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ASSOCIATION BETWEEN SERUM 25-HYDROXYVITAMIN D LEVEL AND ANTHROPOMETRIC INDICES AMONG INSTITUTIONALIZED ELDERLY PEOPLE IN KELANTAN, MALAYSIA

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ABSTRACT

Elderly people in institutionalized home care might have the risk of getting certain nutrient deficiencies due to lack of food intake and comorbidities. This study was intended to investigate the prevalence of vitamin D deficiency among institutionalized elderly people and association between anthropometric indices with serum 25(OH)D level. 47 elderly people from Kelantan, age 60 years and above were interviewed for socio-demographic data and anthropometry measurements. The mean serum 25(OH)D level among elderly was 54.9 ± 19.4 nmol/l shows most of the elderly in this study were in hypovitaminosis D status (83%), but none were classified having vitamin D deficiency. In conclusion, vitamin D deficiency was not prevalent among institutionalized elderly in Malaysia and nutritional status has no or less effect on serum 25(OH)D level.

Keywords: elderly people; serum vitamin D; serum 25(OH)D; institutionalized elderly people.

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1. INTRODUCTION

Vitamin D is well known for its role in bone health and recent work has suggested its role in diabetes and cardiovascular diseases [1]. Vitamin D can be obtained exogenously from a few natural food sources, from food fortification and from supplements. It is also produce endogenously when the skin is exposed to ultraviolet B (UVB) irradiation (280-320 nm) from sunlight [2]. More than 90% of the circulating vitamin D in the body originates from the cutaneous production. Sunlight converts7-dehydrocholesterol in the skin to vitamin D3, which will be transported to the liver and hydroxylated to 25-hydroxyvitamin D [25(OH)D]. It will then be conveyed to the kidney and hydroxylated to 1,25-dihydroxyvitamin D (1,25(OH)D) [3-4].

Vitamin D insufficiency seems to be a common health problem for people who live in countries at high latitudes where sunshine hours are shorter in the winter [5]. However, studies reported countries such as in Hawaii, India, Iran and Saudi Arabia had shown low vitamin D status despite abundant sunlight [6-10]. The possible factors for vitamin D deficiency are the respondents' behaviour of avoiding sunlight or clothing which prevented sunlight exposure [11]. In hospitalized subjects particularly elderly, low vitamin D status seems to be aggravated by disease and immobility and by a low frequency of supplement use [2].

Factors such as obesity, vitamin D supplement use and genetic markers were also significantly associated with 25(OH)D concentrations. In addition, other behavioural factors may also influence the serum vitamin D concentrations, such as indoor lifestyles, sunscreen overuse, and lower intakes of vitamin D [12]. In [3] stated that a low vitamin D is highly prevalent among chronic illnesses, including common cancers, autoimmune diseases, infectious diseases, cardiovascular diseases and chronic obstructive pulmonary disease (COPD) [14].

Vitamin D insufficiency, the preclinical phase of vitamin D deficiency, is most commonly found in the elderly. The major causes of vitamin D deficiency and insufficiency are decreased renal hydroxylation of vitamin D, poor nutrition, scarce exposition to sunlight and a decline in the synthesis of vitamin D in the skin [15]. As nutritional status is regarded as a signal of the beginning of the emergence of degenerative diseases and are prevalent in developed and developing countries [16]. Thus, elderly people in institutionalized setting might be at high risk for nutrient-deficient. The aims of the study were to describe the

prevalence of vitamin D deficiency in elderly institutionalize elderly people in Kelantan, and to investigate the association between anthropometric indices and serum 25(OH) D level.

2. METHODOLOGY

2.1. Study Design and Respondents

This cross sectional study was conducted from August to November 2013 in Rumah Sri Kenangan (RSK) Taman Kemumin, Pengkalan Chepa, Kelantan. There are currently nine RSK distributed around the Peninsular Malaysia and RSK Taman Kemumin was the only RSK in Kelantan. The participants were recruited using purposive sampling technique. The inclusion criteria of this study are, residents of RSK Taman Kemumin aged 60 years and above, resided at least 3 months prior to the study period, no mental illnesses, no edema and no kyphosis. The exclusion criteria included those aged less than 60 years, free living elderly, staff in RSK Taman Kemumin and those who were diagnosed with neuro-psychiatric conditions and terminally ill.

