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Is the Dual Burden of Over- and Under-nutrition a Concern for Poor Households in Ethiopia, India, Peru and Vietnam?

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Abstract

Rapid economic development and increasing urbanisation have led to a dramatic rise in overweight among adults in many low-income countries. Paradoxically, overweight often coexists with persisting under-nutrition among members of the same household. The aim of this study was to assess whether child under-nutrition combined with maternal over-nutrition is a health concern among a sample of pro-poor households, and whether urban residence is associated with the phenomenon. The occurrence of stunted and/or underweight children and overweight mothers within the same household was studied in cohorts of 2,000 children aged between 4.5 and 5.5 years in each of Ethiopia, India (Andhra Pradesh), Vietnam and Peru. Multivariate logistic regression was used to estimate the effect of urban residence controlling for potential confounding factors. The prevalence of child stunting combined with maternal overweight was very low in Ethiopia, India and Vietnam, but as high as 14 per cent in Peru. Underweight child / overweight mother pairs were uncommon in all four countries. Urban residence significantly increased the likelihood of dual burden households only in India. In Peru and Vietnam, living in urban neighbourhoods decreased the coexistence of child stunting and maternal overweight non-significantly. In conclusion, the dual burden of over- and under-nutrition seems to be a health concern only among poor households in Peru. Interventions specifically designed for resource-poor settings that address the nutritional status of each household member individually and promote a healthy lifestyle are needed.

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1. Background

Under-nutrition among children remains a serious problem in impoverished populations around the world. It is estimated to be the underlying cause of one-third of all deaths of children below the age of five years (Black et al. 2008; Black et al. 2010; Black et al. 2003). Inadequate nutrition, especially in the first three years of life, has been shown to have serious short-and mid-term consequences on physical growth and health as well as on mental development (Pelletier et al. 1993). In the long term, undernourished children are more likely to suffer from functional impairments in adult life, resulting in substantial reductions of their overall health, well-being and economic productivity (Grantham-McGregor et al. 2007)

Parallel to persistent under-nutrition, obesity rates are rising globally, including in many low- and middle-income countries with previously very low prevalence (Hossain et al. 2007; Prentice 2006; Subramanian et al. 2011). For several decades it has been assumed that obesity in low-income countries is a disease only of the higher socioeconomic strata (Monteiro et al. 2004). However, a systematic review by Monteiro et al. (2004) suggests that overweight is increasingly common in lower socioeconomic groups in developing countries.

Overweight (BMI > 25kg/m²) in developing countries is particularly frequent in women, but still relatively rare in men (Martorell et al. 2000). Causes for rising obesity in developing countries are complex and theories regarding these are still only speculative, but lifestyle changes, attitudes towards overweight and body image might play a role (Hossain et al. 2007; Case and Menendez 2009). The Barker hypothesis suggests that nutritional deprivation in the womb and in early childhood might additionally increase the susceptibility to obesity and co-morbidities such as type 2 diabetes and cardiovascular diseases in adult life (de Boo et al. 2006; Kimm 2004).

High obesity rates are a particular concern in urban areas in low-income country settings, while rural areas are often less affected (Martorell et al. 2000; Prentice 2006; Popkin 1998; Harpham 2009). Wang et al. (2002) speculate that better living conditions, access to energy-denser diets and less physical activity might explain higher prevalence of overweight in urban compared to rural areas in some low- and middle-income countries.

Obesity and its related diseases threaten to overwhelm the healthcare systems of many low-income countries that are already strained by the burden of infectious diseases and HIV/AIDS. Obesity could also present a tremendous economic burden that includes costs for lost work productivity due to morbidity and premature mortality (Nugent 2008).

