The double burden of malnutrition in India

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INTRODUCTION

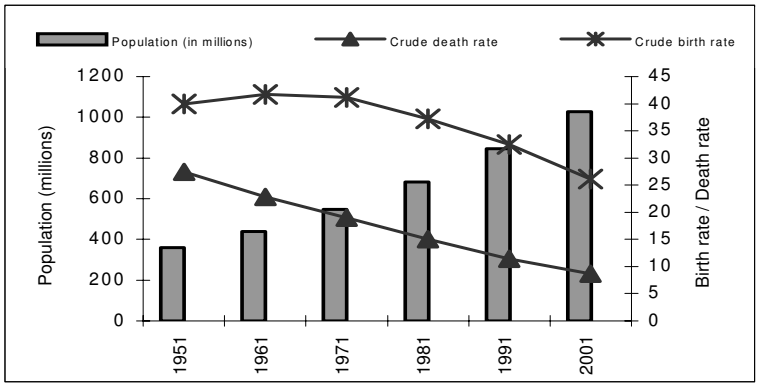
India is a vast and varied subcontinent. Covering 2.4 percent of the global landmass, it supports more than one-sixth of the world's population. In 2001, India's population had reached 1 028 million people, living in 220 million households in 35 states and union territories (Map). As a developing country with high population density, ever since Indian independence, planners in India have recognized the importance of planned growth of the economy with emphasis on human resource development. Policy-makers recognize that optimal nutrition and health are prerequisites for human development. Article 47 of the Constitution of India states that "the State shall regard raising the level of nutrition and standard of living of its people and improvement in public health among its primary duties". Over the last five decades, successive five-year plans have lain down policies and multisectoral strategies to combat nutrition-related public health problems and improve the nutritional and health status of the population.

Currently, the country is undergoing a rapid socio-economic, demographic, nutritional and health transition. Although India has not yet overcome the problems of poverty, undernutrition and communicable diseases, it is increasingly facing additional challenges related to the affluence that results from industrialization, urbanization and economic betterment. Over the last two decades, overnutrition and obesity have emerged as public health problems; there have been increases in the prevalence of diabetes and cardiovascular disease (CVD), especially in urban areas. The magnitude of these problems varies among states and socio-economic strata and between urban and rural areas, and it is a matter of concern that these diseases occur a decade earlier in India than elsewhere and that they affect poor segments of the population and those in rural areas. Case fatality rates are reported to be higher in poor and rural populations, probably because of poor access to health care and consequent delayed diagnosis and treatment. This case study reviews the impact of ongoing socio-economic, demographic and life style transitions on nutritional status, and the health implications of the ongoing nutrition transition.

Demographic transition

Demographic transition is a global phenomenon. Technological advances and improved quality and coverage of health care have resulted in a rapid fall in India's crude death rate, from 25.1 per 10 000 population in 1951 to 9.8 in 1991. The reduction in crude birth rate has been less steep, falling from 40.8 per thousand in 1951 to 29.5 in 1991 (RGI, 1951 to 2001). As a result, the annual exponential population growth rate was more than 2 percent from 1971 to 1991. The census of 2001 confirmed that the pace of demographic transition in India has been steady, albeit slow, and that India has joined China in having a population of more than 1 billion (Figure 1).

FIGURE 1
Population and birth and death rates in India, 1951 to 2001



Source: RGI, 1951 to 2001.

Box 1. Population projections 1996 to 2016

The population is projected to increase from 934 million in 1996 to 1 264 million in 2016.
Between 1996 to 2001 and 2011 to 2016 there will be declines of:

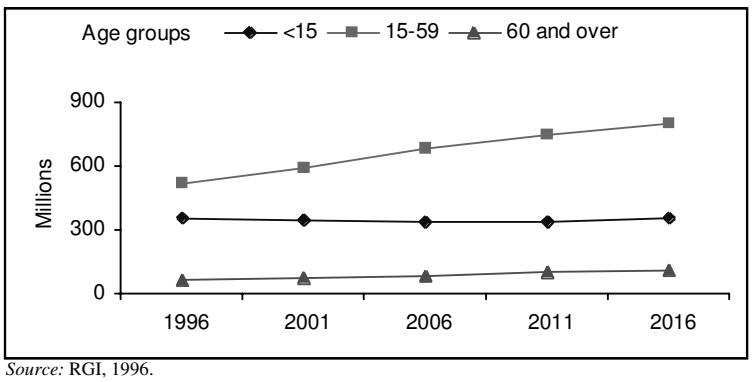
- crude birth rate, from 24.10 to 21.41;
- crude death rate, from 8.99 to 7.48;
- natural growth rate, from 1.51 to 1.39 percent;
- infant mortality rate, from 63 to 38 per 1 000 live births for males; and from 64 to 39 for females.

Source: RGI, 1996.

Population projections for the period 1996 to 2016, carried out by the Registrar General of India (RGI, 1996) are given in Box 1. Although there has been a substantial reduction in birth rates, population growth will continue for the next three decades because of:

- the large proportion of the population in the reproductive age group (contributing about 60 percent of total population growth);
- high fertility caused by a lack of contraception (contributing about 20 percent of total population growth);
- high desired fertility resulting from the prevailing high infant mortality rate (contributing about 20 percent of total population growth).

FIGURE 2
Population projections for India, 1996 to 2016



Source: RGI, 1996.

Most of India's population growth between 1996 and 2016 will be caused by increased numbers of people in the 15 to 59 years age group – the working age (Figure 2). The Malthusian assumption that population growth leads to overcrowding, poverty, undernutrition, environmental deterioration, poor quality of life and increase in disease burden has been challenged in the last few decades; population growth can also be a major resource for economic growth, as outlined in Box 2. If India successfully faces the challenge of providing its younger, better-educated, skilled, well-nourished and healthy workforce with appropriate employment and adequate remuneration, the economic status of both the people and the country can improve rapidly.

Box 2. Economic implications of demographic transition

The next two decades will witness:
- increase in the 15 to 59 years age group, from 519 to 800 million;
- low dependency ratios.

The challenge is to ensure:
- adequate investment in human resources development;
- appropriate employment and adequate remuneration for the workforce.

The opportunity is to:
- utilize the abundant human resources available to accelerate economic development.

The current phase of demographic transition also represents a major opportunity for improving the health and nutritional status of the population. The under 15 years age group will not increase in numbers. The health and nutrition infrastructure will therefore not have to cope with ever-increasing numbers of children needing health and nutrition care, leaving it free to concentrate on the quality and coverage of health and nutrition services needed to improve health and nutritional status. If the health and nutrition needs of the literate and aware 15 to 59 years age group are met, massive improvement in nutrition and health status can be made. Appropriate counselling will enable people to adopt life styles and diets that prevent the escalation of overnutrition and the attendant non-communicable disease (NCD) risk. For the increasing numbers of people over 60 years of age, provisions for managing their nutritional and health problems would have to be made.

Economic transition

Since the 1950s, India has adopted the concept of a mixed economy for overall agricultural and industrial development. In the last decade, the service sector has become the high-growth sector. Over the last three decades, there has been a steady increase in gross domestic product (GDP) and per capita net national income; per capita net national product reached US$237 in 2000 (Government of India, 2003). Agriculture remains a major determinant of GDP growth, and is the most important sector for rural employment. Over the years there has been slow but steady reduction in poverty (Table 1), which had declined to 26.2 percent in 2000 (Planning Commission, 2004). Rises in per capita income (Figure 3) have not been matched by increased energy consumption (NNMB, 1979 to 2002), and there are large inter-state differences in per capita income and poverty ratios.

FIGURE 3
Trends in per capita income and energy intake, 1974 to 2002

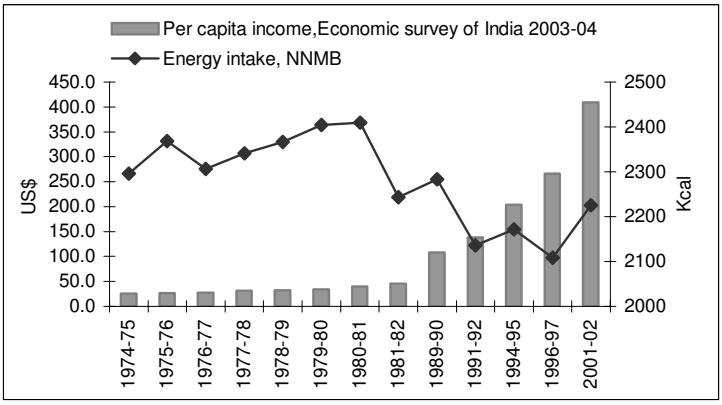


TABLE 1
Economic indicators, 1950 to 2001

	1950/1951	1960/1961	1970/1971	1980/1981	1990/1991	2000/2001
GDP at current prices (million US$)	2 195	3 729	9 706	29 926	117 461	440 856
Per capita net national product (1993/1994 prices, US$)	85	102	115	123	168	237
Poverty (%)*			54.9	44.5	36	26.1

US$1 = RS 43.5.
Sources: Government of India, 2003; * Planning Commission, 2003.

Social transition

Improvement in the quality of life is the central pillar of India's planned development. The adult literacy rate improved from 18.3 percent in 1951 to 65.4 percent in 2001 (Table 2). India now has the world's largest trained workforce in science, administration and technology. Attempts are under way to ensure universal primary education and to improve secondary and vocational education (Government of India, 2003). Efforts are also being made to ensure that higher and technical education gets due attention (Table 3) (Department of Education, 2002). The urban population has continued to grow because of rural–urban migration; in 2001, 30 percent of Indians lived in urban areas. Of the 26 megacities (each housing more than 10 million people) that are forecast worldwide by 2015, five will be in India.

Although urban amenities have failed to cope with the increase in population, cities and towns have become the engines of social change, rapid economic development and improved access to education, employment and health care. Rural and urban populations continue to lack access to safe drinking-water (38 percent in 1981 and 68 percent in 2001) and good environmental sanitation (less than 30 percent) (RGI, 1951 to 2001). With better communication and transportation, urban and rural areas can be linked, both economically and socially, to create an urban–rural continuum of communities and to achieve sustained, rapid improvement in quality of life in both.

TABLE 2
Social indicators, 1950 to 2001

	1950/1951	1960/1961	1970/1971	1980/1981	1990/1991	2000/2001
Population (millions)	359	434	541	679	839	1 019
Urban population (%)	17.3	18.0	19.8	23.1	25.5	27.7
Male literacy rate (%)	27.16	40.40	45.96	56.38	64.10	75.85
Female literacy rate (%)	8.86	15.35	21.97	29.76	39.30	54.16
Overall literacy rate (%)	18.33	28.30	34.45	43.57	52.20	65.38

Source: Government of India, 2003.

TABLE 3
School enrolment by gender (millions), 1970 to 2001

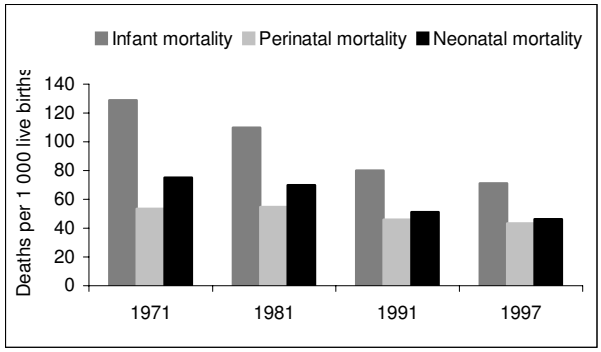
Year	Primary (I–V)			Middle/upper primary (VI–VIII)			Higher/secondary (IX–XII)		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
1970/1971	35.7	21.3	57.0	9.4	3.9	13.3	5.7	1.9	7.6
1980/1981	45.3	28.5	73.8	13.9	6.8	20.7	7.6	3.4	11.0
1990/1991	57.0	40.4	97.4	21.5	12.5	34.0	12.8	6.3	19.1
2000/2001	64.0	49.8	113.8	25.3	22.0	42.8	16.9	10.7	27.6

Source: Department of Education, 2002.

Health transition

Over the last five decades, there have been steady but slow reductions in the rates of births, deaths, infant mortality and under-five mortality (RGI, 1971 to 2000) (Table 4). India still has high infant, perinatal and neonatal mortality (Figure 4), but there has been a steady reduction in the death rate and an improvement in longevity.

FIGURE 4
Child mortality indicators, 1971 to 1997



Source: RGI, 2000.

TABLE 4
Health indicators, 1950 to 2001

	1950/1951	1960/1961	1970/1971	1980/1981	1990/1991	2000/2001
Birth rate (per 1 000)	39.9	41.7	41.2	37.2	33.9	25.8
Death rate (per 10 000)	27.4	22.8	19	15	12.5	8.5
Male life expectancy at birth (years)	32.5	41.9	46.4	50.9	58.6	63.8
Female life expectancy at birth (years)	31.7	40.6	44.7	50	59	66.9
Overall life expectancy at birth (years)	32.1	41.3	45.6	50.4	58.7	

Source: Government of India, 2003; RGI, 2000; UNDP, 2003.

Access to health services is still sub-optimal, especially in remote areas with high morbidity. Immunization coverage is low (complete immunization coverage at 12 months was 35.4 percent in 1992/1993 and 42.0 in 1998/1999), and child morbidity and mortality rates are high (IIPS, 1992/1993; 1998/1999). India's shares of global communicable disease and maternal and perinatal problems are high and have not shown substantial reduction in the last two decades (Box 3) (Planning Commission, 2002). The estimated disease burden to communicable diseases and ischaemic heart disease (IHD) is shown in Table 5. Diabetes and CVD have shown sharp rises in the last two decades; India faces the dual burden of high communicable and rising non-communicable disease prevalence (World Bank, 1993).

Box 3. India's share of global health problems

India accounts for:

- 26 percent of the world's childhood vaccine-preventable deaths;
- 20 percent of maternal deaths;
- 68 percent of leprosy cases;
- 30 percent of tuberculosis cases;
- 10 percent of HIV-infected people.

Source: Planning Commission, 2002.

TABLE 5
Burden of five major diseases (million DALYs)[1]

Disease	Age (years)					
	0-4	5-14	15-44	45-59	60+	Total
			Diarrhoea			
Male	42.1	4.6	2.8	0.4	0.2	50.2
Female	40.7	4.8	2.8	0.4	0.3	48.9
			Worm infection			
Male	0.2	10.6	1.6	0.5	0.1	13.1
Female	0.1	9.2	0.9	0.5	0.1	10.9
			Tuberculosis			
Male	1.2	3.1	13.4	6.2	2.6	26.5
Female	1.3	3.8	10.9	2.8	1.2	3120
			IHD			
Male	0.1	0.1	3.6	8.1	13.1	25
Female	-	-	1.2	3.2	13	17.5

[1] DALY = disability-adjusted life year.
- = less than 0.05 million.
Source: World Bank, 1993.

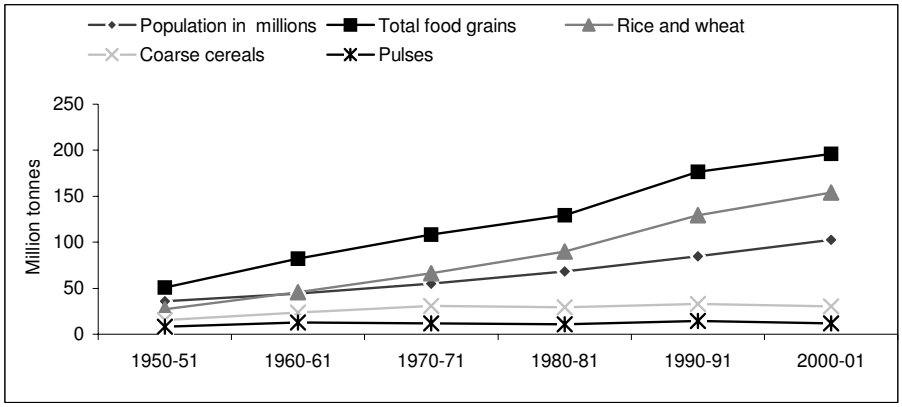
SUSTAINABLE FOOD PRODUCTION TO MEET NUTRITIONAL NEEDS

Nutritionists view agriculture as an input for dietary intake, while farmers look for returns on their investments. The green revolution showed that food grain production can be increased fourfold when farmers are assured of returns on investment (Figure 5). However pulse and coarse grain production has stagnated (Ministry of Agriculture, 2002a).

Cereals and pulses

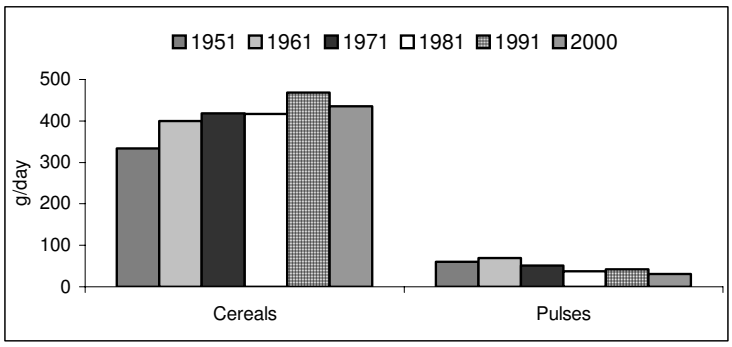
Over the last five decades, the per capita net availability of cereals has been improving, and by 1991 it was sufficient to meet the recommended dietary allowance (RDA) (Figure 6). However, per capita pulse availability and consumption have declined. Pulses are a major source of protein among poorer segments of the population, so this trend must be reversed (Ministry of Agriculture, 2002b).

FIGURE 5
Trends in production of important food items, 1950 to 2001



Source: Ministry of Agriculture, 2002a.

FIGURE 6
Per capita net availability (per day), 1950 to 2001



Source: Ministry of Agriculture, 2002b.

Horticulture

Vast areas of India are subtropical, and agroclimatic conditions are well suited to the cultivation of vegetables, fruits and plantation crops. Horticultural products provide higher yields per hectare, obtain higher sale prices and sustain agro-industries. As a result, greater areas are being brought under horticulture, and the production of fruits and vegetables is increasing. In 2000, India produced 46.6 million tonnes of fruits and 96.5 million tonnes of vegetables. Less than 1 percent of this production is processed. Losses during packaging and transport are about 30 percent.

Except among affluent urban segments of the population, per capita vegetable and fruit consumption continues to be low because of problems with access and affordability. Investment in infrastructure for preservation, cold storage, refrigerated transportation, rapid transit, grading, processing, packaging and quality control will help the horticultural sector to achieve its full economic potential and to provide vegetables and fruits at affordable cost throughout the year. In this way, the micronutrient needs of the population can be met through a sustainable food-based approach.

National agricultural policy

The National Agricultural Policy (NAP) (Ministry of Agriculture, 2000) emphasizes crop diversification, horticulture and food processing for sustainable agriculture growth. NAP and the Tenth Five-Year Plan (Planning Commission, 2002) have set a target of a 3.97 percent growth for agriculture. This is to be achieved through:

- efficient use of resources and the conservation of soil, water and biodiversity;
- equity across different regions and farmers;
- a demand-driven approach that caters to domestic markets and maximizes the benefits of exporting agricultural products in the face of the challenges of economic liberalization and globalization;
- technological, environmental and economic sustainability.

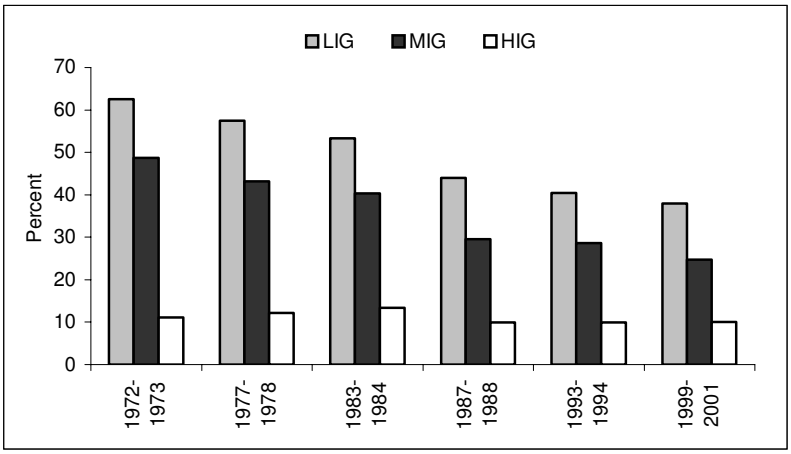
Increasing economic growth and improved access are expected to lead to dietary diversification and increased consumption of pulses, vegetables, fruits and dairy products. Once dietary diversification at affordable cost is possible and the majority of the population have a balanced diet, it will be possible to achieve nutrition security.

MAP: INDIA'S STATES (CENSUS INDIA)

CONSUMPTION EXPENDITURE ON FOOD

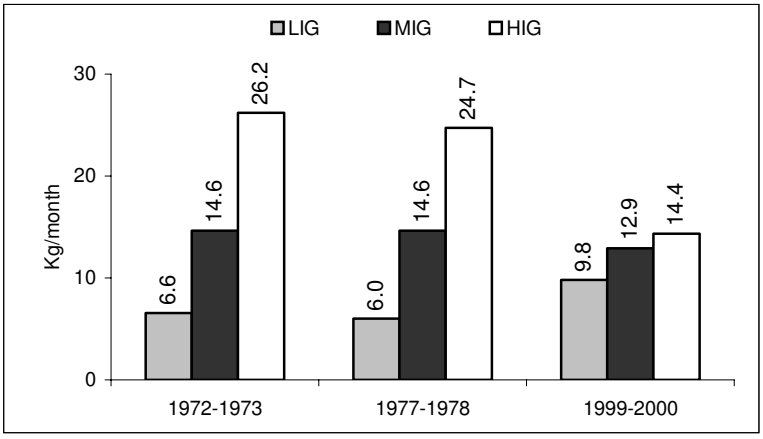
The National Sample Survey Organization (NSSO) is a permanent survey organization that was set up in the Department of Statistics of the Government of India in 1950. NSSO has been carrying out five-yearly consumer expenditure surveys since 1972/1973, providing time series data in rural and urban areas of all India's states. Household food consumption at the national and state levels is computed on the basis of data on household monthly per capita consumption expenditure (MPCE) in 12 MPCE classes (with expenditure ranging from less than US$5 to $30). NSSO surveys have excellent sampling design, large sample sizes, clearly stated estimation procedures and national coverage, but do not provide insight into the actual dietary intake of households or individuals or into the intra-family distribution of food.

FIGURE 7
Expenditure on cereals (percentages), 1972 to 2001



Source: NSSO, 2001.

FIGURE 8
Consumption of cereals in rural areas of India (kg/month), 1972 to 2001



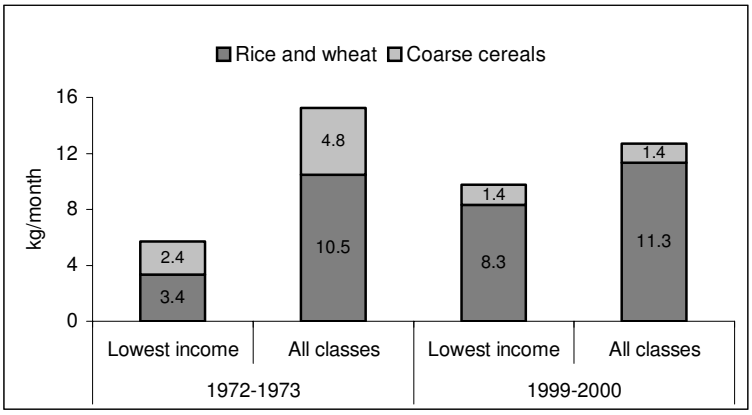
Source: NSSO, 2001.

Cereals

Data from NSSO surveys from 1972 to 2000 show that expenditures on cereal in the lowest (LIG) and middle-income groups (MIG) declined. Among the highest income group (HIG), cereals accounted for a fairly low proportion of total expenditure, which has remained essentially unchanged over the last three decades (Figure 7). People in the lowest income group were consuming greater quantities of cereals, even though they were also spending a reduced proportion of their total expenditure on these (Figure 8). This is because there has been a reduction in the relative cost of cereals, especially those supplied through the public distribution system (PDS). There was a decline in household consumption of cereals in the middle-income group, while monthly cereal consumption in high-income rural households dropped from 26.2 kg in 1972/1973 (about 1kg/day) to 14.4 kg in 1999/2000. Data from diet surveys conducted by the National Nutrition Monitoring Bureau (NNMB, 1979 to 2002) show that the average intake of cereals in even the highest income group has never exceeded 400 g/day. It would therefore seem likely that the high cereal consumption among high-income rural households might be because cooked food is shared with guests, relatives and servants. The sharing of food with guests and servants has declined over the last two decades, which accounts for the steep reduction in cereal consumption in high-income group households. The simultaneous increase in cereal consumption in the lower-income group confirms this.

With wheat and rice available through the PDS, poorer segments of the population now use these as staple cereals. The consumption of coarse cereals rich in micronutrients and minerals has declined (Figure 9). The Tenth Five-Year Plan (Planning Commission, 2002) recommends that locally produced and procured coarse grains be made available through a targeted public distribution system (TPDS) at subsidized rates. This may substantially reduce the cost of subsidies without any decrease in the energy provided; an improved micronutrient intake from coarse cereal would be an added benefit. Such a measure would also improve targeting, as only the most needy are likely to buy these coarse grains.

FIGURE 9
Cereal consumption, 1972 to 2000



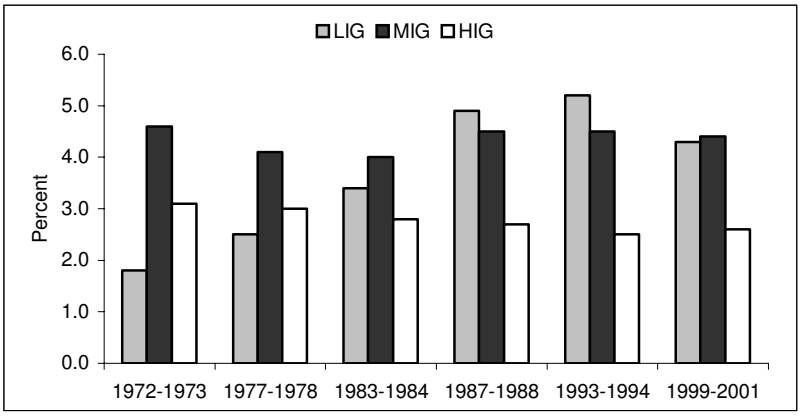
Source: NSSO, 2001.

Pulses

Between 1972 and 2001, there was a substantial increase in the proportion of expenditure spent on pulses in the lowest income group (Figure 10), but expenditure on pulses remained

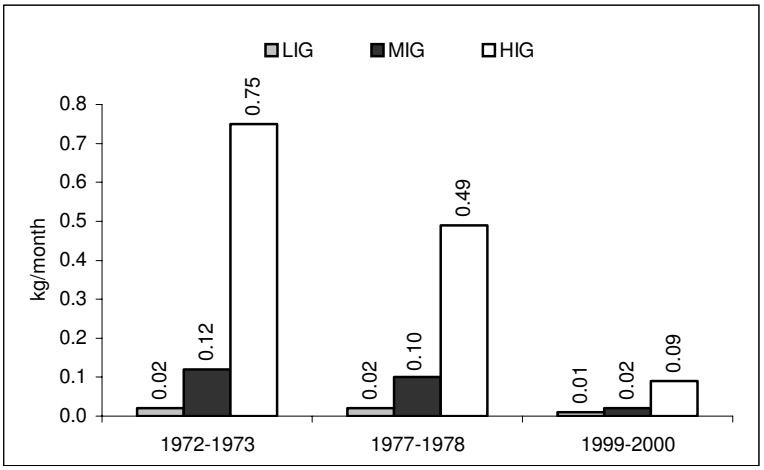
relatively unaltered in the middle and highest income groups. In spite of increased expenditure, household consumption of pulses declined in all income groups and in both urban and rural areas (Figure 11). Data from the NSSO 2000 survey show that middle and upper income groups spent more on milk and animal products, so their protein intakes were not adversely affected by the reduction in pulses. Pulses are still the major source of protein in the lowest income group. In order to ensure adequate protein intake for this group, it is therefore essential to increase the cultivation of a variety of pulses and legumes, so that they can be made available at affordable prices, perhaps through TPDS.

FIGURE 10
Expenditure on pulses (percentages of total), 1972 to 2001



Source: NSSO, 2001.

FIGURE 11
Consumption of pulses in rural areas (kg/month), 1972 to 2001



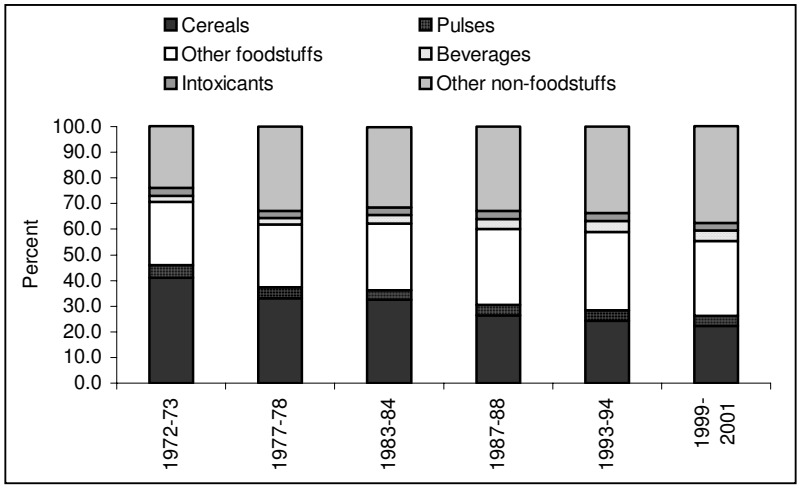
Source: NSSO, 2001.

Time trends in monthly per capita expenditure

MPCE on food and non-food items over the last three decades is shown in Figure 12. The proportion of total expenditure spent on foodstuffs has declined considerably over the last three decades – from 70.6 percent in 1972 to 55.3 percent in 1999/2000 – mainly because of the

decline in cereal prices. Expenditures on pulses, vegetables, other foods and beverages increased. However, pulse and vegetable intakes among the poor remain low. There are massive urban–rural and inter-district/state differences in the costs of vegetables, milk, fish and meat. Therefore data on the quantities of these foodstuffs consumed by state or expenditure group are not available from NSSO surveys. India uses diet surveys for such information.

FIGURE 12
Percentage distribution of MPCE in rural areas, 1972 to 2001



Source: NSSO, 2001.

Nutrient intake computed from NSSO surveys

NSSO uses household expenditures on food to compute the energy, protein and fat intakes of the population. Over the last three decades, overall energy and protein consumption in rural areas has shown a small decline while remaining unaltered in urban areas. There have been increases in fat consumption in both rural and urban areas (Table 6).

TABLE 6
Average daily per capita nutrient intakes, 1972 to 2000

Year	Energy (kcal)		Protein (g/day)		Fat (g/day)	
	Rural	Urban	Rural	Urban	Rural	Urban
1972/1973	2 266	2 107	62	56	24	36
1983	2 221	2 089	62	57	27	37
1993/1994	2 153	2 071	60.2	57.2	31.4	42
1999/2000	2 149	2 156	59.1	58.5	36.1	49.6

Source: NSSO, 2001.

TABLE 7
Average per capita calorie consumption by income group, 1972 to 1994

Expenditure class	Rural			Urban		
	1972/1973	1977/1978	1993/1994	1972/1973	1977/1978	1993/1994
Lowest 30 percent	1 504	1 630	1 678	1 579	1 701	1 682
Middle 40 percent	2 170	2 296	2 119	2 154	2 438	2 111
Top 30 percent	3 161	3 190	2 672	2 572	2 979	2 405

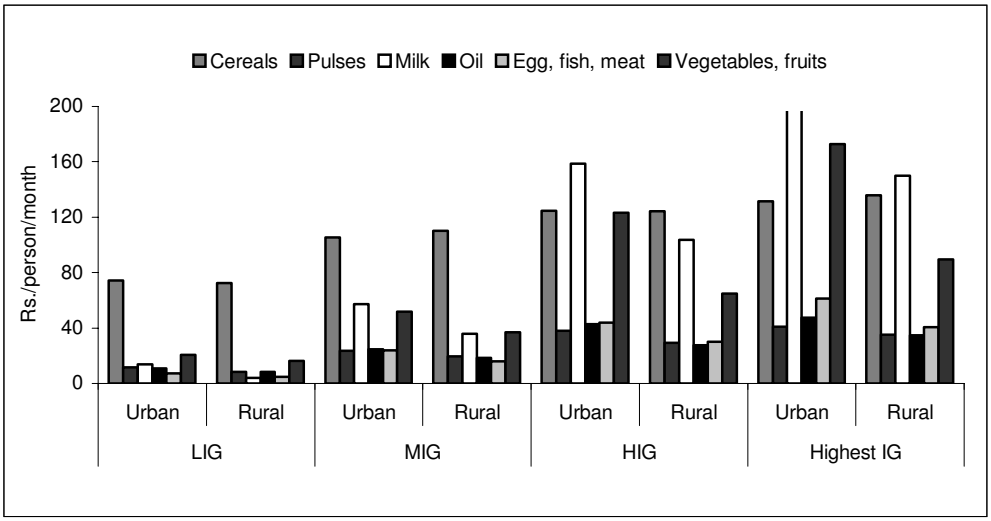
Source: NSSO, 2001.

Changes in energy consumption in different income groups in urban and rural areas are shown in Table 7; energy consumption has shown small increases in both the urban and rural poor and substantial declines among the urban and rural rich. As indicated earlier, data on household consumption expenditure in high-income groups include the food shared with guests and servants, so therefore have to be interpreted with caution. There are massive interstate differences in food expenditures.

Urban–rural differences

Data from the NSSO 55th round (1999/2000) on urban–rural differences in food expenditure are given in Figure 13. Among the urban and rural poor, most food expenditure was on cereals. Dietary diversification is seen mainly among middle- and high-income groups in both urban and rural areas; diversity is greater in urban areas, perhaps because of access to a wider variety of foodstuffs.

FIGURE 13
Expenditure on foodstuffs by income group



Source: NSSO, 2001.

Summary

Data from NSSO consumption expenditure surveys indicate the following:

- Expenditure on food has declined, mainly because of reductions in the cost of cereals.
- In spite of a steep decline in cost, cereal consumption has not increased, except in the lowest income group. This apparent paradox has been the subject of widespread debate among economists and nutritionists in India, and the consensus view is that it might be because cereal requirements are being met.
- In spite of increased expenditure on pulses, consumption among all segments has declined because of the soaring cost of pulses. Pulse consumption is very low among the poor.
- Rural populations consume more cereals, fewer pulses and less oil and fat compared with urban populations.

- Dietary diversification is seen mainly in middle- and high-income groups in urban and rural areas. Increasing incomes and wider availability of diverse foodstuffs accelerated this trend in the 1990s.
- There has been only a small increase in energy consumption among the poor in spite of steep declines in the cost of cereals. Among the middle- and high-income groups, energy consumption has declined.
- The energy consumption of the urban high-income group is associated with consumption of increased quantities of sugar, oil, milk and milk products and lower quantities of cereals. Changes in the energy density of the diet and sedentary lifestyles appear to be the major factors for the steep increase in obesity among this group.

DIETARY INTAKE DATA FROM NUTRITION SURVEYS

Since 1975, the National Nutrition Monitoring Bureau (NNMB) has been providing data on dietary intake (by 24-hour dietary recall) and nutritional status (by anthropometry and nutritional deficiencies) for ten states of India (Kerala, Karnataka, Andhra, Tamil Nadu, Maharashtra, Orissa, Gujarat, Madhya Pradesh, West Bengal and Uttar Pradesh). NNMB is the only survey that provides data on intra-family food distribution and the dietary intake and nutritional status of all age groups. Proposals to expand the network to cover all states have not yet been implemented. A one-time district nutrition survey was carried out in the mid-1990s in order to obtain data on the dietary intake and nutritional status of individuals in other states. Both the NNMB 1994 survey and this one-time survey used the same methodology of data collection, using representative samples of households in every state. The combined data were reported as the India Nutrition Profile (INP) (DWCD, 1995/1996).

INP provides data on the dietary intake and nutritional status of all age groups, in all states and in both urban and rural areas. Both the NNMB and INP surveys used 24-hour dietary recall to assess food intake. The amounts consumed were compared with the RDAs for India drawn up in 1989 by the Indian Council of Medical Research (ICMR, 1989).

Household food intake obtained by 24-hour dietary recall is used to compute the average intakes of household members expressed as consumption units (CUs) per day (NNMB, 1981). The CUs for different age and gender groups were worked out from the basis of the energy consumption of an average adult male doing sedentary work being 1 CU (Box 4). The reference man is between 20 and 39 years of age, weighs 60 kg and is physically fit and moderately active. The reference woman is between 20 and 39 years of age, weighs 50 kg and is moderately active.

Box 4. Consumption units

Adult male (sedentary worker)	1.0	Child (nine to 12 years)	0.8
Adult male (moderate worker)	1.2	Child (seven to nine years)	0.7
Adult male (heavy worker)	1.6	Child (five to seven years)	0.6
Adult female (sedentary worker)	0.8	Child (three to five years)	0.5
Adult female (moderate worker)	0.9	Child (one to three years)	0.4
Adult female (heavy worker)	1.2		
Adolescent (12 to 21 years)	1.0		

Source: NNMB, 1981.

Nutrient intake is computed using the *Nutritive value of Indian foods* (NIN, 2004), first published by the National Institute of Nutrition (NIN) in 1971 and updated many times since then. Analysis of the iron content of foodstuffs using recent techniques shows that the iron available is only about 50 percent of the values previously reported; hence, values for iron content have been revised in the latest edition.

Food intake in urban and rural areas

Data from the NNMB and INP surveys show that average intakes of cereals in the mid-1990s were near the RDAs, but intakes of pulses, vegetables and fruits were low (Table 8). There are significant differences in food intake among states. Reported intakes of foodstuffs are higher in INP than in NNMB data, probably because there are higher dietary intakes – especially of cereals and pulses – in states not included in the NNMB survey, but covered by INP. Dietary intake was higher in some states with high per capita income (Punjab), but not others (Maharashtra), which suggests that greater per capita income is not always associated with higher dietary intake. Data from both NNMB and INP show that cereal intakes were higher in some of the poor states (Orissa in NNMB, Uttar Pradesh in INP), perhaps because most of the population of these states work as manual labourers and require high cereal intakes. NSSO (1975 to 2001) consumer expenditure surveys show similar interstate differences. Consumption of cereals is higher in rural areas, while that of pulses, milk and milk products, fruits and fat and oils is higher in urban areas.

