

فيتامين "د" ومستوى اللياقة البدنية المرتبطة بالصحة لدى عينة من الاطفال العمانيين

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مقدمة: يتوافر ضوء أشعة الشمس طيلة العام في سلطنة عمان إلا أنه وبسبب الرفاهة والمدنية التي انتقلت من الغرب يعيش أكثر الناس نمطا حياتيا غير صحي يتسم بقلّة الحركة والابتعاد عن تعرض أجسامهم لأشعة الشمس بسبب ارتفاع حرارتها وتوافر سبل الراحة داخل القاعات والمنازل والمكاتب المغلقة ووسائل النقل والأماكن المظلة بالإضافة إلى ذلك فإن الزي التقليدي للمرأة والرجل على حد سواء يحجب أشعة الشمس المفيدة عن الجسم مما قد يزيد من احتمالية عوامل الخطورة على الجهاز الدوري التنفسي (Cardiorespiratory) وربما يمهّد الطريق لظهور بعض أعراض الاكتئاب.

الهدف من الدراسة: تقصي العلاقة بين عناصر اللياقة البدنية المرتبطة بالصحة، معدل كثافة العظام ونسبة فيتامين «د» والتعرف على مدى شيوع أعراض الإكتئاب لدى الاطفالالعمانيين ٩ - ١٢ سنة.

الطريقة والإجراءات: تألفت عينة الدراسة من ٩٧ طفلا ٤٥ ذكر و ٥٢ أنثى تم انتقاؤهم بشكل عشوائي بعد انخراطهم مباشرة في النادي الصيفي بجامعة السلطان قابوس من مجتمع الدراسة المتكون من ٥٠٠ مشارك وكان معدل أعمارهم ١٢,٩ ± ٠,٦. وقد أجريت لهم قياسات للياقة البدنية المرتبطة بالصحة بعد أن تم تعديلها لتناسب المرحلة العمرية مثل التحمل الدوري التنفسي (Modified Bruce protocol) والقوة العضلية (Strength Grip of Dynamometer) والجلد العضلي (up-sit Modified) والمرونة (Flexibility Modified) والتكوين الجسماني (Composition Body) الذي تضمن كثافة العظام وكتلة العضلات ونسبة الدهون باستخدام جهاز ديكسا لتحليل مكونات الجسم (DEXA Hologic Delphi) بالإضافة إلى أخذ عينة من الدم لتحليل مستوى فيتامين د لدى العينة باستخدام - DiaSorin 25-Hydroxy V tamin D. كما تم توزيع استبانة على عدد ١٨٦ مشترك بشكل عشوائي متضمنة العينة من الذكور والاناث حالة السابقة للتعرف على مدى شيوع أعراض الاكتئاب بينهم قبل المشاركة في فعاليات النادي الصيفي.

النتائج: توصلت الدراسة إلى أن ٨٢٪ من الفتيات لديهن مستويات منخفضة من فيتامين "د" ($>50 \text{ nmol/L}$) في حين ان ٤٢٪ من الذكور وأظهرت الدراسة أن الفتيات اللواتي يعانين من نقص في فيتامين "د" لديهن زيادة في نسبة دهون الجسم بالمقارنة مع أفراد عينة الدراسة الذين لديهم نسبة فيتامين "د" طبيعية بدلالة إحصائية ($p=0.011$; $Vs. 24\%$). ولم تظهر الدراسة فروقا في مستويات عناصر اللياقة البدنية بين الفتيات ذوي نسبة فيتامين "د" العادية وأقرانهن اللاتي يعانين من نقص فيها على عكس ما أظهرته الدراسة بالنسبة للذكور حيث ان مستوى قوة القبضة كان منخفضا لدى الاطفال الذين لديهم مستوى منخفض لفيتامين د. وأشارت التحليلات الأولية بأن ما يزيد عن ٣٠٪ من العمانيين الاطفال يعانين من أعراض الاكتئاب الشديد والمتوسط.

الاستنتاجات: تستنتج الدراسة أن هناك نسبة عالية من الفتيات يعانين من نقص كبير في فيتامين "د" كما أن لديهن الاستعداد للمعاناة المبكرة من الامراض المرتبطة كهشاشة العظام (osteoporosis) والإكتئاب بسبب نقص فيتامين "د". وتستنتج الدراسة أيضا أن الفتيات اللواتي لديهن نقص في فيتامين "د" ممكن أن يكون لديهن في ذات الوقت نقص في مستوى القوة العضلية وزيادة في مستوى دهون الجسم مما قد يؤثر على صحتهم لان ذلك من المؤشرات المنذرة لعوامل الخطورة. كما أن نسبة كبيرة من الاطفال لديهم أعراضا اكتئابية الأمر الذي يستدعي إجراء المزيد من الدراسات على عينات أكبر للتعرف على الأسباب تمهيدا لإيجاد الحلول.

