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Effect Of Nutrition Education And Sun Exposure On Vitamin D Status Among Postmenopausal Malay Women

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Abstract- A total of 169 subjects aged 49 to 74 years were recruited from rural community in the region of Sepang. They were randomized into four groups: control (CG, n = 42), nutrition education (NEG, n = 42), sun exposure (SEG, n = 42) and lastly nutrition education with sun exposure (NESEG, n = 43). Serum 25(OH)D was measured using an enzyme-linked immunosorbent (ELISA Kit) and parathyroid hormone (PTH) was measured using immunoradiometric assay (IRMA). Vitamin D intake was assessed using three-day food records. A questionnaire was used to assess knowledge, attitude and practice among the subjects. Measurements were made at baseline, 4 months and 12 months. The mean of vitamin D intake for all groups at baseline were lower (CG = 2.6 ± 1.8 µg; NEG = 2.9 ± 1.7 µg; SEG = 2.8 ± 1.9 µg and NESEG = 3.4 ± 2.5 µg) than the recommended nutrient intakes (RNI) for Malaysia (10 µg). Serum 25(OH)D for all groups were in the range of 50 – 100 nmol/l (defined as hypovitaminosis D). Serum 25(OH)D was found to significantly correlate with BMI, fat mass, serum PTH, knowledge and practice scores. After intervention, knowledge and practice scores of NEG and NESEG increased compare with baseline and higher than CG and SEG. The nutrition education had an additional benefit of increasing the knowledge and practice scores. However, after intervention, vitamin D intake and serum 25(OH)D levels decreased for all the groups. It indicated that to increase of serum 25(OH)D levels for postmenopausal Malay women could be conducted through vitamin D supplementation, as well as through nutrition education and sun exposure.

Keywords- *Nutrition education, sun exposure, serum 25(OH)D, vitamin D status, postmenopausal women.*

I. INTRODUCTION

Vitamin D is of major importance for bone to facilitate the absorption of calcium from the diet. So, low vitamin D intakes and blood levels of 25 hydroxyvitamin D (25(OH)D), the metabolite that best reflects vitamin D status, are clearly linked to bone lose and fracture [12], even helping gum disease [10]. It has also been reported that deficiency can lead to loss of muscle strength [3]. In elderly populations, one study found vitamin D supplementation decreased fractures by 58% [9]. Vitamin D deficiency is an endemic problem in the elderly. The major causes of vitamin D are deprivation of sunlight, a consequential decline in the synthesis of cutaneous vitamin D3 and decreased renal hydroxylation of 25(OH)D to its metabolically active form by the aging kidney. Therefore, vitamin D deficiency can be reversed easily and inexpensively through exposure to UV light.

Suriah et al. [26] in her study with postmenopausal Malaysian women. found that there were 27% Malay women who were hypovitaminosis D and 71% who were vitamin D insufficiency compared to 87% and 11% Chinese women respectively. Thus, the present study was conducted to assess the vitamin D status of postmenopausal Malay women after nutrition education and sun exposure intervention.

II. MATERIALS AND METHODS

A. Subjects

This research was conducted in 15 villages around Sepang, Selangor, Malaysia. Volunteers were invited with the assistance of village head and subject recruitment was conducted in various community halls of the villages. Subjects were initially screened for eligibility by using a questionnaire. Malay women who were aged between 49 and 74 years and more than 5 years postmenopausal were eligible for the study. Subjects were excluded if they were taking estrogen replacement therapy or had chronic illnesses (such as diabetes, kidney disease, heart disease, or cancer).

The screening yielded 169 eligible individuals who underwent random assignment and completed their baseline measurements. The subjects were randomly assigned to four groups: control (n=42), sun exposure (n=42), nutrition education (n=42) and lastly nutrition education with sun exposure (n=43).

