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Research Article

ASSOCIATION BETWEEN 25-HYDROXYVITAMIN D LEVEL AND TYPE 2 DIABETES AMONG ADULT EMPLOYEES

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A R T I C L E I N F O

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Introduction: Increasing evidence suggests that Vitamin Dplays a function in the progress of chronic diseases includingtype 2 diabetes (DM). **Aim of the work:** was to explore the association of Vitamin Dlevels with widely wide-spread DM in a sample of predominantly healthful working adults more than 45 of age. **Subjects and Methods:** This cross-sectional Study (2016-2017) involved 823 at 9 working sites in different governorates, Egypt (83.2% male, mean age 51.8 ±5.5 years). Sociodemographic and medical history had been assessed by self-report. Scientific characteristics have been got including blood samples to check vitamin D levels and diabetes status by means of fasting plasma glucose (FPG) and glycosylated hemoglobin (HbA1c). Vitamin Dwas grouped into considered one of 4 categories (<10 ng/ml, 10-19.9 ng/ml, 20-29.9 ng/ml, ≥30 ng/ml). Bivariate associations betweenvitaminD levels and a composite indicator for DM (FPG ≥126 mg/dl or HbA1c ≥6.5% or self-reporteddiagnosis) had been calculated; multivariable units confirmed this association further, controlling for expertise confounders. **Results:** severe vitamin D deficiency (<10 ng/ml) was related to growing FPG (β 3.14; 95%CI: 0.78, 5.48; p≤0.01) and HbA1c (β 0.15; 95%CI: 0.08, 0.24; p≤0.001) values in adjusted linear regression models. In multivariable models, severVitamin Ddeficiency used to be associated with DM (OR 2.54; 95%CI 1.16, 5.63; p≤0.05) after controlling for abilities confounders. **Conclusions:** vitaminD deficiency is associated with widespread DM in working adults. The findings spotlight that the workplace is also a targeted location for conducting big-scale health screening to establish these at risk of DM making use of vitamin D.

INTRODUCTION

The global prevalence of vitamin D (25-hydroxyvitamin D) deficiency is estimated at 30-87% [1]. In Europe, these estimates variety between 15-30% in the community sample [2]. Deficiency of 25-hydroxy vitamin (25(OH)D) has been characterized as values <20 ng/ml (50 nmol/l) and has been recognized as an intent of childhood rickets and adult osteomalacia for the reason that the early 19th century. Sever deficiency has been outlined as not up to 10 ng/ml (25 nmol/l) [3]. In the final 40 years, observational experiences have linked 25(OH)D deficiency to the development of chronic stipulations including cardiovascular ailment [4] and diabetes mellitus [5]. Even as countrywide and global recommendations were developed to make sure good calcium homeostasis [6], few deal with the renovation of sufficient 25(OH)D levels as a method of stopping chronicdisorders seeing that of constrained scientific evidence for a causal hyperlink [7,8]. The prevalence of type 2 diabetes has Increased in industrial nations and is expected to reach an international-vast occurrence of four.4% through 2030 [9]. Earlier work also files that the mean age of type 2 diabetes diagnosis has decreased in some settings from 52 to 46 years between 1988 and 2000 [10]. Both trends are hence more and more likely to have an impact on adults of working age, compounding their financial and social effects and highlighting their relevance to public health. Diabetes prevention is now a public health priority in many countries global.

Deficiency of 25(OH)D has been implicated in the pathogenesis of diabetes although particular pathophysiological pathways stay uncertain [5]. Prior observational work, nonetheless, calls this association into question. Although maybe regarding small pattern sizes and reduced energy to notice small but significant associations, some reports file no association [11]. In addition, many of those have explored the association of diabetes and Vitamin Dlevels in old people and chronically ill participants, but not in healthful adults like working populations.

