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Vitamin D deficiency among Moroccan women aged 18 to 65 years in the region of Rabat-Salé-Kénitra, Morocco

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Abstract: Vitamin D deficiency is a significant public health issue, affecting nearly one billion people worldwide and influencing both bone and overall health. This cross-sectional study aimed to assess the prevalence of vitamin D inadequacy among Moroccan women and explore its relationship with body mass index and parathyroid hormone levels. Conducted at the Military Hospital of Rabat from June 2014 to June 2015, it included 718 women aged 18 to 65 who presented with overweight or obesity. Anthropometric measurements and blood samples were collected to assess levels of 25-hydroxyvitamin D, parathyroid hormone, and calcium. The findings revealed that 41.08% of participants were classified as moderately deficient in vitamin D, while 24.37% were severely deficient. The median serum 25(OH)D level was significantly lower in deficient women (11 µg/L) compared to those with normal levels (26 µg/L). Furthermore, parathyroid hormone levels increase while vitamin D levels decrease, revealing a significant inverse correlation (R^2 = 0.002) and the linear regression between body mass index and vitamin D concentration indicating an inverse relationship between the two parameters (R^2 = 0.004). These results underscore the need for sustainable vitamin D supplementation to improve the health of Moroccan women and mitigate associated risks.

Keywords: *Body mass index, Moroccan women, Parathyroid hormone, Vitamin D deficiency.*

1. Introduction

Vitamin D deficiency is a significant public health issue worldwide, affecting up to one billion people across all ages, genders, and regions [1, 2]. This essential nutrient plays a critical role in calcium metabolism and skeletal health throughout life [3]. It also helps regulate parathyroid hormone (PTH) levels, which reduces bone loss [4]. Severe vitamin D deficiency can lead to osteomalacia in adults and rickets in children [5] as well as secondary hyperparathyroidism, increased bone turnover, progressive bone loss, and a higher risk of fragility fractures [6].

Beyond bone health, vitamin D deficiency has been linked to various conditions, including hypertension, diabetes, metabolic syndrome, left ventricular hypertrophy, congestive heart failure, and chronic vascular inflammation [7, 8]. Low 25-hydroxyvitamin D (25(OH)D), levels are primarily caused by inadequate dietary intake and insufficient sun exposure. Sunlight, specifically ultraviolet B (UVB) rays, is the main source of vitamin D, but its effectiveness is influenced by factors such as season, time of day, duration of exposure, sunscreen use, skin pigmentation, and latitude [9, 10] . With age, the skin's ability to produce vitamin D decreases, making dietary sources increasingly important [6, 11]. Dietary sources of vitamin D include seafood, shrimp, mushrooms, fatty fish, fish oils, egg yolk, and fortified dairy products [12].

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This study aimed to assess the prevalence of vitamin D inadequacy among Moroccan women and explore its relationship with body mass index and parathyroid hormone levels.

2. Materials and Methods

2.1. Study Design

The study took place at the Military Hospital of Rabat, Morocco, over a one-year period from June 2014 to June 2015. The study population consisted of a sample of 718 women aged 18 to 65 who sought consultation at the clinical nutrition unit due to issues related to overweight or obesity. Exclusion criteria encompassed chronic diseases or other health conditions that might influence vitamin D levels in the blood, as well as the use of vitamin D supplements or medications that could influence vitamin D levels. Additionally, individuals who were unable to provide informed consent were excluded. During the recruitment process, a meeting was held with the women to elucidate the study's objectives and obtain their consent. The study was carried out in accordance with ethical and legal guidelines.

3. Data Collection

3.1. Anthropometric Measurements

At the time of recruitment, each participant's anthropometric measurement were taken using standard methods [13]. Waist circumference was measured in centimeters with a standardized technique. Height was recorded to the nearest 0.1 cm using a stadiometer (Fazzini-2 meters), while body weight was measured to the nearest 0.1 kg using a portable scale (Seca 750-Germany). The Body Mass index (BMI) was calculated by dividing weight in kg by squared of height in m^2. BMI was categorized as follows: underweight (<18.5 kg/m^2), normal weight (18.5 to 24.9kg/m2), overweight (24.9 to 29.9 kg/m2), obesity (29.9 to 34.9 kg/m2), severe obesity (34.9 to 39.9 kg/m2), and morbid obesity (>40 kg/m2) based on guidelines from the World Health Organization and the National Institutes of Health [14, 15].