TABLE 8
Food intakes in rural and urban areas (g/CUs per day)

	NNMB						INP (1995/1996)		RDA
	Rural				Urban slums				
	1975–1979	1988–1990	1995–1996	2000–2001	1975–1979	1993–1994	Rural	Urban	
Cereals and millets	505	490	450	457	416	380	488	420	460
Dairy products	116	92	85	85	42	75	126	143	150
Pulses and legumes	34	32	29	34	33	27	33	55	40
Vegetables									
Green leafy	8	9	15	18	11	16	32	23	40
Others (includes tubers)	54	49	47	57	40	47	70	75	60
Fruits	13	23	24	25	26	26	15	37	50
Fats and oil	14	13	12	14	13	17	14	21	20
Sugar and jaggery	23	29	21	23	20	22	20	22	30

Sample sizes: NNMB, rural – 1975–1979, 33 048; 1996–1997, 14 391; 2000–2001, 30 968. Urban slums – 1975–1980, 32 500; 1993–1994, 5 447. INP – 46 457.
Sources: NNMB; INP.

Time trends in food intake

Data on time trends in food intake in rural areas and urban slums in nine states are available from NNMB surveys (Table 8). These data show that there has been some decline in cereal consumption in both urban and rural areas over the last three decades. There has also been a substantial decline in the cost of cereals and an improvement in their availability. The decline is therefore not due to economic constraints. Over the same period, there has also been a decline in the consumption of pulses, which are a major source of protein in Indian diets. This

is partly attributable to soaring costs and the inability of poor people to purchase them in adequate quantities, in spite of higher expenditure on pulses.

Although India's milk output has increased massively, there has not been any improvement in the per capita consumption of milk. Consumption of vegetables and fruits also continues to be very low. In rural areas, there has not been any significant increase in the per capita consumption of fats and oils and of sugar and jaggery. However in urban areas – even among slum dwellers – there has been an increase in oil consumption and some increase in sugar consumption. Data from NNMB surveys suggest that dietary intake has not undergone any major shift towards increased consumption of fat and oils, sugar and processed food, and there has been no increase in energy intake. These data are confirmed by the consumer expenditure on food items reported in NSSO.

Nutrient intake

INP provides data on nutrient intake in the urban and rural areas of all states (Table 9). The nutrient intakes reported in INP are higher than those in NNMB because of higher intakes in states not covered by NNMB. At the aggregate national level, total energy intake was less than 2 300 kcal/CUs/day in the mid-1990s. There are substantial interstate differences in energy and other nutrient intakes.

TABLE 9
Nutrient intakes in rural and urban areas (g/CUs/day)

	RDA (sedentary man)	NNMB								INP (1995/1996)	
		Rural					Urban Slums			Rural	Urban
		1975–1979	1988–1990	1996–1997	2000–2001	% Δ[1]	1975–1979	1988–1990	% Δ[2]		
Energy (kcal)	2 425	2 340	2 283	2 108	2 255	-4	2 008	1 896	-6	2 321	2 259
Protein (g)	60	62.9	61.8	53.7	58.7	-7	53.4	46.75	-12	70	70
Calcium (mg)	400	590	556	521	523	-11	492	*		631	673
Iron (mg)	28.0	30.2	28.4	24.9	17.5[3]	-42	24.9	19.0	-24	23.2	22.3
Vitamin A (mcg)	600	257	294	300	242	-6	248	352	42	355	356
Thiamine (mg)	1.2	1.6	1.5	1.2	1.4	-13	1.3	*		1.9	1.9
Riboflavin (mg)	1.4	0.9	0.9	0.9	0.8	-11	0.8	0.8	-2	1.0	1.0
Niacin (mg)	16.0	15.7	15.5	12.7	17.1	9.0	14.6	*		19.7	18.8
Vitamin C (mg)	40	37	37	40	51	38	40	42	5	55	62
Folic acid (mcg)	100	*	*	153	62		*	*		*	*

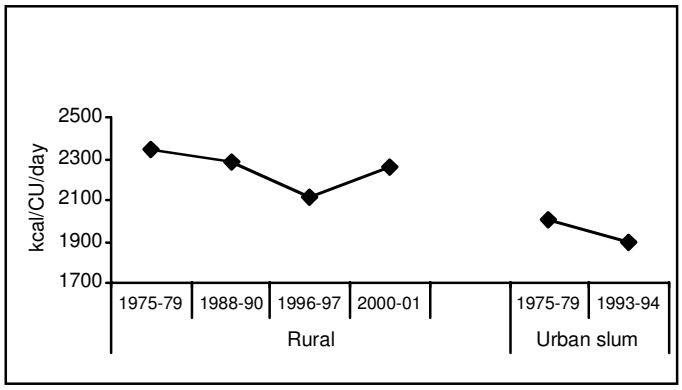
Sample sizes: NNMB, rural – 1975–1979, 33 048; 1996–1997, 14 391; 2000–2001, 30 968. Urban slums – 1975–1980, 32 500; 1993–1994, 5 447. INP – 46 457.
[1] Changes in intake from 1975–1979 to 2000–2001.
[2] Changes in intake from 1975–1979 to 1993–1994.
[3] Method of estimation different.
* Data not available.
Sources: NNMB, 1979; 2002; INP, 1996.

Time trends in nutrient intakes

Data on time trends in nutrient intakes are available from NNMB surveys (Table 9). These data show there has been a small decline in energy intake over the last three decades (Figure 14). There has also been some decline in the intakes of most nutrients in both urban

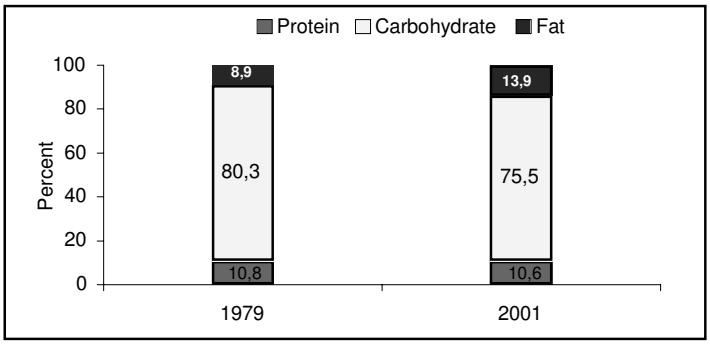
and rural areas. The percentage of total energy intake derived from carbohydrates has declined and there has been some increase in the percentage dietary energy from fats (Figure 15). In spite of this, the proportion of dietary energy from fat remains less than 15 percent. These aggregate measures mask large disparities between the intakes of urban and rural populations and among different socio-economic groups. In India, the dietary intake of iron has always been low. The steep decline in iron intake reported in the last NNMB survey can be attributed to different estimation methods, which showed that absorbable iron was 50 percent less than it was in earlier surveys.

FIGURE 14
Time trends in energy intake, 1975 to 2001



Source: NNMB reports.

FIGURE 15
Macronutrient intake in rural areas as percentage of total energy, 1979 to 2001



Source: NNMB reports.

Urban–rural differences in nutrient intakes

Energy intake is lower in urban areas (Table 9), in spite of higher intake of fats and oils, because of lower cereal consumption. Data from NNMB surveys suggest that the consumption of all nutrients is lower in urban slums than in rural areas. INP, which covered most states, did not show any significant differences in nutrient intake between urban and rural areas. Interstate differences in nutrient consumption and the fact that NNMB data were available

only on urban slums are two of the factors responsible for the apparent differences between NNMB and INP survey data.

Source of dietary energy

Data on total energy intakes and percentages of energy intake from fat, carbohydrate and protein for different age groups, as reported by NNMB and INP, are given in Table 10. Carbohydrates remain the major source of energy in Indian diets. There has been some reduction in the percentage of total energy intake from carbohydrates and some increase in the percentage from fats over the past three decades.

TABLE 10
Sources of dietary energy

Gender and age (years)	Total dietary energy intake (kcal)				Percentage dietary energy from fat				Percentage dietary energy from protein				Percentage dietary energy from carbohydrates			
	NNMB			INP	NNMB			INP	NNMB			INP	NNMB			INP
	1979	1996	2001	1996	1979	1996	2001	1996	1979	1996	2001	1996	1979	1996	2001	1996
Males and females[1]																
1–3	834	807	706	926	14.8	14.3	12.1	15.1	10.9	10.4	10.1	13.2	74.3	75.3	77.7	71.7
4–6	1 118	1 213	1 029	1 299	12.9	13.6	10.8	13.2	10.8	10.3	10.2	12.7	76.3	76.4	79.1	74.1
7–9[2]		1 467	1 251	1 520		12.3	10.1	13.9		10.6	10.1	13.1		77.1	79.8	73.1
Males																
10–12	1 439	1 738	1 524	1 847	8.8	12.7	11.8	12.1	10.9	10.5	10.6	12.3	80.3	76.7	77.6	75.6
13–15	1 618	2 004	1 856	2 185	9.3	12.4	11.9	11.9	10.7	10.5	10.5	12.3	80.0	77.1	77.6	75.8
16–17	1 926	2 369	2 114	2 514	8.0	12.6	11.0	11.3	10.4	10.4	10.4	12.6	81.6	77.0	78.7	76.1
< 18[3]	2 065	2 488	2 225	2 592	8.9	12.4	13.9	12.2	10.8	10.2	10.6	12.3	80.3	74.8	75.5	75.5
Females																
10–12	1 394	1 635	1 500	1 482	9.0	12.2	11.3	12.3	11.2	10.4	10.5	12.3	79.8	77.4	78.1	75.4
13–15	1566	1 848	1 689	2 097	9.1	11.7	11.2	12.2	10.5	10.4	10.3	12.5	80.4	77.9	78.5	75.3
16–17	1 704	2 030	1 856	2 327	8.8	12.9	11.7	12.3	10.3	10.2	10.1	12.8	80.9	76.6	77.7	74.9
<18[3]	1 698	2 106	1 878	2 293	9.1	13.9	13.9	12.6	10.7	9.9	10.6	12.4	80.2	76.2	75.5	75.0

Sample sizes: NNMB – 1975–1979, 33 048; 1996–1997, 14 391; 2000–2001, 22 945. INP – 46 457.
[1] No gender disaggregation of data before ten years of age.
[2] Data not available.
[3] No gender disaggregation of data after 18 years of age.
Sources: NNMB, 1979; 2002; INP, 1996.

Dietary diversity

The second National Family Health Survey (NFHS-2) (IIPS, 1998/1999) collected data on frequency of consumption of various types of foods (daily, weekly or occasionally) to assess dietary diversity among 90 000 married women aged 15 to 49 years living in 26 states. The survey did not include the quantities of intake. Data from the survey are presented in Tables 11 and 12. Adult women in India consume cereals every day; their diets tend to be monotonous and there is very little dietary diversity. Fruits are eaten daily by only 8 percent of women, and once a week by only one-third. Almost one-third of women never eat chicken, meat or fish, and very few (only 6 percent) eat these foods every day. Eggs are consumed even less frequently than chicken, meat or fish.

TABLE 11
Women's frequency of consumption of selected foods

Type of food	Daily	Weekly	Occasionally	Never
Milk or curd	37.5	17.4	34.1	10.9
Pulses or beans	46.9	40.8	11.6	0.6
Green leafy vegetables	41.8	43.4	14.3	0.4
Other vegetables	65.1	28	6.6	0.2
Fruits	8.1	24.9	62.3	4.7
Eggs	2.8	25.0	37.9	34.2
Chicken, meat or fish	5.8	26.1	37.3	30.8

Source: IIPS, 1998/1999.

There were substantial differences in food consumption patterns according to background characteristics (Table 12). Age does not play an important role in women's consumption patterns, but women in urban areas are more likely than those in rural areas to include every type of food in their diet, particularly fruits and milk or curd. Illiterate women have less varied diets than literate women, and seldom eat fruits. Poverty has a strong negative effect on dietary diversity. Women from households in the low socio-economic group are less likely than others to eat items from each type of food group listed, and their diets are particularly deficient in fruits and milk or curd. There are substantial interstate differences in the consumption of different types of food.

TABLE 12
Women's food consumption (percentages of survey population)

	Milk or curd	Pulses or beans	Green leafy vegetables	Other vegetables	Fruits	Eggs	Chicken, meat or fish
			Residence				
Urban	65.3	92.8	88.4	95.0	53.9	39.7	41.7
Rural	51.3	86.0	84.1	92.4	25.6	23.6	28.5
			Economic status				
Low	35.0	81.4	82.1	91.6	17.0	23.8	29.1
Medium	58.1	89.4	85.3	93.1	31.5	28.6	33.1
High	80.0	94.3	90.0	95.7	62.0	32.3	33.6
Total	**55.0**	**87.8**	**85.2**	**93.1**	**33.0**	**27.8**	**31.9**

Source: IIPS, 1998/1999.

Summary

During the past three decades there have been:

- reductions in energy intake from cereals, except among the poor; overall there has been a small decrease in total energy intake in both urban and rural areas;
- some increase in percentage of dietary energy derived from fat, and a reciprocal reduction in that derived from carbohydrate;
- some increase in consumption of fats and oils in urban populations, even in urban slums;
- increasing dietary diversity among upper-income groups in rural and – especially – urban areas;
- cereal-based and monotonous diets for the rural poor, with low micronutrient content;

- low iron intake, which coupled with the poor bioavailability of iron from Indian diets is responsible for a high prevalence of anaemia

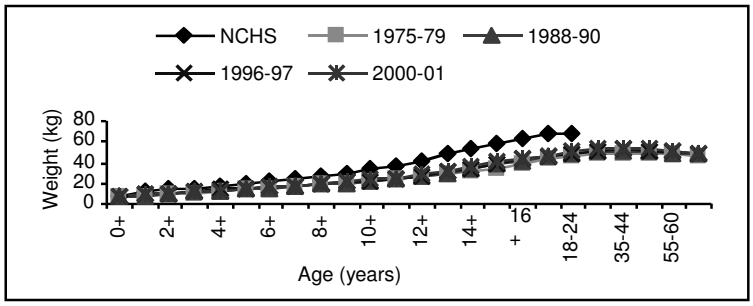
DIETARY INTAKE AND NUTRITIONAL STATUS IN DIFFERENT AGE GROUPS

As well as the dietary intake and nutritional status data collected by NNMB and INP, NFHS 1 and 2 (IIPS, 1992/1993; 1998/1999) provide state-level estimates of time trends in the nutritional status of women and preschool children in all major states during the 1990s. The District-Level Household Survey (DLHS) 2002/2003 (Ministry of Family and Health Welfare, 2004) provides district-level estimates on the nutritional status of preschool children. In addition, several smaller studies provide follow-up data on the nutritional status of specific groups over decades. This section reviews these data on time trends in the dietary intake and nutritional status of different age groups.

Time trends in anthropometric indices

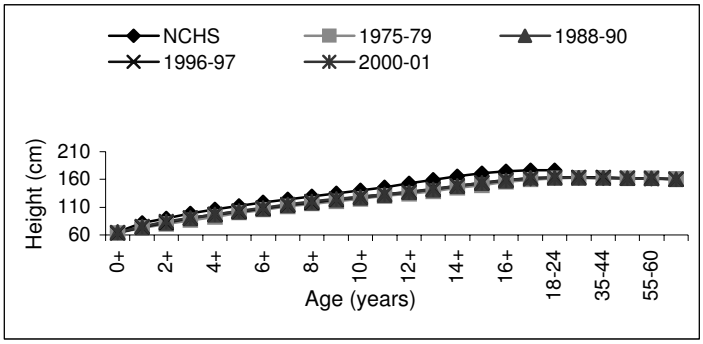
Data from NNMB rural surveys of trends in weight, height, mid-arm circumference and triceps fat fold thickness in males and females of all age groups are shown in Figures 16 to 21. Even in the rural population, adult height has increased by about 4 cm. Increases in body weight have been greater, mainly due to fat deposition, as shown by rising fat fold thickness over this period. These affected all age groups, and especially women.

FIGURE 16
Trends in mean weights in rural males, 1975 to 2001



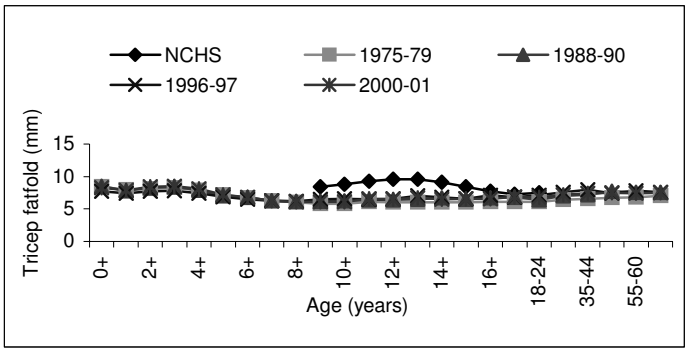
Source: NNMB reports.

FIGURE 17
Trends in mean heights in rural males, 1975 to 2001



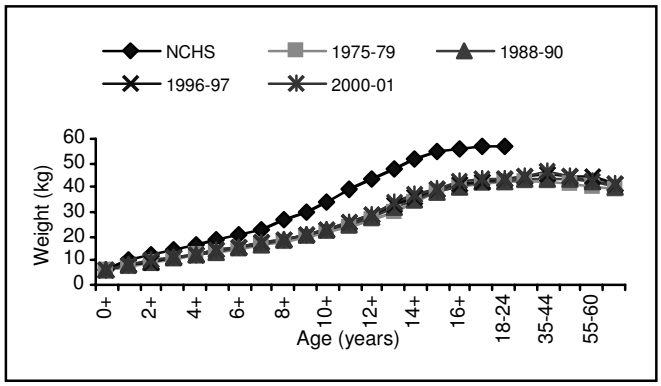
Source: NNMB reports.

FIGURE 18
Trends in mean tricep fat fold thickness in rural males, 1975 to 2001



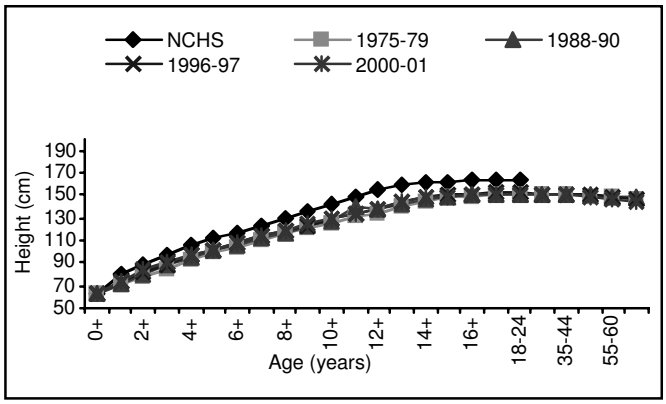
Source: NNMB reports.

FIGURE 19
Trends in mean weights in rural females, 1975 to 2001



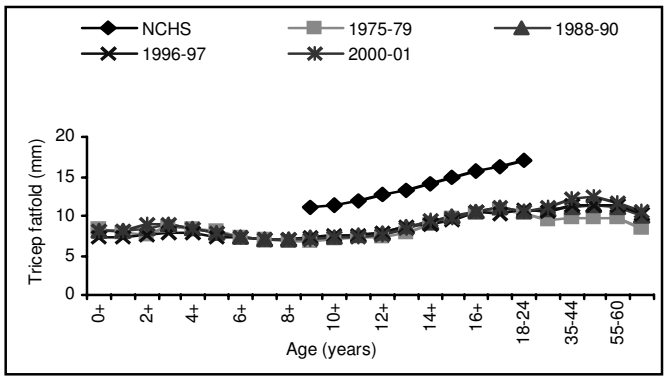
Source: NNMB reports.

FIGURE 20
Trends in mean heights in rural females, 1975 to 2001



Source: NNMB reports.

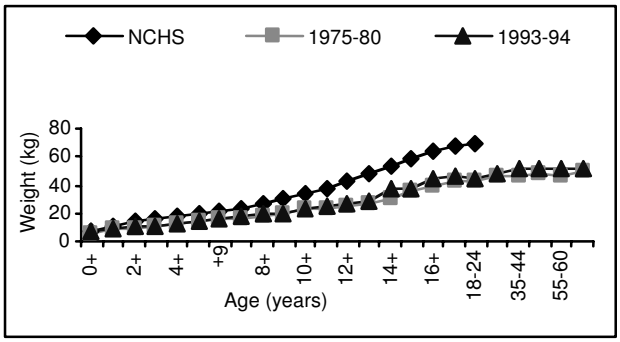
FIGURE 21
Trends in mean tricep fat fold thickness in rural females, 1975 to 2001



Source: NNMB reports.

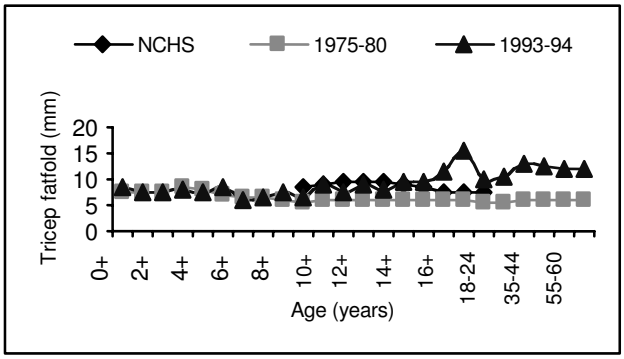
Data from NNMB surveys in urban slums are shown in Figures 22 to 25. Mean body weight, mid-upper arm circumference and fat fold thickness at triceps have increased in all age groups. Most of the body weight increase is due to increased fat, as shown by rising fat fold thickness.

FIGURE 22
Trends in mean weights in urban males, 1975 to 1994



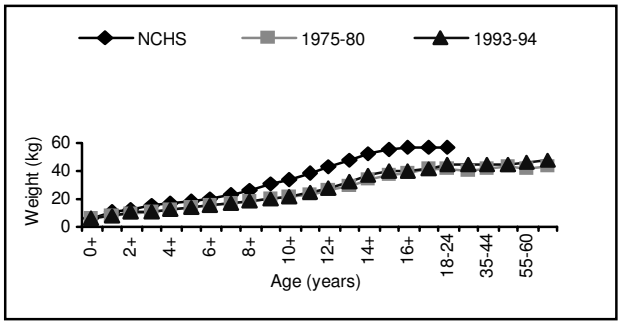
Source: NNMB reports.

FIGURE 23
Trends in mean tricep fat fold thickness in urban males, 1975 to 1994



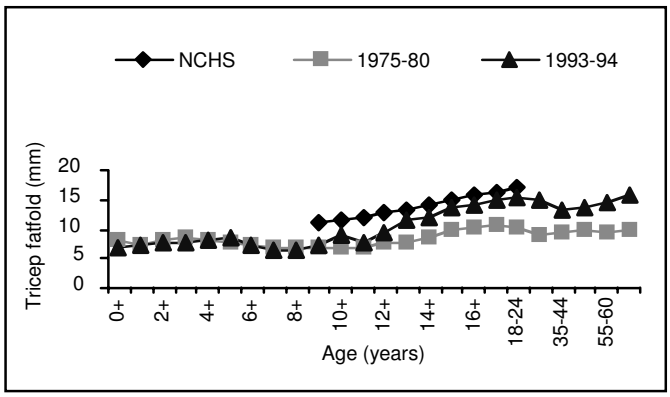
Source: NNMB reports.

FIGURE 24
Trends in mean weights in urban females, 1975 to 1994



Source: NNMB reports.

FIGURE 25
Trends in mean tricep fat fold thickness in urban females, 1975 to 1994



Source: NNMB reports.

Low birth weight

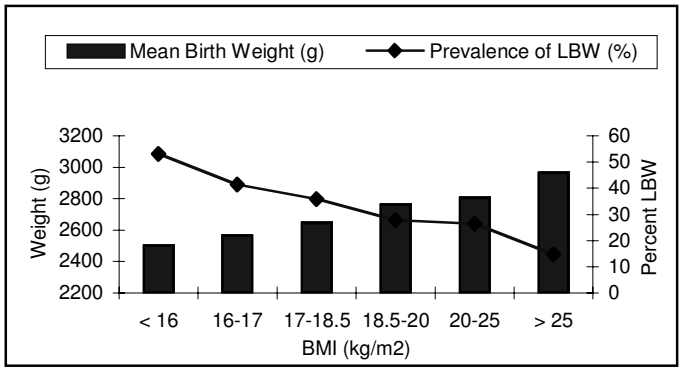
Nearly one-third of Indian infants weigh less than 2.5 kg at birth. Incidence of low birth weight (LBW) is highest among low-income groups (Table 13). There is clear correlation between birth weight and maternal body weight (Figure 26); low birth weight rate doubles when Hb levels fall below 8 gm/dl. Low birth weight incidence has remained unaltered over the last three decades (Figure 27) (NFI, 2004).

TABLE 13
Birth weight and socio-economic status

	Low-income	Middle-income	High-income
Age (years)	24.1	24.3	27.8
Parity	2.41	1.96	1.61
Height (cm)	151.5	154.2	156.3
Weight (kg)	45.7	49.9	56.2
Hb (g/dl)	10.9	11.1	12.4
Birth weight (kg)	2.70	2.90	3.13

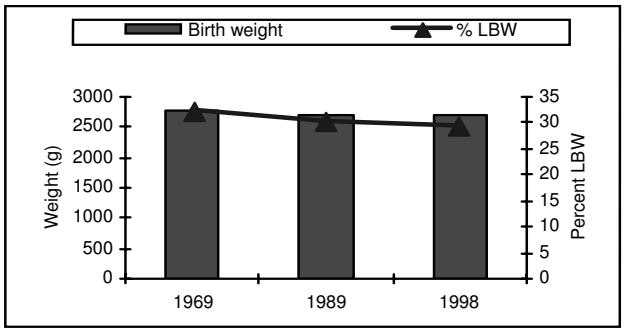
Source: Ramachandran, 1989.

FIGURE 26
Birth weight in relation to maternal body mass index



Source: Planning Commission, 2002.

FIGURE 27
Trends in birth weight, 1969 to 1998



Source: NFI, 2004.

Although there has been no decline in the prevalence of low birth weight, India has achieved a substantial decline in infant mortality (RGI, 2002). As more low-birth-weight newborns survive, there is growing concern regarding the relationship between low birth weight and poor growth during childhood and adolescence, as well as increased risk of chronic degenerative diseases in later life.

Under the Reproductive and Child Health Programme 1 and 2 (Ministry of Family and Health Welfare, 1998/1999; 2002), efforts are under way to provide effective antenatal care and reduce rates of low birth weight. Factors such as maternal height, which has a significant influence on birth weight, cannot be improved with short-term corrective interventions, but anaemia, pregnancy-induced hypertension and low maternal weight gain during pregnancy can be detected and treated. Effective management of these could result in substantial reductions in both pre-term births and the birth of small-for-date infants.

Growth during infancy and early childhood

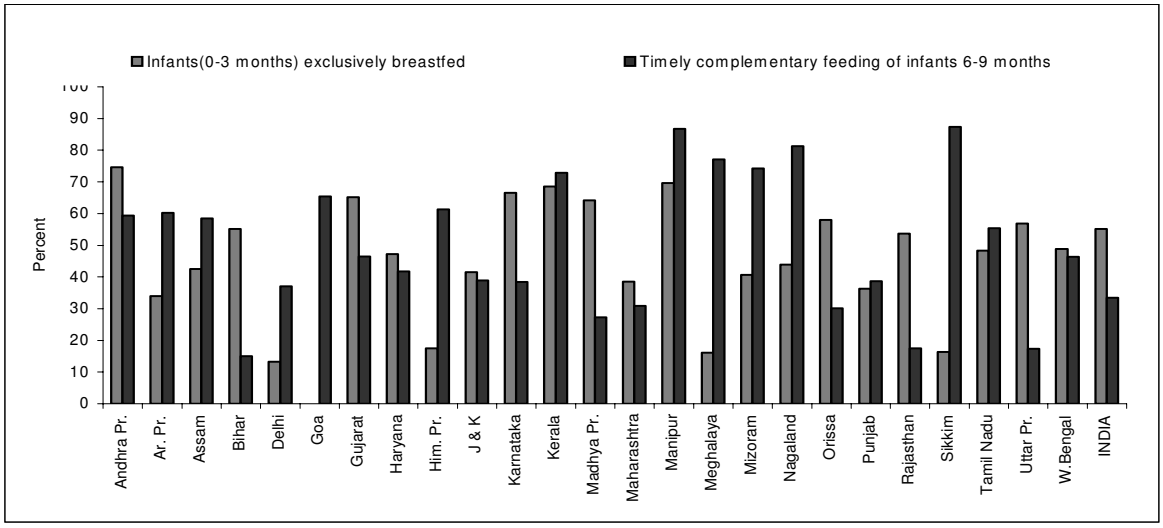
Growth during infancy and childhood depends on birth weight, adequacy of infant feeding and absence of infection. Available data clearly indicate that exclusively breastfed infants thrive better during the first six months of life and have lower morbidity episodes (diarrhoea,

respiratory tract infection and fever) than those receiving supplements in addition to breastmilk. In India, steps taken to protect and promote the practice of breastfeeding have been effective, and breastfeeding is now almost universal (Planning Commission, 2002). However, the message that exclusive breastfeeding up to six months followed by the gradual introduction of semi-solids is critical for the prevention of undernutrition in infancy has not been as effectively communicated. Data from NFHS 2 (IIPS, 1998/1998) indicate that although breastfeeding is nearly universal and the mean duration of lactation is more than two years, only 55.2 percent of infants up to three months of age receive exclusive breastfeeding. In spite of the emphasis on the need to introduce complementary food gradually, only 33.5 percent of infants in the six to nine months age group receive breastmilk and semi-solid food.

There are substantial interstate differences in exclusive breastfeeding and the timely introduction of semi-solid food (Figure 28). Early introduction of supplements is a major problem in states such as Delhi, Himachal Pradesh and Punjab, while late introduction is a problem in Bihar, Uttar Pradesh, Madhya Pradesh, Rajasthan and Orissa. Kerala fares well in terms of appropriate infant feeding practices, and this might be one of the reasons for the relatively low undernutrition rates in this state (IIPS, 1998/1999).

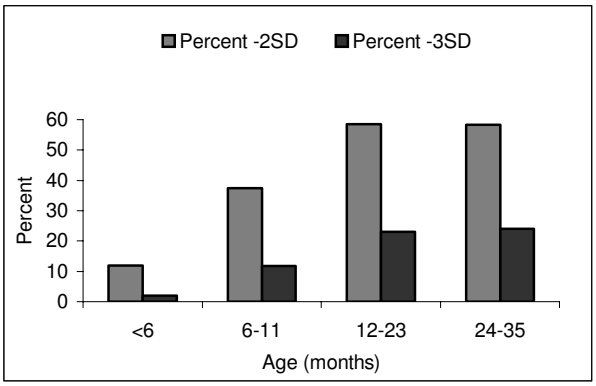
Early introduction of milk substitutes and late introduction of complementary food are associated with increased risk of undernutrition and infection. Faulty infant feeding practices are causing the prevalence of undernutrition to increase steeply with age, from 11.9 percent at less than six months to 58.5 percent in the 12 to 23 months age group (Figure 29). A major thrust of the Tenth Five-Year Plan is to prevent the onset of undernutrition in infancy and early childhood through nutrition education, so that by 2007 more than 80 percent of women breastfeed exclusively up to six months and the complementary feeding rate at six months goes up to 75 percent (IIPS, 1998/1999).

FIGURE 28
Infant feeding practices by state



Source: IIPS, 1998/1999.

FIGURE 29
Prevalence of undernutrition (weight for age less than –2 SD)

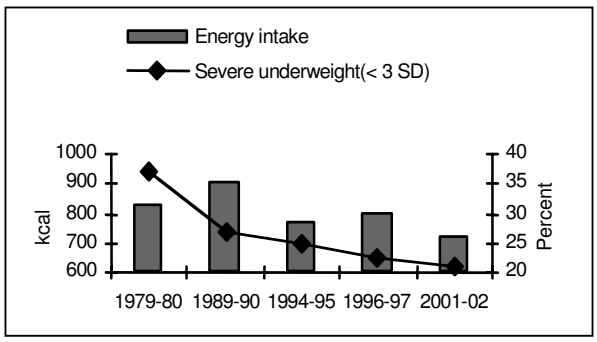


Source: IIPS, 1998/1999.

Time trends in the dietary intake and nutritional status of preschool children

Data from NNMB on energy intake and the prevalence of undernutrition in children under three years of age are shown in Figure 30. There has been a steady decline in undernutrition in children, even though the dietary intake has not shown a major change. The decline in undernutrition is most probably attributable to better access to health care and the effective management of infections.

FIGURE 30
Energy intake and undernutrition in children aged one to three years, 1979 to 2002



Source: NNMB reports.

Preschool children constitute one of the most nutritionally vulnerable segments of the population, and their nutritional status is considered to be a sensitive indicator of community health and nutrition. Their dietary intake has not improved substantially over the last two decades (Table 14).

TABLE 14
Average nutrient intakes among preschool children, 1975 to 1997

	1–3 years			4–6 years		
	1975–1979	1988–1990	1996–1997	1975–1979	1988–1990	1996–1997
Protein (g)	22.8	23.7	20.9	30.2	33.9	31.2
Energy (kcal)	834	908	807	1 118	1 260	1 213
Vitamin A (µg)	136	117	133	159	153	205
Thiamine (mg)	0.50	0.52	0.40	0.76	0.83	0.70
Riboflavin (mg)	0.38	0.37	0.40	0.48	0.52	0.60
Niacin (mg)	5.08	5.56	4.60	7.09	8.40	7.40

Source: NNMB, 2000.

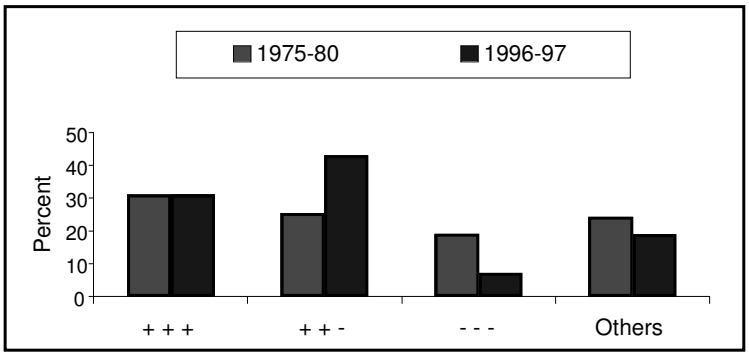
Data on energy intake in children, adolescents and adults from NNMB 2000 are shown in Table 15. Mean energy consumption as a percentage of RDA is lowest among preschool children. Time trends in the intra-family distribution of food (Figure 31) indicate that although the proportion of families in which both adults and preschool children have adequate food has remained at about 30 percent over the last 20 years, the proportion of families with inadequate intake has decreased substantially. However, the proportion of families in which preschool children receive inadequate and adults adequate intakes has nearly doubled, even though the RDA for preschool children forms only a very small proportion (an average of 1 300 kcal/day) of the family's total intake of about 11 000 kcal/day (assuming a family size of five). It therefore appears that poor young child feeding and care practices – and not poverty – is the factor responsible for inadequate dietary intake. The Tenth Five-Year Plan (Planning Commission, 2002) emphasizes the importance of health and nutrition education to ensure proper intra-family distribution of food, based on needs.

TABLE 15
Average energy intakes for children, adolescents and adults

	Males			Females		
Age group	kcals	RDA	% RDA	kcals	RDA	% RDA
Preschool	889	1 357	65.5	897	1 351	66.4
School age	1 464	1 929	75.9	1 409	1 876	75.1
Adolescents	2 065	2 441	84.6	1 670	1 823	91.6
Adults	2 226	2 425	91.8	1 923	1 874	102.6

Source: NNMB, 2000.

FIGURE 31
Comparison of adequate energy status of preschool children and adults, 1975 to 1997

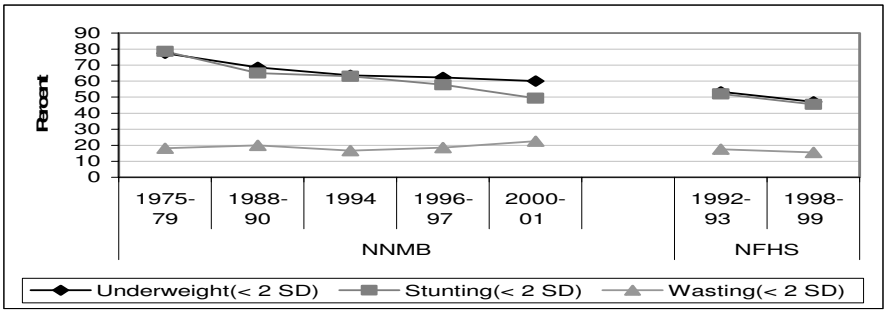


Dietary intake	Adult male	Adult female	Preschool children
+++	Adequate	Adequate	Adequate
++-	Adequate	Adequate	Inadequate
---	Inadequate	Inadequate	Inadequate

Time trends in prevalence of undernutrition in preschool children

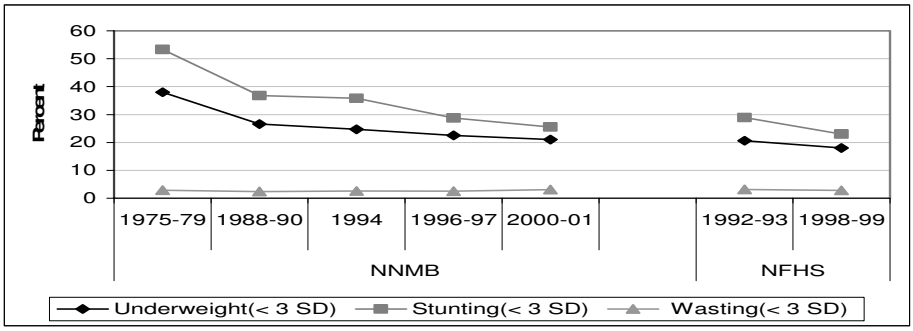
Over the last three decades, there has been a steep decline in the prevalence of moderate and severe undernutrition as assessed by weight-for-age and height-for-age (Figures 32 and 33), but very little change in the prevalence of wasting. In spite of the steep decline in the prevalence of stunting, the mean height of children has changed only very slightly. The increase in adult height has also been a modest 2 to 4 cm in three decades.

FIGURE 32
Trends in prevalence of undernutrition in children (percentages), 1975 to 1999



Sample sizes: NNBB – 1975–1980, 6 428; 1988–1990, 13 432; 1996–1997, 8 654; 2000–2001, 6 646. INP – 46 457. NFHS – 1992–1993, 25 584; 1998–1999, 24 600.
Sources: NNMB; INP; IIPS.

