Original Article

Differences in nutrient intakes and physical activity levels of Japanese and Australian Caucasian males living in Australia and Japanese males living in Japan

Masaharu Kagawa PhD[1], Yoko Saito MHSE[2], Deborah Kerr PhD[1], Hayato Uchida PhD[2], and Colin W Binns MBBS MPH PhD[1]

[1] *School of Public Health, Curtin University of Technology, Australia*
[2] *School of Human Science and Environment, University of Hyogo, Japan*

The aim of the study was to determine the nutritional status and nutrient intakes of young Japanese males living in Australia and compared with Japanese males living in Japan and Australian Caucasian males. Four-day dietary records were obtained from 65 Japanese living in Australia (JA), 81 Japanese living in Japan (JJ), and 70 Australian Caucasian males (AA) aged 18-30 years old, together with body composition and physical activity level assessments using anthropometry and the questionnaire. Australian males were significantly taller and heavier than the Japanese counterparts and also showed a greater percent body fat (%BF) and height-corrected sum of skinfolds compared with Japanese males living in Japan (%BF: JJ = 16.6 ± 5.2, AA = 18.7 ± 5.6; height corrected sum of skinfolds: JJ = 78.8 ± 37.3, AA = 96.0 ± 39.5) (*P*-<0.05). A greater proportion of Australian Caucasian males (98.6%) were involved in vigorous physical exercise than Japanese males (JA = 72.3%; JJ = 85.2%). The JA group consumed a greater amount of energy from protein and fat sources as well as greater calcium, iron, dietary fibre and niacin equivalents intakes than the JJ group (*P*-<0.05). The results suggest that Japanese males living in Australia consumed more energy-dense westernised diet than Japanese males living in Japan. Because of lower physical activity level than Australian males, consumption of energy-dense diet may increase the risk of weight gain among Japanese males who stay in Australia for a long-term.

Key Words: nutrient intakes, energy contribution, physical activity, Japanese males, Australia.

Introduction

In the past 50 years Japan has experienced rapid changes in their food supply and nutrient intakes. The National Nutrition Survey of Japan (NNS) is undertaken on a regular basis, and has shown significant increases in protein and fat consumption, while carbohydrate intake has fallen (Fig. 1).[1-3] The change in diet and nutrient intakes has resulted in changes to the physical and health status of the Japanese people, including decreased mortality rate from infectious diseases and malnutrition. The stature and body mass of the Japanese have shown a steady secular trend in all age groups during the 20th century and a progressively earlier onset of the adolescent growth spurt.[3] These changes in body size and physiques overlap the periods of rapid changes in Japanese diet after recovery from World War II and the remarkable growth of Japanese economy. In addition, the life expectancy of the Japanese has increased from 46.9 years for males and 49.6 years for females in 1935-36[4] to 78.4 years for males and 85.3 years for females in 2003.[5] In the most recent World Health Report, Japan is reported to have the longest life expectancy (at birth) of 81.9 years (male: 78.4 years; females: 85.3 years) as well as the longest healthy life expectancy (HALE) of 75.0 years (males: 72.3 years; females: 77.7 years) among the 192 member states of the World Health Organization (WHO).[6]

While changes in diet and nutrient intakes have improved growth and reduced premature mortality from infectious diseases, increased energy and fat intakes have caused an increase in morbidity and mortality from chronic lifestyle-related diseases[7] and the proportion of overweight and obese individuals is increasing in Japan.[8] Using the WHO classification of obesity, Japan has higher proportions of overweight and obese individuals than other Asian countries, including South Korea, China, and Philippines.[9] Japan has gone through the epidemiologic transition in only a matter of decades, from the 1930's when the leading causes of death were infectious diseases and malnutrition to the lifestyle-related health problems, including cancer, and cardiovascular diseases, of today.[7] While these dietary-associated changes in physique, causes of death, and the increase in life expectancy have been observed in Japanese living in Japan, changes in eating patterns and associated health risks have also been reported in studies assessing Japanese-descendants living overseas.

Correspondence address: Professor Colin W. Binns, School of Public Health, Curtin University of Technology, GPO Box U1987 Perth WA 6845
Tel: +61-8-9266-2952; Fax: +61-8-9266-2958
E-mail: c.binns@curtin.edu.au
Accepted 17th August 2005

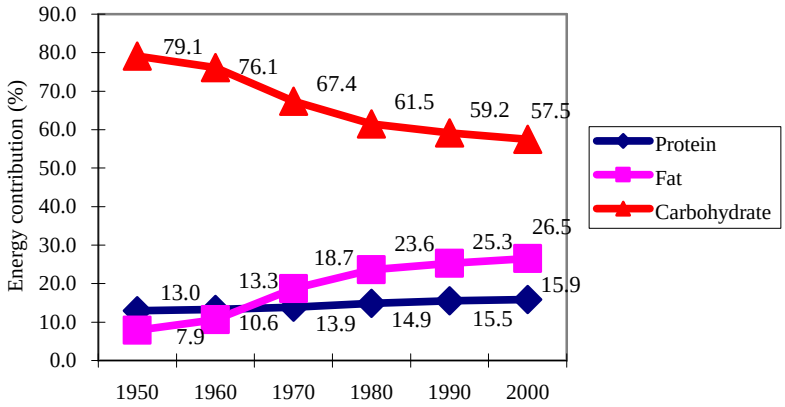


Figure 1. Secular trend of major nutrient intakes between 1950 and 2000 in Japan. *(The data between 1950-1970 were adopted from the reference[3] and the data after 1980 were adopted from the reference[1])*

Studies on Japanese living in Hawaii and Japanese-Brazilians indicated changes in eating patterns and energy contributions that are even more westernised than the Japanese data.[10,11] Studies of Japanese living in Hawaii also suggested that those who consumed a more western diet are more likely to gain body mass[12] and are at higher risk of developing chronic health problems, such as type II diabetes, coronary heart disease, and atherosclerosis[13-15] compare to those living in Japan or those who consumed a more traditional diet. These findings support the hypothesis that Japanese living in foreign countries for a long period will shift their diet toward a more western style.

