The Modified Frailty Index as Preoperative Predictor for Post-Spinal Surgery: Retrospective Study

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Abstract

Background: Frailty indicates increased susceptibility to stress secondary to the declines of physiological homeostatic reserve with aging due to cumulative cellular damage over the individuals' life.

Objectives: assessment of using the 5-item and 11-item modified frailty indices (mFI-5 and mFI-11) and the Clinical Frailty Scale (CFS) for early prediction of complications during lumbar spinal surgery.

Patients and Method: 137 files were reviewed to extract the perioperative data and 6-m follow-up findings concerning pain as evaluated by the Numerical Rating Scale (NRS) and Oswestry Disability Index (ODI). ΔNRS and ΔODI were calculated and at cutoff point of ≥50% indicated procedure success. The incidence and multiplicity of complications were recorded. Statistical analyses were applied to evaluate the relation between FIs and the frequency of complications.

Results: NRS and ODI scores were decreased by ≥50% in 113 (82.5%) and 71 (51.8%), respectively and were negatively correlated with patients' age, BMI, the presence and multiplicity of medical disorders. Statistical analyses defined the presence of multiple medical disorders as the negative significant predictor for spinal surgery success. The mFI-11 defined significantly higher percentage of frail patients (65.7%) than the mFI-5 (40.9%) and CFS (41%). Statistical analyses defined high mFI-11 score as the significant predictor for getting multiple complications.

Conclusion: Spinal surgery success is inversely related patients' age, BMI and the presence of multiple chronic medical illnesses. The incidence and multiplicity of surgery-related complications were positively related to the FI scorings. The mFI-11 showed the highest predictability for complication and is better to be applied for preoperative evaluation.

Keywords: Lumbar spine surgery; Frailty indices; Success rate; Complication rate.

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Introduction

Frailty is a state of increased susceptibility to stress secondary to the accumulative declines of homeostatic reserve in physiological systems with aging process **(Pugh and Lone, 2021)**. Frailty is the result of cumulative cellular damage from diverse etiologies over the life of the individual, and with the progressive prevalence of older adults, the frailty prevalence increased in parallel **(Jenkins et al., 2023)**.

Multiple environmental as socio-demographic influences, and health-related factors as psychological impacts, nutritional issues, diseases and its complications and low physical activity are the predisposing factors for frailty **(Lee et al., 2020)**. The absence of internationally standard definition for frailty made its diagnosis a dilemma **(Oviedo-Briones et al., 2021)**, but several scores were proposed for evaluation of frailty so as to help to identify patients at risk of frailty-induced adverse outcomes **(Subramaniam et al., 2022)**.

The prevalence of degenerative spine disease is another line paralleled the increased prevalence of elderly people and commonly affects lumbar, cervical spine and even thoracic spine **(Lokhande, 2023)**. Open surgical procedures are indicated whenever conservative treatment is ineffective for symptomatic patients **(Salzmann et al., 2019)**, but despite being the gold standard line of therapy, it has multiple shortcomings including excessive muscle damage and bone resection, epidural scarring with extended hospital stay, possible need for intensive care unit (ICU) admission, increased need of postoperative (PO) analgesics and consumption of resources **(Li et al., 2023)**. Endoscopic surgical procedures provide favorable outcomes with special regard to perioperative complications and reduced hospital stay; however, endoscopic approach was associated with greater total in-hospital costs than open procedures **(Findlay et al., 2023)**.

The increased prevalence of degenerative spine disease that parallel the progressive prevalence of elderly people resulted in a surge of spinal surgeries **(Patel et al., 2024)** and this necessitated the implement of an easily accessible and validated preoperative risk stratification tool and not rely on age as the sole factor for assessment of fitness for surgery **(Walczak and Velanovich, 2022)**. This study tried to evaluate the possibility of application of the frailty index (FI) for early prediction of spine surgery-related complications.

Patients and Methods

Design : Retrospective cohort study.

Setting : Department of Neurosurgery, Faculty of Medicine, Helwan University.

Study Rational: The study rational is to assess perioperative data of patients underwent lumbar spinal surgery and determine the items of three of the documented frailty index (FI). Then, the calculated indices and the perioperative data were related to patients' outcomes to determine the best predictor for outcomes of these patients.

Ethical consideration: The study protocol was approved by the departmental committee to allow exploration of the files of patients underwent spinal surgery since Jan 2021 to extract the required data and after data collection and interpreting it with the outcomes, the final approval by the Local Ethical Committee was obtained.

Exclusion criteria: Files of patients operated upon before Jan 2021 were discarded, files missing perioperative and follow-up data were also excluded.

Inclusion criteria: Files containing complete perioperative data and 6-m follow-up findings for at least 6-m postoperative were explored using the study tools.

