Original Article

Change in diet and body mass index in Taiwanese women with length of residence in Australia

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The purpose of this cross-sectional study was to examine and compare anthropometric measurements and dietary intake of Taiwanese Chinese females living in Taiwan and Australia, including any effect of length of Australian residence. Height, weight, waist and hip circumference and percent total body fat were measured and dietary intake estimated using a 7-day record. Participants were Taiwanese females without systemic disease (100 from Sydney metropolitan area, Australia, 97 from Ping-Tung County, Taiwan). Subjects in Australia had similar body mass index (weight-kg/height-m^2) and percent total body fat but higher waist and hip circumference than those in Taiwan (22.9±3.0 vs. 22.8±3.1 kg/m^2, p >0.05; 31.4±5.8 vs. 31.0±6.2 %, p >0.05; 76.2±7.5 vs. 72.1±7.3 cm, p = 0.0001; 97.3±6.2 vs. 93.3±6.2 cm, p = 0.0001, respectively), significance unaffected by age adjustment. Total energy intake was higher in Australia (2367±574 vs. 1878±575 Kcal) as was the caloric adjusted intake of carbohydrate and saturated fat, measured as grams (342.8±91.5 vs. 264.9±91.0 g; 30.7±9.1 vs. 23.0±9.1 g) or as percentage of caloric adjusted intake (57.3±1.4 vs. 55.6±2.3 %; 12.1±0.7 vs. 11.2±1.1 %), all p < 0.001, respectively. There was a trend for anthropometric measures to increase in subjects who had lived in Australia greater than 5 years, and they also have 14 times the odds of having a waist circumference greater than 80 cm compared to those living in Australia less than 5 years (95% CI, 1.84, 112.0). The increase in waist circumference and higher energy and saturated fat intake associated with length of residence in Australia for Taiwanese females suggests an increased risk of cardiovascular disease and diabetes.

Key Words: body mass index, diet, anthropometry, obesity, Chinese, Taiwanese immigrants in Australia

Introduction

Obesity is related to increased risk of cardiovascular disease (CVD) and diabetes.[1] The prevalence of obesity has increased dramatically in both industrialized and developing nations in the last 25 years.[1] The operational definitions of obesity and overweight are based on body size and are different for men and women. The World Health Organization (WHO), [1] defines overweight and obesity for women as body mass index (BMI) $\geq$ 25kg/m^2 and BMI $\geq$ 30kg/m^2, respectively. There is increasing evidence that these cut-offs are not appropriate for all ethnic groups, and in Asian populations, it is now accepted that these BMI cut-offs should be reduced.[2] Another definition of obesity is based on percent total body fat (%TBF), with a %TBF >35% considered as obese for females (irrespective of ethnicity).[3] There is a wide body of evidence indicating that regional body fat distribution, rather than the total quantity of body fat, is a better predictor of CVD morbidity and mortality,[4] with centrally located fat being a greater risk than peripherally located fat.[5] Therefore, not only BMI, but also %TBF and the pattern of fat distribution must be measured to assess the association of CVD risk with weight gain.

Twenty three percent of the current Australian population was born overseas and includes a wide range of ethnic groups and cultures.[6] In the last 30 years or so, the European sources of postwar immigration have diminished and been replaced by increasing numbers from Asian countries such as China, Hong Kong and Vietnam.[7] The Chinese population is one of the fastest growing populations in Australia.[8] Research data on Asian ethnic groups in Australia are limited and early work often classified people as simply Asian-born, rather than by country of origin. It has been found that mortality from CVD in the immigrant Asian population was significantly less than that in the Australia-born population.[9] However, mortality rates[9] and BMI[10] tended to increase with length of residence in Australia. Many immigrants adopt new (western) dietary patterns[11], and this, together with a more sedentary lifestyle, has been implicated in observed weight gain and health deterioration.[12,13,14] Australians are reducing their intake of many high fat foods such as meat and high-fat dairy products, [14] while immigrants may be increasing their consumption of these foods.

The Chinese population has considerable within-group diversity in socioeconomic level and dietary practices, based on region of origin in China, Hong Kong, Taiwan and other Asian countries.[15] It is therefore important to

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Manuscript received 29 November 2005. Initial review completed 12 December 2005. Revision accepted 3 April 2006.

compare the cardiovascular risk factors and dietary habits among Chinese immigrants with those of the population of their region of origin, but little such research has been conducted. In general there are fewer data on CVD in women than in men. Premenopausal women appear to be protected from CVD when compared to men.[16] At any given age, CVD risk for females is less than for males, but women have equal mortality from CVD, it simply occurs at a later age.[17] Lanham *et al.*,[18] found that the %TBF of Chinese Australian females was significantly higher than that of Chinese females living in China, and in a study of longitudinal changes in nutrient intakes in Chinese females in Australia, Zhang *et al.*,[19] found increasing dietary intake of energy and fat with length of residence. Thus, it seems that Australian Chinese females may be at increased risk of CVD on settling in Australia.

