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Lifestyle Intervention Improved Nutritional Knowledge, Dietary Composition and Health Status of Midlife Malaysian Women

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ABSTRACT

Lifestyle has been shown to exert a major impact on the quality of life and health in mid-life women coping with menopausal changes. This study aimed to assess the efficacy of a lifestyle intervention package in improving nutritional knowledge and composition, dietary habits and related health status in mid-life women. Between Nov 1999 to Oct 2001, 360 disease free women, non users of HRT, aged 45 years and above with intact uterus were recruited into the study. The women were randomised into three groups - I (control), II (lifestyle intervention) and III (lifestyle intervention with HRT) respectively. After 12 months, 85.6% completed the study. The lifestyle intervention programme, well accepted by the participants, brought about an improved dietary composition, better eating habits, more exercise participation and increment in knowledge with concomitant improvement of the health status. The benefits observed were significant reduction in energy, fat and carbohydrate intake with increased intake of legumes; milk and cheese/yogurt; and reduction of tea and coffee. Body weight was reduced and more importantly preventing abdominal obesity in the intervention groups with HRT was more effective. Further adaptations of the dietary component with advice on obtaining micronutrients from local produce would contribute towards a more balanced diet in midlife women as dairy products were not popular and these women had low meat intake.

INTRODUCTION

Perimenopause in women begins in the early forties with declined functions in various body systems such as vasomotor, uro-genital, breast, skin, cardiovascular, endocrine, musculo-skeletal and mind (Lobo, 1999). Increased body weight with increment in total and abdominal obesity is linked closely to the menopausal transition and general ageing. Associated with menopausal transition and increased body weight were the rise of serum cholesterol, triglycerides, LDL-C, IDL-C and Lp(a) [Wing *et al.,* 1991; Poehlman *et al.,* 1995; Svendsen *et al.,* 1995; Lahti-Kroski *et al.,* 2000].

Obesity itself is an independent risk factor for premature death and harbinger

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of conditions such as hyperlipidaemia, hypertension and insulin resistance which are major risk factors of cardiovascular disease [Barrett-Connor, 1995; Calle *et al.,* 1999]. Of the three independent and significant factors impairing lipoprotein profiles namely menopause, age and increased abdominal fat distribution, only obesity was modifiable by lifestyle changes [Berg *et al.,* 2004]. Obesity developed if energy intake exceeded energy expenditure over a period of time. Food intake and energy expenditure, controlled by genetics and behaviour [Jebb, 1999], focused nutrition and modification of dietary habits for achievement of healthy weight and reduction in risks of co-morbid conditions being the final goal [Jebb, 2002].

Many studies in the past decade showed that exercise decreased cardiovascular risk between 10 and 50% [Berlin & Colditz, 1990], reduced the risks of certain cancers, improved diabetes and fitness including psychological well being [Biddle *et al.,* 2000] making it a critical element of any prevention or treatment programme [Fox, 2002]. Current health practices emphasise rationing and reducing access to health care in order to contain rapidly rising costs. By good self management of health habits, people can remain healthier, live longer and slow the ageing process by modifying individual risk factors through primary prevention [Bandura, 2000]. The health and quality of life in middle aged women have been shown to depend strongly upon knowledge, attitude and practice towards menopause with its accompanying changes [Liao & Hunter, 1998]. For disease free women, lifestyle interventions would help maintain health and reduce the risk of developing chronic diseases by modification of risk factors without resorting to HRT.

Based on current evidence, a lifestyle intervention package was tailored for midlife Malaysian women incorporating nutritional knowledge, physical exercises, good health habits and information pertaining to menopause. The efficacy of the intervention package in improving nutritional knowledge, dietary habits and related health status in women aged 45 years and above was assessed.

MATERIALS AND METHODS

The study design was prospective longitudinal, carried out in a referral hospital (HUKM) situated in a residential suburb of the capital city. Recruitment was via distribution of 2000 flyers to residential areas around the hospital over a period of 25 months but subjects from other areas responded as well. Participants were part of first year recruitment, between November 1999 and October 2001 whereby 519 women underwent initial screening by telephone and 360 disease free women, aged 45 years and above with intact uterus were accepted. Exclusion criteria included those on hormone replacement therapy, on pharmacological treatment, presence of chronic diseases, secondary causes for osteoporosis and contraindication to HRT. The study was a Master of Science project [Pon, 2003] and had received approval from the Medical Faculty Research Ethics Committee.

All subjects gave written informed consent upon participation in the study. Initial clinical examination and anthropometric measurements [Health-O Meter, USA] followed by ultrasound were carried out in the gynaecology clinic [Figure 1]. Mammogram, chest X-ray and bone scan were later done to rule out the presence of existing disease. Socio-demographic information, lifestyle characteristics, medical and reproductive history were collected via questionnaires. All questionnaires were in three languages i.e. English, Malay and Chinese, validated in a pilot study consisting of 50 nurses, aged 45-55 between July and September 1999. Based on feedback, content and language accuracy, the questionnaires were modified accordingly.

