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ASSOCIATION BETWEEN HIGH ACHIEVED HEMOGLOBIN LEVEL AND PHYSICAL HEALTH RELATED QUALITY OF LIFE IN PATIENT WITH CHRONIC KIDNEY DISEASE

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Abstract

Background: Chronic kidney disease (CKD) is a long-term progressive condition that leads to gradual loss of kidney function. One of its most common complications is anemia, primarily caused by decreased production of erythropoietin. Anemia in CKD patients is associated with symptoms such as fatigue, decreased physical endurance, and difficulty in performing daily activities, all of which contribute to a decline in health-related quality of life (HRQoL). Effective management of hemoglobin levels may help improve physical health and overall patient well-being.

Objective(s): To assess the association between achieved hemoglobin levels and physical healthrelated quality of life in patients diagnosed with chronic kidney disease.

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Methodology: A cross-sectional analytical study was carried out among 80 patients with diagnosed chronic kidney disease in a hospital setting using a convenience sampling technique. Participants were categorized into two groups based on their hemoglobin levels: ≥12 g/dL and <12 g/dL. Relevant demographic and clinical data, including age, gender, CKD stage, and hemoglobin levels, were collected using a structured data collection tool. Physical health-related quality of life was evaluated using a standardized questionnaire. Data analysis was performed using statistical software, applying descriptive statistics and appropriate inferential tests to determine the relationship between hemoglobin levels and quality of life.

Results: The results indicated that patients with higher hemoglobin levels demonstrated better physical health-related quality of life compared to those with lower levels. Increased hemoglobin was associated with improved physical functioning, lower levels of fatigue, and greater ability to carry out daily activities.

Conclusion(s): The study concludes that higher hemoglobin levels are significantly associated with better physical health-related quality of life in patients with chronic kidney disease. Proper diagnosis and management of anemia may play a crucial role in improving physical health outcomes and enhancing overall quality of life in this population.

INTRODUCTION

Chronic kidney disease (CKD) is strongly associated with anemia, particularly in patients with advanced non-dialysis CKD, where approximately 40% of individuals are affected. Anemia in CKD is linked to increased morbidity, reduced functional capacity, and higher mortality, making early detection and management essential for improving outcomes [60,25]. As CKD progresses, patients experience a significant decline in health-related quality of life (HRQoL), characterized by fatigue, physical weakness, and difficulty performing daily activities independently. In addition to physical impairment, CKD also negatively affects psychological well-being and social functioning, emphasizing the need to evaluate both clinical and patient-reported outcomes to identify modifiable factors that can improve overall well-being [3,4,5].

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Quality of life (QoL) is a critical outcome in chronic renal failure, as patients with end-stage renal disease (ESRD) continue to experience poor QoL despite advances in dialysis therapies that have improved survival rates [1,6]. Multiple interrelated factors, including comorbid conditions such as diabetes, hypertension, anemia, and arthritis, contribute to the deterioration of QoL in CKD patients [8,41,47]. These conditions often require long-term polypharmacy, increasing the risk of adverse drug interactions and poor treatment adherence, further worsening patient outcomes. Additionally, CKD patients frequently report reduced energy levels and diminished physical capacity, highlighting the need for comprehensive disease management strategies that address both medical and functional limitations.

A substantial body of evidence suggests that hemoglobin (Hb) levels play a crucial role in determining physical HRQoL in CKD patients. Higher Hb levels are associated with improvements in physical functioning, vitality, and psychological well-being, whereas low Hb levels are linked to fatigue, reduced activity levels, and impaired daily functioning [4,13]. However, the relationship between Hb correction and outcomes remains complex, as aggressive anemia management using erythropoiesis-stimulating agents (ESAs) may increase the risk of cardiovascular complications [2,16,17]. While ESA therapy can improve energy levels and reduce anemia-related symptoms, optimal Hb targets remain debated due to potential safety concerns, highlighting the importance of balancing treatment benefits and risks [34].

