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Assessment of vitamin D levels, awareness among Lebanese pharmacy students, and impact of pharmacist counseling

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Abstract Vitamin D inadequacy, frequently underdiagnosed, affects people of all age groups worldwide. This prospective study aims at determining the percentage of inadequate vitamin D levels among students and evaluating the impact of pharmacist counseling on raising the awareness of the importance of sun exposure and adequate vitamin D intake. A total of 160 university students were recruited. Blood samples were taken to check the vitamin D, calcium, and phosphorous levels. Vitamin D levels ≤ 30 ng/mL were defined as inadequate. Scores were given to the questions and aimed at gathering patient knowledge about vitamin D before and after pharmacist counseling. A total of 115 (71.87%) patients had vitamin D levels < 30 ng/mL, with a mean vitamin D serum level of 16.80 ± 5.85 ng/mL. The mean level of calcium was 9.51 ± 1.23 mg/dL and, of phosphorus 3.62 ± 0.95 mg/dL. The mean difference in the knowledge score of the recommended daily amount of vitamin D before and after pharmacist counseling was 2.81 versus 5.88 ($p < 0.001$). Concerning patient education for diseases and drugs that affect vitamin D levels, pharmacist counseling was effective in raising the awareness ($p < 0.001$). Given that vitamin D inadequacy is linked to many disease progressions, it is important that health professionals provide interventional strategies and education measures to correct inadequate levels in patients of all age groups.

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1. Introduction

Vitamin D, the sunshine vitamin, plays a physiological role in maintaining the extracellular calcium

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ion levels in the body. Extracellular calcium is essential for the functioning of many metabolic processes and neuromuscular activities. Vitamin D influences calcium levels by controlling its absorption from the intestine, through direct effects on bone and also through its effects on parathyroid hormone secretion [1,2].

Vitamin D plays an essential role in various metabolic processes and neuromuscular activities [3–6]. Bones constitute an important part of the skeletal system that requires a balanced store from vitamin D, calcium, and phosphorus. It plays an important role in promoting enterocyte differentiation and the intestinal absorption of calcium and phosphorus, thereby promoting bone mineralization. Vitamin D is not an essential vitamin because it can be obtained through nutrition or by endogenous production through the cutaneous involvement under the action of sunlight [7]. Vitamin D₃ or cholecalciferol, after formation in the skin, and vitamin D₂ (ergocalciferol) or D₃, either from dietary sources or supplements, undergo first hydroxylation in the liver, to form 25-hydroxyvitamin D₃ [25 (OH) D], and then the second hydroxylation in the kidneys to form 1,25 dihydroxyvitamin D₃ (activated form), which is responsible for exerting the biologic actions. Vitamin D₃ is more potent than D₂ because the latter has lower affinity to the binding proteins and thus has rapid clearance. Therefore, the recommendation is to prescribe Vitamin D₃ to effectively increase the serum levels. Among the various forms of vitamin D, the level of 25 (OH) D is the best indicator of vitamin D stores, since it is the major circulating form of vitamin D and has a half-life around 2–3 weeks.

The normal vitamin D range varies between populations and is dependent upon many factors. Total body vitamin D stores can be assessed by measuring the serum concentration of total 25 (OH) D. In adults, vitamin D deficiency is defined as a serum 25 (OH) D level <20 ng/mL, insufficiency as a serum 25 (OH) D level of 20–30 ng/mL, and sufficiency levels above 30 ng/mL [8]. The clinical presentation of vitamin D deficiency occurs when the levels are <25 ng/mL, which can cause bone pain, fracture, and muscle weakness. The 25 (OH) D cut-offs to define this condition vary and have recently been defined as desirable level at 20 ng/mL (50 nmol/L), and the Endocrine Society Guidelines set at 30 ng/mL (75 nmol/L) [9,10].

Vitamin D inadequacy is due to many factors such as age (80 years), race (nonwhite), body mass index >30 kg/m², limited exercise, inadequate sun exposure, poor diet, drugs that affect vitamin D metabolism, and diseases that interfere with its

absorption [9]. Vitamin D inadequacy, emerging as a major health problem globally, is a highly prevalent condition, affecting people across all age groups [12–14]. Despite the adequate sunshine in Middle Eastern countries and more particularly in Lebanon, the incidence of hypovitaminosis D is high in all age groups, even in young individuals [15,16].

Several studies conducted all over the world, and particularly in Middle Eastern countries, mainly Lebanon, have shown low vitamin D levels in school children and postmenopausal women [17–19]. There is a high risk of low vitamin D levels in the Lebanese population since there is a lack of vitamin D fortified food. The supportive evidence indicates that low vitamin D levels are associated with increased rates of rickets, osteomalacia, and altered bone mass. Because of the lack of data on vitamin D status in Lebanese pharmacy students and limited evidence of the effectiveness of pharmacist counseling, this study was conducted to assess both vitamin D levels and awareness in healthy university pharmacy students and to evaluate the impact of pharmacist intervention on raising the awareness.

2. Methods

2.1. Study design and study population

This is an observational prospective multicenter study conducted at the Lebanese International University, a private university, in Beirut. The information was obtained from the students at each site. Institutional review board approval from the involved site was obtained. All participants gave informed consent for the enrollment prior to study conductance.

In this study, 250 pharmacy students aged >18 years were approached and screened for eligibility via mails and flyers; posters were also used as recruitment tools. The participants needed to be healthy with no signs and symptoms of low vitamin D levels. Furthermore, those with musculoskeletal pain, malignancy, pregnancy and lactation, intestinal malabsorption, intake of medications that affect vitamin D (supplements, enzyme inducers), or any evidence of liver, kidney, or gastrointestinal disease were excluded from the study.

2.2. Data collection and measurement

One peripheral nonfasting blood sample was taken from each participant by a professional medical laboratory technician. The serum was collected in special tubes, separated after complete

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