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Original Article

Public Health Section

Prevalence of Vitamin D Deficiency and its Associated Risk Factors on Osteoarthritis: A Cross-sectional Survey

RAMADEVI KUNDUR[1], RAMAIAH ITUMALLA[2], EITIMAD HASHIM ABDEL-RAHMAN[3], MALAK SAAD ALTHAWAINY[4]

ABSTRACT

Introduction: Vitamin D Deficiency (VDD) and several other metabolic factors are known to be involved in the aggravation of Osteoarthritis (OA). A better understanding of the role of these metabolic factors and diseases is required to alleviate the OA progression.

Aim: To analyse the prevalence of VDD in OA patients and its correlation with co-morbidities such as diabetes, hypertension (HT), Cardiovascular Disease (CVD) and acidity and also to assess the effect of Body Mass Index (BMI) and increasing age on the developmental process of OA.

Materials and Methods: A cross-sectional survey was undertaken during September 2018 to March 2019 in King Khaled, King Salman and Hail General Hospitals located in Ha'il province of Kingdom of Saudi Arabia (KSA). The study included 501 participants of OA patients that visited these hospitals. Data pertaining to the variables in this study such as diabetes, HT, cardiovascular problems, vitamin D and calcium deficiency, acidity and anthropometric details was obtained using a structured questionnaire. Data analysis was done using descriptive statistics and Pearson's correlation with the statistical program SPSS version 21.

Results: VDD, calcium deficiency and acidity were the most prevalent factors observed in the patients. Vitamin D and calcium deficiency was observed to be higher in females than males. VDD significantly correlated to diabetes, HT, acidity and age, both in females and males. Cardiovascular disease and BMI correlated with VDD only in males but not in females. BMI showed positive correlation with HT in males ($p<0.01$) but not females, and also correlated with age ($p<0.01$) irrespective of gender.

Conclusion: The study concluded that VDD is more prevalent in females than males in Ha'il region. It is correlated to variables such as diabetes, HT, acidity, BMI and increasing age, which are identified as risk factors contributing to the progression of OA.

Keywords: Body mass index, Cardiovascular disease, Diabetes, Hypertension

INTRODUCTION

The worldwide prevalence of VDD has become one of the public health concerns in many countries around the globe [1]. VDD has been implicated to be the major cause for the development of OA and increased risk of cardiovascular diseases, disorders of glucose metabolism, cancers and neurodegenerative diseases [2]. In Saudi Arabia, there is widespread prevalence of VDD in population with different age groups [3]. Vitamin D is essential to maintain the bone health and crucial for calcium homeostasis in the human body [4]. Vitamin D is implicated in cartilage regeneration in OA, but the specific mechanism isn't well-defined yet [5]. However, the results of various studies have been inconsistent [5,6]. Metabolic Syndrome (MetS) is a complex condition characterised by obesity, HT, hyperglycaemia, hypertriglyceridemia. MetS, OA and VDD are related to each other, sharing obesity as a common risk factor [2,6]. The possible mechanisms are unclear, but positive associations have been observed in some studies [2,6,7]. Therefore, prospective studies must be focused on protective part of vitamin D in an alleviation of OA.

A recent study in the KSA reveals that VDD is as high as 100% in the Saudi Arabian female population. VDD has become almost like an epidemic in the country and region in general [8]. Causative factors for low level of vitamin D are inactivity of the individuals at risk, chronic diseases, diabetes mellitus and obesity [2,6,9].

Obesity, BMI and acidity is highly prevalent in Ha'il region of KSA [10,11], which are also the co-morbidities in OA. It is essential to assess the risk factors that are related with OA, to understand the mechanisms and design strategies for its prevention. Hence, the purpose of the study was to observe the prevalence and effects of VDD in OA patients and its correlation to other co-morbidities such as diabetes, HT, CVD and acidity and also to assess the effect of Body Mass Index (BMI) and increasing age on the developmental process of OA.

MATERIALS AND METHODS

A cross-sectional survey was conducted during the period from September 2018 to March 2019 at King Khaled, King Salman and Ha'il General Hospitals located in Ha'il, Saudi Arabia. Ethical clearance was obtained from the University of Ha'il-RG191240.