The purpose of this cross-sectional study was to compare the dietary intake, physical activity and anthropometric measurements of Taiwanese Chinese females living in Taiwan and Australia, and to determine if length of residence had any effect on these parameters.

Methods

A total of one hundred and ninety seven Taiwanese females (100 living in the Sydney metropolitan area, Australia, and 97 living in Taiwan), without any systemic disease and taking no medication, participated in this study. The Australian group consisted of community-dwelling volunteers aged 20 to 62 years who had migrated to Australia from Taiwan, and had lived in Australia for at least six months. Subjects were recruited by a snowball sampling technique in which subjects were invited to participate by friends and relatives of representative Asian contacts, or via relevant community groups approached by the Asian researcher. The data collection period in Sydney was during September and November, which is spring in Australia, while the scheduled period for Taiwanese data collection was about January till February, which is winter in Taiwan. In order to minimise any potential impact of climate difference on the results, Ping-Tung County (southernmost part of Taiwan) was chosen, as the temperature there in winter (about 20°C) is similar to the temperature in spring in Sydney. Yanpu Shiang was randomly selected (by drawing from a box with the 25 names) from the 25 country villages in Ping-Tung County (after excluding villages with aboriginal populations). The Taiwanese group consisted of Taiwanese females aged 20 to 60 years who were selected using a random number table from a list of the women living in Yanpu Shiang, Ping-Tung County provided by the Household Registration Office, Ping-Tung County. This study was approved by the Human Ethics Committee of the University of Sydney and subjects gave informed consent in their native language.

The height of the subjects was measured to the nearest centimeter (cm) on a stand-alone stadiometer in Taiwan. In Australia, the height was self-reported and verified by tape measure in a random sample. Agreement was 100%. Body weight was measured in kilogram (kg) using a standard scale incorporated into the bioelectric impedance analyzer (BIA) and recorded to the nearest 0.5 kg. BMI was calculated as the ratio of body weight to body height squared and expressed as kg/m^2. Waist circumference (WC) and hip circumference (HC) were measured with a flexible tape measure and recorded to the nearest 0.5 cm. WC was measured at the smallest circumference between the ribs and the iliac crest. HC was measured at the largest circumference in the buttock/gluteal area. Percent total body fat (%TBF) was measured using a stand-on portable BIA (Tanita 105, Tanita Corporation, Japan).

Dietary intake was measured using a 7-day dietary record. Subjects were given information on how to complete the 7-day record within a 2 week period after an initial interview. Subjects provided detailed descriptions of types and amounts of foods and beverages consumed, meal-by-meal, for a continuous 7 days. It was stressed that it was very important to retain the usual eating habits during the registration period and to write everything in the notebook. The portion sizes were primarily in household units or by weight. The data collected from the 7-day dietary record were entered into the nutrient data base computerized package for Chinese food, Nutrition Master[20] by the Chinese speaking author (WPL). The intake of energy, fat (saturated, polyunsaturated and monounsaturated), protein and carbohydrate was calculated and crude nutrient intakes have been presented as absolute amounts and as percentages of total energy intake. To avoid the potential confounding influence of differences in total energy intake on absolute nutrient intake, crude data have also been adjusted for total caloric intake using a linear model suggested by Willett.[21]

Physical exercise was assessed by self-assessment questionnaire. The intensity of exercise was graded on an eight level scale from imperceptibly weak to very very strong. At the lowest level subjects did not perceive that they had "exercised" at all. Levels 1-4 were classified as non-vigorous exercise while levels 5-8 were classified as vigorous exercise.

Age-adjusted mean values of the anthropometric data were calculated by using a general linear model. Data were analyzed using SPSS Windows release 12.0. Demographic characteristics, anthropometric measures and dietary intakes were presented as mean ± standard deviation (SD); significance was set at $p < 0.05$. The distribution of continuous variables was examined and these data were found to be normally distributed. When the number of subjects in each group was equal, differences in variables between groups were examined by a t-test. Non-parametric tests (Mann Whitney U) were used for the groups with unequal number of subjects. Chi-squared analyses were used to compare variables expressed as a %. Simple regression analysis was used to predict the values of %TBF based on BMI. Pearson's correlation tested the correlation between variables, and odds ratios were also calculated.

