Adiposity, dietary and physical activity patterns in ethnic Chinese youths: a cross-country comparison of Singaporean Chinese and Chinese Americans

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During the last decade, childhood obesity has been on the increase in Singapore and many newly industrialized Asian countries. We compared the mean body mass index (BMI) and triceps skinfold (TSF) values, as well as the dietary and physical activity patterns of Singaporean Chinese and Chinese American youths. Chinese Americans had a higher mean BMI but a lower mean TSF than Singaporean Chinese. Dietary comparisons suggest that Singaporean Chinese ate fish and grain products more often than Chinese American youths, while Chinese American youths consumed processed meats, dairy products and snack foods more frequently. Mean frequency of consumption of low fat, traditional Chinese foods such as rich porridge was higher among the Singaporean Chinese, while typical 'American' foods including cheese were consumed more often among the Chinese Americans. Certain food items that were more 'neutral' in terms of their cultural identity, such as carbonated drinks, cookies and bread were consumed with the same mean frequencies in both cohorts. In terms of physical activity, Singaporean Chinese youths, on average, spent more time in sedentary activities, less time sitting, and more time in light or moderate activities. The mean time spent on vigorous activities per day was only one hour in both cohorts. Our study suggests differences in body fat distribution and composition, as well as in dietary and activity patterns, between Chinese American and Singaporean Chinese youths. There is a need to develop obesity indicators that are appropriate for the specific populations involved, and to carefully investigate environmental influences on childhood obesity.

Introduction

Childhood obesity has recently been recognized as an emerging problem in many newly industrialized Chinese societies[1–4]. For example, in Singapore, in 1976, only 2% of Primary Six schoolchildren (mostly 12-year-olds) were identified as obese, based on a relative weight of ≥120% of standard weight-for-height from the Harvard growth standards. In 1983, the corresponding rate was 12%[1]. Recent data from the Ministry of Health in Singapore shows that the prevalence of obesity among Primary Six children was 19% for boys and 12% for girls in 1990[5]. In Hong Kong, the prevalence of overweight among a selected group of adolescents was found to be about 3-4%[2]. Table 1 summarizes selected published studies on childhood obesity in ethnic Chinese populations. Comparison of data across these studies is difficult since each study uses a different criteria for defining overweight.

The causes of obesity are multi-factorial. Both genetic and environmental factors have been implicated[6]. Among the environmental causes, diet and physical activity have been most widely studied. This paper will focus on these environmental factors.

Dietary patterns among the Chinese

Although the Chinese diet is generally considered low in fat, rapid economic development in many Chinese-dominated newly industrialized nations have resulted in increasing meat and animal fat consumption. In Singapore for example, where 78% of the population is of Chinese ethnicity, food availability data from the Food & Agricultural Organisation (FAO)[7] indicates that fat levels doubled between 1961–63 (41 grams) and 1986–88 (81 grams). A survey of 40 Chinese households in Singapore carried out in 1984–85 revealed that dietary patterns were influenced by affluence and the primary language spoken[8]. In particular, more affluent households tended to purchase more red meat/offal, poultry, fruit, eggs and vegetables other than green leafy, while lower-income households were consuming more eggs and milk in 1984 than in 1970. The affluent households also tended to use corn or soybean oil as opposed to lard or other vegetable oils, and to eat high fibre biscuits more than the less affluent house-

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Table 1. Studies of childhood obesity in ethnic Chinese populations.

Country	Population	Variables measured	Analysis	Results
Singapore[1]	705 511 school children measured from 1976–83(51% boys, 49% girls): • 346 208 6–7 yr olds • 359 303 11–12 yr olds	Weight, standing height, relative weight (using the Harvard growth standards for ideal weight-for height).	•Obesity defined as ≥ 120% of ideal weight-- for-height •Computed prevalence by year, gender, and age	Annual prevalence: Boys: 1.4% (1974) 8.2%(1983) Girls: 1.0%(1974) 8. 5%(1983) 6–7 years 1.4%(1976) 3.1%(1983) 11–12 years 2.2%(1976) 12.1%(1983)
Hong Kong[2]	1535 adolescents aged 14–27 years (82% aged 16–21 years) from two secondary schools and one commercial school	Height, weight BMI (weight/height^2) ; physical activity assessed by questionnaire; parents' height and weight as reported by the subjects.	•A BMI of 25 is the cut-off for defining overweight •Computed percent overweight by age and sex •Computed energy expenditure by converting hours spent in various activities to metabolic equivalence •Used univariate analysis to assess associations of activity and parents' BMI with subject's overweight	1)Per cent overweight: 14–15 years 4.1% 16–17 years 2.6% 18–19 years 2.5% 20+ years 5.3% All age groups: 3.5% Males: 4.0% Females: 3.0% 2)Time spent in exercise and activity score were not related to overweight 3)Correlation between parents' BMI and subject's BMI was not different from zero.
Taiwan[3]	20 677 individuals aged 3–70 years (49% males, more than 70%≤20 years) were measured in 12 districts selected by stratified random sampling	Mid-arm circumferences (TSF)	•Computed pre valence based on triceps skinfold (TSF) and >120% of average body weight for each age group, for 10–15 year old boys and girls (1986–88) •Compared prevalences with a previous survey (1980–82)	1)Prevalence (only results for 10 and 15 year olds are given here): *Based on 120% of average weight:* *Boys* 10yr 15yr; *Girls* 10yr 15y 1980–82 8.4 10.2 4.6 9.2% 1986–88 14.4 10.5 14.1 9.7% *Based on TSF:* Boys 10yr 15yr; Girls 10yr 15yr 1986–88 21.5 18.6 10.0 14.8% 2)Mean BMI (1986–88) Boys (8–19yr): 19.0–27.2 kg/m^2 Girls (8–19yr): 18.6–24.5 kg/m^2 Mean TSF (1986–88) Boys (8–19yr): 10.3–13.2mm Girls (8–19yr): 12.6–19.9mm
China[4]	4314 boys and girls aged 7–18 years from the Northern Chinese	BMI, subscapular and TSF	• Cut-offs for overweight defined by standard deviation from predicted values of BMI and the sum of measured skinfolds (SF)	1)Prevalence of overweight (1983): *Criteria: BMI Sum SF Both* Boys: 7.1 5.6 2.9% Girls: 9.0 6.0 4.0 2)Range of mean BMI (1983) Boys: (7–18yr): 15.0–20.0 kg/m^2 Girls :(7-18 yr): 14.7–20.1 Range of mean sum SF (1983) Boys: (7–18yr): 12.9–16.2mm Girls: (7–18yr): 15.1–29.5

holds. There were also some indications that more English-speaking than Chinese-speaking households had made changes in their diet during the last five years.

Similarly, in Taiwan, fat availability per capita increased from 86 grams (28% of calories) in 1980 to 118 grams (36% of calories) in 1986[9]. Finally, in China, fat availability per person in both rural and urban regions increased by 180% from 16 grams or 8% of calories (1961–63) to 44 grams or 15% of calories (1986–88)[7]. Increases in the availability of processed foods that are high in fat content, and increased consumption of meat[7,9] are likely explanations for the increases in fat intake seen in these societies.

In the United States, the process of acculturation can be expected to lead to major changes in the dietary patterns of immigrants from China, Hong Kong, Taiwan, Singapore and elsewhere. Indeed, several studies have documented changes in the food habits of various Chinese immigrant groups in the United States and Canada[10–13]. Yang & Fox, in 1979, administered a questionnaire designed to assess changes in food habits in a group of first generation immigrant Chinese adults living in Nebraska[10]. They reported more people following 'American style' breakfast and lunch patterns. Dinner, for most subjects, however, generally remained Chinese-style. They also found that immigrants from Taiwan made fewer changes in food habits than those from China or Hong Kong.

Physical activity

There is a dearth of information on the physical activity patterns of ethnic Chinese children and youths. In a survey of 887 youths, all over 14-years-old, from two schools in Hong Kong, it was found that 25% and 40% of the respondents did not report having recently taken any moderate or vigorous exercise, respectively. The relationship between activity and overweight was weak and statistically insignificant[2]. In a population-based cross-country study of colorectal cancer of Chinese Americans and of Chinese living in China, both higher energy expenditure and intakes were observed among the Chinese in China. The risk of colorectal cancer was observed to increase the duration of exposure to a sedentary lifestyle and high saturated fat consumption. Differences in the rates of colorectal cancer between the Chinese Americans and the population in China could be explained by differences in these lifestyle factors[14].

The purpose of this paper is to compare adiposity, using body mass index (BMI) and triceps skinfolds (TSF), as well as dietary and physical activity patterns, between ethnic Chinese youths living in Singapore, and their age and sex counterparts living in California.

