The role of income and education in food consumption and nutrient intake in a Chinese population

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The purpose of this study was to investigate the role of socio-economic status in the transition of food consumption and nutritional status in a Tianjin population and to identify some related underlying nutritional problems in this population. A random representative sample of appproximately nine million people in Tianjin was obtained using the stratified multistage cluster sampling method. A total of 2236 eligible subjects (1096 men and 1140 women) aged between 15 and 64 years were enrolled in the autumn of 1992. Food weighing plus a three-day food record method were used to assess food consumption and nutrient intakes. The population was categorized into four income groups by average per capita income and three educational groups by years of education. There were marked differences in daily mean consumption of foods among groups with different income levels and educational attainment after adjustment for confounding factors. The low income and/or least education group consumed more cereals while the high income and/or most educated group consumed more fruit, milk and meat. Due to the differences in food consumption, intakes of protein, fat, riboflavin, calcium, selenium, zinc and vitamin E increased while intakes of carbohydrate and manganese decreased with increasing levels of income and education. Vitamin A, calcium and riboflavin intakes were low in all groups classified by either income or education. Vitamin A intake was lower in the low income group than in the other three groups but intakes of calcium and riboflavin were higher in the high income and/or the most educated group than in the other groups. Socio-economic status plays an important role in food consumption and nutritional status in this population. Low intakes of vitamin A, calcium and riboflavin exist in all socio-economic groups. However, higher income and/or educational attainment contribute to increased intakes of calcium and riboflavin. Higher income also relates to an increased intake of vitamin A.

Key words: socio-economic status, education, food consumption, nutrient intakes, nutritional status, Chinese, Tianjin, vitamin A, riboflavin, calcium.

Introduction

In tandem with rapid economic transformation in China, the Chinese population has experienced a substantial change in diet.[1,2] Concurrently, the incidences of cardiovascular disease, cerebrovascular disease and some cancers have risen significantly.[3,4] In Tianjin, a large city in northern China with a population of nine million, cardiovascular disease, cerebrovascular disease and cancers were the main causes of mortality and accounted for 73.15% of all deaths.[5] For this reason, the Tianjin Project, the first national project to research and intervene to reduce the incidence and mortality of non-communicable diseases, was commenced in 1984. Diet has been identified as one of major risk factors associated with the observed change in disease patterns.[6,7] The change in diet may partially account for the increased incidence and mortality of chronic diseases. Alternatively, due to the transition from a planned economy to a market one, income differences in this population have been expanding greatly. Special attention may need to be paid to the low intakes or even deficiencies of some nutrients in socio-economically disadvantaged groups within the population in order to ascertain whether a similar nutritional status can be maintained throughout the wider community.

Income and education are considered to be two of the most important factors influencing nutritional status. Increased income makes it possible for people to select better foods to meet their personal needs. Well-educated individuals are thought to choose their foods in a more informed way. However, it is still not clear to what extent income and educational attainment influence food patterns and nutritional status in this population. We studied the differences in food consumption and consequent nutritional status among different socio-economic groups. Thus, we were able to ascertain and differentiate between some nutritional problems in these groups so that better designs for well-targeted nutrition intervention strategies could be established.

Subjects

The sample was a subsample of the third National Nutrition Survey of China for Tianjin, which was carried out in Autumn 1992. It was a random representative sample of

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Tianjin's non-institutionalized population of approximately nine million people. Subjects were selected using a stratified multistage cluster random sampling method.[8] Firstly, 960 households were selected, although data from three households were discarded due to incomplete collection. The number of people in the 957 households amounted to 3302. Among them, 110 were not available for study during the survey. In line with the key population in the Tianjin project, we selected subjects aged 15–64 years as the study population. Therefore, of the 3288 participants, 2236 people (1096 men and 1140 women) were left as eligible subjects for this study after excluding those aged below 15 years or above 64 years. The characteristics of the study population are listed in Table 1.

The mean age of the study population was 37.8 years for men and 37.6 years for women. The 2236 subjects were divided into urban and rural groups based on their dwelling places. Furthermore, 2215 participants who reported their family income were classified into four different income sections according to the monthly average income per capita of their family. First, those in the top 10 percent of income were categorized as belonging in the high income group and those in the bottom 10 percent of income were classified in the low income group. Those left were evenly divided into the mid-high and mid-low groups. Categorization by educational level was also performed such that 2223 subjects whose education attainment levels were available were classified into three groups in terms of number of years of education.

Methods

Food consumption and nutrient intake

Dietary intakes were assessed using food weighing and a three-day food record method. Standardized scales of 5 kg (0.01 kg) were used to weigh most of the foods and scales of 0.5 kg (0.001 kg) were used to weigh condiments like salt, monosodium glutamate etc. A description of the survey method is available elsewhere.[9,10] Briefly, after the supper of the first day of the survey, trained health workers visited the sampled households to weigh and record all the foods left within the households that day, including raw materials, processed and home-made foods. After the suppers of the second and third day of the survey, the same investigators visited the same households to ask and record the amounts of foods bought and discarded during that day. After the supper of the fourth day, they asked about the amounts of foods bought and discarded during that day and weighed all foods left. At the same time, individuals were asked about food consumption and this was recorded on a 24 h recall basis for three consecutive days. The estimated amounts of total individual food intakes were reconciled through adjusting the estimated amounts of the three-day individual food records according to the weighed sums consumed by the household members. This was because the data obtained by the weighing method were considered more precise.

