

Part G. Advances in methodological issues in the use of international food datasets

Understanding the nutrition transition: measuring rapid dietary changes in transitional countries

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Abstract

Objective: To understand methodological concerns related to dietary intake collection in transitional societies.

Design: Three days of household weighing and measurement of all food used and repeated 24-hour recalls.

Setting: Eight Chinese provinces.

Subjects: Five thousand nine hundred and fifty-two and 5152 adults aged 20–45 years in 1989 and 1997, respectively.

Results: Great variance exists in the types and quantity of animal products used in common recipes. For example, the proportion of pork from lean cuts in 'stir-fried fresh pepper and pork' varies between 14 and 24% in urban and rural areas and the total pork content for 100 g (dish) varies by 15 to 19 g between rural and urban areas in each of eight provinces. Another challenge relates to the variation in the edible vegetable oil content added during food preparation. Reliance on standard recipes for each fried dish would miss the variations in oil use over time, space and socio-economic status.

Conclusions: Dietary change is rapid in transitional countries. Reliance on recipes standardised for animal food and edible oil contents will lead to very large systematic errors in the measurement of energy, fat and protein intakes.

Keywords
Nutrition transition
Recipes
Diet assessment

Research on dietary behaviour and trends in rapidly changing transitional economies must be able to measure increased dietary diversity, large variance in the composition of common dishes, increased use of edible oil, shifts in the structure of consumption within and between food groups, and increased consumption of processed foods^{1,2}. Also, as the epidemiological and nutrition transition progresses, concern for malnutrition and the classic maternal and child health focus has to shift towards a broader-based focus of diets appropriate for both undernutrition and overnutrition and their relation to non-communicable diseases. Our research in China illustrates the challenges and the methods used to address them.

The challenges in studying nutrition in a developing country are understood. They include incomplete food composition tables and lack of extensive research and experience with individual measurement of dietary intake for children and adults. For instance, the Institute of Nutrition and Food Safety in China had never collected individual food intake in a large-scale study prior to our 1989 survey. Also, research experience in cultures where

consumption is directly from common dishes was minimal. In addition, with few processed and packaged foods, individual consumption patterns might be expected to be more heterogeneous.

There are, of course, important ways that dietary research is facilitated in transitional economies such as China. There is no sophisticated understanding of good and bad dietary patterns as they relate to disease, and so there is little sense of 'good' and 'bad' foods. Thus there are fewer problems related to systematic recall biases that affect diet research. However, we are seeing the emergence of 'Western ideals' for body image that might lead to biased responses to questions about diet in the future (Bentley, personal communication).

The first part of the paper presents some of the ways we addressed the measurement of dietary change in China. Included is an evaluation of the decision to obtain ingredients for each composite dish from our respondents and not to use recipe files. Another was our measurement of fats and condiments used in household food processing.

The second part presents some of the dietary shifts

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measured in China between 1989 and 1997. This is coupled with related cross-national studies that provide a sense of selected key dimensions of dietary change in the developing world.

The China Health and Nutrition Survey

The China Health and Nutrition Survey (CHNS) follows the human subjects approval procedures of both the University of North Carolina School of Public Health and the Chinese Academy of Preventive Medicine.

The sample comprises the 1989, 1991, 1993 and 1997 panels of the CHNS. The CHNS covered eight provinces that vary substantially in geography, economic development, public resources and health indicators (Guanxi, Guizhou, Henan, Hubei, Hunan, Jiangsu, Liaoning and Shandong) for the first three panels, replacing Liaoning with Heilongjiang in 1997. A multi-stage, random cluster process was used to draw the sample surveyed in each of the provinces. Counties in the eight provinces were stratified by income (low, middle and high) and a weighted sampling scheme was used to randomly select four counties in each province (one low-income, two middle-income, one high-income). Within each county, the town where the county government is located was selected, and three villages were chosen randomly. In addition, each provincial capital and a lower-income city from each province were selected. Within each city, urban and suburban neighbourhoods were selected randomly. The sample design consisted of 188 primary sampling units, including 3870 households and covering about 16 000 individuals. Except for part of the samples from Guangxi and Guizhou provinces, most persons studied had a Han background (85%).

