TITLE PAGE

Wealth Index and Risk of Childhood Overweight and Obesity: Evidence from Four Prospective Cohorts in Peru and Vietnam

Running Title: Wealth Index and Childhood Overweight in Peru and Vietnam

Rodrigo M. Carrillo-Larco[1]

J. Jaime Miranda[1, 2]

Antonio Bernabé-Ortiz[1, 3]

1. CRONICAS Center of Excellence in chronic diseases, Universidad Peruana Cayetano Heredia, Lima, Peru.
2. Department of Medicine, School of Medicine, Universidad Peruana Cayetano Heredia, Lima, Peru.
3. Escuela de Medicina, Universidad Peruana de Ciencias Aplicadas, Lima, Peru.

Corresponding Author:
J. Jaime Miranda, MD, MSc, PhD
CRONICAS Center of Excellence in Chronic Diseases
Universidad Peruana Cayetano Heredia
Address: Av. Armendáriz 497, 2do Piso, Miraflores, Lima 18, Peru
Telephone: +511 241 6978
E-mail: jaime.miranda@upch.pe

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ABSTRACT

INTRODUCTION

Childhood obesity has become a public health issue worldwide (de Onis et al. 2010), and prevalence of overweight and obesity has increased about 47% from 1980 to 2013 (Ng et al. 2014). When analysed by socioeconomic indicators, the prevalence of childhood obesity has different patterns between developed and developing countries. Childhood obesity is higher among the wealthier in developing countries, yet it is more common among the poor in developed countries (Dinsa et al. 2012).

Several developing countries have gone through a rapid economic transition, and are now considered emerging economies; however, there are still numbers of people living under poverty. Overall, economic transition has a negative effect on the rates of childhood obesity (Cai 2014; Swinburn et al. 2011; Wang and Lim 2012). In terms of national averages of gross domestic product (GDP), Peru is classified as an upper-middle income country and Vietnam as lower-middle income country. These socioeconomic features – economic transition and GDP– have affected health parameters of both countries. Peru undergoes epidemiological and nutritional transition (Chaparro and Estrada 2012; Huicho et al. 2009), with growing prevalence of childhood overweight and obesity whilst still hosting chronic malnutrition rates of 25% (Alvarez-Dongo et al. 2012; Loret de Mola et al. 2014; Pajuelo-Ramirez et al. 2013). In Vietnam, the nutritional status of children has also changed: between 1992-93 and 1997-98 the prevalence of underweight decreased from 70% to 64%; and prevalence of overweight and obesity is 20% in school-aged children (Nguyen et al. 2013; Thang and Popkin 2003).

Childhood is a critical period to fight obesity as the effects of socioeconomic disparities on obesity risk appear and become stronger during childhood (Jansen et al. 2013). Moreover, the health consequences of childhood obesity at adulthood may be preventable (McMullen 2014). Overall, socioeconomic patterns are different between countries, and childhood is an important stage to prevent the effect of socioeconomic status on obesity. Therefore, studying children at different age ranges in countries where economic growth goes at different pace provides important scoping to identify key issues for the development of preventative strategies. This is particularly relevant as obesity prevention programs may have a different effect according to socioeconomic status (Beauchamp et al. 2014). Furthermore, previous studies have included surrogates to assess socioeconomic status such as parental educational attainment or household size (Wrotniak et al. 2012; Zadzinska et al. 2012). Thus, there is need to explore the risk of childhood obesity according to socioeconomic status with a more comprehensive definition of socioeconomic status for developing countries, such as wealth index, which also has other strengths in comparison to other methods to assess socioeconomic status (Howe et al. 2012). Data to calculate wealth index is available for many countries as much of the work on this indicator has been developed with Demographic and Health Surveys. In addition, it is less susceptible to changes in income and expenditure (Howe et al. 2012).

In the present study we contrast four prospective cohorts: two in Peru and two in Vietnam. The aim of the present study is to estimate the incidence of overweight and obesity according to socioeconomic status, and to assess whether socioeconomic status, as per wealth index, is a risk factor for the development of overweight and obesity in school-aged children in one lower-middle and one upper-middle income country, where risk factors for non-communicable diseases are on the rise.

METHODS

Study Design and Setting

This is a secondary analysis of a longitudinal cohort: the Young Lives study, which is being conducted in four developing countries: Ethiopia, India, Peru and Vietnam (Barnett et al. 2013).