HEALTH-RELATED PHYSICAL FITNESS AND VITAMIN D DEFICIENCY IN OMANI CHILDREN

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Conclusion: Our results showed that a high percentage of the females are deficient in vitamin D, susceptible to the early diagnosis of osteoporosis and depression due to their deficiency. This indicates that children at this stage should be involved in physical activity program and meet the required sunlight exposure during all season to gain a healthy lifestyle.

Introduction

Exercise and bone maintenance are inextricably linked. Evolution has ensured that as muscles get bigger and become more powerful, bones also get heavier and stronger so they are not overpowered. Osteoporosis is a condition that causes a reduction in the bone mass and a deterioration of bone structure. Osteoporosis weakens bones and weak bones can easily fracture. In turn, fractures cause pain and can put severe limitations on our daily lives because they reduce mobility. Less mobility, due to an osteoporosis-related fracture or simply taking no exercise, means the muscles are not being used enough. This lack of movement results in a cutback in the production of new and healthy bone tissue. Thus, weaker muscles result in weaker bones.

Most people reach their “peak bone mass” in their 20s. This is when bones have achieved their maximum density and strength. After peak bone mass is reached, bone density remains stable during adulthood, and then begins to decline. Physicians once thought that reaching this peak depended primarily on diet, including sufficient calcium intake, and exposure to sunlight, which is necessary for the production of Vitamin D in the skin. In fact, Vitamin D is necessary for the absorption of calcium from food, for the healthy functioning of bone tissues, and thus for maintaining bone strength. Holmes and Kummerow, (1983) found that elevations of 25(OH)D caused damage to tissues. Excess 25(OH)D was found primarily in the kidneys, liver, lungs, aorta, and heart -- places known to develop calcifications with D intoxication.

A recent study has shown that in laying down the bone foundation that will serve for a lifetime, exercise is just as important as diet. This is true throughout childhood and adolescence, but especially more important around the growth spurt at puberty (Bass et al., 1998, Kilani, & Abu Eisheh, 2010)

Those boys who did the most vigorous daily activity had nine percent more bone area and 12 percent more bone strength than the less active ones (Janzet.al., 2004). Most physically active young girls gain about 40% more bone mass than the least active girls of the same age (Lehtonen-Veromaaet.al., 2004). In girls, the bone tissue accumulated during the ages 11 to 13 approximately equals the amount lost during the 30 years following menopause. (Bass et.al.,1998). When astronauts first traveled beyond the Earth's atmosphere, the first and most obvious impact was that their muscles atrophied soon after it was realized that their bones weakened (Vicoet.al., 2000). Grimstonet.al. (1993) studied gymnasts' vs. swimmers' bone mineral density and found that the gymnasts have more BMD than the swimmers due to high impact and gravity effect during tumbling and acrobatic skills. Egan et.al., (2006) searched BMD in female athletes: rugby, netball, running, and non-active as control and also found that the running group have the greatest BMD the other groups. Kemmleret. al., (2006) confirmed Egan results when he also found greater BMD in the pelvis, legs and total body bone strength for runners when compared with sedentary group. Saxon et.al. (2005) pointed out that the Mechano-sensitivity of bone is saturated over time and that pause during loading increases BMD. In a retrospective study which contained 4 impact groups, Dooket.al. (1997) found unexpected results. The impact of activities led to an increase of bone mass even if calcium supplement was low (Grimston&Zernicke, 1993, Dook, et.al. 1997).Impact stimuli increase the bone quality. According to O'Connor and Lanyon (1982), an increase of bone mass can be explained by 61- 81% through the loading rate. This in itself explains that active young children with high agility may build and maintain their bone health faster than inactive ones especially when they play under sun lighting.

Ideally, the best place to get vitamin D is from your skin being exposed to the UV-B that is in normal sunlight. However, UV-B does not penetrate deeply into your skin. The darker the pigmentation or the more tanned your skin is, the less UV-B penetrates. Window glasses allow only 5 percent of the UV-B light range that produces D to get into your home or car. These circumstances prevail in Oman so one should consider it. Even the timing of the sun exposure is also a major factor. Sun exposure must take place when UV-B is present. The actual degree of your sun exposure is quite complex since it involves knowing the amount of UV-B and one's skin color. This doesn't sound very complex, but the amount of UV-B is not constant. It is a major variable and is influenced by a number of factors: latitude, time of year, clouds or pollution, smog and ozone smog or dust as sometimes happen in Oman, and altitude.