A total of 47 elderly consisting of 25 males and 22 females were identified and took part voluntarily in this study. Written informed consent was obtained from the respondents before prior to enrolment. Respondents were interviewed on socio-demographic information by using structured questionnaire. Data such as age, gender, marital status, ethnicity, previous employment, educational level were obtained. Ethical approval was granted by UniSZA Human Research Ethics Committee (UniSZA.N/1/628-1(51)) and the study was approved by the Department of Social Welfare under the Ministry of Women, Family and Community Development, Malaysia (JKMM 100/12/5/2:2013/197).

2.2. Assessment of Nutritional Status

Anthropometric measurements were taken by using standard techniques. Height was measured using portable height stadiometer (SECA Bodymeter 217) and reading were taken twice to the nearest 0.1 cm. Respondent was told to be barefoot, legs straight, shoulders relaxed and to look straight ahead at the horizontal plane [17]. Respondent was asked to inhale deeply, hold the breath and maintain an erect position just before taking the measurement. If the respondents are unable to stand properly, the arm span was chosen as an alternative to height measurement. If the subject were unable to horizontally stretch the arm in line with shoulders, knee height was used as a last alternative. Estimations of the height from arm span and knee height for both genders were based on the Malaysian Elderly Specific Equation by [18].

The weight measurement was taken where respondents were asked to wear minimum clothing and for those who are able to stand, weight measurement was taken using portable electronic weighing scale (SECA 881). Respondents who may not be able to stand comfortably during measurement, the weighing chair scale (SECA 952) was used to obtain weight measurement. Reading of weight was taken twice to the nearest 0.1 kg. The body mass index (BMI) was derived using equation: weight in kilogram divided by height in meter square; BMI = weight (kg) / height $(m)^2$. BMI was defined as underweight with BMI < 18.5 kg/m^2; normal with BMI 18.5 to 24.9 kg/m^2; overweight with BMI 25.0 to 29.9 kg/m^2 and obese with BMI ≥ 30 kg/m^2 [19].

Mid Upper Arm Circumference (MUAC) was measured with the subject standing or lying on the bed while relaxing the arm to the side with the palm of the hand facing the thigh. A non-stretchable measuring tape was placed around the arm, perpendicular to the long axis of the arm and at midway of the acromion and olecranon process. All measurements were taken twice to the nearest centimeter and if both measurements differ > 0.4 cm, a third measurement was obtained. The average of the measurement was taken and accounted. MUAC categorization was based on cut off point for Asian [20].

For clinical indices, respondent's nourishment status was assessed using the Mini Nutritional Assessment-Short Form (MNA-SF) [21]. The form contains six simple questions including changes in food intake, involuntary weight loss, mobility, psychological stress or acute disease, neuropsychological problem and BMI, scored from zero to two or three. Respondents were categorized as "normal nutritional status" (12-14 points), "at nutritional risk" (8-11 points) and "malnourished" (0-7 points).

2.3. High Density Lipoprotein Cholesterol (HDL-and Total Cholesterol (TC) Determination

Venous blood samples were collected from the participants by phlebotomist in the morning after ten hours of fasting. The specimens were stored at -20◦C and serum samples were analyzed for HDL-C and TC. All laboratory assays were performed using commercially-available kits (Randox, UK). All analysis was done using SELECTRA-E chemistry analyzer (Vital Scientific, Netherlands).

2.4. Serum 25-Hydroxyvitamin D Concentration

Vitamin D status of the respondents was assessed using fasting venous blood. Vitamin D adequacy was evaluated by measuring serum 25(OH)D concentration, as this was the primary circulating form of vitamin D. The biochemical test used was the LAISON(R) 25 OH Vitamin

D TOTAL Assay. This assay used chemiluminescent immunoassay (CLIA) technology for the quantitative determination of 25(OH)D. These biochemical analyses were outsourced to a private laboratory with International Quality Control Certificate of Accreditation (MS ISO 15189). Vitamin D concentrations of respondents were further classified into three categories i.e. vitamin D deficiency (< 25 nmol/l), hypovitaminosis D (25 to 75 nmol/l) and normal vitamin D range (> 75 nmol/l) [22].