Perioperative data: The collected preoperative data included age, gender, weight and if possible body mass index, medical history including the presence of chronic medical diseases, past history of cerebrovascular stroke, intracranial surgery, spinal surgeries, receiving spinal or epidural anesthesia ad its outcome if possible, previous surgeries for cancer especially that metastasizing to bone, single or multilevel disease. Intraoperative and immediate postoperative data included the type of the procedure whether discectomy, spinal fusion, spinal fixation, duration of surgery, intraoperative complications, need for ICU admission and if required the duration of ICU stay, development of In-ICU complications, duration of hospital stay and surgical outcome. Follow-up data included the extent of pain and disability if still present.

Tools for Procedural Evaluation: The registered data concerning preoperative and postoperative data concerning the following items were evaluated:

1. **Pain severity**: the 0-10 numeric rating scale (NRS) was applied to determine pain severity with 0= no pain and 10= worst pain **(Farrar et al., 2001)**. Pain data included the severity of day and night back and leg pain, and was presented as mean of total NRS pain score. Pain scores were recorded before surgery was compared to that determined at-hospital discharge, and at 1, 3 and 6-m PO.
2. **Pain-induced Disability**: the Oswestry Low Back Pain Disability Questionnaire which consisted of 10-items scored on Likert 1-5 scale for a minimum score of 5 and maximum score of 50 was used to assess pain-induced disability **(Davidson and Keating, 2002)**. Oswestry Disability Index (ODI) was calculated according to the equation ODI= [(Total score/50)*(100)] and was categorized as magnitude of disability: minimal= ODI<20%, moderate= ODI ranged between 20 and 40%, severe= ODI score was in range of 40–60%, crippled if ODI=60-80% and in case bed-bound patient ODI was mostly >80% **(Fairbank and Pynsent, 2000)**.
3. The magnitude of improvement in pain and its related disability was defined as ΔNRS and ΔODI (1-m postoperative score- preoperative score). ΔNRS and ΔODI of ≥50% was considered as procedure success as previously documented by **(Manchikanti et al., 2010)**.
4. The frequency of intraoperative and postoperative complications was recorded and registered as total incidence and frequency per patients. Also, patients' distribution according to multiplicity of complications was revised.

Frailty evaluation tools

1. **The 11-item modified frailty index (mFI-11)**

   This measure for the extent of frailty depends on evaluation of the 11-items including the presence of history of diabetes mellitus (DM), chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF), myocardial infarction (MI), angina or cardiac interventional procedures, hypertension requiring medication, peripheral vascular disease, transient ischemic attack (TIA) or cerebrovascular accident (CVA) without or with deficit and impaired sensorium, and non-independent functional status

(**Tsiouris et al., 2013**). Each variate was scored by 0 = no, 1 =yes, and the collective score was divided by 11 to yield the patient's score that range between 0 and 1.0. The extent of frailty was graded as non-frail at score range of 0-0.08; mild frailty at range of 0.09-0.17, moderate at 0.18-0.26 and at score of ≥0.27 patient had severe frailty (**Shin et al., 2017**).

2. **The 5-item modified Frailty Index (mFI-5)**
The mFI-5 relied on the presence of history of DM, COPD, CHF, hypertension requiring medication and non-independent functional status. Each item was scored by 0 or 1 and the index is graded as non-frail in case of mFI-5 = 0, pre-frail if mFI-5 = 1 and frail at mFI-5 ≥ 2 (**Chimukangara et al., 2017**).
3. **Clinical Frailty Scale (CFS)**
The CFS is utilized to predict the outcomes of older people hospitalized with acute illnesses and can be used to help predict in-patient mortality. The CFS categorizes patients into two broad categories as Non-frail (CFS=1-4) and Frail (CFS=5-9). The Non-Frail category includes 4 grades: Very fit (CFS=1), Fit (CFS=2), Managing well (CFS=3) and Living with very mild frailty or vulnerable to frailty (CFS=4). Frail category include Mildly frail (CFS=5), Moderate frailty (CFS=6), Severely frail (CFS=7), Very severely frail (CFS=8) and Terminally Ill (**Wallis et al., 2015**).

Study outcomes

1. The primary outcome of this study was defining the procedural outcomes to evaluate the competence of the provided therapy defined as the percentage of patients had improved pain and disability scores by ≥50% and the incidence and multiplicity of complications
2. The secondary outcomes include:
    - The relation between the collected patients' data and the procedural outcomes regarding the ΔNRS and ΔODI, and the rate and multiplicity of surgery-related complications
    - Defining the relation between frailty indices and the rate and multiplicity of surgery-related complications
    - Defining the best frailty index to be applied for the prediction of incidence and multiplicity of surgery-related complications.