It is important to know the level of UV-B exposure. Longer exposure will not increase vitamin D production, but will increase the danger of skin damage and possible skin cancer. Darker skin pigmentation, application of sunscreen, aging and clothing can also have a dramatic effect on pre-vitamin D3 production.

Severe Vitamin D deficiency softens bones. In children, the result is rickets, charac-

terized by malformed legs. Adults may develop a rare condition called osteomalacia, distinguished by weakened muscles as well as bones.

The best way to evaluate a person's vitamin D status would be to measure concentrations of an inactive form known as 25-hydroxy-vitamin D (25-D) that circulates in the blood. There are rarely obvious symptoms of D-marginal deficiency. Vitamin D also moves calcium around our bodies, into and out of bone, muscle, hair, arteries, and cells. Both low and high levels of vitamin D appear to contribute to misbehaving calcium (Sullivan et.al. 2003). The amount of calcium (Ca) that is required to support optimal growth in children and in turn, maximize peak bone mass remains a topic of considerable debate and disagreement among scientists and clinicians alike, both within and between nations. (Heaney, 2000; Specker, 2000; Holick, 2006)

In addition, Ca supplementation studies in growing children have shown that an increase in Ca intake is associated with higher bone mineral status in the order of 1% to 5%, with the effect appearing to be stronger in the pre-pubertal years, and the greatest impact being seen in the early months of the supplementation period. (Johnston, et.al., 1992; Nowson et.al., 1997). Ca supplementation in teenage girls with low dietary Ca intake (mean intake ~600 mg/day) was studied and results showed significantly greater bone mineral content/bone mineral density (BMC/BMD) following supplementation of 300 mg/day of Ca in fortified fruit juice. (Lambert et.al., 2000). If the results of this study show that high percentage of low BMD occurred in the sample chosen, this could indicate other nutritional factors to be considered especially milk and Ca supplementation.

Stear and Coworkers (UK) showed that Ca supplementation (1000 mg/day) in a total of 131 female adolescents aged 17 years resulted in an increase in bone-size adjusted bone mass; the effect was still persistent at the femoral neck after 14 months of follow-up. Dodiuk, et.al., (2000) examined the effectiveness of Ca supplementation on BMD 5 years after discontinuation of treatment and found that the beneficial effect of short-term (12 months) Ca supplementation on BMD in 14-year-old girls was sustained. Supplementation with milk/dairy products/milk-derived products has been shown to improve the nutritional quality of the diet to a much greater extent than that of Ca alone. In addition, increased insulin-like growth factor I (IGF1) levels have been reported in children (Bonjour et.al., 1997)

Statement of the problem and significance

It is well-documented that vitamin D (in combination with PTH) plays a crucial role in the regulation of Ca and phosphorus (P) metabolism, and promotes Ca absorption from the gut and kidney tubules (Lambert et.al., 2000). Supplementation trials have shown vitamin D to improve Ca absorption, lower PTH levels, and reduce winter-time bone loss in postmenopausal women (Dawson-Hughes, et.al., 1991). The child population is especially at risk for vitamin D insufficiency/deficiency. Vitamin D and Ca supplementation trials have been shown to significantly reduce fracture rates in the institutionalized and free-living elderly populations, but vitamin D given as

supplement alone does not appear to be as effective. Because nutrition and exercise are a modifiable pathogenic factors of osteoporosis, which has important practical and public health implications, it is therefore crucial to increase bone density and bone development in children. Thus, active lifestyle and physical activity outside halls and complex buildings are necessary for children and adults.

Many people in Oman live sufficiently high in the mountains for more Ultraviolet (UV) -B to reach their skins. However, many people in Oman do not expose their skin to sunlight due to the modern society they are living in, avoiding heat through shade and by means of air conditioning whether at home, work or in automobiles with shielded windows up to 50%. For both sexes, if they have to be outside for any reason, they cover both the head and body by the traditional clothing that they wear. For those reasons, the proper amount of sun is presumably not possible; and an oral form of vitamin D should be considered as supplement. High quality cod liver oil is probably the best choice, as it also supplies vitamin A that helps limit vitamin D toxicity and also beneficial omega-3 fats. Milk does provide vitamin D, but only about 250 units per 8 ounces. So one would need to drink a halfgallon of milk per day to receive enough vitamin D. In addition, one would need to consume 25 eggs to get the daily amount of Vitamin D which is impossible. The assumption that children in Oman are receiving the proper amount of an essential source to obtain Vitamin D from fish, milk, and eggs, must be investigated. It will be important to take calcium while receiving vitamin D, or it will tend to take calcium out of the bones. Finally, children raised in such a society who are kept safe from sun exposure spend a great deal of time indoors with video hi-tech games, computers, playstations and TV. Besides, they tend to imitate what they see from media to get the junk food and increase the sedentary life time. A tendency to become depressed is a probability.