Previous studies were however, mainly focused on the elderly or females and were lacking in information on young adults, particularly of young males. A small number of studies have been reported on the immediate impact of immigration to eating pattern or nutrient intakes. One study focused on Asian students (aged above 18 years old) living in the US and observed changes in diet and eating behaviours three months after immigration.[16] However, more than half (54%) of the subjects in the study were females and the majority (89%) were from either Taiwan (49%) or China (40%). Because of differences in traditional meal preparation methods and the differing rates of westernisation that are occurring in Asian countries,[9] it may not be appropriate to extrapolate from other Asian studies to Japanese subjects. Also males are expected to have a lower frequency of meal preparation by themselves compared to females. Hence, there is a need for a study that is specific for Japanese males in order to determine changes in nutrient intakes after their emigration to the foreign country.

There have been no studies reported of diet or nutrient intakes of Japanese living in Australia, even though the Ministry of Foreign Affairs of Japan reported an increase in the number of Japanese immigrants to the Oceanic region, which include Australia.[17] Australia is one of the most culturally diverse countries in the world and consequently a variety of cuisines and food ingredients are available. A recent study suggested that while an increased variety in food has a beneficial impact on Australian populations, there is a potentially increased risk of morbidity and mortality among Asian migrants because of changes in their physical activity level and diet. [18]

In addition, while previous cross-ethnic studies conducted in the US and Brazil used 24-hour recall[14,19] or food frequency questionnaire[11,20] there have been fewer studies that have used a three or a four-day dietary record[21] to obtain details of their diets. In comparison with a 24-hour recall or food frequency questionnaires, dietary record does not rely on memory and it is possible to obtain accurate information of portion size.[22] The objective of this study was to examine differences in nutrient intakes of Japanese males living in Australia using a four-day dietary record and to compare this with Japanese males living in Japan as well as that of Australian Caucasian males living in Australia. The study also measured body composition and lifestyle factors of the participants.

Subjects

Three study groups were recruited; 1) Japanese males living in Australia (JA), 2) Japanese males living in Japan (JJ), and 3) Australian Caucasian males living in Australia (AA). The inclusion criteria were young males aged between 18 and 30 years old, who have no chronic health problems that interfere with their daily lifestyle. The Japanese subjects were also required to hold a Japanese passport and to consider themselves to be “Asian”. Australian subjects were included if they had an Australian passport and recognized themselves as “Caucasian”. The recruitment processes for the JA and the AA were conducted in Perth, Western Australia and the JJ group was recruited at Himeji city in Hyogo Prefecture, Japan. The JJ and the AA subjects were recruited from universities and the JA subjects were recruited from educational institutions in Perth, including universities, TAFE, and language institutions. The numbers who completed the assessments were 68 JA, 82 JJ, and 72 AA respectively. After exclusion of over- or under-reporters of dietary record based on criteria explained in the methodology section below, 65 JA, 81 JJ, and 70 AA subjects were included in the analysis. Among the 65 JA individuals, 32 had spent more than three months in Australia (49.2%) and 33 had spent less than three months (50.8%). A majority of subjects in each group lived either with their family (JJ = 53.1%, AA = 44.3%) or with a host family (JA = 46.2%), followed by living with roommates for JA (41.5%) and AA (27.1%). Unlike the groups recruited in Australia, more of the JJ individuals lived by themselves (44.4%).

Methods

The study was approved by the Human Research Ethics Committee of Curtin University of Technology and the study adhered to the principles of medical research established by the National Health and Medical Research Council.[23] Informed consent was obtained from each subject prior to his involvement in the study. Subjects were asked to complete the following:

Questionnaire

Information on lifestyle variables, and physical activity level (frequency and intensity of exercises) were obtained using a questionnaire of which questions were adopted and modified from the Australian National Nutrition Survey (ANNS), the Japanese National Nutrition Survey (JNNS), and the Hawaii' Cancer Research Survey. Questions were translated and back-translated into Japanese until the translated questions had equivalent meaning to the original questions. The translation process was confirmed with two additional Japanese (one of whom is an accredited interpreter) prior to its distribution.

Anthropometry

Anthropometry was conducted according to the protocol of the International Society for the Advancement of Kinanthropometry (ISAK).[24] Stature, body mass, eight skinfolds (triceps, subscapular, biceps, iliac crest, supraspinale, abdominal, front thigh, and medial calf), five girths (arm [relaxed], arm [flexed and tensed], minimum waist, gluteal, and maximum calf) and two bone breadths (humerus, and femur) were measured. Subjects were measured with light clothing, such as shorts and T-shirt. Stature and body mass were measured without shoes. From the measurement, percent body fat (%BF), the body mass index (BMI; body mass (kg)/stature $(m)^2$), waist to hip ratio (WHR; waist circumference (cm)/gluteal circumference (cm)) were calculated. The body density equation by Durnin and Womersley[25] and Siri's body fat prediction[26] equations were used to estimate %BF of the subjects. Technical Error of Measurement (TEM) of anthropometric measurements was within the range of intra-tester error for a level three anthropometrist (within 5% for skinfolds and within 1% for other measurements) as recommended by ISAK.[27]

