Contents

The Nutrition Transition and Prevention of Diet-related Diseases in Asia and the Pacific

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Executive Summary

The nutrition transition, currently occurring in Asia and the Pacific, is one facet of a more general demographic, nutritional, epidemiological transition which accompanies development and urbanization. The nutrition transition itself is marked by a shift away from relatively monotonous diets of varying nutritional quality (based on indigenous staple grains or starchy roots, locally grown legumes, other vegetables and fruits, and limited foods of animal origin) toward more varied diets that include more preprocessed food, more foods of animal origin, more added sugar and fat, and often more alcohol. This shift is accompanied by reduced physical activity in work and leisure, leading to a rapid increase in overweight and obesity. Consequently, there is an epidemiological transition from endemic deficiency and infectious diseases (for which poor nutrition is a risk factor), toward diet-related chronic diseases, including ischemic heart disease (IHD), diabetes, obesity, hypertension, stroke, and certain cancers.

Twenty-four Asian countries were grouped by per capita gross national product (GNP) into lower low- (13), upper low- (4), middle- (4), and high- (3) income groups. An additional group was defined for the Small Island Developing States (SIDS) of the Pacific. Case studies of key diet-related chronic diseases were undertaken for the People's Republic of China (PRC) and for Sri Lanka.

The adult populations of rapidly developing countries have dietary and activity patterns vastly different to those when they were young. Many of these adults faced fetal and early childhood insults related to inadequate nutrition. A so-called fetal programming hypothesis is particularly applicable in the Asian countries and Pacific SIDS. Low-income countries in South and Southeast Asia still have high levels of low birthweight (LBW) and stunting. Related public health problems will continue well into the future. More research is needed on effects of fetal programming, LBW, and stunting in Asia and the Pacific.

Country-level food disappearance data were used to examine diet changes in the five country groups. These confirmed the broad patterns discussed above, although with some important variations. Intake of dairy products was lower in the high-income group, and higher in the lower low-income group. In the Republic of Korea, the largest high-income country, traditional diets are still widely consumed and contain few dairy products. In India, the largest lower low-income country, there is high consumption of dairy products. In general, food disappearance data indicated increased consumption of vegetables and fruits, though household data in the PRC and Sri Lanka do not appear to support this.

Dietary change has occurred concomitant with equally important shifts in physical activity patterns. Shifts in the structure of occupations have been considerable. At the same time, energy expenditures in many occupations have decreased and inactivity during leisure has increased. The rapid increase of television use is one clear trend. The health implications of these shifts toward reduced physical activity are not well researched in Asia. Furthermore, there is little basis for creating a clear cost-savings analysis of the effects of these shifts, except for increased obesity.

The epidemiological transition was reviewed for two countries in each group, from data on the proportions of deaths by cause. Early in this transition, and even when the proportions of deaths due to endemic deficiency, infectious, and parasitic diseases remain high, stroke is an important cause of death. The prevalence of hypertension and stroke continues to increase with development, unless there are adequate resources to limit hypertension. At a later stage of the transition, cardiovascular diseases (CVDs), including IHD, become the primary cause of deaths from chronic diseases. Finally, as incomes continue to rise, deaths from certain cancers increase in absolute and relative importance. Variations in this broad pattern include the emerging epidemic of adult-onset diabetes in urban India, the very high levels of obesity in the SIDS, and the high CVD levels in low-income countries with high fat diets (e.g., the Kyrgyz Republic) compared to lower levels in countries with lower fat diets (e.g., the Republic of Korea).

Obesity is now a major disease in Asia and the Pacific. International standards that delineate overweight and obesity may not be appropriate for this region, in which metabolic diseases tend to occur at lower body mass index (BMI) limits than in other regions. Data from eight countries, that are representative of the five groups, confirm increases in obesity levels with development and urbanization. There are some variations; for example, in the SIDS, obesity is higher than their income levels would have predicted. In the Republic of Korea, obesity is low because of high vegetable and low fat intakes. Data from four countries suggest that obesity is not very strongly correlated to income, except in Indonesia, where high income is indicative of urbanization. In general, obesity is a problem of the urban poor as well as the rich. The urban poor have added predisposing factors, associated with LBW.

Between 3 and 15% of Asian households contain both underweight and overweight individuals: typically an underweight child and an overweight, nonelderly adult. Expressed differently, in 30 to 60% of households where a household member is underweight, another is overweight. This has implications for policy interventions. It is oversimplistic to assume that communicable diseases are associated with poverty and noncommunicable diseases (NCDs) with affluence.

For the PRC and Sri Lanka, the relative risks of underlying diet-related factors (overweight, dietary fat, fruit and vegetable intake) as well as early childhood risk factors (LBW and stunting), were calculated for the five major diet-related chronic diseases (CVDs, cancers, diabetes, hypertension, and stroke). This analysis excluded the economic costs of lost days of work and lower productivity due to morbidity from these same diet-related chronic diseases.

In the PRC in 1995, these diseases accounted for 41.6% of all deaths, and 22.5% of all hospital expenditures. The resulting costs were equivalent to 2.1% of the gross domestic product (GDP), of which three-quarters were costs to the hospital system. At least 20 to 25% of these diseases are attributable to dietary factors. The LBWs of those who were adults in 1995 accounted for at least 10% of stroke and CVD, 33% of diabetes, and almost 50% of hypertension. From the data available, it was projected for the PRC that in 2025 diet-related chronic diseases will cause 52.0% of all deaths; dietary factors, especially overweight, will contribute between 32 and 53% to risks for these chronic diseases; and that childhood factors will have declined in significance because stunting is expected to account then for between 6 and 22% of diet-related chronic diseases.

In Sri Lanka in 1995, diet-related chronic diseases accounted for 18.3% of all deaths and 16.7% of all hospital expenditures (10.2% of public hospital expenditures). The resulting costs from diet-related chronic diseases were equivalent to 0.3% of GDP. In Sri Lanka, the prediction for 2025 is that diet-related chronic diseases will account for 20.9% of all deaths. In Sri Lanka in 1995, dietary factors contributed between 10 and 20% to risks for these chronic diseases. LBW accounted for between 1.4% to 18%, its greatest impact being on diabetes. In 2025 in Sri Lanka, it is projected that dietary factors, especially overweight, will account for 18 to 40% of diet-related chronic diseases, and that the importance of LBW as a predisposing factor will increase.

National nutrition policies have had impressive effects in selected developed countries, particularly Norway. The PRC has issued national dietary guidelines. Agricultural and pricing policies are also important. The high production and relatively cheap availability of vegetable oils in Asia has had potentially adverse effects on diets and health.

Mass communication efforts are needed. Promoting traditional diets has been helpful in limiting fat intake and obesity in the Republic of Korea. Health promotion efforts in Mauritius have succeeded in reversing several adverse trends contributing to CVD. Thailand has successfully used mass media for other areas of health promotion, and is developing pilot schemes on chronic diseases. There may also be lessons from mass media efforts in Brazil. In the Asia-Pacific region, Singapore has been the leader in exercise promotion and weight control in schools.

National food and agricultural policies, that consider diet-related chronic diseases, are a future priority. Key elements include agricultural policy shifts, promotion of traditional, healthful eating patterns, use of mass media to build public awareness regarding diet and exercise, and school-based programs. The PRC has progressed furthest in Asia toward a national plan, but needs increased capacity to link economic policy to nutritional concerns. Similarly, there is not yet enough experience in Asia and in Pacific SIDS to move to full-scale programs. Rather, implementation and evaluation of pilot studies, as well as capacity building, are needed now. It is important to continue research on the underlying causes of the demographic, nutrition, and epidemiological transition and to evolve strategies with respect to urban and rural nutrition and related emerging problems.

Finally, it is emphasized that NCDs affect the urban poor as well as the rich of Asia. Obesity is not well correlated with income. Over the next half-century, interventions against NCDs will be most important for the poor of the Asia-Pacific region. That 20 to 60% of households in this region have both undernourished and overweight members is indicative of the need to address these issues as issues of poverty and not of wealth.

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List of Abbreviations

ADB	Asian Development Bank
BMI	Body mass index
CHNS	China Health and Nutrition Survey
CVD	Cardiovascular disease
DNA	Deoxyribonucleic acid
GDP	Gross domestic product
GNP	Gross national product
HDL-C	High density lipoprotein cholesterol
IFPRI	International Food Policy Research Institute
IHD	Ischemic heart disease
IR	Insulin resistance
IUGR	Intrauterine growth retardation
LBW	Low birthweight
LDL-C	Low density lipoprotein cholesterol
MUFA	Monounsaturated fatty acids
NCD	Noncommunicable disease
NIH	National Institutes of Health
NIDDM	Noninsulin dependent diabetes mellitus
NNMB	National Nutrition Monitoring Bureau
OECD	Organisation for Economic Cooperation and Development
PAR	Population attributable risks
PI	Ponderal index
PUFA	Polyunsaturated fatty acids
RR	Relative risk
SES	Socioeconomic status
SIDS	Small Island Developing States
SFA	Saturated fatty acids
TC	Total cholesterol
UNICEF	United Nations Children's Fund
TG	Triglycerides
WCRF	World Cancer Research Fund
WHO	World Health Organization

Glossary

Body mass index	Body weight in kilograms divided by height in meters squared (kg/m^2).
Cardiovascular diseases	Diseases involving the heart and the blood vessels.
Dalda	A type of ghee made from vegetable oil in India.
Fetal programming	The hypothesis that intrauterine nutrition has long-term metabolic effects that adversely affect cardiovascular disease and related risk factors.
Food balance (sometimes called food disappearance data)	A macrolevel measure of food available for consumption; estimated as production plus imports minus exports and net of food extraction costs at the mill level and food fed to animals.
Ghee	Butter fats that are refried: common in South Asian cuisine.
Ischemic heart disease	A disease of the heart caused by narrowed coronary arteries and thus less blood and oxygen reaching the heart, including heart attack and related heart problems.
Intrauterine growth retardation	Birthweight below a given low percentile limit for gestational age (e.g., birthweight less than 10th percentile for gestational age); typically reflects inadequate supply of nutrients and oxygen to the fetus.
Low birthweight	Birthweight below 2,500 grams.
Malnutrition	Various forms of poor nutrition caused by a complex array of factors including dietary inadequacy, infections, and sociocultural factors.
Morbidity	Any measure of disease, excluding mortality.
Obesity	Excessive body fat content; commonly measured by BMI (see above). The Asian standard for obesity is a BMI above 24.99 and the international standard is a BMI above 30.
Overnutrition	Excess energy imbalance caused by energy intake exceeding energy expenditure.
Overweight	Excess weight relative to height; commonly measured by BMI (see above). The Asian standard for overweight is 23.00 to 24.99, and the international standard is a BMI from 25 to 29.99 for grade I, 30–39.99 for grade II, and greater than 40 for grade III.
Stunting	The process of failure to reach linear growth potential as a result of inadequate nutrition and/or poor health. This implies long-term malnutrition and poor health, measured as height for age 2 Z-scores below a standard.
Syndrome X	A clustering of risk factors for cardiovascular disease, including obesity, adult onset diabetes, hyperlipidemia, and hypertension. Syndrome X is also known as metabolic sydrome.
Undernutrition	Inadequate dietary intake. This may occur in association with infection.

Underweight	Low weight-for-age; i.e., 2 Z-scores below a weight-for-age standard. This implies stunting and/or wasting.
Wasting	Low weight-for-height (weight divided by height) 2 Z scores below a weight-for-height standard. This describes a recent or current severe process leading to significant weight loss, usually as a consequence of acute starvation and/or severe disease.
Z-score	The deviation of an individual's value from the median value of a reference population, divided by the standard deviation of the reference population.

Introduction

The food supplies and therefore the diets of developing countries, are in a state of rapid transition. This nutrition transition is accompanied by equally rapid changes in levels of physical activity and in the body composition of humans, and is part of a general demographic, nutritional, epidemiological transition. A demographic transition, from rural societies with low life expectancy at birth and families with many children, to urban societies with higher life expectancy at birth and fewer children, has been well documented [1, 2]. The epidemiological transition that follows the demographic transition is also fairly well understood: a shift from endemic deficiency and infectious diseases, mostly of early life, to epidemic chronic diseases, generally of later life [3].

There is now sufficient evidence to propose a general theory for this causally and chronologically linked demographic, nutrition, and epidemiological transition. When populations undergo massive social and technological change that includes increasing urbanization, their food supplies and therefore their diets change. Consequently, disease patterns also change. This can be traced in countries that are now economically developed; for example, Britain between the sixteenth and eighteenth centuries, following the agrarian and industrial revolutions. In Africa, Asia, Latin America, and in the Small Island Developing States (SIDS) of the Pacific, such transitions are taking place very much faster and, in some cases, with extreme rapidity.

Current evidence suggests that some diet-related diseases become epidemic at a speed that is a function of the velocity of demographic and nutrition transition, and that they emerge as epidemics in a predictable sequence. The implications for public policy-making are immense. It follows that a full understanding of these transitions is vital as a basis for policy-making, not only in the field of public health, but also in health care, rural and urban development, agriculture, industry, transport, employment, education, and finance.

The nutrition transition in Asia and in the SIDS of the Pacific is a central part of a sequence of transitions. These begin with the demographic transition. Increased urbanization and technological change lead to a shift from physically active to sedentary occupations, less walking and cycling, more use of cars and television, increased use of labor saving devices at work and home, and changes in income profiles.

The nutrition transition itself is marked by a shift from relatively monotonous diets based on indigenous staple grains or starchy roots, locally grown legumes, other vegetables and fruits, and (except for prosperous subpopulations) limited foods of animal origin, toward more varied diets that include more preprocessed food, more foods of animal origin, more sugar and fat, especially in processed drinks and foods, and often more alcohol. The most immediate result of the combination of such relatively energy-dense diets with physically inactive lives, is a rapid increase in overweight and obesity. This is a usual, though not inevitable, consequence of urbanization.

The consequent epidemiological transition is from a predominance of endemic deficiency and infectious diseases, often caused or exacerbated by poor nutrition, to epidemic, chronic diseases. Diet-related chronic diseases include tooth decay, gastrointestinal disorders, obesity, adult-onset diabetes, hypertension, peripheral vascular disease and stroke, hyperlipidemia, angina and ischemic heart disease (IHD), and certain cancers. Most of these diseases also have nondietary causes; for example, the use of tobacco with lung cancer. There is also genetic predisposition to some of these diseases. The risk of this eventuating in overt clinical symptoms is increased by inappropriate environmental factors, including diet.

This review describes the nutrition transition and nutrition-related changes that affect key chronic diseases in Asia. These changes include, among others, fetal and infant nutrition insults, and poor dietary and activity patterns. Other behavioral changes that also contribute to these diseases, such as increased tobacco use and air pollution, are not discussed. First, the chronic diseases affected by dietary and related

lifestyle changes are reviewed, and then their health and economic consequences, intervention options, and policy are examined.

Countries in the Asia-Pacific region are at very different stages in the nutrition transition. Moreover, large subpopulation groups, within even the poorest countries, already face a heavy burden from diet-related chronic diseases. In India, for example, urban residents in general, and other residents in wealthy areas such as the Punjab, have very different diets, body composition, and chronic disease profiles than residents in other areas. Obesity and cardiovascular diseases (CVDs) are prevalent at very high rates in urban India [4, 5]. In most Asian and Pacific countries, there are subpopulations that face food insecurity and undernutrition. There are also significant differences in the undernutrition profiles of Asian men and women. However, in the countries studied here, gender differences in obesity are smaller than those of other regions of the developing world.

The diverse Asian countries covered in this review are grouped using gross national product (GNP) per capita as the sole indicator (table 1). Detailed health cost data were obtained for the People's Republic of China (PRC) and Sri Lanka. A separate group was created for some SIDS of the Pacific. SIDS are in a relatively advanced stage of epidemiological and nutrition transition and face great problems of diet-related chronic diseases. Their needs, their institutional and logistical infrastructure, the underlying causes of their nutrition-related problems, and their abilities to absorb loans, are very different from those of the larger countries of Asia.

TABLE 1. Asian countries and Small Island Developing States (SIDS) of the Pacific that are in nutrition transition; grouped on 1998 gross national product (GNP) per capita, unless otherwise stated

Group	Countries	1998 GNP per capita (US$)
High-income	Singapore	30,060
	Hong Kong, China	23,670[a]
	Korea, Rep. of	7,970
Middle-income	Malaysia	3,600
	Thailand	2,200
	Kazakhstan	1,310
	Philippines	1,050
Low-income		
Upper	Uzbekistan	870
	Sri Lanka	810
	People's Republic of China	750
	Indonesia	680
Lower	Pakistan	480
	India	430
	Mongolia	400
	Bangladesh	350
	Kyrgyz Republic	350
	Tajikistan	350
	Lao PDR	330
	Vietnam	330
	Cambodia	280
	Nepal	210
	Afghanistan	<760
	Bhutan	<760
	Myanmar	<760
SIDS	Fiji Islands	2,110
	Federated States of Micronesia	1,800
	Tonga	1,690
	Marshall Islands	1,540
	Vanuatu	1,270
	Maldives	1,230
	Kiribati	1,180
	Samoa	1,020
	Papua New Guinea	890
	Solomon Islands	750
	Cook Islands	—
	Nauru	—
	Tuvalu	—

Source: ref. 6.
a. GDP = Gross domestic product.

Dietary and related factors leading to increases in chronic diseases

Many studies have shown the nutrition transition in Asia and the Pacific, as well as the developing world in general [7, 8]. Typically, there are dramatic increases in overall fat intake and a corresponding reduction in the proportion of dietary energy from starchy staple foods, accompanied by a shift from coarse grains and legumes toward more refined grains (mainly rice and wheat), a greater intake of meat, fish, dairy products, and edible oils, and a reduction in fruit and vegetable intake [9]. The general effect is to make diets less bulky, and more energy-dense. There are, however, important variations among these countries. For example, the increase in fat intake and decrease in vegetable intake in the Republic of Korea are far less than might be expected from its development status [10].

This review describes the nutrition transition in Asia and in some SIDS of the Pacific, as well as some of the factors that predict high levels of chronic disease: low birthweight (LBW) and stunting, inappropriate diets, low levels of physical activity, and urbanization. The analyses are mainly at country level, with some household and individual level studies. This broad approach, using averages, inevitably obscures variations within countries.

Fetal and infant insults and related effects: low birthweight (LBW) and stunting

A growing set of studies [11–17] suggests that fetal and infant nutrition insults affect predisposition to CVDs, obesity, hypertension, and adult-onset diabetes. These same insults also may compromise immune function [18]. These early nutrition-related insults contribute to later, diet-related chronic diseases. LBW (associated with thinness) and stunting, have both been linked with these adverse risk profiles, but the mechanisms for this are unclear and this leads to uncertainty about appropriate interventions [19, 20].

High rates of LBW and stunting, accompanied by concurrent rapid shifts in diets and activity patterns and increased obesity, are of special importance in rapidly developing countries, such as those of Asia and the SIDS of the Pacific. There are very high incidences of LBW in the lower low-income countries, particularly in Bangladesh, India, Nepal, Pakistan, and Sri Lanka and in the Lao PDR. There is, however, enormous variation in LBW rates among countries in the same income groups.

There are no systematic data on the proportion of LBW babies who were born with disproportionately retarded intrauterine growth (IUGR) and who were born very thin. In one 12-month birth cohort sample of all pregnancies in 33 communities, representative of metropolitan Cebu in the Philippines, 36.7% of LBW babies had disproportionately low ponderal indices (PI) at birth [22]. This topic is considered later in a discussion of fetal programming and the effects of LBW on subsequent cardiovascular-related outcomes.

For analysis of stunting, defined as 2 Z-scores below the height-for-weight standard in children aged 2.0 to 5.9 years, the data used are from large, nationally representative surveys. Stunting prevalence is very high in Bangladesh and Indonesia, countries with high LBW rates (fig. 1 and 2), but there are high stunting rates in other upper and lower low-income countries, and in the Republic of Fiji Islands, the only SIDS for which we have data. Elsewhere in Asia, researchers have shown a decline in the proportion of children who are stunted, albeit a decline that is slower than declines in wasting and in LBW [23].

Shifts in the structure of diets

Food disappearance data, from the Food and Agriculture Organization of the United Nations (FAO), were used to document the nutrition transition in Asia and in some SIDS of the Pacific. These are the only data that allow comparisons among countries of the total food available for human consumption. National-level data on food available for consumption comprise the sum of total food production, plus imports, minus exports, and net of losses from processing at the mill

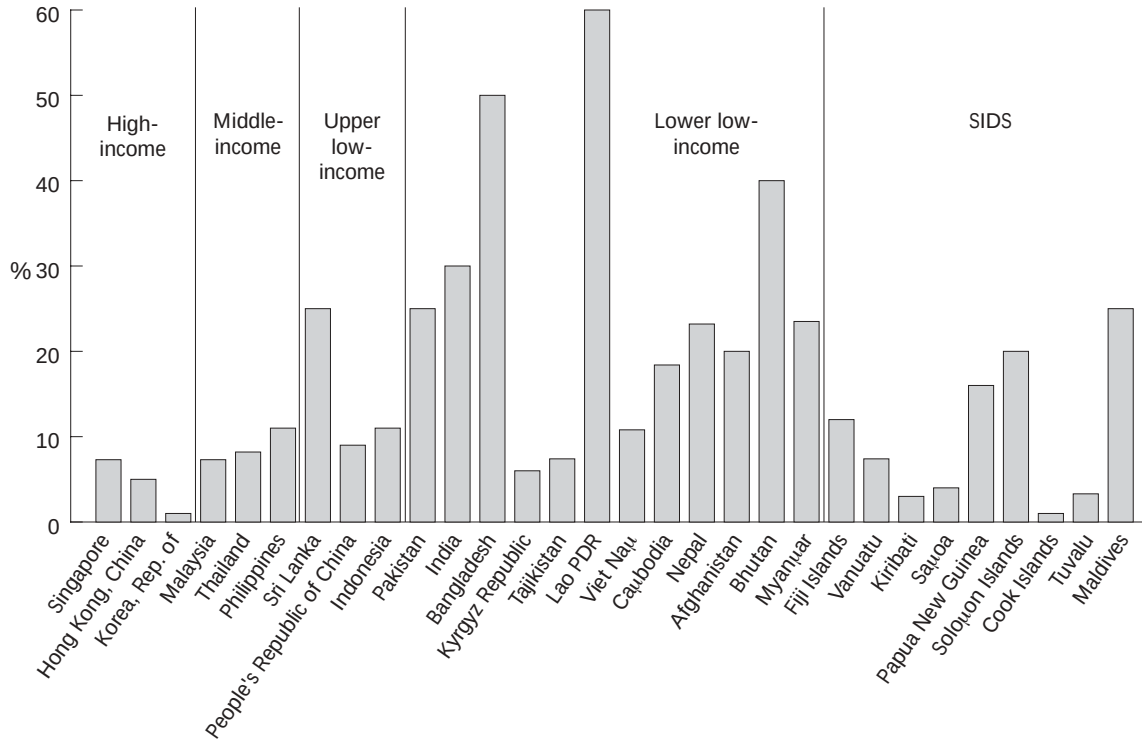

FIG. 1. Prevalence (%) of low birthweight in Asian countries, grouped by income, and Small Island Developing States (SIDS) of the Pacific. Source: ref. 21

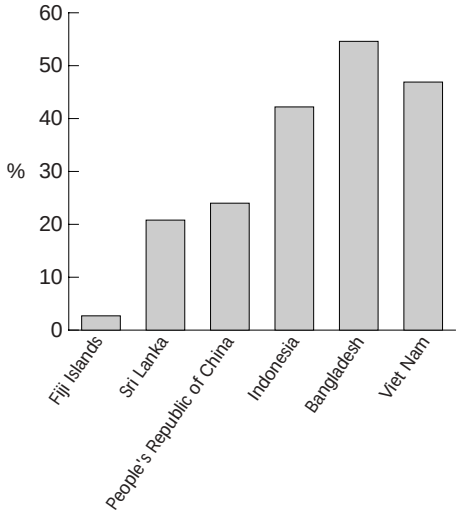

FIG. 2. Prevalence (%) of stunting among children aged 2 to 6 years in Asian countries and the Fiji Islands. These data are the most recent available for each country in the 1990s, e.g., 1993 for the People's Republic of China, Indonesia and Viet Nam. Sources: Fiji, data provided by the Pacific Commissions; Indonesia [24]; PRC, People's Republic of China Health and Nutrition Survey (1993), http://www.cpc.unc.edu/projects/china/china_home.html; Viet Nam [25]; Sri Lanka [26]; Bangladesh country report, ADB regional technical assistance project 5824, ADB Manila, 2000

level and food fed to animals. They do not, however, reflect actual consumption as there are additional losses in the food-chain that link producers and processors to consumers.

Typically scholars who have compared food disappearance data with household and individual food intake data, estimate that disappearance data measure about 20% to 27% more food available for consumption than actual consumption levels. In addition, it is important to note that a greater proportion of perishable foods is lost, wasted, or discarded between production and consumption than is the case with nonperishable foods. For example, food balance data overestimate the amount of fruits and vegetables available for consumption, relative to grains and tubers. Moreover, assumptions of food extraction and perishability have not been adjusted over time and it is possible that improvements in storage and distribution of food, in particular for the more perishable fruits and vegetables, might underestimate intakes today compared to intakes more than two decades ago.