Statistical analyses

Statistical analyses were conveyed using the IBM® SPSS® Statistics software (Ver. 26, 2019; IBM Corporation; Armonk, USA). Data were subjected to correlation analyses using Pearson's Correlation analysis and correlated data were verified using the Receiver Operating Characteristic (ROC) curve analysis as judged by the significance of the difference between the area under the curve (AUC) for each variate and the area under the reference line at the cutoff point of P less than 0.05 to indicate significance. Multivariate Regression analysis was applied to determine the highly significant predictors for the outcome.

Results

The files of patients who had lumbar spinal surgery through two years were collected (n=162 case) but 25 files were discarded because of missed data and the data of 137 patients were revised to extract the required data that was arranged in the following tables. Patients older than 60 years were more frequent (45.2%) than those in range of 50-59 years (33.6%) or younger than 50 years (21.2%) with mean age of 57.6±8.4. There were 82 males (59.9%) and 55 females (40.1%) and the frequency of obese patients with body mass index (BMI) >30 kg/m^2 was higher than those had BMI <30 kg/m^2. Seventy-three patients had 102 chronic medical diseases for a frequency of 1.4 per patient. Diabetes mellitus and neuropsychiatric disorders are the most frequent and represent 46% of the chronic medical diseases, hypertension and previous cardiac insults represent 37.2%, chronic obstructive pulmonary disease (COPD) represents 12.7% and peripheral vascular diseases were reported in only 4 patients (**Table.1**).

Table 1. Personal and chronic medical disease data

Personal data				**Chronic medical diseases**			
Data		**Number**	**%**	**Data**		**Number**	**%**
Age (years)	<50	29	21.2	Frequency	No	64	46.7
	50-60	51	37.2		Yes	73	53.3
	>60-70	48	35	Type	Diabetes mellitus	24	32.9
	>70	9	6.5		COPD	13	17.8
	Mean (±SD)	57.6 (8.4)			Cardiac	18	24.7
Gender	Male	82	59.9		Hypertension	20	27.4
	Female	55	40.1		Peripheral vascular D	4	5.5
BMI	Overweight	64	46.7		Neurologic	23	31.5
	Obese	73	53.3	Incidence of medical diseases / affected patient		1.4	
	Mean (±SD)	30.2 (2.1)					

BMI: Body mass index; COPD: Chronic obstructive pulmonary disease; Vascular D: Vascular disease; SD: Standard deviation

Discectomy represented the most frequent operative procedure; 34.3%, 13.1% of patients had discectomy for one level, 11.7% of patients had two levels and 9.5% had discectomy for three-levels. Thirty-two patients (23.4%) had decompression for lumbar stenosis, 19 patients had additionally instrumentation and twenty-nine patients (21.2%) had spondylolistheiasis. Twenty-seven patients (19.7%) had lumbar fracture and two patients (1.5%) had correction of scoliosis/kyphosis deformity. Mean operative time was 93.2±15.3 min and 52.5% of surgeries consumed operative time of <90 min. Eleven patients (8%) required transfusion of one blood unit, while the others did not require supplemental blood transfusion. Seven patients (5.1%) were directly transferred to surgical ICU for being cardiac patients with history of ischemic insults and stayed for a mean duration of 30±6.6 hours and then were ward-discharged, while the remaining 130 patients stayed at post-anesthetic care unit (PACU) for a mean duration of 16.2±4.2 min and were ward-discharged. The mean duration of postoperative hospital stay was 38.9±9.3 hours (**Table.2**).

Table 2. Operative and immediate postoperative data

Data			No.	%
Operative procedure	Discectomy for	1-level	18	13.1
		2-levels	16	11.7
		3-levels	13	9.5
	Lumbar stenosis	Decompression	13	9.5
		Decompression and Instrumentation	19	13.9
	Spondylolistheiasis		29	21.2
	scoliosis/kyphosis deformity		2	1.5
	Lumbar fracture		27	19.7
Operative time (min)		<90	72	52.5
		90-120	52	38
		>120	13	9.5
		Mean (±SD)	93.2 (15.3)	
Need for blood transfusion		Yes	11	8
		No	126	92
Need for postoperative admission to Surgical ICU		Yes	7	5.1
		No	130	94.9
Durations of postoperative stay	ICU stay (h)	Mean (±SD)	30 (6.6)	
	PACU (min)		16.2 (4.2)	
	Hospital (h)		38.9 (9.3)	

ICU: Intensive care unit; PACU: Post-anesthetic care unit; SD: Standard deviation

Regarding the procedural success, all patients showed progressive decrease of their NRS pain score and ODI scores during follow-up (Fig. 1) with a mean Δ values of 3.85 (±1.4) for NRS pain score and 17.4 (±7.9) for ODI score. The mean percentage of change in NRS pain score at 1-m postoperative in relation to preoperative score was 58.4 (±18.8%) and 113 patients (82.5%) showed decreased NRS pain score by ≥50%. On contrary, the percentage of change in ODI score was 45.9 (±14.1%) and only 71 patients (51.8%) documented decreased disability index by ≥50% (**Table.3, Fig.1**).