Purpose

It is imperative to assess children in Oman where sun exposure is limited and inactive lifestyles are prevalent with respect to BMD and vitamin D status. Physical assessment would also be of interest to compare and classify children according to whether they have high or low fitness levels. Muscle and bone strength in health-related physical fitness profile for an age range of between 5 and 20 years will be determined. The objectives of this research proposal are to:

- 1- Assess health-related physical fitness components for the sample in the study;
- 2- Test their vitamin D level using blood sample;
- 3- Determine their range body composition (BMD, FAT, LEAN MASS) status;
- 4- Assess their psychological status using Beck Depression Inventory (BDI, BDI-II);
- 5- Profile their data based on active/inactive, depress/ none depress according to Vitamin D and BMD status;

Methods

The study sample (N = 97) were males and females randomly chosen immediately-

ly after their involvement in the Summer Club at Sultan Qaboos University consisting of 500 average age of 12.9 ± 1.6 . Health-related fitness components were modified and measured to suit the age groups such as cardiovascular endurance (Modified Bruce protocol). In the present study, children were required to perform the maximal exercise test on a motor-driven treadmill. The test starts at a low work level, allowing time for warm-up. Children were encouraged to perform to voluntary exhaustion. The test was terminated if the subject develops signs of breathlessness, fatigue, loss of walking-coordination or when the target heart rate is achieved. Muscle strength (Dynamometer of Grip Strength), muscular endurance (Modified sit-up), and flexibility (Modified Flexibility). (Kilani, H. & Lala, O., 2001) Body composition was tested including Lumbar spine and whole body BMD, as well as body fat and lean masses were measured using DEXA Hologic Delphi. Before the scanning, the height and weight of the children were measured. Body composition measurements were performed using a Dual X-ray Absorptiometry (DXA), Hologic Delphi, W fan beam X-ray bone densitometer. The whole body was scanned and scan results were analyzed as follows:

The total body scan image was divided into 10 regions including the left and right arm, ribs, thoracic spine, lumbar spine, pelvis, left and right leg, and head. The data from the 10 body regions were summed-up to provide values for the whole body mass composition; the bone mineral content (BMC) expressed in grams, bone mineral density (BMD) expressed in g/cm^2 , the fat content (FC) expressed in grams, the body muscle mass and body lean mass (BLM) (sum of the body muscle mass and the BMC), and Fat mass (FM). Lean mass and fat mass were also expressed as percentage of total body mass.

The DiaSorin 25-Hydroxy Vitamin D assay consists of two-step procedure. The first step involves a rapid extraction of 25-OH Vitamin D and other hydroxylated metabolites in serum or plasma with acetonitrile. Following extraction, the treated sample is then assayed using equilibrium RIA procedure. The RIA method is based on an antibody with specificity to 25-OH-D. The sample, antibody and tracer are incubated for 90 minutes at 20-25°C. Phase separation is accomplished after a 20-minute incubation at 20-25°C with a second antibody precipitating complex. A NSB/ Addition buffer is added after this incubation period to centrifugation to aid in reducing non-specific binding. Bound radioactivity is inversely proportional to the concentration of 25-OH-Vitamin D. The questionnaire was distributed to 186 randomly elected samples to identify the prevalence of depressive symptoms among them before participating in the Summer Club events. The Beck Depression Inventory (BDI, BDI-II), a 21-question multiple-choice self-report inventory instrument for measuring the severity of depression will be used. Other instruments will be used for children from 7 years old called Child Depression Inventory (CDI). CDI is a symptom-oriented instrument for assessing depression in children between the ages 7 and 17 years. The basic CDI consists of 27 items, but a 10-item short form is also available for use as

a screener. All participants were asked to fill in the Children Depression Inventory (CDI) and Self-esteem Scale (SES) during June 2011, after they indicated their consent to participate in the study. It took between 10-15 minutes from each participant to fill the two questionnaires.

