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Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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Fasting Calorie Restriction Improved the Quality of Dietary Intake among Aging Men in Klang Valley, Malaysia

Nur Islami Mohd Fahmi Teng[1], Suzana Shahar[1], Zahara Abdul Manaf[1], Hasnah Haron[1] and Wan Zurinah Wan Ngah[2]
[1]Faculty of Health Sciences, Universiti Kebangsaan Malaysia,
[2]Faculty of Medicine, Universiti Kebangsaan Malaysia,
Jalan Raja Muda Abdul Aziz, 50300, Kuala Lumpur, Malaysia

Abstract: This study used the new model of Fasting Calorie Restriction, which aimed at providing a feasible way of controlling eating. The present study aimed at determining the changes in dietary patterns following a three-month Fasting Calorie Restriction intervention. Twenty-five apparently healthy men (aged 50-70 years, BMI 23.0-29.9 kg/m^2) were randomized into Fasting Calorie Restriction or Control groups. Those assigned to the Fasting Calorie Restriction group were instructed to restrict their daily energy intake to 2100 kJ/day and practice Muslim *Sunnah* fasting for 2 days a week for three months. Dietary data and Healthy Eating Index were obtained using a Diet History Questionnaire at the baseline, 6 and 12 weeks. Statistical analysis was carried out using a repeated measured of Analysis of Covariance using the baseline data as covariate. Energy intake decreased significantly ($p<0.01$) in the Fasting Calorie Restriction group. We also found a significant increase ($p<0.05$) in thiamine, riboflavin and niacin intakes in the Fasting Calorie Restriction group throughout the intervention period. Analysis of the Healthy Eating Index showed a significant main effect ($p<0.05$) for fat, saturated fat and cholesterol scores. Food variability decreased significantly ($p<0.001$) (9.5±0.9 at the baseline to 8.1±1.1 at week 12) in the Fasting Calorie Restriction group. Fasting Calorie Restriction in this study was beneficial in reducing overall energy and fat intake. However, it also decreased the food variability among subjects. There is a need to evaluate the long-term effects of Fasting Calorie Restriction on food variability and micronutrient status.

Key words: Dietary pattern, fasting, calorie restriction, healthy eating index

INTRODUCTION

Calorie Restriction (CR) has been one of the preferred eating models promoted for health benefits in humans because of its ability to slow the aging process (Morley *et al*., 2010). It has remained the fundamental recommended way of weight loss (Strychar, 2006), since studies have proven its beneficial effects in human health. A randomized, controlled study showed that 16 to 25% of CR in humans might improve surrogate biomarkers of aging including oxidative stress, cardiovascular diseases, insulin resistance and body composition, which have been well known biomarkers of longevity (Heilbronn *et al*., 2006; Larson-Meyer *et al*., 2006; Riordan *et al*., 2008).

Besides CR, diet quality is also important for human health as recent findings showed that the Mediterranean diet, with or without calorie restriction, resulted in longevity (Esposito *et al*., 2011). The Mediterranean diet, characterized by a moderate amount of fat and high portion of monounsaturated fat and high intake of vegetables, legumes, fruits and grains has been associated with reducing the risk of cardiovascular disease (Covas *et al*., 2006). This diet is comparable to a traditional Okinawa diet, practiced by elderly Okinawans in Japan, who are known for their long average life expectancy (Appel, 2008). Okinawans traditionally consume a high quality diet, known to be less than 30% of calorie intake of other Japanese. On the other hand, the "Western" dietary pattern, characterized by high consumption of red meat, high fat dairy products, eggs, potatoes, refined grains and sweets (Kerver *et al*., 2003) was associated with an increased risk of cardiovascular diseases and diabetes (Hu *et al*., 2000; van Dam *et al*., 2002).