Table 3. Procedural success as judged by pain and disability scorings of the studied patients during 6-m follow-up

Time \ Scales		Numeric rating pain score	Oswestry Disability Index (ODI)
Preoperative		6.7±1.3	37.1±10.7
At discharge		2.9±1.7	28.4±7.9
1-m postoperative		2.8±1.6	19.7±6.9
3-m postoperative		2.9±1.7	18.5±6.6
6-m postoperative		3±1.6	17±6.7
Δ value		3.85±1.4	17.4±7.9
% of change	<50%	24 (17.5%)	66 (48.2%)
	≥50%	113 (82.5%)	71 (51.8%)
	Mean (±SD)	58.4±18.8	45.9±14.1

SD: Standard deviation

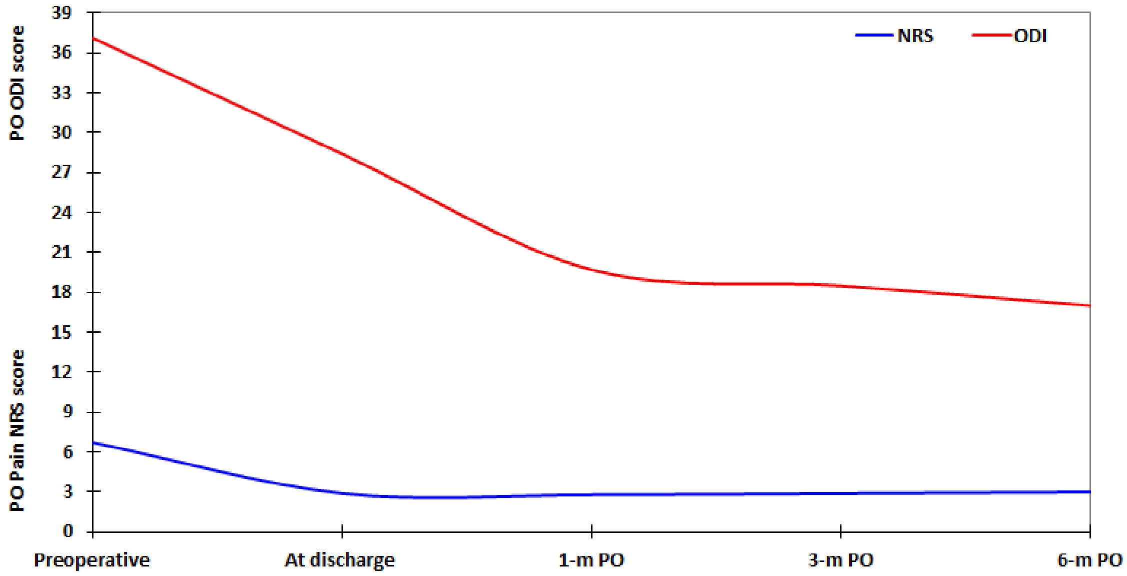

Fig. (1): Mean PO pain NRS score & ODI score of patients as determined during 6-m PO follow-up

The extent of improved pain scores (ΔNRS) showed negative significant correlation with patients' age, BMI, the presence and the multiplicity of medical disorders. Similarly, the extent of improved disability (ΔODI) was inversely related to patients' age and the presence and multiplicity of medical disorders. The ROC curve analysis for the correlated variates with ΔNRS arranged these variate as the most significant predictors for low ΔNRS as follows BMI (P=0.008), presence of multiple medical disorders (P=0.010) and old age (P=0.036) as shown in table 4 and figure 2. Regression analysis assured the ability of high BMI (β=-0.292, P<0.001) and the presence of multiple medical disorders (β=-0.240, P=0.003) for prediction of low ΔNRS in one model and defined high BMI (β=-0.336, P<0.001) as the most significant negative predictor for spinal surgery success concerning to postoperative pain (**Table.4, Fig.2**).

Table 4. Statistical analyses of patients' data as predictors for spinal surgery success

Variates		ΔNRS		ΔODI	
		Correlation analysis			
		r	P	r	P
Age		-0.285	0.001	-0.294	<0.001
Male gender		0.158	0.066	0.141	0.101
BMI		-0.251	0.003	-0.120	0.389
Medical disorders	Presence	-0.370	<0.001	-0.281	0.001
	Multiplicity	-0.482	<0.001	-0.336	<0.001
Operative time		-0.036	0.672	-0.095	0.269
ICU admission		-0.122	0.155	-0.098	0.255
Variates		**Receiver Operating Characteristic (ROC) Curve Analysis**			
		AUC (±Std.)	P	AUC (±Std.)	P
Age		0.702 (0.140)	0.036	0.746 (0.063)	0.029
BMI		0.819 (0.096)	0.008	Excluded	
Medical	Presence	0.570 (0.117)	0.563	0.632 (0.099)	0.239

disorders	Multiplicity	0.747 (0.106)	0.010	0.779 (0.065)	0.013

r: Pearson's correlation coefficient; ΔNRS: The extent of change in the numerical rating scale; ΔODI: The extent of change in the numerical rating scale; BMI: Body mass index; ICU: Intensive care unit; AUC: Area under curve; Std.: Standard error.