The Young Lives study started in the year 2002 with two baseline groups in each country: a younger cohort included children aged 6-18 months and an older cohort included children aged 7-8 years. The follow-ups were conducted in the years 2006-07 and 2009-10 for both cohorts. Children in the younger cohort at the first and second follow-up were 4-5 and 7-8 years old, respectively; the corresponding figures for children in the older cohort are 11-12 and 14-15 years old.

Only information from Peru and Vietnam was included in this secondary analysis. The other countries were not included because preliminary analysis revealed low prevalence of overweight and obesity, preventing us from creating multivariable models. For example in Ethiopia, in the younger cohort, 4.9% and 1.2% of children were overweight or obese; in India, in the younger cohort, 1.4% was overweight and 0.9% obese. Moreover, we did not include the baseline round of the younger cohorts (children aged 6-18 months) because we targeted school-aged children. We included the first (hereafter known as *Baseline*) and second follow-ups of the younger cohorts, and the baseline assessment and second follow-up of the older cohorts.

Participants

Regarding this secondary analysis, the exclusion criteria for eligibility included missing values in key variables: child body mass index (BMI), age or sex, and household wealth index. Regarding the Peruvian younger cohort, 4.8% of the participants were excluded at baseline; whilst with regard to the Peruvian older cohort, 0.6% of the participants were excluded at baseline. The same exclusion criteria applied for Vietnam: at baseline 2.9% and 0.1% were excluded in the younger and older cohort, respectively (Figure 1).

Sampling and Procedures

Exact details about sampling procedures and data collection methods have been published elsewhere (Barnett et al. 2013). In order to choose the participants in both cohorts, the Peruvian team followed a multi-stage, cluster-stratified, random sampling; whereas in Vietnam a multi-stage, purposive, random sampling was conducted (Online Resource 1).

Variables

Outcome Variable

The outcome was assessed at the second follow-up of either cohort. The outcome variable was the occurrence of overweight and obesity as per BMI, using age- and sex-specific cut-off points proposed by the World Obesity Federation (Cole and Lobstein 2012). We decided to combine overweight and obesity to have sufficient observations in both countries to fit multivariable models. Weight and height were measured in all children.

Exposure Variable

The exposure variable was household wealth index in tertiles: bottom (poorest), middle and top (richest). The exposure was assessed at baseline of either cohort as was not expected to change markedly during follow-up. This wealth index was constructed as a simple average of three individual indexes: housing quality index (number of rooms, as well as floor, roof and wall material) consumer durables index (possession of radio, television, refrigerator, motorcycle, car, telephone, mobile phone and bike) and housing services index (source of drinking water, having electricity, type of toilet, and type of cooking fuel). A wealth index approach has become a common assessment method regarding socioeconomic status in developing countries

and it is a useful measure of the household socioeconomic status.(Howe et al. 2012) This variable was assessed with a face-to-face questionnaire answered by the household head or the mother.

Baseline Assessment

Co-variables were assessed at baseline and with a face-to-face questionnaire answered by the household head or the mother. For the younger cohorts in Peru and Vietnam we included: child age, child gender, birth weight (2,500g-4,000g, ≤2,500g, ≥4,000g), breastfeeding (*Did you ever breastfed the child?*, Yes/no), and number of meals the child had the previous day (<5, >5 or 5), maternal nutritional status as per BMI (normal weight (≥18.5 and <25), overweight (≥25 and <30), obesity (≥30)), maternal education (none/primary, high school, higher education), and household location (rural/urban). Co-variables for the older cohorts in Peru and Vietnam included: child age, child gender, and birth order (first, second and third or more), maternal nutritional status as per BMI (normal weight (≥18.5 and <25), overweight (≥25 and <30), obesity (≥30)), maternal education (none/primary, high school, higher education), and household location (rural or urban).

Statistical Analysis

To describe the exposure, outcome and co-variables we used proportions and 95% confidence intervals (95%CI); means and standard deviations are also presented. Proportions were used to present categorical variables, while means were used for numerical variables. Comparisons between categorical variables were performed using Chi squared test. Cumulative incidence per 100 children-years and 95%CI were calculated for developing overweight and obesity, after excluding those children who had overweight and obesity at baseline. We excluded these children because the incidence calculates the number of new cases over subjects at risk, thus subjects who already have the condition of interest should be excluded. Relative risk (RR) and 95%CI were assessed using generalized lineal models with Poisson family and log link, fitting the model using robust standard errors to account for the cluster effect introduced by the sampling procedure. The analyses were conducted with STATA 11.0 (StataCorp, College Station, TX, USA).