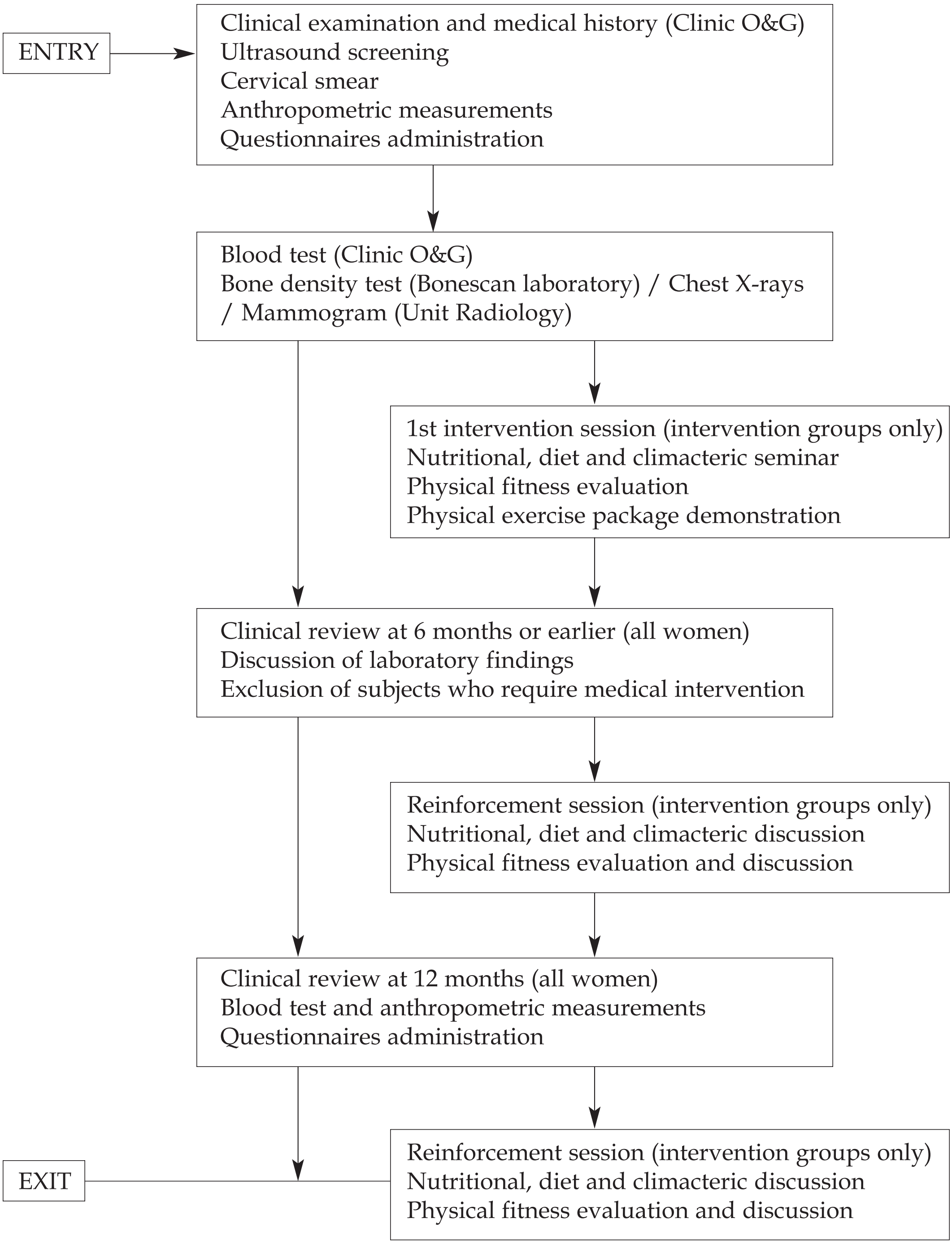

Figure 1. Flow of subjects through the study

Blood was taken at the O&G Clinic and tested by the Chemical Pathology Unit, HUKM. Except for haemoglobin, parameters such as height, weight, hip and waist circumference, serum lipids and blood sugar were repeated after 12 months. Lipid profile and blood sugar were determined by an automated enzymatic colorimetric system [Cobas Integra, Roche Diagnostic, NJ, USA]. Haemoglobin was determined by Coulter STKS [Beckman Coulter Inc; CA, USA]. Stratification of body mass index [WHO, 1998], lipid profile [NCEP Expert Panel, 2001] and blood sugar [WHO, 1999] were according to population norms.

Nutritional knowledge, attitude, dietary practices (KAP) and a semiquantitative food frequency (FFQ) questionnaire were administered by a dietician. Both FFQ and KAP were modified from the instrument developed by the Cardio-vascular Intervention Group Study MOH-UIA-UKM-UM-UPM-USM-1998 [Norimah, 1997; Norimah & Margettes, 1997; Maisarah, 1999]. The KAP consisted of 20 questions with each correct answer given a score of 1. Knowledge items included nutrients for a balanced diet; ways to obtain the necessary nutrients; most and least eaten food group according to the food pyramid; type of nutrients that provided the most energy and body building; foods rich in vitamin-mineral-fibre and calcium; foods that contained the most carbohydrate, protein, fibre and cholesterol; foods with high salt content; ways of cooking that increased fat content; outcome of excessive caloric intake; risks of disease caused by obesity; and how to balance food intake to avoid obesity/maintain ideal weight and the use of body mass index. The risks of excess sugar and poor calcium intake rounded up the final questions. Based on a maximum score of 20 points, the subjects were categorised into poor (0-9, <50%), moderate (10-14, 50-<75%) and high (15-20, ≥75%) knowledge groups.

Subjects were asked to state the frequency of intake of each kind of food listed per day, week or month and serving size was based upon the Malaysian Food Composition Table [Tee *et al.,* 1997]. Food quantification was aided by food photographs, matchboxes and household utensils. Food intake was converted to gram and analysed using the software Diet 4 which was based on the Malaysian Food Composition Table. To adjust for differences in age of subjects, the weighted nutrient intake method [Teoh, 1975] was used for comparison to Malaysian RNI [NCCFN, 2005] (Table 1).

Table 1. Weighted nutrient intake conversion

Age (years)	No. subjects (x)	Energy intake, kcal/day (y)	xy
40-49	156	2180	340080
50-59	170	2180	370600
≥60	34	1780	60520

$$\text{Weighted energy intake} = \Sigma xy/\Sigma x = 771200/360 = 2142.2\text{kcal/day}$$

An energy intake (EI) / basal metabolic rate (BMR) ratio of <1.2 or >1.8 respectively indicated an estimation of EI below or above normal. BMR was determined with the formula of Ismail *et al.* [1997].

$$\frac{[0.0535 \times \text{Body weight (kg)} + 1.994] \times 1000 \text{ kcal]}}{100}$$

At the end of the first visit, the women were randomised into three groups by choosing one of three similar envelopes [Figure 2]. No blinding of subjects was performed as ethical consideration dictated that the women may choose the treatment that they were willing to undergo. Those who changed groups from the initial selection were "marked"