Even though chronic diseases similar to cardiovascular disorder or type 2 diabetes were as soon as proposal to be a crisis of old age agencies, there is a shift toward onset during the population´s working age [12]. Apparently healthful humans can endure from 25(OH)D deficiency as well as from

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type 2 diabetes. The occupational doctor and the workplace is for that reason a promising atmosphere for screening and prevention. Following the guidelines of the American Diabetes association 2011 [13,14] type 2 diabetes screening of healthy adults will have to on the age of 45 every three years. Unluckily only few healthy employees of this age turn to a surgeon (GP) on a regular groundwork. The compliance of routine screenings, notably the so-referred to as "check-up 35" supplied through the General Practitioner and paid by using the general public healthinsurance in Egypt is only 25%.Work settings must exceed the participation expense of this public strategy. Likewise, a work atmosphere can result in early detection of 25(OH)D deficiency as that is general in all age groups [3] and a significant numbers of earlier unrecognized diabetes circumstances [15]. The query if Vitamin Ddeficiency and diabetes mellitus are linked together in the workforce remains to be unanswered.

Aim of the Work

The aim of the present study is to investigate the connection between Vitamin Dlevels and the prevalence of type 2 diabetes in working adults more than 45 of age.

SUBJECTS AND METHODS

Study sample

This study is based on cross-sectional data through private occupational health insurance company. AllFull- and part-time employees more than 45 years (n=1.539) at 9 working sites in different governorates, Egypt were invited to take part in a health assessment in the workplace. Participation used to be voluntary and recruitment took place during working hours. No incentives except a full personal health report have been offered. Secondary analysis of all data used to be permitted by the Management Committee of the private occupational insurance company. Written informed consent used to be given by each participant. Members had been recruited and examined between May 2015 and April 2017. Data were collected between 8am and 5pm utilizing participant-completed questionnaires and a medical examination.

Self-Reported Characteristics

Paper questionnaires constructed from 25 items assessed respondents' age, gender, administration level, and medical history for chronic diseases (cardiovascular disease, hypertension, type 2 diabetes). The work-related stress stage was measured by using the Effort-Reward Imbalance ratio, which has been previously shown to be involving diabetes mellitus [16]. Questionnaire models additionally assessed health behaviors including current smoking status (present, earlier, under no circumstances), fish consumption (< or ≥ 2 times a weekand physical undertaking level (3 instances per week, greater than every week, as soon as a week, 1-3 occasions a month, seldom or by no means).

Clinically-Assessed Characteristics

The medical examination assessed anthropometric indices (body mass index, waist circumference), physiological measures including diastolic and systolic blood pressure measurements, and assortment of blood and urine specimens. The body mass index was calculated within the traditional method (weight in kilograms/peak in meters^2) with the participant dressed in gentle garments and without sneakers. The waist circumference was measured in centimeters horizontally around the smallest circumference between the ribs and iliac crest, or on the navel if no normal waistline used to be reward. Blood pressure used to be recorded twice with the participant in a seated position using an automated CritikonDinamap transportable and Neonatal relevant signs reveal (model 8100). Readings, expressed in millimeters of mercury (mmHg), have been made making use of the dominant arm after a standardized 5 minutes restInterval. We used the mean of those measures in our analysis. Arterial hypertension used to be considered to be reward if one of the most following prevalent was met in keeping with definitions of the WHO [17]: (1) diastolic blood pressure ≥90 mmHg; (2) systolic blood pressure ≥140 mmHg; (3) self-mentioned hypertension. A spot morning urine sample was got to assess urine albumin and fasting a.m. Blood samples assessed the following biochemical markers: serum C-reactive protein (CRP), creatinine, glycosylated hemoglobin (HbA1c), 25-hydroxyvitamin D, and fasting plasma glucose (FPG). All urine and blood samples were processed at a single laboratory at which standardization strategies were adopted every day for each assay. Exceptionally, FPG used to be measured by way of the glucose hexokinase enzymatic assay (Olympus Glucose OSR6121) and HbA1c by the Roche 2d generation hemoglobin A1c immunoassay. Vitamin D samples were analyzed with ordinary laboratory tactics utilizing the Roche Modular Analytics E170 vitamin D 3 (25-OH) assay.

Diagnosis of Type 2 Diabetes

Following the factors of the American Diabetes association [18] and consensus statements issued through the arena health institution (WHO), worldwide Diabetes Federation, and European association for the study Diabetes [19] diabetes mellitus used to be viewed present if at least one of the most following was met: (1) FPG ≥126 mg/dl (7.0 mmol/l); (2) HbA1c ≥6.5% (48 mmol/mol); (3) self-suggested diabetes with affirmation of healthcare professional diagnosis.

