

Short Communication

Regional clustering of anthropometric dimensions of primary school children in rural and suburban Vietnam

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Nutrition transition is one of the driving forces of the upcoming global epidemic of diabetes mellitus and cardiovascular diseases. We hypothesized that in previously deprived rapidly changing regions, the progress of the obesity epidemic is clustered per community and that screening with anthropometric school surveys can detect the negative effects of the nutrition transition in its early stages. In 16 different rural and urban communities in Binh Thuan Province, southern Vietnam, anthropometric surveys were conducted in local primary schools. Anthropometry of 2613 children showed a significant difference of the prevalence of wasting, stunting, and overweight between urban and rural communities. During the transition from high stunting rates to overweight, communities pass through an episode with dual burden of both conditions at different pace. Anthropometry of primary school children can reveal inter-community differences and identify the early stages of the nutrition transition.

Key Words: Anthropometry, Child, Obesity, Body Mass Index, Vietnam

INTRODUCTION

Nutrition transition is a process that takes place in all developing countries. Rapid socio-economic transition, changes in lifestyle and nutrition and the consequent rapid changes in body composition pose a serious health threat by raising the risk of overweight related non-communicable diseases such as diabetes mellitus and cardio-metabolic diseases.¹⁻³

Nutrition transition proceeds at different pace and the economic- and nutritional status can differ significantly within populations. Nutrition related disorders are not evenly distributed among populations and may even lead to a dual burden of under- and over-nutrition.⁴

The epidemiologic description of the nutrition transition is difficult and tools to distinguish sub-populations based on their risk for developing diabetes mellitus and the metabolic syndrome are therefore urgently needed but not yet available.

Primary school surveillance is an established public health technique to detect local differences in prevalence of disease and to guide disease control programs. Whether school surveys can also be used to monitor nutrition transition is not clear.

In this study we hypothesized that the early effects of the nutrition transition are clustered per community, the lowest administrative level in Vietnam, and that this can be detected by conducting school surveys and looking at childhood obesity as an indicator of the nutrition transition. Childhood obesity is considered a risk factor for

developing diabetes at later age and its prevalence is rising in developing countries.⁵⁻⁷

Vietnam is an example of a country in rapid transition from high rates of poverty and malnourishment to industrialization, more affluent living standards and rapid changes in food intake.⁸ The prevalence of diabetes mellitus and the metabolic syndrome is still relatively low in Vietnam but is expected to change rapidly.⁹ In this study we tested whether children's anthropometric dimensions differ significantly between communities in an area where living conditions have only recently started to change.

MATERIALS AND METHODS

Study site

The study was conducted in Binh Thuan province in the south of Vietnam, 150 km north of Ho Chi Minh City. The provincial capital Phan Thiet, with its approximately 200,000 inhabitants, recently changed from a relatively quiet town to a busy hub for the beach tourist industry.

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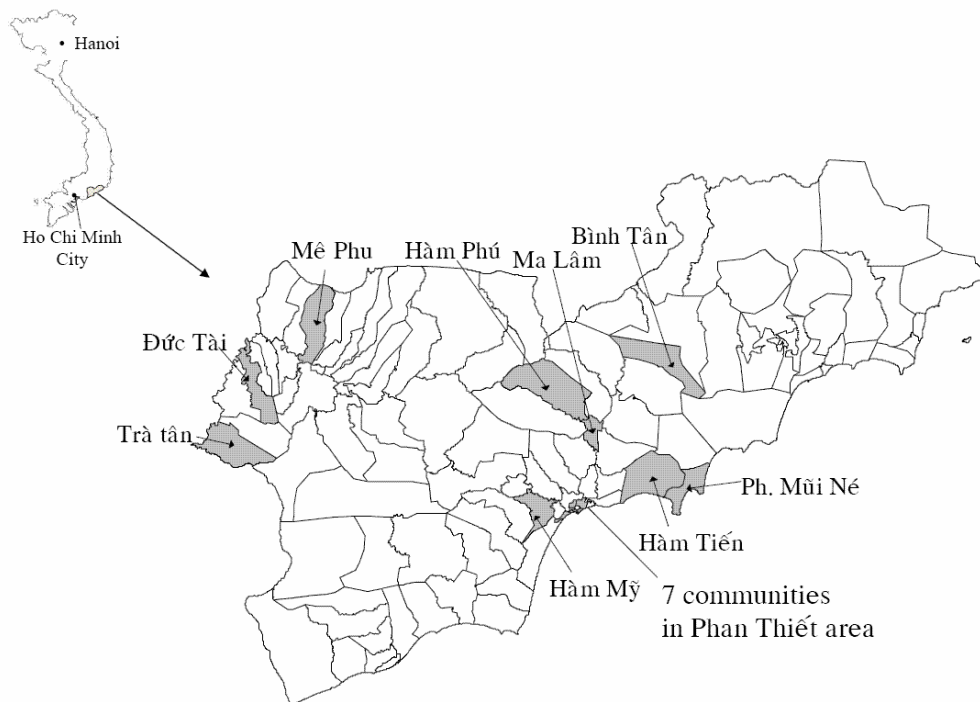