Methods of dietary assessment

Measurement of household food inventory

Household food consumption was determined on a daily basis by calculating changes in food inventory. Chinese scales with a minimum and maximum limit of 20 g and 15 kg, respectively, were used. All foods in stock at the initiation of the survey (including edible oils, sugar and salt), foods purchased and/or produced at home during the survey period, and food preparation waste (including spoiled rice and food fed to animals) were weighed and considered in the calculation of household food consumption. This was the only method that was used by the Institute for national and large-scale surveys prior to the CHNS.

Measurement of individual intake

Individual dietary data for the same three consecutive days were recorded for all household members, regardless of age or relationship to the household head. This was

achieved by asking each individual, except children aged below 12 years, each day, to report all food consumed away from home on a 24-hour recall basis. For the younger children, the mother or a mother substitute who handled food preparation and feeding in the household was asked to recall the child's food consumption. The same daily interview was used to collect at-home individual consumption. Using food models and picture aids, trained field interviewers recorded the types, amounts, type of meal and place of consumption of all food items during 24 hours of the previous day. Respondents were prompted about snacks and shared dishes. Food items consumed at restaurants, canteens and other locations away from home were systematically recorded. Housewives and other household members were encouraged to provide additional information to use in determining the amounts of particular food items in dishes consumed in the household. The amount of each dish was estimated from the household inventory, and the proportion of each dish consumed was reported by each person interviewed. Thus, the amount of individual consumption was determined by the total amount in the dish and the proportion of the dish that each person consumed.

There are clear reasons for collecting 24-hour dietary intake data. China has conquered the problems of food scarcity at the national level and has undergone a remarkable transition in the structure of food consumption. This has gone hand in hand with marked changes in eating behaviour. For instance, away-from-home (AFH) food consumption has increased in response to the dynamic changes in real disposable income and market labour force patterns. Within-household variations in food intake and eating patterns appear to be expanding³. Food and nutrition policy is focusing less on food security needs and more on the health-related needs of selected age-gender groups. As this occurs, individual dietary intake becomes more important.

The major concern is that the traditional eating pattern in China involves the preparation and serving of a limited number of complex dishes. These dishes consist of staple and side foods. The former includes all food made of grains and served in a separate bowl to each person, and the latter consists of all meat and vegetable dishes cooked and placed in the centre of the table in big bowls or plates for all people to share. This pattern of household consumption from common plates increases the difficulty of obtaining accurate measurement of individual food consumption. In addition, snacks and food eaten away from home are dependent on respondent's memory. These limitations have hindered the development of collection of individual dietary intake data in China, as they were felt to reduce the validity and precision of the individual 24-hour recall method. The combination of the two methods developed for the CHNS allowed us to lessen the errors associated with this eating method. Both total

quantities available for consumption as well as ingredients are understood prior to editing the 24-hour recall for each family member.

Recipe names and contents were measured by asking the name of the recipe consumed and recording for each individual the quantities of separate foods found in the recipe.

Conversion to nutrients: the Chinese food composition table

When the 1989 CHNS began, the food composition table (FCT) for China was limited to 660 foods and was not poised for the rapid shift in Chinese food supply that occurred with the introduction of multinational food companies and modern processed foods. Also, the available FCT of China was based on food as purchased and grown and consisted of raw food items. It did not measure processing and preparation wastage⁴. This FCT has been expanded to encompass closer to 2000 foods and now includes adequate representation of processed foods.

However, there is one gap. The Chinese FCT does not include any recipes, so measurement of AFH food intake must rely on knowledge of the ingredients used in food preparation. Studies are underway, including work with the CHNS, to collect adequate recipe data to provide at least an understanding of the average components of current dishes consumed in China.