In order to assure comparability between estimates resulting from younger or older cohorts, the multivariable models in both Peru and Vietnam were adjusted for the same co-variables. Four models were constructed in the multivariable analyses. The first, a crude model, only included the outcome and exposure variables. Model A added child's gender, age, and birth order. Given additional data availability in the younger cohorts, model A in this group also included birth weight, breastfeeding and number of meals the child had the previous day. Model B only included maternal education, maternal nutritional status, and household location. Model C included all previous variables. The cluster variable was included in the four models as a confounder. These models were fitted using a hierarchical approach,(Victora et al. 1997) conducted to understand whether the influence of socioeconomic status on the development of overweight and obesity is the same when controlling for child-related or family-related variables only.

Ethics

The Young Live Study had ethical approval from the ethics committee of Social Science division, University of Oxford; this approval was for the study as a whole. Further details on the ethics procedures have been published elsewhere (Young Lives, Ethics; Young Lives, The ethics of social research with children and families in young lives: Practical experiences).

RESULTS

Sample Description

The study included 4,018 and 3,856 children-years in the younger and older Peruvian cohort, respectively; and 5,029 and 6,787 children-years in the younger and older Vietnamese cohort, respectively (Figure 1).

There were 1,954 and 710 children at baseline in the younger and older Peruvian cohort, respectively. At baseline, mean age (±SD) of children in the younger cohort was 5.3 (±0.4) years; 50.5% were boys, and 69.5% lived in urban settings. Mean age (±SD) of children in the older cohort, at baseline, was 7.9 (±0.3) years, 54.1% were boys, and they were predominately from urban settings (74.1%).

In Vietnam, at baseline, there were 1,944 and 999 children included in the younger and older cohort, respectively. Participants in the younger cohort had a mean age (±SD) of 5.3 (±0.3) years, 51.6% were boys, and the majority (79.5%) lived in rural areas. At baseline, children in the older cohort had a mean age (±SD) of 8.0 (±0.3) years, 50.2% were boys, and 80.1% lived in rural settings.

Nutritional Status at Baseline

At baseline in Peru, prevalence of overweight and obesity in the younger cohort was 16.2% (95%CI 14.5%-17.9%) and 5.4% (95%CI 4.0%-6.4%), respectively. There was more overweight and obesity at the top tertile of wealth index (28.3%) compared to the bottom (18.4%) and middle (17.8%) tertiles ($p<0.001$). The prevalence of childhood overweight and obesity in the older cohort was 15.4% (95%CI 12.7%-18.1%) and 3.3% (95%CI 2.0%-4.7%), respectively. There was more overweight and obesity as the wealth index grows up: 9.0%, 22.0%, and 25.4% in the bottom, middle and top tertile, respectively ($p<0.001$). Distribution of co-variables at baseline according to nutritional status and wealth index is presented in Online Resource 2 and 3, for both Peruvian cohorts.

At baseline in Vietnam, 5.8% (95%CI 4.6%-7.1%) were overweight and 4.7% (95%CI 3.6%-5.9%) were obese in the younger cohort. There was higher prevalence of overweight and obesity in the highest tertile of wealth index: 4.4%, 4.8%, and 21.4% in the bottom, middle and top tertile respectively ($p<0.001$). Regarding the older cohort, 2.4% (95%CI 1.1%-3.8%) were overweight and 0.4% (95%CI 0.0%-0.9%) were obese. Also, there were more children with overweight and obesity at the top tertile of wealth index: 1.1 % and 7.3% in the bottom and top tertile, respectively ($p<0.001$); there were none in the middle tertile. Distribution of co-variables at baseline according to nutritional status and wealth index is presented in Online Resource 4 and 5, for both Vietnamese cohorts.

Overweight and Obesity Incidence and Comparisons by Socioeconomic Status

In Peru, the overall cumulative incidence of overweight and obesity was 4.8 (95%CI 4.1-5.5) and 1.7 (95%CI 1.3-2.2) per 100 children-years for the younger and older cohort, respectively. The cumulative incidence of overweight and obesity was 9.2 (95%CI 7.6-11.1) at the top wealth index tertile for the younger cohort, yet the incidence was smaller in the older cohort: 2.3 (95%CI 1.6-3.3). Further details about the cumulative incidence according to co-variables and to wealth index are shown in Table 1.

In Vietnam, the overall incidence of overweight and obesity was 1.5 (95%CI 1.2-1.8) per 100 children-years for the younger cohort and 0.3 (95%CI 0.2-0.5) for the older cohort. The cumulative incidence of overweight and obesity was higher at the top wealth index tertile when compared to the middle and bottom tertile in either the younger or older cohort: 2.8 (95%CI 2.0-3.8) and 0.7 (95%CI 0.4-1.2), respectively. Further details about the cumulative incidence by wealth index tertiles according to co-variables are shown in Table 2.