Figure 1. Map of Binh Thuan Province. Study communities are indicated in gray.

Binh Thuan comprises ten administrative districts divided into 122 communities. Fifteen of these communities can be considered urbanized quarters of Phan Thiet city. Between the two last censuses, the total population rose from 767.000 in 1989 to 1.140429 in 2004 (population density 120/km²). Binh Thuan is mainly a rural province, but urbanization is in progress and the proportion of the rural population is declining, from approximately 75% in 1991 to 65% in 2004 (data from Provincial Statistics Department). Half of the provincial domestic product is generated by agriculture, forestry and fishery, 20% by small industry and construction (increasing) and 30% by services (increasing). Between 1995 and 2004 the gross domestic product per capita almost quadrupled to \$3.550 a year.

The study was conducted in December 2005 and January 2006. Sixteen communities were selected, 11 non adjacent rural communities and 5 (sub-) urban communities, in and around Phan Thiet city (Figure 1). The selected communities were representative for the entire province with respect to socioeconomic characteristics and ecological conditions. The populations in the urbanized and rural communities were mainly of ethnic Vietnamese (Kinh) origin.

Anthropometry in children

In all study communities anthropometry was performed at public primary schools. At each school the body dimensions were measured of approximately 150 pupils with ages between 6 and 10 years, thereby diminishing the effect of pubertal growth spurt. Only complete classes

were examined. In communities with more than one primary school we selected one school on pragmatic grounds. Height, weight and waist circumference were

measured of all children, using a standard mechanical scales and a gauge. Weight was measured while children were bare foot and wearing light clothing. For all surveys the same mechanical scale was used, which was calibrated before each survey. Waist circumference was measured using the umbilicus as reference point. Measurement of weight was precise to 0.5 kg, height and waist circumference to 1 cm. All children received a dairy drink as a reward for their participation.

Statistics and interpretation of results

Height and weight were expressed as Z-scores of height-for-age (Z-HtA), weight-for-age (Z-WtA) and weight-for-height (Z-WtHt). The body mass index (BMI) was expressed as Z-scores, and percentiles. Z-scores were calculated as the number of standard deviations (SD) below or above the median in the 2000 reference distribution tables of the National Center of Health and Statistics of the WHO, using the program NutStat, a part of the program EpiInfo™ (version 3.3.2, CDC Atlanta, GA). Stunting was defined as Z-HtA \leq -2 SD and wasting as Z-WtA \leq -2SD. A BMI above the 85th percentile was considered as overweight. Data are presented as mean and 95% confidence interval of the mean. One-Way ANOVA, student's t-test and the chi-square test were used to test for differences between communities, using SPSS (v 12.0.2, SPSS Inc., Chicago, Ill).

RESULTS

The communities and number of examined children are shown in Table 1. In the 16 communities, 2613 primary school children were measured, of whom 1650 lived in rural areas and 963 in urban communities. Sixty four (2.4%) children in the examined classes were absent from school during the surveys. The mean age of the children

Table 1. Communities in Binh Thuan, studied for gestational diabetes and anthropometry among primary school children.