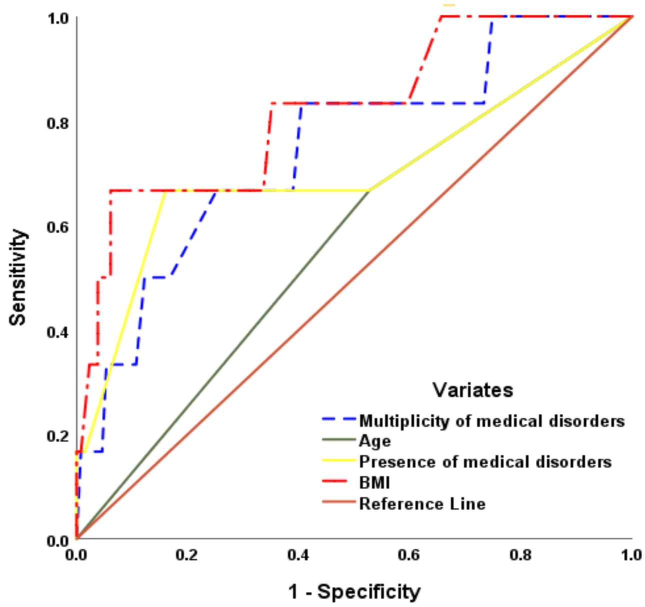

Fig. 2. The ROC curve analysis of preoperative patients' data as predictors for the success of spinal surgery as judged by ΔNRS

Regarding ΔODI as a measure for spinal surgery success, the ROC curve analysis for the correlated variates with ΔODI defined the presence of multiple medical disorders (P=0.013) and old age (P=0.029) as the significant negative predictors for improved ODI, as shown in figure 3. Regression analysis assured the ability of the presence of multiple medical disorders (β=-0.445, P<0.001) and old age (β=-0.292, P=0.008) for prediction of low ΔODI in one model and defined the presence of multiple medical disorders (β=-0.482, P<0.001) as the most significant negative predictor for spinal surgery success as judged by change in ΔODI (**Fig.3**).

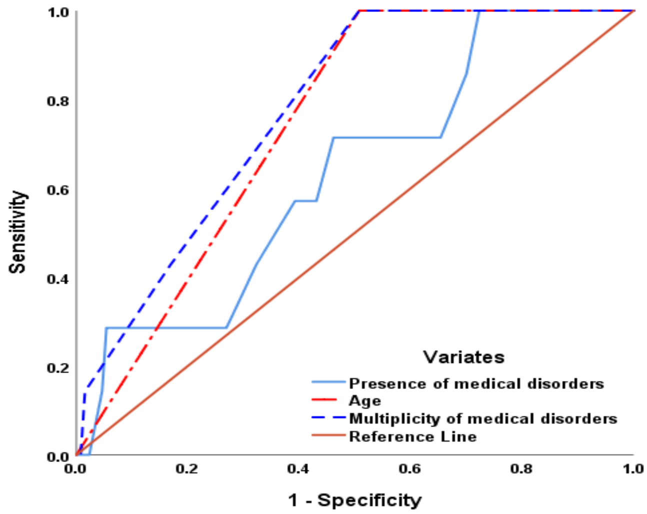

Fig. 3. The ROC curve analysis of preoperative patients' data as predictors for the success of spinal surgery as judged by ΔODI

During surgery, 14 intraoperative (IO) complications (10.4%) were encountered; 10 accidental durotomy had occurred (7.3%), two patients had inadequate decompression, one patient had nerve root injury and another had epidural hematoma. Thirty postoperative complications (21.7%) had occurred, but wound infection was the most frequent and affected 9 patients (6.6%), 8 patients (5.8%) complained of manifestations of postoperative urinary tract infection, 6 patients (4.4%) developed postoperative anemia and another 6 patients developed transitory neurological deficit (n=2), deep venous thrombosis (n=2) and radicular pain due to misplaced screw was detected in two patients, and only one patient developed postoperative ileus. These 44 complications affected 31 patients (22.6%), where 3 patients (2.2%) each had developed three complications, 7 patients each had two complications and 21 patients (15%) developed one complications, while 106 patients had uneventful operative course and passed their postoperative period free of events (**Table.5**).