Risk of Overweight and Obesity According to Socioeconomic Status

The bottom wealth index tertile was considered as the reference group in multivariable analyses. In both younger cohorts, from Peru and Vietnam, there was no evidence of a higher risk of overweight and obesity by

socioeconomic status. On the contrary, there was higher overweight and obesity risk in both –Peru and Vietnam– older cohorts. Peruvian children in the older cohort showed higher risks of overweight and obesity: twofold on middle vs. bottom tertile and fourfold on the top vs. bottom tertile of wealth index (Figure 2). Corresponding RR estimates for Vietnam were 7.69 (middle vs. bottom tertile of wealth index) and 9.11 (top vs. bottom tertile of wealth index) (Figure 2). Further details about the multivariable models are shown in Table 3 and Online Resource 6.

Risk of Overweight and Obesity According to Socioeconomic Status: A Hierarchical Approach

In Peru, the magnitude of the association between child-related variables and overweight and obesity tended to be higher than maternal ones, except for the older cohort when comparing top versus bottom tertile (Table 3); however in Vietnam, the magnitude of the association between child-related variables and overweight and obesity was higher than maternal ones in the older cohort when comparing top versus bottom tertile (Online Resource 6).

In the Peruvian younger cohort, the risk of overweight and obesity was statistically significant when adjusting only for child-related variables; with regard to the Peruvian older cohort, the risk of overweight and obesity was significant when adjusting for either child- or family-related variables (Table 3). In the Vietnamese younger cohort, the risk of overweight and obesity was statistically significant when adjusting only for child-related variables and when comparing bottom versus top tertile; in the Vietnamese older cohort, when comparing bottom versus top tertile, there was higher risk of overweight and obesity after adjusting for either child-related or family-related variables (Online Resource 6).

DISCUSSION

Main Findings

Our results show that, relative to lowest socioeconomic strata, the incidence of childhood overweight and obesity is higher among the wealthier group. Overall, there is a dissimilar impact of socioeconomic status on childhood overweight and obesity in two developing countries in different world regions; this is supported by the different cumulative incidences found in Peru when compared to Vietnam, also by the magnitude of the relative risks reported. The effect of socioeconomic status on the risk of developing overweight and obesity appears to be different depending on the child age, being much stronger among older children. In addition, it appears that maternal characteristics plays a more important role among younger than older children.

The results –higher risk of obesity among wealthier individuals– could also contribute to picture how economic transition affects the risk of childhood obesity: in the older cohort, the risk of overweight and obesity was much higher in Vietnam than in Peru among individuals at the top wealth index tertile. As Vietnam continues its path towards upper-middle-income country, the current Peruvian status, its risk estimates for overweight and obesity will likely decrease and get closer to those observed in Peru. Similarly, if Peru keeps its economic growth towards a high-income country, the higher risk observed among the better-off relative to the worse-off in terms of socioeconomic indicators might disappear.

Previous Studies

The overall cumulative incidence of childhood obesity assessed from kindergarten to eighth grade (1998-2007) in the United States was 11.9 per 100 children-years, and opposite to our results, the smaller incidence was observed among the top socioeconomic quintile (Cunningham et al. 2014). In Europe, greater deprivation means a higher prevalence of childhood overweight (Knai et al. 2012; Stamatakis et al. 2010) and a similar pattern has been described in Australia (O'Dea et al. 2014). However, results from other developing countries are similar to ours (Friedman et al. 2009; Hyska et al. 2014; Navti et al. 2014; Schooling et al. 2010; Wrotniak et al. 2012; Zadzinska et al. 2012). Thus, the effect of socioeconomic status on childhood obesity is different between developed and developing countries; and within the latter there are different patterns of childhood obesity according to socioeconomic status.

Evidence from transitional countries in Europe is valuable. A cross-sectional study in Albania reported there were more children with overweight and obesity in urban settings, versus rural areas. Although they aimed to assess the demographic correlates of childhood overweight and obesity, they failed to include a more comprehensive parameter of socioeconomic status relying only in location (Hyska et al. 2014). In Ukraine, children whose mother was from middle/upper social class have 60% higher odds of overweight and obesity (Friedman et al. 2009). A study in Poland that included cohorts of children followed through different settings of economic and political transition revealed similar results: the risk of overweight and obesity in boys was 34% higher for those whose mothers had secondary and post-secondary education, versus elementary or basic vocation plus higher (Zadzinska et al. 2012).