The control group (CG) continued with their usual diet and activity. The sun exposure group was requested to do outdoor activities at 10 a.m. for 20 to 30 minutes, three times a week. The nutrition education group (NEG) received three sessions of nutrition education using materials which includes nutrition module, VCD and leaflet. The contents of the education material were functions, food sources, exposure to sunlight and effect of deficiency vitamin D. In the first session, nutrition education was delivered in the class using VCD and module. In the second and the third sessions, a home visit to each subject was carried out where they were given leaflet and to review back the information on vitamin D. As for the nutrition education with sun exposure group (NESEG), they received nutrition education as the NEG and also requested to do outdoor activities, such as gardening, sweeping the yard, walking to the shop, etc around 10 a.m. for 20 to 30 minutes, three times a week. The intervention was carried out for 3 months. The study protocol was approved by the research ethics committee of the National University of Malaysia. All subjects provided written informed consent.

B. Measurements

- Socio-demographic and reproductive history

At baseline subjects were interviewed to obtain socio-demographic information which included age and household income. Reproductive history including age at menopause, length of menopause, reproductive and cause of menopause were also recorded. At baseline, 4 month and 12 month subjects underwent measurements of anthropometry, provided fasting blood, 3-day food records and fill in the knowledge, attitude and practice (KAP) questionnaire.

- Food intake

Dietary intake was measured using 3-day food records for overall nutrients intake.. The subjects recorded all foods at the time of eating in local household measurements (i.e. bowls, cups, glasses, teaspoons and tablespoons). Vitamin D was calculated based on content of vitamin D in the food label and several references [11,21]. Vitamin D adequacy was assessed by comparison with the Recommended Nutrient Intakes (RNI) for Malaysia [20].

- Anthropometry

Subjects weight and height were also measured, in light clothing and without shoes, using a digital balance (SECA, Germany) with height attachment, to the nearest 100 g and 0.1 cm respectively. The body mass index was calculated as weight/height2 (kg/m2). Fat mass were measured by skinfold. Skinfold thickness measurements were taken at four sites (tricep, bicep, subscapula and suprailiac) using Harpenden skinfold calipers. Durnin dan Womersley Regression (1984) was used to define the fat mass [31].

- Biochemical analysis

Vitamin D status was most accurately reflected by serum 25(OH)D. Serum was kept frozen in batches at – 70oC and analyzed by an enzyme-linked immunosorbent (ELISA Kit) using the IDS OCTEIA 25(OH)D EIA kit (Immunodiagnostic Systems Inc., USA) . Intact parathyroid hormone was measured by immunoradiometric assay (IRMA) using the DiaSorin N-tact PTH SP IRMA kit (DiaSorin Inc., MN, USA).

- Knowledge, attitude and practice (KAP)

A set of questionnaire was used to assess knowledge, attitude and practice levels about vitamin D. The knowledge statement consisted of 20 items, the attitude statement consisted of 15 items and the practice statement consisted of 8 items. The validity of the questionnaire was determined using two methods, face validity and content validity. The instrument was pre-test to ensure that subjects understood the statements in the questionnaire. The reliability of the questionnaire was tested using the reliability analysis with the Statistical Package for Social Sciences (SPSS) version 13.0. The reliability analysis carried out showed that the Cronbach's alpha value for knowledge, attitude and practice were 0.73, 0.72 and 0.70 respectively. Cronbach's alpha value above 0.7 was regarded as having a moderate internal consistency in the questionnaire.

- Statistical analysis

Descriptive statistics were used to obtain the mean and standard deviation of the various parameters. Pearson's correlation was used to assess relationships between various indicates in the subjects. Analysis of covariance (ANCOVA) and Duncan's post-hoc test were used to determine group differences before and after intervention. All p values were two-tailed. The Statistical Package for Social Sciences (SPSS) software version 13.0 (SPSS Inc., Chicago, USA) was used for the data analysis.