Dietary assessment

Each subject was asked to complete a four-day dietary record. This was modified from the diet record method of Geekie *et al.*,[28] and included food photographs to assist in portion size description. Detailed instructions were given to each subject at the time of recruitment and an instruction paper was also attached in the diary for their guidance. Each subject was allocated at least one weekend day as well as weekdays to enable differences in eating behaviours on different days to be studied. To include Japanese dishes, photographs with known ingredients and nutritional values from the Japanese nutrition education package "Sonomanma ryouri cards" (meal planning real-size cards) (1994, Adachi, Tokyo) were scanned into the dietary record booklet. Pictures of foods included in the booklet were those commonly seen in Japanese and Asian restaurants in Perth, such as katsudon (rice with deep fried pork), curried rice, and steamed rice, were selected and scanned. All scanned images were adjusted to 25% of the real size. Utensils such as chopsticks and spoons were also scanned and adjusted to the same 25% ratio to assist subjects in comparing the dish sizes. The information obtained from the diary was reviewed in a face-to-face interview setting in order to confirm the items recorded in the diary and to identify any missing information. Food Works® Professional edition (version 3.01.472, 2003, Xyris Software, Brisbane) was used for dietary analysis of groups living in Australia. Foods were selected from a list available in the program and those with no exact products were replaced with similar nutritional values. A new meal list was created for any mixed meal with a detailed recipe recorded by subjects. Average nutrient intakes of the recorded days were calculated using the program. The same procedure was conducted for the JJ group using a Japanese dietary analysis program; Eiyo-kun® (version 3.01, 2001, Kenpakusha, Tokyo). Prior to the analysis, the presence of under- and over-reporters was examined. Over-reporters were defined as consumption of energy more than 1.6MJ/day based on the previous study results.[29] To determine under-reporters, the basal metabolic rate (BMR) of subjects was calculated by the Harris-Benedict equation. The values were then multiplied by the cut-off value of 0.88 according to the Goldberg critical evaluation of energy intake data using 99.7% confidence interval.[29]

Statistical analysis

Statistical analysis was conducted using SPSS® statistical package for Windows (version 10.0.7, 1999, SPSS inc., Chicago). Obtained categorical results were assessed using the ANOVA method. In order to adjust ethnic differences in energy intakes, nutrient intakes were expressed as per 1000kJ energy intake. Their intakes were also compared with the appropriate age groups of the National Nutrition Survey results obtained in each country.

Results

Physical characteristics of the study groups are shown in Table 1. Australian males were significantly taller, heavier, and had greater BMI and sum of skinfolds values

Table 1. Physical characteristics of study groups

	Japanese males living in Australia Mean ± SD	Japanese males living in Japan Mean ± SD	Australian males living in Australia Mean ± SD
Number of subjects	65	81	70
Age (years) [b,c]	23.6 ± 2.9	20.4 ± 1.7	23.1 ± 3.2
Stature (cm) [a,b]	171.8 ± 5.1	173.0 ± 5.3	182.2 ± 6.8
Body mass (kg)[a,b]	64.3 ± 7.6	64.2 ± 9.1	80.1 ± 11.5
BMI (kg/m^2)[a,b]	21.8 ± 2.3	21.4 ± 2.8	24.1 ± 3.0
WHR[b,c]	0.81 ± 0.04	0.79 ± 0.04	0.82 ± 0.04
Waist girth (cm)[a,b]	74.8 ± 5.4	73.0 ± 6.4	82.9 ± 7.5
Gluteal girth (cm)[a,b]	92.4 ± 4.7	92.1 ± 5.5	100.8 ± 6.2
% body fat[b]	17.0 ± 5.2	16.6 ± 5.2	18.7 ± 5.6
Sum of eight skinfolds (mm)[a,b]	82.0 ± 34.1	80.1 ± 38.5	102.9 ± 42.5
Height-corrected sum skinfolds (mm)[b]	81.4 ± 34.4	78.8 ± 37.3	96.0 ± 39.5

[a] = Significant difference between AA and JA at the 0.05 level.
[b] = Significant difference between AA and JJ at the 0.05 level.
[c] = Significant difference between JA and JJ at the 0.05 level.

Table 2. Differences in physical activity levels between the study groups

Questions	Response	Japanese males living in Australia (%)	Japanese males living in Japan (%)	Australian Caucasian males living in Australia (%)
Hours involved in strenuous exercise (per week)[a,b]	None	33.8	23.5	5.7
	0.5-3 hours	41.5	48.1	48.6
	4-10 hours	21.5	19.8	35.7
	11-30 hours	1.5	8.6	8.6
	31 hours or more	1.5	0.0	1.4
Hours involved in vigorous exercise (per week)[a]	None	47.7	35.8	21.4
	0.5-3 hours	38.5	43.2	48.6
	4-10 hours	9.2	17.3	25.7
	11-30 hours	4.6	3.7	4.3
	31 hours or more	0.0	0.0	0.0
Hours involved in moderate exercise (per week)[a,b]	None	35.4	24.7	2.9
	0.5-3 hours	33.8	37.0	55.7
	4-10 hours	21.5	30.9	32.9
	11-30 hours	3.1	6.2	8.6
	31 hours or more	6.2	1.2	0.0
Frequency of vigorous exercise (per week)[a,b]	Never	27.7	14.8	1.4
	1-3 times	41.5	60.5	50.0
	4-6 times	21.5	16.0	37.1
	7 or more times	9.2	8.6	11.4

[a] = Significantly different between JA and AA at the 0.05 level. [b] = Significantly different between JJ and AA at the 0.05 level.
[c] = Significantly different between JA and JJ at the 0.05 level.