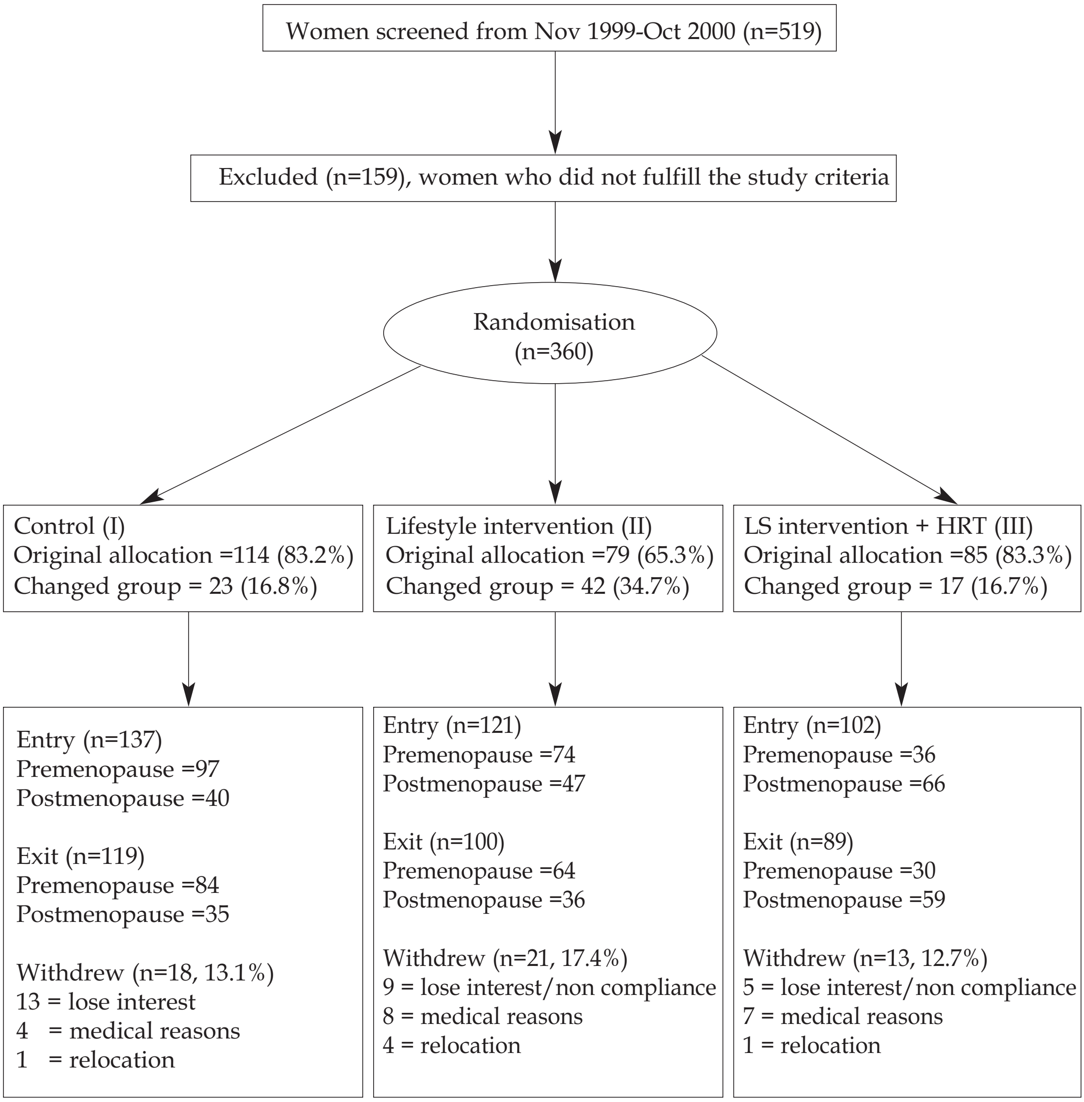

Figure 2. Number of subjects at screening, entry, exit and drop-outs.

throughout the study to enable subgroup analyses to be carried out later. A total of 137, 121 and 102 women were randomised into three groups namely control (I); lifestyle intervention (II) and lifestyle intervention with hormone replacement therapy (III) respectively. After 12 months, 308 women or 85.6% completed the study with 119, 100 and 89 women remaining in groups I, II and III, a dropout rate of 13.1%, 17.4% and 12.7% respectively.

Lifestyle intervention consisted of three major components i.e. nutritional/ dietary advice, structured exercises and health management. The physical activity programme was designed by qualified physiotherapists specific for midlife women incorporating low impact aerobics, toning and strengthening exercises without a need for special equipment. Women were encouraged to exercise three times per week for a total duration of more than 90 minutes and to increase physical movement by walking or taking stairs in their daily activities. In order to assess the fitness of each participant, a series of physical tests were carried out by physiotherapists at each intervention session. These included exercise tolerance, body posture, functional joint mobility, muscle power and flexibility. Assessment results including blood pressure, exercise heart rate and body mass index permitted counseling to be specific to each participant.

The nutritional programme was modified from the Healthy Eating Manual advocated by the Ministry of Health [MOH Malaysia, 1997]. Dietary and nutritional advice included food preparation, portion size estimation and recipe modification of common dishes to reduce fat intake. Each three hour intervention session was helmed by dieticians and physiotherapists with 20-30 participants. Advice on good health habits, menopause and the accompanying changes was given by a clinician to emphasise the importance of health management. Three small illustrated booklets on each topic were provided as references. The intervention programme was of low intensity namely low monitoring with reinforcement sessions carried out at 6 months and 12 months. Physical reassessment by physiotherapist was carried out coupled with a short questionnaire to determine adherence to the programme. Controls were provided with general health advice and asked to continue with their former lifestyle except in cases that required medical intervention whereby they were excluded from the study.

Hormone replacement therapy consisted of 0.625mg conjugated equine oestrogen and medroxyprogesterone acetate 5mg daily provided to group III. Women used either the cyclical regime, for those who prefer monthly menses or continuous combined regime. Women were asked to defer from HRT until they had completed the mammogram and bone density test.

Data were analysed using SPSS for Windows version 9.0 [SPSS Inc. Chicago USA]. The software programme Diet4 was used to analyse energy and nutrient intake. A one way ANOVA was carried out at baseline. A 2 (time) x 3 (groups) ANOVA was done to determine the overall effects of intervention with t-test for post-hoc comparison. Categorical variables were compared by Chi^2. Subjects who changed groups from original randomisation were blocked in initial analysis, added in later and the results compared. The changes were not statistically significant and results of the groups were represented as it were. The differences were considered significant if $p<0.05$.

RESULTS

The participants had an average age of 51.65±5.40 years with 43% in the age range of 45-49 years and 9.4% above 60 years old. Majority were Chinese followed by Malays and Indians reflecting an urban composition. Three quarters were married and majority had attained secondary or higher level schooling. The average age for groups I, II and III were 50.51±5.48, 51.27±5.21 and 53.64±5.01 years respectively ($p<0.005$). Group III was significantly older and had more postmenopausal women who were not currently employed (Table 2). The average age at menopause was 49.89±2.95 years with a median of 50.0 years, similar between groups. The reproductive history was not significantly different between groups.

