Natural Resources for Human Health
eISSN: 2583-1194

Original Research

Received 16 July 2026
Revised 17 Aug 2026
Accepted 03 Sep 2026

Natural Resources for Human Health 2026, Vol. 6 (20s): 1032–1042

KEYWORDS:
Vitamin D, metabolic disorders, risk factors, UniMAIWP`

Vitamin D Level and Susceptible to The Metabolic Disorder Among Working Adults

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ABSTRACT: **Purpose**: Vitamin D deficiency is prevalent worldwide and is inversely associated with metabolic disorders along with its classic role in calcium homeostasis and bone metabolism. The aim of the study is to evaluate the Vitamin D levels from the staff working at University College of MAIWP International (UCMI) and MRANTI Park Bukit Jalil (MRANTI Park), Kuala Lumpur, Malaysia.

Methods: In this analytical cross-sectional study, a minimum of 200 staff with fasting blood samples was collected to determine the level of their vitamins D status (25-hydroxyVitamin D), haematological profile, glucose, renal profile and lipid profile. The sociodemographic characteristic data was collected using a simple open-ended questionnaire. Standard procedures were also followed to measure the systolic and diastolic blood pressure, height, weight, waist circumference, and BMI. The t-test, chi-square test, general linear model, and multiple logistic regression were used to analyze the data in order to ascertain whether vitamin D status and other risk factors that are susceptible to metabolic disorders were significantly correlated.

Results: The study reveals that levels of 25(OH)D (Vitamin D) are significantly associated with reduced hemoglobin levels and increased uric acid, indicating potential health implications. Additionally, significant differences in participant characteristics were observed based on Vitamin D levels, particularly in gender distribution and work environment.

Conclusion: The outcomes of this study could reveal the status and the prevalence of Vitamin D among the staff, and might reflect key lifestyle differences, and helps to target health promotion and preventive efforts.

INTRODUCTION

Vitamin D, referred to as the "sunshine" hormone, is essential for immune and neuromuscular system regulation, calcium homeostasis, and cell proliferation and differentiation (Ross et al., 2011). For people who are not exposed to sunlight, vitamin D deficiency or insufficiency is a serious health issue that can result in a number of health problems, such as impaired bone homeostasis, autoimmune diseases, infectious diseases, dementia, Alzheimer's disease, cancers, diabetes, cardiovascular disease, inflammatory bowel disease, and all-cause mortality (Holick, 2007).

Numerous studies on Vitamin D supplementation have produced inconsistent results regarding its effects on musculoskeletal and non-musculoskeletal outcomes. This variability is largely attributed to the absence of a consensus on optimal Vitamin D levels and the specific populations that would benefit from treatment. In Malaysia, there are studies have conducted among the different occupational workers and highlighted the high prevalence of Vitamin D insufficiency among Malay adults in Kuala Lumpur (Moy and Bulgiba, 2011). A systematic review shows that there are 35 published papers were based on determine the Vitamin D status among physicians, nurses, hospital employees, health sciences or medical students, and other health professionals (Singh et al., 2011 and Vu et al, 2011). Apart from the indoor or office-based workers (Haliloglu et al, 2017) a few studies were also conducted among the outdoor workers (Kwon et al, 2015 and Roomi et al, 2015). Most of the studies have revealed that individuals who work predominantly indoors and shift workers are at risk of developing Vitamin Deficiency or insufficiency and prone to develop metabolic disorders and musculoskeletal disorders. There were a few studies have been conducted among the Malaysian adolescents, students in and around Klang Valley (Al-Sadat et al, 2016 and Quah et al, 2018) however, to our knowledge there were no studies have been conducted among the staff at University College of MAIWP International (UCMI) and MRANTI Park Bukit Jalil (MRANTI Park), Kuala Lumpur, Malaysia. The objective of this study is to determine the status of Vitamin D level among public adults working at UCMI and MRANTI Park, Kuala Lumpur.