African countries have also provided evidence to support the different effect of socioeconomic status on childhood obesity. Botswana is undergoing a rapid nutritional transition, and Wrotniak *et al.* in a cross-sectional study reported similar results to ours, though with smaller estimates: children in private school had 300% higher odds of being obese versus their peers in public schools; also, children in families with high assets had 260% higher odds, versus children living in families with low assets (Wrotniak et al. 2012). In a cross-sectional study in Cameroon, Navti *et al.* found that children at the highest socioeconomic status had higher odds of being overweight (Navti et al. 2014); their estimates were similar to what we found in Vietnam, yet they used a different method to assess socioeconomic status (Navti et al. 2014).

These studies provide evidence that childhood obesity is more common among the wealthier groups regardless of where the developing country is, and despite the definition of socioeconomic status.

Results Interpretation

The impact of socioeconomic status on overweight and obesity are independent of maternal characteristics among the older children in both Peru and Vietnam but not in the younger ones. This observation is supported by our results, when considering regression Model B comparing bottom versus top tertile, the results are significant for the older cohorts, but not for the younger cohorts. However, which maternal characteristic exerts a stronger effect on childhood obesity needs to be further addressed. In an attempt to explore which maternal characteristic plays a more important role in the risk of childhood overweight and obesity according to socioeconomic status, we conducted post-hoc analyses with the Peruvian younger cohort. Comparing bottom with middle wealth index tertile, when only adding to the crude model maternal education, the relative risk went from 1.65 ($p=0.007$) to 1.30 ($p=0.191$); yet when only including maternal nutritional status the estimate increased to 1.69 ($p<0.001$). When running the same post-hoc analysis by comparing bottom versus top tertile, the new estimates were: 2.24 ($p<0.001$) and 3.18 ($p<0.001$). Thus, it seems that at younger ages, maternal education exerts a major impact on the risk of childhood overweight and obesity according to socioeconomic status. Maternal education has not been much exploited in previous intervention programs (Hillier-Brown et al. 2014).

In this study we found sufficient evidence that the incidence of overweight and obesity is higher in the top wealth index category, and it is much stronger among older children. Therefore, our findings call for the implementation of relevant and appropriate obesity prevention strategies alongside improvements in socioeconomic status, e.g. poverty reduction strategies; the so-called lifting people out poverty, should anticipate mechanisms for not pushing people into obesity. These prevention strategies call for active and creative thinking and meaningful conversations across fields, for example between those concerned with health and development in the international strategies agenda. At the in-country level, our research findings call for interactions between ministries of economy, welfare, education, health and social protection, among others, to convey and implement such preventative strategies.

We provide evidence that the burden of childhood overweight and obesity in two developing countries is much higher among the rich, in comparison to the poor; similar results have been reported for cardiovascular risk factors, including obesity, in India (Subramanian et al. 2013). However, it would be inappropriate to fight childhood overweight and obesity only in these high-risk populations, because health needs goes beyond just socioeconomic status (Businge et al. 2014; Razak and Subramanian 2014). Therefore, as people progress towards wealthier socioeconomic status, interventions and prevention strategies must be creative to avoid social development coming along with growing rates of childhood overweight and obesity.

Strengths and Limitations

This study benefits of a prospective design, which rules out reverse causality. We have included a wide sample size of children in two developing countries, at different development stage, and in different world regions. In addition, we have included several potential confounders, which were also the same when comparing the younger or older cohorts. Moreover, we used a comprehensive method to assess socioeconomic status –wealth index–, as previous reports used characteristics such as household size and parental education (Zadzinska et al. 2012), or type school and assets (Wrotniak et al. 2012). The wealth index approach is commonly used in developing countries and it has some strengths: it is less prone to change according to seasonality patterns of consumption, and it does assess the socioeconomic status at the household level (Howe et al. 2012).

However, limitations must be addressed too. First, due to data availability we did not include the same variables across the younger and older cohorts. Thus, we were not able to compare children within a country.

