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THESIS APPROVAL PAGE FOR MASTER OF SCIENCE IN ORAL BIOLOGY

Title of Thesis: "Evaluation of Vitamin D Deficiency, Dental Caries, and Inflammatory Bowel Disease within the Active Duty Population"
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Master of Science Degree
May 7, 2020

THESIS/MANUSCRIPT APPROVED:

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7. Title Evaluation of Vitamin D Deficiency, Dental Caries, and Inflammatory Bowel Disease within th	
8. Intended Publication/Meeting ACG 2020	
9. Required by 01JUN20	10. Date of Submission
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Evaluation of Vitamin D Deficiency, Dental Caries, and Inflammatory Bowel Disease within the Active Duty Population

George L. Hauser, DDS, Charlene A. Hauser, DO and Joseph F. Capetillo, DMD, MS

- OBJECTIVES:** Vitamin D plays an important role in the development of adult teeth, and thus plays a role in the development of Dental Caries. Patients with inflammatory bowel disease (IBD) are known to have low vitamin D levels associated with disease activity. This study proposes to examine the association between Vitamin D levels and Dental Caries in the Active Duty IBD population.
- METHODS:** This study consisted of a retrospective chart review of all clinical and procedural encounters of adult active duty patients with confirmed IBD seen in the CRDAMC GI clinic and endoscopy suite during fiscal years 17 and 18. Serum 25-hydroxy Vitamin D level (25-OHD) and Dental Caries status were collected from clinical encounters. Vitamin D Deficiency (VDD) was defined as 25-OHD < 30 ng/mL. Caries risk assessment was defined as high risk (HC) or not. Chi-Square Test and Phi Correlation were used to analyze the data.
- RESULTS:** 76 total patients were identified, of which 56 patients had Vitamin D levels and caries risk measured and recorded. 62.5% of patients had deficient 25-OHD. 10.7% of patients were HC. Of the patients with VDD (35), 8.6% were identified as HC. A significant relationship between VDD and HC in the IBD patients in this study could not be established. The Chi-Square Tests with VDD and HC yielded a value of 0.448 with $p = 0.503$. The Phi Correlation value was -0.089 with $p = 0.503$. This indicates that the strength of association between the VDD and HC is not strong.
- DISCUSSION:** The study was unable to demonstrate an association between IBD patients with or without VDD and HC.
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INTRODUCTION

Dental caries is a multifactorial disease process[1, 2]. Surgical intervention is costly not only in terms of the materials, but also in the time that the Soldier is away from his or her unit[3]. Across the Enterprise this becomes a significant factor for

Commanders at all levels, both in terms of manpower cost and dollar cost.

Vitamin D plays an important role in the development of adult teeth. Studies in the early 20th century demonstrated the importance of Vitamin D in the formation of the permanent dentition in children and the decrease in caries incidence in the same

population when supplied with the appropriate amount of Vitamin D [4, 5]. This line of reasoning continued into the 21st century when it was investigated by Uwitonze et al. They also concluded that insufficient Vitamin D levels can have a detrimental effect on oral health [6]. Based on literature search, most studies evaluating the correlation between VDD and oral health have been completed on children or in the pre-natal setting.

Inflammatory bowel disease (IBD), which includes both Crohn's disease (CD) and ulcerative colitis (UC) affects over 1 million people in the United States and Europe and is most active during the ages of 15-30[7, 8]. Patients with IBD are known to have low vitamin D levels, most often associated with disease activity. Between 31-33% of patients with CD and UC have VDD. This can change dynamic bone formation and may be associated with anti-inflammatory properties. Poor vitamin D levels in IBD is thought to be secondary to malabsorption and aberration in the gut microbiome [9].

An incredibly valuable micronutrient throughout the body, vitamin D is especially important in the immune system. Vitamin D is converted to 25-Hydroxy vitamin D (25-OH)D and 1,25(OH)₂ Vitamin D (Calcitriol) in the liver and kidneys respectively. Calcitriol is subsequently utilized throughout the immune system and effects B and T cells through control of autoregulatory effects and modulation of auto-antibody formation in the immune process [10]. Low vitamin D levels prevent these regulatory processes and could lead to increased disease activity and subsequent malabsorption causing a repetitive vicious cycle [9].

Two studies released in early 2018 examined the link between Vitamin D levels and dental caries. One examined Korean children and the other Swedish children [11,

12]. The Korean study suggested that Vitamin D deficiency may be a risk factor for dental caries [11]. The Swedish study was not as strong in its conclusions, but stated an association between Vitamin D status and caries was supported [12]. Furthermore, a 2019 study of Alaskan Natives showed that maternal vitamin D insufficiency increased their children's risks for severe early childhood caries, making vitamin D vitally important in tooth enamel formation prenatally [13]. One study from 2014 compared caries rate to Crohn's Disease patients and found that those who had undergone surgery to treat CD had a higher rate of caries[14].