Table 3. Energy and nutrient intakes per 1000kJ and the energy contributions from major nutrients and fat types of the study groups

	Japanese males living in Australia Mean ± SD	Japanese males living in Japan Mean ± SD	Australian Caucasian males living in Australia Mean ± SD
Total energy (total/1000kJ)[a,b]	8.53 ± 1.87	9.17 ± 2.19	11.1 ± 2.44
Protein (g/1000kJ)[b,c]	9.62 ± 1.81	8.50 ± 1.19	10.14 ± 2.19
Total fat (g/1000kJ)[b,c]	8.73 ± 1.54	7.60 ± 1.35	8.26 ± 1.55
Carbohydrate (g/1000kJ)[b,c]	28.00 ± 4.03	31.52 ± 3.81	28.64 ± 4.27
Cholesterol (mg/1000kJ)[b,c]	37.01 ± 13.18	44.41 ± 13.59	31.87 ± 15.74
Calcium (g/1000kJ)[a,b,c]	76.80 ± 27.64	54.15 ± 18.98	92.29 ± 27.97
Iron (g/1000kJ)[a,b,c]	1.19 ± 0.31	0.91 ± 0.19	1.32 ± 0.33
Zinc (g/1000kJ)[b,c]	1.21 ± 0.33	1.06 ± 0.18	1.24 ± 0.25
Dietary fibre (g/1000kJ)[a,b,c]	2.07 ± 0.55	1.14 ± 0.32	2.42 ± 0.79
Vitamin A equivalent (μg/1000kJ)	82.38 ± 35.38	88.57 ± 116.63	104.50 ± 108.71
Thiamin (mg/1000kJ)[a,b,c]	0.14 ± 0.04	0.12 ± 0.03	0.19 ± 0.07
Riboflavin (mg/1000kJ)[a,b]	0.16 ± 0.11	0.16 ± 0.05	0.23 ± 0.09
Niacin equivalent (mg/1000kJ)[a,b,c]	4.09 ± 0.84	1.96 ± 0.58	4.63 ± 0.97
Vitamin C (mg/1000kJ)[a,b]	11.18 ± 6.83	8.79 ± 4.20	14.23 ± 8.34
Total folate (μg/1000kJ)[a,c]	24.00 ± 5.64	32.73 ± 16.69	29.64 ± 8.38
Energy contribution from			
Protein (%)[b,c]	16.3 ± 3.1	14.4 ± 2.0	17.1 ± 3.7
Carbohydrate (%)[b,c]	47.3 ± 6.7	50.4 ± 6.1	47.9 ± 6.0
Fat (%)[b,c]	32.3 ± 5.7	28.1 ± 5.0	30.6 ± 5.7
Energy contribution from			
Monounsaturated fat (%)[a,b,c]	12.3 ± 2.6	9.7 ± 2.2	11.0 ± 2.3
Polyunsaturated fat (%)[b,c]	4.5 ± 1.2	5.6 ± 1.5	4.0 ± 1.1
Saturated fat (%)[b,c]	12.5 ± 2.7	7.9 ± 2.0	12.8 ± 3.3

[a] = Significant difference between AA and JA at the 0.05 level; [b] = Significant difference between AA and JJ at the 0.05 level.
[c] = Significant difference between JA and JJ at the 0.05 level.

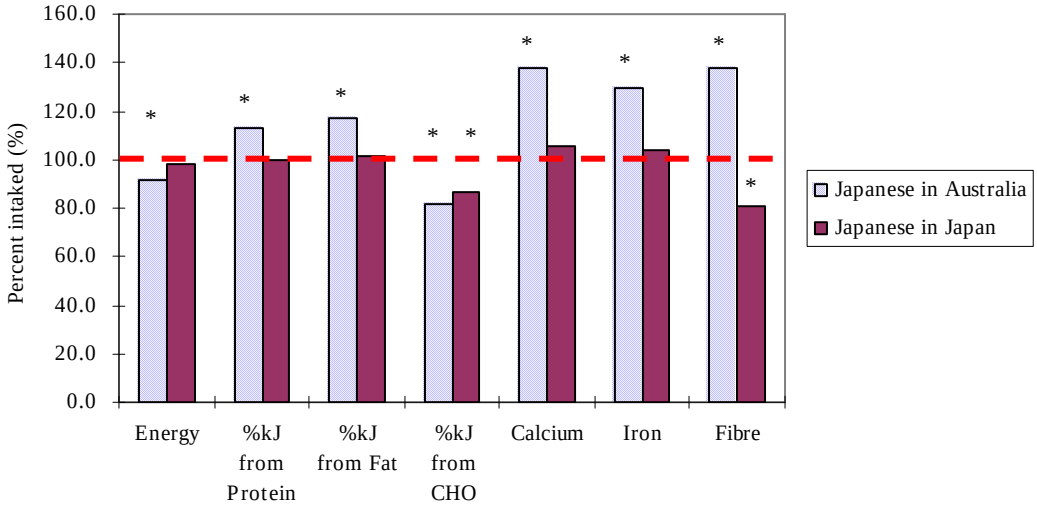


Figure 2. Nutrient intakes of Japanese groups compared with the National Nutrition Survey
[#] Adopted and modified from the 2002 National Nutrition Survey for Japan[1], males aged 20-29 years old. Energy value originally in kcal was converted by multiplying 4.184kJ. * = Significantly different with the values of the National Nutrition Survey at the 0.05 level.

