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Quality of Life One Year After Surgically Treated Proximal Femur Fractures and Its Determinants: A EuroQol-5D-5L Based Evaluation

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Original Article

Quality of Life One Year After Surgically Treated Proximal Femur Fractures and Its Determinants: A EuroQol-5D-5L Based Evaluation

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Running title: Quality of Life for Patients Following Surgically Treated Proximal Femur Fractures– After 1 Year

Keywords: Quality of Life, Proximal Femur Fracture, EQ-5D-5L, Physiotherapy, Elderly, Surgical Outcome, Regression Analysis

Abstract.

Objective: This study evaluated the health-related quality of life (HRQoL) one-year post-surgery in patients with proximal femur fractures using the EuroQol-5D-5L instrument, and identified the key predictors of QoL, including age, fracture type, postoperative complications, and physiotherapy adherence.

Material and Methods: A cross-sectional observational study was conducted on 95 patients aged 60–75 years who underwent operative management for proximal femoral fractures at Sri Ramakrishna Hospital. The EQ-5D-5L questionnaire was used for data collection. Descriptive statistics and multiple linear regression analysis (MRA) were employed to determine the influence of selected variables on EQ-5D-5L index scores.

Results: The mean EQ-5D-5L index score was 0.768 ± 0.217 . Longer physiotherapy adherence was significantly associated with higher QoL ($p\text{-value} < 0.001$), while advancing age negatively impacted outcomes ($p\text{-value} = 0.002$). Fracture type also showed a significant association ($p\text{-value} = 0.034$), with femoral neck and head fractures yielding better outcomes than intertrochanteric and subtrochanteric types. The presence of complications showed a negative trend but was not statistically significant ($p\text{-value} = 0.081$). The regression model explained 61.5% of the variance in QoL (Adjusted $R^2 = 0.598$).

Conclusion: Physiotherapy adherence emerged as the strongest predictor of better post-surgical QoL, emphasizing the critical role of long-term rehabilitation. Age and fracture type also significantly influenced recovery outcomes. These findings highlight the need for personalized rehabilitation strategies and early intervention to enhance postoperative functional recovery in elderly hip fracture patients.

Keywords: elderly surgical outcome, EQ-5D-5L, proximal femur fracture, quality of life, regression analysis

Introduction

Hip fractures are a primary health problem, with high-risk sufferers being the aged, women, and the elderly¹. In 2019, universally, the incidence of hip fractures was approximated to be 182 per 100,000 population².

The probability of fracture increases with aging and the progressive reduction in bone density, and it differs depending on the population being considered. One year later, among patients with hip fractures, 40% are still unable to move unaided or unassisted, 60% struggle with the necessary functions of daily life, and 80% face alterations in other daily activities, especially tasks like getting groceries and driving. Furthermore, 27% of these patients are admitted to a nursing home for the very first time³. Moreover, individuals greater than 65 years of age accounted for 85% of the hip fractures⁴.

Age-related deterioration is characterized by lowered neuromuscular coordination, vision, reaction time, and balance, which contribute to a greater chance of falling and subsequent hip fractures among the elderly^{5,6}. Between 25 and 75% of individuals who walked without dependence before the fracture become dependent after a year, or do not extend to the same pre-fracture level of autonomy⁷. Thus, the elements that can interfere with the patient's HRQoL comprise the method of treatment, delayed surgery, and post-surgical complications⁸. Studies have demonstrated that about 97% of proximal femur fractures are managed surgically⁹.

The significance of evaluating patient-reported quality of life (HRQoL) provides details on the benefits of therapeutic treatments, without denying that health status is influenced by mood, social support, coping mechanisms, socioeconomic conditions, and services for healthcare, with major implications for patient-reported quality of life outcomes¹⁰. More than 90% of individuals with a hip fracture who are older than 65 years have coexisting medical conditions, and these elements have a significant impact on prognosis and treatment¹¹.

