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Role Of Frailty In Predicting Postoperative Recovery In Geriatric Surgery Using Edmonton Frail Scale And Barthel Index: An Observational Study

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Abstract
Background:
Frailty has emerged as an important predictor of adverse surgical outcomes in elderly patients. However, its role in predicting early postoperative functional recovery remains unclear, particularly in Indian populations.
Objectives:
To evaluate the association between preoperative frailty, assessed using the Edmonton Frail Scale (EFS), and postoperative functional recovery measured by the Barthel Index in geriatric patients undergoing elective surgery.
Methods:
This hospital-based prospective observational study included 22 patients aged ≥60 years undergoing elective surgery. Preoperative frailty was assessed using the EFS, and functional status was evaluated using the Barthel Index preoperatively and on postoperative day 5 or at discharge. Statistical analysis included Pearson correlation and paired t-test, with $p < 0.05$ considered significant.
Results:
The mean age of participants was 67.45 ± 7.58 years. The mean EFS score was 8.73 ± 4.67, and the mean preoperative and postoperative Barthel Index scores were 64.23 ± 19.88 and 67.73 ± 19.96, respectively. A weak positive correlation was observed between EFS and postoperative Barthel Index ($r = 0.217$), which was not statistically significant ($p = 0.332$). No significant difference was found
between preoperative and postoperative functional status ($p = 0.159$). Recovery patterns varied across frailty categories, with no consistent linear trend.
Conclusion:
Preoperative frailty did not demonstrate a statistically significant association with early postoperative functional recovery. These findings suggest that postoperative recovery in geriatric patients is multifactorial and may not be solely determined by frailty status. Further studies with larger sample sizes and longer follow-up are required.

Keywords: *Frailty; Edmonton Frail Scale; Barthel Index; Geriatric Surgery; Functional Recovery; Postoperative Outcomes*

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I. Introduction

The global demographic transition toward an ageing population has resulted in a substantial increase in the number of elderly individuals undergoing surgical procedures. Improvements in healthcare, advances in anaesthetic techniques, and increased life expectancy have contributed to a growing proportion of patients aged 60 years and above presenting for elective and emergency surgeries. However, this population is particularly vulnerable to adverse perioperative outcomes due to age-related physiological decline, reduced functional reserve, and a higher prevalence of comorbid conditions[1].

Traditionally, chronological age has been considered a key determinant of surgical risk. However, increasing evidence suggests that age alone is an inadequate predictor of postoperative outcomes, as it does not account for the wide variability in physiological and functional status among elderly individuals[2]. Some patients maintain independence and resilience despite advanced age, while others exhibit significant vulnerability within the same age group. This variability has led to the emergence of frailty as a more comprehensive and clinically relevant concept in perioperative risk assessment.

Frailty is defined as a multidimensional clinical syndrome characterized by decreased physiological reserve and increased susceptibility to stressors, resulting from cumulative decline across multiple organ

systems[2]. It is associated with impaired homeostatic mechanisms and reduced ability to recover from surgical stress. Makary et al. demonstrated that frailty is a strong predictor of postoperative morbidity and mortality in elderly surgical patients[1].

Various tools have been developed to assess frailty in clinical practice. The Edmonton Frail Scale (EFS) is a validated and user-friendly instrument that evaluates multiple domains including cognition, general health status, functional independence, medication use, nutrition, mood, continence, and functional performance[3].

Assessment of postoperative functional recovery is equally important in geriatric patients. Restoration of independence in activities of daily living is a key determinant of quality of life. The Barthel Index is a widely used and validated tool that measures functional independence in activities such as feeding, bathing, dressing, mobility, and continence[4].

Preoperative evaluation of elderly patients should also consider geriatric syndromes and overall physiological reserve, as these significantly influence surgical outcomes[5]. Studies have shown that frailty may be a better predictor of outcomes than chronological age alone[6]. The conceptual understanding of frailty has been further refined through different models, including the phenotypic model described by Fried et al.[7] and the deficit accumulation model proposed by Rockwood et al.[8].