Results

Table 1 presents demographic characteristics and anthropometric measures. Taiwanese females were found to have lower mean age and duration of education, but higher rates of employment compared with Australian Taiwanese females. There were no differences in the mean values of BMI, %TBF or WHR between groups. However, subjects living in Australia had significantly

Table 1. Demographic characteristics and anthropometric measures of all Chinese females and stratified by country of residence: mean ± SD

	All (n=197)	Taiwan (n=97)	Australia (n=100)
Age	40±9.1	36±9.4	43±7.6 ***
Range	22-62	26-62	22-60
Years of education	11±2.9	9±2.7	12±2.2 ***
% Employed	35	50	18 ***
Height (cm)	157.9±5.0	157.0±5.2	158.7±4.7 *
Weight (kg)	57.1±8.1	56.5±8.4	57.8±7.7
Waist (cm)	74.2±7.7	72.1±7.3	76.2±7.5 ***
Waist (cm) (Age adjusted)		72.9±7.4	75.4±7.4 *
% > 80cm	20	13	26 *
Hip (cm)	95.3±6.5	93.3±6.2	97.3±6.2 ***
Hip (cm) (Age adjusted)		93.7±6.4	96.9±6.4 **
WHR	0.78	0.77	0.78
BMI (kg/m^2)	22.9±3.0	22.8±3.1	22.9±3.0
% ≧23 (kg/m^2)	44	45	43
% ≧25 (kg/m^2)	23	26	21
% ≧30 (kg/m^2)	3	0	6 *
TBF (%)	31.2±6.0	31.0±6.2	31.4±5.8
% <35%	78	75	81
BMI <23 (kg/m^2), %(n)	73 (109)	77 (52)	70 (57)
BMI <25 (kg/m^2), %(n)	93 (139)	96 (55)	91 (74)
% >35%	22	25	19
BMI≧23 (kg/m^2), %(n)	98 (47)	97 (28)	100 (19)
BMI≧25 (kg/m^2), %(n)	75 (36)	76 (22)	74 (14)

*, ** and *** significantly different between Taiwan and Australia at the 0.05, 0.01 and 0.001 level respectively

higher WC (p<0.001) and HC (p<0.001) than the subjects living in Taiwan; this was the case both for crude values and after adjustment for age.

Using the WHO general definition of overweight and obesity, 21% of Australian Taiwanese and 26% of Taiwanese females were overweight (BMI ≥ 25kg/m^2), while 6% of Australian Taiwanese and none of the Taiwanese were obese (BMI ≥ 30kg/m^2). However, using the WHO[2] definition for the Asia Pacific region, 43% of Australian Taiwanese and 45% of Taiwanese females were overweight (BMI ≥ 23kg/m^2), while 21% of Australian Taiwanese and 26% of the Taiwanese were obese (BMI ≥ 25kg/m^2). According to the WHO definition of obesity based on %TBF (TBF > 35%), 19% of Australian females and 25% of Taiwanese females were obese. Simple regression analysis of %TBF versus BMI shows significant association (r=0.94, p<0.0001 for Taiwan, r=0.90, p<0.0001 for Australia). This regression predicts that Taiwanese females have %TBF of 35% and 45% for a BMI of 25 and 30, while Australian Taiwanese females have predicted %TBF values of 35% and 44%, respectively. Using the WHO recommended cut-offs for central obesity (WC > 80cm), 26% of Australian females were considered to be centrally obese compared with only 13% of Taiwanese females.

Thus, although there is no significant difference in weight, BMI or %TBF between groups, a higher % of Taiwanese females would be classified as overweight and obese, based on BMI of 23 kg/m^2 and 25 kg/m^2 respectively. On the other hand, the Australian group had a significantly higher prevalence of excess central body fat, as estimated by waist >80cm.

In order to investigate whether or not length of residence in Australia influenced any of these parameters, the Australian Taiwanese females were divided into 2 groups, those living in Australia less than, or greater than, 5 years (Table 2); the numbers in each group were 28 and 72 respectively. Subjects living in Australia greater than 5 years had significantly higher weight, WC, HC, BMI and %TBF compared with subjects living in Australia less than 5 years; after adjustment for age, the above differences remained (data not shown). None of the subjects living in Australia less than 5 years had BMI or %TBF values above the recommended cut-off for obesity for the Asia Pacific region. In fact, subjects living in Australia greater than 5 years have 3 times (95% CI 1.14, 7.93) the odds of being overweight (BMI ≥23 kg/m^2) and 14 times (95% CI 1.84, 112.0) the odds of having central obesity (WC >80 cm), compared to the subjects living in Australia less than 5 years. An examination of the WC of those who had lived in Australia for an even shorter time (less than 2 years) indicates that the increase in waist may be an early consequence of Australian living. Subjects in Taiwan were found to have the lowest values of WC, those who had lived in Australia greater than 2 years had the highest values, while those who had been in Australia less than 2 years had an intermediate value, but the small number of subjects in this category means that the CI are wide (Fig 1-1).