III. RESULTS

A total of 142 subjects out of the 169 recruited completed this intervention, yielding a total dropout rate of 16%. The dropout rate for the control group (CG) was 19.1%, nutrition education group (NEG) was 7.1%, sun exposure group (SEG) was 28.6% and nutrition education with sun exposure (NESEG) was 9.3%. The reasons for drop-outs were moving home, sick, death, working, and take care their grandson.

The socio-demographic and reproductive history of the subjects are shown in Table 1. Majority of subjects were from low household income group. The mean age of subjects was 62.2 ± 7.0 years old and the age of menopause was around 50 years old. Most subjects in all groups underwent menopause naturally.

TABLE I. DEMOGRAPHIC CHARACTERISTICS AND REPRODUCTIVE HISTORY OF SUBJECTS

Characteristics	***CG* (n = 42)**	***NEG* (n = 42)**	***NESEG* (n = 43)**	***SEG* (n = 42)**
Age (yr)	61 ± 6.8	63 ± 7.8	62 ± 7.3	63 ± 6.1
Age at menopause (yr)	50 ± 4.4	48 ±7.8	49 ± 4.8	49 ± 3.8
Length of menopause (yr)	11.1 ± 9.4	13.5± 9.3	13.4± 8.7	13.2 ±6.9
Reproductive (yr)	36 ± 4.1	34 ± 8.3	35 ± 5.3	35 ± 4.5
Cause of menopause				
• Natural	95%	100%	93%	98%
• Surgical	5%	0%	7%	2%
Household income status				
• Low (<RM2000)	95%	98%	95%	90%
• Middle (RM2000-RM5000)	5%	2%	5%	10%
• High (>RM5000)	0%	0%	0%	0%

Table 2 shows the anthropometry measurements at baseline. The mean weight for all groups at baseline: CG were 62.9 ± 15 kg, NEG were 61.7 ± 14 kg, SEG were 57.1 ± 11.3 kg and NESEG were 62.9 ± 11.4 kg. Based on WHO (1998), BMI of the subjects for all groups were pre-obesity with range of BMI from 25 – 28 kg/m^2. The result of this study also found that fat mass of the subjects for all groups were normal. The statistical analysis with ANCOVA, BMI of SEG was significantly different with the CG, the NEG and the NESEG ($p<0.05$).

TABLE II. ANTHROPOMETRY OF THE SUBJECTS AT BASELINE (MEAN ± SD)

Anthropometry	CG (n = 42)	NEG (n =42)	SEG (n =42)	NESEG (n = 43)
Weight (kg)	62.9 ± 15	61.7 ± 14	57.1 ± 11.3	62.9 ± 11.4
Height (m)	1.50 ± 0.05	1.52 ± 0.06	1.52 ± 0.06	1.52 ± 0.06
BMI (kg/m2)	27.6 ± 6.0	26.8 ± 5.7	24.5 ± 4.5*	27.0 ± 4.30
Fat mass (kg)	26.8 ± 9.1	25.9 ± 9.1	22.9 ± 7.10	27.2 ± 7.10

* significant difference between groups at $\rho<0.05$

TABLE III. VITAMIN D INTAKE AND BIOCHEMICAL CHARACTERISTIC OF SUBJECTS AT BASELINE

	CG (n = 42)	NEG (n = 42)	SEG (n = 42)	NESEG (n = 43)
Vitamin D intake (µg)	2.6 ± 1.8	2.9 ± 1.7	2.8 ± 1.9	3.4 ± 2.5
Biochemical :				
PTH (pmol/l)	5.50 ± 2.70	5.2 ± 2.0	5.9 ± 2.3	5.9 ± 3.2
25(OH)D (nmol/l)	49.8 ± 22.7	57.1 ± 20.6	50.1 ± 25.5	53.2 ± 23.7