Methods

Recruitment
Recruitment efforts were directed at high school and college-aged individuals. In Singapore, a total of 280 subjects, aged 17–22 years, were voluntarily recruited from among first year female students of the National University of Singapore (103 females), Army recruits (117 males) and students at a polytechnic (40 females and 20 males). Males were not recruited from the university because in Singapore, young men usually attend two years of military service before entering university. The Army recruits in the cohort were just about to begin their two year stint of military service and had not yet undergone rigorous physical training. Only recruits with a t least a certain level of secondary school education were selected. At the polytechnic, where there was an obesity screening program, special efforts were made to recruit obese individuals. In California, 113 subjects aged 16–22, were initially recruited from the Bay Area of California. Recruitment sources were the University of California at Berkeley, several Chinese social clubs at high schools and the Chinese School in San Jose.

The eligibility criteria required the individuals to:

- have lived in the country of study for more than 8 years
- have no medical problems that would predispose them to obesity or growth disorders, such as congenital hip dislocations, thyroid problems, or congenital heart disease.

In the analysis of the growth data, two additional criteria were imposed: subjects had to be of Southern Chinese origin, and be at least 17-years-old. These criteria were instituted for the following reasons. Most Singaporean Chinese originated from Southern China, and growth differences are known to exist between Northern and Southern Chinese[15]. None of the Singaporean participants was younger than 17 years.

Data collection and analysis

The protocol for the conduct of this study was approved by the Committee for the Protection of Human Subjects at the University of California. In accordance with its policies, informed consent to participate was obtained from every subject.

Standard protocol for measuring height, weight and skinfolds was followed[16]. A detailed description of the protocol is given in another paper[17]. Mean and median values were computed, and statistical differences between the two cohorts were assessed using the two-tailed student's t-test. The means and medians were also compared with the reference population in the United States[18].

Dietary patterns of the participants were determined using a food frequency questionnaire developed specifically for Chinese American and Singaporean Chinese youths. Nutrient values of each of the 120 listed food items were derived from one of the following food composition tables: 1. *Handbook No. 8* (United States Department of Agriculture); 2. *Journal of Food Composition and Analysis* (Special issue: Chinese Food Composition Tables; 3(3,4)), 1990; 3. *Nutrient composition of Malaysia Foods* (ASEAN Sub-committee on protein: Food habits research and development, 1988; 4. *Guo-ming ying-yang chindao so chih. National Nutrition Guidelines* (Ministry of Health, Republic of China), 1991.

The validity of this dietary questionnaire, and the methodology for analyzing the dietary data have been described elsewhere[19]. Mean macronutrient intakes, and mean frequency of consumption of selected food groups were estimated, and compared between the two cohorts.

Physical activity patterns were assessed from a brief questionnaire that asked for estimations of time spent on vigorous, light to moderate, sitting down and sedentary activities during typical week days and weekends, in the past year. Somewhat similar questions have been applied to the Chinese American adult population in an epidemiologic study of colorectal cancer[14]. The subjects were also asked if, when compared to others of their age, they considered themselves 'very active', 'active', 'somewhat active' or 'sedentary'.

Results and discussion

Cohort differences in height, weight, and adiposity indices
The distributions of height, weight, body mass index (BMI) and triceps skinfold (TSF) of the Chinese American and Singaporean Chinese youths are shown in Figure 1(a) males and (b) females. Means and medians are presented in Table 2.

The Chinese American females are almost 3 kg heavier, on average, than the Singaporean Chinese females. However, this difference is not significant and may be due to the smallness of the Californian Cohort. There was no difference in height between the two female cohorts. Among the males, the Chinese Americans are taller by about 3 cm ($P<0.05$), and heavier by almost 8 kg, than their counterparts in Singapore ($P<0.01$).

The Chinese American females have a higher mean body mass index ($P<0.05$) than the Singaporean Chinese. However, their mean triceps skinfold is, unexpectedly, lower ($P<0.05$). The mean TSF of the Singaporean Chinese females was 21.5±7 mm, as compared to only 18.9±5 mm in the Chinese American females. The Chinese American males also have a higher mean BMI value than their counterparts in Singapore ($P< 0.05$), and a lower mean TSF value, but the difference in TSF does not achieve statistical significance (P=0.3). The median TSF of the Chinese American youths is almost the same as that of the Singaporean Chinese.

When compared with US growth reference data from the National Health and Nutrition Examination Survey[18], mean and median values of BMI of the Chinese Americans are lower, but TSF values are different only among females.

Correlations between BMI and TSF
Spearman's rank correlation coefficients between BMI and TSF are shown in Table 3. These coefficients, rather than Pearson's correlation coefficients, were used since the numbers were relatively small and the distributions of BMI and TSF were not normal. It is noted that the correlations for both males and females are lower in the Chinese American than in the Singaporean Chinese cohort. They are also lower than Pearson correlation coefficients for American youths of European origin[20].

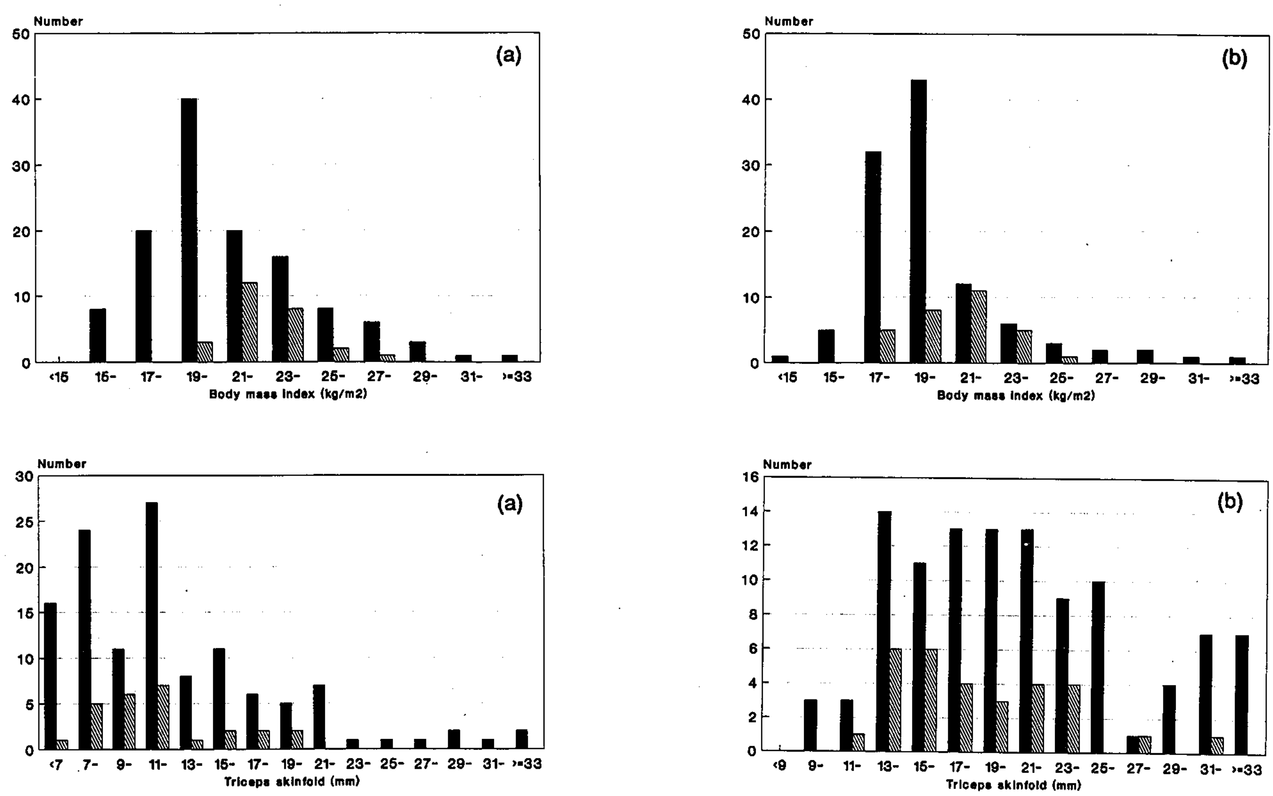

Figure 1. Distribution of body mass index and triceps skinfolds in (a) male and (b) female youths. ■ Singaporean Chinese ▨ Chinese American.

in the Singaporean Chinese, particularly among the females. These observations support the conclusion of previous researchers that environmental factors may have influenced the body composition of the two cohorts[21,22], and that these influences may interact with gender[23]. Johnston et al. in an extensive review of the use of equations for predicting estimates of body composition, concluded that such equations can, at best, be used only for genetically and 'environmentally' similar groups[21]. Recently, Hazuda and co-workers[23] found that socio- economic status (SES) and structural assimilation (entrance into the social structure of the host society) predicted body fat distribution in Mexican Americans, and that these associations were different for females and males. In particular, SES was positively associated with waist-to-hip ratio in men but inversely associated with skinfold thickness and waist-to-hip ratio in women. In

Table 2. Comparison of means and medians for height, weight, BMI and triceps skinfold of Singaporean-Chinese and Chinese-American youths.