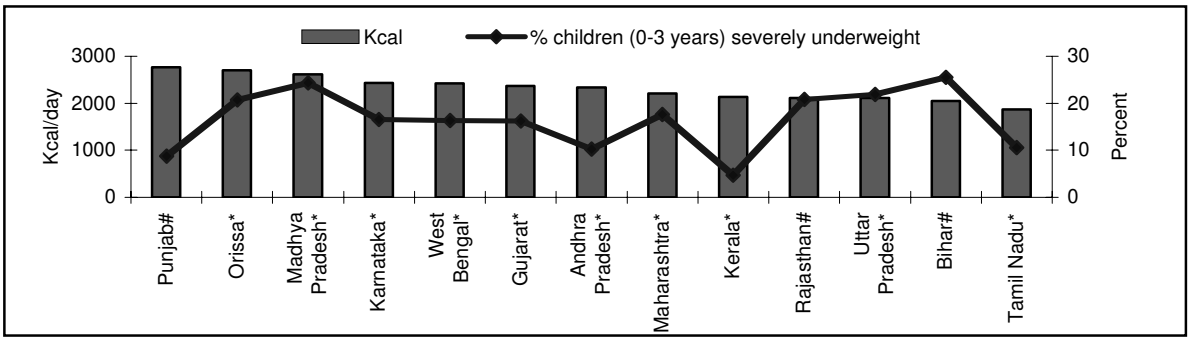
FIGURE 33
Prevalence of severe undernutrition in children (percentages), 1975 to 1999



Sample sizes: NNBB – 1975–1980, 6 428; 1988–1990, 13 432; 1996–1997, 8 654; 2000–2001, 6 646. INP – 46 457. NFHS – 1992–1993, 25 584; 1998–1999, 24 600.
Sources: NNMB; INP; IIPS.

Indian children are short compared with the National Center for Health Statistics (NCHS) norms; even when they have appropriate weight for height they are classified as undernourished according to these norms. The so-called South Asian paradox (high undernutrition rates but comparatively good health status) disappears when the body mass index (BMI)-for-age is the criterion for defining undernutrition. Early detection and correction are needed if wasting is to be reduced so that Indian children can achieve their growth potential. There are considerable interstate differences in the dietary intake and nutritional status of children (Figure 34). Although dietary intake is a major determinant of nutritional status in children, it is not the only one. Energy intake is low and undernutrition high in Uttar Pradesh, Bihar and Rajasthan. However, in spite of low energy intakes, the prevalence of undernutrition in Kerala and Tamil Nadu is low, probably because there is more equitable intra-family distribution of food based on needs, and better access to health care. The combination of high energy intakes and high undernutrition prevalence in Madhya Pradesh and Orissa is probably due to inequitable food distribution and poor access to health care (IIPS, 1998/1999).

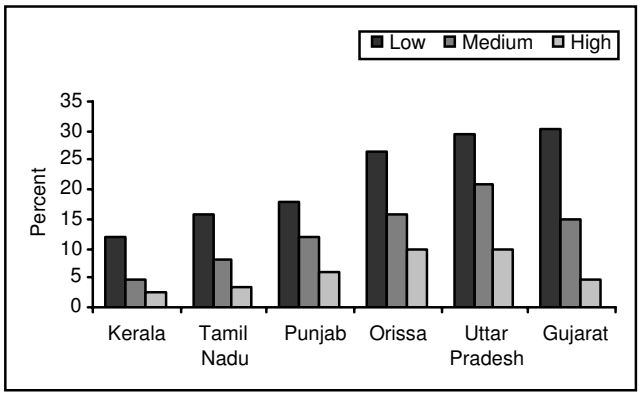
FIGURE 34
Energy intake and undernutrition among children, by state



Sources: INP; IIPS, 1998/1999.

The nutritional status of poor children in Kerala is similar to that of rich children in Uttar Pradesh and Orissa (Figure 35). This is probably attributable to better access to health care and more equitable intra-family food distribution in Kerala than in Uttar Pradesh. These data clearly indicate that lack of access to health care is a major factor in undernutrition among preschool children. The decline in fertility and the reduction in family size may also have contributed to this because the prevalence of severe forms of undernutrition is higher in large families (IIPS, 1998/1988).

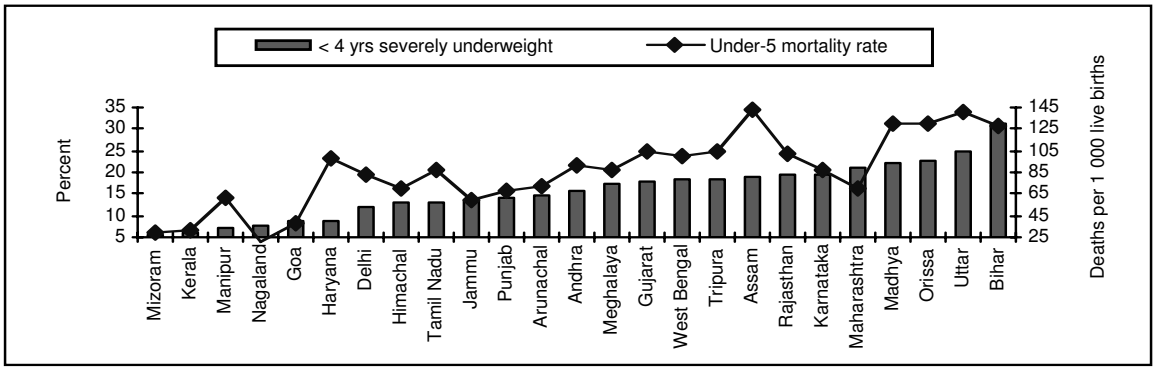
FIGURE 35
Nutritional status of children (weight-for-age) by income group and state



Sources: IIPS, 1992-93.

Poor dietary intake, poor care practices and poor access to health care are some of the major factors responsible for undernutrition and a high under-five mortality rate (U5MR). In most of the states where undernutrition is high (e.g., Orissa), U5MR is also high; in states where undernutrition is low (e.g., Kerala), U5MR is also low (Figure 36). There are exceptions to this, however; in Maharashtra U5MR is relatively low, in spite of relatively high undernutrition rates – this might be because access to health care is relatively good. In Punjab, in spite of high per capita income and dietary intake and good access to health care, both undernutrition and U5MR are relatively high. These data indicate the importance of health care in reducing both undernutrition and U5MR (IIPS, 1992/1993).

FIGURE 36
Prevalence of severe underweight and U5MR by state

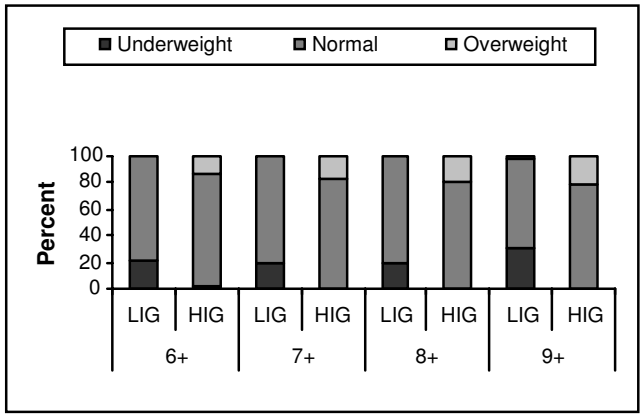


Sources: IIPS, 1998/1999.

Nutritional status of affluent schoolchildren

Studies carried out by NFI in 1991 (NFI, 2004) show that the growth of affluent children up to six years of age is similar to the NCHS and WHO norm. Data from NFI studies in Delhi between 2000 and 2004 (NFI, 2004) show that while undernutrition is a problem among children from low-income groups (LIG) who are studying in government schools, overnutrition is the cause for concern among high-income-group (HIG) schoolchildren from six years of age (Figure 37).

FIGURE 37
Comparison of weight-for-age in Delhi schoolboys



Source: NFI, 2004.

Growth of adolescents from affluent urban families

The heights and weights of adolescent girls and boys from affluent income groups are comparable to NCHS norms (Table 16), and higher than those of adolescents surveyed by NNMB. NFI data on height and weight distribution (compared with NCHS norms) in Delhi schoolchildren from affluent families are shown in Figures 38 and 39. Even in these affluent segments of the population, some children are stunted (-2 SD height for age). There are overweight children in all classes and age groups. Among children over ten years of age there is a reduction in overweight because children of this age try to lose weight through exercise or skipping meals (NFI, 2004). However, the adolescents have inconsistent eating and exercise habits and tend therefore to have cyclical weight gain and loss, thereby incurring the health hazards associated with this pattern.

FIGURE 38
Height-for-age

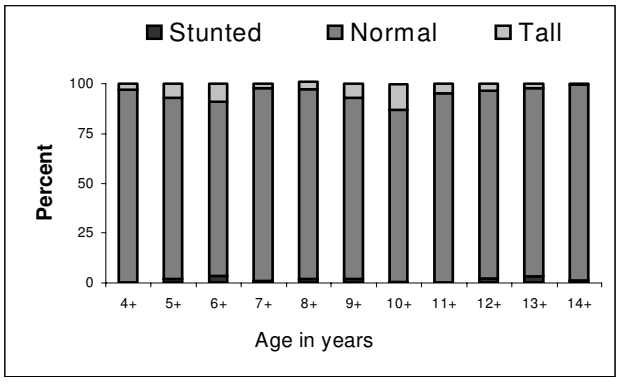
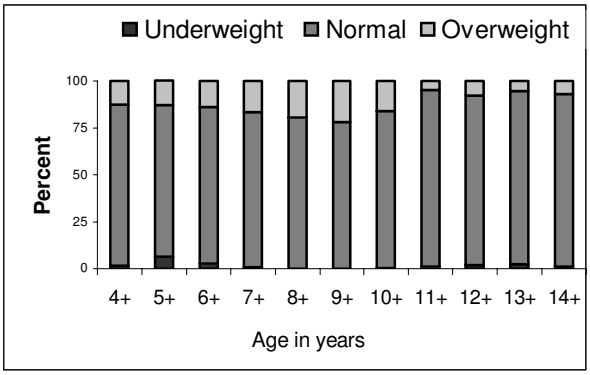


TABLE 16
Growth of adolescents from urban affluent families

Age (years)	Well-to-do		NCHS		Average Indian	
	Boys	Girls	Boys	Girls	Boys	Girls
Height (cm)						
10+	138.5	138.9	137.5	138.3	128.1	128.1
11+	143.4	145.0	140.0	142.0	133.1	133.1
12+	148.9	151.0	147.0	148.0	137.4	138.4
13+	154.9	153.4	153.0	155.0	143.0	144.1
14+	161.7	155.0	160.0	159.0	148.6	147.9
15+	165.3	156.0	166.0	161.0	153.0	149.8
16+	168.4	156.0	171.0	162.0	158.0	151.2
17+	173.0		175.0	163.0	161.2	152.1
Weight (kg)						
10+	32.3	33.6	31.4	32.5	23.1	23.1
11+	35.3	37.2	32.2	33.7	25.1	25.7
12+	38.8	43.0	37.0	38.7	27.3	28.7
13+	42.9	44.5	40.9	44.0	30.8	32.6
14+	48.3	46.7	47.0	48.0	34.8	36.0
15+	52.2	48.8	52.6	51.4	38.6	38.9
16+	55.5	49.8	58.0	53.0	42.3	41.3
17+	57.9		62.7	54.0	46.0	42.8

FIGURE 39
Weight-for-age



Nutritional status of adults

NNMB and INP data show that the prevalence of undernutrition in adults is higher in rural than urban areas (Table 17). Overnutrition is higher in urban areas. Over the last three decades there has been a progressive decline in undernutrition and some increase in overnutrition in both urban and rural areas. The prevalence rates of both under- and overnutrition are higher in women than men.

TABLE 17
Prevalence of under- and overnutrition among adults, 1975 to 2001

	Underweight						Overweight					
	NNMB				INP		NNMB				INP	
	1975–1979	1989–1990	1996–1997	2000–2001	1993–1994	1995–1996	1975–1979	1989–1990	1996–1997	2000–2001	1993–1994	1995–1996
Rural	53.2	49.0	48.5	38.6		34.6	2.9	3.1	46.5	6.6		4.1
Urban					20.3	27.7						6.0
Male	55.6	49.0	45.5	37.4	22.2	28.6	2.3	2.6	4.1	5.7	5.0	4.3
Female	51.8	49.3	47.7	39.3	19.4	36.3	3.4	4.1	6.0	8.2	10.6	4.6

Sample sizes: NNMB – 1975–1979, 11 973; 1989–1990, 21 398; 1993-1994, 2 772; 1996–1997, 30 773; 2000–2001, 11 074. INP – 17 7841.
Sources: NNMB; INP.

Nutritional status of women

Data from NFHS-2 (IIPS, 1998/1999) indicate that the prevalence of undernutrition among women in urban areas is half that of rural areas (Table 18). Overnutrition is four times higher in urban than in rural areas. In women, as age increases, the prevalence of undernutrition declines while that of overnutrition increases.

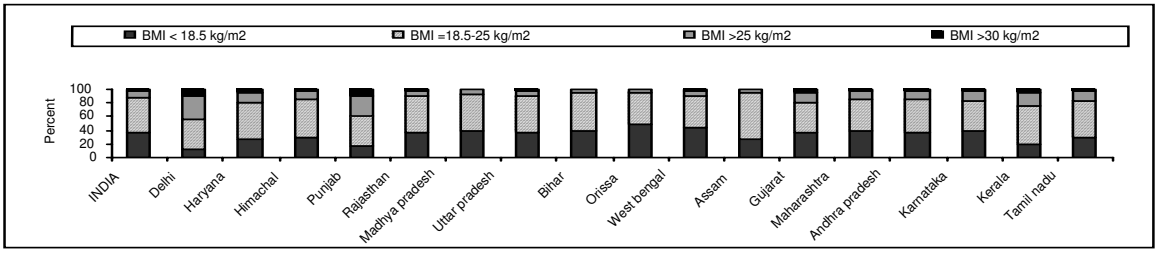
TABLE 18
Prevalence of under- and overnutrition among women (15 to 45 years)

Characteristic	Mean BMI	BMI < 18.5	BMI ≥ 25
Rural	19.6	40.6	5.9
Urban	21.1	22.6	23.5
		Age (years)	
15–19	19.3	38.8	1.7
20–24	19.3	41.8	3.6
25–29	19.8	39.1	7.3
30–34	20.4	35.0	11.7
35–49	21.1	31.1	16.8
Overall	**20.3**	**35.8**	**10.6**

Sample size: 77 119.
Source: IIPS, 1998/1999.

Data from NFHS-2 show that although undernutrition continues to be high among women in poorer segments of the population, overnutrition and obesity are emerging as major problems in all states of India. There are substantial differences in the prevalence of under- and overnutrition among states, but all states have to prepare to detect and manage this dual nutrition problem in women (Figure 40).

FIGURE 40
Comparison of BMI in women, by state



Source: IIPS 1998/1999.

Summary

Over the past three decades there have been:

- a very small (2 to 4 cm) increase in adult height;
- a significant increase in mean body weights, mostly owing to increased body fat as shown by increased fat fold thickness, which is greater in urban than rural areas.

In the absence of increased energy consumption, increased fat deposition is attributed to reduced physical activity. Very few studies have documented changes in physical activity patterns over the last three decades, but it is documented that over this period there have been:

- reduction in the number of people engaged in manual work;
- substantial improvement of mechanical aids in agriculture, industry and allied activities;
- improved access to water and fuel near households, in both urban and rural areas;
- improved availability of urban transport at affordable costs, resulting in fewer people walking or cycling to work, school or market;
- more mechanical aids that reduce physical activity during cooking and household tasks;
- TVs and computers in affluent urban households, which contribute to steep reductions in physical activity.

These lifestyle changes have led to reductions in energy requirements. Unchanged energy intakes combined with reduced energy requirements are associated with a positive energy balance and fat deposition.

MICRONUTRIENT DEFICIENCIES

Goitre caused by iodine deficiency, blindness by vitamin A deficiency (VAD) and anaemia by iron and folate deficiency are major public health problems in India. Over the last three decades, there has been a steep decline in keratomalacia caused by severe VAD, but no decline in the prevalence of anaemia caused by iron and folic acid deficiency; the declines in VAD and iodine deficiency disorders (IDDs) have been very slow. Data from NNMB surveys, IIPS and DLHS provide valuable insights for assessing the progress achieved in combating these deficiencies, help to formulate future interventions and provide baseline information for assessing the impacts of future interventions.

Anaemia

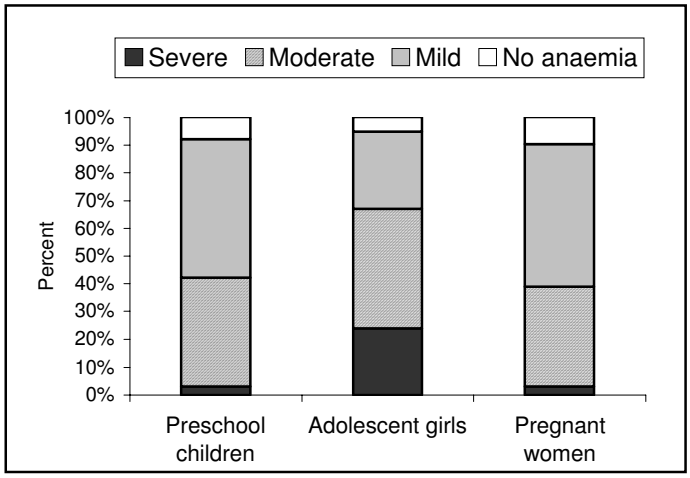
In India, the prevalence of anaemia is high because of:

- low dietary intake of iron (less than 20 mg/day, according to NNMB 2000) and folate (less than 70 mg/day);
- poor bioavailability of iron (only 3 to 4 percent) in the phytate fibre-rich Indian diet;
- chronic blood loss caused by infections such as malaria and hookworm infestations.

Data from DLHS (all states 1 100 households/district; Ministry of Family and Health Welfare, 2002/2003) and the NNMB survey (from eight states, NNMB, 2002) show that

prevalence of anaemia is very high (ranging from 80 to more than 90 percent) in preschool children, pregnant and lactating women and adolescent girls (Figure 41). Criteria used for assessing anaemia in DLHS are given in Table 19.

FIGURE 41
Prevalence of anaemia (percentage)



Source: Ministry of Family and Health Welfare, 2002/2003.

TABLE 19
Anaemia measurement criteria used in DLHS (g/dl)

	Normal	Mild	Moderate	Severe
Pregnant women and preschool children	≥ 11	8.0–10.9	5.0–7.9	≤ 5
Adolescent girls	≥ 12	10.0–11.9	8.0–9.9	≤ 8

Source: Ministry of Family and Health Welfare, 2002/2003.

Moderate and severe anaemia is seen even among upper-income group families. There are interstate differences in prevalence, which are probably attributable to differences in dietary intake and access to health care.

Anaemia is associated with increased susceptibility to infections, reduced work capacity and poor concentration. Anaemia remains a major cause of maternal mortality in India, accounting for more than 20 percent of all maternal deaths. In response to the low dietary intake of iron and folate, the high prevalence of anaemia and its adverse health consequences, India was the first developing country to adopt a National Nutritional Anaemia Prophylaxis Programme to prevent anaemia among pregnant women and children. Screening for anaemia and iron–folate therapy in appropriate doses have been essential components of antenatal and paediatric care for the last three decades, but coverage of these programmes is very low. As a result, very high rates of anaemia in pregnant women persist, and the impacts of severe anaemia on birth weight and maternal mortality remain unaltered. Anaemia continues to be a major problem affecting all segments of the population, and there has been no substantial decline in the adverse health consequences associated with it.

Strategies for the prevention, detection and management of anaemia in the Tenth Five-Year Plan

The total Indian population of more than 1 billion people will have to double their iron and folate intakes and sustain these new levels life long. The major intervention strategies required for the prevention and management of anaemia are:

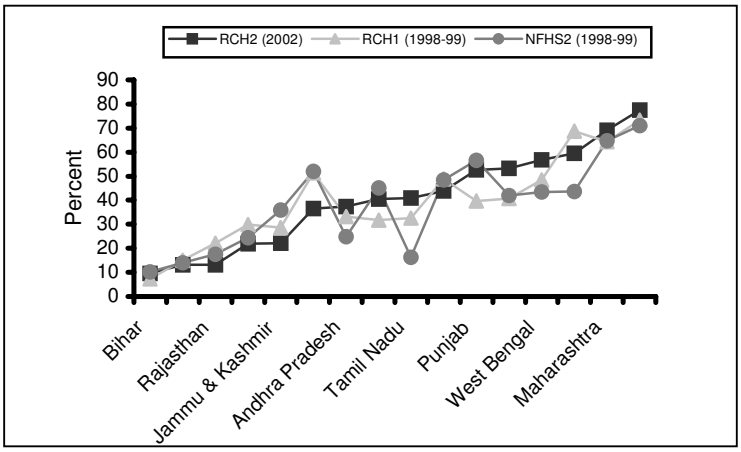
- dietary diversification to include iron- and folate-rich foods and food items that promote iron absorption;
- health and nutrition education to improve the consumption of iron- and folate-rich foodstuffs;
- food fortification, especially the introduction of iron and iodine-fortified salt at affordable costs;
- screening for early detection of anaemia among vulnerable groups (such as children and pregnant women);
- management of anaemia according to its severity/chronicity, the physiological status of the individual and the time available for treatment.

The Tenth Five-Year Plan (Planning Commission, 2002) has set the goal of reducing the prevalence of anaemia by 25 percent and of moderate/severe anaemia by 50 percent, by 2007.

Vitamin A deficiency

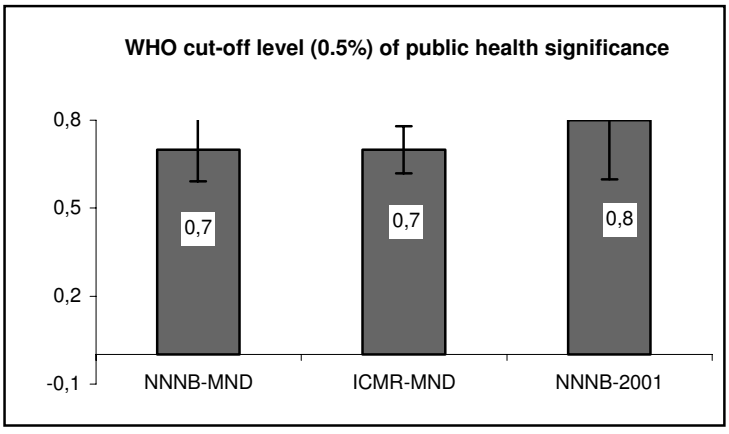
Vitamin A is an important micronutrient for maintaining normal growth, regulating cellular proliferation and differentiation, controlling development, and maintaining visual and reproductive functions. Diet surveys show that intakes of vitamin A are significantly lower than the recommended daily allowance in all groups, and that they have not increased over the decades (NNMB, 1979 to 2002). IIPS, Ministry of Family and Health Welfare (1998/1999) and DLHS surveys show that coverage of the Massive Dose Vitamin A Programme has been poor (Figure 42). However, over the years there has been a steep decline in severe forms of VAD in children; blindness caused by VAD is now very rare. All the large national surveys (NNMB, 2002; ICMR, 2004a; NNMB, 2001) have clearly shown that the prevalence of clinical VAD in children under five years of age in India is currently less than 1 percent (Figure 43). The decline in VAD in children appears to be caused by better access to health care and a consequent reduction in the severity and duration of common childhood morbidity to infections, especially measles.

FIGURE 42
Coverage of the Massive Dose Vitamin A Programme by state



Sources: Ministry of Family and Health Welfare, 1998/1999; 2002/2003; IIPS, 1998/1999.

FIGURE 43
Prevalence of Bitot's spots among children aged one to five years (percentages)



Sources: NNMB, 2002; ICMR, 2004a; NNMB, 2001.

Strategies for managing VAD in the Tenth Five-Year Plan

Clinical VAD often coexists with other micronutrient deficiencies; hence there is a need for broad-based dietary diversification programmes aimed at improving the overall micronutrient status of the population. In addition, the ongoing Massive Dose Vitamin A Programme in children aged nine to 36 months will be continued and its implementation strengthened.

Goals for the Tenth Plan

- Achieve universal coverage for each of the five doses of vitamin A.
- Reduce prevalence of night blindness to less than 1 percent, and that of Bitot's spots to less than 0.5 percent, in children between six months and six years of age.

- Eliminate VAD as a public health problem.

Iodine deficiency disorders

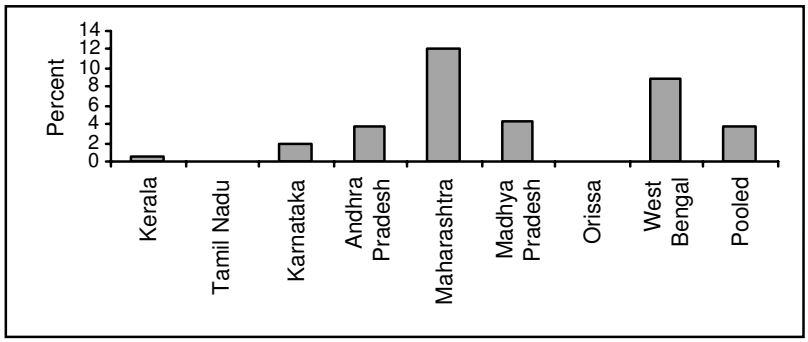
Iodine deficiency disorders (IDDs) have been recognized as a public health problem in India since the 1920s. IDD is caused by a lack of iodine in water, soil and foodstuffs, and it affects all socio-economic groups in defined geographic areas. Surveys carried out by central and state health directorates, ICMR and medical colleges have shown that no Indian territory is free from the problem of IDD. An estimated 167 million people are at risk of IDD – 54 million of whom have goitre while more than 8 million have neurological handicaps. Universal use of iodized salt is a simple, inexpensive method of preventing IDD.

Ongoing interventions to reduce IDD

The Government of India launched the National Goitre Control Programme (NGCP) in 1962. Initially, the programme aimed to provide iodized salt to the well-recognized sub-Himalayan "goitre belt". However, the erratic availability of the salt, the availability of cheaper non-iodized salt and a lack of awareness regarding the need to use iodized salt meant that there was no substantial reduction in IDD. It was then decided to introduce universal iodization of all the salt used for human consumption. This was implemented in a phased manner from 1986, and major efforts were made to increase the production of and access to iodized salt (Salt Department, 2003/2004). In August 1992, the NGCP was renamed the National Iodine Deficiency Disorders Control Programme (NIDDCP) and took into its ambit control of the entire spectrum of IDD. India became the second largest producer of iodized salt in the world, after China. In 1997, the central government banned the storage and sale of non-iodized salt, but lifted the ban in October 2000 because "matters of public health should be left to informed choice and not enforced".

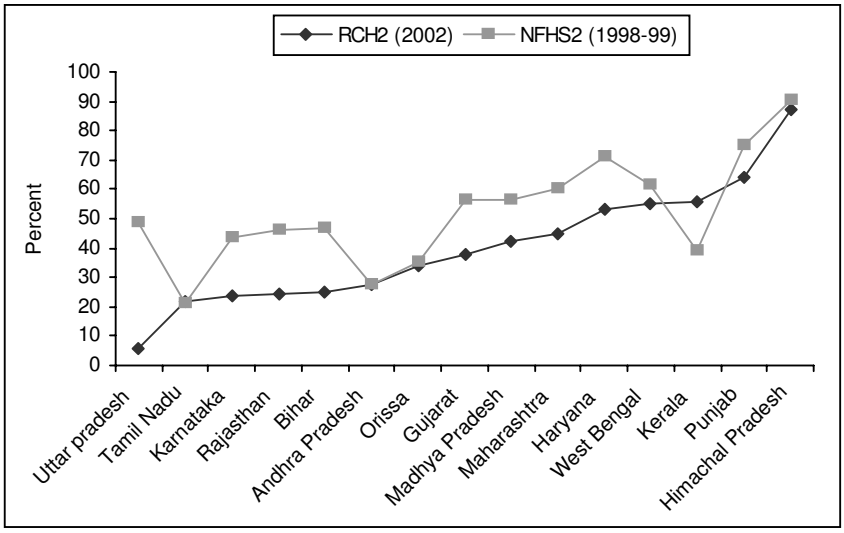
NNMB 2002 data on prevalence rates of goitre in six- to 12-year-old children are shown in Figure 44. The relatively high prevalence of goitre in these non-endemic states is a source of concern. Data from DLHS (Ministry of Family and Health Welfare, 2002/2003), which undertook spot tests of iodization in the salt consumed in 3 05 106 households, are presented in Figure 45. There has been some decline in the consumption of iodized salt since the ban on using non-iodized salt was lifted.

FIGURE 44
Prevalence of goitre in children aged six to 12 years, by state



Source: NNMB, 2002.

FIGURE 45
Percentages of households consuming iodized salt, by state



Source: Ministry of Family and Health Welfare, 2002/2003.

Strategies for the prevention of IDDs in the Tenth Five-Year Plan

On 25 June 2005, the Union Minister for Health and Family Welfare announced the decision of the Government of India to reimpose the ban on sales of non-iodized salt for human consumption. It is expected that this announcement will ensure universal access to iodized salt, such that the goals set in the Tenth Five-Year Plan can be achieved.

Goals for the Tenth Plan

- Achieve universal access to iodized salt.
- Generate data on iodized salt consumption by district.
- Reduce the prevalence of IDD in India to less than 10 percent by 2010.

PREVALENCE OF NON-COMMUNICABLE DISEASES

Soon after independence, India established systems for assessing per capita income, purchasing power, poverty, undernutrition and micronutrient deficiencies. Data from these surveys were used to assess interstate differences and time trends. A similar system for tracking overnutrition and the risk of non-communicable diseases (NCDs) was not established until the 1990s, and even now the coverage of this is not as extensive as that of other surveys. In view of this, for documenting time trends in prevalence of NCDs related to overnutrition, India has to depend on research studies carried out in different parts of the country. The differences in methodology of data collection, criteria used for case definition and parameters reported make it difficult to make comparisons among studies and to draw conclusions regarding time trends. However, from the existing data, it is clear that there has been an increase in prevalence rates of diabetes, hypertension and CVD over the last two decades,

especially in affluent urban segments of the population. Prevalence of these diseases is lower in poorer segments and in rural areas, but case fatality rates may be higher in these areas because of poor access to health care.

The National Cancer Registry Programme (NCRP) (ICMR, 1983) established cancer registries based on hospitals and populations in the mid-1980s, and generates data on time trends and regional differences in cancer incidence, prevalence and mortality. Data from NCRP show that India has the lowest cancer rates in the world, although it also has relatively high rates of tobacco use (nearly half of the cancers in men are tobacco-related). In spite of increasing longevity, there has not been any increase in overall cancer incidence over the last two decades. However, there have been changes in the incidences of cancer in specific sites, for example, a decrease in prevalence of cervical cancer and an increase in breast cancer.

As NCDs are emerging as major public health problems in India, ICMR undertook an assessment of the disease burden of these diseases in 2004 using the DISMOD II model (ICMR, 2004b). The major data sources utilized for this exercise were medical certifications of causes of disease, a survey of causes of death (rural), cancer registry data, and review of 180 published articles, ten published reports, five unpublished reports and one personal communication dealing with diabetes, hypertension, IHD, stroke and cancers. The ICMR assessment provides national-level estimates of the disease burden of NCDs in the first five years of the new millennium.

This section of the case study reviews the available data on time trends in prevalence of hypertension, diabetes, IHD, stroke and cancers over the last two decades; ICMR estimates of the disease burdens of NCDs; and the relationship between nutritional status and NCD.

Diabetes and impaired glucose tolerance

Community-based studies on prevalence of diabetes in urban and rural areas have been conducted in all regions of the country (Figure 46); all these studies show that there has been progressive increase in prevalence of diabetes in both urban and rural areas over the last three decades.

Data from the Chennai on time trends in prevalence of diabetes and impaired glucose tolerance (IGT) in urban and rural urban populations (Figures 47 and 48) show that both have increased at escalating rates in urban and rural areas (A. Ramachandran, 2005). Potential factors associated with the higher prevalence of diabetes in urban areas are shown in Figure 49.

FIGURE 46
Prevalence of diabetes, 1971 to 1998

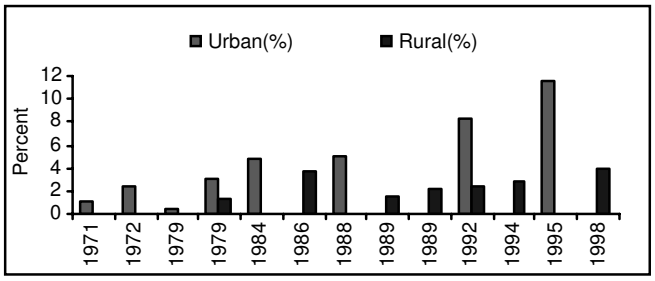
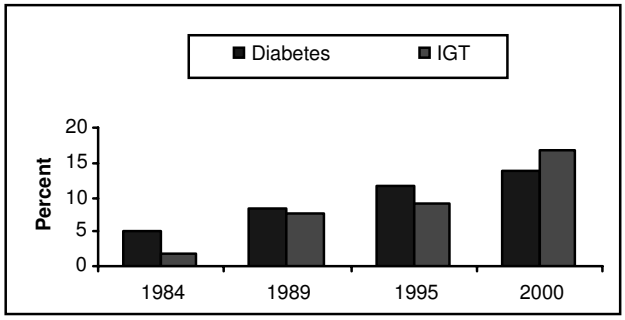
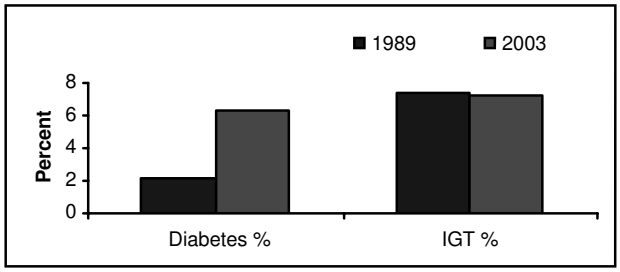


FIGURE 47
Increasing prevalence of diabetes and IGT in urban southern India, 1989 and 2003



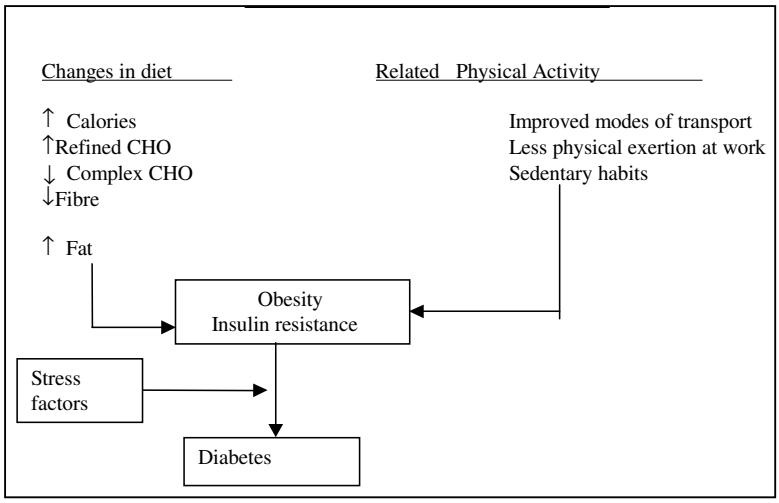
Source: A. Ramachandran, 2005.

FIGURE 48
Temporal changes in prevalence of diabetes and IGT in urban southern India



Source: A. Ramachandran, 2005.

FIGURE 49
Factors associated with the prevalence of diabetes and IGT in urban areas

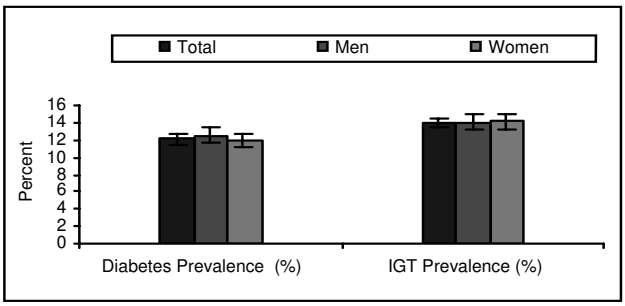


In 2000, the Diabetes Epidemiology Study group initiated a multicentre community-based study using the stratified random sampling method to assess the prevalence of diabetes and IGT in Bangalore, Chennai, Mumbai, Delhi, Kolkata and Hyderabad. The oral glucose

tolerance test was carried out on 11 216 people (5 288 men and 5 928 women) aged 20 years and over in a representative sample drawn from all socio-economic strata. Information on socio-economic status, physical activity and anthropometric data were collected (National Urban Diabetes Survey, 2001). Age-standardized prevalence rates of diabetes and IGT are shown in Figure 50. Diabetes and IGT increase progressively with age (Figure 51), and subjects under 40 years of age have higher prevalence of IGT than diabetes (12.8 percent versus 4.6 percent, $p < 0.0001$). Diabetes is not usually listed as a predisposing cause of death in death certificates in India; data from hospital-based studies suggest that major causes of death in patients with diabetes are infections, renal failure, IHD and stroke.

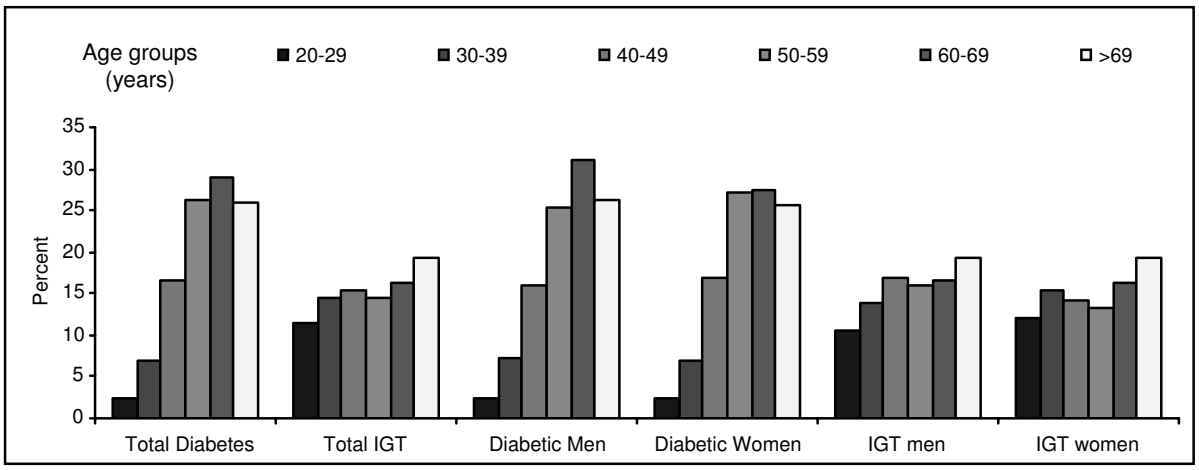
Summary results of ICMR's estimates of the disease burden of diabetes in 1998 and 2004 are presented in Table 20. The number of cases increased from 58.35 million in 1998 to 66.58 million in 2004 (37.73 million in urban and 28.85 million in rural areas). By 2004, diabetes accounted for 100 000 deaths a year, and is responsible for 1.15 million years of life lost (YLLs) to disease and 2.26 million disability-adjusted life years (DALYs) (ICMR, 2004b)

FIGURE 50
Prevalence rates of diabetes and IGT in India's urban population



Source: National Urban Diabetes Survey, 2001.

