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Exploring Age-Related Patterns in Vitamin D Deficiency and Gender Variations

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ABSTRACT

Younger adults and adult males had a higher rate of vitamin D deficiency compared to older individuals and females, indicating important opportunities for preventive measures. Aim of this study: to find out The Association Between Age and Levels of Vitamin D Deficiency and Gender Differences, Material and Method: Samples were collected from Misurata Central Laboratory between Statistical analysis of vitamin D status data, T, the following text verification set, by electrochemical-liquid, Vitamin D status was determined according to the cut-off values proposed by the IOM deficient < 30 nmol/L, inadequate 25(OH)D level between 30 and 50 nmol/L) and sufficient 25(OH)D level > 50 n/mol/L. Results: Between Groups: 76.411 (variation due to differences between age groups). Within Groups: 33,789.708 (variation within each age group). Degrees of Freedom (df): 4 (age groups) for between groups and 2797 for within groups. Mean Square: Between Groups: 19.103. Within Groups: 12.081. F-Statistic: 1.581. P-Value: 0.176. The p-value (0.176) indicates that there is no statistically significant difference in Vitamin D levels across age groups. The F-statistic (1.581) is low, reinforcing that the variation in Vitamin D levels attributed to age is minimal compared to the variation within age groups. Gender and Vitamin D Levels, Between Groups: 247.378 (variation due to gender differences). Within Groups: 453.122 (variation within gender groups). Degrees of Freedom (df): 4 (gender groups) for between groups and 2797 for within groups. Mean Square: Between Groups: 61.845. Within Groups: 0.162. F-Statistic: 381.750. P-Value: 0.000. Interpretation: The p-value (0.000) indicates a statistically significant difference in Vitamin D levels between genders. The very high F-statistic (381.750) suggests that the variation in Vitamin D levels due to gender is substantial and meaningful. Conclusion: Age does not significantly affect Vitamin D levels in this dataset. However, gender significantly impacts Vitamin D levels, with notable differences observed between males and females.

1. INTRODUCTION

Vitamin D deficiency is widespread, especially among young people and people with central obesity. Appropriate fortification policy, health education and regular screening in primary health centers can help prevent and treat vitamin D deficiency. (AlQuaiz et al., 2018), The link between vitamin D deficiency and Alzheimer's disease. We also observed a statistically significant effect modification of this association according to gender.