Aggregate FAO food disappearance data measure aggregate consumption and do not measure food distribution to specific areas, to urban and rural populations, to households of various income levels, or to individuals in various age-gender groups. Moreover, using comparisons of country groups means losing detailed variations among countries. Some country groups (table 1) are dominated by one or two countries

with large populations, e.g., the high-income group by the Republic of Korea, the middle-income group by Thailand and the Philippines, the SIDS by Papua New Guinea, the upper low-income group by the PRC, and the lower low-income group by India.

Three-year averages were calculated for each country and the averages were weighted for 1996 population size within country groups, so that the values would represent the actual population sizes within country groups.

In general, Asia and Pacific SIDS are becoming less dependent on locally produced and frequently monotonous diets based on staple grains and starchy roots. They are being replaced by diets that include much more fat, more foods of animal origin, and often more sugary food and drink, much of which is produced elsewhere in the country or imported [27]. At the same time, the shift toward diets that are notably more energy-dense, that contain much more fat, more added sugar and sometimes more alcohol, with a marked reduction of starchy staples, is increasing the incidence of diet-related chronic diseases, some of which have become epidemic with remarkable speed.

Available food consumption data are summarized in table 2. The total energy available for consumption has increased and most countries are experiencing large shifts in the structure of their diets. The proportions of energy by dietary components are presented for each country group.

TABLE 2. Trends in foods available for consumption [annual totals in kg per capita] from 1962 to 1996 for Asian countries, grouped by income, and Small Island Developing States (SIDS) of the Pacific

Food group		1962	1967	1972	1977	1982	1987	1992	1996
Cereals	High-income	175.6	192.8	217.3	210.9	184.6	184.4	163.2	163.3
	Middle-income	126.6	129.8	136.7	135.4	136.2	129.8	142.6	133.9
	Upper low-income	122.5	145.0	153.0	165.3	194.3	200.9	197.4	192.1
	Lower low-income	147.8	144.2	151.8	148.9	154.7	159.5	164.7	171.9
	SIDS	36.4	43.2	50.8	55.1	61.5	68.1	74.8	88.0
Starchy roots	High-income	42.3	51.4	44.8	31.5	22.8	16.7	16.9	18.4
	Middle-income	28.6	25.1	20.3	37.9	29.7	28.3	31.3	31.4
	Upper low-income	108.5	109.2	107.1	101.5	81.9	63.6	59.3	62.5
	Lower low-income	11.5	15.0	17.1	20.2	20.8	19.7	20.4	21.1
	SIDS	307.4	297.9	282.4	268.3	255.4	243.7	225.5	208.1
Cereals and starchy roots	High-income	217.8	244.2	262.1	242.4	207.4	201.0	180.1	181.7
	Middle-income	155.2	154.9	157.0	173.3	165.9	158.1	173.9	165.3
	Upper low-income	231.0	254.2	260.1	266.8	276.3	264.4	256.7	254.7
	Lower low-income	159.3	159.3	168.9	169.1	175.5	179.3	185.1	193.0
	SIDS	343.8	341.2	333.2	323.3	316.9	311.8	300.3	296.0
Dairy products	High-income	5.1	4.6	7.0	10.2	14.8	19.9	25.6	27.9
	Middle-income	12.4	14.5	14.7	17.6	16.8	18.8	34.5	40.8
	Upper low-income	2.9	2.5	6.5	3.3	4.2	5.5	8.9	10.1
	Lower low-income	38.5	35.5	35.7	37.8	41.7	46.8	50.2	55.0
	SIDS	9.5	12.6	15.0	14.0	14.2	14.5	16.3	16.7
Eggs	High-income	2.4	3.2	5.0	6.0	7.3	8.7	9.5	9.7
	Middle-income	5.2	5.4	5.7	6.6	6.3	6.2	8.6	8.3
	Upper low-income	1.8	1.8	1.9	2.1	2.6	4.7	7.2	12.5
	Lower low-income	0.4	0.5	0.6	0.7	0.8	1.1	1.2	1.3
	SIDS	0.7	0.7	0.8	0.8	1.0	1.1	1.2	1.3
Dairy products and eggs	High-income	7.5	7.8	12.0	16.2	22.0	28.5	35.1	37.6
	Middle-income	17.6	19.9	20.4	24.2	23.1	25.0	43.1	49.1
	Upper low-income	4.5	4.3	8.5	5.4	6.8	10.2	16.1	22.6
	Lower low-income	38.9	35.9	36.2	38.5	42.6	47.9	51.4	56.3
	SIDS	10.2	13.3	15.8	14.9	15.3	15.6	17.4	18.0
Meat/poultry	High-income	8.6	10.8	13.5	16.8	23.7	28.8	40.2	48.1
	Middle-income	12.7	15.2	15.0	15.8	18.1	18.7	27.7	30.6
	Upper low-income	4.6	8.6	9.2	9.4	13.7	19.2	26.9	35.2
	Lower low-income	4.9	5.0	4.9	4.9	5.3	5.8	6.5	6.9
	SIDS	15.9	17.8	20.9	22.8	22.9	25.5	27.9	27.3

continued

TABLE 2. Trends in foods available for consumption [annual totals in kg per capita] from 1962 to 1996 for Asian countries, grouped by income, and Small Island Developing States (SIDS) of the Pacific *(continued)*

Food group		1962	1967	1972	1977	1982	1987	1992	1996
Fish, and other seafood	High-income	15.9	22.0	32.0	39.5	44.7	49.0	48.7	51.7
	Middle-income	17.5	24.8	28.3	29.2	29.9	30.0	31.6	31.4
	Upper low-income	5.5	5.6	5.5	6.2	6.5	10.1	14.2	22.7
	Lower low-income	3.6	4.2	4.5	4.2	4.1	4.4	5.1	5.4
	SIDS	18.3	23.1	30.1	26.8	36.9	39.4	30.4	25.5
Fruits	High-income	11.5	19.9	26.1	33.5	44.6	55.1	82.8	94.9
	Middle-income	81.8	81.0	73.3	100.0	109.6	105.3	88.0	93.5
	Upper low-income	16.3	14.4	13.9	14.3	17.5	28.0	33.1	51.5
	Lower low-income	26.6	28.1	26.0	25.4	27.0	29.1	29.8	33.4
	SIDS	176.3	179.5	181.7	181.1	176.6	168.6	173.6	165.9
Vegetables	High-income	70.4	84.4	97.1	168.7	171.2	160.5	167.6	169.5
	Middle-income	47.6	47.0	48.7	47.6	47.6	45.6	45.3	48.5
	Upper low-income	59.1	42.2	36.7	38.2	47.8	71.8	88.6	123.2
	Lower low-income	32.5	35.3	37.5	38.8	41.1	43.8	44.4	46.3
	SIDS	65.7	69.6	70.5	70.0	71.5	73.0	71.7	67.9
Fruits and vegetables	High-income	81.9	104.3	123.2	202.2	215.8	215.7	250.4	264.4
	Middle-income	129.4	128.0	121.9	147.7	157.2	151.0	133.3	142.0
	Upper low-income	75.5	56.7	50.5	52.6	65.3	99.9	121.6	174.7
	Lower low-income	59.1	63.4	63.5	64.2	68.1	72.8	74.2	79.6
	SIDS	242.0	249.1	252.1	251.1	248.0	241.6	245.3	233.8
Animal fats	High-income	1.1	1.3	2.2	3.2	2.3	2.4	2.7	3.3
	Middle-income	0.7	1.0	1.0	1.0	1.0	1.0	1.8	1.4
	Upper low-income	0.3	0.5	0.6	0.7	0.8	1.0	1.3	1.6
	Lower low-income	1.0	1.0	1.0	1.0	1.0	1.1	1.3	1.5
	SIDS	1.3	1.6	1.9	2.2	2.0	2.3	2.1	2.7
Added sugar	High-income	4.6	6.4	9.7	13.5	17.0	27.0	32.8	35.5
	Middle-income	12.1	15.7	17.0	20.5	20.6	22.4	26.2	31.7
	Upper low-income	3.5	4.1	4.5	5.2	7.5	8.7	8.5	9.1
	Lower low-income	16.3	16.7	17.3	17.8	17.8	18.5	19.7	20.1
	SIDS	9.2	11.4	13.1	13.2	14.1	13.2	12.2	13.6

Source: FAOSTAT, Food and Agriculture Organization of the UN. http://apps.fao.org/
Notes: Values are 3-year averages, weighted based on countries' within groups income at each point in time. For country groups, see table 1.

Trends in per capita food availability are presented in figures 3 and 4 for lower low-income and high-income countries. The lowest income countries, dominated by India, show an actual increase in cereal and starchy roots availability and more modest increases in other foods. In contrast, the highest income countries have decreased their supplies of cereals and starchy roots, tripled their fruits and vegetable availability, and increased their dairy and egg, meat and poultry, and added sugar availability.

Apart from increases among lower low-income and a slight increase among upper low-income countries, there is a marked decline in the availability of cereals and starchy roots—items that have provided much of the dietary energy of Asians and Pacific islanders for centuries (fig. 5). These aggregate trends mask a significant shift away from so-called coarse and higher fiber grains to rice and wheat, which are usually refined [9, 28].

For all the countries studied here, there is a marked increase in availability of eggs and dairy products (fig. 6). Surprisingly, the highest intakes are in the lower low-income countries. This reflects partially, among the high-income countries, the low importance of dairy products in the Republic of Korea. Hong Kong, China has a high supply of dairy products, but this accounts for little in the total weighted average in the high-income group. India is predominant in the lower low-income group and is a high consumer of dairy products. This gives the impression that the availability in the lower low-income group is high relative to all other groups. Eggs and dairy products are important sources of saturated fats in the diet. In India, consumption of *ghee*, a highly saturated fat product, is important because high consumption of saturated fats is closely related to chronic diseases.

Meat and dairy products are also major sources of saturated fats and major contributors to chronic diseases. A very rapid annual growth in consumption of meat and dairy products from 1993 to 2020 has been projected [29], e.g., for the PRC, consumption

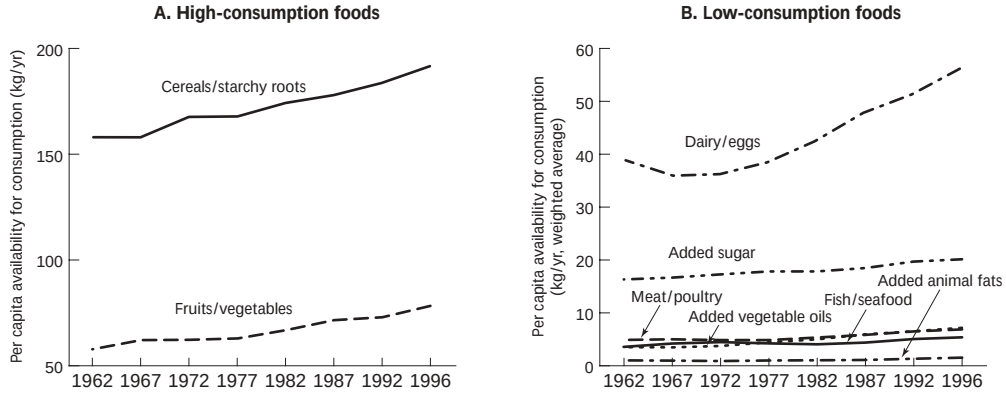

FIG. 3. Trends in per capita food available for consumption for lower low-income Asian countries. Source: FAOSTAT, Food and Agriculture Organization of the UN. http://apps.fao.org. Notes: Values are 3-year averages; for the names of lower low-income Asian countries, see table 1

FIG. 4. Trends in per capita food available for consumption for high-income Asian countries. Source: FAOSTAT, Food and Agriculture Organization of the UN. http://apps.fao.org. Notes: Values are 3-year averages; for the names of high-income Asian countries, see table 1

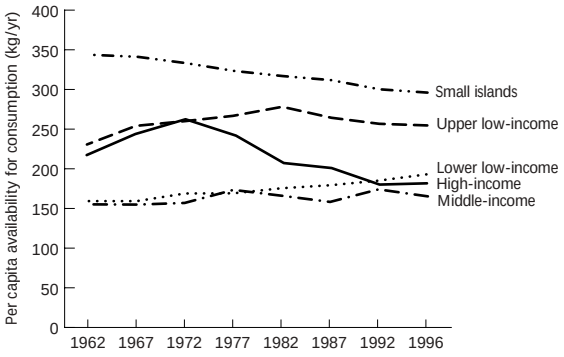

FIG. 5. Trends in food cereals and starchy roots available for consumption per capita in Asian countries, grouped by income, and Small Island Developing States (SIDS) of the Pacific. Source: FAOSTAT, Food and Agriculture Organization of the UN. http://apps.fao.org. Notes: Values are 3-year averages, weighted for 1996 country population size within groups; for country groups, see table 1

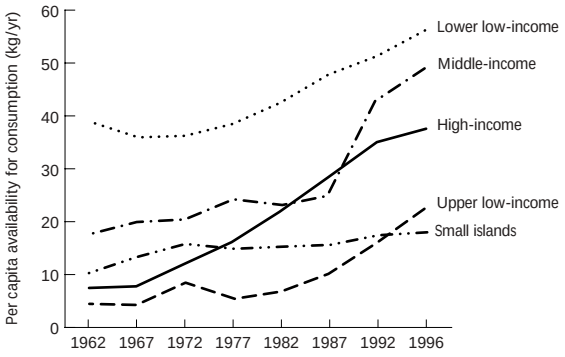

FIG. 6. Trends in dairy and egg products available for consumption per capita in Asian countries, grouped by income, and Small Island Developing States (SIDS) of the Pacific. Source: FAOSTAT, Food and Agriculture Organization of the UN. http://apps.fao.org. Notes: Values are 3-year averages, weighted for 1996 country population size within groups; for country groups, see table 1

of meat and dairy products is projected to increase at 3.0% and 2.8% per year, respectively, over this period. The corresponding rates of increase for combined meat and dairy products for East Asian countries, other than the PRC, and for Southeast Asia, are about 2.0% and 2.8% [29]. Other research from the PRC finds a much higher income elasticity and rate of change in meat and dairy product consumption [30].

Fruit and vegetable availability has increased markedly for the high-income and the upper low-income countries (fig. 7). It is improving slightly for the middle-income and lower low-income countries. It remains very high for the SIDS. However, continuing reductions in fruit and vegetable intake have been indicated by household surveys in the PRC [9].

The availability of added animal fats and vegetable oils has increased markedly for all the countries studied. Availability is particularly high for edible vegetable oils. These vary in origin from country to country and include red palm, coconut, corn, soybean, and cottonseed oils. In Sri Lanka and the Philippines, coconut oil is a major source of saturated fat. In Malaysia, edible oil comes largely from red palm oil, which has a high polyunsaturated to saturated fat ratio and is more healthy than coconut oil. The processing of these edible oils varies greatly. There is little systematic research on the composition of these oils. One small study has found trans fatty acid levels of about 50% in *dalda*, a vegetable *ghee* widely consumed in India (Willett WC, personal communication, 2000).

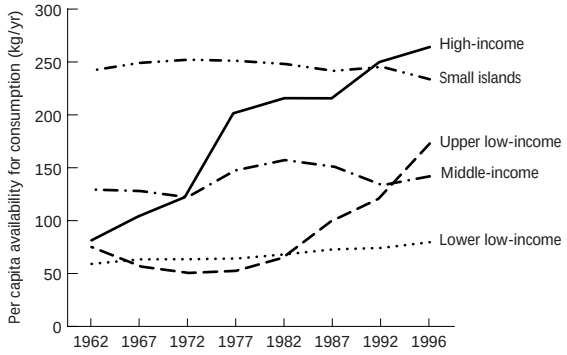

FIG. 7. Trends in fruits and vegetables available for consumption per capita in Asian countries, grouped by income, and Small Island Developing States (SIDS) of the Pacific. Source: FAOSTAT, Food and Agriculture Organization of the UN. http://apps.fao.org. Notes: Values are 3-year averages, weighted for 1996 country population size within groups; for country groups, see table 1

Figures 8 and 9 show that the high-income countries already have a very high consumption of added fats and that all the low-income countries show very rapid recent increases in availability of these items. Increased edible oil is a key reason for the marked increases in energy density of Asian diets [8].

Availability of sugar, added in processed food production and at home, is increasing among the middle- and high-income countries and is high in all countries, except upper low-income countries (fig. 10). In particular, note the high level for lower low-income countries and the contrasting very low level for upper low-income countries. This relates mainly to the very low levels of added sugar consumed in the PRC, as compared to most other countries in Asia.

Figures 11 to 15 depict subcategories within macronutrient categories, to emphasize some of the changes in availability of energy. Energy from added sugar was separated from energy from carbohydrates, to describe its energy contribution meaningfully. Energy from sweeteners in food balance sheets was considered to be 'energy from added sugar' and this was subtracted from total carbohydrate energy to get 'energy from carbohydrate excluding added sugar.' This is a rough

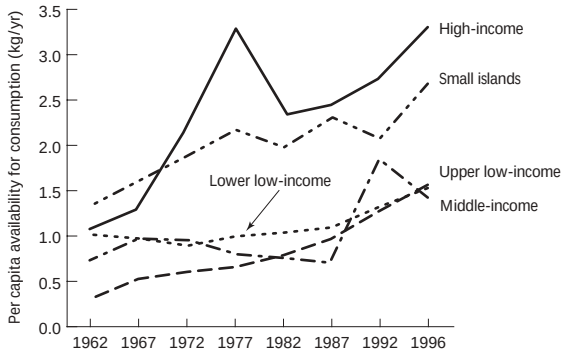

FIG. 8. Trends in added animal fats available for consumption per capita in Asian countries, grouped by income, and Small Island Developing States (SIDS) of the Pacific. Source: FAOSTAT, Food and Agriculture Organization of the UN. http://apps.fao.org. Notes: Values are 3-year averages, weighted for 1996 country population size within groups; for country groups, see table 1

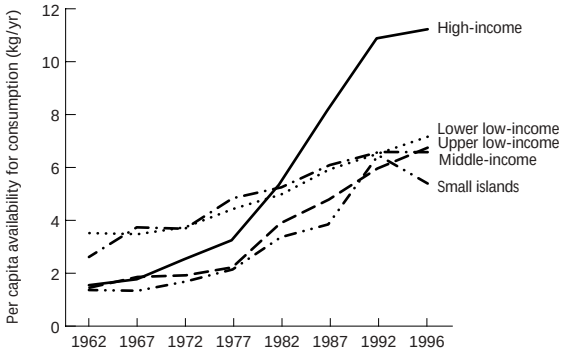

FIG. 9. Trends in added vegetable oils available for consumption per capita in Asian countries, grouped by income, and Small Island Developing States (SIDS) of the Pacific. Source: FAOSTAT, Food and Agriculture Organization of the UN. http://apps.fao.org. Notes: Values are 3-year averages, weighted for 1996 country population size within groups; for country groups, see table 1

estimation for both 'energy from added sugar' and 'energy from carbohydrate excluding added sugar,' because energy from sweeteners also comes, though minimally, from other nutrients.

Similarly, 'energy from added animal fat' was considered to be from animal fats such as butter, *ghee*, and fish liver oil in the food balance sheets. These refer, however, to a limited category of foods including added animal fats, but not any other fats of animal origin, such as those in meats. At the same time, 'energy from added animal fat' also includes minimal amounts of energy from other nutrients, similar to the case for added sugar. A very rough approximation for 'energy from vegetable oil' was made by subtracting 'energy from added animal fats' from 'total fat energy.' 'Energy from vegetable oil' is, therefore, essentially 'energy from fat excluding added animal fats and therefore differs from the calories from vegetable oil presented in the sources used here, i.e., the food balance sheets. Although these data are not ideal, these are the best approximation available to illustrate the important trends in fat intake.

The high-income countries have shifted from diets dominated by complex carbohydrates to diets with more fats, added sugar, and protein (fig. 11; table 3). These countries have per capita available energy for consumption of over 3,000 kcal/day. Figures 12 to 15 present energy data for the other country groups. The bulk of the population of Asia has less than 3,000 kcal/day available for consumption per capita and, as indicated, actual energy consumption is lower.

In general, this change to more diverse diets improves access to adequate micronutrients and decreases the incidence of micronutrient deficiencies.

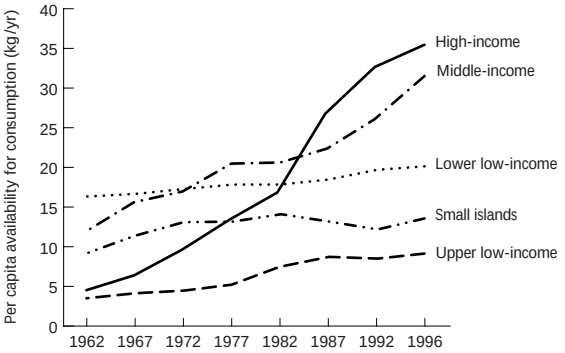

FIG. 10. Trends in added sugar available for consumption per capita in Asian countries, grouped by income, and Small Island Developing States (SIDS) of the Pacific. Source: FAOSTAT, Food and Agriculture Organization of the UN. http://apps.fao.org. Notes: Values are 3-year averages, weighted for 1996 country population size within groups; for country groups, see table 1

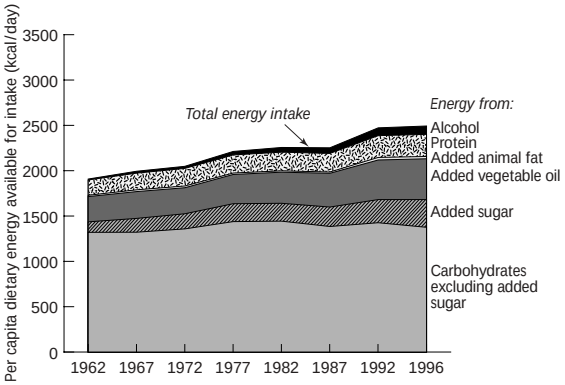

FIG. 12. Trends by source for per capita dietary energy available for intake in middle-income countries of Asia. Source: FAOSTAT, Food and Agriculture Organization of the UN. http://apps.fao.org. Notes: Values are 3-year averages; middle-income countries are listed in table 1

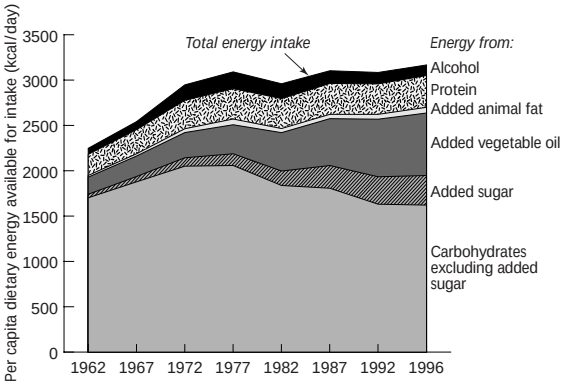

FIG. 11. Trends by source for per capita dietary energy available for intake in high-income countries of Asia. Source: FAOSTAT, Food and Agriculture Organization of the UN. http://apps.fao.org. Notes: Values are 3-year averages; high-income countries are listed in table 1

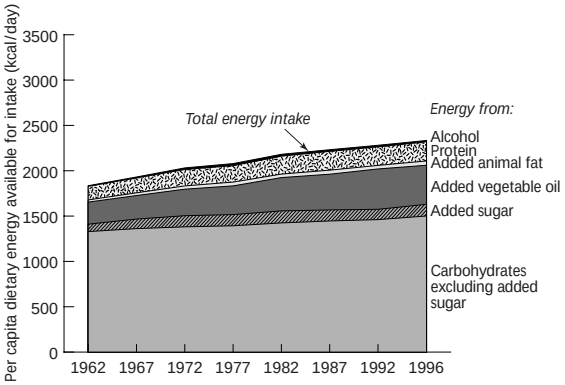

FIG. 13. Trends by source for per capita dietary energy available for intake in Small Island Developing States (SIDS) of the Pacific. Source: FAOSTAT, Food and Agriculture Organization of the UN. http://apps.fao.org. Notes: Values are 3-year averages; Pacific SIDS are listed in table 1

TABLE 3. Trends (1962 to 1996) in per capita total dietary energy available for consumption, and in the proportions (%) from different macronutrients, in Asian countries, grouped by income, and Small Island Developing States (SIDS) of the Pacific

Group	Year	Per capita total dietary energy (kcal/day)	% dietary energy from			
			Carbohydrate	Fat	Protein	Alcohol[a]
High-income	1962	2,247	77.8	8.8	10.3	3.0
	1967	2,543	76.4	9.6	10.5	3.5
	1972	2,948	72.7	10.9	10.6	5.8
	1977	3,091	70.7	12.5	10.8	6.0
	1982	2,959	67.5	15.8	11.1	5.5
	1987	3,103	66.4	18.1	11.0	4.5
	1992	3,084	62.8	22.3	10.9	4.1
	1996	3,167	61.5	23.7	11.1	3.7
Middle-income	1962	1,908	75.2	15.4	8.9	0.5
	1967	1,995	73.9	15.8	9.2	1.1
	1972	2,050	74.4	15.0	9.5	1.1
	1977	2,213	73.9	15.3	9.0	1.7
	1982	2,258	72.7	15.9	9.1	2.3
	1987	2,254	70.9	17.1	9.1	2.8
	1992	2,474	68.0	18.8	9.7	3.5
	1996	2,497	67.3	19.0	9.8	3.7
Upper low-income	1962	1,715	80.1	9.4	10.1	0.5
	1967	1,953	78.7	11.2	9.6	0.5
	1972	2,017	79.1	11.0	9.3	0.6
	1977	2,110	79.1	11.0	9.2	0.8
	1982	2,436	76.4	13.2	9.1	1.2
	1987	2,583	73.1	15.6	9.4	1.9
	1992	2,672	69.4	18.8	9.8	2.1
	1996	2,831	65.8	21.2	10.4	2.6
Lower low-income	1962	2,020	76.7	13.0	10.1	0.1
	1967	1,949	76.8	13.0	10.0	0.2
	1972	2,034	77.3	12.7	9.9	0.2
	1977	2,044	76.6	13.4	9.8	0.2
	1982	2,115	76.1	13.9	9.8	0.2
	1987	2,215	75.2	14.8	9.7	0.2
	1992	2,309	74.7	15.4	9.6	0.3
	1996	2,422	74.2	15.9	9.6	0.3
SIDS	1962	1,834	76.9	14.6	8.2	0.4
	1967	1,931	76.0	15.0	8.5	0.5
	1972	2,031	74.1	16.2	8.9	0.9
	1977	2,079	73.0	17.3	8.7	1.1
	1982	2,181	71.4	18.6	9.1	0.9
	1987	2,232	70.2	19.7	9.3	0.8
	1992	2,281	69.0	21.3	9.0	0.8
	1996	2,334	69.9	20.5	9.1	0.6

a. % energy from alcohol = 100 – (% energy from carbohydrate + % energy from protein + % energy from fat).
Values are 3-year averages, weighted based on country in groups at each year; for country groups, see table 1.