FIGURE 51
Prevalence rates of type-2 diabetes and IGT in India's urban population



Source: National Urban Diabetes Survey, 2001.

TABLE 20
Projections of disease burden of diabetes, 1998 and 2004

	1998			2004		
	Urban	**Rural**	**Total**	**Rural**	**Urban**	**Total**
Population (thousands)	262 152	708 781	970 933	319 727	746 031	1 065 758
No. of cases of diabetes (thousands)	30 939	27 409	58 348	37 734	28 849	66 583
No. of deaths due to diabetes	51 251	44 299	95 550	62 506	46 627	109 133
No. of YLLs	529 959	484 983	1 014 942	646 351	510 471	1 156 822
No. of DALYs	1 016 866	971 890	1 988 756	1 240 195	1 022 968	2 263 163

Source: ICMR, 2004b.

A WHO burden of disease study carried out in 2000 estimated that 2.7 million DALYs are attributable to diabetes; ICMR estimates for 2004 correspond closely to this estimate (ICMR, 2004).

Hypertension

Hypertension is probably the most common NCD, and is the most common factor responsible for IHD and cerebrovascular accidents. In the early 1970s, the reported prevalence of hypertension was low, ranging from 2 to 5 percent of the adult population. However, over the years rates have increased and currently range from 5 to 15 percent in urban adults. Yagnik (1998) showed that some Indian people are prone to developing hypertension from early childhood. Gopinath *et al.* (1994) investigated 10 200 Delhi schoolchildren (5 709 males and 4 506 females) aged five to 14 years and showed that hypertension existed even among this age category. Prevalence of hypertension increases with age, BMI, parental history of hypertension, and diabetes. A community-based study of hypertension (systolic BP > 140 and diastolic BP more than 85) in 6 543 people aged 15 to 25 years in Delhi in 1985 to 1987 showed overall prevalence of hypertension was 3.9 per 1 000 population (Reddy, 1998; Table 21).

TABLE 21
Hypertension rates by age and gender (thousands)

Age (years)	Male			Female			Total		
	No. examined	**Hyper-tensive**	**PR ± SE**	**No. examined**	**Hyper-tensive**	**PR ± SE**	**No. examined**	**Hyper-tensive**	**PR ± SE**
15–19	1 744	47	26.9 ± 4.0	1 874	27	14.4 ± 3.7	3 618	74	20.5 ± 2.0
20–24	1 342	80	59.6 ± 8.2	1 583	48	30.3 ± 6.7	2 925	128	43.8 ± 6.6
Total	**3 086**	**127**	**41.2 ± 5.0**	**3 457**	**75**	**21.7 ± 4.0**	**6 543**	**202**	**30.9 ± 3.6**

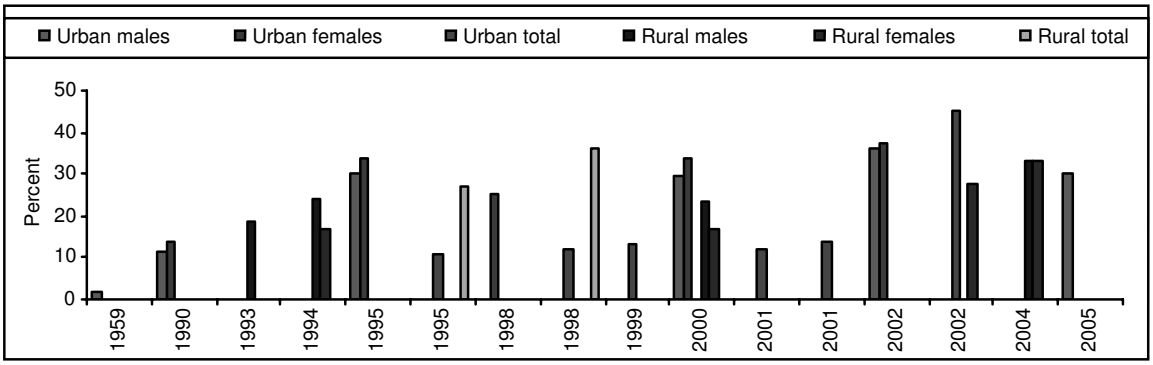
Sample size: 6 543.
PR = prevalence rate per 1 000, SE = standard error.
Source: Gopinath *et al.,* 1994.

Results from some of the major community-based studies on hypertension over the last two decades are shown in Figures 52 and 53. There have been clear increases in prevalence of hypertension among men and women living in urban and rural areas. Prevalence is lower in rural than in urban areas.

ICMR undertook an assessment of the burden of disease of hypertension (systolic BP > 140 mmHg and/or diastolic BP > 90 mmHg), based on studies carried out between 1995 and 2002

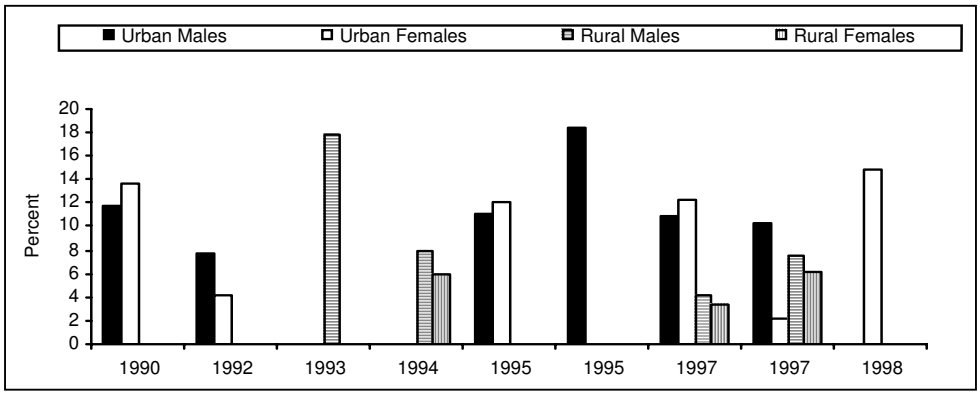
in the urban and rural areas of different regions. Meta-analysis of the data indicated that prevalence of hypertension was 157.4 per thousand at the national level (ICMR, 2004b).

FIGURE 52
Prevalence of hypertension (SBP > 140/DBP > 90), 1959 to 2005



Sources and sample size: Padmavathy et al, 1959: 1642;Gopinath et al, 1990: 6372(Males), 7351 (Females); Kutty et al, 1993: 1130; (Females); Gupta et al., 1994: 1982 (rural males), 1166(rural females); Gupta et al, 1995: 1415 (males) 797(females); Gopinath etal.5998 (Urban males), 7136 (Urban females), 616 (Rural males), 1116 (Rural females), Singh et al, 1998: 3714; Chadha et al., 1998: 13134 (urban), 1982 (rural); Gupta et al.,2000: 1415(urban males), 797 (urban females), 1982 (rural males), 1166(rural females); Misra et al., 2001: 532; Mohan et al., 2001: 1175; Gupta et al., 2002: 550 (urban males), 573 (urban females); Ahlawat et al, 2002: 937; Reddy et al, 2002: 3307; Hazarika et al, 2004: 3180; Prabhakaran et al., 2005: 2122.

FIGURE 53
Percentage prevalence of hypertension (SBP > 160/DBP > 90), 1990 to 1998

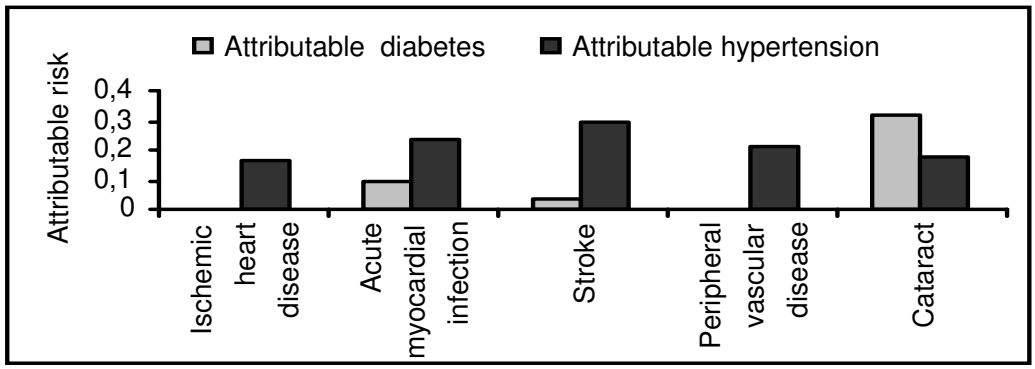


Sources and sample size: Gopinath et al, 1990: 6372(Males), 7351 (Females); Kutty et al, 1993: 1130; (Females); Gupta et al., 1994: 1982 (rural males), 1166(rural females); Gupta et al, 1995: 1415 (males) 797(females); Gopinath etal.5998 (Urban males), 7136 (Urban females), 616 (Rural males), 1116 (Rural females), Singh et al, 1998: 3714.

Health consequences of hypertension

ICMR estimated the risk ratios for NCD that are associated with hypertension; 16 percent of IHD, 21 percent of peripheral vascular disease, 24 percent of acute myocardial infarctions and 29 percent of strokes can be attributed to hypertension (ICMR, 2004b). ICMR also computed the risks of NCDs that are attributable to diabetes and hypertension (Figure 54). Because hypertension and diabetes often coexist, the actual risk of various NCDs when both are present may be higher than the risk for either individually.

FIGURE 54
Risks of NCD that are attributable to diabetes and hypertension



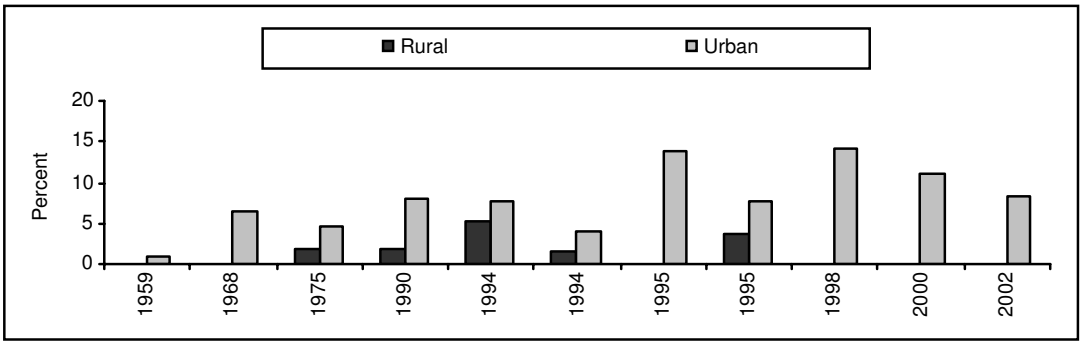
Source: ICMR, 2004b.

Ischaemic heart disease

IHD, also known as coronary artery disease, is becoming an important cause of death in India. The findings of some of the major studies on prevalence of IHD in urban and rural areas in different parts of India are shown in Figure 55. Over the last three decades, there has been a progressive increase in prevalence of IHD, particularly during the last decade, especially in urban areas. Most of this increase is attributed to lifestyle changes, which have affected people in urban areas more than rural ones (ICMR, 2004b). For the purpose of ICMR's meta-analysis of these studies, which were carried out during the 1990s, IHD was diagnosed on the basis of:

- history of documented angina or infarction and previously diagnosed CHD;
- affirmative response to the Rose questionnaire;
- electrocardiogram changes: Minnesota codes 1-1, 4-1, 5-9, 5-2 or 9-2.

FIGURE 55
Prevalence of IHD (percentages), 1959 to 2002



Age-specific prevalence rates of IHD among males and females were obtained by pooling the data of these five studies (separately for urban and rural areas), the results of which are given in Table 22. There is a steep increase in IHD prevalence in both sexes in the 40 to 50 years age group. Prevalence rates in women are similar to or higher than those in men.

TABLE 22
Age-specific prevalence derived from selected studies of IHD

Age group	Urban						Rural					
	Male			Female			Male			Female		
	Sample size	No. of cases	PR	Sample size	No. of cases	PR	Sample size	No. of cases	PR	Sample size	No. of cases	PR
20–24	125	1	8.0	147	1	6.8	285	5	17.5	191	2	10.5
25–29	1 374	27	19.6	1 677	44	26.2	512	7	13.7	624	9	14.4
30–34	1 584	27	17.1	2 091	48	22.9	888	11	12.4	1 302	14	10.8
35–39	1 459	63	43.2	1 796	87	48.4	1 011	19	18.8	1 376	22	15.9
40–44	1 418	67	47.3	1 549	102	65.8	836	15	17.9	1 033	24	23.2
45–49	1 093	91	83.2	1 234	130	105.4	724	15	20.7	954	37	38.8
50–54	1 053	98	93.1	1 162	130	111.9	675	21	31.11	722	36	49.9
55–59	985	160	162.4	1 054	161	152.8	937	25	26.7	825	42	50.9
60 +	835	145	173.6	941	165	175.4	591	42	71.1	519	35	67.4

PR = prevalence rate per thousand.
Source: ICMR, 2004b.

Indices of the burden of disease of IHD in India are presented in Table 23. Estimated prevalence rates are 64.4 per thousand in urban and 25.3 per thousand in rural populations. Projections of the burden of disease of IHD in India from 1998 to 2004 are given in Table 24. The number of IHD cases is estimated to have increased from 34.78 million in 1998 to about 39.43 million in 2004 (20.58 million in urban and 18.85 million in rural areas). In 2004 , the total number of DALYs attributable to IHD was estimated to be 16 million (ICMR, 2004b).

TABLE 23
Indices of disease burden of IHD

	Urban	Rural
Prevalence rate/1 000	64.4	25.3
Death rate/1 000	0.8	0.4
YLLs/100 000	728.7	351.5
DALYs/100 000	2 703.4	986.2

Source: ICMR, 2004b.

TABLE 24
Projections of disease burden of IHD, 1998 and 2004

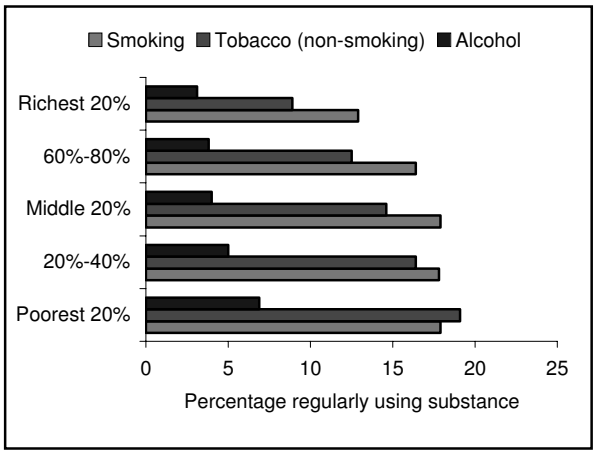
	1998			2004		
	Urban	Rural	Total	Rural	Urban	Total
Population (thousands)	262 152	708 781	970 933	319 727	746 031	1 065 758
No. of cases of IHD	16 874 724	17 910 896	34 785 620	20 580 827	18 852 203	39 433 030
No. of deaths to IHD	207 548	256 014	463 562	255 782	298 412	554 194
No. of YLLs	1 991 451	2 470 149	4 461 600	2 329 851	2 622 299	4 952 150
No. of DALYs	7 388 453	6 930 974	14 319 427	8 643 450	7 357 358	16 000 808

Source: ICMR, 2004b.

It is often assumed that IHD affects mainly the well-to-do. However, several studies suggest that poor people are vulnerable to IHD. A community-based cross-sectional survey

looked at the prevalence of CHD and coronary risk factors in Rajasthan by educational level in 3 148 residents over 20 years of age (1 982 men and 1 166 women) in three villages (Gupta, Gupta and Ahluwalia, 1994). The prevalence of CHD (diagnosed by electocardiography) showed an inverse relation with education in both sexes; prevalence of coronary risk factors such as smoking and hypertension were higher among the uneducated. NSSO (1975 to 2000) surveys have documented higher prevalence of tobacco use among the poorer segments of the population (Figure 56). Lack of physical exercise and stress are common among the urban poor in sedentary jobs. It is therefore not surprising that there is high prevalence of hypertension and IHD among this segment. Results of some of the studies carried out in Delhi show that prevalence of hypertension and IHD is high among poorer segments of the population in urban areas. Some data indicate that untreated/poorly controlled severe hypertension and IHD were higher among low-income groups, perhaps because of poor access to health care; data also indicate that mortality rates associated with IHD are higher among the poor (Srinath Reddy, personal communication). It is therefore important to recognize that not only the urban affluent are at risk of hypertension and IHD in India. Programmes aimed at lifestyle modifications for all segments of the population are of critical importance for preventing IHD. Facilities for screening to detect IHD and for managing those with the disease also have to be built up.

FIGURE 56
Prevalence of alcohol and tobacco use in India, by income quintale



Source: NSSO, 1995/1996.

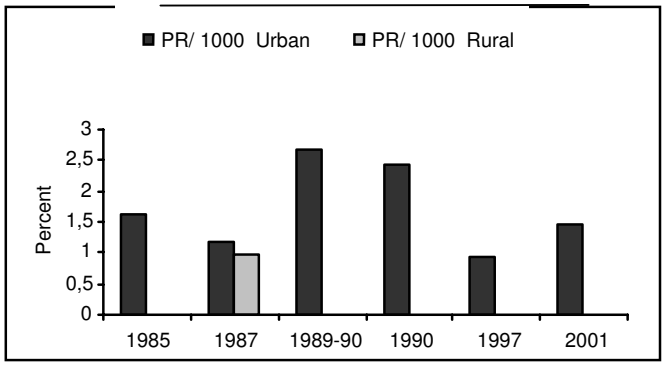
Stroke

WHO defines stroke as "rapidly developed clinical signs of focal disturbances of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than vascular origin". The 24-hour threshold in the definition excludes transient ischaemic attacks. Stroke is the acute severe manifestation of cerebrovascular disease, and is one of the leading causes of mortality and morbidity in developed countries.

ICMR undertook a meta-analysis of stroke from well-designed studies with adequate sample sizes (Figure 57). The weighted average of stroke prevalence was 1.54 per thousand. Estimated prevalence of stroke is lower in India than in developed countries. However, it may increase proportionally with increasing longevity. The prevalence rates, stroke-specific

mortality rates, case fatality rates, all-cause mortality rates and age distribution of population (1998) were inputs for a DISMOD analysis of stroke data.

FIGURE 57
Prevalence of stroke, 1985 to 2001



Source: ICMR, 2004b.

The YLLs to stroke are 496.3 per 100 000, and the DALYs 597.6 per 100 000 (Table 25).Projections of the burden of disease of stroke in India for 1998 to 2004 are given in Table 26. In 2004, the total number of stroke cases in India was expected to be 1.64 million and the total number of DALYs attributable to stroke 6.37 million.

TABLE 25
Indices of disease burden of stroke

Prevalence rate/1 000	**1.54**
Death rate/1 000	0.6
YLLs/100 000	496.3
DALYs/100 000	597.6

Source: ICMR, 2004b.

TABLE 26
Projections of disease burden of stroke, 1998 and 2004

	1998	**2004**
Population (thousands)	970 933	1 065 758
No. of cases of stroke	14 95 237	16 41 267
No. of deaths due to stroke	5 93 362	6 39 455
No. of YLLs	48 18 740	52 89 357
No. of DALYs	58 02 295	63 68 970

Source: ICMR, 2004b.

Cancers

NCRP estimates that there are about 700 000 new cases of cancer a year and about 2 million cases of cancer in the country (ICMR, 1990 to 2005). Age-adjusted cancer incidence in India varies from 91.9 to 120.9 per 100 000 in urban males and from 108.7 to 134.8 per 100 000 in urban females. The cumulative incidence rates in selected population-based cancer registries

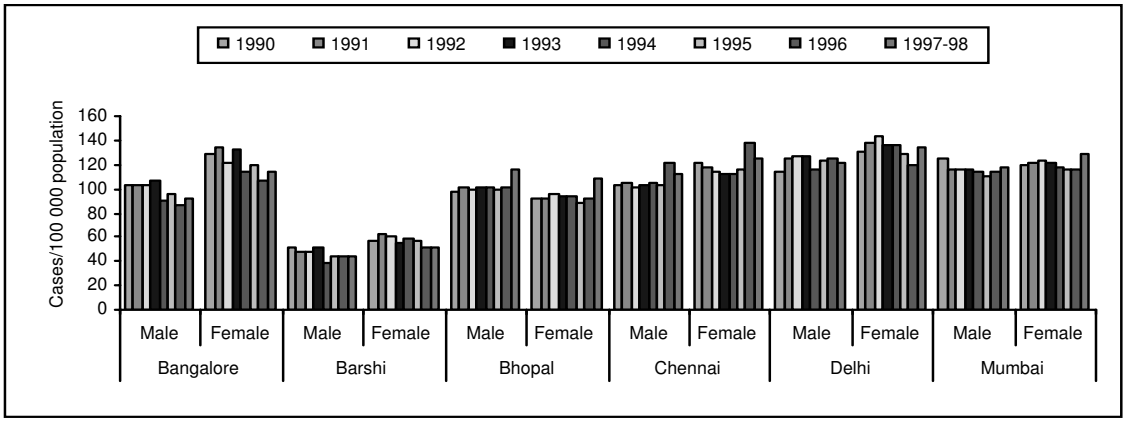
in India are given in Table 27. Over all, cancer incidence in India is among the lowest in the world. Incidences of cancers reported in the urban cancer registries are similar to cancer incidences among Indians in Singapore and are substantially lower than cancer rates reported in other countries. Cancer epidemiologists have been exploring the protective role of the Indian diet – with its high fibre, phytate and spices, including turmeric – in the observed low prevalence of malignancies in India. Cancers associated with tobacco use account for 36 to 55 percent of all of cancers in men and for 10 to 16 percent of those in women. Anti-tobacco education and reduction of tobacco use can result in further substantial reductions in cancer rates in India. Data on time trends in prevalence of cancers (all sites) from the six population-based cancer registries are shown in Figure 58. It is obvious that, unlike CVD and diabetes, there has not been any increase in overall cancer prevalence over time.

TABLE 27
Cumulative incidence rate, cumulative risk and possibility of developing cancer at all sites

Registry	Cumulative rate (%)		Cumulative risk (%)		Possibility of one in no. of persons developing cancer	
	Males	Females	Males	Rural	Males	Females
			0 to 64 years			
Bangalore	8.06	10.80	7.75	10.24	13	10
Barshi	4.05	5.04	3.97	4.91	25	20
Bhopal	10.49	10.80	9.96	10.24	10	10
Chennai	10.11	11.69	9.62	11.03	10	9
Delhi	10.45	12.21	9.92	11.49	10	9
Mumbai	9.37	11.17	8.94	10.57	11	9
			0 to 74 years			
Bangalore	11.08	13.39	10.49	12.53	10	8
Barshi	5.10	5.86	4.97	5.69	20	18
Bhopal	15.34	12.50	14.22	11.75	7	9
Chennai	13.19	14.35	12.35	13.37	8	7
Delhi	13.97	15.23	13.04	14.13	8	7
Mumbai	13.98	14.82	13.04	13.77	8	7

Source: ICMR, 1990 to 2005.

FIGURE 58
Trends in prevalence of cancer rates (per 100 000 population), 1990 to 1998



Source: ICMR, 1990 to 2005.

The Bombay cancer registry has population-based data on incidence of cancer from the 1960s to the present (Yeole, 2001). Analysis of time trends from the 1960s until 1999 confirms that although there have been massive changes in prevalence of some cancers (reductions in cervical cancer and increases in breast cancer) there has been no increase in overall prevalence of cancers over the last five decades.

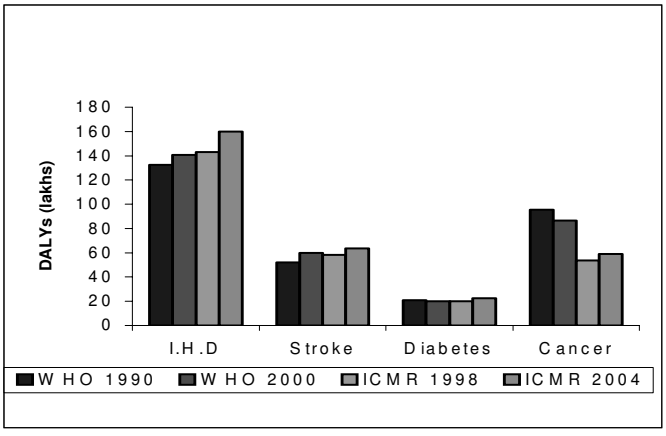
ICMR estimates of the burden of disease of cancer (all sites), based on data from NCRP's population-based cancer registries, are given in Table 28. The number of cases of cancer in 2004 is expected to be 820 000, and the total number of DALYs due to cancer in India is estimated at 5.9 million. This estimate is low compared with the 8.6 million DALYs estimated in the WHO burden of disease study (2000) (Figure 59). To obtain cancer disease burden estimates, ICMR used mortality rates obtained by pooling the data of all six population-based registries. However, if the cancer mortality rates reported in the Chennai registry (which are the highest reported) are used, the figures become comparable to those in the WHO study.

TABLE 28
Projections of disease burden of cancer

	Male	Female
Population (thousands)	550 404	515 354
No. of cases	390 809	428 545
No. of deaths	138 622	121 192
No. of YLLs	13 96 508	16 17 787
No. of DALYs	25 48 392	33 48 444

Source: ICMR, 2004b.

FIGURE 59
WHO and ICMR estimates/projections of disease burden of cancer, 1990 to 2004



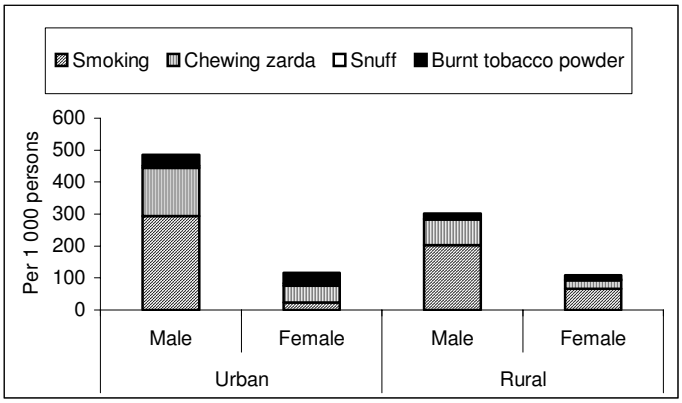
Source: ICMR, 2004b.

Tobacco as a risk factor for NCDs in India

Data on tobacco use in India from the fiftieth NSSO survey (NSSO, 1975 to 2000) are shown in Figure 60. Prevalence rates of tobacco use are highest among urban males, followed by rural males. The countrywide prevalence of tobacco use (rural and urban) is 35.5 percent.

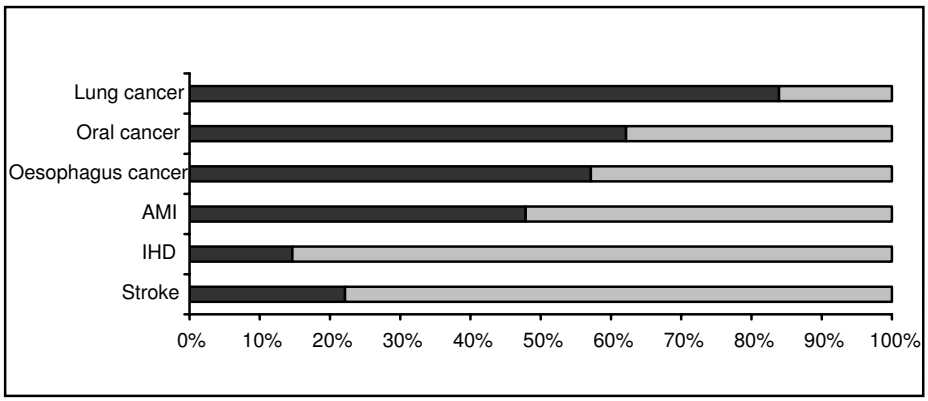
The risk ratios associated with tobacco use in NCDs are presented in Figure 61; 15 percent of IHD cases, 48 percent of acute myocardial infarction (AMI) and 22 percent of strokes are attributable to tobacco use, which is also the major factor responsible for cancers of the lung, mouth and oesophagus. A strategy for controlling the use of tobacco would therefore result in significant reductions of these NCDs.

FIGURE 60
Use of tobacco in various forms



Source: ICMR, 2004b.

FIGURE 61
Disease risk attributable to tobacco use



Source: ICMR, 2004b.

FACTORS RESPONSIBLE FOR THE EMERGING PROBLEM OF OVERNUTRITION

Data presented in the section on food and nutrient intake indicate that over the last three decades there has not been any significant change in the energy intake of the Indian population, except in affluent families, especially in urban areas; even in this segment, however, most of the increase in consumption of energy-dense fast foods is among adolescents and youth. It is therefore obvious that increase in dietary intakes of fats, oils and sugar is not a major factor in overnutrition in India. Over this period, there has been a progressive reduction

in physical activity in all segments of population. Reduction in energy expenditure and unchanged dietary intake results in a positive energy balance, and could be a major factor responsible for the rising prevalence of overnutrition in adults in India. Available evidence to support this is reviewed in this section.

Cross-sectional studies undertaken among affluent housewives aged 30 to 60 years in Delhi show that their dietary intake remained unaltered, at between 2 100 and 2 300 kcal/day (Wasuja and Siddhu, 2003). In each age group, energy expenditure is lower than intake by about 50 to 75 kcal/day. This is associated with a weight gain of about 5 kg per decade (Table 29). The women were not making any conscious effort to increase physical activity or take up regular exercise. It is possible that a similar situation exists among men in these segments of population. A small but persistent positive energy balance accounts for the slow but steady weight gain in adults among affluent segments of the population.

TABLE 29
Energy intake and expenditure in affluent urban housewives

Group	Weight (kg)	BMI (kg/m2)	% body fat	Total daily energy intake (kcal/day)	Total daily energy expenditure (kcal/day)	Energy balance (kcal)	Measured RMR (kcal/day)	PAR_{RMR} (TDEE/ measured RMR)
D3 (30–39 yrs) [n = 22]	59	24.8	32.8	2 134	2 056 ± 238.7 (1 724.5 - 2 665.5)	+ 78	1 562 ± 260 (1 166 - 2 059)	1.33 ± 0.14 (1.12 - 1.59)
D4 (40–49 yrs) [n = 20]	64	26.4	36.5	2 264	2 191 ± 306.6 (1 785.4 - 2 817.3)	+ 73	1 779 ± 273 (1 267 - 2 304)	1.24 ± 0.10 (1.10 - 1.49)
D5 (50–59 yrs) [n = 20]	69	28.6	40.3	2 195	2 146 ± 173.1 (1 849.4 - 2 494.0)	+ 49	1752 ± 274 (1224 - 2203)	1.24 ± 0.12 (1.06 - 1.51)

Source: Wasuja and Siddhu, 2003.

During the last three decades, there have been a progressive decline in the poverty ratio and a steep increase in per capita income. Economic improvement inevitably results in improved purchasing power, including the ability to purchase and consume higher-value food items. This, in turn, can lead to some increase in the energy intake from fats, sugar and refined carbohydrates, and reductions in the energy intake from complex carbohydrates and in dietary fibre. Simultaneously, there has also been a reduction in physical activity and perhaps an increase in work-related stress because of changes in occupation. This combination of factors might be responsible for some of the rapid increase in overnutrition and hypertension in segments of the population that are emerging from poverty. It would also apply to rural migrants who settle in urban areas.

It is well documented that Indians have higher body fat per BMI compared with Caucasians. Prevalence of abdominal obesity is higher in India. Both overnutrition and abdominal obesity are associated with increased risks of hypertension, diabetes and CVD.

It is however important to remember that the seeds of obesity in adult life are often sown decades earlier. The thrifty gene hypothesis proposes that populations who have faced energy scarcity over millennia may have evolved so that the majority have the thrifty gene, which conserves energy. If energy intake of people with this gene obtain adequate or excess energy intake, they lay down fat, develop abdominal obesity and insulin resistance – which may progress to diabetes – and incur risk of hypertension and CVD. Barker's thrifty phenotype

hypothesis puts the evolution of thriftiness into the intrauterine period; Indians with one-third low birth weight rate can be deemed to have acquired the risk of this metabolic syndrome before birth.

Yagnik and colleagues in Pune explored the relationship between low birth weight and glucose and insulin metabolism using the oral glucose tolerance test on 477 children born in KEM hospital, Pune (Yagnik, 1998). They found that Indian newborns weighed less because they had low muscle mass and small abdominal viscera. However, they also conserved their subcutaneous fat. At four years of age, plasma glucose and insulin concentrations 30 minutes after glucose administration were inversely related to birth weight (Table 30), and directly related to current weight and skin fold thickness. The relationship between glucose/insulin and birth weight was independent of current weight. Thus, poor intrauterine growth with relatively excess growth later was associated with metabolic endocrine abnormalities, which could lead to diabetes in adult life. Adolescent obesity is well-documented in both urban and rural areas and may be the stepping-stone to adult obesity.

TABLE 30
Birth weight, plasma glucose and insulin concentrations in four-year-old urban children

Birth weight (kg)	Number	Plasma glucose (mmol/l) at 30 min	Plasma insulin (pmol/l) at 30 min
=< 2.4	36	8.1	321
-2.6	36	8.3	337
-2.8	44	7.8	309
-3.0	42	7.9	298
=>3.0	43	7.5	289
All	201	7.9	310
P for trend		0.01	0.04

Source: Yagnik, 1998.

In a study in urban Delhi, Bhargava and colleagues found that low- and middle-income adults who were undernourished in infancy, childhood and adolescence were prone to develop overweight, abdominal obesity, hypertension and diabetes by the time they were 30 years of age (Bhargava *et al.,* 2004) (Tables 31 and 32).

TABLE 31
Trends in nutritional status of the Delhi cohort

	Male		Female	
Age	Number	Weight (kg)	Number	Weight (kg)
At birth	803	2.89 ± 0.44	561	2.79 ± 0.38
2 yrs	834	10.3 ± 1.3	609	9.8 ± 1.2
12 yrs	867	30.9 ± 5.9	625	32.2 ± 6.7
30 yrs	886	71.8 ± 14.0	640	59.2 ± 13.4

Source: Bhargava *et al*., 2004.

TABLE 32
Current status of the Delhi cohort

Characteristic	Men		Women	
	Number	Value	Number	Value
Weight (kg)	886	71.8 ± 14.0	640	59.2 ± 13.4
Height (m)	886	1.70 ± 0.06	638	1.55 ± 0.06
BMI	886	24.9 ± 4.3	638	24.6 ± 5.1
Waist: hip ratio	886	0.92 ± 0.06	639	0.82 ± 0.07
BMI >= 25	886	47.4	638	45.5
BMI >= 23	886	66.0	638	61.8
Central obesity (%)	886	65.5	639	31
IGT test	849	16	539	14

Source: Bhargava *et al*., 2004.

The lesson to be learned from these data is that it is never too early for Indians to start practising healthy lifestyle and dietary habits. Early detection and correction of undernutrition, until children attain appropriate weight-for-height is essential to promote linear growth. Adolescents and adults should ensure a balanced diet with no more than adequate energy intake. Exercise has to become part of the daily routine in order to promote muscle and bone health, as well as to prevent the development of adiposity in all age groups.

LINKAGES BETWEEN OVERNUTRITION AND NCDS

Overnutrition and diabetes

Studies from Chennai (Ramachandran, 2005) show that increasing BMI brings an increased risk of diabetes in both men and women, and a steep increase when BMI rises beyond 23 (Figure 62). There is a progressive increase in prevalence of diabetes with increasing waist-to-hip ratio (WHR) in both men and women (Figure 63). Indians have higher body fat per BMI than Caucasians (Figure 64). The associations between abdominal obesity and the metabolic syndrome of hypertension, dyslipedaemia, insulin resistance and diabetes have been well documented. Comparison of the insulin resistance and insulin response of Indians and United Kingdom citizens showed that both fasting and two-hour insulin levels are lower in Indians in rural areas and in Caucasians in the United Kingdom; urban Indians and Indians residing in the United Kingdom have substantially higher fasting and two-hour insulin levels, indicating insulin resistance (Figure 65). Data from the affluent urban population show that the prevalence of insulin resistance is high in children and young adults, as well as adults (Yagnik, 1998).