Further research is recommended to study this association longitudinally and to determine whether treatment of vitamin D deficiency could potentially improve Alzheimer's disease. (Ahmed Mohamed et al., 2021), Vitamin D was inversely and independently associated with insulin resistance only in women deficient in vitamin D. However, this needs to be confirmed in placebo-controlled clinical studies. (Chen et al., 2021), The positive association between vitamin D deficiency and hypertriglyceridemia was significant in men (but not women) and in people aged 50 to 65 years. In conclusion, younger people, middle-aged women and men with hypertriglyceridemia are at greater risk of vitamin D deficiency. (Cheng et al., 2022), In a healthy young population, seasonal variations were observed in 25OHD and LH levels (higher in S) and in TT, FT, SHBG and T/E2 levels (higher in W). The lower TT and FT values in S are accompanied by higher LH levels, ruling out a central mechanism of testosterone decline. 25OHD correlated negatively with TT, FT and T/E2 and positively with E2, suggesting a relationship between VD status and changes in gonadal steroids.(Costanzo et al., 2021), its relationship between age, sex, skin color, smoking, diet, sun exposure, sports, diabetes, hypertension, various types of diseases and other types of vitamins, there is also a direct relationship between vitamin D deficiency and lack of S. Ca +(Eljamay, 2022), The function of vitamin D and PA in weight problems and sarcopenia became different among men and women, and the relationship between PA and sarcopenia became modified by using serum diet D reputation. Those findings highlighted the need to supplement nutrition D in individuals with an inactive state and provide distinctive intervention techniques for sarcopenia in men and women. (Jia et al., 2022), there may be a moderate increase in serum 25(OH)D stages from 18 via 45 years of age inside the healthful population. The seasonal version of 25(OH)D tiers is distinguished in both genders with men having barely lower degrees in some months of iciness and better stages in summer in comparison to women. the prevalence of girls having 25(OH)D ranges less than five ng/ml is better than that of fellows. (Karacan et al., 2020), nutrition D deficiency/insufficiency is substantial among children around the world and in Turkiye. that seasonal variations, age and gender affect the serum tiers of 25-hydroxyvitamin D in kids. In this context, the significance of diet D-rich foods or diet D supplementation is growing(Keleş Alp & MiRza, 2022), 71% of the take a look at populace had poor nutrition D3 tiers, 12.9% had insufficient even as most effective sixteen% had everyday diet D3 ranges.(Khan & Khan, 2022), Nutrition D deficiency is quite widely wide-spread among network-dwelling adults in Kosovo and coffee serum 25(OH)D has been associated with low muscle power. this means an urgent need for the improvement of complete prevention strategies, that specialize in pharmacological (supplementation) but also on non-pharmacological techniques along with training, food fortification or lifestyle bits of advice. (Krasniqi et al., 2024), The 25(OH)D3 degree, as well as its seasonal variation and the prevalence of diet D deficiency, are all depending on BMI, and age one at a time. The effects of the study propose that 1 in three women and 1 in 2 men with BMI ≥forty are diet D poor(Lagunova et al., 2009), vitamin D deficiency and older age are each related to a better risk of depression, while older age is a protective factor for diet D deficiency.(Mo et al., 2023), designed scientific trials and experiments on animal fashions must be done to determine the function of non-environmental factors that could differentiate diet D levels in females and men.(Wierzbicka & Oczkowicz, 2022), diet D deficiency/insufficiency is considerable among youngsters inside the international and in Turkiye. Our take a look at discovered that seasonal variations, age and gender have an effect on the serum ranges of 25-hydroxyvitamin D in children. in this context, the importance of diet D-wealthy foods or diet D supplementation is increasing. Çocuk ve Adölosanlarda Yaş, 2022.), there is a dating among kidney failure and the percentage of Ca+, Vit D, and PTH, and there may be no relationship between kidney failure and Gender and age.(Eljamay, S. M 2024.), the connection between diet D deficiency and oxidative stress may be unbiased of age and gender.(Alice Barros Câmara, 2021.), Low nutrition D tiers were related to extra fatigue in men however now not in women. The look at underscores the significance of subgroup evaluation of women and men when comparing the effect of vitamin D in scientific trials for the reason that effect may differ among the sexes. the continued "Palliative-D examine" will monitor whether or not nutrition D supplementation might also counteract fatigue in both women and men. (Caritha Klassone, 2021.), imply 25(OH) D values had been better in children and decrease in teenagers and women. approximately ninety% of non-seniors and probably healthy residents of the city metropolitan vicinity of Rio de Janeiro supplied exceptional stages of 25(OH) D in the course of the summer season months; however, in over half of the aged, the serum concentrations of 25(OH) D had been insufficient (Lenora M. Camarate S.M, 2021.).

2. METHOD

Study Design, subjects and data collection This cross-sectional study was conducted from February and March 23. until e March 2023. All participants, were community-dwelling middle-aged and older men and women

The Data Collection

Samples were collected from Misurata Central Laboratory between Statistical analysis of vitamin D status data, T, the following text verification set, by electrochemical-liquid

Serum/plasma collection and vitamin D status

Vitamin D status was determined according to the cut-off values proposed by the IOM in 2011: deficient < 30 nmol/L, inadequate 25(OH)D level between 30 and 50 nmol/L) and sufficient 25(OH)D level > 50 n/mol/L (Ross et al., 2012). Instrument by electrochemiluminescence protein binding assay (ECLIA) using by electrochemiluminescence protein binding assay (ECLIA) using Roche Diagnostics, Cobas e411 analyzer, Roche Diagnostics, Cobas e411 analyzer.

