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ORIGINAL ARTICLE

Body mass index (BMI) dynamics in vietnam

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Objective: To provide an overview of dynamic shifts in body mass index (BMI) and nutritional status patterns of the Vietnamese population from 1992 to 2002.
Design: Nationally representative, cross-sectional surveys.
Setting and subjects: Secondary data obtained from The Living Standard Survey in 1992 (24 068 individuals) and the National Health Survey in 2002 (158 019 individuals).
Methods: Nutrition status was defined by comparing measured BMI, grouped for under- and overweight with the Centers for Disease Control and Prevention 2000 BMI growth charts for the 2–17 year-olds and the World Health Organization 1995 cutoff points for the 18–65 year-olds.
Results: Over the 1992 and 2002 period, minimal changes were observed in the prevalence of overweight (from 1.4% (95% confidence interval (95% CI): 1.0–1.8) to 1.8% (1.6–2.0)) and underweight (from 32.1% (30.4–33.7) to 33.5% (32.8–34.1)) among 2–17 year-olds. In contrast, among 18–65 year-olds, the prevalence of overweight and obesity increased (from 2.0% (1.5–2.4) to 5.2% (5.0–5.4)) and underweight declined (from 32.6% (31.2–33.9) to 24.8% (24.3–25.3)). Urban residents experienced larger reductions in underweight and increases in overweight than rural residents. Analyses of BMI levels for the 15th, 50th and 85th percentiles, by age, revealed a trend of increasing BMI that was higher among adults, females and urban residents.
Conclusion: Although underweight remains the main concern, overweight is an emerging problem in Vietnam. Early prevention is needed to prevent overweight from causing undesirable effects on health and economic in the transitional period.
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Introduction

A comprehensive economic reform program (termed Doi Moi) – changing Vietnam from a centrally planned to a free market economy — was initiated in 1986 with subsequent rapid economic growth since 1990. The annual gross domestic product (GDP) increased from 4.4% in the late 1980s to more than 7% and inflation rates were reduced significantly — regardless of the regional financial crisis in the late 1990s. During that time, per capita GDP (in purchasing power parity (PPP) terms) increased from less than $1000 (USD) to almost $2500 (USD) and the prevalence of the total population living under the poverty line was reduced from 70% in the early 1980s, to 58% in the mid-1990s and to 37% in the late 1990s (National Centre for Social Sciences and Humanities, 2001; United Nations Development Programme (UNDP), 2005). The development of the agriculture sectors and economic growth in the last two decades transformed Vietnam (a) from a country highly dependent on food aid to a food exporter, (b) from a country of famine to one with a surplus of foods and (c) from a country of staple-based diets to one with more balanced and nutritious diets (Ministry of Health – National Institute of Nutrition, 2003b; United Nations Development Programme (UNDP), 2005). Compared with dietary data in 1990, the consumption of both meat and total fat doubled in 2000, the consumption of egg tripled and the consumption of fruit increased 10-fold (Ministry of Health – National Institute of Nutrition, 2003b).

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The improvement of the nutrition status was also attributed to the successful implementation of the national nutrition policies in Vietnam. The first policy on nutrition (The National Plan of Action for Nutrition 1995–2000) focused on food insecurity, child and mother malnutrition; the follow-up policy (The National Nutrition Strategy 2001–2010) added additional strategies to deal with nutrition-related health problems (Hop and Khan, 2002; Ministry of Health – National Institute of Nutrition, 2003b). As a result of the successful economic reforms and nutrition policies from 1985 to 2002, the prevalence of underweight (low weight for age) was reduced from 51.5 to 30.1% and the prevalence of stunting (low height for age) was reduced from 59.7 to 33.0%, when compared with the corresponding 1977 National Center for Health Statistics (NCHS) reference populations (National Institute of Nutrition – General Statistical Office, 2003). The prevalence of women, aged 20–49 years, with a body mass index (BMI) less than 18.5 was reduced from 33.1% in 1990 to 26.3% in 2000 (Ministry of Health – National Institute of Nutrition, 2003b). Experiences from other transitional economies reveal that (a) the current surplus in food and nutrient intake, (b) the poor nutrition status in the past (e.g., low birth weight, stunting) and (c) the low physical activity might accelerate this shift towards an epidemic of overweight, obesity and other related noncommunicable diseases (NCDs) with severe consequences and burdens in the Vietnamese nutrition, health and economic areas (Barker, 1998; Popkin, 2001, 2002b; Popkin *et al*., 2001; Wang *et al*., 2002; Popkin and Gordon-Larsen, 2004). Although Vietnam is considered to be one of the developing countries with good progress in human development (United Nations Development Programme (UNDP), 2005), the income gaps between urban and rural residents and between the rich and the poor have widened quickly since the 1990s (National Centre for Social Sciences and Humanities, 2001).

Information about the nutrition status of Vietnamese, mostly among young children and women at reproductive age, is only documented in domestic reports (Ministry of Health – General Statistical Office, 2003; National Institute of Nutrition – General Statistical Office, 2003; Ministry of Health – National Institute of Nutrition, 2003b) with limited international access. The published papers tend to be small-scale studies or to focus on very specific age groups (Hop *et al*., 1997; Hanh *et al*., 2001; Hop le and Xuan Ngoc, 2004). This study is the first to focus on both under- and overweight in both children and adults, using large scale, nationally representative data sets to provide an overview of dynamic shifts in BMI and nutritional status patterns of the Vietnamese population from 1992 to 2002.

