

Studies on the relationship between changes in dietary patterns and health status

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In order to study the relationship between dietary composition and health and disease, we investigated retrospectively the changes in diet composition, health status and disease specific mortality of the Shanghai population from 1950 to 1985. The results showed that remarkable changes occurred in dietary composition, health status and disease mortality. The energy from grain products decreased from 80-83% in the 1950s to 68-72% in the 1980s, and the energy from animal foods increased from 6.5-8.5% in the 1950s to 17.5-18.0% in the 1980s. With the changes in dietary composition, notable changes also occurred in the nutritional composition of the diet. From the 1950s to the 1980s, energy from fat was increased from 16.3-20.1% to 24.0-28.0%, and the energy from carbohydrates decreased from 72.0-73.5% to 62.2-65.8%. Almost certainly as a result of the changes in diet, health status and disease mortality also changed. For example, the average height in males of 18-20 years old increased from 164.89 cm in 1955 to 167.33 cm in 1974, and the average life span of males and females increased from 42.0 years and 45.6 years in 1950 to 72.1 years and 76.4 years in 1985, respectively. At the same time, the rank order of mortality causes also changed. Before 1950, the first three causes of death were measles, tuberculosis and senility, but in 1985 they were malignant tumours, cerebrovascular disease, and ischaemic heart disease. In particular, the mortality from ischaemic heart disease is now higher than in Japan. The causes of these changes may be the changes of dietary composition and nutritional composition of diet, although there are other factors. Therefore, changes in dietary composition which maintain or improve life expectancy, yet decrease the burden of chronic non-communicable disease is required.

Introduction

The dietary patterns in today's world may be divided into three types:

- 1) Food consumption from both plant and animal origin is fairly optimal, and intakes of energy, protein and fat meet nutritional needs. A typical example is Japan. This type of dietary pattern not only includes some good points of the Western dietary style, but preserves many characteristics of the Eastern diet as well.
- 2) The diet in the developed countries of Europe and America which consist of low intakes of plant food and high intakes of animal food, so that the intakes of energy, protein, and fat are all high. It may result in a range of chronic conditions such as obesity and cardiovascular diseases.
- 3) The type of diet, which mainly consists of plant foods and is low in protein and fat, and which may result in nutritional deficiencies. It can be found in most developing countries including India, Indonesia, and Pakistan.

In order to study the relationship between dietary patterns and health status, we retrospectively investigated the change in dietary patterns of the Shanghai population.

Materials and methods

The data about changes in the dietary patterns were taken from "The Yearbook of Shanghai Statistics"¹. The eight categories of commonly consumed foods include: grain, edible vegetable oil, pork, poultry, fresh egg, seafood, fresh vegetable and sugar. Twenty-six kinds of foods were

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assigned to them, according to the dietary habits of Shanghai inhabitants. These foods were identified in a recent survey.

The standard population was derived from population surveys in 1953, 1964, and 1982, inclusive of a projected 10% itinerant population. This standard population was based on age, gender and stature of adult males with low physical activity^{2,3}. Such a person's daily average food consumption, energy and nutrient intake, the composition of the food and its proportion of energy sources, as well as the intake of protein from vegetable or animal sources, were calculated. These calculations were based on the food consumption survey each year for that standard population. All statistical data about health and disease have been published by the Shanghai Statistics Bureau and Shanghai Public Health Bureau. To ascertain its accuracy, our data was compared with the results of an investigation in 1982. The two data sets were in close agreement.

Results

Changes in food consumption

Consumption of sucrose and foods of animal origin were significantly increased yearly except in 1960. However, consumption of grain and vegetables rose slightly. If consumption in 1950 was 100, then for meat, egg, seafood and sucrose in 1985 it was 281, 492, 291 and 282, respectively (Fig. 1). Regarding food composition, energy from grain products in 1950 was 80% and from animal food was 8.5%, whereas in 1985 they were 68% and

