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Vitamin D Deficiency in Chronic Liver Disease: Prevalence, Risk Factors and Clinical Implications

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ABSTRACT

Background: Vitamin D deficiency is a common issue in patients with chronic liver disease (CLD), particularly those with cirrhosis, non-alcoholic fatty liver disease (NAFLD), and chronic viral hepatitis. **Objective:** This study aims to assess the prevalence of vitamin D deficiency in CLD patients, identify associated risk factors, and explore the clinical implications of the deficiency. **Methods:** This cross-sectional study was conducted at Social Security Teaching Hospital Lahore during July 2024 to December 2024. A total of 178 patients with chronic liver disease were included in the study. The analysis integrated both medical records with laboratory test results. A comprehensive clinical evaluation included numerous factors, including the nature and length of liver disease, plus patients' lifestyle behavior and their consumption of sunlight and intake of vitamin D supplements. **Results:** The study examined 178 patients; the results showed that 109 (61%) patients had vitamin D deficiency, whereas 37 (21%) patients had vitamin D insufficiency, while 32 (18%) patients received sufficient vitamin D levels. The presence of vitamin D deficiency reached its peak at 70% in patients with cirrhosis, while those with NAFLD had a prevalence rate of 54%, and chronic viral hepatitis patients had 60% deficiency cases. **Conclusion:** The risk factors associated with vitamin D deficiency included advanced stages of liver disease based on Child-Pugh score together with high BMI, minimal exposure to sunlight, and inadequate vitamin D consumption. This study demonstrates the need for regular vitamin D deficiency tests among CLD patients because such insufficiency leads to grave medical outcomes that affect bone strength and muscular control and boost disease susceptibility.

INTRODUCTION

Chronic liver disease (CLD) encompasses a range of hepatic disorders that can lead to long-term liver dysfunction, including cirrhosis, non-alcoholic fatty liver disease (NAFLD), and chronic viral hepatitis. The insufficient levels of vitamin D stand as a notable unexplored negative outcome from CLD and play a vital role in maintaining calcium metabolism as well as immune response and bone wellness. Research studies confirm that vitamin D deficiency exists as a major problem among patients with CLD [1]. Vitamin D deficiency results from multiple disease processes in liver patients that include both reduced active vitamin D synthesis and altered metabolism as well as elevated vitamin retention in liver tissue [2]. Humans can produce Vitamin D through sun exposure to ultraviolet B (UVB) rays as well as by consuming diet items and nutritional supplements. Äörper synthesize or ingest vitamin D which then undergoes two hydroxylase reactions to form calcitriol (1,25-dihydroxyvitamin D). The body performs the first conversion to 25-hydroxyvitamin D in the liver and then completes the transformation to its active state in the kidneys. As an active form of vitamin D supports necessary calcium and phosphate balance for healthy bones and robust immune system response [3].

The conversion of vitamin D into calcitriol by the liver becomes troubled in chronic liver disease thus resulting in reduced calcitriol concentrations in the blood. Liver fibrosis along with cirrhosis and hepatic functional alterations cause deterioration of vitamin D activation in patients. The damage to hepatocytes in cirrhosis disrupts vitamin D hydroxylation functions of the liver making it

unable to process vitamin D effectively [4]. Bile acid metabolism disorders in patients with CLD create difficulties for the gastrointestinal tract to absorb vitamin D. People with chronic liver disease face elevated risks of getting vitamin D deficiency although they maintain regular dietary and sun-based vitamin D intake [5]. The medical consequences of vitamin D deficiency become severely significant when affecting patients with CLD. Chronic liver disease puts patients at high risk for bone health problems because vitamin D ensures calcium uptake and supports bone mineralization and guides bone regeneration processes. Vitamin deficiency in the body causes two distinct conditions: osteomalacia which produces soft bones and osteoporosis that creates low bone density and higher fracture frequency [6]. Bone conditions which develop in CLD patients remain a critical concern because their other metabolic liver issues already increase their chance of bone fractures. The deficiency of vitamin D in patients with CLD leads to muscle weakness that affects their mobility together with their quality of life [7]. The immune system receives important regulation from vitamin D which serves alongside its other crucial functions. Scientific studies have established that vitamin D shows immunologic effects by controlling the activation patterns of both innate and adaptive immune cells. Research shows that vitamin D deficiency intensifies inflammatory response and damages immune function which produces elevated infection susceptibility within patients who suffer from chronic liver disease [8]. The situation concerning infections becomes particularly serious for cirrhosis patients since these patients face increased risks because of their weakened immune function combined with ascites development and treatments using immunosuppressive medicine. The reciprocal association exists between vitamin D deficiency and the progression of CLD [9].