Table 5. The recorded intraoperative **and** postoperative **complications, and their distribution among patients**

Data			No.	%
Intraoperative complications	Accidental durotomy		10	7.3
	Epidural hematoma		1	0.7
	Nerve root injury		1	0.7
	Inadequate decompression		2	1.5
Postoperative complications	Superficial wound infection		6	4.4
	Deep wound infection		3	2.2
	Transitory neurological deficit		2	1.5
	Deep venous thrombosis		2	1.5
	Radicular pain due to misplaced screw		2	1.5
	Postoperative anemia		6	4.4
	Urinary tract infection		8	5.8
	Ileus		1	0.7
Total			44	32.1%
Patients' distribution according to number of complications	Non-complicated		106	77.4
	Complicated	One complication	21	15.
		Two complications	7	5.1
		Three complications	3	2.2
		Total	31	22.6

Application of the mFI-11 defined significantly (P=0.0004 and 0.005, respectively) higher percentage of frail patients (65.7%) than the mFI-5 (40.9%) and CFS (41%) as shown in figure 4. Regarding the severity of frailty, according to the mFI-11, there were 52 patients were mildly frail, 29 patients were moderately and 9 patients were severely frail. On contrary, mFI-5 defined 39 patients as pre-frail and 17 patients as frail. However, according to the CFS, 34 patients had mild, 19 patients had moderate and 10 patients had severe-to-very frailty (**Table. 6, Fig.4**).

Table 6. Frailty indices of the studied patients

Data			No.	%
Modified Frailty Index-11 (mFI-11)	Non-Frail		47	34.3
	Frail	Mild	52	38
		Moderate	29	21.2
		Severe	9	6.5
		Total	90	65.7
Modified Frailty Index-5 (mFI-5)	Non-Frail		81	59.1
	Pre-Frail		39	28.5
	Frail		17	12.4
Clinical Frailty Scale (CFS	Non-Frail	Very fit	0	
		Fit	5	3.6
		Well	17	12.4
		Living with mild frailty	52	38
		Total	74	54
	Frail	Living with mild frailty	34	24.8
		Living with moderate frailty	19	13.9
		Living with severe frailty	7	5.1
		Living with very severe frailty	3	2.2
		Terminal	0	0
		Total	63	46

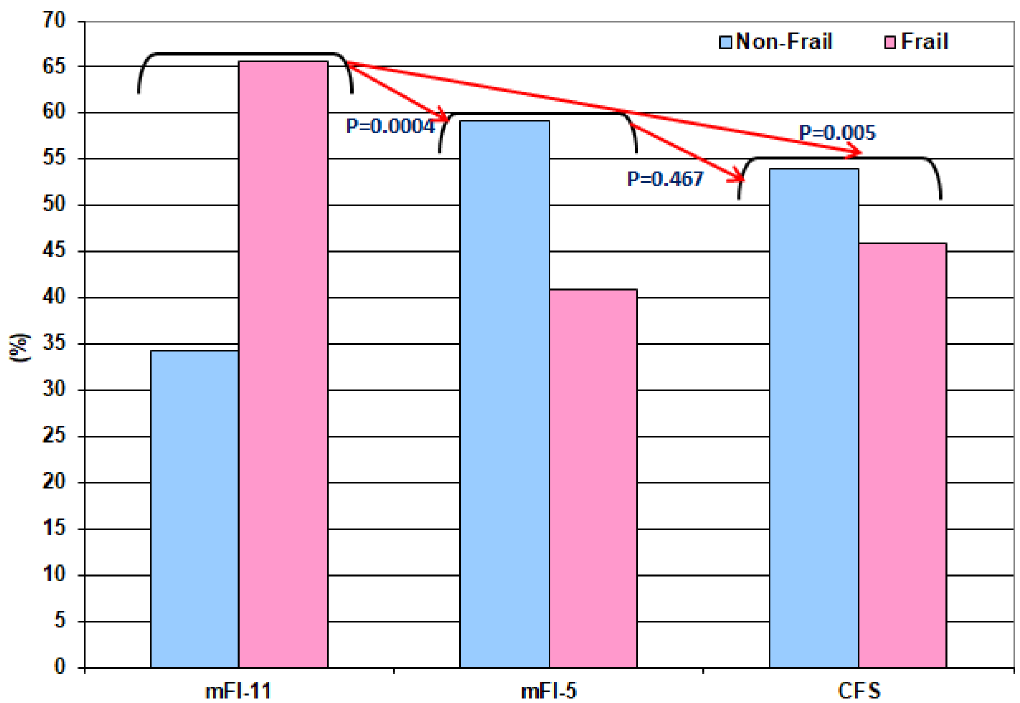

Fig. (4): Incidence of Frailty according to the applied index

Correlation analysis showed positive significant relations between frailty scores and both incidence and multiplicity of complications. However, the correlation with mFI-11 scorings was the highest and was lowest with the mFI-5 regarding the incidence and with the CFS as regards the multiplicity of complications. Using the ROC curve analysis, the mFI-11 showed the highest AUC for prediction of the possibility of getting complications, followed by the CFS and lastly the mFI-5 (**Fig. 5**). Despite of the significant correlation between the frailty indices and the multiplicity of complications, the ROC curve analysis could not defined a predictor for this multiplicity (**Table. 7, Fig. 6**).