The mean of vitamin D intake for all groups at baseline : CG were 2.6 ± 1.8 µg, NEG were 2.9 ± 1.7 µg, SEG were 2.8 ± 1.9 µg and NESEG were 3.4 ± 2.5 µg. It was lower than the recommended nutrient intakes (RNI) for Malaysia of 10 µg for women 50 – 70 years of age. These values could be grossly underestimated due to the unavailability of vitamin D values in local foods. The cut-off point to determine adequate serum 25(OH)D concentrations is < 25 nmol/l is defined as vitamin D deficiency, 25 - 50 nmol/l is defined as vitamin D insufficiency, 50 - 100 nmol/l is defined as hypovitaminosis D and > 100 nmol/l is defined as desirable [18]. Using these cut-off point, Table 3 shows that the mean for all groups in the range of 50 – 57 nmol/l (defined as hypovitaminosis D).

Table 4 shows the percentage of vitamin D status of subjects at baseline. Results indicate a majority of the subjects in the NEG (57%), SEG (58%) and NESEG (50%) falls in the hypovitaminosis D category while a greater percentage of the CG subjects were vitamin D insufficiency.

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TABLE IV. PERCENTAGE OF SUBJECTS ACCORDING TO VITAMIN D STATUS AT BASELINE

Vitamin D status	CG (%) (n = 42)	NEG (%) (n = 42)	SEG (%) (n = 42)	NESEG (%) (n = 43)
Vitamin D deficiency (<25 nmol/l)	5.3	5.4	2.6	5.3
Vitamin D insufficiency (25 – 50 nmol/l)	57.9	32.4	39.5	42.1
Hypovitaminosi D (50-100 nmol/l)	34.2	56.8	57.9	50.0
Desirable (>100 nmol/l)	2.6	5.4	0	2.6

Base on the KAP score at baseline, knowledge scores on vitamin D for all groups was under 50%. However, attitude and practice scores for all groups were above 60% (Table 5).

TABLE V. KAP SCORES OF SUBJECTS AT BASELINE (MEAN ± SD)

Variable	Pearson (r)
Age	0.098
BMI	-0.217**
Fat mass	-0.185*
Intake vitamin D	0.004
PTH	-0.163*
Knowledge scores	0.115*
Attitude scores	0.074
Practice scores	0.148**

Table 6 shows the correlations between serum 25(OH)D levels and other variables. Serum 25(OH)D levels was found to negatively and significantly correlate with BMI (r = -0.217, p<0.01), fat mass (r = -0.185, p<0.05) and PTH levels (r = -0.163, p<0.05). Serum 25(OH)D levels also was found to positively and significantly correlate with knowledge scores (r = 0.115, p<0.01) and practice scores (r = 0.148, p<0.01).

TABLE VI. CORRELATIONS BETWEEN SERUM 25(OH)D LEVELS AND OTHER VARIABLES

	CG (n = 42)	NEG (n = 42)	SEG (n = 42)	NESEG (n = 43)
Knowledge scores (%)	46 ± 17	45 ± 18	45 ± 20	47 ± 21
Attitude scores (%)	66 ± 5	67 ± 6	67 ± 6	69 ± 7
Practice scores (%)	60 ± 13	62 ± 13	59 ± 12	60 ± 11

* Correlations was significant at p<0.05
** Correlations was significant at p<0.01

Table 7 presents the changes of vitamin D intake and biochemical after intervention. At 4 months, Vitamin D intake of all groups increased but at 12 months decreased. Based on ANCOVA, there were not significantly different for all the groups. However, vitamin D intake of the NESEG at 4 months showed a significant difference with baseline (p<0.05).