Statistical Analysis

Descriptive statistics were used to describe the data. For categorical variables, frequencies and percentages were reported. Differences between groups were analyzed using Pearson's chi-square test (or Fisher's exact test for cells <5). For continuous variables, means and standard deviation and median and interquartile range (25th and 75th percentiles) were used to present the data while analysis was performed using Student's t-test and Wilcoxon-Mann-Whitney, respectively. Frequencies and percentages were tabulated for depression analysis. An apriori two-tailed level of significance was set at the 0.05 level. Statistical analyses were conducted using STATA version 12.1 (STATA Corporation, College Station, TX).

Results

The demographic and bone densitometry characteristics of the study sample (N = 97) are summarized in Table 1. Fifty-three percent of the cohort (51/97) has low vitamin D levels (<50 nmol/L). The overall mean age of the cohort was 13 ± 2 years with no significant differences in age among the two groups (12.8 versus 12.9 years; $p = 0.856$). Fifty-six percent (54/96) of the patients were females, with the females more likely to be vitamin D deficient than males (82% versus 18%; $p < 0.001$). The overall mean weight, height and BMI of the study cohort were 42 ± 15 kg, 147 ± 12 cm and 18.9 ± 4.8 kg/m², respectively, with no significant differences amongst the groups ($p > 0.05$).

The Bone Mineral Content (BMC), bone mineral density, fat mass, lean BMC, and lean mass are $1,263 \pm 344$ g, 0.84 ± 0.1 g/cm³, 9,775 (5,852-15,234g), 29.4 ± 8.7 kg, and 28.1 ± 8.4 kg respectively, with no significant differences amongst the groups ($p > 0.05$). However, the vitamin D deficient group was associated with higher fat percent compared to those with normal vitamin D status (29% versus 24%; $p = 0.011$).

The association between vitamin D and various physical exercise attributes are stratified gender-wise (females and males), and presented in Tables 2 and 3 respectively. Grip scores were significantly higher in males than females (21 versus 15; $p < 0.001$). They were also significantly lower in vitamin D deficient participants in males (16 versus 23; $p = 0.039$) but not females (16 versus 13; $p = 0.057$). Females were also associated with higher flex scores (5.0 versus -0.7; $p < 0.001$), lower sit-up scores (13 versus 16; $p = 0.001$), lower end-2 scores (131 versus 160; $p < 0.001$), higher end-3 scores (176 versus 155; $p < 0.001$), and higher end-4 scores (187 versus 180; $p = 0.008$). There were no significant differences in all physical exercise attribute scores ($p > 0.05$) in females between those with normal and those with low vitamin D levels. These results were also replicated in males except for grip and end-2 scores for which those with low vitamin levels were associated with low (16 versus 23; p

= 0.039) and high scores (150 versus 137; p = 0.034), respectively. Figures 1 & 2 illustrate classification of depression prevalence among females and males (1= no depression symptoms, 2= mild, 3= moderate, and 4= severe depression symptoms) with no significant differences between males and females.

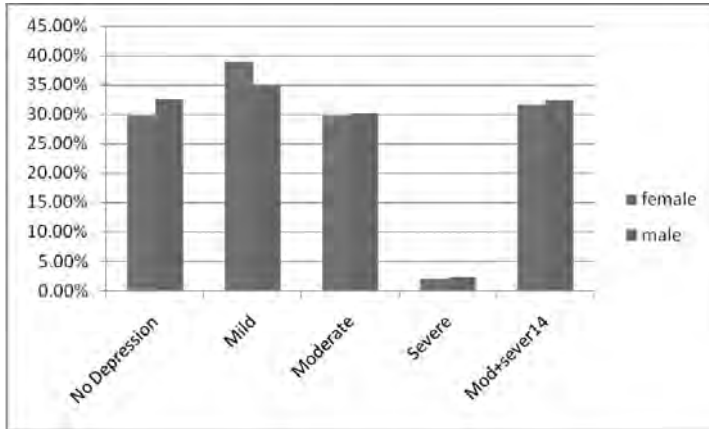


Figure 1: Classification of depression prevalence among females & males (n=97)

Table 1: Association between Vitamin D and various demographic and bone densitometry characteristics (N=97)