The intakes of total energy (Kcal) and all components (grams) were significantly higher in Australia compared to Taiwan (Table 3). The % of total energy consumed as fat was significantly lower in Taiwan (28.5%) than in Australia (30.2 %); values for carbohydrate and protein were not different. However, when these values are adjusted for the difference in total caloric intake, the situa-

Table 2. Demographic characteristics and anthropometric measures of Chinese females living in Australia less than or greater than 5 years: mean ± SD

	In Australia < 5 years (N= 28)	In Australia > 5 years (N=72)
Age	40±6.3	44±7.9 *
Range	25-52	22-60
Years of Education	13±2.0	12±2.6
% Employment	7	22
Height (cm)	159.0±4.2	158.6±4.9
Weight (kg)	54.3±4.8	59.2±8.3 **
Waist (cm)	72.3±4.7	77.3±7.8 **
% > 80cm	4	35 **
Hip (cm)	94.5±4.9	98.4±6.3 **
WHR	0.77	0.79
% >0.80	21	36
% >0.85	4	13
BMI (kg/m^2)	21.4±1.6	23.4±3.1 **
%≧23 (kg/m^2)	25	50 *
%≧25 (kg/m^2)	0	29 **
%≧30 (kg/m^2)	0	8
%TBF	28.0±2.5	32.3±6.0 ***
%>35%	0	26 **

*, **, *** significantly different between groups at the 0.05, 0.01, 0.001 level, respectively. values were tested by nonparametric tests

tion is altered and the % of total energy consumed as fat or protein is significantly higher in Taiwan (29.7%, 14.8%) than in Australia (29.2%, 13.5%), respectively; with values for carbohydrate being significantly less. These values for fat intake in both Taiwan and Australia are close to the recommended upper limit for dietary fat (<30% of total energy).[22] The Australian Taiwanese had a significantly higher intake of saturated fat, both crude (12.2% vs. 11.2 %) and after total caloric adjustment (12.1% vs. 11.2%). The intake of saturated fat of both groups is higher than the recommended contribution of saturated fat to total energy (< 10%), with each group having a correspondingly lower intake of polyunsaturated fat than recommended.[23] The crude values for % intakes of poly- and mono- unsaturated fat were not significantly different between countries, but after caloric adjustment, Australian Taiwanese had significantly lower percentages of both (monounsaturated fat, 10.2% vs. 11.1%; polyunsaturated fat 6.9% vs. 7.3%). Adjustment for age did not alter the significant differences for any of the above crude or caloric adjusted values (data not shown). In an analysis of all 197 subjects together, WC was found to be significantly correlated with saturated fat intake, both crude and caloric adjusted (Pearson correlation coefficients 0.15, $p<$ 0.05 and 0.14, $p<$ 0.05, respectively). When data were stratified by country of residence, these relationships were no longer significant, the coefficients being 0.08 and -0.02 (crude) and 0.10 and -0.02 (caloric adjusted) in Australia and in Taiwan, respectively.

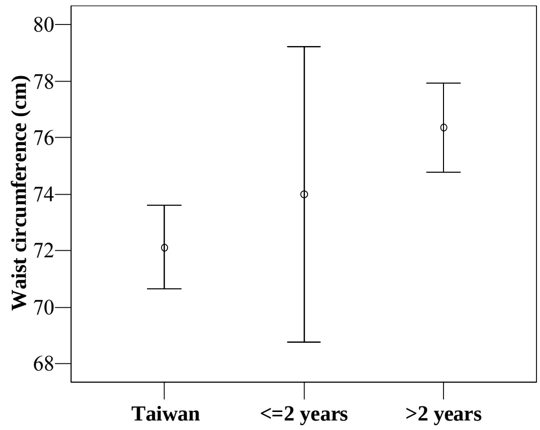


Figure 1-1. Mean waist circumference in Taiwan and Australia (Australian data categorized by length of residence in Australia): mean (95% CI)

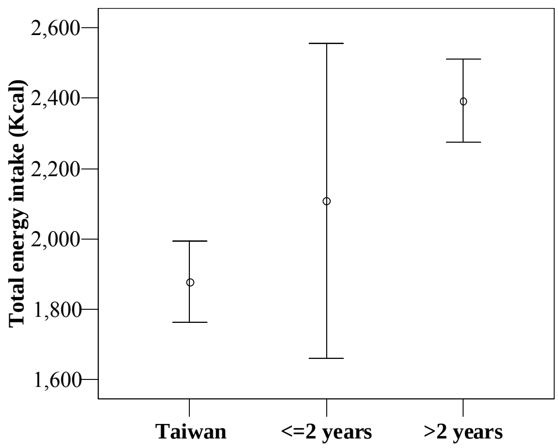


Figure 1-2. Intake of total energy in Taiwan and Australia (Australian subjects categorized by length of residence in Australia): mean (95% CI)