Evidence from cohort and cross-sectional studies further supports the association between anemia severity and reduced HRQoL in CKD patients. Studies such as REACH-J and NHANES have demonstrated that patients with lower hemoglobin levels exhibit poorer physical functioning, increased fatigue, and reduced daily activity compared to those with higher Hb levels [45,16]. Similarly, multinational and regional studies have reported that individuals with Hb levels above 12 g/dL show better mobility, vitality, and overall physical health compared to anemic patients [35,32]. However, some studies in dialysis populations have found no significant association between Hb

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levels and overall HRQoL, suggesting that in advanced ESRD, other factors such as comorbidities and disease burden may play a more dominant role in determining quality of life [24,44,59].

Hemodialysis remains a life-sustaining treatment for ESRD patients, improving survival but also contributing to multiple complications that negatively affect both physical and psychological health [17]. Continuous assessment of HRQoL is therefore essential, as declining QoL is associated with increased morbidity and mortality in dialysis patients [44,59]. In addition to physical complications such as infections, cardiovascular events, and vascular access problems, patients also face significant psychological burdens influenced by biological, social, and environmental factors [63,60]. Mental health issues are common in CKD patients and further exacerbate functional limitations, underscoring the importance of integrated care approaches that address both physical and psychological dimensions of the disease to improve overall patient outcomes.

Literature Review

Hoshino et al. (2020) conducted a multinational observational study demonstrating that lower hemoglobin levels are consistently associated with reduced physical health-related quality of life (HRQoL) in chronic kidney disease (CKD) patients. They reported that severe anemia (Hb <10 g/dL) significantly impairs physical functioning and activity levels, while even mild-to-moderate anemia (Hb 10–12 g/dL) is associated with measurable reductions in HRQoL compared with Hb >12 g/dL (Hoshino et al., 2020). Similar dose–response relationships were observed in large multicenter analyses, where progressive increases in hemoglobin were linked with improvements in vitality, fatigue reduction, and better physical component scores of validated HRQoL instruments such as KDQOL and SF-36 (Finkelstein et al., 2009; Parker et al., 2022). These findings collectively support the current study's premise that anemia severity plays a central role in determining physical well-being in CKD patients.

Evidence from interventional and longitudinal studies further reinforces the beneficial role of hemoglobin improvement on physical outcomes. Alexander et al. (2007) demonstrated that

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correction of anemia using erythropoiesis-stimulating agents (ESAs) improves fatigue, vitality, and exercise tolerance in non-dialysis CKD patients, although the study design limited causal inference. In line with this, Ortiz et al. (2023) reported that patients whose hemoglobin increased from <10 g/dL to 11–12 g/dL experienced significant improvements in energy, physical functioning, and overall HRQoL. Similarly, Lee et al. (2022) identified an optimal hemoglobin range (11–12.5 g/dL) associated with the best functional outcomes, while higher levels (>13 g/dL) did not yield additional HRQoL benefits, suggesting a plateau effect. These findings align with the present study's observation that anemia-related fatigue, weakness, and reduced activity levels are key contributors to diminished physical quality of life.

However, randomized controlled trials and systematic reviews highlight important limitations and safety concerns regarding aggressive hemoglobin correction. Clement et al. (2009), synthesizing evidence from CHOIR, CREATE, and TREAT trials, reported only modest improvements in HRQoL with higher hemoglobin targets, while simultaneously identifying increased cardiovascular risks at higher Hb levels. Similarly, Guedes et al. (2020) found that although higher hemoglobin levels were associated with slight improvements in fatigue, gains in overall physical functioning were often small and clinically limited, with considerable heterogeneity across studies. These inconsistencies suggest that while anemia correction improves some patient-reported outcomes, the magnitude of benefit may be influenced by comorbidities, inflammation, and disease severity in CKD populations.

Further evidence indicates that anemia interacts with multiple physiological and functional domains, amplifying its effect on physical HRQoL. Studies have shown that low hemoglobin levels are associated with reduced exercise capacity, decreased gait speed, muscle weakness, and higher fatigue burden, all of which contribute to functional decline and reduced independence (Müller et al., 2024; Yamamoto et al., 2022; Ahmad et al., 2024). Additionally, anemia has been linked to poorer sleep quality, increased symptom burden, and reduced daily activity levels, further worsening physical well-being (Martinez-Lopez et al., 2024; Zhang et al., 2022). Collectively, these findings strongly support

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the results of the current study, emphasizing that anemia is a multifactorial determinant of reduced physical HRQoL in CKD patients, although optimal management requires balancing clinical benefits with potential cardiovascular risks and patient-specific factors.

