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Assessment of Vitamin D status among senior executive managers in large scale industries in the 10th of Ramadan city, Egypt

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Abstract:***Background:****Vitamin D deficiency, is an epidemic problem, and has been proved to be associated with low bone mineral density (BMD) especially in females even in most sunny countries. Solar ultraviolet (UV) rays is the main source of 25-hydroxyvitamin D (25(OH) vitamin D) ,so it has been hypothesized as a main factor affecting vitamin D status. There is a limited number of studies on males in the literature especially who are at risk of limited sun exposure as in senior executive managers.* ***The objective****of this study is to assess vitamin D25(OH) status in apparently healthy senior executive managers and its impact on BMD and to determine the potential influence of some related lifestyle and socioeconomic factors.* ***Methods****:This cross-sectional study involved 59 men aged 40-59 years working in the tenth of Ramadan city ,Egypt , who were randomly selected and medically examined. Men had their 25(OH)D, intact PTH, BMD (lumbar spine (L1-L4) and neck femur).****Results****: Mean serum level of 25(OH)D was an optimal level in 62.7% of the studied group 35.2(7.6) and 19(2.5) a hypovitaminsis state, which was found in 13.6% (insufficienct subjects) and 23.7% (deficient subjects) ,that reached a significant difference. A strong negative correlation of25(OH)D with PTH was found whilemoderate positive correlation of 25(OH)D with BMD was detected.Sun exposure was the main determining factor for 25 (OH)D level.****Conclusion****: Senior executive managers are vulnerable for vitamin D25(OH) deficiency, which can affect their BMD in a risky pattern.*
Keywords:*Vitamin D, Senior executive Manager, 10 thof Ramadan city, Egypt.*

I. Introduction

It is now generally accepted that vitamin D deficiency is a worldwide health problem[(1),] spanning many continents and including all ages, genders and racial/ethnic groups[(2)].There is renewed interest in vitamin D synthesis, metabolism, and action. The two principal driving forces for heightened interest can be traced to: 1) the worsening, worldwide trend to nutritional vitamin D insufficiency[(3)]; and 2) new knowledge regarding the nonhormonal, intracrine, and paracrine actions of 1-hydroxylated vitamin D metabolites in man[(4).] It is currently estimated that one billion people suffer from vitamin D deficiency worldwide[(5)]. Very low vitamin D levels have been reported from the Arab world[(6).]

The importance of vitamin D for bone health is well known. Prolonged vitamin D deficiency in adults clinically manifests itself asosteomalacia and osteoporosis[(7)].The extraskeletal effects of vitamin D are plausible as based on preclinical data and observational studies. The greatest risk for cancer, infections, cardiovascular and metabolic diseases is associated with 25-hydroxyvitamin D levels below 20 ng/mL[(8)].Moreover, low vitamin D status may play a role in nonmusculoskeletal diseases, including a variety of cancers, multiple sclerosis, infection, hypertension, and diabetes mellitus[(9)]. There are 2 forms of vitamin D,vitamin D2 (ergocalciferol) comes from irradiation of the yeast and plant sterol ergosterol, and vitamin D3 (cholecalciferol) is found in oily fish and cod liver oil and is made in the skin. Vitamin D represents vitamin D2 and vitamin D3[(10)].

Worldwide, naturally occurring dietary sources of vitamin D are limited, and food fortification is optional, inconsistent, inadequate, or nonexistent[(11)].Vitamin D is mainly derived from sun light exposure of the skin[(12)].The amount of sun exposure necessary to meet requirements depends on factors such as age, latitude, season, time of day, time of year, clothing and skin pigmentation[(7)].For sunlight, it is important to remember that the electromagnetic spectrum is defined by wavelength and that only the visible light waves can be seen by the human eye. UV radiation has shorter wavelengths than does visible light, with UVA (320–400 nm) and UVB (280–320 nm) being the wavelengths of primary importance for human health. Vitamin D is produced on exposure of the skin to solar UVB radiation in the ranges of 290 to 315 nm [(13)].