METHODS

SAMPLE SIZE CALCULATION

In this cross-sectional study, the subjects were recruited from the UCMI and MRANTI Park, Kuala Lumpur, Malaysia. The minimum number of necessary samples was collected to meet the desired statistical constraints. Sample size was determined using the online calculator for sample size calculation (https://www.calculator.net/sample-size-calculator.html) with confidence level of 95% and 5% margin of error. Based on the sample size calculation, a minimum of 100 individuals were recruited. Adults more than 20 years old inlcuding male and female subjects and fasting more than 8 hours before blood withdrawal are the general inclusion criteria. Non-Malaysians were not excluded. All the subjects were given written consent to participate in the study.

QUESTIONNAIRE

A short questionnaire enquiring socio-demographic characteristics and nature of workplace, such as age, gender, race and the risk factors such as smoking, family history of diabetes and hypertension and the other diseases and information on workplace was self-administered.

BIOCHEMICAL PARAMETERS

Ten millilitres of blood (fasting for 6-8 hours) samples was collected by phlebotomist from the respective subjects. Centrifugation was used to separate the plasma/serum, which was then stored below -20ºC until further examination. Since serum 25-hydroxyVitamin D (25 (OH) D) is the main form of vitamin D in circulation, its concentration was measured to assess vitamin D adequacy. Serum 25-hydroxyvitamin D [25(OH)D] concentrations were measured using CL-1200i Chemiluminescence Immunoassay System (Mindray, China).

The serum concentration of 25(OH)D is a reliable "gold standard" indicator of vitamin D status and is a good reflection of cumulative exposure to sunlight and dietary intake of vitamin D (Springbett et al, 2010). According to circulating 25 OH vitamin D, there are several types of vitamin D status (Zittermann and Gummert, 2010). The categories are as follows: (i) deficiency (< 25 nmol/l), which results in clinical changes like rickets, osteomalacia, myopathy, calcium malabsorption, severe hyperparathyroidism, impaired immune and cardiac function; (ii) insufficiency (25–49.9 nmol/l), which results in reduced bone mineral density, impaired muscle function, low intestinal calcium absorption rates, and elevated PTH levels; (iii) hypovitaminosis (100 nmol/l), which results in slightly elevated PTH levels; (v) adequacy (25 OH Vitamin D levels exceed 250 nmol/l). The auto biochemical analyzer method was used to measure blood glucose, HbA1C, lipid profiles, uric acid, calcium, full blood count, renal function, and liver function. The standard methods for BMI were used to gather anthropometric measurements, including height, weight, and waist circumference. The participants' blood pressure was taken while they were seated. All biochemical analyses were performed according to standardized laboratory protocols with routine calibration, internal quality-control procedures, and participation in external quality-assurance programs where applicable.

STATISTICAL ANALYSIS

Categorical variables were represented by frequencies and percentages, while continuous variables were represented by mean ± standard deviation. Participants with missing data for variables included in the analyses were excluded. The significance of the relationship between categorical variables was examined using Pearson Chi-square tests. The means within and between groups were tested using Student's t-tests. To look for significant differences between means, analysis of variance (Anova) was utilized. A statistically significant p-value was less than 0.05. Gender differences on quantitative variables were adjusted using the General Linear Model (GLM). To predict the risk factors significantly associated with vitamin D insufficiency, multiple logistic regression was used, incorporating risk factors with $p < 0.2$ into the model. The two-tailed α level of 0.05 was used for statistical testing. The SPSS 23 software program was used to analyze the data.

RESULTS

SOCIO-DEMOGRAPHIC, CLINICAL, AND WORK-RELATED CHARACTERISTICS

The socio-demographic, clinical, biochemical, and work-related characteristics of the 103 participants, stratified by serum Vitamin D levels into three categories: <12 ng/mL (deficient), 12–20 ng/mL (insufficient), and >20 ng/mL (adequate) (Table 1). The mean age of participants was 36.16 ± 10.15 years, with no significant difference across Vitamin D groups ($p = 0.871$). A significant gender disparity was observed in Vitamin D status ($p < 0.001$), where all participants in the deficient group (<12 ng/mL) were female, and 76.7% of those with adequate Vitamin D levels were male (Table 1). Ethnicity showed no statistically significant association with Vitamin D status ($p = 0.573$), although the cohort was predominantly Malay (99.0%). No significant associations were found between Vitamin D status and medical history, including hypertension, diabetes, and other diseases ($p = 0.697$) (Table 1).