Data analysis: Data analysis was done with SPSS 27.0 and results were evaluated at 95% confidence level. In the study, while the relationship between the age and gender with Level of Vit D, was analyzed with the P-Value, Anova, and crosstabulation test, the normal distribution of quantitative variables was examined with the descriptive statistic

3. ETHIC APPROVAL

We collected data from a private medical laboratory in Misrata City after permission by the lab manager to use the data

4. RESULT

Table 1 show that the study has a total sample size of 2802 participants, which is a robust dataset size providing statistical reliability, Demographic characters Gender Distribution Equal distribution between males and females: 1401 (50%) each. The mean and standard deviation values (1.50 and 0.500) indicate a binary coding system for gender, likely 1 for male and 2 for female. Age Distribution, Ages are segmented into multiple categories, with percentages decreasing as age increases, most respondents are in the 26–30 years category (11.3%) and 36–40 years (11.2%). The lowest representation is in the 76–80 years (2%) and >81 years (2.3%) categories. The overall mean age group appears to correspond to the younger cohorts, as expected in population demographics with natural attrition in older age ranges. The standard deviation for age (3.477) suggests moderate variability. Vitamin D levels are categorized as Normal, High, Low, Moderate Low, and The Severe Low category has the majority representation (63.2%) indicating a public health concern. Normal levels are only seen in 9.2%, which may indicate an issue with Vitamin D sufficiency. High levels are quite rare, comprising 0.9% of the total dataset.

Table (1) demographic characters

	N(%)	Mean	Std. Deviation
Gender			
Male	1401(50%)	1.50	0.500
Female	1401(50%)		
Ages			
16 - 20 years	251(9%)		
21 - 25 years	296(10.6%)		
26 - 30 years	318(11.3%)		
31 - 35 years	283(10.1%)		
36 - 40 years	313(11.2%)		
41 - 45 years	244(8.7%)		
46 - 50 years	255(9.1%)	6.60	3.477
51 - 55 years	195(7%)		
56 - 60 years	170(6.1%)		
61 - 65 years	103(3.7%)		
66 - 70 years	113(4%)		
71 - 75 years	78(2.8%)		
76 - 80 years	57(2%)		
> 81 years	65(2.3%)		
Variable of Vit D			
Normal	257(9.2%)		
High	802.9%)	4.9857	1.56079
Low	622(22.2%)		
Moderate	73(2.6%)		
Low	**1770(63.2%**		
Sever Low	**)**		
Total	2802(100%)		

Table 2 show that This table explores the relationship between age groups and Vitamin D levels using a crosstabulation approach. Below are key insights: General Summary, the table evaluates the count of individuals across various age groups with specific Vitamin D level categories: Normal, High, Low, Moderate Low, and Severe Low. Total participants across all categories remain consistent with the dataset size (2802). Severe Vitamin D Deficiency: Severe Low Vitamin D levels dominate across nearly all age groups. The highest counts are seen in middle-age ranges: 21–25 years: 204, 26–30 years: 204, 36–40 years: 193, Normal Vitamin D Levels: Lowest representation overall compared to other categories. Highest counts for Normal Vitamin D levels are found in: 36–40 years: 32, 31–35 years: 29, Other Categories: High Vitamin D levels are uncommon across all age groups. Moderate Low levels are minimal, with counts remaining under 10 for most age ranges. Young and Older Populations: Younger groups (e.g., 10–15 years) show relatively higher representation in Severe Low and Normal Vitamin D categories. Older age groups (> 66 years) also show consistent patterns of Severe Low Vitamin D, with fewer participants achieving Normal or High levels, Statistical Notation: Subscript letters (e.g., a, b, c) denote subsets of categories within age and Vitamin D variables where differences are not statistically significant at the 0.05 level.