Multivariate regression analysis for the frailty indices as predictors of possibility of getting multiple complication defined high score of the mFI-11 as the predictor with higher significance (β=0.313, P<0.001) than the CFS (β=0.253, P=0.002), but excluded the mFI-5 as a predictor in one model and in the second model assured that high score on the mFI-11 scale was the only predictor for the possibility of getting multiple complications (β=0.338, P<0.001).

Table 7. Statistical analyses of preoperative frailty indices as predictors for oncoming spinal surgery complications

Dependent variate / Independent variates	Incidence of complications				Multiplicity of complications			
	Pearson's correlation analysis							
	r		P		r		P	
The mFI-11	0.338		<0.001		0.398		<0.001	
The mFI-5	0.277		0.001		0.286		0.001	
The CFS	0.284		0.001		0.252		0.003	
	Receiver Operating Characteristic (ROC) Curve Analysis							
Independent variates	AUC	Std.	P	95% CI	AUC	Std.	P	95% CI
The mFI-11	0.699	0.057	0.001	0.586-0.811	0.716	0.224	0.201	0.277-1.000
The mFI-5	0.656	0.059	0.008	0.540-0.772	0.675	0.180	0.300	0.322-1.000
The CFS	0.687	0.057	0.002	0.582-0.793	0.466	0.213	0.843	0.049-0.884

r: Pearson's correlation coefficient; mFI: Modified frailty index; CSF: Clinical Frailty Scale; AUC: Area under curve; Std.: Standard error.

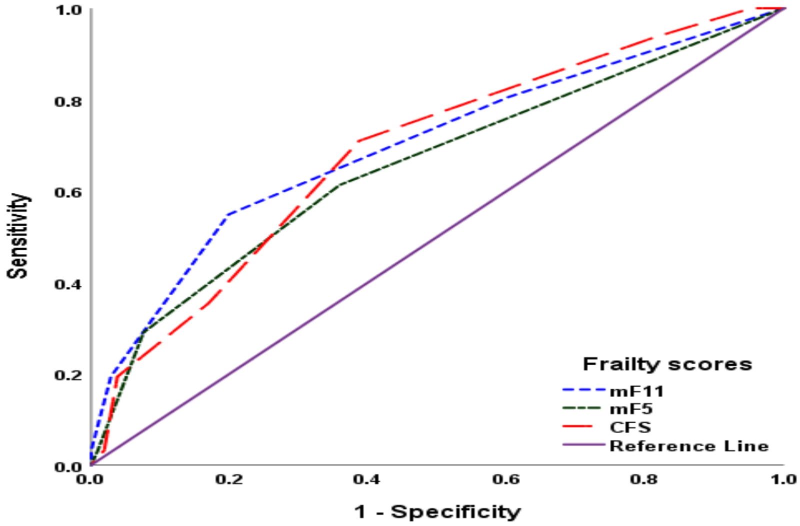

Fig. 5. The ROC curve analysis of preoperative frailty indices as predictors for the incidence of spinal surgery complications

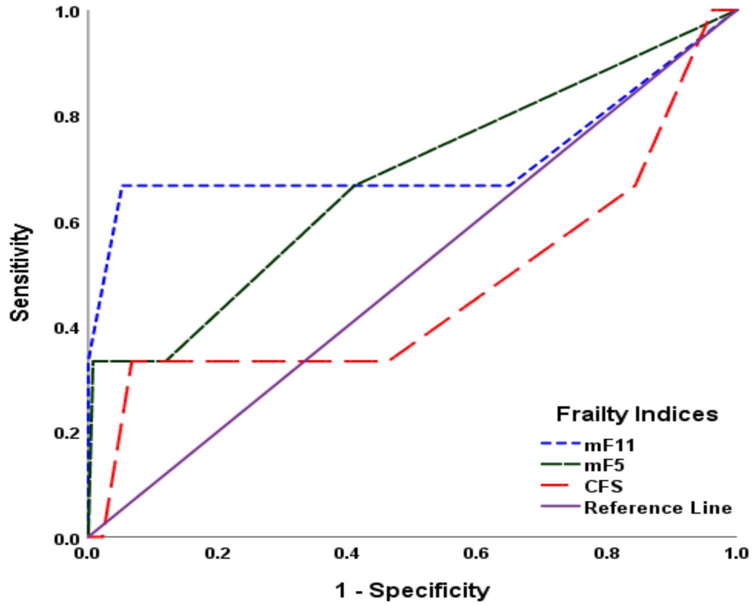

Fig. 6. The ROC curve analysis of preoperative frailty indices as predictors for multiplicity of spinal surgery complications

Discussion

Revision of the studied files of patients underwent lumbar spinal surgeries detected that the majority of patients were aged, obese, males and had chronic medical problems. These patients' characteristics adversely affected the success of surgery in terms of improvement of pain and pain-related disability, where the extent of improvement as presented by ΔNRS and ΔODI was found to be inversely related to age, BMI and presence of medical disorders.