MEASURE	FEMALES			MALES		
HEIGHT (cm)						
Group	Singaporean Chinese (n+108)	Chinese in California (n=30)	Americans (NHANESII)[a]	Singaporean Chinese (n=123)	Chines in California (n=26)	Americans (NHANES II)[a]
Mean±SD	159.4±5.3	159.7±5.4	163.5±5.6	170.6±5.6*	173.6±5.6*	176.5±6.7
Median	159.5	158.4	1163.7	170.7	173.7	176.9
WEIGHT(kg)						
Group	Singaporean Chinese	Chinese in California	Americans (NHANESII)[a]	Singaporean Chinese	Chinese in California	Americans (NHANES II)[a]
Mean±SD	51.5±9.0	54.2±6.0	60.2±11.0	62.5±11.6†	70.3±9.4†	71.7±11.6
Median	49.5	54.6	57.1	61.1	69.5	69.5
***BMI*(kg^2)**						
Group	Singaporean Chinese	Chinese in California	Americans (NHANESII)[a]	Singaporean Chinese	Chinese in California	Americans (NHANES II)[a]
Mean±SD	20.2±3.1*	21.2±2.2*	22.6±4.2	21.4±3.8*	22.6±2.8*	23.5±3.6
Median	19.5	21.3	21.6	20.8	22.5	23.0
TSF(mm)						
Group	Singaporean Chinese	Chinese in California	Americans (NHANESII)[a]	Singaporean Chinese	Chinese in California	Americans (NHANES II)[a]
Mean±SD	21.5±6.9*	18.9±4.7*	20.7±8.6	13.1±6.6	11.9±4.0	11.6±6.5
Median	20.8	17.9	19.0	11.4	11.2	10.0

[a]Najjar and Rowland (1981)[18]
**P*<0.05(two-tailed t-test); †*P*<0.01 (two-tailed t-test)

Table 3. Spearman's correlation coefficients between body mass index (BMI) and triceps skinfolds (TSF) in Singaporean Chinese and Chinese-American youths.

	Males	Females
Singaporean Chinese, 17–22 years, 1992 (n=231)	0.78 (P<0.001) (n=123)	0.64 (P<0.001) (n=108)
Chinese American, 17–22 years, 1992 (n=56)	0.65 (P<0.001) (n=26)	0.51 (P<0.001) (n=30)
American youths, aged 16–18 years	0.72	0.74

women only, structural assimilation was inversely associated with BMI and subscapular-to-triceps skinfold ratio (an index of truncal or central body fat distribution). Neither cultural or structural assimilation was related to obesity or body fat distribution in men.

Further, although both BMI and TSF have been widely used to assess obesity in the United States, their validity as indicators of obesity in ethnic Chinese populations must be questioned[17]. Garn et al. have noted that since weight is the numerator in BMI, BMI may reflect lean and fat tissue to a comparable degree. Furthermore, BMI may be influenced by relative sitting height (sitting height/stature) to the extent that shorter-legged individuals may have BMI values that are higher by as much as 5 units[20]. The latter is especially relevant in the comparison of Chinese populations living in different environments. Studies of Chinese children and youths in Hong Kong have shown a secular trend in the relative sitting height of Chinese youths suggesting that body proportions may be influenced by changes in the environment[24]. Thus, differences in the environment of the Chinese Americans and the Singaporean Chinese may contribute to differences in body composition and body proportion, and suggest a need for defining appropriate standards of obesity for these populations. In an earlier paper[17], we suggested that the development of these standards should be based not only on population-specific reference data but also on an understanding of how these standards reflect body fat distribution and their association with morbidity and mortality.

Another relevant observation is that the correlations between TSF and BMI were different between the Chinese Americans and the Singaporean Chinese, and were lower in the Chinese American cohort. This suggests that there may be less homogeneity in the 'environment' (including cultural practices relating to food) of the Chinese Americans, almost all of whose parents are first generation immigrants to the United States. Thus, it is postulated that immigrant populations require a period of time to adjust their lifestyles and the rates of acculturation are subject to individual variation.

Acculturation involves continuous and intense contract between two previously autonomous cultures, and often leads to changes in one or both systems [25,26]. One obvious change during the acculturation process that may impact on growth relates to dietary patterns.

Dietary patterns

Macronutrient intakes. The distribution of the intakes of calories, fat, protein and carbohydrate of both cohorts are shown in Figures 2–5. Mean and median intakes of their macronutrients are given in Table 4. The mean caloric and fat intakes of the Singaporean cohort (2500 kcal and 73 grams, respectively) are lower but not inconsistent with the availability of calories and fat per person for the nation (Food availability is the total quantity of a food produced, imported, and in stock minus the amount exported, put to industrial, or other non-food consumption use, fed to livestock or used for seed, and lost during storage or transportation). Based on FAO statistics, energy availability amounted to 2882 kcal and fat availability to 80.9 grams in 1986–88 in Singapore[7].

Mean and median estimates of energy, protein, fat and carbohydrate intakes are all higher in the Singapore cohort than in the California cohort. While it may seem that the higher macronutrient intakes in the Singapore youths is biologically congruent with the higher adiposity level in this population, as indicated by higher triceps skinfold, there are at least two methodological reasons why this observation cannot be supported.

First, the validation study suggests that the dietary questionnaire may estimate nutrient intakes somewhat differently for the two cohorts. This may be partly due to the higher frequency of consumption of Chinese mixed (stir-fried) dishes among the Singaporean Chinese which makes it difficult to assess the proportion of meat/fish in the 'midst' of vegetables. For example, a person who consumes small amounts of chicken and pork in two separate mixed dishes at one meal is probably more likely to over-estimate the consumption of meat than an individual who is served a 3 oz piece of steak. Certainly, the protein intakes of the Singapore cohort are very high, based on current recommended allowance for protein for the US population[27], and also on protein availability figures for Singapore. In 1981–83, FAO estimated that 74.5 grams of protein were available per person. The mean protein estimate for the Singaporean cohort studies was 114 grams. Another reason for the high macronutrient estimates among the Singaporean Chinese may be the use of a plate size (10") that was larger than that commonly used by food stall holders (7–8"), for photographing portion sizes shown in the diet questionnaire. Although subjects were shown an actual sized picture of the plate pictured in the questionnaire, they may have difficulty in assessing the actual portions of food consumed. Second, the validation study of the dietary questionnaire shows that only mean estimates of fat agree with corresponding values from food records.

On the other hand, the findings that Chinese American females consumed a lower mean caloric intake than Singaporean Chinese may also reflect a greater consciousness of dieting and the value of thinness in American society[28–30]. The generally higher socio-economic level of the Chinese American cohort may also partly explain their lower caloric intakes. Although it is commonly assumed that the more wealthy eat more, this is true perhaps only in developing societies where food scarcity is a problem. In developed countries, an inverse relationship between caloric intake and socio-economic status has been observed[31,32].

Frequency of consumption of selected food items. The dietary questionnaire elicited information relating to both the frequency of consumption of 120 individual foods and the usual portions consumed. Since there are apparent problems with the estimation of portion size particularly in the Singapore cohort, a comparison of only the frequencies of consumption of individual food items as well as food groups was made. The food groups were arbitrarily selected to provide a system of classification that reflects broad groups within which individuals tend to substitute food items. These groups were grains (including breads, rice and noodles), fish and shellfish,

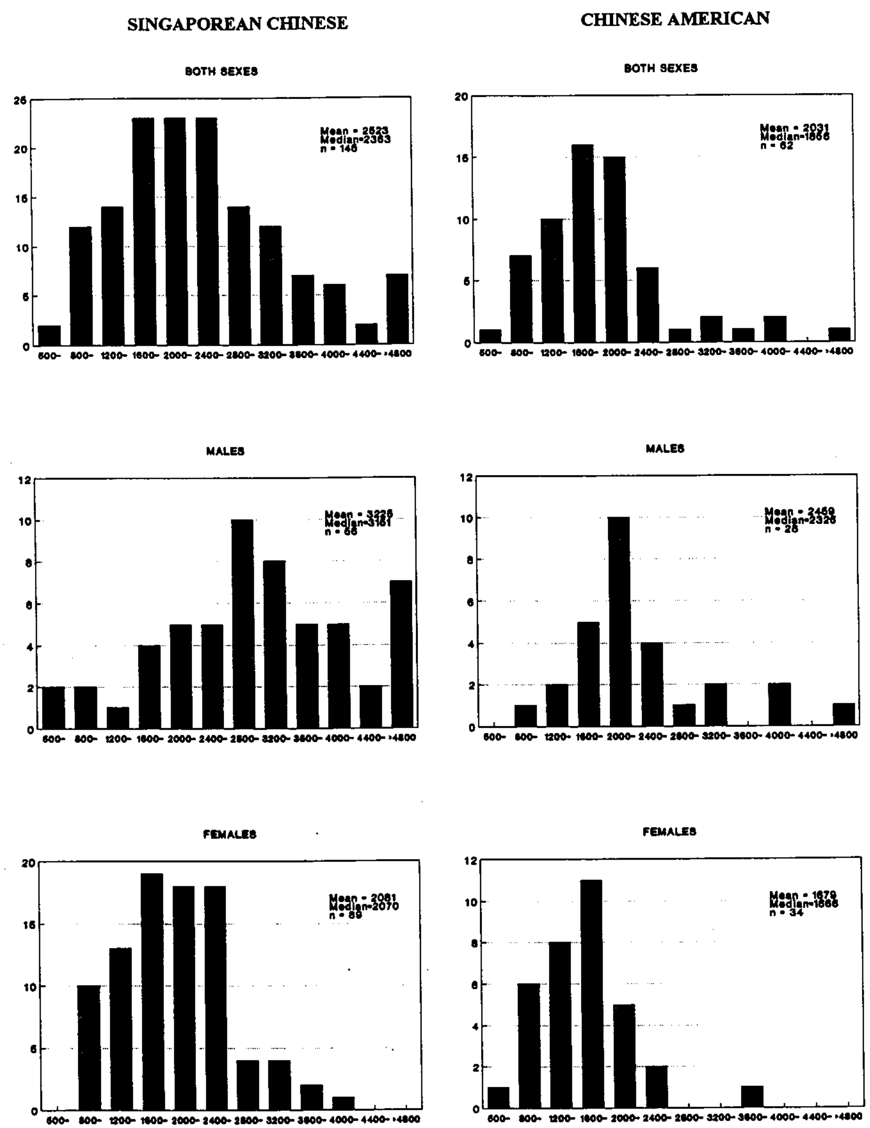

Figure 2. Distribution of energy intake (k/cal).