Dairy foods and other foods of animal origin contain micronutrients that can improve the nutrition quality of otherwise relatively monotonous diets.* However, the rapid shift toward more energy-dense diets that contain more fat, more saturated fat, often more sugar, and more foods of animal origin, contributes to an increase in chronic diseases.

Shifts in physical activity patterns

Reduced physical activity and habitual inactivity accompany the nutrition transition in persons of all ages [27]. Modernization and industrialization lead to

* Allen LH, Gillespie S. Effectiveness of large-scale nutrition interventions. Washington DC: IFPRI, 2000 (Unpublished manuscript).

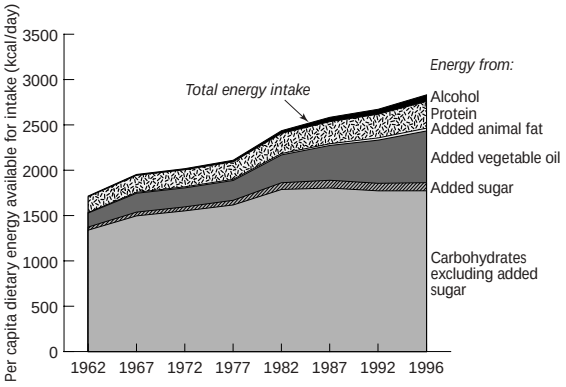

FIG. 14. Trends by source for per capita dietary energy available for intake in upper low-income countries of Asia. Source: FAOSTAT, Food and Agriculture Organization of the UN. http://apps.fao.org. Notes: Values are 3-year averages; upper low-income countries are listed in table 1

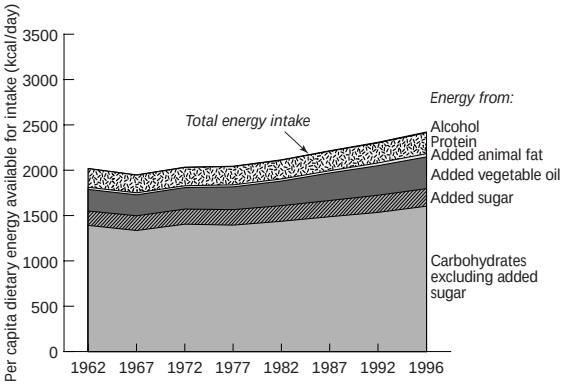

FIG. 15. Trends by source for per capita dietary energy available for intake in lower low-income countries of Asia. Source: FAOSTAT, Food and Agriculture Organization of the UN. http://apps.fao.org. Notes: Values are 3-year averages; lower low-income countries are listed in table 1

reduced physical activity, at work and at home, for men and women. The only systematically collected information available at the national level for the countries studied here is on the occupations of men and women. As occupations shift from agriculture and manual labor, to manufacturing and to the service sector, the levels of energy expended by humans naturally drop. The equally profound shifts in activity within occupations have been studied very little. In the PRC, these shifts toward reduced activity within the same occupation have been related to increased obesity [31]. Figures 16 and 17, and table 4, contain national data for the proportions of men and women employed in agriculture, service, and manufacturing in Asia and Pacific SIDS. These data are based on large, continuous, national surveys. In all of the country groups, men are shifting much more than women from agriculture toward industry and service sector jobs.

No Asian or Pacific studies were available for another important determinant of physical activity—modes of transportation. However, there is a shift away from walking and cycling to mass transit and cars—a major change in regular physical activity and thus in energy expenditure. Reduced physical activity outside work is also apparent.

One of the most remarkable changes in the Asia-Pacific region is the explosion of new information sources and mechanisms that reach households even in the most isolated villages and towns. The expansion of mass media, such as television, has major influences on consumer knowledge and attitudes, as well as on diets and physical activity. The percentage of households that own television sets has increased dramatically throughout Asia, particularly in the PRC and higher income countries. In the PRC, the China National Health Surveys [32] showed that television ownership

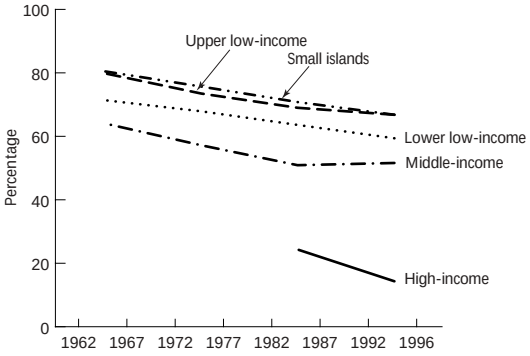

FIG. 16. The percentage of adult males engaged in agricultural occupations in Asian countries, grouped by income, and Small Island Developing States (SIDS) of the Pacific. Source: [6]. Notes: values are weighted averages, based on country population size withing groups; for country groups, see table 1

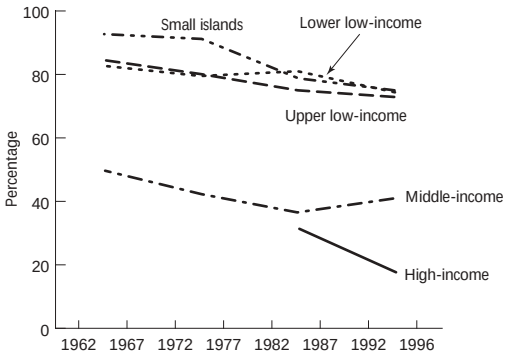

FIG. 17. The percentage of adult females engaged in agricultural occupations in Asian countries, grouped by income, and Small Island Developing States (SIDS) of the Pacific. Source: [6]. Notes: values are weighted averages, based on country population size withing groups; for country groups, see table 1

TABLE 4. The proportions (%) of economically able men and women, aged 18 to 65, employed by work sector in Asian countries, grouped by income, and Small Island Developing States (SIDS) of the Pacific, in the 1960s, 1970s, 1980s, and 1990s

Group	Agriculture (%)[a]				Industry (%)				Service (%)			
	1960	1970	1980	1990	1960	1970	1980	1990	1960	1970	1980	1990
Male												
High-income[b]	7.0[c]	4.2[c]	24.3	14.4	52.4[c]	51.5[c]	32.2	37.7	40.6[c]	44.3[c]	38.2	45.4
Middle-income	64.1	57.2	50.9	51.6	14.0	17.5	19.2	18.8	22.0	25.3	30.0	28.7
Upper low-income	79.9	73.5	69.0	66.8	6.8	12.0	15.3	16.4	13.3	14.5	15.7	16.8
Lower low-income	71.4	67.9	63.6	59.4	11.2	12.6	13.9	16.3	17.4	19.6	22.6	24.4
SIDS	80.5	75.7	70.8	66.8	8.4	9.2	10.2	10.6	11.2	15.1	19.1	22.6
Female												
High-income	9.7[c]	4.7[c]	31.5	17.8	49.7[c]	61.2[c]	27.6	29.9	40.7[c]	34.2[c]	37.8	50.8
Upper low-income	84.5	80.1	75.0	72.9	6.3	8.0	12.2	13.3	9.2	11.9	12.9	13.8
Lower low-income	82.7	79.5	81.0	74.4	8.9	10.5	9.8	14.3	8.8	10.6	9.2	11.4
Middle-income	49.7	42.3	36.5	40.9	18.3	17.7	17.8	15.1	32.0	4.0	45.7	42.6
SIDS	92.7	91.2	78.8	75.0	2.5	3.1	4.9	6.6	17.3	16.6	16.3	18.3

a. Agriculture includes mining and forestry.
b. For lists of country groups, see table 1.
c. Data for Singapore only.

increased, even for the lowest income tertile: from 43% of households in 1989 to 76% in 1993, and to 89% in 1997. Habitual television watching affects diet and activity patterns. Diets can change as a result of exposure to advertising and role models in the television programs. People consume snacks while watching television. Watching television is sedentary and displaces more active leisure activities. There is a vast literature, from high-income countries in other regions, that has linked watching television to greater inactivity and obesity [33–35], but no comparable studies have been made yet in the Asia-Pacific region.

Weighted averages were calculated for television ownership per 1,000 people from 1965 to 1995, in the country groups studied here (fig. 18). The explosion in television ownership began much earlier for higher income countries but now has reached all countries studied in the region. The levels and the rates of increase in ownership are far greater in the upper lower-income and middle-income countries.

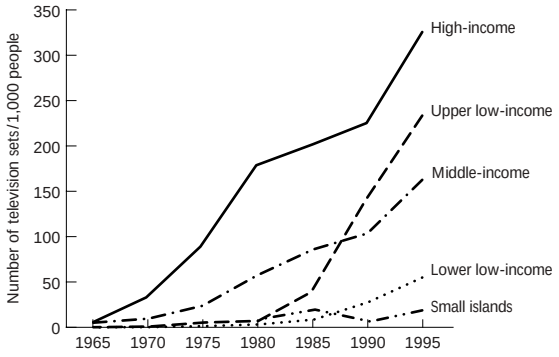

FIG. 18. Ownership of televisions in Asian countries, grouped by income, and Small Island Developing States (SIDS) of the Pacific. Source: [6]. Notes: values are weighted averages, based on country population size withing groups; for country groups, see table 1

Urbanization

During the last half century, there has been a large shift of populations from rural to urban areas throughout the developing world. Urbanization is occurring more slowly in Asia and the Pacific than in Latin America, the Middle East, and Africa. In Asia and the Pacific, however, the rate of increase in urban populations from the 1960s to the present has been more than four times greater than the increase in rural populations. The urban proportion of Asian-Pacific populations has increased continuously in the past three decades and this trend continues (fig. 19).

During the twentieth century, the population in rural Asia decreased, while it increased in urban areas [36]. As people move into cities, their food supplies change, and therefore, so do their diets and body composition. High levels of obesity are particularly apparent in lower- and middle-income countries. Urban occupations, transportation and food marketing systems, housing markets, and concentration of population, combine to create different patterns of food supply and demand, and of time allocation [37]. The consequence is overnutrition, meaning that people eat more than they need. This causes overweight, obes-

ity, and other major chronic diseases, such as CVDs. In the developing world, rapid urbanization results in the co-existence of malnutrition and obesity within many households. This is further discussed below.

The urban diet, even in very low-income countries and the poorest areas of cities, contains much more energy from fats and sugar than the rural diet. Urban food is more likely to be processed and often contains more highly refined cereals and sugars and fewer unrefined, staple foods than rural diets. In urban areas, even poor people are able to afford processed foods that are relatively high in fat and also in refined starches and sugars. Edible oils, in particular, can be very cheap. This enables urban people on low incomes to prepare meals that approximate the fat levels of those eaten only by higher income groups in previous decades [8]. Further, the high intake of processed food in the urban diet greatly increases consumption of salt; a factor linked to hypertension.

In Asia and the Pacific, urban diets are generally more diverse than rural diets, contain more animal food and therefore more animal protein, and often contain more micronutrients. However, the effect of relatively energy-dense diets and physical inactivity is to increase the incidence of overweight, obesity, and other diet-related chronic diseases.

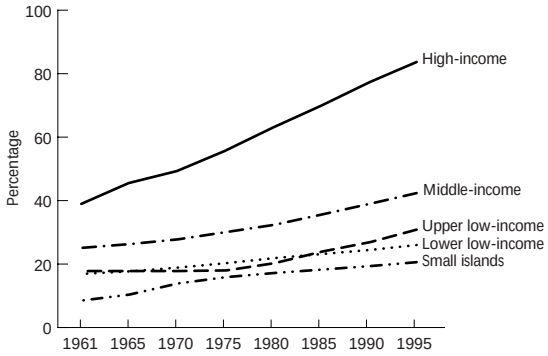

FIG. 19. Trends in the percentage of persons residing in urban areas of Asian countries, grouped by income, and Small Island Developing States (SIDS) of the Pacific. Source: [6]. Notes: values are 3-year averages, weighted for country population size withing groups; for country groups, see table 1

The importance of the nutrition transition for health

Diet-related chronic diseases

It has been agreed for many years that the nature and quality of diets affect the risk of chronic diseases, including some that for half a century have been the major causes of premature death in the developed world [38, 39]. Diet-related chronic diseases vary in severity. They include diseases that are disagreeable, notably tooth decay and various gut disorders; others that are disabling, such as adult-onset diabetes, obesity, and osteoporosis; and others that are deadly, notably IHD and other CVDs, with hyperlipidemia and angina or precursors, cerebrovascular disease and its precursor hypertension, and certain cancers [39]. A major report [40] specifies cancers, the risks for which are modified by food and nutrition (including alcohol), as well as by physical activity and body composition. Some of these cancers have additional nondietary causes, notably the use of tobacco and cancers of the mouth, throat, esophagus, and lung. The same report [40] lists other cancers for which the evidence of relationship with diet is inconclusive. Similar reports have focused on diet-related factors and CVD [39, 41–43].

In has been proposed [44] that chronic diseases tend to emerge and become epidemic in a predictable order, as a result of a nutrition transition to which human physiology is not adapted. Thus, overweight and obesity, adult-onset diabetes, and cerebrovascular disease become public health problems within a generation. Severe gut diseases, notably cancers of the colon and rectum, emerge later in the stages of dietary change and economic development. CVDs and breast cancer might take two generations to become epidemic. This hypothesis, based on preliminary observations and anecdotes, is supported by some epidemiological studies [40] but has not yet been rigorously tested.

Diets that increase the risk of chronic diseases are those relatively high in total fat, saturated fat, sugar, salt, alcohol, refined grains, and foods of animal origin. Diets that protect against chronic diseases are relatively high in minimally processed grains, legumes, fiber, vegetables, fruits, and foods of plant origin. However, plant-based diets that are monotonous, very high in staple grains or starchy roots, and low in vegetables, fruits, and foods of animal origin can increase the risk of deficiency diseases. Such "poverty diets" [40] emphasize the need for plant-based diets to be varied and not too high in grains or roots of any one type. It has been estimated [40] that appropriate diets and lifestyle can reduce cancer risks by 30% to 40%. Comparable estimates, based on epidemiological and other analyses, could and should be made for other major diet-related chronic diseases.

The major relationships between various components of the diet and chronic diseases are summarized in table 5. Perhaps the most important aspect of these findings is that linked demographic and nutrition transitions produce lifestyle shifts that are associated with rapid increases in the risk of major diet-related chronic diseases. This emphasizes the importance of further research to underpin effective policies and programs that are designed to control epidemic diet-related chronic diseases.

General mortality trends

It is commonly supposed that infectious and deficiency diseases are the main public health problems throughout Asia and the Pacific but the following review of mortality trends reveals a more complex picture.

Infectious and parasitic diseases were the major causes of all deaths in Asia during much of the twentieth century and before. Although they remain very important, they no longer represent the major cause of death in any country studied here. In the countries that are furthest along in the nutrition transition (such as Singapore, with higher fat diets and higher rates of obesity) cancers and CVD together account for close to 60% of all deaths: a rate similar to those of North America and western Europe. In the PRC and the Republic of Korea, now more than half of all

TABLE 5. The possible effects of dietary intake and body composition on noncommunicable diseases

Dietary factor	Mechanisms	Health outcomes
Excess energy intake↑	Adipose tissue development ↑, metabolic changes	NIDDM ↑(a), CHD ↑(a), hormone-dependent (e.g., breast) or GI (e.g., colon andrectal) cancers ↑(a), osteoarthritis ↑(a), gallbladder disease ↑(a)
Total fat ↑	Passive overconsumption, IR↑	NIDDM↑(b), CHD↑(a), prostate cancer ↑(b), breast cancer ↑(c), colon and rectal cancer ↑(b)
Animal fat↑	Unclear, fat metabolism byproducts	Colon cancer ↑(b)
Saturated fat ↑	TC↑, LDL-C↑, TG ↑, HDL-C ↓	Atherosclerosis ↑(a) , CHD ↑(a), hypertension ↑(b), NIDDM ↑(b)
Trans fatty acids ↑	LDL-C ↑, HDL-C ↓,TC ↑, immune system ↓	Cancers ↑(d), CHD ↑(c)
Monounsaturated fatty acids↑	LDL-C ↓	Cancers ↓(c), CHD ↓(b)
Polyunsaturated fatty acids↑	HDL-C↑, some are antiinflammatory	Cancers ↑(b), CHD ↓(b)
Sodium ↑	Abnormal renal function ↑, disturbed electrolyte balance↑	Hypertension ↑(a), stroke ↑(a)
Antioxidants ↓	Oxidize LDL-C, change functions	CHD ↑(b)
Dietary fiber ↓	TC↑, HDLC ↓, IR↑, TG↑	CHD ↑(b), NIDDM ↑(b), stroke ↑(c), colon cancer (c)↑
Fetal malnutrition/ stunting↑	Central adipose tissue ↑, IR↑, metabolic changes	NIDDM ↑(b), hypertension ↑(b), CHD ↑(b)
Fruit and vegetable ↑	Prevent oxidization LDL-C, fiber ↑	Stroke ↓(b), cancers ↓(a)

The relationships between dietary factors and health outcomes are categorized as (a) well-established; (b) fairly well-established but data not complete; (c) still under debate; and (d) indicative data to date. Epidemiological studies support much of what is presented here but the literature is controversial, especially with respect to mechanisms. This table omits the effects of reduced physical activity, which are most important in increasing obesity, reducing fitness, and increasing insulin resistance.

CVD = cardiovascular diseases; GI = gastrointestinal; HDL-C = high density lipoprotein cholesterol IR = insulin resistance; LDL-C = low density lipoprotein cholesterol; NIDDM = noninsulin dependent diabetes mellitus; TC = total cholesterol; TG = total glycerides.

deaths are caused by these two categories of chronic disease. They are also important causes of death in less developed countries.

There are no systematic data on morbidity available for the Asia-Pacific region. Few countries have reliable and representative morbidity data over meaningful periods. However, reasonably reliable trends for the proportions of deaths, by cause of death, for selected countries in each country group, can be constructed from World Health Organization (WHO) sources (table 6).

Causes of death data are not uniformly collected and classified across the region [46]. Death registrations are fully operational in only a few Asian countries and there are many gaps. The focus here is on the proportion of deaths by cause, rather than on age-specific rates or overall rates of death by cause. A major increase in chronic diseases in Asia has been predicted over the next two decades, based on demographic projections from these same, poorly measured mortality data of 1960 to 1990 [47]. The present review emphasizes the nutrition transition-related dynamics that will be a major component of driving this change, and suggests that these dynamics are accelerating the increases in disease predicted [47]. From this source, for two randomly selected countries in each economic grouping, trends are presented in the proportion of deaths, by cause of death, for as many time points as are available, from the 1960s to the 1990s (table 6). This is indicative of trends across the whole region. The five categories are for infectious and parasitic diseases, cancers, diabetes, CVD, and all other causes. Accidents are a major component. It was not possible to obtain detailed age-specific mortality data, and so age-standardized trends cannot be followed.

Actual data and projections of deaths by cause, in India and the PRC for 1990 and 2020 are projected in figure 20. It has been projected [47] that India will experience a marked reduction in mortality, related to a large decline in deaths caused by infectious disease and parasitic infections. In contrast, it was predicted [47] that the PRC will experience an increase in mortality, related to the large increase in noncommunicable diseases (NCDs), in particular CVD and cancers,

TABLE 6. Trends in the proportion of deaths, by cause, in some Asian countries, grouped by income, and in the Fiji Islands, during the 1960s, 1970s, 1980s, and 1990s

Group	Causes of death	1960s	1970s	1980s	1990s
High-income					
Singapore (year)		(1967)	(1975)	(1987)	(1996)
	All infectious diseases	14.8	18.2	12.5	14.4
	Cancers	14.2	18.2	23.8	25.6
	Diabetes	—	2.3	3.7	2.1
	Cardiovascular disease	8.2	28.3	35.5	37.8
	Other	62.8	33.0	24.5	20.2
Korea, Rep. of (year)				(1987)	(1995)
	All infectious diseases			5.8	4.6
	Cancers			16.7	21.0
	Diabetes			1.4	3.3
	Cardiovascular disease			22.0	21.1
	Other			54.2	50.0
Middle-income					
Malaysia (year)		(1965)	(1976)	(1987)	(1996)
	All infectious diseases	18.5	17.6	12.0	13.7
	Cancers	6.5	8.9	10.4	10.1
	Diabetes	0.8	1.5	—	—
	Cardiovascular disease	9.1	20.0	18.9	18.9
	Other	65.0	52.0	58.7	57.3
Thailand (year)		(1966)	(1975)	(1987)	(1995)
	All infectious diseases	14.0	17.2	7.3	6.4
	Cancers	1.5	3.2	7.3	9.3
	Diabetes	0.2	0.5	0.9	1.3
	Cardiovascular disease	2.5	4.4	3.5	15.5
	Other	81.2	74.7	81.1	67.5
Upper low-income					
Sri Lanka (year)		(1967)	(1975)	(1988)	(1991)
	All infectious diseases	6.4	10.1	12.2	9.5
	Cancers	3.7	3.7	5.7	5.9
	Diabetes	1.3	1.2	1.2	1.3
	Cardiovascular disease	11.9	10.3	30.2	29.8
	Other	76.7	74.7	50.7	53.5
People's Republic of China (year)				(1987)	(1994)
	All infectious diseases			19.3	20.5
	Cancers			15.9	19.3
	Diabetes			—	—
	Cardiovascular disease			27.5	28.2
	Other			37.3	32.0
Lower low-income					
Kyrgyz Republic (year)					(1995)
	All infectious diseases				12.4
	Cancers				8.4
	Diabetes				1.0
	Cardiovascular disease				36.8
	Other				41.5
India (year)			(1975)	(1987)	
	All infectious diseases		29.9	17.4	
	Cancers		3.6	3.6	
	Diabetes		0	1.3	
	Cardiovascular disease		8.9	9.2	
	Other		57.6	68.4	

continued

TABLE 6. Trends in the proportion of deaths, by cause, in some Asian countries, grouped by income, and in the Fiji Islands, during the 1960s, 1970s, 1980s, and 1990s *(continued)*

Group	Causes of death	1960s	1970s	1980s	1990s
Fiji Islands (year)			(1970)	(1985)	
	All infectious diseases		10.4	15.2	
	Cancers		7.5	10.1	
	Diabetes		3.4	5.5	
	Cardiovascular disease		20.6	36.0	
	Other		58.0	33.2	

Source: ref. 45.
Data before 1975 and after 1990 are not available.

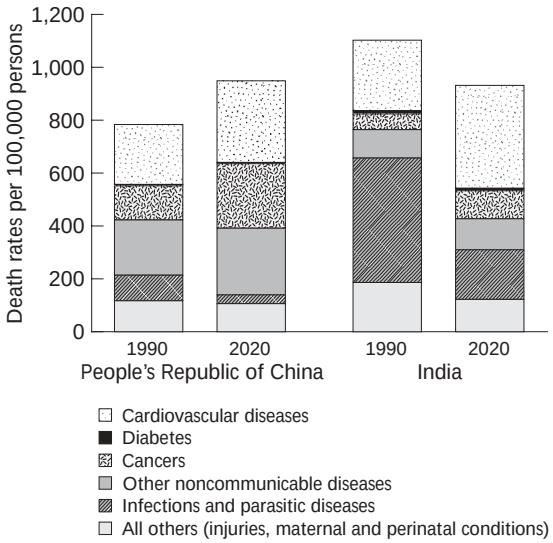

FIG. 20. Actual (1990) and projected (2020) deaths by cause in the People's Republic of China and India. Source: Modified from ref. 47

combined with an aging of the population. Deaths in India from these same NCDs will also increase, reducing the overall decline in deaths.