than their Japanese counterparts (P<0.05). Japanese males in Japan were younger than their counterparts but there were no differences in stature and body mass between the two Japanese groups studied. While the JA group did not show significant differences with the JJ and the AA, the JJ group significantly differ in the WHR, total body fat (expressed as %BF), and height-corrected sum of skin-folds values (P <0.05) from that of the AA group. The level of physical activity was compared between the study groups (Table 2). Australian males were involved in more exercise than Japanese males. About 95% of Australians are involved in strenuous exercise for at least 30 minutes a week, while only 50 to 60% of Japanese were at this level. Similar results were observed from questions on involvement in vigorous and moderate exercises (vigorous exercise: JA = 52.3%, JJ = 64.2%, AA = 78.6%; moderate exercise: JA = 64.6%, JJ = 75.3%, AA = 97.1%). In addition, while 27.7% of the JA group and 14.8% of the JJ group reported that they do not undertake any vigorous exercises during the week, only 1.4% of the AA group reported the same. These results indicate that Japanese males were not as physically active as the Australian Caucasian males. There were no differences in the proportion of Japanese males who engaged in exercise (length and frequency) by their place of residence.

Dietary intake results obtained from four-day dietary record were compared with the appropriate age categories of the National Nutrition Surveys (NNS) from Australia and Japan for each study group (Fig. 2,3). The JJ results showed almost identical results to the 20-29 years old males in the Japanese National Nutrition Survey (JNNS), except for energy intake from carbohydrate sources and dietary fibre intake. Nutrient intakes of the JA group were significantly different from the JNNS results. The Japanese living in Australia had a significantly (P<0.05) lower total energy intake and energy contribution from carbohydrate. The JA group consumed a greater amount of energy from protein and fat sources and also consumed a greater amount of calcium, iron and dietary fibre in comparison with the equivalent age group reported in the JNNS (P<0.05). Australian males had similar energy contribution from protein and intakes of calcium and dietary fibre to the 19-44 years old cohort results of the Australian National Nutrition Survey (ANNS) results (Fig. 3). The energy intake in relation to the basal metabolic rate (EI/BMR) ratio was calculated for each study group (Fig. 4). The EI/BMR ratios of the JA, JJ, and AA groups were 1.24, 1.32, and 1.39 respectively. This indicates the JA group consume lesser amount of energy in relation to their calculated basal metabolic rate. Australian Caucasian males showed significantly higher energy intake in relation to their calculated basal metabolic rate than the EI/BMR ratio obtained from Japanese males living in Australia (P<0.05).

Table 3 shows results of energy and nutrient intakes per 1000kJ energy intake that were obtained from the dietary record. It illustrates significant ethnic differences in nutrient intakes. The Australian Caucasian males consumed significantly (P<0.05) greater amounts of total energy, calcium, iron, dietary fibre, thiamine, riboflavin, niacin equivalent and vitamin C than their Japanese counterparts. The Japanese groups differed in their nutrient intakes, depending on their place of residence. In comparison with the JJ group, the JA consumed significantly higher amounts of protein, total fat, calcium, iron, zinc, dietary fibre, thiamin and niacin equivalent. By contrast, the JJ consumed greater amounts of carbohydrate and total folate than the JA. In addition, the JJ group consumed the greatest amount of cholesterol of the three groups. The energy contributions from major nutrients (i.e protein, carbohydrate and fat) and energy contributions

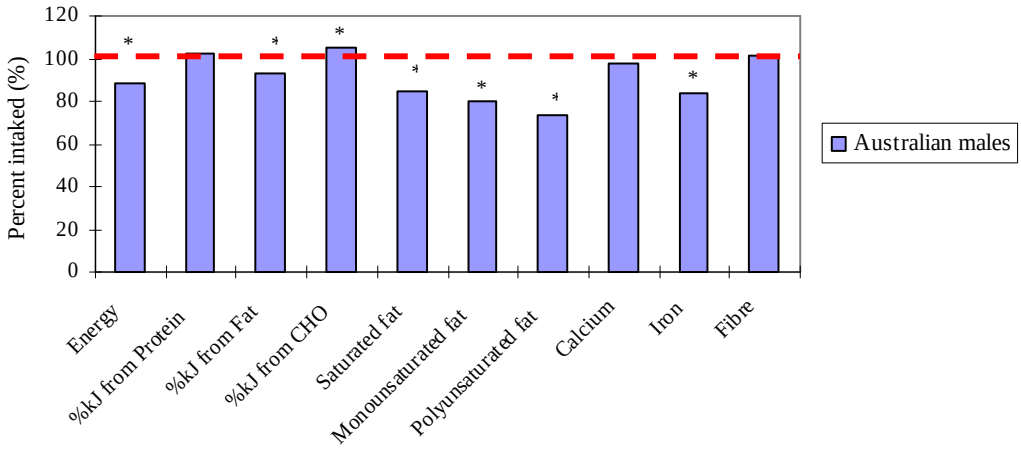
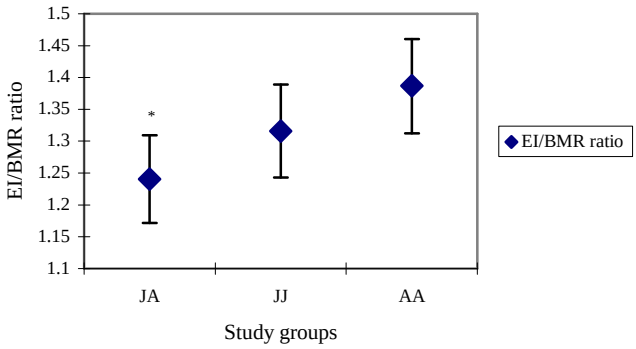


Figure 3. Nutrient intakes of Australian Caucasian males compared with the Australian National Nutrition Survey. # Adopted and modified from the National Nutrition Survey of Australia (1995)[30], males aged 19-44 years old. * = Significantly different with the values of the National Nutrition Survey at the 0.05 level.