Subjects and methods

Nutritional status data

Data for this study were compiled from the Vietnam Living Standard Survey 1992–1993 (LSS92) and the Vietnam National Health Survey 2002 (NHS02).

Vietnam Living Standard Survey 1992–1993. The nationally representative survey of both rural and urban areas was administered by the State Planning Committee and the General Statistical Office (GSO) with technical support from World Bank experts (General Statistical Office, 1994). The survey was conducted in 150 communities (120 in rural areas and 30 in urban areas) throughout the country, with a probability proportional to size (based on the number of households in the 1989 Population Census). Households were selected using a two-stage, self-weighted random sample to (a) provide every household in the country an equal probability of being selected and (b) ensure that 20% of selected households were from urban areas. In total, the survey included 4800 households with 24 068 eligible individuals (General Statistical Office, 1994). Data collection was implemented during the 12-month period from October 1992 to October 1993 by 15 data collector teams that included trained anthropometricians. Each household was visited twice, with a 1-week interval between visits (General Statistical Office, 1994). Follow-up living standard surveys were conducted in 1997–1998, 2002 and 2004; however, anthropometric measurements were not available in the 2002 and 2004 surveys.

Vietnam National Health Survey 2002. The largest, nationally representative health survey ever conducted in Vietnam was conducted by the Vietnam Ministry of Health and the GSO with technical support from Swedish experts (Ministry of Health – General Statistical Office, 2003). The survey was based on a stratified, three-stage sample design with 122 strata, defined by urban or rural domains of all 61 Vietnam provinces. The sample selection was conducted independently within each stratum. In the first stage, communes or wards (subdistricts) were selected with a probability proportional to size (based on the number of households in the 1999 Population and Housing Census). In the second stage, two enumeration areas (EAs) were selected in each sampled commune or ward, with systematic sampling at a rate inversely proportional to the number of EAs in the commune or ward. In the third stage, 15 households were selected in each sampled EA, again by systematic sampling. All household members were selected for the survey. In total, the surveys included 122 strata, 1200 subdistricts, 2400 EAs and 36 000 households with 158 019 eligible individuals (Ministry of Health – General Statistical Office, 2003; Department of Economic and Social Affairs, 2005). Data collection was implemented during the 12-month period from November 2001 to November 2002 by 62 data collector teams that included trained anthropometricians. Each household was visited twice, with 4-week intervals between visits (Ministry of Health – General Statistical Office, 2003).

Nutrition status measures

BMI was calculated based on measured weight and height; weighted BMI percentiles were calculated. Pregnant and

lactating women, children under 2 year and adults older than 65 years were not included because BMI would not provide valid information about their nutrition status (WHO Expert Committee, 1995; Kuczmarski *et al*., 2002).

For subjects aged 2–17 years. BMI was compared with the age and sex-specific CDC 2002 BMI growth charts. Subjects with a BMI of less than the 5th percentile (Z-BMI <-1.645) were considered to be underweight, whereas the subjects with a BMI of greater or equal to the 85th percentile (Z-BMI $\geqslant 1.036$) were considered at risk of being overweight (WHO Expert Committee, 1995; Kuczmarski *et al*., 2002). In this report, we considered the 'at-risk of being overweight' as 'overweight' to make them comparable with the adult BMI classification. BMI growth charts provided the ability to deal with nutrition status in comparison with height and to compare the data with current international publications.

For subjects aged 18–65 years, BMI was compared with the cutoff points defined by the WHO: $< 18.5\,kg/m^2$ is underweight (chronic energy deficiency), 18.5–24.9 kg/m^2 is normal and $\geqslant 25\,kg/m^2$ is overweight (WHO Expert Committee, 1995).

The gender and date of birth were defined, based on the survey answers of household heads. Age calculation was based on the measured date and date of birth using e-date command of Stata 9.1 (StataCorp, 2005b). Age groupings followed the age characteristics such as preschool, school age, prior to teen age, teen age at puberty, teen age after puberty, and young-, middle- and older adults. The 2–17 year-olds were classified as children and 18–65 year-olds were classified as adults. The urban and rural classifications were based on the classification at the time of each survey.

Statistical analysis
Survey commands were used to account for survey design effects, sampling weight and to provide nationally representative results. All eligible subjects (all household members) were included in the analysis. The survey subpopulation excluded the subjects (a) whose valid measurements of weight and height were not obtained (e.g., the measurements of weight and height were not obtained or did not follow the standardized procedure), (b) who were pregnant or lactating women, (c) who were children under 2 year or adults more than 65 years or (d) who had extreme and implausible height, weight and BMI for their age (StataCorp, 2005a). The data were presented as percentages with 95% confidence interval (95% CI); 15th, 50th and 85th percentiles; stratified by sex and place of residence; average annual absolute changes in prevalence; and ratio of underweight to overweight prevalence. As there was a 10-year interval between LSS92 and NHS02, the annual changes (equal to one-tenth of the difference between the two surveys — based on the assumption of linearity) make the study results comparable with other studies and easier to communicate. Data screening and analyses were conduced using Stata 9.1 SE version (StataCorp, 2005b).

Ethical consideration
The study was approved by the Institutional Review Board of the Vietnam General Office Statistics and the Ministry of Health. Full access to the data set was approved by the Vietnam General Statistical Office and the Vietnam Ministry of Health.