Classification of Vitamin D Levels

We used broadly approved cut-off values for 25(OH)D to create four vitamin D levels: sever deficiency, <10 ng/ml (25 nmol/l); moderate deficiency, 10-19.9 ng/ml (25-49.9 nmol/l); insufficiency, 20-29.9 ng/ml (50-74.9 nmol/l); sufficiency, ≥30 ng/ml (75 nmol/l) [3,5].

Data Analysis

We present descriptive, univariate evaluation utilizing approach and normal deviations. In cases where in the distribution of a parameter was skewed, we utilized a metamorphosis (e.g., logarithmic, squared, rectangular root, or 1/rectangular root) to higher approximate a traditional distribution. Due to the transformation, the signal of a quantity appears in some cases terrible, where confident is expected. Next, we proven linear pattern for continuous variables and used the p for linear-by-linear scan for categorical variables. Bivariate correlations between our indicator of generic type 2 diabetes and a range of self-said (demographic and behavioral) and clinically-associated variables had been assessed using Cramers V for express variables. Biserial correlations were used to correlate continuous with dichotomous variables. Bivariate correlations were assessed betweenvitaminD levels and HbA1c and FPG levels using Pearson correlation coefficient. Moreover, Figure 1 shows locally weighted

regression (LOWESS) of HbA1c with 25(OH)D and FPG with 25(OH)D.

Separate linear regression units verified the association of continuous values for FPG and HbA1c with the 4 levels of 25(OH)D levels. We used a two-step strategy, controlling for all variables that confirmed significant correlation within bivariate comparisons (age, body mass index, hypertension, and C-reactive protein) complemented via variables (smoking, work stress, alcohol consumption, and physical exercise) which were previously said to be related to type 2 diabetes before. A backward removal modeling approach was then utilized to limit the quantity of confounders for predictive modeling, establishing with a one-by means of-one elimination of the least tremendous confounder. The stopping rule for exclusion was a moderate significance level ($p \leq 0.05$). Identified confounders had been age, body mass index, smoking, and urine albumin. In a final step, we carried out multivariable logistic regression analyses and used odds ratios (OR) with 95% confidence intervals (95% CI) to demonstrate the association of 25(OH)D levels with prevalent diabetes mellitus. As earlier than, backward elimination was used to lessen threat of overfitting the model. We used Stata 12.1 MP (College Station, TX: StataCorp LP) for all statistical analysis.

RESULTS

A total of 1539 worker participated in the study (53.4% response rate). Of these, 823 contributors furnished total information for the evaluation. The mean age of this ultimate sample dimension was 51.8 ±5.5 years, 16.8% of individuals had been female, and 14.9% were present smokers (Table 1). The excluded subjects didn't range significantly from these included in the evaluation with respect to age, gender, and smoking popularity.

A total of 115 participants (13.9%) fulfilled criteria for prevalent diabetes mellitus with two-thirds self-reporting the analysis. The overall mean 25(OH) D level was 22.2 ±10.7 ng/ml with severe deficiency reward in 14% of members and moderate deficiency in 32%. Contributors with sever 25(OH)D deficiency were more likely to be female and to have significantly bigger values for waist circumference, FPG, and HbA1c (p value≤0.01). In contrast, those within the perfect 25(OH)D class were extra prone to devour alcohol and actively smoke, but are also extra bodily active. Systolic and diastolic blood pressure did not fluctuate between groups. The percentage of participants with regularly occurring diabetes mellitus expanded with reducing levels of 25(OH)D (3.1% to 7.4%).

Compared to these in the non-diabetic workers, contributors with regularly occurring diabetes showed lowerlevels of 25(OH)D (22.0 ±10.8 ng/ml vs. 20.3 ±10.0 ng/ml, $p \leq 0.05$).

Bivariate comparisons of diabetes mellitus with multiple variables (Table 2) confirmed high significance ($p \leq 0.001$) correlations with age, a diagnosis of arterial hypertension, urine albumin, body mass index, and waist circumference. Despite the fact that correlations had been reasonably smaller, we found significant associations between prevalent diabetes mellitus and systolic blood pressure and CRP ($p \leq 0.01$) as well as diastolic blood pressure ($p \leq 0.05$). Recruitment interval used to be no longer related to diabetes mellitus.