from different types of fat were also significantly different between the Japanese males who reside in Australia and Japan (P <0.05). Apart from the energy contribution from monounsaturated fat, the JA group showed a similar energy contribution pattern to the Australian Caucasian males. Both JA and AA groups reported greater energy contributions from protein (JA = 16.3%, AA = 17.1%) and fat (JA = 32.3%, AA = 30.6%) but lower contribution from carbohydrate (JA = 47.3%, AA = 47.9%) than the JJ group (protein = 14.4%, fat = 28.1%, carbohydrate = 50.4% respectively). With regards to energy contribution from fat types, both JA and AA groups consumed greater amount of monounsaturated (JA = 12.3%, AA = 11.0%) and saturated (JA = 12.5%, AA = 12.8%) fat but smaller amount of polyunsaturated fat (JA = 4.5%, AA = 4.0%) than the JJ group (monounsaturated = 9.7%, saturated = 7.9%, and polyunsaturated = 5.6%).



* = Significantly different with AA at the 0.05 level.

Figure 4. Differences in energy intake to the basal metabolic rate (EI/BMR) ratio between the study groups

Discussion

This study aimed to compare and determine any differences in nutrient intakes of Japanese young adult males living in Japan (JJ) and Australia (JA) and young Australian Caucasian males (AA). The nutrient intakes of the JJ subjects in the current study were comparable to the results of the same age category of the Japanese National Nutrition Survey (JNNS)[1], suggesting that the JJ group represent the norm of the study population. The AA group showed lower total energy intakes compared to the results of the comparable age group (19-44 years old) of the Australian National Nutrition Survey (ANNS).[30] The lower energy intake of the AA group may be because of lower fat intakes compared to the ANNS result. In comparison to the JNNS, the nutrient intakes of Japanese males living in Australia showed greater energy intakes from protein and fat as well as calcium and iron intakes. In addition, the JA group reported significantly lower energy intake than the JNNS result. These differences in energy and nutrient intakes obtained from the JA group may indicate a change in diet, including meat and dairy products consumptions, of Japanese males living in Australia.

The EI/BMR ratios of each study group were calculated in order to determine the balance between energy intake and energy expenditure. A low EI/BMR ratio value may indicate low energy consumption due to dieting or inadequate access to food, and also a possible under-reporting of dietary intake by the subjects. After excluding suspected over- and under-reporters, the study found no significant difference between the JA and the JJ groups but showed that the JA has the lowest EI/BMR ratio among three groups. Considering the significant difference in total energy intake between the JA group and the JNNS results, the result may indicate a decline in the total energy intake among the JA group. The low energy intake by the JA group may be because of 1) missing meals, most often breakfast 2) small meal sizes, as reported the dietary diary, and 3) the poor meal preparation skills of Japanese males. In addition, the JA subjects may have more financial constraints than their JJ counterparts because many JA subjects were holders of working holiday visas, which restrict their working hours compared to the AA subjects and Japanese live in Japan. In this study, Australian Caucasian males consumed a greater amount of energy than Japanese males in relation to their BMR. At the same time, the study found that

greater proportion of the AA group was involved with exercise more frequently than Japanese males. The greater energy consumption among Australian Caucasian males may be a consequence of their effort to balance out their "expected" energy expenditure.

Significant differences in nutrient intakes between ethnic groups may be explained by differences in body size and their energy requirements related to their BMR and exercise level. However, significant differences in energy contributions from major nutrients, such as protein, carbohydrate, and fat across study groups may indicate differences in their diet. The JA group consumed a greater proportion of energy from protein and fat but consumed lower amount of energy from carbohydrate than the JJ group. The energy contributions from protein, fat, and carbohydrate among the JA group were similar to that of Australian Caucasian males. This difference in energy contribution of the JA group from the energy contribution of the JJ group may also indicate a change in food consumption.

Most of the nutrient intakes of the JA group lay in the middle of intakes by the JJ and AA groups. The JA group consumed a significantly greater amount of calcium, iron, dietary fibre, and niacin equivalent than the JJ group. Calcium and dietary fibre are two of the major nutrients that Japanese consume less of than the Recommended Dietary Allowance (RDA) of Japan (700mg calcium and 20-25g dietary fibre intakes for Japanese male aged 18-29 years old).[31] Although they did not consume 100% of all of the Japanese RDA values, the JA group achieved better intakes than the JJ group. The increase in calcium and dietary fibre could be due to increased intakes of dairy products as well as cereals, fruits and vegetables, which are common meal pattern of Australian households.

The changes in nutrient and energy intakes by the JA group are similar to the findings of a previous study that documented the westernisation of dietary habits among overseas students, predominantly from China and Taiwan, when they moved to the US.[16] Acknowledging that the food supply in Japan has become more westernised and increased protein and fat consumptions in recent years, the current study show that further westernisation is evident in the diet of Japanese males living in Australia. Improvement in some nutrients, including calcium and dietary fibre may have some benefit to the JA group. However, the increased energy contribution from fat has potential health concerns as it could lead to the development of health problems in the long-term if they remain in Australia or their dietary change becomes permanent.