Excessive solar UV-B irradiation will not cause vitamin D intoxication because excess vitamin D3 and previtamin D3 are photolyzed to biologically inactive photoproducts[(10)].Serum 25 (OH) vitamin D is considered to be the best indicator of overall vitamin D status of an individual[(14)].Although $1,25(OH)_2$ D is the principal active hormonal form of vitamin D,it is not the ideal measure for vitamin D status . This is mainly because the plasma half life of circulating $1,25(OH)_2$ Dis only 4-6 houres[(15)]. $1,25(OH)_2$ D circulates in the serum at

concentrations that are roughly 0.1%of the prohormone 25(OH) D[16]. On the other side 25(OH)D has a plasma half life of approximately 2-3 weeks[17].

A number of studies performed in sunny countries as Saudi Arabia[18] and United Arab Emirates[19] have reported a high prevelance of vitamin D deficiency.The same thing has been proved in Egypt inspite of tropical climate[20] .In Egypt most of the studies have been conducted on women.There is a lack of information about 25(OH)D levels in males especially who work mainly indoorsand who are presumably at risk of vitamin D deficiency due to limited opportunity for exposure to solar UV radiation. The present study was to assess vitamin D status in apparently healthy senior executive managers, its impact on bone mineral density (BMD), and to determine the potential influence of related lifestyle and socioeconomic factors.

II. Subjects And Methods

A cross sectional study was conducted on the senior executive managers of large scale industry factories who agreed to participate in the study in their workplace on the month of September 2013 in the 10th of Ramadan city. The study was conducted in Medical Biochemistry and Community Departments, fecaulty of Medicine Zagazig University.

Study sample and procedure

Sample size was calculated to be 59 subjects obtained from senior executive managers of large scale industry factories (which have more than 1000 employee and exporting strategy) 38 factories fulfill this criteria by random technique. average top managers 3 for each factory, total number 114 mangers (whole population), sample size was calculated by using epi info (Epidemiological information package) software version 6.1.sample size. We used the following data to calculate sample size. Prevalence 28% of vit D defiency, confidence interval 95%, power of the test is 80%.

Inclusion criteria:

The eligible participantsfor the present study (senior executive managers) are all adult male workers aged from 40 to 59 years old.

Exclusion criteria:

Chronic diseases that affect vitamin D status such as malabsorption, chronic liver disease, renal impairment, thyroid dysfunction, the use of vitamin D supplements, medications causing vitamin D deficiency like (rifampicin, ketoconazole, phenytoin, valproic acid, corticosteroids, orlistat) etc. and a family history of vitamin D disorders were all excluded.

Pilot study:

A pilot study was done before starting on 20% of the sample (12 person) to test the power of the study tools in inquiring about the accused risk factors and those in pilot study not included in the results to avoid contamination of the sample.

Ethical issues:

Before interview, senior executive managers were informed of the general aim of the study and their participation in the study was fully voluntary. Confidentiality of collected data was guaranteed to participants and informed consent was obtained.

III. Methods

All subjects were studied within the same period (September, 2013) to avoid seasonal variation in the level of vitamin D and are subjected for all the following:

1- pre-constructed questionnaire inquiring about :*Socio demographic data, skin colour, The current physical activity was calculated using the Global Physical Activity Questionnaire developed by the WHO, based on the metabolic equivalent of task (MET) values (21). , sun exposure, sunscreen use, clothing and occupational history, mode of travel to office, sun film on car windowpanes, number of hours spent inoffice anddaily consumption of dairyproducts.Symptoms attributable to hypovitaminosis D are frequent fractures, bone ache, back pain, muscle spasm,muscle weakness and waddling gait.

2- A full clinical examination and anthropometric measurements were done for all subjects.

3- Laboratory investigations

venous blood sample (3 ml) was obtained from each subject. Blood samples were centrifuged within 2 hours of sampling, and serum was frozen and stored at -20^{o}C until analyzed for measurement of serum 25 (OH) D, calcium, phosphorus, and alkaline phosphatase, intact parathormone hormone levels.

Detection of 25 OH vitamin D by ELISA

Vitamin D level was determined in serum by Enzyme Linked Immune Sorbent Technique (ELISA) using OH vitamin D ELISA kit; Catalog No.EIA-4696 (DRG International, Inc.), CA, U.S.A. the status of 25OH vit. D was evaluated as follows:According to Endocrine Society Clinicl Practice Giudelines,vitamin D deficiency was defined as a 25(OH)D < 20ngl/L(50nmol/l), and insufficiency as a 25(OH)D between 21and 29ng/l(52.5and72.5nmol/L), and 25(OH)Dlevel ≥30ng/l (75nmol/l) as the optimal level.[22]

Detection of parathyroid hormone by ELISA

Intact PTH level was detected in serum by Enzyme Linked Immune Sorbent Technique (ELISA) using PTH ELISA kit; Catalog No.PT019T (Calbiotech, Inc), CA, U.S.A. The normal level for intact PTH is 8.8 to 76.6 pg/ml.