Post-hoc analysis showed that, when including in the final model only variables shared in common by the four cohorts, results were quite identical (data not shown). Second, the sampling in either country excluded the richest settings. This is particularly relevant for Vietnam as these households were poorer than the average Vietnamese household. Thus, the highest socioeconomic status presented in this study does not necessarily represent the highest socioeconomic status in the general population. If the richest group had been included, our estimates could have been greater. Thus, our results are conservative and alert of a possible higher risk of overweight and obesity among the better-off. Third, the sampling procedures were not exactly the same in Peru and Vietnam. The Vietnamese team followed a purposive procedure at some stages of the sampling; though they still cover the diversity of Vietnamese children. Fourth, the loss of respondents through study rounds could have added attrition bias. Nonetheless, it has been reported that there is low attrition bias and that the attrition rate has a minor impact on any result (Barnett et al. 2013). Finally, we did not include an important confounder such as physical activity as this variable was not available at baseline. In post-hoc analysis when we included physical activity assessed at follow-up, the models did not vary much (data not shown). We believe this –lack of adjustment for physical activity– did not affect our results and we are still able to hypothesize that maternal characteristics play a more important role in obesity prevention among younger children.

Conclusions

There is strong evidence of higher risk of overweight and obesity in older children in Peru and Vietnam, especially among those at the highest wealth index; however, no strong association was found among younger children. The effect of socioeconomic status on childhood overweight and obesity was stronger in Vietnam than in Peru. These results are important in the current global childhood obesity epidemic, and in particular for those countries undergoing economic, epidemiological and nutritional transition.

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CONFLICT OF INTERESTS

The authors declare no conflict of interests.

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TABLES AND FIGURES

Table 1: Cumulative incidence and 95% Confidence Interval (95% CI) of childhood overweight and obesity according to socioeconomic status at baseline. The Young Lives Study, Younger (2006-07 to 2009-10) & Older Cohort (2002 to 2009-10), Peru.

Variables	Younger Cohort			Older Cohort		
	WI: Bottom	WI: Middle	WI: Top	WI: Bottom	WI: Middle	WI: Top
Mother						
Maternal Education						
None/Primary	1.7 (1.1-2.8)	2.7 (1.7-4.2)	7.8 (4.7-12.9)	1.4 (0.9-2.4)	1.5 (0.7-2.9)	2.2 (0.7-6.7)
High School	1.9 (0.8-4.5)	4.7 (3.3-6.9)	8.8 (6.7-11.7)	1.2 (0.5-3.3)	1.3 (0.6-2.7)	2.7 (1.6-4.5)
Higher Education	9.2 (2.3-36.8)	4.2 (2.1-8.3)	10.5 (7.8-14.2)	0.0 (0.0-0.0)	0.8 (0.1-5.4)	1.6 (0.7-3.3)
Maternal BMI						
Normal weight	1.8 (1.1-3.0)	3.1 (2.0-4.9)	7.9 (5.5-11.2)	1.2 (0.6-2.2)	1.3 (0.6-2.9)	1.3 (0.6-3.2)
Overweight	2.8 (1.5-5.0)	3.1 (2.0-4.9)	8.4 (6.2-11.5)	1.5 (0.8-3.1)	1.1 (0.5-2.4)	2.9 (1.8-4.8)
Obesity	1.2 (0.2-8.8)	8.1 (4.9-13.4)	11.9 (8.2-17.4)	1.0 (0.1-7.3)	2.0 (0.8-5.5)	2.3 (1.0-5.2)
Location						
Urban	2.1 (1.1-4.2)	4.3 (3.2-5.7)	9.2 (7.6-11.2)	1.8 (1.0-3.3)	1.2 (0.7-2.2)	2.3 (1.5-3.3)
Rural	2.0 (1.3-3.1)	2.2 (1.1-4.2)	7.0 (1.0-49.9)	1.1 (0.6-2.1)	1.5 (0.6-4.0)	0.0 (0.0-0.0)
Children						
Gender						
Male	2.5 (1.5-4.1)	3.3 (2.2-4.9)	9.4 (7.2-12.3)	0.8 (0.4-1.9)	1.0 (0.5-2.1)	2.3 (1.4-3.8)
Female	1.5 (0.9-2.9)	4.2 (2.9-6.0)	9.0 (6.9-11.8)	2.0 (1.2-3.3)	1.7 (0.9-3.2)	2.1 (1.2-3.8)
Age (years)β						
4y / 6-7y	2.5 (1.4-4.5)	3.3 (1.8-6.0)	4.6 (1.9-11.0)	2.0 (1.2-3.3)	1.0 (0.4-2.1)	2.4 (1.4-4.1)
5y / 8-10y	1.8 (1.1-2.9)	3.8 (2.8-5.1)	9.5 (7.8-11.6)	0.8 (0.3-1.8)	1.6 (0.9-3.0)	2.1 (1.2-3.6)
6y	0.0 (0.0-0.0)	5.9 (1.5-23.7)	12.9 (6.5-12.8)			
Birth Weight (g)						
2,501-3,999	2.1 (1.3-3.3)	4.0 (3.0-5.3)	9.9 (8.2-12.1)	No data		
≤2,500	1.8 (0.2-12.4)	2.5 (0.6-9.9)	5.8 (2.2-15.5)			
≥4,000	0.0 (0.0-0.0)	4.9 (1.8-13.0)	6.7 (2.2-20.8)			
Breastfeeding						
Yes	2.0 (1.3-2.9)	3.8 (2.9-4.9)	9.2 (7.6-11.1)	No data		
No	20.0 (2.8-142.3)	0.0 (0.0-0.0)	5.8 (0.8-41.3)			
Child birth order						