Inclusion criteria: The participants who had complaints of bone related problems such as knee pain and other joints pain consistently for more than six months were selected for the study.

Exclusion criteria: Participants with chronic illnesses such as liver diseases or renal impairment and on medications such as steroids which could interfere with vitamin D metabolism. Participants with less than six months of bone related complaints were excluded as they are assumed to have only temporary inflammations in joints and may not be related to OA.

A 20% non response rate was expected. A target of 600 participants was set, and the final sample size came to 501. Data pertaining to the variables in this study such as diabetes, HT, cardiovascular problems, vitamin D and calcium deficiency and anthropometric details was obtained.

A structured questionnaire and sample size was designed according to the World Health Organisation (WHO) STEPS guidelines manual. This manual explains the order of events essential to conduct a STEPS survey [12]. The purpose of the study was stated in the

questionnaire and the participants consent was taken before the questionnaire was administered.

STATISTICAL ANALYSIS

The responses were tabulated and analysed using Statistical Package for the Social Sciences, SPSS (USA, Version 21.0.). Descriptive statistics are presented as percentage frequency. Pearson's correlation was used at significance levels of $p<0.05$ and $p<0.01$.

RESULTS

The demographic characteristics are presented in [Table/Fig-1]. The mean age of the population was 40.44±12.51 and the mean BMI was 28.1±4.23.

Vitamin D Deficiency (VDD), calcium deficiency, diabetes, HT, CVD were higher in females than males, except acidity [Table/Fig-2].

Gender	Variables	Mean (SD)
Males (239)	Age (years)	41.2±14.44
	BMI (kg/m^2)	27.67±4.244
Females (262)	Age (years)	45.39±11.46
	BMI (kg/m^2)	30.97±3.327

[Table/Fig-1]: Mean age and BMI of the male and female OA patients.

Variables	Frequency N (%)	
	Female (n=262)	Male (n=239)
Vitamin D Deficiency (VDD)	196 (74.8)	91 (38.1)
Calcium deficiency	172 (65.6)	102 (42.7)
Diabetes	113 (43.1)	59 (24.7)
Hypertension	116 (44.3)	65 (27.2)
CVD	36 (13.7)	31 (13.0)
Acidity	147 (56.1)	143 (59.8)

[Table/Fig-2]: Frequencies of various metabolic disorders in OA patients.

In males [Table/Fig-3], VDD positively correlated with CVD, BMI, age, diabetes, HT, acidity and BMI positively correlated with HT and age ($p<0.01$).

Variables		Diabetes	HT	CVD	Acidity	Age	BMI
VDD	Pearson's correlation	0.131	0.160	0.210	0.136	0.135	0.237
	p-value	0.044*	0.013*	0.001**	0.036*	0.036*	<0.001
BMI	Pearson's correlation	0.036	0.214	0.065	0.040	0.281	-
	p-value	0.579	0.001**	0.314	0.539	<0.001**	-

[Table/Fig-3]: Pearson's Correlation of VDD and BMI with metabolic components in male OA patients.
VDD: Vitamin D deficiency; HT: Hypertension; CVD: Cardiovascular diseases; *Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed)

In females [Table/Fig-4], VDD positively correlated with diabetes, hypertension, age and acidity ($p<0.01$), and BMI showed correlation only to age ($p<0.01$).

		Diabetes	HT	CVD	Acidity	Age	BMI
VDD	Pearson's correlation	0.224	0.232	0.079	0.181	0.342	0.050
	Significance (2-tailed)	<0.001	<0.001	0.201	0.003**	<0.001	0.419
BMI	Pearson's correlation	0.100	0.055	0.086	0.016	0.209	-
	Significance (2-tailed)	0.108	0.374	0.165	0.792	0.001**	-

[Table/Fig-4]: Pearson's Correlation of VDD and BMI with metabolic components in female OA patients.
Statistical test: Pearson's correlation; VDD: Vitamin D deficiency; HT: Hypertension; CVD: Cardio vascular diseases; *Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed)