Mean EI for all subjects at baseline was 1615±226 kcal per day which was 75.4% of Malaysian RNI with no difference seen between groups. At baseline, mean %EI consisted of 53% from carbohydrates, 15% from protein and 32% from fats. Protein estimates were 115% above the Malaysian RNI. A high intake of fruits and vegetables was observed. Breakdown of

Table 2. Sociodemographic and reproductive attributes of participants

Sociodemographic attributes	*All (%)*	*Group I (%)*	*Group II (%)*	*Group III (%)*
	N=360	N=137	N=121	N=102
Age (years)#				
45-49	43.3	55.5	48.8	20.6
50-54	31.9	29.2	27.3	41.2
55-59	15.3	9.5	14.9	23.5
^{3} 60	9.4	5.8	9.1	14.7
Ethnicity				
Malay	33.1	30.7	35.5	33.3
Chinese	61.1	62.0	56.2	65.7
Indian	5.0	5.8	7.4	1.0
Others	0.8	1.5	0.8	-
Marital status				
Single	10.0	10.9	9.9	8.8
Married	75.6	73.7	79.3	73.5
Widowed	10.0	5.8	5.0	2.0
Divorced/separated	4.4	9.5	5.8	15.7
Educational level				
No formal schooling	3.9	5.1	-	6.9
Primary school	20.0	18.2	20.7	21.6
Secondary school	55.0	54.7	52.9	57.8
College/tertiary	21.1	21.9	26.4	13.7
Employment*				
Currently employed	49.4	59.1	47.9	38.2
Not employed	50.6	40.9	52.1	61.8
Household income (RM)				
≤ 500	6.1	6.6	4.1	7.8
501-1000	18.9	22.6	17.4	15.7
1001-3000	42.2	39.4	41.3	47.1
3001-5000	18.1	18.2	18.2	17.6
> 5000	14.7	13.1	19.0	11.8
Reproductive attributes				
Postmenopause#	42.5	29.2	38.8	64.7
Nos. of birth				
0	11.9	16.1	9.9	8.8
1-4	70.3	65.0	74.4	72.5
≥5	17.8	19.0	15.7	18.6
Ever on oral contraceptives?	35.8	35.0	38.0	34.3
Ever breastfed?	64.4	65.2	69.7	57.0
			Mean±SD	
Age of menarche (years)	13.50±1.66	13.45±1.97	13.46±1.59	13.70±1.80
Average nos. children	2.93±1.73	2.74±1.79	2.84±1.64	3.26±1.71

*p=0.006, #p=0.0005

macro and micronutrient intake by sub-groups showed no statistical difference at baseline (Table 3). Factorial ANOVA showed significance within subject interaction (i.e. intervention) for intake of energy, carbohydrate, fats and protein intake (p<0.0001, all). Intervention resulted in significant reduction of overall energy intake, 4.9% and 3.2% in groups II and III respectively. Group I had a significant reduction in iron intake from 12.75mg to 11.68 mg (p=0.035) in spite of a 1.7% higher energy balance, mainly from a 5.6% increased fat intake. Group II showed

Table 3. Comparison of energy and nutrient intake at baseline and 12 months

Energy/nutrient intake	*Baseline*	*12 months*	*Change (D)*	*Percent change (%D)*
Group I	N=137	N=119		
Energy (kcal)	1554±233	1565±198	10.5±190.0*	1.69±12.06*
Carbohydrates (g)	203.5±35.5	201.6±31.7	-2.1±30.1[$]	0.36±14.53[‡]
Protein (g)	57.0±11.0	57.7±10.6	0.7±9.4*	2.92±18.68*
Fat (g)	57.2±12.2	58.7±10.0	1.5±11.4[†]	5.64±21.55[#]
Vitamin C (mg)	100.2±67.5	100.9±85.8		
Calcium (mg)	413.8±213.4	421.5±188.0		
Iron (mg)	12.8±5.6	11.7±4.8[≠]		
Group II	N=121	N=100		
Energy (kcal)	1667±216	1571±172*	-95.7±185.9	-4.92±10.76[a]
Carbohydrates (g)	221.4±35.6	207.4±27.6*	-14.0±31.6	-4.98±14.11[a]
Protein (g)	61.8±10.7	57.2±8.8*	-4.5±10.8	-5.69±14.08[a]
Fat (g)	59.2±12.0	56.5±11.5[≠]	-2.7±13.6	-2.09±22.75[a]
Vitamin C (mg)	108.4±84.7	105.8±96.8	-	-
Calcium (mg)	464.0±199.0	448.1±170.9	-	-
Iron (mg)	12.3±3.9	12.3±6.1	-	-
Group III	N=102	N=89		
Energy (kcal)	1635±214	1564±160[§]	-71.3±213.0	-3.25±2.47[b]
Carbohydrates (g)	217.1±36.2	205.3±25.1[§]	-11.9±34.8	-3.68±15.37[b]
Protein (g)	60.0±9.8	61.61± 10.2	1.6±11.3	4.39±19.49[c]
Fat (g)	58.6±9.9	55.1±10.0[#]	-3.6±12.4	-4.35±20.15[b]
Vitamin C (mg)	111.5±63.8	97.1±50.4	-	-
Calcium (mg)	457.9±207.0	469.4±215.1	-	-
Iron (mg)	12.1±4.1	11.3±3.5	-	-

Weighted energy intake (all) =2142.2 kcal
Weighted ferrum intake (all) =17.23 mg
*p<0.000; [#]p=0.001; [§]p=0.002; [†]p=0.004; [‡]p=0.012; [$]p=0.013; [≠]p=0.035; baseline vs. 12 months
[a] I vs. II (%Δ): energy (p=0.0005), carbohydrate (p=0.004), protein (p=0.0005) and fat (p=0.006)
[b] I vs. III (%Δ):energy (p=0.005), carbohydrate (p=0.046) and fat (p=0.0005)
[c] II vs. III (%Δ): protein (p=0.0005)
One way ANOVA was performed at baseline, 2x3 ANOVA for overall intervention effects and t-test for post hoc comparison

decreased intake of all macronutrients while group III had a selective reduction in intake of carbohydrate 3.7%, fat 4.4% with 4.4% increment in protein. Post-intervention, groups II and III showed a reduction in total energy intake without compromising intake of important minerals such as iron. Except for the difference in protein intake, groups II and III were similar in intake of other nutrients.