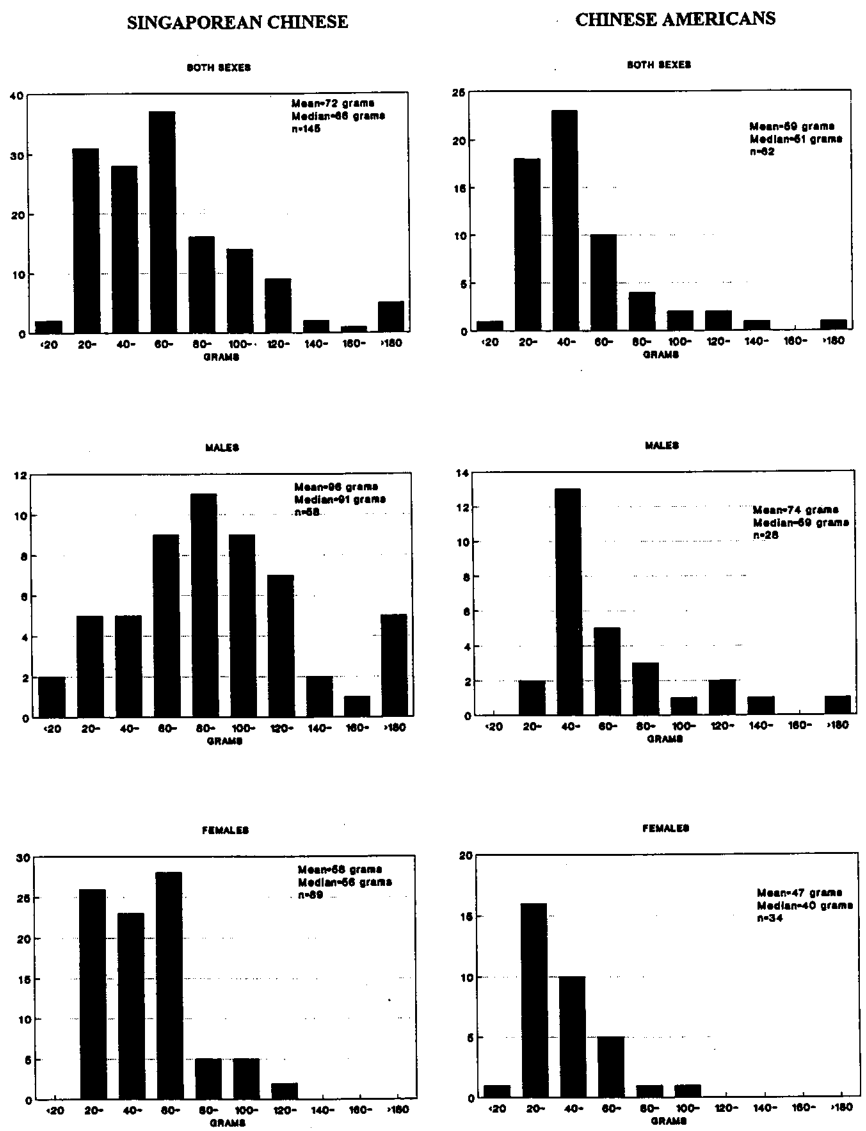

Figure 3. Distribution of fat intake.

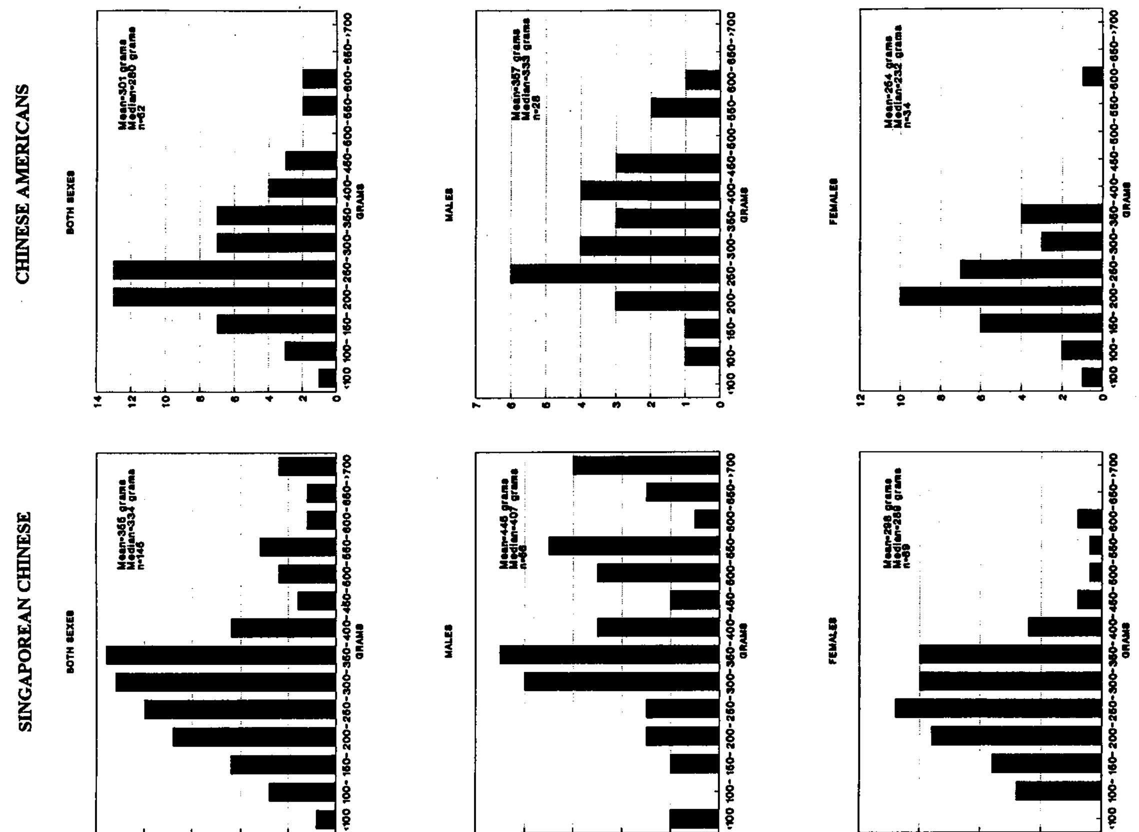

Figure 5. Distribution of carbohydrate intake.