Regarding clinical characteristics, body mass index (BMI), blood pressure, HbA1c, and cholesterol levels did not significantly differ across the Vitamin D categories. However, blood glucose levels were significantly associated with Vitamin D status ($p = 0.030$), with lower levels observed in the deficient group (Table 1). Work-related factors showed significant associations with Vitamin D levels. Indoor workers constituted 100% of the deficient group, compared to only 70% of those with adequate levels ($p = 0.003$). Job type also influenced Vitamin D status significantly ($p = 0.041$), with security personnel and riders exhibiting higher adequacy rates. Total work hours per day and total working days per week did not significantly differ between groups (Table 1).

HAEMATOLOGICAL AND LIPID PROFILE PARAMETERS

The relationship between serum 25(OH)D Vitamin D levels and full blood count parameters as well as lipid profiles among the study participants is presented in the table 2. Several haematological indices were significantly associated with Vitamin D levels (Table 2). Participants with adequate Vitamin D levels (>20 ng/mL) had significantly higher hemoglobin concentrations (14.69 ± 1.75 g/dL) compared to those in the deficient group (<12 ng/mL: 12.88 ± 1.61 g/dL; $p < 0.001$). A similar trend was observed for red blood cell (RBC) count ($p < 0.001$) and hematocrit ($p < 0.001$), all of which showed a positive correlation with serum Vitamin D levels ($r = 0.394$, $r = 0.379$, and $r = 0.417$, respectively; all $p < 0.001$) (Table 2).

Although red cell distribution width (RDW) approached significance ($p = 0.065$), other red cell indices such as MCV, MCH, and MCHC did not show significant differences across Vitamin D categories. Among white blood cell components, only eosinophil percentage differed significantly across groups ($p = 0.048$), with a higher mean in the sufficient group. No statistically significant differences were observed in platelet count, mean platelet volume (MPV), or white blood cell counts. In terms of lipid profiles, none of the parameters including total cholesterol, LDL, HDL, triglycerides, or non-HDL cholesterol showed statistically significant associations with Vitamin D levels. Although triglycerides and the total cholesterol/HDL ratio exhibited near-significant trends ($p = 0.096$ and $p = 0.074$, respectively), these did not meet the threshold for statistical significance (Table 2).

LIVER AND RENAL FUNCTION MARKERS

Among the liver function tests, bilirubin levels were significantly different across Vitamin D categories ($p = 0.036$), with higher levels observed in participants with sufficient Vitamin D (>20 ng/mL: 10.3 ± 4.83 mg/dL) compared to those with deficiency (<12 ng/mL: 7.28 ± 2.67 mg/dL) (Table 3). A weak but significant positive correlation was observed between bilirubin and

Vitamin D levels ($r = 0.249$, $p = 0.011$). Although albumin and total protein approached statistical significance ($p = 0.054$ *and* $p = 0.056$, respectively), no other liver enzymes including AST, ALT, ALP, and GGT showed significant associations with Vitamin D levels (Table 3).

Renal function parameters showed stronger associations with Vitamin D status. Uric acid levels were significantly higher among individuals with sufficient Vitamin D (358.8 ± 102.5 μmol/L) compared to deficient participants (286.5 ± 75.4 μmol/L; $p = 0.007$), with a moderate positive correlation ($r = 0.309$, $p = 0.001$). Serum creatinine levels also increased with Vitamin D levels ($p < 0.001$), demonstrating a strong positive correlation ($r = 0.516$, $p < 0.001$). In contrast, eGFR was inversely associated with Vitamin D levels ($p = 0.004$; $r = –0.324$, $p = 0.001$), indicating decreased filtration capacity among those with higher serum Vitamin D (Table 3). Among electrolytes, serum sodium exhibited a significant positive correlation with Vitamin D levels ($p = 0.003$; $r = 0.273$). No significant differences were observed for calcium, corrected calcium, phosphate, potassium, or chloride levels across the Vitamin D groups (Table 3).