At entry, 53.3% of participants had normal BMI, 33.9% were overweight and 9.5% obese, a similar distribution between groups. An overall non-significant effect of the intervention programme could be seen on the weight, waist and hip circumference (Table 4). Group III had a mean weight loss of 1.7kg with a loss of 0.86cm and 0.39cm off the waist and hips. Body weight in group II remained stable minus 0.31cm and 0.30cm from the waist and hips. Group III lost the most body fat, 3.55g (-4.6±20.2%) followed by group II, 2.68 g (-2.1±22.8%). Waist circumference increased marginally but hips were trimmed by 0.40cm accounting for a small

Table 4. Comparison of anthropometric measurements at baseline and 12 months

Anthropometric Measurements	*Group I*	*Group II*	*Group III*
	Mean±SD		
Baseline	N=137	N=121	N=102
Weight (kg)	58.74±8.10	60.43±8.89	60.02±10.23
Height (m)	1.55±0.05	1.55±0.05	1.54±0.06
Body mass index (kg/m^2)	24.41±3.63	25.03±3.54	25.29±4.55
Waist circumference (cm)	78.00±7.53	80.21±8.41	80.78±9.00
Hip circumference (cm)	97.38±7.92	97.53±8.68	97.20±7.71
12 months	N=119	N=100	N=89
Weight (kg)	58.62±8.02	60.43±8.89	58.73±9.19
Height (m)	1.55±0.05	1.55±0.05	1.54±0.05
Body mass index (kg/m^2)	24.50±3.57	24.96±3.48	25.14±4.43
Waist circumference (cm)	78.07±7.67	79.90±8.22	79.92±8.43
Hip circumference (cm)	96.98±5.95	97.23±8.03	96.81±7.77

	%					
BMI classification (WHO, 1995]	B/line	12mths	B/line	12mths	B/line	12mths
Below normal (<18.5)	2.2	1.2	3.3	5.0	4.9	5.7
Normal (≥18.5-25.0)	59.9	60.3	46.3	48.0	51.0	46.9
Overweight (>25.0-29.9)	31.4	32.5	40.5	39.0	30.4	36.0
Obese I (≥30.0-34.9)	5.8	6.0	9.9	8.0	10.7	9.1
Obese II (≥35.0-39.9)	0.7	-	-	-	1.0	2.3
Obese III (≥40.0)	-	-	-	-	2.0	-
WHR classification [WHO, 1998]						
≤0.85	48.9	42.0	40.5	32.0	33.3	25.8
>0.85	51.1	58.0	59.5	68.0	66.7	74.2

Table 5. Comparison of blood sugar at baseline and 12 months

Blood sugar (mmol/L)	*Group I*	*Group II*	*Group III*
		Mean±SD	
Baseline	N=137	N=120	N=101
FBS	5.32±0.97	5.40±1.38	5.35±1.05
2 HPP	6.49±2.75	6.63±3.17	6.76±2.34
12 months	N=119	N=100	N=89
FBS	5.31±0.71	5.27±1.51	5.16±0.71
2 HPP	7.28±3.33	6.71±3.73	7.59±2.46
Diabetes classification [WHO 1999]		(%)	
Baseline	N=137	N=120	N=101
FBS			
Normal (<6.1)	91.2	90.0	91.1
IGT (≥6.1-<7.0)	3.6	5.8	5.0
DM (≥7.0)	5.1	4.2	4.0
2 HPP*			
Normal (<6.1)	83.2	82.5	72.3
IGT (≥6.1-<7.0)	12.4	13.3	22.8
DM (≥7.0)	4.4	4.2	5.0
12 months	N=119	N=100	N=89
FBS			
Normal (<6.1)	91.6	91.0	92.1
IGT (≥6.1-<7.0)	5.9	8.0	2.2
DM (≥7.0)	2.5	1.0	5.6
2 HPP*			
Normal (<6.1)	75.6	82.0	60.7
IGT (≥6.1-<7.0)	16.8	17.0	27.0
DM (≥7.0)	7.6	1.0	12.3

*p=0.004

weight loss of 0.12kg in group I concomitant with a very slight loss of body fat. Thus comparatively, increased abdominal obesity was observed in the controls post-intervention. Three-fifths (58.3%) of all women had high waist hip ratio (WHR) at baseline, with no statistical difference between groups. Post-intervention, women with high WHR increased 6.9%, 8.5% and 7.5% to 58%, 68% and 74% in groups I, II and III respectively. All anthropometric changes were statistically not significant.

Mean fasting blood sugar (FBS) and two-hour post-prandial (2HPP) blood sugar showed non-significant overall changes post-intervention. FBS decreased in groups II and III with group I unchanged whereas mean 2HPP blood sugar were increased in all groups. Group II had a minimal increment of 0.08mmol/L while groups I and III increased by 0.79 and 0.83mmol/L respectively. Ninety percent of women had normal FBS at baseline and this was maintained after 12 months.

Impaired glucose tolerance (IGT) and diabetes mellitus (DM) were seen in 20% of women at baseline which increased to 26.6% post-intervention. The increase in DM was mainly in groups I and III. On the other hand, group II had a rise in those with IGT without overt diabetes, which was statistically significant (Table 5).

Generally a more atherogenic lipid profile was seen after 12 months in all groups with decreased mean HDL-C, increased mean LDL-C and mean TC (Table 6). Overall intervention effects were observed between subjects for TG (p=0.0022) and TC (p=0.0024); within subjects for HDL-C (p=0.0001) and both within and between subjects for LDL-C (p=0.0213 and 0.0324). Group I had significant increment (5.2%) of mean TC mainly attributable to the rising level of LDL-C

Table 6. Comparison of lipid levels at baseline and 12 months

Lipid levels (mmol/L)	*Group I*	*Group II*	*Group III*
		Mean±SD	
Baseline	N=137	N=120	N=101
TG	1.12±0.58	1.17±0.70	1.23±0.62
TC	5.63±0.92	5.55±0.92	5.90±0.84
HDL-C	1.59±0.31	1.58±0.30	1.57±0.41
LDL-C	3.53±0.87	3.46±0.86	3.77±0.84
12 months	N=119	N=100	N=89
TG	1.09±0.50	1.07±0.48	1.33±0.57‡
TC	5.92±0.92$	5.67±0.94	5.91±0.99
HDL-C	1.48±0.29*	1.42±0.27*	1.44±0.32†
LDL-C	3.97±0.94*	3.73±0.83#	3.89±0.94

Dyslipidaemia Classification (NCEP Expert Panel, 2001]	(%)					
	B/line	12mo	B/line	12mo	B/line	12mo
TG						
Optimal; <1.7	87.0	87.6	85.8	86.0	81.2	80.5
Borderline; 1.7 to <2.2	9.2	8.8	5.8	6.0	10.9	9.2
High; ≥2.2	3.8	3.5	8.3	8.0	7.9	10.3
TC						
Normal; <5.2	27.5	26.5	38.3	43.0	17.5	23.0
Borderline; 5.2 to <6.2	38.9	39.8	29.2	28.0	48.1	42.5
High; ≥6.2	33.6	33.6	32.5	29.0	34.4	34.5
LDL-C						
Normal; <3.4	36.6	38.9	44.2	45.0	32.7	35.6
Borderline; 3.4 to <4.1	31.3	30.1	27.5	29.0	29.7	29.9
High, ≥4.1	32.1	31.0	28.3	26.0	37.6	34.5
HDL-C						
Good; ≥1.6	90.1	91.2	90.0	89.0	89.1	86.2
Average; ≥1.0 to <1.6	6.9	5.3	9.2	11.0	5.9	9.2
Poor; <1.0	3.1	3.5	0.8	0	5.0	4.6

