

The Impact of Vitamin D Deficiency on Functional Recovery in Musculoskeletal Rehabilitation: A Cross-Sectional Study in a Tertiary Hospital in Riyadh

Mayyer A. Alanazi¹, Mohammed Alghamdi², Nariman K. Abu Alsaud³

Abstract

Background: Vitamin D has an important function in musculoskeletal health as it affects the muscle, bone, and recovery processes. In Saudi Arabia, insufficient vitamin D levels are a public health concern even with high sun exposure, which might hinder rehabilitation of patients with musculoskeletal disorders.

Objective: To determine the relationship between serum vitamin D concentration and functional recovery of patients undergoing rehabilitation for musculoskeletal disorders at a tertiary hospital in Riyadh.

Methods: One hundred twenty adult patients with musculoskeletal disorders undergoing physical therapy were enrolled in a cross sectional study conducted from January to June, 2022. Participants were divided based on serum 25(OH)D levels as deficient (<20 ng/mL), insufficient (20–30 ng/mL), or sufficient (>30 ng/mL). Functional outcomes were measured with Timed Up and Go Test (TUG), handgrip strength, Visual Analog Scale (VAS) for pain assessment, and the Functional Independence Measure (FIM). Analysis of variance (ANOVA) and Pearson correlation tests were used in analyzing the data.

Results: Patients with adequate vitamin D levels demonstrated optimal performance across all outcomes: achieving faster TUG times (mean 12.3 sec), higher grip strength (22.1 kg), reduced pain on the VAS (mean 3.9), and greater functional independence valued at FIM 105.7. Correlation analysis also revealed significant associations of vitamin D levels with TUG ($r = -0.62$), grip strength ($r = +0.58$), pain ($r = -0.55$), and FIM ($r = +0.65$) for all $p < 0.01$.

Conclusion: The sufficiency of vitamin D is strongly associated with improved outcome measures in functional rehabilitation of musculoskeletal disorders. The active management and routine assessment of vitamin D levels should be part of rehabilitation programs in these clinical scenarios.

Keywords: Vitamin D deficiency, Musculoskeletal rehabilitation, Functional recovery, Physical therapy, Saudi Arabia, Pain, Mobility, FIM, TUG test

Introduction

Musculoskeletal disorders (MSDs) are among the primary sources of disability globally as well as having a profound effect on one's quality of life. This, in turn, adds more strain to healthcare services, especially in rehabilitation facilities. In Saudi Arabia, the growing concerns of musculoskeletal conditions along with other issues like ageing, chronic diseases and sedentary lifestyle, have mounted the scarcity of efficient rehabilitation strategies in tertiary care hospitals.

Among the various factors influencing recovery in rehabilitation, physiotherapy, and other advancement of technology, vitamin D status captures attention in recent times. It is widely accepted that vitamin D plays a major role in vitamin D deficiency or insufficiency osteoporosis, as well as calcium homeostasis and bone metabolism. However, emerging evidence suggests the importance of vitamin D goes further to muscle strength, neuromuscular coordination, and pain control – essential elements in physical rehabilitation. Numerous research has associated lack of vitamin D with delayed functional recovery and reduced muscle performance and persistent musculoskeletal pain in patients undergoing rehabilitation (Shinchuk & Holick, 2007; Heath & Elovic, 2006).

Despite high sun exposure in the Middle East, Vitamin D deficiency is still prevalent in the region and is attributed to conservative clothing and dietary habits. In Saudi Arabia, population studies have reported those affected by vitamin D deficiency exceeding 60%, especially among women and hospitalized patients. These concerns are alarming since it seriously undermines recovery in rehabilitation units where rapid muscle recovery is critical.

Though some global studies indicate a connection between vitamin D status and musculoskeletal performance, not many have studied this association in the frame of multidisciplinary rehabilitation approaches in the Gulf region. Also, there seems to be a lack of local studies that integrate focal markers with physical therapy benchmarks to measure recovery.

This study attempts to determine the correlation between serum levels of vitamin D and functional recovery in patients undergoing rehabilitation for musculoskeletal conditions at a tertiary care hospital in Riyadh. The study hopes to influence policies regarding screening, supplementation, and physical therapy protocols by integrating lab results with rehabilitation outcomes.

Literature Review

Vitamin D is crucial to musculoskeletal health as it assists in bone metabolism and a variety of others perturbing interactions in the field of health, rehabilitation. Physical therapy in association with laboratory diagnostics comes together in highly multidisciplinary rehabilitation practices that provides hints into better optimizing functional outcomes. Furthermore, vitamin D plays a monumental role in modulating musculoskeletal recovery, rehabilitation progress as well as recovery from pain, thereby widening the scope for literature highlighting its sufficiency.