Several studies have demonstrated that frailty is associated with adverse postoperative outcomes, including complications, prolonged hospitalization, and delayed recovery[9]. Some studies have even questioned surgical candidacy in severely frail patients due to poor expected outcomes[10]. In addition, elderly patients are at increased risk of postoperative complications such as delirium, which further impacts recovery[11].

Comprehensive geriatric assessment has been shown to be useful in predicting postoperative complications and guiding perioperative management[12]. Furthermore, frailty has been consistently associated with increased postoperative complications and poorer recovery outcomes[13]. Surgical risk in elderly patients is influenced by multiple interacting factors beyond frailty alone, including procedure-related stress and baseline health status[14].

More recent evidence also suggests that frailty is associated with long-term adverse outcomes such as death or new disability following surgery[15]. Despite this growing body of evidence, there is limited data from Indian tertiary care settings evaluating the relationship between frailty and early postoperative functional recovery using standardized tools.

In this context, the present study was undertaken to evaluate the role of preoperative frailty, assessed using the Edmonton Frail Scale, in predicting postoperative functional recovery measured by the Barthel Index in geriatric patients undergoing elective surgery.

II. Materials And Methods:

Source of data:

Elderly patients (≥ 60 years) scheduled for elective major surgeries under anaesthesia admitted at Sapthagiri Institute of Medical Sciences and Research center.

Methods of collection of data:

A) Study design: A hospital based prospective observational study.
B) Study period: JULY 2025 to FEBRUARY 2026
C) Place of study: Sapthagiri Institute of Medical Sciences and Research center, SIMSRC
D) Sample size: To determine the minimum number of participants required to assess the **correlation between the Edmonton Frail Scale (EFS) and the Barthel Index**, the following formula for sample size estimation for correlation studies is used:

Formula:

$$n = [(Z\alpha/2 + Z\beta) / (0.5 \times \ln((1 + r)/(1 - r)))]^2 + 3$$

Where:

- n = required sample size
- $Z\alpha/2$ = Z value for type I error ($\alpha = 0.05$, two-tailed) = 1.96
- $Z\beta$ = Z value for power ($1 - \beta = 0.80$) = 0.84
- *r* = expected correlation coefficient = 0.6
- ln = natural logarithm Substituting values:

$\ln((1 + 0.6)/(1 - 0.6)) = \ln(4) = 1.3863$
$0.5 \times \ln(4) = 0.6931$
$n = (2.8 / 0.6931)^2 + 3 = (4.039)^2 + 3 = 16.31 + 3 = 19.31$
Adjustment for Dropout Rate:
Assuming a 15% dropout rate:

$19.31 + (0.15 \times 19.31) = 22.2 \approx 22$ participants
Final Sample Size: A total of 22 elderly surgical patients were included in this observational study.
Justification for $r = 0.6$:

The assumed correlation coefficient (r = 0.6) is based on the study by Rolfson et al. (2006)3 which reported a statistically significant negative correlation between EFS and Barthel Index scores (r = – 0.58, p = 0.006) in elderly inpatients. This supports the assumption of a strong correlation for sample size estimation.

E) Inclusion Criteria:
- Patients aged 60 years or older
- Scheduled for elective general, orthopedic, or urologic surgery
- Able to provide informed consent
- Ambulatory and conscious at the time of preoperative assessment.

F) Exclusion Criteria:
- Emergency surgeries
- Patients with terminal illness
- Patients with severe cognitive dysfunction or communication difficulties preventing assessment
- ICU-admitted patients preoperatively

G) Methodology:
- After obtaining approval and clearance from the institutional ethics committee, the patients fulfilling the inclusion criteria were enrolled for the study after obtaining informed consent. (Annexure – 1)
- Eligible patients were identified during pre-anaesthetic check-up.
- After informed consent, clinical and demographic data (age, sex, comorbidities, ASA grade, type/duration of surgery) was recorded. (Annexure 2).
- EFS was administered by the investigator.
- Baseline Barthel Index score was recorded.
- Postoperatively, the Barthel Index was re-assessed on day 5 (or at discharge). (Annexure-3) Assessment tools:

a. Edmonton Frail Scale (EFS)
- A validated tool used to assess **frailty** across 9 domains: cognition, general health status, functional independence, social support, medication use, nutrition, mood, continence, and functional performance.
- Total score ranges from 0 to 17.
- Frailty Classification:
  - 0–3: Not frail
  - 4–5: Vulnerable
  - 6–7: Mild frailty
  - 8–9: Moderate frailty
  - ≥10: Severe frailty