TABLE VII. CHANGES OF VITAMIN D INTAKE AND BIOCHEMICAL AFTER 4 MONTHS (N=157) AND 12 MONTHS (N=142)

	Mean of change ± s.d (4 months)	95% Confidence Interval	Mean of change ± s.d (12 months)	95% Confidence Interval
Intake Vitamin D (µg)				
CG	0.24 ± 0.5	(-1.3,0.8)	-0.54 ±0.4	(-1.4,0.3)
NEG	0.71 ± 0.5	(-1.7,0.2)	-0.68 ± 0.5	(-1.7,0.36)
SEG	0.89 ± 0.7	(-2.3,0.5)	-0.71 ± 0.6	(-1.9,0.4)
NESEG	1.10 ± 0.6	(-2.2,0.03)*	-0.70 ± 0.6	(-1.9,0.6)
Serum 25(OH)D				
CG	1.5 ± 4.9	(-11.4,8.3)	-15.2 ± 5.7 a	(-3.7,26.8)*
NEG	10.1 ± 4.4	(1.1,19.1)*	-13.3 ± 8.6 a	(-4.2,30.9)*
SEG	9.1 ± 6.0	(-3.2,21.4)*	-7.20 ± 5.8 b	(-4.8,19.1)
NESEG	9.4 ± 4.0	(1.2,17.6)*	-9.80 ± 9.8 a	(-10.5,30)*
Serum PTH (µg)				
CG	-0.44 ±0.57	(-0.71,1.58)	-0.12 ± 0.39	(-0.78,0.95)
NEG	0.15 ± 0.41	(-0.98,0.69)	-0.05 ± 0.21	(-0.46,0.80)
SEG	0.57 ± 0.51	(-1.60,0.46)	-0.77 ± 0.69	(-1.90,0.37)
NESEG	-0.25 ±0.34	(-0.44,0.93)	-0.93 ± 0.76	(-1.81,0.69)

[a,b,c] Significant difference between groups at p < 0.05
* Significant difference with baseline at p < 0.05

At 4 months after intervention, serum 25(OH)D of all groups increased but at 12 months it decreased. However based on ANCOVA, there were significant increased in 25(OH)D for the NEG, SEG and NESEG with baseline. After 12 months, the lost of serum 25(OH)D levels for the CG, the NEG and the NESEG were significantly different compared to baseline. Serum PTH of the groups did not change throughout the study. However, these lost of PTH levels were not significantly different compared to baseline for all the groups' analysis.

TABLE VIII. CHANGES OF KNOWLEDGE, ATTITTUDE AND PRACTICE SCORES AFTER 4 MONTHS (N=157) AND 12 MONTHS (N=142)

	mean of change ± s.d (4months)	95% confidence interval	mean of change ± s.d (12 months)	95% confidence interval
Knowledge scores (%)				
CG	0.9 ± 0.6	(-2.1,0.3)	1.4 ± 0.6 [a]	(-2.8,0.1)*
NEG	1.9 ± 0.6	(-3.2,0.7)*	3.1 ± 0.6 [b]	(-4.3,1.9)*
SEG	1.1 ± 0.9	(-3.0,0.9)	2.1 ± 0.9 [a]	(-3.9,0.2)*
NESEG	2.6 ± 0.8	(-4.3,0.9)*	3.8 ± 0.7 [c]	(-5.3,2.4)*
Attittude scores (%)				
CG	-1.6 ± 0.9	(-0.2,3.4)	3.7 ± 1.0 [a]	(-5.7,1.6)*
NEG	-1.7 ± 0.9	(-0.1,3.4)	2.4 ± 1.1 [b]	(-4.5,0.18)*
SEG	-1.7 ± 1.3	(-0.9,4.4)	0.5 ± 1.2 [c]	(-3.0,1.9)
NESEG	-1.3 ± 1.1	(-0.9,3.6)	2.6 ± 1.1 [b]	(-4.8,0.3)*
Practice scores (%)				
CG	0.2 ± 0.8	(-1.7,1.3)	5.1 ± 0.8 [a]	(-6.7,3.6)*
NEG	1.1 ± 0.4	(-1.9,0.2)*	5.7 ± 0.9 [b]	(-7.5,3.9)*
SEG	0.7 ± 0.7	(-2.2,0.8)	5.1 ± 0.9 [a]	(-6.8,3.3)*
NESEG	1.5 ± 0.7	(-3.0,0.0)*	7.5 ± 0.7 [b]	(-8.8,6.1)*

[a,b,c] Significant difference between groups at $p < 0.05$
* Significant difference with baseline at $p < 0.05$

After intervention, knowledge and practice scores of all the groups increased with NESEG having the highest than the other groups. However, at 4 months after intervention, attitude scores of all groups increased but at 12 months it decreased.

