logistic regression model for height-for-age (stunting).

Factors	***OR***	***SE***	***p***	**95 % *CI***
Normal height for age	Base Outcome Odds Ratio = 1.00			
Child age (years)	1.133	0.056	**0.013**	1.027-1.249
Child sex (girls)	1.451	0.324	0.095	0.936-2.247
Overcrowding	1.635	0.413	0.051	0.997-2.683
Low birth weight	1.746	0.648	0.133	0.843-3.616
Maya ancestry				
No Maya surname (reference)				
One Maya surname	1.457	0.404	0.175	0.845-2.511
Two Maya surnames	1.693	0.540	0.098	0.906-3.164
Number of children				
1-3 (reference)				
4-6	0.875	0.248	0.639	0.502-1.526
> 7	0.825	0.493	0.749	0.255-2.665
Maternal age (years)				
26-36 (reference)				
37-47	1.221	0.314	0.435	0.738-2.021
> 48	1.509	0.618	0.315	0.676-3.366
Maternal education				
None or Basic (reference)				
Middle	0.289	0.101	**0.001**	0.145-0.575
High	0.221	0.077	**0.001**	0.111-0.441

n = 724, *OR*: Odds ratio; *SE*: Standard error; *CI*: Confidence interval; Overcrowding: > 2.5 persons per room; Low birth weight: < 2 500 g; Maternal education: None or Basic = no formal education, elementary or junior high complete or incomplete; Middle = high school or short vocational degrees complete or incomplete; High = bachelors, masters, doctorate, and technical degrees complete or incomplete. Hosmer-Lemeshow χ^2= 14.25, p = 0.161.

Table 6. Logistic regression model for excessive sum of skin folds (SumSkfs).

Factors	*OR*	*SE*	*P*	95 % *CI*
Normal SumSkfs	Base Outcome Odds Ratio = 1.00			
Child age (years)	0.746	0.033	**0.000**	0.682-0.815
Child sex (girls)	1.561	0.294	**0.018**	1.108-2.259
Overcrowding	0.627	0.153	0.056	0.388-1.011
Low birth weight	0.605	0.240	0.206	0.278-1.317
Maya ancestry				
No Maya surname (reference)				
One Maya surname	0.981	0.248	0.941	0.597-1.611
Two Maya surnames	1.168	0.356	0.609	0.642-2.125
Number of children				
1-3 (reference)				
4-6	0.790	0.212	0.381	0.467-1.336
> 7	1.157	0.562	0.763	0.447-2.997
Maternal age (years)				
26-36 (reference)				
37-47	1.088	0.232	0.692	0.716-1.654
> 48	1.658	0.623	0.178	0.794-3.465
Maternal education				
None or Basic (reference)				
Middle	0.487	0.139	**0.012**	0.278-0.856
High	0.406	0.113	**0.001**	0.235-0.703

n = 723, *OR*: Odds ratio; *SE*: Standard error; *CI*: Confidence interval; Overcrowding: > 2.5 persons per room; Low birth weight: < 2 500 g; Maternal education: None or Basic = no formal education, elementary or junior high complete or incomplete; Middle = high school or short vocational degrees complete or incomplete; High = bachelors, masters, doctorate, and technical degrees complete or incomplete. Hosmer-Lemeshow χ^2= 12.26, p = 0.268.

Discussion

In the studied sample, maternal education level was strongly associated with nutritional status categories in children and youngs. The odds for stunting decreased by 71 % with a Middle education level and by 78 % with a High level. The odds of excessive WC dropped by 47 % with a High level, while the odds of excessive SumSkfs decreased by 51 % with a Middle level and by 59 % with a High level. Mother's education level apparently functions as a protective factor against both stunting and adiposity, findings which coincide with previous studies reporting the importance of maternal education level as a predictor of child health (Geale 2010; Semba *et al.* 2008; Urke *et al.* 2011; Victora *et al.* 1992).

Observed differences in height between maternal education level indicated that the offspring of mothers with Middle and High levels were an average of 6 cm taller than the offspring of mothers with a None or Basic level. This suggests that in this sample a relatively higher mother's education level had a substantially positive influence on offspring nutritional status. These results agree with a study which found that a maternal education level higher than junior high positively affected linear growth in children (Chrzastek-Sprunch *et al.* 1984).

Our results confirmed the association between maternal education level and child adiposity based on skinfold measurements. Adiposity was clearly lowest among the children of mothers with Middle and High education levels. Nonetheless, child adiposity can also be affected by other factors, such as physical activity, dietary patterns, parental socioeconomic status and urban-rural residency (Biehl *et al.* 2013), which need to be considered in future studies.