Continuous values for HbA1c ($r=-0.088$; $p \leq 0.01$) and FPG ($r=-0.064$; $p \leq 0.01$) were negatively associated with 25 (OH)D levels (Figure 1). Linear regression analysis indicated independent associations of both parameters with severe 25(OH)D deficiency (FPG: $\beta=3.14$, $p \leq 0.01$; HbA1c: $\beta=0.15$, $p \leq 0.001$) after adjusting for potential confounders utilizing a backward elimination (Table 3).

Comparing with those with sufficient 25(OH)D levels, contributors with insufficient, deficient and severely deficient 25(OH)D levels had higher odds of prevalent diabetes (Table 4). For those in the severely deficient class, OR used to be 2.34 (95%CI: 1.12, 4.93) for prevalent diabetes mellitus. In every case, associations increased modestly as a substitute than being attenuated following adjustment for a variety of potential confounders and remained statistically significant (OR 2.54 [95%CI: 1.16, 5.63]).

Table 1 Characteristics of study population (n=823) according to 25-hydroxyvitamin D levels

Variables	Total N=823		Sufficiency 21%		Insufficiency 33%		Moderate Deficiency 32%		Sever Deficiency 14%		P value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Age (Years)	51.8	±5.5	51.9	±6.1	51.8	±5.3	51.9	±5.7	52.3	±5.7	0.85
Gender (% female)	16.8		13.5		15.5		17.4		24.7		≤0.001
Upper management (%)	10.3		10.8		10.8		9.2		11.2		0.75
BMI (Kg/m2)	24.3	±3.9	23.9	±3.1	24.5	±3.8	24.4	±3.8	24.7	±4.1	0.028
Waist circumference (cm)	95.4	±11.6	93.4	±10.4	95.7	±11.4	95.8	±11.5	96.2	±12.4	0.01
Systolic BP (mmHg)	140	±15.4	140	±15.2	140	±15.3	140	±15.3	140	±16.2	0.98
Diastolic BP(mmHg)	83.2	±11.4	83.3	±11.2	82.7	±11.2	82	±11.6	83.9	±11.8	0.93
Hypertension (%)	56.8		54.3		56.6		56.4		63.3		0.15
CRP(mg/l)	1.9	±3.2	1.7	±2.4	1.7	±4.1	1.8	±2.6	1.8	±2.8	0.51
FPG(mg/dl)	92.1	±15.4	90.2	±10.1	92.1	±13.8	92.7	±16.2	93.8	±22.5	0.007
HbA1c (%)	5.74	±0.49	5.66	±0.27	5.71	±0.42	5.75	±0.52	5.84	±0.67	≤001
Serum creatinine(mg/dl)	1.08	±0.17	1.13	±0.17	1.08	±0.16	1.08	±0.17	1.06	±0.16	≤0.001
Urine albumin (mg/l)	6.9	±31.4	9.1	±50.3	6.5	±31.3	6.5	±16.1	5.6	±14.4	0.05
Diabetes mellitus (%)	6.2		3.1		6.7		6.9		7.4		0.08
ERI	1.4	±0.6	1.4	±0.4	1.4	±0.6	1.4	±0.4	1.3	±0.5	0.014
Fish consumption (%)	13.2		11.3		11.4		15.4		15.1		0.028
Physical exercise (%)	44.1		59.3		43.7		38.7		33.4		≤0.001
Current smoker (%)	14.9		18.6		12.7		15.6		12.1		0.018