Results

The 1992 sample population included persons living in urban areas (19.9%), females (51.8%) and those younger than 18 year (44.7%); in 2002, the composition of this same population was 23.0, 51.5 and 37.7%, respectively. The subpopulation in both surveys had a slightly lower proportion of adults and females (at reproductive ages) because of the exclusion of pregnant, lactating women and adults older than 65 years.

Characteristics of the overweight
In general, the prevalence of overweight and obesity increased from 1992 to 2002. Among children younger than 18 years, the prevalence of overweight and obesity in 1992 and 2002 increased slightly (from 1.4 to 1.8%; *P*-value = 0.07). The prevalence of overweight and obesity of urban residents was higher than of the rural population, except for the 2–5-year-old children in the 1992 survey. The overweight and obesity differences between urban and rural populations were greater in the 2002 survey than in the 1992 survey. The overweight prevalence was comparable among male and female children (Table 1).

Among 18–65 year-olds, the prevalence of overweight and obesity in 2002 was 5.2%, statistically higher than the prevalence in 1992 of 2.0% (*P*-value <0.001). In both surveys, the prevalence of overweight and obesity was higher in urban populations, the differences being larger in 2002. Female adults had a higher prevalence of overweight compared to the male subjects of the same age in both 1992 and 2002 (Table 1).

Table 1 and Figure 1a show the annual absolute change of overweight prevalence being 0.32% among adults — much higher than among children (0.04%). Although the prevalence of overweight among adult females was higher than for adult males as stated above, the annual increase rates were identical. When stratified by age group, male subjects had higher annual increasing rates, except for the 55–65 year-olds. The increasing rates of overweight were higher among urban residents in all age groups, especially among the 2–9 and the 55–65 year-olds. Among the 2–5 year-olds, the annual rate of overweight increased 0.58% among urban children, but decreased 0.20% among rural children.

Table 1 Overweight plus obesity by age groups, sex and area of residency: prevalence and annual changes between 1992 (LSS92) and 2002 (NHS02) surveys in Vietnam[a,b,c,d]

Age groups	LSS92 prevalence percentage (95% CI)					NHS02 prevalence percentage (95%CI)					Annual absolute changes in the prevalence[e,f] percentage (95%CI)				
	Male	Female	Rural	Urban	Total	Male	Female	Rural	Urban	Total	Male	Female	Rural	Urban	Total
2–5	4.4 (2.8,6.1)	4.9 (3.2,6.7)	4.9 (3.3,6.6)	3.3 (1.3,5.2)	4.7 (3.2,6.1)	4.2 (3.5,4.9)	4.0 (3.3,4.8)	2.9 (2.4,3.5)	9.0 (7.2,10.8)	4.1 (3.6,4.7)	−0.02 (−0.20,0.15)[NS]	−0.09 (−0.28,0.10)[NS]	−0.20 (−0.38,−0.02)*	0.58 (0.31,0.84)***	−0.06 (−0.21,0.10)[NS]
6–9	0.7 (0.3,1.1)	0.3 (0.0,0.5)	0.5 (0.2,0.8)	0.5 (−0.2,1.2)	0.5 (0.2,0.8)	2.4 (2.0,2.8)	1.4 (1.1,1.7)	1.0 (0.8,1.2)	6.1 (4.9,7.3)	1.9 (1.6,2.2)	0.17 (0.11,0.23)***	0.12 (0.08,0.16)***	0.05 (0.01,0.09)*	0.56 (0.42,0.70)***	0.14 (0.10,0.18)***
10–14	0.1 (−0.1,0.2)	0.3 (0.0,0.5)	0.1 (0.0,0.2)	0.6 (−0.1,1.3)	0.2 (0.0,0.3)	1.5 (1.2,1.8)	1.0 (0.8,1.3)	0.8 (0.6,1.0)	3.2 (2.5,4.0)	1.3 (1.1,1.5)	0.14 (0.11,0.18)***	0.08 (0.04,0.11)***	0.08 (0.05,0.10)***	0.26 (0.16,0.36)***	0.11 (0.08,0.14)***
15–17	0.0 (0.0,0.0)	0.3 (−0.1,0.6)	0.0 (0.0,0.0)	0.6 (−0.2,1.5)	0.1 (−0.1,0.3)	0.6 (0.4,0.9)	0.5 (0.3,0.7)	0.3 (0.2,0.5)	1.6 (0.9,2.2)	0.6 (0.4,0.7)	0.06 (0.04,0.09)***	0.03 (−0.01,0.07)[NS]	0.03	0.09	0.05 (0.02,0.07)***
18–34	0.4 (0.1,0.6)	1.4 (0.9,1.9)	0.6 (0.3,0.9)	1.6 (0.9,2.2)	0.8 (0.6,1.1)	2.3 (2.0,2.6)	2.5 (2.2,2.7)	1.7 (1.5,1.9)	4.3 (3.7,4.9)	2.4 (2.2,2.6)	0.19 (0.16,0.23)***	0.11 (0.05,0.16)***	0.11 (0.08,0.15)***	0.28 (0.19,0.37)***	0.15 (0.12,0.19)***
35–54	1.7 (0.9,2.5)	4.8 (3.5,6.0)	1.9 (1.3,2.4)	8.0 (5.2,10.8)	3.3 (2.4,4.2)	5.8 (5.4,6.2)	8.4 (8.0,8.9)	4.8 (4.5,5.2)	13.6 (12.9,14.4)	7.2 (6.9,7.5)	0.41 (0.32,0.50)***	0.36 (0.23,0.50)***	0.30 (0.23,0.36)***	0.57 (0.28,0.85)***	0.39 (0.29,0.48)***
55–65	1.8 (0.6,3.0)	3.0 (1.7,4.3)	1.2 (0.5,1.9)	6.7 (4.1,9.2)	2.5 (1.5,3.4)	5.3 (4.5,6.2)	9.9 (8.9,10.9)	4.9 (4.3,5.6)	16.6 (14.5,18.7)	7.9 (7.2,8.7)	0.35 (0.20,0.50)***	0.69 (0.53,0.86)***	0.38 (0.28,0.47)***	0.99 (0.66,1.33)***	0.55 (0.43,0.67)***
Children (2–17)	1.4 (0.9,1.9)	1.4 (0.9,1.9)	1.4 (0.9,1.9)	1.2 (0.5,1.9)	1.4 (1.0,1.8)	2.0 (1.8,2.3)	1.6 (1.4,1.8)	1.1 (1.0,1.3)	4.7 (4.0,5.3)	1.8 (1.6,2.0)	0.07 (0.01,0.12)*	0.02 (−0.04,0.07)[NS]	−0.03 (−0.08,0.02)NS	0.34 (0.25,0.44)***	0.04 (0.00,0.09)[NS]
Adult (18+)	1.0 (0.6,1.3)	3.0 (2.4,3.6)	1.1 (0.9,1.4)	4.5 (3.4,5.6)	2.0 (1.5,2.4)	4.1 (3.9,4.4)	6.2 (5.9,6.5)	3.5 (3.3,3.7)	10.0 (9.5,10.6)	5.2 (5.0,5.4)	0.32 (0.27,0.36)***	0.32 (0.26,0.39)***	0.24 (0.20,0.27)***	0.55 (0.43,0.67)***	0.32 (0.28,0.37)***
Total	1.2 (0.9,1.5)	2.2 (1.8,2.7)	1.3 (1.0,1.6)	3.2 (2.4,4.1)	1.7 (1.4,2.0)	3.3 (3.1,3.5)	4.4 (4.2,4.6)	2.5 (2.3,2.6)	8.2 (7.7,8.7)	3.8 (3.7,4.0)	0.21 (0.17,0.24)***	0.22 (0.17,0.26)***	0.12 (0.09,0.15)***	0.50 (0.40,0.60)***	0.21 (0.18,0.25)***