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Table 1: Comparison of food consumption between Shanghai population and other world regions (g/daily per person)

| Regions | Year | Grain | Vegetable | Meat | Egg | Seafood | Milk | Fat | Sucrose |
|---------------|-----------|-------|-----------|------|-----|---------|------|-----|---------|
| North America | 1978 | 205 | 231 | 298 | 40 | 21 | 738 | 58 | 143 |
| South America | 1978 | 295 | 131 | 209 | 15 | 12 | 372 | 31 | 116 |
| Europe | 1978 | 215 | 221 | 216 | 38 | 42 | 879 | 52 | 109 |
| Australia | 1977-1978 | 216 | 256 | 322 | 37 | 15 | 964 | 23 | 122 |
| Asia | 1975-1980 | 442 | 192 | 24 | 14 | 57 | 74 | 18 | 45 |
| Japan | 1980 | 330 | 308 | 61 | 40 | 95 | 170 | 38 | 63 |
| China | 1982 | 527 | 309 | 39 | 9 | 11 | 8 | 17 | 7 |
| Shanghai | 1980-1985 | 486 | 216 | 67 | 16 | 29 | 7 | 20 | 15 |

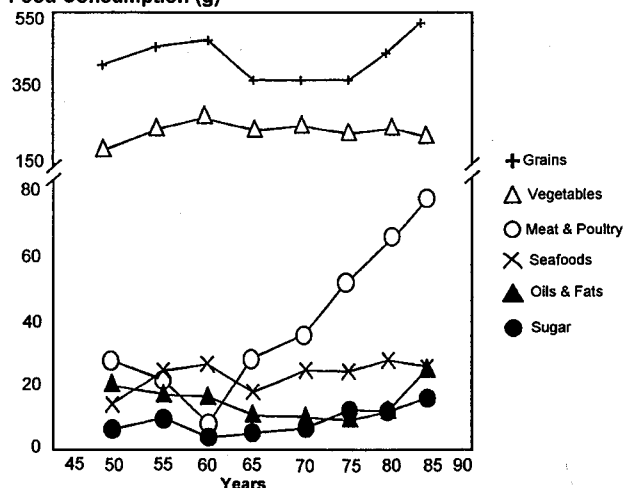
Notes: North America: America and Canada; South America: Brazil and Argentina; Europe: Britain, France, West Germany, Austria, Denmark, Norway, Sweden, Switzerland and Spain; Australia: Australia and New Zealand; Asia: India, South Korea and Japan

Table 2. Energy and nutrition intakes/ capita/ day in Shanghai (1950- 1985)

| Year | Energy (kcal) | Protein (g) | Fat (g) | Carbo (g) | Calcium (mg) | Iron (mg) | Vit A (μg^{***}) | Vit B1 (mg) | Vit B2 (mg) | Niacin (mg) | Vit C (mg) |
|-------|---------------|-------------|---------|-----------|--------------|-----------|-------------------------------|-------------|-------------|-------------|------------|
| 1950 | 1780 | 43.1 | 39.7 | 312 | 227 | 14 | 333.9 | 1.08 | 0.44 | 14.83 | 52.8 |
| 1955 | 1970 | 50.1 | 35.7 | 61 | 308 | 17 | 500.1 | 1.20 | 0.52 | 16.86 | 80.7 |
| 1960 | 1718 | 41.9 | 25.9 | 268 | 342 | 20 | 733.2 | 1.18 | 0.50 | 17.34 | 138.4 |
| 1965 | 1737 | 45.8 | 38.8 | 300 | 376 | 17 | 731.0 | 1.10 | 0.50 | 15.19 | 116.9 |
| 1970 | 1789 | 47.2 | 41.7 | 305 | 388 | 18 | 746.1 | 1.13 | 0.56 | 15.57 | 121.1 |
| 1975 | 1951 | 50.0 | 52.0 | 320 | 371 | 18 | 687.4 | 1.26 | 0.57 | 16.72 | 111.5 |
| 1980 | 2268 | 58.1 | 61.5 | 370 | 396 | 20 | 731.5 | 1.46 | 0.66 | 19.24 | 113.2 |
| 1985 | 2497 | 61.1 | 77.6 | 388 | 392 | 21 | 721.6 | 1.54 | 0.70 | 20.15 | 106.4 |
| 1982* | 2337 | 72.0 | 63.0 | 365 | 610 | 24 | 497.0 | 2.00 | 1.00 | 17.00 | 115.0 |
| RDA** | 2400 | 70.0 | -- | -- | 800 | 12 | 800.0 | 1.20 | 1.20 | 12.00 | 60.0 |

