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OPEN ACCESS ORIGINAL ARTICLE

Evaluation of Vitamin D's Effect in Reduction of Obesity in a Rabbit Model

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ABSTRACT

Background: Obesity is currently a global health problem, and it is one of the risk factors leading to a high number of deaths per year. Several studies were carried out to identify the causes of overweight and obesity. Vit. D deficiency is presumed to have an effect on the development of obesity.
Objective: This study's objective is to evaluate the impact of vitamin D in reduction of obesity in a rabbit model and its effect on the lipid profile.
Methods: Ten male rabbits were split up into two groups for the experiment; (a) control group (with a fatty rich diet), (b) vitamin D group (with a fatty rich diet + vitamin D supplementation for 4 weeks). Blood samples for lipid profile (TG, LDL, and HDL) were collected before and at the end of the study, and their body weights were measured as well.
Results: Following four weeks of the trial, the animals in the control group weighed significantly more than those in the vitamin D group. The increase in serum TG and LDL were significant for the control animals in related to the vitamin D animals. In addition, there is a significant rise in the good serum HDL in the control group compared to the vitamin D group.
Conclusion: The results of this study demonstrated that vitamin D has an important effect in reduction of body weight and obesity.

Keywords: Vitamin D, obesity, rabbit model, body weight, TG, LDL, HDL

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INTRODUCTION

A fat-soluble vitamin, vitamin D is involved in numerous vital bodily processes. Although maintaining the equilibrium of calcium in the skeleton is the primary role of vitamin D, it is also critical for many other metabolic processes, including immunological response, neuromuscular functioning, and growth (1). The body stores vitamin D, which come from two sources; exogenous source, provided through the diet, and endogenous source, where the body can make it when the skin is exposed to sunlight (2). Numerous endocrine and metabolic disorders are exacerbated by vitamin D deficiency. A lack of vitamin D increases the risk of adult fractures, causes growth retardation, and induces rickets (3). Numerous research have demonstrated a positive relationship between vitamin D insufficiency and obesity; nevertheless, it is still unclear what potential mechanisms underlie this effect. Additionally, research is being done on the connection between vitamin D supplementation and obesity (4). The state of excessive fat storage is commonly referred to as obesity (5). The primary pathological characteristic of obesity is the accumulation of extra energy in adipose tissue, which occurs when an excessive amount of high-fat food is consumed because energy intake surpasses energy expenditure (6). It plays a significant role in the onset of conditions including diabetes, liver disease, and others, as well as the decline in bone health (7). One of the risk factors for obesity, according to the World Health Organization (WHO), is an unhealthy diet and physical inactivity. The WHO encourages all efforts to help reduce obesity (8).

Low exposure to sunlight, which results in their skin being exposed to the sun for a shorter period of time, the expansion of adipose tissue that would sequester vitamin D, which would reduce its bioavailability in the circulation (9), and the fact that obese patients have lower vitamin D synthesis than their peers who are not obese are thought to be the main causes of vitamin D deficiency in obese patients (10).

Information recently produced by many study teams emphasizes how vitamin D affects obesity. Mechanistic theories and unambiguous validation in animal models are desperately needed. The objective of this study is to evaluate how vitamin D affects the lipid profile and how it reduces obesity in a rabbit model.

MATERIALS & METHODS

Experimental Protocol and Animal Ethics Approval

Experiment protocol and animal ethics were approved by the Faculty of Medicine and Health Sciences (HUCOM), Hadhramout University, Hadhramout.

Experimental Design

10 local native male rabbits (weighing 1.5 ± 0.15 kg) is selected for the study. A week before the experiment, the animals were acclimated to the lab environment. In their housing, the rats had unrestricted access to tap water and food (Gold Coin, standard laboratory chow). The rats were kept in a 12-hour light/dark cycle at 28±2°C (10). After that, the rabbits were housed with free access to food (a fatty rich diet) and water for a period of (4 weeks). The rabbits were randomly divided into two groups: one as a control group (5 rabbits), the second (5 rabbits) which were given the standard dose of vitamin D (300 IU/Kg) orally, once per day during the 4 weeks of the experiment (10). At the end of the experiment all animals were sacrificed with an intravenous administration of sodium pentobarbital (30 mg/kg).

Blood Collection

Their body weights were measured both before and after the study, and blood samples were taken both before and after the experiment started. All rabbits had blood extracted from their marginal ear veins, and the samples were kept in tubes with Ethylene diamine tetraacetic acid (EDTA) (1 mL blood/animal). All rabbits had their serum

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triglyceride (TG), low density lipoprotein (LDL), and high-density lipoprotein (HDL) levels assessed (10).

Lipid Profile Studies

Using Bio-diagnostic Kits, spectrophotometric measurements of the lipid profile levels including TG, LDL and HDL were made (10, 11).

Data Analysis

Data obtained were analyzed using the Statistical Package for the Social Sciences (SPSS, version 20). The results of this research were analyzed, summarized and univariate data distributions were expressed as means ± SD. $P < 0.05$ was considered as the level of significance between the non-treated and treated groups.

RESULTS

The rabbit body weights, serum lipid profile (TG, LDL, and HDL levels) were evaluated at the start of the study and also at the end of the study for each of the two groups. At the end of the study, it is found that there is a significant elevation in the body weight of the control group relative to its weight at the beginning of the study ($P < 0.005$), while in vitamin D group, the average body weight of the rabbits at the start and at the end of the study was not significant statistically ($P < 0.571$). Between the two groups (the control group and the vitamin D group), there was statistically significant elevation in the body weight for the control group relative to the vitamin D group ($P < 0.001$), at the end of the study Table 1.