1. Vitamin D and Muscle Function

The presence of vitamin D receptors (VDRs) in muscle tissue allows vitamin D to impact skeletal muscle health. These receptors also foretell the uptake of calcium and protein synthesis which are integral to muscle contraction, repair and recovery. Muscle strength, coordination as well as Tu-65 falls, fatigue enduring longer rehabilitation has been reported to negatively be impacted by vitamin D deficiency (Shinchuk & Holick, 2007).

Post surgery or injury recovery, vitamin D supplementation was reported to alleviate muscle recovery which highlights its impact. That's the conclusion Rojano-Ortega (2023) arrived to after conducting a systematic review. Further, Wintermeyer et al. corroborated that muscle regeneration as well as its anti-inflammatory recovery boosting effects demands adequate serum levels of vitamin D. This ensures patients undergoing physical therapy make progress (Wintermeyer et al., 2016).

2. Influence on Functional Rehabilitation

In rehabilitative clinical settings, functional recovery typically involves an increase in strength, active range of motion, ambulation, and relief of pain. Shin et al. demonstrate that vitamin D deficient patients undergoing total knee arthroplasty (TKA) exhibited significantly worse postoperative functional outcomes than their vitamin D sufficient counterparts. "This underscores the predictive value of vitamin D status in recovery from musculoskeletal surgery and post-surgical rehabilitation."

Bridging this gap, Ali et al. (2021) performed a quasi-experimental study that found combined physiotherapy and vitamin D supplementation resulted in improved self-reported outcomes and reduced musculoskeletal pain amongst patients in rehabilitation programs (Ali et al., 2021).

3. Pain, Balance, and Coordination

The neuromuscular effects of Vitamin D are increasingly coming to light. Levinger et al. (2017) showed that patients suffering from knee osteoarthritis and low serum vitamin D critically compromised balance and knee function during recovery tasks, implying that vitamin D might influence proprioception and coordination during the rehabilitation process (Levinger et al., 2017).

Along these lines, Matossian-Motley and Drake (2016) noted that, in acute rehabilitation settings, low 25(OH) D levels were significantly correlated with non-specific musculoskeletal pain, supporting earlier work suggesting that vitamin D status might modulate recovery from pain and strengthen physical recovery.

4. Regional and Clinical Relevance

The wide available sunlight in Saudi Arabia does not seem to help with its high prevalence of Vitamin D deficiency, especially in women and hospitalized patients because of lack of sun exposure, traditional attire, and minimal intake of dietary sources. Heath and Elovic observed the lack of diagnosis of vitamin D deficiency in rehabilitation units and its functional progress impacts (Heath & Elovic, 2006).

This framework of epidemiological data highlights, for the pathology of Ivy, the need for systematic corrective action of Vitamin D deficiency in severe tertiary care facilities, particularly with an inpatient-based multidisciplinary rehabilitation service for musculoskeletal disorders.

Methodology

Study Design and Setting

This cross sectional observational study was carried out in a tertiary care setting of a multidisciplinary rehabilitation department of a Saudi hospital located in Riyadh, Saudi Arabia, from January to June 2022. This rehabilitation unit is equipped with a central diagnostic laboratory, which enables comprehensive evaluations of clinical functions alongside biochemical indicators.

Participants

The study enlisted a total of 120 adult patients, aged 18 to 75, who were undergoing physical therapy for various musculoskeletal conditions. Participants were recruited from the inpatient and outpatient rehabilitation services. The criteria for inclusion in the study are listed below:

- Musculoskeletal disorders diagnosis confirming (osteoarthritis, recovering from a fracture, soft tissue injuries).
- Active participant in an ongoing physical therapy program for at least two weeks.
- A 25-hydroxyvitamin D [25(OH)D] serum test performed within the 7 days prior to or the 7 days post commencement of therapy.

Patients were also excluded from the study if they suffered from:

- Metabolic bone disease which include osteomalacia and hyperparathyroidism.
- Neurological disorders that impair mobility.
- Cognitive deficits that would hinder compliant rehabilitation
- Current therapy starting with high-dose (>4000 IU/day) vitamin D supplementation.

Data Collection

Demographic and clinical data were collected from the electronic medical records which included age, gender, diagnosis, comorbidities, and rehabilitation duration. Participants' vitamin D status was categorized according to serum 25(OH)D level as follows:

- Deficient <20ng/mL
- Insufficient 20-30ng/mL

- Sufficient >30ng/mL

Functional Outcome Measures

Functional status was evaluated by licensed physical therapists at the end of the rehabilitation period using:

- Timed Up and Go (TUG) for evaluation of functional mobility

Evaluating upper body strength, the ‘Handgrip Strength Test’ was used.