IV. DISCUSSION

We found the inverse relationship between serum 25(OH)D and BMI, which is consistent with other studies. Need et al. [22] suggested that it may be due to a larger body pool of vitamin D and 25(OH)D or to slower saturation and mobilization of these compounds from adipose tissues or both. Obese people have decreased bioavailability of vitamin D from cutaneous and dietary sources because of a tendency for vitamin D to deposit in adipose tissue. An alternative explanation was proposed by Bell et al. [2], who indicated that the vitamin D endocrine system on obese people is altered, with increased production of 1,25 dihydroxyvitamin D exerting negative feedback control on hepatic synthesis.

An effort to increase serum 25(OH)D levels could be achieved by increasing vitamin D intake or through dietary supplements of vitamin D. Many studies found that serum 25(OH)D were significantly and positively correlate with vitamin D intake. The result was reversed with this study. The fact, vitamin D intake of all the subjects were lower than RNI for Malaysia could be due to the consumption of fatty fish, milk and milk products of the subjects were low. The majority of subjects were in the low household income group. The study in Boston, reported that elderly adults who had low income were a high risk for vitamin D deficiency [12]. A limitation of the study is that the vitamin D intake could have been underestimated due to lack of vitamin D database of local Malaysian foods.

Serum 25(OH)D levels was inversely related to parathyroid hormone (PTH) levels. The relationship between serum 25(OH)D and PTH was similar to that found by others [8,12,14]. The production of 25(OH)D is stimulated by PTH [17].

After 12 months, serum 25(OH)D levels decreased for all the groups. This may result from the fact that age-related declines in skin synthesis of vitamin D. However, decreasing of serum 25(OH)D levels of the SEG was the lowest compared to the other groups. Melin et al. [19] reported that serum 25(OH)D levels were positively correlated with outdoor hours (≥ 3 hours/week) .

Nutrition education interventions have targeted persons to bring about changes in knowledge, attitude and behavior. Based on the popularity of television, videotaped lessons was found to be effective for delivering nutrition education and it is especially suitable for elderly with limited reading skill. The result found that the group who received nutrition education using video and leaflets improved on their nutrient intake like dietary fiber, vitamin A and vitamin C.

We also found increase in their knowledge and practice of the NEG and NESEG was higher than the CG and SEG.. Successful nutrition intervention programs of most studies were when nutrition messages were limited to one or two, simple, practical and targeted to specific needs the most important source of vitamin D is from synthesis of the vitamin D by sunlight exposure to the skin. Factors that affect cutaneous absorption include the use of sunblock, the level of sunlight exposure (e.g. time of day), clothing habits and skin pigmentation due to the presence of melanin concentration. These information were included in the nutrition education package for the NEG and NESEG, Besides the nutrition information, the NESEG were also required to do outdoor activities at 10 am for 20 to 30 minutes, three times a week. These could be the contribution reasons why these groups had high serum 25(OH)D more than CG.

V. CONCLUSION

Serum 25(OH)D levels was significantly correlate with BMI, fat mass, serum PTH, knowledge and practice scores. After 4 months intervention, vitamin D intake, serum 25(OH)D levels, knowledge and practice scores of NEG and NESEG increased compare with baseline. However, after 12 months intervention, knowledge and practice scores of NEG and NESEG increased but vitamin D intake and serum 25(OH)D levels decreased for all the groups. It indicated that to increase of serum 25(OH)D levels for postmenopausal Malay women could be conducted through vitamin D supplementation as well as nutrition education and sun exposure.

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