Table 1: The impact of vitamin D supplementation on body weight in experimental animals

	Groups	At the beginning of study (Mean ± SD)	At the end of study (Mean ± SD)	"*P*" values compared between the two groups
Body weight (g)	Control group	1488 ± 413	1723 ± 443	$P < 0.001$
		$P < 0.005$		
	Vitamin D group	1479 ± 527	1577 ± 321	
		$P < 0.571$		

Regarding the lipid profile, there was a statistically significant elevation in serum TG and LDL levels at the end of the study for the control group compared to the beginning of the study. Furthermore, alteration in serum TG and LDL levels was statistically significant in vitamin D group compared to the control group. In addition, vitamin D significantly elevate HDL in the vitamin D treated group as compared to the control group (Table 2). This is beneficial for cardiovascular health and indicates improved lipid metabolism.

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Table 2: The impact of vitamin D supplementation on lipid profile levels in experimental animals

Parameters	Groups	At the beginning of study (Mean ± SD)	At the end of study (Mean ± SD)	"*P*" values compared between the two groups
TG (mg/dL)	Control group	72.8 ± 23.0	183.8 ± 64.1	*P* < 0.001
	Vitamin D group	70.7 ± 20.2	75.3 ± 14.0	*P* < 0.323
LDL (mg/dL)	Control group	7.88 ± 3.40	12.60 ± 9.30	*P* < 0.001
	Vitamin D group	8.00 ± 2.89	9.13 ± 8.11	*P* < 0.737
HDL (mg/dL)	Control group	26.11 ± 2.23	27.15 ± 4.40	*P* < 0.337
	Vitamin D group	28.16 ± 3.80	34.80 ± 3.30	*P* < 0.005

DISCUSSION

Vitamin D receptors (VDR) are present in adipose tissue, indicating that vitamin D may directly influence fat cell biology. It has been shown to inhibit adipogenesis, the process of converting pre-adipocytes into mature fat cells (11, 12). Vitamin D is believed to enhance insulin sensitivity, which is crucial for glucose metabolism and can help mitigate obesity-related insulin resistance. Improved insulin sensitivity can lead to better energy utilization and reduced fat accumulation (13). Vitamin D has anti-inflammatory properties that may reduce chronic inflammation associated with obesity. Inflammation in adipose tissue is linked to metabolic dysfunction and can impair lipid metabolism (14).

In this study, the impact of daily intake of oral vitamin D by rabbits, in reducing obesity was investigated. The present data clearly show that daily intake of vitamin D positively impacts in reducing obesity. The fatty-enriched diet led to a significant increase in body weight and fat deposition especially in the control group, while in the treated vitamin D group, there is no marked changes in their weight.

These results were in accordance with a rodent study who reported that mice resist the diet-induced obesity when they intake vitamin D during their study, and remain lean (15, 16). However, in contrast to the current study, there was no effect on body weight and fat deposition in their animals if either giving or not vitamin D (17).

Different genetic and non-genetic mechanisms induced by vitamin D have been thought to play a role in reduction of obesity incidence. It has been established that vitamin D increases adipocyte lipolysis, decrease the adipogenic genes expression and activity, increase the lipolytic genes expression,

and lowering the adipocytes lipid content (18). As a result, vitamin D supplementation is important in preventing the amplification of adipose tissue.

In the present study, especially in the control group, a fatty-enriched diet was given to the rabbits, and this lead to a significant increase in serum TG and LDL levels (P < 0.001), while HDL level was not significantly affected at the end of the study (P < 0.337). These findings are in line with a related study, which reported that their rabbits' serum TG and LDL levels significantly increased in their control group, and their HDL levels significantly decreased, in contrast to our findings (19). Different results are obtained from different studies, regarding the effects of vitamin D supplementation on serum TG and LDL. One of these studies, showed a significant increase in serum TG and LDL (20). In another study, there was no effect (21). Yet in other study there was a significant decrease (22). It is thought that these differences in outcomes may be due to many causes including race (23), physiological (23) and physiopathological condition (24), sex, age (25), and other individual differences (20). To assess the impact of vitamin D supplementation on serum HDL levels, a study was carried out. According to the findings, serum HDL significantly increased with ongoing vitamin D supplementation (25). The present data showed that the administration of vitamin D, once per day during the duration of the study, in the treated vitamin D group, produced a significant increase in serum HDL (P < 0.005), while serum TG and LDL are not significantly affected (P < 0.323, P < 0.737, respectively) for the control group.

The reason for the decrease in TG and LDL, and the increase in serum HDL in the vitamin D group compared to the control group could be attributed to the effect of vitamin D in stimulating the expression of the HDL main liver protein apolipoprotein A-I (apoA-I), LDL apolipoprotein B-100 (apoB-100), and TG Apolipoprotein B (apoB) (26, 27). The primary apolipoproteins of low-density lipoprotein (LDL) and high-density lipoprotein (HDL) are apoB and apoAI, respectively. In the liver, ApoB assembles very-low-density lipoprotein (VLDL), the precursor of LDL. The primordial particle that forms at the beginning of the assembly is transformed into VLDL2. Following its passage to the Golgi apparatus, the VLDL2 particle has the option of being secreted or changed into the triglyceride-rich VLDL1 particle. The process involved in the storage of triglycerides in cytosolic lipid droplets (28).

CONCLUSION

The findings of this study highlight the potential of vitamin D as a therapeutic agent in the management of obesity and dyslipidemia. By demonstrating significant reductions in body weight and improvements in lipid profiles in a rabbit model, the study provides valuable insights into the role of vitamin D in metabolic health. Further research is needed to elucidate the underlying mechanisms, optimal dosing, and long-term effects of vitamin D supplementation in obesity and lipid metabolism, with the ultimate goal of translating these findings to human health interventions.

Conflict of Interest

The author reports no conflicts of interest in this work.

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