3.2. Biochemical Analysis

3.2.1. Blood Sampling

Blood sample were collected from each participant at the end of the health visit to evaluate serum 25(OH)D concentration, PTH and calcium levels. All analyses were conducted in the hospital clinical laboratory. Following saponification and extraction of serum sample, vitamin D and 25(OH)D levels were quantified using reverse phase high performance liquid chromatography with a C(30) column and UV detection at 265nm. In this study, vitamin D status was categorized based on criteria from WHO : optimal if vitamin D levels were ≥20 µg/L, moderate if levels were between 10 µg/L and <20 µg/L, and severe if levels were ≤10 µg/L. Parathyroid hormone 1-84 was measured using chemiluminescence immunoassay (ELISA).

Additionally, serum calcium and phosphorus levels were assessed by endpoint assay with a multichannel analyzer (Roche/Hitachi model; Roche, Branchburg, NJ).

3.3. Urine Sampling

24-hour urine samples were collected to evaluate urinary excretion of calcium and phosphorus.

3.4. Statistical Analyses

All statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS, version 26.0). Variables with a normal distribution were presented as mean ± standard deviation (SD), while those with a non-normal distribution were reported as median. The relationship between serum vitamin D levels and PTH and BMI measurements was assessed using Pearson correlation. Two-sided R^2=0,002 and R^2=0,004, statistically considered, the relationship between the variable is extremely weak.

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3.5. Ethical Considerations

All precautions according to the Declaration of Helsinki were taken to protect the privacy and confidentiality of the personal information of those involved in the research. Informed consent was obtained from the participants, who were properly informed of the objectives and methods.

4. Results

4.1. Anthropometric Parameters in the Study Population

Table 1 summarizes the anthropometric data for Moroccan women. The mean age was 46,346 ± 13,490 years, with an average weight of 87,394 ±17,62 kg, a mean height of 1,597 ± 0,072 m, a mean waist circumference of 107,376 ±11,463 cm, and an average BMI of 34,26 ± 6,78 kg/m².

Figure 1 summarizes the classification of BMI among Moroccan women. Approximately one-third of the women are classified as obese (34.679 %). The prevalence of severe obesity and morbid obesity is higher at 28.830% and 15.459 % respectively.

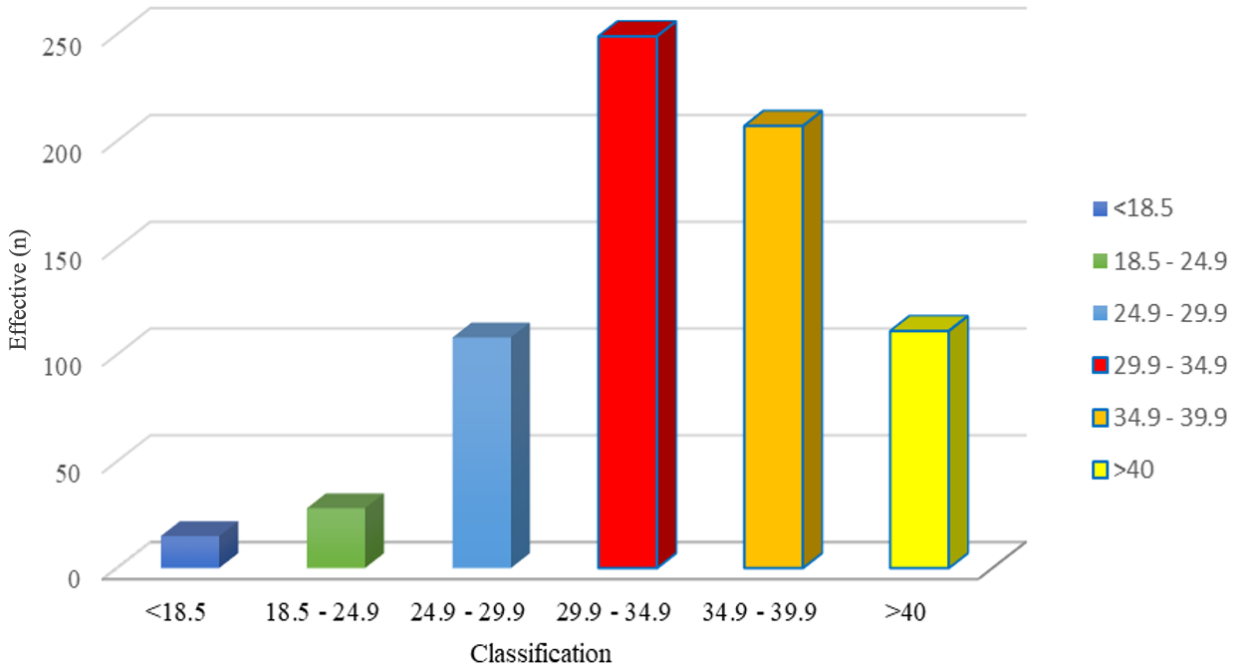

Figure 1.
Body Mass Index classification for Moroccan Women.