DISCUSSION

VITAMIN D STATUS AND SOCIO-DEMOGRAPHIC, CLINICAL, AND OCCUPATIONAL FACTORS

This study revealed a high prevalence of Vitamin D deficiency and insufficiency among adults in a Malaysian urban workforce, particularly among female and indoor-working participants. These findings align with global and regional trends showing widespread Vitamin D insufficiency despite abundant sunlight in tropical regions (Siddiqee et al, 2021; Mohd Saffian et al, 2022 and Md Isa et al, 2022).

The gender disparity observed in Vitamin D status is consistent with earlier studies indicating that females are at higher risk for hypovitaminosis D, potentially due to cultural clothing practices, less outdoor activity, and lower dietary intake (de Santana et al., 2022 and Mustafa et al, 2023). Our finding that all individuals in the deficient group were female supports this evidence and raises concerns for targeted health interventions. Although BMI and other metabolic parameters were not significantly associated with Vitamin D levels, the observed inverse association between Vitamin D and blood glucose ($p = 0.030$) is noteworthy. This is consistent with studies suggesting that Vitamin D deficiency may impair insulin secretion and increase insulin resistance, contributing to dysglycemia and elevated fasting glucose levels (Khaton et al, 2026 and Argano et al, 2023).

Work environment also emerged as a strong predictor of Vitamin D status. Participants working indoors showed significantly lower Vitamin D levels than those engaged in outdoor occupations, reaffirming that reduced sunlight exposure is a critical determinant of hypovitaminosis D (Sowah et al, 2017). Similar findings have been reported in occupational health studies, where shift workers and office employees frequently exhibit low Vitamin D levels (Cinar et al, 2014 and Mendez et al, 2025). The lack of association between age and Vitamin D levels in our cohort might reflect the relatively narrow age distribution of participants, primarily consisting of working-age adults. Additionally, our findings did not reveal significant differences in HbA1c or lipid profile, possibly due to the overall young and metabolically healthy profile of the cohort. These results showed the need for workplace health initiatives that address modifiable risk factors for Vitamin D deficiency, such as increased outdoor activity, dietary supplementation, and educational campaigns especially targeting women and indoor workers.

ASSOCIATION BETWEEN VITAMIN D AND HAEMATOLOGICAL & LIPID PARAMETERS

The present study demonstrates a significant positive relationship between serum Vitamin D levels and several haematological parameters, including haemoglobin concentration, RBC count, and haematocrit. These findings align with existing literature that associates Vitamin D status with erythropoiesis and anaemia risk (Al Mansoori et al, 2023).

Vitamin D plays a supportive role in hematopoiesis by modulating erythropoietin sensitivity and anti-inflammatory cytokine activity, which can influence RBC production. A study (Soepnel et al, 2023) found that Vitamin D deficiency was associated with anaemia and lower haemoglobin levels, particularly among women of reproductive age. Similarly, a cross-sectional analysis by another study (Arabi et al, 2020) supported the role of Vitamin D in erythropoiesis, indicating that Vitamin D supplementation may improve haemoglobin status in deficient individuals.

While other red cell indices (MCV, MCH, MCHC) and platelet parameters were not significantly associated with Vitamin D levels in this study, the observed correlation between eosinophil percentages and Vitamin D levels is noteworthy. Elevated

eosinophil levels have been linked to immunomodulatory roles of Vitamin D, particularly in allergic and inflammatory responses (Mirzakhani et al, 2025 and Ghaseminejad-Raeini et al, 2023).

The lack of significant association between Vitamin D and lipid profiles in this population is consistent with previous study (Gholamzad et al, 2023). Another previous study suggested that Vitamin D may modulate lipid metabolism by influencing lipoprotein lipase activity and insulin sensitivity (Argano et al, 2023). However, a cross-sectional study by Ghaseminejad-Raeini et al. 2023 concluded that the evidence linking Vitamin D to lipid profiles is inconclusive, particularly in non-obese, generally healthy populations. In our results cohort of primarily young, working adults with a relatively healthy metabolic profile, the absence of significant dyslipidemia may have contributed to the null findings. Nonetheless, the borderline *p-values* observed for triglycerides and the total/HDL cholesterol ratio suggest potential trends that merit further exploration in larger, more diverse populations. Our findings suggested that the strong correlation between Vitamin D levels and key red blood cell parameters reinforces the broader physiological importance of Vitamin D beyond bone health, particularly in hematologic function.