Table 1. The characteristics of the study population aged between 15 and 64 years

Item	Men	Women	Total
Age (year)*	37.8 ± 13.4	37.6 ± 13.0	37.7 ± 13.2
15–24	214	222	436
25–34	220	247	467
35–44	326	342	668
45–54	176	170	364
55–64	160	159	319
Body weight (kg)*	66.7 ± 12.3	58.6 ± 10.7	62.5 ± 12.2
Body height (m)*	1.70 ± 0.06	1.59 ± 0.06	1.64 ± 0.08
BMI (kg/m^2)*	23.1 ± 3.9	23.2 ± 4.1	23.2 ± 4.0
Income			
High	118	107	225
Mid-high	443	460	903
Mid-low	422	440	862
Low	103	122	225
Education (years)			
0–6	402	546	948
7–12	584	543	1118
> 13	103	54	157
Area			
Urban	547	548	1105
Rural	549	582	1131
Total	1096	1140	2236

*, Mean ± SD.

Body height and weight measurement

Height and weight were measured using a stadiometer and beam balance scale. The subjects wore light indoor clothing without shoes. The measurement was conducted twice and the mean of readings was used for analysis.

Statistical analyses

The data were analyzed with SAS software.[11] The nutrient intakes were converted into the percentage of Chinese Recommended Dietary Allowances (RDA) where the RDAs for those nutrients were available.[12] FREQ was used to calculate the distribution of the study population. The difference of food consumption and nutrient intake among and between groups was compared with an analysis of covariance (ANCOVA) provided by GLM, and a two-tailed Student's *t*-test was used to assess the significance of the differences between the groups. Fisher's exact test was used to test the significance of the differences among the groups. In the ANCOVA analysis, age, sex, locality, and income or education levels were used as covariates except in the comparison of nutrient intakes as percentages of RDA because the factors of age and sex are considered in Chinese RDA. A probability of < 0.05 was accepted as statistically significant.

Results

Differences in food consumption

It was found that there were marked differences in the daily mean consumption of foods among groups with different income levels. Among these groups, statistical significance was detected for almost all categories of foods except for sugar (Table 2). The low and mid-low income groups consumed significantly more cereals but less legumes than the mid-high and high income groups and the low income group consumed even more cereal than the mid-low group. In contrast, the consumption of fruits significantly increased with increasing levels of income. Vegetable consumption was lower in the low income group than in the other three groups. Meat consumption was also lower in the low and mid-low income groups than in the mid-high and high income groups, and lower in the low income group than in the mid-low

Table 2. Daily food consumption (g) adjusted for age, sex, area and educational attainment per capita of the Tianjin population aged between 15 and 64 years by income

Food category	Income groups				$P <$
	Low* (n = 225)	Mid-low* (n = 862)	Mid-high* (n = 903)	High* (n = 225)	
Cereals	465 ± 10$^{ab, ac, ad}$	429 ± 6$^{ab, bc, bd}$	412 ± 5$^{ac, bc}$	403 ± 9$^{ad, bd}$	0.0001
Legumes	4 ± 1$^{ac, ad}$	5 ± 1$^{bc, bd}$	10 ± 1$^{ac, bc}$	10 ± 1$^{ad, bd}$	0.0001
Vegetables	283 ± 13$^{ab, ac, ad}$	330 ± 7^{ab}	324 ± 7^{ac}	324 ± 12^{ad}	0.0074
Roots and potato	60 ± 7^{ab}	42 ± 4$^{ab, bc, bd}$	56 ± 4 ^{bc}	62 ± 6^{bd}	0.0006
Fruits	19 ± 7$^{ab, ac, ad}$	40 ± 4$^{ab, bc, bd}$	54 ± 4$^{ac, bc, cd}$	75 ± 6$^{ad, bd, cd}$	0.0001
Meat	54 ± 5$^{ab, ac, ad}$	65 ± 3$^{ab, bc, bd}$	85 ± 3$^{ac, bc}$	89 ± 5$^{ad, bd}$	0.0001
Milk	29 ± 5^{ad}	32 ± 3^{bd}	35 ± 3^{cd}	61 ± 5$^{ad, bd, cd}$	0.0001
Eggs	25 ± 3$^{ab, ac, ad}$	33 ± 2$^{ab, bc}$	43 ± 2$^{ac, bc, cd}$	35 ± 3$^{ad, cd}$	0.0001
Fish	34 ± 5$^{ac, ad}$	40 ± 3$^{bc, bd}$	48 ± 3$^{ac, bc}$	53 ± 5$^{ad, bd}$	0.0057
Oils	23 ± 2$^{ab, ac, ad}$	28 ± 1$^{ab, bc, bd}$	31 ± 1$^{ac, bc}$	33 ± 1$^{ad, bd}$	0.0001
Alcohol	−1 ± 1^{ac} †	2 ± 1^{bc}	4 ± 1$^{ac, bc}$	2 ± 1	0.0035
Sugar	2.6 ± 0.4	1.6 ± 0.3^{bc}	2.4 ± 0.2 bc	2.2 ± 0.4	0.0539
Nuts	3 ± 1	2 ± 1$^{bc, bd}$	5 ± 1^{bc}	6 ± 1^{bd}	0.0010
Drinks	0 ± 2^{ad}	0 ± 1^{bd}	1 ± 1^{cd}	5 ± 1$^{ad, bd, cd}$	0.0082
Condiments	34 ± 2$^{ab, ac, ad}$	41 ± 1$^{ab, bc}$	38 ± 1$^{ab, bc}$	39 ± 2^{ad}	0.0028