*p=0.0005; †p=0.001; #p=0.004; $p=0.009; ‡p=0.030; baseline vs. 12 months

(12.5%). Group II also showed a significant rise (7.8%) of mean LDL-C with minor impact on TC (2.2%). LDL-C in group III increased 3.2% with no change in TC but TG increased significantly. Although the lipid profile worsened with age, the intervention groups were comparatively better than the controls. At entry, a third of all women had high TC (33.0%) and LDL-C (31.8%) whereas a quarter (26.7%) had high TG. Another 39.2% and 29.8% had borderline high TC and LDL-C with similar distribution between groups. Post-intervention, cases of borderline and high TC reduced by 4.7% and 5.5% in groups II and III respectively. All changes in lipids risk categories were statistically insignificant.

All groups displayed a similar pattern of food consumption at baseline with minor variations. Fish was the main source of protein followed by poultry and meat in all groups (Table 7). Meat intake was generally low with 5% reporting daily intake and a quarter, 2-3 times weekly. Post-intervention, group III showed increased fish and seafood consumption, 2-3 times per week. Groups I and II showed an increase of non-meat eaters from 22% to 26% and 16% to 22%, while group III declined by 3%. Group III also had 8.5% increase in weekly meat intake. Increased fish and meat consumption probably accounted for the higher protein intake seen in group III after 12 months. Egg consumption increased in group I but reduced in groups II and III with none reporting daily consumption. Consumption of legumes increased in groups I and II with more having it once to thrice weekly. Vegetable and fruit intake was high in all groups.

At entry, consumption of dairy products was low; a third took cheese/yogurt once per month with another third never. Post-intervention, consumption of cheese and yogurt increased in group II with 7% reduction in non cheese-yogurt eater which decreased in other groups. Milk consumption increased in all groups with non-milk drinkers in group I falling by 14.3% while group II had 9% rise in daily milk drinkers. The number of non-coffee drinkers increased in groups II and III by 11% and 2.5% while non-tea drinkers increased 5.4% and 7.6% in groups I and III. Only group I showed more fast food consumption post-intervention. All changes in food consumption did not reach statistical significance. Post-intervention, groups II and III had a healthier food consumption pattern compared to group I who ate more eggs and fast food, which probably accounted for the higher fat intake.

At baseline, 83.9% of participants reported having a daily breakfast. Post-intervention, changes in breakfast and snacking practices were seen mainly in controls with an increase from 77.4% to 89.2% of those who have breakfast daily. Groups II and III remained at 89.9% and 85.9% respectively, similar to baseline. At entry, 31.4% and 15.8% of all women reported snacking one or more times per day. Group I had an increase of 8% women who snacked one or more times daily while groups II and III remained at 39.3% and 42.5% respectively. Group III also had an increase in those who seldom snacked from 18.6% to 32.8%. Popular snacks included bread, biscuits, cereals and pastries. All changes in dietary practices were not statistically significant.

Two thirds (62.5%) of women reported regular physical activity with an average time of 2.52±3.66 hours per week at baseline (Table 8). Most (99%) did not smoke and 8.6% regularly took alcohol as medicinal tonic. Post-intervention, participation in regular exercises increased in all groups with the largest gain in group II (17.7%) followed by group III (14.6%) with augmentation in exercise duration of 0.97 and 0.42 hours per week. Group I had 7.5% increase in regular exercisers, 0.23 hour increment in exercise duration and 10.3% more subjects who took supplementary

Table 7. Comparison of food frequency at baseline and 12 months

	Frequency (%)									
	Everyday		*2-3 per wk*		*1 per wk*		*1 per month*		*Never*	
	B/line	*12 mo*	*B/line*	*12 mo*	*B/line*	*12 mo*	*B/line*	*12 mo*	*B/line*	*12 mo*
Fish/seafood										
I	37.2	38.7	48.2	44.5	10.9	10.9	2.9	3.4	0.7	2.5
II	32.2	33.0	54.5	49.0	5.8	12.0	4.1	4.0	3.3	2.0
III	42.2	30.3	49.0	60.7	4.9	6.7	2.9	1.1	1.0	1.1
Poultry										
I	12.4	4.2	56.9	53.8	16.1	31.9	8.8	5.0	5.8	5.0
II	15.7	4.0	54.5	59.0	19.0	29.0	5.8	3.0	5.0	5.0
III	10.8	4.5	49.0	57.3	27.5	31.5	6.9	5.6	5.9	1.1
Meat										
I	3.6	4.2	24.1	21.8	23.4	21.8	27.0	26.9	21.9	25.2
II	7.4	-	19.8	18.0	36.4	35.0	20.7	25.0	15.7	22.0
III	2.9	2.2	26.5	25.8	19.6	28.1	26.5	22.5	24.5	21.3
Eggs										
I	5.8	5.0	42.3	43.7	31.4	35.3	15.3	10.9	5.1	5.0
II	2.5	1.0	52.9	48.0	34.7	38.0	8.3	8.0	1.7	5.0
III	4.9	-	51.0	47.2	34.3	37.1	6.9	13.5	2.9	2.2
Legumes										
I	16.1	10.1	42.3	45.4	25.5	32.8	14.6	10.9	1.5	0.8
II	14.9	12.0	46.3	57.0	21.5	25.0	15.7	6.0	1.7	-
III	14.7	7.9	51.0	57.3	23.5	22.5	7.8	10.1	2.9	2.2
Vegetables										
I	93.4	92.4	5.8	7.6	0.7	-	-	-	-	-
II	88.4	91.0	7.4	9.0	2.5	-	1.7	-	-	-
III	91.2	93.3	7.8	6.7	1.0	-	-	-	-	-
Fruits										
I	67.9	68.9	24.8	26.9	5.1	-	0.7	3.4	1.5	0.8
II	66.9	69.0	24.0	22.0	5.0	8.0	1.7	1.0	2.5	-
III	76.5	84.3	16.7	13.5	4.9	2.2	2.0	-	-	-
Cheese/yogurt										
I	4.4	1.7	9.5	12.6	16.8	16.8	29.9	26.1	39.4	42.9
II	5.8	4.0	12.4	17.0	17.4	21.0	29.8	30.0	34.7	28.0
III	5.9	4.5	16.7	20.2	12.7	15.7	31.4	23.6	33.3	36.0
Milk										
I	28.5	28.6	18.2	19.3	8.8	10.9	17.5	13.4	27.0	12.7
II	33.1	42.0	24.0	21.0	13.2	10.0	9.9	6.0	19.8	21.0
III	45.1	39.3	13.7	20.2	9.8	18.0	11.8	5.6	19.6	16.9
Coffee										
I	41.0	37.8	17.9	21.8	3.7	4.2	3.7	4.2	33.6	31.9
II	29.2	26.0	17.5	13.0	5.0	3.0	7.5	6.0	40.8	52.0
III	34.3	32.6	19.6	14.6	2.9	4.5	3.9	5.6	39.2	42.7
Tea										
I	28.4	23.5	14.2	13.4	4.5	8.4	10.4	6.7	42.5	47.9
II	24.2	23.0	15.8	14.0	10.8	10.0	2.5	3.0	46.7	50.0
III	16.7	20.2	20.6	23.6	5.9	6.7	1.0	1.1	55.9	48.3
Fastfood										
I	-	-	-	1.7	6.0	5.9	37.3	42.0	56.7	50.4
II	-	-	2.5	2.0	2.5	6.0	39.2	28.0	55.8	64.0
III	-	-	2.0	-	3.9	1.1	26.5	30.3	67.6	68.5