Table 1.
Anthropometric Parameters in the Study Population.

	N	Min.-Max.	Mean-SD	Variance
Age (Years)	718	18.00-65.00	46,346-13,4906	181,99
Weight (Kg)	718	10-205	87,394-17,62	310,64
Waist size(cm)	718	59-183	107,376-11,463	131,41
Height (m)	718	1,120-1.9	1,597-0,072	0,01
BMI (Kg/m²)	718	4,056- 70,35	34,26-6,78	45,97

Variables with a normal distribution were presented as mean ± standard deviation (SD), while those with a non-normal distribution were reported as median.

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4.2. Prevalence of vitamin D Deficiency Categories in Moroccan Women

Table 2 displays the prevalence of vitamin D deficiency across all subject groups. The results indicate that vitamin D deficiency is common among Moroccan women, with 41,08% classified as having moderate deficiency and 24,37% experiencing severe deficiency.

Figure 2 illustrates the vitamin D status across three groups: Total, Normal, and Abnormal subjects. The median vitamin D level was notably higher in the Normal subjects, at 26,0 µg/L, compared to those with vitamin D deficiency, who had a median level of 11,0 µg/L.

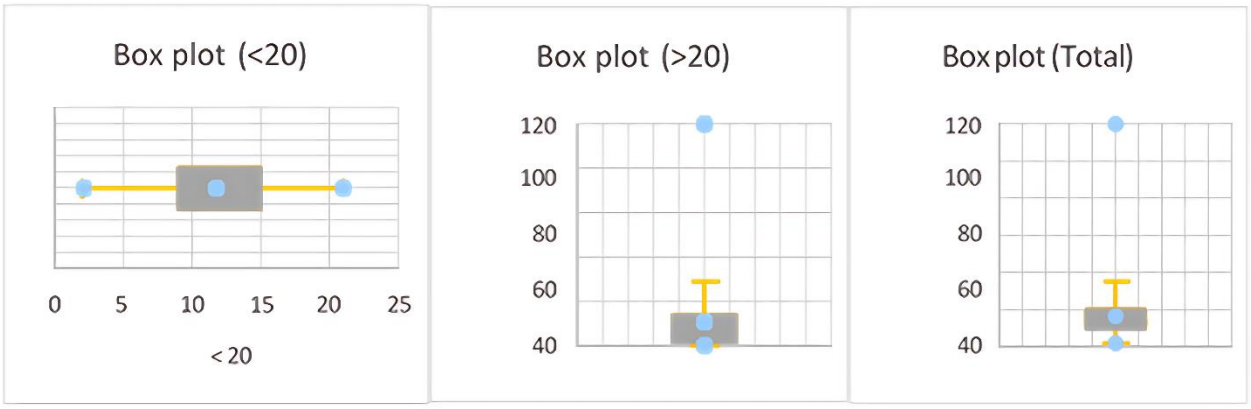

Figure 2.
Median of vitamin D status in all subjects groups.

Table 2.
Prevalence of vitamin D deficiency categories in Moroccan Women

Classification	Effective (n)	Prevalence (%)
<10	175	24.373
10.0-20	295	41.086
20-30	186	25.905
30-45	42	5.849
> 45	20	2.785

4.3. Serum and Urine Parameters of Study Participants

Table 3 illustrates serum and urine parameters of study participants. In fact, the mean phosphorus was 45,273 ± 49,31 mg/l with a mean PTH of 82,398 ± 57,34 pg/l, a mean calcium level in the blood was 105,986± 69,09 mg/l, and in urine was 119,49 ± 60,01 mg/24h and average of 536,52 ± 172,49 mg/24h for phosphorus excretion in urine.