*, Mean ± SE; ^{a}, low income group; ^{b}, mid-low income group; ^{c}, mid-high income group; ^{d}, high income group. Superscript letters indicate significant difference between the two groups at a 5% level.
† Only two subjects categorized into the low income group were found to be drinking alcohol during the survey.

income group. The high income group was found to consume more milk than any of the other three groups. Consumption of eggs seemed to increase with increasing levels of income, but a decrease in consumption of eggs was identified in the high income group compared to that of the mid-high income group. The low and mid-low income groups were also found to consume significantly less fish and oils than the other two groups and the low income group consumed significantly less oils than the mid-low income group. The high income group was found to have the highest consumption of beverages and the use of condiments was the lowest in the low income group.

To a lesser extent, there were differences in the consumption of foods among the groups with different educational attainment (Table 3). Consumption of cereals, roots and potato decreased with increasing years of education. Conversely, consumption of fruits, meat, milk and eggs increased with increasing educational attainment. No significant differences in consumption of legumes, vegetables, fish, oils, alcohol, sugar, nuts, drink or condiments were observed among the three groups.

Table 3. Daily food consumption (g) adjusted for age, sex, area and income per capita of the Tianjin population aged between 15 and 64 years by educational attainment (years)

Food category	Educational attainment (years)			$P <$
	0–6* (n = 948)	7–12* (n = 1118)	13– * (n = 157)	
Cereals	452 ± 5$^{ab, ac}$	431 ± 4$^{ab, bc}$	384 ± 11$^{ac, bc}$	0.0001
Legumes	6 ± 1	8 ± 1	8 ± 2	0.2405
Vegetables	313 ± 6	323 ± 6	330 ± 14	0.3654
Roots and potato	60 ± 3^{ab}	49 ± 3^{ab}	46 ± 7	0.0429
Fruits	34 ± 3$^{ab, ac}$	44 ± 3$^{ab, bc}$	64 ± 8$^{ac, bc}$	0.0008
Meat	64 ± 3$^{ab, ac}$	73 ± 2$^{ab, bc}$	89 ± 6$^{ac, bc}$	0.0001
Milk	18 ± 3$^{ab, ac}$	27 ± 2$^{ab, bc}$	64 ± 6$^{ac, bc}$	0.0001
Eggs	31 ± 1$^{ab, ac}$	35 ± 1$^{ab, bc}$	44 ± 3$^{ac, bc}$	0.0004
Fish	43 ± 2	46 ± 2^{ab}	42 ± 6	0.5655
Oils	30 ± 1	29 ± 1	29 ± 2	0.9429
Alcohol	4 ± 1	4 ± 1	1 ± 2	0.2411
Sugar	2 ± 0	2 ± 0	3 ± 0	0.1802
Nuts	3 ± 1^{ab}	4 ± 1^{ab}	5 ± 1	0.0552
Drinks	1 ± 1	2 ± 1	1 ± 2	0.5311
Condiments	38 ± 1	40 ± 1	40 ± 2	0.3670

*, Mean ± SE; ^{a}, 0–6 years education group; ^{b}, 7–12 years group; ^{c}, 13– years group. Superscript letters indicate a significant difference between the two groups at a 5% level.

Differences in nutrient intake

As a consequence of the differences in food consumption among different income groups, the levels of nutrient intakes or the percentages of nutrients reaching RDA were significantly different for most of the nutrients (Table 4 and Table 6). Intakes of energy, protein, fat, vitamin A, niacin, riboflavin, calcium, selenium, zinc and total vitamin E tended to increase with increasing income, while the intake of fibre tended to decrease. The high income group was identified as having the highest intakes of vitamin C and iron. The consumption of carbohydrates and manganese were significantly higher in the low income group than in the other three groups. Means of Body Mass Index (BMI) of the four groups were maintained at around 23 and no significant difference among groups was detected. Thiamin, phosphorus and copper intakes were also similar througthout the four groups. Even in the high income group, the intakes of calcium, vitamin A and riboflavin were still lower than the RDA, only reaching 60.3%, 64.7% and 72.4% of the RDA, respectively. The low income group consumed 46.5%, 33.9% and 55.7% of the RDA of calcium, vitamin A and riboflavin, respectively. Sodium intake was high, ranging from 5648 mg to 6322 mg per day with an increase in the high income group, but potassium intake and the ratio of sodium to potassium were similar in all the groups.