At very early stages of economic development and nutrition transition, when deaths caused by infectious disease and parasitic infections are still very high, the chronic disease that causes much mortality is hemorrhagic stroke. Hypertension and stroke rates increase with economic development [39]. Where resources allow, treatment of hypertension can lead to a decrease in cerebrovascular disease, as in the Republic of Korea. India and the PRC are vast countries in which different areas, and rural and urban areas in general, are at different stages of transition. A most remarkable epidemic of adult-onset diabetes and related conditions is emerging in urban India [5].

At a later stage of the nutrition transition, CVDs emerge as the primary cause of chronic disease deaths. In the Republic of Fiji Islands, where major diet and lifestyle shifts have been followed by very high levels of obesity, diabetes, and other causes of CVD, over a third of deaths were caused by CVDs by the 1970s. CVDs were also the most common cause of death in the1990s in the Kyrgyz Republic, a country with very high levels of obesity and also very high consumption of fats. In 1993, over 30.4% of the dietary energy intake of Kyrgyz adults came from fat [48]. The Republic of Korea is at a relatively late stage of transition and its low level of deaths from CVD is remarkable [10]. It is suggested that this is because of a high intake of vegetables and low intake of fat, and therefore less obesity than might be expected in a high-income country.

At late stages of the nutrition transition, in countries with relatively high average incomes, deaths from certain cancers increase in absolute and relative importance. Deaths from cancers in Singapore and the Republic of Korea account for 21 to 26% of total deaths. In the PRC, cancers cause almost 20% of all deaths. These rates are all similar to those in developed countries. Elsewhere in Asia, almost 5 to 10% of deaths are caused by cancers. Mortality by site-specific cancers varies among countries [40].

One chronic disease that is linked directly to obesity and inactivity, and for which there are relatively good Asian and Pacific data, is adult-onset diabetes. From the best available sources on adult-onset diabetes in Asia, the following data and projections were published for total cases in the region: 1994, 51.2 million; 2000, 94.7 million; and 2010, 138.1 million [49]. The International Diabetes Institute, Caulfield, Australia, and the World Health Organization (WHO) have developed country-specific estimates of the prevalence of diabetes. WHO, on its website [http://www.diabetes.com.au/home.htm] has projected that the most rapid increase in diabetes will be in India, where a rise is projected from the 1997 estimate of 20.8 million cases to 57.2 million in 2025 . In the PRC, the corresponding projected rise is from 17.1 million to 37.6 million cases.

Two pathologies that are intimately related to diet, and that are believed or known to increase the risk of various chronic diseases, are now briefly reviewed. These are nutrition and other insults to fetal and infant

Diet-related conditions that increase the risk of chronic diseases

Fetal programming

There have been extensive reviews of the effects of fetal and infant insults on health. David Barker and colleagues at the University of Southampton [11–13] have brought into mainstream medical literature the notion of metabolic programming, i.e., that insults operating at a critical period in early life result in long-term changes in the structure or function of humans and also a range of animal models [50].

Fetal and perinatal insults are combinations of undernutrition of the mother and fetus or child, caused by diets that are low or deficient in key micro- and macronutrients. In the case of obesity in later life, the hypothesis is that fetal growth retardation results in metabolic changes that are adaptive to nutritionally stressful circumstances *in utero*. A similar argument can be made for postnatal growth retardation, manifested as stunting. As the child grows, the metabolic efficiencies that were necessary to cope with undernutrition become maladaptive to subsequent overnutrition, leading to the development of abnormal lipid profiles, altered glucose and insulin metabolism, and obesity. Such fetal programming does not by itself lead to increased morbidity and mortality. Rather, it shifts metabolism such that LBW infants become more susceptible to obesity, adult-onset diabetes, and CVD when faced with a richer, more energy-dense diet, reduced physical activity, and increased adiposity, as children or as adults.

Evidence that supports the fetal programming hypothesis is growing on two fronts. First, there is extensive literature on the effects of experimental manipulation of the pre- and early postnatal environment in animals [50]. Second, most of the limited studies on humans have been done in developed countries, although studies in developing countries are beginning to emerge [51]. Studies on humans are difficult because they require detailed information about status at birth, early postnatal growth, and health or anthropometric status in later childhood and adulthood. The few studies done have generally relied on current status assessment of children or adults, with data for infancy obtained from medical records linking birth status with later hypertension, diabetes, and CVD [50].

There are two critical questions regarding the results and applicability of this work. First, although the epidemiology indicates a clear relationship between fetal programming and later life, is this the result of continuation of the same insults to the fetus and infant, or are there impacts during pregnancy and infancy that affect the biology of the individual in ways that subsequent environmental factors cannot? Second, the mechanisms for this relationship are not well understood and therefore interventions cannot be guided precisely [19, 20]. The most important studies on this in Asia are those that have measured not only the prenatal environment and pregnancy outcomes, but also environmental insults after infancy, (e.g., in the Philippines [22, 52, 53]).

Some of the best reviews are those of these early nutrition insults on hypertension, adult-onset diabetes, and CVD, e.g., a meta-analysis of studies linking birthweight with blood pressure [54]. The 27 best studies show a range of reductions in systolic blood pressure of 1.3 to 2.10 mm of Hg (average, 1.7) per one kg increase in birthweight, over birthweights ranging from 1 to 5 kg. However, these studies either excluded or neglected to consider the very high birthweights related to gestational diabetes. The research on diastolic blood pressure is weaker and less consistent, with reductions in the range –0.3 to –1.7 mm of Hg per kg increase in birthweight. It is clear that obesity potentiates this birthweight-hypertension relationship. Moreover, with every decade of age, the reduction in systolic blood pressure with birthweight increases by 0.35 mm of Hg per kg.

Fewer studies have examined the relationship between birthweight and adult-onset diabetes [13]. Insulin production and insulin resistance, both important in the etiology of adult-onset diabetes, appear to be affected by fetal development, but it is hard to select a specific risk ratio (RR). For CVD, although its

definitions have not always been consistent, a general result is clear. LBWs, in particular low PI births, appear to be strongly positively related to CVD [13, 50] .

It has been suggested [11, 55] that long-term health risks are greater for disproportionately IUGR infants, i.e., those who are thinner (low PI). Recent research has shown that subsequent catch-up growth and obesity are needed for fetal programming to be expressed [50]. This would lessen the risk of CVD in Asians, compared to those born in high-income countries, because a much smaller proportion of babies born in Asia have low PIs [50]. A study in the Philippines [22], where 36.7% of a population of LBW babies had low PIs, is cited above. Further studies of this same birth cohort showed that girls who were relatively thin at birth, but who grew rapidly in the first six months, had earlier menarche.* Similarly, it has been shown that girls who were relatively thin at birth but relatively fat as adolescents had higher blood pressure and total cholesterol than those who stayed thin, or those who were relatively heavy at adolescence but not thin at birth [53].

As with adult-onset diabetes, the risk of CVD for LBW or LBW-low PI births seems to be compounded by subsequent adiposity. It has been suggested [19] that this relates to a different mechanism than that proposed by Barker [11–13]. It is clear, however, that individuals from LBW and LBW-low PI births are at a two- to four-fold greater risk of CVD in the environments studied to date. This means that the remarkable nutrition transition in Asia and the Pacific will lead to far worse CVD morbidity patterns than might be expected from current and recent high levels births and fetal programming effects.

Postnatal effects: stunting

Underweight during infancy and stunting in early childhood are risk factors for subsequent obesity. In some cases, infant and early childhood growth retardation result from the same underlying factors that cause IUGR, e.g., poverty, poor maternal nutrition, poor weaning diet, and consequent increased risk of infections [56, 57]. IUGR increases the risk of stunting in infancy and later childhood [58]. Independent of IUGR, many children in developing countries, and indeed impoverished and undernourished children in North America and other developed regions, become stunted during infancy as the result of inappropriate weaning practices, repeated infections, and poor diet: all in the context of poverty [58]. The highest incidence of stunting occurs in the weaning period and soon after. Early childhood stunting is not readily reversible when children remain in the same poor environments. Improved diets and other environmental effects will, however, lead to catch-up growth [59].

The stunting-obesity relationship is supported by data from a number of studies [17, 60–64]. This limited literature suggests RRs of 2.0 to 8.0 for the stunting-obesity effect. A conservative RR of 3.0 was chosen for economic analysis in this review. The literature does not yet support any direct effects of stunting on hypertension, diabetes, or CVD. These possible effects of stunting have not been studied while controlling for birthweight effects. Moreover, the literature is too small for meta-analysis. In the few longitudinal studies of the role of LBW as a cause of stunting in Asia, for example [58], half or more of stunted children did not have LBWs.

Obesity: the effect of diet and physical activity on the risk of chronic diseases

There is a massive and growing literature on the causes of overweight and obesity [65]. Obesity increases the risk of other major chronic diseases, notably CVD and certain cancers. Approaches to correct obesity in adult life remain a matter for debate, but there is an established consensus, reflecting common sense and known biological mechanisms, that energy-dense diets and physical inactivity increase the risk of overweight and obesity. Therefore, the incidence of overweight and obesity in any country can be seen as a function of the energy density of diets and levels of physical inactivity [66]. A large literature shows that nutrient-dense diets, with relatively low energy density, and also regular physical activity, not only predict relatively low levels of obesity, but are also effective approaches for reducing obesity, as well as the risk of adult-onset diabetes, CVD, and certain cancers [67].

Obesity is now a major public health problem in Asia and the Pacific. A generation ago, it was identified as a major problem perhaps only in some western Pacific islands. National surveys from several Asian countries have since shown that the problem is more widespread. Overweight is a lesser condition than obesity and is usually defined by a body mass index (BMI) between 25 to 30. BMI is defined as weight in kg divided by height in meters squared (kg/m^2). Overweight is a precursor of obesity and can increase the risk of other diseases such as diabetes, hypertension, and CVD.

International standards used to delineate the overweight and obese are not appropriate for Asia. A BMI of 25 in an Asian adult appears to have a far greater adverse metabolic effect than it would in a Caucasian adult [68]. WHO and the International Obesity Task

* Adair LS. Fetal programming of age at menarche? Chapel Hill, NC: University of North Carolina-Chapel Hill, 2000 (Unpublished manuscript).

Force (IOTF) formed a group of scientists and agencies in Asia to review this. This group has proposed BMI lower limits of 23 for overweight and 25 for obesity for Asians [69]. The issue is complex, however, as there is extensive racial and ethnic heterogeneity in the Asia-Pacific region. For example, BMI-morbidity relationships for East or South Asians, might not be appropriate for Pacific islanders [69]. Patterns of metabolic disease vary across Asia and the Pacific. Asians tend to put on more abdominal fat, whereas Pacific islanders tend to suffer overweight- and obesity-related diseases at greater BMIs, but are more prone to diabetes [69].

Hence, approaches to obesity must be considered in a regional, subregional, and national context. This change would affect considerably definitions of overweight and obesity in different parts of Asia and the Pacific. For example, the 1997 China Health and Nutrition Survey (CHNS) [27] regarded only 2.6% of the sampled population as obese, according the international BMI lower limit of 30. The survey sample included 8,378 adults from eight provinces. However, 19% would have been regarded as obese if the lower limit was 25. With the BMI upper limits of 23 for overweight and 25 for obesity, total overweight and obesity in PRC would rise from 19.1 to 36.6% for this sample. In this review, the widely accepted WHO BMI lower limits of 25 for overweight and 30 for obesity are retained. This could be changed in future because all the necessary data are available.

Data were obtained from highly reliable, nationally representative or nationwide surveys collected by the following: the present authors and their associates, for the Kyrgyz Republic and the PRC; the World Bank, for Vietnam; the Rand Corporation, for Indonesia; and three governments, Malaysia, the Philippines, and the Republic of Korea. In all cases, weight and height data were measured using standard World Bank or other protocols [24, 25, 32, 70] and the 1993 CHNS [32]. The data available are representative of the middle-, upper-, and lower low-income country groups, and Pacific SIDS. The Kyrgyz Republic, currently the poorest of the Central Asian republics, had a much higher living standard when it was part of the former Soviet Union. Therefore, its higher intakes of meat, dairy products and fat up to 1992, as well as its concurrent occupational structure and activity pattern, are not representative of its current position as a lower income country [48].

In Asia and the Pacific, gender differences in obesity are usually smaller and less consistent than in Africa, the Americas, and Europe [71] (fig. 21; table 7). Except for Nauru and the Kyrgyz Republic, higher levels of economic development are linked with high obesity levels. Pacific SIDS, such as Samoa and Nauru have been the subject of many studies related to their high rates of obesity and related chronic diseases. Nearly half of the populations of the western Pacific have BMIs above 30.

Where data exist, obesity levels are higher in urban than rural areas (fig. 22; table 7). This relates to marked differences between urban and rural residents in patterns of diet and activity.

Obesity levels are not only associated with being wealthy. Income-obesity relationships in four Asian countries for which representative national data were available (the PRC, Indonesia, the Kyrgyz Republic, and Viet Nam) are shown in figure 23. These data are for adults aged 18 and older. In Indonesia, there is a pronounced difference in overweight and obesity patterns by income tertile. This pattern is not so clear-cut in the other three countries. In the Kyrgyz Republic, overweight is constant across income groups, though obesity increases slightly with income. In the

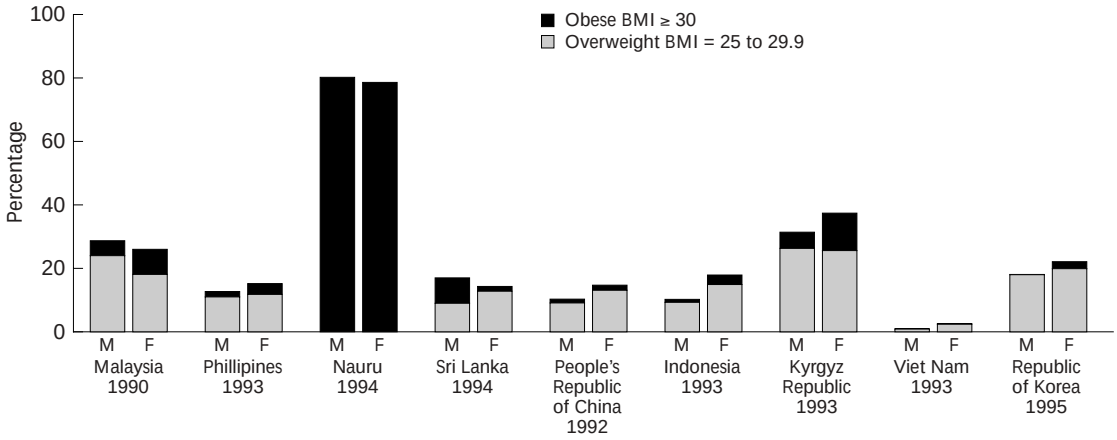

FIG. 21. The prevalence of obesity as a % of total adult population, by gender, in some Asian countries and in the Republic of Nauru. Source: [71]. Notes: BMI = body mass index; M = male; F = female

PRC, there is a small increase in obesity in the high income tertile. In Viet Nam, no pattern is apparent.

There is one further complex situation. In many households, underweight and overweight persons coexist. As Asian and Pacific populations shift toward more-energy dense and lower fiber diets and lower activity levels, it is predicted that there will be a major problem of coexistence of underweight and overweight persons in the same household. Figure 24 presents evidence from low-income countries for which large, nationwide surveys contain anthropometric weight and height data for all members of individual households. Households with both underweight and overweight members represent 3 to 15% of all households in these countries, levels that are far above chance [72]. An underweight child coexisting with an overweight, nonelderly adult was the predominant pair combination. In Figure 24, BMI limits were used for all age groups, rather than using stunting or other measures which would increase significantly the proportion of such households. Therefore, these assessments reflect the current nutrition status of their members.

Early analysis suggests that the speed of the nutrition transition is increasing the likelihood that both underweight and overweight problems will coexist in the same household [72]. As the overall prevalence of undernutrition declines, there appear to be shifts in diet and activity patterns that lead, in many households, to a greater coexistence of obesity with persistent undernutrition. Because dietary shifts toward energy-dense diets (linked with obesity) are occurring much more rapidly among lower income households, it can be expected that increasing proportions of such households will have underweight and overweight members coexisting in the near future [30, 31]. Furthermore, among households noted in figure 24 with underweight members, 30% to 60% also had overweight members [72]. This research challenges the assumption that underweight and overweight are opposing public health concerns and illustrates the need for public health programs in Asia and the Pacific that address simultaneously both underweight and overweight.

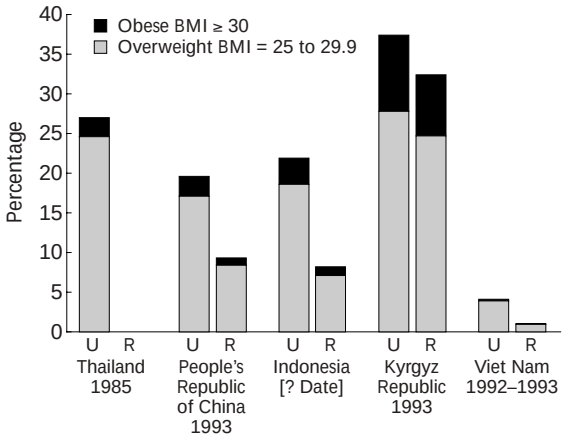

FIG. 22. The prevalence (%) of obesity in urban and rural areas of some Asian countries. Source: ref. 71. Notes: BMI = body mass index, R = rural, U = urban.

TABLE 7. The prevalence of obesity (% of total adult population) by gender and by urban and rural residence in some Asian countries and in the Republic of Nauru

	BMI = 25.0 to 29.9		BMI ≥ 30		BMI < 25		Year
By gender							
	Male	Female	Male	Female	Male	Female	
Republic of Korea	18.0	19.9	0.8	2.2	18.8	22.1	1995
Malaysia	24.0	18.1	4.7	7.9	28.7	26.0	1990
Philippines	11.0	11.8	1.7	3.4	12.7	15.2	1993
Nauru			80.2	78.6			1994
People's Republic of China	9.1	13.1	1.2	1.6	10.3	14.7	1993
Indonesia	9.3	14.9	0.93	3.0	10.3	17.9	1993
Kyrgyz Republic	26.3	25.6	5.1	11.8	31.3	37.3	1993
Viet Nam	0.87	2.4	0.05	0.16	0.92	2.5	1992–3
By urban vs. rural residence							
	Urban	Rural	Urban	Rural	Urban	Rural	
Thailand	24.6		2.4		27.0		1985
People's Republic of China	17.1	8.4	2.5	0.92	20.4	9.8	1993
Indonesia	18.6	7.1	3.3	1.1	21.8	8.1	1993
Kyrgyz Republic	27.8	24.7	9.6	7.7	37.4	32.4	1993
Viet Nam	3.9	0.95	0.21	0.08	4.1	1.0	1992–3

Sources: ref. 10, 71.
BMI = body mass index.

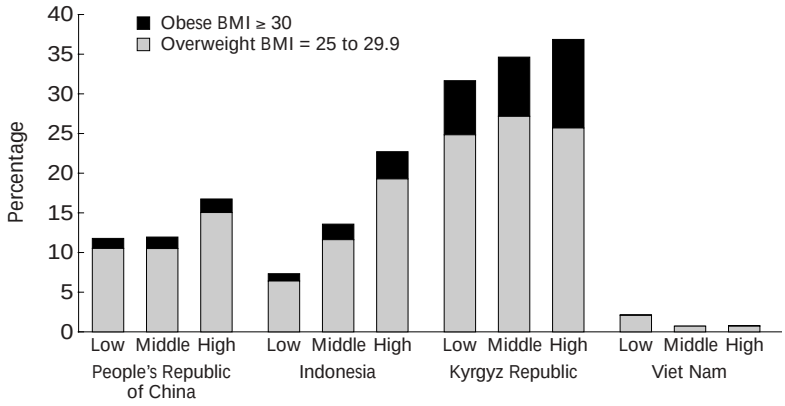

FIG. 23. The prevalence (%) of obesity by income tertile in the People's Republic of China, Indonesia, the Kyrgyz Republic, and Viet Nam. Sources: PRC, People's Republic of China Health and Nutrition Survey (1993), http://www.cpc.unc.edu/projects/china/china_home.html; Indonesia [24]; Kyrgyz Republic [70]; Viet Nam [25]. Notes: BMI = body mass index.

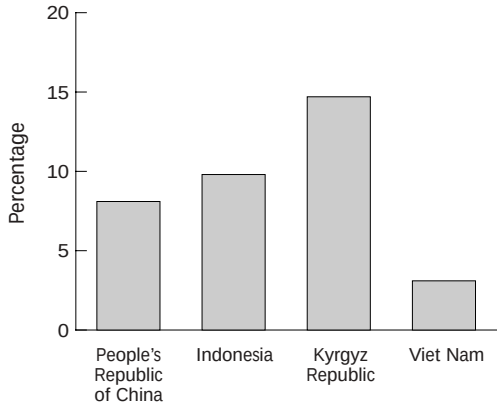

FIG. 24. Proportions (%) of all households with both underweight and overweight members in the same household, in the People's Republic of China, Indonesia, the Kyrgyz Republic, and Viet Nam. Sources: PRC, People's Republic of China Health and Nutrition Survey (1993), http://www.cpc.unc.edu/projects/china/china_home.html; Indonesia [24]; Kyrgyz Republic [70]; Viet Nam [25].

Major diet-related chronic diseases

Cardiovascular disease (CVD)

CVD is the term used by the scientific community to embrace not just conditions of the heart [ischemic heart disease (IHD), valvular, muscular, and congenital heart disease] but also hypertension and conditions involving the cerebral, carotid, and peripheral circulation. Diabetes is usually placed in a separate category from CVD. It is well recognized that the risk of CVD is related to diet, physical activity, and body [38, 39]. The patterns of food supplies and of food and nutrition that modify the risk of CVD are also well known.

The governments of many developed and many developing countries have issued dietary and other recommendations designed to control the incidence of CVD [41, 43]. The basic agreed finding is that varied diets that are high in vegetables, fruits, and starchy staple foods (preferably in minimally processed form) and that are relatively low in energy density, fats, saturated fats, sugar, and salt, are most protective against CVD. Such diets approximate those that have been traditional in many countries in Asia and Pacific SIDS, where public health problems have been food insecurity, undernutrition, and monotony of diets. However, when people have enough to eat and when diets are varied, diseases of undernutrition are not major public health problems. Table 3 summarizes these general relationships.

Additionally, there is conclusive evidence that regular physical activity maintained throughout life, together with nutrient-dense diets**,** protects not only against obesity and therefore indirectly against CVD. This finding has very important implications for developing countries in Asia and the Pacific, where protective diets and lifestyles are not as established as they are in developed countries. Programs and policies designed to control obesity and CVD in Asia and the Pacific should emphasize what is valuable in traditional and existing agriculture and food systems, food supplies, diets, and activity patterns.

Inappropriate diets are a major determinant of the risk of cerebrovascular diseases including hypertension and stroke [43]. Dietary recommendations for preventing these pathologies are the same as those for obesity and CVD except for an added focus on diets with less salt.

Cancers

There is also now a consensus that, in broad terms, the same diets and associated lifestyles that protect against obesity, diabetes, cerebrovascular diseases, and CVD, also protect against certain cancers, i.e., major cancers of epithelia as well as hormone-related cancers that become or remain epidemic as a consequence of demographic, nutrition transitions [40]. These cancers include those of the lung, breast, endometrium, colon, and rectum, and also cancers that may be associated with traditional diets, such as those of the mouth, throat, esophagus, and stomach (table 5).

It has been estimated [40] that cancer incidence might be reduced by 30% to 40% through appropriate diets and associated lifestyle. At 1995 levels, such a reduction would correspond to three to four million cases per year worldwide. This report is remarkable for its global perspective and for reconciling its recommendations with those for other major chronic diseases, including obesity and CVD, adult-onset diabetes and osteoporosis [40]. Its findings are consistent with those of this review. Diets and physical activity that protect against cancer also protect against other chronic diseases, and have no deleterious effect on other diseases.

Current diet recommendations, following food science, emphasize food and dietary patterns more than individual macro- and microconstituents. Food-based dietary guidelines are now generally accepted [73]. The diets that are most protective against chronic diseases, especially in sedentary populations, comprise mainly foods of plant origin. These diets are varied and high in nutrients, but relatively low in energy. They include substantial amounts of legumes and other vegetables, fruit, and minimally processed grains and other starchy

staples. They are also relatively low in fat, especially saturated fat, and in sugar, salt, and alcohol. In general they contain only modest amounts of foods of animal origin. The World Cancer Research Fund (WCRF) emphasized the importance of year-round variety in diets, and also the value of small amounts of meat, fish, poultry, and dairy foods, especially when diets might otherwise be monotonous [40].

Health costs

Epidemic, diet-related chronic diseases, entail important human and economic costs. The human costs have been quantified in terms of disability and death [47]. To date, however, there are almost no estimates of the economic costs in developing countries, although a study is in process for the Pacific islands [74]. There have also been studies for the United States, for example [75].

