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Urban Rural differences in Vitamin D status in Erbil Governorate: A Cross-Sectional Study

Sarwar Ali Abdulraheem[1], Yassin Ahmad Asaad[2]

[1,2] Department of Community Medicine, College of Medicine, Hawler Medical University, Erbil, Kurdistan Region, IRAQ

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ABSTRACT

Vitamin D deficiency has become a widespread public health issue globally, with an estimated 1 billion people affected worldwide. Surprisingly, this includes countries with abundant sunlight, such as Iraq. This study focuses on differences in vitamin D status between urban and rural populations in the Erbil Governorate of the Kurdistan Region. It also aims to explore how demographic characteristics, lifestyle behaviors, and environmental factors influence the risk of deficiency.

A cross-sectional study was conducted out involving a total of 445 participants, comprising 316 individuals from urban areas and 129 from rural regions. Information on sociodemographic factors, lifestyle behaviors, dietary patterns, and awareness of vitamin D was gathered through structured face-to-face interviews. Serum levels of 25-hydroxyvitamin D [25(OH)D] were assessed using a chemiluminescence immunoassay method. Data analysis was performed using SPSS software, version 27, to identify patterns and associations within the studied population.

The study included 445 participants with complete data on sociodemographic, lifestyle, and clinical variables. The overall mean serum 25-hydroxyvitamin D [25(OH)D] level was 20.93 ng/mL (SD = 14.64), with a median of 18.31 ng/mL, indicating a non-normally distributed and generally low vitamin D status across the sample. Rural residents (n = 129) had significantly higher vitamin D levels (mean = 21.89 ng/mL, SD = 11.56) compared to urban residents (n = 316; mean = 20.54 ng/mL, SD = 15.73; p = 0.018). The mean age of participants was 31.96 years (SD = 18.12), and the sample comprised 206 males (46.3%) and 239 females (53.7%), with no substantial gender imbalance between urban and rural areas. Dietary intake of vitamin D-rich foods was generally low: only 5.4% consumed fortified milk or foods daily, and 58.9% reported rarely or never consuming fish. However, rural participants were more likely to consume milk or eggs daily (59.7% vs. 42.1%) and eggs several times per week (42.6% vs. 29.7%). Supplement use was limited, with only 13.5% reporting regular vitamin D supplementation, though urban residents were more likely to use supplements regularly (16.1% vs. 7.0%; p = 0.041). Common deficiency-related symptoms included fatigue (69.9%), hair loss (58.9%), bone pain (52.8%), and muscle weakness (47.2%). Despite 82% awareness of sunlight's role in vitamin D synthesis, only 42% had modified their behavior to improve vitamin D status. The prevalence of vitamin D deficiency and insufficiency: 55.1% were deficient (<20 ng/mL), 26.9% were inadequate (20–29 ng/mL), and just 18.0% had enough (≥30 ng/mL). In general, 82.0% had low levels of vitamin D.

This study reveals a clear difference in vitamin D levels between urban and rural communities in the Erbil Governorate, emphasizing the significance of sun exposure and lifestyle behaviors in maintaining adequate vitamin D status. Although awareness about vitamin D and its sources is relatively high, actual preventive actions—such as increasing sun exposure or enhancing diet—are still limited. These results highlight the necessity of tailored public health initiatives that, depending on the unique requirements and cultural background of each group, not only increase awareness but also promote significant behavior change.

Keywords: Disparity, Erbil Governorate, Rural and Urban, Vitamin D.

Corresponding author: sarwar.ali@koyauniversity.org

1 INTRODUCTION

It has long been known how important vitamin D is for keeping bones healthy and keeping calcium levels in the body in check. More and more study is showing that it also has big effects on the immune system, muscle function, and even mental health. This is why medical and public health research is becoming more interested in it[1]. A lack of vitamin D can lead to heart disease, immune system problems, osteoporosis, and weak muscles[2]. The fact that many individuals in countries like Iraq, where there is a lot of sun, are vitamin D deficient implies that social and behavioral issues make it hard for people to acquire adequate sun. Three main things that make it harder for the body to make its own vitamin D are living in cities more, spending more time indoors, and wearing clothes that cover up the skin[3], [4].

