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Impact of Low-Dose Vitamin D Supplementation on Serum 25 (OH) D out of An Indoor worker in Large Scale Automotive Industry

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Abstract
Vitamin D deficiency is a worldwide epidemic and yet, it is a problem that is largely unknown by majority of population. Young adult workers are also potentially at high risk for vitamin D deficiency. Our study aimed to investigate the nutritional vitamin D status of indoor workers aged 24-61 years in 6 of October City, Egypt and assess the viability of low-measurements oral vitamin D supplementation in these populations. We directed a planned controlled trial during March 2016 to March 2017, contrasting the viability of vitamin D supplements (400 IU/day) with non-intervention for one year in indoor workers their ages 24-61 years. Serum 25 (OH)D focuses was estimated at gauge and after vitamin D supplementation, separately. At the baseline, 95% of indoor workers had vitamin D deficiency (<20 ng/mL). No difference was observed between the intervention and control groups with regard to anthropometric data. Serum 25(OH)D concentrations of the indoor workers intervention group and indoor workers control group were 12.77±3.01ng/ml and 14.17±3.59ng/mL at base line and increased to 17.34±3.78ng/mL, 18.04±4.01 ng/mL after vitamin D supplementation, respectively. Although, after adjusting for potential confounders, the 400 IU oral vitamin D supplementation increased serum 25(OH)D concentration in indoor workers (β=0.81,p=0.0426), the prevalence of vitamin D deficiency was still very high among indoor workers (79.23% in intervention group and 72.38% in control group. High prevalence of vitamin D lack was basic in the study populations. Day by day measurements of 400 IU oral vitamin D supplementation was not ready to increase serum 25(OH)D concentrations. A reasonable proposal with respect to the level of vitamin D supplementation is required for those Egyptian populations.

***Keywords:** Serum 25(OH)D; Vitamin D; Supplementation; Indoor workers*

Introduction

Vitamin D has a place with a gathering of secosteroid particles that are related with bone and calcium digestion [1]. The critical impacts of vitamin D are found in calcium homeostasis and musculoskeletal wellbeing, as well as in the respectability of the inborn resistant framework which have been Investigated extensively in recent years [2,3]. Public awareness is developing on the relative high prevalence of vitamin D deficiency in the all-inclusive community [1] which is related with an increased risk of several diseases, including Cancer [2], coronary illness, hypertension [4], diabetes [5], age-related subjective decrease, Parkinson's infection, different sclerosis and joint inflammation [3].

The significant type of vitamin D in the body incorporates vitamin D2 (Ergocalciferol) which is for the most part gotten from dietary sources, and vitamin D3 (cholecalciferol) which is orchestrated in the skin activated by sun presentation, or all the more particularly bright B (UVB) irradiation [6]. A main source of vitamin D is the cutaneous synthesis of 7-dehydrocholesterol from daylight introduction [7]. Serum 25-hydroxyvitamin D (25(OH) D) is the major circulating from of vitamin D, reflecting both cutaneous union and Dietary intake [8]. Although sufficient dietary intake of vitamin D can balance the absence of dermal union, dietary wellsprings of vitamin D are constrained with strengthened items [9].

Various mediations with vitamin D supplementation have been examined, with variable outcomes. An investigation led in Canadian patients with Crohn's illness detailed that a high measurement of vitamin D3 at 10,000 IU every day altogether expanded 25-hydroxy-vitamin D levels from a mean of 73.5 nmol/L to 160.8 nmol/L, while a low dosage of vitamin D3 at 1000 IU day by day did not essentially change 25-hydroxy-vitamin D levels, as qualities just expanded from 71.3 nmol/L to 82.8 nmol/L [10]. A US study, in which female participants adult 65 years or more seasoned were given oral supplementation of 800 IU vitamin D3, revealed that serum 25(OH) D levels ascended from 13.8 to 33.1 ng/mL following a year and to 35.5 ng/mL following two years of supplementation [11]. Right now, in any case, there is no standard meaning of the ideal serum levels of 25(OH)D. Distinctive measurements of vitamin D intervention studies have been accounted for from different populations [5,12,13].