In CR interventions, low energy intake may limit the intake of other nutrients (Foote *et al*., 2004; Traill *et al*., 2012). Thus, it is also essential to determine the impact of CR on the overall dietary pattern. However, there are no available CR studies assessing the effects of CR on the dietary pattern and diet quality. One CR study suggested that cereal fiber may enhance adherence to a CR regimen (Gilhooly *et al*., 2008). Another study examining the effects of CR with different glycemic loads (Das *et al*., 2007), reported that there was no effect of glycemic load on sustainability of weight loss. Nevertheless, many broad ranges of healthy diets could promote weight loss. Therefore, overall diet quality is still the fundamental consideration in development of any dietary intervention.

Corresponding Authors: Suzana Shahar, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Jalan Raja Muda Abdul Aziz, 50300, Kuala Lumpur, Malaysia

One measurable determination of diet quality was by using the Healthy Eating Index (HEI). The HEI was first developed by the United States Department of Agriculture (USDA) in 1995 to monitor adherences to dietary guideline (Kennedy *et al*., 1995). It was revised in 2005 to reflect the 2005 Dietary Guidelines and underwent validity and reliability evaluation (Guenther *et al*., 2008). HEI could be used to measure compliance towards nutritional intervention guidelines and to monitor dietary trends over time in a population (Kennedy *et al*., 1995).

Given the difficulties of practicing CR in free living people, (Dirks, 2006), we developed a new model of controlling eating, the Fasting Calorie Restriction (FCR) regimen. This model was a combination of a 300 to 500kcal restriction and Muslim Sunnah Fasting for three months practice. In Muslim fasting, the observant must fast from sunrise until sunset, with no food and drink allowed during the fasting hours.

It is necessary to begin any intervention for aging men starting at the age of 50 because they will start to experience a decreased in nutritional status (Farham, 2008). The present study also focused on those with BMI 23.0-29.9 kg/m^2, because a study by the Malaysian Society of Andrology and The Study of The Aging Male (MSASAM) indicated that Malaysian men had a significant proportion of chronic diseases such as diabetes, hypertension and dyslipidemia (Tan *et al*., 2007). These conditions have always been associated with higher weight in old age (Adams *et al*., 2006). The BMI range chosen was due to the recent finding that revealed that the BMI of 23.0 kg/m^2 was the starting point of metabolic abnormalities and chronic diseases associated with overweight and obesity among Malaysian populations (Cheong *et al*., 2012).

Previously, we reported that a three month FCR improved body composition without compromising quality of life (Teng *et al*., 2011). In the present study, we aimed to evaluate the impact of FCR regimen on overall dietary pattern following the intervention. In addition, we also analyzed the effect of this regimen on body weight.

MATERIALS AND METHODS

Subjects and procedures: A randomized controlled trial (RCT) carried out involved 25 healthy older men, aged 50-70 years old. The criteria of inclusion were healthy people (no history of uncontrolled chronic diseases, physical and mental disabilities), BMI of 23.0-29.9 kg/m^2 and not practicing Muslim *Sunnah* fasting for at least three months prior to the study. Demographic details, including socioeconomic profiles, were collected before the study commenced. Sample size was calculated based on body weight changes data from our pilot study (Teng *et al*., 2011) with 95% CI and 80% power. This calculation allowed for a dropout rate of 20%. Subjects were randomized into two groups: Intervention (FCR) and Control (CO). The FCR regimen consisted of a reduction of between 300 to 500 kcals per day from their habitual energy intake combined with two days of Muslim Sunnah fasting per week for a period of three months. The habitual intake is considered as acceptable if it is within 30% of their energy requirement (McCrory *et al*., 1999) as calculated using the Harris Benedict equation which was then multiplied by the appropriate activity factors (determined using the International Physical Activity Questionnaires, IPAQ). Intervention subjects needed to undergo dietary counseling sessions (individual and group counseling at baseline and week six of intervention) and received a booklet consisting of FCR guidelines together with seven days of menu recommendations. The booklet included tips on practicing FCR: (1) Sunnah fasting on Monday and Thursday (2), Achieving a normal body weight (3), Variety of food choices (4), Increasing fruit and vegetable intake (5), Choosing low fat and low cholesterol foods (6), Choosing whole meal grains (7), Reducing intake of sugar and sweets (8) and Moderation in food intake (9) Exercise. A group of dieticians developed the menu based on Malay's eating habits. Subjects were advised to make healthy food choices and on ways to reduce calorie intake. For example, low fat milk could replace coconut milk in order to reduce caloric intake. Assessment of compliance with the regimen was through a weekly phone call, 3-days food record and a fasting book log. The Klang Valley of Malaysia was the locus of the study. Ethics approval was obtained from the Universiti Kebangsaan Malaysia Medical Research Centre.