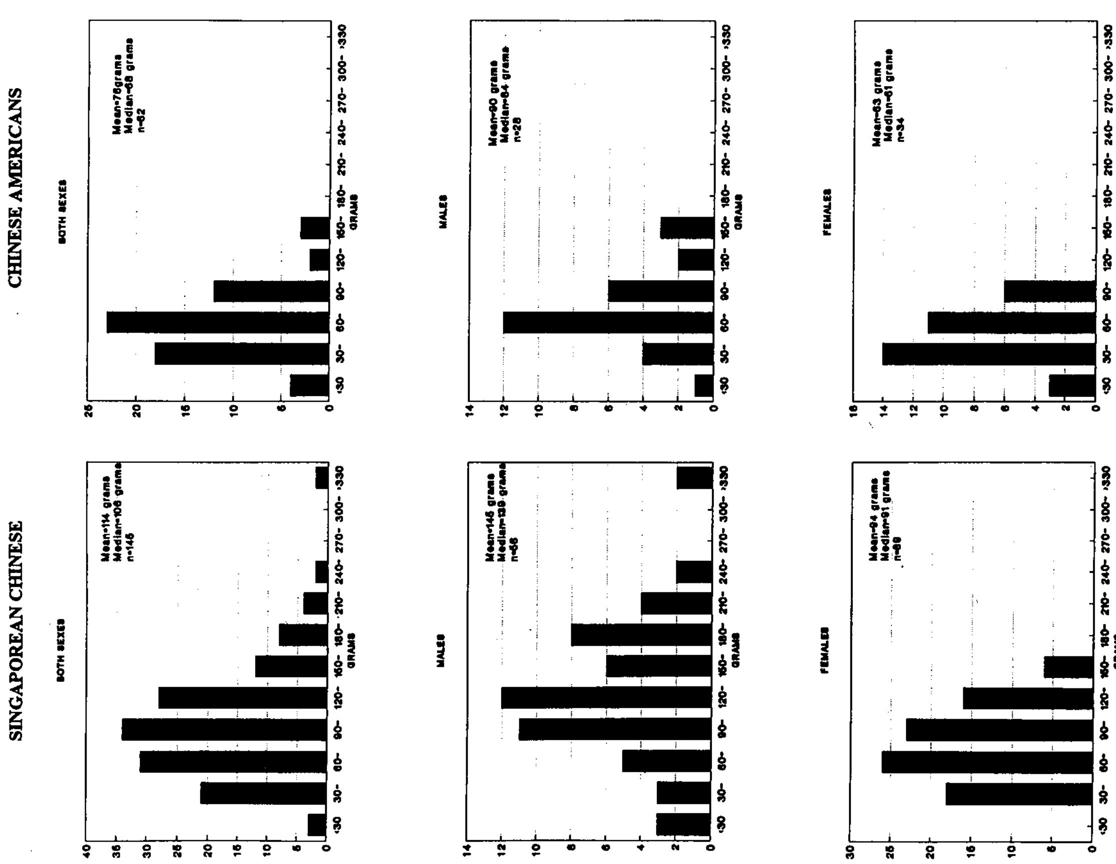

Figure 4. Distribution of protein intake.

Table 4. Means and medians of macronutrient estimates.

				FEMALES			Males		
Nutrient	Singapore (n= 145)	California (n=72)	Sig	Singapore (n=89)	California (n=34)	Sig	Singapore (n=56)	California (n=28)	Sig
Energy(kcal)									
Mean	2523±1128	2031±840	§	2081±698	1679±574	§	3225±1317	2459±920	§
Median	2363	1856	-	2070	1666	-	3251	2326	-
Fat(g)									
Mean	72.5±39.5	59.2±33.8	†	57.9±25.0	46.6±19.7	§	95.6±46.9	74.5±40.9	‡
Median	66.3	50.6	-	55.9	39. 8	-	91.5	59.0	-
Protein(g)									
Mean	113.5±60.4	75.6±32.4	§	93.9± 35.9	63.8±23.6	§	144.7±76.7	90.3±35.7	§
Median	105.5	68.1	-	90.5	60.7	-	138.6	84.1	
CHO(g)									
Mean	354.8±155.4	300.7±122.0	§	298.2±106.4	254.1±98.6	NS	444.7±178.2	357.4±125.1	‡
Mean	334.2	280.5	-	288.6	232.2	-	406.9	333.0	-
%fat									
Mean	25.2±5.2	25.8±6.3	NS	24.7±5.2	25.1±6.1	NS	26.1±5.3	26.8±6.5	NS
Median	25.7	25.2	-	24.7	25.1	-	26.1	25.6	-
%protein									
Mean	18.0±4.3	15.0±3.2	§	18.2±4.0	15.2±3.4	§	17.7±4.8	14.8±3.1	§
Median	17.1	14.9	-	17.4	15.1	-	16.9	14.5	-

*P-value computed using the t-test † $P<0.05$; ‡$P<0.01$; § $P<0.001$.

meats (including poultry), processed meats, dairy products, vegetables, fruit and snacks (including deserts). Sixteen food items which could not be classified into any of these groups were analyzed individually.

Singaporean Chinese youths tended to consume more fish and shellfish products, and grains, and less processed meats, dairy products, and snacks. There were no significant differences in the consumption of meat (including poultry), fruits, and vegetables (see Figure 6). A comparison of individual food items showed significant differences in the mean frequencies of consumption of 68 of the 120 food items. Table 5 (a) provides a list of the items for which the mean frequencies of consumption differed by at least 3 times between the two cohorts, in descending order of magnitude of difference. In contrast, Table 5 (b) provides a list of food items for which the difference in mean frequency of consumption is no more than 1.5-fold.

Items that are traditionally 'Chinese' foods such as fish-ball, soya milk, rice porridge, and dried salted fish, tended to be consumed more frequently by the Singapore cohorts. 'Western' foods such as cheese and milk were consumed more frequently by the California cohort. Also, beef which is more popular in European cultures than Asian cultures was consumed about four times more frequently by the Chinese American youths than by their Singaporean counterparts.

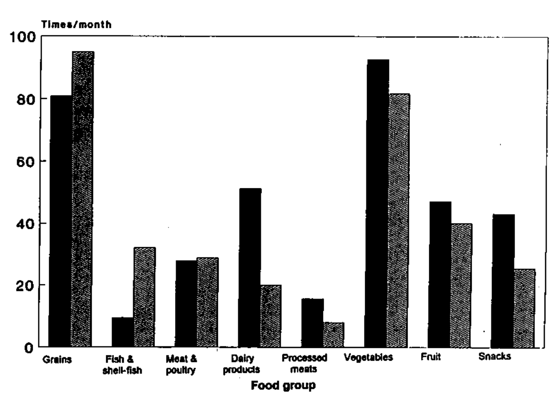

Figure 6. Mean frequency of consumption of selected food groups.

Certain food items that were more 'neutral' in terms of their cultural identity, such as soda, cookies and bread were consumed with the same mean frequencies in both cohorts. The mean frequencies of consumption of several food items were surprisingly similar between the two cohorts. These included tofu, mangoes, Chinese teas and French fries. The similarity in the frequency of consumption of tofu may be due to the promotion of tofu as a 'health, low fat food' in California, and its ready availability in the grocery stores of urban California. While most tropical fruits were consumed much more frequently by the Singaporean Chinese, mangoes were consumed with equal frequency in both cohorts. However, unlike most of the other tropical fruits, mangoes are often available in both regular grocery stores, and in the Chinese markets of the Bay Area. Although Chinese teas often accompany traditional Chinese meals, the frequency of its consumption in both cohorts was rather low (about four times a month). In Singapore, the consumption of Black or 'English' teas is popular, and this may explain the low consumption of Chinese teas. Among the Chinese American youths, it is h highly likely that plain water, sodas or juices are more popular than Chinese teas during meal times. The low mean frequency of consumption of French fries in the Chinese American cohort is surprising. It is possible that the highly educated subjects in our cohort have a dietary pattern that is quite different from other youths. However, there is little doubt that the process of acculturation has played a major role in dietary changes among Chinese Americans.

Dietary changes and acculturation. Among immigrants, it has been observed that the extent of dietary change is associated with the length of exposure to the new environment[33], the ability to speak the new language[10,33], and opportunities for social contact with members of the new community[10,33,34]. A few studies of the food habits of Chinese Americans and Canadians suggest that acculturation takes place even among first generation immigrants[10–13]. Analysis of the dietary patterns of the Chinese Americans in this study supports the observation that Chinese immigrants in the United States are likely to adopt at least some of the food

Table 5(a). Comparison of the mean frequency of consumption of selected food items between Chinese-American and Singaporean-Chinese youths.