Baseline, n for groups I=137, II=121, III=102
Post intervention, n for groups I=119, II=100, III=89

Table 8. Comparison of lifestyle practices at baseline and 12 months

Lifestyle practices	*Group I (%)*		*Group II (%)*		*Group III (%)*	
	B/line	*12mo*	*B/line*	*12mo*	*B/line*	*12mo*
	N=137	N=119	N=121	N=100	N=102	N=89
Regular physical exercises	60.6	68.1	65.3	83.0	61.8	76.4
Supplementary vitamins and minerals*	66.4	73.1	54.5	67.0	59.8	57.2
Traditional medicine or supplementary foods	65.0	58.0	59.5	62.0	59.8	50.6
Supplementary calcium	53.3	63.9	54.5	56.0	44.1	46.1
Smoking						
Never	96.4	97.5	96.7	98.0	97.1	98.9
Past user	1.5	1.7	2.5	1.0	2.9	1.1
Current user	2.2	0.8	0.8	1.0	-	-
Alcohol						
Never	88.3	91.6	92.6	92.0	85.3	88.8
Previous user	3.6	1.7	0.8	2.0	2.9	3.4
Current user	8.0	6.7	6.6	6.0	11.8	7.8
Exercise duration (hr/wk)	2.20±3.04	2.43±3.18	2.60±4.23	3.57±4.79	2.74±3.71	3.16±4.09

calcium. A decline of 7% and 9% in those who took traditional medicine or supplementary food was observed in groups I and III respectively. All lifestyle changes were not statistically significant.

All groups showed an increase in the proportion of subjects with high knowledge scores post-intervention especially groups II and III although no statistical difference was seen (Table 9). A better indicator would be the familiarity of subjects towards the food pyramid. At baseline, two-fifths (43%) knew of the food pyramid with no significant difference between groups. Post-intervention, significantly ($p<0.001$) more women in groups II (88.0%) and III (88.8%) knew of the food pyramid compared to group I (58.8%).

DISCUSSION

The findings of this study reflected middle aged Malaysian women of higher income and better education in an urban community. They were more likely to possess better health status, and be open to health information and guidance. As expected, the women sampled had a healthy lifestyle and good dietary practices i.e. 62% exercised regularly, 84% breakfasted each morning and only 1% smoked regularly. Although findings from this study may not be extrapolated to all Malaysian women, it would provide impetus for more research into the subject.

Total EI at baseline correlated well with BMI ($r=0.364$, $p<0.05$), an indication

Table 9. Comparison of nutritional knowledge at baseline and 12 months

Knowledge score category	*Group I (%)*	*Group II (%)*	*Group III (%)*
Baseline	N=137	N=121	N=102
High (≥75%)	41.6	41.3	32.3
Moderate (74-50%)	40.1	38.8	46.1
Poor (<50%)	18.2	19.8	21.6
Knowledge of food pyramid	43.1	49.6	35.3
12 months	N=119	N=100	N=89
High (≥75%)	57.1	74.0	66.3
Moderate (74-50%)	31.9	21.0	28.1
Poor (<50%)	10.9	5.0	5.6
Knowledge of food pyramid*	58.8	88.0	88.8

*p<0.001

that the estimation of food intake was valid. Based on the results of EI ratio [Ismail *et al.*, 1997], majority of the subjects had estimates of food intake within norm. The estimated mean EI was almost 25% below present RNI level but 11% of the previous Malaysian RDA, an observation consistent with other local studies [Suriah *et al.*, 1996, Chee *et al.*, 1996, Chee *et al.*, 1997]. The use of raw vegetables and fruits as reference of vitamin C content gave rise to high estimates of vitamin C intake [Bingham *et al.*, 1994; Chee *et al.*, 1997, Shahar *et al.*, 2000]. Likewise the Asian food staple rice, considered a low quality protein, gave rise to a high protein estimate.

A significant reduction of energy and fat intake was achieved in groups II and III post-intervention. More importantly, the reduction of energy intake was achieved without compromising essential minerals such as iron [Pathak *et al.*, 2004; Gibson, 2004]. In contrast, group I showed increased energy intake with 5.6% more fat as well as lower iron intake, an unhealthy trend as 20% of women were anaemic at baseline. Regrettably, calcium intake remained poor after intervention, ~440mg daily whilst Malaysian RNI advised a daily intake of 1000mg for prevention of osteoporosis in women above 50 years. More emphasis on this aspect would further improve efficacy of the intervention programme.

The lower energy/fat intake most likely accounted for the reduction in waist and hip circumference in groups II and III post-intervention. Group III had a lower fat intake balanced by higher protein compared to group II who showed overall reduction of all macronutrients. Reduction of 2-5% fat intake among the intervention groups would be in line with the WHO [1995] recommendation of less than 30% fat intake for reduction of chronic diseases since baseline fat intake was 32%.