Nutrients analysis: A Diet History Questionnaire (DHQ) (Shahar *et al*., 2000) was used to estimate food intake through a detailed interview, which consisted of 7 days of food intake. Validation and design of this questionnaire was based on local dietary habits. The weight of each food item consumed was then converted to household serving size and further analyzed using Nutritionist Pro software (Axxya Systems-Nutritionist Pro, Stafford, TX) to obtain energy and nutrient intake (Mirnalini *et al*., 2008). Derivation of the adjusted nutrient intake came from the actual nutrient intake divided by the actual energy intake and the score expressed per 1000 kcal. DHQ was collected at baseline, week six and week twelve.

Healthy eating index: A healthy eating index was developed using the Malaysia Dietary Guidelines (MDG), 2010 (NCCFN, 2010) and secondary data from the Malaysia Adult Nutritional Survey 2003 (Mirnalini *et al*., 2008). Modification of the scoring criteria was based on serving size recommendations in MDG 2010 to determine the standard value of the maximum score in

Table 1: Component and Scoring Criteria of the Healthy Eating Index

Component	Range of score	Criteria for perfect score of 10	Criteria for score 8	Criteria for minimum score of 0
Food group				
Grains	0 to 10	4-8 servings[a]		0 serving
Vegetables	0 to 10	≥ 3 servings/day[a]		0 serving
Fruits	0 to 10	≥ 2 servings/day[a]		0 serving
Meat	0 to 10	½-1 servings[a]		0 serving
Fish	0 to 10	1 servings[a]		0 serving
Legumes	0 to 10	½ -1 servings[a]		0 serving
Milk	0 to 10	1-3 servings[a]		0 serving
Total fat	0 to 10	≤ 30% of energy[a]		≥ 35% of energy[b]
Sodium	0 to 10	≤ 2000 mg[a]	2400 mg	≥ 4200 mg[b]
Variety	0 to 10	7-16 types of foods		0 types of foods

[a]Based on Malaysia Dietary Guidelines (NCCFN 2010)

[b]Based on the 85th percentile of Malaysia Adult Nutrition Study, Mirnalini *et al.* (2008)

Table 2: Socio-demographic and baseline characteristics of subjects [Expressed as mean±SEM or n (%)]

Characteristics	FCR (n = 12)	Control (n = 13)
Age, (mean±SD)[a]	59.3±1.0	58.3±1.8
Marital Status, n (%)		
Married 12 (100)	13 (100)	
Working status, n (%)[b]		
Retired, n (%)	7 (58.3)	8 (61.5)
Working, n (%)	5 (41.7)	5 (38.5)
Educational level, n (%)[c]		
No formal education	1 (8.3)	1 (7.7)
Primary school	1 (8.3)	2 (15.4)
Secondary school	2 (16.7)	6 (46.1)
College/University	8 (66.7)	4 (30.8)
Household income, n (%)[c]		
<MYR 1500 (USD 481)*	2 (16.7)	4 (30.8)
MYR1500-3500 (USD 481-1121)*	4 (33.3)	7 (53.8)
>MYR 3500 (USD 1121)*	6 (50.0)	2 (15.4)
Health Status, n (%)[b]		
No disease	8 (66.7)	9 (69.2)
Hypertension	4 (33.3)	4 (30.8)
Weight (kg), (mean±SD)[a]	71.6±1.7	72.9±2.3
BMI (kg/m^2), (mean±SD)[a]	27.0±0.5	26.5±0.5

[a]NS-not significant using Independent Sample T Test

[b]NS-not significant using Chi Square Test

[c]NS-not significant using Fisher Exact Probability Test

*Conversion rate as on December 5th, 2011.