FIGURE 62
Risk for diabetes associated with increasing BMI

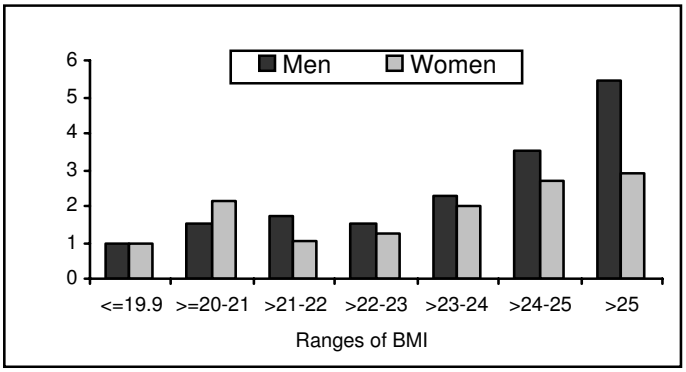
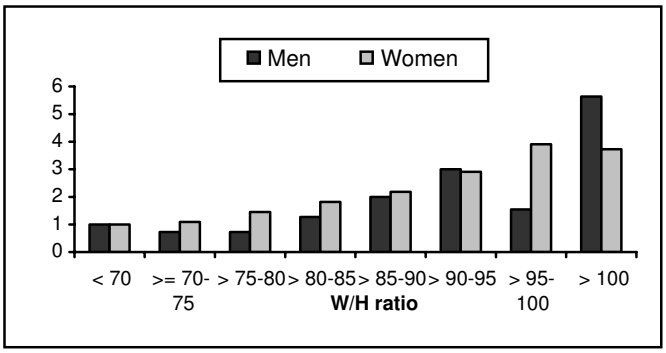
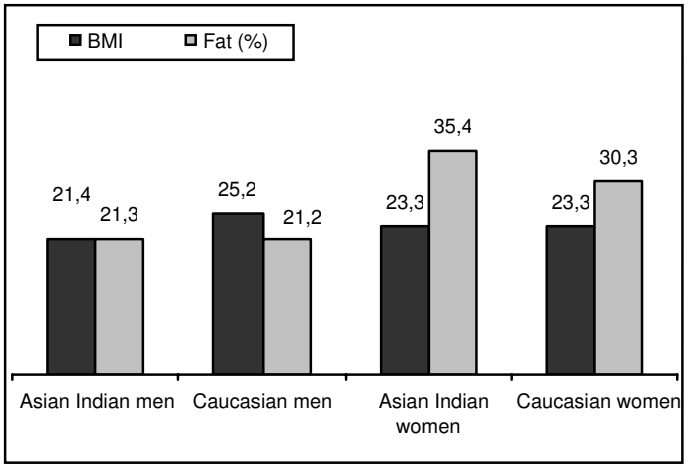


FIGURE 63
Diabetes and WHRs



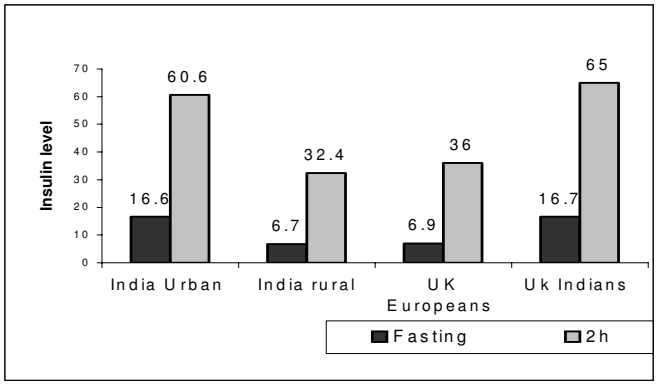
Source: Ramachandran, 2005.

FIGURE 64
Comparison of body fat (percentage) and BMI in Indians and Caucasians



Source: Ramachandran, 2005.

FIGURE 65
Insulin resistance/serum insulin responses in Indians and Caucasians

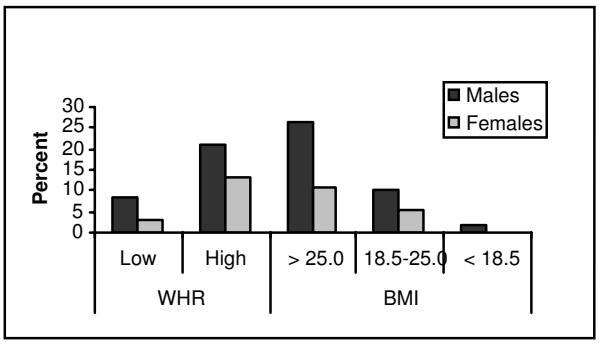


Source: Ramachandran, 2005.

Overnutrition and hypertension

NFI carried out studies to explore the relationships between overnutrition and hypertension in people from different income groups working at a government institution (NFI, 2004). A larger proportion of subjects had high WHR (50.3 percent) than BMI > 25 (30.8 percent). The higher the BMI and WHR, the higher were the prevalence rates of hypertension in both men and women (Figure 66). The prevalence of high blood pressure in the normal and overweight subjects was higher when WHR was high.

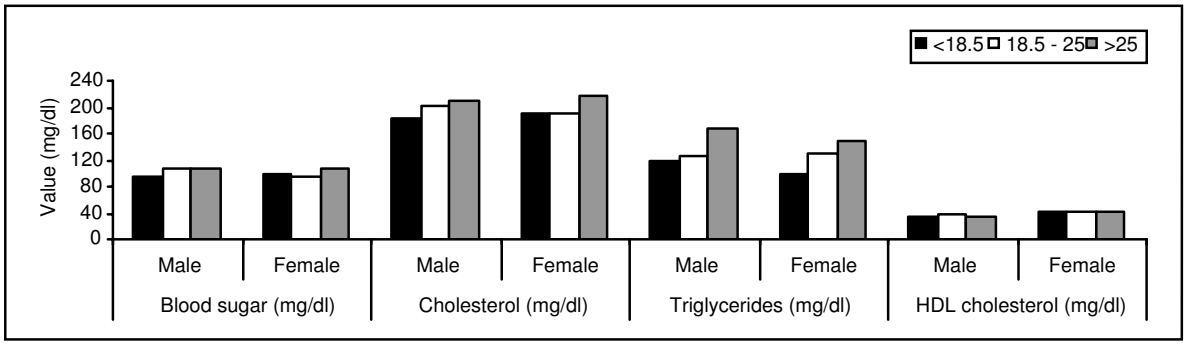
FIGURE 66
Prevalence of high blood pressure by income group and BMI



Source: NFI, 2004.

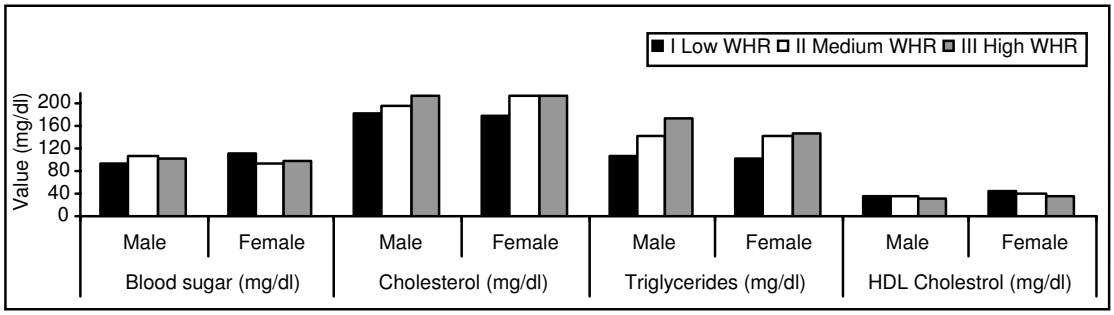
Serum cholesterol and triglycerides in men were significantly higher in subjects with BMI > 25, and increased significantly with increasing BMI and WHR in both men and women (Figures 67 and 68). Most cholesterol levels greater than 180 mg percent and most blood sugar levels of 140 mg percent were seen in subjects with high BMI and WHR.

FIGURE 67
Effect of BMI on biochemical parameters



Source: NFI, 2004.

FIGURE 68
Effect of WHR on biochemical parameters



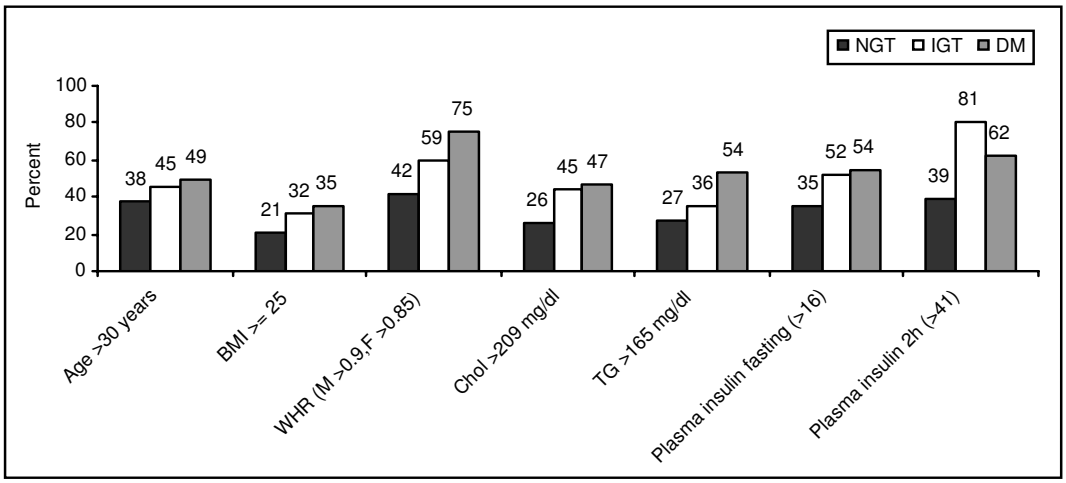
Source: NFI, 2004. WHR I Males < 0.93, Females < 0.81; WHR II Males 0.93-1.00, Females 0.81-0.89; WHR III Males >1.00, Females >0.89.

Linkages between obesity and diabetes and CVD

The susceptibility of urban Indians to central adiposity has been highlighted in all studies. All studies in India show that central obesity is more strongly associated with glucose intolerance than generalized obesity is. A cluster of risk factors have been demonstrated to be associated with central obesity. These include glucose intolerance, general obesity, hyperinsulinaemia, hypertriglyceridaemia and hypertension, all of which are important risk factors for IHD. Recent studies comparing body fat topography in migrant Asians with that of Caucasians have also reported a higher WHR, with hyperglycaemia, elevated plasma insulin concentrations, altered blood lipids and increased risk of coronary heart disease in Indians.

Indians are at higher risk of metabolic syndrome, with type-2, diabetes, dyslipedaemia, hypertension and CVD (Ramachandran, Snehlata and Vijay, 2004). Data from Chennai provide information on glucose tolerance and different CVD risk factors (Figure 69). These data indicate that the risk of glucose intolerance and diabetes increases with age, BMI, WHR, blood cholesterol (> 209 mg/dl) and triglyceride level (> 165 mg/dl). Cardiovascular risk is lowest in people with normal glucose tolerance and highest in those with diabetes.

FIGURE 69
Glucose intolerance and CVD risk factors



Source: Ramachandran *et al.*, 2004.

Comparison of newly diagnosed non-insulin-dependent diabetes mellitus patients at KEM hospital, Pune with migrant Indian and Caucasian patients in the United Kingdom showed the following:

- Diabetic patients in India are about a decade younger at diagnosis (20 percent are under 35 and 50 percent under 40 years of age).
- Obesity (using BMI as the criterion) is less common, but central obesity (increased WHR) is a very striking feature in Indian patients. The highest glucose concentrations were found in subjects who were generally thin but centrally obese.
- Hypercholesterolaemia is uncommon (5 percent), but plasma triglycerides and non-esterified fatty acids are significantly elevated in Indian patients with IGT or diabetes compared with those who have normal glucose tolerance (NGT).
- Both IGT and diabetic patients show higher fasting hyperinsulinaemia than NGT subjects do, but post-glucose plasma immunoreactive insulin (IRI) concentrations are diminished in diabetic patients. Plasma IRI concentrations show an inverted U-shaped distribution in relation to plasma glucose concentration, suggesting that insulin resistance and compensatory hyperinsulinaemia precede diabetes. Even NGT Indians are substantially more hyperinsulinaemic and insulin-resistant than Caucasians.

In Indians the cardiovascular risk factors (obesity, central obesity, hypertension, high plasma triglycerides and elevated non-esterified fatty acids) are increased in diabetic patients and also in those with IGT, a condition that precedes diabetes by many years. Electrocardiographic changes suggestive of IHD were associated with older age, higher blood pressure, higher plasma triglycerides and immunoreactive insulin concentrations. Cardiovascular risk factors were all related to plasma insulin levels and seem to occur as part of the complex metabolic profile called the insulin resistance syndrome, the metabolic syndrome or Syndrome X.

NATIONAL NUTRITION POLICY AND PLAN OF ACTION: THE RESPONSE TO NUTRITION TRANSITION

In 1950, India faced two major nutritional problems. One was the threat of famine and the resultant acute starvation caused by low agricultural production and the lack of an appropriate food distribution system. The other was chronic energy deficiency caused by:

- low dietary intake because of poverty and low purchasing power;
- high prevalence of infection because of poor access to safe drinking-water, sanitation and health care;
- poor utilization of available facilities because of low literacy and lack of awareness.

The country adopted a multisectoral, multipronged strategy to combat these problems and improve the nutritional status of the population (Box 5). Successive five-year plans laid down the policies and strategies for achieving these goals.

Box 5. Initiatives to improve the nutritional status of the population, 1950 to 1990

- Increasing food production: building buffer stocks.
- Improving food distribution: building up the public distribution system (PDS).
- Improving household food security through:
  - improving purchasing power;
  - food-for-work programmes;
  - direct or indirect food subsidies.
- Food supplementation to address the special needs of vulnerable groups, the Integrated Child Development Services (ICDS) and midday meals.
- Nutrition education, especially through the Food and Nutrition Board (FNB) and ICDS.
- Efforts of the health sector to tackle:
  - adverse health consequences of undernutrition;
  - adverse effects of infection and unwanted fertility on nutritional status;
  - micronutrient deficiencies and their health consequences.

Source: Planning Commission, 2002.

Progress achieved in seven five-year plans was reviewed in 1991/1992. It was obvious that the threat of famine has disappeared and there has been a significant decline in severe forms of undernutrition. However, mild and moderate undernutrition and micronutrient deficiencies were widespread. India prepared and adopted the National Nutrition Policy in 1993 (DWCD, 1993). This policy advocated a comprehensive intersectoral strategy involving 14 sectors (which directly or indirectly affect the dietary intake and nutritional status of the population) in combating the multifaceted problem of undernutrition and improving the nutritional status of all sections of society. The policy sought to strike a balance between short-term direct nutrition interventions and long-term institutional/structural changes to create an enabling environment and the necessary conditions for improving nutritional and health status. It also set goals to be achieved in each sector by 2000. A National Plan of Action (DWDC, 1995) was drawn up and approved in 1995. In order to achieve intersectoral coordination at the highest level, a National Nutrition Council was formed with the Prime Minister as chairperson and the Planning Commission as the Secretariat. The council was to act as the national forum for policy and strategy formulation, review performance and suggest mid-course corrections. A similar set-up was envisaged for the state level. An interdepartmental coordination committee under the Department of Women and Child Development (DWCD) was to coordinate and review the implementation of nutrition programmes.

Review of the situation in 2000/2001 prior to formulation of the Tenth Five-Year Plan (Planning Commission, 2002) showed that although undernutrition and micronutrient deficiencies continue to be major public health problems, overnutrition and obesity are also emerging as a major problem in many states. In response to this, the Tenth Five-Year Plan envisaged a paradigm shift:

- from household food security and freedom from hunger to nutrition security for the family and the individual;
- from untargeted food supplementation to screening of all the people in vulnerable groups, identification of those with various grades of undernutrition and appropriate management;
- from ad hoc unfocused interventions addressing the prevention of overnutrition to the promotion of appropriate lifestyles and dietary intakes for the prevention and management of overnutrition and obesity.

The plan gave high priority to the effective implementation of focused and comprehensive interventions aimed at improving the nutritional and health status of individuals. It was emphasized that the increased outlays to combat the dual nutrition burden should result in improved outcomes and outputs in terms of reducing both under- and overnutrition. In view of the massive interstate differences, the Tenth Five-Year Plan laid down state-specific goals based on the current nutritional status and investment provided for the sector in the state plan. The national goals conform to the Millennium Development Goals and, although ambitious, may be achievable through improved coverage, quality and content of nutrition-related services.

SUMMARY AND CONCLUSIONS

Data suggest that there has not been much change in the predominantly cereal-based dietary intake in India over the last three decades, except among affluent segments of the population. In spite of increasing per capita income and reduced poverty, dietary diversity is seen mainly among the affluent. Undernutrition rates remain high; starting before birth, they are aggravated throughout infancy by poor infant feeding practices and perpetuated in childhood by poor intra-family distribution of food and poor access to health care. There has been a substantial reduction in severe undernutrition, most of which is due to improved access to health care. India can achieve substantial improvement in nutritional status through health and nutrition education and improved access to health and nutrition services.

Prevention of intrauterine growth retardation through antenatal care, and early detection and correction of undernutrition so that children attain appropriate weight for height are essential to promoting linear growth; they can be achieved through the effective implementation of ongoing intervention programmes utilizing the available infrastructure.

Low intakes of vegetables and fruit, poor bioavailability of iron and limited use of iodized salt are responsible for micronutrient deficiencies' being major public health problems even today. Dietary diversification, better coverage under the national anaemia control programme, massive-dose vitamin A administration and universal access to iodized, and later iron and iodine-fortified, salt are some of the interventions that could help the country to achieve rapid reductions in micronutrient deficiencies.

Over the last decade, there has been a progressive increase in overnutrition. Reduced physical activity is the major factor behind this. In affluent urban segments, increased energy intake from fats, refined cereals and sugar, combined with simultaneous reductions in physical activity have contributed to steep increases in overnutrition in all age groups. Nutrition education on healthy dietary patterns containing plenty of fruit and vegetables, maintenance of energy balance through regulation of dietary intake, and increasing energy expenditure through physical activity as part of the daily routine will promote muscle and bone health and prevent the development of adiposity in all age groups. Such information can be passed on to large segments of the urban upper- and middle-income groups through the media (television, Internet) that this segment has access to.

Indians appear to have a predisposition for adiposity – especially abdominal – insulin resistance and diabetes, hyper-triglyceridaemia and CVD. This predisposition could be genetic or environmental, and can manifest itself at birth, in childhood, during adolescence and in adult life. It is never too early for Indians to start practising healthy lifestyle and dietary habits.

It therefore seems that India could combat the dual nutrition burden through efficient implementation of time-tested, effective and inexpensive interventions to achieve significant reductions in both over- and undernutrition and their adverse health consequences within the next two decades.

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Food consumption, food expenditure, anthropometric status and nutrition-related diseases in Mexico

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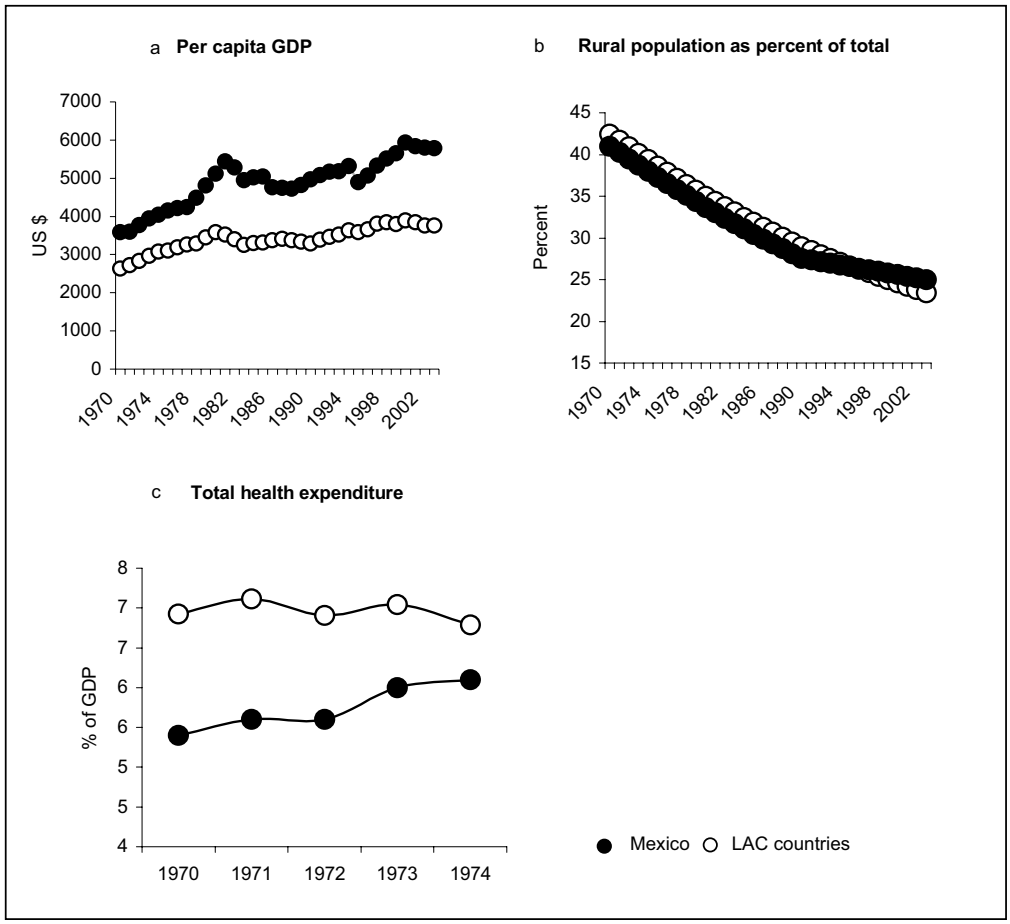
INTRODUCTION

Mexico, as are other Latin American countries, is experiencing an epidemiological and nutrition transition characterized by a rapid rise in the prevalence of obesity and chronic diseases such as diabetes mellitus, high blood pressure and cardiovascular diseases (CVDs) (Flores *et al.,* 1998; Rivera-Dommarco *et al.,* 2001). Although the morbidity and mortality related to acute communicable diseases, such as diarrhoeas and respiratory infections, undernutrition and some micronutrient deficiencies, have shown important reductions during the last three decades, different forms of undernutrition, such as child stunting and anaemia, remain relevant public health problems.

Mexico's gross national product (GNP) per capita increased by 62 percent between 1970 and 2003. This change is greater than that observed for the Latin America and the Caribbean (LAC) region as a whole (43 percent) (Figure 1a). Currently, 75 percent of the population live in urban locations. The percentage of population living in rural locations decreased by 39 percent in the 1970 to 2003 period (Figure 1b). During recent decades, health status has been affected by environmental and economic conditions. Child mortality has decreased by 74.5 percent in 33 years, which is similar to the LAC regional average (Figure 1c) but three times greater than the rate observed for other Organisation for Economic Co-operation and Development (OECD) countries during the same period. In Mexico, health expenditure as a percentage of GNP was lower than the average for Latin American countries during the 1998 to 2002 period.

Currently, Mexico has more than 100 million inhabitants. As one of the world's mega-countries, implementation of social policies is complex, and the expected impact difficult to measure (Barquera, Rivera-Dommarco and Gasca-Garcia, 2001). Although Mexico has been developing food and nutrition programmes since the early twentieth century and has devoted more resources to these programmes than any other Latin American country (Rivera-Dommarco *et al.,* 2001; Rivera *et al.,* 2004b), until recently social policies were not evaluated (Barquera, Rivera-Dommarco and Gasca-Garcia, 2001; Ministry of Social Development, 2000). Food and nutrition programmes in the last eight years have improved their targeting and have incorporated objectives related to improving nutritional status and education. It is expected that these improved programmes will have positive impacts on nutrition and health. Conversely, consumer access to industrialized foods has increased in recent years owing to technological developments and economic growth.

FIGURE 1
Development indicators in Mexico, Latin America and the Caribbean



Mexico is also characterized by major epidemiological differences across country regions, urban/rural residence and socio-economic status. Imbedded in these differences is the *polarization* of the transition, which means that different subpopulations within the country are undergoing different stages of transition. In Mexico, polarization has been described across four regions (Bobadilla *et al.,* 1993; Hernandez-Diaz *et al.,* 1999; Rivera-Dommarco *et al.,* 2001). The *North region* is the most industrialized. It has a higher per capita income and infrastructure level than the rest of the country, close cultural and economic relations with the border states of the United States and adequate access to basic and health services. The *Central region* is less developed than the North, but still contains large developed cities such as Guadalajara and many rural towns that live from agriculture. *Mexico City* is the third most populated city in the world. It has a very developed economy and access to food and basic services, combined with high immigration from the south and poverty pockets. It also receives several subsidies and social programmes targeting the poor. The *South region* is considered the least developed. It has the largest rural and indigenous population in the country, and access to certain basic services and subsidies is limited; in this region health problems such as infectious diseases and undernutrition still represent a relevant public health concern. While the health sector in all of these regions is still facing the challenge of preventing and treating acute diseases (Frenk *et al.,* 1991),

non-communicable chronic diseases such as diabetes and hypertension are rapidly increasing.

In order to address this complex situation, it will be important to understand how nutrition and related health conditions have evolved together over the last decades in the context of social, economic and market changes. The following subsections document the main characteristics of the epidemiologic and nutrition transition in Mexico, including nutrient intake, trends in food expenditure, nutritional status, prevalence of obesity and chronic diseases and mortality trends, with emphasis on polarization among the different regions of the country, between urban and rural populations and among socio-economic groups. The information is used to discuss the double burden of disease and the role of current and future national programmes in addressing emerging health challenges.

METHODS

The analysis in this case study is based on diverse nationwide databases generated from surveys collected mostly by the National Institute of Public Health and from other cross-sectional surveys and registries collected by diverse governmental agencies (Table 1). Variables and measurements were stratified by region, urban/rural residence and socio-economic status, when possible. The case study team also analysed trends over time for variables such as nutrient intake in women, household food expenditure, prevalence of chronic diseases and mortality.

TABLE 1
Socio-demographic and health surveys used in this report

Survey name and year	Agency	Description
Mexican Nutrition Survey I (MNS–1), 1988	Ministry of Health	Women 12 to 45 years and children < 5 years Representative of the country, four regions and urban/rural locations n = 7 426 children, and 9 449 women
Mexican Nutrition Survey 2 (MNS–2), 1999	National Institute of Public Health	Children < 12 years, and women 12 to 45 years Representative of the country, four regions and urban/rural locations n = 3 521 children, and 2 596 women
Mexican Chronic Diseases Survey (MCDS), 1994	Ministry of Health	Adults 20 to 69 years Representative of urban locations of the country and four regions n = 2 125
Mexican Health Survey (MHS), 2000	National Institute of Public Health	Adults > 19 years Representative of the country, states, regions and urban/rural locations n = 45 294
Mexican Household Income and Expenditure Surveys (MHIES), 1989 to 2002	National Institute of Informatics, Statistics and Geography (INEGI)	Representative of the country, states, regions and urban/rural locations n = 11 531 in 1989, 10 508 in 1992, 12 815 in 1994, 14 042 in 1996, 10 952 in 1998, 10 089 in 2000, 17 167 in 2002
National Mortality Register, 1980 to 2000	INEGI	All reported mortality from 1980 to 2000

Country regions

The country was divided into four regions with common geographic and socio-economic characteristics: 1) North region, which comprises Baja California, Southern Baja California, Coahuila, Durango, Nuevo Leon, Sonora, Sinaloa, Tamaulipas and Zacatecas; 2) Central region, which comprises Aguascalientes, Colima, Guanajuato, Hidalgo, Jalisco, Mexico, Michoacan, Nayarit, Querétaro, San Luis Potosí and Tlaxcala; 3) Mexico City; and 4) South region, which comprises Campeche, Chiapas, Guerrero, Morelos, Oaxaca, Puebla, Quintana Roo, Tabasco, Veracruz and Yucatan. This regionalization scheme was used in epidemiologic transition analysis for intra-country comparisons (Hernandez-Diaz *et al.,* 1999; Rivera *et al.,* 2002; Sepulveda-Amor *et al.,* 1990).

Place of residence

In addition, subjects were classified as urban or rural according to the population size of their place of residence. For variables obtained from the Mexican Nutrition Survey (MNS), these classifications were ≥ 2 500 inhabitants for urban areas and < 2 500 inhabitants for rural ones, while for variables obtained from the Mexican Health Survey (MHS) and the Mexican Household Income and Expenditure Survey (MHIES) the corresponding figures were ≥ 15 000 inhabitants and < 15 000 inhabitants.

Socio-economic status index

MNS–1 (1988) and MNS–2 (1999) obtained socio-economic information such as household conditions, basic services infrastructure (i.e., water source and disposal) and possession of domestic appliances (i.e., radio, television and refrigerator). A principal components factor analysis was carried out using this information to extract a main factor that explained more than 50 percent of the socio-economic information variability (Flores *et al.,* 1998; Long-Dunlap *et al*. 1995). This factor was divided into quintiles and used as a relative measure of socio-economic status.

Nutrient and dietary information

Nutrient intake information for Mexico was obtained from MNS–1 and MNS–2, which are two nationwide representative surveys with sufficient sampling power to allow data to be disaggregated by region and urban/rural location. Detailed descriptions of the survey sampling procedures and methods have been published elsewhere (Resano-Perez *et al.,* 2003; Rivera-Dommarco *et al.,* 2001; Sepulveda-Amor *et al.,* 1990). Food and nutrient intake information was available for females aged 12 to 49 years and for children aged one to 11 years in 1999. These surveys also had anthropometric information for women aged 12 to 49 years and for children under five years of age.

A 24-hour dietary recall (24HDR) was administered to obtain dietary information for randomly selected sub-samples of 9 449 (MNS–2) and 2 596 (MNS–1) women. Trained and standardized personnel applied the questionnaires and converted consumption into grams or millilitres of food items. For MNS–2, aberrant food consumption was reviewed by hand and updated when a clear mistake was detected, or eliminated if the value was not biologically plausible. Complete food intake data were not available from MNS–1, but a database with estimated nutrient intake generated from 24HDR was obtained and used for the analysis. Nutrient intakes were then estimated for foods, using a comprehensive nutrient composition database compiled from several sources (Muñoz *et al.,* 1996; Souci, Fachmann and Kraut, 2000; USDA/ARS, 1999; Wuleung and Flores, 1962). Nutrient adequacies were calculated relative to the dietary reference intakes (Institute of Medicine, 2000a; 2000b; 2001; 2002; National Research Council, 1989); the estimated average

requirement was used for protein, vitamins A and B12, folic acid, iron and zinc; the adequate intake was used for calcium and vitamin D; and the estimated energy requirement was used for energy. A cut-off of 30 percent of total energy intake was considered fat adequacy. Requirements were adjusted for pregnant and lactating women. To estimate intake by food groups, grams consumed were aggregated into selected groups and reported as mean consumption, stratified by region, location and socio-economic index tertile.

Estimation of household adult equivalent

To estimate household food expenditure using MHIES, the individual adult equivalent (AE) was obtained by dividing the recommended dietary allowance (RDA) for energy of each household member – according to age and sex – by the energy RDA for an average adult. The sum of all of the individual AEs within a household was then computed to obtain the number of household AEs. Family members not currently living in the house were excluded from this estimation, but their income contribution was included in the total household income.

Quantity of food purchased per AE

Household food quantities purchased per AE were used as a proxy for food intake. Data from seven MHIES conducted between 1989 and 2002 were used. These surveys were collected by the National Institute of Geography, Informatics and Statistics. They contain nationally representative information on approximately 15 000 households and their members. Information was available for 1989, 1992, 1994, 1996, 1998, 2000 and 2002. A questionnaire based on a seven-day diary record of house purchases and containing about 215 foods was included in each MHIES, with slight variations in some years. A database with the quantities of each food purchased per household was developed. All foods were converted into grams, and food group quantities were estimated for cereals, meats, eggs, milk and dairy products, legumes, fats and oils, vegetables, fruits, and sugars. In addition, soda, alcohol and tobacco were converted into millilitres and grams and included in the final tables. From this database, the following indicators were obtained: 1) percentage of families purchasing each food group during the seven-day survey period; 2) percentage of total food expenditure allocated to each food group; 3) mean g/day per AE in families reporting expenditure on that item; and 4) per capita mean g/day per AE. The data were stratified by region, urban/rural residence and income quintile (only the extreme income quintiles are presented in this case study).

Percentage of food expenditure outside the home

In addition to food expenditure at home, MHIES also reported expenditure on food outside the home. It was therefore possible to calculate food expenditure outside the home as a percentage of total food expenditure per AE. This expenditure was not disaggregated according to food item.

Breastfeeding characteristics in Mexico

The information on breastfeeding practices in Mexico in this case study is based on a previous analysis of MNS–2 (González-Cossío *et al.,* 2003).

Children's nutritional status

Nutritional status derived from anthropometric indicators was available for children under five years of age from MNS–1 and MNS–2. In addition, MNS–2 collected information for children of five to 12 years of age. Using weight, height (or length) and age, the case study

team calculated height-for-age, weight-for-height and weight-for-age Z-scores relative to the National Center for Health Statistics/World Health Organization (NCHS/WHO) reference population (HAZ, WAZ and WHZ, respectively) (WHO, 1983; 1995). Underweight was defined as WAZ < -2, stunting as HAZ < -2, wasting as WHZ < -2 and overweight as WAZ > +2. For school-age children, MNS–2 used two different criteria of classification for overweight (Cole *et al.,* 2000; Must, Dallal and Dietz, 1999).

Adult nutritional status and chronic disease prevalence

Adult nutritional status and prevalence rates of chronic diseases were obtained from two representative national surveys: the Mexican Chronic Diseases Survey (MCDS, 1994) and MHS (2000) (Olaiz, Rojas and Barquera, 2003). MCDS was implemented in four urban areas of Mexico and is representative of the country's urban locations. MHS was implemented in urban and rural locations with sample power to be representative of each state. In this survey, the rural population was defined as those living in locations with < 15 000 inhabitants. Prevalence rates of low weight (body mass index [BMI] < 18.5 kg/m^2), normal weight (BMI 18.5 to 24.9 kg/m^2), overweight (BMI > 25 kg/m^2) and obesity (BMI > 30 kg/m^2) were calculated. Diabetes mellitus was defined as a fasting glucose concentration of ≥ 126 mg/dl, or a non-fasting concentration of > 200 mg/dl, and/or a previous medical diagnosis of diabetes (Expert Committee on the Diagnosis and Classification of Diabetes Mellitus, 2005; WHO, 1994). Hypertension was defined as systolic pressure ≥ 140 mm/Hg and/or diastolic pressure ≥ 90 mm/Hg for people under 60 years of age. For those aged 60 years and over, hypertension was defined as systolic pressure ≥ 160 mm/Hg and/or diastolic pressure ≥ 90 mm/Hg. Hypercholesterolaemia was defined as fasting blood cholesterol concentrations of ≥ 200 mg/dl, and hypertriglyceridaemia as fasting triglyceride concentrations of ≥ 150 mg/dl (Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults, 2001).

Trends in communicable and non-communicable disease mortality

The mortality indicators for the years 1950 to 2000 were obtained from estimations made by the Ministry of Health for the national health programme (Ministry of Health, 2001). Mortality rates for intestinal infectious diseases, acute respiratory diseases and undernutrition in children aged one to nine years, and ischaemic heart disease (IHD) and diabetes mellitus in adults aged 20 to 74 years were obtained from the National Institute of Informatics, Statistics and Geography (INEGI) using the International Classification of Diseases version 9 (ICD-9) for the years 1979 to 1995 (WHO/PAHO, 1978) and version 10 (ICD-10) for 2000 and 2002 (WHO, 1992).

TABLE 2
Women's energy and nutrient intakes and percentage adequacies by region and location, 1988 and 1999

Intake	Region										Location			
	National		North[a]		Central[b]		Mexico City[c]		South[d]		Urban[º]		Rural	
	Median	Adequacy (%)	Median	Adequacy (%)	Median	Adequacy (%)	Median	Adequacy (%)	Median	Adequacy (%)	Median	Adequacy (%)	Median	Adequacy (%)
							1988							
n	9 449		2 655		2 102		2 279		2 409		8 007		1 442	
Energy (kcal)	1 624	80.9	1 624	79.3	1 620	81.1	1 590	79.3	1 670	84.1	1 624	80.6	1 625	81.7
12 to 19 years	1 595	82.7	1 618	81.0	1 568	82.0	1 584	84.0	1 633	85.9	1 603	83.1	1 544	81.7
20 to 29 years	1 646	79.3	1 604	75.9	1 678	81.4	1 598	77.6	1 671	80.9	1 646	79.3	1 654	79.0
30 to 39 years	1 657	81.5	1 681	80.0	1 635	82.0	1 575	77.7	1 709	84.7	1 638	80.4	1 710	84.8
40 to 49 years	1 576	81.4	1 606	81.3	1 467	77.0	1 602	81.2	1 620	84.6	1 580	81.5	1 525	81.2
Fat (g)	44.8	66.6	45.3	66.5	44.5	66.2	46.2	68.4	43.5	65.9	45.6	67.8	40.6	61.3
Protein (g)	58.5	138.5	57.9	126.1	57.0	136.6	62.3	142.9	57.7	144.3	59.8	139.9	54.3	131.5
Vitamin A (mcg ER)	123.3	23.8	151.8	29.8	114.1	22.5	163.3	31.8	91.8	17.5	134.5	25.8	81.7	15.9
Vitamin B12 (mcg)	1.6	79.5	1.8	86.5	1.6	80.0	1.9	96.5	1.3	60.0	1.7	83.0	1.3	63.0
Vitamin D (mcg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
							1999							
n	2 596		776		738		283		799		1 687		909	
Energy (kcal)	1 471	70.7	1 402[bcd]	64.2[bcd]	1 500[acd]	72.0[acd]	1 362[abd]	65.7[abd]	1 560[abc]	77.3[abc]	1 465º	69.8º	1 492	74.7
12 to 19 years	1 591	82.9	1 499	69.8	1 591	83.6	1 777	89.6	1 616	86.4	1 614	85.0	1 563	81.3
20 to 29 years	1 488	70.6	1 467	64.2	1 520	71.6	1 279	60.5	1 696	81.9	1 475	69.7	1 560	75.4
30 to 39 years	1 436	68.8	1 347	60.0	1 492	70.1	1 377	69.8	1 455	73.6	1 436	68.0	1 421	72.5
40 to 49 years	1 338	65.0	1 225	55.7	1 337	61.4	1 191	57.8	1 442	73.6	1 338	61.6	1 324	70.7
Fat (g)	48.6	69.9	50.9[bcd]	69.4[bcd]	51.9[acd]	72.9[acd]	49.8[abd]	72.4[abd]	45.3[abc]	66.4[abc]	52.0º	73.2º	37.4	56.3
Protein (g)	47.2	111.6	46.0[bcd]	99.4[bcd]	48.1[acd]	113.3[acd]	46.3[abd]	110.0[abd]	48.8[abc]	121.3[abc]	48.4º	111.3º	45.4	113.2
Vitamin A (mcg ER)	360.3	68.7	326.6[cd]	61.4[bcd]	343.0[cd]	64.9[acd]	468.8[abd]	92.7[abd]	341.8[abc]	62.9[abc]	403.0º	76.7º	244.3	47.2
Vitamin B12	1.6	84.6	1.7[bcd]	86.8[bcd]	1.7[acd]	86.7[acd]	2.0[abd]	100.2[abd]	1.3[abc]	66.4[abc]	1.9º	95.5º	0.8	38.4
Vitamin D (mcg)	3.6	71.2	7.2[bcd]	143.4[bcd]	1.3[acd]	25.0[acd]	5.6[abd]	112.5[abd]	3.5[abc]	70.0[abc]	4.3º	85.8º	<1.0	<1.0

[a, b, c, d] Different superindices represent statistically significant differences among regions. º Statistically different from rural locations.
Sources: MNS–1, 1988; MNS–2, 1999.