Administration:
Performed during the **preoperative anaesthesia evaluation**.

b. Barthel Index of Activities of Daily Living
- A widely used tool to measure **postoperative functional recovery**.
- Assesses 10 basic ADLs (feeding, bathing, grooming, dressing, bowel and bladder control, toilet use, transfers, mobility, and stair use).
- Scores range from 0 to 100, with higher scores indicating **greater independence**.

Administration:
- Assessed at **preoperative baseline** and **postoperative day 5** (or before discharge, whichever is earlier).

H) Statistical analysis:
Software Used:
Data were entered into Microsoft Excel and analyzed using IBM SPSS version 26. Descriptive Statistics:
- Continuous variables were expressed as Mean ± Standard Deviation (SD) if normally distributed, or Median with Interquartile Range (IQR) if not.
- Categorical variables were expressed as frequencies and percentages.

Inferential and Comparative Analysis:

1. Correlation Analysis:
   - The Pearson correlation coefficient (r) was used to assess the strength and direction of association between EFS score and postoperative Barthel Index score, if both variables are normally distributed.
   - If the data are not normally distributed, the Spearman rank correlation coefficient was used instead.

2. Comparison of Functional Status (Pre-op vs Post-op Barthel Index):
   - If normally distributed: Paired t-test
   - If not normally distributed: Wilcoxon signed-rank test

3. Comparison Across Frailty Categories:
   - Patients may be grouped into frailty categories (non-frail, vulnerable, mildly frail, moderately frail, severely frail) based on EFS scores.
   - Postoperative Barthel scores was compared across frailty categories using:
     - ANOVA, if data is normally distributed and variance is equal
     - Kruskal-Wallis test, if not Significance Level:

All tests were two-tailed. A p-value < 0.05 was considered statistically significant.

III. Results

Study Population

A total of 22 geriatric patients (≥60 years) undergoing elective surgeries were included in the study. The age of the patients ranged from 60 to 88 years, with a mean age of 67.45 ± 7.58 years.

Descriptive Statistics

The distribution of frailty and functional status among the study population analysed using descriptive statistics.

Table 1: Descriptive Statistics

Variable	Mean ± SD	Min – Max
Age	67.45 ± 7.58	60 – 88
EFS Score	8.73 ± 4.67	1 – 17
Barthel Index (Pre-op)	64.23 ± 19.88	36 – 98
Barthel Index (Post-op)	67.73 ± 19.96	26 – 100

The mean Edmonton Frail Scale (EFS) score of 8.73 suggests that the study population predominantly fell within the moderate frailty category, although a wide range (1–17) indicates inclusion across all frailty levels. The mean preoperative Barthel Index score of 64.23 indicates moderate dependency, while the postoperative mean of 67.73 reflects a slight improvement in functional status. However, the large standard deviations indicate considerable inter-individual variability.

Normality Testing

The Shapiro–Wilk test was used to assess the normality of continuous variables.

Variable	p-value	Interpretation
EFS Score	0.527	Normal
Post-op Barthel	0.605	Normal

Since both variables were normally distributed (p > 0.05), parametric tests were applied.

Correlation Analysis (Primary Objective)

The relationship between preoperative frailty and postoperative functional recovery was assessed using Pearson's correlation.

Table 2: Correlation Analysis

Variables	r-value	p-value
EFS vs Post-op Barthel	0.217	0.332

A weak positive correlation was observed (r = 0.217), which was not statistically significant (p = 0.332). This indicates that higher frailty scores were not associated with poorer postoperative functional outcomes.