This study proposes to examine the association between Vitamin D and dental caries in the Active Duty IBD population. Many patients with IBD are able to remain on active duty and subsequently their care impacts the Army mission.

The US Army Dental Corps is aggressive and proactive in both treating and educating the Active Duty Soldiers. A correlation between IBD, VDD and dental caries should increase dental surveillance in an effort for primary prevention and an increase in Soldier readiness. This would change the way GI and primary care providers educate their patients on ensuring proper oral health, and potentially increase the frequency of dental examinations for the IBD population.

METHODS

Data collection started by using the Military Health System Management Analysis and Reporting Tool (M2) system. A search of the M2 database for all patients enrolled at Carl R. Darnall Army Medical Center (CRDAMC) Medical Expense/Performance Reporting System (MEPRS) code BAGA or BAG5 (Gastroenterology or Gastroenterology endoscopy APU) with diagnosis code K51.00+ (UC) and K52.00+ (CD) during 2017-2018 was completed

generating a list of patients. This was then filtered to only include adult, active duty patients. Patients younger than 18 years of age were excluded, as were retirees and dependents. A total of 76 patient records were identified that met the criteria. The patients were cross referenced with the DOD electronic medical record known as the Armed Forces Health Longitudinal Technology Application (AHLTA) to find their vitamin D levels. A Department of Defense assigned identifier (DODID) was utilized to cross reference patients through the dental electronic medical record known as Corporate Dental System (CDS) to identify patients as enrolled in the High dental caries program. VDD was defined as 25-OHD < 30 ng/mL. Caries risk assessment was defined as high risk or not.

The caries risk status is entered by the dental provider or member of their team at the annual exam for all active duty patients. For the purposes of this study we categorized moderate and low caries risk as no risk (HC 0) and only looked at high caries risk (HC 1). A patient is defined as high caries risk if they meet any of the three criteria: 1) three or more caries lesions; 2) presence of multiple factors that may increase caries risk; 3) xerostomia.

The caries risk and 25-OHD were collected simultaneously and recorded in the final data entry sheet wherein the patients were de-identified. Chi-Square Test and Phi Correlation were used to analyze the data. The Chi-Square Test was run to examine whether there was an association between VDD and HC in the active duty IBD patient; the Phi Correlation tested the strength of association between VDD and HC. An *a priori* power analysis was not completed because this study relied on a convenience sample of CRDAMC patients within a 365 day time-frame. However, a post-hoc power analyses was completed to assess the power of the effective sample size. In this study we

considered an alpha value of 0.05 or less to be significant. We analyzed the data with the IBM SPSS software, version 25.

RESULTS

76 total patients with inflammatory bowel disease were identified. However, 26% of patients ($n = 20$) were missing Vitamin D and Caries assessment. Thus, the effective sample size was 56 patients. Of the effective sample, 62.5% had deficient 25-OHD and 10.7% were HC. Of the patients with VDD ($n = 35$), 8.6% were identified as HC. These results are in Table 1.

The Chi-Square Tests with VDD and HC yielded a value of 0.448 with $p = 0.503$ (Table 2).

The Phi Correlation = -0.089, and $p = 0.503$ (Table 3). This indicates that the strength of association between the VDD and HC was very weak and not statistically significant. Thus, we did not appear to find a significant relationship between VDD and HC in active-duty adult IBD patients at CRDAMC. Post-hoc power analysis completed using the SPSS software resulted in $\alpha = 0.50$.

DISCUSSION

The study was unable to demonstrate an association between IBD patients with or without VDD and HC. This does not mean that an actual relationship between VDD and HC does not exist, but rather that we were unable to detect a statistical association in our sample.

Our post-hoc power analysis ($\alpha = 0.50$) suggesting that the low power of the study potentially accounted for the lack of significant findings.

The number of active duty patients at Fort Hood with IBD is considerably less than the incidence of the disease in the American population. The CDC estimates that 1.3% of the American population has been diagnosed with IBD[15]. We did

consider that the active duty population would be healthier and younger, and estimated that the IBD rate would be one-third that of the American population; it turned out to be one-tenth.

The fact that the Military population is healthier is unsurprising, and opens an opportunity to gather data from a larger sampling of the Military. This pilot study lays the groundwork for a much larger cohort that could be captured at the Regional level, Army-wide or across the entire Department of Defense.

LIMITATIONS

Dental caries is a disease that can have multiple factors irrespective of an individual's systemic health and Vitamin D levels; diet, frequency of fermentable carbohydrate intake and the oral microbiome all impact the development, progression and frequency of dental caries. Another potentially limiting factor is the dependence on the dental provider to not only diagnose the patient as high caries risk at the time of the annual exam, but to ensure that it is entered in CDS as such. Naturally, good oral hygiene practice is one of the most important aspects of maintaining a healthy and low caries risk dentition.