DISCUSSION

In this study, females had higher VDD and calcium deficiency than males, both of which are vital for bone strength and functioning and a major contributor of OA. Calcium and Vitamin D are two known essential nutrients for bone health and maintenance. However, 90% of females do not get enough calcium and over 50% of females undergoing bone loss treatment had insufficient vitamin D levels [4]. This study confirms that these are the major contributors for progression of OA in females. The study also confirms the overwhelmingly high VDD in KSA reported upto 100% regardless of the medical condition, especially in females [8,9]. In 1980's, a deficiency of 30% was reported in the general population of KSA [13]. A systematic review conducted in KSA found that the prevalence of VDD is 81% and almost similar to other gulf countries showing association to bone problems as well as insulin resistance [9]. VDD affects bone mineral density and is attributed to calcium homeostasis, poor exposure to sunlight, less dietary vitamin D supplementation, obesity, age and sedentary lifestyle and smoking [3,4,13].

A number of studies have been published on VDD in KSA which are presented below [Table/Fig-5] [3,4,8,9,13,14].

Sr. No.	Author (s) and year	Study population	Conclusion
1	Sedrani SH et al., (1983) [13]	Circulating serum vitamin D levels were determined in 59 young and 24 elderly subjects in both sexes. Elderly subjects were exposed to natural Ultravoilet (UV) light and Vitamin D levels were assessed.	Vitamin D levels were lower in elderly subjects and males. UV light exposure in the elderly subjects increased the Vitamin D levels 2.5 fold.
2	Ardawi MS et al., (2012) [4]	A cross-sectional study in randomly chosen 834 men aged 24-74 years. Vitamin D, Parathyroid Hormone (PTH), Bone Mineral Density (BMD) were examined.	VDD present in 87.8%, it affected BMD and bone turnover markers. It was largely attributed to older age, obesity, sedentary lifestyle, no education, poor exposure to sunlight, smoking, and poor dietary vitamin D supplementation.
3	Al-Mogbel ES (2012) [8]	A cross-sectional study was done in 465 young adult Saudi females aged 19 to 40 years. Vitamin D, PTH and bone biochemical parameters were measured	VDD prevalence among young healthy Saudi females was 100%. A significant inverse correlation between serum Vitamin D concentrations and PTH was observed
4	Al-Daghri NM et al., (2015) [14]	A total of 2225 healthy Saudi adolescents aged 13-17 years and 830 adults aged 18-50 years, were assessed for Vitamin D, fasting blood sugar and lipid profiles.	VDD was higher in females, both adolescent and adults. Inverse association was observed between vitamin D and cardiometabolic risk factors in adolescent boys and adult women. VDD was significantly associated to diabetes and obesity only in adolescent boys.
5	Al-Daghri NM (2018) [9]	A systematic review on the prevalence studies done in KSA from 2011 to 2016.	The over-all prevalence of VDD in Saudi Arabia from 2011 to 2016 is 81.0%. VDD in KSA was associated with bone and insulin-resistant diseases.
6	Farhat KH et al., (2019) [3]	A cross-sectional study in 1702 Saudis aged 35-90 years. Biochemical investigations were done for Vitamin D, blood sugar and cholesterol	VDD prevalence is 76.1%. Blood sugar, age and cholesterol levels were significantly associated with vitamin D status. Those with normal blood sugar and cholesterol level had higher serum vitamin D levels compared to those with diabetes and hypercholesterolemia.

[Table/Fig-5]: Select list of studies on Vitamin D in Saudi Arabia [3,4,8,9,13,14].

The VDD is associated with a range of diseases such as diabetes, HT, CVD and cancer [2,3,14]. This study too had similar observations; VDD positively correlated with diabetes, HT and acidity which were

the common co-morbidities observed in both male and female OA patients. However, the correlation was stronger in females as compared to males [Table/Fig-3,4].