FCR -Fasting Calorie Restriction group

MYR-Malaysia Ringgit

BMI-Body Mass Index

each nutrient. This index has been tested for face validity by a panel of dietitians in the country. We also performed test-retest reliability of the HEI measurements at three time points in our data set and obtained a coefficient of more than 0.7 for each item, indicating good reliability (Downing, 2004).

HEI was categorized into 10 components (Table 1). Calculations of the score for item numbers 1-7 were done proportionately, as described by Kennedy *et al.* (1995). Individuals scored a 10 on item number 8 who consumed within the recommendation and '0' when the maximum value exceeded. For item number 9, the recommendation by MDG (2010) for the intake of sodium was 2400 mg/day, but the recommendation by World Health Organization (2007) was 2000 mg/day. Therefore, the maximum score of 10 was given to intakes below 2000 mg/day while the score of 8 was given to intakes of 2400 mg/day. The minimum score of 0 was given if the sodium intake was 4200 mg or above, which is around the 85th percentile of the population study previously (Mirnalini *et al.*, 2008). The definition of diet variety was the cumulative number of different types of food consumed on at least weekly basis. Data from DHQ were divided into 10 food groups (grains and cereal, vegetables, fruits, meat, fish, legumes, milk and dairy products, condiments, sweets and snacks, energy containing beverages). The frequency and amount of consumption were not taken into account. Food counted as a distinct item if it was prepared in an obviously different manner (e.g., coconut rice, cooked rice, fried rice) or in a different variety (e.g., brown rice, white rice). A total HEI score of 81-100% showed that the overall diet quality was good. A score between 51-80% was categorized as needing improvement and below 51% as poor.

Statistical analysis: Analyses were carried out using SPSS version 18.0. Examination of the normality of data was by Kolmogorov-Smirnov test. If the data were skewed, the log transformation was attempted. Expression of the value of variables was as mean±standard deviation. Changes in body weight and dietary data from the baseline to week six and twelve was examined using repeated measures ANOVA, with no adjustment for baseline variables as there was no variability among subjects in the two groups. Presentation of results was with three p-values: (1) time effect to test whether there was a change over time (2), group effect to test the difference between both groups (3), intervention effect which is the test of time and group interaction. The significance level was set at $p<0.05$.

RESULTS

Subject characteristics: A total of 28 subjects participated, with 25 subjects completing the study (n = 12, FCR group, n = 13, CO group). One dropped out due to non-compliance with the FCR intervention and two others were no longer interested in the study. All of FCR subjects completed 2 days fasting every week and achieved the goal of reducing at least 300 kcal/day calories from their baseline intake. The mean age of subjects was 58.8 years old and BMI of 26.8 kg/m^2 as shown in Table 2.

Nutrient intake and body composition: Table 3 shows that there was a significant group effect for energy ($p<0.01$) and carbohydrate ($p<0.05$) intake. Energy intake was reduced by -18% in FCR group. A significant intervention effect ($p<0.01$) was also found for fat intake ($p<0.001$).

With respect to the micronutrient intake, a significant intervention effect ($p<0.05$) was observed in thiamine (adjusted value) ($p<0.05$), riboflavin ($p<0.05$), niacin (adjusted value) ($p<0.01$) and iron (adjusted value) ($p<005$) intake. All of these nutrients showed improvement in the FCR group at weeks 6 and 12 as compared to the baseline; while there was no apparent change observed in CO group. For riboflavin, the intervention effect remained significant when the value was adjusted for energy.

There was a reduction in body weight by -3.14% when compared to the baseline in the FCR group. A significant intervention effect was found for fat mass which was reduced by -6.35% in FCR as compared CO group which increased by +2.7% (Fig. 1-3).