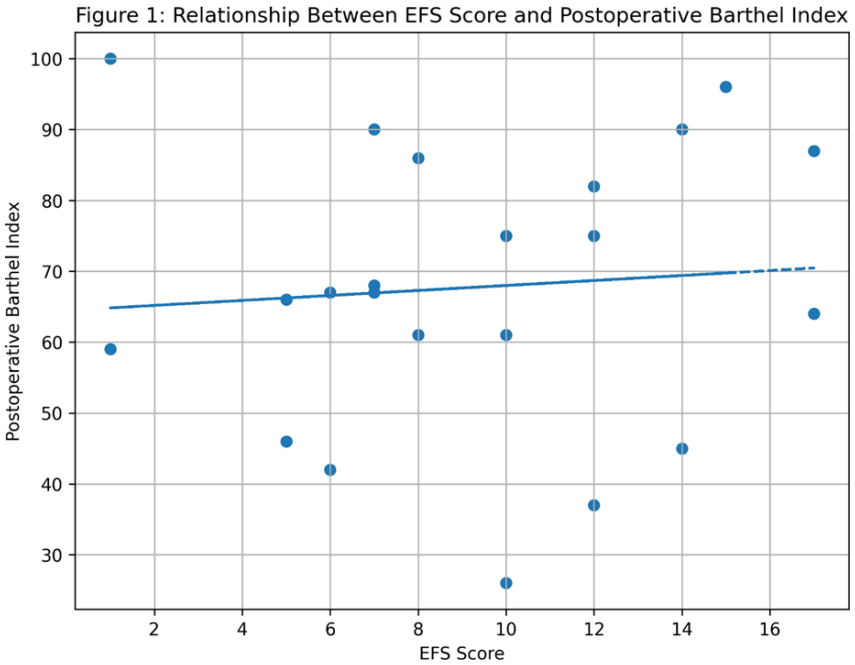

Figure 1: Scatter plot showing the relationship between EFS score and postoperative Barthel Index demonstrates a widely dispersed distribution of data points, indicating the absence of a strong linear relationship.

Preoperative vs Postoperative Functional Status

A paired t-test was used to compare preoperative and postoperative functional status.

Table 3: Paired Comparison

Parameter	Mean ± SD
Pre-op Barthel	64.23 ± 19.88
Post-op Barthel	67.73 ± 19.96

t-value = -1.461

p-value = 0.159

Although a slight increase in postoperative scores was observed, the difference was not statistically significant.

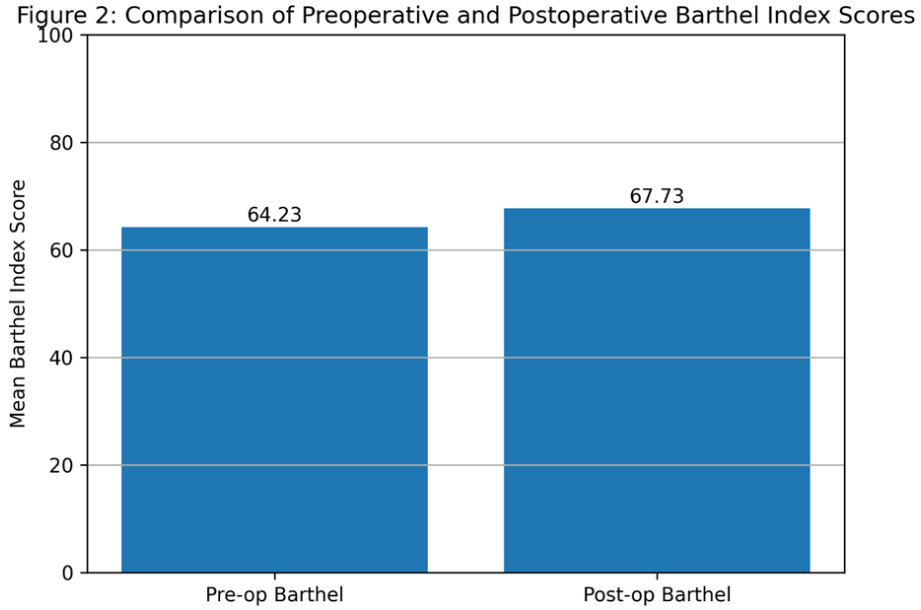

Figure 2: Bar graph comparing mean preoperative and postoperative Barthel Index scores.