Even though Iraq receives ample of sunlight throughout the year, vitamin D insufficiency is nevertheless a frequent concern for many different demographic groups. Studies have revealed that severe deficiency is common in places with optimum sun exposure, with rates as high as 84% in Baghdad and 76% in Hilla [5], [6]. The Erbil Governorate, which is in the Kurdistan Region of Iraq, is a great place to look at differences in vitamin D levels between those who live in cities and people who live in the country. People who live in cities usually have better access to healthcare facilities and fortified foods, but they also tend to live more sedentary, indoor lives that limit their exposure to sunshine, which is the main way that vitamin D is made. In contrast, rural dwellers often spend additional time outside as part of their everyday activities, which might promote the body's natural synthesis of vitamin D. However, these groups typically experience problems such as limited availability to fortified foods and fewer opportunities for health education, possibly resulting in deficiencies[7], [8].

This study aims to uncover critical lifestyle, environmental, and sociodemographic determinants while also analyzing and contrasting vitamin D levels in the urban and rural populations of Erbil. To present a full assessment of the vitamin D deficient condition in the region, it also intended to examine public awareness, perceptions, and activities connected to the vitamin.

2 METHODOLOGY

2.1 STUDY DESIGN AND PARTICIPANTS

A descriptive cross-sectional design was used in this study, which was carried out in the Erbil Governorate between September 2024 and March 2025. A total of 445 participants were recruited using stratified sampling to ensure proportional representation of both urban (n=316) and rural (n=129) residents.

2.2 INCLUSION CRITERIA

Included individuals aged 5 years and above who had lived in the area for at least one year and provided informed consent. Individuals with chronic liver or kidney disease or those taking medications known to affect vitamin D metabolism (e.g., corticosteroids) were excluded.

2.3 DATA COLLECTION AND SAMPLING TECHNIQUE

The convenience sampling technique was used to collect data. They were collected through structured, face-to-face interviews using a validated questionnaire[9], [10] that captured:

- Sociodemographic data: age, sex, education, occupation, income
- Lifestyle factors: sun exposure, clothing, sunscreen use, physical activity
- Dietary intake: frequency of milk, fish, eggs, and supplement use
- Knowledge and attitudes: importance of vitamin D, awareness of sun exposure benefits

The questionnaire was pilot tested and refined for local cultural context. Cronbach's alpha for internal reliability was 0.71.

Vitamin D Testing Blood samples were collected to assess serum 25(OH)D levels using chemiluminescence immunoassay. Vitamin D status was categorized as: deficient (<20 ng/ml), insufficient (20-29 ng/ml), sufficient (≥30 ng/ml), and toxic (>100 ng/ml).

2.4 ETHICAL CONSIDERATION

The study was approved by the Scientific and Ethical Committee of Hawler Medical University. Participants provided verbal informed consent, and confidentiality was strictly maintained.

2.5 STATISTICAL ANALYSIS

Data were analyzed using SPSS v27. Descriptive statistics summarized participant characteristics. Chi-square and Mann-Whitney U tests were used to assess associations. A p-value of <0.05 was considered statistically significant.

3 RESULTS

Totally, 445 persons responded the questionnaire, and they were willing to participate. The mean age was 31.96 ± 18.12 years; 53.7% were female. Most participants (71%) lived in urban areas, and 47.2% had a university education. About 33.9% were students, and 82.2% reported sufficient income (Table 1).

Table 1. Sociodemographic characteristics of the participants.