Materials and Methods

The study employed a cross-sectional analytical design conducted at Doctor Hospital, Lahore over a four-month period following synopsis approval. A total of 80 patients were included in the study using a non-probability convenience sampling technique. This design was selected to assess the association between hemoglobin (Hb) levels and physical health-related quality of life (HRQoL) in patients with chronic kidney disease (CKD), in line with the study objectives.

The study population consisted of adult patients aged 18 years and above diagnosed with CKD stages 3–5, including both dialysis and non-dialysis cases. Patients were required to have documented hemoglobin levels within the last three months and the ability to understand and complete the SF-36 questionnaire. Patients with acute kidney injury, recent blood transfusion, pregnancy, severe psychiatric illness, or terminal comorbid conditions were excluded to minimize confounding factors affecting hemoglobin levels and HRQoL outcomes.

Data collection was performed using multiple clinical and research tools, including a weighing scale, stadiometer, blood pressure apparatus, hematology analyzer, and structured performa sheets. Hemoglobin levels were measured through laboratory analysis, while physical health-related quality of life was assessed using the SF-36 questionnaire focusing on domains such as physical functioning, pain, and general health. Demographic and clinical data were also recorded systematically to ensure comprehensive profiling of participants.

The primary independent variable of the study was hemoglobin level (g/dL), while dependent variables included physical functioning, pain, and general health status as measured through SF-36 scores. The main outcome of interest was physical HRQoL, specifically the physical component summary score, while secondary outcomes included associations between hemoglobin levels and

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demographic or clinical characteristics. These measures were used to evaluate how variations in hemoglobin influence physical health outcomes in CKD patients.

Data were analyzed using IBM SPSS Statistics, with descriptive statistics applied to summarize participant characteristics, including means, standard deviations, frequencies, and percentages. Hemoglobin levels were categorized for comparative analysis, and inferential statistics such as Chi-square test, independent t-test, or ANOVA were applied where appropriate. A p-value of ≤0.05 was considered statistically significant, ensuring robust evaluation of the relationship between hemoglobin levels and physical HRQoL outcomes in the study population.

Results

The present study included 80 patients with CKD, with an age range of 19–71 years. The largest proportion of participants belonged to the 29–38 years age group (32.5%), followed by 39–48 years and 49–58 years groups (22.5% each), while fewer participants were observed in the 19–28 years (10%) and 59–71 years (12.5%) categories. Regarding gender distribution, females slightly outnumbered males, with 51.25% female and 48.75% male participants. In terms of disease characteristics, most patients were in CKD stage 3 (40%), followed by stage 4 (33.8%) and stage 5 (26.3%). Additionally, 58.7% of patients were not on dialysis, while 41.2% were undergoing dialysis, indicating a heterogeneous clinical profile across the sample.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	43.595	2	21.797	24.576	<.001
Within Groups	68.293	77	.887		
Total	111.888	79			

The analysis of physical quality of life (QoL) demonstrated significant differences across study groups. One-way ANOVA results showed a statistically significant variation in physical QoL (F =

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24.576, $p < 0.001$), indicating that physical health status differed meaningfully between groups. The effect size analysis further confirmed the strength of this difference, with Cohen's d (3.088), Hedges' g (3.059), and Glass's delta (3.715) all indicating a very large effect. These findings suggest that differences in hemoglobin-related grouping or clinical stratification are strongly associated with substantial variation in physical QoL, both statistically and clinically.

				95% Confidence Interval	
		Standardizer[a]	Point Estimate	Lower	Upper
Physical_QoL	Cohen's d	.64536	3.088	2.431	3.737
	Hedges' correction	.65165	3.059	2.407	3.700
	Glass's delta	.53647	3.715	2.787	4.631

The association between hemoglobin (Hb) group and dialysis status was highly significant ($\chi^2 = 68.745$, $p < 0.001$), confirming a strong relationship between lower Hb levels and dialysis dependency. Cross-tabulation results showed that all patients with Hb levels >12 g/dL were not on dialysis (39 patients), whereas the majority of patients with Hb <12 g/dL were undergoing dialysis (33 out of 41). This pattern indicates that reduced hemoglobin levels are strongly associated with progression to dialysis-dependent CKD, reflecting worsening disease severity and clinical outcomes.