Subjective pain intensity was evaluated using the Visual Analog Scale (VAS) while the Functional Independence Measure (FIM) was used to quantify global rehabilitation outcomes.

In an effort to avoid performance bias, therapists blind to the patients’ vitamin D levels conducted all assessments.

Statistical Analysis

Data analysis was conducted using IBM SPSS Statistics, version 26.2. Descriptive statistics were computed for the demographic and clinical characteristics. For the functional outcome measures evaluated among the three groups based on vitamin D status, one-way ANOVA and independent t-tests were applied. The relationship between serum vitamin D levels and functional performance score was examined using Pearson’s correlation. A significance level of $p < 0.05$ was used.

Ethical Considerations

Ethics approval was obtained prior to conducting the study. Furthermore, the participants provided written informed consent prior to data collection. The study adhered to the principles outlined in the Declaration of Helsinki.

Results

Participant Overview

A total of 120 patients participated in the study. Based on their serum 25-hydroxyvitamin D [25(OH)D] levels, they were classified into three groups:

- **Deficient** (<20 ng/mL): 40 patients (33.3%)
- **Insufficient** (20–30 ng/mL): 45 patients (37.5%)
- **Sufficient** (>30 ng/mL): 35 patients (29.2%)

Functional Outcomes by Vitamin D Status

The functional outcomes measured at the end of rehabilitation demonstrated notable differences among the three vitamin D groups. Table 1 summarizes the results across four key domains: mobility (TUG), muscle strength (grip strength), pain (VAS), and overall function (FIM).

Table 1. Functional Outcomes by Vitamin D Status

Vitamin D Status	N (Patients)	Mean TUG (sec)	Mean Grip Strength (kg)	Mean VAS Pain Score (0–10)	Mean FIM Score (0–126)
Deficient (<20 ng/mL)	40	18.5	14.8	7.2	80.5
Insufficient (20–30 ng/mL)	45	15.2	18.5	5.8	92.3
Sufficient (>30 ng/mL)	35	12.3	22.1	3.9	105.7

Statistical Findings

- **Mobility (TUG):** Patients with sufficient vitamin D demonstrated the fastest mobility with a mean TUG of 12.3 seconds, compared to 18.5 seconds in the deficient group. This difference was statistically significant ($p < 0.01$).
- **Muscle Strength:** Grip strength was significantly greater in patients with higher vitamin D levels (22.1 kg in sufficient group vs. 14.8 kg in deficient group; $p < 0.01$).
- **Pain Intensity:** The VAS pain score decreased with increasing vitamin D levels, with the sufficient group reporting the least pain (mean = 3.9), which was also statistically significant ($p < 0.01$).
- **Functional Independence:** FIM scores were highest in the sufficient group (mean = 105.7), reflecting greater autonomy in daily activities. The difference between all groups was statistically significant ($p < 0.01$).

Correlation Analysis

Pearson correlation analysis revealed significant associations:

- **Negative correlation** between vitamin D level and TUG time ($r = -0.62$)
- **Positive correlation** with grip strength ($r = +0.58$)
- **Negative correlation** with pain scores ($r = -0.55$)
- **Positive correlation** with FIM scores ($r = +0.65$)

These results demonstrate a consistent and clinically meaningful association between **higher serum vitamin D levels and better rehabilitation outcomes** in musculoskeletal patients.

Discussion

The results of this study indicate that there is an important relationship between serum vitamin D levels and functional outcomes in patients rehabilitating their musculoskeletal system at the level three rehabilitation settings (Riyadh, Saudi Arabia). Patients with sufficient vitamin D levels ($>30\text{ng/mL}$) reported better mobility, greater muscular strength, lower pain levels, and greater achievement of independence overall compared to those with insufficient or deficient levels.

These findings are in close accordance with other studies conducted earlier which have described the physiological importance of vitamin D in relation to muscle performance, pain, and recovery from injuries. For instance, Shinchuk & Holick (2007) described the positive impact of vitamin D on muscular and neuromuscular coordination accompanied with an increase in movements. Most recently, Rojano Ortega (2023), demonstrated the beneficial impact of vitamin D on recovery from exercise-induced muscle damage. The strong positive correlation found in this study between vitamin D levels and grip strength ($r = +0.58$) reinforces these physiological hypotheses.

Also, our findings are in agreement with those of Shin et al (2017) regarding poor recovery post knee surgery in patients with lower levels of vitamin D. In the same way, Ali et al. (2021) reported marked improvements in pain and physical functioning after physiotherapy in patients receiving vitamin D.