Several existing epidemiologic studies have proposed a high prevalence of vitamin D insufficiency in British young people [14– 16]. A German report directed among grown-up adult 18 - 39 years revealed that vitamin D levels <30 ng/mL were distinguished in 85% of males and 87% of females. Enhanced comprehension of vitamin D status in various gatherings of German population will encourage the usage of fitting precaution methods [17].

The points of our study were to investigate the nutritional status of vitamin D among indoor workers some workers in Multinational Automotive Industry and to assess the efficiency of low- dose vitamin D intervention in indoor workers.

Material and Methods

Study Design and Participants

Indoor workers participants: A prospective controlled trial was done in an indoor specialist from March 2016 to March 2017. Participants were voluntarily recruited from A Multinational Automotive Company in 6 of October City, Egypt through coordination between the human services administration and Health and Safety Management there. In order to avoid contamination between groups, a Department – cluster randomized trial was utilized to randomize the office into an intervention department and a control department. By and large, 460 indoor workers aged 24-61 years agreed to enlist in the study.

All participants were Egyptian. Exclusion criteria included the accompanying conditions: effectively taking vitamin D supplements or related strengthened sustenance ; had an irresistible malady in the previous three months; experienced any real infections (Cushing disorder, acromegaly, extreme weakness, essential hypothyroidism or hyperthyroidism, epilepsy, dangerous tumors); had intense and ceaseless gastritis, gastric ulcer or other stomach related framework ailments; had rheumatic or intrinsic coronary illness; had a resting heart rate <45/min or >100/min; liver capacity was altogether anomalous or alanine aminotransferase (ALT) was three times higher than the ordinary furthest farthest point; had proof of renal brokenness or serum creatinine two times higher than the typical maximum cutoff; required long haul utilize of statins or glucocorticoid drugs; self-answered to be HIV-positive; or announced some other evident sicknesses. Composed educated assent was gotten from every member and the investigation convention was affirmed by the Medical Ethics Review Committee of the principle branch based of the organization in USA for Disease Control and Prevention.

Interventions and Procedures

All eligible indoor workers participants were asked to complete a questionnaire at baseline, which include demographic characteristics, disease history, daily lifestyle and family information. After over-night fasting, 5mL peripheral venous blood were collected into a vacuum-evacuated tube containing ethylene diamine tetraaceticacid(EDTA) anticoagulant from each participant and were subsequently centrifuged at 1000rpm/min for 10min. Supernatants were stored at−80°C, until they were used to measure baseline vitamin-D concentrations. Participants in the intervention group were provided with vitamin D supplements and instructed to orally take one tablet daily during the study period (each tablet contained 400IU vitamin D_3. Vitamin D supplementation tablets were uniformly from Pharmaceuticals Co. Cairo, Egypt). Participants in both groups were provided with telephone call weekly to remind them to take daily supplementation. After the 12-month intervention, each participant worker completed a standardized questionnaire including demographics, lifestyle factors, physical activity, dietary intake, and fortified food supplementations. Additionally, 5mL fasting peripheral venous blood was sampled. Both before and after the intervention, fasting peripheral venous blood samples were collected. The sample collection, transportation and preservation were carried out in strict accordance with regulations.
Routine procedures were operated by professionals, and investigation instructors were in charge of quality control, thus ensured the accuracy and reliability of the test results.

Measurements

Anthropometric estimations were performed via trained healthcare workers; body mass index (BMI) was calculated as weight in kilograms divided by the square of the t in meters (kg/m^2). Dietary intake assessments were conducted by standardized food portions after a year's follow-up in indoor workers and at pattern. Food variety score was measured as the total number of food items expended over a year [18]. Serum 25(OH)D (comprised of 25(OH)D2 and 25(OH)D3) concentrations were quantitatively determined by using a commercially available enzyme immunoassay pack (OCTEIA 25-(OH)D Kit, Immuno Diagnostic Systems, Boldon, UK) at the organization particular referral research center. Exactness testing appeared inside run coefficient of varieties (CVs) of ≤7%, within-laboratory CVs of <9.5%, and between-lab accuracy CVs of ≤10.1% [19]. Tests randomized crosswise over plates. Quality control materials were investigated each day to test if the estimating esteem was inside scientific estimating range. Standard control was utilized for the modification of estimating bend when the clump of reagent was changed.