After undergoing surgical care for a hip fracture, it is essential to utilize health-related outcome measures to evaluate both the effectiveness of all medical and surgical treatments on the HS and the patient-reported quality of life (HRQoL) for all the recipients of care. The EQ-5D is for assessing health status, which is preference-based. It is used globally in clinical trials. The EQ-5D-5L tool outlines five key areas: movement ability, personal hygiene, routine tasks, physical discomfort, and emotional distress. The EQ Visual Analogue Scale (VAS) records an individual's present health status using a vertical scale, where the top and bottom are labeled as 'the best imaginable health you can envision' and 'the worst imaginable health you can envision',

respectively. The need for this study is due to the increasing incidence of proximal femur fractures in the elderly, often resulting in long-term disability and reduced quality of life. Surgical intervention is common, yet post-surgical recovery varies widely based on age, fracture type, comorbidities, and physiotherapy adherence. We identified key predictors and developed a regression model to forecast health status. The findings can guide improved rehabilitation and individualized care strategies.

Material and Methods

The study employed a cross-sectional research design with analytical evaluation of measured variables and retrospective data collection. The research took place in the Department of Orthopaedics, Sri Ramakrishna Multispecialty Hospital, Coimbatore 641044. The sampling method was purposive. The FRAIL-HIP study by **Loggers SA et al., 2022**, reported comparable baseline age distributions between operative and non-operative groups (67.07 ± 1.21 vs 65.07 ± 1.52 years), supporting the comparability of study groups

$$n = z^2 \frac{p \times q}{d^2}$$

where,

n = sample size

p = proportion of patients with a higher quality of life who underwent operative management for proximal femur fracture = 31% (**Loggers SA et al., 2022**)

q = (100-p)% = (100-31)% = 69%

d = allowable margin of error = 9.3%

z = value of 95% confidence interval = 1.96

On substituting these values, the final calculated sample size was **95**.

Inclusion criteria were age group from 60 to 75 years, both genders, who finished 1 year following the surgical treatment of proximal femur fracture, patients residing within a 30-kilometer radius

surrounding Sri Ramakrishna Hospital after discharge, and a minimum elementary school education level of 4th grade. Exclusion criteria were involvement in any additional medication research during the study period, patients who completed surgery after more than 1 year and 6 months, known metastatic disease, an interval between fracture occurrence and hospital admission exceeding three days, bilateral proximal femoral fractures, and any surgical delay for any medical reasons.

This cross-sectional study was conducted on 95 individuals who satisfied the specified eligibility conditions, after approval from the Institutional Committee, Medical Superintendent, and orthopedic surgeon was granted. The data were collected from the Medical Records Department and the Information Technology Department. Data of all the consecutive patients from January 2023 to January 2024 at Sri Ramakrishna Hospital with radiologically confirmed proximal femur fracture were collected, both before and after surgery from post-operative day 1 (POD 1), together with demographic information, prior medical history, and details on the procedure, including the type of fracture, complications, and any co-morbidities after the completion of 1 year post-surgery. The study procedures were explained and informed consent was obtained from the patients. EQ 5D 5L questionnaires were administered only after acquiring written consent from all the patients and their families.

India lacks an EQ-5D value set for both the 3-level and the updated 5-level versions. Earlier HTA/HRQoL studies in India evaluated health preferences utilizing the Thailand value set. The Indian value set is still under development, so the Thai value set was utilized instead.¹⁵ Approval was secured from the EuroQol Scientific Organization to use their EuroQol-5D-5L for Paper Interviewer Administration in English, Tamil, and Hindi for this research.

All statistical analyses were conducted using Microsoft Excel (for inputting and tidying data). Continuous variables (age, EQ-5D-5L Index) were characterized with means and standard deviations.

Categorical variables (fracture type, comorbid conditions, physiotherapy adherence, surgery type) are shown using percentages and frequencies.