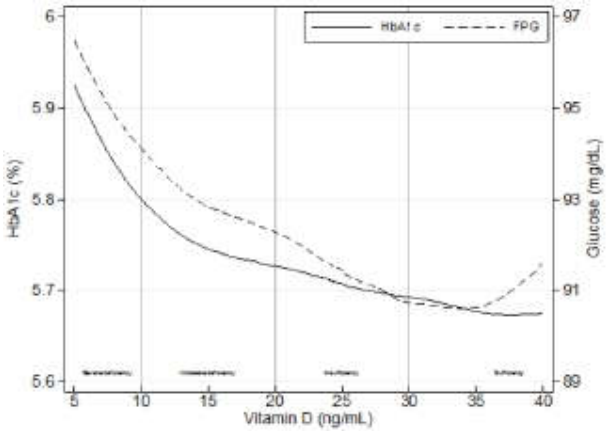

Figure 1 Crude associations of mean levels of glycosylated hemoglobin (HbA1c) and fasting plasma glucose (FPG) with 25-hydroxyvitamin D levels

Table 2 Bivariate correlations of multiple variables with prevalence of type 2 diabetes, n=823

Variables	Diabetes mellitus (r)
Self-Reported Characteristics	
Age	0.127
Gender	-0.003
Upper management	-0.010
ERI	-0.018
Physical exercise	0.068
Fish consumption	0.010
Recruitment period	0.037
Current smoker	0.043
Clinically Assessed Characteristics	
25-hydroxyvitamin D	-0.038
Urine albumin	0.108
Serum creatinine	-0.036
Systolic BP	-0.073
Diastolic BP	0.006
Hypertension	0.093
BMI	-0.197
Waist circumference	0.206
C-reactive protein	0.063

Table 3 Independent association of 25 hydroxyvitamin D categories with continuous values of FPG and HbA1c, n=823*

Variables	Sufficiency	Insufficiency		Moderate Deficiency		Sever Deficiency	
	Reference Category	β	95% CI	β	95% CI	β	95% CI
			Backward Elimination				
FPG	1	1.08	-0.76 2.93	1.86	0.02, 3.68	3.14	0.78, 5.48
HbA1c	1	0.04	-0.02, 0.11	0.06	0.04 0.13	0.15	0.08, 0.24

*adjusted for age, body mass index, smoking, and urine albumin

Table 4 Crude and adjusted association of 25-hydroxyvitamin Dcategories with prevalent type 2 diabetes, n= 823

Variables	Sufficiency	Insufficiency		Moderate Deficiency		Sever Deficiency	
	Reference Category	OR	95% CI	OR	95% CI	OR	95% CI
			Model 1				
DM	1	2.18	1.14, 4.12	2.23	1.18, 4.2	2.34	1.12, 4.93
			Model 2				
DM	1	2.19	1.10, 4.32	2.28	1.17, 4.51	2.54	1.16, 5.63

*Model1 unadjusted and Model 2 backward elimination,adjusted for age, body mass index, smoking, and urine albumin

DISCUSSION

This cross-sectional study is one of few studies that observed an association between 25(OH)D levels and laboratory indicators of type 2 diabetes in a significant sample of healthy adults in the personnel in Egypt, so far as we know. When the elegant variable used to be defined in phrases of prevalence and used either self-reported analysis or threshold values for laboratory warning signs, an association was present for those with insufficient, deficient and severely deficient levels, when compared with these with a typical stage. Importantly, these associations remained robust to adjustment by means of potential confounders.

In our sample, sever 25(OH)D deficiency (<10 ng/ml) used to be present in 14% of all individuals; 32% had levelscontinuous with moderate deficiency (10-19.9 ng/ml). These findings are moderately diminished than in another study, which reported a 16% prevalence of severe deficiency in individuals aged 18-79 years [3]. Deficiency of 25(OH)D used to be related to female gender and obese, whereas adequate levels were associated with common bodily exercise, smoking consumption. The association of existence variety reasons has been explored before [20]. Increased body mass index and no more bodily exercise have been associated with 25(OH)D deficiency. These findings could also be related as physical inactiveness may be more present amongst overweight persons. A number of bodily exercise is normally done outdoors and as a consequence permits photosynthesis ofvitaminD. In addition, vitaminD is a lipophilic vitamin and saved in body fats cells which makes it more complicated for overweight individuals to take potential of this nutrition. The association of 25(OH)D deficiency and female gender is common in Arabian nations as a result of the follow of purdah whereby all skin is blanketed [20,21], however not in European areas most commonly. Only 16.8% of our studysample have been female with a mean age of 51.8 years. This association could be involving postmenopausal effects which has been proven before [22]. Relatively, 25(OH)D deficiency was inversely related to smoking consumption. Our study involving smoking is contrary to many of the present literature [23]. Higher 25(OH)D levels may have been discovered in people who smoke in this sample on the grounds that of legal rules requiring workers to smoke external the work buildings. This regulation could thus have ended in more generic sunlight exposure and higher production of vitamin D precursors within the skin. An additional reason would be using a Roche assay that over estimates 25(OH)D levels in people who smoke by using unknown mechanisms [24].