TABLE 3
Women's energy and nutrient intakes and percentage adequacy, by socio-economic status and education, 1988 and 1999

Intake	Socio-economic status						Education			
	Low[a]		Medium[b]		High[c]		Primary school and less▲		Middle and higher	
	Median	Adequacy (%)	Median	Adequacy (%)	Median	Adequacy (%)	Median	Adequacy (%)	Median	Adequacy (%)
					1988					
N	3 254		2 638		3 153		5 179		4 230	
Energy (kcal)	1 654	82.3	1 623	81.1	1 592	79.3	1 655	82.4	1 591	79.1
12–19 years	1 585	83.4	1 600	82.6	1 595	82.5	1 623	85.5	1 568	80.6
20–29 years	1 670	78.6	1 669	81.6	1 583	77.9	1 665	79.8	1 624	78.4
30–39 years	1 734	86.2	1 596	78.6	1 605	78.9	1 699	83.3	1 598	78.7
40–49 years	1 563	83.2	1 550	81.2	1 575	79.7	1 584	82.6	1 539	79.1
Fat (g)	39.4	59.6	45.8	67.0	50.3	74.9	41.9	63.1	48.4	72.2
Protein (g)	55.3	138.5	58.9	135.6	62.0	140.1	57.6	136.1	60.0	141.3
Vitamin A (mcg ER)	82.4	15.6	129.1	24.9	169.2	33.6	93.8	18.5	158.3	31.2
Vitamin B12 (mcg)	1.2	58.0	1.6	81.5	1.9	96.5	1.4	70.0	1.8	90.0
Vitamin D (mcg)	-	-	-	-	-	-	-	-	-	-
					1999					
N	877		905		814		1 341		1 249	
Energy total (kcal)	1 455.7[bc]	74.4[bc]	1 432.6[ac]	68.4[ac]	1 510.7[ab]	70.9[ab]	1 435.9▲	70.1▲	1 505.3	71.1
12–19 years	1 528.3	77.7	1 634.7	83.6	1 776.8	88.5	1 547.8	81.8	1 683.0	85.0
20–29 years	1 528.7	76.9	1 425.7	65.5	1 556.7	71.1	1 448.1	71.2	1 517.0	70.3
30–39 years	1 401.0	72.9	1 374.9	63.5	1 494.1	70.1	1 435.9	68.8	1 433.7	68.0
40–49 years	1 288.6	65.7	1 382.7	66.0	1 365.2	61.6	1 288.6	62.9	1 437.8	69.0
Fat (g)	37.0[bc]	56.9[bc]	49.1[ac]	70.2[ac]	56.4[ab]	78.4[ab]	41.3▲	61.7▲	54.6	78.0
Protein (g)	45.0[bc]	114.5[bc]	46.5[ac]	107.3[ac]	50.3[ab]	114.1[ab]	45.5▲	107.2▲	50.2	118.4
Vitamin A (mcg ER)	237.3[bc]	45.8[bc]	315.4[ac]	60.1[ac]	493.7[ab]	95.5[ab]	254.3▲	48.6▲	468.8	87.8
Vitamin B12 (mcg)	0.7[bc]	36.4[bc]	1.6[ac]	84.6[ac]	2.2[ab]	113.2[ab]	1.2▲	60.8▲	2.0	101.9
Vitamin D (mcg)	<1.0[bc]	<1.0[bc]	4.0[ac]	80.0[ac]	5.0[ab]	99.1[ab]	0.8▲	15.3▲	5.6	112.5

Sample sizes: children < 11 years of age, 1 249; females 12 to 49 years of age – 1988, 9 449; 1999, 2 596.
[a,b,c] Different superindices represent statistically significant differences among socio-economic quintiles.
▲ Statistically different from middle and higher education.
Sources: MNS–1; MNS–2.

Macronutrient intake

The case study results show that there was an apparent decrease of 12.6 percent in total energy adequacy between 1988 and 1999. This reduction was observed across all regions and socio-economic status quintiles, and in both urban and rural locations (Table 2). Rural locations had higher adequacies than urban ones, and the South had higher adequacies than the other three regions. However, differences across regions and locations were higher in 1988 than in 1999. It should be noted that the dietary intake data of the 1988 and 1999 surveys are not directly comparable. Different food composition databases were used in the analysis of each survey. Also, the availability of food outside the home increased dramatically between 1988 and 1999, and the data indicate that in 1999 people ate away from home more often. As food consumption outside the home is often underreported, underreporting in 1999 can be expected. In addition, the case study team had clear indications of large rates of underreporting among overweight and obese women, probably resulting from a slim ideal body shape in Mexican society. According to case study

estimates, obese women were 1.51 times more likely to underreport than women within the normal range of reference body weight (95 percent confidence interval = 1.35, 1.69) (Campirano *et al.,* 2001). The prevalence of high BMI (> 25) in women increased from 35 percent in 1988 to 59 percent in 1999; therefore, greater underreporting is expected in 1999. Thus it is clear that these surveys are not directly comparable and that the 1999 survey has greater underreporting.

Despite the evidence for underreporting of energy intakes, both fat intake and fat adequacy showed increases between 1988 and 1999 in all but rural locations and populations in the lowest socio-economic status quintile (Tables 2 and 3). A similar trend was seen for the percentage of energy derived from fat, where the increase between surveys was far smaller in rural and poor populations. This increase apparently occurred at the expense of both protein and carbohydrate intakes (Table 4). Protein adequacy at the national level was above the adequacy rate, and decreased from 1988 to 1999 across all groups.

TABLE 4
Nutrient intake by age group, 1988 and 1999

Gender	Age (years)	Total dietary energy intake (kcals)		% dietary energy from fat		% dietary energy from protein		% dietary energy from carbohydrates	
		1988	1999	1988	1999	1988	1999	1988	1999
Male	0–4	-	995	-	33.4	-	13.9	-	53.2
	5–11	-	1 439	-	31.8	-	12.8	-	56.7
Female	0–4	-	912	-	33.3	-	13.7	-	52.5
	5–11	-	1 319	-	32.2	-	12.6	-	56.2
	12–19	1 595	1 591	25.1	31.4	13.9	12.5	62.5	57.4
	20–29	1 646	1 488	26.1	31.7	14.3	12.9	60.7	55.8
	30–39	1 657	1 436	26.3	31.6	14.4	13.5	60.6	55.8
	40–49	1 576	1 338	26.1	27.4	14.2	12.7	61.6	60.8
Overall	**12–49**	**1 624**	**1 471**	**25.8**	**31.3**	**14.2**	**13.0**	**61.3**	**56.9**

Sources: MNS–1, 1988; MNS–2, 1999.

Micronutrient intake

At the national level, the adequacy of intakes of vitamins A and B12 and folate increased between the 1988 and 1999 surveys (Tables 2, 3 and 5). The magnitude of the increase was substantial for both vitamin A (from 23.8 to 68.7 percent) and folate (from 18.0 to 67.0 percent). While the intake adequacy of these vitamins increased similarly across all stratification levels, the absolute adequacy of intake of vitamin A (but not folate) remained much lower in the lowest socio-economic quintile (45.5 percent) than in the highest (95.5 percent); regional differences for vitamin A adequacy were minor. The adequacy of iron intake, on the other hand, decreased by about 30 percent at the national level, and reductions were observed in all the stratification levels. Intake data for neither vitamin D nor zinc were available in MNS–1 (1988) (Tables 5 and 6). Vitamin D adequacy at the national level in MNS–2 was 71.2 percent, but there was a large discrepancy between the lowest and the highest socio-economic status tertiles. The median adequacy for zinc intake in MNS–2 was 82.8 percent, and varied little among regions and socio-economic status quintiles.

TABLE 5
Women's mineral intakes and percentage adequacy, by region and location, 1988 and 1999

Intake	National		Region								Location			
			North[a]		Central[b]		Mexico City[c]		South[d]		Urban[o]		Rural	
	Median	Adequacy (%)	Median	Adequacy (%)	Median	Adequacy (%)	Median	Adequacy (%)	Median	Adequacy (%)	Median	Adequacy (%)	Median	Adequacy (%)
							1988							
n	9 449		2 655		2 102		2 279		2 409		8 007		1 442	
Iron (mg)	11.8	144.3	10.9	131.4	12.1	148.8	11.5	141.3	12.2	151.0	11.6	141.5	12.8	157.8
Calcium (mg)	643.2	60.6	619.5	58.8	697.7	64.7	687.9	65.3	580.4	55.5	648.6	61.2	622.0	57.8
Zinc (mg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Folate (mcg)	60.9	18.0	67.7	20.3	54.6	15.8	87.2	26.1	48.6	14.6	65.4	19.4	42.6	12.7
							1999							
n	2 596		776		738		283		799		1 687		909	
Iron (mg)	8.3	101.2	8.5^{bcd}	99.2^{bcd}	8.4^{acd}	103.2^{acd}	6.8^{abd}	82.3^{abd}	9.2^{abc}	112.5^{abc}	7.9^{o}	96.8^{o}	9.4	116.1
Calcium (mg)	673.2	64.5	513.0^{bcd}	50.0^{bcd}	714.1^{acd}	68.8^{acd}	665.9^{abd}	64.9^{abd}	733.0^{abc}	69.1^{abc}	652.9^{o}	63.3^{o}	729.6	68.3
Zinc (mg)	6.0	82.8	5.7^{bcd}	77.6^{bcd}	6.0^{acd}	83.4^{acd}	5.6^{abd}	77.5^{abd}	6.3^{abc}	87.2^{abc}	6.0^{o}	83.1^{o}	6.0	82.6
Folate (mcg)	220.9	67.0	215.1^{bcd}	64.5^{bcd}	229.9^{acd}	70.4^{acd}	187.7^{abd}	58.0^{abd}	238.2^{abc}	71.4^{abc}	213.4^{o}	64.5^{o}	250.3	73.8

[a,b,c,d] Different superindices represent statistically significant differences among regions.
[o] Statistically different from rural locations.
Sources: MNS–1, 1988; MNS–2, 1999.

TABLE 6
Women's mineral intakes and percentage adequacy, by socio-economic status and education, 1988 and 1999

Intake	Socio-economic status						Education			
	Low[a]		Medium[b]		High[c]		Primary school and less[▲]		Middle and higher	
	Median	Adequacy (%)	Median	Adequacy (%)	Median	Adequacy (%)	Median	Adequacy (%)	Median	Adequacy (%)
					1988					
N	3 254		2 638		3 153		5 179		4 230	
Iron (mg)	12.8	155.4	11.8	147.3	10.8	131.1	12.6	154.7	10.9	133.2
Calcium (mg)	611.5	57.2	639.6	60.6	687.7	64.7	630.0	59.9	665.0	61.5
Zinc (mg)	-	-	-	-	-	-	-	-	-	-
Folate (mcg)	42.9	12.6	64.3	19.0	80.1	24.5	49.9	14.7	75.8	22.8
					1999					
n	877		905		814		1 341		1 249	
Iron (mg)	9.2^{bc}	109.2^{bc}	7.8^{ac}	98.7^{ac}	8.1^{ab}	96.1^{ab}	8.3$^{▲}$	101.6$^{▲}$	8.2	100.1
Calcium (mg)	726.2^{bc}	67.3^{bc}	622.0^{ac}	59.1^{ac}	679.6^{ab}	66.3^{ab}	690.5$^{▲}$	65.6$^{▲}$	659.9	63.2
Zinc (mg)	5.9^{bc}	79.2^{c}	5.7^{ac}	78.8^{c}	6.4^{ab}	87.9^{ab}	5.8$^{▲}$	79.4$^{▲}$	6.2	86.7
Folate (mcg)	229.9^{bc}	68.6^{bc}	225.0^{ac}	67.8^{ac}	206.4^{ab}	63.0^{ab}	226.3$^{▲}$	68.6$^{▲}$	215.9	64.9

[a,b,c] Different superindices represent statistically significant differences among socio-economic index tertiles.
[▲] Statistically different from middle and higher education.
Sources: MNS–1, 1988; MNS–2, 1999.

TABLE 7
Mean food intake in Mexico

	National		Location				Socio-economic index						Region							
			Urban *		Rural		Low[a]		Medium[b]		High[c]		North[d]		Central[e]		Mexico City[f]		South[g]	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	S.D
Cereals	263.9	(169.6)	236.9*	(151.3)	348.8	(194.3)	347.1^{bc}	(195.4)	249.8^{ac}	(156.9)	212.5^{ab}	(130.5)	203.7^{efg}	(138.1)	279.2^{dfg}	(159.7)	195.7^{deg}	(109.4)	324.0^{def}	(197.3)
Rice	13.9	(38.6)	13.9*	(38.1)	13.7	(40.2)	11.1^{bc}	(32.8)	13.2^{ac}	(42.9)	16.6^{ab}	(38.7)	13.8^{efg}	(34.8)	8.2^{dfg}	(24.2)	12.8^{deg}	(32.5)	20.2 ^{def}	(52.5)
Wheat	63.3	(75.9)	68.1*	(74.6)	48.0	(77.7)	45.8^{bc}	(66.5)	65.5^{ac}	(78.1)	74.6^{ab}	(78.2)	67.3^{efg}	(90.1)	68.4^{dfg}	(76.0)	66.4^{deg}	(67.8)	53.8 ^{def}	(69.8)
Maize	186.8	(169.3)	154.9*	(143.2)	287.1	(202.4)	290.1^{bc}	(200.8)	171.1^{ac}	(145.4)	121.3^{ab}	(116.5)	122.6^{efg}	(129.1)	202.6^{dfg}	(158.5)	116.5^{deg}	(92.3)	250.0 ^{ef}	(203.8)
Breakfast cereals	3.8	(26.5)	4.8*	(29.9)	0.8	(8.4)	0.2^{bc}	(3.1)	3.7^{ac}	(22.3)	6.8^{ab}	(37.2)	7.4^{efg}	(45.4)	4.5^{dfg}	(23.6)	2.7^{de}	(17.2)	1.7^{de}	(16.1)
Starchy roots and tubers	12.0	(41.3)	11.6*	(40.8)	13.3	(42.8)	9.7^{bc}	(34.1)	13.0^{a}	(44.7)	13.0^{a}	(43.1)	12.4^{efg}	(38.8)	15.9^{dfg}	(47.9)	12.1^{deg}	(44.9)	7.9 ^{def}	(31.8)
Potato	10.9	(35.0)	10.4*	(33.5)	12.3	(39.2)	8.7^{bc}	(29.9)	11.9^{ac}	(38.4)	11.7^{ab}	(35.3)	11.3^{efg}	(31.7)	14.5^{dfg}	(41.0)	10.1^{deg}	(32.5)	7.5 ^{def}	(30.9)
Meat	81.3	(96.3)	88.0*	(100.8)	60.2	(76.7)	63.2^{bc}	(78.0)	75.4^{ac}	(84.8)	100.3^{ab}	(113.4)	89.1^{efg}	(111.4)	70.1^{dfg}	(89.2)	83.1^{deg}	(86.3)	86.9 ^{def}	(97.9)
Beef	24.4	(63.8)	28.0*	(68.6)	13.3	(44.0)	13.7^{bc}	(43.9)	22.5^{ac}	(57.2)	34.3^{ab}	(78.9)	35.6^{efg}	(86.0)	23.8^{dfg}	(61.5)	20.9^{deg}	(47.3)	20.5 ^{def}	(57.9)
Pork	10.4	(40.7)	11.7*	(43.9)	6.5	(28.1)	8.1^{bc}	(30.3)	9.8^{ac}	(39.8)	12.8^{ab}	(47.7)	5.0^{efg}	(22.7)	14.0^{dfg}	(51.2)	9.5^{deg}	(31.9)	10.7 ^{def}	(41.3)
Poultry	23.4	(58.4)	25.2*	(60.8)	17.9	(49.4)	15.6^{bc}	(42.6)	20.0^{ac}	(53.9)	32.4^{ab}	(70.2)	24.7^{efg}	(70.9)	16.1^{dfg}	(42.7)	25.3^{deg}	(52.5)	29.0 ^{def}	(65.9)
Eggs	23.0	(46.4)	23.2*	(48.6)	22.5	(38.9)	25.8^{bc}	(48.4)	23.1^{ac}	(41.3)	20.8^{ab}	(48.9)	23.8^{efg}	(37.6)	16.3^{dfg}	(36.4)	27.4^{deg}	(62.6)	26.7 ^{def}	(48.3)
Processed meat	9.7	(30.1)	11.0*	(31.1)	5.6	(26.2)	6.0^{bc}	(23.7)	8.6^{ac}	(26.5)	13.4^{ab}	(36.3)	14.8^{efg}	(39.7)	9.3^{dfg}	(27.9)	10.3^{deg}	(32.5)	6.7 ^{def}	(22.9)
Fresh fish	5.0	(34.5)	5.3*	(36.5)	3.9	(27.2)	3.3^{bc}	(25.8)	5.7^{ac}	(38.7)	5.6^{ab}	(36.4)	3.4^{efg}	(31.8)	4.8^{dfg}	(38.7)	5.2^{deg}	(31.8)	5.9 ^{def}	(33.1)
Processed fish	0.9	(11.2)	0.9*	(10.3)	1.2	(13.8)	1.0^{bc}	(12.6)	1.1^{ac}	(12.9)	0.8^{ab}	(8.2)	1.5^{efg}	(11.9)	0.5^{dg}	(6.4)	0.5^{dg}	(6.4)	1.3^{def}	(15.9)
Dairy products	137.6	(204.0)	159.1*	(214.3)	70.2	(148.7)	54.5^{bc}	(131.9)	137.1^{ac}	(194.7)	201.8^{ab}	(232.4)	112.3^{efg}	(166.8)	168.5^{dfg}	(214.9)	180.3^{deg}	(223.3)	96.5 ^{def}	(190.5)
Fresh milk	118.6	(190.4)	136.0*	(199.8)	63.9	(144.0)	47.2^{bc}	(122.1)	122.0^{ac}	(186.2)	170.4^{ab}	(217.7)	97.8^{efg}	(156.1)	144.3^{dfg}	(197.9)	159.4^{deg}	(216.0)	81.1 ^{def}	(176.2)
Cheese	10.4	(40.0)	12.0*	(43.2)	5.4	(27.1)	4.4^{bc}	(18.2)	9.8^{ac}	(32.5)	15.6^{ab}	(54.7)	9.6^{efg}	(31.0)	12.7^{dg}	(48.2)	11.5^{dg}	(43.4)	8.0^{def}	(32.8)
Yoghurt	8.6	(47.4)	11.0*	(53.6)	0.9	(13.4)	2.9^{bc}	(24.5)	5.3^{ac}	(42.9)	15.8^{ab}	(61.4)	4.9^{ef}	(35.9)	11.5^{dfg}	(61.2)	9.5^{deg}	(41.6)	7.4 ^{ef}	(39.6)
Nuts	1.3	(15.6)	1.4*	(15.5)	1.2	(15.9)	0.7^{bc}	(6.5)	1.6^{ac}	(16.5)	1.6^{ab}	(19.3)	1.2^{efg}	(10.2)	1.6^{dfg}	(16.3)	2.4^{deg}	(26.6)	0.5^{def}	
Legumes	35.3	(64.6)	28.3*	(55.0)	57.2	(84.4)	52.5^{bc}	(82.2)	36.9^{ac}	(63.7)	20.6^{ab}	(42.7)	40.9^{efg}	(70.0)	36.8^{dfg}	(58.8)	14.5^{deg}	(43.3)	42.5 ^{def}	(73.9)
Processed/ canned fruits, vegetables	2.4	(21.9)	2.9*	(24.1)	1.0	(12.2)	0.5^{bc}	(6.1)	1.6^{ac}	(12.3)	4.6^{ab}	(33.1)	4.1^{efg}	(20.1)	2.0^{dfg}	(17.1)	2.9^{deg}	(31.3)	1.6 ^{def}	(20.4)
Fresh vegetables	68.4	(94.0)	71.2	(93.9)	59.8	(93.6)	55.9^{bc}	(84.5)	73.2^{ac}	(103.6)	73.9^{ab}	(91.1)	53.8^{efg}	(88.7)	77.7^{dfg}	(94.0)	65.3^{deg}	(78.2)	69.5 ^{def}	(103.7)
Green leafy vegetables	1.2	(12.4)	1.1*	(11.1)	1.5	(15.9)	1.3^{b}	(12.5)	1.1^{ac}	(13.7)	1.3^{b}	(11.1)	1.0^{fg}	(9.3)	0.7^{fg}	(8.0)	1.1^{deg}	(12.8)	2.0^{def}	(16.7)
Fresh fruit	84.7	(163.6)	90.3*	(169.5)	67.2	(142.4)	52.9^{bc}	(118.8)	72.0^{ac}	(145.3)	120.3^{ab}	(198.1)	68.3^{efg}	(150.9)	82.6^{dfg}	(172.0)	102.5^{deg}	(170.8)	86.4 ^{def}	(156.8)
Citrus	47.1	(125.8)	49.4*	(129.3)	39.8	(113.5)	33.0^{bc}	(100.5)	37.4^{ac}	(112.2)	66.4^{ab}	(149.6)	41.2^{efg}	(118.9)	45.4^{dfg}	(133.5)	49.5^{deg}	(110.8)	50.9 ^{def}	(129.6)
Fats and oils	10.0	(17.8)	9.7*	(17.3)	10.8	(19.1)	10.2^{bc}	(19.4)	9.7^{ac}	(15.5)	10.0^{ab}	(18.4)	7.8^{efg}	(11.5)	12.5^{dfg}	(20.6)	9.5^{deg}	(18.5)	9.0 ^{def}	(17.1)
Animal fat (butter, lard)	2.0	(9.3)	1.6*	(8.3)	3.1	(11.9)	2.8^{bc}	(11.7)	1.3^{ac}	(5.1)	2.0^{ab}	(10.0)	1.6^{efg}	(6.2)	3.6^{dfg}	(13.7)	0.4^{deg}	(2.9)	1.5 ^{def}	(7.3)
Vegetable oil	8.0	(15.3)	8.1*	(15.4)	7.7	(15.0)	7.4^{bc}	(15.2)	8.5^{ac}	(15.2)	8.0^{ab}	(15.5)	6.2^{efg}	(10.2)	8.9^{dfg}	(16.3)	9.2^{deg}	(17.9)	7.5 ^{def}	(15.0)
Sweet drinks and sugar	204.7	(274.1)	230.8*	(285.5)	122.6	(215.1)	139.8^{bc}	(235.9)	190.4^{ac}	(240.1)	266.8^{ab}	(313.2)	253.1^{efg}	(272.0)	184.7^{dfg}	(243.5)	245.8^{deg}	(325.0)	172.1^{def}	(265.1)
Soft drinks	184.8	(275.8)	210.7*	(288.1)	103.4	(213.4)	120.8^{bc}	(234.6)	167.8^{ac}	(241.4)	248.7^{ab}	(316.6)	238.0^{efg}	(271.3)	165.1^{dfg}	(244.9)	223.3^{deg}	(329.3)	150.7^{def}	(266.3)
Sugar	13.7	(30.0)	13.3*	(30.9)	14.7	(26.8)	15.8^{bc}	(34.4)	14.2^{ac}	(27.8)	11.6^{ab}	(28.0)	9.0^{efg}	(19.6)	14.2^{dfg}	(32.7)	12.2^{deg}	(24.3)	16.8 ^{def}	(34.5)
Confectionery	6.2	(27.7)	6.7*	(29.2)	4.5	(22.0)	3.3^{bc}	(15.8)	8.3^{ac}	(33.5)	6.6^{ab}	(29.0)	6.1^{efg}	(30.1)	5.4^{dfg}	(22.1)	10.4^{deg}	(36.0)	4.6 ^{def}	(25.4)

Mean g or ml of purchased food

* Statistically different from rural.

[a,b,c,] Different superindices represent statistically significant differences among socio-economic index tertiles.

[d,e,f,g.] Different superindices represent statistically significant differences among regions.

Sources: MNS–1, 1988; MNS–2, 1999.

Food intake

Food intake information was not available from MNS–1. However, some trends in food intake among stratification groups were observed with data from MNS–2 (Table 7). Consumption rates of both maize products and legumes were substantially greater in the lowest socio-economic quintile (290.1 and 52.5 g, respectively) than in the highest (121.3 and 20.6 g, respectively). Similar differences in maize and legume consumption were also apparent among regions, with the highest intakes occurring in the South and the lowest in Mexico City. In contrast, women of higher socio-economic status consumed more meat than those of lower socio-economic status (100.3 versus 63.3 g). Of the regions, Mexico City had the highest meat consumption (89.1 g) and the Central region the lowest (70.1 g). Milk intake showed a similar pattern to meat, although with more dramatic differences: the highest socio-economic quintile consumed about four times more milk products than the lowest (201.8 versus 54.5 g). Fresh vegetable and fruit intakes, as well as soft drink consumption were also greater among the highest socio-economic quintile than the lowest. At the national level, a total of 204.7 g of sweet drinks and sugar were consumed daily, with a higher intake in the North (253.1 g) than the South region (172.1 g). Urban locations consumed almost twice the amount consumed in rural locations. The average daily fats and oils consumption was 10.0 g, and did not differ substantially among stratification groups.

Trends in national food expenditure 1989 to 2002

The most notable trends in terms of grams of food or food group purchased per capita at the national level were a decrease in purchases of cereals and legumes, and an increase in purchases of meats, milk and dairy products, and vegetables. Some of these trends were not universal, however. The decline in cereal purchase was apparent in the lowest income quintile, but not in the highest, with the result that cereal purchase per AE in the lowest quintile (301 to 326 g/d/per AE) was more similar to that in the higher quintile in 2002 (337 g/d/per AE) than it had been in previous years (316 and 412 g/d/per AE, respectively). Per capita legume purchase showed a decreasing trend from 1989 to 2002 across all income quintiles. For meat and vegetable purchases, the increases observed at the national level were observed in the lowest but not the highest income quintile. In this period, fruit consumption increased by 29.0 g in the highest quintile, but by only 2.0 g in the lowest (Table 8). Although there was no clear trend in egg purchase at the national level, there was an apparent increase among the lowest quintile group.

Looking at regional trends, cereal purchase was higher in the South region and rural locations, showing a decreasing trend in the North region, Mexico City and urban locations. The decrease in legume purchase, on the other hand, was similar across the regions. Per capita meat purchases increased, particularly in Mexico City. The South region consumed less fruit, milk and dairy products and more sugar and cereals than the other three regions. Mexico City consumed more meat, fruit and vegetables than the other regions, and urban locations showed higher expenditures on fruit, vegetables, milk and dairy products and meat, and lower expenditures on sugar, fats and oils, legumes and cereal than rural ones (Annex 2).

TABLE 8
Mean daily consumption per AE and percentages of total expenditure on food, by food group, national total and extreme income quintiles, 1989 to 2002

Food group	Year*	National (total)					Income quintile per AE									
							I					V				
		%[1]	%[2]	g/d[3]	$(RC)_4$	Per capita (g/d)[5]	%[1]	%[2]	g/d[3]	$(RC)_4$	Per capita (g/d)[5]	%[1]	%[2]	g/d[3]	(RC)[4]	Per capita (g/d)[5]
Cereals (g)	1989	94.1	16	438	(1.00)	412	90	27	459	(1.00)	412	91	9	352	(1.00)	320
	1992	94.3	17	399	(0.91)	377										
	1994	94.3	18	365	(0.83)	344	92	27	344	(0.75)	316	89	12	337	(0.96)	301
	1996	95.7	20	390	(0.89)	373	93	30	370	(0.81)	346	93	13	352	(1.00)	326
	1998	94.6	20	368	(0.84)	348	90	29	363	(0.79)	326	92	13	330	(0.94)	304
	2000	95.3	19	380	(0.87)	362	94	28	418	(0.91)	393	91	12	327	(0.93)	299
	2002	96.0	19	362	(0.83)	347	93	27	361	(0.79)	337	94	12	347	(0.99)	324
Meats (g)	1989	78.5	33	119	(1.00)	93	53	26	48	(1.00)	26	84	35	176	(1.00)	147
	1992	80.1	29	122	(1.02)	97	52	25	60	(1.25)	31	85	31	178	(1.01)	151
	1994	82.8	30	125	(1.05)	104	60	25	58	(1.20)	34	86	31	192	(1.09)	165
	1996	82.9	26	112	(0.94)	93	60	20	47	(0.98)	28	85	28	171	(0.97)	146
	1998	80.6	26	119	(1.00)	96	56	21	53	(1.11)	30	83	26	173	(0.98)	144
	2000	84.5	25	130	(1.09)	110	70	23	70	(1.45)	49	83	24	190	(1.08)	157
	2002	85.1	25	129	(1.08)	110	74	23	69	(1.43)	51	82	22	179	(1.02)	147
Eggs (g)	1989	61.9	5	55	(1.00)	34	53	8	36	(1.00)	19	55	3	73	(1.00)	40
	1992	62.3	5	57	(1.02)	35	53	8	38	(1.06)	20	59	3	75	(1.02)	44
	1994	60.2	5	58	(1.04)	35	54	8	39	(1.10)	21	55	3	75	(1.03)	41
	1996	65.8	6	54	(0.98)	36	59	9	33	(0.94)	20	58	4	72	(0.99)	42
	1998	60.9	5	56	(1.01)	34	55	8	39	(1.08)	21	50	4	74	(1.02)	37
	2000	63.8	4	60	(1.07)	38	67	6	44	(1.24)	30	52	3	77	(1.06)	40
	2002	59.9	4	60	(1.08)	36	62	7	47	(1.30)	29	47	2	77	(1.07)	36
Milk and dairy products (g)	1989	72.8	13	266	(1.00)	194	45	12	123	(1.00)	55	83	13	366	(1.00)	304
	1992	72.2	12	271	(1.02)	195	40	13	118	(0.96)	47	83	13	374	(1.02)	311
	1994	73.5	13	267	(1.00)	196	40	12	110	(0.90)	44	84	13	379	(1.04)	319
	1996	75.1	13	250	(0.94)	188	44	11	107	(0.87)	47	87	14	356	(0.97)	311
	1998	73.9	14	261	(0.98)	193	38	12	107	(0.87)	40	85	15	373	(1.02)	318
	2000	77.3	14	259	(0.97)	200	52	12	115	(0.94)	60	84	15	383	(1.05)	323
	2002	78.1	13	273	(1.02)	213	52	10	149	(1.22)	77	85	13	384	(1.05)	328
Legumes (g)	1989	55.1	5	72	(1.00)	40	65	12	76	(1.00)	50	35	3	84	(1.00)	29
	1992	56.0	6	69	(0.95)	39	63	12	67	(0.87)	42	37	3	69	(0.82)	25
	1994	53.3	5	68	(0.94)	36	62	12	68	(0.89)	42	36	3	75	(0.89)	27
	1996	59.0	7	66	(0.91)	39	67	13	61	(0.80)	41	39	4	71	(0.84)	28
	1998	54.0	6	66	(0.91)	35	62	13	63	(0.82)	39	37	3	73	(0.87)	27
	2000	52.5	4	66	(0.92)	35	67	8	68	(0.89)	46	32	2	71	(0.84)	23
	2002	47.9	5	64	(0.88)	31	65	9	65	(0.85)	42	26	3	69	(0.82)	18
Fats and oils (g)	1989	45.6	5	49	(1.00)	23	53	9	36	(1.00)	19	31	3	74	(1.00)	23
	1992	43.1	4	52	(1.05)	22	50	8	35	(0.98)	18	31	3	71	(0.96)	22
	1994	44.5	5	55	(1.11)	25	51	8	38	(1.07)	19	33	3	82	(1.11)	27
	1996	47.1	6	50	(1.02)	24	50	8	32	(0.88)	16	35	4	72	(0.98)	25
	1998	40.6	5	54	(1.09)	22	48	7	37	(1.04)	18	30	3	78	(1.06)	23
	2000	43.3	4	59	(1.19)	26	53	6	42	(1.17)	22	33	3	86	(1.16)	28
	2002	36.9	4	59	(1.18)	22	51	5	44	(1.22)	22	24	3	84	(1.14)	20
Vegetables (g)	1989	85.1	9	144	(1.00)	122	79	11	79	(1.00)	62	79	7	216	(1.00)	170
	1992	83.9	10	145	(1.01)	122	77	13	75	(0.96)	58	79	8	206	(0.95)	164
	1994	83.4	10	147	(1.02)	122	79	14	80	(1.02)	63	76	8	208	(0.96)	158
	1996	85.8	8	159	(1.11)	136	80	10	81	(1.03)	64	81	7	228	(1.05)	184
	1998	82.8	10	151	(1.05)	125	78	12	79	(1.01)	62	76	8	220	(1.02)	166
	2000	83.5	9	163	(1.14)	136	84	11	96	(1.22)	80	76	7	228	(1.05)	172
	2002	83.2	9	173	(1.20)	144	84	12	103	(1.31)	87	74	7	235	(1.09)	173

Fruits (g)	1989	53.7	6	151	(1.00)	81	29	5	71	(1.00)	21	65	6	246	(1.00)	160
	1992	53.4	5	178	(1.18)	95	26	5	78	(1.10)	20	66	6	272	(1.10)	179
	1994	55.3	6	179	(1.18)	99	27	5	91	(1.28)	25	66	6	271	(1.10)	179
	1996	54.6	5	162	(1.07)	88	28	4	69	(0.97)	19	68	6	260	(1.06)	178
	1998	50.8	5	154	(1.02)	78	25	5	95	(1.35)	24	63	6	240	(0.98)	152
	2000	57.5	6	193	(1.28)	111	38	5	88	(1.25)	33	67	6	312	(1.27)	210
	2002	52.6	5	178	(1.18)	94	34	5	81	(1.14)	28	60	7	300	(1.22)	181
Sugar (g)	1989	39.8	3	76	(1.00)	30	57	6	67	(1.00)	38	24	2	118	(1.00)	28
	1992	38.4	3	76	(1.01)	29	52	7	68	(1.02)	36	24	2	97	(0.83)	23
	1994	39.0	4	76	(1.01)	30	54	7	66	(0.98)	35	25	2	100	(0.85)	25
	1996	41.5	4	68	(0.90)	28	53	7	55	(0.82)	29	27	3	95	(0.80)	26
	1998	37.3	3	72	(0.95)	27	48	7	59	(0.88)	28	27	2	113	(0.95)	30
	2000	39.2	3	72	(0.95)	28	54	5	61	(0.92)	33	29	2	102	(0.86)	30
	2002	36.1	3	79	(1.05)	29	55	6	71	(1.06)	39	23	2	112	(0.95)	26

Data weighted by the expansion factors.
Sample sizes: 1989, 11 531 (expanded cases, 15 947 773); 1992, 10 508 (expanded cases, 17 798 635); 1994, 12 815, (expanded cases, 19 440 278); 1996, 14 042 (expanded cases, 20 467 038); 1998, 10 952 (expanded cases, 22 163 568); 2000, 10 089 (expanded cases, 23 452 319); 2002, 17167 (expanded cases, 24 650 169).
[1] Percentage of families reporting expenditure during the seven-day survey period.
[2] Percentage of total food expenditure.
[3] Mean grams per AE among families reporting expenditure.
[4] Relative change.
[5] Mean grams per capita.
Source: MHIES, 1989 to 2002.

While there was no apparent time trend in the per capita purchase of free sugar, there was a large per capita increase in the purchase of soda, particularly among the highest income group (Tables 8 and 9). Soda expenditure per AE in Mexico increased by 19 percent over the 13-year period. By income, it increased by 20 percent in the lowest quintile and by 21 percent in the highest. By region, soda expenditure showed the highest increasing trend in the Central region (27 percent). In 2002, however, the North was the region with the highest soda consumption (315 ml/AE), which was 57.5 percent higher than that of the South. Tobacco expenditure showed an increasing trend, particularly in the North region, rural locations and the highest income quintile (Annex 3). The trends observed for the extreme upper and lower income quintiles were somewhat similar when the data were disaggregated by urban and rural residence.

In summary, trends in per capita food expenditure have led to cereal and egg intakes in the lowest and highest income groups becoming more similar; food expenditures in the lowest income quintile are moving closer to those in higher income groups, but there are still large gaps in meats, milk and dairy products, vegetables and fruits. There are no apparent trends in the per capita purchases of fats and oils, or sugar, although the purchase of sugar is consistently greater among the lowest income group. Overall, the purchasing habits of the highest income quintile changed little between 1989 and 2002.

Food expenditure outside the home

In 2002, food expenditure outside the home accounted for 25.4 percent of total food expenditure by AE. Relative to 1989, this expenditure had increased across all regions, locations and income quintiles. However, it was more than twice as large in the highest income quintile than in the lowest (Table 10).

TABLE 9
Mean daily consumption per AE and percentages of total expenditure on soda, alcohol and tobacco, by national total and extreme income quintiles, 1989 to 2002

Food groups	Year*	National (total)					Income quintile per AE									
							I					V				
		%[1]	%[2]	ml/d[3]	(RC)[4]	Per capita (ml/d)[5]	%[1]	%[2]	ml/d[3]	(RC)[4]	Per capita (ml/d)[5]	%[1]	%[2]	ml/d[3]	(RC)[4]	Per capita (ml/d)[5]
Soda (ml)	1989	49.5	5	203	(1.00)	100	29	7	102	(1.00)	30	58	4	276	(1.00)	159
	1992	51.8	6	211	(1.04)	109	27	8	104	(1.03)	28	60	6	296	(1.07)	179
	1994	53.3	5	228	(1.12)	121	33	4	104	(1.02)	35	60	4	319	(1.15)	193
	1996	51.4	7	200	(0.98)	103	31	7	91	(0.89)	28	61	6	283	(1.02)	171
	1998	58.2	8	232	(1.14)	135	33	10	128	(1.26)	43	66	8	317	(1.15)	210
	2000	60.7	8	256	(1.26)	155	40	8	129	(1.26)	51	67	7	354	(1.28)	238
	2002	61.5	8	242	(1.19)	149	39	9	122	(1.20)	48	69	8	335	(1.21)	232
Alcohol (ml)	1989	5.8	10	168	(1.00)	10	5	7	89	(1.00)	4	9	9	207	(1.00)	19
	1992	5.2	9	201	(1.20)	10	4	9	167	(1.87)	7	9	11	249	(1.21)	22
	1994	6.9	10	189	(1.13)	13	6	12	86	(0.96)	5	10	10	282	(1.37)	28
	1996	5.4	9	187	(1.12)	10	5	11	196	(2.20)	9	9	9	230	(1.11)	21
	1998	6.6	9	187	(1.12)	12	5	13	271	(3.04)	14	10	10	208	(1.00)	20
	2000	6.9	11	172	(1.02)	12	4	11	153	(1.72)	6	11	13	213	(1.03)	24
	2002	4.3	12	252	(1.51)	11	2		196	(2.20)	5	7	12	350	(1.70)	25
Tobacco (g)	1989	15.7	5	3.4	(1.00)	0.54	11	5	1.6	(1.00)	0.18	19	5	4.3	(1.00)	0.83
	1992	21.1	6	2.8	(0.82)	0.60	14	6	1.6	(1.01)	0.23	26	6	4.1	(0.94)	1.06
	1994	11.3	7	3.4	(1.00)	0.39	7	9	2.1	(1.30)	0.14	15	7	5.2	(1.19)	0.76
	1996	9.2	5	3.3	(0.95)	0.30	6	6	1.6	(1.00)	0.10	12	5	4.8	(1.11)	0.58
	1998	8.7	5	3.8	(1.10)	0.33	5	6	1.5	(0.97)	0.08	11	5	5.9	(1.37)	0.63
	2000	9.1	6	3.7	(1.06)	0.33	5	6	1.7	(1.04)	0.08	11	5	5.5	(1.26)	0.62
	2002	7.1	6	4.9	(1.44)	0.35	2	6	3.0	(1.87)	0.07	11	6	6.8	(1.58)	0.77

TABLE 10
Median daily food expenditure outside the home as percentage of total food expenditure, 1989 to 2002.