[a]For children from 2–17 years, overweight plus obesity is defined as BMI ⩾85th percentile (BMI *z*-score ⩾1.036) of 2000 CDC BMI for age growth chart.
[b]For 18–65-year-old subjects, overweight plus obesity is defined as BMI ⩾25 kg/m^2.
[c]The results were weighted to be nationally representative.
[d]Data were presented as percentage and (95% CI).
[e]Values are equal to one-tenth of the difference of corresponding subgroups between 2002 and 1992 surveys.
[f]Test for the differences of corresponding subgroups between LSS92 and NHS02: *$P<0.05$; **$P<0.01$, ***$P<0.001$.

Characteristics of the underweight

Among children less than 18 years, the prevalence of underweight in 1992 and 2002 was not statistically different (a prevalence of 32.1 and 33.5%, respectively; *P*-value = 0.11). In general, the underweight prevalence was higher among children living in rural areas, except for the rural 2–9 year-olds in 1992. In both surveys, girls had a higher prevalence of underweight among 2–9 year-olds, but lower among 10–17 year-olds when compared with boys of the same ages (Table 2).

Among the 18–65 year-olds, the prevalence of underweight in 2002 was 24.8%, statistically lower than the prevalence in 1992 of 32.6% (*P*-value <0.001). Adults living in rural areas had a higher prevalence of underweight compared with adults living in urban areas. Among the 18–34 year-olds, women had a similar prevalence of underweight to men in 1992, but higher than men in 2002. For the 35–65 year-olds, the underweight prevalence of male and female subjects was similar in 1992 and 2002 (Table 2).

Table 2 and Figure 1b show the adult subjects had an annual decreasing rate of underweight of 0.78%, whereas children had a 0.14% annual increasing rate of underweight. When stratified by age groups and place of residence, the increased underweight prevalence could be found only among the rural 2–9 year-olds.

The shift from underweight to overweight

Compared with the 1992 survey, except for rural children, the 2002 survey had smaller ratios of underweight to overweight, especially among adults. The largest annual changes in ratios were found in the urban children, rural adults and male adults (Table 3).

BMI distribution

The 85th percentile of BMI was higher in the 2002 survey, especially among the 25–65 year-olds and the 10–14 year-olds (Figure 2). The 15th and 50th percentiles of BMI were higher in 2002 among the 25–65 year-olds, but similar among the 2–24 year olds. The results were consistent with results shown in Tables 1 and 2, where the levels of increasing underweight prevalence and decreasing overweight prevalence were higher among adults than among children.

Stratifying by place of residence, the urban population in the 2002 survey had an 85th percentile of BMI higher than that in the 1992 survey (Figure 3). The 85th percentile of BMI among rural and urban populations in 1992 was almost the same among the 2–24 year-olds. Among the 25–65 year-olds, the urban curves were higher than the rural curves in both surveys. The 15th percentile curves were identical for subjects younger than 25 years, regardless of the place of residence. For the older subjects, the 15th percentile curves were higher for urban residents in both surveys.