Characteristic	All (N=97)	Vitamin D status		p
		Normal (≥ 50 nmol/l) (n=46; 47%)	Low (<50 nmol/l) (n=51; 53%)	
Demographic				
Age, mean \pm SD, years (N=73)	12.9 \pm 1.6	12.8 \pm 1.8	12.9 \pm 1.4	0.856
Gender, n (%), (N=96)				
Female	54 (56%)	12 (27%)	42 (82%)	<0.001
Male	42 (44%)	33 (73%)	9 (18%)	
Weight, mean \pm SD, kg (N=95)	42 \pm 15	41 \pm 15	43 \pm 15	0.546
Height, mean \pm SD, cm (N=95)	147 \pm 12	146 \pm 14	147 \pm 11	0.560
BMI, mean \pm SD, kg/m ² (N=95)	18.9 \pm 4.8	18.6 \pm 4.8	19.2 \pm 4.8	0.575
Bone densitometry data				
BMC, mean \pm SD, g, (N=86)	1,263 \pm 344	1,253 \pm 323	1,270 \pm 363	0.813
BMD, mean \pm SD, g/cm ³ , (N=86)	0.84 \pm 0.10	0.85 \pm 0.09	0.83 \pm 0.11	0.590

Fat mass, median (IQR), g, (N=86)	9,775 (5,852, 15,234)	7,906 (4,943, 13,641)	11,734 (7,011, 15,503)	0.044
Lean BMC, mean±SD, kg, (N=86)	29.4±8.7	30.2±9.4	28.7±8.1	0.426
Lean mass, mean±SD, kg, (N=86)	28.1±8.4	29.0±9.1	27.4±7.8	0.403
Fat percent, mean±SD, (N=85)	27±9	24±10	29±8	0.011

BMI = Body mass index;
SD = Standard deviation;
IQR = Interquartile range;
BMC = Bone mineral content;
BMD = Bone mineral density;

Analyses were evaluated using Pearson's chi-squared test, Fisher's Exact test, Student's t-test and Wilcoxon-Mann-Whitney test, wherever appropriate.

Table 2: Association between vitaminD and various physical exercise attributes (N=97)

Characteristic	All (N=97)	Vitamin D status		P
		Normal (≥50 nmol/l) (n=46; 47%)	Low (<50 nmol/l) (n=51; 53%)	
GRIP score (N=96)				
Mean ±SD	17.8±7.2	19.9±8.7	16.1±5.2	0.009
Median (IQR)	16 (13, 22)	17 (13, 25)	16 (12, 18)	0.070
Low GRIP (<17)	53 (55%)	21 (47%)	32 (63%)	0.0013
Normal GRIP (17/19)	14 (15%)	4 (9%)	10 (20%)	
High GRIP (>19)	29 (30%)	20 (44%)	9 (18%)	
FLEX score (N=96)				
Mean ±SD	2.5±7.4	1.6±8.7	3.3±6.1	0.265
Median (IQR)	2.6 (-2.2, 7.1)	0.7 (-2.3, 6.6)	3.5 (-0.7, 7.6)	0.216
Low FLEX (<2)	43 (45%)	25 (56%)	18 (35%)	0.058
Normal FLEX (2/3)	7 (7%)	1 (2%)	6 (12%)	
High FLEX (>3)				
SIT-UP score (N=96)				
Mean ±SD	14.6±5.4	15.2±7.2	13.6±3.1	0.149
Median (IQR)	14 (11, 17)	15 (11, 20)	14 (11, 15)	0.042

Low SIT-UP (<14)	41 (44%)	16 (37%)	25 (49%)	0.016
Normal SIT-UP (14/15)	23 (24%)	7 (16%)	16 (32%)	
High SIT-UP (>15)	30 (32%)	20 (47%)	10 (20%)	
END 1 score (N=96)				
Mean ±SD	145±0.65	156±0.62	135±0.66	0.126
Median (IQR)	129 (121, 136)	127 (122, 134)	130 (120, 140)	0.219
Low END1 (>130)	37 (39%)	14 (31%)	23 (45%)	0.235
Normal END1 (130)	8 (8%)	3 (7%)	5 (10%)	
High END1 (<130)	51 (53%)	28 (62%)	23 (45%)	
END 2 score (N=96)				
Mean ±SD	152±19	144±19	158±18	<0.001
Median (IQR)	149 (139, 163)	141 (133, 155)	157 (143, 174)	<0.001
Low END2 (>150)	43 (45%)	14 (31%)	29 (57%)	0.024
Normal END2 (150/152)	4 (4%)	2 (4%)	2 (4%)	
High END2 (<152)	49 (51%)	29 (64%)	20 (39%)	
END 3 score (N=94)				
Mean ±SD	167±18	161±18	173±16	0.001
Median (IQR)	169 (153, 184)	161 (147, 173)	174 (165, 186)	<0.001
Low END3 (>150)	48 (51%)	14 (31%)	34 (69%)	<0.001
Normal END3 (150/152)	5 (5%)	4 (9%)	1 (2%)	
High END3 (<152)	41 (44%)	27 (60%)	14 (29%)	
END 4 score (N=94)				
Mean ±SD	184±13	182±13	184±14	0.099
Median (IQR)	187 (178, 194)	184 (176, 190)	189 (181, 196)	0.038
Low END4 (>182)	56 (61%)	23 (52%)	33 (69%)	0.048
Normal END4 (182)	2 (2%)	0 (0%)	2 (4%)	
High END4 (<182)	34 (37%)	21 (48%)	13 (27%)	