In line with these findings, **Tan et al., (2023)** after revision of the national claims database reported that old, male and/or obese patients were significantly more likely to receive 2-level interspinous process devices and showed 9.3% reoperation rate within three years postoperative. Also, **Khalid et al., (2023)** reported that sarcopenic obesity was associated with higher odds of non-home discharge, readmission, and postoperative mortality of patients underwent surgical management of spine metastasis. **Cannizzaro et al., (2023)** found advanced age and obesity are risk factors for developing lumbar adjacent segment degeneration after lumbar surgery for degenerative spine pathologies. Moreover, **Wang et al., (2023)** found sagittal abdominal diameter was significantly associated with severe L4-L5 and L5-S1 levels intervertebral disc degeneration and BMI and subcutaneous abdominal fat thickness were significantly correlated with lower back pain especially in females. Furthermore, **Xu et al., (2024)** found patients with sacroiliac joint pain after posterior lumbar interbody fusion had higher BMI with greater abdominal obesity and concluded that abdominal obesity is a significant predictor of postoperative sacroiliac joint pain.

The preoperative presence and multiplicity of medical disorders increased the vulnerability for complications especially that related or secondary to their chronic medical problems. This assumption goes in hand with **Son et al., (2023)** detected higher incidence of wound complications, myocardial infarction, renal failure, and urinary tract infection/urinary incontinence with significantly higher revision surgery and readmission rates among patients underwent multilevel anterior cervical discectomy and fusion and had hyperlipidemia than those had normal lipid profile. Also, **Passias et al., (2024A)** who detected higher rate of postoperative complications, cardiac insults and mortalities in patients had previous CABG or stenting before undergoing spinal surgery and found the risk of myocardial infarction is twice doubled in patients had previous stenting than those had CABG.

The incidence and multiplicity of complications were found to be significantly related to the preoperative frailty scorings and statistical analyses defined the mFI-11 scorings are more predictive for postoperative events with higher significance than other indices despite of their significant predictability for oncoming complications.

In line with these findings, **Seitz et al., (2023)** found mFI-5 strongly and independently predicted increased odds of postoperative morbidity for patients undergoing 3-column osteotomy as surgical intervention for adult spinal deformity and was the only mFI-5 ≥ 2 significant independent predictor of readmission

Kweh et al., (2024) found the risk of major complications after spinal surgery was independently associated with both the mFI-5 (P=.047) and mFI-11 (P=0.000) and both were statistically significant predictors of risk of all complications, surgical site infection and 6-month mortality with higher significance for the ability of mFI-11 to predict these outcomes. Also, **Passias et al., (2024B)** reported that for adult spinal deformity patients undergoing correction longer length of postoperative hospital stay was related to increasing frailty severity and found frailty independently predicted occurrence of any complication and reoperation. Moreover, **Vadhera et al., (2024)** assured the strong predictability of the Adult Spinal Deformity-Comorbidity, Seattle Spine and the mFI-5 scores for major complications and discharge disposition after adult spinal deformity in comparison to Charlson Comorbidity Index and suggested that the Seattle Spine and the mFI-5 scores are the preferred for clinical risk stratification and outcomes research in these patients. Also, **Asada et al., (2024)** documented that in patients undergoing anterior cervical spine surgery, frailty evaluated by the mFI-11 was significantly associated with postoperative dysphagia. In general, **Branstetter 4th et al., (2024)** revised the registry of the American College of Surgeons for patients underwent neurosurgical procedures and found increased frailty was associated with higher rate of 30-day postoperative mortality, with a dose-dependent effect.

The simplicity of mFI-5 and being easier to be launched for daily clinical use was its documented advantage **(Kweh et al., 2024)**, however, the reported superiority of mFI-11 might be attributed to inclusion of multiple risk factors especially that related to brain affection that may lead cognitive dysfunction and impaired sensorium, which commonly affect old aged population who represent the main bulk of patients undergoing spinal surgery for degenerative diseases. In support of the necessity for evaluations of brain functions, a newly model for cognitive frailty was developed to assess the cognitive function and its possibility of postoperative cognitive impairment **(Huang et al., 2024)**.

Conclusion

Spinal surgery success is inversely related patients' age, BMI and the presence of multiple chronic medical illnesses. The incidence and multiplicity of surgery-related complications were positively related to the FI scorings. The mFI-11 showed the highest predictability for complication and is better to be applied for preoperative evaluation.

Recommendations

Evaluation of the mFI-11 as predictor for outcomes of intracranial surgeries and to try to include the newly developed cognitive frailty index is recommended.

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