First	No data			1.5 (0.6-3.6)	2.6 (1.4-4.8)	1.3 (0.6-2.9)
Second				0.7 (0.2-2.9)	0.0 (0.0-0.0)	2.5 (1.3-4.9)
Third or more				1.6 (0.9-2.7)	1.2 (0.5-2.6)	3.2 (1.8-5.7)
Number of meals the previous day						
5	1.8 (0.9-3.7)	5.3 (3.8-7.4)	8.5 (6.4-11.1)	No data		
<5	2.2 (1.3-3.7)	2.5 (1.4-4.4)	9.7 (6.3-14.9)			
>5	1.9 (0.8-4.5)	2.5 (1.3-4.7)	9.9 (7.1-13.8)			

β Baseline age for either the younger or older cohort, respectively. WI=wealth index. Baseline assessment of the younger cohort was conducted in 2006-07 and of the older cohort it was conducted in 2002; follow-up of both cohorts was conducted in 2009-10.

Table 2: Cumulative incidence and 95% Confidence Interval (95% CI) of childhood overweight and obesity according to socioeconomic status at baseline. The Young Lives Study, Younger (2006-07 to 2009-10) & Older Cohort (2002 to 2009-10), Vietnam.

Variables	Younger Cohort			Older Cohort		
	WI: Bottom	WI: Middle	WI: Top	WI: Bottom	WI: Middle	WI: Top
Mother						
Maternal Education						
None/Primary	0.8 (0.4-1.4)	1.4 (0.7-2.5)	1.0 (0.3-3.0)	0.2 (0.1-0.6)	0.3 (0.1-1.0)	0.6 (0.2-1.9)
High School	0.3 (0.0-2.0)	1.0 (0.5-1.9)	2.7 (1.7-4.2)	0.0 (0.0-0.0)	0.1 (0.0-0.6)	0.8 (0.4-1.6)
Higher Education	0.0 (0.0-0.0)	3.0 (0.4-21.3)	5.5 (3.1-9.9)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.8 (0.2-3.3)
Maternal BMI						
Normal weight	0.7 (0.3-1.3)	1.2 (0.7-1.9)	2.7 (1.8-3.8)	0.0 (0.0-0.0)	0.2 (0.1-0.6)	0.4 (0.2-0.9)
Overweight	3.7 (1.2-11.5)	3.4 (1.1-10.5)	5.5 (2.6-11.5)	0.5 (0.1-3.5)	1.1 (0.2-7.7)	2.5 (1.1-5.6)
Obesity	0.0 (0.0-0.0)	8.9 (1.3-63.5)	11.8 (3.0-47.5)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)
Location						
Urban	0.0 (0.0-0.0)	1.1 (0.4-3.5)	4.4 (2.9-6.6)	0.0 (0.0-0.0)	0.5 (0.1-3.9)	1.1 (0.6-1.9)
Rural	0.8 (0.4-1.3)	1.1 (0.7-1.8)	1.8 (1.1-3.0)	0.1 (0.0-0.4)	0.2 (0.1-0.5)	0.4 (0.1-1.0)
Children						
Gender						
Male	0.8 (0.4-1.7)	1.3 (0.7-2.2)	2.9 (1.9-4.5)	0.0 (0.0-0.0)	0.3 (0.1-0.8)	0.8 (0.4-1.6)
Female	0.7 (0.3-1.6)	0.9 (0.5-1.9)	2.6 (1.9-4.3)	0.3 (0.1-0.8)	0.2 (0.0-0.7)	0.6 (0.3-1.3)
Age (years)β						
4y / 6-7y	0.5 (0.1-2.0)	2.8 (1.4-5.5)	5.2 (2.7-10.0)	0.1 (0.0-0.6)	0.2 (0.0-0.7)	0.7 (0.4-1.6)
5y / 8y	0.8 (0.5-1.5)	0.8 (0.4-1.4)	2.4 (1.7-3.4)	0.2 (0.0-0.7)	0.2 (0.1-0.8)	0.7(0.3-1.4)
6y/-	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	-	-	-
Birth Weight (g)						
2,501-3,999	0.9 (0.5-1.7)	1.2 (0.7-1.9)	2.7 (1.9-3.7)	No data		
≤2,500	1.4 (0.2-9.8)	0.0 (0.0-0.0)	3.6 (1.2-11.1)			