Using cautious assumptions, estimates are presented here for the human and economic costs of such diseases in the PRC and Sri Lanka. Estimates are presented for losses in 1995 and for projected losses in 2025, to give a sense of how these costs might evolve, together with nutrition and epidemiological transitions. These estimates should be treated cautiously, as ballpark estimates, rather than as definitive. They are intended to provide policy guidance on targeting interventions, as well as to show how the relative costs of undernutrition (including nutrient deficiencies) and overnutrition might change over time. The numbers of deaths, economic costs of hospital resources, and economic costs of premature mortality are included. No data were available from which to estimate the costs of lost work outputs due to morbidity, whether from lost workdays, or from lowered productivity by those with chronic diseases continuing to work. Therefore, the total costs presented here are almost certainly underestimates.

The five diet-related chronic diseases considered here are CVD (especially IHD), diabetes, hypertension, stroke, and cancers. Among these, CVD, stroke and cancers are major causes of premature death. Hypertension and diabetes, themselves life-threatening diseases at late stages of pathology, also increase the risk of stroke and CVD.

Figure 25 depicts the major causal pathways included in the model and some other important pathways which could not be modeled because epidemiological data were too limited (for example, the effects of *trans* fatty acid intake on IHD) or because of overlapping effects. For example, the link between overweight and hypertension, although well established, was not modeled. The effects of overweight on IHD directly were modeled. It is not valid to double count and to add the indirect effects of overweight, via hypertension, on IHD. The focus here is on diet and does not include the additional effects of physical activity, except in so far as activity has indirect effects, via energy imbalance and overweight status. However, physical activity is known to have direct effects on hypertension, diabetes, and CVD. Therefore, again, the estimates here are cautious.

The effect of inappropriate diets on disease risk is multidimensional. There are potentially overlapping effects, e.g., LBW, via obesity, on CVD; LBW, via hypertension, on CVD; and LBW, via diabetes, on CVD. Therefore, care was taken, when estimating overall effects, not to double count such effects. The separate effects of different pathways can be added only if the clinical studies, on which the RR estimates are based, also control for confounding effects. For example, in order to be able to add up the effects of LBW, via overweight and via hypertension, on CVD, it is necessary to control for current weight in the link between LBW and hypertension and in the link between hypertension and CVD. Because studies do not always adjust for confounding factors, caution was exercised here and, when adding up effects via different pathways, the maximum amount of overlap was assumed. In the literature on cardiovascular and cancer epidemiology, there is an attempt to control for key biological confounding factors other than nutrition. However, studies on fetal and infant undernutrition are very new and only a few have controls for subsequent confounding factors [43]. For example, to analyze the effects of LBW or LBW-low PI on adult-onset diabetes requires controls for obesity, which is another direct determinant of diabetes. Such studies to date have lacked adequate controls for current weight.

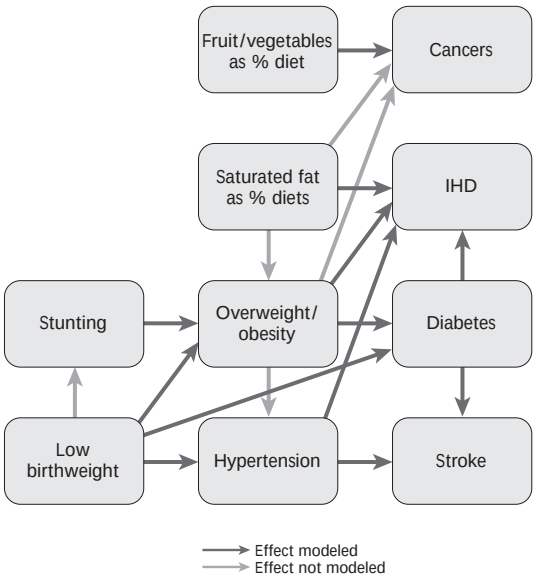

FIG. 25. Important pathways for diet-related chronic diseases.
Notes: IHD = ischemic heart disease.

Figures 26 to 28 illustrate RRs for IHD, stroke, and diabetes, respectively. These RRs are taken from existing literature, using meta-analyses wherever possible. Much of this literature is for populations in rich countries, often the United States, and the majority of the studies are for men. The applicability of these RRs to Asian and Pacific island populations, and to women or men and women combined, is not clear. If anything, studies suggest that RRs for some of these chronic conditions are even higher in Asian populations [76, 77]. It is not possible to give separate RRs for morbidity and mortality. Such RRs are not generally available, except for CVD, and even for CVD it is not yet possible to separate out all the pathways for mortality and morbidity.

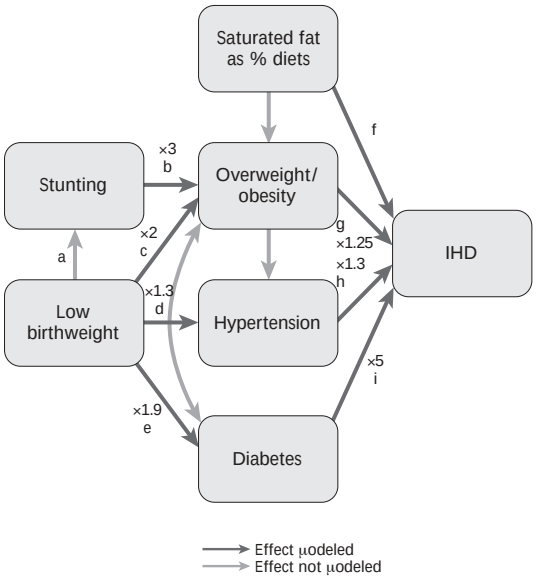

FIG. 26. Relative risks (RR) for ischemic heart disease (IHD), expressed as multiples (×).

Sources and notes:

a Assumes that all low birthweight babies and some normal birthweight babies become stunted. Data on overlap between stunting and low birthweight are limited.

b see text.

c see text.

d [54] citing [78]; that the relative risk (RR) of hypertension is 1.6 for birthweights from <5 lbs as compared to birthweight >10 lb (>2.27 to >4.54 kg) is 1.6. The RR of hypertension for birthweights <5 lbs as compared to those >5 lbs (<2.27 kg compared to >2.27 kg) is assumed to be 1.3, using linear interpolation and controls for current body mass index (BMI).

e [13] using a Health Professional Study of the USA for men, with controls for current body mass index (BMI).

f [43] citing [79]; data are cross-country regression averages for men, for ten-year incidence of IHD, which increases by 78 per 100,000 per 1% increase in saturated fat as % of diet calories.

g [80] using a study from Framingham, MA for 12-year, age-adjusted IHD rates in which RR is averaged across three tertiles of subscapular skinfold thickness.

h [43] citing [81], for effects on IHD from treatment trials of hypertension, associated with long-term decline of diastolic blood pressure of 5–6 mm of Hg.

i [43] citing [82] for death rates for IHD averaged across men and women.

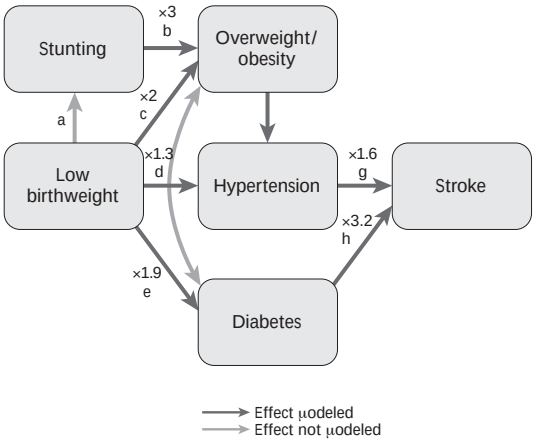

FIG. 27. Relative risks (RR) for stroke, expressed as multiples (×)

Sources and notes:

a–e as for fig. 26.

f [83]; for US adults.

g [43] citing [81], for effects on IHD from treatment trials of hypertension, associated with long term decline of diastolic blood pressure of 5–6 mm of Hg.

h [43]; average for men and women, from a heart study based in Framingham, MA, USA.

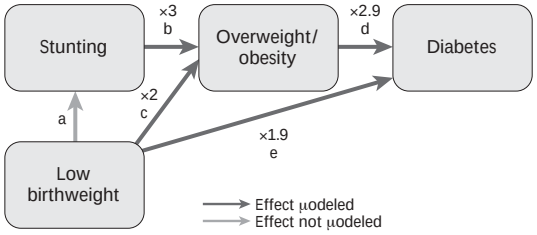

FIG. 28. Relative risks (RR) for diabetes, expressed as multiples (×)

Sources and notes:

a,b,c,e as for fig. 26.

d RR for BMI>25 as compared to BMI<25; estimated from [83]; using National Health and Nutrition Survey data (NHANES II).

Case study for the People's Republic of China

Table 8 summarizes the health cost data used for the PRC, including prevalence rates (e.g., for overweight and obesity, hypertension, LBW, and stunting), and mortality rates from cancers, CVD, and stroke, as well as from all causes. Crude, rather than age-specific, mortality rates were used, because age-specific RR data have not been developed for Asia. However, some age-specific mortality data are available. The available projections for 2020 [47] are age-specific. Analyses are presented for 1995, and projections for 2025, when shifts in diet, obesity, and disease profiles will increase health costs considerably. The projections to 2025 were made because investments for the prevention of diet-related NCDs face a long interval before economic benefits are obtained. For example, an investment in reducing LBW might not affect adult hypertension or adult-onset diabetes for 20 to 50 years.

For the 2025 mortality rates predicted for the PRC, baseline predictions for 2020 [47] were used. These show very large increases in death rates for diet-related chronic diseases, consistent with the predictions made here for dietary patterns, obesity, and hypertension. Predictions relating hypertension and intake of saturated fats assume that rural areas will catch up with current rates of increase in urban areas, and that there will be modest increases in fat intake in urban areas. These trends are now being observed in developed countries.

It was assumed, based on consumption data from the PRC Health and Nutrition Surveys [32], that fruit and vegetable intake will not increase markedly by 2025. In the 1991 CHNS survey, which obtained 3-day sets of dietary data on 7,450 adults in eight provinces, only 20% of those sampled consumed the recommended amount of 500 to 700 g/day of fruits and vegetables. The Nutrition Society of China has established 500 to 700 g/day of fruits and vegetables as the level recommended as protective against chronic diseases [86].

Trends in overweight and projected proportions of overweight are important for economic analyses. Recent data for the PRC show a major shift in the proportion of the population that is overweight. For example, a study in eight provinces [87] found that 6.2% of men and 11.2% of women had BMIs of 25 or above in 1989. By 1997 this had increased to 17.3% in men and to 20.7% in women. The results were almost identical when a cohort was followed for eight years. The sample sizes were 2,403 men and women in 1989 and 4,049 in 1997. This result is consistent with an acceleration in the level of consumption toward increased consumption of meat (mostly pork), edible oil, and other sources of fat in the diets of these same adults [31].

There is no simple way to use this information to predict obesity in the PRC in 2025, but there is no reason to believe that the 1989 to 1997 rate of increase will not be matched. However, a more conservative view was taken here. If this documented rate of increase were to continue, an additional 1.39 % of Chinese men would become overweight each year: a cumulative increase of 39% from 1997 to 2025. For women, the corresponding increases would be 1.35% and 38%. It was assumed, conservatively, that male and female overweight in the PRC would increase at only half this rate. This suggests that an additional 19.5% of men and 19.0% of women will be overweight in the PRC in 2025, i.e., totals of 36.8% of men and 39.7% of women.

Hospital costs in the PRC account for most health system costs, because most health care is provided through outpatients visits to doctors at hospitals, and through hospital stays as inpatients. Hospital doctors also prescribe the drugs required and these are sold at hospital pharmacies. No data are available for medical expenditures other than those for doctors and hospitals. In the 1980s, the pharmaceutical sector outside hospitals was small, but there is evidence that this has grown rapidly. According to a recent estimate (G. Henderson, personal communication, 2000) it accounts for as much as 15% of drug expenditures: more in large cities, less in rural areas.

Some of the costs of chronic diseases in the PRC are summarized in tables 9 and 10. The human costs

TABLE 8. Data and assumptions for calculating the costs of diet-related chronic diseases in the People's Republic of China in 1995, and projections for 2025

Data category	1995	2025
Nutrition and diet-related factors		
Overweight and obesity, men	8.1% [a]	36.8% [a]
Overweight and obesity, women	12.2% [a]	39.7% [a]
Saturated fat intake	7.0% [b]	12.7% [b]
Fruit and vegetable intake (g/day per capita)	235	232
Low birthweight (LBW)	27% [c]	9% [d]
Stunting	45% [e]	24% [f]
Morbidity by cause		
Hypertension, men	19.1% [a]	25% [a]
Hypertension, women	18.2% [a]	25% [a]
Diabetes	1.4% [a]	2.4% [a]
Mortality by cause (per 10,000; men and women combined)		
Ischemic heart disease (IHD)	29.61	93.4
Stroke	90.20	155.8
Diabetes	6.24	
Cancers	90.58	243.9
All causes	520.43	948.8
Other variables		
Total population (million)	1,188	1,547
Rural population	70% [a]	45% [a]

Sources: overweight and obesity [84]; diet and stunting, China Health and Nutrition Surveys, 1989–97 http://www.cpc.unc.edu/projects/china/china_home.html; LBW [85]; morbidity and mortality, Chinese Academy of Preventive Medicine. The cost of diet-related noncommunicable disease in China: Beijing (draft manuscript for the Asian Development Bank, Manila, 2000); population, gopher://gopher.undp.org:70/00/ungophers/popin/wdtrends/urban

a. Percentage of total adult population.
b. Percentage of diet, by weight.
c. Percentage of all births in 1965.
d. Percentage of all live births, 1995 actual figures.
e. Percentage of all live births.
f. Percentage of children 5 and under

Bases for predictions: overweight, projections using trend lines; saturated fat intake, current intake, supplemented by estimates of the authors that production will increase by 2.8% per year, assuming that fat intake in rural areas will rise to current urban levels, and that fat intake in urban areas will increase to the rates seen in the United States in the 1960s; fruit and vegetable intake, extrapolation from current trends, assuming that the current decline will stabilize; hypertension, assuming that rural rates will catch up with urban rates, but that urban rates will not rise further since Asian levels are already high relative to developed countries; mortality, [47], using 2020 baseline data; population, see above; LBW and stunting, levels 30 years previously (to estimate the childhood conditions of current adults), i.e., actual 1995 levels are used for 2025, and estimated 1965 levels are used for 1995.

are very large. Diet-related chronic diseases account for 2.57 million deaths annually, 41.6% of all deaths. Stroke causes one in five of these deaths. Hypertension rates are high and are not far behind US rates, whereas obesity and saturated fat consumption are lower. Deaths from diet-related chronic diseases in the PRC are predicted to rise dramatically to 7.63 million total deaths in 2025, 52.0% of all deaths. Cancers alone will account for more than a quarter of all deaths in that year.

The economic costs of diet-related chronic diseases are very large (tables 9–11). Total hospital spending in 1998 on diet-related chronic diseases was estimated as US$11.74 billion. This represents 1.6% of GDP, and 22.6% of all hospital expenditures. Hospital expenditures include nearly all health system spending, as discussed above. Hospital stays for these chronic diseases are expensive. The average hospital stay in the PRC for all treatments, from combined data for urban and rural areas for 1998, cost US$300 and lasted 16 days, compared to over US$500 and 20 to 30 days for diet-related chronic diseases.

These diseases also have large economic costs in terms of lost productivity due to premature deaths. If each adult death from these diseases causes, on average, 10 years of lost productivity, then the GDP lost, in present value terms, is US$2,210: assuming 1995 wages at US$300 per year; real growth of wages at 3%

TABLE 9. Costs of diet-related chronic diseases in 1995, and projected adult deaths from these diseases in 2025, in the People's Republic of China

1995 estimates	
Number of adult deaths	2.57 million (41.6% of all deaths)
Hospital costs	US$11.74 billion (22.6% of all hospital costs; 1.6% of GDP)
Productivity losses due to premature death	US$3.41 billion (0.5% of GDP)
Total cost	US$17.50 billion (about 2.1% of GDP)
2025 prediction	
Number of adult deaths	7.63 million (52.0% of all deaths)

Source: Authors' calculations, based on tables 8 and 10.
US$1.00 = 8.09 yuan; GDP = gross domestic product.

TABLE 10. 1998 hospital costs and 1995 human costs, in terms of rural and urban mortality rates, for major diet-related chronic diseases (cancers, ischemic heart disease, hypertension, and stroke) in the People's Republic of China

Condition	1998 hospital costs (million yuan)	1995 mortality rates per 100,000 persons		
	Total	Rural	Urban	Total
Cancers	14,838	82.83	106.33	90.58
Diabetes	6,954	3.78	11.97	6.24
Ischemic heart disease	33,800	23.09	44.83	29.61
Hypertension	15,695	—	—	—
Stroke	23,699	87.03	106.33	90.20
Major diet-related	94,986	196.73	269.46	216.63
All causes	419,678	532.50	492.25	520.43

Source: 1998, Chinese Academy of Preventive Medicine. The cost of diet-related noncommunicable disease in China, Beijing (draft manuscript for the Asian Development Bank, Manila, 2000), using China National Health Services Survey (1998) .

Notes: Costs for 1998 are based on the number of outpatient visits per 1,000 persons, multiplied by average cost per visit, plus number of inpatient admissions per 1,000 persons, multiplied by average cost per hospital stay. Cost data are presented by disease category, see table 11. US$1.00 = 8.09 yuan.

per year, and a 12% discount rate. There is, of course, the issue of labor surplus. Underemployment and unemployment exist in many developing countries and are increasing in the PRC. However, the US$300 per year figure assumed here for average wages is very modest for a country with a 1995 per capita income of more than twice that level. Therefore, the estimate here of productivity loss from these chronic diseases is conservative. Assuming that about 60% of those over 18 are active in the labor market, then annual losses from these chronic diseases are US$3.41 billion due to premature deaths, i.e., about 0.5% of GDP. Diet-related chronic diseases in the PRC have total annual costs of about 2.1% of GDP, in terms of lost productivity due to premature deaths and to hospital costs. Hospital costs account for three quarters of this loss.

There are no data available for loss of work output for patients who survived or for lowered work rates in general from diet-related chronic diseases, including lost productivity from persons who are debilitated and being treated as outpatients or not being treated at all. For Tianjin, the data available include lost wages, and the costs per patient hospitalized for stroke and heart attack.* These costs are about twice as high as the costs of hospitalization at city hospitals in table 11. This implies that the losses of work output due to morbidity are similar to those from mortality, and that the estimate here of 2.1% GDP loss is only about 60% of the total cost.

How much of the chronic disease in the PRC can be traced back to dietary causes? Detailed calculations in table 12 lay out population attributable risks (PARs) for adult diet and health factors, and five chronic conditions, based on the pathways identified in figures 25 to 28.

* Tian H. Chronic disease intervention project cost-effectiveness evaluation from 1991–96 in Tianjin city. Tianjin, PRC: Tianjin Municipal-Academic Station, September 1999 (mimeo.) (In Chinese).

TABLE 11. 1998 hospital costs and related data for chronic diseases in the People's Republic of China

Disease	Category	Prevalence[a] (1/1000)	Inpatient visits per 1,000 population per year	Out-patient visits during last two weeks prior to survey per 1,000 population	Average cost (yuan) for one out-patient visit	Average length of individual stay (days)	Average cost (yuan) per inpatient	Average cost (yuan) of outpatient per 1,000 population per year	Average cost (yuan) of inpatient stay per 1,000 population per year	Average cost (yuan) for outpatient visits and inpatient stays per 1,000 population per year
Cancers	All hospitals	1.2	0.8	0.8	326	31	8,172	6,361	6,129	12,490
	City hospital	2.3	1.5	1.4	376	39	11,894	13,288	17,841	31,129
	Rural hospitals	0.8	0.5	0.6	281	25	5,092	4,018	2,546	6,564
Diabetes	All hospitals	3.2	0.4	1.1	152	26	3,950	4,274	1,580	5,854
	City hospital	9.8	1.2	3.0	184	28	4,161	14,519	5,035	19,554
	Rural hospitals	0.9	0.1	1.4	71	17	3,213	2,629	321	2,950
Heart disease	All hospitals	14.2	2.3	6.6	117	21	3,626	20,112	8,340	28,451
	City hospital	34.5	5.0	11.4	175	26	5,214	51,767	26,070	77,837
	Rural hospitals	7.4	1.4	5.0	71	16	1,754	9,167	2,456	11,623
Hypertension	All hospitals	15.8	0.8	5.3	81	19	2,819	11,098	2,114	13,212
	City hospital	39.3	1.8	10.1	122	21	3,406	31,990	6,165	38,155
	Rural hospitals	7.9	0.4	3.6	42	15	1,933	3,914	773	4,687
Stroke	All hospitals	5.9	1.7	3.1	146	30	4,728	11,911	8,038	19,949
	City hospital	13.1	4.2	6.7	163	33	5,377	28,208	22,583	50,791
	Rural hospitals	3.4	0.9	2.0	123	25	3,715	6,278	3,158	9,436
All Diseases	All hospitals	157.5	35.4	163.9	63	16	2,384	268,894	84,370	353,264
	City hospital	273.3	48.3	161.9	119	23	4,037	499,235	194,947	694,181
	Rural hospitals	118.4	31.0	164.6	45	13	1,532	191,298	47,538	238,836

Source: Chinese Academy of Preventive Medicine. The cost of diet-related noncommunicable disease in China, Beijing (draft manuscript for the Asian Development Bank, Manila, 2000) using National Health Services Survey 1998.

a. Prevalence data are from self-reporting of particular chronic diseases. US$1.00 =8.09 yuan

TABLE 12. Pathways for calculation of population attributable risks (PARs) of dietary effects on chronic diseases for application to existing 1995 data (and projections, to 2025) in the People's Republic of China

Contribution of	To	PAR direct effect (%)	PAR indirect effect (%)	Pathways for indirect effects
Childhood dietary effects				
Stunting	Overweight	55.6 (41.9)	NA	NA
LBW	Hypertension	44.8 (10.5)	NA	NA
LBW	Diabetes	33.9 (14.6)	NA	NA
Effects on CVD				
Animal fat intake	CVD	14.9 (28.3)	NA	NA
Overweight	CVD	12.2 (32.2)	NA	NA
Hypertension	CVD	20.6 (24.5)	NA	NA
Diabetes	CVD	6.5 (10.7)	NA	NA
Stunting	CVD	N/A	6.8 (13.5)	Via overweight
LBW	CVD	N/A	9.2 (2.6)	Via hypertension
LBW	CVD	N/A	2.2 (0.3)	Via diabetes
Effects on stroke				
Hypertension	Stroke	25.2 (24.5)	—	—
Diabetes	Stroke	2.1 (10.7)	—	—
Overweight	Stroke	—	6.0 (13.1)	Via hypertension
Stunting	Stroke	—	3.4 (5.5)	Via overweight and hypertension
LBW	Stroke	—	11.3 (2.6)	Via hypertension
LBW	Stroke	—	0.7 (1.6)	Via diabetes
Effects on hypertension				
Overweight	Hypertension	24.0 (53.3)	—	—
LBW	Hypertension	44.8 (10.5)	—	—
Stunting	Hypertension	—	13.3 (22.3)	Via overweight
Effects on diabetes				
LBW	Diabetes	33.9 (14.6)	—	—
Overweight	Diabetes	22.7 (33.1)	—	—
Stunting	Diabetes	—	12.6 (22.0)	Via overweight
Effects on cancers [a]				
Fruit and vegetable intake	Cancers	22.7	—	—

Source: data from tables 1–11 and figures 1–9; calculations by the authors.

a. Relative risk data for cancers may not take into account fully the observed large fruit and vegetable deficiency, relative to recommended levels, in the People's Republic of China, and hence the PAR above is tentative. For comparison, the desired/recommended levels of nutrition-related variables are as follows: LBW, 0%; stunting 0%; hypertension 0%; fruit and vegetable intake, 700 g/day (recommended in the People's Republic of China; [86]). Animal intake, 8 to 10% of dietary calories; overweight, 0%; CVD = cardiovascular disease; LBW = low birthweight; NA = not applicable; PAR = population attributable risk.

These conditions are also traced back to childhood stunting and LBW as appropriate. The most important pathways are summarized in table 13 for 1995 and in table 14 for 2025. Because of concerns about overlaps between different pathways, the single most important pathway for each condition was chosen. Where the most important factor is hypertension, the PAR for overweight is also presented. Hence the results are a minimum estimate of the effects of diet. In the PRC in 1995, dietary factors accounted for between one-fifth and one-quarter of each of these chronic diseases.