Both JA and AA groups consumed more energy from saturated and monounsaturated fats than the JJ group. The average energy contribution of fat in the JA group was 32.3%, which was greater than the recommended range of 20-25% suggested by Japanese RDA and the intake recorded in the JNNS (27.9%).[1] Continuation of a high fat diet and low intensity and frequency of physical activity could increase chronic disease rates in the JA group in the longer term. A study by Ferreira *et al.,*[32] using 530 Japanese-Brazilians (aged 40-79 years) reported that groups of obese subjects and those with central adiposity consumed more energy from fat than non-obese subjects. In addition, while the results on Asian males vary between the studies, recent studies using the data from the National Surveys conducted in Canada and the US reported that immigrants will often experience unnecessary weight gain and the amount of weight gain positively correlates with the duration of residence in the foreign country.[33,34] Continuation of increased energy intake from fat and low level of physical activity of the JA group may increase weight gain or increased abdominal fat accumulation in long-term. As obesity and abdominal fat deposition are correlated with a number of health problems, continuation of the lifestyle that the JA group reported in the current study may increase health risks of this specific population living in Australia.

In order to prevent avoidable health consequences JA individuals need a greater awareness of the diet they consume. When Japanese students move to western countries they need to be given advice about how to obtain or prepare an appropriate diet while they are overseas. Further health promotion is needed to increase their awareness of exercise levels in order to maintain their own fitness and appropriate body composition.

The current study is the first report on nutrient intakes of Japanese males who are living in Australia and the obtained data may be useful to understand the effect of living environment on diet and lifestyle of Japanese males living overseas. There were a few limitations that need to be considered when interpreting the findings of this study. While the current study examined the nutrient intakes of the JA group by cross-sectional design, future studies should conduct longitudinal follow-up assessments in order to determine the changing patterns of eating behaviours and the associated nutrient intakes of subjects living overseas. In addition, this study included the sample size which was not sufficient enough to analyse according to their living conditions (eg, living with host family, share mates, or living by themselves alone).

Conclusion

The study examined differences in nutrient intakes between three groups of males; 1) the Japanese males living in Australia, 2) the Japanese males living in Japan, and 3) the Australian Caucasian males in Australia. Japanese males living in Australia consumed a diet that is higher in calcium, iron, dietary fibre, niacin equivalent intakes and has higher energy contributions from protein and fat, than Japanese males living in Japan. The study showed that the energy contribution pattern obtained from Japanese males living in Australia was similar to that of the Australian Caucasian males, which indicate further shift in the diet of the JA group toward a western diet compared with the JJ group. It is important to provide adequate health information to promote healthy eating behaviours among Japanese males living in Australia to avoid unnecessary increase of health risks during their stay in overseas.

Acknowledgements

Researchers would like to acknowledge Janine Wright for guidance on dietary assessment tools and provision of the seven-day food and drink dietary which was modified for this study. We would like to thank the students in Japan and Australia who made this study possible.