Healthy eating index (HEI): Analysis of HEI score showed significant intervention effects for fat ($p<0.05$) and diet variability ($p<0.001$). The fat HEI score improved dramatically in the FCR group while no improvement was observed in the CO group. However, the variability of diet decreased significantly in the FCR group following the intervention period. Most of the subjects felt they needed to limit the food in order to achieve a calorie reduction in their diet. There was a significant time effect in the HEI score for fruit ($p<0.05$) and fat ($p<0.01$) intake. Fruit intake improved in both groups following the intervention period. The total HEI score significantly ($p<0.001$) improved in both groups. The score in the FCR group improved from 60.1±8.5 at the baseline to 68.6±3.7 at week 12, while the score in the CO group improved from 61.7±8.1 at the baseline to 64.2±6.2 at week 12. The improvement was greater in the FCR group. Even so, the HEI score still required categorization as needing improvement (Table 4). There was no significant difference observed between socio-demographics and diet quality. Grain intake was reduced significantly in both groups ($p<0.001$), however the reduction was greater in the FCR group.

DISCUSSIONS

The new model used was the FCR, which aimed at promoting a feasible way of controlling eating. It involved a religious practice that has widely been acknowledged by its observance worldwide.

We found improvement in overall fat intake scores as assessed using HEI in the FCR group. Sarri *et al.* (2004) also reported an improvement on these diet components following adherence to the Mediterranean type of diet. However, types of fat had not been analyzed in their study. In general, we recognized that subjects' reduced their saturated fat intake. It has been broadly known that higher fat intake may result in cardiovascular related disease and obesity (Newby *et al.*, 2003) and its prevalence in Malaysia was increasing (Khambalia, 2010). However, while diet

Table 3: Mean energy and nutrients at baseline, week 6 and week 12 (Expressed as mean±SEM)

	FCR (n = 12)			Control (n = 13)			
Characteristics	Baseline	Week 6	Week 12	Baseline	Week 6	Week 12	p-value (time, group, intervention effect)