Assessment of oil and other condiment use

In China, an additional problem relates to the measurement of cooking oil and other condiments used in the food preparation process, since the Chinese FCT is based on food as purchased and not as cooked. For this reason, measurement of cooking oil would have been omitted from the traditional 24-hour recall undertaken in China. Stir-frying is a major cooking method for Chinese dishes and there is no standard recipe available for most dishes. Any combination of vegetables and meat is regarded as a dish. As we shall show, the amount of cooking oil used with each dish varies considerably from family to family. Since the amount of each dish consumed by each individual within the household varies significantly, a

method of allocating oil between household members was developed that is based on meat and vegetable consumption. The proportion of meat and vegetables consumed by each individual from the total household consumption of these food groups is calculated. This proportion is used to allocate household cooking oil to each individual. Underlying this is the knowledge that Chinese households utilise frying of foods predominantly for dishes containing vegetables (including tofu and beans), beef, pork, chicken, fish and seafood. They combine edible oils, normally soyabean, peanut and vegetable oils, with these dishes, but rarely with staple foods containing rice, wheat flour and other grains.

Following this approach, individual daily consumption of cooking oils and condiments was estimated from the household dietary data. These data, based on the food inventory method and partial weighing and measuring of the dishes, are a very accurate measure of total household intake of edible oil. The proportion of these household oils consumed by each individual, based on their proportion of the household consumption of vegetable and meat foods, was added to the 24-hour dietary recall to measure individual nutrient intakes.

Food grouping system

A variety of ways exist to describe patterns of food consumption. One might describe single foods, food groups or foods by level of processing. One might also describe food use by the place where foods are purchased or consumed (at home vs. away from home), by time of day or by specific meal or snack patterns. These possibilities led a working group of University of North Carolina at Chapel Hill (UNC-CH) and Chinese Institute of Nutrition and Food Safety (INFS) researchers to develop a food grouping system that summarises intakes of foods in a nutritionally meaningful way. The complexity of eating behaviour has led most researchers to use simple food grouping systems such as those measuring intakes of 8–10 food groups such as starchy staples (cereal-based foods), meats, dairy products, and so forth. We feel that this approach aggregates foods into too few food groups to pick up important shifts in eating behaviour and misses

Table 1 Distribution of pork per 100 g of a stir-fried fresh pepper and pork (*zhu rou chao qing jiao*) recipe (1997 China Health and Nutrition Survey)

Group	Amount per meal per capita (g)	Grams of pork per 100 g dish	Fatty pork	Normal pork	Lean pork	Total
Urban	119.4	50.9	2.2%	83.9%	14.9%	100%
Rural	104.6	60.7	1.6%	74.4%	24.0%	100%
Low income tertile	109.8	58.7	0.9%	84.1%	15.0%	100%
Middle income tertile	104.9	57.6	3.2%	71.6%	25.2%	100%
High income tertile	112.1	56.0	1.2%	76.0%	22.8%	100%
Total sample	109.1	57.3	1.8%	77.0%	21.2%	100%
Mean grams of fat in 100 g pork	–	–	90.4	37.0	6.2	–
Energy density (kcal per 100 g)	–	–	816	395	143	–
<i>n</i>	1848	1794	32	1381	381	1794

Table 2 Distribution of eggs per 100 g of a stir-fried tomato and eggs (*xi hong shi chao jin dan*) recipe (1997 China Health and Nutrition Survey)

	Amount per meal per capita (g)*	Grams of egg per 100 g dish*	<i>n</i>
Urban	157.9 ± 71.4	40.6 ± 14.9	343
Rural	183.7 ± 78.9	43.9 ± 14.8	98
Low income tertile	168.5 ± 73.0	44.5 ± 15.4	67
Middle income tertile	164.9 ± 93.1	39.8 ± 15.9	129
High income tertile	163.1 ± 64.1	41.2 ± 14.2	245
Total	163.3 ± 73.4	41.3 ± 14.9	441

* Mean ± standard deviation.

key food trends that have important implications for health. For instance, many studies have examined overall dairy or milk consumption whereas the health effects of consuming higher- and lower-fat milks, or butter and margarine, are quite different.

The food grouping system that we have used separates all foods into 39 descriptive and nutrient-based groups. Initially major food groups were based on food groupings used by the INFS. Then fat and β -carotene compositions were used to develop more refined food groupings, and nutrient thresholds were used to separate major food groups into more distinct, nutrient-based food groups.

Results

Recipes

There was a large number of recipes consumed, most of which are not found in any Chinese restaurant. Rather the common dishes are stir-fried dishes such as *zhu rou chao qing jiao* containing fresh pepper and pork and *xi hong shi chao jin dan* containing tomato and eggs.