CORELATION BETWEEN VITAMIN D AND LIVER AND RENAL FUNCTION

In terms of corelation between Vitamin D and liver and renal function the present study identified significant associations between serum Vitamin D levels and multiple renal function markers, with additional trends noted in liver function parameters. Notably, Vitamin D was positively correlated with serum bilirubin, creatinine, uric acid, and sodium, and inversely correlated with eGFR.

The positive association between Vitamin D and bilirubin may reflect the antioxidant properties of both compounds. Bilirubin, a product of heme catabolism, has been shown to possess cytoprotective effects, particularly through its role in reducing oxidative stress (Tomaro et al, 2002 and Lin et al, 2025). Studies have proposed that higher bilirubin levels may be protective against cardiovascular and metabolic disorders conditions also influenced by Vitamin D status (Sharma et al, 2021).

A significant and moderately strong positive correlation was found between creatinine and Vitamin D levels ($r = 0.516$, $p < 0.001$). While this might suggest impaired renal clearance, the concurrent inverse correlation with eGFR ($r = –0.324$, $p = 0.001$) suggests a complex interplay. Some studies indicate that individuals with higher muscle mass (often having higher creatinine) also tend to have better Vitamin D status (Tieland et al, 2013 and Pagano et al, 2024). Therefore, the elevation in creatinine observed here may not necessarily indicate renal dysfunction but could be a surrogate for lean body mass. Uric acid, which also showed a significant positive correlation with Vitamin D ($p = 0.001$), is intricately tied to oxidative metabolism and inflammation. Several reports suggest that Vitamin D may modulate serum uric acid levels by influencing renal reabsorption processes, although findings remain inconsistent across populations (Chen et al, 2020 and Ma et al, 2024). One proposed mechanism involves Vitamin D's regulatory role in renal tubular function and uric acid transporters (Gembillo et al, 2020).

Electrolyte analysis revealed a significant association only for sodium, with levels positively correlated with Vitamin D status ($p = 0.003$). Vitamin D receptors are expressed in renal tubular cells and may influence sodium reabsorption through interactions with the renin-angiotensin-aldosterone system (RAAS) (Santoro et al, 2015). However, the clinical relevance of this association remains uncertain without concurrent data on blood volume status or dietary intake.

In contrast to expectations, calcium and phosphate levels did not differ significantly across Vitamin D categories. This may be due to homeostatic control mechanisms such as parathyroid hormone (PTH) activity, which maintains tight serum calcium regulation despite fluctuations in Vitamin D status (Martínez-Reina et al, 2026). Finally, liver enzymes (AST, ALT, ALP, GGT) were not significantly associated with Vitamin D levels. While Vitamin D metabolism partly occurs in the liver, previous findings on the association between hepatic enzyme activity and Vitamin D remain inconsistent (Targher et al, 2007). The absence of significant differences in this study may reflect the relatively healthy liver function among participants.

STUDY LIMITATIONS

This study must be interpreted with a few limitations. Firstly, the sample size is less and focused on a particular university situated in Kuala Lumpur. This study must be further analysed with a large number of sample size among various public and private universities with all the three main ethnic groups in Malaysia. Secondly, the genetic polymorphisms of Vitamin D receptor must be analysed to determine the association between the subjects. Lastly, the reported associations between vitamin D status and metabolic indicators were not be interpreted as causal relationships.

CONCLUSION

The study reveals a significant association between Vitamin D levels and reduced hemoglobin levels, as well as increased uric acid, indicating potential co-morbid and health implications. Additionally, Vitamin D levels were observed to differ significantly based on participants' characteristics, particularly in terms of gender distribution and work environment. The outcomes of this study highlight the status and prevalence of Vitamin D among the staff, reflecting key lifestyle differences and aiding in targeting health promotion and preventive efforts.

Author Contributions

AA conceived and designed the study, conducted data collection and analysis, and drafted the manuscript. AA, VR and NAM contributed to the study design and provided critical revisions to the manuscript for important intellectual content. All the authors reviewed and approved the final manuscript and agreed to be accountable for all aspects of the work.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

DATA AVAILABILITY

The corresponding author can provide data supporting this study's results, given a reasonable request.