Multiple linear regression was conducted to assess the influence of various independent variables on the EQ-5D-5L index. The framework was used to forecast the outcome of the dependent variable Y (EQ 5D 5L index). The predictors included:

- Age (continuous variable)
- Fracture type (categorical variable: Intertrochanteric, Subtrochanteric, Femoral Neck, Femoral Head)
- Comorbid conditions (binary: a = none, p = existent)
- Compliance with physiotherapy (categorical: physiotherapy received only during hospital stay, physiotherapy continued for less than 3 months post-discharge, physiotherapy continued for more than 3 months, physiotherapy continued for more than 6 months)

Physiotherapy compliance was documented from the respective physical therapist who delivered post-discharge home-based physiotherapy sessions. Fracture type was confirmed by radiological diagnosis. Comorbid conditions were obtained from preoperative medical records.

Dummy variables were generated for the encoding of categorical predictors, using one category as the reference.

The framework of the multiple regression model is:

$$y = \beta_0 + (X_1) \beta_1 + (X_2) \beta_2 + (X_3) \beta_3 + (X_4) \beta_4 + \varepsilon$$

Where y signifies EQ 5D 5L, β_0 indicates the intercept, X_1 to X_4 are the four independent variables, and β_1 denotes the coefficients derived from the regression analysis linked to each of the independent variables. ε indicates the deviation in the model's predictions, indicating the disparity between our prediction of Y and the true value.

Prior to developing the model, the subsequent six hypotheses need to be confirmed:

Scatter plots are employed to visualize potential linear relationships between the four predictors and the outcome variable. Lack of multicollinearity influences significant variations in the values

of the regression coefficients. Tolerance is calculated as $1 - R^2$, while the Variance Inflation Factor (VIF) is derived as the reciprocal of $(1 - R^2)$, that is, $VIF = 1 / (1 - R^2)$ — with R^2 denoting the proportion of variation in the dependent variable that can be forecasted by the explanatory variable — and employed to investigate this presumption. Residual independence is evaluated, and in this context, the outcome of the Durbin-Watson statistical test is analyzed and ranges from 1.5 to 2.0; the residuals exhibit constant variance. Verification can be accomplished by constructing a plot comparing the standardized residuals to the standardized predicted values. Normality of the residuals is assessed using a Q-Q plot. The plot can be employed to confirm this premise. Values of Cook's distance consistently below 1 ensure that outliers are not present.

The assumptions of multiple linear regressions were evaluated as follows: Figure 1 shows the linear relationship between the dependent variables and the predicted variables, namely complications and physiotherapy adherence assessed using scatter plot. The Durbin-Watson Test for Autocorrelation measured 1.63, which used to check the independence of residuals in the multiple regression model, suggests no notable autocorrelation in the residuals. Values between 1.5 and 2.0 indicate absence of autocorrelation as shown in Table 1. The results of Multicollinearity check in which all VIF values were significantly lower than the standard threshold of 10, and tolerance values consistently exceeded 0.2, demonstrating no multicollinearity. Therefore, it can be concluded that the predictors are not linearly correlated with each other to a degree that would distort the regression estimates as given in Table 2. Assumption a quantile–quantile (Q-Q) plot can be used to verify the normality. The residuals are distributed approximately along the 45-degree reference line in Figure 2 and the points are quite close to the line, suggesting that the residuals are approximately normally distributed. The visualization of standardized residuals against the corresponding standardized predictions to check for homoscedasticity plot indicated that the residuals' variance was not completely uniform throughout the predicted values as shown in Figure 3, suggesting a moderate breach of the homoskedasticity assumption. However, the overall pattern did not exhibit severe funneling. Therefore, this violation was considered acceptable. Figure 4 presents Cook's Distance values for all observations. All Cook's Distance values were well below the threshold of 1, indicating no influential outliers. This finding supports the robustness and stability of the regression model

Results

A multivariate regression analysis (MRA) was utilized to examine the factors influencing postoperative quality of life in proximal femur fracture patients, with the EuroQol-5D-5L Index as the outcome variable. The model generated a Multiple R value of 0.790, indicating a robust positive association between the predicted EQ-5D scores and the actual scores received from patients, demonstrating that the model predictions are accurate. The specified predictors accounted for approximately 61.5% of the variance in the EQ-5D utility scores, as indicated by an R-square (R^2) value of 0.614933 as shown in Table 3. This suggests a strong model fit, which is particularly significant in medical and rehabilitation research, where outcomes are influenced by various biological, social, and behavioral factors.