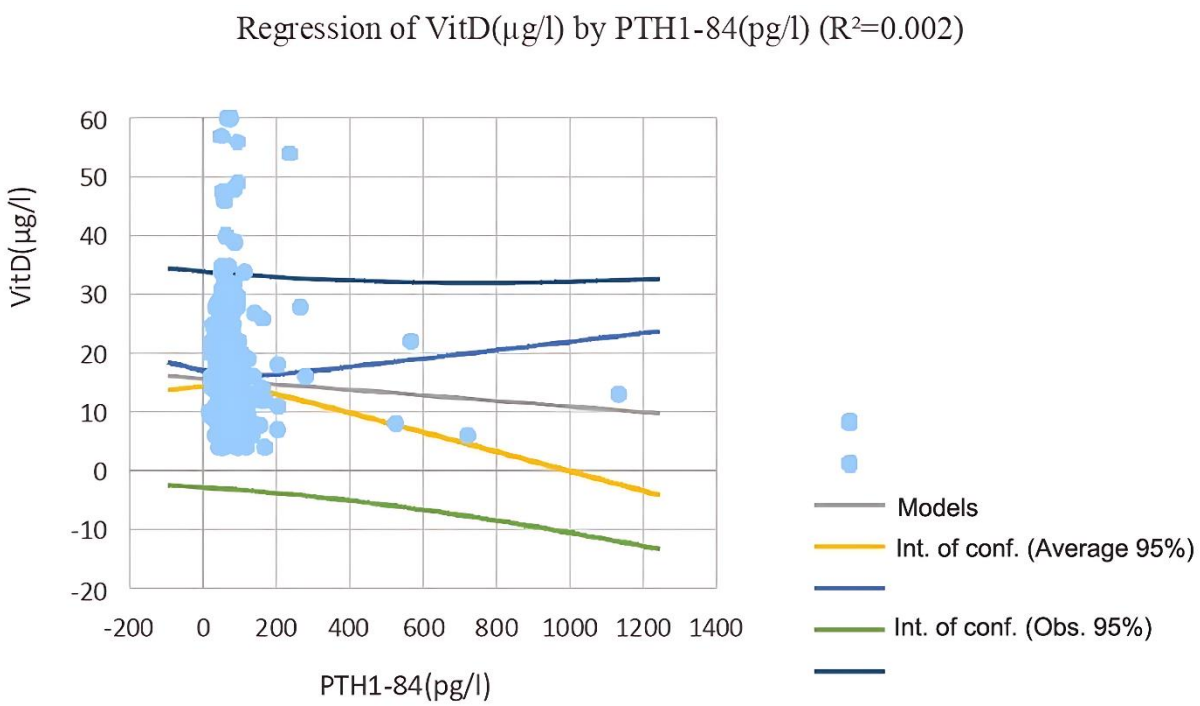

Figure 3.
Relationship between vitamin D levels and parathyroid hormone in Moroccan women.

Table 3.
Serum and urine parameters of study participants

	Minimum	Maximum	Mean	SD	Variance
phosphorus (mg/l)	23	654	45,2734	49,31	2431,55
PTH (pg/l)	15	1130	82,3988732	57,3472784	3288,71
calcium in blood(mg/l)	0.8	1366	105,986484	69,0929586	4773,837
calcium in urine (mg/ 24h)	6	938	119,4949	60,01204	3601,444
phosphorus (mg/24h)	0.4	1586	536,520909	172,495159	29754,58

4.4. Relationship Between Vitamin D And Parathyroid Hormone

Figure 3 displays the relationship between serum 25-hydroxyvitamin D (25OHD) and parathyroid hormone levels, the curves show that, generally, as PTH levels increase, vitamin D levels decrease, revealing a significant inverse correlation between the two (R^2 = 0,002).

4.5. Relationship Between Body Mass Index and Vitamin D

Figure 4 represents a linear regression between body mass index and vitamin D concentration with an R^2 = 0.004, indicating an inverse relationship between the two parameters.