It would be possible to replace ingredients with recipes if there were minimal nutritionally important differences in the composition of recipes between persons from various geographic entities (urban vs. rural, between provinces) and socio-economic groupings (e.g. income levels). As we show this is not the case. The most interesting difference is seen by examining Table 1. We selected one of the most common recipes, a stir-fried pork and pepper dish, used

by our sample households. Each adult consumed about 110 g of this dish, half of which was pork. The fatty pork found in less than 2% of the recipes contains over 90% fat and has an energy density double that of normal pork and over five times that of lean pork. The normal pork, used in 77% of the recipes, is very high in fat and energy density also. Not only are there large variations in the distribution of pork in this dish, but, as the first two rows show, the amount of pork varies between urban and rural areas.

As shown in Table 2, stir-fried tomato and eggs, another common recipe, also varies widely in consumption with rural adults consuming much more than those in urban areas. There are differences of about 10% in the proportion of eggs in this dish.

The energy density of these dishes and the total fat they contributed to the diet varied considerably between each province and between urban and rural areas in all provinces (unreported results). For instance, in one province (Hubei), urban residents consumed an average of 46 g of pork and rural residents consumed an average of 59 g of pork ($n = 311$ persons) in the dish *zhu rou chao qing jiao*. In another higher consumption province (Guizhou), among 693 persons, an average of 61 g of pork was consumed per 100 g of the dish in urban areas and 65 g of pork among the rural residents.

A second methodological issue related to use of a recipe relates to AFH consumption. For this component of the diet, the absence of a recipe file may be deleterious. Without a recipe file, consumers are asked to remember the food content of these dishes prepared and cooked by others. There is potential for systematic error if people underestimate components of AFH food.

Little research has been undertaken on the proportions of food consumed away from home in China. Even in 1997, AFH food intake in China represents a low proportion of total energy intake (Table 3). Yet, as these results show, AFH food consumption is associated with income and urban residency. China is urbanising rapidly and also continues to experience a very rapid growth in income per capita. Thus, we would expect AFH intake to grow as a proportion of overall consumption. What is remarkable is that in 1989 there was virtually no

Table 3 Percentage of energy consumed at home and away from home (from 1989–1997) for Chinese adults aged 20–45 years*

	Urban		Rural		Low income tertile		Middle income tertile		High income tertile		Total	
	1989	1997	1989	1997	1989	1997	1989	1997	1989	1997	1989	1997
Home	90.8	86.0	93.4	92.5	94.9	94.8	92.2	91.2	90.1	86.5	92.52	90.8
Restaurant/food stall	0.04	7.4	0.02	2.8	0.02	1.5	0.03	3.8	0.03	6.7	0.03	4.0
Others	9.16	6.6	6.58	4.75	5.08	3.7	7.77	5.0	9.87	6.8	7.45	5.2
Total	100	100	100	100	100	100	100	100	100	100	100	100
<i>n</i>	1980	1355	3972	3796	1993	1650	2012	1769	1947	1732	5952	5152

* Food consumed is separated into three parts: at home, restaurant or food stall, and other (relative's or friend's house, festival/celebration, others).

Table 4 Comparison of the standard 24-hour recall and the modified method for Chinese persons aged 1 year and older used by the China Health and Nutrition Survey, 1991*

	Energy† (kcal)	Protein† (g)	Fat† (g)	kcal from fat (%)
Traditional dietary recall	2108	69.1	29.5	12.6
No guest, no AFH‡	2120	69.3	27.0	11.5
AFH only	2056	67.9	33.6	14.5
Modified dietary recall§	2377	69.6	57.9	21.9
No guest, no AFH	2388	69.8	55.5	20.9
AFH only	2307	68.5	60.0	23.2

* Source: Zhai *et al.*⁶.† All means are statistically significant ($P \leq 0.01$).

‡ A family is termed away from home (AFH) only if, during any meal over a 3-day span, one or more food items for any family member were eaten away from home.

§ The modified recall is the traditional 3 days of individual dietary recall data plus the oil and condiments consumption measured with the household inventory.

meaningful food intake from food stalls and restaurants, and for the total sample this has grown to 4% of energy by 1997. This is still a very small figure compared with studies we did in the Philippines and elsewhere in Asia (e.g. Bisgrove and Popkin⁵).