2.5. Statistical Analysis

Data were analyzed using IBM SPSS (Statistical Package for Social Sciences) version 20.0. Independent sample t-test was used to examine differences among continuous anthropometric data. Pearson correlation was used to examine the correlation between serum 25-hydroxyvitamin D (25(OH)D) concentration with anthropometric variables and blood lipid. The level of significance used was set at $p < 0.05$ for all statistical tests.

3. RESULTS AND DISCUSSION

A total of 47 elderly from 55 initial participants were included in the final analysis. Eight were excluded due to incomplete data. Table 1 summarizes the characteristics of study participants according to gender. There were 25 elderly men and 22 elderly women participated in this study. Majority were in age group of 70 to 79 years old (51.1%), Malay (76.6%), having a normal BMI (42.6%) and mid upper arm circumference (87.2%). This study found no significant correlation between serum 25(OH)D3 and anthropometric variables except for age among total sample. In general, age is considered as a risk factor for vitamin D deficiency due to a decrease in vitamin D3 synthesis in the skin and lower intakes of dietary vitamin D [12, 23].

The increasing prevalence of vitamin D deficiency with age was also reported in the US NHANES III report earlier (1988-1994) [24], and study by [25] found that efficiency of vitamin D synthesis which occurs in layer of skin is decreased with the aging process. In [12, 26] found that the prevalence of vitamin D deficiency is higher in younger age elderly people whereby they found that individuals between 50 and 59 years old were having highest total serum 25(OH)D3 levels, while individuals in group of 40-49 years old and over 90 years old groups had lowest values. However, the age related differences were not statistically significant.

Table 1. Characteristics of study participants according to gender (n = 47)

Characteristics	Men (n = 25)	Women (n = 22)
Age (years), mean ± SD	72.0 ± 6.4	72.5 ± 8.1
Age group, n (%)		
60-69	8 (32)	8 (36)
70-79	14 (56)	10 (46)
≥ 80	3 (12)	4 (18)
Ethnicity, n (%)		
Malay	17 (68)	19 (86)
Chinese	6 (24)	1 (5)
Indian	2 (8)	2 (9)
Weight (kg), mean ± SD	55.0 ± 13.0	43.9 ± 10.2
Height (cm), mean ± SD	160.3 ± 5.3	144.9 ± 7.2
BMI (kg/m^2), mean ± SD	21.4 ± 4.4	20.9 ± 4.2
BMI classification, n (%)		
Underweight (< 18.5 kg/m^2)	9 (36)	6 (27)
Normal weight (18.5-24.9 kg/m^2)	9 (36)	11 (50)
Overweight (25.0-29.9 kg/m^2)	6 (24)	4 (18)
Obese (> 29.9 kg/m^2)	1 (4)	1 (5)
MUAC (cm), mean ± SD	24.7 ± 2.3	24.9 ± 3.5
MUAC classification, n (%)		
Extreme wasting (< 21 cm)	-	2 (9)
Undernourished (21-22 cm)	3 (12)	1 (5)
Normal (> 22 cm)	22 (88)	19 (86)
MNA scores, mean ± SD	9.3 ± 3.1	9.6 ± 1.8
MNA classification, n (%)		
Malnourished (> 11 points)	9 (36)	5 (23)
At risk of malnutrition (8-11points)	9 (36)	14 (64)
Normal (< 8 points)	7 (28)	3 (13)
Serum 25(OH)D (nmol/l)	62.4± 19.7	46.3 ± 15.1
Serum 25(OH)D status, n (%)		
Normal range (> 75 nmol/l)	7 (28)	1 (5)
Hypovitaminosis D (25-75 nmol/l)	18 (72)	21 (95)

Vitamin D deficiency (< 25 nmol/l)	-	-
HDL-C (mmol/l)	1.1 ± 0.2	1.3 ± 0.2
HDL-C classification, n (%)		
Normal (> 1.1 mmol/l)	15 (60)	19 (86)
Abnormal (≤ 1.1 mmol/l)	10 (40)	3 (14)
TC (mmol/l)	4.9 ± 1.0	6.0 ± 1.2
TC classification, n (%)		
Normal	15 (60)	5 (23)
Abnormal	10 (40)	17 (77)

According to MNA-SF scores, majority of elderly people in this present study is at risk of malnutrition (48.9%) and some were even malnourished (29.8%). In [27] had observed that there was no improvement in percentage of under-nutrition in shelter homes, even though regular and nutritious meals and health care facilities were provided. This might be due to long term previous eating lifestyle and food habits along with loneliness and social isolation which could contribute to this problem [28].