To prevent overestimation and considering the number of predictors, the model's Adjusted R-Square value was computed and determined to be 0.598. This figure shows that, even after accounting for the number of predictors, the model still accounts for a noteworthy portion (59.8%) of the variance in the outcome.

The narrow difference between R^2 and Adjusted R^2 indicates that, for the majority of the predictors used in the model, their statistical significance is meaningful and they are not merely contributing noise to the model. Additionally, the importance of the overall regression model was further validated by the ANOVA table, which indicated an F-statistic of 35.53 and a p-value below 0.001. This indicates, at the very least, that the model is important for explaining the outcome variable. The likelihood (under 0.1%) that the relationship between the predictors and the outcome is merely accidental is very low.

* Age ($\beta = -0.0118$, p-value = 0.002), indicating that the EQ-5D-5L score decreased as age increased.

* Fracture type ($\beta = 0.0308$, p-value = 0.034), indicating that particular fracture types could result in better functional outcomes one year post-surgery.

* Compliance with physiotherapy proved to be the most significant and the strongest predictor ($\beta = 0.1040$, $p\text{-value} < 0.001$).

* The comorbid condition showed a negative coefficient ($\beta = -0.0614$), suggesting that comorbidities impede recovery, though these findings are borderline ($p\text{-value} > 0.05$), indicating they are statistically insignificant.

Physiotherapy adherence demonstrates the most substantial positive relationship with Quality of Life. The existence of comorbidities seems to diminish quality of life, although this finding is not statistically significant ($p\text{-value} = 0.081$).

The error term ε in the regression equation appears to be normally distributed.

•The model assumptions are met, validating the use of the following regression formula:

$$\text{Outcome (EQ 5D 5L Index)} = 1.38932316 + -0.011764583 *(\text{Age}) + 0.030800875 *(\text{Fracture Type}) + 0.103959978 *(\text{Physio Adherence}) + -0.061398049 *(\text{Comorbidities}) + \varepsilon$$

Discussion

The multiple linear regression analysis was conducted with age, fracture type, comorbidities status, and physiotherapy compliance as independent variables. The model accounted for 61.5% of the variation in the EuroQol-5D-5L Index, showing a moderately strong capacity to forecast patient-reported outcomes based on these clinical and rehabilitation elements. Increased age demonstrated a statistically notable correlation with decreased quality of life, aligning with earlier research that points to slower recovery, diminished physiological resilience, and a greater comorbidity burden in elderly individuals. Roy O Mathew (2013) stated that age has a notable impact on quality of life and correlates with the diminished recovery of daily living activities, while sex and race further affect functional outcomes and survival after a hip fracture¹⁶.

Individuals with intertrochanteric and subtrochanteric fractures exhibited considerably lower EQ-5D-5L scores compared to those with femoral head fractures, probably due to increased fracture complexity, surgical challenges, and extended healing times. Fractures of the femoral neck

exhibited no notable difference. TMendonça (2008) reported a worse prognosis in trochanteric fractures, attributed to earlier functional rehabilitation, especially gait training. FNF patients experienced fewer postoperative complications, reduced pain perception, and enhanced walking capability.¹⁷

A significant discovery was the detrimental consequences of comorbidities on overall quality of life. The comorbidities did not show a significant correlation with EuroQol-5D-5L utility scores ($p\text{-value} > 0.05$, $p=0.08$), indicating that while comorbidities may impede recovery, this is not statistically proven. Additional factors such as age, fracture type, and adherence to rehabilitation may have significantly influenced overall quality of life, with a significant proportion of the patients studied having an undisplaced fracture or a lesser degree of displacement. A second factor that contributed to a detrimental impact on Quality of Life is the milder comorbidities.