There was no significant difference in total energy or nutrient intakes between the subjects living in Australia less than or greater than 5 years (data not shown). Since the values for waist measurement indicated that women may be in transition during their first 2 years in Australia, dietary intakes were also examined in this way, even though only nine subjects had lived in Australia less than 2 years. Subjects living in Australia greater than 2 years had a significantly higher intake of total energy compared to those in Taiwan (Fig 1-2). Crude data for nutrient intakes expressed as % of total energy intake demonstrated a significant increase for saturated fat only (p<0.001). However, after adjustment for caloric intake, the % of total energy intake consumed as saturated fat (Fig 2-1) or carbohydrate (Fig 2-2) were significantly increased in subjects living in Australia greater than 2 years compared with those in Taiwan, while corresponding values for protein (Fig 2-3), total fat (Fig 2-4), monounsaturated fat (Fig2-5) and polyunsaturated fat (Fig 2-6) were significantly decreased (all $p<$ 0.001). Adjustment for age

Table 3. Daily dietary intake of Chinese females living in Australia and Taiwan: mean ± SD

	Taiwan (N=97)	Australia (N=100)
Total energy (Kcal)	1878±574.7	2367±573.9 ***
Fat (g)	59.4±21.0	79.0±20.7 ***
Sat fat	23.0±11.6	30.6±11.3 ***
Poly fat	13.2±5.1	18.0±6.1 ***
Mono fat	20.3±8.0	26.1±8.0 ***
% Energy as fat	28.5±5.9	30.2±4.9 *
% Energy as sat fat	11.2±2.8	12.2±2.7 *
% Energy as poly fat	6.4±2.1	7.3±1.9
% Energy as mono fat	10.5±3.3	10.7±2.8
Total energy adjusted †		
Fat (g)	61.7±17.7	76.8±17.7 ***
Sat fat (g)	23.0±9.1	30.7±9.1 ***
Poly fat (g)	14.2±3.4	17.1±3.4 ***
Mono fat (g)	21.3±4.4	25.0±4.4 ***
% Energy as fat	29.7±0.7	29.2±0.4 ***
% Energy as sat fat	11.2±1.1	12.1±0.7 ***
% Energy as poly fat	7.3±0.5	6.9±0.3 ***
% Energy as mono fat	11.1±1.2	10.2±0.7 ***
Protein (g)	65.7±17.0	80.4±19.1***
% Energy as protein	14.4± 2.9	13.7 ± 2.5
Total energy adjusted †		
Protein (g)	67.4±13.4	78.8±13.4 ***
% Energy as protein	14.8±1.7	13.5±1.0 ***
Carbohydrate (g)	271±99.4	337±102 ***
% Energy as carbohydrate	57.1±7.7	56.1±6.1
Total energy adjusted †		
Carbohydrate (g)	265±91.0	343±91.5 ***
% Energy as carbohydrate	55.6±2.3	57.3±1.4 ***

*, *** significantly different between groups at the 0.05, 0.001 level, respectively Sat fat = saturated fat, Poly fat = polyunsaturated fat, Mono fat = monounsaturated fat † Energy-adjusted nutrient intakes were calculated using a linear regression model.

did not alter the significant differences for any of the above crude or caloric adjusted values (data not shown). When similar comparisons were made for subjects living in Australia less than 2 years (compared with those in Taiwan), none of the parameters exhibited significant differences for either crude or caloric adjusted values. Thus it appears that the dietary habits for subjects living in Australia less than 2 years are clearly in transition.