Statistical Analysis

The continuous and categorical variables were presented as means (standard deviation) and frequencies (percentage), respectively. A comparison of the demographic characteristics, Anthropometry information and clinical study between the intervention and control groups were conducted in indoor workers participants using two-sample *t*-tests and chi-square tests, respectively. Linear regression analyses were applied to quantify the associations between vitamin D supplementation and serum 25(OH)D concentrations. In the multivariable regression models, gender, age, BMI, physical activity, outdoor activity time and food variety score were taken as potential confounders. All data from the questionnaires were entered and analyses were performed using in SPSS version 17. The statistically significant level was $p < 0.05$.

Results

Participant Characteristics

In this study, 509 indoor workers were enrolled at the baseline, and 44 (8.8%) of them excluded from final analyses due to incomplete at a acquisition at the end of the follow-up. Overall, 450 indoor workersaged24-61 years (222 males, 228 females) were included. Demographic characteristics are shown in Table1; distributions of gender, age, BMI, blood pressure and hemoglobin concentration did not show significant difference between the intervention group and the control group.

Table 1. Characteristics of the intervention and control groups in indoor workers.

Variables	Total participants (N=450)	Intervention Group (N=150)	Control Group (N=300)	P value
Gender, N (%)				
Male	222 (49.29)	72 (48.09)	151 (50.21)	0.6657
Female	228 (50.71)	77 (51.91)	149 (49.79)	
Age(years)	11.83± 1.68	11.74 ± 1.69	11.90 ± 1.67	0.3231
BMI (kg/m²)	18.94± 3.07	18.87 ± 3.06	18.99 ± 3.08	0.2220
SBP (mmHg)	109.05 ± 11.09	108.40 ± 11.29	109.60 ± 10.94	0.2752
DBP (mmHg)	65.87± 7.55	65.22 ± 7.57	66.38 ± 7.51	0.1172
Hemoglobin (g/L)	130.64 ± 9.82	129.70 ± 9.41	131.4 ± 10.08	0..775
Follow – up (kg/m²)	20.02 ± 3.54	20.14 ± 3.47	19.93 ± 3.59	0.0718

Serum 25(OH)D Levels at Baseline and Follow-Up

Indoor workers' serum 25(OH)D concentrations at the baseline and after the12-month follow-up are presented in Table 2. The mean baseline serum 25(OH) D concentration was 13.56 ± 3.42 ng/mL among indoor workers. At the baseline, a total of 427 (95%) indoor workers suffered from vitamin D deficiency, which including 148 indoor workers in the intervention group (98.36% of150) and 279 in the control group (92.89% of 300). The control group had a significantly higher mean serum 25(OH) D concentration compared with intervention group at the baseline ($p < 0.0001$). After the 12 months' vitamin D supplementation, serum 25(OH) D concentrations increased from 12.77 ± 3.01 to 17.34 ± 3.78 ng/mL in the intervention group and from 14.17 ± 3.59 to 18.04 ± 4.0 ng/mL in the control group. Serum 25(OH) D in the two groups increased about 4.57±3.60 ng/mL and 3.87 ± 3.81 ng/mL respectively. Paired *t*-test analysis found that serum 25(OH) D concentrations of before and after the intervention in each group increased in both groups ($p<0.0001$). However, there was a marginally significant difference in the increment of serum 25(OH) D concentrations between the intervention group and the control group ($p = 0.0544$). At the end of the study, 118 indoor workers in the intervention group (79.23%of 150) and 217in the control group (72.38%of300)still suffered from vitamin D deficiency (< 20 ng/mL).

Table 2. Comparison of changes in serum 25(OH)D before and after the intervention indoor workers

	Total Participants (*N* = 450)	Intervention Group (*N* = 150)	Control Group (*N* = 300)	*p* Value [a]
Baseline Follow-up (ng/mL).	13.56 ± 3.42	12.77 ± 3.01	14.17 ± 3.59	<0.0001 0.0718
Difference	17.73±3.92 4.17±3.73	17.34±3.78 4.57±3.60	18.04±4.01 3.87±3.81	0.0544
***p*value[b]**	<0.0001	<0.0001	<0.0001	

[a]*Intervention vs. control group;* [b] *Baseline vs. follow-up.*

Relationship between Vitamin D Supplementation and Serum 25(OH)D Concentrations in Indoor workers