The differences in percentage of energy from protein, fat and carbohydrates were marked among the low, mid-low and mid-high income groups (Table 8). The low and mid-low

Table 4. Nutrient intake percentage of Chinese Recommended Dietary Allowances adjusted for educational attainment and area in the Tianjin population aged between 15 and 64 years by income

Nutrient	Chinese RDA**	Income groups				$P <$
		Low* (n = 225)	Mid-low* (n = 862)	Mid-high* (n = 903)	High* (n = 225)	
Energy	10 (mJ)	89.1 ± 2.2[ac, ad]	90.4 ± 1.2[bc, bd]	93.9 ± 1.2[ac, bc]	96.9 ± 2.0[ad, bd]	0.0042
Protein	70 (g)	89.1 ± 2.2[ac, ad]	90.6 ± 1.2[bc, bd]	96.4 ± 1.2[ac, bc, cd]	102.3 ± 2.0[ad, bd, cd]	0.0001
Calcium	800 (mg)	46.5 ± 2.5[ac, ad]	49.9 ± 1.4[bc, bd]	53.6 ± 1.4[ac, bc, cd]	60.3 ± 2.3[ad, bd, cd]	0.0001
Iron	12 (mg)	177.6 ± 6.7[ad]	174.1 ± 3.8[bd]	178.8 ± 3.6[cd]	197.2 ± 6.2[ad, bd, cd]	0.0093
Zinc	15 (mg)	78.9 ± 2.0	77.8 ± 1.1[bc, bd]	81.7 ± 1.1[bc]	85.1 ± 1.8[bd]	0.0010
Vitamin A***	800 (µg)	33.9 ± 7.8[ab, ac, ad]	56.2 ± 4.5[ab, bc]	66.7 ± 4.3[ac, bc]	64.8 ± 7.2[ad]	0.0011
Thiamin	1.2 (mg)	83.5 ± 2.9	81.5 ± 1.6	81.7 ± 1.6	83.4 ± 2.6	0.8497
Riboflavin	1.2 (mg)	55.7 ± 2.4[ac, ad]	60.0 ± 1.3[bc, bd]	67.2 ± 1.3[ac, bc, cd]	72.4 ± 2.1[ad, bd, cd]	0.0001
Niacin	12 (mg)	109.8 ± 4.1[ac, ad]	108.2 ± 2.3[bc, bd]	120.8 ± 2.2[ac, bc]	119.6 ± 3.8[ad, bd]	0.0001
Vitamin C	60 (mg)	159.6 ± 9.1[ad]	168.8 ± 5.1[bd]	165.7 ± 4.9[cd]	187.2 ± 8.4[ad, bd, cd]	0.0790
Selenium	50 (µg)	98.1 ± 3.5[ac, ad]	102.8 ± 2.0[bc, bd]	115 ± 1.9[ac, bc, cd]	124.4 ± 3.2[ad, bd, cd]	0.0001

*, Mean ± SE; **, Chinese Recommended Dietary Allowances (RDA) for adult man with lightest labour; ***, vitamin A retinol equivalent; [a], low income group; [b], mid-low income group; [c], mid-high income group; [d], high income group. Superscript letters indicate a significant difference between the two groups at a 5% level.

income groups had a lower percentage of energy from protein than the mid-high and high income groups, and the high income group had a higher percentage of energy from protein than the mid-high income group. Percentages of energy from fat or carbohydrates also varied with income. However, the high income group was able to maintain about the same level of fat and carbohydrate percentages as the mid-high income group.

In line with the differing food consumption patterns among the groups with different educational attainment, intakes of carbohydrates and manganese decreased with increasing years of education (Table 5 and Table 7). The group with low education attainment was found to have the lowest intakes of selenium, zinc and copper. Intakes of protein, calcium, vitamin C, niacin, riboflavin, thiamin and potassium were significantly higher in the most educated group than in the other two groups. Intakes of vitamin A, iron, vitamin E, phosphorus and magnesium, sodium and the ratio of sodium to potassium were not found to be significantly different among the three groups. Even though the most educated group was found to have the highest intakes of calcium and riboflavin, the levels were still quite low, 58.1% and 77.1% of the RDA, respectively. Vitamin A intake was also found to be low, 54.7% of the RDA in the least educated group, 55.8% in the 7 to 12 years education group and 67.3% in the most educated group. The percentages of energy source from protein, carbohydrate and fat are listed in Table 9. The percentages of energy from protein and fat increased significantly from the 0 to 6 years education group to the 7 to 12 years group and to the 13 years or above group. The percentage of energy from carbohydrates decreased with educational attainment in this population.