* From data of nutrition survey in Shanghai; ** RDA of China; *** Retinol equivalents

17.5%, respectively. This change was similar to the trend of food composition changes in Japan after the Second World War^{4,5} but the consumption levels of foods from animal sources including meats, eggs, seafood and milk products were one tenth of that in European and American countries and Australia and one third of that in Japan. It was similar to the dietary pattern found in developing countries (Table 1).

Figure 1. Mean food consumption/ capita/ day Food Consumption (g)

Change in intakes of energy and nutrients

With the change of food consumption, the intake of energy and nutrients change. There is a trend for an annual increase in energy and nutrient intake (Table 2). Compared

with the Chinese RDA⁶, the energy intake in 1985 was 104% of the RDA; intakes of protein, calcium and iron were 87%, 49% and 178% of the RDA, respectively; vitamin A, thiamine, riboflavin, niacin and ascorbic acid intakes were 90%, 128%, 58%, 168% and 177%, respectively. It illustrates that the intakes of protein, calcium and riboflavin were below the Chinese RDA, especially for calcium and riboflavin.

The composition of the macronutrients in foods changed considerably. The energy intake derived from fat increased each year, higher than the average values for other cities in China and for Japan in 1985 (Table 3). Animal fats increased to 55% of total fats, higher than the average values for other cities in China, the world, Asia and developing counties (Table 4).

Table 3. Energy distribution in Shanghai (% total energy)

| Year | Protein | Fat | Carbohydrate |
|--|---------|-------|--------------|
| 1950 | 9.7 | 20.1 | 72.0 |
| 1955 | 10.2 | 16.3 | 73.5 |
| 1960 | 10.8 | 12.0 | 77.2 |
| 1965 | 10.5 | 20.1 | 69.4 |
| 1970 | 10.6 | 21.0 | 68.4 |
| 1975 | 10.2 | 24.0 | 65.8 |
| 1980 | 10.2 | 24.0 | 65.8 |
| 1985 | 9.8 | 28.0 | 62.2 |
| Mean value of cities other than Shanghai | 10.25 | 20.69 | 69.29 |

The ratio of P to S (polyunsaturated to saturated fatty acids) changed from 1.644 in 1950 to 1.083 in 1985.

During the same period, the quality of dietary proteins improved yearly, which was reflected by increased intakes of animal proteins each year except in 1960. In 1985, it increased to 23.36%, which was higher than the average level for Asian and developing countries.

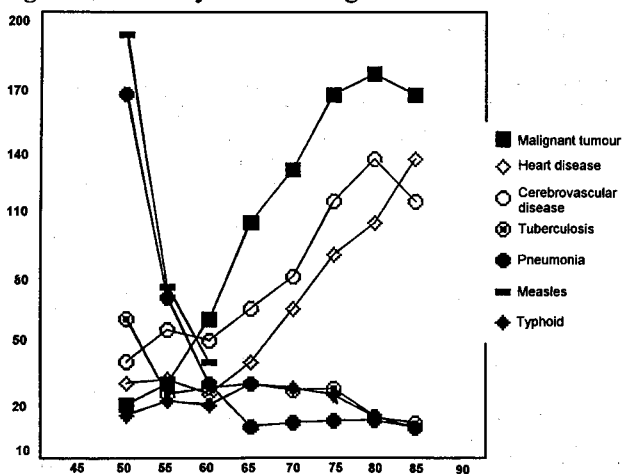
Table 4. Fats from plants and animals sources