The association of vitamin D supplementation with serum 25(OH)D concentrations in indoor workers are shown in Table 3. In different multivariable regression analyses models, the baseline serum 25(OH)D concentrations of the intervention group were lower than that of the control group ($\beta=-1.52, p<0.0001$), and difference persisted after adjustment for age, gender, BMI, physical activity, outdoor activity time and food variety score ($\beta=-1.49, p<0.0001$). After vitamin D supplementation, the crude model showed no significant difference in serum 25(OH)D concentrations between the intervention group and the control group($\beta=-0.69, p=0.0718$).After adjustment for age, gender and BMI in model 2, the difference became significant (β=−0.76,*p*=0.0496),but in model 3 the difference turned out to be insignificant when further adjusted by physical activity, outdoor activity time, food variety score and baseline serum25 (OH) D concentrations(β=0.04,*p*=0.9134).The adjusted models 2 and 3 both showed a positive association between vitamin D supplementation and the increment of serum 25(OH)D concentrations (β = 0.76, p = 0.0444; β = 0.81, p = 0.0426,respectively).

Table 3. Adjusted association of vitamin D intervention with 25(OH)D concentrations among indoor workers (N = 450).

Variables	Model1		Model2		Model3	
	β(se)	*p*Value	β(se)	*p*Value	β(se)	*p*V
Baseline						
Controlgroup	REF		REF		REF	
Interventiongroup	−1.39(0.33)	<0.0001	−1.52(0.33)	<0.0001	−1.49(0.34)	<0
Follow-up						
Control group	REF		REF		REF	
Intervention group	−0.69 (0.38)	0.0718	−0.76 (0.38)	0.0496	0.04 (0.37)	0.9134
Increment						
Control group	REF		REF		REF	
Intervention group	0.70 (0.36)	0.0544	0.76 (0.38)	0.0444	0.81 (0.39)	0.0426

Model1:Crude;Model2: Adjustmentforage,genderandBMI;Model3:Adjustmentforage,gender,BMI,physical activity,outdooractivitytimeandfoodvarietyscore,(follow-upmodelalsoadjustedbaseline 25 (OH) D).

Discussion

In this study, vitamin D status in prospective interventional cohorts of indoor workers was evaluated. Our outcomes showed that the indoor workers had low mean serum 25(OH)D concentrations at baseline (13.56 ± 3.42 ng/mL and 16.58 ± 3.66 ng/mL). After vitamin D supplementation, significant difference was detected in changes of serum 25(OH)D concentrations in indoor workers between the intervention versus control groups (p = 0.0426). In spite of the small extent of the increments of serum 25(OH)D concentrations, we didn't locate that low-measurements (400 IU/day) vitamin D supplementation could significantly improve vitamin D deficiency in the participants.

The serum 25(OH)D levels in the present study were much lower than other watched populations detailed in previous domestic investigations [15,20]. An overview led in Hangzhou (30◦ N), uncovered that indoor workers adult 28-51 years had a mean serum 25(OH)D grouping of 56 nmol/L (22.4 ng/mL), adolescents 12– 16 years of age had a mean centralization of 52 nmol/L (20.8 ng/mL) [21]. Another investigation in Huzhou (30.86◦ N) demonstrated that individuals experienced low vitamin D status, and specified that from 1 year to 17 years old, it diminished ceaselessly and fundamentally with age [22]. Different past studies, be that as it may, specified lower 25(OH)D levels from various areas around the globe [21– 26].

As a worldwide prevalence of vitamin D deficiency has been reported for in recent decades, vitamin D status changes across various populations and regions [27– 30]. Observational studies have recommended that a large part of considered population have suboptimal levels of 25(OH)D [31– 33].