In this study, about 290 (58%) had acidity irrespective of gender, which is similar to a previous study in Ha'il [11], and correlated with high levels of VDD especially in females. Vitamin D is implicated to have a gastro-protective function and acid reflux prevention [15]. It regulates gastrin secretion, smooth muscles in pyloric region, reduces free radicals and oxidative stress [16]. There are several reports, which show that VDD contributes to the onset of diabetes. Vitamin D has been identified as a modulator of inflammation and beta cells survival and with increase in age, if vitamin D is sufficient, it can provide protection against diabetes [2,17,18]. However, few studies also report that there is no evidence of association between VDD and the onset of diabetes, impairment of glucose metabolism is not a risk factor to develop OA, neither did supplementation of Vitamin D improve insulin secretion [19,20]. Another study reported that diabetes is predictive of severe OA progression independent of BMI or age [21]. OA and diabetes have common risk factors such as obesity and increasing age, which explains as to why there is a higher prevalence of OA in the diabetic population [22].

In this study, VDD showed positive correlation to HT (more strongly in females than males) whereas BMI strongly correlated to HT in males but not in females. There are several studies reporting a positive association and possible role of vitamin D in controlling HT [23-25], whereas others reported that supplementing high doses of vitamin D did not reduce HT [26,27]. HT was observed to be higher in males although females were more obese and BMI increase affects males more than females [28]. VDD was found to be associated with BMI and CVD in males but not females, in this study. This is similar to a previous study in KSA; VDD was high among Arab adolescent boys and mostly associated with cardio metabolic risk factors, indicating a disadvantage for males [2,14]. Vitamin D supplementation for six months improved myocardial efficiency in elderly subjects with heart failure history [29]. On the contrary, in another study, vitamin D supplementation in hypertensive patients with low Vitamin D had no significant effect on blood pressure and cardiovascular risk factors [30].

In KSA, reports show that VDD is largely attributed to obesity and age [2,9,31]. Although age has its effect on both genders, the effects of obesity seem to be riskier in males than in females. Vitamin D is inversely associated with BMI and thereby to obesity irrespective of gender [32]. Supplementation of vitamin D leading to a reduction in BMI has been observed [33]. BMI was the only factor observed to be linked to the progression of OA after adjusting for weight, as other metabolic components showed no significance [34]. Therefore, increase in BMI could aggravate OA irrespective of other factors.

The effect of VDD in OA is ambiguous. There are several reports showing that VDD is observed in OA patients [3,4,35]. Uncertainity of VDD role in OA was observed in a study where supplementation of vitamin D for two years didn't reduce knee pain in OA patients [36]. In another study, a small but statistically significant benefit was seen in OA patients with knee pain when oral vitamin D was given [37]. Due to this ambiguity about vitamin D supplementation for treatment and prevention of OA, further studies are recommended. The health authorities and policy makers can consider vitamin D screening in the region in order to tackle the issue.

Limitation(s)

As the data collection was only based on questionnaire, the usual anomalies such as outliers and participant's reluctance and negligence in accuracy are possibilities despite all the precautionary measures. The results of the study may not be generalised to the whole country.

CONCLUSION(S)

In present study, vitamin D and calcium deficiency have been the most prevalent factors observed in OA patients and correlated significantly to age, diabetes, HT and acidity in both males and females. Acidity is high in Ha'il region irrespective of gender and could be a contributing factor in aggravation of OA. BMI increase is age related and correlated to HT in males but not in females. This study recommends that vitamin D and calcium supplementation along with a decrease in BMI could help to reduce the burden of OA progression. Further research is required to elucidate the intricate metabolic mechanisms of metabolism to alleviate OA progression.

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PARTICULARS OF CONTRIBUTORS:
1. Assistant Professor, Department of Clinical Laboratory Science, College of Applied Medical Sciences, University of Ha'il, Ha'il, Saudi Arabia.
2. Assistant Professor, Department of Health Management, College of Public Health and Health Informatics, University of Ha'il, Ha'il, Saudi Arabia.
3. Assistant Professor, Open Arab University, Sudan Branch Khartoum st. 21 Amarrat Khartoum, Sudan.
4. Student, Department of Clinical Laboratory Science, College of Applied Medical Sciences, University of Ha'il, Ha'il, Saudi Arabia.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Ramaiah Itumalla,
Office No. 50, Department of Health Management, College of Public Health and Health Informatics, University of Hail, Ha'il, Saudi Arabia.
E-mail: ramuhealthcare@gmail.com

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