ETHIC STATEMENT

Ethical approval was obtained from Ethics Committee of the UCMI (JKEUCMI/RMC/08/2025/39). Written inform consent was obtained from subjects before conducting any procedures. All the subjects were given consent prior involving in this study,

Conflict of Interest

The authors have no conflict of interest to declare.

FINANCIAL DISCLOSURE

This project has been funded by UCMI/TNCPP/RMC/GERAN/2024(56). The article processing charges was funded from UniMAIWP/RMC/TASREF/Geran/S&T/2026 (06)

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Table 1: Characteristics of the Study Participants

Variables			25 (OH) D levels			
		All	<12 ng/ml	12-20 ng/ml	>20 ng/ml	p-value[a]
Number of Subjects		103	24	49	30	
Socio-demographic						
Age		36.16 ± 10.15	35.21 ± 8.99	36.53 ± 10.7	36.3 ± 10.15	0.871
Gender	Male	35 (34.0)	0 (0)	12 (24.5)	23 (76.7)	
	Female	68 (66.0)	24 (100)	37 (75.5)	7 (23.3)	**<0.001[b]***
Ethnicity	Malay	102 (99.0)	24 (100)	48 (98.0)	30 (100)	

	Chinese	0	0	0	0	
	Indian	1 (1.0)	0	1 (2.0)	0	0.573[b]
Medical History	Hypertension	8 (7.8)	3 (12.5)	4 (8.2)	1 (3.3)	
	Diabetes	1 (1.0)	0	1 (2.0)	0	
	Others	6 (5.8)	1 (4.2)	2 (4.1)	3 (10.0)	
	None	88 (85.4)	20 (83.3)	42 (85.7)	26 (86.7)	0.697[b]
Clinical and Biochemical Characteristics	Body mass index(kg/m2)	26.81 ± 5.62	27.98 ± 5.91	27.02 ± 5.95	25.53 ± 4.70	0.269
	Systolic blood pressure(mmHg)	120.16 ± 13.31	117.79 ± 12.43	121.63 ± 14.33	119.63 ± 12.34	0.500
	Diastolic blood pressure(mmHg)	81.21 ± 9.08	80.25 ± 8.12	81.51 ± 10.18	81.5 ± 8.05	0.841
	Fasting blood glucose(mmol/L)	5.18 ± 1.34	4.80 ± 0.38	5.43 ± 1.81	5.08 ± 0.77	**0.030[c*]**
	HBA1c (%)	5.57 ± 1.00	5.46 ± 0.50	5.69 ± 1.37	5.45 ± 0.38	0.906[c]
	Total cholesterol(mmol/L)	5.41 ± 1.12	5.37 ± 1.25	5.44 ± 0.96	5.41 ± 1.30	0.973
Work-related Factors						
Work Location	Indoor	90 (87.4)	24 (100)	45 (91.8)	21 (70.0)	
	Outdoor	8 (7.8)	0	1 (2.0)	7 (23.3)	
	Both	5 (4.9)	0	3 (6.1)	2 (6.7)	**0.003[b*]**
Job Type	Office	65 (63.1)	16 (66.7)	34 (69.4)	15 (50.0)	
	Laboratory	21 (20.4)	6 (25.0)	10 (20.4)	5 (16.7)	
	Sales/Marketing/Business	5 (4.9)	0	4 (8.2)	1 (3.3)	
	Security/Police	4 (3.9)	0	0	4 (13.3)	
	Runner/Rider	2 (1.9)	0	0	2 (6.7)	
	Manufacturing	3 (2.9)	1 (4.2)	1 (2.0)	1 (3.3)	
	Workshop	1 (1.0)	0	0	1 (3.3)	
	Contractor	1 (1.0)	0	0	1 (3.3)	
	Lawyer	1 (1.0)	1 (4.2)	0	0	**0.041[b*]**
Work time (hours/day)		7.94 ± 1.68	8.35 ± 0.48	7.88 ± 1.71	7.70 ± 2.18	0.717[c]
Work time (days/week)		5.09 ± 0.76	5.13 ± 0.34	5.04 ± 0.68	5.13 ± 1.07	0.317[c]

Categorical data is presented as frequency with percentages in parentheses.