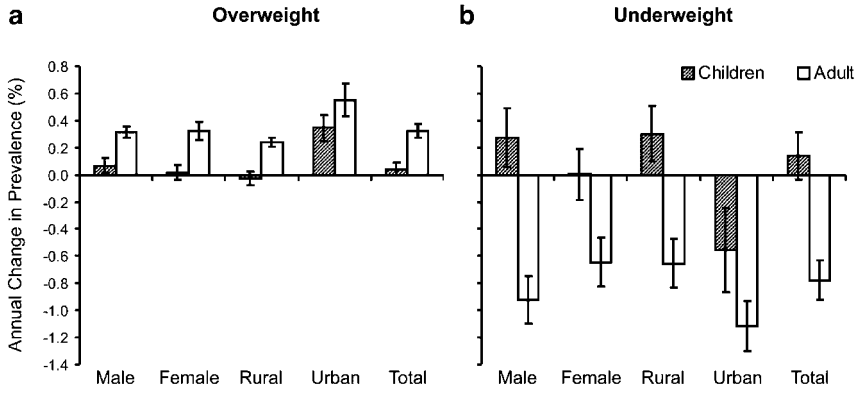

Figure 1 Annual changes in the overweight and underweight prevalence between 2002 and 1992 surveys in Vietnam by sex and place of residence.

Except for the 2–9 year-olds, female subjects had higher 85th percentile BMI curves than male subjects. The male and female subjects in 2002 had higher 85th percentile curves than the respective same-sex curves in 1992. The 15th percentile curves were almost identical among subjects younger than 25 years. For the older subjects, the 15th percentile curves were higher for males in both surveys (Figure 4).

Discussion

The key finding of our study was the coexistence of both underweight and overweight subjects, with different prevalence levels and prevalence changes among different sexes, ages and places of residence. The prevalence of overweight among Vietnamese adults in 1992 and 2002 was 2.0 and 5.2%, respectively — lower than of the populations in China (13.1%) and Indonesia (14.6%) in the early 1990s (Doak *et al*., 2005). Although there was a substantial reduction in underweight prevalence among Vietnamese adults from 32.6% in 1992 to 24.8% in 2002, the prevalence of underweight was still much higher than those of Chinese (9.7%) and Indonesian (19.2%) adults (Doak *et al*., 2005). Compared with most other developing countries, particularly those in Southeast Asia (e.g., Indonesia, Thailand, Malaysia and the Philippines), Vietnamese children had a lower prevalence of overweight, a higher prevalence of underweight, and a lower annual absolute increase of overweight prevalence (de Onis and Blossner, 2000; Wang *et al*., 2002; Doak *et al*., 2005). For instance, the prevalence of overweight among 2–17 year-olds in Vietnam was less than 2% in both surveys (1992 and 2002) — smaller than those of Indonesia (5.1%), China (9.5%), Brazil (9.4%) and the Kyrgyz Republic (28.2%) in the early 1990s (Doak *et al*., 2005). Compared with data from other countries in the late 1990s, the overweight prevalence among 6–17 year-olds in Vietnam (0.3 and 1.3% in 1992 and 2002, respectively) was also less than that from other developing countries such as Brazil (13.9%) and China (7.7%); however, the pattern was similar: the urban children had a higher prevalence of overweight and the prevalence was similar between male and female children (Wang *et al*., 2002).

In Vietnam, the annual increase of overweight prevalence was similar to Chinese 6–9 year-olds, but less than Chinese 10–17 year-olds. Our finding that the annual increase of overweight prevalence in Vietnam was higher among male and urban children was similar to the findings from Brazil and China found in a study by Wang *et al*. (2002). The prevalence of underweight among Vietnamese 6–17 year-olds in 2002 ($>30\%$) was much higher than those of children from China ($<15\%$) and Brazil ($<10\%$) in 1997 (Wang *et al*., 2002). The annual decrease of underweight was higher in Vietnamese children, compared with Chinese and Brazilian children (Wang *et al*., 2002).

Our findings show that female adults had a higher prevalence of overweight than male adults, especially among the 35–65 year-olds. This finding is consistent with the independent survey on nutrition in 2000 organized by the National Institute of Nutrition (Ministry of Health – National Institute of Nutrition, 2003b). This might be partially linked with weight gain among women during the pregnancy, lactating, and pre- and postmenopause periods (Butte and Hopkinson, 1998; Lovelady *et al*., 2000; Sammel *et al*., 2003). It might also result from the shorter stature of Vietnamese women (about 10 cm) than men in all age groups, as the BMI of short women would be especially sensitive to slight weight gains (Popkin *et al*., 1996; ACC/SCN, 2000; Ministry of Health – National Institute of Nutrition, 2003b). Except for the 55–65 year-olds, male subjects had higher annual increasing rates of overweight that predict a high prevalence of overweight male adults in the near future. Male and urban groups experienced higher rates of underweight reduction than female and rural groups, respectively.