Year*	National (total)		Income quintile per AE			
			I		V	
	%[1]	(RC)[2]	%[1]	(RC)[2]	%[1]	(RC)[2]
1989	23	(1.00)	13	(1.00)	34	(1.00)
1992	24	(1.04)	19	(1.46)	29	(0.85)
1994	26	(1.13)	15	(1.15)	39	(1.15)
1996	22	(0.96)	16	(1.23)	31	(0.91)
1998	22	(0.96)	15	(1.15)	32	(0.94)
2000	24	(1.04)	13	(1.00)	35	(1.03)
2002	25	(1.09)	15	(1.15)	37	(1.09)

Data weighted by the expansion factors.
Sample sizes: 1989, 11 531 (expanded cases, 15 947 773); 1992, 10 508 (expanded cases, 17 798 635); 1994, 12 815, (expanded cases, 19 440 278); 1996, 14 042 (expanded cases, 20 467 038); 1998, 10 952 (expanded cases, 22 163 568); 2000, 10 089 (expanded cases, 23 452 319); 2002, 17167 (expanded cases, 24 650 169).
[1] Percentage of total food expenditure.
[2] Relative change.
Source: MHIES, 1989 to 2002.

Breastfeeding patterns in Mexico

In Mexico, the average duration of breastfeeding is nine months, but only 25.7 percent of mothers reported exclusive breastfeeding for four months, and 20.3 percent for six months. Among the socio-demographic factors associated with shorter periods of exclusive breastfeeding are living in urban locations, being a non-indigenous family, and having a BMI above the mean (Table 11).

TABLE 11
Breastfeeding by socio-economic, demographic and anthropometric characteristics, 1999

	Duration of breastfeeding (months, median)	Ever breastfed (%)	Exclusive breastfeeding[1] (%)	
			4 months (< 123 days)	6 months (< 183 days)
N			**502**	**750**
National	**9**	**92.3**	**25.7**	**20.3**
Region				
North	6	91.8	16.5	10.5
Central	8	91.6	25.0	19.1
Mexico City	7	92.0	11.6	12.3
South	15	93.5	36.5[4]	30.5[4]
Location				
Urban	7	92.3	20.9	15.0
Rural	14	92.2	36.1[4]	33.2[4]
Ethnicity[2]				
Indigenous	>24	93.5	48.2	48.4
Non-indigenous	8	92.3	23.2[4]	17.8[4]
Socio-economic status[3]				
Low	15	92.3	39.8	33.8
Middle	8	91.6	17.3	14.2
High	6	93.1	20.7[4]	14.3[4]
Number of children				
1	7	94.1	22.8	16.6
2	8	91.6	26.1	19.9
≥ 3	12	91.5	27.8	23.6
Maternal age				
> 19 years	12	92.2	27.6	23.1
19 to < 25 years	10	93.5	24.5	21.6
25 to < 35 years	8	92.2	25.9	18.3
≥ 35 years	9	89.9	26.5	20.8
BMI (kg/m^2)				
< mean (25.7)	10	93.6	33.2	25.7

[1] Exclusive breastfeeding = receiving *only* breastmilk (consumption of pharmaceutical products – medicines or vitamin/mineral preparations – was not explored).
[2] Indigenous = mother speaks a native language.
[3] Calculated through principal components analysis.
[4] $p < 0.05$.
Source: Gonzalez-Cossio *et al.,* 2003.

Nutritional status of children under five years of age

Table 12 presents the prevalence of low HAZ, WAZ and WHZ in 1988 and 1999. In 1988, almost one-quarter of children under five years of age in Mexico were stunted (HAZ < -2.0 SD of the NCHS reference population) and 6.3 percent were wasted (WHZ < -2.0 SD of the NCHS reference population). Eleven years later, in 1999, wasting was no longer a public health concern in Mexico, with only 2.1 percent of children being wasted, but a substantial percentage remained stunted – almost 18 percent. The low prevalence of wasting in Mexico runs parallel to an equally low prevalence of this condition in almost all Latin American countries, which have an average prevalence of less than 3 percent (de Onis and Blössner, 2003). In contrast, stunting continues to be a public health problem in several Latin American countries (ACC/SCN, 2000). Relative to countries with similar per capita GNP (Chile, Brazil and Argentina), Mexico had a higher prevalence of stunting in 1999. Moreover, the reduction of 5.1 percentage points in the 11 years between surveys (from 22.9 percent in 1988 to 17.8 percent in 1999) is below the reduction rate experienced by several other Latin American countries during the same period (Hernandez *et al.,* 2003). Wasting declined to less than 2.5 percent in all regions, in urban and rural areas and in all socio-economic quintiles. The largest drop was observed in the North[1] and Central regions. As mentioned earlier, this condition is no longer a public health problem in Mexico.

On the other hand, stunting rates in 1999 were not only high at the national level but also heterogeneous in the different regions, in urban and rural locations and across socio-economic categories. Stunting rates in the lowest socio-economic quintile were six times those of the highest; rates were almost three times as high in rural as in urban areas and in the South (the poorest region) than in Mexico City and the North (the wealthiest regions). The decline in stunting rates between 1988 and 1999 was almost totally accounted for by the changes observed in the lowest socio-economic group, and was more pronounced in the Central region and in urban areas (Table 12). It should be noted that localities that were classified as rural in 1988 might have become urban by 1999 owing to population growth; changes in stunting rates between the two data points may therefore be partially explained by the urbanization process. Similarly, geographic regions that were regarded as being within the metropolitan area of Mexico City in 1999 were considered part of the Central region in 1988. This may partially explain the increase in stunting rates in Mexico City – which has incorporated more poor populations into its surrounding metropolitan area – and the sharp decline in stunting in the Central region. Parallel to the sharp drop in wasting and the slow decline in stunting, overweight (WAZ > +2 SD of the NCHS reference population) in children under five years of age has increased slightly at the national level and in all regions, with the highest increases in the South and Mexico City, a smaller increase in the North and a decline in the Central region. Despite the lower increase in overweight rates, the North has the highest prevalence (Figure 2).

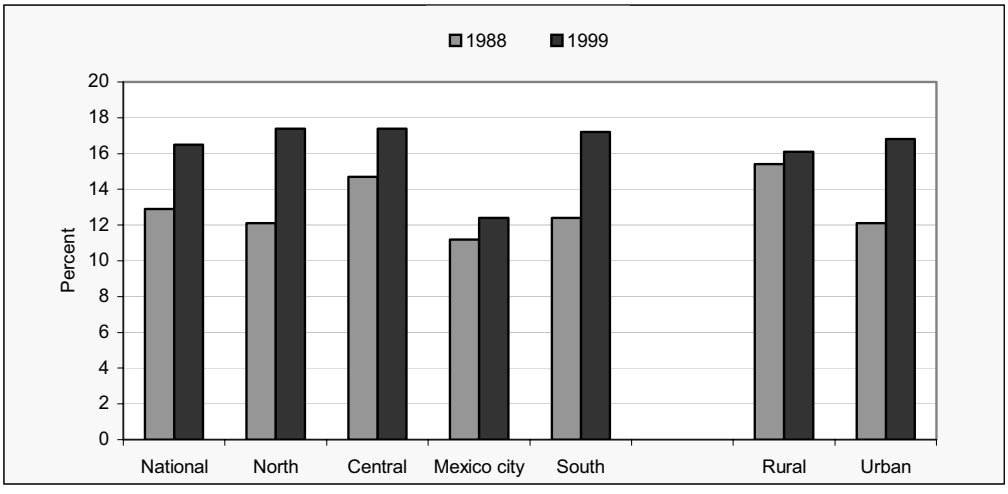
[1] The apparent prevalence of wasting in the North region in 1988 has been questioned because it was too high for the level of development of the northern states of Mexico at that time.

TABLE 12
Prevalence of low HAZ, WAZ and WHZ in children (0 to four years) by region, urban or rural location and socio-economic quintile, 1988 and 1999

	HAZ				WAZ				WHZ			
	< -2 SD		< -3 SD		< -2 SD		< -3 SD		< -2 SD		< -3 SD	
	1988	1999	1988	1999	1988	1999	1988	1999	1988	1999	1988	1999
National	**22.9**	**17.8**	**9.3**	**5.7**	**13.9**	**7.6**	**2.9**	**1.2**	**6.3**	**2.1**	**1.6**	**0.6**
Region												
North[1]	11.0	7.1	3.9	1.7	10.5	3.3	1.4	0.8	10.1	2.2	2.9	0.6
Central[2]	25.1	14.5	9.6	4.4	13.8	6.1	3.0	1.3	7.1	2.3	1.5	1.0
Mexico city[3]	9.8	13.1	2.6	3.7	6.1	6.8	0.6	0.3	3.6	2.3	1.0	0.2
South[4]	34.1	29.2	15.6	10.2	20.5	12.0	4.7	1.8	5.3	1.7	1.4	0.4
Location												
Rural[5]	34.7	32.2	17.1	10.9	19.6	12.3	4.5	2.2	5.9	2.1	1.7	0.6
Urban[6]	18.8	11.7	14.2	3.5	12.3	5.7	2.4	0.8	6.4	2.0	1.6	0.6
Socio-economic status												
Low[7]	42.0	35.3	20.4	13.3	24.0	15.6	6.0	2.5	5.7	2.6	1.4	0.8
Medium[8]	16.9	15.0	5.0	3.8	11.1	6.5	1.5	1.0	6.8	2.4	1.5	0.8
High[9]	6.2	6.0	2.8	1.2	5.7	2.8	1.4	0.4	6.1	1.4	2.0	0.4

Sample sizes: 1988, 5904 (weight, 7 101 607); 1999, 8 011 (weight, 10 612 397).
[1] Sample sizes: 1988, 1 430 (weight, 1 097 654); 1999, 2 317 (weight, 1 984 629).
[2]Sample sizes: 1988, 1 411 (weight: 2 235 041); 1999, 2 533 (weight, 3 648 563).
[3] Sample sizes: 1988, 1 478 (weight, 1 422 801); 1999, 571 (weight, 1 492 824).
[4] Sample sizes: 1988, 1 585 (weight, 2 346 111); 1999, 2 590 (weight, 3 486 381).
[5] Sample sizes: 1988, 1 022 (weight, 5 526 366); 1999, 3 312 (weight, 3 161 671).
[6] Sample sizes: 1988, 4 882 (weight, 1 575 241); 1999, 4 699 (weight, 7 450 726).
[7]Sample sizes: 1988, 1 531 (weight, 2 229 853); 1999, 2 414 (weight, 2 882 015.
[8]Sample sizes: 1988, 2 862 (weight, 3 267 560); 1999, 2 804 (weight, 3 454 492).
[9] Sample sizes: 1988, 1 511 (weight, 1 604 194); 1999, 2 572 (weight, 4 025 820).
Sources: MNS–1, 1988; MNS–2, 1999.

FIGURE 2
Prevalence of overweight in children aged 0 to 4.9 years, national total, by region and by residence, 1988 and 1999



Sources: MNS, 1988; 1999.

Prevalence of overweight in school-age children

The prevalence of overweight in children aged five to 11 years was analysed from MNS–2 in 1999. No data were available on the anthropometry of school-age children from MNS–1 in 1988. Approximately one-quarter of children were overweight according to the reference proposed by Must, Dallal and Dietz (1991), while according to the Cole *et al.* (2000) classification, the prevalence was almost 20 percent. Prevalence was substantially higher in the wealthier North and Mexico City relative to the South and Central regions; it was twice as high in urban as in rural areas, higher in females and in the children of more educated women, and lower in indigenous populations (Table 13).

TABLE 13
Prevalence of overweight in school-age children (five to 11 years) by region, residence, gender, maternal education level and ethnicity

Variable		n	Cole	Must
			%	%
National		**10 901**	**19.5**	**27.3**
Region	North	3 188	25.6	34.9
	Central	3 292	18.0	25.6
	Mexico City	855	26.6	33.4
	South	3 566	14.3	22.2
Location	Urban	6 142	22.9	30.6
	Rural	4 759	11.7	19.9
Sex	Female	5 505	21.2	28.7
	Male	5 396	17.7	25.9
Maternal education	No education	2 415	12.0	19.8
	Elementary school	5 087	17.6	25.1
	Middle school	1 839	25.6	34.1
	High school or more	1 560	25.6	33.3
Indigenous ethnicity	No	9 750	20.4	19.8
	Yes	1 151	12.1	11.5

Sources: Cole *et al.,* 2000; Must, Dallal and Dietz, 1999; MNS–1, 1988; MNS–2, 1999.

Prevalence of adult overweight, obesity and non-communicable chronic diseases

The changes in prevalence of overweight and obesity in Mexican adults were studied by comparing the results of MNS–1 (1988) and MNS–2 (1999), which included only women, and the results of MCDS (1994) and MHS (2000), which included both men and women.

Between 1988 and 1999, the prevalence of overweight and obesity increased in women by almost 70 percent (from 35 to 59 percent) (Table 14): overweight (BMI of 25 to 29.9) by almost 50 percent (from 24 to 35 percent), and obesity (BMI ≥ 30) by 150 percent (from 9 to 24 percent). These dramatic increases were observed in all regions, in both urban and rural areas and in all socio-economic groups. The prevalence of BMI < 18.5, indicating low weight in adults, was less than 2 percent in women in 1999, indicating that undernutrition in women is no longer a public health concern in Mexico.

Adult underweight is not a public health problem among males either, as observed in MHS, which recorded prevalence of about 2 percent in both men and women. The prevalence of adequate weight in men and women decreased from 21.9 percent in 1994 to

21.2 percent in 2000. Stratifying by age, only 22 percent of adults aged 40 to 59 years had adequate weight in 2000. This age group also had the highest prevalence of obesity (35.4 percent) in 2000, representing a relative increase of 2.6 percentage points (about 8 percent) since 1994. However, the highest relative increases in obesity were observed in the youngest age group (20 to 39 years), where it increased by 6.9 percentage points (47 percent) over the study period, followed by the oldest group (60 to 75 years), which showed a 7.6 percentage point increase (36 percent). As expected, urban locations and the North region had the highest prevalence of overweight and obesity. Obesity increased more in the North and Central regions (by about 8 percentage points during the six-year period), followed by the South (about 6 percentage points) and Mexico City (3 percentage points) (Table 15).

Diabetes mellitus and hypertension have increased dramatically in Mexico. According to the case study analysis, between 1994 and 2000, diabetes mellitus increased by 3.3 percentage points in males and by 4.6 in females. Hypertension did not show relevant increases by sex, but substantial increases were observed in the 40 to 59 years age group, in urban locations and in the North region. High cholesterol and triglyceride concentrations were more prevalent in men than in women. The prevalence of these increased between 1994 and 2000 in males and females, all age groups, urban and rural locations, and all regions (Table 16). Awareness of these conditions is an issue. Prior to the survey, only 41 percent of the people with hypertension and 77 percent of those with diabetes were aware of their condition (NHS, 2000; Olaiz, Rojas and Barquera, 2003).

TABLE 14
BMI trends in women aged 20 to 49 years, by residence and socio-economic status, 1988 and 2000

		BMI							
		Underweight (< 18.5 kg/m^2)		Normal (18.5–24.9 kg/m^2)		Overweight (> 25 kg/m^2)		Obese (> 30 kg/m^2)	
		1988	2000	1988	2000	1988	2000	1988	2000
National		**7.7**	**1.8**	**55.7**	**33.4**	**36.6**	**64.7**	**9.4**	**29.0**
	Urban	7.5	1.8	55.7	32.0	36.7	66.2	9.6	30.7
Location[1]	Rural	8.7	1.8	55.4	34.9	35.9	63.2	9.1	27.2
Socio-economic status									
	Low	9.3	2.4	55.8	37.7	34.9	59.9	9.7	25.1
	Medium	7.0	1.5	51.7	30.2	41.3	68.3	10.6	32.8
	High	6.8	1.6	59.2	32.1	34.0	66.4	8.4	29.3

Sample sizes: 1988, 10 746; 2000, 21 481.
[1] Location: rural = < 15 000 inhabitants; urban = > 15 000 inhabitants.
Sources: MNS–1, 1988; MHS, 2000.

TABLE 15
BMI trends in adults aged 20 years and over, by gender, age, residence and region, 1994 and 2000

		BMI							
		Underweight (< 18.5 kg/m^2)		Normal (18.5–24.9 kg/m^2)		Overweight (25–29.9 kg/m^2)		Obese (> 30 kg/m^2)	
		1994	2000	1994	2000	1994	2000	1994	2000
National		**1.7**	**1.8**	**42.2**	**32.5**	**35.9**	**37.5**	**20.2**	**28.3**
Sex	Male	1.9	1.8	46.0	36.1	36.1	40.5	15.9	21.6
	Female	1.5	1.7	39.4	30.8	35.8	36.1	23.4	31.3
Age (years)	20–39	2.2	2.1	49.4	38.5	33.6	37.7	14.8	21.7
	40–59	0.4	1.0	24.4	22.1	42.4	41.5	32.8	35.4
	60–75	1.8	1.9	33.0	28.3	43.8	40.8	21.4	29.0
Location[1]	Urban	1.6	1.6	40.9	29.4	37.7	40.3	19.8	28.7
	Rural	-	1.9	-	35.5	-	38.4	-	24.2
Region	North	0.9	1.7	38.8	28.0	36.7	39.1	23.6	31.2
	Central	2.4	1.8	45.6	31.6	33.8	40.1	18.2	26.5
	Mexico City	1.5	1.3	44.1	32.3	33.9	42.9	20.5	23.5
	South	1.9	1.7	38.2	36.2	42.6	38.5	17.3	23.6

Sample sizes: 1994, 2 125; 2000, 45 294.
[1] Location: rural = < 15 000 inhabitants; urban = > 15 000 inhabitants. The 1994 survey did not include rural areas.
Sources: MCDS, 1994; MHS, 2000.

TABLE 16
Prevalence of diabetes mellitus, hypertension, high blood cholesterol and high triglycerides in adults, by gender, age group, residence and region, 1994 and 2000

		Diabetes mellitus[1]		Hypertension[2]		High cholesterol (> 200 mg/dl)		High triglycerides (> 150 mg/dl)	
		1994	2000	1994	2000	1994	2000	1994	2000
Sex	Male	4.3	7.6	39.3	39.2	29.1	48.2	47.4	53.5
	Female	3.7	8.3	27.8	30.9	23.5	42.2	34.1	45.0
Age (years)	20–39	1.9	2.0	18.6	20.9	19.8	33.3	33.5	42.5
	40–59	7.2	12.5	38.3	45.2	38.4	69.2	53.6	63.5
	60–75	14.0	21.1	53.1	53.5	43.8	65.0	50.9	67.0
Location[3]	Urban	4.0	8.8	26.1	34.2	26.0	42.2	39.7	45.6
	Rural	-	7.2	-	33.0	-	43.0	-	53.1
Region	North	3.4	9.8	25.4	38.4	21.7	39.5	36.3	39.9
	Central	5.0	7.6	30.0	33.7	28.2	48.2	32.2	53.5
	Mexico City	1.7	8.9	23.7	27.9	29.8	53.5	46.7	30.0
	South	5.2	7.3	23.6	30.4	23.7	33.4	47.7	45.2

Sample sizes: 1994, 2 125; 2000, 2 422.
[1] Diabetes mellitus = fasting glucose > 126 mg/dl, or post-prandial glucose > 200 mg/dl (WHO), or previous medical diagnosis of diabetes mellitus.
[2] Hypertension = systolic blood pressure ≥ 140 mm/Hg, and/or diastolic blood pressure ≥ 90 mm/Hg in adults < 60 years, and systolic blood pressure ≥160 mm/Hg, and/or diastolic blood pressure ≥ 90 mm/Hg in adults ≥ 60 years.
[3] Location: rural = < 15 000 inhabitants; urban = > 15 000 inhabitants.
Sources: MCDS, 1994; MHS, 2000.

Biochemical indicators of anaemia status

Results from MNS–1 (1988) and MNS–2 (1999) show increases in the prevalence of anaemia over the 11-year period in pregnant women (from 18.2 to 27.8 percent) and non-pregnant women (from 15.4 to 20.8 percent) (Table 17) (Martinez *et al.,* 1995; Shamah-Levy *et al.,* 2003). Child anaemia was not evaluated until MNS–2, which recorded a prevalence of 27.2 percent at the national level (Table 17). A number of factors could explain the increase in anaemia; for example, haemoglobin was measured *in situ* with a portable photometer in 1999, but not in 1988, when venous blood was used. Changes in feeding patterns among the population also partially explain the increase. The total protein intake decreased over this period, from 58.5 to 47.2 g (Table 2), while data on expenditure show almost no change in meat purchases at the national level between 1989 and 2002 (Table 8). Another important factor could be that comprehensive national interventions oriented to reduce micronutrient deficiencies in poor locations, such as the Progresa/Oportunidades programmes, did not start until 1999, when their design and targeting were improved by the results MNS–2.

The highest prevalence of anaemia in women was observed in rural locations, particularly in those with indigenous populations. The main socio-economic factors associated with high prevalence of anaemia were number of children, lower socio-economic status, indigenous background and residence in rural locations. As reported in other studies, these factors are closely associated with poverty (ACC/SNC, no date; Becerra *et al.,* 1998; Diallo *et al.,* 1995; Frith-Terhune, Cogswell and Kettel Khan, 2000; Zavaleta, Caulfield and Garcia, 2000).

TABLE 17
Prevalence of anaemia in women aged 12 to 49 years and children aged 0 to five years, by region and residence, 1988 and 1999

	Non-pregnant (%)		Pregnant (%)		Children (%)
	1988	1999	1988	1999	1999
n	*15 146*	*16 496*	*7 420*	*6 970*	*5 526*
National	**15.4**	**20.8**	**18.2**	**27.8**	**27.2**
Region					
North	19.7	20.9	21.6	21.1	26
Central	12.4	20.6	13.9	27.7	27.5
Mexico City	13.4	14.9	15.1	12.3	27.2
South	17.5	23.2	22.8	29.9	27.6
Location					
Urban	15.6	20.2	18.5	27.7	26.1
Rural	14	22.6	16.8	28	29.5

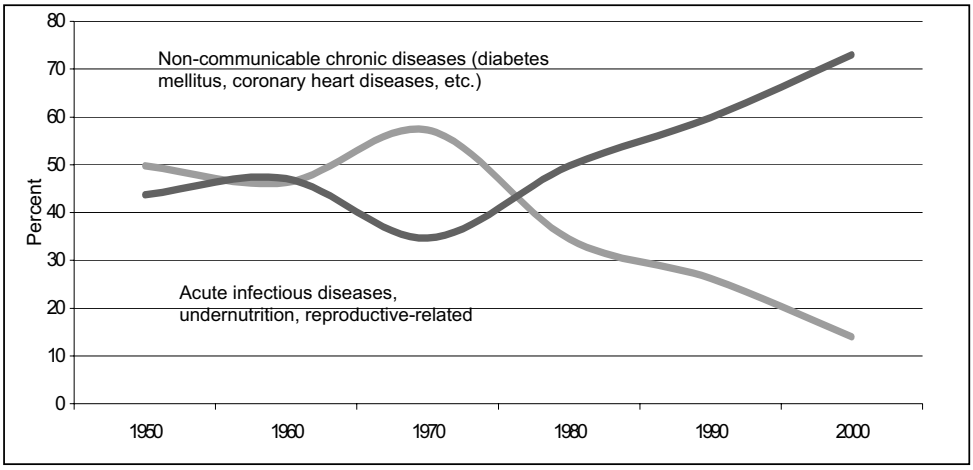
Anaemia = < 12 g/dl haemoglobin in non-pregnant and < 11 g/dl in pregnant women.
Sources: MNS–1, 1988; MNS–2, 1999.

Mortality trends

The case study's analysis of the mortality register found decreasing trends in child mortality and in mortality among the 15 to 59 years age group. All-cause mortality per thousand inhabitants decreased from 16 in 1950 to 4.5 in 2000. Mortality due to communicable diseases, undernutrition and reproduction represented 49.8 percent of all-cause mortality in 1950, decreasing to 14 percent in 2000. In contrast, mortality due to non-communicable chronic diseases has been increasing in the last five decades,

contributing 43.7 percent of all-cause mortality in 1950 and 73 percent in 2000 (Figure 3). Thus, a decreasing trend in mortality due to infectious gastrointestinal diseases, acute respiratory infections and undernutrition was observed, while non-communicable chronic diseases such as diabetes mellitus, hypertension and IHD show a steady increase over time, which is consistent with the epidemiologic transition theory (Ministry of Health, 2001).

FIGURE 3
Mortality trends: percentage contributions to all-cause mortality of non-communicable chronic diseases and acute infectious diseases, 1950 to 2000



Physical activity in Mexico

There is only limited information on the physical activity of the Mexican population. Using data from MNS–2 (1999), Hernández *et al.* (2003) concluded that females aged from 12 to 49 years have very limited physical activity. Only 16 percent reported the regular practice of sports. Several socio-demographic factors are associated with this, and women were more likely to practise sports if they were less than 20 years of age, had no children and were of high socio-economic status.

FOOD AND NUTRITION PROGRAMMES IN MEXICO

Social policy in Mexico has included diverse food aid programmes designed to improve nutritional status in the country. Since the 1990s, the government has changed its food policy substantially, moving from generalized to selective targeting programmes, which have been demonstrated to be a more effective strategy for transferring resources and inputs to the poor. Among current programmes are ones for food distribution, micronutrient supplementation and fortification. Most of these include health and nutrition education components. The two most important national poverty alleviation integrated nutrition programmes are Oportunidades and Liconsa. In addition, the government has national food fortification and food coupon programmes directed to vulnerable populations. Several other initiatives are being implemented to address the double burden of disease: the Mexican Institute of Social Security's Preven-IMSS is an integrated health programme with an important nutrition and physical activity component; and the Ministry of Health has a programme for adults and elderly people that emphasizes prevention of non-communicable chronic diseases as one of its objectives.

The Oportunidades programme

The current comprehensive national programme for human development – Oportunidades – has three main components: nutrition, education and health. Among its diverse inputs are cash transfers, food coupons, food supplements for preschool children and pregnant women, and medical services (Barquera, Rivera-Dommarco and Gasca-Garcia, 2001). This programme has the general objective of supporting families that are suffering from extreme poverty by increasing the capacities of their members and increasing their education, health care and food options (Ministry of Social Development, 2000). In addition, it acts as a link to new services and development programmes to improve socio-economic conditions and quality of life.

The education component supports the registration and regular assistance of participating children through scholarships and school materials support. The health component has four specific strategies: delivering free health care services; preventing child undernutrition at the pre-gestational age through the delivery of food supplements; promoting and improving self-sufficiency through education; and improving families' health care and nutrition status. The food component provides direct cash transfer supports to beneficiary families in order to improve dietary quantity, quality and diversity with the aim of improving nutritional status. Supplement delivery and nutrition education are designed to reinforce adequate nutrition among infants and women.

In 2004, the programme had an annual budget of about US$2 273 million, and covered 5 million families in rural and urban areas in more than 70 000 locations of Mexico's 31 states. In order to measure the programme's impact on beneficiary families, external academic institutions designed evaluations (Bautista *et al.,* 2003; Behrman and Hoddinott, 2000; Parker, 2004; Rivera *et al.,* 2004b). Among the impacts observed during these evaluations are: a 12 percent reduction in the prevalence of disease in children under five years of age; an 8 percent increase in pregnant women's attendance at health care centres; a 59 percent increase in attendance at health care centres among the programme's beneficiaries; a 19 percent reduction in the number of days of morbidity among adults; a height increase in children under three years of age; and a 23.9 percent decrease in anaemia prevalence in children under two years of age.

The Liconsa programme

Iron deficiency anaemia (IDA) is a public health problem in Mexican children. Among children aged 12 to 23 months, MNS–2 (1999) found prevalence of anaemia of 49 percent, with iron deficiency (percentage transferrin saturation < 16) at 66 percent. Thus, approximately two-thirds of anaemic children were iron-deficient (Shamah-Levy *et al.,* 2003). Although total dietary iron intake in Mexican children is high relative to recommendations, the intake of haem iron is low, while the consumption of foods that inhibit iron absorption – such as phytates – is high.

Since 1944, a Federal Government programme – Liconsa – has been distributing low-cost milk to low-income families with children aged one to 11 years (Barquera, Rivera Dommarco and Gasca-Garcia, 2001). Since 1970, the milk distributed by this programme has been fortified with vitamins A and D according to sanitary norms. No further nutritional improvements were introduced until 2002, when in response to the high prevalence of IDA and its detrimental effects the government decided to fortify further the milk that Liconsa was distributing to about 5 million children. Every 400 ml daily ration of milk now contains 6.6 mg of iron (as gluconate), 6.6 mg of zinc (as oxide), 60 mg of vitamin C, 40.2 mcg of folic acid, and 0.55 mcg of vitamin B12.

The effectiveness and efficacy of the new fortified milk was assessed in 2003 among children aged 12 to 30 months at baseline by the National Institute of Public Health (Rivera *et al.,* 2005; Villalpando *et al.,* 2005). A double blind effectiveness trial was carried out at 17 milk distribution centres located in four states in Central Mexico. Baseline prevalence of anaemia fell in both the non-fortified (from 43.9 to 23.9 percent) and fortified (from 47.6 to 17.8 percent) groups by 20.0 and 29.8 percentage points, respectively. Thus, 33 percent of the reduction in the group receiving the fortified milk was attributable to the programme. The programme was effective in reducing the prevalence of anaemia in 12 to 30-month-old children over a six-month period. Extrapolating these results to all the children who were exposed to the programme during the course of the study, it is estimated that more than 50 000 cases of anaemia were prevented during the six-month period. A far larger number of older children (ages not evaluated) probably also benefited as a result of the programme. Based on these results, the National Institute of Public Health recommended that distribution of fortified milk be continued and incorporated into other food assistance programmes that distribute milk.

The Preven-IMSS programme

The Mexican Institute for Social Security (MISS) provides health services to approximately 50 percent of the population. As part of recent efforts to improve these services, MISS designed and implemented an integrated strategy for health programmes called Preven-IMSS, which focuses on a portfolio of preventive actions aimed at improving the health status of target populations. This is the first massive prevention programme to be launched by MISS. Starting in 2002, actions were organized for different age groups and vulnerable populations: children up to ten years of age; adolescents aged ten to 19 years; women aged 20 to 59 years; men aged 20 to 59 years; and elderly adults over 60 years of age. Activities include major food and nutrition, physical activity and health education components (MISS, 2005).

The main preventive actions among *children* focus on health promotion; nutrition education; disease control and prevention; early identification of diseases; oral health; vaccination; and miscellaneous issues such as personal hygiene, breastfeeding issues and fever control. For *adolescents* activities include physical activity; prevention of accidents, violence and addiction; oral health; sexual health and education; nutrition education; overweight and obesity detection and control; parasite treatment; vaccination; condom use; prevention of human immunodeficiency virus (HIV) and sexually transmitted diseases (STD); visual, auditory and postural defects; and reproductive health.

Activities directed to *women,* include health care education; physical activity; oral health; sexual education; prevention of addiction, accidents and family violence; nutrition education; detection and control of overweight and obesity; detection of anaemia; prevention of HIV and STD; prevention of tuberculosis; mammary cancer; cervical and uterine cancer; diabetes mellitus; high blood pressure; reproductive health; post-pregnancy care; climaterium attention and prevention of menopause complications; and vaccination. Activities for *men* focus on health care education; nutrition education; physical activity; diabetes mellitus; high blood pressure; obesity; prevention of accidents and violence; prevention of HIV and STD; prevention of tuberculosis; oral health; sexual education; and vaccination.

Among *older adults* the main preventive actions focus on health care education; physical activity; oral health; prevention of accidents and family violence; sexual education; prostate disease; detection and control of undernutrition, overweight and

obesity; vaccination; prevention of tuberculosis; post-menopause care; mammary, cervical and uterine cancer; diabetes mellitus; and high blood pressure.

For each preventive action there is a set of activities and objectives designed for each age group. As part of the promotion strategy, this programme produces a magazine with health care information related to its activities, which is sold at newspaper shops nationwide. In addition, television advertisements are broadcast every day, focusing on lifestyles, nutrition and obesity, and promoting the magazine to the general public.

Ministry of Health programmes for non-communicable chronic diseases

The Ministry of Health has a number of programmes that include prevention as a component. Rather than being integrated health or nutrition programmes, these focus on the most relevant public health problems such as obesity, diabetes mellitus, high blood pressure and cancer. For each of these diseases there is a programme providing general management and prevention guidelines for government health service providers to follow.

DISCUSSION

At present, as in the past, there are many clear differences in dietary patterns and disease risk among different subpopulations of Mexico, including among different socio-economic groups, between rural and urban locations and among regions. As this case study makes clear, trends or rates of change in dietary patterns and disease risk over the last decade and a half also differ along the same lines. Many trends in dietary intake, food expenditure and health status are very clearly differentiated according to socio-economic status or income level, suggesting that poverty continues to play an important role in dietary patterns – perhaps more so than cultural differences by region or locality.

The case study found that total energy consumption dropped by about 9 percent between 1988 and 1999, but there is clear indication that underreporting was greater in 1999 than in 1988. Given the increases in per capita GNP, food availability and the prevalence of obesity observed in the country, the case study team consider that total energy intake is not decreasing in Mexico. Furthermore, the increase in total fat intake observed over the period is very likely to be underestimated, given the issues described earlier. Despite the marked underreporting of intakes in MNS–2, both fat intake and percentage of energy derived from fat had increased since MNS–1, 11 years earlier. This implies that the overall energy density of the diet also increased, which is consistent with the important shift in BMI distribution towards overweight and obesity. There is also consistency in the time-based trends observed: among women, the increase in percentage of energy intake from fat that occurred between MNS–1 and MNS–2 was greater among women of higher socio-economic status, as was the increase in prevalence of overweight and obesity that was determined from the same surveys. Nonetheless, in the absence of comparative data on physical activity, the relative contribution to weight gain of increased energy intake and decreased energy expenditure in the population cannot be assessed adequately. In order more fully to understand the contribution of dietary changes in this phenomenon, it is necessary to collect reliable information on physical activity and related lifestyle factors.

Vegetable fat was the greatest source of dietary fat in both rural and urban populations, with the second most important sources being milk in urban and maize products in rural areas. As the purchase of milk products continues to rise, a good public health measure to help reduce fat intake may be to promote greater availability of reduced-fat milk and milk products. Although maize is not likely to be an important source of fat *per se*, maize

products are often prepared with fat (e.g., tortillas are fried in vegetable oil and tamales are prepared with lard). Education campaigns are the only way of achieving changes in such food preparation or selection practices.

While there is much concern about sugar intake and its likely contributions to obesity and chronic diseases, there is no satisfactory way of quantifying total sugar intake in Mexico. Dietary intake data derived from national surveys and food expenditure data are largely confined to capturing the intake of sugar added at the table or to dishes prepared at home, thereby omitting sugar derived from industrialized foods (e.g., sweet drinks, cookies, cakes), which may often be consumed outside the home. Soda may well be a sentinel food for total sugar intake, but other sources may be important contributors. In order adequately to quantify and monitor the intakes and specific food sources of sugar, it is necessary to include sugar in the food composition database used for dietary intake assessment in the future.

The gap that remains between lower- and upper-income quintiles in the purchase of micronutrient-rich foods (meats, milk and dairy products, vegetables and fruit) suggests that there will also remain inequalities in the micronutrient adequacy of the diet among socio-economic status groups. When expressed as percentage adequacy of intakes there was a clear trend of greater adequacies at higher socio-economic levels for vitamins A, D and B12, while the adequacies of iron, zinc, folate and calcium showed no apparent trend with socio-economic level. This can be explained by the fact that the foods that contribute most to intakes of vitamins A, D and B12 are also those for which the greatest intake and purchase discrepancies occur (i.e., meat, dairy products and vegetables). On the other hand, the foods that contribute most to intakes of calcium, iron, zinc and folate come from food groups with similar intakes or purchase distributions among different socio-economic or income groups (i.e., maize products, legumes). Biochemical indicators for micronutrient status determined in MNS–2 conform with the dietary data. Most notable is the apparent increase in the prevalence of anaemia with an apparent decrease in the adequacy of iron intakes among women.

While the adequacy of intakes of vitamins A and B12 and folate has improved substantially, iron adequacy decreased by about 30 percent. (Although the iron adequacy estimate according to United States dietary recommendations was > 100 percent, the case study team considers this to be an overestimate of the true adequacy because the bioavailability of iron from the Mexican diet – about 7.5 percent [Rivera *et al.,* 2005] – is far lower than the 18 percent assumed for the United States population [Institute of Medicine, 2001].) Tortillas and beans have high contents of phytic acid and other food components that inhibit iron absorption, so percentage iron adequacies are not useful predictors of iron intakes without accounting for bioavailability.

Owing to the underreporting of intakes in MNS–2, it is likely that the changes in nutrient intakes and adequacy were underestimated. The case study team therefore thought that expressing nutrient intakes as density (nutrient/100 kcal) may be more indicative of the quality of the diet. It was found that the density of iron was also lower in MNS–2 than in MNS–1, which could be attributable either to differences in the iron content of some key foods in the food composition tables used in each of the surveys, or to the increased energy density of the diet, as suggested by the greater percentage of energy derived from fats in MNS–2. Vitamin A and folate showed large increases in total intake, and higher densities of these nutrients were also found in MNS–2, despite the underreporting and the increased energy density of the diet. Interestingly, the trend was reversed for the folate densities recorded in MNS–1 and MNS–2; while folate densities were higher in higher socio-economic levels and urban areas in MNS–1, the opposite was true in MNS–2. This is

difficult to interpret, as biochemical data for overt folate deficiency do not suggest that such a trend exists (Shamah-Levy *et al.,* 2003).