Food items for which the mean frequency of consumption (per month) differs between the two cohorts, by a factor of more than three					
Food item	Cohort	Mean	SD	Sig[1]	Ratio[2]
Mangosteens	Calif[3]	0.0026	0.0140	$P<0.01$	126.2
	Spore[4]	0.3280	0.8010		
Kaya	Calif	0.0671	0.0300	$P<0.001$	66.2
	Spore	4.4441	8.5970		
Rambutans	Calif	0.0173	0.1060	$P<0.05$	36.5
	Spore	0.6312	2.4010		
Jackfruit	Calif	0.0200	0.1280	$P<0.01$	21.2
	Spore	0. 4237	1.1990		
Guava	Calif	0.0306	0.0870	$P<0.01$	20.4
	Spore	0.6241	1.5930		
Fried fish ball	Calif	0. 2729	0.4560	$P<0.001$	11.1
	Spore	3.0268	4.1830		
Papaya	Calif	0.2295	0.6400	$P<0.001$	8.8
	Spore	2.0120	3.2200		
Natural cheese	Calif	5.1439	7.9120	$P<0.001$	8.3
	Spore	0.6165	1.5060		
Condensed milk	Calif	1.4613	4.6290	$P<0.001$	8.1
	Spore	11.8610	22.1000		
Milk, low fat	Calif	28.4148	27.0190	$P<0.001$	7.8
	Spore	3.6637	8.3300		
Chinese mustard	Calif	0.8916	1.5420	$P<0.001$	6.8
	Spore	6.0909	10.9650		
Cereals	Calif	12.3097	13.8540	$P<0.001$	6.5
	Spore	1.9003	4.4940		
Fishball, plain	Calif	0.8419	1.4670	$P<0.001$	5.8
	Spore	4.8747	6.6630		
Liver, any kind	Calif	0.1974	0.4030	$P<0.01$	5.5
	Spore	1.0813	1.9690		
Rice porridge	Calif	1.5239	2.2700	$P<0.001$	5.0
	Spore	7.6920	10.5510		
Fresh fruit juice	Calif	19.8639	25.1620	$P<0.001$	4.5
	Spore	4.3718	6.0940		
Soyal milk, fresh	Calif	0.9839	3.9620	$P<0.001$	4.2
	Spore	4.1397	6.3410		
Beef, not mixed	Calif	4.5452	5.7950	$P<0.001$	4.2
	Spore	1.0821	2.1660		
Hot chocolate	Calif	1.8761	3.2590	$P<0.001$	4.2
	Spore	7.8571	10.5190		
Rice noodle, fried	Calif	1.0787	1.6200	$P<0.001$	4.2
	Spore	4.4781	5.709		
Ham, deli meat	Calif	9. 6219	10.0280	$P<0.001$	3.9
	Spore	2.4794	4.2090		
Corn	Calif	4.5077	5.060	$P<0.001$	3.9
	Spore	1.1651	2.2500		
Durians	Calif	0.1948	1.1280		3.9
	Spore	0.7494	2.2440		
Chinese doughnut	Calif	0.3981	0. 7410	$P>0.01$	3.8
	Spore	1.5298	2.9260		
Beef and veg. mixed	Calif	6.0103	6.2810	$P<0.001$	3.3
	Spore	1.8062	5.5400		
Processed cheese	Calif	5.8000	8.1690	$P<0.001$	3.3
	Spore	1.7653	3.6700		
Dried shimp	Calif	0.6052	1.1420	$P<0.05$	3.2
	Spore	1.9294	4.1800		
Apple juice	Calif	6.0742	10.4450	$P>0.001$	3.2
	Spore	1.9142	3.8690		
Dried, salted fish	Calif	0.5806	2.5650	$P<0.01$	3.1
	Spore	1.8250	3.1000		
Peaches	Calif	3.7942	6.0430	$P<0.001$	3.1
	Spore	1.2151	2.8720		
Veal, not mixed	Calif	0.1826	0.3900		3.1
	Spore	0.5693	2.5030		
Fish, any kind	Calif	3.9471	5.2290	$P<0.001$	3.1
	Spore	12.1311	13.6830		
Bananas	Calif	10.3198	13.2580	$P<0.001$	3.0
	Spore	3.3796	4.7900		

Table 5(b). Similarities in the mean frequency of consumption of selected food items of Chinese-American and Singaporean-Chinese youths.

Food items for which the mean frequency of consumption (per month) differs between the two cohorts, by a factor of no more than 1.5					
Food item	Cohort	Mean	SD	Sig[1]	Ratio[2]
Carrots	Calif[3]	6.4606	7.3290	$P<0.05$	1.5
	Spore[4]	4.3756	5.4620		
Non-carbonated drinks	Calif	14.2839	20.1880		1.4
	Spore	9.8432	16.9620		
White potatoes	Calif	4.5129	5.5430		1.4
	Spore	3.2152	6.4690		
Jams	Calif	5.3794	7.6180		1.4
	Spore	3.8342	7.7840		
Eggs	Calif	9.8465	9.7350		1.4
	Spore	13.7561	22.6530		
Watermelon	Calif	2.2152	4.5000		1.4
	Spore	3.0240	3.9090		
Nuts	Calif	2.5981	3.9270		1.3
	Spore	1.9352	2.7480		
Pineapple	Calif	0.9276	1.3680		1.3
	Spore	1.2314	2.4660		
Milk, whole	Calif	5.7677	17.5330		1.3
	Spore	7.544	12.6940		
Pease, long beans	Calif	5.2723	5.5380		1.3
	Spore	4.0845	5.1500		
Peanut butter	Calif	4.5903	6.6960		1.3
	Spore	3.6013	6.7910		
Cabbage	Calif	4.3813	3.7480		1.3
	Spore	5.5840	7.6880		
Citrus fruits	Calif	10.3226	8.7110		1.3
	Spore	8.1251	9.9340		
Ice Cream	Calif	4.3839	4.9220		1.2
	Spore	3.5301	5.0870		
Canned meats	Calif	2.7490	7.2350		1.2
	Spore	2.3201	2.9530		
Asparagus	Calif	0.9723	1.9020		1.2
	Spore	1.1365	2.9040		
White bread, roll	Calif	16.1703	21.728 0		1.2
	Spore	13.8469	11.2780		
French fries	Calif	3.5019	3.7590		1.2
	Spore	3.0242	4.0000		
Pears	Calif[3]	3.2474	4.0350		1.1
	Spore[4]	2. 8427	4.0940		
Glutinous rice	Calif	0.8755	1.5980		1.1
	Spore	0.7769	1.8430		
Chicken and veg. mixed	Calif	5.8439	5.2490		1.1
	Spore	5.2507	9.2890		
Chicken, not mixed	Calif	4.9258	3.9100		1.1
	Spore	5.3425	5.6740		
Apples	Calif	8.6747	8.2840		1.1
	Spore	8.0125	8.5890		
Other dark green veg.	Calif	6.9548	9.6390		1.1
	Spore	7.5277	9.8100		
Regular wine	Calif	0.2174	0.7290		1.1
	Spore	0.2017	0.6320		
Sausages	Calif	2.0929	2.8760		1.1
	Spore	1.9459	2.7190		
Tofu	Calif	5.2710	6.3520		1.1
	Spore	4.9159	5.5290		
Sherbert	Calif	0.5555	1.0880		1.1
	Spore	0.5909	1.3350		
Carbonated drinks	Calif	16.5316	22.3030		1.1
	Spore	15.7067	28.6760		
Bacon	Calif	1.0903	3.8890		1.0
	Spore	1.1296	2.9700		
Dumplings pork	Calif	1.9677	4.1810		1.0
	Spore	2.0368	3.1800		
Wheat noodle soup	Calif	2.6071	8.1620		1.0
	Spore	2.6575	4.0840		
Green squashes	Calif	1.5961	3.0360		1.0
	Spore	1.6043	2.6450		
Fried rice	Calif	3.2697	4.3590		1.0
	Spore	3.2704	5.9510		

[1]Statistical significance of the difference between the means of the two cohorts, using the two tailed t-test. If no P-value is given, the difference is not significant. [2]Ration = higher mean frequency/lower mean frequency. [3]n =62; [4]n= 187.

habits of their new culture. What factors may help to explain the acceptability of new foods into a diet?

The differences observed in the mean frequencies of consumption of 68 of the 120 food items listed on the dietary questionnaire suggest that the Chinese American youths consumed 'Western' or 'American' foods such as dairy products, breakfast cereals and processed meats more frequently than their Singaporean counterparts. Many of these food products are easily available in Singapore today so that availability is not the primary reason for explaining these differences in food preferences.

Fieldhouse[35] has identified five factors that may influence the acceptability of new food innovations in the market. These are *relative advantage, compatibility, complexibility, trialability and observability*. The greater the perceived relative advantage of an innovation, the more quickly it will be accepted. Compatibility is the degree to which the innovation is perceived as consistent with the existing values and needs of the society. Complexibility is the degree of ease of use. A trialable product or innovation represents less risk to the individual group. A new soy-protein meat substitute can be tried on a limited basis and represents little risk. Enriching all wheat products with calcium and thereby changing their taste is less 'trialable'. Finally, observability is the degree to which the results of an innovation are easily noted by others.

The foods that are consumed more frequently by the Chinese Americans, such as dairy products, breakfast cereals and processed meats are highly observable and are compatible with the food values of American society, which promotes the consumption of dairy products for the growth of teens. Furthermore, the convenience of use of these products is consistent with changing lifestyles accompanying changing family structures. In the Singapore cohort, despite the availability of these products, and their relative advantage, they are less compatible with the values of Singapore society. First, these 'convenience' foods compete with freshly cooked traditional foods (breakfast through supper) sold in 'hawker' centers that are conveniently located within walking distance of public housing in which more than 80% of the population resides[36]. Secondly, cheese and dairy products have never been highly acceptable in the traditional Chinese diet. Lactose intolerance is common among the Chinese[37,38], and intestinal lactase deficiency due to genetic factors has been implicated in lactose intolerance[38,39]. However, the higher mean consumption of dairy products among the Chinese American participants suggests that lactase deficiency may be acquired. Indeed, a theory of adaptation has been proposed[37,40]. Specifically, lactase deficiency could be acquired from a lack of challenge from the substrate (from diets low in lactose), resulting in a decrease in the enzyme. In a comparative study of Australian-born Asians with Asian students studying in Australia, the incidence of lactose intolerance was found to be much lower in the Australians[41]. Thus among the Chinese Americans, it is suggested that the process of acculturation has encouraged the consumption of dairy products. Conversely, without the motivational forces of acculturation, it is less likely that Singaporean Chinese will quickly adopt dairy products into their regular diet. A study of 98 Singaporeans, aged 1–42 years, showed a high prevalence of lactose intolerance due to lactase deficiency[42].