A High maternal education level was also associated with the risk for excessive WC in the studied children and teens. Although the association between excessive WC and health risk in children is not as clear as in adults, some reports suggest a strong association between WC and health risk factors (Colín-Ramírez *et al.* 2009; Flodmark *et al.* 1994; Freedman *et al.* 1999; McCarthy *et al.* 2001). For example, WC has been significantly associated with adverse levels of triacylglycerol, low density lipoprotein cholesterol, high density lipoprotein cholesterol and insulin in a sample of 2 996 African-American and European-American children 5 to 17 years old in the U.S. (Freedman *et al.* 1999). The authors state that "these findings likely reflect the ability of waist circumference to function as an index of both fat distribution and generalized obesity" (Freedman *et al.* 1999: 314). Similar results have been found in adolescents (Flodmark *et al.* 1994; Freedman *et al.* 1999). In another study it was found that in a sample of 8 to 10 years old Mexican children systolic hypertension was more common among those with high WC (Colín-Ramírez *et al.* 2009). Indeed, some authors propose adoption of WC as a valid alternative indicator to body mass index (BMI) at early ages (McCarthy *et al.* 2001).

Very few studies have been done on the relationship between maternal education level and child growth parameters in Merida. One study using a mixed methodology and a sample of 217 children of both sexes aged 9 and 10 years old from Merida found a 4.3 cm difference in 9 years old and a 5.1 cm difference in 10 years old children with mothers that had basic (less than high school) versus high (university) education levels (Moguel-Canul 2011). Qualitative results indicated that maternal education level influenced feeding practices but not knowledge about nutrition. Dickinson and co-workers (2003) reported the relationship between social conditions, including maternal education level, and somatic parameters in youngs 14-16 years old in Merida, Yucatan. Significant differences were identified in weight, WC, suprailiac and subscapular skinfolds and BMI in 16 years old girls by maternal education level. The daughters of mothers with higher education levels (high school and higher) were thinner (49.62 kg vs. 54.90 kg, $p < 0.01$) and had a lower BMI (20.52 kg/m^2 vs. 22.75 kg/m^2, $p < 0.001$) than those of mothers with a lower education level (less than high school). These same daughters also had a smaller WC (66.21 cm vs. 70.47 cm, $p < 0.01$) and smaller suprailiac (13.61 mm vs. 16.61 mm, $p < 0.01$) and subscapular (12.10 mm vs. 15.19 mm, $p < 0.01$) skinfolds than daughters of mothers with a lower education level (Dickinson *et al.* 2003).

As in many other populations, Yucatecan mothers are generally the primary caregivers of children. This close relationship between mother and child can be attributed to the place occupied by women in the family, which is influenced by the gender role established for them by society since childhood (Pagés y Piras 2010; Sabaté *et al.* 1995; West y Zimmerman 1999). Their behaviours, abilities and knowledge can therefore be expected to have a profound impact on health in their children. A study by the state Institute for Gender Equity in Yucatan (Instituto para la Equidad de Género en Yucatán, IEGY) involving 302 families from Merida and seventeen communities in Yucatan, found that in most families (75.25 %) the mother is responsible for domestic activities such as house cleaning, cooking, buying food and childcare (IEGY 2011). Women clearly maintain a traditional role in Yucatecan society. This highlights the importance of formally educating mothers since higher education levels allow women to take better advantage of available resources. Unfortunately, the average education level of women aged 15 and older in Yucatan in 2005 was 7.4 years (i.e. Basic), and nationally it was 7.9 years. Among women aged 24 in Yucatan only 10.2 % had a high education level (bachelor's degree and higher), while nationally it was 12.7 % (INEGI and Unifem nd). The overall low mother's education level in Yucatan may be contributing to the current high prevalence of negative nutritional outcomes in children and youngs.

The specific pathways through which mother's education level affects child nutritional outcomes have not been well defined. Some evidence suggests that maternal practices and knowledge are key pathways (Armar-Klemesu *et al.* 2000; Behrman and Wolfe 1987). For instance, in a sample of 556 households in Accra, Ghana, it was found that maternal education was strongly associated with better child feeding, health seeking practices and hygiene practices (Armar-Klemesu *et al.* 2000).

The present study has limitations in the form of a lack of data on the pathways through which maternal education can act as a protective factor against environmental perturbations, and of data on maternal anthropometric parameters to quantify the confounding role of maternal height on child health. Nevertheless, the regression analyses demonstrated the importance of mother's education level, which is consistent with findings from several studies conducted in other countries (Geale 2010; Semba *et al.* 2008; Urke *et al.* 2011).

Maternal education level is clearly an indicator of the socioeconomic status of the mother's family of origin, as well as a factor affecting a mother's behaviour towards important life aspects, such as childcare. The present analysis controlled for the influence of variables that describe family socioeconomic conditions, such as level of overcrowding and number of children. However, it did not address whether maternal education level in the studied sample was a reflection of the mothers' socioeconomic status or the capital status they can invest in childcare.

The present results do not elucidate the pathways by which maternal education level influences child stunting and adiposity in the studied sample, but they do highlight the importance of investing in education as part of public policy. Policies supporting maternal and health education may be particularly relevant in the context of states like Yucatan in which the population suffers alarming rates of overnutrition and concurrently high rates of low height-for-age in children and adolescents.

In conclusion, completion of a high school or higher education level by mothers in the present sample was positively associated with better child health outcomes. These findings can be of great importance when designing health education programs or interventions targeting childhood nutrition problems in Yucatan.

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