Table 2 Underweight by age groups, sex and area of residency: prevalence and annual changes between 1992 (LSS92) and 2002 (NHS02) surveys in Vietnam[a,b,c,d]

Age groups	LSS92 prevalence percentage (95% CI)					NHS02 prevalence percentage (95%CI)					Annual absolute changes in the prevalence[e,f] percentage (95%CI)				
	Male	Female	Rural	Urban	Total	Male	Female	Rural	Urban	Total	Male	Female	Rural	Urban	Total
2–5	17.9 (15.6,20.2)	18.7 (16.0,21.3)	17.3 (15.3,19.2)	23.6 (18.8,28.5)	18.3 (16.4,20.1)	26.3 (24.9,27.8)	27.2 (25.7,28.7)	28.0 (26.7,29.3)	21.6 (19.6,23.7)	26.8 (25.7,27.9)	0.85 (0.57,1.12)***	0.86 (0.55,1.16)***	1.08 (0.84,1.31)***	−0.20 (−0.73,0.33)[NS]	0.85 (0.64,1.07)***
6–9	31.4 (28.1,34.7)	37.2 (34.0,40.3)	33.3 (30.2,36.3)	39.2 (34.0,44.3)	34.2 (31.5,36.9)	35.3 (33.9,36.6)	38.0 (36.7,39.4)	38.1 (36.9,39.3)	30.1 (28.3,31.9)	36.6 (35.6,37.7)	0.39 (0.03,0.74)*	0.08 (−0.26,0.43)[NS]	0.48 (0.15,0.81)**	−0.91 (−1.45,−0.37)**	0.24 (−0.05,0.53)[NS]
10–14	46.2 (43.0,49.3)	38.9 (36.2,41.5)	42.7 (40.1,45.3)	41.6 (36.5,46.8)	42.5 (40.2,44.8)	42.5 (41.3,43.7)	34.2 (33.0,35.4)	40.0 (39.0,41.1)	31.3 (29.7,32.9)	38.5 (37.6,39.4)	−0.37 (−0.71,−0.03)*	−0.47 (−0.76,−0.17)**	−0.26 (−0.55,0.02)[NS]	−1.03 (−1.57,−0.50)***	−0.40 (−0.65,−0.16)**
15–17	38.5 (34.9,42.1)	21.9 (18.5,25.2)	30.9 (28.0,33.8)	26.1 (22.0,30.2)	29.9 (27.5,32.4)	35.1 (33.7,36.6)	16.6 (15.5,17.7)	26.1 (25.1,27.2)	26.4 (24.3,28.4)	26.2 (25.2,27.2)	−0.34 (−0.73,0.05)[NS]	−0.53 (−0.88,−0.17)**	−0.48 (−0.79,−0.17)**	0.03 (−0.43,0.49)[NS]	−0.37 (−0.64,−0.11)**
18–34	29.6 (27.6,31.7)	30.5 (28.1,33.0)	28.4 (26.3,30.5)	35.0 (31.8,38.2)	30.0 (28.2,31.9)	22.9 (22.1,23.7)	30.3 (29.4,31.1)	26.1 (25.4,26.9)	27.3 (26.1,28.5)	26.4 (25.8,27.1)	−0.67 (−0.89,−0.45)***	−0.03 (−0.29,0.23)[NS]	−0.22 (−0.45,0.00)*	−0.77 (−1.11,−0.43)***	−0.36 (−0.56,−0.17)***
35–54	30.5 (28.1,32.8)	30.1 (27.7,32.5)	32.4 (30.4,34.5)	23.3 (20.3,26.4)	30.3 (28.5,32.1)	21.3 (20.5,22.0)	22.2 (21.5,23.0)	24.7 (24.0,25.5)	13.7 (12.9,14.6)	21.8 (21.2,22.4)	−0.92 (−1.16,−0.67)***	−0.79 (−1.04,−0.53)***	−0.77 (−0.99,−0.55)***	−0.96 (−1.28,−0.65)***	−0.85 (−1.04,−0.66)***
55–65	48.9 (44.7,53.2)	47.8 (43.7,51.9)	52.0 (48.3,55.7)	36.2 (30.9,41.5)	48.3 (45.0,51.6)	32.2 (30.4,34.0)	31.2 (29.6,32.7)	36.3 (34.8,37.8)	18.1 (16.3,19.9)	31.6 (30.3,32.8)	−1.68 (−2.14,−1.22)***	−1.67 (−2.10,−1.23)***	−1.57 (−1.98,−1.17)***	−1.81 (−2.37,−1.25)***	−1.67 (−2.03,−1.32)***
Children (2–17)	33.6 (31.6,35.6)	30.5 (28.8,32.2)	31.7 (29.8,33.6)	33.7 (30.9,36.6)	32.1 (30.4,33.7)	36.3 (35.5,37.1)	30.5 (29.8,31.3)	34.7 (34.0,35.5)	28.2 (27.0,29.3)	33.5 (32.8,34.1)	0.27 (0.05,0.49)*	0.00 (−0.19,0.19)[NS]	0.30 (0.10,0.50)**	−0.56 (−0.87,−0.25)***	0.14 (−0.03,0.32)[NS]
Adult (18–65)	32.2 (30.6,33.9)	32.9 (31.2,34.6)	33.1 (31.3,34.8)	31.0 (29.3,32.7)	32.6 (31.2,33.9)	23.0 (22.4,23.6)	26.5 (25.9,27.1)	26.5 (25.9,27.1)	19.9 (19.1,20.7)	24.8 (24.3,25.3)	−0.92 (−1.10,−0.75)	−0.64 (−0.82,−0.46)***	−0.65 (−0.84,−0.47)***	−1.11 (−1.30,−0.93)***	−0.78 (−0.92,−0.63)***
Total	32.9 (31.3,34.4)	31.8 (30.4,33.1)	32.4 (30.8,34.0)	32.1 (30.4,33.7)	32.3 (31.0,33.6)	28.6 (28.0,29.1)	28.1 (27.5,28.6)	30.1 (29.5,30.6)	22.6 (21.9,23.4)	28.3 (27.9,28.8)	−0.43 (−0.59,−0.27)***	−0.37 (−0.51,−0.22)***	−0.23 (−0.40,−0.07)***	−0.94 (−1.12,−0.76)***	−0.40 (−0.53,−0.26)***