Diabetes used to be present in 13.9% of our study population, which is near to explorations of other employers [15]. Although we determined a significant association of each FPG and HbA1c with severe 25(OH)D deficiency, equivalent findings have been stated inconsistently in prior work. While an inverse association of 25(OH)D and FPG has been observed a few occasions in extraordinary populations [5,25,26], inverse associations with HbA1c weren't detected in more youthful Americans [25] however detected in old individuals [5]. There are several lines of proof to support that vitamin D influences impaired β-cell function, insulin resistance and systematic inflammation [27]. It has been confirmed thatvitaminD receptors exist in many tissues including pancreatic β-cells [4], allowing vitamin D to possibly modulate the insulin response to increased blood glucose.

One third (33%) of all diabetes instances in our apparently healthful study sample were newly detected reflecting the presence of a high proportion of undiagnosed diabetes instances within the sample. As a consequence, the work is a useful environment for health screenings [15]. To our knowledge, the current study is one of few studies to discover the association of 25(OH)D deficiency and the prevalence of type 2 diabetes in healthy working adults. LURIC study determined that greater 25(OH)D levels had been significantly related to better glycemic status in 3,316 aged sufferers scheduled for coronary angiography [5]. An identical outcome was described by means of a Korean study group exploring 12,263 subjects of the Korea national health andnutrition Examination Survey more than 19 of age [28]. Additionally, a meta-analysis with 3,612 diabetes cases (mean age 61.6 years) established an inverse association between circulating 25(OH)D and prevalenttype 2 diabetes [29]. Another meta-analysis with 4,996 instances showed that each 10 nmol/L increments in 25(OH)D levels was significantly related to a 4% lower risk of type 2 diabetes [30]. Nonetheless, while some latest publications record associations of 25(OH)D levels and type 2 diabetes [31,32] there are others mentioning the opposite [33,34] indicating a lack of reliable evidence. Additionally, present study is inconclusive whether Vitamin Dsupplements are beneficial for or else healthy adults in preventing disorders beyond bone disorders [35]. Results of a significant scientific trial at Harvard University (VITAL study) with 25,875 participants must quickly arrive to get a better working out of multiple clinical outcomes.

Study Limitation

When interpreting our findings, several limitations must be taken into consideration. First, as the Studydesign is cross-sectional, it is not feasible to draw any causal conclusion in regards to the direction effects within the associations we observed. Second, the Generalizability of our findings is limited as our sample consisted predominantly of male industrial employees in Egypt. Our findings might no longer be generalizable to other ethnic groups or females. Nevertheless, the homogeneous studysample will have reduced a potential bias of vitamin D variations as different ethnic groups tend to have different Vitamin D levels. Third, we didn't determine anti-diabetic treatment and status of type 1 diabetes of participants. This information will have to be included in the medical history assessment of extra reviews.

CONCLUSION

In conclusion, the findings of our study endorse that Vitamin Dis inversely associated with type 2 diabetes in Egyptian employees with more than 45 of age. Further longitudinal reports should seek to set up obviously the temporal sequence of this association. Finally, randomized controlled trials are needed to evaluate whether vitamin supplementation is a useful intervention in preventing or delaying the onset of type 2 diabetes. Even as Vitamin Dscreenings of healthy adults can't be encouraged because of missing evidence at present, individuals at risk for type 2 diabetes could probably advantage from a screening for 25(OH)D deficiency furthermore to the Endocrine Society guideline [36]. The work seems to be a promising atmosphere for that.

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Conflict of Interest

The authors declare that they've no competing interests.