Colorimetric Biochemical assays

Total serum calcium level was estimated using OCPC kit, catalog No. CALO-0600 (Elitech),Sees, France. Serum phosphorous level was determined using phosphorous kit, catalog No. PHOS-0600 (Elitech), Sees, France. Serum albumin level was measured using albumin kit, catalog No. ALBU-0700 (Elitech), Sees, France. Serum alkaline phosphatase (ALP) level was determined using ALP kit catalog No PASL-0400 (Elitech). The analysis was performed using spectrophotometer.

Radiological study

Dual EnergyX-ray Absorptiometry (DEXA) GE medical System Lunar REF (PROGDY) made in USA was used. Bone mineral content and BMD were determined at two anatomic sites (lumbar spine (L1-L4) and neck femur) ,Osteopenia was defined T-score < −1 and osteoporosis as T-score ≤ −2.5and Severe osteoporosis denotes osteoporosis in the presence of one or more fragility fractures.[23]

Statistical analysis

The collected data were computerized and statistically analyzed using SPSS program (Statistical Package for Social Science) version 14.0. Qualitative data were represented as frequencies and relative percentages and Chi-square test (χ**2**) was used to calculate difference between qualitative variables, while Fisher exact test was used when the expected cell value is less than five. Quantitative data were presented as mean and standard deviation and t test was used to calculate the difference between 2 groupsand Anova (F) test for more than 2 group.Pearson correlation coefficient was usedto show the relation between 2 continuous quantitativedata.The results considered significant when the Probability (P value) was equal or less than 0.05.

IV. Results

The whole studied group was 59 males, No significant difference was found between the three subgroups as regard, age, smoking, BMI(≥ 30), skin colour. Subjects who had optimal 25(OH)D were more physically active than the25(OH)D insufficient and 25(OH)D deficient subjects (54% vs 50% vs7.1% respectively) with significant diference. Significant difference was found as regards sun exposure (15 min/day) (7.2% vs 50% vs 14.2%) in the subjects with optimal, insufficient, deficient 25(OH)D respectively. Daily consumption of milk products was more common in optimal 25(OH)D subjects (91.8%) than insufficient and dificent 25(OH)D (62.5% vs 21.4% respectively) with significant difference. Subjects with insufficient and deficient 25(OH)D had more symptoms suggestive 25(OH)D deficiency (50%, 64.2% respectively) vs (8.95%) of the optimal 25(OH)D subjects with significant difference (table 1).

They were divided according their vitamin D status, 62.7% had optimal 25(OH)D (›30ng/dl). Hypovitaminosis D was found in 37.3%, (13.5%) of them had 25(OH)D insufficiency (20—29 ng/dl), and (23.7%) had 25(OH)D deficiency (≤20 ng/dl)(table 2).

Table 3 shows a significant difference of the mean plasma level of 25(OH)D, in the optimal 25(OH)D subjects [35.3(7.6)]vs both the insufficient and deficient 25(OH)D subjects (19(2.5)). Associated with a significant difference for ALP [88.5(15.2)vs212.2(32.4)], but not detected for serum Ca or P. Mean serum level of PTH was higher in the insufficient and deficient 25(OH)D subjects [197.2(22.7)] in comparison for the optimal 25(OH)D subjects[60.5(17.6)],P≤0.001.Also a significant differenc between both groups as regards normal BMD, osteopenia, osteoporosis [(50%vs 81%), (31.8%vs16.2%), (18.1%vs2.7%) respectively].

A strong negative correlation of 25(OH)D with PTH was detected while moderate positive correlation of 25(OH)D with BMD was found (table 4).

Logistic regression (Multiple regression analysis) independent variable as physical activity, sun exposure, daily consumption of dairy products were examined against level of vitamin 25(OH)D as dependent factor which shows sun exposure was the main determining factors for vitamin D 25 (OH) level.

Table(1):Sociodemographic and some lifestyle factors among groups with optimal,isufficient and deficient25(OH)D.