Overweight and underweight have long been treated as two separate public health problems, as different underlying factors have been assumed. The paradoxical coexistence of child under-nutrition and maternal overweight within the same household, often described as the 'dual burden of malnutrition', is a relatively new phenomenon that has been described in studies from low- and middle-income countries including Benin, Brazil, China, Haiti, Guatemala, South Africa, Malaysia and Mexico (Steyn et al. 2011; Rodrigues et al. 1998; Raphael et al. 2005; Khor and Sharif 2003; Barquera et al. 2007; Angeles-Agdeppa et al. 2003; Deleuze et al. 2005). Comparing nationally representative surveys from 42 developing countries, Garrett and Ruel (2005) found the prevalence of dual burden households ranging from as low as 2 per cent in Ethiopia to as high as 71 per cent in Egypt. Doak et al. (2000) found the phenomenon to be associated with urban residence and income levels in some countries. While the dual burden was significantly associated with urban residence and higher income in China, Indonesia, Vietnam and the USA, they found a significant

association with lower income and urban residence in Brazil and Russia. No consistent significant association could be found for Kyrgyz Republic. A cross-sectional study from poor urban settings in Manila in the Philippines suggests an association with dietary intake, food preferences and choices among children and mothers, physical activity and female body image preferences (Angeles-Agdeppa et al. 2003).

In a recently published study of 18 low-income countries, Jehn and Brewis (2009) found that the phenomenon is more frequent in wealthier countries that are in the midst of the 'nutritional transition'. The concept of nutritional transition which was extensively analysed by Popkin and Gordon-Larsen (2004) and Drewnowski and Popkin (1997), covers rapid changes from a traditional, low-fat, high-fibre, plant-based diet combined with physical labour to a Westernised diet high in meat, saturated fats, sugar and energy combined with a sedentary occupation. The nutritional transition usually occurs in parallel with economic, epidemiological and demographic transitions in a country. Jehn and Brewis (2009) hypothesised that the dual burden might be an integral part of the transitional process and could perhaps be seen as a mere 'by-product' of the rapid increase in maternal overweight due to dietary and lifestyle changes and lack of change in the risk factors for child under-nutrition. Garrett and Ruel (2005) draw similar conclusions based on their analyses of nationally representative datasets from 36 low-income countries.

The aim of this study was to assess whether the coexistence of maternal overweight and child under-nutrition is a health concern in a pro-poor sample in Ethiopia, India, Peru and Vietnam and whether urban residence is associated with the phenomenon. This is the first study that looks at predominantly poor to very poor urban and rural households rather than nationally representative datasets that include all social strata of the population. This study was informed by the following research questions:

1. What is the prevalence of child under-nutrition and maternal overweight among a pro-poor sample in Ethiopia, India, Peru and Vietnam?
2. What is the prevalence of overweight mother / undernourished child pairs among a pro-poor sample in Ethiopia, India, Peru and Vietnam?
3. Is the occurrence of overweight mother / undernourished child pairs affected by urban residence independently from confounding variables?

2. Methods

This study uses data from Round 2 of the longitudinal Young Lives study, collected in 2006. In each of four countries (Peru, Ethiopia, Vietnam and India (in the state of Andhra Pradesh), 2,000 children aged between 6 and 17 months were recruited in 2002. Young Lives employed a sentinel-site sampling approach often used in surveillance systems. Thereby 20 sentinel sites were semi-purposively selected by local experts to represent a range of regions, 'policy contexts' and living conditions, with oversampling of sites covering 'poor' areas (Wilson et al. 2006). Within sites, 100 children were selected by an equivalent of random sampling; the exact sampling procedure varied between sites because of topographical and administrative differences within and between countries, but was carefully documented to ensure a sample indistinguishable from one drawn at random from qualifying households, with reasonable control of bias (Wilson et al. 2006). The response rate was above 90 per cent in all four countries. The attrition rate in Round 2 was below 5 per cent in

all four countries. Although not nationally representative samples, for ease of presentation, country samples will be referred to by the country's name.