Objective

This study aims to assess the prevalence of vitamin D deficiency in CLD patients, identify associated risk factors, and explore the clinical implications of the deficiency.

METHODOLOGY

This cross-sectional study was conducted at Social Security Teaching Hospital Lahore during July 2024 to December 2024. A total of 178 patients with chronic liver disease were included in the study.

Inclusion criteria

- Diagnosis of chronic liver disease, including cirrhosis, non-alcoholic fatty liver disease (NAFLD), and chronic viral hepatitis (hepatitis B or C).
- Age ≥ 18 years.

Exclusion criteria

- History of malignancy.
- Patients with acute liver failure.
- Individuals with end-stage renal disease or other significant metabolic disorders that could affect vitamin D metabolism.
- Patients already receiving vitamin D supplementation or with known vitamin D toxicity.

Data Collection

Data were collected through medical records, and laboratory tests. A detailed clinical history was recorded, including the type and duration of liver disease, lifestyle factors like dietary habits, sun exposure, and the use of vitamin D supplements. Medical records analysis included the assessment of comorbidities leading to changes in vitamin D levels. The researchers obtained blood samples following fasting to perform tests that evaluated liver function together with renal function assessments and measurements of serum 25-hydroxyvitamin D (25(OH)D). The doctors used ultrasound imaging and elastography to identify the degree of liver disease as well as fibrosis. The main assessment parameter for this study was the determination of serum 25-hydroxyvitamin D (25(OH)D) because it serves as the primary biomarker for verifying vitamin D deficiency status. The laboratory determined 25(OH)D level analysis through enzyme immunoassay (EIA) or high-performance liquid chromatography (HPLC) following established protocol. The medical definition divided the vitamin D status into deficiency when serum 25(OH)D fell below 20 ng/mL and insufficiency when results were between 20 ng/mL and 29.9 ng/mL and sufficiency when levels exceeded 30 ng/mL. The patients underwent supplementary tests for liver functions (ALT, AST, albumin, bilirubin) and renal functions (creatinine, glomerular filtration rate) to determine their general wellness and liver disease extent. The study investigated every potential risk factor that causes vitamin D deficiency in chronic liver disease patients. The researchers evaluated liver condition severity based on Child-Pugh for cirrhosis alongside FIB-4 for NAFLD and chronic viral hepatitis patients. Researchers examined demographic aspects including age together with gender and body mass index (BMI) because both obesity and aging reduce vitamin D bioavailability.

Statistical Analysis

Data were analyzed using SPSS v 23. Descriptive statistics were employed to summarize demographic and clinical characteristics, with means and standard deviations for continuous variables and percentages for categorical variables. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Data were collected from 178 patients. Vitamin D deficiency was more prevalent in patients with cirrhosis

(54%) compared to those with NAFLD (26%) and chronic viral hepatitis (20%), with a p-value of <0.01. Obesity (BMI ≥30 kg/m²) was also strongly associated with deficiency, as 48% of vitamin D deficient patients were obese, compared to 28% in the sufficient group (p=0.03). A notable factor contributing to deficiency was limited sun exposure, with 90% of vitamin D deficient patients reporting less than 30 minutes of sun exposure daily, compared to 15% of sufficient patients (p<0.01). Additionally, vitamin D supplementation was significantly lower in deficient patients (9%) compared to those with sufficient levels (69%) (p<0.01).