Community	Urban/ Rural	Population †	Number children studied
Bình Tân	rural	7843	160
Đức Tài	rural	15538	211
Hàm Hiệp	rural	11293	108
Hàm Kiem	rural	6870	157
Hàm Mỹ	rural	14605	166
Hàm Phú	rural	8241	154
Hàm Tiến	rural	12397	171
Ma Lâm	rural	15538	187
Mé Phu	rural	14371	165
Mũi Né	urban	30129	150
Phong Đức Long	urban	18755	164
Phong Đức Nghĩa	urban	11237	162
Phong Đức Thắng	urban	9658	172
Phong Hưng Long	urban	14660	175
Phong Lạc Đạo	urban	13262	139
Trà Tân	rural	23858	171

† Population numbers were derived by loglinear extrapolation from the 1988 and 1998 census data.

was 7.41 years. Table 2 shows the anthropometric characteristics of the total, the urban, and the rural study population. The mean Z-HtA per community ranged from -1.63 to -0.53 ($p < 0.001$, ANOVA). The mean Z-HtA in rural communities was -1.27, significantly lower than the value in urban communities, -1.08 ($p < 0.001$, t test). The overall prevalence of stunting was 21.4% with 23.8% in rural communities and 17.2% in the urban communities ($p < 0.001$, chi-square test). The overall prevalence of wasting was 20.4%. In rural communities this was 22.6% and in urban communities it was 16.7% ($p < 0.001$, chi-square test).

Also BMI and Z-BMI showed significant inter-community variability; the mean BMI scores ranged from 13.7 kg/m² to 15.5 kg/m² ($p < 0.001$, ANOVA), and mean Z-BMI scores ranged from -0.27 SD to -1.81 SD ($p < 0.001$, ANOVA). The mean Z-BMI was -1.49 in rural communities and -1.03 in urban communities ($p < 0.001$, t-test).

Table 2. Anthropometric variables of primary school children in Binh Thuan province, Vietnam.

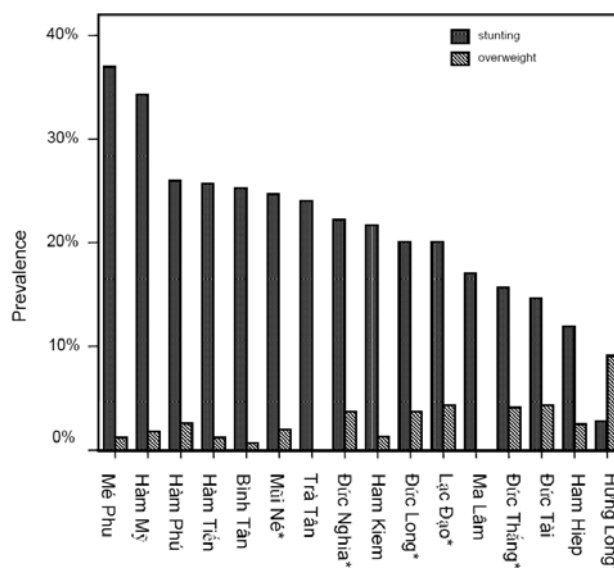
	Total (n=2546)	Urban communities (n=1611)	Rural communities (n=934)	p-value
Age (years)	7.41(7.37, 7.45)	7.42 (7.37, 7.47)	7.41(7.37, 7.45)	n.s.
Z-HtA †	-1.20 (-1.24, -1.16)	-1.08 (-1.14, -1.02)	-1.27 (-1.33, -1.22)	< 0.001
BMI ‡ (kg/m ²)	14.2 (14.15, 14.25)	14.6 (14.49, 14.71)	14.0 (13.94, 14.06)	< 0.001
Z-BMI § (kg/m ²)	-1.32 (-1.37, -1.27)	-1.04 (-1.12, -0.96)	-1.50 (-1.56, -1.44)	< 0.001
Waist circumference (cm)	50.0 (49.84, 50.16)	51.4 (51.09, 51.71)	49.2 (49.03, 49.37)	< 0.001
Wasting (%)	20.4 (18.9, 21.9)	16.7 (14.6, 19.1)	22.6 (20.5, 24.7)	< 0.001
Stunting (%)	21.4 (20.5, 22.3)	17.3 (14.9, 21.7)	23.8 (21.6, 26.0)	< 0.001
Overweight (%)	2.7 (2.1, 3.3)	4.6 (3.3, 5.9)	1.6 (1.0, 2.2)	< 0.001