Data collection used standardised questionnaires administered to the child's primary caregiver by interviewers using the local language. The weight of the child and his/her biological mother was measured with 100g precision using a portable, electronic scale with a capacity of 150kg. Measurements were taken twice and the average was calculated. The height was measured using a tapeline with 0.1cm precision affixed to a plain vertical surface. Measurements were taken twice and the average was calculated. Ethical clearance was obtained from the participating research institutions in the United Kingdom and each study country. Prior to interview, informed consent was obtained from all participants.

2.1 Data analysis

Analyses were conducted using STATA 10.0 (StataCorp; Stata Corporation, College Station, TX, USA). For analysis, only children whose main caregiver was the biological mother and lived in the same household as the child were included. Mothers or children with missing anthropometric data were excluded. Cross-tabulation was used to describe mothers' and children's nutritional status by wealth and residence.

Multivariate logistic regression models were developed to compare dual burden households with normal weight mother / non-undernourished child households, adjusted for cluster effect, non-random sample design and potential confounders. To assess how far dual burden households differed from overweight mother / normal weight child and normal weight mother / undernourished child pairs, additional regression models were developed. References for all models were normal weight mother and child pairs. For all tests the significance was set at 0.05.

2.2 Dependent variables

The dependent variables were defined as the nutritional status of the mother / child pairs. Maternal overweight was defined as $>25\text{kg/m}^2$, and obesity as $>30\text{kg/m}^2$ according to international classification (WHO 2006a). For this paper's analysis, obesity and overweight were grouped and described as overweight. Underweight ($<18.5\text{kg/m}^2$) and normal weight (from 18.5kg/m^2 to 25kg/m^2) were collapsed into one group owing to sample size.

Child anthropometric indices were calculated based on WHO child growth standards for children below the age of five (WHO 2006b) or above it (WHO 2007). Two common indicators for child's under-nutrition were tested: child stunting and child underweight. Child stunting, or low height-for-age, reflects a failure to reach linear growth potential as a result of long-term, cumulative sub-optimal health (infections, health service access, unhealthy environment, unsafe water, insufficient sanitation, etc.) and/or insufficient nutritional conditions (quality and quantity of food, energy, macronutrients, micronutrients, toxic factors, etc.) (Eveleth 1996). Children with a height-for-age z-score two standard deviations below the reference values were considered to be stunted. The first dependent variable is consequently defined as overweight mother / stunted child pair.

The second pair consists of an overweight mother (BMI $> 25 \text{ kg/m}^2$) and an underweight child. Child underweight, or low weight-for-age, represents a child's body mass relative to chronological age. It can be an indicator for insufficient short- and/or long-term health and nutritional conditions (Eveleth 1996). Children with a weight-for-age z-score two deviations below the reference values were classified as underweight. The second dependent variable comprises an overweight mother / underweight child pair.

2.3 Independent variables and covariates

The exposure of interest in this study was urban residence. Households were classified as urban or rural by the respective Young Lives country teams on the basis of their communities in Ethiopia, India and Vietnam, and on an individual household basis in Peru. Households were described as either urban, equals '1', or rural, equals '0'.

Covariates were identified based on a review of the literature and included child age and gender, maternal height and age, socioeconomic status, birth weight, number of children and region.

3. Results

The total sample size for all four study countries and characteristics of mother / child pairs are presented in Table 1, illustrating some differences (maternal education and number of children) as well as expected similarities (age, sex distribution).

Table 1. *Characteristics of study population by country*

	Ethiopia	India	Peru	Vietnam
No of mother / child pairs	1,726	1,889	1,842	1,860
Child characteristics				
Sex (% male)	53.3	53.4	50.4	51.4
Age (mean, SD)	4.7 (0.46)	4.8 (0.39)	4.8 (0.47)	4.7 (0.47)
Low birth weight (<2,500g) (%)	4.9	18.7	7.6	8.2
Maternal characteristics				
Age (mean)	31.7	27.7	31.3	31.3
Low education (%)	50.9	50.9	8.6	10.5
3 or more children (%)	76.1	39.9	51.7	26.3
Household characteristics				
Urban residence (%)	37.6	25.9	56.0	20.6
Household size (mean)	6.1	5.5	5.5	4.7
Wealth index (%)				
Very poor	80.3	39.5	14.8	15.1
Poor	18.3	39.5	34.6	41.4
Less poor	1.2	19.5	30.9	41.4
Non-poor	N/A	1.3	19.5	1.9