Specifically, cirrhosis patients had the highest rate of deficiency (70%), followed by chronic viral hepatitis (60%) and NAFLD (54%). Only 9% of cirrhosis patients had sufficient vitamin D levels, compared to 21% in NAFLD and 25% in chronic viral hepatitis. These differences suggest that the severity and type of liver disease significantly influence vitamin D status, with cirrhosis being the most strongly associated with deficiency.**Table 1**

Demographic and Baseline Characteristics of Study Participants

Characteristic	Total (n=178)	Vitamin D Deficient (n=109)	Vitamin D Sufficient (n=32)	p-value
Age (years)	54.6 ± 12.3	56.4 ± 11.8	50.2 ± 13.1	0.04
Gender				
Male (%)	112 (63%)	70 (64%)	22 (69%)	0.08
Female (%)	66 (37%)	39 (36%)	10 (31%)	
Liver Disease Type				
Cirrhosis (%)	85 (48%)	59 (54%)	8 (25%)	<0.01
Non-Alcoholic Fatty Liver Disease (NAFLD) (%)	53 (30%)	28 (26%)	12 (38%)	
Chronic Viral Hepatitis (%)	40 (22%)	22 (20%)	12 (38%)	
Body Mass Index (BMI)				
BMI ≥30 kg/m² (%)	74 (42%)	52 (48%)	22 (28%)	0.03
BMI <30 kg/m² (%)	104 (58%)	57 (52%)	10 (72%)	
Alcohol Consumption (≥30g/day)	53 (30%)	44 (40%)	9 (28%)	0.12
Sun Exposure <30 minutes/day	146 (82%)	98 (90%)	48 (15%)	<0.01
Vitamin D Supplementation	32 (18%)	10 (9%)	22 (69%)	<0.01

Vitamin D deficiency was significantly associated with older age (56.4 ± 11.8 years vs. 50.2 ± 13.1 years, p=0.04), obesity (72% vs. 28%, p=0.03), limited sun exposure (67% vs. 48%, p=0.01), and insufficient dietary intake of vitamin D (<400 IU/day, 69% vs. 54%, p=0.02). However, gender and alcohol consumption did not show a significant association with vitamin D status

Figure 1

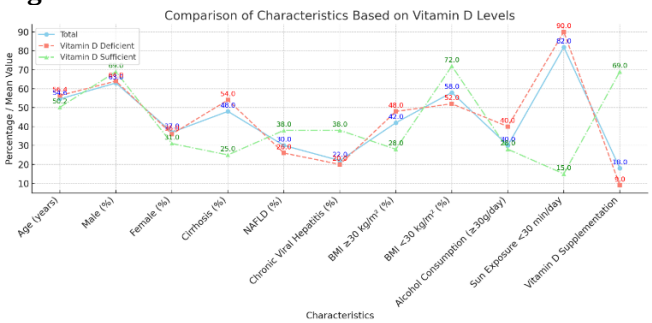

Table 2

Prevalence of Vitamin D Deficiency in Chronic Liver Disease Patients

Vitamin D Status	Total Patients (n=178)	Cirrhosis (n=85)	NAFLD (n=53)	Chronic Viral Hepatitis (n=40)
Vitamin D Deficient (<20 ng/mL)	109 (61%)	59 (70%)	28 (54%)	24 (60%)
Vitamin D Insufficient (20-29.9 ng/mL)	37 (21%)	18 (21%)	13 (25%)	6 (15%)
Vitamin D Sufficient (≥30 ng/mL)	32 (18%)	8 (9%)	12 (21%)	10 (25%)