Discussion

To some extent, food habits and nutritional status reflect the food availability and socio-economic conditions of a region. However, the effects of income and education are sometimes divergent in countries with different levels of development and culture. For example, Arija *et al.* reported that medium and high social classes followed very similar diets;[13] however, the population group with the lowest socio-economic status had the lowest intake of nutrients in the Spanish Reus population, while a report from Australia suggested that some parents on low incomes were able to maintain nutrient intakes similar to that of the wider community.[14] A cross-sectional study of food and nutrient intakes classified by socio-economic status may provide precious information about the possible transition towards a population's future nutrition status in places where food consumption and lifestyle have been undergoing radical change. In the Tianjin population, the group classified in the bottom 10 per cent of income had a poor quality diet, with carbohydrates accounting for 65% of their energy source (itself not necessarily a nutritional problem and possibly an advantage). However, the percentage of those whose energy intake reached the RDA in the lowest income group was similar to that of the wider community and their mean BMI was also similar to other income groups.

Due to the low consumption of legumes, vegetables, fruits, meat and eggs in the low income group, intakes of calcium, riboflavin and vitamin A, especially, were far below the RDA in this group. In contrast, the high income group had a better quality diet. The consumption of fruit and milk

Table 5. Nutrient intake percentage of Chinese Recommended Dietary Allowances adjusted for income and area in Tianjin population aged between 15 and 64 years by educational attainment (years)

Nutrient	Educational attainment (years)			$P <$
	0–6* (n = 948)	7–12* (n = 1118)	13– * (n = 157)	
Energy	94.8 ± 1.0[ab]	89.7 ± 0.9[ab]	93.0 ± 2.3	0.0004
Protein	92.8 ± 1.0[ac]	90.8 ± 0.9[bc]	99.0 ± 2.4[ac, bc]	0.0039
Calcium	48.4 ± 1.1[ac]	50.5 ± 1.0[bc]	58.1 ± 2.8[ac, bc]	0.0052
Iron	174.6 ± 3.0	175.4 ± 2.8	187.7 ± 7.3	0.2447
Zinc	77.9 ± 0.9[ab, ac]	80.5 ± 0.8[ab]	82.9 ± 2.2[ac]	0.0358
Vitamin A**	54.7 ± 3.5	55.8 ± 3.2	67.3 ± 8.6	0.4015
Thiamin	80.7 ± 1.3[ac]	77.6 ± 1.2[bc]	87.6 ± 3.1[ac, bc]	0.0052
Riboflavin	56.8 ± 1.0[ac]	58.3 ± 0.9[bc]	77.1 ± 2.6[ac, bc]	0.0001
Niacin	107.6 ± 1.8[ac]	106.8 ± 1.7[bc]	130.5 ± 4.5[ac, bc]	0.0001
Vitamin C	155.8 ± 4.1[ac]	162.3 ± 3.7[bc]	188.3 ± 10.0[ac, bc]	0.0120
Selenium	104.3 ± 1.6[ab, ac]	109.3 ± 1.4[ab]	116.0 ± 3.9[ac]	0.0064

*, Mean ± SE; **, vitamin A retinol equivalent; [a], 0–6 years education group; [b], 7–12 years group; [c], 13– years group. Superscript letters indicate a significant difference between the two groups at a 5% level.

was observed to be higher and only the consumption of eggs was lower in this income group than that in the mid-high income group. These differences resulted in a significantly increased intake of calcium, selenium and riboflavin in the high income group. However, their intake of vitamin A did not significantly increase when compared with that in the mid-high income group and, even so, the increased intakes of calcium and riboflavin in the high income group were still very low, only reaching a little more than 60 and 70%, respectively, of the RDA. Meanwhile, fibre intake and percentage of energy from fat in the high income group remained at the same level as those in the mid-high income group.

These findings suggest that, in this population, the shift in food selection due to the increase in income may not eliminate low intakes or even possible deficiencies of some nutrients in the short run. However, some further improvement of intakes of these nutrients can be expected in the future. These low intakes may be attributed to low contents of these nutrients in locally available foods. It has been demonstrated that intake levels of nutrients were positively associated with a food price related formula and policy.[15] In other words, this population had low intakes of these nutrients because people tended to choose cheaper foods more often and cheaper foods contained lower levels of certain nutrients. Therefore, encouraging the production of foods rich in calcium, riboflavin and vitamin A, combined with proper guidance for food selection, would be a better way to solve the problem of nutrient deficiencies.