If these adult conditions are traceable back to childhood factors, then the most important cause of diet-related chronic diseases in adults is currently LBW. However, there is a lack of good data for LBWs of the current adult population. A conservative estimate was used, assuming that the incidence of LBW in 1965 was three times what it is now. It was also assumed, based on current trends in the PRC, that stunting has decreased more slowly than LBW, and has fallen from around 45% 30 years ago or earlier, to 24% currently. This is consistent with improvements in women's BMIs, which affect birthweights, and with slower improvements in the complementary feeding of infants, which affects stunting. In the PRC in 1995, LBW accounted for at least 10% of stroke and CVD, a third of diabetes, and almost half of hypertension, according to our calculations. One way to test this would be to examine location-specific patterns of diet-related chronic diseases and to compare these with what is known about variation in birthweight. Another way to test this would be to look at morbidity and

TABLE 13. Estimated contributions of diet-related and childhood factors to chronic diseases in the People's Republic of China in 1995

Diseases	Key factor	PAR (share of condition attributable to this diet factor)
Diet-related factors		
Cancers	Fruit and vegetable intake	22.7%[a]
CVD	Hypertension	20.6%
CVD	Overweight	12.2%
Diabetes	Overweight	22.7%
Stroke	Hypertension	25.2%
Stroke	Overweight	6.0%
Hypertension	Overweight	24.0%
Childhood factors		
CVD	LBW	9.2% (via hypertension)
Stroke	LBW	11.3% (via hypertension)
Diabetes	LBW	33.9% (direct effect)
Hypertension	LBW	44.8% (direct effect)

Source: based on table 12.

a. Estimates for cancers are from ref. 40 and represent the proportion of all cancers deaths preventable by changes in diet, exercise, and alcohol consumption. This represents an average from all cancers. Some cancers are more preventable by diet than others, especially by fruit and vegetable intake.

This table picks out the most important diet-related pathways for each of the outcomes. If overlap between different pathways is not 100%, then these are underestimates of dietary effects on chronic diseases.

CVD = cardiovascular disease; LBW = low birthweight; PAR = population attributable risk.

TABLE 14. Projected contributions of diet-related and childhood factors to chronic diseases in the People's Republic of China in 2025

Diseases	Key factor	PAR (share of condition attributable to this diet factor)
Diet-related factors		
Cancers	Fruit and vegetable intake	22.7% [a]
CVD	Saturated fat	28.30%
CVD	Overweight	32.3%
Diabetes	Overweight	33.1%
Stroke	Hypertension	24.53%
Stroke	Overweight	13.1%
Hypertension	Overweight	53.3%
Childhood factors		
CVD	Stunting	13.5% (via overweight)
Stroke	Stunting	5.5% (via overweight)
Diabetes	Stunting	13.8% (via overweight)
Hypertension	Stunting	22.3% (via overweight)

Source: based on table 12.

a. Estimates for cancers are from ref. 40. They represent the proportion of all cancers deaths preventable by changes in diet, exercise and alcohol consumption. This represents an average from all cancers. Some cancers are more preventable by diet than others, especially by fruit and vegetable intake.

This table picks out the most important diet-related pathways for each of the outcomes. If overlap between different pathways is not 100%, then these are underestimates of dietary effects on chronic diseases.

CVD = cardiovascular disease; LBW = low birthweight; PAR = population attributable risk.

mortality due to diet-related chronic diseases in rural migrants to urban areas.

Significant changes in morbidity and mortality patterns are predicted for the PRC in 2025 (table 8). Hypertension rates will not increase much beyond the already very high rates in urban areas. LBW, an important source of higher risk of hypertension will decrease. Overweight and obesity, also associated with increased hypertension, will increase quite sharply. Overweight and obesity will become the main underlying factor for CVD, diabetes, and hypertension. Hypertension will remain the most important underlying factor for stroke. Overweight and obesity will account for a third of CVD and of diabetes, and more than half of all hypertension by 2025. In other words, the importance of diet in chronic diseases will intensify.

In early life, childhood stunting is predicted to become the main risk factor, accounting for between 5% and 22% of CVD, diabetes, hypertension, and stroke. Childhood factors have yet not been studied for cancers in later life. This importance of stunting is related to the much reduced level of incidence of LBW in 1995 as compared to 30 years earlier. Stunting also reduced over this period but its decline was smaller than that of LBW. Stunting in the PRC has proved more resistant to improvement than LBW, possibly because of inadequacies in infant feeding patterns.

The differences between the major pathways are shown in figure 29 for 1995, and in figure 30 for 2025. It is striking to note how the priority pathways shift from LBW-hypertension, to stunting-overweight. This change in pathways has cost implications. It is not possible to predict hospital expenditures in 2025, but it is clear from the 1995 data that CVD costs about four times as much as stroke, in relation to the number of deaths caused.

When total expenditure on CVD is divided by the number of deaths from CVD, and compared with total expenditure on stroke divided by the number of deaths from stroke, CVD expenses are three times higher per

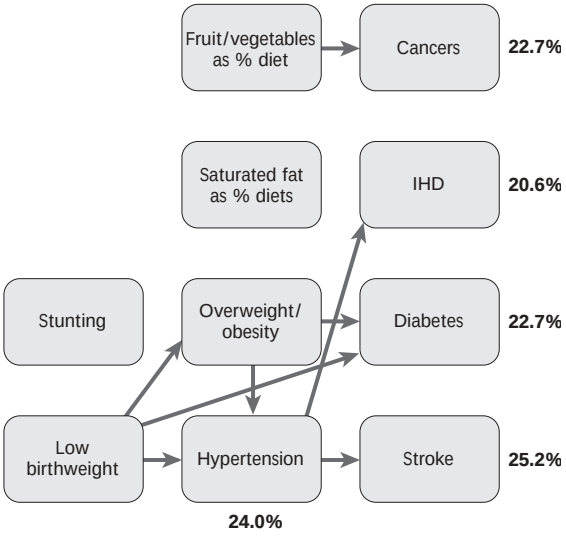

FIG. 29. Main pathways for dietary effects on chronic diseases in the People's Republic of China, 1995. Notes: Percentages next to boxes indicate the estimated minimum contribution of key dietary factors to each disease condition; IHD = ischemic heart disease

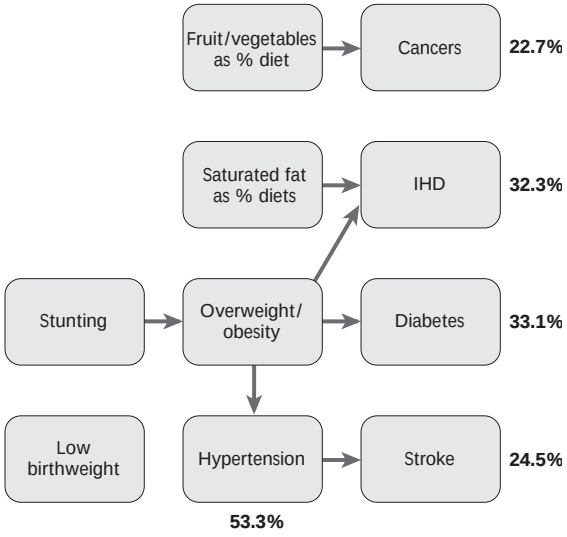

FIG. 30. Main pathways for dietary effects on chronic diseases, in the People's Republic of China, projected for 2025. Notes: Percentages next to boxes indicate the estimated minimum contribution of key diet factors to each disease condition; IHD = ischemic heart disease

death, even if hypertension expenditures are added to stroke expenditures. Thus the large predicted increase in CVD is going to increase health costs seriously. Improvements in patterns of care for CVD and stroke, decreasing the length of hospital stays, would moderate this increase in costs. Moreover, as these diseases and related patterns of care become more common, improved technology and disease management might reduce costs per person. On the other hand, the PRC to date imports very little technology. A push to open its markets to new medical technology could drastically increase the costs of medical care.

It is more difficult to predict the effect of increased cancers on hospital costs in 2025. Cancer expenditures are currently the lowest per death of the three major conditions. However, cancer treatment is still relatively new in the PRC. Many cancers are diagnosed there relatively late in relation to possibilities of treatment. It is quite likely that cancer care will become increasingly resource-intensive by 2025. Estimates by the World Cancer Research Fund (WCRF) researchers [88] are that cancer treatment expenditures will increase by a factor of 25 in developing countries by 2025.

It is typically more expensive and more difficult to intervene to reduce overweight than to reduce hypertension. Although medical 'quick fixes' are not necessarily desirable, there are modestly priced drugs, such as diuretics, for controlling hypertension. Drugs to treat CVD are also available, but are more expensive. There are, however, few proven, cost-effective interventions to reduce overweight.

In order to reduce mortality and morbidity from diet-related chronic diseases, and to reduce associated costs, it is important that the PRC begins to invest in policies to avert the above predictions for 2025. Findings here suggest three priorities. First, (as a 'quick fix') is it is important to monitor the population for hypertension, particularly in urban areas and particularly for those aged 40 and above, i.e., the age groups when mortality from CVD and stroke become significant. Those identified with hypertension are candidates for treatment, usually through drugs (the 'quick fix' mentioned above) but also through modifications to behavior and diet. Second, there is a good case for the continuation of efforts to reduce stunting. Stunting has potentially deadly consequences, when combined with more affluent diets in later life. Third, it will be important to devote more resources to those age groups for whom diet modification and establishing healthy exercise patterns are possible. Current evidence suggests that the right time to intervene is in early life, before poor diet and activity patterns become habitual. To wait until chronic diseases become clinically evident, at late stages in the disease process, is cost-ineffective and very expensive in terms of treatment options.

Physical exercise is currently given much lower priority than academic studies in schools in the PRC, because of strong academic competition. Schoolchildren spend increasing proportions of their time on extra lessons outside school. This reduces the time available for physical activity.

The data presented in this review underscore the public health importance of diet-related chronic diseases in the PRC. It is suggested that diet currently is responsible for about 20% of diet-related chronic diseases and that this figure which will rise to between 25% and 45% by 2025, varying among different diseases. The 1995 costs of this problem are estimated conservatively as 2.4% of GDP, a figure which is expected to climb substantially by 2025.

Case study for Sri Lanka

The costs of diet-related chronic diseases are large and growing in Sri Lanka, although there are a number of important differences from the PRC. Table 15 summarizes the major costs. Sri Lanka has successfully reduced the incidence of communicable diseases. Diet-related chronic diseases caused 18.3% of all deaths in Sri Lanka in the mid-1990s (table 16). It is, however, possible that the relatively weak system in Sri Lanka for reporting cause of death understates the proportions of death from these chronic diseases.

Diet-related chronic diseases, including obesity, are less prevalent in Sri Lanka than in India. However, data from India, the nearest neighboring country with adequate data is used here to project future rates of overweight and obesity in Sri Lanka. The National Nutrition Monitoring Bureau (NNMB), New Delhi has made representative surveys of the rural regions of poorer states in India and a large-scale survey has been conducted in urban squatter areas [89]. The rural surveys were conducted in eight states, mainly in southern India; with its less energy-dense, vegetarian diets, less diet-related chronic diseases, and probably less obesity. For 1975 to 1976, 1988 to 1990, and 1996 to 1997, respectively, the totals for overweight persons were 2.3, 2.6, and 3.8% for men and 3.4, 4.1, and 6.0% for women. For comparison, the large-scale, urban squatter survey* showed that 11.6% of women aged 12 to 47 were overweight. The rural sample sizes were very large: over 30,000 in 1996 to 1997. Data are available, but for women of child-bearing age from only two years. These data [71] show that there was a 5.0% increase in the prevalence of obesity per 10-year period for women, extrapolating trends from 1989 to 1994. In order to make projections for Sri Lanka, it was assumed that increases in overweight and obesity would be the same as those measured in India, although from a lower base.

In Sri Lanka in 1995, the hospital costs for diet-related chronic diseases were estimated as US$12.6 million and accounted for about 10.2% of estimated public hospital expenditures and 16.7% of all hospital expenditures: equivalent to 0.1% of GDP. These data were obtained from detailed estimates for the National Hospital for Sri Lanka, which represented one-third of total public health expenditures, and an estimated 20.3% of total hospital expenditures** (table 17). Hospitals provided the large majority of care for these chronic diseases.

Public hospital costs in Sri Lanka are markedly lower than those in the PRC, due to a lower average length of stay. The two countries have similar GDPs. In Sri Lanka, the average in a public hospital, even for chronic diseases, is only six days and its average cost is about US$90. Inpatients in public hospitals pay, on average, an additional cost of about US$25 per stay, largely for drugs. The cost per day for treatment of chronic diseases in a public hospital in Sri Lanka is about 75% of that for the PRC in terms of public expenditure. However, the total costs per patient for the two countries are probably similar if the patient's out-of-pocket expenditures are included. Private hospital costs per patient in Sri Lanka are at least 2.5 times those of public hospitals. Patients tend to favor private hospitals, particularly for the treatment of chronic diseases.

Productivity losses due to premature mortality (i.e., lost work output) were estimated as US$27 million, about 0.2% of GDP. It was assumed that 60% of those aged 18 and over are in the labor market. The average annual wage was taken as US$375. It was assumed that an adult death from a diet-related chronic disease would result, on average, in 10 years loss of productivity. It was also assumed that real wages would increase at 1% per annum, and that future wages could be discounted at 12% per year. It was concluded that a

* Tian H. Chronic disease intervention project cost-effectiveness evaluation from 1991–96 in Tianjin city. Tianjin, PRC: Tianjin Municipal-Academic Station, September 1999 (mimeo.) (In Chinese).

** Tudawe I. The Cost of diet-related chronic disease in Sri Lanka. Colombo: Hector Kobbukedawa Agricultural Research and Training Institute. Asian Development Bank, Manila, 2000. Draft.

TABLE 15. Costs of major diet-related chronic diseases and projected adult deaths from these diseases in 2025 in Sri Lanka

1997 estimates	
Number of deaths annually	19,847 (18.3% of all deaths)
Hospital costs	US$12.6 million (16.7% of hospital costs; 0.1% of GDP)
Productivity losses due to premature death	US$29 million (0.2% of GDP)
Total monetary cost	US$41.6 million (0.3% of GDP)
2025 prediction	
Number of adult deaths	38,477 (20.9% of all deaths)

Source: Authors' calculations, based on tables 16 and 17. See text for assumptions.

GDP = gross domestic product.

premature death from diet-related chronic diseases, which results in 10 years lost work, is valued at 6.6 times the annual wage, when appropriately discounted. When added to the hospital costs, this suggests that the total economic cost of diet-related chronic diseases is about 0.3% GDP per year. This underestimates the true costs, however, because data are lacking on morbidity associated with these diseases and associated productivity losses. Although these costs are an order of magnitude lower than those estimated [92] for childhood undernutrition in South Asia, they are large and important enough to be of policy significance.

The case has been made [93] that programs focusing on chronic diseases tend to redistribute resources away from the poor. There is evidence for this, but the links from LBW and stunting to chronic diseases suggest that there are complementarities in programming for both undernutrition and overnutrition. Moreover, there is evidence for a marked shift toward the poor in the burden of diet-related chronic diseases [30, 94].

In 2025, diet-related chronic diseases in Sri Lanka are projected to increase modestly, so as to account for 20.9% of all deaths. There is not enough information to project the associated hospital costs, but these are likely to grow. As the population ages and as more funds go to the hospital system, the resources used to treat diseases such as CVD and cancers are likely to rise quite dramatically.

In 1995, more than 20% of cancers in Sri Lanka were attributable to inadequate fruit and vegetable intake (tables 18–20). CVD was nearly 16% attributable to saturated fat intake, with diabetes almost as important a contributing factor. Almost 10% each of diabetes, stroke, and hypertension were attributable to overweight. Diabetes is almost as important as a contributory factor for stroke.

TABLE 16. Data and assumption for calculating the costs of diet related chronic diseases in Sri Lanka in 1995, and projections for 2025

Category	1995	2025
Nutrition and diet-related factors		
Overweight and obesity, men	3.8% [a]	16% [a]
Overweight and obesity, women	6.0% [a]	20% [a]
Saturated fat	9.8% [b]	12% [b]
Fruit and vegetable intake (g/day per capita)	215	215
Low birthweight (30 years ago)	25% [c]	22% [d]
Stunting (30 years ago)	35% [e]	24% [f]
Morbidity		
Hypertension, men and women combined	16.2% [a]	18.6% [a]
Diabetes	3.7% [a]	10.1% [a]
Mortality (per 100,000, men and women combined)		
Ischemic heart disease (IHD)	39.8	58.7
Stroke	26.5	37.6
Other cardiovascular diseases (CVD)	101.6	137.6
Cancers	28.6	50.6
All causes	562.4	735.5
Other variables		
Population size (million)	18.1	25.1
Urban population	22.7% [f]	42.6% [f]

a. Percentage of adult population
b. Percentage of diet by weight
c. Percentage of all births in 1965
d. Percentage of all births in 1995
e. Percentage of adult population
f. Percentage of total percentage.

Sources: Obesity, Fourth National Health and Nutrition Survey, cited by Tudawe I (unpublished draft 2000). The cost of diet-related disease in Sri Lanka, Colombo: Hector Kobbukedawa Agricultural Research and Training Institute (Unpublished draft for Asian Development Bank, Manila, 2000); diet, Central Bank surveys; LBW [85]; stunting [23]; morbidity [26]; mortality, Registrar General's statistics, based on death certificates; population, gopher://gopher.undp.org:70/00/ungophers/popin/wdtrends/urban;

Bases for predictions: overweight, assumes a percentage point increase similar to that for India (see text); saturated fat, based on 1995 intake, and assuming that increase will not continue much above the existing high rate for urban India; fruit and vegetable intake, assumes that the current decline will stabilize; hypertension, assumes that rural rate will approach current Indian rural rate, and that the urban rate will approach the current Indian urban rate, weighted by urban and rural population shares for 2025; mortality, uses trend increases as for India from a baseline scenario [47] applied to data for Sri Lanka for the 1990s (for India, the increases were 15.8% per decade for CVD, 14% per decade for cerebrovascular disease, 11.8% for other cardiovascular disease, 25% per decade for cancers and 11. 4% per decade for noncommunicable diseases plus injuries, with all % increases calculated on the base year 1995) rates; population: see above; LBW and stunting, uses levels 30 years previously (to estimate the childhood conditions of current adults), i.e., actual 1995 levels are used for 2025, and estimated 1965 levels are used for 1995, estimated levels for 1965 are assumed similar to rates for 1971 which are the earliest available data.

TABLE 17. Data and assumptions used to estimate the costs for diet-related chronic diseases in Sri Lanka in 1995

Data category	Value	Data Source
Total annual cost, National Hospital of Sri Lanka (NHSL)	SLRe 946.268 /–	NHSL records
NHSL expenditures as % of expenditures at all public hospitals	34%	NHSL records
Public hospital patients as % of all hospital patients	80%	Tudawe I. (personal communication, 1 March 2000)
Proportion of all inpatients suffering from diet-related chronic diseases who are treated at NHSL	10.2%	Date from Tudawe[a] assuming that the proportions for diagnosed and undiagnosed patients are similar
% of all diet-related disease patients who are treated at public hospitals as % of all those for all diet-related disease patients	60%	[90]
Relative cost of private over public hospital treatment per patient	2.5 times	[90]
Public hospital expenditure on diet-related chronic disease as % of that for all hospitals	37.5%	Calculated from above
Public hospital expenditure on all disease as % of that for all hospitals	61.5%	Calculated from above
Average cost per inpatient/day	SLRe 865/–	Estimated from 1997 NHSL records
Average cost per chronic disease patient/day	SLRe 865/–	An NHSL "Bed-head ticket" survey for first quarter of 1999 suggested that these costs were, on average, similar to those for all patients: data from Tudawe[a]
Average length of stay, all patients	6 days	1999 NHSL records
Average length of stay, diet-related chronic disease patients	6 days	NHSL "Bed-head ticket" survey for the first quarter of 1999
Average daily wage	SLRe 81/–	Marga Institute; Pereira M, personal communication, 1 March 2000
Average annual wage	US$375 per year	Based on average daily wage above
Proportion of adults in the labor market	60%	Data for 1993 [91]

Sources: ref. 90, 91.

a. Tudawe I. The cost of diet-related chronic disease in Sri Lanka. Colombo: Hector Kobbukedawa Agricultural Research and Training Institute. Asian Development Bank, Manila, 2000. Draft.

US$1.00 = SLRe 59.7/– (2000).

Among childhood factors, LBW is most important. It accounts for 18.4% of the PAR for diabetes. Stunting is less of a concern. This reflects in part that stunting levels in Sri Lanka are only marginally higher than LBW levels, because of relatively good breastfeeding practices in Sri Lanka. However, Sri Lanka, and South Asia in general, face the problem of low maternal BMI, which limits progress against LBW.

For diabetes, the combinations of LBW and diets high in saturated fats and added sugar, and possibly greater genetic predisposition, give great cause for concern, especially for projections to 2025 (table 16). With little progress on LBW and increases predicted in saturated fat intake, the prevalence of diabetes in Sri Lanka is predicted to increase dramatically: by a factor of 2.7 [76]. Diabetes also contributes strongly to other chronic diseases. In Sri Lanka in 2025, it is estimated that diet-related factors (saturated fat intake) will account for almost 40% of CVD. Diabetes will contribute about 29% to CVD. Overweight will account for about 24% of diabetes and 27% of hypertension. Diabetes will account for almost 18% of stroke cases. LBW will remain the most important childhood factor for all four conditions (CVD, stroke, diabetes, hypertension) and its importance will grow compared to 1995.

It appears that the costs of diet-related chronic diseases in Sri Lanka are less important than in the PRC; and at this time less important than current problems related to undernutrition in Sri Lanka. However, the costs of these diseases in Sri Lanka are appreciable and will increase substantially. These costs

TABLE 18. Estimated contributions of diet-related and childhood factors to chronic diseases in Sri Lanka in 1995

Disease	Key factor	PAR (share of condition attributable to this factor)
Diet-related factors		
Cancers	Fruit and vegetable intake	22.7% [a]
CVD	Saturated fat intake	15.6%
CVD	Diabetes	12.9%
Diabetes	Overweight	8.5%
Stroke	Hypertension	8.9%
Stroke	Diabetes	7.5%
Hypertension	Overweight	8.9%
Childhood factors		
CVD	LBW	2.4% (via diabetes)
Stroke	LBW	1.4% (via diabetes)
Diabetes	LBW	18.4% (direct effect)
Hypertension	LBW	7.0% (direct effect)

Source: based on table 17.

a. Estimates for cancers are from ref. 40, and represent the proportion of all cancer deaths preventable by changes in diet, exercise, and alcohol consumption. This represents an average from all cancers. Some cancers are more preventable than others by diet, especially by fruit and vegetable intake.

This table picks out the most important diet-related pathway for each of the outcomes. If overlap between different pathways is not 100%, then these are underestimates of dietary effects on chronic diseases.

CVD = cardiovascular disease; LBW = low birthweight; PAR = population attributable risk.

TABLE 19. Projected contributions of diet-related and childhood factors to chronic diseases in Sri Lanka in 2025

Disease	Key factor	PAR (share of condition attributable to this factor)
Diet-related factors		
Cancers	Fruit and vegetable intake	22.7% [a]
CVD	Saturated fat	39.9%
CVD	Diabetes	28.8%
Diabetes	Overweight	24.3%
Stroke	Diabetes	18.2%
Stroke	Overweight	10.0%
Hypertension	Overweight	26.5%
Childhood factors		
CVD	LBW	5.3% (via diabetes)
Stroke	LBW	3.3% (via diabetes)
Diabetes	LBW	26.4% (direct)
Hypertension	Stunting	8.6% (via overweight)
Hypertension	LBW	6.2% (direct)

Source: based on table 17.

a. Estimates for cancers are from ref. 40, and represent the proportion of all cancer deaths preventable by changes in diet, exercise, and alcohol consumption. This represents an average from all cancers. Some cancers are more preventable than others by diet, especially by fruit and vegetable intake.

This table picks out the most important diet-related pathway for each of the outcomes. If overlap between different pathways is not 100%, then these are underestimates of dietary effects on chronic diseases.

CVD = cardiovascular disease; LBW = low birthweight; PAR = population attributable risk.

are, if anything, lower than those in other countries of South Asia. Sri Lanka has made more progress against LBW than have other countries in South Asia, and against hypertension and obesity than has India. However, the pattern that we described here for Sri Lanka is likely to be broadly typical of South Asia as a whole. In Sri Lanka, as elsewhere in South Asia, the key policy priorities for these chronic diseases are diet, especially saturated fat and added sugar intake, and physical activity. Not all Sri Lankans consume meat. Coconut milk is an important factor in saturated fat intake. In the long run, improving birthweight is important, particularly because of the association of LBW with diabetes.

TABLE 20. Pathways for calculation of population attributable risks (PARs) of dietary effects on chronic diseases: for application to existing 1995 data (and projections to 2025 in brackets) in Sri Lanka

Contribution of	To:	PAR direct effect in %	PAR indirect effect in %	Pathways for indirect effects
Childhood dietary effects				
Stunting	Overweight	55.6 (41.9)	NA	NA
LBW	Hypertension	44.8 (10.5)	NA	NA
LBW	Diabetes	33.9 (14.6)	NA	NA
Effects on CVD				
Animal fat intake	CVD	14.9 (28.3)	NA	NA
Overweight	CVD	12.2 (25.9)	NA	NA
Hypertension	CVD	20.6 (24.5)	NA	NA
Diabetes	CVD	6.5 (10.7)	NA	NA
Stunting	CVD	NA	6.8 (10.8)	Via overweight
LBW	CVD	NA	9.2 (2.6)	Via hypertension
LBW	CVD	NA	2.2 (0.3)	Via diabetes
Effects on stroke				
Hypertension	Stroke	25.2 (24.5)	NA	NA
Diabetes	Stroke	2.1 (10.7)	NA	NA
Stunting	Stroke	NA	3.4 (4.7)	Via overweight and hypertension
LBW	Stroke	NA	11.3 (2.6)	Via hypertension
LBW	Stroke	NA	0.7 (1.6)	Via diabetes
Effects on hypertension				
Overweight	Hypertension	24.0 (45.6)	NA	NA
LBW	Hypertension	44.8 (10.5)	NA	NA
Stunting	Hypertension	—	13.3 (19.1)	Via overweight
Effects on diabetes				
LBW	Diabetes	33.9 (14.6)	NA	NA
Overweight	Diabetes	22.7 (44.8)	NA	NA
Stunting	Diabetes	—	12.6 (18.8)	Via overweight
Effects on cancers				
Fruit and vegetable intake	Cancers	22.7	NA	NA

Source: calculations by the authors.