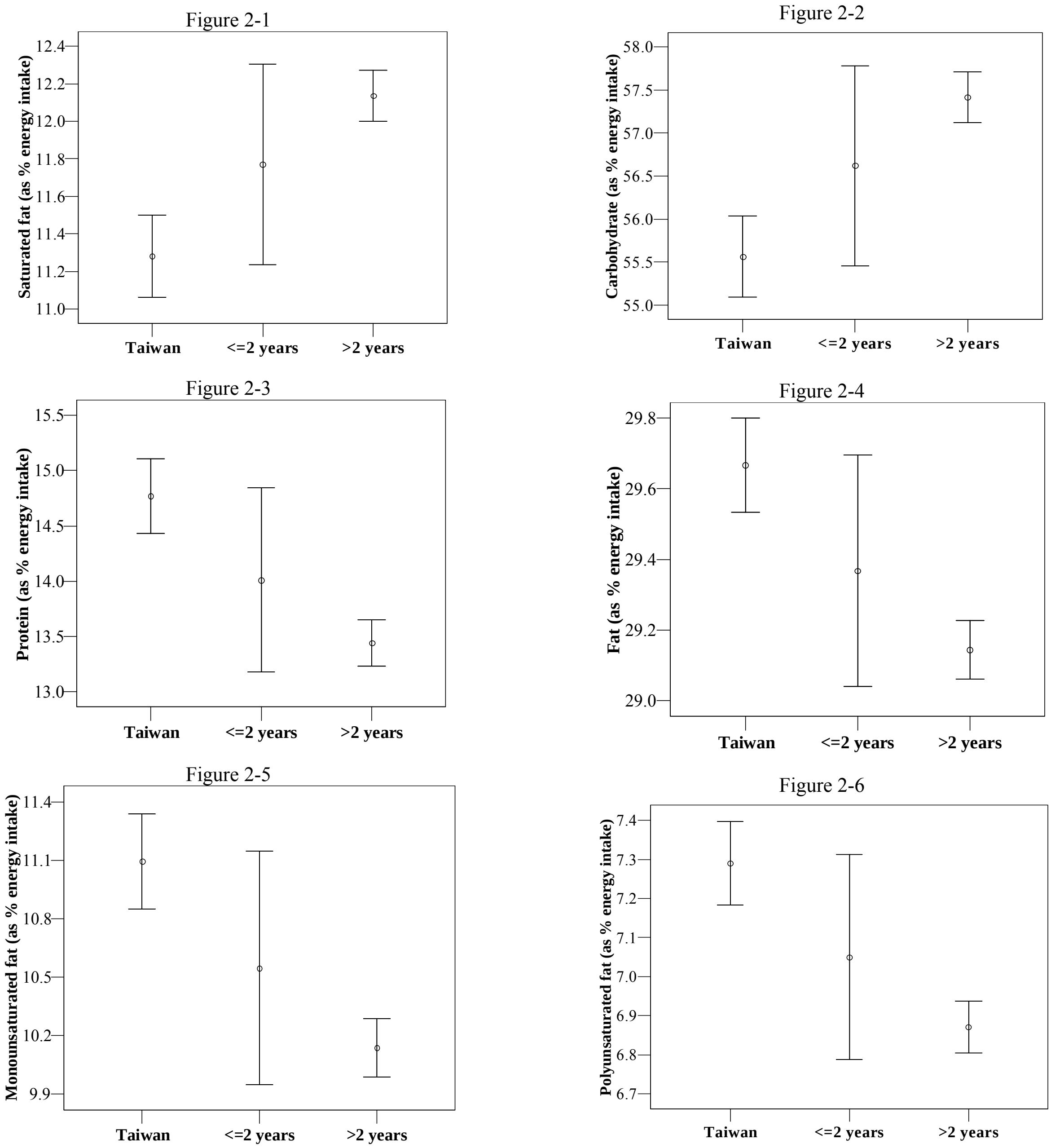
With respect to physical activity data, there was no significant difference in time of exercise per day between subjects living in Taiwan or Australia (16±26.8 minutes vs. 14±20.7 minutes, $p>0.05$). Only about half of the subjects in each group (57% in Taiwan and 46% in Australia) had undertaken exercise in the past two months. Furthermore, only 2% of those engaging in regular exercise classified it as vigorous in both groups. There was no significant difference in the percentage of those exercising by length of residence in Australia, but after 5 years no one was recorded as doing vigorous exercise.

Discussion

This cross-sectional study investigated dietary intake, anthropometric measures and physical activity levels of Taiwanese Chinese females living in Taiwan and Australia. Subjects living in Australia were found to have higher WC than those living in Taiwan, and the total energy and % energy as saturated fat were also significantly higher in Australian Taiwanese females. The use of a simple WC measurement has been shown to be the best single measure of abdominal fat at a population level[23,24] and to be an independent risk factor for CVD and diabetes.[25] Thus, although there was no significant differences in BMI and %TBF between Australian Taiwanese and Taiwanese females, the body fat distribution of the Taiwanese females in Australia tended to be more centralized and this is associated with higher energy and saturated fat intake.

Increase in weight, WC, BMI and %TBF are associated with length of residence in Australia, those with more than 5 years residence having significantly higher measures compared with those living in Australia less than 5 years. Although we did not find significantly higher intake of total energy, % energy as fat and saturated fat among those with greater than 5 years residence, subjects who had lived in Australia less than 2 years appear to have a dietary pattern intermediate between those living in Taiwan and those who had been in Australia greater than 2 years.

Several physiological changes may influence patterns of body fat distribution, such as effects of aging, [26] decreasing resting metabolic rate and menopausal transition.[27,28] Among these factors, menopausal transition seems to be the major issue.[27,29] Many studies have shown that hormonal replacement therapy for postmenopausal women can prevent the increment of total



Figures 2-1 to 2-6. Intakes (expressed as a % of caloric intake) of saturated fat, carbohydrate, protein, total fat, monounsaturated fat and polyunsaturated fat, respectively, adjusted for total caloric intake (Australian subjects categorized by length of residence in Australia): mean (95% CI)

body fat and abdominal fat.[30,31] Although the mean age of Australian Taiwanese females was higher than that of Taiwanese females, only 2.5 % of studied subjects were postmenopausal. After adjustment for age, Taiwanese females in Australia still have significantly higher WC and HC than those in Taiwan. Therefore, the higher mean WC and HC among the Australian Taiwanese females appear not to be an effect of aging. Thus, Australian Taiwanese appear to have a greater tendency to develop central fat than those in Taiwan at a relatively low BMI. This tendency has been noted in other Asian women.[32,33] There is a large body of evidence that excess intra-abdominal fat is linked with a greater risk of obesity-related morbidity than is overall adiposity.[34] Therefore, Australian Taiwanese females may have an increased risk of CVD, since their body fat is more centralized.