Table (2) Crosstabulation of Age with Variable of Vit D

Age * Variable of Vit D Crosstabulation						
Age	**Valeur Variable of Vit D**					**Total**
	Normal	**High**	**Low**	**Moderate Low**	**Sever Low**	
10 - 15 years	22_{a}	$4_{a, b}$	$8_{b, c}$	8_{a}	19_{c}	61
16 - 20 years	11_{a}	$10_{a, b}$	40_{a}	$1_{a, b}$	189_{b}	251
21 - 25 years	13_{a}	$8_{a, b}$	$66_{a, b}$	$5_{a, b}$	204_{b}	296
26 - 30 years	23_{a}	10_{a}	74_{a}	7_{a}	204_{a}	318
31 - 35 years	29_{a}	7_{a}	58_{a}	7_{a}	182_{a}	283
36 - 40 years	32_{a}	7_{a}	77_{a}	4_{a}	193_{a}	313
41 - 45 years	24_{a}	8_{a}	49_{a}	7_{a}	156_{a}	244
46 - 50 years	$22_{a, b}$	$6_{a, b}$	78_{b}	$7_{a, b}$	142_{a}	255
51 - 55 years	15_{a}	0_{a}	45_{a}	6_{a}	129_{a}	195
56 - 60 years	22_{a}	5_{a}	34_{a}	5_{a}	104_{a}	170
61 - 65 years	10_{a}	1_{a}	30_{a}	2_{a}	60_{a}	103
66 - 70 years	$14_{a, b}$	$7_{a, b}$	$26_{a, b}$	7_{b}	59_{a}	113
71 - 75 years	8_{a}	1_{a}	18_{a}	4_{a}	47_{a}	78
76 - 80 years	7_{a}	1_{a}	10_{a}	2_{a}	37_{a}	57
> 81 years	$5_{a, b}$	5_{b}	9_{a}	$1_{a, b}$	$45_{a, b}$	65
Total	257	80	**622**	73	**1770**	2802
Each subscript letter denotes a subset of Valeur Variable of Vit D categories whose column proportions do not differ significantly from each other at the .05 level						

Table 3 show that the correlations are computed for the total sample size (N = 2802), ensuring robust statistical reliability. This table examines the correlations between Vitamin D levels, age, and gender. Below are the key observations and insights: Vitamin D and Age: Pearson Correlation: -0.035 P-Value: 0.063 Interpretation: There is a very weak negative correlation between Vitamin D levels and age, and it is not statistically significant ($P > 0.05$). This implies no meaningful relationship between age and Vitamin D levels in this dataset. Vitamin D and Gender: Pearson Correlation: 0.490**, P-Value: 0.000, Interpretation: There is a moderate positive correlation between Vitamin D levels and gender, and it is statistically significant ($P < 0.01$). This suggests that gender has a notable influence on Vitamin D levels.

Table (3) **Correlations between Variable of Vit D with Age and Gender**

Correlations		**Age**	**Gender**
Variable of Vit D	Pearson Correlation	-0.035-	0.490**
	P-Value	0.063	**0.000**
	N	2802	2802
**. Correlation is significant at the 0.01 level (P-Value).			

Table 4 show that The ANOVA table evaluates the relationship between Vitamin D levels, age, and gender: Age: The F-value is 1.581 with a p-value of 0.176, indicating no statistically significant difference in Vitamin D levels across different age groups ($p > 0.05$). Gender: The F-value is 381.750 with a p-value of 0.000, suggesting a highly significant difference in Vitamin D levels between genders ($p < 0.001$). This indicates that gender strongly influences Vitamin D levels.

Table (4) **ANOVA test between Variable of Vit D with Age and Gender**

ANOVA		Sum of Squares	df	Mean Square	F	P-Value
Age	Between Groups	76.411	4	19.103	1.581	**0.176**
	Within Groups	33789.708	2797	12.081		
Gender	Between Groups	247.378	4	61.845	381.750	**0.000**
	Within Groups	453.122	2797	0.162		
	Total	700.500	2801			

The figure1 illustrates the distribution of Vitamin D levels by gender across different deficiency categories: Normal Levels: There are slightly more males (248) than females (9), indicating a higher prevalence of normal Vitamin D levels among males. High Levels: The difference is minimal, with males at 22 and females at 0. Low Levels: A significant number of males (566) compared to females (0), suggesting that males are markedly more affected by Vitamin D deficiency in this category. Moderately Low Levels: Males show 56 while females have a very low count of 19. Severely Low Levels: This category also shows a stark difference, with 1259 males significantly surpassing 511 females.