SD=Standard deviation;

IQR=Interquartile range;

Analyses were evaluated using Pearson's chi-squared test, Fisher's exact test, Student's t-test and Wilcoxon-Mann-Whitney test, wherever appropriate.

Discussion: Vitamin D is unique among hormones because it can be made in the

skin from exposure to sunlight (Holick, et.al., 2007, 2008). Vitamin D comes in two forms. Vitamin D₂ is obtained from the UV irradiation of the yeast sterol ergo-sterol and is found naturally in sun-exposed mushrooms. Vitamin D₃ is synthesized in the skin and is present in oil-rich fish such as salmon, mackerel, and herring; which are not available in Oman. Commercially available, vitamin D₃ is synthesized from the cholesterol precursor 7-dehydrocholesterol naturally present in the skin or obtained from lanolin. Both vitamin D₂ and D₃ are used for food fortification and in vitamin D supplements. Vitamin D that comes from the skin or diet is biologically inert and requires its first hydroxylation in the liver by the vitamin D-25-hydroxylase (25-OHase) to 25(OH)D (Holick, 2007). However, 25(OH)D requires a further hydroxylation in the kidneys by the 25(OH)D-1 α -OHase (CYP27B1) to form the biologically active form of vitamin D 1,25(OH)₂D (3, 8). 1,25(OH)₂D interacts with its vitamin D nuclear receptor, which is present in the small intestine, kidneys, and other tissues (DeLuca, 2004). 1,25(OH)₂D stimulates intestinal calcium absorption (Christakos, et.al., 2003). Without vitamin D, only 10 to 15% of dietary calcium and about 60% of phosphorus are absorbed. Vitamin D sufficiency enhances calcium and phosphorus absorption by 30–40% and 80%, respectively (Heaney, 2004).

Since children aged 9–18 years has a rapid growth spurt characterized by a marked increase in their requirement of calcium and phosphorus to maximize skeletal mineralization, the metabolism of 25(OH)D to 1,25(OH)₂D increases. In our study, vitamin D was deficient in high percentages for females and in moderate percentages in males which indicate non-sufficient exposure to the sunlight as it was assumed. In the past, children of all races obtained most of their vitamin D from exposure to sunlight and drinking vitamin D-fortified milk, and therefore, they did not need to take vitamin D supplements. However, children are spending more time indoors now, and when they go outside, they often wear sun protection that limits their ability to make vitamin D in their skin. Children and adolescents are also drinking less vitamin D-fortified milk. (Sullivan et.al., 2005).

Moreover, the females & males who were more having depression than those who did not have vitamin D deficiency, Figure 1. A systematic review and meta-analysis of 14 studies with a total of 31,424 participants revealed an association between vitamin D levels and depression which concluded that low vitamin D concentration is associated with depression (Anglin et.al., 2013). Given the high prevalence of both vitamin D deficiency and depression, an association between these two conditions would have significant public health implications, particularly as supplementation with vitamin D and regular exercise under sunlight for the skin exposure. However, vitamin D and depression may be linked is still unclear. Vitamin D deficiency may result in depression, or depression may increase the risk for low vitamin D levels. For example, depressed people may spend more time indoors, and are less likely to eat a healthy diet and take care of themselves, all of which could affect vitamin D levels. On the other hand, there are vitamin D receptors everywhere in the body including

the brain. These receptors need vitamin D to do their job. More research is urgently needed to determine whether vitamin D can prevent and treat depression.

In young children who have little mineral in their skeleton, this defect results in a variety of skeletal deformities classically known as rickets. In addition, reduction in serum calcium level may affect ventricular contraction, thus cardiomyopathy may develop in rickets. (Uysal, et.al.,1999) However, BMDs were not marked at this age group nor cardiovascular endurance (Modified Bruce protocol). The reason for these asymmetrical results may be due to small number of subject running for four stages on the treadmill. In turn, the increased blood levels of 1,25 (OH)₂D enhance the efficiency of the intestine to absorb dietary calcium and phosphorus to satisfy the growing skeleton's requirement for these minerals during its rapid growth phase.