The increment in the consumption of meat and eggs from the low income group to the mid-low income group and even to the mid-high income group was very significant. This trend of meat consumption in this population was in agreement with an opinion voiced years ago that to improve the

Table 6. Body mass index and nutrient intake adjusted for age, sex, area and educational attainment in the Tianjin population aged between 15 and 64 years by income

Nutrient	Income groups				$P <$
	Low* ($n = 225$)	Mid-low* ($n = 862$)	Mid-high* ($n = 903$)	High* ($n = 225$)	
BMI (kg/m^2)	22.9 ± 0.3	23.4 ± 0.2	23.5 ± 0.2	23.0 ± 0.3	0.2785
Fat (g)	57.9 ± 2.5$^{ab, ac, ad}$	65.1 ± 1.4$^{ab, bc, bd}$	73.3 ± 1.4$^{ac, bc}$	76.0 ± 2.3$^{ad, bd}$	0.0001
Carbohydrate (g)	379.3 ± 7.6$^{ab, ac, ad}$	354.2 ± 4.3^{ab}	349.0 ± 4.1^{ac}	346.6 ± 7.0^{ad}	0.0021
Fibre (g)	13.8 ± 0.5$^{ac, ad}$	13.1 ± 0.3^{bc}	12.5 ± 0.3$^{ac, bc}$	12.5 ± 0.5^{ad}	0.0442
Total vitamin E (mg)	24.3 ± 1.4$^{ab, ac, ad}$	30.3 ± 0.8$^{ab, bc, bd}$	33.7 ± 0.8$^{ac, bc}$	36.4 ± 1.3$^{ad, bd}$	0.0001
α (mg)	9.0 ± 0.3	8.6 ± 0.2^{bd}	8.7 ± 0.2^{cd}	9.6 ± 0.3$^{bd, cd}$	0.0033
$\beta + \gamma$ (mg)	10.2 ± 0.9$^{ab, ac, ad}$	14.0 ± 0.5$^{ab, bc, bd}$	16.3 ± 0.5$^{ac, bc}$	17.5 ± 0.8$^{ad, bd}$	0.0001
δ (mg)	4.1 ± 0.5$^{ab, ac, ad}$	6.1 ± 0.3$^{ab, bc, bd}$	7.6 ± 0.3$^{ac, bc}$	7.9 ± 0.5$^{ad, bd}$	0.0001
Sodium (mg)	5648 ± 178$^{ab, ad}$	6048 ± 101^{ab}	5991 ± 97	6322 ± 165^{ad}	0.0350
Potassium (mg)	1883 ± 72	1905 ± 41^{bc}	2014 ± 39^{bc}	2039 ± 67	0.0596
Na/K molar ratio	5.36 ± 0.27^{a,b}	5.96 ± 0.15^{a,b}	5.80 ± 0.15	5.68 ± 0.25	0.1756
Magnesium (mg)	354.8 ± 9.1	336.9 ± 5.2^{bd}	339.0 ± 5.0^{cd}	366.9 ± 8.5$^{bd, cd}$	0.0038
Manganese (mg)	7.6 ± 0.2$^{ab, ac, ad}$	7.1 ± 0.1^{ab}	7.0 ± 0.1^{ac}	7.0 ± 0.2^{ad}	0.0204
Copper (mg)	2.3 ± 0.1	2.2 ± 0.0^{bc}	2.3 ± 0.0^{bc}	2.3 ± 0.1	0.1127
Phosphorus (mg)	1149 ± 25	1110 ± 14	1130 ± 14	1157 ± 23	0.1664

*, Mean ± SE; ^{a}, low income group; ^{b}, mid-low income group; ^{c}, mid-high income group; ^{d}, high income group. Superscript letters indicate significant difference between the two groups at a 5% level.

Table 7. Body mass index and nutrient intake adjusted for age, sex, area and income in the Tianjin population aged between 15 and 64 years by educational attainment (years)

Nutrient	Educational attainment (years)			$P <$
	0–6* ($n = 948$)	7–12* ($n = 1118$)	13–* ($n = 157$)	
BMI (kg/m^2)	23.2 ± 0.1	23.3 ± 0.1	23.3 ± 0.4	0.9677
Fat (g)	65.6 ± 1.2^{ab}	69.9 ± 1.1^{ab}	71.6 ± 2.8	0.0179
Carbohydrate (g)	373.9 ± 3.6$^{ab, ac}$	357.7 ± 3.2$^{ab, bc}$	329.4 ± 8.4$^{ac, bc}$	0.0001
Fibre (g)	13.4 ± 0.2^{ac}	13.0 ± 0.2	12.2 ± 0.5^{ac}	0.1096
Total vitamin E (mg)	32.0 ± 0.7	32.4 ± 0.6	31.0 ± 1.6	0.6972
α (mg)	8.9 ± 0.1	9.0 ± 0.1	8.4 ± 0.3	0.2280
$\beta + \gamma$ (mg)	14.9 ± 0.4	15.2 ± 0.4	14.8 ± 1.0	0.8441
δ (mg)	6.6 ± 0.2	6.8 ± 0.2	6.7 ± 0.6	0.8339
Sodium (mg)	6008 ± 84	6149 ± 75	5873 ± 197	0.2756
Potassium (mg)	1854 ± 34^{ac}	1889 ± 31^{bc}	2145 ± 80$^{ac, bc}$	0.0041
Na/K molar ratio	5.98 ± 0.13	5.93 ± 0.11	5.48 ± 0.30	0.3010
Magnesium (mg)	348.2 ± 4.2	345.3 ± 3.8	335.6 ± 10.1	0.5182
Manganese (mg)	7.5 ± 0.1$^{ab, ac}$	7.2 ± 0.1$^{ab, bc}$	6.6 ± 0.2$^{ac, bc}$	0.0001
Copper (mg)	2.3 ± 0.0$^{ab, ac}$	2.2 ± 0.0^{ab}	2.1 ± 0.1^{ac}	0.0261
Phosphorus (mg)	1126 ± 12	1126 ± 11	1131 ± 28	0.9783