We examined the impact of physiotherapy adherence on long-term health-related quality of life and the physiological recovery mechanisms, functional adaptation processes, and psychosocial factors that together influence patients' experiences after surgery. Prolonged involvement in physiotherapy aids various elements of physical rehabilitation at both the tissue and systemic levels¹⁹. Progressive training promotes muscle growth, boosts lower-limb strength, and refines neuromuscular coordination, all essential for regaining gait stability, balance, and safe walking. Systematic reviews show that physiotherapy approaches focusing on mobility, balance, and strength correlate with enhanced performance-based results and are associated with a higher quality of life reported by patients post-hip fracture surgery, in contrast to minimal or no supervised rehabilitation²⁰. Additionally, the act of performing repetitive weight-bearing and functional movements probably aids in improving proprioception and joint flexibility, which subsequently diminishes compensatory movement patterns and secondary musculoskeletal stress. These modifications are essential in lowering the likelihood of future falls and any decline in mobility—an important factor in the quality-of-life view of older adults²¹. In addition to fundamental muscle conditioning, extended physiotherapy promotes the development of functional skills. Rehabilitation programs consistently encourage patients to restore balance, execute sit-to-stand movements, and navigate varying terrains—essential activities for independent living. Research indicates that more intense and extended physiotherapy correlates with improved discharge results,

including quicker mobilization and a higher chance of returning home, instead of staying in long-term care facilities²². Physiotherapy significantly contributes to dealing with the psychological effects of trauma, fear avoidance, and lack of activity. Regular therapeutic involvement aids in restoring self-efficacy, diminishes fear of falling, and boosts confidence in mobility. Psychological resilience and optimistic beliefs about recovery are widely acknowledged factors influencing self-reported health results following orthopedic injuries. Qualitative studies with physiotherapy practitioners reveal that fear avoidance strategies and insufficient support systems can hinder effective rehabilitation, underscoring the necessity of psychologically informed physiotherapy techniques²³. This highlights the essential importance of ongoing rehabilitation in restoring self-sufficiency and improving overall health and well-being following fractures.

Collectively, these results underscore the significance of a multidisciplinary strategy in handling fracture patients, emphasizing not merely surgical and immediate care, but also long-term rehabilitation. Encouraging sustained involvement in physiotherapy should be regarded as a fundamental element of fracture rehabilitation plans. The findings reflect the achieved QoL at one year rather than the degree of recovery or change from prior status. Patients who reach similar QoL levels at one year may have had very different pre-fracture health and recovery trajectories. Thus, the identified factors should be interpreted as being associated with QoL outcomes at one year, not necessarily as predictors of recovery.

Conclusion

The findings emphasize multiple impacts on postoperative recovery, reinforcing the necessity for early mobility techniques, tailored physiotherapy, and the prevention of complications. The EQ-5D-5L instrument effectively captured the long-term impact of proximal femur fractures on daily functioning and overall well-being. The present findings reflect the quality of life achieved at one year following surgery rather than recovery or improvement from a pre-fracture state. To validate these findings and offer targeted therapies for enhancing patient outcomes post-hip fracture surgery, further multi-center and longitudinal studies are recommended.

Limitations of the study included a lack of evaluation of the pre-injury functional status, which is an additional strong predictor of quality of life before and after fracture. Comorbidities or complications could have been examined closely based on the severity level. The research did not

consider factors like income, nutritional status, the number of comorbidities, and health perception after the fracture, all of which may affect the extent of the impact on quality of life. The application of a non-Indian EQ-5D-5L value set might not entirely reflect some culturally unique health preference weights.

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Conflict of Interest

There is no conflict of interest.