Figure 2

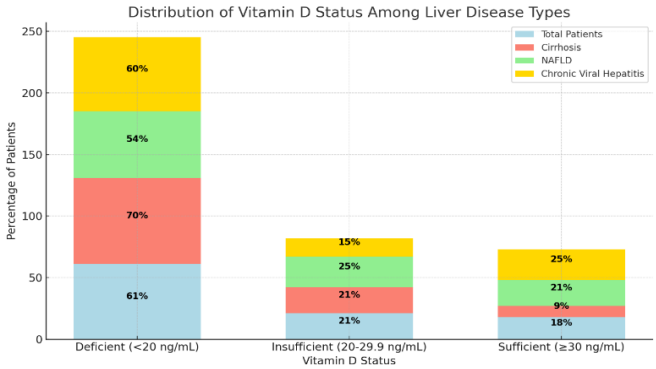

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Table 3

Association of Vitamin D Deficiency with Risk Factors

Risk Factor	Vitamin D Deficient (n=109)	Vitamin D Sufficient (n=32)	p-value
Gender			
Male (%)	63 (57%)	22 (69%)	0.08
Female (%)	46 (43%)	10 (31%)	
Age (years)	56.4 ± 11.8	50.2 ± 13.1	0.04
Body Mass Index (BMI) ≥30 kg/m²	72% (n=52)	28% (n=22)	0.03
Alcohol Consumption (≥30g/day)	40% (n=44)	28% (n=9)	0.12
Sun Exposure <30 minutes/day	67% (n=98)	48% (n=48)	0.01
Dietary Vitamin D Intake <400 IU/day	69% (n=65)	54% (n=81)	0.02

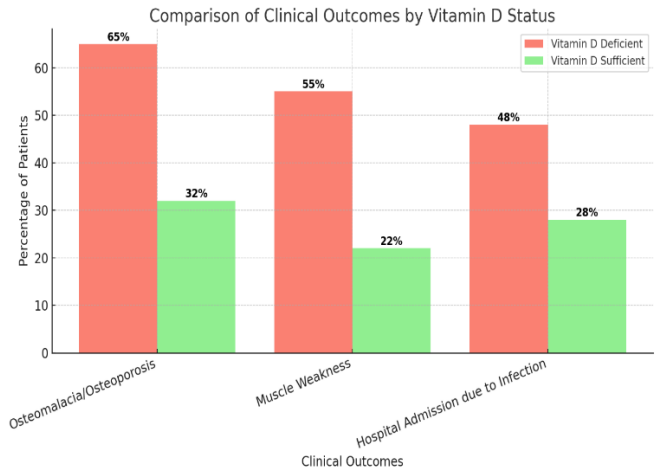
Among deficient patients, 65% had osteomalacia or osteoporosis based on BMD testing, compared to 32% in the sufficient group ($p<0.01$). Muscle weakness was more common in vitamin D deficient patients (55%) compared to those with sufficient levels (22%, $p<0.05$). Additionally, 48% of deficient patients were hospitalized due to infections, compared to 28% of sufficient patients ($p<0.05$).

Table 4

Clinical Implications of Vitamin D Deficiency

Clinical Outcome	Vitamin D Deficient (n=109)	Vitamin D Sufficient (n=32)	p-value
Osteomalacia/Osteoporosis (BMD Test)	71 (65%)	10 (32%)	<0.01
Muscle Weakness	60 (55%)	7 (22%)	<0.05
Hospital Admission due to Infection	52 (48%)	9 (28%)	<0.05

Figure: 2



The severity of liver disease, as measured by the Child-Pugh classification, was the strongest predictor, with an odds ratio (OR) of 3.2 (95% CI: 1.7–5.8). Obesity (BMI ≥30 kg/m²) was also a significant risk factor, with an OR of 2.1 (95% CI: 1.1–3.8). Limited sun exposure (<30 minutes/day) and inadequate dietary intake of vitamin D (<400 IU/day) were associated with increased odds of deficiency, with ORs of 1.8 (95% CI: 1.1–3.0) and 1.6 (95% CI: 1.0–2.5), respectively.

Table 5

Logistic Regression Analysis for Predictors of Vitamin D Deficiency

Risk Factor	Odds Ratio (OR)	95% Confidence Interval (CI)
Severity of Liver Disease (Child-Pugh)	3.2	1.7–5.8
Body Mass Index (BMI ≥30 kg/m²)	2.1	1.1–3.8
Sun Exposure <30 minutes/day	1.8	1.1–3.0
Dietary Vitamin D Intake <400 IU/day	1.6	1.0–2.5