Although large quantities of resources are being directed to programmes to prevent micronutrient deficiencies among the poorest populations (e.g., Oportunidades and Liconsa), certain micronutrient deficiencies – such as those of iron, zinc and folate – still persist in populations of moderate to high socio-economic status levels. The fortification of maize flour with iron and folate is mandatory in Mexico, but only about half the population consumes maize products made from flour. The other half derives maize products from a nixtamalized maize dough, which is currently not fortified because of technological and logistic difficulties. One possible public health measure would be to encourage industry to fortify additional basic foods with micronutrients in order to reach the entire population.

Prevalence of child stunting, which is a result of chronic undernutrition early in life, showed a substantial decrease (23 percent) between the two surveys. This change was not homogeneous, however, and prevalence was as high as 38 percent in the South region, 40.1 percent in rural locations and 40.8 percent in the lowest socio-economic quintile. Stunting therefore continues to be a main public health and nutrition challenge. Mexico has a higher prevalence of stunting than the average for Latin American countries (Rivera *et al.,* 2004a). This problem coexists with another common form of malnutrition – overweight and obesity, which is present in high prevalence in not only developed regions but also in rural locations and the South. Overall, 62.3 percent of men and 67.6 percent of women over 20 years of age are overweight or obese. This represents relative increases of 19.8 and 13.6 percent, respectively, in only seven years. Diabetes mellitus, which is commonly associated with overweight and obesity, has also doubled in recent years (Barquera, Rivera Dommarco and Gasca-Garcia, 2001).

Although the collection and interpretation of data on nutritional and health status may have become more standardized, there is a great need to adapt and improve methods of data collection on dietary habits. The important impact of underreporting on the interpretation of dietary intake data is of concern, and efforts should be made to develop innovative methods of quantifying food consumption, both inside and outside the home. This is of great concern because underreporting appears to be intimately linked with degree of overweight. Trends in the quality of food consumed outside the home may be of special concern, but these cannot be assessed with the data that are available at present; food consumption outside the home may be underestimated in the food intake surveys, and the types of foods consumed outside the home are not captured by food expenditure studies. Although food expenditure data may reflect consumption in urban areas fairly accurately, they are less reliable among rural populations, where domestic agricultural production contributes more to total intakes. Surveys combining food intake data for both inside and outside the home, expenditure data and food production data would be useful for monitoring dietary trends and informing the design of dietary and food policy interventions.

CONCLUSIONS

Although this analysis used cross-sectional surveys that lack the conditions necessary to establish causal relationships, the information obtained can be used to identify opportunities for action and research aimed at reducing and controlling nutrition-related diseases. The double burden of disease related to under- and overnutrition represents one of Mexico's most challenging public health problems (Ministry of Health, 2001). Anaemia and other micronutrient deficiencies coexist with rising levels of obesity, type-2 diabetes,

high blood pressure and dislipidaemias. Clearly, nutritional recommendations must be developed to avoid collateral negative effects, but this is not a simple task. For example, there is a need for interventions that promote higher energy intakes, particularly among schoolchildren from marginal communities and among vulnerable groups. This situation needs to be addressed through targeted interventions with educational messages promoting adequate calorie intakes that include the consumption of a variety of fruits and vegetables, and not only energy-dense foods as these can be a factor in the development of future nutrition-related chronic diseases. Funds for the prevention and control of obesity in children and adults should become a health expenditure priority in order to avoid the higher costs generated by cardiovascular risk factors associated with excess body fat and adiposity.

In Mexico, the diet is changing rapidly and becoming more homogeneous across regions, locations and socio-economic groups. The same is happening with morbidity and mortality patterns. Increasing urbanization and modernization could reduce, for better or worse, the polarization currently observed in the country. The national food fortification policy (i.e., folate, zinc, iron) and the distribution of micronutrient supplements to vulnerable groups are playing a key role in reducing the prevalence of stunting and micronutrient deficiencies. The importance of MNS–2's recommendation to improve the targeting of nutrition inputs to the most vulnerable populations has been recognized, as has the importance of evaluating the impact of food and nutrition programmes in order to distribute scarce resources more efficiently.

Overweight, obesity and other diet-related non-communicable diseases are currently the main nutrition and public health problem. The success of focusing health policy on preventing infectious diseases, improving reproductive health and preventing some micronutrient deficiencies has modified the shape of Mexico's population pyramid. It is now necessary to adapt the health systems to face a relatively new type of disease, which can only be prevented and controlled by organized responses involving not only policy planners, but also communities, families and people interacting with the health and education sectors to regulate, promote and inform about diseases. The coexistence of obesity and undernutrition has been documented in diverse Latin American countries (Garret and Ruel, 2003; Popkin, Richards and Montiero, 1996; Sawaya *et al.,* 2003).

In Mexico, an estimated 6.1 percent of overweight mothers have a stunted child under five years of age (Barquera, 2005). This fact, together with the high prevalence of obesity in adults, suggests that programmes aimed at improving nutrition should always consider the high risk of obesity. Thus, nutrition programmes must address the double burden of disease, and focus on comprehensive integrated approaches – including the promotion of adequate nutrition through education and environmental changes – rather than trying to solve the problem though one-dimensional interventions such as the use of supplements or food coupons. The health sector, which for a long time was concerned exclusively with infections and other acute health problems, must now pay attention to nutrition-related chronic diseases, which are a very different type of health problem. Thus, health professionals require training so that they can encourage appropriate behavioural change in the population (WHO, 2002).

Among the topics that should be addressed through integrated nutrition programmes are general education on health and nutrition in order to foster a culture where healthy eating practices are promoted, increasing the consumption of fruits and vegetables, and implementing regulatory measures focused on food and nutrition in public schools (Kennedy, Nantel and Shetty, 2004). Studies need to be carried out in order to identify cost-effective policies aimed at preventing, reducing and controlling nutrition-related

diseases, including behavioural change and environmental modifications. Such interventions could use the experiences and data from previous studies (mostly conducted in developed countries) as a reference. However, given the unique characteristics of Mexico – in terms of heterogeneous socio-economic development, infrastructure and cultural background – it will be necessary to evaluate the feasibility and impact of these. Improved methods of data collection for evaluation and monitoring purposes should also be emphasized.

Various institutions, universities and government bodies are implementing a wide range of research projects in Mexico to improve the understanding of and to prevent nutrition-related and other emerging diseases. The results of these studies will contribute to ameliorating and controlling these health challenges (Fernald, Gertler and Olaiz, 2005; Fernald *et al.,* 2004; Rivera *et al.,* 2005; 2004b).

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ANNEX 1 :ACHIEVEMENT OF POPULATION NUTRIENT INTAKE GOALS, 1988 AND 1999

Gender	Age group (years)	% of population with 15–30% energy intake from fat		% of population with < 10% energy intake from free sugars[1]	% of population with 55–75% energy intake from carbohydrate		% of population consuming ≥ 400 g/day fresh fruits and vegetables
		1988	1999	1999	1988	1999	1999
Male	10–11	-	36.7	99.4	-	45.1	-
Female	10–11	-	30.5	99.4	-	41.7	-
	12–19	41.2	36.9	95.0	43	47.2	9.3
	20–29	41.8	37.6	98.1	45.1	41.9	8.6
	30–39	39.4	40.3	97.3	44.9	43.2	10.7
	40–49	41.2	45.0	98.5	42.8	48.2	8.3
	12–49	40.9	39.6	97.4	44.2	44.3	9.3

[1] Determined from intakes of sugar added to foods or beverages in the household only. Will be recalculated in a future report to include sugar derived from composite dishes and industrialized foods.
Sources: MNS–1, 1988; MNS–2, 1999.

ANNEX 2: MEAN DAILY CONSUMPTION PER AE AND PERCENTAGE OF TOTAL EXPENDITURE ON FOOD, BY FOOD GROUP AND REGION, 1989 TO 2002

Food group	Year	Region																			
		North					Central					Mexico City					South				
		%[1]	%[2]	g/d[3]	(RC)[4]	Per capita (g/d)[5]	%[1]	%[2]	g/d[3]	(RC)[4]	Per capita (g/d)[5]	%[1]	%[2]	g/d[3]	(RC)[4]	Per capita (g/d)[5]	%[1]	%[2]	g/d[3]	(RC)[4]	Per capita (g/d)[5]
Cereals (g)	1989	94.3	15	346	(1.00)	326	94.7	17	428	(1.00)	406	94.7	12	361	(1.00)	341	93.0	20	545	(1.00)	507
	1992	92.5	16	332	(0.96)	307	95.7	17	403	(0.94)	385	95.2	13	342	(0.95)	325	93.5	20	458	(0.84)	428
	1994	94.4	19	333	(0.96)	314	94.7	18	362	(0.85)	343	95.2	12	312	(0.87)	297	93.3	21	409	(0.75)	381
	1996	95.1	18	346	(1.00)	329	96.6	22	395	(0.92)	382	96.6	16	363	(1.01)	351	94.4	23	434	(0.80)	410
	1998	94.4	19	317	(0.92)	299	94.5	21	372	(0.87)	351	96.7	15	334	(0.93)	323	93.5	22	418	(0.77)	391
	2000	95.4	18	328	(0.95)	313	96.2	20	366	(0.86)	352	95.1	15	321	(0.89)	306	94.4	22	463	(0.85)	437
	2002	95.6	19	312	(0.90)	298	96.2	21	380	(0.89)	365	97.7	16	324	(0.90)	317	94.9	21	401	(0.74)	381
Meats (g)	1989	80.1	29	116	(1.00)	93	78.4	32	102	(1.00)	80	90.3	38	147	(1.00)	133	72.2	34	127	(1.00)	92
	1992	76.0	26	127	(1.10)	97	82.6	28	112	(1.10)	93	92.7	33	160	(1.08)	148	75.0	29	114	(0.90)	86
	1994	80.8	29	134	(1.16)	109	83.9	29	114	(1.12)	96	92.1	34	163	(1.11)	151	79.3	31	119	0.94)	95
	1996	82.3	24	117	(1.01)	96	80.9	23	92	(0.90)	75	93.0	31	139	(0.95)	129	78.5	27	107	(0.84)	84
	1998	78.8	24	118	(1.02)	93	79.7	24	102	(0.99)	81	93.3	30	148	(1.00)	138	75.4	28	117	(0.92)	88
	2000	82.6	23	140	(1.21)	116	84.5	23	112	(1.09)	94	90.5	27	148	(1.00)	134	82.0	29	129	(1.01)	106
	2002	81.7	24	134	(1.16)	110	83.1	22	109	(1.06)	90	93.7	30	157	(1.07)	147	84.1	28	126	(0.99)	106
Eggs (g)	1989	61.7	6	72	(1.00)	44	60.5	5	53	(1.00)	32	66.3	4	63	(1.00)	42	61.6	5	44	(1.00)	27
	1992	56.8	5	68	(0.94)	38	60.1	4	56	(1.06)	34	69.8	4	66	(1.04)	46	66.0	6	48	(1.09)	32
	1994	57.2	6	72	(1.00)	41	59.7	4	56	(1.06)	33	67.6	4	68	(1.07)	46	60.4	5	47	(1.06)	29
	1996	62.1	7	67	(0.92)	41	64.0	6	48	(0.91)	31	74.6	6	63	(1.00)	47	64.1	7	45	(1.01)	29
	1998	56.8	6	65	(0.91)	37	60.7	5	53	(0.99)	32	70.9	4	62	(0.98)	44	57.9	5	50	(1.12)	29
	2000	58.5	5	69	(0.96)	41	62.6	4	55	(1.05)	35	69.5	4	68	(1.08)	47	64.9	4	52	(1.17)	34
	2002	54.5	5	72	(0.99)	39	57.2	4	56	(1.06)	32	66.5	3	62	(0.99)	41	62.1	5	55	(1.24)	34
Milk and dairy products (g)	1989	82.4	14	264	(1.00)	218	75.1	15	301	(1.00)	226	85.4	10	304	(1.00)	260	57.7	13	183	(1.00)	106
	1992	77.7	14	283	(1.07)	220	76.8	13	306	(1.02)	235	87.3	11	319	(1.05)	279	57.6	11	176	(0.96)	101
	1994	83.8	16	277	(1.05)	232	75.9	13	294	(0.98)	223	88.3	11	328	(1.08)	289	58.5	11	178	(0.97)	104
	1996	83.2	15	243	(0.92)	202	76.5	15	279	(0.93)	213	88.6	12	295	(0.97)	262	58.5	11	170	(0.93)	99
	1998	83.3	16	242	(0.92)	202	76.1	15	301	(1.00)	229	90.3	12	305	(1.00)	275	55.7	12	186	(1.01)	103
	2000	85.7	16	258	(0.98)	221	81.6	15	297	(0.99)	243	87.5	13	309	(1.02)	271	61.6	11	167	(0.91)	103
	2002	85.1	16	263	(1.00)	224	82.3	14	297	(0.99)	244	89.0	12	369	(1.22)	329	62.4	10	163	(0.89)	102
Legumes (g)	1989	41.4	5	87	(1.00)	36	57.1	5	71	(1.00)	40	46.1	3	51	(1.00)	24	65.3	7	75	(1.00)	49
	1992	38.0	5	78	(0.90)	30	58.2	6	70	(1.00)	41	48.0	3	53	(1.02)	25	67.3	7	68	(0.90)	46
	1994	39.7	5	76	(0.87)	30	57.0	5	67	(0.95)	38	45.1	3	55	(1.07)	25	60.0	7	68	(0.90)	41
	1996	51.4	7	74	(0.85)	38	64.5	8	71	(1.00)	46	52.7	4	52	(1.02)	27	63.0	7	64	(0.85)	40
	1998	42.8	5	77	(0.88)	33	57.4	6	68	(0.96)	39	51.7	4	53	(1.03)	27	59.3	9	65	(0.86)	38
	2000	39.4	4	73	(0.84)	29	55.8	4	65	(0.92)	36	45.8	3	57	(1.10)	26	61.9	5	69	(0.92)	43
	2002	29.3	5	73	(0.84)	21	49.5	5	65	(0.91)	32	42.9	3	50	(0.98)	21	61.7	7	66	(0.88)	41
Fats and oils (g)	1989	41.5	5	62	(1.00)	26	44.9	5	48	(1.00)	22	34.8	3	49	(1.00)	17	54.2	6	45	(1.00)	24
	1992	37.7	5	73	(1.18)	28	42.8	4	50	(1.03)	21	36.4	3	56	(1.15)	20	49.4	5	43	(0.96)	21

1996	49.6	6	62	(1.01)	31	48.9	6	48	(1.00)	24	40.0	4	53	(1.09)	21	48.2	6	43	(0.95)	21
1998	38.5	5	63	(1.02)	24	41.1	4	51	(1.05)	21	35.0	4	56	(1.15)	20	44.9	5	50	(1.11)	22
2000	43.0	4	73	(1.18)	31	43.0	4	53	(1.10)	23	43.3	3	66	(1.36)	29	43.9	4	52	(1.15)	23
2002	31.6	4	66	(1.06)	21	34.2	4	59	(1.22)	20	32.2	3	57	(1.16)	18	46.0	4	56	(1.24)	26

Data weighted by the expansion factors.
Sample sizes: 1989, 11 531 (expanded cases, 15 947 773); 1992, 10 508 (expanded cases, 17 798 635); 1994, 12 815, (expanded cases, 19 440 278); 1996, 14 042 (expanded cases, 20 467 038); 1998, 10 952 (expanded cases, 22 163 568); 2000, 10 089 (expanded cases, 23 452 319); 2002, 17167 (expanded cases, 24 650 169).
[1] Percentage of families reporting expenditure during the seven-day survey period.
[2] Percentage of total food expenditure.
[3] Mean grams per AE among families reporting expenditure.
[4] Relative change.
[5] Mean grams per capita.
Source: MHIES, 1989 to 2002.

ANNEX 3: MEAN DAILY CONSUMPTION PER AE AND PERCENTAGE OF TOTAL EXPENDITURE ON FOOD, BY FOOD GROUP AND REGION, 1989 TO 2002

Food group	Year	Region																			
		North					Central					Mexico City					South				
		%[1]	%[2]	g/d[3]	(RC)[4]	Per capita (g/d)[5]	%[1]	%[2]	g/d[3]	(RC)[4]	Per capita (g/d)[5]	%[1]	%[2]	g/d[3]	(RC)[4]	Per capita (g/d)[5]	%[1]	%[2]	g/d[3]	(RC)[4]	Per capita (g/d)[4]
Vegetables (g)	1989	80.0	8	126	(1.00)	101	87.3	9	145	(1.00)	127	87.2	9	213	(1.00)	185	84.5	9	118	(1.00)	100
	1992	72.2	8	130	(1.03)	94	86.1	9	147	(1.01)	126	90.1	11	236	(1.11)	212	86.4	11	119	(1.00)	103
	1994	74.0	9	133	(1.06)	99	86.2	11	153	(1.05)	132	87.5	11	217	(1.02)	190	84.4	11	120	(1.02)	102
	1996	78.6	7	139	(1.10)	109	87.6	8	150	(1.03)	131	90.8	10	229	(1.08)	208	85.4	9	130	(1.10)	111
	1998	71.1	8	122	(0.97)	87	86.4	9	148	(1.02)	128	89.6	10	216	(1.01)	193	83.1	11	128	(1.08)	106
	2000	73.8	8	140	(1.11)	104	86.7	9	165	(1.14)	143	86.8	9	212	(1.00)	184	84.5	10	143	(1.21)	121
	2002	68.7	7	141	(1.12)	97	84.2	8	167	(1.15)	140	90.4	10	231	(1.08)	209	87.3	10	158	(1.34)	138
Fruits (g)	1989	44.9	5	125	(1.00)	56	57.4	6	147	(1.00)	84	73.4	7	211	(1.00)	155	44.9	5	129	(1.00)	58
	1992	44.3	4	147	(1.18)	65	60.4	6	171	(1.17)	103	79.4	7	243	(1.16)	193	41.3	5	169	(1.32)	70
	1994	46.2	5	148	(1.19)	69	62.4	5	169	(1.15)	105	76.2	7	253	(1.20)	193	44.4	6	174	(1.35)	77
	1996	49.6	4	132	(1.06)	66	55.2	5	150	(1.03)	83	74.9	5	207	(0.98)	155	43.4	4	147	(1.14)	64
	1998	42.9	4	119	(0.96)	51	54.6	5	149	(1.01)	81	73.0	6	197	(0.93)	144	39.3	5	138	(1.08)	54
	2000	47.8	5	160	(1.29)	77	61.3	6	200	(1.37)	123	79.3	7	233	(1.11)	185	46.4	5	163	(1.27)	76
	2002	38.3	5	166	(1.33)	63	56.5	5	177	(1.21)	100	73.8	6	221	(1.05)	163	44.8	5	143	(1.11)	64
Sugar (g)	1989	26.4	3	78	(1.00)	21	41.8	3	67	(1.00)	28	26.5	3	94	(1.00)	25	51.7	4	80	(1.00)	41
	1992	27.2	3	80	(1.02)	22	37.4	3	68	(1.01)	25	30.1	2	84	(0.88)	25	49.6	5	82	(1.03)	41
	1994	27.4	3	76	(0.98)	21	38.7	3	71	(1.06)	28	28.8	3	89	(0.94)	25	50.5	5	79	(0.99)	40
	1996	34.1	4	74	(0.95)	25	43.4	4	59	(0.88)	26	33.5	3	69	(0.73)	23	50.1	5	74	(0.92)	37
	1998	27.6	3	69	(0.89)	19	40.6	3	62	(0.93)	25	31.3	3	79	(0.84)	25	44.1	4	79	(0.99)	35
	2000	28.5	3	79	(1.01)	22	42.0	3	64	(0.96)	27	33.3	2	74	(0.78)	25	46.7	4	75	(0.94)	35
	2002	23.2	3	86	(1.10)	20	37.2	3	71	(1.06)	26	29.6	2	72	(0.76)	21	47.4	5	86	(1.08)	41
Soda (ml)	1989	72.6	8	259	(1.00)	188	51.6	5	174	(1.00)	90	46.7	4	226	(1.00)	106	33.8	4	169	(1.00)	57
	1992	71.5	10	274	(1.06)	196	56.5	5	182	(1.05)	103	46.6	4	234	(1.04)	109	35.4	6	177	(1.05)	63
	1994	71.1	5	299	(1.15)	213	55.4	4	197	(1.13)	109	52.0	4	237	(1.05)	123	39.3	4	198	(1.17)	78
	1996	69.2	9	248	(0.96)	172	54.9	6	177	(1.02)	97	42.9	5	201	(0.89)	86	41.3	7	174	(1.02)	72
	1998	73.4	11	281	(1.09)	207	62.4	9	221	(1.27)	138	53.4	6	217	(0.96)	116	47.0	8	206	(1.22)	97
	2000	80.4	12	335	(1.29)	269	64.8	8	231	(1.33)	150	57.0	6	236	(1.04)	134	46.7	8	217	(1.28)	101
	2002	78.4	12	315	(1.22)	247	66.0	8	221	(1.27)	146	58.7	6	231	(1.02)	136	47.7	8	200	(1.18)	96
Alcohol (ml)	1989	7.0	10	262	(1.00)	18	4.8	7	148	(1.00)	7	4.9	10	82	(1.00)	4	6.6	12	154	(1.00)	10
	1992	7.1	11	239	(0.91)	17	4.2	9	169	(1.14)	7	4.9	8	165	(2.01)	8	5.4	8	211	(1.37)	11
	1994	8.1	12	255	(0.98)	21	7.2	8	201	(1.36)	15	4.7	6	98	(1.19)	5	6.5	10	141	(0.91)	9
	1996	7.1	9	209	(0.80)	15	5.8	8	209	(1.41)	12	3.5	5	103	(1.25)	4	5.2	10	180	(1.17)	9
	1998	10.7	10	181	(0.69)	19	6.2	7	134	(0.91)	8	4.7	8	113	(1.38)	5	5.5	12	290	(1.88)	16
	2000	8.9	12	208	(0.79)	18	7.3	10	174	(1.17)	13	7.3	11	93	(1.13)	7	5.0	12	199	(1.29)	10

Tobacco (g)	1989	18.8	7	6.0	(1.00)	1.12	16.9	5	2.9	(1.00)	0.50	24.2	4	2.9	(1.00)	0.71	8.2	4	1.8	(1.00)	0.15
	1992	29.2	9	3.8	(0.64)	1.11	23.7	6	2.6	(0.87)	0.61	25.5	5	3.2	(1.08)	0.81	11.3	4	1.7	(0.91)	0.19
	1994	15.7	9	3.1	(0.53)	0.49	13.1	7	3.4	(1.17)	0.45	11.2	6	5.1	(1.73)	0.57	6.1	6	2.9	(1.58)	0.17
	1996	10.7	6	3.5	(0.59)	0.37	12.4	5	3.4	(1.14)	0.42	7.6	5	3.9	(1.31)	0.29	5.9	4	2.3	(1.27)	0.14
	1998	11.3	7	3.5	(0.58)	0.39	10.9	6	3.5	(1.17)	0.38	9.0	4	5.7	(1.92)	0.51	4.6	4	2.8	(1.56)	0.13
	2000	11.2	7	4.0	(0.68)	0.45	11.4	7	3.6	(1.22)	0.41	9.6	4	4.0	(1.36)	0.39	5.3	6	2.8	(1.56)	0.15
	2002	9.0	10	15.9	(2.66)	1.42	9.0	6	6.4	(2.17)	0.58	9.8	4	5.2	(1.75)	0.51	2.2	5	7.4	(4.10)	0.17

Data weighted by the expansion factors.
Sample sizes: 1989, 11 531 (expanded cases, 15 947 773); 1992, 10 508 (expanded cases, 17 798 635); 1994, 12 815, (expanded cases, 19 440 278); 1996, 14 042 (expanded cases), 20 467 038; 1998, 10 952 (expanded cases, 22 163 568); 2000, 10 089 (expanded cases, 23 452 319); 2002, 17167 (expanded cases, 24 650 169).
[1] Percentage of families reporting expenditure during the seven-day survey period.
[2] Percentage of total food expenditure.
[3] Mean grams or millilitres per AE among families reporting expenditure.
[4] Relative change.
[5] Mean grams or millilitres per capita.
Source: MHIES, 1989 to 2002.

ANNEX 4: MEDIAN DAILY FOOD EXPENDITURE OUTSIDE THE HOME AS PERCENTAGE OF TOTAL FOOD EXPENDITURE, 1989 TO 2002

	Region								Location[1]			
Year*	North		Central		Mexico City		South		Urban		Rural	
1989	2	(1.00)	21	(1.00	28	(1.00	19	(1.00)	24	(1.00)	16	(1.00)
1992	2	(1.00)	25	(1.19	28	(1.00	19	(1.00)	25	(1.04)	20	(1.25)
1994	2	(0.96)	26	(1.24	34	(1.21	24	(1.26)	28	(1.17)	20	(1.25)
1996	2	(1.09)	18	(0.86	28	(1.00	21	(1.11)	24	(1.00)	18	(1.13)
1998	2	(1.00)	20	(0.95	27	(0.96	20	(1.05)	24	(1.00)	17	(1.06)
2000	2	(1.00)	22	(1.05	25	(0.89	24	(1.26)	25	(1.04)	19	(1.19)
2002	2	(1.22)	23	(1.10	31	(1.11	23	(1.21)	28	(1.17)	20	(1.25)

Data weighted by the expansion factors.
Sample sizes: 1989, 11 531 (expanded cases, 15 947 773); 1992, 10 508 (expanded cases, 17 798 635); 1994, 12 815, (expanded cases, 19 440 278); 1996, 14 042 (expanded cases, 20 467 038); 1998, 10 952 (expanded cases, 22 163 568); 2000, 10 089 (expanded cases, 23 452 319); 2002, 17167 (expanded cases) 24 650 169).
[1] Location: urban > 15 000 inhabitants; rural ≤ 15 000 inhabitants.
Source: MHIES, 1989 to 2002.

ANNEX 5: MEAN DAILY CONSUMPTION PER AE AND PERCENTAGE OF TOTAL EXPENDITURE ON FOOD, BY FOOD GROUP AND LOCATION, 1989 TO 2002

Food groups	Year	Location[1]									
		Urban					Rural				
		%[2]	%[3]	g/d[4]	(RC)[5]	Per capita (g/d)[6]	%[2]	%[3]	g/d[4]	(RC)[5]	Per capita (g/d)[6]
Cereals (g)	1989	95.8	14	387	(1.00)	371	91.1	22	534	(1.00)	486
	1992	95.3	15	358	(0.92)	341	92.7	22	470	(0.88)	436
	1994	94.9	16	335	(0.87)	318	93.4	24	412	(0.77)	385
	1996	96.1	18	354	(0.91)	340	95.0	25	452	(0.85)	429
	1998	95.8	17	333	(0.86)	319	92.5	24	427	(0.80)	395
	2000	96.0	17	335	(0.86)	321	94.1	23	461	(0.86)	434
	2002	97.0	18	325	(0.84)	315	94.3	24	428	(0.80)	403
Meats (g)	1989	87.9	35	132	(1.00)	116	61.5	29	86	(1.00)	53
	1992	88.2	30	136	(1.04)	120	66.5	25	89	(1.04)	59
	1994	90.0	32	141	(1.07)	127	71.5	26	94	(1.09)	67
	1996	88.8	27	124	(0.94)	110	73.1	23	87	(1.01)	64
	1998	88.1	27	132	(1.01)	117	68.4	24	92	(1.06)	63
	2000	88.6	26	141	(1.07)	125	77.4	24	108	(1.25)	83
	2002	89.1	26	142	(1.08)	127	78.2	23	102	(1.19)	80
Eggs (g)	1989	66.1	5	60	(1.00)	40	54.1	6	45	(1.00)	24
	1992	67.4	4	60	(0.99)	40	54.0	6	51	(1.14)	28
	1994	63.8	4	61	(1.01)	39	54.7	6	52	(1.15)	28
	1996	69.2	6	59	(0.98)	41	60.1	7	45	(1.01)	27
	1998	64.1	5	60	(0.99)	38	55.6	6	49	(1.11)	28
	2000	64.3	4	63	(1.04)	40	63.0	5	54	(1.21)	34
	2002	61.3	4	62	(1.02)	38	57.6	5	57	(1.28)	33
Milk and dairy products (g)	1989	83.9	13	296	(1.00)	249	52.5	13	179	(1.00)	94
	1992	84.2	12	302	(1.02)	254	52.2	13	187	(1.05)	98
	1994	85.8	13	302	(1.02)	259	54.2	13	178	(1.00)	97
	1996	85.6	14	277	(0.94)	237	57.5	11	181	(1.01)	104
	1998	85.8	14	283	(0.95)	242	54.4	13	206	(1.15)	112
	2000	86.6	14	282	(0.95)	244	61.0	13	203	(1.14)	124
	2002	86.6	13	303	(1.02)	262	63.2	12	200	(1.12)	127
Legumes (g)	1989	52.1	4	63	(1.00)	33	60.6	9	87	(1.00)	53
	1992	53.3	4	63	(1.00)	33	60.5	9	78	(0.89)	47
	1994	49.3	4	60	(0.96)	30	59.5	9	77	(0.89)	46
	1996	55.9	6	59	(0.94)	33	64.3	10	76	(0.87)	49
	1998	51.2	5	59	(0.95)	30	58.4	10	75	(0.85)	44
	2000	48.4	3	60	(0.95)	29	59.9	7	76	(0.87)	45
	2002	42.2	4	57	(0.90)	24	57.8	7	73	(0.83)	42
Fats and oils (g)	1989	41.4	4	51	(1.00)	21	53.3	8	47	(1.00)	25
	1992	38.4	3	54	(1.05)	21	51.0	6	50	(1.05)	25
	1994	39.8	3	57	(1.11)	23	51.8	6	53	(1.12)	28
	1996	42.7	5	52	(1.02)	22	54.4	7	48	(1.02)	26
	1998	36.8	4	54	(1.06)	20	47.0	6	53	(1.13)	25
	2000	40.3	3	64	(1.25)	26	48.5	5	53	(1.11)	25
	2002	31.4	3	57	(1.11)	18	46.4	5	61	(1.29)	28

Vegetables (g)	1989	86.7	8	166	(1.00)	144	82.3	9	101	(1.00)	83
	1992	85.2	9	168	(1.01)	144	81.8	11	105	(1.04)	86
	1994	83.8	10	166	(1.00)	139	82.8	12	115	(1.14)	96
	1996	86.6	8	181	(1.09)	157	84.4	9	122	(1.20)	103
	1998	83.5	9	170	(1.03)	142	81.8	11	118	(1.17)	97
	2000	83.0	8	178	(1.07)	148	84.4	11	138	(1.36)	116
	2002	82.7	8	184	(1.11)	153	84.1	10	154	(1.52)	129
Fruits (g)	1989	62.6	6	166	(1.00)	104	37.4	6	107	(1.00)	40
	1992	63.2	5	195	(1.18)	123	37.1	5	132	(1.23)	49
	1994	64.7	6	194	(1.17)	126	40.7	5	141	(1.32)	57
	1996	64.0	5	180	(1.08)	115	38.9	4	114	(1.06)	44
	1998	59.3	5	166	(1.01)	99	37.0	5	120	(1.12)	45
	2000	63.8	6	208	(1.26)	133	46.5	6	157	(1.47)	73
	2002	57.6	5	195	(1.18)	112	43.9	5	140	(1.31)	61
Sugar (g)	1989	32.2	2	74	(1.00)	24	53.4	4	78	(1.00)	42
	1992	31.5	3	74	(1.01)	23	49.9	5	79	(1.01)	39
	1994	31.1	3	71	(0.97)	22	51.3	6	81	(1.04)	42
	1996	35.0	3	65	(0.88)	23	52.3	5	72	(0.93)	38
	1998	33.2	3	72	(0.98)	24	44.0	5	72	(0.92)	32
	2000	33.7	2	72	(0.97)	24	48.7	4	73	(0.93)	35
	2002	29.3	3	70	(0.95)	20	47.9	5	89	(1.15)	43

Data weighted by the expansion factors.
Sample sizes: 1989, 11 531 (expanded cases, 15 947 773); 1992, 10 508 (expanded cases, 17 798 635); 1994, 12 815, (expanded cases, 19 440 278); 1996, 14 042 (expanded cases, 20 467 038); 1998, 10 952 (expanded cases, 22 163 568); 2000, 10 089 (expanded cases, 23 452 319); 2002, 17167 (expanded cases, 24 650 169).
[1] Location: urban > 15 000 inhabitants; rural ≤ 15 000 inhabitants.
[2] Percentage of families reporting expenditure during the seven-day survey period.
[3] Percentage of total food expenditure.
[4] Mean grams per AE among families reporting expenditure.
[5] Relative change.
[6] Mean grams per capita.
Source: MHIES, 1989 to 2002.

ANNEX 6: MEAN DAILY CONSUMPTION PER AE AND PERCENTAGE OF TOTAL EXPENDITURE ON FOOD, BY FOOD GROUP AND LOCATION, 1989 TO 2002

Food group *	Year	Location[1]									
		Urban					Rural				
		%[2]	%[3]	ml/d[4]	(RC) ¥	Per capita (ml/d)[6]	%[2]	%[3]	ml/d[4]	(RC)[5]	Per capita (ml/d)[6]
Soda (ml)	1989	70.8	5	224	(1.00)	122	29.2	6	150	(1.00)	61
	1992	70.9	6	226	(1.01)	133	29.1	8	173	(1.15)	70
	1994	67.6	5	251	(1.12)	148	32.4	4	178	(1.19)	79
	1996	69.2	6	217	(0.97)	123	30.8	7	161	(1.07)	68
	1998	70.0	8	245	(1.09)	161	30.0	9	202	(1.35)	93
	2000	70.9	8	273	(1.22)	185	29.1	9	212	(1.41)	103
	2002	70.9	8	259	(1.16)	178	29.1	9	201	(1.34)	99
Alcohol (ml)	1989	62.1	8	169	(1.00)	9	37.9	12	165	(1.00)	10
	1992	69.7	9	195	(1.15)	11	30.3	10	215	(1.30)	9
	1994	59.9	9	177	(1.05)	12	40.1	13	206	(1.25)	15
	1996	63.9	8	162	(0.95)	9	36.1	11	233	(1.41)	12
	1998	65.9	8	151	(0.89)	11	34.1	13	258	(1.56)	15
	2000	67.8	11	161	(0.95)	12	32.2	12	193	(1.17)	12
	2002	68.5	12	269	(1.59)	12	31.5	11	215	(1.31)	8
Tobacco (g)	1989	71.7	5	3.7	(1.00)	0.65	28.3	6	2.8	(1.00)	0.34
	1992	73.0	6	2.9	(0.78)	0.72	27.0	8	2.6	(0.96)	0.40
	1994	64.6	6	3.3	(0.90)	0.40	35.4	9	3.6	(1.32)	0.37
	1996	66.4	5	3.6	(0.98)	0.35	33.6	6	2.6	(0.95)	0.22
	1998	69.0	5	4.1	(1.11)	0.40	31.0	6	3.0	(1.10)	0.21
	2000	68.7	5	3.9	(1.04)	0.38	31.3	6	3.2	(1.17)	0.25
	2002	75.0	6	9.5	(2.57)	0.80	25.0	9	5.7	(2.09)	0.28

Data weighted by the expansion factors.
Sample sizes: 1989, 11 531 (expanded cases, 15 947 773); 1992, 10 508 (expanded cases, 17 798 635); 1994, 12 815, (expanded cases, 19 440 278); 1996, 14 042 (expanded cases, 20 467 038); 1998, 10 952 (expanded cases, 22 163 568); 2000, 10 089 (expanded cases, 23 452 319); 2002, 17167 (expanded cases, 24 650 169).
[1] Location: urban > 15 000 inhabitants; rural ≤ 15 000 inhabitants.
[2] Percentage of families reporting expenditure during the seven-day survey period.
[3] Percentage of total food expenditure.
[4] Mean grams or millilitres per AE among families reporting expenditure.
[5] Relative change.
[6] Mean grams or millilitres per capita.
Source: MHIES, 1989 to 2002.

ANNEX 7: MAIN CAUSES OF DEATH BY LOCATION, 1990 AND 2001

Cause	Rural[1]					Urban[1]					National				
	1990		2001			1990		2001			1990		2001		
	n	%	n	%	Change	n	%	n	%	Change	n	Rate[2]	n	Rate[2]	Change
Diabetes mellitus	7 936	4	14 976	9	88.7	17 711	8	34 829	13	96.7	25 647	29.9	49 805	49.1	64.2
Coronary heart disease	10 011	5	14 581	3	45.6	19 392	9	30 626	11	57.9	29 403	34.3	45 207	44.5	30.0
Cirrhosis and others hepatic chronic diseases	7 994	4	11 004	5	37.7	9 591	4	14 335	5	49.5	17 585	20.5	25 339	24.9	21.8
Cerebrovascular disease	8 591	4	9 859	4	14.8	11 076	5	15 729	6	42.0	19 667	22.9	25 588	25.2	10.0
Chronic obstructive pulmonary diseases	5 423	3	6 196	4	14.3	6 960	3	9 694	4	39.3	12 383	14.4	15 890	15.6	8.5
Acute respiratory infections low	13 636	7	5 672	3	-58.4	10 108	5	7 272	3	-28.1	23 744	27.7	12 944	12.7	-53.9
Malnutrition caloric protean	7 331	4	4 682	3	-36.1	4 309	2	3 873	1	-10.1	11 640	13.6	8 555	8.4	-37.9
Asphyxia and injury in during birth	5 984	3	4 225	3	-29.4	8 587	4	6 781	3	-21.0	14 571	17.0	11 006	10.8	-36.1
Aggression (homicide)	7 403	4	4 091	2	-44.7	6 382	3	5 695	2	-10.8	13 785	16.1	9 786	9.6	-40.0
Nephritis and nephrosis	3 477	2	3 992	2	14.8	4 752	2	6 457	2	35.9	8 229	9.6	10 449	10.3	7.4
Hypertensive diseases	2 858	1	3 847	2	34.6	-	-	-	-	-	-	-	-	-	
Motor vehicle accidents	3 660	2	3 293	2	-10.0	4 585	2	4 888	2	6.6	8 245	9.6	8 181	8.1	-16.1
Intestinal infectious diseases	15 403	8	2 862	2	-81.4	6 674	3	-	-	-	22 077	25.7	-	-	-
Alcohol consumption	2 473	1	2 537	2	2.6	-	-	-	-	-	-	-	-	-	-
Malign bronchial or tracheal tumours	1 761	1	2 087	1	18.5	3 245	1	4 308	2	32.8	5 006	5.8	6 395	6.3	8.0

[1] Location: rural < 15 000 inhabitants; urban ≥ 15 000 inhabitants.
[2] Rate per 100 000 inhabitants.
Total population: 1990 = 85 784 220; 2001 = 101 453 433.
Source: INEGI. 2002.