The mean values of %TBF, BMI and WC for all 197 subjects were within healthy ranges according to WHO cut-offs for both Caucasian and Asia Pacific populations. The mean BMI of 22.9kg/m^2 is significantly lower than that of Australia and New Zealand (26.5kg/m^2), but similar to that of Asian populations (23.0kg/m^2).[35] The prevalence of overweight and obesity was 23% and 2%, respectively, based on cut-offs for Caucasians.[1] Recent data from Western countries shows considerable difference in the prevalence of obesity (BMI $\geqq$ 30 kg/m^2) among Caucasian populations.[36] For example, in France the prevalence was 9% for males and 8% for females, in the USA it was 20% for males and 25% for females, and in Australia, 19% for males and 22% for females. Thus, the Taiwanese population studied has a much lower prevalence of obesity than that of some Western populations, but according to cut-offs for the Asian Pacific Region, the prevalence of obesity (23%) is slightly higher than that of females in Taiwan (21%),[37] and lower than in China (31%).[38]

Taiwanese women who have migrated to Australia are now living in what is still a predominantly Caucasian population and would not be considered in a high risk category according to current Caucasian standards of BMI. However, the relationship between BMI and %TBF varies across ethnic groups.[39] For example, Deurenberg *et al.,*[40] found that Singaporeans have a high %TBF at a relatively low BMI. Wang *et al.,*[41] indicated that American Chinese have a lower BMI but a higher %TBF than Caucasians for the same age and sex. Studies on Chinese populations from different regions such as Hong Kong,[42] and Singapore[43] suggest that Chinese populations have a higher %TBF for a given BMI. The International Association for the International Obesity Task Force[2] recommended that %TBF greater than 35% be considered as obese. Our results confirm existing data on the relationship between BMI and %TBF in Asian populations, and predict about 35% TBF at BMI 25 (the obesity cut off for the Asia Pacific Region). Using standards for the Asia Pacific Region, the mean BMI is approaching for overweight (BMI $\geqq$ 23 kg/m^2).

The subjects living in Australia less than 5 years have a BMI that is 2 units lower, and %TBF that is 13% lower than the corresponding values for those living in Australia greater than 5 years. There is evidence of an increase in T2DM and increased CVD risk in parts of Asia where the average BMI is actually below the WHO recommended cut-off point for overweight of 25.[44,45] The association of BMI and comorbidities seems to vary within populations according to environmental and dietary changes.[46] In our study, it is apparent that length of residence in Australia is associated with not only increased BMI and %TBF, but also with a more centralized distribution of body fat with consequent implications for cardiovascular risk.

The role of diet in obesity is well documented. A diet that is high in energy, total fat, saturated fat and carbohydrate is associated with increased %TBF and BMI.[47, 48] A diet high in saturated fats has shown the most consistent significant adverse association with coronary events, whilst a diet high in mono-unsaturated fats and polyunsaturated fat is associated with a favorable blood lipid profile.[49] Immigrants tend to increase their BMI as they assimilate into new environments and dietary habits change.[50,51] Cairney and Ostbye[52] indicated that length of residence in a western country has a significant impact on BMI among Asian immigrants. They further indicated that this situation may be caused by the increase in overall energy intake and an increase in proportion of energy from fat. A similar finding was observed in our study where total energy and % energy intake as saturated fat intake and carbohydrate were higher, and polyunsaturated and monounsaturated fat intake were lower in Australian Taiwanese females compared to Taiwanese females. From our data there is also some evidence that subjects may be in transition: subjects who lived in Australia less than 2 years have values of total energy intake, saturated fat intake and WC intermediate between those for subjects living in Taiwan, or living in Australia greater than 2 years. Those parameters were significantly increased in those with greater length of residence in Australia, up to 5 years, and afterwards were much the same. Our results show that there is a significant positive relationship between WC and saturated fat intake**.** Higher intake of total energy and saturated fat in Australian Taiwanese females in the absence of any differences in physical activity levels could partially explain the increase in hip and waist circumference.

Physical activity is known to have a positive impact on BMI and %TBF and to improve the health of individuals.[53] Bennett[10] found that Chinese immigrants to Australia were relatively inactive compared to other ethnic groups. In our study only about 50% of subjects participated in any regular exercise, whether they were living in Australia or Taiwan. The mean time for exercise each day is only 14 minutes for subjects living in Australia and 16 minutes for subjects living in Taiwan. The current physical activity guidelines for prevention of the transition to overweight or obesity require undertaking 45-60 minutes of moderate physical activity each day.[54] Our study suggests lower levels of activity among the whole population studied, with no significant difference between the two subgroups. Thus lower physical activity does not appear to offer an explanation for increased waist and hip circumference values seen in the subjects living in Australia.