Energy (kcal)	1681±55.2	1413±30.4	1371±53.8	1701±80.4	1742±61.2	1646±136.2	0.057, 0.008**, 0.098
Energy (kcal/kgBW/day)	23.6±0.9	20.4±1.1	19.8±1.0	23.4±1.1	23.9±1.6	22.7±2.2	0.063, 0.081, 0.125
CHO (g)	207.5±9.9	186.0±5.3	189.4±5.7	224.3±13.7	226.8±10.3	214.5±17.3	0.407, 0.017*, 0.516
CHO (% of energy)	49.6±3.9	52.6±0.9	55.8±2.9	52.8±3.1	52.1±2.1	52.7±1.8	0.238, 0.917, 0.216
Protein (g)	56.2±1.1	64.4±0.9	56.9±2.5	64.9±2.8	73.5±1.0	63.8±1.3	0.038*, 0.065, 0.953
Protein (% of energy)	13.3±0.9	18.3±1.1	16.3±1.2	15.0±1.4	16.9±0.9	14.5±0.6	0.000**, 0.441, 0.067
Fat (g)	69.5±5.1	44.1±1.9	42.9±3.2	60.4±4.3	60.0±3.9	66.3±3.9	0.038*, 0.005**, 0.000**
Fat (% of energy)	37.0±1.4	28.0±1.1	27.8±2.2	32.1±2.7	31.0±2.9	34.0±1.5	0.015*, 0.222, 0.008*
Thiamine (mg/day)	0.68±0.09	0.84±0.09	0.75±0.03	0.79±0.06	0.75±0.05	0.90±0.07	0.359, 0.566, 0.114
(mg/1000kcal/day)	0.40±0.06	0.60±0.01	0.47±0.05	0.55±0.05	0.43±0.05	0.49±0.07	0.063, 0.190, 0.026*
Riboflavin (mg/day)	0.83±0.09	0.93±0.06	1.0±0.1	1.0±0.1	0.89±0.06	0.87±0.05	0.998, 0.847, 0.049*
(mg/1000kcal/day)	0.50±0.06	0.67±0.04	0.71±0.02	0.59±0.04	0.51±0.05	0.51±0.03	0.293, 0.125, 0.003**
Niacin (mg/day)	6.51±0.49	7.38±0.5	8.98±0.9	7.70±0.1	8.73±0.3	8.73±0.5	0.001**, 0.543, 0.269
(mg/1000kcal/day)	3.93±0.05	5.24±0.08	6.63±0.09	4.60±0.05	5.05±0.06	5.04±0.9	0.000**, 0.195, 0.004**
Vitamin C (mg/day)	82.1±11.4	85.5±11.0	82.2±16.5	95.6±21.9	81.5±18.6	89.1±17.4	0.289, 0.586, 0.820
(mg/1000kcal/day)	48.6±11.2	55.9±6.5	57.2±12.3	56.5±9.5	50.1±11.1	50.4±8.2	0.401, 0.976, 0.471
Vitamin A (mg/day)	794.0±103.9	801.5±69.5	804.8±107.3	940.4±129.7	881.2±74.0	948.6±100.0	0.885, 0.282, 0.878
(mg/1000kcal/day)	470.3±119.3	571.7±66.3	594.7±143.3	561.3±67.5	502.3±85.4	533.7±66.9	0.616, 0.841, 0.194
Calcium (mg/day)	385.0±55.3	390.6±29.7	388.8±47.6	450.5±64.6	431.5±48.7	463.2±39.4	0.845, 0.222, 0.787
(mg/1000kcal/day)	233.4±55.4	276.6±35.4	287.2±29.8	264.8±11.6	251.1±26.4	265.0±24.3	0.383, 0.850, 0.266
Iron (mg/day)	12.6±4.9	13.0±1.6	13.4±1.9	10.9±2.9	11.3±0.9	11.7±1.2	0.215, 0.353, 0.999
(mg/1000kcal/day)	7.6±0.08	9.2±1.1	9.8±1.3	6.4±0.05	6.4±0.6	6.7±0.1	0.008**, 0.047*, 0.049*
Zinc (mg/day)	5.4±1.2	5.1±1.2	3.8±2.5	5.5±1.1	5.5±1.6	4.0±2.7	0.054, 0.213, 0.117
(mg/1000kcal/day)	3.4±1.0	3.2±1.1	2.2±0.7	4.0±0.9	4.1±1.0	2.2±0.06	0.089,0.336, 0.098