Continuous data is presented as Mean ± Standard Deviation.

[a] One-way Anova

[b] Chi-square test

[c] Kruskal Wallis test

* $p<0.05$

Table 2: Relationship of Vitamin D Levels with Full Blood Count and Lipid Profile.

Variables		25 (OH) D levels				
	All	<12 ng/ml	12-20 ng/ml	>20 ng/ml	p-value[a]	Correlation test, p-value (r)[c]
Full Blood Count						
Hemoglobin (g/dL)	14.02 ± 2.94	12.88 ± 1.61	14.16 ± 3.79	14.69 ± 1.75	**<0.001**[b*]	**<0.001** (0.394)[d*]
RBC Count (10^{12}/L)	4.70 ± 0.48	4.46 ± 0.46	4.65 ± 0.43	4.96 ± 0.47	**<0.001***	**<0.001** (0.379) *
RDW (%)	14.84 ± 1.34	15.39 ± 1.51	14.72 ± 1.14	14.6 ± 1.44	0.065	
Hematocrit (%)	40.64 ± 4.92	37.82 ± 4.59	40.3 ± 4.20	43.44 ± 4.93	**<0.001***	**<0.001** (0.417) *
MCV (μm^3)	86.77 ± 8.0	85.08 ± 7.25	86.9 ± 7.62	87.92 ± 9.11	0.102[b]	
MCH (pg/cell)	29.41 ± 2.96	28.99 ± 2.80	29.42 ± 2.94	29.72 ± 3.17	0.362[b]	
MCHC (%)	33.84 ± 1.18	34.06 ± 1.05	33.75 ± 1.06	33.82 ± 1.45	0.560	
WBC Count (10^9/L)	7.25 ± 2.16	6.93 ± 1.35	7.20 ± 2.31	7.59 ± 2.42	0.528	
Neutrophil (%)	59.37 ± 10.68	62.32 ± 7.07	59.33 ± 7.65	57.08 ± 15.87	0.202	
Lymphocytes (%)	31.25 ± 9.39	29.17 ± 6.31	31.43 ± 6.83	32.6 ± 14.0	0.408	
Monocytes (%)	5.66 ± 1.61	5.09 ± 1.50	5.77 ± 1.57	5.92 ± 1.70	0.134	
Eosinophils (%)	3.25 ± 2.51	2.96 ± 2.59	2.97 ± 2.57	3.94 ± 2.29	0.048[b]	
Basinophils (%)	0.46 ± 0.25	0.46 ± 0.18	0.46 ± 0.24	0.46 ± 0.33	0.657[b]	
Platelets (10^9/L)	279.3 ± 60.8	294.0 ± 56.7	277.5 ± 64.1	270.7 ± 58.0	0.364	
MPV (fL)	8.41 ± 0.87	8.48 ± 0.81	8.44 ± 0.83	8.29 ± 1.00	0.680	
Lipid Profile						
Total Cholesterol (mmol/L)	5.41 ± 1.12	5.37 ± 1.25	5.44 ± 0.96	5.41 ± 1.30	0.973	
Triglycerides (mmol/L)	1.28 ± 1.37	0.98 ± 0.41	1.15 ± 0.63	1.76 ± 2.34	0.096[b]	
HDL (mmol/L)	1.52 ± 1.02	1.53 ± 0.41	1.45 ± 0.41	1.62 ± 1.80	0.101[b]	
LDL (mmol/L)	3.50 ± 1.03	3.44 ± 1.13	3.54 ± 0.90	3.48 ± 1.17	0.924	
Total HDL Ratio (mmol/L)	4.09 ± 1.46	3.65 ± 1.05	4.02 ± 1.29	4.54 ± 1.88	0.074	
Non-HDL-C (mmol/L)	3.99 ± 1.16	3.84 ± 1.24	3.98 ± 1.00	4.12 ± 1.33	0.597[b]	

Data is presented as Mean ± Standard Deviation

HDL, high-density lipoprotein; LDL, low-density lipoprotein; MCH, mean cell hemoglobin; MCHC, mean cell hemoglobin concentration; MCV, mean cell volume; MPV, mean platelet volume; Non-HDL-C, Non-high-density lipoprotein cholesterol; RBC, red blood cell; RDW, red cell distribution width; WBC, white blood cell.