| Year | Total (g) | Animal source | | Plant source | |
|------------|-----------|---------------|-------|--------------|-------|
| | | Weight(g) | % | Weight(g) | % |
| 1950 | 39.68 | 14.16 | 35.69 | 25.52 | 64.31 |
| 1955 | 35.73 | 11.27 | 31.54 | 24.46 | 68.46 |
| 1960 | 25.87 | 3.60 | 13.92 | 22.27 | 86.08 |
| 1965 | 38.79 | 18.95 | 48.85 | 19.84 | 51.15 |
| 1970 | 41.66 | 22.27 | 53.46 | 19.38 | 46.54 |
| 1975 | 52.04 | 33.60 | 64.57 | 18.44 | 35.43 |
| 1980 | 61.53 | 39.21 | 63.71 | 22.31 | 36.29 |
| 1985 | 77.61 | 42.70 | 55.02 | 34.91 | 44.98 |
| China 1982 | 68.20 | 31.78 | 46.60 | 36.42 | 53.40 |
| World | 63.40 | 32.97 | 52.00 | 30.43 | 48.00 |
| 1979-81 | | | | | |
| Asia | 38.70 | 15.79 | 40.80 | 22.91 | 59.20 |
| 1979-81 | | | | | |
| Countries: | | | | | |
| Developed | 120.40 | 80.07 | 66.50 | 40.33 | 33.50 |
| 1979-81 | | | | | |
| Developing | 40.60 | 15.87 | 39.10 | 24.73 | 60.90 |
| 1979-81 | | | | | |

Changes in health and diet-related diseases

Changes in health and diet-related diseases of the Shanghai population came with changes in their dietary composition and nutrient intake, however, there were other health-influencing factors. All these changes had both beneficial as well as adverse effects on health. The benefits were evidenced mainly by developmental growth and life expectancy. The height and body weight of 18-20 year old males in 1955 were 164.89 cm and 53.45 kg, respectively, and those in 1974 were increased to 167.33 cm and 55.22 kg, respectively. The life expectancies of Shanghai males and females in 1950 was 42.0 and 45.6, respectively, and improved significantly, reaching 75.1 in males and 76.4 in females. The prevalence of changes in mortality from diseases also changed prominently (Figure 2).

Figure 2. Mortality rate in Shanghai



Malignant tumours, cerebrovascular disease, and heart disease have become the three leading causes of death for

the Shanghai population. This closely resembles some developed countries and in Japan after the Second World War. The mortality of heart disease is mostly associated with diet and nutrition and was lower than in developed countries, but higher than in Japan. The results from stepwise regression analysis about the above three diseases with food categories and dietary composition are shown in Table 5 and Table 6. There was a significant positive correlation ($P < 0.01$) between consumption of meats, eggs, sucrose, and saturated fatty acids and malignant tumours, heart disease and cerebrovascular disease.

Table 5. The relationship between the kind of foods and diseases correlation coefficient

| Food | Heart Disease | Cerebrovascular Disease | Malignant Disease |
|------------------|---------------|-------------------------|-------------------|
| Cereals | -0.2009 | -0.4542 | -0.6067 |
| Vegetables | -0.0920 | 0.1124 | 0.1340 |
| Meat and Poultry | 0.9008* | 0.8036* | 0.7461* |
| Eggs | 0.7892* | 0.4996 | 0.4929 |
| Sugar | 0.9359* | 0.8460* | 0.7871* |

Table 6. The relationship between nutrient intake and disease

$$Y = -7.8538 + 4.2654 X_1 + 0.2349 X_2$$

Y: Mortality of heart disease ($1/10^5$)
 X_1 : Saturated fat
 X_2 : Cholesterol

$$Y = 70.781 + 3.8212 X_1 - 21.5971 X_2$$

Y: Mortality of cerebrovascular disease ($1/10^5$)
 X_1 : Saturated fat
 X_2 : Polyunsaturated fat/ saturated fat (P/S)

$$Y = 172.4629 - 0.4605 X_1 + 9.3315 X_2$$

Y: Mortality and malignant tumours ($1/10^5$)
 X_1 : Carbohydrate
 X_2 : Saturated fat