References

1. Hilger J, Friedel A, Herr R, Rausch T, Roos F, Wahl DA, *et al*. A systematic review of vitamin D status in populations worldwide. *Br. J. Nutr*. 2013;9:1-23.
2. Zittermann A. The estimated benefits of vitamin D for Germany. *MolNutr Food Res.* 2010;54:1164-71.
3. Hintzpeter B, Mensink GBM, Thierfelder W, Muller MJ, Scheidt-Nave C. Vitamin D status and health correlates among German adults. *Eur J ClinNutr*. 2008;62:1079-89.
4. Anagnostis P, Athyros VG, Adamidou F, Florentin M, Karagiannis A. Vitamin D and cardiovascular disease: a novel agent for reducing cardiovascular risk? *CurrVascPharmacol*. 2010;8:720-30.
5. O'Hartaigh B, Neil Thomas G, Silbernagel G, Bosch JA, Pilz S, Loerbroks A, *et al*. Association of 25-hydroxyvitamin D with type 2 diabetes among patients undergoing coronary angiography: cross-sectional findings from the LUdwigshafen Risk and Cardiovascular Health (LURIC) Study. *Clin Endocrinol.* 2013;79:192-98.
6. [Internet] http://ec.europa.eu/food/fs/sc/scf/out157_en.pdf
7. Thomas GN, Scragg R, Jiang CQ, Chan W, Marz W, Pilz S, *et al*. Hyperglycemia and vitamin D: a systematic overview. *Curr Diabetes Rev*. 2012;8:18-31.
8. Ye Z, Sharp SJ, Burgess S, Scott RA, Imamura F, Langenberg C, *et al*. Association between circulating 25-hydroxyvitamin D and incident type 2 diabetes: a mendelian randomization study. *The Lancet Diabetes & Endocrinology*. 2014;3:35-42.
9. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. *Diabetes Care*. 2004;27:1047-53.
10. Koopman RJ, Mainous AG, Diaz VA, Geesey ME. Changes in age at diagnosis of type 2 diabetes mellitus in the United States, 1988 to 2000. *Ann Fam Med*. 2005;3:60-63.
11. Del Gobbo LC, Song Y, Dannenbaum DA, Dewailly E, Egeland GM. Serum 25-hydroxyvitamin D is not associated with insulin resistance or beta cell function in Canadian Cree. *J. Nutr*. 2011;141:290-95.
12. Mattke S, Liu H, Caloyeras JP, Huang CY, van Busum KR, Khodyakov D, *et al*. Workplace wellness programs study: Final report; 2013.
13. American Diabetes Association. Prevalent of Medical Care in Diabetes-2011. *Diabetes Care*. 2010;34:11-61.
14. Freund T, Lekutat C, Schwantes U, Szecsenyi J, Joos S. Gesundheitsuntersuchung und Impfstatus-Ergebnisseeiner Patient enbefragung in deutschen Hausarztpraxen. Gesundheitswesen. 2010;72:804-07.
15. Oberlinner C, Neumann SM, Ott MG, Zober A. Screening for pre-diabetes and diabetes in the workplace. *Occup Med*. 2008;58:41-45.