Note: SD = Standard deviation

3.1 Prevalence of maternal obesity and child stunting

Maternal overweight was found in all four countries ranging from a low of 6.5 per cent in Ethiopia to a high of 55.4 per cent in Peru. Overweight was consistently higher in urbanised areas (Table 2) and wealthier households (Figure 1). Stunting rates were high from 23.9 per cent in Vietnam to 31.1 per cent in Peru, being consistently higher in rural areas and poorer households. The prevalence of coexisting maternal overweight and child stunting was below 3 per cent in Ethiopia, India and Vietnam but as high as 14.7 per cent in Peru. Surprisingly, the dual burden was not always more frequent in urban areas. In Peru and Vietnam more dual burden households were found in rural sites. No consistent association between household wealth and the coexistence of maternal overweight and child stunting could be found. In India, Vietnam and Peru the phenomenon was more common in poorer households, while it was more common in wealthier households in Ethiopia.

Table 2. *Prevalence of dual burden pairs, maternal overweight, child underweight and stunting, by country and residence*

	OWUC ^a (n, %) ^b			OWSC ^a (n, %) ^b					
	rural	urban	total	rural	urban	total			
Ethiopia (n=1,726)	3 (0.2)	8 (1.2)	11 (0.6)	8 (0.7)	15 (2.3)	23 (1.3)			
India (n=1,889)	17 (1.2)	26 (5.3)	43 (2.2)	14 (1.0)	17 (3.4)	31 (1.6)			
Peru (n=1,860)	24 (2.9)	15 (1.4)	39 (2.1)	170 (20.9)	102 (9.8)	272 (14.7)			
Vietnam (n=1,842)	7 (0.4)	2 (0.5)	9 (0.5)	17 (1.1)	1 (0.2)	18 (0.9)			