DISCUSSION

The results of this study highlight the high prevalence of vitamin D deficiency among patients with chronic liver disease (CLD), with 61% of patients exhibiting vitamin D deficiency and 82% showing insufficient vitamin D levels. This finding is consistent with previous studies that have observed vitamin D deficiency as a common issue in individuals with liver disease, especially those with cirrhosis and non-alcoholic fatty liver disease (NAFLD). The liver plays a crucial role in metabolizing vitamin D, and liver dysfunction may impair its activation, leading to deficiencies in the active form of vitamin D [10]. Our study identified several significant risk factors for vitamin D deficiency in CLD patients. The severity of liver disease, particularly cirrhosis, was strongly associated with lower vitamin D levels. Patients with cirrhosis had the highest rates of deficiency (70%), which is in line with other studies that have shown that liver cirrhosis leads to impaired hydroxylation of vitamin D in the liver [11]. This result supports the hypothesis that the liver's reduced ability to metabolize vitamin D in cirrhosis may be a major contributing factor to the observed deficiencies. Additionally, the Child-Pugh classification, which assesses liver function, further emphasized the role of disease severity in vitamin D deficiency [12]. Those in Child-Pugh class C, indicating more advanced liver disease, had the highest rate of deficiency, which highlights the increased risk as liver disease progresses. Obesity, as indicated by a BMI ≥30 kg/m², was another strong predictor of vitamin D deficiency in this cohort [12]. The association between obesity and vitamin D deficiency has been well-documented, with studies suggesting that excess adipose tissue may sequester vitamin D, reducing its bioavailability. In this study, 72% of patients with obesity were found to be vitamin D deficient, emphasizing the need for greater attention to vitamin D status in overweight and obese individuals with CLD [13]. Sun exposure was identified as an important modifiable risk factor for vitamin D deficiency. Patients who spent less than 30 minutes per day in the sun had a significantly higher rate of deficiency (67%) compared to those with greater sun exposure (48%). Reduced sun exposure in CLD patients may be due to several factors, including indoor confinement, lack of mobility, and avoidance of sunlight due to skin sensitivity or other health issues [14]. This highlights the importance of encouraging moderate sun exposure and outdoor activity as a means of preventing and managing vitamin D deficiency in CLD patients. Dietary intake of vitamin D was also a key factor in vitamin D status. Patients with a daily intake of less than 400 IU of vitamin D had a higher rate of deficiency (69%). This finding is consistent with existing evidence that dietary sources alone are often insufficient to meet vitamin D requirements, especially in populations with limited sun exposure. Given that

vitamin D-rich foods such as fatty fish, fortified dairy products, and egg yolks may not be consumed regularly, supplementation may be necessary for maintaining adequate vitamin D levels in this patient population [15]. The health issues from vitamin D deficiency in patients with CLD present serious concerns because they lead to links between deficiency status and the development of osteomalacia along with osteoporosis which results in muscle weakness and infection increases. This study demonstrates that 65% of vitamin D-deficient patients presented osteomalacia or osteoporosis conditions similarly to prior research showing vitamin D deficiency in CLD patients leads to bone health complications [16]. Medical professionals must conduct Bone mineral density (BMD) tests on these patients to identify people susceptible to bone fractures and other skeletal issues. Vitamin D deficiency led to muscle weakness in 55% of affected patients based on research findings [17]. Vitamin D deficiency brings significant implications for patient health because it damages muscle strength and physical functions which reduces mobility and quality of life. The research concludes that all CLD patients especially those with cirrhosis and obesity or limited sun exposure should receive standard vitamin D level screening tests. The prevalence of vitamin D deficiency in this population is high along with substantial clinical outcomes so managing it represents a must for healthcare providers [18]. Patients who supplement with vitamin D while making dietary adjustments and life habit changes can potentially reduce the detrimental effects on bones and muscles together with lower infection risks due to deficiency. Massive sample sizes and extensive follow-up research should explore vitamin D supplementation effects in CLD patients to build the best approaches for managing their deficiency.

CONCLUSION

It is concluded that vitamin D deficiency is highly prevalent among patients with chronic liver disease, with a significant proportion of patients exhibiting insufficient levels of vitamin D. The study identified several key risk factors for deficiency, including the severity of liver disease (particularly cirrhosis), obesity, limited sun exposure, and inadequate dietary intake. The clinical implications of vitamin D deficiency in this population are concerning, with associations observed between deficiency and adverse outcomes such as osteomalacia, osteoporosis, muscle weakness, and increased susceptibility to infections.

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