Discussion

Since the founding of the People's Republic of China, the dietary patterns of the Shanghai population have changed considerably. The consumption of sucrose, foods from animal origin including eggs, meats and seafood increased yearly, but grain consumption declined each year. Although the trend of changes in dietary pattern was similar to that which occurred in Japan after the Second World War, the composition of food from animal sources was still lower than in Japan, especially milk and seafood. For example, the consumption of milk products by the Shanghai population was only 4.1% of that in Japan. As to the proportions of foods from animal sources, the diets of Shanghai inhabitants were mainly meats, especially pork, which was 56% of total foods of animal origin, whereas eggs, milk and seafood were 13.4%, 24.4% and 6.0%, respectively. However, meats in the diet of Japanese people were only 16.7% of total foods of animal origin; eggs, milk and seafood were 10.9%, 46.4% and 26.0%, respectively. The changes in dietary composition in the Shanghai population mentioned above resulted in nutritional changes. It was noticed that the intake of fats, especially saturated fatty acids, increased markedly;

however, the intakes of protein, calcium, vitamin A and riboflavin were still insufficient. Intake of fats was lower than the average value in developed countries, but higher than the average values for cities in China (other than Shanghai), the world, Asia, and developing countries. The energy intake from fats in 1985 increased to 28% of total energy, which was higher than the average values for cities in China (except Shanghai) or in Japan. This situation was clearly associated with dietary changes which contained a large amount of animal foods, especially pork.

Although these changes in dietary composition and nutritional intake had an important role in health improvement of the Shanghai population, there were some adverse health effects. Mortality from malignant tumours, heart disease and cerebrovascular disease increased yearly, and they have now become the three major causes of death. There were certainly other factors influencing health. However, the change in dietary composition and nutritional intake must have been important factors. The characteristics of the dietary and nutritional patterns in Shanghai show that either deficient or excess food and nutrient contents may cause disease. There is an urgent need to modify the dietary pattern, and we suggest the following nutritional goals for the population:

- (1) Adequately increase the intake of foods from animal sources to supply high-quality protein, calcium, vitamin A and riboflavin. The daily average of a person's animal-derived food intake should not exceed 200 grams (119g in 1985).
- (2) Reduce the intake of fats, especially saturated fatty acids (for example, reduce the intake of pork, presuming it to be dominantly saturated, and increase the intake of milk and seafood).
- (3) Increase the intake of soybean and its products to improve the quality of protein and supply calcium. It has been generally accepted that soybean, which contains 40% of protein, is an ideal nutritional source of proteins. Soybean and its products would supply both the good quality and large quantity of proteins.
- (4) Increase the intake of vegetables, especially green leafy vegetables, to compensate for shortages of carotene, ascorbic acid and folic acid.
- (5) Keep or slightly lower the present intake of grain (from the present levels in China) to prevent adverse health effects which were produced by the dietary patterns in Europe and America and to preserve the beneficial aspects of the Chinese dietary pattern.

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食物結構與健康疾病關係的探討

摘要

為研究食物結構與健康疾病的關係，本文用回顧性方法調查研究了上海居民 1950 年至 1985 年食物結構的變化及其與健康和疾病的關係。結果表明，上海居民的食物結構 35 年來發生了明顯變化。主要表現在來源於糧食的熱能由 50 年代的 80~83% 降至 80 年代的 68~72%；來源於動物性食物的熱能由 50 年代的 6.5~8.5% 增至 80 年代的 17.5~18.0%。隨著食物結構的變化，膳食營養結構也發生了明顯變化，主要表現為來源於脂肪的熱能由 50 年代的 16.3~20.1% 增至 80 年代的 24.0~28.0%；來源於碳水化物的熱能由 50 年代的 72.0~73.5% 降至 80 年代 62.2~65.8%。由於食物結構和營養結構的變化，上海居民的健康和疾病狀況也發生了變化，以 18~20 歲男青年為例，1955 年的平均身高為 164.89 厘米，1974 年增至 167.33 厘米。1950 年平均壽命，男 42.0 歲，女 45.6 歲；1985 年男增至 72.1 歲，女增至 76.4 歲。與此同時，上海居民的死因順位也發生了變化。1950 年前前三位是：麻診、肺結核、老衰；1985 年為惡性腫瘤、腦血管病和心臟病。其中心臟病的死亡率已高於日本。儘管還有其他因素的影響，但食物和營養結構的變化也是重要因素。因此，迫切需研究、調整食物結構。

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