In fact, majority of elderly in the present study were at risk of malnutrition despite having a normal BMI. However, we found no significant association between serum 25(OH)D3 level with total MNA-SF score. This result was in contrast with a finding done by [29], whereby the MNA scores were significantly associated with fair correlation with serum 25(OH)D3 levels. The key aspects discussed by [30] which proposed that since these components are independent of each other, vitamin D-deficiency in these subjects could not be explained by overall malnutrition alone. Similar to this, in [31] concluded that poor vitamin D status can increase age-related muscle mass loss as lower 25(OH)D3 concentrations were prospectively associated with greater muscle mass loss in elderly individuals and this relationship is independent of bone mineral density, inflammation, diet and other risk factors.

In this study, the mean serum 25(OH)D was 54.9 ± 19.4 nmol/l (minimum 29.0 nmol/l, maximum 103.0 nmol/l). Serum 25(OH)D status shows that most of the elderly in this study were in status of hypovitaminosis D (83%), but none were classified as having vitamin D deficiency. Our finding was similar with the study conducted among elderly in Germany B. [32], Japan [30] and among those in community-dwelling elderly [33]. It can be speculated that, regardless of the place of living of the elderly whether in community dwelling or the

institutionalized home care, the high prevalence of hypovitaminosis will still be occurring. In addition, even though Malaysia received abundance of sunlight exposure throughout the year, other risk factors such as limited outdoor activities, frequently stayed in shelter room and other behavioural factors may become the risk factors that can affect the serum vitamin D concentrations [12].

Table 2. Serum 25-hydroxyvitamin D (25(OH)D) concentration in elderly(n = 47)

	25(OH)D(nmol/l)		**P-Value[a]**
	Mean	**SD**	
Gender			0.003
Male	62.4	19.7	
Female	46.3	15.1	
BMI classification			0.587
Underweight	60.4	23.2	
Normal weight	53.5	19.4	
Overweight	50.3	13.9	
Obese	50.7	3.3	
MNA classification			0.804
Malnourished	57.6	13.1	
At risk of malnutrition	54.1	22.9	
Normal	52.7	19.2	
MUAC classification			0.902
Extreme wasting	51.9	9.8	
Undernourished	58.8	28.9	
Normal	54.7	19.1	
HDL			0.531
Normal	53.8	20.3	
Abnormal	57.8	17.1	
TC			0.076
Normal	60.7	21.1	
Abnormal	50.6	17.1	

[a]t-test or ANOVA ($p < 0.05$ is considered statistically significant different)

In order to further look into the associations, vitamin D concentration in elderly was further grouped by gender, BMI, MNA scores, MUAC, HDL-C and TC status (Table 2). Elderly men

have significantly higher serum 25(OH)D concentration compared to elderly women with mean serum 25(OH)D of 62.4 ± 19.7 nmol/l for elderly men and 46.3 ± 15.1 for elderly women (p = 0.003). Since the level of several hormones including sex hormones can be modified by vitamin [34], it is not surprising that women had lower level of vitamin D in serum than men in the present study. There is evidence reported the alteration in calcium and vitamin D homeostasis among women experiencing their menopausal stage [35].

Besides, when compared to men, elderly women were observed to sit or rest on their bed while men spent their times in many outdoor activities. However, the finding contradicts with the previous study done by [36-37, 1] whereby they reported women were found to have higher serum vitamin D as women are having a larger amount of subcutaneous fat, which may store more vitamin D as compared to men. In [38], hypothesized that vitamin D-binding protein (DBP) may also play a role in gender differences in vitamin D status and the positive correlations were found between DBP and percentage of body fat in women.