Variables	Urban	Rural	P- Value
Age group in years			**0.003**
0 – 20 years	98 (31.0%)	51 (39.5%)	
21 - 40 years	132 (41.8%)	41 (31.8%)	
41 and above	86 (27.2%)	37 (28.7%)	
Gender			**0.721**
Male	148 (46.8%)	(46.3)	
Female	148 (46.8%)	58 (45.0%)	
Residency	316(71.0%)	129(29.0%)	
Monthly family income			**0.001**
More than sufficient	22 (7.0%)	30 (23.3%)	
Sufficient	278 (88.0%)	88 (68.2%)	
Less than sufficient	16 (5.1%)	11 (8.5%)	
Education level			**<0.001**
Illiterate	40 (12.7%)	36 (27.9%)	
Primary school	38 (12.0%)	24 (18.6%)	
Preparatory school	58 (18.4%)	39 (30.2%)	
Graduated *	180 (57.0%)	30 (23.3%)	
Occupation			**<0.001**
Indoor office worker	82 (25.9%)	8 (6.2%)	
Outdoor worker (construction, agriculture, etc.)	38 (12.0%)	29 (22.5%)	
Housewife	64 (20.3%)	29 (22.5%)	
Student	101 (32.0%)	50 (38.8%)	
Unemployed	31 (9.8%)	13 (10.1%)	
Time Spent Outdoors			**<0.001**
<30 min/day	198 (62.7%)	39 (30.2%)	
30–60 min/day	68 (21.5%)	35 (27.1%)	
>60 min/day	50 (15.8%)	55 (42.6%)	
Symptoms			
Fatigue	219 (69.3%)	92 (71.3%)	**0.682**
Muscle weakness	147 (46.5%)	63 (48.8%)	**0.652**
Bone pain	168 (53.2%)	67 (52.0%)	**0.795**
Hair loss	182 (57.6%)	80 (62.0%)	**0.378**
Fracture history	58 (18.4%)	37 (28.7%)	**0.018**
Total			**445 (100%)**

*Including those who graduated from the institute, college and postgraduates

3.1 LIFESTYLE AND AWARENESS

38.2% of participants never exercised; 38% spent less than 30 minutes outdoors daily. Only 13.5% regularly used vitamin D supplements. Despite 77.8% acknowledging vitamin D's importance and 82% knowing sunlight improves its synthesis, only 42% adopted relevant lifestyle changes (Table 2).

Table 2. Lifestyle pattern of the participants

Variables	Urban	Rural	P- Value
Engaging in physical activity			**0.002**
Daily	32 (10.1%)	39 (30.2%)	
A few times a week	40 (12.7%)	27 (20.9%)	
A few times a month	98 (31.0%)	39 (30.2%)	
Never	146 (46.2%)	24 (18.6%)	
Time spending out side			**<0.001**
Less than 30 min/day	198 (62.7%)	39 (30.2%)	
30 min to 1 hr./day	68 (21.5%)	35 (27.1%)	
1 to 2 hr./day	28 (8.9%)	29 (22.5%)	
More than 4 hr./day	22 (7.0%)	26 (20.2%)	
Type of clothing			**<0.001**
Full coverage (long sleeves, long pants, cover head)	188 (59.5%)	25 (19.4%)	
Moderate coverage (short sleeves, no covered head)	54 (17.1%)	52 (40.3%)	
Minimal coverage (sleeveless, shorts	1 (0.3%)	1 (0.8%)	
Varies depending on the situation	73 (23.1%)	51 (39.5%)	
Using sunscreen when outdoors			**<0.001**
Yes, always	68 (21.5%)	12 (9.3%)	
Sometimes	78 (24.7%)	15 (11.6%)	
Rarely	62 (19.6%)	30 (23.3%)	
Never	108 (34.2%)	72 (55.8%)	
Taking vitamin D Supplement			**0.041**
Yes, regularly	51 (16.1%)	9 (7.0%)	
Sometimes	113 (35.8%)	49 (38.0%)	
Rarely	59 (18.7%)	32 (24.8%)	
Never	93 (29.4%)	39 (30.2%)	
Total			**445 (100%)**

3.2 HEALTH SYMPTOMS

Common symptoms included fatigue (69.9%), hair loss (58.9%), bone pain (52.8%), and muscle weakness (47.2%). Urban residents reported a higher frequency of symptoms (p = 0.002) (Table 3).