	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	68.745[a]	3	<.001
Likelihood Ratio	88.358	3	<.001.
Linear-by-Linear Association	56.062	1	.001
N of Valid Cases	80		

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Correlation analysis further demonstrated a strong and statistically significant negative relationship between hemoglobin group and physical QoL ($r = -0.542$, $p < 0.001$; reported matrix showing r up to -0.842). This indicates that as hemoglobin levels decrease, physical quality of life declines significantly. The findings collectively highlight that lower Hb levels are associated with poorer physical functioning and increased likelihood of dialysis, reinforcing hemoglobin as a key determinant of physical health outcomes in CKD patients.

Discussion

The present study demonstrated a clear and clinically meaningful association between hemoglobin levels and physical health-related quality of life (HRQoL) in patients with chronic kidney disease (CKD). Patients with higher hemoglobin levels consistently showed better outcomes in key physical domains, including physical functioning, bodily pain, and general health perception. This pattern is physiologically plausible, as hemoglobin is essential for oxygen transport, and its reduction leads to tissue hypoxia, fatigue, and decreased physical capacity. These findings reinforce that anemia is not merely a laboratory abnormality in CKD but a major determinant of functional status and daily activity performance.

The observed improvement in physical functioning with higher hemoglobin levels reflects enhanced oxygen delivery to muscles and tissues, resulting in better energy utilization and exercise tolerance. This contributes to improved mobility, independence, and ability to perform routine tasks, all of which are particularly important in CKD patients who already face significant disease-related limitations. Similarly, the association between hemoglobin levels and bodily pain suggests that anemia may indirectly worsen pain perception through fatigue, muscle weakness, and reduced physical resilience, while correction of anemia may improve overall comfort and reduce symptom burden.

General health perception was also positively influenced by higher hemoglobin levels, indicating that patients not only experienced physical improvements but also perceived their overall health

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status more favorably. This subjective improvement likely reflects a combination of reduced symptoms, better physical functioning, and improved ability to engage in daily life activities. The findings align with existing literature indicating that optimized hemoglobin levels contribute to better health-related outcomes, although overly aggressive correction of anemia may introduce risks such as cardiovascular complications, emphasizing the need for a balanced therapeutic approach.

Despite these positive associations, several limitations should be considered. The cross-sectional design limits causal inference, and the relatively small, single-center sample restricts generalizability. Additionally, reliance on self-reported SF-36 data may introduce response bias, and unmeasured confounders such as comorbid conditions, nutritional status, and medication use may have influenced the results. Nevertheless, the study provides valuable evidence supporting the role of hemoglobin optimization in improving physical HRQoL in CKD patients and highlights the importance of individualized anemia management strategies aimed at achieving optimal—not excessive—hemoglobin levels.

CONCLUSION(S)

This study concludes that hemoglobin levels are significantly associated with physical health-related quality of life in patients with chronic kidney disease. Individuals with higher hemoglobin levels showed better physical functioning, reduced pain, and a more positive perception of their overall health status. These findings suggest that effective management of hemoglobin levels is essential in improving the overall quality of life in patients with chronic kidney disease

The study highlights the importance of regular hemoglobin monitoring and timely management of anemia in chronic kidney disease (CKD) patients through appropriate interventions such as iron therapy and erythropoiesis-stimulating agents. Healthcare professionals should adopt a holistic approach that not only focuses on clinical management but also emphasizes improving patients' quality of life through supportive care and structured patient education programs aimed at increasing awareness regarding anemia and its consequences. Furthermore, future research should

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include larger, multi-center, and longitudinal studies to establish stronger causal relationships and enhance the generalizability of findings. However, the present study is limited by its relatively small sample size, cross-sectional design, reliance on self-reported questionnaire data that may introduce response bias, and its restriction to a limited clinical setting, all of which may affect the robustness and broader applicability of the results.

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