References

1. Kenkou Eiyou Jouhou Kenkyukai. Kokumin eiyou no genjou-The National Nutrition Survey in Japan, 2002 [Jap]. 1 ed. Tokyo: Daiichi Shuppan; 2004.
2. NIH-NJST. Health and nutrition information infrastructure database system home page. http://nihn-jst.nih.go. jp: 8888/pls/nns/nns_main_e.htm01.
3. Kenkou Eeiyou Jouhou Kenkyukai, Eiyou Chousa Kenkyu Han, editors. Sengo Shouwa no eiyou doukou-Kokumin eiyou chousa 40 nen wo furikaeru [Jap]. Tokyo: Daiichi Shuppan; 1998.
4. Suzuki T. Nihon jin no karada- Kenkou, karada no data-shu [Jap]. Tokyo: Asakura Shoten; 1996.
5. WHO. The World health report 2003-Shaping the future. Geneva: WHO; 2003.
6. WHO. The World health report: Changing history. Geneva: WHO; 2004.
7. The Ministry of Health, Labour and Welfare. Jinkou doutai chousa (gaisuu) Gaiyou [Jap]. http://www.mhlw. go.jp/toukei/saikin/hw/jinkou/geppo/nengai02/index.html.
8. Matsumura Y. Nutrition trends in Japan. Asia Pac J Clin Nutr2001; 10 (Supplement):S40-S47.
9. Kim S, Moon S, Popkin BM. The nutrition transition in South Korea. Am J Clin Nutr 2000;71:44-53.
10. Takata Y, Maskarinec G, Franke A, Nagata C, Shimizu H. A comparison of dietary habits among women in Japan and Hawaii. Public Health Nutrition 2004; 7 (2):319-326.
11. Freire RD, Cardoso MA, Shinzato AR, Ferreira RG. Nutritional status of Japanese-Brazilian subjects: comparison across gender and generation. Br J Nutr 2003; 89: 705-712.
12. Maskarinec G, Novotny R, Tasaki K. Dietary patterns are associated with body mass index in multiethnic women. J Nutr 2000; 130:3068-3072.
13. Wenkam NS, Wolff RJ. A half century of changing food habits among Japanese in Hawaii. J Am Diet Assoc 1970; 57 (1): 29-32.
14. Huang B, Rodriguez BL, Burchfiel CM, Chyou P-H, Curb JD, Yano K. Acculturation and prevalence of diabetes among Japanese-American men in Hawaii. Am J Epidem 1996; 144 (7): 674-680.
15. Egusa G, Watanabe H, Ohshita K, Fujiwara R, Yamane K, Okubo M, Kohno N. Influence of the extent of Westernization of lifestyle on the progression of preclinical atherosclerosis in Japanese subjects. J Athero Thrombosis 2002; 9 (6):299-304.
16. Pan Y-L, Dixon Z, Himburg S, Huffman F. Asian students change their eating patterns after living in the Unites States. J Am Diet Assoc 1999; 99 (1): 54-57.
17. Ministry of Foreign Affairs of Japan. Kaigai zairyu houjinsu toukei [Jap]. http://www.mofa.go.jp/ mofaj/ toko/tokei/hojin02/index.html.
18. Wahlqvist ML. Asian migration to Australia: Food and health consequence. Asia Pac J Clin Nutr 2002; 11 (Suppl): S562-S568.
19. Kim KK, Yu ES, Liu WT, Kim J, Kohrs MB. Nutritional status of Chinese-, Korean-, and Japanese-American elderly. J Am Diet Assoc 1993; 93 (12):1416-1422.
20. Kudo Y, Falciglia GA, Couch SC. Evolution of meal patterns and food choices of Japanese-American females born in the United States. Eur J Clin Nutr 2000; 54: 665-670.
21. Tomisaka KJL, Maruyama C, Anh NTL, Lien DTK, Khoi HH, Chuyen NV. Dietary patterns and risk factors for Type 2 diabetes mellitus in Fijian, Japanese and Vietnamese populations.Asia Pac J Clin Nutr 2002;11(1):8-12.
22. Thompson FE, Byers TE. Dietary assessment resource manual. J Nutr 1994; 124: 2245S-2317S.
23. NHMRC. National Statement on Ethical Conduct in Research Involving Humans; 1999.
24. Norton K, Whittingham N, Carter L, Kerr D, Gore C, Marfell-Jones M. Measurement techniques in anthropometry. In: Norton K, Olds T, eds. Anthropometrica. 1st ed, Sydney: University of New South Wales Press; 1996, 25-75.
25. Durnin JVGA, Womersley J. Body fat assessed from total body density and its estimation from skinfold thickness: measurements on 481 men and women aged from 16 to 72 years. Br J Nutri 1974; 32: 77-97.
26. Siri WE. Body volume measurement by gas dilution. In: Brozek J, Henschel A, editors. Techniques for measuring body composition. Washington, DC: National Academy of Sciences; 1961, 108-117.
27. Gore C, Norton K, Olds T, Whittingham N, Birchall K, Clough M, Dickerson B, Downie L. Accreditation in anthropometry: an Australian model. In: Norton K, Olds T, eds. Anthropometrica. Sydney: University of New South Wales Press; 1996, 395-411.
28. Geekie MA, Raats M, Sparks P, Shepherd R. Validation of a 7d food and drink diary: a tool for the assessment of nutrient intake. Proc Nutrition Soc 1997; 56 (1A):120A.
29. Goldberg GR, Black AE, Jebb SA, Cole TJ, Murgatroyd PR, Coward WA, Prentice AM. Critical evaluation of energy intake data using fundamental principles of energy physiology: 1. Derivation of cut-off limits to identify under-recording. Eur J Clin Nutr 1991;45:569-581.
30. McLennan W, Podger A. National Nutrition Survey: Nutrient Intakes and Physical Measurements. Canberra: Australian Bureau of Statistics; 1998. Report No.: Cat. No. 4805.0.
31. KEJK. Recommended Dietary Allowances-Dietary Reference Intakes [Jap]. Tokyo: Daiichi Shuppan; 1999.
32. Ferreira SR, Lerario DD, Gimeno SG, Sanudo A, Franco LJ. Obesity and central adiposity in Japanese immigrants: role of the western dietary pattern. J Epidem 2002; 12 (6): 431-438.
33. Goel MS, McCarthy EP, Phillips RS, Wee CC. Obesity among US immigrant subgroups by duration of residence. J Am Med Assoc 2004; 292 (23):2860-2867.
34. McDonald JT, Kennedy S. Is migration to Canada associated with unhealthy weight gain? Overweight and obesity among Canada's immigrants. Social Sci Med 2005; 61(12):2469-81.

Original Article

Differences in nutrient intakes and physical activity levels of Japanese and Australian Caucasian males living in Australia and Japanese males living in Japan

Masaharu Kagawa PhD[1], Yoko Saito MHSE[2], Deborah Kerr PhD[1], Hayato Uchida PhD[2], and Colin W Binns MBBS MPH PhD[1]

[1] *School of Public Health, Curtin University of Technology, Australia*
[2]*School of Human Science and Environment, University of Hyogo, Japan*

比较居住在澳大利亚的日本男性和澳大利亚白种男性及居住在日本的日本男性他们摄入的营养素和身体活动性水平的差异

本文研究的目的是测定居住在澳大利亚的年轻日本男性的营养状况和营养素的摄入，及与居住在日本的日本男性和澳大利亚白种男性作比较。选择年龄在 18-30 岁之间的 65 个居住在澳大利亚的日本人（JA），81 个居住在日本的日本人（JJ），和 70 个澳大利亚白种男性并记录四天的饮食，用人体测量学和问卷评估人体内各种组成成分和身体活动性水平。结果显示，澳大利亚男性比与之配对的日本人显著性地高和重，并且与居住在日本的日本男性相比显示更大的体脂百分数（%BF）和高度-校正皮肤褶总数(%BF: JJ = 16.6 ± 5.2, AA = 18.7 ± 5.6;: 高度-校正皮肤褶总数 JJ = 78.8 ± 37.3, AA = 96.0 ± 39.5)(P<0.05)。澳大利亚白种男性比日本男性有更大的涉及健壮的体育运动的比例(AA=98.6%; JA = 72.3%; JJ =85.2%)。JA 组消耗更大的来源于蛋白质和脂肪的能量， 并且比 JJ 组摄入更多的钙，铁，膳食纤维和尼亚辛等价物(P<0.05)。结果提出居住在澳大利亚的日本男性比居住在日本的男性消耗更多的高能西方饮食。因为比澳大利亚男性较低的身体活动性水平，消耗高能的饮食可能对长期居住在澳洲日本男性有提高体重增加的危险。

关键词：营养素摄入、能量贡献、身体活动性、日本男性、澳大利亚。