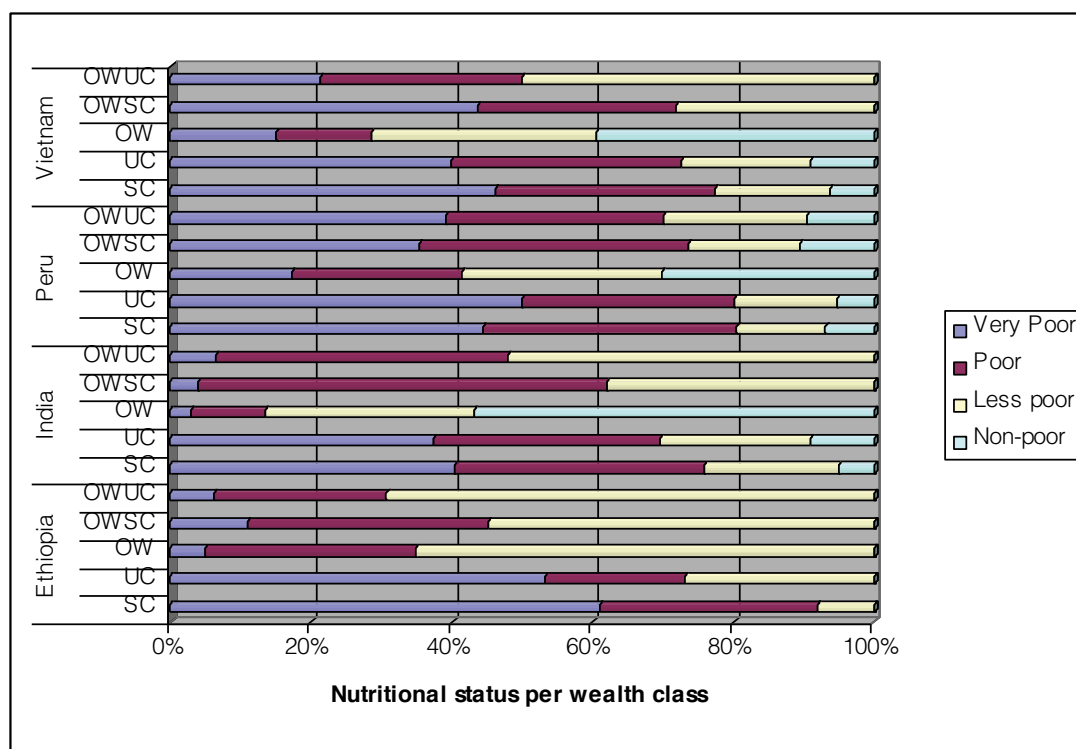
	OW ^a (n, %) ^b			UC ^a (n, %) ^b			SC ^a (n, %) ^b		
	rural	urban	total	rural	urban	total	rural	urban	total
Ethiopia (n=1,726)	25 (2.3)	88 (13.5)	113 (6.5)	302 (28.0)	107 (16.4)	409 (23.8)	318 (35.4)	148 (22.7)	527 (30.6)
India (n=1,889)	70 (5.0)	136 (27.7)	206 (10.9)	653 (46.6)	158 (32.2)	810 (42.9)	426 (30.4)	87 (17.7)	513 (27.2)
Peru n=1,860)	368 (45.3)	653 (63.2)	1021 (55.4)	67 (8.2)	25 (2.4)	92 (4.9)	413 (50.9)	161 (15.6)	574 (31.1)
Vietnam n=1,842)	94 (6.4)	48 (12.2)	141 (7.6)	283 (19.3)	29 (7.4)	312 (16.9)	412 (28.1)	29 (7.4)	441 (23.9)

Note:

^a OWUC= overweight mother / underweight child pair, OWSC= overweight mother / stunted child pair, OW= Overweight mother, UC= Underweight child, SC= Stunted child

^b Refers to percentage of urban or rural population

Figure 1. Prevalence of maternal overweight, child stunting and underweight and dual burden pairs by wealth quartile and country (percentage refers to each wealth quartile)



Note: OWUC= overweight mother / underweight child pair, OWSC= overweight mother / stunted child pair, OW= Overweight mother, UC= Underweight child, SC= Stunted child

3.2 Prevalence of maternal obesity and child underweight

The prevalence of child underweight varied greatly, ranging from a low 4.9 per cent in Peru to a very high 42.9 per cent in India. Underweight occurred more often in rural areas and poorer households. The occurrence of underweight children with overweight mothers was below 3 per cent in all countries. Underweight children with an overweight mother were more likely to live in urban areas in Ethiopia, India and Vietnam and less likely in Peru. The reason appears to be that underweight is much higher in rural areas in Peru and maternal obesity is constantly high regardless of setting.

Overweight mother / underweight child pairs were more likely to live in wealthier households in India, Ethiopia and Vietnam and in poorer ones in Peru.

3.3 Urban residence and the dual burden

Tables 3 and 4 present the results of the logistic regression models after adjustments for the sampling approach and controlling for potential confounders and covariates.

Table 3. *Results of logistic regressions showing the association between urban residence and overweight / underweight pair, overweight / non-underweight and non-overweight / underweight pairs, by country^a*

	Odds ratio (95% confidence interval)			
	Ethiopia n= 1,726	India n= 1,889	Peru n=1,860	Vietnam n=1,842
OWUC ^b	5.56 (0.4-68.1)	3.32 (1.2-9.2)*	0.82 (0.3-2.3)	1.17 (0.1-9.8)
OW / Non-UC ^b	1.80 (0.7-4.3)	2.32 (1.5-3.5)*	1.49 (1.0-2.1)*	1.31 (0.8-1.9)
Non-OW / UC ^b	0.92 (0.6-1.5)	0.80 (0.6-1.1)	0.57 (0.2-1.6)	0.43 (0.2-0.9)*