CHO-Carbohydrate

*$p<0.05$, significant using Repeated Measures ANOVA

**$p<0.01$, significant using Repeated Measures ANOVA

Table 4: The Healthy Eating Index score at baseline and 12 week (Expressed as mean±SEM)

	FCR (n = 12)			Control (n = 13)			
Characteristics	Baseline	Week 6	Week 12	Baseline	Week 6	Week 12	p-value (time, group, intervention effect)
Grains							
Serving/day	5.9±0.05	4.9±003	4.6±0.05	6.2±0.9	6.0±0.1	5.4±0.2	0.000**, 0.163, 0.225
HEI score	9.8±0.06	10	10	9.4±0.8	9.8±0.07	9.8±0.08	0.055, 0.376, 0.762
Vegetable							
Serving/day	1.92±0.05	2.0±0.0	2.0±0.0	1.73±0.04	1.69±0.06	1.69±0.04	0.674, 0.379, 0.067
HEI score	6.4±0.05	6.7±0.0	6.7±0.0	5.8±0.6	6.7±0.0	5.7±0.9	0.884, 0.067, 0.360
Fruit							
Serving/day	0.90±0.08	1.12±0.05	1.17±0.05	0.75±0.05	0.84±0.04	0.84±0.05	0.010*, 0.343, 0.343
HEI score	4.5±1.1	5.6±1.0	5.8±1.2	3.8±0.9	4.2±1.0	4.2±1.2	0.011*, 0.350, 0.356
Meat							
Serving/day	1.02±0.04	1.10±0.05	1.09±0.02	1.38±0.01	1.54±0.04	1.54±0.05	0.799, 0.053, 0.968
HEI score	5.1±1.1	5.5±1.0	5.4±0.7	6.5±1.4	6.9±1.2	6.9±1.0	0.898, 0.060, 0.998
Fish							
Serving/day	1.2±0.09	1.4±0.04	1.3±0.07	1.2±0.08	1.3±0.04	1.3±0.05	0.494, 0.726, 0.921
HEI score	7.5±1.2	10.0	9.2±1.0	8.1±1.4	8.5±1.6	8.5±2.1	0.250, 0.565, 0.485
Legume							
Serving/day	0.13±0.05	0.14±0.05	0.15±0.04	0.10±0.03	0.11±0.01	0.1±0.01	0.843, 0.399, 0.990
HEI score	1.25 +± 0.5	1.42±0.3	1.50±1.8	0.9±0.4	1.1±0.2	1.1±0.6	0.843, 0.399, 0.990
Milk							
Serving/day	0.17±0.05	0.25±0.03	0.25±0.01	0.08±0.04	0.08±0.02	0.15±0.03	0.492, 0.363, 0.787
HEI score	1.7±1.9	2.5±2.1	2.5±1.5	0.8±1.5	0.8±1.8	1.5±2.1	0.492, 0.363, 0.787
Fat							
Kcal (%/day)	37.0±2.4	28.0±0.9	27.8±2.4	32.1±4.3	31.0±3.0	34.0±2.5	0.015*, 0.222, 0.008**
HEI score	5.2±1.1	9.9±0.0	9.8±0.09	7.5±1.1	8.7±1.2	7.0±1.8	0.003**, 0.193, 0.011*
Sodium							
(mg/day)	2469±185	2417±153	2363±186	2298±134	2327±122	2357±158	0.773, 0.538, 0.050
HEI score	9.1±0.07	9.3±0.05	9.6±0.04	9.6±0.05	9.6±0.03	9.7±0.1	0.122, 0.324, 0.364
Variability							
HEI score	9.5±0.05	8.8±0.4	8.1±0.5	9.3±0.4	9.5±0.09	9.7±0.06	0.059, 0.043*, 0.000**
HEI							
Overall score	60.1±2.2	69.8±3.2	68.6±1.2	61.7±1.2	64.8±3.3	64.2±2.8	0.000**, 0.269, 0.067

*p<0.05, significant using Repeated Measures ANOVA

**p<0.01, significant using Repeated Measures ANOVA

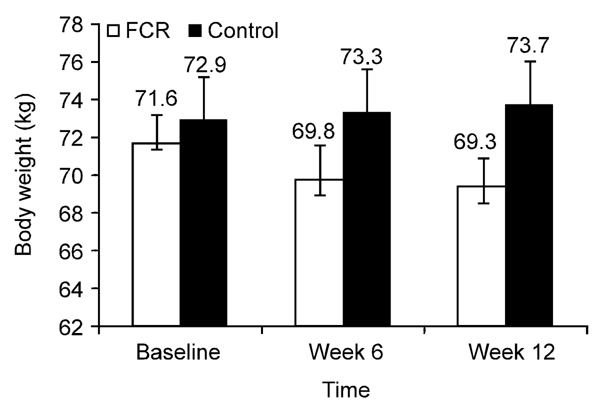

Fig. 1: Body weight at baseline, week 6 and week 12 **p<0.001, significant for intervention effect (p<0.001) using Repeated Measures ANOVA

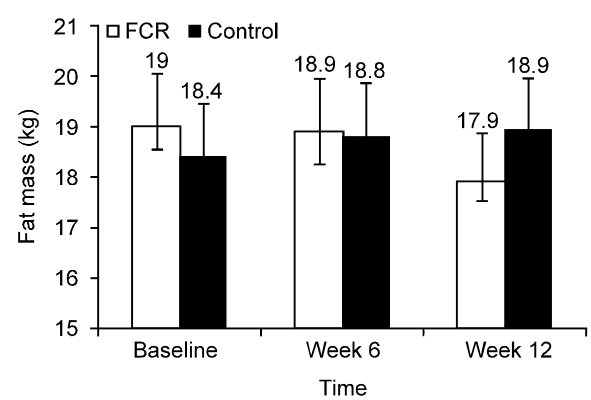

Fig. 2: Fat mass at baseline, week 6 and week 12 **p<0.05, significant for intervention effect using Repeated Measures ANOVA