*, Mean ± SE; ^{a}, 0–6 years education group; ^{b}, 7–12 years group; ^{c}, 13– years group. Superscript letters indicate a significant difference between the two groups at a 5% level.

Table 8. Percentage of energy source from protein, fat and carbohydrates adjusted for age, sex, area and educational attainment by income

Nutrient	Income level				P <
	Low* (n = 225)	Mid-low* (n = 862)	Mid-high* (n = 903)	High* (n = 225)	
Protein	12.5 ± 0.2[ac, ad]	12.6 ± 0.1[bc, bd]	12.9 ± 0.1[ac, bc, cd]	13.3 ± 0.2[ad, bd, cd]	0.0001
Fat	22.5 ± 0.7[ab, ac, ad]	25.5 ± 0.4[ab, bc, bd]	27.3 ± 0.4[ac, bc]	27.8 ± 0.6[ad, bd]	0.0001
Carbohydrate	65.0 ± 0.7[ab, ac, ad]	61.7 ± 0.4[ab, bc.bd]	59.2 ± 0.4[ac, bc]	58.6 ± 0.6[ad, bd]	0.0001

*, Mean ± SE; [a], low income group; [b], mid-low income group; [c], mid-high income group; [d], high income group. Superscript letters indicate a significant difference between the two groups at a 5% level.

Table 9. Percentage of energy source from protein, fat and carbohydrates adjusted for age, sex, area and income by educational attainment (years)

Nutrient	Educational attainment (years)			P <
	0–6* (n = 948)	7–12* (n = 1118)	13–* (n = 157)	
Protein	12.4 ± 0.1[ab, ac]	12.6 ± 0.1[ab, bc]	13.4 ± 0.2[ac, bc]	0.0001
Fat	24.2 ± 0.3[ab, ac]	26.3 ± 0.3[ab, bc]	28.2 ± 0.7[ac, bc]	0.0001
Carbohydrate	63.0 ± 0.3[ab, ac]	60.6 ± 0.3[ab, bc]	58.2 ± 0.7[ac, bc]	0.0001

*, Mean ± SE; [a], 0–6 years education group; [b], 7–12 years group; [c], 13– years group. Superscript letters indicate a significant difference between the two groups at a 5% level.

nutritional status of the Chinese people, a greater consumption of animal food should be encouraged.[16] However, in the high income group, an increase in milk consumption and a decrease in egg consumption were observed when compared to the mid-high income group. There was no significant difference in meat or fish consumption between the high and mid-high groups. The percentages of energy from fat and carbohydrates were not significantly different between these groups. It seems possible that this population may maintain a relatively low level of consumption of animal foods and increase fruit consumption even when a large increase in income has been achieved.

On the whole, the most educated people can be expected to receive more nutritional messages and be more aware of nutrition in their diets and, as a result, have more nutritionally adequate diets. The MONICA Augsburg Dietary Survey verified that although the percentage of carbohydrates, protein and fat of the total energy intake was nearly the same in all educational attainment groups, mean daily intakes of vitamins (except niacin), minerals and trace elements were better in men with higher educational attainment.[17] However, in this population the percentage of energy source from carbohydrates was significantly lower, and the percentage of energy from fat and protein markedly increased with years of education. In Tianjin, it was observed that consumption of meat and fruits significantly increased with increasing years of education. Concurrently, consumption of cereals, and root vegetables, including potato were found to decrease from the 0–6 years education group to the 7–12 years group. Intakes of some of the most deficient nutrients such as calcium and riboflavin improved greatly with increasing levels of education. Therefore, not only had intakes of some vitamins and minerals increased but increased intakes of fat and protein and decreased intakes of carbohydrates were also observed with increasing years of education. Perhaps the increased intakes of calcium and riboflavin were attributable to an increase in fruits, animal food and, in particular, milk consumption.

In the MONICA survey, the level of educational attainment seemed to contribute more to increased consumption of meat and eggs than did income levels. The higher income levels seemed to contribute to a higher intake of sodium, but increased educational attainment tended to reduce the intake of salt, although no significant difference in sodium intake was detected among the three groups categorized by educational attainment. It is of interest that intakes of copper and manganese decreased with increasing educational attainment.