Physical activity patterns

Differences in the physical activity patterns of the two cohorts are shown in Table 6. On average, Singaporean Chinese youths spend more time in sedentary activities (sleeping, lying down), less time sitting, and more time in light or moderate activities (such as walking, shopping, climbing stairs, cleaning). On average, the Chinese Americans in our cohort spent almost two more hours than the Singaporean Chinese in sitting down activities. This may be due to the fact that there were more university students in the Chinese American cohort than among the Singaporean Chinese, particularly among the males. When this physical activity information is analyzed by gender, similar observations are made. However, among the females, the cohort differences in mean time spent on the various activities are not statistically significant.

Table 6. Physical activity patterns.

Cohort	Sedentary activity (hrs)	Sitting (hrs)	Light or moderate act ivity (hrs)	Vigorous activity (hrs)
Chinese Americans				
Both sexes (n=62)	9.4±2.1**	10.7±2.7**	3.2±1.5*	0.8±0.8
Female (n=34)	9.5±1.6	10.8±2.4	3.2±1.3	0.5±0.1
Male (n=28)	9.3±2.6**	10.4±3.1**	3.2±1.7*	1.1±0.8
Singaporean Chinese				
Both sexes (n=241)	10.7±2.9**	8.6±3.1**	3.7±1.9*	1.0± 0.9
Female (n=114)	9.9±2.7	10.0±2.8	3.3±1.5	0.7± 0.6
Male (n=127)	11.4±3.0**	7.4±2.9**	4.0±2.2*	1.2±1.1

* $P<0.05$ (difference between the Chinese Americans and Singaporean Chinese).
**$P<0.01$ (difference between the Chinese Americans and Singaporean Chinese).

The mean time spent on vigorous activities per day was only one hour in both cohorts. This was unexpected. With the greater land space and value placed on 'exercise and health' in American society, one may have predicted that the Chinese Americans were likely to engage in more vigorous exercise. The value placed on academic success in Asian societies may have pressured the Chinese American subjects to spend more time in academic pursuits than in physical exercise. School work as a deterrent to physical activity has not been investigated in Asian populations. However, it has been perceived to be a deterrent to exercise in female American adolescents[43]. A recent national survey of physical activity in Singapore, of individuals aged 18–69 years, showed that proportionately fewer Chinese were classified as 'high activity' compared to the Malays and the Indians, the other two major ethnic groups in the country[44].

There were some differences in the responses of the two cohorts to the question: '*Compared to other individuals your age, do you consider yourself:* Very active – Active – Somewhat active – Sedentary? This question was used as a surrogate measure for activity status, and agreed relatively well with the average daily number of hours spent on vigorous activity (data not show). In particular, more of the chinese American subjects considered themselves 'sedentary'. However, the differences do not achieve statistical significance by chi-square analysis. The subjects' responses are shown in Table 7.

There were significant differences in the amount of time spent watching television between the Singaporean and American youths of Chinese ethnicity, see Table 8. During young childhood (5–12 years), a greater proportion of Singaporean Chinese spent more than two hours a day watching television ($P<0.06$). Similarly, during adolescence, proportionately more Singaporean Chinese watched television

Table 7. Subjects' perceptions of activity status.

Cohort	Very active	Active active	Somewhat	Sedentary
Chinese Americans				
Both sexes (n=60)	5(8%)	15(25%)	26(43%)	14(23%)
Female (n=32)	1(3%)	5(16%)	17(53%)	9(28%)
Male (n=28)	4(14%)	10(36%)	9(32%)	5(18%)
Singaporean Chinese				
Both sexes (n=218)	13(6%)	56(26%)	122(56%)	27(12%)
Female (n=102)	6(6%)	15(15%)	65(64%)	16(15%)
Male (n=116)	7(6%)	41(35%)	57(49%)	11(9%)

Using χ^2 analysis: Both sexes $P<0.15$; Females $P<0.5$; Males $P<0.20$.

Table 8. Proportion of participants who watched television for > 2 hours/day.

Cohort	5–12 years	12–16 years	
	All week	*Weekdays*	*Weekends*
Chinese Americans	37(65%)	30(55%)	47(84%)
Singaporean Chinese	214(79%)	185(68%)	239(89%)
Significance	$P<0.06$	$P<0.02$	NS

for more than two hours a day, but only on weekdays ($P<0.05$). Again, this may be partly due to the fact that most Singaporeans live in apartments. While play-grounds are available in Singapore, the hot and humid weather may discourage parents from allowing their children to play outdoors. It is also possible that the higher socio-economic level of the Chinese American cohort may have influenced their activity patterns. SES has been shown to be associated with exercise patterns in White American adults[45].

Limitations of the study

The major limitations of this study were the convenience samples and the smallness of the cohorts. Thus, caution should be used in generalizing the results to the populations of Chinese American and Singaporean Chinese youths. Further , the recruitment of subjects in Singapore included a group of students from a polytechnic which had an obesity screening program. From there, we recruited enough obese subjects to reflect the known and prevailing prevalence of obesity among youths in Singapore. We did not have such an opportunity in California since obesity is not recognized as a problem among Chinese American youths, and we are not aware of any obesity studies or programs that target Chinese Americans. Further, it is possible that our cohort in California was highly selected on a basis which reflected higher socio-economic background, and that the distributions of height, BMI and TSF were narrower than they would have been if the sample had been randomly selected.

Another limitation of this study was the validity of the dietary and physical activity assessment methodologies used. Our dietary validation study was unable to provide conclusive evidence of the validity of the macronutrient estimates used in the analyses, due partly to the very small number of participants. It appears that the Chinese American youths were estimating usual dietary intakes somewhat differently from Singaporean Chinese. Particularly, there is some evidence of overestimation of intake among the Singaporean Chinese males. The physical activity questionnaire was not validated due partly to a lack of resources and partly to an inability to motivate subjects to wear accelorometers for any reasonable duration of time. However, there was good agreement between the responses to the question that was chosen as a surrogate measure for activity status (self-reports of activity status), and reported average daily number of hours spent on vigorous activity.

Conclusion

The rising prevalence of childhood obesity in newly industrialized nations is a challenge for public health researchers and practitioners. This study suggests that there may be differences in body fat distribution and composition, as well as in dietary and activity patterns, between ethnic Chinese youths living in California and their counterparts living in the newly industrialized nation of Singapore. Thus, there is a need to develop obesity indicators that are appropriate for the specific populations involved, and to carefully investigate the

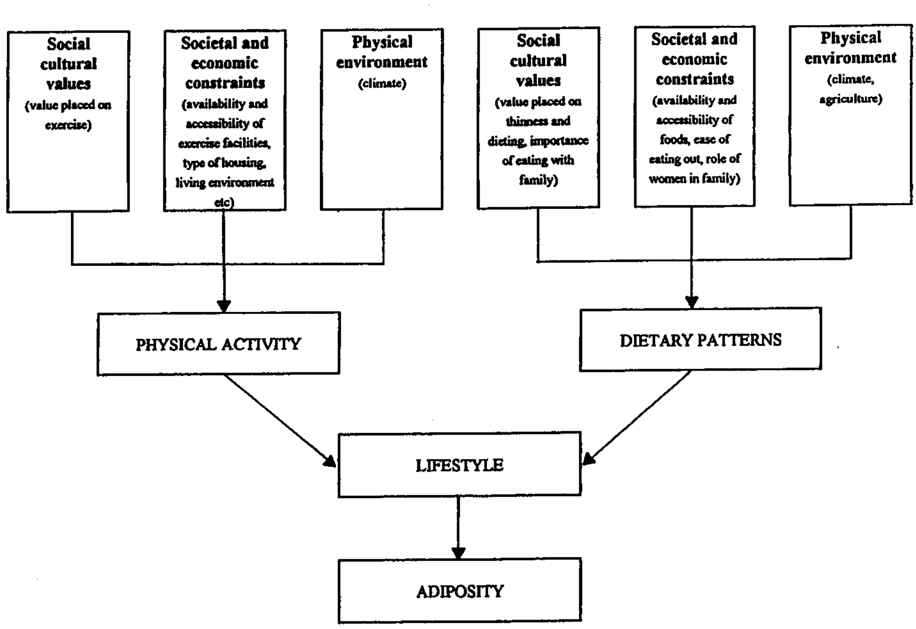

Figure 7. A model to illustrate the concept and role of the physical, social and cultural environments in adiposity.

environmental influences on childhood obesity.

Future research should focus not only on dietary and activity behavior, but should also investigate the roles of the physical, social and cultural environments[46], and their effects on lifestyle. For example, changes in the family environment that may promote undesirable dietary and activity patterns among children may be more fundamental causes of childhood obesity than dietary preferences alone. An import question to ask is: *How are dietary and activity patterns affected by environmental changes?* A model is proposed to illustrate the inter-connection between health-related human behaviors and the physical, social and cultural environments (Figure 7). In this model, public health intervention strategies must include attempts to coordinate efforts with professionals from other disciplines such as social work, anthropology, and psychology, and even with the business community which has employed marketing strategies to change consumer behavior. Disease prevention in the realm of public health has expanded its approach from a concern with sanitation and immunization to healthy living. In this light, increasing emphasis must be given to developing a more integrated approach to disease prevention and health promotion at all levels – research, intervention and policy.