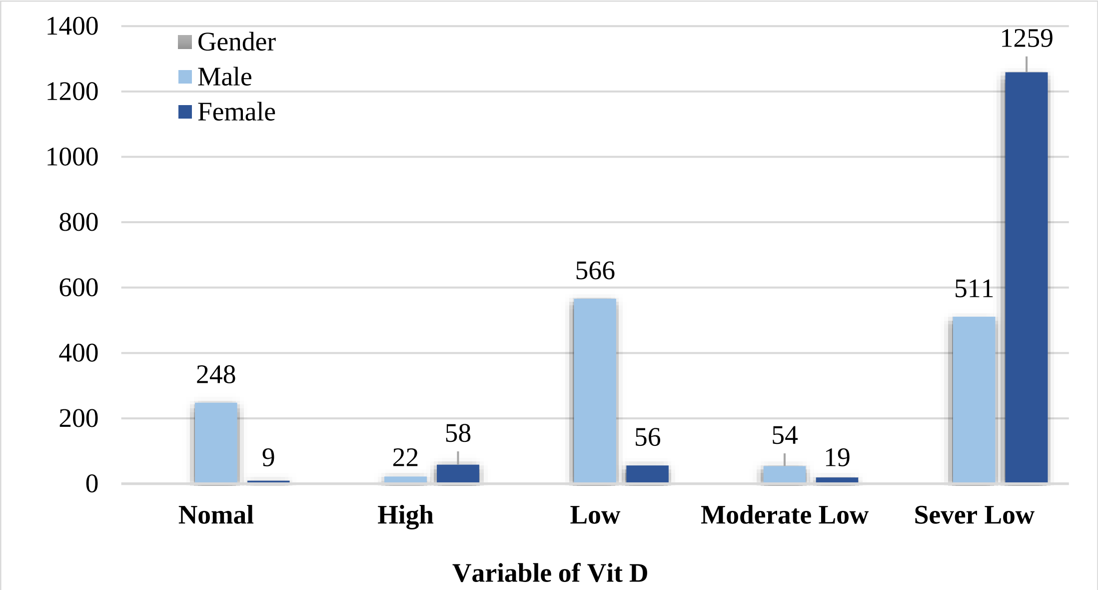

Figure (1) relationship between Vitamin Deficiency and Gender

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5. DISCUSSION

The demographic distribution and the relationship between Vitamin D levels, age, and gender among a dataset of 2802 participants. Here's a breakdown of the main findings: Demographic and Dataset Overview Sample Size and Gender Distribution, Total participants: 2802, equally distributed between males and females (1401 each, 50%). Gender coding: Binary system (likely 1 for male, 2 for female) with a mean of 1.50 and standard deviation of 0.500. Ages segmented across multiple categories, with younger cohorts dominating. Highest age group representation: 26–30 years (11.3%) and 36–40 years (11.2%). Lowest age group representation: 76–80 years (2%) and >81 years (2.3%). Mean age and standard deviation: Suggest a younger participant pool with moderate variability. Vitamin D Levels Severe deficiency (Severe Low) dominates (63.2%), followed by Low (22.2%). Normal Vitamin D levels are rare (9.2%), and High levels are very uncommon (0.9%).

This indicates a significant public health concern regarding Vitamin D sufficiency. Crosstabulation of Age and Vitamin D Levels Severe deficiency persists across all age groups, particularly high in middle-aged participants (e.g., 21–25 years and 26–30 years with 204 participants each). Normal Vitamin D levels have the highest counts in age groups 31–35 and 36–40 years but remain the lowest representation overall. Minimal representation in High and Moderate Low categories across all age ranges. Correlation Analysis of Vitamin D and Age, Weak negative correlation (r = -0.035) with a p-value of 0.063 (not statistically significant).

Suggests no meaningful relationship between age and Vitamin D levels, Vitamin D and Gender Moderate positive correlation (r = 0.490\)) with a p-value < 0.001 (statistically significant). Indicates a notable influence of gender on Vitamin D levels.