Group / Variable	Group1(N=37) Optimal 25(OH)D ≥30ng/dl	Group2(N=8) Insufficient 25(OH)D 20-29ng/dl	Group3(N=14) Defficient 25(OH)D ≤ 20ng/dl	Test of siginifcance	P value
Age (years)Mean (SD)	52.3 (5.3)	51.2 (4.4)	53.5(6.3)	0.484	0.619
Smoking	25(67.5%)	5(62.5%)	8(57.1%)	0.469	0.780
BMI(Kg/m2)	17(45.9%)	2(25%)	5(53.7%)	1.3	0.501
Skin color Fair Intermediate Dark	 5(13.5%) 29(78.3%) 3(8.2%)	 1(12.5%) 6(75%) 1(12.5%)	 2(14.2%) 10(71.4%) 2(14.2%)	0.509	0.973
Physical activity	20(54%)	4(50%)	1(7.1%)	9.3	0.009*
Sun exposure(5-15min)	36(97%)	4(50%)	2(14.2%)	36.1	0.000*
Daily Consumption of dairy products	34(91.8%)	5(62.5%)	3(21.4%)	24.9	0.000*
Symptoms suggestive vitamin D deficiency	7(18.9%)	4(50%)	9(64.2%)	10.4	0.000*

*significant

Table(2): Distribution of 25(OH)D level among the studied subjects according to Endocrine SocietyClinical PracticeGiudelines[22].

Total N=59 / Variable	Optimal25(OH)D ≥30ng/dl	Insufficiet 25(OH)D 20-29ng/dl	Defficient25(OH)D ≤ 20ng/dl
N	37	8	14
%	62.7%	13.6%	23.7%

Table(3): Comparison of Biochemical parameters and BMD between optimal25(OH)D and the[insufficient ,deficient]25(OH) D.

Group / Variable	Optimal25(OH)D group No(37) Mean(SD)	Insufficient and deficient25(OH)D group No(22) Mean (SD)	Test of significance	P value
25(OH)D{ng/dl}	32.2(7.6)	19(2.5)	9.7	0.000*
Serum Ca mg/dl	8.9(1.1)	9(1)	0.122	0.724
Serum po4 mg/dl	3.3(0.6)	3.4(0.7)	0.33	0.563
Serum ALP KAU	88.5(15.2)	212(32.4)	16.8	0.001*
I PTH pg/mmol	60.5(17.6)	197.2(22.7)	24.24	0.000*
BMD -Normal -Osteopenia -Osteoprosis	 30(18%) 6(16.2%) 1(2.7%)	 11(50%) 7(31.8%) 4(18.1%)	7.3	0.025*

* significant

Table(4) Pearson correlation of 25(OH)D level with PTH and BMD

1st Variable / 2nd Variable	IPTH		BMD	
	r1	P1	r2	P2
25(OH)D	-0.72	0.003*	+0.54	0.025*

*significant

V. Discussion

Vitamin D, the sunshine vitamin, has received a lot of attention recently as a result of a meteoric rise in the number of publications showing that vitamin D plays a crucial role in a plethora of physiological functions[24].Background of vitamin D deficiency and insufficiency are prevalent worldwide, but relatively few

studies have examined vitamin D status in working populations[25]. In Egypt most of the studies have been conducted on women.There is a paucity of information about 25(OH)D level in males espically who work mainly indoors and who are presumably at risk of vitamin D deficiency due to limited opportunity for exposure to solar UV radiation. Our skin is the major source of vitamin D; 90–95% of most people's vitamin D requirement comes from casual sun exposure[26] and <10% is derived from dietary sources[27]. Thus, the major cause of vitamin D deficiency is inadequate exposure to sunlight[22].

Below latitude of approximately 35▫North,UVB radiation is sufficient for vitamin D3 synthesis all the year round[28].The latitude of the tenth of Ramadan city,Egypt,where this study was carried out ,is 30.3▫North. So we can not suspect any problem with adequacy of sun exposure. In this cross-sectional study, we investigated circulating 25(OH)D levels in apparently healthy senior executive managers (indoor workers) traveling to office by sun film on car windowpanes, spent about 8-10 long hoursin air-conditioned office building, which has sunscreens on window panels. Hypovitaminosis D was found in 37.3% (13.6%) of them who had 25(OH)D insufficiency (20—29 ng/dl) and (23.7%) had 25(OH)D deficiency(≤20 ng/dl) (table 1).