[a] One-way ANOVA

[b] Kruskal Wallis test

[c] Pearson's correlation coefficient between significant p-value variables with Vitamin D levels

[d] Spearman correlation

* $p < 0.05$

Table 3: Relationship of Vitamin D Levels with Liver Function Test and Renal Function Test.

Variables		25 (OH) D levels				
	All	<12 ng/ml	12-20 ng/ml	>20 ng/ml	p-value[a]	Correlation test, p-value (r)[c]
Liver Function Test						
Total Protein (g/L)	76.76 ± 8.64	76.85 ± 4.54	78.42 ± 3.61	74.0 ± 14.57	0.056[b]	
Albumin (g/L)	44.93 ± 2.20	44.0 ± 1.76	45.17 ± 2.32	45.3 ± 2.18	0.054	
Globulin (g/L)	32.62 ± 4.15	32.85 ± 4.21	33.25 ± 3.77	31.41 ± 4.55	0.153	
AGR (g/dL)	1.41 ± 0.23	1.37 ± 0.21	1.38 ± 0.20	1.48 ± 0.28	0.197[b]	
Bilirubin (mg/dL)	9.08 ± 4.34	7.28 ± 2.67	9.21 ± 4.48	10.3 ± 4.83	**0.036***	**0.011** (0.249) *
AST (U/L)	20.17 ± 7.61	19.2 ± 7.32	20.0 ± 8.26	21.2 ± 6.82	0.160[b]	
ALT (U/L)	23.97 ± 18.16	20.21 ± 12.4	22.80 ± 14.19	28.88 ± 25.81	0.144[b]	
ALP (U/L)	72.12 ± 16.59	71.71 ± 15.65	72.37 ± 16.66	72.03 ± 17.72	0.987	
GGT (U/L)	32.28 ± 29.87	21.29 ± 13.29	33.10 ± 33.59	39.73 ± 31.17	0.053[b]	
Renal Function Test						
Uric Acid (µmol/L)	326.2 ± 84.6	286.5 ± 75.4	325.7 ± 68.3	358.8 ± 102.5	**0.007***	**0.001** (0.309) *
Urea (mmol/L)	3.94 ± 1.19	3.55 ± 0.96	3.90 ± 1.33	4.32 ± 1.03	0.058	
Creatinine (µmol/L)	73.6 ± 31.1	60.6 ± 7.66	73.0 ± 41.0	84.9 ± 17.0	**<0.001[b]***	**<0.001** (0.516)[d]*
eGFR (ml/min/1.73m^2)	108.8 ± 17.3	116.7 ± 7.71	109.6 ± 19.2	101.3 ± 16.9	**0.004***	**0.001** (-0.324) *
Calcium (mmol/L)	2.36 ± 0.10	2.34 ± 0.07	2.37 ± 0.12	2.36 ± 0.08	0.379	
Corrected Calcium (mmol/L)	2.26 ± 0.85	2.26 ± 0.54	2.27 ± 0.10	2.25 ± 0.77	0.739	
Phosphate (mmol/L)	1.19 ± 0.16	1.20 ± 0.15	1.20 ± 0.18	1.17 ± 0.16	0.700	
Sodium (mmol/L)	139.8 ± 2.05	139.4 ± 1.71	139.3 ± 2.09	140.8 ± 1.90	**0.003***	**0.005** (0.273) *
Potassium (mmol/L)	4.88 ± 3.81	4.51 ± 0.38	4.57 ± 0.37	5.69 ± 7.06	0.408[b]	
Chloride (mmol/L)	102.4 ± 2.22	102.8 ± 2.81	102.1 ± 2.09	102.6 ± 1.87	0.425	

Data is presented as Mean ± Standard Deviation

AGR, albumin/globulin ratio; ALP, alkaline phosphate; ALT, alanine aminotransferase; AST, aspartate aminotransferase; eGFR, estimated glomerular filtration rate; GGT, gamma-glutamyl transferase.

[a] One-way ANOVA, [b] Kruskal Wallis test, [c] Pearson's correlation coefficient between significant p-value variables with Vitamin D levels

[d] Spearman correlation

* $p < 0.05$