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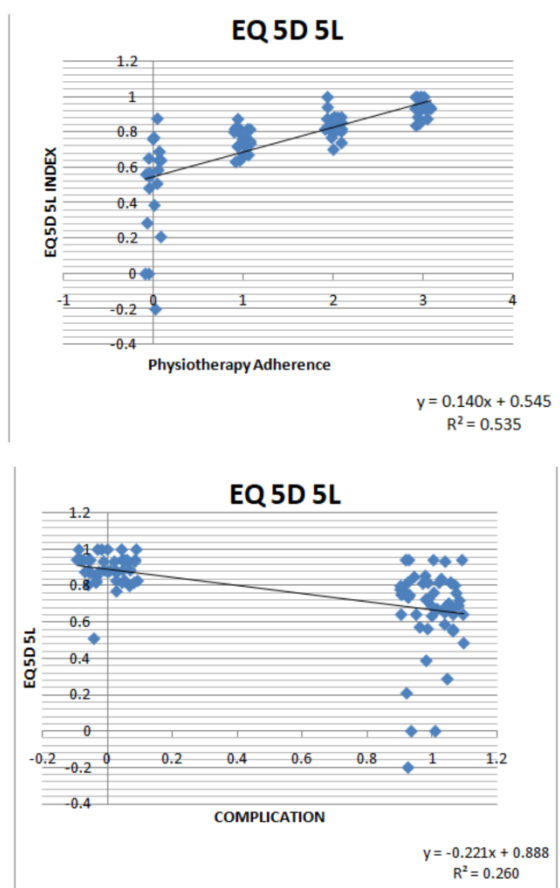
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EQ-5D-5L – European Quality of Life – 5 Dimension – 5 Level

Figure 1: Scatter Plots Demonstrating the Linear Relationship Between Predictor Variables and the EQ-5D-5L Index, the upper scatter plot illustrates the positive association between physiotherapy adherence and EQ-5D-5L Index scores, indicating improved quality of life with greater adherence to physiotherapy. The lower scatter plot demonstrates the relationship between complications and EQ-5D-5L Index scores, showing a negative trend in quality-of-life outcomes among patients with complications. Trend lines and corresponding R^2 values are presented to assess the strength and direction of the linear relationships between the predictor variables



Q-Q Plot – Quantile-Quantile plot

Figure 2: Assumption of quantile – quantile plot – Normality check

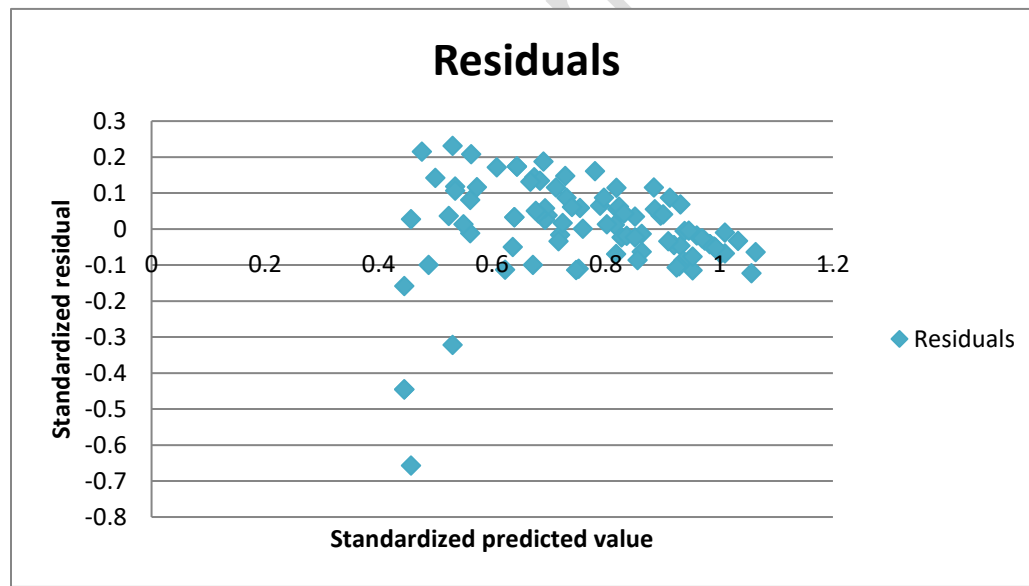


Figure 3: Residual Scatter Plot for Assessment of Homoscedasticity in the Multiple Linear Regression Model