In our cohort, it seemed the pain-modulating effect of vitamin D was also evident. Patients with deficient levels reported the highest pain scores while those with sufficient levels reported the least. This supports the findings from Matossian-Motley & Drake (2016) that rehabilitative patients with low Vitamin D tended to have increased musculoskeletal pain.

From a regional standpoint, the extreme lack of Vitamin D in Saudi Arabia, because of limited sun exposure, conservative dress, and dietary habits, is a relevant public health issue. This study, in the context of other findings, reinforces the notion of routine screening for Vitamin D deficiency in rehabilitation settings, considering ample evidence of its ability to enhance recovery and decrease overall healthcare burden while increasing patient satisfaction.

Strengths and Limitations

An interdisciplinary framework combining laboratory diagnostics with actual physical therapy results is a distinct strength of this study. Furthermore, the application of functional assessment protocols (TUG, Grip Strength, FIM) improves objectivity and validity in the evaluation outcome measures.

Nevertheless, certain limitations must be recognized. Causal inference is somewhat limited due to the cross-sectional design. Seasonal changes and Vitamin D intake through diet were not controlled, which may artificially inflate serum levels. Besides, while physical therapists were blinded to Vitamin D levels, unaccounted for active commuting, solar exposure, or other physical activity could introduce bias.

Conclusion

There is a distinct relationship between the serum vitamin D concentrations and the functional recovery outcomes in patients undergoing rehabilitation for musculoskeletal disorders. The patients with adequate levels of vitamin D demonstrated significantly better outcomes in mobility, muscle strength, pain level, and functional independence. These results emphasize the clinical importance of periodic vitamin D assessments and its supplementation as an adjunct to rehabilitation programs. The combination of laboratory assessment with physical therapy could improve care of patients and foster individualized, targeted rehabilitation therapy in outpatient departments of teaching hospitals.

References

1. Ali, M., Uddin, Z., & Hossain, A. (2021). Combined effect of vitamin D supplementation and physiotherapy on reducing pain among adult patients with musculoskeletal disorders: A quasi-experimental clinical study. *Frontiers in Nutrition*, 8, 717473. <https://www.frontiersin.org/articles/10.3389/fnut.2021.717473/full>
2. Heath, K. M., & Elovic, E. P. (2006). Vitamin D deficiency: Implications in the rehabilitation setting. *American Journal of Physical Medicine & Rehabilitation*, 85(11), 916–923. https://journals.lww.com/ajpmr/fulltext/2006/11000/Vitamin_D_Deficiency_Implications_in_the.0009.aspx
3. Levinger, P., Begg, R., Sanders, K. M., & Nagano, H. (2017). The effect of vitamin D status on pain, lower limb strength and knee function during balance recovery in people with knee osteoarthritis: An exploratory study. *Archives of Osteoporosis*. <https://link.springer.com/article/10.1007/s11657-017-0378-4>
4. Matossian-Motley, D. L., & Drake, D. A. (2016). Association between serum 25(OH)D level and nonspecific musculoskeletal pain in acute rehabilitation unit patients. *JPEN: Journal of Parenteral and Enteral Nutrition*, 40(3), 403–410. <https://aspenjournals.onlinelibrary.wiley.com/doi/abs/10.1177/0148607114555909>
5. Rojano-Ortega, D. (2023). Effects of vitamin D supplementation on muscle function and recovery after exercise-induced muscle damage: A systematic review. *Journal of Human Nutrition and Dietetics*. <https://onlinelibrary.wiley.com/doi/abs/10.1111/jhn.13084>
6. Shinchuk, L., & Holick, M. F. (2007). Vitamin D and rehabilitation: Improving functional outcomes. *JPEN: Journal of Parenteral and Enteral Nutrition*, 31(4), 419–427. <https://aspenjournals.onlinelibrary.wiley.com/doi/abs/10.1177/0115426507022003297>
7. Shin, K. Y., Park, K. K., Moon, S. H., Yang, I. H., & Choi, H. J. (2017). Vitamin D deficiency adversely affects early post-operative functional outcomes after total knee arthroplasty. *Knee Surgery, Sports Traumatology, Arthroscopy*. <https://link.springer.com/article/10.1007/s00167-016-4209-8>
8. Wintermeyer, E., Ihle, C., Ehnert, S., Stöckle, U., & Ochs, G. (2016). Crucial role of vitamin D in the musculoskeletal system. *Nutrients*, 8(6), 319. <https://www.mdpi.com/2072-6643/8/6/319>