variability was associated with a better nutritional quality (Murphy *et al*., 2006), findings of this study showed that the variability decreased significantly in the FCR group. This study showed that the subjects ate the same type of meal every day. Thus, it showed that the FCR subjects did limit their food choice even though suggestions were given to eat a variety of foods through our menu guidelines and counseling sessions. A study by McCrocy *et al*. (1999) found that people tend to limit their food choices during dieting. Although access to a variety of foods may lead to increased energy intake, as supported by previous studies (McCrory *et al*., 1999; Spiegel *et al*., 1990), lack of variety makes it harder to meet other nutrient recommendations. Interestingly, thiamine, riboflavin, niacin and iron intake improved in the FCR group. Those nutrient intakes have previously

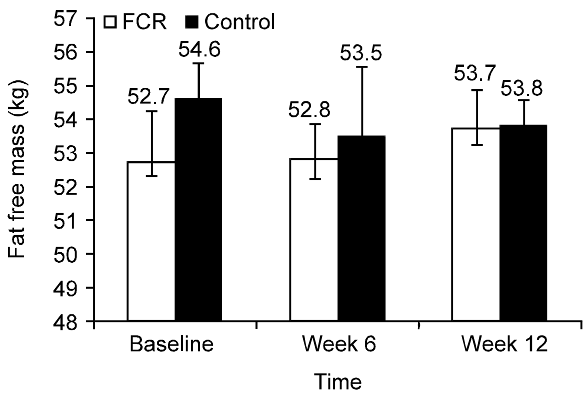

Fig. 3: Fat free mass at baseline, week 6 and week 12 NS-not significant using Repeated Measures ANOVA

been reported to be inadequate in the diet of elderly individuals (Shahar *et al*., 2001). Therefore, we believe that the decrease in diet variability did not affect nutrient intake among our subjects.

It is noted that 97% of the Malaysian population consumed rice every day, which is a source of complex carbohydrates (Norimah *et al*., 2008). However, excessive intake of carbohydrates has been associated with the development of metabolic syndrome (Liu *et al*., 2001). Thus, the findings of our study that the FCR group showed a reduction in grains, particularly rice, intake is desirable. However, our study did not measure the magnitude of under-reporting using an objective measure such as total energy expenditure and doubly labeled water as adopted in other CR studies (Das *et al*., 2007). Future studies should consider these evaluation techniques.

There is a concern that weight loss among older people may decrease both fat mass and fat free mass which may lead to sarcopenia and physical function impairment (Roubenoff, 2000). However, despite reductions in body weight and fat mass in our FCR subjects, their fat free mass was preserved. The maintenance of fat free mass is in line with the previous study that reported the preservation of fat free mass following a diet therapy program (Villareal *et al*., 2006).

There are several limitations in this study. First, dietary intakes were self-reported and thus prone to under-reporting. However, the weight reduction among subjects in the FCR group showed good compliance towards the diet regimen. A suggestion for future study is to include an objective measure of energy expenditure such as a doubly labeled water technique to precisely measure under-reporting. Second, the small sample size was unlikely to represent the population. There is a need to conduct a similar study on a larger scale. Another limitation was that the HEI was not currently validated for use among the Malaysian population. However, reliability testing showed that this index was acceptable. Finally, the FCR group seems to had a higher education level and received extra attention by counselors. This probably increased the study compliance.

Conclusion: In conclusion, the FCR intervention had successfully reduced energy and fat intake during the 12-week study period. This regimen was found to be suitable for implementation among aging men who are at risk for metabolic abnormalities. However, a specific menu guideline on a variety of foods with low energy content and evaluation of the long term effects of FCR on diet variability and micronutrient status is needed in future study.

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