For comparison, the desired or recommended levels of nutrition-related variables are as follows: LBW, 0%; stunting, 0%; hypertension, 0%; fruit and vegetable intake, there are no Sri Lankan standards but the People's Republic of China recommends 700 g/day and the US about 750 g/day (as 5 servings) [86]; saturated fat intake, 8 to 10% of dietary calories (note that there are no standards for animal fat intake, and data were not available on saturated fat intake); overweight, 0%.

CVD = cardiovascular disease; LBW = low birthweight; NA = not applicable; PAR = population attributable risk.

Program options for diet-related interventions to control epidemic, chronic diseases in Asia and the Pacific

The understanding and control of epidemic diet-related chronic diseases, in the context of endemic deficiency and infectious diseases, are imperative challenges facing governments and other policymakers throughout Asia and the Pacific. It is probable, as more substantial and reliable data emerge, that future benefit-cost analyses will indicate that the estimates made in this review are underestimates**.**

There are enormous potential benefits from policies and programs to control epidemic diet-related chronic diseases. Furthermore, the dietary and other determinants of important chronic diseases are well understood, and preventative lines of approach are already fairly well defined. Approaches that focus on the nutrition of the mother and child, from preconception to weaning, and thereafter in infants and children throughout preschool and school are strongly recommended. There is limited experience in this area in Asia and in Pacific SIDS. Few large-scale programs and evaluations have been undertaken to date. Moreover, basic data on nutrition and epidemiologic transitions is lacking in most Asian countries and in Pacific SIDS. Without such information, intervention programs will be guesswork to some extent and their results will be hard to assess. It is, however, encouraging that interventions designed to control other chronic diseases can be efficient and effective, for example, smoking control [95] and low-cost drug therapies for hypertension reduction for stroke prevention [96].

Diet-related programs, designed to control chronic diseases, can and should be highly cost-effective. In the United States, for example, a government-backed campaign that reduced national fat consumption by between 1% to 3% of total calories, saved, over a 10-year period, US$4.1 to 12.7 billion in medical costs and lost productivity [97]. Increased physical activity, as specified in other US government-backed campaigns could significantly reduce CVD in the United States [97]. Figure 31 depicts the web of factors that influence obesity prevention. This is an example of the types of changes that can be made at national and community levels in any country. Policies that have indirect effects on chronic diseases, via improved birthweight and decreased stunting, have been discussed.*

No attempt is made here to summarize any of the policies or programs in this area that have been proposed or instituted in developed countries. There are hundreds of such initiatives, but they have limited application in Asia and the Pacific. Asian policymakers and their advisors can, of course, benefit from knowledge of initiatives undertaken in North America, western Europe, and other developed regions. However, these initiatives generally address issues at late stages in the demographic, nutrition, epidemiological transition, when traditional agricultural and food systems have mostly disappeared, and where long established food habits and reliance on domestic supply have been largely replaced by an internationalized food supply. There are exceptions, as in some Mediterranean countries. Asian developing countries and Pacific SIDS are generally in early or mid-transition. Traditional agriculture, food systems and food habits still flourish, or at least survive, in Asia and in Pacific SIDS. On the whole, it is felt that policies and programs for Asia and for Pacific SIDS should not take the initiatives of developed regions as a model.

In Asia and in Pacific SIDS, there have been few systematic attempts to use food and nutrition policy to prevent NCDs and to enhance adult health. The focus to date has been on food insecurity. Many programs have been successful, in countries as diverse as the PRC, Sri Lanka, and Thailand. Given a national commitment to address a health problem, a number of Asian countries and Pacific SIDS have the ability to make changes. The first step is creating a priority for change and the second is an examination of country-specific food prices, credit, research, and education programs that will work.

* Allen LH, Gillespie S. Effectiveness of large-scale nutrition interventions. Washington DC: IFPRI, 2000 (Unpublished manuscript).

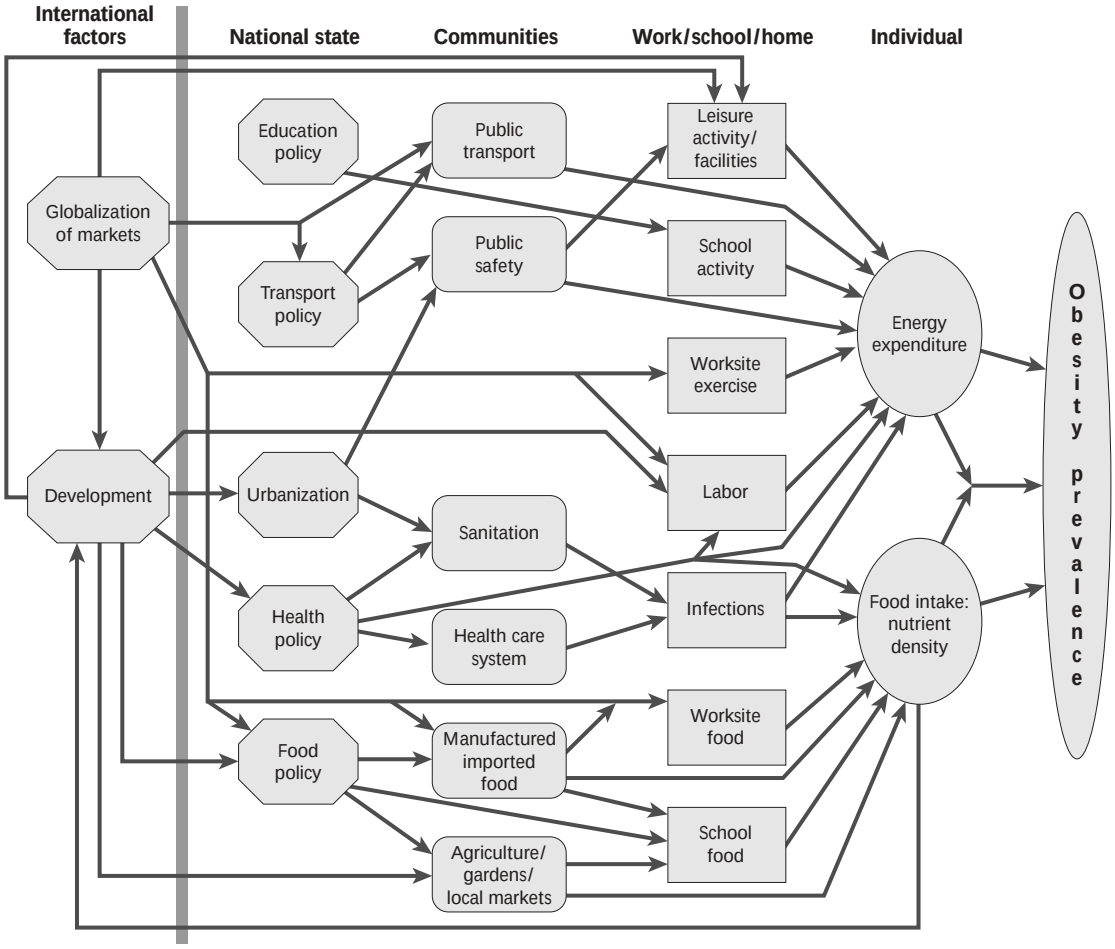

FIG. 31. Causal web of societal influences on the prevalence of obesity. Source: International Obesity Task Force, website: http://www.iotf.org/home.html. Figure developed by C. Ritenbaugh

The PRC is one of the few countries in Asia, indeed in the world, that has addressed nutrition and public health issues in terms of food supply systems on a national level. In 1993, the Government of the PRC organized the National Commission for Food Reform and Development. The State Council issued in 1993 the first document that addressed future food production and marketing, in terms of its significance for nutritional well-being [98]. This Council issued the first dietary guidelines for the PRC, focused on food and its production to eliminate undernutrition, dietary excess, and obesity. The Council attempted explicitly to increase production of and therefore consumption of fish, seafood, poultry, and soybeans. These guidelines point out many difficulties faced in the PRC from large pockets of undernutrition. However, they and additional sources [99] provide, a clear basis for developing and implementing food and nutrition policies to shift the composition of diets.

The coexistence of under- and overnutrition in the same household is relevant here. This challenges the assumption that underweight and overweight are opposing public health concerns. It illustrates the need for public health programs that are able to address underweight and overweight simultaneously. If large proportions of households with an underweight member also contain an overweight member, programs targeting the reduction of underweight must be capable of addressing overweight as well. For example, public health policies which aim to reverse undernutrition for one of a household at risk, by improving either the energy density of the household food supply or household food insecurity, might have the undesired consequence of contributing to overweight and obesity in another member of that household. This has been shown in unpublished research from Chile [100], where the programs that focused on undernutrition significantly enhanced the likelihood of overweight.

The 1993 State Council guidelines [98] and the ongoing government effort in the PRC are unique. They reflect the Ministry of Agriculture's recognition of the need to achieve a more balanced diet for the

population and the role that the nutrition community is playing in this activity.

Mauritius affords another example of a large-scale integrated national program. In 1987, the Ministry of Health in Mauritius created a nationwide health promotion program, focused on the prevention of CVD. This was prompted by a high level of CVD. Price policy, other legislative and fiscal measures, and widespread education in the community, workplace, and schools and the media were used. The results were remarkable: hypertension was reduced considerably, cigarette smoking in men and women declined, heavy use of alcohol declined, mean serum cholesterol decreased, and there was increased activity beyond the baseline values [101, 102]. However, obesity levels continued to increase and there was little change in the rate of glucose intolerance. Full details of the populations and the levels of change are found elsewhere [101, 102].

Agricultural development

Changes in agricultural systems can have major effects on food supplies and therefore on diets. One of the more important negative effects of agricultural development in Asia has been attributable to the initiatives that created the supply of very cheap edible oils. The past five decades have seen a revolution in the production and processing of oilseed-based fats. After World War II, there was initially a rapid increase in the world supply of meat, meat products, and milk. This created a need for protein to provide animal feed. This in turn became the motivating factor for the oilseed revolution. One result of the work on oilseeds was the development of the cheap supply of edible oil. The impact of the increased availability of cheap fats on the human diet has been great [8]. Technological breakthroughs in the development of high yield oilseeds and in the refining of high quality vegetable oils have greatly reduced the cost of baking and frying fats, margarine, butter-like spreads, and salad and cooking oils, relative to animal-based products [103].

Major economic and political initiatives led to the development of oil crops in Southeast Asia (palm oils) as well as in the United States, Brazil, and Argentina (soybean oils). The nutrition transition in developing nations begins typically with major increases in the domestic production and imports of oilseeds and vegetable oils, rather than with increased imports of meat and milk. Vegetable oils then contribute far more energy to the human food supply than do meat or animal fats [104]. Between 1991 and 1996 to 1997, global production of vegetable fats and oils rose from 60 to 71 million tons. In contrast, the production of visible animal fats (butter and tallow) remained steady at approximately 12 million tons. Principal vegetable oils include soybean, sunflower, rapeseed, palm, and peanut oils. With the exception of peanut oil, the global availability of each approximately tripled between 1961 and 1990. By the 1990s, soybeans accounted for the bulk of vegetable oil consumption worldwide. The production and exports of vegetable oils are promoted through direct subsidies, credit guarantees, food aid, and market development programs [104, 105]. Fortification of edible oils with any micronutrient may be inadvisable for Asia and the Pacific, because it would add an aura of healthfulness, promoting intake of products that have mixed or negative effects on health. In contrast to livestock and oilseeds, far less emphasis has been placed, worldwide and in Asia and the Pacific, on encouraging vegetable and fruit production.

Price mechanisms

All Asian and Pacific countries have policies that affect the prices and availability of food in one way or another. Governments engage in numerous direct and indirect methods to affect food prices. These range from direct subsidies, that lower purchase prices, to subsidies and taxes on various inputs, e.g., fertilizers, insecticides, and credit. Import and export policies, research programs, and many other activities have profound effects on the cost of food items.

Moreover, because many foods either complement or substitute for others, a change in the price of one item can change the consumption of other items considerably. For example, a reduction in the price of pork in the PRC increased consumption of pork and reduced consumption of other sources of protein such as wheat and rice [106]. Similarly, increasing the price of edible vegetable oils would reduce their intake and increase consumption of other foods. The importance of price policy for its effects has been on increased energy intake and consumption of a related array of staple foods in poor countries reviewed [107, 108]. Price changes can have impacts on micronutrient deficiencies, by increasing fruit and vegetable intake and other food sources of micronutrients [109–111].

Preservation of traditional diets

The Republic of Korea provides an example of the possible benefits of promotion of health through retention of traditional diets. Despite very rapid economic change and a very high level of GNP per capita, fat intake level and obesity in the Republic of Korea are approximately half of what would be expected for a country at that economic level [10]. In addition, vegetable intake is much higher than would be expected. One plausible explanation is that movements to retain

traditional diets have been strong in the Republic of Korea. A unique training program, offered by the Rural Development Administration, began in the 1980s. The Home Management Division of the Rural Living Science Institute (Suwon, Republic of Korea) has since trained thousands of extension workers to provide monthly training sessions in cooking methods for traditional Korean foods, e.g., rice, kimchi (pickled and fermented cabbage), and fermented soybean products. The program appears to reach a significant component of the newly married women in the Republic of Korea, however, exact statistics are not available [112].

Use of mass media

In the Republic of Korea, mass media campaigns, such as television programs, promote local foods, emphasizing their higher quality and the need to support local farmers. For example, The Korean Broadcasting System (KBS) First Station's daily program, 'Six o'clock My village' introduces famous products of Korean villages and promotes consumption of traditional dishes.

The Republic of Korea also promotes the concept of 'Sin-To-Bul-Yi' which translates directly as "a body and a land are not two different things." This advises people to the eat foods produced of the land in which they were born and are now living.

Thailand affords another example in the use of mass media for promoting good nutrition. In Thailand, maternal and child nutrition are promoted in the context of social marketing of condoms, to protect against sexually transmitted diseases (STD) in general, and HIV-AIDS in particular. Components of this nutrition work are discussed elsewhere,* but such health promotion efforts have not yet included diet-related NCDs. Thailand in 2000 began to promote so-called "healthy Thai" diet guidelines (Tontisirin K, personal communication, 2000). This effort is in its initial stages: development of pilot projects and discussion of a nationwide initiative. It will be important to evaluate such pilot projects and to create and to evaluate similar projects in other Asian and Pacific countries, in order to establish core, NCD-related communication strategies. Other Asian examples of use of the mass media in diet-related-NCD prevention on a mass scale may exist. The example of Mauritius discussed earlier also involved the use of mass media.

Brazil is the only transitional economy for which obesity rates have declined for large segments of the adult population. For urban Brazilian women, in the upper 75% of the income level, the incidence of obesity was reduced by over 28% from 1989 to 1997 [94]. From 1992, after the disclosure of the findings of a 1989 national survey which showed that obesity, not undernutrition, was the main nutritional problem of the adult population in Brazil (Monteiro A, personal communication, 2000), several major TV networks and leading newspapers and magazines have produced, on an almost weekly basis, extensive information on the health consequences of obesity, on the importance of avoiding energy-dense diets and on increasing physical activity. This media coverage, particularly television programs targeted at the female population, has also promoted a thin (sometimes unrealistically thin) image for women. In the search for large-scale approaches to reduce and to prevent obesity, it will be important to understand this Brazilian situation thoroughly and others where there have been significant declines in obesity.

The most important causal agent in the decline of obesity in Brazil was probably the mass media coverage [94]. The first consistent and publicly directed mass intervention to control obesity in Brazil was launched in 1997, after the recorded decline (1989–96). Moreover this intervention is still restricted to some cities in São Paulo State [113].

In the United States, the 'five-a-day' program (meaning five servings of fruits and vegetables) has focused on large-scale education, along with intensive local efforts, to increase fruit and vegetable intake. This program is part of a new generation of proactive initiatives by the US National Institutes of Health. Up to 2000, its impact has been described as limited [114]. Moreover, this effort, like most US diet-related, NCD-linked initiatives, is focused on a single sector. Such limited initiatives fail to link legislation, regulations, price policies, and education.

School-based programs

Schools are an excellent setting for programs designed to protect or to improve good nutrition, together with regular physical activity. Singapore has been a leader in promoting experience and weight control in schools. In the early 1990s, Singapore recognized, as central health concerns, a marked reduction in physical fitness and increased obesity among schoolchildren. The Singapore government departments involved with school health and feeding developed the 10-year 'Trim and Fit Scheme.' This comprehensive program included training of school principals (three days each year); a health education course for teachers on exercise and nutrition; a workshop for school vendors and canteen committees; assessment of students, including identification of students at risk and overweight students; a full set of instructional materials and individual charts for each student; increased provision of water coolers; reduction of the sugar content of all

* Allen LH, Gillespie S. Effectiveness of large-scale nutrition interventions. Washington DC: IFPRI, 2000 (unpublished manuscript).

beverages provided in schools; and increased, more rigorous school workouts for children. The result was an 11% increase, over three years, in the proportion of children assessed as physically fit and a considerable reduction in obesity. For example, during a one-year period when the same BMI standard was used for obesity, there was a decline of about 10% in the proportion of children who were deemed to be overweight (Caterson I, personal communication, 2000).

Research in the United States has shown that physical inactivity and dietary behavior, during the school-age period, have led to high obesity rates and to the early onset of many diet-related NCDs. For example, in a nationally representative sample of over 15,000 adolescents aged 11 to 18, only 40% were involved in daily physical activity programs, an additional 20% participated one to three times per week and the rest did not participate in physical education programs [115].

A project from the 1990s in elementary schools in the United States called "Child and Adolescent Trial for Cardiovascular Health (CATCH) [116], among 4,000 children (ages 10–13), focused on the benefits of eating for a healthy heart and of vigorous physical activities. This was the largest school-based, health promotion study ever done in the United States. It involved nearly 100 ethnically and racially diverse elementary schools. It sought to determine if multicomponent health promotion efforts, targeting child behavior as well as the school environment (classrooms, school lunch, and school physical education programs) and family reinforcement, would reduce the risk of CVD in later life. The results suggested that health behavior, initiated during elementary school years, persists into early adolescence [116].

With regard to the long-term effects of fetal programming, the health risks of LBW and IUGR are exacerbated by subsequent obesity, inactivity, and poor diets. The school system is a critical component of any system to monitor incipient obesity. Of course, other elements of long-term screening and health promotion are also needed.

Proposals for policies and programs addressing epidemic, chronic, diet-related diseases in Asia and Small Island Developing States of the Pacific

The epidemiological transition is rapid throughout Asia and Pacific SIDS. The populations involved are large. Therefore, policies and programs must be designed to understand fully what is happening and why, and to address these issues in all their dimensions. In common with Latin America and Africa, however, developing countries in the Asia-Pacific region have paid little attention to the colossal transitions summarized in this review, and to their current and future impacts. There have been few projects and policies that have addressed diet-related chronic diseases. The evidence reviewed here indicates some elements of programs that have been successful in limited ways. There is, however, still little experience in the field in Asia and the Pacific. It is important to establish a series of small, community-based projects as well reviewing and evaluating and initiating national policies.

First and foremost, at national level, is the need for coordinated food and agricultural policies that consider diet-related chronic diseases. Second is pricing policy. Third are the large-scale activities that promote important, healthful components of traditional eating patterns, as in the Republic of Korea. Fourth are efforts, such as those in Brazil, to begin to build public awareness of the elements of the food-based dietary guidelines and physical activity patterns. Finally, at community and institution levels, the main example is the school nutrition and fitness program of Singapore. There are few examples of other community-based efforts that appear relevant at this time. Clearly reducing child obesity and inactivity are major aspects of any program. In most Asian countries and the Pacific the emerging environment is highly conducive to increased obesity. Environmental assessments and changes are needed [117, 118]. Schools and preschools are the places to begin. From current research, many other components of programs and policies can be identified but there has been little large-scale implementation and evaluation.

In the promotion of physical activity and reduction of inactivity, current thinking seems to be focused on a combination of a more supportive environment including programs and facilities at schools, work sites, and in neighborhoods, etc., and changes in educational and behavioral activities [119]. Figure 32 summarizes some of the options that are being considered for improving physical activity in higher income countries. Without more research and focus on these issues at the country level in Asia and in Pacific SIDS, it will not be possible to set priorities or to consider program options, especially for disadvantaged groups. Most programs in higher income countries focus on improved leisure activity. Little thought has been given to this in the Asian-Pacific region.

For school-based programs, the essential set of potential strategies needed to make the food environment more health-enhancing include promoting meaningful ways of increasing consumption of lower-energy, denser, more healthful foods (e.g., fruits, vegetables, and whole grains), and discouraging the consumption of foods high in fat and sodium. Similarly, attention to making healthy changes in physical activity is essential. There are a myriad of examples of what is needed, but only the most systematic efforts, such as those found in Singapore, tend to work. Operations research is needed here. Many of the program elements needed to create successful school nutrition or other national or local efforts require piloting and evaluation. In the nutrition sector, most Asian countries and Pacific SIDS still focus on addressing the problems of undernutrition, even when the costs of diet-related NCDs are becoming greater than those of undernutrition. Operations research and capacity building are needed to break through this problem. The sharing and comparison of examples of successful operations research in this field, from the Asia-Pacific and other regions, could assist for the development of country-specific programs and policies.

Many elements of a national plan must be country-specific. For example, in the PRC, the promotion of consumption of key foods, in particular soybean foods, are seen as important. This has required a major shift in agricultural policy, whereby soybean has been classified as a cash crop and not a staple, and its pricing

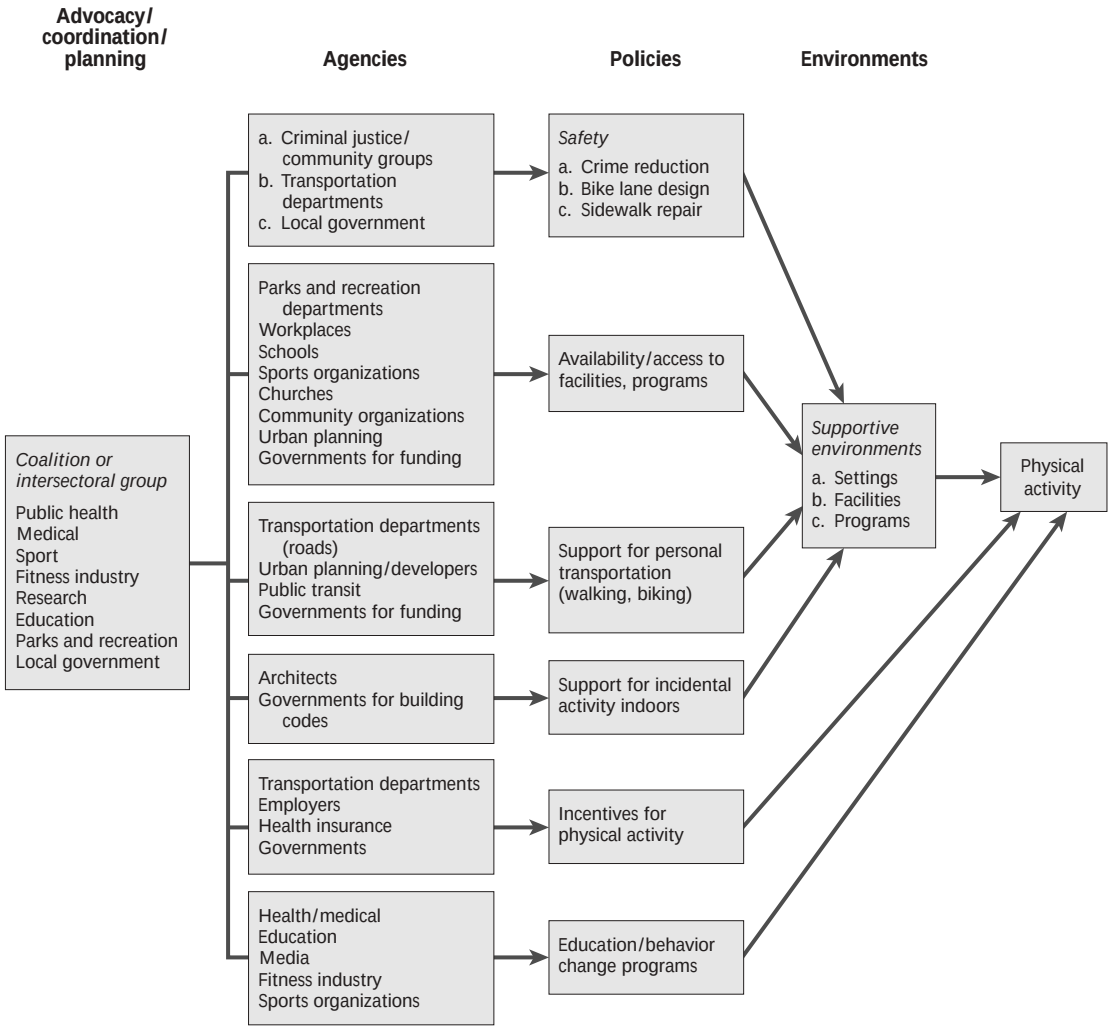

FIG. 32. The development of policy and environmental interventions to promote physical activity. Source: Jim Sallis, San Diego State University

has become more flexible. The Ministry of Agriculture now has more latitude to increase consumption of soybean products; for example, the promotion of more soybean-based foods. The qualitative 1999 Dietary Guidelines for Chinese Residents for the PRC [120] reflect the multidimensionality of diets as well as the nutritional epidemiological transition. They aim to reduce extremes of poverty and excess; promote good health; enhance immunity; reduce risks of stunting and rickets; and prevent CVD, hypertension, osteoporosis, and some cancers. The PRC is also considering ways to prevent further obesity, but no programs and policies have emerged yet. Indeed, there is a general lack of proven programs and policies to address the nutrition transition, as this review shows.