Analysis Based on Frailty Categories

Patients were categorized based on EFS scores, and postoperative outcomes were compared.

Table 4: Frailty vs Functional Outcome

Frailty Category	Mean Post-op Barthel	Mean Recovery (Δ)
Not Frail	63.20	+3.60
Vulnerable	66.80	+5.60
Mild Frailty	73.50	+9.50
Moderate Frailty	54.00	-7.00
Severe Frailty	75.86	+4.71

No consistent linear trend was observed between frailty severity and recovery:

- Mild frailty showed the greatest improvement
- Moderate frailty showed decline
- Some severely frail patients demonstrated improvement

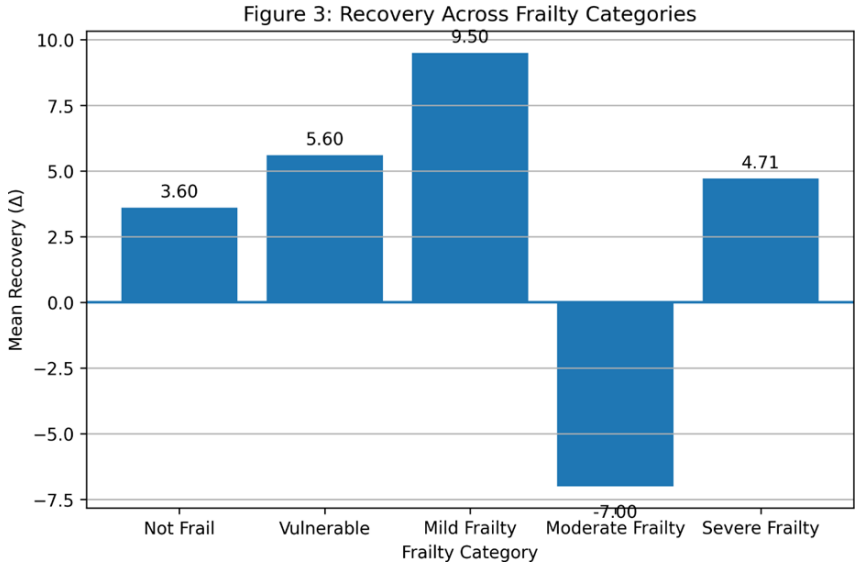

Figure 3: Bar chart illustrating recovery across frailty categories shows inconsistent patterns, supporting the absence of a clear association.

Interpretation of Results

The study did not demonstrate a statistically significant association between preoperative frailty and postoperative functional recovery. Additionally, no significant change was observed between preoperative and postoperative functional status. Recovery patterns varied widely across individuals and frailty categories, suggesting a multifactorial influence.

IV. Discussion

Frailty has been widely recognized as an important determinant of surgical outcomes in elderly patients. Previous studies have demonstrated that frailty is associated with increased postoperative complications, prolonged hospitalization, delayed recovery, and higher mortality rates[1],[2]. Makary et al. established frailty as a strong predictor of surgical morbidity and mortality[1], while Clegg et al. described frailty as a state of increased vulnerability due to cumulative physiological decline[2].

The Edmonton Frail Scale used in the present study is a validated multidimensional tool that allows reliable assessment of frailty in clinical settings[3]. Similarly, the Barthel Index provides an objective measure of functional independence in activities of daily living[4].

In contrast to previous studies, the present study demonstrated a weak positive and statistically non-significant correlation between frailty and postoperative functional recovery ($r = 0.217$, $p = 0.332$).

This finding differs from earlier reports that have consistently shown poorer outcomes in frail patients[9],[13]. Partridge et al. emphasized that frailty is strongly associated with adverse postoperative outcomes in elderly surgical populations[9].

The absence of a statistically significant difference between preoperative and postoperative Barthel Index scores ($p = 0.159$) further indicates that early postoperative functional recovery was limited and not uniformly influenced by frailty status.

The wide dispersion of data points observed in the scatter plot further supports the absence of a strong linear relationship between frailty and postoperative functional recovery.