Assessment of oil allocation

As noted above, the CHNS measures oil consumed separately for each household. Table 4 illustrates the mean of daily intakes of selected nutrients by the traditional 24-hour recall and the modified 24-hour recall method used by the CHNS. The mean intake was separated into households with and without guests plus AFH intake. The most relevant group is the no guest and no AFH group. In this group, the mean intake of fat was 55.5 g for the modified method and 27.0 g for the traditional 24-hour dietary recall method, respectively. This is a very large difference and is reflected in large differences in the energy and percentage of calories from fat measures. It is important to note that the adjustment methods change the protein measure only slightly and have their major effects on fat intake as we show elsewhere⁶.

The dietary transition in China

Using the UNC-CH-INFS food grouping system, we

summarise the change from 1989 to 1997 for Chinese adults aged 20–45 years in a number of components of their diet.

In Table 5, we present data on food diversity. We counted the number of food groups consumed by each person and present mean intake and the proportion with high, medium and low numbers of food groups consumed. There is a marked increase in diversity of the Chinese diet across all groupings of socio-economic status. The urban increase is particularly noticeable. Over time, the proportion of Chinese of all income groups who consume less than eight food groups has declined while those who consume more than 10 food groups has increased considerably.

The shift in foods consumed is considerable. We highlight a few points in Table 6. One is the reduction in grain intake and its replacement by other foods. This includes large reductions in coarse grain intake in rural areas (these same declines occurred earlier in urban areas) and declines in refined grain intake. A second is the reduction in vegetable intake in rural areas with no change in urban vegetable intake. Related are increases in edible oils, meat and meat products, and eggs.

The effect of these shifts towards a more diverse diet, and one with a marked shift away from traditional low-energy-density high-fibre foods toward more meat, oil and other higher-energy-density foods, is linked with two important nutritional effects. One is greater overall nutrient density as is shown in Table 7. The overall increase in energy density of the Chinese diet is from 2.20 to 2.42 kcal g⁻¹. This is a considerable increase as reviews on the subject note^{7,8}.

The second effect is a marked reduction in the proportion of Chinese people with low-fat diets and much greater consumption of a higher-fat diet. In fact, Table 8 shows that less than 4% of the Chinese adults in the CHNS sample consumed a low-fat diet in 1997, down from over 18% in 1989. The higher-fat diet is now consumed by over a third of all Chinese adults aged 20–45 and over 60% of adults residing in urban areas. The new Chinese FCT do not have saturated fat measures for all foods so we present fat from animal sources as a crude proxy. This shows the large increase in animal fat intake, particularly in urban areas.

Table 5 Diversity in the Chinese diet among adults aged 20–45 years (1989 and 1997 China Health and Nutrition Surveys)

	Urban		Rural		Low income tertile		Middle income tertile		High income tertile		Total	
	1989	1997	1989	1997	1989	1998	1989	1997	1989	1997	1989	1997
Food groups consumed*												
Mean number	9.9	11.6	8.3	9.1	7.6	8.6	9.0	9.8	10.1	11.0	8.8	9.9
Percentage consuming < 8	23.5	7.3	41.6	26.6	52.8	34.1	31.5	17.9	20.6	11.3	35.6	20.3
Percentage consuming 8–10	23.3	15.8	29.3	33.3	29.0	33.9	29.1	30.2	23.4	20.5	27.3	27.6
Percentage consuming > 10	53.2	76.9	29.1	40.1	18.2	32.0	39.4	51.8	56.0	68.2	37.1	52.1

* Using the University of North Carolina at Chapel Hill–Institute of Nutrition and Food Safety (UNC-CH-INFS) food groups that contain 39 food groups based first on the major food groupings and then on nutrient-based subgroups.