Note:

^a Adjusted for child age and gender, maternal height, maternal age, socioeconomic status, birth weight, number of children, region, cluster effect and non-random sample design. Reference pair non-underweight child / non-overweight mother

^b OWUC= overweight mother / underweight child pair, OW / Non-UC= overweight mother / non-underweight child pair, Non-OW / UC= non-overweight mother / underweight child pair

* Significant at the P<0.05 level

Table 4. *Results of logistic regressions showing the association between urban residence and overweight / stunted pair, overweight / non-stunted and non-overweight / stunted pairs, by country^a*

	Odds ratio (95% confidence interval)			
	Ethiopia n= 1,726	India n= 1,889	Peru n=1,860	Vietnam n=1,842
OWSC ^b	3.11 (0.6-15.7)	2.80 (0.7-11.1)	0.88 (0.6-1.2)	0.24 (0.3-1.5)
OW / Non-SC ^b	1.81 (0.7-4.9)	2.50 (1.5-4.0)*	1.68 (1.2-2.4)*	1.41 (0.9-2.1)
Non-OW / SC ^b	0.93 (0.5-1.7)	0.67 (0.5-0.9)*	0.34 (0.2-0.6)*	0.38 (0.2-0.7)*

Note:

^a Adjusted for child age and gender, maternal height, maternal age, socioeconomic status, birth weight, number of children, region, cluster effect and non-random sample design. Reference pair non-stunted child / non-overweight mother

^b OWSC= overweight mother / stunted child pair, OW / Non-SC= overweight mother / non-stunted child pair, Non-OW / SC= non overweight mother / stunted child pair

* Significant at the P<0.05 level

Urban residence was significantly associated with the coexistence of maternal overweight and child underweight only in India, where urban households were more than three times more likely to experience the dual burden of malnutrition than rural households, when compared with non-overweight mother / non-underweight child pairs. Interestingly, urban residence non-significantly increased the likelihood for dual burden households in Ethiopia, while it had a non-significant decreasing effect on Peru and Vietnam.

Overweight among mothers without under-nutrition in children was significantly increased in urban areas in India and Peru, but not in Ethiopia and Vietnam. In India, Peru and Vietnam stunting among children was significantly lower in urban areas than rural ones.

4. Discussion

The objective of this paper was to study whether the coexistence of maternal overweight and child under-nutrition is a concern for poor households in Ethiopia, India, Peru and Vietnam and whether urban residence affects this association.

As expected, both child stunting and underweight were high in the four samples. Higher prevalence of child stunting than child underweight could be found in Ethiopia, India and Vietnam, suggesting that long-term nutritional and health deficits that can reduce linear growth predominate in these samples. In India, child underweight exceeded child stunting, suggesting long- as well as short-term dietary deficiencies and poor health conditions. High levels of child underweight on the Indian subcontinent have been reported by several authors; these present an exception to the international rule that raised levels of underweight that are not attributed to high levels of stunting are predominantly found in disaster areas (Bharati et al. 2010; de Onis et al. 2004; Nandy et al. 2005). In Ethiopia, India and Vietnam we found low to medium levels of maternal obesity, and in Peru very high levels. Overweight was higher in urban areas and wealthier households, which is consistent with other studies in developing countries (Martorell et al. 2000; Ntandou et al. 2008). This observation seems plausible, as urban, wealthier households often have greater access to processed, energy-dense Westernised diets and are less physically active, because of sedentary occupations, than rural or poor households. High body weight is moreover often desired as it is perceived as a sign of wealth, health and female beauty in many non-Western cultures.