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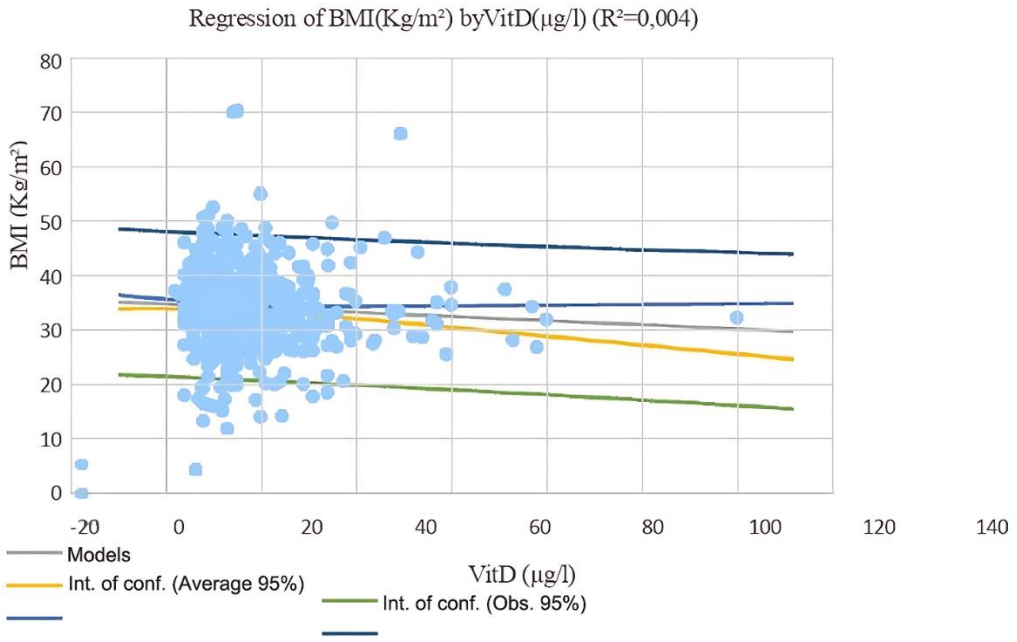

Figure 4.
Association between body mass index and serum vitamin D level in Moroccan women.

5. Discussion

Vitamin D deficiency has become a global public health issue, with recent studies indicating alarmingly high rates worldwide. This study aimed to assess the prevalence of vitamin D deficiency among young Moroccan women. Despite Morocco's abundant sunlight throughout the year, our findings reveal a significant deficiency in vitamin D among the participants. Over 65% of the women were found to be deficient, with 41,08% exhibiting insufficiency or mild to moderate deficiency (serum 25(OH)D levels between 10-20 ug/L) and 24,37% showing severe deficiency (25(OH)D <10 ug/L). The median serum 25(OH) D level was notably lower among the deficient women (11 ug/L) compared to those with normal levels (26ug/L).

These findings align with global data, where similar trends have been observed, for instance, a cross-sectional study in Jordan found that 97% of women had serum vitamin D levels <50 nmol/L [16]. Likewise, in Qatar, 97% of healthcare professionals were reported to be vitamin D deficient [17]. A Tunisian study highlighted a low prevalence of deficiency in 47% of participants [18] while research from Lebanon indicated that 72% of subjects had low serum vitamin D levels [19]. In Morocco, a study revealed that 91% of healthy adult females were deficient [20]. In Europe, the prevalence varies significantly, with 51% of individuals in Ireland, 50% in Germany, 40% In Spain, and 14% in France reported to be deficient [21-23]. Key risk factors contributing to vitamin D deficiency include limited sunlight exposure and inadequate dietary intake.

Our results showed that as PTH levels increased, vit D levels decreased, revealing a significant inverse correlation between the two ($R^2 = 0.002$). In a similar vein, a study of Chinese women showed that a significant inverse relationship between 25(OH)D and PTH concentration was observed below 15.25 (14.22-16.28) ng/mL, and PTH decreased slowly with increasing 25(OH)D above 16.75 (15.43-18.06) ng/mL [24]. Another study carried out in Brazil on a sample of 13668 subjects demonstrated a significant, negative correlation between 25(OH)D and PTH levels ($p < 0.0001$). These data suggest that people suffering from vitamin D deficiency have high PTH values (31.2 pg/mL), while those with vitamin D values above 100 ng/mL have lower PTH levels (23.4 pg/mL) [25]. Other studies confirm the negative correlation between vitamin D and PTH [26, 27].

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Our results showed an inverse relationship between body mass index and serum vitamin d level. A study carried out on a sample of 201 women aged between 20 and 40 showed that serum vitamin D levels were significantly and negatively associated with body mass index (ß= -0.96, 95% CI: -1.40, -0.51, p < 0.001) [28]. The work of lee and colleagues demonstrated that correlation analysis asserted significant inverse relationships between 25(OH)D levels and BMI (r=-0,282; p=0,001) [29]. A meta-analysis of 34 relevant articles proclaimed an overall significant, but weak, inverse association between serum 25(OH)D levels and BMI (Fisher's Z = -0.15, 95% CI: -0.19, -0.11) with significant heterogeneity between studies [30].

6. Conclusion

To sum up, our study revealed a significant prevalence of vitamin D deficiency among Moroccan women. Sustainable vitamin D supplementation could greatly benefit their health. This could enhance bone health and offer protection against various non-musculoskeletal issues. However, further national research with larger sample sizes is necessary to validate these findings.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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