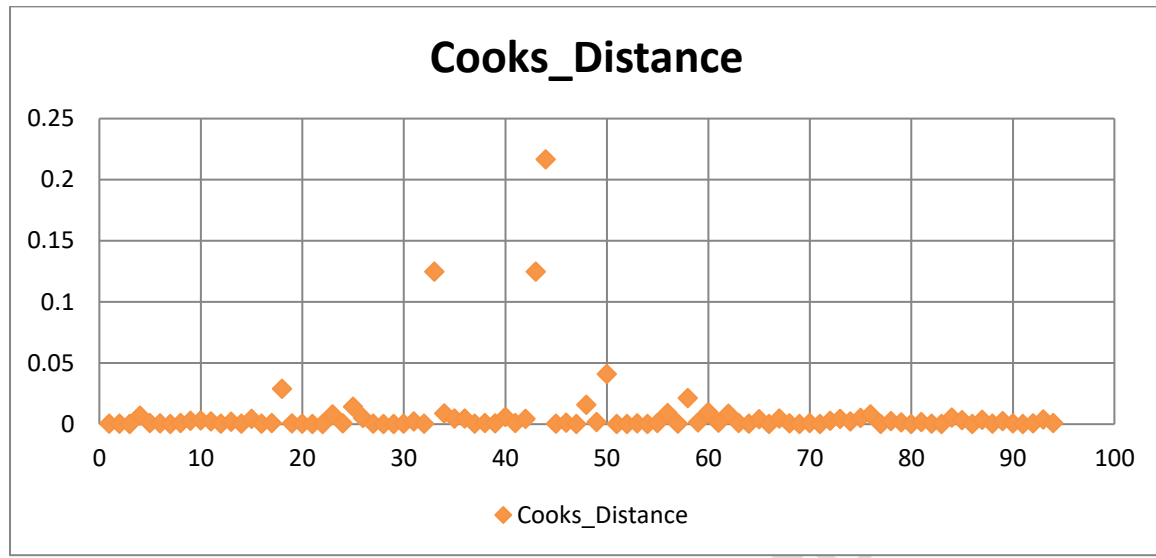


Figure 4: Cook's Distance Plot for Identification of Influential Outliers in the Multiple Regression Model

Table 1: Durbin Durbin–Watson Test for Assessment of Autocorrelation and Independence of Residuals

Durbin-Watson calculations	
sum of squared difference of residuals	2.749538
sum of squared residuals	1.683012
Durbin-Watson statistics	1.633689

Table 2: Multicollinearity Assessment of Predictor Variables Included in the Multiple Regression Model

Variable	Tolerance	VIF
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Age	0.80	1.25
Fracture type	0.93	1.00
Physiotherapy adherence	0.57	1.74
complications	0.92	1.49

VIF - Variance Inflation Factor

Table 3: Multiple Linear Regression Analysis of Factors Influencing EQ-5D-5L Index among Patients Following Surgically Treated Proximal Femur Fracture

Regression Statistics						
Multiple R	0.784177					
R Square	0.614933					
Adjusted R Square	0.597626					
Standard Error	0.137515					
Observations	94					
ANOVA						
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>	
Regression	4	2.687685	0.671921	35.53213	1.02E-17	
Residual	89	1.683012	0.01891			
Total	93	4.370697				
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	1.389323	0.26467	5.249266	1.03E-06	0.86343	1.915217
Age	-0.01176	0.003727	-3.15697	0.002176	-0.01917	-0.00436
fracture type	0.030801	0.014302	2.153586	0.033976	0.002383	0.059219
Physiotherapy adherence	0.10396	0.016617	6.256122	1.35E-08	0.070942	0.136978
Complication	-0.0614	0.034809	-1.76387	0.081185	-0.13056	0.007766

ANOVA – Analysis of Variance, Multiple R - Multiple Correlation Coefficient, R Square (R^2) - Coefficient of Determination, Adjusted R Square - Adjusted Coefficient of Determination, Df – degrees of freedom, SS – Sum of Squares, MS – Mean Square, F – F statistics, P value – probability value