[a]For children from 2–17 years, underweight is defined as BMI $\leqslant$5th percentile (BMI *z*-score $\leqslant -1.645$) of 2000 CDC BMI for age growth chart.
[b]For 18–65-year-old subjects, underweight is defined as BMI$<$18.5 kg/m^2.
[c]The results were weighted to be nationally representative.
[d]Data are presented as percentage and (95% CI).
[e]Values are equal to one-tenth of the difference of corresponding subgroups between 2002 and 1992 surveys.
[f]Test for the differences of corresponding subgroups between LSS92 and NHS02: *$P<0.05$; **$P<0.01$, ***$P<0.001$.

The urban population had a higher prevalence of overweight, a lower prevalence of underweight, a higher increasing rate of overweight and a higher decreasing rate of underweight than the rural population. The urban population had a higher income and food energy intake, whereas participating in fewer physical activities (Wang *et al.*, 2002; Popkin, 2002b; Ministry of Health – National Institute of Nutrition, 2003b; Popkin and Gordon-Larsen, 2004). In addition, the higher prevalence of overweight among urban females than among rural females might be linked with higher weight gain during pregnancy and a shorter duration of breastfeeding (National Institute of Nutrition – General Statistical Office, 2003; Hilson *et al.*, 2006).

The urban children showed higher reduction rates of underweight and increased rate of overweight prevalence than rural children. The 2–5 year-olds in 2002 had a higher prevalence of underweight, a lower prevalence of overweight, and lower 15th, 50th and 85th percentile BMI values. The trends were similar to the analysis by de Onis and Blossner (2000) relating to the changes of overweight prevalence from 1992 to 1998 among children younger than 5 years in Vietnam. Stratifying to the place of residence, urban 2–9 year-olds experienced improved nutrition status, but the rural children did not. There are two potential explanations for this. First, in both the 1992 and 2002 surveys, children living in rural areas were both shorter and lighter than those in urban areas. Absolute and relative rates of increments in height were similar in rural and urban children (about 0.40 cm/year); however, the rate of weight increments among urban 2–5 and 6–9 year-olds were 0.16 and 0.25 kg/year, respectively — higher than among rural children (0.08 and 0.14 kg/year, respectively). The (a) lower rate weight increments and (b) similar rate height increments lead to the lower BMI and higher prevalence of underweight among the rural 2–9 year-olds. Our study results were consistent with those of Thang and Popkin (2003a) when comparing the children involved in both the Living Standard Surveys in 1992 and 1998 (i.e., there was a higher prevalence and a lower underweight reduction rate (low weight for age) and stunting (low height for age), a lower rate of escape and a higher rate of becoming undernourished among the rural residents and poor 6–11 year-olds) (Thang and Popkin, 2003a). Second, an explanation for the poorer nutrition status among the urban 2–9 year-olds in 1992 is that they were born in the years between 1982 and 1990. During that time, the rural population obtained significant benefits from the successes of the agriculture reforms (since 1981). These reforms provided a surplus of food in the rural areas, whereas the urban population was affected negatively by the failure of the 'price, wages and money' reform (in 1985) that reduced the purchasing capacity of the urban population (National Centre for Social Sciences and Humanities, 2001). Since the 1990s, energy intake and diet quality among Vietnamese has improved. However, compared with the urban population, rural diets —

Table 3 Ratio of underweight to overweight prevalence in 1992 (LSS92) and 2002 (NHS02) surveys in Vietnam[a]

	1992 ratio					*2002 ratio*					*Annual absolute changes in ratio*[b]				
	Male	*Female*	*Rural*	*Urban*	*Total*	*Male*	*Female*	*Rural*	*Urban*	*Total*	*Male*	*Female*	*Rural*	*Urban*	*Total*
Children (2–17)	24.6	21.4	22.1	27.7	23.0	17.8	19.3	30.3	6.0	18.5	−0.68	−0.21	0.82	−2.17	−0.45
Adult (18–65)	32.9	11.1	29.2	6.9	16.6	5.6	4.3	7.6	2.0	4.8	−2.73	−0.68	−2.16	−0.49	−1.19
Total	28.2	14.3	25.3	9.9	19.2	8.8	6.4	12.1	2.7	7.4	−1.94	−0.79	−1.32	−0.72	−1.17

[a]Ratio is equal to prevalence of underweight (%)/prevalence of overweight (%).
[b]Is equal to (2002 ratio–1992 ratio)/10.