Asian countries and Pacific SIDS are not yet ready for the urgently needed, large-scale program and policy initiatives to combat diet-related NCDs. Moreover, the development of food and nutrition policies and health policies represents a new and pressing agenda for countries where problems of dietary excess and deficit exist side by side. In such countries, the prevailing policies to address deficits in the agricultural and health sectors are quite different from those needed to address problems of excess. Dietary guidelines, like the example cited above for the PRC, will be most successful if combined with systematic promotion of healthful diets. Additional elements might emerge from the examples discussed above and from future programs, as these are evaluated for effectiveness and cost-effectiveness. Therefore, it is still premature to think of developing national investment plans. The funding and evaluation of pilot studies are, however, needed as key step forward. The need for action is most urgent in the middle- and high-income countries and the SIDS, that are further along in the nutrition

transition, and in which undernutrition is becoming an issue of the past. However, even the lower low-income countries have to think about the problems that are emerging from this transition in urban areas; for example, the impending diabetes epidemic in urban South Asia. The nutrition transition and diet-related chronic diseases in Asia are all concentrated in urban areas, where the following are greater than in rural areas: inactivity; consumption of a more energy dense diets; obesity; and many other environmental factors that promote NCDs. It would be most useful to include, as a major component of an urban nutrition strategy, NCD prevention focused on dietary, activity, and body composition changes. The SIDS have their own particular problems, with their high levels of obesity and overweight.

Capacity building is also a key need. As has been shown here, most Asian countries and Pacific SIDS have yet to invest significantly in prevention of diet-related NCDs. Most of these countries lack institutions that can assist macroeconomic development planners to incorporate food and nutrition issues, related to both under- and overnutrition. Some, such as the PRC, wish to develop this capability. Similarly, it is crucial to develop trained personnel and institutions for the creation of a new array of monitoring, screening, and programs and policies related to the nutrition components of NCDs. The following elements merit emphasis: school health; trade and food production; licensing and pricing policies; national, particularly urban, monitoring; mass media; and the establishment of guidelines to promote healthful elements of traditional diets and to discourage unhealthful elements of new diets.

A strategy that views the elimination of communicable diseases as the only way to improve the health of the poor [93, 121] will miss important causes of poor health and survival among the poor. Diet-related NCDs are problems faced increasingly by the poor of Asia and Pacific SIDS.

Little is still known about patterns and trends in diets and physical activity and the causes of these trends. Large forces of global trade, technological changes in work and leisure, mass media and urbanization are linked with these massive shifts in diets and in activity. The challenge is to seek greater understanding of underlying causes of these changes, so as to address their negative effects.

The shifts that are emerging in the Asia-Pacific region in structure of diets and in activity patterns have been only glimpsed here. With so little program and policy work undertaken yet, it is too early to assess whether similar programs and policies will work in countries with similar shifts in diet and activity patterns. It is clear, however, that several of the country groups delineated here (table 1) are much further along than others in the nutrition transition, and that far more attention should be paid to the prevention of diet-related chronic diseases in these countries.

The model used in this study is a very integrated one which links the nutritional and epidemiological transitions in Asia, and ties both to patterns of economic development (which in turn affects income and levels of physical activity and urbanization). The nutritional/epidemiological/economic model also permits projections forward to 2025, from patterns observed in 1995. To avert the most serious predicted adverse effects requires early intervention, because the basis for adult diet and activity patterns is set in childhood and adolescence. It is necessary to begin now to change the behavior of those who might otherwise die of diet-related NCDs in 2025. Moreover, the study suggests that interventions need to be well-coordinated and comprehensive, encompassing food and agriculture policy, mass media campaigns regarding diet and exercise, and promotion of healthful aspects of traditional diet. The PRC is further along in national planning than other low-income Asian countries, and needs increased capacity to link economic policy to nutritional concerns.

There is not enough experience in Asia as yet to move to full-scale programs. What is emerging is a clear need for a life cycle strategy for urban nutrition. There are also unique and important capacity building components that could be initiated immediately. Implementation and evaluation of pilot studies will be necessary. Finally, it is important to continue research on the underlying causes of the nutrition transition.

References

1. Bongaarts J, Watkins S. Social interactions and contemporary fertility transitions Pop Dev Rev 1996;20:639–82.
2. Bulatao R, Lee R. Determinants of fertility in developing countries. New York: Academic Press, 1983.
3. Omran AR. The epidemiologic transition: A theory of the epidemiology of population change. Milbank Memorial Fund Q 1971;49(4, pt. 1):509–38.
4. Committee on Research Development and Institutional Strengthening for Control of Cardiovascular Diseases in Developing Countries. Control of cardiovascular diseases in developing countries. Washington DC: National Academy Press, 1998.
5. Reddy KS, Yusuf S. The emerging epidemic of cardiovascular disease in developing countries. Circulation 1998;97:596–601.
6. World Bank. World development indicators. Washington DC: World Bank, 2000.
7. Shetty PS, James WPT. BMI distribution in developed and developing countries. In: James WPT, Shetty PS, eds. Body mass index: a measure of chronic energy deficiency in adults. Food and Nutrition Papers No. 56. Rome: FAO, 1994:43–51.
8. Drewnowski A, Popkin BM. The nutrition transition: new trends in the global diet. Nutr Rev 1997;55:31–43.
9. Popkin BM, Ge K, Zhou F, Guo X, Ma H, Zohoori N. The nutrition transition in China: a cross-sectional analysis. Eur J Clin Nutr 1993;47:333–46.
10. Kim S, Moon S, Popkin BM. The nutrition transition in South Korea. Am J Clin Nutr 2000;71:44–53.
11. Barker DJP. Fetal and infant origins of adult disease: Papers. London: British Medical Journal Publishing, 1992.
12. Barker DJP. Mothers, babies and disease in later life. London: British Medical Journal Publishing, 1994.
13. Barker DJP. Mothers, babies and health in later life, 2nd edition. Edinburgh: Churchill Livingstone, 1998.
14. Hoffman DJ, Sawaya AL, Coward WA, Wright A, Martins PA, de Nascimento C, Tucker KL, Roberts SB . Energy expenditure of stunted and nonstunted boys and girls living in the shantytowns of São Paulo, Brazil. Am J Clin Nutr 2000;72:1025–31.
15. Hoffman DJ, Sawaya AL, Verreschi I, Tucker KL, Roberts SB. Why are nutritionally stunted children at increased risk of obesity? Studies of metabolic rate and fat oxidation in shantytown children from São Paulo, Brazil. Am J Clin Nutr 2000;72:702–7.
16. Hoffman DJ, Roberts SB, Verreschi I, Martins PA, de Nascimento C, Tucker KL, Sawaya AL. Regulation of energy intake may be impaired in nutritionally stunted children from the shantytowns of São Paulo, Brazil. J Nutr 2000;130:2265–70.
17. Popkin BM, Richards MK, Monteiro C. Stunting is associated with overweight in children of four nations that are undergoing the nutrition transition. J Nutr 1996;126:3009–16.
18. McDade TW, Beck MA, Kuzawa CW, Adair LS. Prenatal undernutrition and postnatal growth are associated with adolescent thymic function. J Nutr 2001;131(4): 1225–31.
19. Lucas A, Fewtrell MS, Cole TJ. Fetal origins of adult disease-the hypothesis revisited. Br Med J 1999; 319:245-9.
20. Waterland RA, Garza C. Potential mechanisms of metabolic imprinting that lead to chronic disease. Am J Clin Nutr 1999;69:179-97.
21. WHO. Birthweight registration system. Division of Nutrition. Geneva: WHO, 2000.
22. Adair LS, Popkin BM. Birth weight, maturity, and proportionality in Filipino infants. Human Biol 1988;60(2):319–39.
23. ACC/SCN. Fourth Report on the world nutrition situation. Geneva: ACC/SCN in collaboration with IFPRI, 2000.
24. Indonesia family life survey. Santa Monica, CA: Rand Corporation, 1993.
25. Viet Nam living standards survey. Washington DC: World Bank, 1993.
26. Government of Sri Lanka. National health and nutritional survey 1995. Colombo: Government of Sri Lanka, 1995.
27. Popkin BM. The nutrition transition and its health implications in lower income countries. Public Health Nutr 1998;1:5–21.
28. Guo X, Popkin BM, Zhai F. Patterns of change in food consumption and dietary fat intake in Chinese adults, 1989–1993. Food Nutr Bull 1999;20(3):344–53.
29. Delgado C, Rosegrant M, Steinfeld H, Ehui S, Courbois C. Livestock to 2020: the next food revolution. 2020 Vision Discussion Paper 28. Washington DC: International Food Policy Research Institute, 1999:1–72.
30. Guo X, Mroz TA, Popkin BM, Zhai F. Structural changes in the impact of income on food consumption in China, 1989–93. Econ Dev Cult Change 2000;48:737–60.

31. Paeratakul S, Popkin BM, Ge K, Adair LS, Stevens J. Changes in diet and physical activity affect the body mass index of Chinese Adults. International J Obesity 1998; 22:424–32.
32. CHNS. China Health and Nutrition Surveys, 1989, 1991, 1993, 1997. Website: www.cpc.unc.edu/projects/china/china_home.html.
33. Dietz WH, Gortmaker SL. Do we fatten our children at the television set? Obesity and television viewing in children and adolescents. Pediatrics 1985;75:807–12.
34. Gortmaker SL, Must A, Sobol AM, Peterson K, Colditz GA, Dietz W. Television viewing as a cause of increasing obesity among children in the United States, 1986–1990. Arch Pediatr Adolesc Med 1996;150:356–62.
35. Gortmaker SL, Peterson K, Wiecha J, Sobol AM, Dixit S, Fox MK, Laird N. Reducing obesity via a school-based interdisciplinary intervention among youth: Planet health. Arch Pediatr Adolesc Med 1999;153(4):409–18.
36. UN. World urbanization prospects: The 1994 revision: estimates and projections of urban and rural populations and of urban agglomerations. New York: Population Division, Department for Economic and Social Information and Policy Analysis, United Nations, 1995.
37. Popkin BM. Urbanization, lifestyle changes and the nutrition transition. World Dev 1999;27:1905–16.
38. Cannon G. Food and health: the experts agree. London: Consumers' Association, 1992.
39. Committee on Diet and Health. Diet and health: implications for reducing chronic disease risk. Food and Nutrition Board, Commission on Life Sciences and the National Research Council. Washington DC: National Academy Press, 1989.
40. WCRF. Food, nutrition and the prevention of cancer: a global perspective. Washington DC: World Cancer Research Fund in association with the American Institute for Cancer Research, 1997.
41. WHO. Diet, nutrition, and the prevention of chronic diseases: Report of a WHO Study Group. Technical Report Series 797. Geneva: WHO, 1990.
42. Krauss RM, Winston M, Fletcher BJ, Grundy SM. Obesity: impact on cardiovascular disease. Circulation 1998;98:1472–76.
43. Labarthe DR. Epidemiology and prevention of cardiovascular diseases: a global challenge. Gaithersburg, MD, USA: Aspen Publishers, 1998.
44. Trowell H, Burkitt D. Western diseases: their causes and prevention. London: Edward Arnold, 1985.
45. United Nations. Statistical yearbook for Asia and the Pacific. New York: United Nations, 1996.
46. Arriaga E. Causes of death in developing countries and in countries with economies in transition: an overview of current knowledge, data availability and novel methods of data collection. In: Symposium on Health and Mortality. ESA/P/WP.139. New York: Population Division, United Nations, 1998:84–109.
47. Murray CJL, Lopez AD. The global burden of disease. Boston, MA, USA: Harvard University Press, 1996.
48. Popkin BM, Kohlmeier L, Zohoori N, Baturin A, Martinchik A, Deev A. Nutritional risk factors in the former Soviet Union. In: Bobadilla JL, Costello C, Mitchell F, eds. Premature death in the new independent states. Committee on Population, Commission on Behavioral and Social Sciences and Education. Washington DC: National Academy Press, 1997:314–34.
49. Zimmet PZ, McCartney DJ, de Courten MP. The global epidemiology of non-insulin-dependent diabetes mellitus and the metabolic syndrome. J Diabetes Complications 1997;11:60–8.
50. Barker DJP. Fetal origins of cardiovascular and lung disease. New York: Marcel Dekker Inc, 2001.
51. Stein CE, Fall CHD, Kumaran K, Osmond C, Cox V, Barker DJP. Fetal growth and coronary heart disease in South India. Lancet 1996;348:1269–73.
52. Adair LS. Low birth weight and intrauterine growth retardation in Filipino infants. Pediatrics 1989;84:613.
53. Kuzawa C, Adair LS. The CLHNS cardiovascular risk study: modeling lifelong influences on blood pressure in Filipino adolescents. FASEB J 2000;14:A791.
54. Leon DA, Koupilova I. Birth weight, blood pressure and hypertension: epidemiological studies. In: Barker DJP, ed. Fetal origins of cardiovascular and lung disease. New York: Marcel Dekker Inc, 2001:23–48.
55. Godfrey KM, Barker DJP. Maternal nutrition in relation to fetal and placental growth. Eur J Obstetr Gynecol 1995;61:15–22.
56. Cebu Study Team. Underlying and proximate determinants of child health: the Cebu longitudinal health and nutrition study. Am J Epidemiol 1991;133(2):185–201.
57. Guilkey DK, Popkin BM, Akin JS, Wong E. Prenatal care and pregnancy outcome in the Philippines. J Dev Econ 1989;30:241–72.
58. Adair LS, Guilkey DK. Age-specific determinants of stunting in Filipino children. J Nutr 1997;127:314–20.
59. Adair LS. Filipino children exhibit catch-up growth from age 2 to 12 years. J Nutr 1999;129:1140–8.
60. Sawaya AL, Dallal G, Solymos G, de Sousa MH, Ventura ML, Roberts SB, Sigulem DM. Obesity and malnutrition in a shantytown population in the city of Sao Paulo, Brazil. Obesity Res 1995;3:107s–15s.
61. Yajnik CS, Fall CH, Vaidya U, Pandit AN, Bavdekar A, Bhat DS, Osmond C, Hales CN, Barker DJP. Fetal growth and glucose and insulin metabolism in four-year-old Indian children. Diabetic Med 1995;12(4):330-6.
62. Forrester TE, Wilks RJ, Bennett FI, Simeon D, Osmond C, Allen M, Chung AP, Scott P. Fetal growth and cardiovascular risk factors in Jamaican schoolchildren. Br Med J (Clin Res Ed.) 1996;312:156–60.
63. Schroeder DG, Martorell R, Flores R. Infant and child growth and fatness and fat distribution in Guatemalan adults. Am J Epidemiol 1999;149:177–85.
64. Sichieri R, Siqueira KS, Moura AS. Obesity and abdominal fatness associated with undernutrition early in life in a survey in Rio de Janeiro. Int J Obesity 2000;24:614–8.
65. WHO. Obesity: Preventing and managing the global epidemic. Geneva: WHO, 2000.
66. Bray GA, Popkin BM. Dietary fat intake does affect obesity! Am J Clin Nutr 1998;68(6):1157–73.
67. USDHHS. Physical activity and health: A Report of the Surgeon General. Atlanta, GA, USA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, and National Center for Chronic Disease Prevention and Health Promotion, 1996.

68. Deurenberg P, Yap M, Staveren WA. Body mass index and percent body fat: A meta analysis among different ethnic groups. Int J Obesity 1998;22:1164–71.
69. IOTF/WHO. The Asian-Pacific perspective: Redefining obesity and its treatment. International Obesity Task Force/World Health Organization. Caulfield, Australia: International Diabetes Institute, 2000.
70. Kyrgyz Republic multipurpose survey. Chapel Hill, NC, USA: Carolina Population Center, 1993.
71. Popkin BM, Doak C. The obesity epidemic is a worldwide phenomenon. Nutr Rev 1998;56:106–14.
72. Doak C, Adair L, Monteiro C, Popkin BM. Overweight and underweight co-exists in Brazil, China, and Russia. J Nutr 2000;130:2965–80.
73. FAO/WHO. Preparation and use of food-based dietary guidelines. WHO/NUT/96.6 Geneva: WHO, 1996.
74. Dalton A, Crowley S. The economics of non-communicable diseases in the Pacific Islands. Washington DC: World Bank, 2000.
75. Wolf AM, Colditz GA. Current estimates of the economic cost of obesity in the United States. Obesity Res 1998;6:97–106.
76. Zimmet PZ. Kelly West Lecture, 1991. Challenges in diabetes epidemiology—from West to the rest. Diabetes Care 1992;15:232–52.
77. Zimmet PZ, McCarty DJ, de Courten MP. The global epidemiology of non-insulin-dependent diabetes mellitus and the metabolic syndrome. J Diabetes Complications 1997;11(2):60-8.
78. Curhan GC, Chertow GM, Willett WC, Speigelman D, Colditz GA, Manson JE, Speizer FE, Stampfer MJ. Birthweight and adult hypertension and obesity in women. Circulation 1996;94:1310–15.
79. Keys A. Seven countries. Cambridge, MA: Harvard University Press, 1980.
80. Kannel WB, D'Agostino RB, Cobb JL. Effect of weight on cardiovascular disease. Am J Clin Nutr 1996;63 (suppl.): 419S–22S.
81. Collins R, Peto R. Antihypertensive drug therapy: effects on stroke and coronary heart disease. In: Swales J, ed. Textbook of hypertension. Oxford: Blackwell Scientific Publications, 1994:1156–64.
82. Will JC, Casper M. Death rates for ischemic heart disease among persons aged 45–64 years, by gender, diabetic status, and race, United States, 1986. Am J Public Health 1996;86:576–9.
83. Pi-Sunyer FX. Health implications of obesity. Am J Clin Nutr 1991;53:1595S–1603S.
84. Chinese Academy of Preventive Medicine. Chinese national nutrition surveys. Beijing: Chinese Academy of Preventive Medicine, 1992.
85. UNICEF. The state of the world's children. New York: Oxford, 1995.
86. Stookey JD, Wang Y, Ge K, Lin H, Popkin BM. Measuring diet quality in China: the INFH-UNC-CH diet quality index. Eur J Clin Nutr 2000;54:811–21.
87. Bell C, Ge K, Popkin BM. Weight gain and its predictors in Chinese adults. Int J Obesity 2001;25:1079–86.
88. Gardner G, Halliwell B. Nourishing the underfed and overfed. In: Brown LR, ed. State of the world. Washington DC: Worldwatch Institute, 2000:59–78.
89. Sachdev HPS. Nutritional status of children and women in India: recent trends. Bull Nutr Found India 1997; 18(3):1–2.
90. Samarasinghe D, Akin JS. Health strategy and financing study. Colombo: Ministry of Health and Women's Affairs, Government of Sri Lanka, 1994.
91. World Bank. World development report. Washington DC: World Bank, 1995.
92. Horton S. Opportunities for investments in nutrition in low-income Asia. Asian Dev Rev 1999;17 (2):246–73.
93. Gwatkin DR, Guillot M. The burden of disease among the global poor. Washington DC: World Bank Human Development Network, 2000.
94. Monteiro CA, Benicio MHD'A, Conde WL, Popkin BM. Shifting obesity trends in Brazil. Eur J Clin Nutr 2000;54:342–6.
95. Jha P. Curbing the epidemic: governments and the economics of tobacco control. Washington DC: World Bank, 1999.
96. Eastern Stroke and Coronary Heart Disease Collaborative Research Group. Blood pressure, cholesterol, and stroke in eastern Asia. Lancet 1998;352:1801–7.
97. CDC. An ounce of prevention…what are the returns? 2nd Edition. Atlanta, GA, USA: Centers for Disease Control, 1999:1–29.
98. State Council. An outline for reforming and developing China's food structure in the 1990s. China Food Daily, 1993: June 16.
99. Geissler C. China: the soyabean-pork dilemma. Proc Nutr Soc 1999;58:345–53.
100. Uauy R, Albala C, Kain J. Obesity trends in Latin America: transiting from under- to overweight. J Nutr 2001; 131:893–9.
101. Dowse GK, Gareeboo H, Alberti KG, Zimmet P, Tuomilehto J, Purran A, Fareed D, Chitson P, Collins VR. Changes in population cholesterol concentrations and other cardiovascular risk factor levels after five years of the non-communicable disease intervention programme in Mauritius. Br Med J 1995;311:1255-9.
102. Uusitalo U, Feskens EJ, Tuomilehto J, Dowse G, Haw U, Fareed D, Hemraj F, Gareeboo H, Alberti KG, Zimmet P. Fall in total cholesterol concentration over five years in association with changes in fatty acid composition of cooking oil in Mauritius: cross sectional survey. Br Med J 1996;313:1044-46.
103. Williams GW. Development and future direction of the world soybean market. Quart J Int Agric 1984;23:319–37.
104. Morgan N. World vegetable oil consumption expands and diversifies. Food Rev 1993;16:26–30.
105. USDA. U.S. Fats and oils statistics. 1909-65, Statistical Bulletin No. 376, ERS, Washington DC: US Department of Agriculture, 1966.
106. Guo X, Popkin BM, Mroz TA, Zhai F. Food price policy can favorably alter macronutrient intake in China. J Nutr 1999;129:994–1001.
107. Alderman H. The effect of food price and income changes on the acquisition of food by low-income households. Washington DC: International Food Policy Research Institute, 1986.
108. Pitt M, Rosenzweig MR. Agricultural prices, food consumption and the health and productivity of

Indonesian farmers. In: Singh I, Squire L, Strauss J, eds. Agricultural household models: extensions, applications and policy. Baltimore, MD, USA: Johns Hopkins University Press, 1986,153–82.

109. Bouis HE. The determinants of household-level demand for micronutrients: an analysis for Philippine farm households. Washington DC: International Food Policy Research Institute, 1991.
110. Behrman J. Household behavior and micronutrients: what we know and what we don't know. Agricultural Strategies for Micronutrients, Working Paper 2. Washington DC: IFPRI, 1995.
111. Bouis HE, Novenario-Reese MJ. The determinants of demand for micronutrients: an analysis of rural households in Bangladesh. Brief Discussion Papers No. 32. Washington DC: IFPRI, 1997.
112. Rural Living Science Institute, Rural Development Administration (South Korea). '99 Education training plan. Suwon, Republic of Korea: Rural Living Science Institute, 1999 (in Korean).
113. Matsudo VKR. Passport for health. World health 50th year. Ministry of Plan Implementation, Sri Lanka. Fourth National Health and Nutrition Survey 1995. Colombo: Government of Sri Lanka, 1997, No. 3:16–7.
114. Serdula MK, Coates RJ, Byers T, Simoes H, Mokdad AH, Subar AF. Fruit and vegetable intake among adults in 16 states: results of a brief telephone survey. Am J Pub Health 1995;85(7):236–9.
115. Gordon-Larsen P, McMurray RG, Popkin BM. Determinants of adolescent physical activity and inactivity patterns. Pediatrics 2000;105:1–8.
116. Nader PR, Stone EJ, Lytle LA, Perry CL, Osganian SK, Kelder S, Webber LS, Elder JP, Montgomery D, Feldman HA, Wu M, Johnson C, Parcel GS, Luepeker RV. Three-year maintenance of improved diet and physical activity: the CATCH cohort. Child and adolescent trial for cardiovascular health. Arch Pediatrics Adolesc Med 1999;153:695–704.
117. Egger G, Swinburn BA. An ecological approach to the obesity pandemic. Br Med J 1997;315:477–80.
118. Swinburn B, Egger G, Raza F. Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity. Prevent Med 1999; 29(6 Pt 1):563–70.
119. Sallis JF, Bauman A, Pratt M. Environmental and policy interventions to promote physical activity. Am J Prevent Med 1998;15:379–97.
120. Nutrition Society of China. Dietary guidelines for Chinese residents. Beijing: Institute of Nutrition and Food Hygiene, 1999.
121. Gwatkin DR. Health inequalities and the health of the poor: what do we know? What can we do? Bull WHO 2000;78 (1):3–17.