All data are given as mean or percentage and between brackets the lower and upper 95% confidence intervals;

† Z-HtA: Z-score for height for age

‡ BMI: body mass index

§ Z-BMI: z-score for the BMI

**Figure 2.** Prevalence of stunting and overweight among primary school children in 16 communities in Binh Thuan province, Vietnam. The asterisk indicates (sub)urban communities.

Overweight was more prevalent in urban than in rural communities, 4.6% and 1.6% respectively ($p < 0.001$, chi-square test) with an overall prevalence of 2.7%. In two communities there were no overweight children at all, in three communities the prevalence was between 4-5% and in one community we found a relatively high prevalence of 9.1%.

Figure 2 shows the prevalence of stunting and overweight by community, ranked by the prevalence of stunting. There was a negative correlation between the prevalence of stunting and overweight ($R^2 = 0.38$, $p = 0.011$), especially among the urban communities ($R^2 = 0.94$, $p < 0.001$).

DISCUSSION

This study shows that anthropometric data of children are clustered by community in Binh Thuan. It also shows that the nutritional status of communities can differ markedly, even if they are only separated by 30 km. This implies that prevention and intervention programs should be con-

ducted on a small scale, and take inter-community differences into account.

The narrow age range of the children enabled a good comparison between communities and the use of Z-scores controlled for age and sex differences. The ratio between boys and girls in each school, were also comparable between the communities, making confounding by sex differences unlikely. The NCHS reference tables that were used to calculate the Z-scores are based on data from the United States, where childhood obesity is much more common.^{7,10} Applying these reference tables to Vietnamese children introduces an underestimation of the true prevalence of overweight, but it has little or no effect on the comparison between communities. In a previous study in Binh Thuan, we documented that there was a fairly good linear correlation between anthropometric Z-scores generated by the LMS method and the NCHS based Z-scores in children.¹¹ In this study, the LMS method was not applied because of the limited study population size.

Binh Thuan ranks in the middle among all Vietnamese regions, with respect to economic development. More prosperous provinces may show a higher prevalence of childhood overweight. Especially in the heavily urbanised areas of Ho Chi Minh City and Hanoi, the economic status of the population is much higher and diabetes mellitus and obesity are more common.^{9,12,13} Binh Thuan appears to be in the very early stage of the nutrition transition that was described by Popkin.^{1,2} To date, in Binh Thuan stunting still predominates in nearly all communities. But, there was already one community where the prevalence of overweight exceeded that of stunting and overall there was an inverse relation between the prevalence of stunting and overweight. This is probably the earliest effect of the nutrition transition that can be measured at a population level.

The study aimed at finding out if there were inter-community differences in childhood body dimensions that could possibly offer tools for interventions that are tailored to the local situation. The study does not explain the differences between the communities or schools and did not study the factors that cause imbalances between diet and physical exercise. Further studies are needed to tease out the factors that can be utilized for designing health interventions at community or school level. Similar to Binh Thuan, most of Vietnam is probably still in the early stage of the nutrition transition and the epidemiologic transition to cardio-metabolic diseases. Predictions, based on experiences from other regions and the observed increasing prevalence of diabetes mellitus in Vietnamese cities, indicate that diabetes mellitus will become a serious public health problem in Vietnam with great challenges to the preventive and curative health services.³ It also implies that with a rising prevalence of overweight and obesity, communities in Vietnam will be confronted with a dual burden of stunting and overweight. Poverty reduction programs in Vietnam used to focus on malnutrition, but these should now be carefully tailored to the needs of every community in order not to contribute to overweight. For example, nutrition programs that offer food supplementation should be combined with the promotion of physical activity.