Age in ANOVA test, F-value: 1.581, p-value: 0.176. No significant differences in Vitamin D levels across age groups. In Gender, F-value: 381.750, p-value: 0.000. Strongly significant difference in Vitamin D levels between genders. Figure 1 Insights: Vitamin D and Gende Normal and High Vitamin D levels: Slightly higher prevalence among males. Low, Moderate Low, and Severe Low Vitamin D levels: Males show significantly higher counts, especially in Severe Low (1259 males vs. 511 females).

In figure 1 shows the distribution of Vitamin D levels across different deficiency categories, segmented by gender (male and female). Here's a breakdown of the results: Males (248) significantly outnumber females (9) in the "Normal" category. This suggests that males are more likely to have sufficient Vitamin D levels compared to females. High Vitamin D Levels: Very rare overall, with 22 males and no females in this category. Highlights that elevated Vitamin D levels are uncommon in the population. Low Vitamin D Levels: Substantial gender disparity: 566 males vs. 58 females. Indicates that males are more prone to mild Vitamin D deficiency. Moderate Low Vitamin D Levels: Similar to the "Low" category, males (56) significantly surpass females (19), though the numbers are relatively lower compared to other categories. Severely Low Vitamin D Levels: The largest group overall, with 1259 males and 511 females. Severe Vitamin D deficiency is a significant concern across both genders, but males are more severely impacted. Gender Influence: The clear disparity across all categories, particularly in the "Severe Low" group, aligns with the statistical findings showing a significant correlation between gender and Vitamin D levels. Males seem to dominate both ends of the spectrum—having either sufficient levels or severe deficiency. Public Health Concern: The overwhelming prevalence of "Severe Low" levels highlights an urgent need for interventions, such as dietary supplementation, lifestyle modifications, or awareness programs to address Vitamin D deficiencies, especially among males.

Anomalies in Females: The starkly low representation of females in the "Normal" and "High" categories, along with the significant count in "Severe Low," may point to underlying factors like hormonal, lifestyle, or socio-economic influences that require further exploration.

6. CONCLUSION

There is no significant effect of age on Vitamin D levels in this dataset. However, gender does have a significant impact on Vitamin D levels, with notable differences observed between males and females. These findings emphasize the importance of considering gender-specific factors when addressing Vitamin D deficiencies, while age does not seem to be a major influencing factor in this case.

7. REFERENCES

Ahmed Mohamed, A., Salah Ahmed, E. M., Farag, Y. M. K., Bedair, N. I., Nassar, N. A., & Ghanem, A. I. M. (2021). Dose–response association between vitamin D deficiency and atopic dermatitis in children, and effect modification by gender: A case-control study. Journal of Dermatological Treatment, 32(2), 174–179. https://doi.org/10.1080/09546634.2019.1643447

AlQuaiz, A. M., Kazi, A., Fouda, M., & Alyousefi, N. (2018). Age and gender differences in the prevalence and correlates of vitamin D deficiency. Archives of Osteoporosis, 13(1), 49. https://doi.org/10.1007/s11657-018-0461-5

Aziza.M.AGWAIDA.ALSHEEKH, Eljamay, S. M, (2024), The Relationship between Vitamin D Deficiency and Anemia and it's Risk in Females, Derna Academy Journal for Applied Sciences (DAJAS) - Legal Filing Number (2023-133), P(182 – 191).

Chen, X., Chu, C., Doebis, C., Von Baehr, V., & Hocher, B. (2021). Sex-Dependent Association of Vitamin D With Insulin Resistance in Humans. The Journal of Clinical Endocrinology & Metabolism, 106(9), e3739–e3747. https://doi.org/10.1210/clinem/dgab213

Cheng, Y.-L., Lee, T.-W., Lee, T.-I., Kao, Y.-H., Wu, C.-Y., & Chen, Y.-J. (2022). Sex and Age Differences Modulate Association of Vitamin D with Serum Triglyceride Levels. Journal of Personalized Medicine, 12(3), Article 3. https://doi.org/10.3390/jpm12030440