Other limitations may include not screening the patients for Vitamin D supplementation, and the effects that may have on disease activity level of IBD and caries rate. This study did not look for any immune-modulating drugs the IBD patient may have, nor did it look at the type of treatment the patient was undergoing.

FUTURE WORK

Further studies to include a larger military population would potentially increase the number of patients in the study, allowing for more accurate statistical analysis of a correlation.

A future study along the same lines could also examine implant survival rates in the IBD population with VDD and the effects on bone density, either in Hounsfield units assessed via CBCT prior to implant placement or insertion torque of the implant.

FINAL WORD

While the data is not strong enough to recommend increased dental surveillance for the IBD population, it is certainly an opportunity to involve GI and primary care providers in promoting increased oral hygiene as part of a holistic approach to increasing the well-being and quality of life for the Soldiers, Sailors, Airmen and Marines in our care.

CONFLICTS OF INTEREST

The authors do not have any conflicts of interest to disclose.

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VDD * HC Crosstabulation

		HC		Total	
		0	1		
VDD	0	Count	18	3	21
		% within VDD	85.71%	14.29%	100.00%
		% within HC	36.00%	50.00%	37.50%
		% of Total	32.14%	5.36%	37.50%
		Adjusted Residual	-0.67%	0.67%	
	1	Count	32.00%	3.00%	35.00%
		% within VDD	91.43%	8.57%	100.00%
		% within HC	64.00%	50.00%	62.50%
		% of Total	57.14%	5.36%	62.50%
		Adjusted Residual	0.67%	-0.67%	
Total	Count	50.00%	6.00%	56.00%	
	% within VDD	89.29%	10.71%	100.00%	
	% within HC	100.00%	100.00%	100.00%	
	% of Total	89.29%	10.71%	100.00%	

Table 1. VDD 0 is a patient with normal OHD-25 levels, and VDD 1 is deficient. HC 0 means that patient is not high caries risk, while HC 1 indicates that they are in the high risk category.

Chi-Square Tests

	Value	df	Asymptotic Significance (2- sided)	Exact Sig. (2- sided)	Exact Sig. (1- sided)
Pearson Chi-Square	.448 ^a	1	.503		
Continuity Correction ^b	.050	1	.823		
Likelihood Ratio	.435	1	.509		
Fisher's Exact Test				.661	.401
N of Valid Cases	56				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.25.

b. Computed only for a 2x2 table

Table 2. Statistical analysis of data obtained from the 56 valid patients.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	-.089	.503
	Cramer's V	.089	.503
N of Valid Cases		56	

Table 3. Results of post-hoc power analysis.

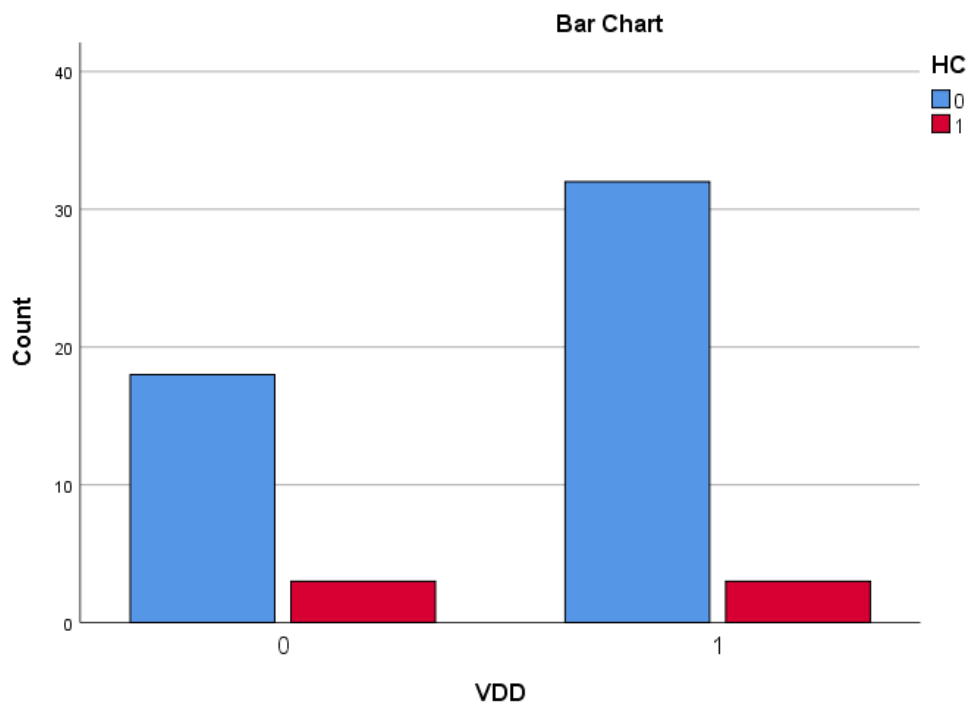


Figure 1. Bar chart illustrates the number of VDD (1) and non-deficient IBD patients (0) either with high caries risk (red) or not (blue).