Based on body fat, group III lost the most, followed by group II although it was comparatively lesser than other studies such as the Vanguard Women's Health Trial [Henderson *et al.*, 1990], Women's Health Trial Feasibility Study in Minority Populations [Coates *et al.*, 1999] and Worcester Area Trial or Counseling in Hyperlipidemia [Herbert *et al.*, 1999]. Previous studies had shown that women on HRT had the highest reduction of abdominal fat, a positive attribute of oestrogen replacement [Espeland *et al.*, 1997] as observed in group III. Besides HRT, increased exercise participation with a longer duration brought about a decreased energy balance which halted the progression of abdominal obesity as group II had successfully shown. In contrast, controls with smaller WHR at the onset showed increased abdominal obesity post-intervention, possibly influenced by changes wrought by onset of menopause [Wing *et al.*, 1991; Poehlman *et al.*, 1995; Svendsen *et al.*, 1995; Lahti-Kroski *et al.*, 2000].

After 12 months, a more atherogenic lipid profile was seen in all groups, similar to other ageing populations of women [Van der Graff *et al.*, 1997]. Although the lipid profile worsened with age, the intervention groups were better off compared to the controls. The deterioration was blunted in the intervention groups compared to controls, which showed a substantial rise in LDL-C and TC. Group II had increased LDL-C without significant impact on TC while Group III had increased TG, an effect of HRT that had been observed in other studies [Wahl *et al.*, 1983; Walsh *et al.*, 1991; Miller *et al.*, 1991]. The therapeutic effect of HRT on total cholesterol and LDL-C had been substantiated by other studies which showed up to 30% lipid reduction in postmenopausal women [Grandy *et al.*, 1992; Fung *et al.*, 1999; Mendelsohn & Karas, 1999].

Lifestyle intervention alone impeded the age-dependent increase of LDL-C and TC, indirectly lowering the risk of cardiovascular disease. Each 1 mmol/l increment of TC was associated with 35% increased risk of coronary death and 25% increased risk of fatal or non-fatal ischaemic stroke [Asia Pacific Cohort Studies Collaboration, 2003]. Unlike other studies which showed a favourable effect of exercise on HDL-C level, all groups had lower HDL-C post-intervention. Low HDL-C level was associated to the ageing process and negatively influenced by body mass index, central obesity and dyslipidaemia especially TG [Hansel *et al.*, 2006; Kim *et al.*, 2006]. The intervention programme could not reverse the reducing trend in HDL-C, probably due to the shorter duration of intervention i.e. 12 months whereas two years of frequent participation in moderate intensity exercises showed a rise in HDL-C levels in older men and postmenopausal women [King *et al.*, 1995].

IGT and DM were seen in 20% of women at baseline which increased to 26.6% after 12 months. The increase in diabetes was mainly in groups I and III while group II showed an increase of those with impaired glucose tolerance. Group III being older and having twice the number of postmenopausal women compared to group I and II, had more diabetics and higher 2HPP blood sugar at baseline, which may have influenced the outcome post-intervention. Physical activity, recommended for prevention of DM in postmenopausal women had shown an inverse relationship to 2HPP glucose level [Cederholm & Wibell, 1985; Folsom *et al.*, 2000]. Exercise acted by increasing insulin sensitivity, decreasing TG and TC as well as improving glucose tolerance in obese women [Zierath & Wallberg-Henriksson, 1992]. Comparatively, increased exercise participation with a longer duration in group II was able to delay the onset of diabetes, a clinically important outcome as diabetic women were three-fold more likely to die of heart disease [Barrett-Connor *et al.*, 1991].

The findings showed that participation in the study motivated all women to live healthier, an effect augmented by selection bias as health-conscious, strongly motivated women were the volunteers. This probably accounted for overall improvement in nutrition and food habits of all participants although to a lesser degree in group I. Dropouts from the intervention groups may have increased the effectiveness of the intervention package as those who deemed themselves less competent or not achieving targets may have removed themselves from the programme. We have tried to minimise this aspect by repeatedly contacting the subjects to ensure that they turn up. This strategy probably accounted for the low dropout of 14.4% as similar intervention studies had shown a higher dropout rate [Graffagnino *et al.*, 2006; Melin *et al.*, 2006].

Cross contamination between groups were likely as blinding of subjects was not feasible over a fairly long intervention period of 12 months. Repeated visits for blood and various tests brought many women together where they exchanged views and ideas which accounted for the overall increase in nutritional knowledge, exercise participation and duration which made statistical analysis of these components inconclusive. The control group too showed lifestyle changes of 10% increase in women who took calcium supplementation, 12% more took daily breakfast, 8% more exercised regularly with increased milk consumption and reduction in coffee/tea intake.

Similar to findings of Cook *et al.* [2001] that increased knowledge improved dietary practices and nutritional status, this study showed an improved diet, dietary practices and lifestyle changes, concomitant with a rise in knowledge. Thus women were encouraged to change their behaviour with better knowledge of nutrition and health [Shewry *et al.*, 1990]. Although all groups showed an increase of subjects with high knowledge scores post intervention, groups II and III had a higher awareness of the food pyramid which provided a practical guide for daily food consumption. Familiarity with the food pyramid among other aspects of knowledge and practice was significantly associated with the extent of nutrient use [Bhargava, 2004]. Post-intervention, groups II and III had a healthier food consumption pattern and nutritional composition compared to group I, with an increase of 8% women who snacked once/more per day, higher eggs intake and more frequent fast food consumption.

Generally the lifestyle intervention package was well received by the participants. The exercise programme was positively accepted as it was a home-based programme that required no special equipment or regular attendance at group meetings. It allowed the participants flexible control over time and place of activity. Furthermore, as a low intensity intervention programme, the cost of implementation was modest with obvious benefits to the participants. Despite increased consumption of milk and dairy products, overall level of intake remained low as dairy products were generally not popular. As midlife women had low meat intake, calcium and iron intake from other sources needed to be emphasised. Further adaptations of the dietary component with advice on obtaining micronutrients from local produce would contribute towards a balanced diet in midlife Malaysian women.

CONCLUSION

The lifestyle intervention programme brought about improved nutritional composition, dietary habits, exercise participation and increment in knowledge with concomitant improvement in health status. The benefits observed were from reduction in energy, fat and carbohydrate intake with increased intake of legumes for low fat protein and fiber; milk and cheese for calcium; and reduction of tea and coffee. Body weight was reduced plus abdominal obesity prevented in the intervention groups with HRT being more effective. The lifestyle intervention package with a flexible exercise programme was well received by the participants. Further adaptations of the dietary component with suggestions on acquiring micronutrients especially calcium and iron from local produce would contribute towards a balanced diet in midlife Malaysian women.

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