We can't assume that there were malnutrition since the optimal nutrition from various sources will not be sufficient for the sufficient production of vitamin D for the body. Therefore, the best sources to have vitamin D are from the sunlight exposure to the skin. As we mentioned earlier and despite the fact that sunlight is available almost all year round in Oman, heat is so high that prevent kids from playing outside in the schools and most of the physical education classes for girls were substituted with other subject. (Mehana, & Kilani, 2010) Vitamin D deficiency also causes muscle weakness; affected children have difficulty standing and walking (Holick, 2006). Our males who have vitamin D deficiency scored low in grip strength. Muscle weakness is a prominent feature of the clinical syndrome of severe vitamin D deficiency. Clinical findings in vitamin D deficiency myopathy include proximal muscle weakness, diffuse muscle pain, and gait impairments such as a waddling way of walking. (Schott & Wills, 1976)

Wortsman and his colleagues, (2000) found that there was an inverse association of serum 25(OH) D and body mass index (BMI) greater than 30 kg/m², and thus, obesity is associated with vitamin D deficiency. Children in our study who have higher fat percentages (29±8) were vitamin D deficient. This is because the body fat sequesters the fat-soluble vitamin. When obese and non-obese adults were exposed to simulated sunlight or received an oral dose of 50,000 IU of vitamin D₂, they were able to raise their blood levels of vitamin D by not more than 50% compared with non-obese adults. (Wortsman et al., 2000)

Conclusion: Our results showed that a high prevalence of the females are deficient in vitamin D, and are susceptible to early diagnosis of osteoporosis and depression due to this deficiency. Male children were also at moderate risk of vitamin D deficiency. This indicates that children at this stage should be involved in physical activity program and meet the required sunlight exposure during the entire season to gain healthy lifestyle. Therefore, we recommend screening for vitamin D deficiency in children and adolescents at risk for deficiency especially in Oman where a prevalence of inactivity, malnutrition, short sleep duration and unhealthy habits were reported. (Kilani, et.al., 2013) In addition, we suggest that obese children should reduce their fat

percentages by diet and exercise and increase time exposure of their skin to sunlight or are given at least two to three times more vitamin D for their age group to satisfy their body's vitamin D requirement. We also recommend prescribing vitamin D supplementation for muscle weaknesses prevention and to improve muscle strength with regular exercise. Finally, we suggest repeating this study on a large number of sampling to represent most regions in Oman.

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ABSTRACT

Introduction: Despite the fact that sunlight is available throughout the year in Oman, more people stay away from getting exposed to the sun due to its high temperature, enjoying the availability of means of comfort inside the halls, homes, offices, shielded vehicles and places. People are experiencing sedentary, unhealthy lifestyle. Moreover, the traditional dress for women and men like obscures sunlight beneficial for the body, which may increase the likelihood of other risk factors on the cardio-respiratory and perhaps pave the way for the emergence of some of the symptoms of depression.

Objective: To investigate the relationship between the elements of the health-related fitness, bone density, and ratio of Vitamin D; and to identify the prevalence of symptoms of depression among Omani children 9-12 years old.

Methods: The study sample of 54 girls and 42 boys were randomly chosen immediately after their involvement in the Summer Club at Sultan Qaboos University consisting of 500 average age of 12.9 ± 1.6 . Health-related fitness components were modified and measured to suit the age groups such as cardiovascular endurance (Modified Bruce Protocol) and muscle strength (Dynamometer of Grip Strength), muscular endurance (Modified sit-up) and flexibility (Modified Flexibility). Body composition was tested including Lumbar spine and whole body BMD, as well as body fat and

lean masses were measured using DEXA Hollogig Delphi. The DiaSorin 25-Hydroxy Vitamin D assay consisting of a two-step procedure was used. The questionnaire was distributed to 186 randomly selected samples to identify the prevalence of depressive symptoms among them before participating in the Summer Club events.

Results: Eighty two percent (82%) of the females and forty two percent (42%) of the males were deficient in vitamin D (<50 nmol/L). Those females who were classified with deficit in vitamin D was associated with higher fat percentage compared to those with normal vitamin D status (29% versus 24%; $p = 0.011$). There were no significant differences in all physical exercise attribute scores ($p > 0.05$) in females between those with normal and those with low vitamin D levels. These results were also replicated in males except for grip and cardio-respiratory components. Initial analysis also indicates that the prevalence of symptoms of depression among Oman children 9-12 years old was 30% ranging from mild to severe depression.

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