16. Li J, Jarczok MN, Loerbroks A, Schöllgen I, Siegrist J, Bosch JA, *et al*. Work Stress is Associated with Diabetes and Prediabetes: Cross-Sectional Results from the MIPH Industrial Cohort Studies. *Int J Behav Med*. 2013;20:495-503.
17. Whitworth JA. World Health Association/International Society of Hypertension: statement on management of hypertension. *J Hypertention*. 2003;21:1983-92.
18. American Diabetes Association. Diagnosis and Classification of Diabetes Mellitus. *Diabetes Care.* 2009;33:62-69.
19. World Health Association. Use of glycated hemoglobin (HbA1c) in the diagnosis of diabetes mellitus: Abbreviated report of a WHO consultation. *Diabetes Research and Clinical Practice*. 2011;93:299-309.
20. Thuesen B, Husemoen L, Fenger M, Jakobsen J, Schwarz P, Toft U, *et al*. Determinants of vitamin D status in a general population of Danish adults. Bone. 2012;50:605-10.
21. Muhairi SJ, Mehairi AE, Khouri AA, Naqbi MM, Maskari FA, Kaabi JA, *et al*. Vitamin D deficiency among healthy adolescents in Al Ain, United Arab Emirates. *BMC Public Health*. 2013;13:33.
22. Narula R. Vitamin D Deficiency Among Postmenopausal Women with Osteoporosis. *JCDR*. 2013;7:336-38.
23. Cutillas-Marco E, Fuertes-Prosper A, Grant WB, Morales-Suárez-Varela M. Vitamin D deficiency in South Europe: effect of smoking and aging. *Photodermatol Photoimmunol Photomed*. 2012;28:159-61.
24. Grimnes G, Almaas B, Eggen AE, Emaus N, Figenschau Y, Hopstock LA, *et al*. Effect of smoking on the serum levels of 25-hydroxyvitamin D depends on the assay employed. *Eur. J. Endocrinol*. 2010; 163:339-48.
25. Ford ES, Zhao G, Tsai J, Li C. Associations between concentrations of vitamin D and concentrations of insulin, glucose, and HbA1c among adolescents in the United States. *Diabetes Care*. 2011;34:646-48.
26. Husemoen LLN, Thuesen BH, Fenger M, Jørgensen T, Glümer C, Svensson J, *et al*. Serum 25(OH)D and type 2 diabetes association in a general population: a prospective study. *Diabetes Care*. 2012;35:1695-700.
27. Pittas AG, Lau J, Hu FB, Dawson-Hughes B. The role of vitamin D and calcium in type 2 diabetes. A systematic review and meta-analysis. *J. Clin. Endocrinol. Metab*. 2007;92:2017-29.
28. Rhee SY, Hwang Y, Chung HY, Woo J. Vitamin D and diabetes in Koreans: analyses based on the Fourth Korea National Health and vitamin Examination Survey (KNHANES), 2008-2009. *Diabetes. Med*. 2012;29:1003-10.
29. Forouhi NG, Ye Z, Rickard AP, Khaw KT, Luben R, Langenberg C, *et al*. Circulating 25-hydroxyvitamin D concentration and the risk of type 2 diabetes: results from the European Prospective Investigation into Cancer (EPIC)-Norfolk cohort and updated meta-analysis of prospective studies. *Diabetologia*. 2012;55:2173-82.
30. Song Y, Wang L, Pittas AG, Del Gobbo LC, Zhang C, Manson JE, *et al*. Blood 25-hydroxy vitamin D levels and incident type 2 diabetes: a meta-analysis of prospective studies. *Diabetes Care*. 2013;36:1422-28.
31. Anderson JL, May HT, Horne BD, Bair TL, Hall NL, Carlquist JF, *et al*. Relation of vitamin D deficiency to cardiovascular risk factors, disease status, and incident events in a general healthcare population. *Am J Cardiol*. 2010;106:963-68.
32. Schöttker B, Herder C, Rothenbacher D, Perna L, Müller H, Brenner H. Serum 25-hydroxyvitamin D levels and incident diabetes mellitus type 2: a competing risk analysis in a large population-based cohort of older adults. *Eur J Epidemiol*. 2013;28:267-75.
33. Buijsse B, Boeing H, Hirche F, Weikert C, Schulze MB, Gottschald M, *et al*. Plasma 25-hydroxyvitamin D and its genetic determinants in relation to incident type 2 diabetes: a prospective case-cohort study. *Eur J Epidemiol*. 2013;28:743-52.
34. Schafer AL, Napoli N, Lui L, Schwartz AV, Black DM. Serum 25-hydroxyvitamin D concentration does not independently predict incident diabetes in older women. *Diabetes Med*. 2014;31:564-69.
35. Seida JC, Mitri J, Colmers IN, Majumdar SR, Davidson MB, Edwards AL, *et al*. Clinical review: Effect of vitamin D3 supplementation on improving glucose homeostasis and preventing diabetes: a systematic review and meta-analysis. *J. Clin. Endocrinol. Metab*. 2014; 99:3551-60.
36. Holick MF, Binkley NC, Bischoff-Ferrari HA, Gordon CM, Hanley DA, Heaney RP, *et al*. Evaluation, treatment, and prevention of vitamin D deficiency: an Endocrine Society clinical practice guideline. *J Clin Endocrinol Metab*. 2011;96:1911-30.

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