≥4,000	2.3 (0.3-16.0)	1.7 (0.2-12.2)	3.6 (0.9-14.5)			
Breastfeeding						
Yes	0.8 (0.4-1.3)	1.1 (0.7-1.7)	2.8 (2.1-3.8)	No data		
No	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)			
Child birth order						
First	No data			0.2 (0.1-0.8)	0.3 (0.1-1.0)	0.7 (0.3-1.6)
Second				0.2 (0.0-1.3)	0.4 (0.1-1.2)	0.9 (0.4-1.9)
Third or more				0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.5 (0.2-1.6)
Number of meals the previous day						
5	0.7 (0.2-2.1)	1.1 (0.5-2.4)	1.5 (0.7-3.2)	No data		
<5	0.8 (0.4-1.6)	0.6 (0.3-1.5)	0.8 (0.3-2.5)			
>5	0.6 (0.1-3.9)	2.1 (1.0-4.2)	4.7 (3.3-6.8)			

β Baseline age for either the younger or older cohort, respectively. WI=wealth index. Baseline assessment of the younger cohort was conducted in 2006-07 and of the older cohort it was conducted in 2002; follow-up of both cohorts was conducted in 2009-10.

Table 3: Relative Risk and 95% Confidence Interval (95% CI) of childhood overweight and obesity. The Young Lives Study, Younger (2006-07 to 2009-10) & Older (2002 to 2009-10) Cohort, Peru.

		Crude	Model A	Model B	Model C
Younger Cohort					
Bottom	n=1,695	1	1	1	1
Middle		**1.65 (1.14-2.38)**	**1.6 (1.07-2.25)**	0.98 (0.65-1.49)	0.97 (0.64-1.47)
Bottom	n=1,695	1	1	1	1
Top		**3.75 (2.69-5.23)**	**3.36 (1.34-4.81)**	1.36 (0.87-2.14)	1.31 (0.83-2.06)
Older Cohort					
Bottom	n=769	1	1	1	1
Middle		**2.68 (1.56-4.62)**	**2.95 (1.71-5.10)**	**2.23 (1.33-3.73)**	**2.37 (1.42-3.93)**
Bottom	n=749	1	1	1	1
Top		**3.52 (2.09-5.94)**	**3.84 (2.26-6.52)**	**4.21 (2.19-8.09)**	**4.25 (2.21-8.18)**

Baseline assessment of the younger cohort was conducted in 2006-07 and of the older cohort it was conducted in 2002; follow-up of both cohorts was conducted in 2009-10. Younger Cohort: model A included child gender, child age at baseline, birth weight, breastfeeding, number of meals the previous day at baseline; model B included only maternal education at baseline, maternal nutritional status at baseline and location (rural/urban) at baseline; model C included all the previous variables . Older Cohort: model A included childe gender, child age at baseline and child birth order; model B only included maternal education (brought from round 2), maternal nutritional status at baseline and location (rural/urban) at baseline; model C included all the previous variables. In bold, $p<0.05$.

Figure 1: Flowchart of the Peruvian and Vietnamese Younger (2006-07 to 2009-10) & Older (2002 to 2009-10) Cohorts. The Young Lives Study.*

*Further details about the attrition rate and follow-up of the Young Lives Study have been published elsewhere.(Barnett et al. 2013) Baseline assessment of the younger cohort was conducted in 2006-07 and of the older cohort it was conducted in 2002; follow-up of both cohorts was conducted in 2009-10.

Figure 2: Relative Risk and 95% Confidence Interval (95% CI) of childhood overweight and obesity. The Young Lives Study, Younger (2006-07 to 2009-10) & Older (2002 to 2009-10) Cohorts, Peru and Vietnam.

Baseline assessment of the younger cohort was conducted in 2006-07 and of the older cohort it was conducted in 2002; follow-up of both cohorts was conducted in 2009-10. Younger Cohort adjusted for child gender, child age at baseline, birth weight, breastfeeding, number of meals the previous day at baseline, maternal education at baseline, maternal nutritional status at baseline and location at baseline. Older Cohort adjusted for child gender, child age at baseline, child birth order, maternal education, maternal nutritional status at baseline and location at baseline. [Y], younger cohort; [O], older cohort.