Table 3. Correlation between serum 25-hydroxyvitamin D (25(OH)D) concentration, anthropometric variables and blood lipid in elderly (n = 47)

Parameters	Pearson's Correlation, r	P-Value
Age (years)	0.184	0.215
BMI (kg/m2)	0.174	0.243
MNA (scores)	0.017	0.908
MUAC (cm)	-0.011	0.940
TC (mmol/l)	-0.220	0.137
HDL-C (mmol/l)	-0.277	0.060

Vitamin D concentrations were comparable between different BMI, MNA, MUAC status (p > 0.05). Majority of elderly people in this study had a normal BMI. In spite of this, no association was found between vitamin D status and BMI. Our finding was in contrast with previous studies that showed significant inverse association between serum 25(OH)D3 and BMI [39-40]. A negative association between vitamin D status and BMI value is well known [41-43] in which lower concentrations of 25(OH)D3 is often observed in obese individuals [37,44] or having high body fat percentage [45]. Accordingly, a study done in Greenlandic Adult Population from 1987 to 2010 has also shown a decreasing trend of serum 25(OH)D3 with increasing BMI value [46]. This negative association is likely due to the deposition of vitamin D in fat tissue that leads to lower serum 25(OH)D3 value [47-50] However, in [45] disputed that the association between adiposity and serum 25(OH)D3 is greater than between

body weight and BMI alone. This may be due to that BMI and body weight do not necessarily reflect the percentage of body fat.

Between normal and abnormal readings of TC and HDL-C, vitamin D concentration did not differ statistically ($p > 0.05$). There is also no significant correlation between serum 25(OH)D and anthropometric variables including age and blood lipid profiles among elderly in this study (Table 3). Our study were in line with a finding reported by [51] that elderly with protein-energy malnutrition who lived in their own homes had slightly reduced serum 25(OH)D3 levels. The present study also found no association between serum 25(OH)D3 level and blood lipid profiles. Nevertheless, in [41] concluded that the evidence in associating serum 25(OH)D3 with blood lipid even after supplementations of vitamin D is still limited. The evidence suggests that there is continuing controversy about the effect of adequate vitamin D consumption among vitamin deficient individuals on serum lipids and lipoproteins. In [51] conducted a meta-analysis of randomized controlled trials and found no statistically significant effects for vitamin D supplementation were observed for TC, HDL-C and TG. The idea of lipid modulating effects of vitamin D supplementation should be further investigated though large-scale, randomized trials with adequate doses which can effectively elevated the active form of vitamin D in plasma and with proper population which has hyperlipidemia as an inclusion criterion.

A primary limitation of this present study is small sample size as compared to most available studies conducted whereby at least hundreds of respondents were included. This may not provide adequate analysis of identifying association of vitamin D with anthropometric indices among the institutionalized elderly. As this study was done in only one institutionalized home care in Kelantan, future studies can be done in other institutionalized home care at the East coast region of Peninsular Malaysia. Despite these limitations, findings from this study could provide general overview of the health, vitamin D status and nutritional status of elderly in institutionalized home care especially in Kelantan. Moreover, this study could also be improved by considering the indirect measurements of sun exposure, outdoor physical activity, vitamin D supplementations, medications use and smoking status of respondents.

4. CONCLUSION

This recent study found that a majority of institutionalized elderly had a normal BMI, but both under-nutrition and over-nutrition are still coexisted. Almost half of the institutionalized elderly people were at risk of malnutrition. There was a vitamin D insufficiency among

institutionalized elderly but majority of them are still classified as having a sufficient vitamin D based on serum 25(OH)D3 concentration as compared to other countries with seasonal variations. Vitamin D insufficiency is reported to be more prevalent in elderly women than men due to several factors such as body fat and outdoor activities engaged. Several confounding variables (such as age, gender, food habits, nutritional status, mental status of individual, smoking habits and lung function) might have affected circulating levels of vitamin D and these have strong individual causal relationships with regard to reducing serum 25(OH)D3 levels in a normal population. This study could provide an overview and beneficial information to clinicians and dietitians regarding the association between serum vitamin D levels and anthropometric indices among elderly people in Malaysia.

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