Socio-economic status played an important role in food consumption in Tianjin. The high income and/or high educational attainment group had higher intakes of fruits, animal foods and a lower intake of cereals. Low intakes of vitamin A, calcium and riboflavin were found throughout all socio-economic groups in this population. The low income group was at highest risk of vitamin A deficiency. However, increased intakes of calcium and riboflavin were observed in the high income and/or most educated group. The increased income also helped to increase the intake of vitamin A.

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The role of income and education in food consumption and nutrient intake in a Chinese population

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本研究的目的是調查社會經濟狀況在天津人群的食物消費和營養狀況轉變中所起的作用，尋找該人群中一些有關的營養問題. 使用多級分層整群隨機抽樣方法從天津約900萬人口中抽得一有代表性樣本. 計有2236名15到64歲合格被調查人參與了1992年秋季的營養調查. 食物稱重和三天食物記錄方法用于評價食物消費和營養素攝入. 人群按照家庭人均月收入分成四組，按照受教育年數分成三組. 不同收入和受教育水平組的平均日食物消費在控制混雜因素后有明顯差异. 低收入和/或受教育水平組消費更多的谷物，但高收入和/或受教育水平組消費更多的水果、牛奶和肉類. 由于食物消費的差异，蛋白質、脂肪、核黃素、鈣、硒、鋅和維生素E攝入隨收入和教育水平提高而升高，但碳水化合物和鎂攝入卻下降. 維生素A、鈣和核黃素攝入在各收入和受教育水平組都很低. 維生素A攝入在低收入組低于其它三組，但鈣和核黃素攝入在高收入和/或受教育水平組高于其它組. 在該人群中，社會經濟狀況影響食物消費和營養狀況. 低攝入維生素A、鈣和核黃素存在于所有社會經濟階層的人群. 盡管如此，較高的收入和/或受教育水平有助于提高鈣和核黃素攝入. 較高的收入也與維生素A攝入增高有關.

References

1. Chinese Academy of Preventive Medicine. Report on a national nutrition survey in 1982 (in Chinese). Beijing: Preventive Medicine Academy Press, 1986.
2. Popkin BM, Ge K, Zhai F, Guo X, Ma H, Zohoori N. The nutrition transition in China: A cross-sectional analysis. Eur J Clin Nutr 1993; 47: 333–346.
3. Ministry of Health China. Research on objectives and strategies for disease prevention and health care in China by year 2000. Beijing: Chinese Science and Technology Press, 1991.
4. Liu L. Development of a program for hypertension prevention and control in China (in Chinese). China J Cardiovasc Dis 1996; 14: 1–2.
5. Tianjin Public Health Bureau. Prevention and control of Non-Communicable Diseases (NCD). An introduction of Tianjin Program. Tianjin: Public Health Bureau Press, 1991.
6. Hodges RE, Rebello T. Dietary changes and their possible effect on blood pressure. Am J Clin Nutr 1985; 41 (suppl.): 1155–1162.
7. Stamler J. The marked decline in coronary heart disease mortality rates in the United States, 1968–81; summary of findings and possible explanations. Cardiology 1985; 72: 11–22.
8. Nutrition and Food Hygiene Institute Chinese Academy of Preventive Medicine. Manual book for the National Nutrition Survey (in Chinese). Beijing: Preventive Medicine Academy Press, 1992.
9. Ge K, Zhai F, Wang Q. Effect of nationality on dietary pattern and meal behaviour in China. Am J Clin Nutr 1997; 65 (Suppl.): 1290S–4S.
10. Tian H, Nan Y, Hu G, Dong Q, Yang X. A dietary survey of the Chinese population in urban and rural areas of Tianjin. Asia Pacific J Clin Nutr 1996; 5: 229–234.
11. SAS Institute Inc. SAS/STAT User's Guide. Version 6, 4th edn. Cary, NC: SAS Institute, Inc., 1990.
12. Chinese Nutrition Association. Recommended dietary allowances (in Chinese). Beijing: Public Health Press, 1988.
13. Arija V, Salas Salvado J, Fernandez-Ballart J, Guco G, Marti-Henneberg C. Consumption, dietary habits and nutritional status of the Reus (IX) population. Evolution of food consumption, energy and nutrient intake and relationship with socioeconomic and cultural level, 1983–93. Med Clinica 1996; 106: 174–179.
14. Buchhorn D. Food consumption of parents on low incomes. Aust J Public Health 1995; 19: 427–429.
15. Yang X, Wu J. Relativity between nutrition environment and population's intake level of nutrients (in Chinese). Acta Nutrimenta Sinica 1997; 19: 437–40.
16. Chen X. Dietary standards and goals for the People's Republic of China with special emphasis on nutritional requirements of Chinese infants. Prog Food Nutr Sci 1990; 14: 83–92.
17. Kussmaul B, Doring A, Stender M, Winkler G, Keil U. Correlation between dietary behaviour and educational attainment: Results of the 1984/85 nutrition survey of the Augsburg MONICA project. Z Ernahrungswiss 1995; 34: 177–182.