There is still no consensus on the ideal level of serum 25(OH)D concentrations for healthy children or adults. The US Endocrine Society characterized vitamin D lack as a 25(OH)D level beneath 20 ng/mL (50 nmol/L), and vitamin D deficiency as a 25(OH)D level of 21– 29 ng/mL (52.5– 72.5 nmol/L) in 2011 [34]. The Institute of Medicine (IOM) discharged diverse reference esteems; 97.5% of the overall public are guaranteed bone wellbeing when serum 25OHD levels are ≥20 ng/mL (50 nmol/L), while serum 25(OH)D concentrations<16 ng/mL (40 nmol/L) mirror a level that is adequate to guarantee bone wellbeing for roughly half of the all-inclusive community [35– 37]. The distinctions may have come about because of various lab examines to quantify serum 25(OH)D levels, hence, the quality controls changed crosswise over various investigations. In the present investigation, 25(OH) D levels were estimated in March 2016 (standard) and after that in March 201 (End of the study).

In the current study, The serum 25(OH)D level varied remarkably with the change in seasons, which was most highest in summer among the population [15,22]. While baseline and final blood were tested in various seasons, the utilization of the intervention and control groups took into consideration studies between groups under the supposition that introduction to vitamin D crosswise over seasons was comparative. Vitamin D insufficiency may bring about rickets among grown-up [38] and osteomalacia among grown-ups [39]. The greater part of our study tests was from an obviously sound population, despite the fact that the mean serum 25(OH)D levels of the example population were lower than different reports, and any vitamin D-related subclinical signs were not found during consider period.

In the multivariable studies, the unadjusted model demonstrated no huge connection in changes of 25(OH)D concentrations between the pattern and catch up with vitamin D supplementation among indoor workers. In any case, on the grounds that the standard

25(OH)D concentrations were not practically identical, benchmark 25(OH)D concentrations were taken as covariates in the multivariable model, and the 25(OH)D concentrations after the intervention in the mediation gather were fundamentally higher than those of the control gathering. In any case, the lack of vitamin D was likewise not clearly enhanced in the mediation gathering (79.23%). A meta-investigation demonstrated that there was no huge contrast in 25(OH)D levels between the lower measurements (<800 IU/day) supplementation versus the fake treatment among teenagers; and the creator proposed that a halfway vitamin D dosage of 1000– 2000 IU every day might be important to take into account most of the population to achieve an alluring 25(OH)D level of 20 ng/mL [40]. An investigation which surveyed high dosage vitamin D supplementation security revealed that a 2000 IU/day intervention for 1 year brought about alluring vitamin D levels in young people [12].

Dietary intake of vitamin D is known to have a littler commitment to vitamin D status than cutaneous creation in light of bright light presentation. The Pediatric Branch of the USA Medical Association prescribes an everyday vitamin D supply of 400 IU for grown-up adult 0~6 years, and 100 IU for grown-up more than 7 years old [41]. The Scientific Advisory Committee on Nutrition in the UK upheld a reference supplement admission of 400 IU vitamin D every day for the all-inclusive community adult more than 4 years, and a maximum farthest point of 4000 IU/day [13]. The US IOM Committee's proposed the AI (sufficient admission) in early stages is evaluated to be 400 IU/day. The RDA (dietary reference admission) is 600 IU/day for individuals >1-year-old, aside from men and women 71 and more seasoned (for whom the RDA is 800 IU/day) [36]. Improper vitamin D supplementation raises medicinal services costs and may cause unfavorable impacts. In this manner, it is important to ensure a direct measurement of vitamin D supplementation fit for the Egyptian population.

At the indoor workers participants of the present study were 6 of October or Cairo Cities, our findings may not generalize to the population in other areas, and extrapolating the conclusions need careful consideration. Additionally, a confounding bias may exist in this. Department cluster randomization was applied in indoor workers. However, as individual randomization was not applied, it might result in a confounding bias between the intervention and control groups.

Conclusion

Our study demonstrated a high prevalence of vitamin D deficiency among indoor workers. This study demonstrated that a daily dose of 400 IU of oral vitamin D supplementation can't practically raise serum 25 (OH) D concentrations, and that prevention of vitamin D deficiency may require a higher dose of vitamin D supplementation or more sun-exposure to the indoor workers.

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Conflicts of Interest:

The author has stated explicitly that there are no conflicts of interest in connection with this article.

Author contributions

The author is one of the principal investigators of this trial, designed and wrote the study protocol, obtained funding, and contributed to writing and editing the manuscript. She shared in writing the first draft of the manuscript and is involved in data acquisition and analysis. She read and approved the final manuscript and meet the criteria for authorship of the International Committee of Medical Journal Editors.

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