This study revealed that more than the third of the participants hadhypovitaminosis D, inspite that the study was conducted during a sunny time of the year. This must be taken into considerationand highlighted the importance of a sensible sun exposure, especially for indoor workers irrespective of the work schedule. Holick, 2005 concluded that for an amount of 1000 IU of cholicalciferol, no more than 5–15 min/day (between 10 AM and 3 PM) on arms and legs or hands, face and arms, during the spring, the summer, and the fall (not during the winter unless one is located below 35° north)], of exposure to sunlight are required[26].

The time of year is an important factor in measurement of vitamin D levels in the diagnosis of insufficiency or deficiency. Bolland et al[29] found that summer is the ideal time to measure vitamin D levels as there is seasonal variation with a 14% increase 25(OH)D concentrations in men in summer. We measured 25(OH)D levelin the summer season, which could have been the highest level.This raise a questionof whether or not the 25(OH)D levels in mid- winter would be lower than that in summer. Also Gulvady etal.,[30]found that 28%of excutives had 25(OH)D deficiency due to limted sun exposure inspite of tropical countery or sunny climate. This finding also goes with a number of previous studies but in subtropic climate.[30,31,25]

Sadat-Ali etal.,[33] were interested by assessing 25(OH)D statusin healthy Saudi males and concluded that between 28% and 37% had 25(OH)D deficiency. Very low vitamin D levels have been reported from other Middle Eastern countries, particularly from Lebanon, Iran, Jordan and Turkey[34,35,36].By revising the lifestyle of subjects with hypovitaminosis D, they were less active,not exposed to sun adequately, consume little dairy products (the impact of civilization or modern life).

There is evidence that the prevalence of rickets and vitamin D deficiency is greater across the Middle East than in Western populations, with a large meta- analysis concluding that 20–80% of apparently healthy individuals suffer from vitamin D deficiency.[37]

Vitamin D sufficiency is pivotal for normal skeletal development , and for achieving and maintaining bone health in adults[38]. However,the subjects with 25(OH)D insufficiency and deficiency (N= 22) had normal serum calcium and phosphorous.This may be explained by the presence of secondary hyperparathyroidism. Moreover, there is a strong negative correlation of PTH with 25OHD, which goes in agreement with Sai et al., 2011[14]. In adults, multiple cross-sectional examinations of the relationship between serum PTH and 25(OH)D levels demonstrated a plateau in suppression of PTH when the 25(OH)D level reaches approximately 30 ng/mL. This is the rationale for selecting 30 ng/mL as the cutoff value for defining optimal vitamin D status[39]. Whereas those less with than 20 ng/ml or 50 nmol/liter fall into the frankly vitamin D-deficient range; where one is likely to observe clinically apparent skeletal effects of the deficient state[16]. A moderate positive correlation of25(OH)D with BMD measured by DEXA was found as 50% of subjects with hypovitaminosis D had low BMD. 31.8% of them were osteopenicand 18.1%had osteoprosis.These findings cope with the results of Bacon etal[40],Arabietal[41],Ardawietal[42].Multiple regression analysis revealed that sun exposure was the main determiningfactore for 25(OH)D status.

Limitations of the study

As with all researches, there were limitations to the present study. One of the obvious limitations of the current research isthe cross sectional study.It cannot measure causation between indoor workers and vitamin Ddefieincy.

- The sample of the study was obtained from one geographic area (10^{th} of Ramadan city). Any attempt to generalize the results of this study to another geographic areas should recognize the geographic limitations.

-The difficulty in interviewed some participants because all interviews were done with very busy participants (senior executive persons) while working, was no available much time to sit with them and answer the questionnaire in comfortable way and take blood sample easily .

VI. Conclusion

we can conclude that senior executive managers are vulnerable for vitamin D deficiency. The significant associations observed between BMD at the hip and lumbar spine and PTH and 25(OH)D emphasize the critical role of this hormone in bone metabolism and bone health. Considering the limited sun exposure, fortifying more foods might have to be deemed as part of a public health strategy in preventing vitamin D deficiency. Further studies are necessary to identify the optimal vitamin D levels necessary to prevent not only secondary hyperparathyroidism but also the extraskeletal effects of 25(OH)D.

VII. Conflict Of Interest

No conflict of interest

VIII. Acknowledgement

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