Table 6 Shift in per capita consumption (g day⁻¹) of the Chinese diet by adults aged 20–45 years (1989 and 1997 China Health and Nutrition Surveys)

Food	Urban		Rural		Low income tertile		Middle income tertile		High income tertile		Total	
	1989	1997	1989	1997	1989	1997	1989	1997	1989	1997	1989	1997
Total grains*	556	489	742	581	811	615	642	556	595	510	684	557
Coarse	46	25	175	54	226	68	98	43	78	30	135	46
Refined	510	465	567	527	585	546	544	513	517	479	549	511
Fresh vegetables	309	311	409	357	436	356	360	357	335	325	377	345
Fresh fruit	14.5	35.9	14.9	16.7	5.5	8.0	13.2	18.1	26.1	37.5	14.8	21.7
Meat and meat products	73.9	96.6	43.9	57.6	36.3	40.2	57.5	63.9	66.5	96.2	53.3	67.8
Poultry and game	10.6	15.5	4.1	11.7	4.1	7.0	6.6	10.2	7.7	20.3	6.1	12.7
Egg and egg products	15.8	31.6	8.5	19.6	6.0	13.9	10.6	21.7	15.8	31.5	10.8	22.7
Fish and seafood	27.5	30.5	23.2	26.9	11.8	16.4	28.7	26.0	33.4	40.1	24.6	27.9
Milk and milk products	3.7	4.0	0.2	0.9	0.8	0.1	0.2	1.4	3.5	3.6	1.3	1.7
Plant oil	17.2	40.4	14.0	35.9	12.9	32.1	15.8	37.1	16.4	41.5	15.0	37.1

* The total grains category includes raw and cooked rice, wheat flour and products, fried wheat/rice products, corn flour, coarse grain (millet, sorghum, corn) and products, starch, starch noodles and products.

Asian and international dietary shifts

Other research has shown a number of other key points about dietary change. We just note each of these here. They include the following.

- A rapid increase in the proportion of sweeteners and vegetable oil as key markers of urbanisation among lower-income countries. There is no research on the composition of edible oils as they might affect national health, but there are some data to indicate that red palm oil might be more healthy whereas edible oil with high *trans*-fatty acid content would be more unhealthy. For instance, one study has found *trans*-fatty acid levels of about 50% in *dalda*, a vegetable ghee widely consumed in India (Willett, personal communication).
- A shift in food sources of energy across most developing countries that is comparable to China, but that has usually changed at a much lower pace. Edible vegetable oil intake predominates as a marker of dietary change in Asia and Africa.
- There are many variants in the types of staples that are consumed at each stage of the transition, as well as in the relative position of meat and meat products, poultry, fish and seafood, and dairy and dairy products at each stage of dietary change between countries as well as within countries. For instance, India is a high dairy consuming country. This is important since eggs and dairy products are such an important source of saturated

fats in the diet. Indian consumption of ghee, a particularly high saturated fat product, is important in that a high consumption of saturated fat is closely related to chronic diseases.

Discussion

Unique features of transitional economies require special methods to capture accurately dietary change. China is used as an example. The traditional eating pattern in China involves the preparation and serving from a common plate of a limited number of complex dishes. These dishes consist of main dishes of mainly staples together with side dishes of meat and vegetables, placed in the centre of the table in big bowls or plates for all people to share. This pattern of household consumption from common plates increases the difficulty of obtaining an accurate measurement of individual food consumption. This mode of eating has hindered the development of individual dietary intake data collection methods in China, as they were felt to reduce the validity and precision of the individual 24-hour recall method.

One of the more important factors differentiating classes as well as transitional countries is edible oil intake. The collection of household use of edible oil, and the development of a method specific to each country to allocate this oil to each individual in the family, appears to be important as a means of improving the quality of 24-hour recall data. The large differences found between the 24-hour and household inventory methods when the adjustment for cooking oil was removed demonstrate this clearly. The large variation in recipe composition was demonstrated for China and it is clear that recipe methods need to be used in limited ways. It is also clear that edible oil intake is so responsive to income and prices, and varies so greatly, that it must be measured separately.