Regarding association between Vitamin D levels to the residency of the participants there was a highly significant statistical association (P=0.018), the Independent-Samples Mann-Whitney U Test showed that Vitamin D levels differ significantly between urban and rural populations. The Vitamin D mean rank scores showed that rural participants had 245.63 compared to urban participants who had 213.76. The data showed that rural dwellers maintain higher Vitamin D levels than urban inhabitants. The distribution revealed that rural residents have their Vitamin D levels concentrated in the higher range but urban residents have their levels spread out with more cases at the lower end, (Figure 1).

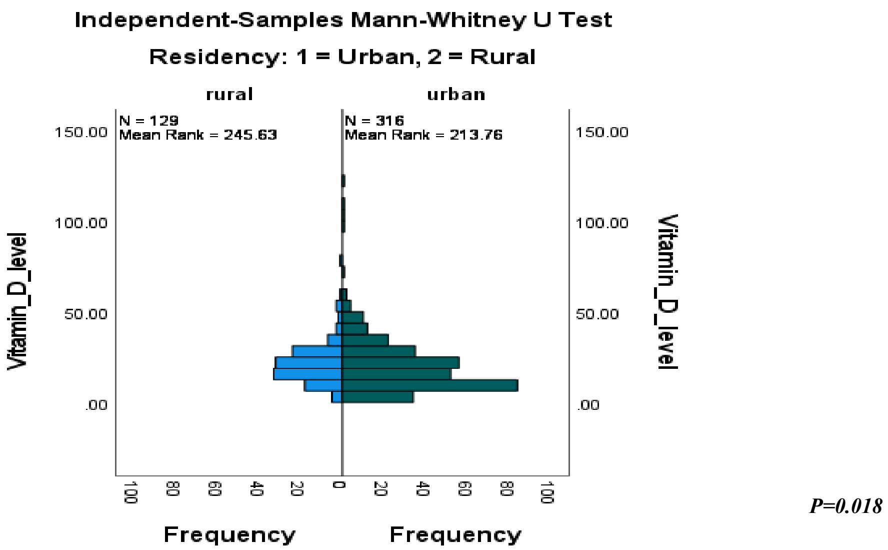

Figure 1. Association between vitamin D levels with the residency of the participants

4 DISCUSSION

The study's results demonstrate that people living in rural regions of the Erbil Governorate have higher average levels of serum 25(OH)D than people living in cities. This tendency seems to be mostly caused by more time spent in the sun due to outdoor employment and daily activities, particularly for people who work in agriculture or other physically demanding industries. These results are similar to what other Middle Eastern countries, such Saudi Arabia and Jordan, discovered. They also found that rural regions had greater levels of vitamin D, mostly because individuals spent more time outside.

The high rates of deficiency among urban dwellers, who frequently have greater access to healthcare services, are probably caused by lifestyle factors like spending a lot of time indoors, being exposed to pollution, and having few opportunities for direct sunlight exposure because of the dense urban infrastructure. This trend emphasizes that behavioral and environmental factors are crucial in determining vitamin D status and that access to medical care alone is insufficient to prevent vitamin D deficiency [11]. While the majority of participants (82%) recognized the importance of sunlight in vitamin D production, only 42% indicated that they had taken any measures in their daily lives to address potential deficiency. This disconnect between knowledge and action is not unique to this investigation. Similar patterns have been observed in other countries, such as Pakistan and Oman, where awareness of vitamin D and its sources is relatively high, yet actual preventive behaviors—such as increasing sun exposure or enhancing dietary intake—remain limited.[12], [13]. Cultural norms—including the widespread practice of donning conservative clothing, limited public health awareness about safe sun exposure, and concerns about skin damage—may serve as significant barriers to adequate sunlight exposure. These factors presumably contribute to reduced cutaneous vitamin D synthesis, particularly in urban settings.