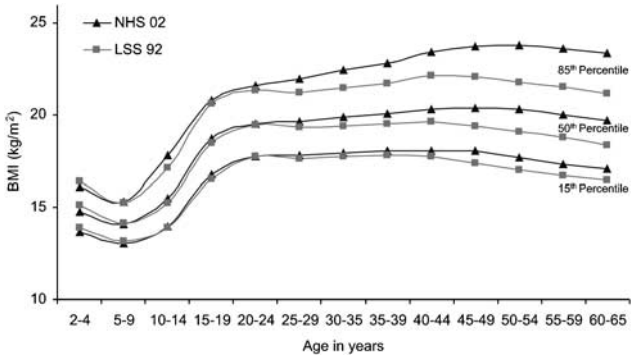

Figure 2 Mean BMI of Vietnamese by percentile levels in 1992 and 2002.

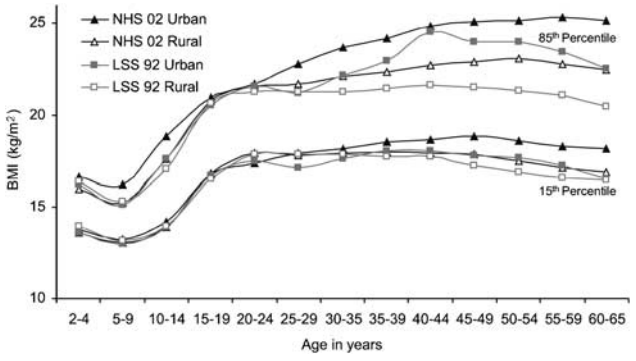

Figure 3 Mean BMI of urban and rural Vietnamese by percentile levels in 1992 and 2002.

especially of the rural poor — were based on starches with lower protein and fat content than urban diets and were lower than the recommended daily allowances for the Vietnamese population (Ministry of Health – National Institute of Nutrition, 2003a, b; Thang and Popkin, 2004). This finding suggests that the inequity in nutrition and health was an issue during the urbanization and the rapid economic growth in Vietnam.

An increasing dual burden — the presence of both overweight and underweight — was indicated by the reduction of the ratio of underweight to overweight

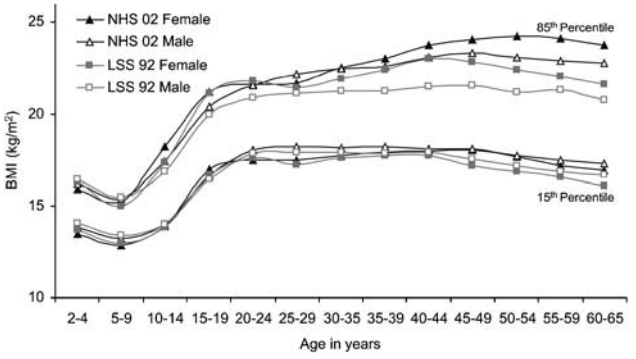

Figure 4 Mean BMI of male and female Vietnamese by percentile levels in 1992 and 2002.

prevalence. In transition, a country's economic growth usually contributes to the improvement of dietary intake (higher in energy, protein and fat), lower physical activity, and can be linked with an increased nutrition and health inequity. Thus, countries in transition usually have an increasing prevalence of overweight and obesity, whereas the main concern remains undernutrition (de Onis and Blossner, 2000; Popkin *et al*., 2001; Popkin, 2002a, b; Ministry of Health – National Institute of Nutrition, 2003b; Thang and Popkin, 2003b; Popkin and Gordon-Larsen, 2004). In the analysis of the nutrition status in seven countries, including Vietnam, Doak *et al*. (2005) found a low dual burden in Vietnam and US households because Vietnam had a low prevalence of overweight, whereas the US had a low prevalence of underweight. Higher per capita GDP among the middle ranges of per capita GDP have been related to the increasing dual burden in developing countries such as Indonesia, China, Brazil and the Kyrgyz Republic (Doak *et al*., 2005). In 2003, the GDP per capita (PPP) of Vietnam reached about $2500 (USD)(United Nations Development Programme (UNDP), 2005), similar to those of Indonesia, China and the Kyrgyz Republic in the early 1990s (Doak *et al*., 2005). Therefore, the rapid increase in Vietnamese GDP per capita raises the issue of a possible increased dual burden occurring in Vietnam in the early 2000s.

Dealing with secondary data, the authors could not control data collection issues (e.g., conducting validity or calibration studies, assessing urban index to address different levels of urbanization and assessing how urbanization and migration could affect the results). LSS92 focused on economic indicators, whereas NHS02 focused on health indicators, making it impossible to conduct an in-depth analysis of other covariates. There were several nutrition surveys conducted by the Vietnam National Institute of Nutrition in 1981–1985, 1986–1990 and 2000. However, the raw data are either unavailable or inaccessible to the public. The use of CDC 2002 BMI growth charts to assess nutrition status of those younger than 18 year, with the intention to make a comparison with the latest results as presented in current papers, makes it incomparable with those obtained from the study using different references such as NCHS 1977 or WHO 1995 cutoff points.

In conclusion, although underweight remains the main concern, overweight is becoming an emerging problem in Vietnam. There is a need to prevent overweight from becoming more severe — as it has in other developing countries in later stages of the (a) economic transition and (b) shift to a nutrition transition stage linked with NCDs.

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Conflict of interest

There are no potential conflicts of interest, these data have not been published or used before in any manner in a journal article, and the abstract was presented at Experimental Biology (EB) 2006.

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