Table 7 Shift in dietary energy density (kcalg⁻¹) for Chinese adults (aged 20–45 years) between 1989 and 1997

	Urban	Rural	Low income tertile	Middle income tertile	High income tertile	Total
1989	2.25	2.18	2.14	2.23	2.25	2.20
1997	2.42	2.42	2.46	2.32	2.48	2.42

Table 8 Shifts in consumption of total and saturated fat by Chinese adults aged 20–45 years (China Health and Nutrition Surveys)

	Percentage with energy from total fat < 10%				Percentage with energy from total fat ≥ 30%				Percentage with energy from animal fat ≥ 10%	
	1989	1991	1993	1997	1989	1991	1993	1997	1989	1997
Urban	13.1	2.6	2.1	1.9	19.8	51.4	58.4	60.1	49.8	68.9
Rural	21.0	10.4	8.9	3.6	12.1	23.0	23.1	29.5	33.3	39.3
Low income tertile	30.4	16.9	13.1	5.8	9.3	14.3	14.2	21.4	26.2	32.1
Middle income tertile	14.8	5.4	6.1	2.7	16.2	31.1	31.4	35.5	42.8	42.6
High income tertile	10.1	1.5	1.1	1.3	18.5	51.4	56.1	54.6	47.8	61.1
Total	18.4	7.9	6.8	3.1	14.7	32.0	33.7	38.5	38.8	48.0

At the same time, the rapid increases in AFH intake, particularly among urban residents, means that an increasingly larger proportion of each person's diet will comprise dishes and foods processed in restaurants and stalls. A recipe file must be developed to capture this component of the diet. At this time such recipe files, if they exist, are not based on samples of such dishes from many food stalls and restaurants.

Some of the methods used to study dietary change in China appear to represent methodological issues that are relevant to all developing countries, or most certainly those in Asia and Africa. One is the measurement of household intake of edible oil and the development of a way to allocate this among household members. Other methods, such as dealing with consumption from a common plate and the need to link individual recall and household measurement to ensure accurate measures, are important for many countries but not all.

A third method, the collection of recipe ingredients at the household level, may be required quite generally. However, little research on the composition of complex dishes exists so we cannot generalise from our findings.

A fourth issue, the increase in AFH consumption in restaurants and food stalls, may be much more important in other countries. In one large study of urban Filipino women, it was found that about 25% of their energy intake and about 45% of their fat intake come from AFH consumption⁵. There is extensive anecdotal evidence on the importance of AFH intake, but few rigorous large-scale analyses⁹.

The changes in diet are so rapid in transitional

economies as presented here for China, and elsewhere for Brazil, South Korea and other countries, that greater attention must be paid to methodological issues such as those noted in this paper^{10,11}.

References

- 1 Popkin BM. The nutrition transition and its health implications in lower income countries. *Public Health Nutr.* 1998; **1**: 5–21.
- 2 Drewnowski A, Popkin BM. The nutrition transition: new trends in the global diet. *Nutr. Rev.* 1997; **55**: 31–43.
- 3 Doak CM, Adair LS, Monteiro C, Popkin BM. Overweight and underweight coexist within households in Brazil, China and Russia. *J. Nutr.* 2000; **130**: 2965–71.
- 4 Institute of Nutrition and Food Safety, Chinese Center for Disease Control and Prevention. *Food Composition Tables*. China: People's Health Press, 1991.
- 5 Bisgrove EZ, Popkin BM. Does women's work improve their nutrition: evidence from the urban Philippines. *Soc. Sci. Med.* 1996; **43**: 1475–88.
- 6 Zhai F, Guo X, Popkin BM, Ma L, Wang Q, Yu W, *et al.* The evaluation of the 24-hour individual recall method in China. *Food Nutr. Bull.* 1996; **17**: 154–61.
- 7 Drewnowski A. Energy density, palatability, and satiety: implications for weight control. *Nutr. Rev.* 1998; **56**: 347–53.
- 8 Rolls BJ. The role of energy density in the overconsumption of fat. *J. Nutr.* 2000; **130**(Suppl. 2): 268S–71S.
- 9 Solomons NW. Micronutrients and urban life-style: lessons from Guatemala. *Arch. Latinoam. Nutr.* 1997; **47**(Suppl 1): 44–9.
- 10 Monteiro CA, Mondini L, de Souza AL, Popkin BM. The nutrition transition in Brazil. *Eur. J. Clin. Nutr.* 1995; **49**: 105–13.
- 11 Kim S, Moon S, Popkin BM. The nutrition transition in South Korea. *Am. J. Clin. Nutr.* 2000; **71**: 44–53.