Costanzo, P. R., Suárez, S. M., Kozak, A. E., & Knoblovits, P. (2021). Seasonal Variations in Sex Steroids in a Young Male Population and Their Relationship with Plasma Levels of Vitamin D. The World Journal of Men's Health, 40(2), 308. https://doi.org/10.5534/wjmh.200156

Eljamay, S. M. (2022). Incident Of Vitamin D Deficiency In Derna City\libya. Journal of Endocrinology and Metabolism Research. https://doi.org/10.37191/Mapsci-2582-7960-3(1)-020

Alp, E. K., & Mirza, S. (2022). Evaluation of Vitamin D Levels According to Age, Gender and Seasonal Characteristics in Children and Adolescents. Genel Tıp Dergisi, 32(4), 405-409.

Jia, S., Zhao, W., Hu, F., Zhao, Y., Ge, M., Xia, X., Yue, J., & Dong, B. (2022). Sex differences in the association of physical activity levels and vitamin D with obesity, sarcopenia, and sarcopenic obesity: A cross-sectional study. BMC Geriatrics, 22(1), 898. https://doi.org/10.1186/s12877-022-03577-4

Karacan, M., Usta, A., Biçer, S., Baktir, G., Gündogan, G., Usta, C., & Akinci, G. (2020). Serum vitamin D levels in healthy urban population at reproductive age: Effects of age, gender and season. Central European Journal of Public Health, 28(4). https://doi.org/10.21101/cejph.a5947

Keleş Alp, E., & MiRza, S. (2022). Evaluation of Vitamin D Levels According to Age, Gender and Seasonal Characteristics in Children and Adolescents. Genel Tıp Dergisi, 32(4), 405–409. https://doi.org/10.54005/geneltip.1098363

Khan, H., & Khan, M. B. (2022). Assessment of vitamin D3 deficiency and insufficiency in age and gender groups. 47(2).

Krasniqi, E., Boshnjaku, A., Ukëhaxhaj, A., Wagner, K.-H., & Wessner, B. (2024). Association between vitamin D status, physical performance, sex, and lifestyle factors: A cross-sectional study of community-dwelling Kosovar adults aged 40 years and older. European Journal of Nutrition, 63(3), 821–834. https://doi.org/10.1007/s00394-023-03303-9

Lagunova, Z., Porojnicu, A., Lindberg, F., Hexeberg, S., & Moan, J. (2009). The dependency of vitamin D status on body mass index, gender, age and season. Obesity and Metabolism, 6(4), 52. https://doi.org/10.14341/2071-8713-4886

Mo, H., Zhang, J., Huo, C., Zhang, M., Xiao, J., Peng, J., Wang, G., Wang, C., & Li, Y. (2023). The association of vitamin D deficiency, age and depression in US adults: A cross-sectional analysis. BMC Psychiatry, 23(1), 534. https://doi.org/10.1186/s12888-023-04685-0

Lagunova, Z., Porojnicu, A. C., Lindberg, F., Hexeberg, S., & Moan, J. (2009). The dependency of vitamin D status on body mass index, gender, age and season. Anticancer research, 29(9), 3713-3720.

Câmara, A. B., & Brandão, I. A. (2019). The relationship between vitamin D deficiency and oxidative stress can be independent of age and gender. International Journal for Vitamin and Nutrition Research.

Klasson, C., Helde-Frankling, M., Sandberg, C., Nordström, M., Lundh-Hagelin, C., & Björkhem-Bergman, L. (2021). Vitamin D and fatigue in palliative cancer: A cross-sectional study of sex difference in baseline data from the palliative D cohort. Journal of palliative medicine, 24(3), 433-437.

Lippi, G., Montagnana, M., Meschi, T., & Borghi, L. (2012). Vitamin D concentration and deficiency across different ages and genders. Aging clinical and experimental research, 24, 548-551.

Wierzbicka, A., & Oczkowicz, M. (2022). Sex differences in vitamin D metabolism, serum levels and action. British Journal of Nutrition, 128(11), 2115–2130. https://doi.org/10.1017/S0007114522000149