In conclusion, school surveys may pick up nutrition transition in its early stages, may expose differences between communities and detect those populations who are prone to overweight and obesity. To gain better insight in the dynamics of the nutrition transition, school surveys should be complemented with longitudinal studies and with intervention studies. With respect to Vietnam, these studies should be implemented soon, before the global epidemic of obesity also starts to affect the morbidity rates in Vietnam.

AUTHOR DISCLOSURES

There are no conflicts of interest for all authors. This study was achieved with financial support of Friesland Foods, Leeuwarden, the Netherlands. Hemocue equipment was kindly provided by Hemocue (Hemocue AB, Ängelholm, Sweden and Hemocue Diagnostics BV, Waalre, the Netherlands)

REFERENCES

1. Popkin BM. The nutrition transition in low-income countries: an emerging crisis. *Nutr Rev.* 1994;52:285-98.
2. Popkin BM. The nutrition transition: an overview of world patterns of change. *Nutr Rev.* 2004;62(7 Pt 2):S140-S143.
3. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. *Diabetes Care.* 2004;27:1047-53.
4. Doak CM, Adair LS, Bentley M, Monteiro C, Popkin BM. The dual burden household and the nutrition transition paradox. *Int J Obes Relat Metab Disord.* 2005;29:129-36.
5. Abraham S, Collins G, Nordsieck M. Relationship of childhood weight status to morbidity in adults. *HSMHA Health Rep.* 1971;86:273-84.
6. Guo SS, Chumlea WC. Tracking of body mass index in children in relation to overweight in adulthood. *Am J Clin Nutr.* 1999;70:145S-148S.
7. de Onis M, Blossner M. Prevalence and trends of overweight among preschool children in developing countries. *Am J Clin Nutr.* 2000;72:1032-9.
8. Thang NM, Popkin BM. Patterns of food consumption in Vietnam: effects on socioeconomic groups during an era of economic growth. *Eur J Clin Nutr.* 2004;58:145-53.
9. Duc Son LN, Kusama K, Hung NT, Loan TT, Chuyen NV, Kunii D, Sakai T, Yamamoto S. Prevalence and risk factors for diabetes in Ho Chi Minh City, Vietnam. *Diabetes Med.* 2004;21:371-6.
10. WHO Expert Committee. Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. 1995. Report No.: 854.
11. Hung LQ, de Vries PJ, Giao PT, Binh TQ, Nam NV, Chong MT, Kager PA. Nutritional status following malaria control in a Vietnamese ethnic minority commune. *Eur J Clin Nutr.* 2005;59:891-9.
12. Hop IT, Xuan Ngoc TT. Overweight/obesity situation and the relation to lipid disorders and hypertension in women aged 20 to 59 years old in Ba Dinh district, Hanoi City. *Asia Pac J Clin Nutr.* 2004;13:S139
13. Cuong TQ, Dibley MJ, Bowe S, Hanh TTM, Loan TTH. Obesity in adults: an emerging problem in urban areas of Ho Chi Minh City, Vietnam. *Eur J Clin Nutr.* 2007 May;61(5):673-81.

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越南鄉村及郊區的小學學童體位測量結果之區域群集現象

營養變遷是即將來臨的全球性糖尿病及心血管疾病流行的強大因素之一。我們假設在之前貧困但快速改變的區域，肥胖流行的發展會在每個社區聚集，以學校體位測量調查可以偵測營養變遷在早期之負效應。在越南南部 Binh Thuan 省的 16 個不同鄉村及城市社區的當地小學執行體位測量調查。2613 名兒童的體位資料顯示城鄉社區在消瘦、發育遲緩及體重過重情況有顯著差異。從高發育遲緩率轉型到體重過重的期間，社區以不同速度的情形下經歷雙重負擔的事件。小學學童的體位測量可以顯示社區間的差異及確認營養變遷的早期階段。

關鍵字：體位測量、兒童、肥胖、身體質量指數、越南