Additionally, the lack of a consistent trend across frailty categories reinforces this observation. Patients with mild frailty demonstrated the greatest improvement, while those with moderate frailty showed a decline, and some severely frail patients also exhibited improvement. This variability highlights the complex and non-linear nature of recovery in geriatric patients.

Several factors may explain the discrepancy between the present findings and existing literature. The small sample size limits statistical power and reduces the ability to detect significant associations. Furthermore, the short follow-up duration may not adequately capture long-term recovery trajectories, which are more strongly influenced by frailty[12].

The heterogeneity of surgical procedures is another important factor, as different surgeries impose varying physiological stress and recovery demands[14].

Postoperative recovery is inherently multifactorial and influenced by comorbidities, nutritional status, anaesthetic techniques, and perioperative care[5,6]. Although frailty has been shown to be a superior predictor compared to chronological age, outcomes are still determined by multiple interacting variables[6].

The conceptual models of frailty proposed by Fried et al.[7] and Rockwood et al.[8] further emphasize its multidimensional nature, which may not be fully captured by a single assessment tool.

Previous studies have also shown that frailty is associated with increased postoperative complications and delayed recovery[13], and may even influence decisions regarding surgical candidacy[10]. Additionally, postoperative complications such as delirium may further impair recovery in elderly patients[11].

Comprehensive geriatric assessment has been shown to improve prediction of postoperative complications and guide individualized management[12]. Furthermore, frailty has been linked to long-term adverse outcomes including death or new disability following surgery[15].

Despite the lack of statistically significant association observed in the present study, frailty assessment remains clinically relevant. It provides valuable insight into patient vulnerability, aids in perioperative risk stratification, and supports individualized management strategies aimed at improving surgical outcomes in elderly patients.

V. Conclusion

In this prospective observational study of geriatric patients undergoing elective surgery, preoperative frailty assessed using the Edmonton Frail Scale did not demonstrate a statistically significant association with early postoperative functional recovery measured by the Barthel Index. A weak positive correlation was observed; however, it was not statistically significant, and no meaningful change was noted between preoperative and postoperative functional status in the immediate postoperative period.

The findings suggest that early postoperative functional recovery in elderly patients is influenced by multiple interacting factors and may not be adequately predicted by frailty status alone. The variability in recovery observed across different frailty categories further highlights the complex and non-linear nature of postoperative outcomes in this population.

Despite the lack of a significant association in the early postoperative period, frailty assessment remains clinically relevant. It provides valuable insight into patient vulnerability and can support perioperative risk stratification and individualized patient management.

Future studies with larger sample sizes, longer follow-up durations, and more homogeneous surgical populations are required to better define the role of frailty in predicting both short-term and long-term functional outcomes.

VI. Limitations

The present study has several limitations that should be considered while interpreting the findings.

First, the sample size was relatively small (n = 22), which limits the statistical power of the study and the ability to detect significant associations. Second, the follow-up period was short, with functional recovery assessed only in the early postoperative phase. This may not accurately reflect the long-term impact of frailty on functional outcomes, as recovery in geriatric patients often occurs over an extended period.

Third, the study included a heterogeneous group of surgical procedures, which may have introduced variability in postoperative recovery due to differences in surgical stress, duration, and complexity. Fourth, potential confounding factors such as comorbidities, nutritional status, type of anaesthesia, and perioperative care were not controlled for, which may have influenced the observed outcomes.

Additionally, the study was conducted at a single center, which may limit the generalizability of the findings to other settings or populations. Finally, the use of a single frailty assessment tool may not fully capture the multidimensional nature of frailty.

The study may have been underpowered to detect weaker correlations than those assumed during

sample size estimation.

These limitations highlight the need for larger, multi-center studies with standardized protocols and extended follow-up to better understand the relationship between frailty and postoperative functional recovery in geriatric patients.

Ethical Approval Statement

The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Institutional Ethics Committee of Sapthagiri Institute of Medical Sciences and Research Center (SIMSRC) prior to the commencement of the study (Ref No:

SIMS & RC / EC-17/PG-01/2025-26). Written informed consent was obtained from all participants before enrolment.

Conflict of Interest

Nil.

Funding

Nil

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