Additionally, the dietary habits identified in this study disclose another layer of the problem. Consumption of naturally vitamin D-rich foods such as oily fish, eggs, and fortified dairy products was generally low. This corresponds with broader research indicating that both economic limitations and cultural food preferences play a role in limiting dietary vitamin D intake among Middle Eastern populations. As a consequence, reliance on endogenous synthesis through sun exposure becomes even more critical—yet remains insufficient due to behavioral and environmental constraints..[14]. Only 13.5% of participants reported routinely taking vitamin D supplements, suggesting that supplement use as a preventive or corrective measure remains largely underused. Notably, the strongest factor linked to sufficient vitamin D levels was frequent outdoor activity. This finding aligns with global health guidelines emphasizing that controlled sunlight exposure continues to be the primary natural source of vitamin D synthesis.[1], [15].

This study brings some crucial strengths to the table. It delivers context-specific insights on vitamin D levels by merging objective biochemical assays with subjective behavioral and perceptual data. By stratifying the sample to include both urban and rural populations, the research captures substantial changes in vitamin D levels connected to lifestyle and environmental factors, boosting the trustworthiness of the findings. Additionally, the use of a culturally adapted questionnaire—tested for consistency (Cronbach's alpha = 0.71)—ensures that self-reported data on behaviors like sun exposure and dietary patterns are both relevant and trustworthy. The integration of both quantitative and qualitative methodologies allows for a more rigorous analysis of the intricate interplay between physiological outcomes and sociocultural norms that strengthen the study's conclusions. However, there are a few factors to keep in mind. The cross-sectional character of the research prohibits the identification of causal links between vitamin D levels and lifestyle habits. Although convenient sampling can be utilized to obtain data, it may limit the generalizability of findings beyond the Erbil Governorate's population. Variables include solar exposure time and dietary habits, which are self-reported, may add biases such as social desirability reporting or erroneous recollection. Finally, the experiment did not take into consideration seasonal differences in sun exposure, which can impact serum vitamin D levels and hide temporal patterns [16], [17]

The large discrepancy in vitamin D levels between rural and urban inhabitants is disturbing and emphasizes the crucial need for public health initiatives. Intervention measures should concentrate on urban dwellers, especially those with restricted outdoor access or sedentary professions. Additionally, campaigns should not merely increase awareness but should drive behavioral improvements. These may include taking brief outdoor breaks during the day or encouraging dietary variety by consuming vitamin D-rich foods.

Teaching about sun exposure and nutrition as part of the curriculum might be a very valuable addition to educational systems at all levels, including schools and universities. For example, governments may consider introducing obligatory fortification programs for staple foods such as milk or bread, which has been successful in other countries. Supplementation strategies can also aid high-risk groups (e.g., women, children, and the elderly) to compensate for major vitamin D deficits.[18].

Culturally sensitive approaches are essential, particularly in communities were conservative dress practices limit sun exposure. Encouraging brief outdoor activity in private spaces (e.g., home gardens) or promoting fortified alternatives to fish and dairy products could align health messaging with local customs. Finally, future research should employ longitudinal designs to clarify causal pathways and evaluate the real-world impact of tailored interventions in similar settings.[19], [20]

CONCLUSION

This research highlights an important public health problem, which is the high prevalence of vitamin D deficiency among the urban population of Erbil despite the high level of awareness of its significance. Although the people in rural areas seem to have more exposure to natural sunlight by outdoor working and commuting time, promoting the synthesis of vitamin D, those who live in the urban areas have lifestyle-related constraints, resulting from indoor work, a reduced time of physical exercise, and environmental factors that could lead to insufficiency of vitamin D.

One fact that stands out is that the knowledge-action gap continues to exist. The importance of vitamin D for health is widely known, but how this translates into practical terms of making real life better is little understood. This highlights that increasing awareness alone will not suffice, but focused interventions are required to translate the knowledge into action. Effective solutions will require a multi-pronged approach that includes culturally appropriate education on safe sun exposure and dietary improvements, policy-level actions such as food fortification programs, and community-based initiatives that encourage outdoor physical activity. Without coordinated efforts at multiple levels, vitamin D deficiency will remain an overlooked but significant threat to public health in the region.

Future strategies must be tailored to the unique sociocultural and environmental contexts of both urban and rural settings to ensure sustainable improvements in vitamin D status and overall health outcomes.

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