Body weight is influenced by socio-economic factors. Studies have found that socioeconomic status (lower levels of education and higher unemployment) have an association with increased body weight and risk of overweight and obesity.[55,56] An association between level of education and body fat is not apparent in this population. Although Taiwanese females had significantly lower levels of education they had a more favorable WC than those who had migrated to Australia. However, there was a higher employment rate in Taiwan, compared to Australia, but the type of employment is unknown. Current Australian immigration policy favors skilled migrants and applicants need to pass a physical examination. Thus immigrants are likely to be healthier than the average population in Taiwan. On the other hand, many have migrated as part of a whole family, and may be unemployed, at least in the early years of settlement. This may explain why Australian Taiwanese females have higher current unemployment levels but have slightly lower prevalence of obesity based on %TBF.

The study population in Australia is a convenience sample and the results are thus not generalisable. Australian immigration policy favors certain categories of people (see above) and there are no refugees from Taiwan. Thus, it is likely that the life style and standard of living of the studied population does not differ greatly from the general population of Taiwanese immigrants in Sydney. The time of data collection was spring in Australia and winter in Taiwan. In order to minimise any potential impact of climate difference on the results, Ping-Tung County (southernmost part of Taiwan) was chosen as the temperature in winter is similar to the temperature in spring in Sydney. The population in this study may not be representative of Taiwanese women living in Taiwan. However there are no ethnic differences between this population and the Taiwanese population as a whole, and the selection of participants was random in this group. It must be acknowledged that the Taiwanese women studied could not represent the diversity of locality, access to facilities, education, occupation and more that can be found in a relatively small Taiwanese rural community as opposed to a large metropolitan city like Sydney in Australia.

All traditional dietary intake methods, including dietary records (3 to 7 days) as used in the present study, 24-hour recall and food frequency questionnaires, rely on information reported by the subjects themselves. Seven-day dietary records are more demanding on the subjects who must report over a longer duration. This may raise the issue of whether or not the usual dietary intake is affected.[57] Studies have indicated that self reporting methods for dietary assessment underestimated dietary intake.[58] However, as we used the same method of dietary measurement for all subjects, differences observed between the groups should be unaffected by such bias. In addition, the use of a seven day dietary record has been suggested as an excellent practical dietary assessment method for small numbers of highly motivated subjects and is used for validating other dietary assessment methods.[59]

In conclusion, the observed increase in BMI, WC and prevalence of obesity associated with length of residence in Australia for Taiwanese females is also associated with higher energy and saturated fat and carbohydrate intake, suggesting an increased risk of CVD and diabetes. Further study will need to assess biochemical risk factors and the impact of these changes on morbidity and mortality in this group in order to provide health professionals with better information on general health and prevention of CVD.

Acknowledgements
The authors thank Dr Helen O'Connor for her advice on collection of dietary data.

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Original Article

Change in diet and body mass index in Taiwanese women with length of residence in Australia

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澳洲的台灣女性飲食及身體質量指數的改變與居留時間長短的關係

這個橫斷性研究的目的為評估及比較居住在台灣及澳洲的台灣華人女性體位測量值及飲食攝取，包括居留澳洲時間長短的任何影響。測量身高、體重、腰圍、臀圍及體脂百分比，飲食攝取則以 7 天記錄評估。參與者為沒有系統性疾病的台灣女性(100 名來自澳洲大雪梨區，97 名來自台灣屏東縣)。與台灣相比，澳洲的研究對象的身體質量指數(體重-公斤/身高-公尺^2)及體脂百分比相似，但是腰、臀圍則較高(分別為 22.9±3.0 vs. 22.8±3.1 公斤/公尺^2, p> 0.05; 31.4±5.8 vs. 31.0±6.2 %, p> 0.05; 76.2±7.5 vs. 72.1±7.3 公分, p= 0.0001; 97.3±6.2 vs. 93.3±6.2 公分, p= 0.0001)，校正年齡後顯著性不受影響。澳洲研究對象有較高的總熱量攝取(2367±574 vs. 1878±575 大卡)，經過能量校正之後，醣類及飽和脂肪酸攝取克數(342.8±91.5 vs. 264.9±91.0 公克; 30.7±9.1 vs. 23.0±9.1 公克)及佔校正熱量百分比(57.3±1.4 vs. 55.6±2.3 %; 12.1±0.7 vs. 11.2±1.1 %)，所有的p<0.001。居留澳洲超過五年者其體位測量值呈現增加的趨勢，且她們腰圍大於 80 公分的機會為居留澳洲五年以下者的 14 倍(95%信賴區間 1.84-112)。對台灣女性而言，腰圍變大與居留澳洲時間長短相關的較高熱量及飽和脂肪酸攝取，指出其心血管疾病及糖尿病的危險性可能隨之增加。

關鍵字：身體質量指數、飲食、體位測量、肥胖、華人、澳洲的台灣移民。