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References

1 Ho TF. Childhood obesity in Singapore primary school children: Epidemiological review and anthropometric evaluation. J Singapore Pediatr Soc 1985;27(Supp 1): 6–40

2 Ho SYC. Assessment of overweight and physical activity among adolescents and youths in Hong Kong. Publ Hlth 1987;101:457–464 .

3 Kao MD, Huang HI, Tzeng MS, Lee NY, Shieh MJ. The nutritional status of Taiwan - Anthropometric measurement 1986–1988 (II) Triceps skinfold and mid-arm circumference. J Chinese Nutr Soc 1991;16: 87–99.

4 Meng Z, Li X, Xu M, Wang S. Inquiry on the appraisable standard of the fat of children and juvenile. Acta Nutrimenta Sinica 1987;9:248–254.

5 Rajan U. Status of child and adolescent fitness in Singapore. Proceedings of the seminar on healthy weight management in children and adolescents; 24 May 1992: Singapore.

6 Bouchard C. Current understanding of the etiology of obesity: genetic and nongenetic factors. Am J Clin Nutr 1991; 53: 156IS–1565S.

7 Food & Agricultural Organisation. Production Yearbook, Vol 45. FAO statistics series #104. Rome: Food & Agricultural Organisation, 1992.

8 Gourley L, Duffy SW, Lee HP, Walker AM, Day NE. A survey of household food purchases and dietary habits in relation to affluence among Singapore Chinese. Eur J Clin Nutr 1988; 42: 333–343.

9 Ministry of Health, Republic of China. National Nutrition Guide, Vol. 2, 1991.

10 Yang GI, Fox HM, Food habit changes of Chinese persons living in Lincoln, Nebraska. J Am Diet Assoc 1979; 75: 420–424

11 Newman JM, Linke R. Chinese immigrant food habits: A study of the nature and direction of change. J Roy Soc Health 1982;102:268–271.

12 Hrboticky N, Krondl M. Dietary acculturation process of Chinese adolescent immigrants. Nutr Res 1985; 5: 1185– 1197.

13 Grivetti LE, Paquette MB. Nontraditional ethnic food choices among first generation Chinese in California. J Nutr Educ 1978;10:109–112.

14 Whittemore AS, Wu-Williams AH, Lee M, Shu Z, Gallagher RP, Deng-ao J, Z. Lun, Wang X, Kun C, Jung D, Teh C, Chengde L, Yao XJ, Paffenbarger RSJ, Henderson BE. Diet, physical activity, and colorectal cancer among Chinese in North America and China. J Natl Can Inst 1990; 82:915–926.

15 Zhang X, Huang Z. The Second National Growth and Development Survey of Children in China, 1985: children 0 to 7 years. Ann Hum Biol 1988;15:289–305.

16 Lohman TC, Roche AF, Martorell R. Anthropometric standardization reference manual. Champaign, IL: Human Kinetics Books, 1988.

17 Wang MC, Ho TF, Sabry ZI. Body mass index and triceps skinfolds in Singaporean Chinese youths Ecol Food & Nutr 1993;30:63–72.

18 Najjar MF, & Rowland M. Anthropometric reference data and prevalence of overweight, United States, 1976–80. Vital and Health Statistics, Series 11, no. 238 (DHHS Publication No. (PHS) 87–1688). Washington, DC: US Govt Printing Office, 1987.

19 Wang MC. Environmental influences on growth and health status in ethnic Chinese population, Berkeley, CA: University of California, 1993 (dissertation).

20 Garn SM, Leonard WR, Hawthorne VM. Three limitations of the body mass index. Am J Clin Nutr 1986;44:996–997.

21 Johnston FE, Paolone AN, Taylor HL, Schell LM. The relationship of body fat weight, determined densitometrically, to relative weight and triceps skinfold in American youths, 12–17 years of age. Am J Phys Anthropol 1982; 57:1–6.

22 Johnston FE, Deechow PC, MacVean RB. Age changes in skinfold thickness among upper class school children of differing ethnic backgrounds residing in Guatemala. Hum Biol 1975; 47: 251–262 .

23 Hazuda HP, Mitchell BD, Haffner SM, Stern MP. Obesity in Mexican American subgroups: findings from the San Antonio Heart Study. Am J Clin Nutr 1991; 53(Suppl): 1529S–1534S.

24 Low WD, Kung LS, Leong JYC, Hsu L, Fang D, Yau ACMC, Lisowski FP. The secular trend in the growth of Southern Chinese girls in Hong Kong, Z Morph Anthrop 1981; 72:77–88.

25 Woods CM. Culture change. Dubuque, Iowa: Wm C. Brown, 1975.

26 McElroy A, Townsend PK. Medical anthropology in ecological perspective, 2nd edn. Colorado:Westview Press, 1989.

27 National Research Council, Sub-committee on the 10th edition of the RDAs. Recommended Allowances. Washington, DC: National Academy press, 1989.

28 Allon N. The stigma of overweight in everyday life. In: Obesity in Perspective. Washington, DC: US Printing Office, 1973: 83–102.

29 Bruch H. Eating disorders: Obesity, anorexia nervosa and the person within. New York: Basic 1973.

30 Levenstein H. Paradox of plenty. A social history of eating in modern America. New York: University Press, 1993.

31 Sobal J, Stunkard AJ. Socio-economic status and obesity: A review of the literature. Psychol 1989; 105:260–275.

32 Rolland-Cachera MF, Bellisle F. No correlation between adiposity and food intake: Why are working children fatter? Am J Clin Nutr 1986; 44:779–787.

33 Ho GP, Noland FL, Dodds ML. Adaptation to American dietary patterns by students from countries. J Am Diet Assoc 1966; 58:277–280.
34 Gupta SP. Changes in the food habits of Asian Indians in the United States: A case study. Sociol Soc 1975; 60:87–99.
35 Fieldhouse P. Food and nutrition: Customs and culture. Dover, New Hampshire: Croom Helm, 1986.
36 Advisory Council on family and community life. Towards better family and community life. Singapore National Printers, 1989.
37 Davis AE, Bolin TD. Lactose intolerance in Asians. Nature 1967; 216:1244–1245.
38 Chung MH, & McGil, DB. Lactase deficiency in Orientals. Gastroenterology 1968; 54:225–226.
39 Bayless TM, Christopher NC. Disaccharidase deficiency. Am J Clin Nutr 1969; 22:181–190.
40 Cuatrecasas P, Lockwood DH, Caldwell JR. Lactase deficiency in the adult. A common occurrence Lancet 1965; 1:14–18.
41 Bolin TD, Davies AE. Lactose intolerance in Australian-born Chinese. Aust Ann Med 1970;19:40–41.
42 Bolin TD, Davis AE, Seah CS, Chua KL, Yong V, Kho KM, Siak CL, Jacob E. Lactose intolerance Singapore. Gastroenterology 1979; 59:76–84.
43 Tappe MK, Duda JL, Ehrnwald PM. Perceived barriers to exercise among adolescents. J Sch 1989; 59:153–155.
44 Hughes K, Yeo PP, Lun KC, Thai AC, Wang KW, Cheah JS. Physical activity in Chinese, Malays Indians in Singapore. Ann Acad Med, Singapore 1990;19:326–329.
45 Jeffery RW, French SA, Forster JL, Spry VM. Socioeconomic status differences in health related to obesity: the Healthy Worker Project. Int J Obesity 1991; 15: 689–696.
46 Coreil J, Levin J S, Jaco EG. Lifestyle - an emergent concept in the sociomedical sciences. Culture Psychiatry 1985; 9: 423–437.

Adiposity, dietary and physical activity patterns in ethnic Chinese youths: a cross-country comparison of Singaporean Chinese and Chinese-Americans

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華人青少年的肥胖症、膳食和體育活動模式：新加坡華人和美國華人的比較

摘要

過去十年中，童年肥胖症在新加坡和許多新興的工業化亞洲國家有所增加。我們比較了新加坡和美國華人青少年的平均體重指數 (BMI) 和三頭肌皮褶值 (TSF) ，同時比較了膳食和體育活動模式。美國華人較新加坡華人有較高的BMI，較低的 TSF。膳食比較提出，新加坡華人青少年時常進食魚類和穀類製品，而美國華人青少年則進食加工肉類、奶製品和快餐食品的次數較多。新加坡華人進食低脂肪、傳統的中國食物和米粥的平均次數較多，而美國華人則較多進食典型的美國食物包括乳酪等。某些食物項目如碳酸鹽飲料、家常小甜餅、和麵包的進食，兩個群體的平均次數是相同的。在體育活動方面，新加坡華人青少年較多坐著活動，較多進行輕微和中等度活動。兩個群體平均每日劇烈活動只有一小時。我們的研究提出了美國和新加坡的華人青少年有不同的體脂分佈和組成，同時有不同的膳食和活動模式，有需要建立適合特定人群的肥胖指標，並謹慎地研究環境對童年肥胖症的影響。