The dual burden of malnutrition, both with child stunting and underweight, occurred in all four countries; however, the prevalence in Vietnam, India and Ethiopia was very low (<3 per cent) suggesting that it is not a public health concern in poor segments of those populations yet. In contrast, the phenomenon occurred in 14.6 per cent of the households in Peru, making it an important health problem that needs to be addressed by interventions.

Urban residence seems to have different (although non-significant) effects on poor households in the four countries. While it increased the risk of dual burden households in Ethiopia and India, it decreased the risk in Peru and Vietnam. These results are consistent with findings from other multi-country studies (Garrett and Ruel 2005; Doak et al. 2000). A negative association between the dual burden and urban residence was reported in several studies from Latin American settings whereas a positive association was observed in Asia and sub-Saharan Africa (Barquera et al. 2007; Garrett et al. 2005). This heterogeneity in the effects of urban residence is interesting and further analysis is needed to fully understand the underlying factors of these differences between countries.

4.1 Methodological considerations

It has to be remembered that a certain percentage of dual burden households would be expected to occur by chance because of the high prevalence of both maternal overweight and child under-nutrition, particularly in Peru. By using multi-logistic regression analyses and grouping households into overweight mother / underweight child, non-overweight mother / underweight child and overweight mother / non underweight child pairs and similar for stunted children, it was possible to explore whether dual burden households were significantly different from non-dual burden households. For comparison reasons this study uses international cut-off points to classify the nutritional status of mother and child. The use of cut-off points specific to ethnic groups might have allowed for a more accurate evaluation

of nutritional status in these groups. Also, the Young Lives questionnaires did not collect data on current pregnancies of the mothers in the Round 2 surveys. Weight gain during pregnancy occurs mainly during the second and third trimester of the pregnancy and might have led to the misclassification of some mothers as overweight who were actually in the second or third trimester of a pregnancy (Carmichael et al. 1997). The assessment of urbanicity might also have introduced some biases, as definitions and understandings of urban neighbourhoods might vary between countries and cultures. Finally, the small sample size of overweight mothers in Ethiopia, India and Vietnam might have reduced the statistical power to identify significant association between the dual burden and urban residence. One also needs to keep in mind that the Young Lives study was designed to study relationships between aspects of childhood poverty, rather than as a tool for collecting national statistics, and thus nationally representative samples were decided against. The transferability and generalisation of the study's findings is therefore subject to some limitations. The strength of these analyses is the broadness of Young Lives data, which allowed us to control for a greater number of potential covariates than possible in previous studies.

Conclusion

Overall, the coexistence of maternal overweight with child under-nutrition seems to be a health concern only for Peru, the wealthiest country in our samples. Interventions to address the dual burden, which take country-specific risk factors into account are needed. For example, for the Peruvian context interventions should be directed primarily at less wealthy households with many children. Furthermore, interventions should target each household member individually rather than the whole household at once. For example, blanket supplementations of high-energy foods to the whole household to tackle child under-nutrition should be avoided and could be replaced by targeted interventions for undernourished children at school.

In our pro-poor samples in Ethiopia, India and Vietnam, child under-nutrition still exceeds adult obesity and the dual burden of overweight and malnutrition is still rare. Consequently, reducing child under-nutrition should continue to be treated as a priority by interventions and programmes. However, there is evidence that at least two of these countries, India and Vietnam, have entered the nutritional transition (Griffiths and Bently 2001; Nguyen et al. 2007).

Rising levels of adult obesity as well as the dual burden of overweight and malnutrition are likely to occur more frequently very soon. For early prevention, we suggest programmes specifically designed for resource-poor settings to promote healthy eating habits and regular physical activity that prevent both child under-nutrition and the onset of adult obesity. Our observations support the hypothesis made by Jehn and Brewis (2009), and supported by others, that the dual burden might occur as a by-product in the process of the economic and nutritional transitions of a country. Nevertheless, we would like to stress the importance of early interventions to reduce the occurrence of the dual burden in countries like India, Vietnam and Ethiopia that have just entered or are about to enter the nutritional transition.

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