

ORIGINAL ARTICLE

Is Frailty Syndrome a Predictor of Morbimortality in Postoperative Cardiac Surgery? – A Retrospective Cohort Study

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Abstract

Background: Frailty is a biological syndrome suggested as a better predictor of morbimortality than chronological age.

Objective: To assess associations between frailty and morbimortality outcomes in postoperative cardiac surgery.

Methods: A retrospective cohort study was conducted with cardiac surgery patients. Frailty and maximal inspiratory pressure (MIP) were assessed before surgery. Postoperative outcomes were: extracorporeal circulation time; use of vasopressor; mean arterial pressure (MAP); red blood cell (RBC) transfusion; cardiac arrhythmia and/or heart arrest; presence of intra-aortic balloon pump; antibiotic use; extubation time; length of stay in the intensive care unit (ICU); length of postoperative stay; mortality. One-way ANOVA was used to compare postoperative variables between frailty categories; Spearman was used to evaluate the correlations between frailty and postoperative variables. Age, sex, and MIP were introduced into multiple regression models to find the independent association between postoperative variables and frailty. A significance level of $p < 0.05$ was adopted.

Results: The medical records of 200 patients were analyzed (65.7±7.2 years; 68.5% men; 63.5% non-frail, 22.5% pre-frail, 14% frail). Frailty was not a predictor of postoperative outcomes. Age was an independent predictor for alterations in MAP (PR: 1.028, 95% CI: 1.003-1.053, $p=0.025$), need for RBC transfusion (PR: 1.034, 95% CI: 1.007-1.062, $p=0.014$), longer extubation time (PR: 1.052, 95% CI: 1.023-1.083, $p<0.001$), length of stay in the ICU (β : 0.031, 95% CI: 0.010-0.053, $p=0.005$), length of postoperative stay (β : 0.017, 95% CI: 0.003-0.031, $p=0.015$).

Conclusions: Frailty was not a predictor of morbimortality following cardiac surgery in middle-aged and older adults; however, age did predict morbidities in this setting.

Keywords: Fragility Syndrome; Cardiac Surgery; Postoperative Complications; Morbimortality.

Introduction

Frailty is a biological syndrome that reflects a state of decreased physiological reserve and vulnerability to stressors.^{1,2} The prevalence of frailty is dependent on the population and the frailty assessment tool used; in non-hospitalized Brazilian older adults, it is estimated to be around 24%³ and seems to reach 60% of older adults with previous cardiovascular disease (CVD).⁴ Frailty and CVD

share several pathobiological commonalities, and chronic low-level inflammation may represent a mutual basis for both conditions.⁵ In CVD, frailty leads to a two-fold increase in mortality, an effect that persists even after adjustment for age and comorbidities.⁶

The rate of surgical procedures in older adults is rising, and advanced age can increase the risk of morbidity and mortality after surgery.⁷ Frailty has proven to be an independent risk factor for poor outcomes after surgery

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DOI: <https://doi.org/10.36660/ijcs.20210180>

Manuscript received July 01, 2021; revised manuscript November 12, 2021; accepted December 10, 2021.

(e.g., prolonged hospitalizations and faster functional decline) and high healthcare costs.⁸ The assessment of frailty may facilitate identifying vulnerable surgical patients, and appropriate pre and postsurgical management can be implemented.⁹⁻¹¹

Lower levels of muscular strength, one of the factors of frailty, are associated with a higher risk of mortality in the adult population, regardless of age.^{12,13} Indeed, extremity muscle strength can be considered a surrogate of weakness in other skeletal muscles, such as respiratory muscles.¹⁴ Furthermore, surgery may lead to respiratory dysfunction, including decreased vital capacity, tidal volume, total lung capacity, and respiratory muscle weakness. These impairments were correlated with a higher rate of postoperative pulmonary complications.¹⁵ So, assessment of inspiratory muscle strength, as a predictor of morbimortality, may be necessary for patients with CVD, particularly for those undergoing cardiac surgery, when postoperative pulmonary impairments are expected.

Whereas frailty and CVD coexist in many cases, the main purpose of this study, besides tracking the prevalence of frailty, was to assess the associations between frailty and morbimortality outcomes in postoperative cardiac surgery in middle-aged and older adults. The association between maximal inspiratory pressure (MIP) and postoperative morbimortality was also verified.

Methods

This study was a retrospective cohort study conducted in a tertiary hospital in Southern Brazil, reported according to Strengthening the Reporting of Observational Studies in Epidemiology (STROBE).¹⁶

Participants

The sample size calculation was based on data from a review study.⁶ A total estimated sample was 188 individuals, considering a frailty prevalence of 25% and a risk of morbimortality at four times higher for frail individuals, with a power of 90% and an α of 5%. The analyzed data were retrieved from clinical records of 200 consecutive patients who underwent cardiac surgery from January 2015 to June 2017. The inclusion criteria were adults (i.e., ≥ 18 years old), both sexes, who were hospitalized for the following elective cardiac surgeries: 1) coronary artery bypass grafting (CABG), 2) valve replacement, or 3) both. Exclusion criteria included missing clinical record data from pre or postoperative assessment. The Institutional

Review Board approved the study on September 29, 2017 (No. 2.306.582).

Preoperative assessment

In the preoperative period at the hospital, characteristics from patients were registered (i.e., age, gender, type of cardiac surgery, and body mass index). The frailty score and MIP were also assessed.

Frailty syndrome

Frailty was assessed using the Fried scale tool, which encompasses slowness, weakness, low physical activity, exhaustion, and unintentional weight loss. Patients who presented three or more of the five items described above were classified as frail, while those who presented none of these features were classified as non-frail. Patients who checked one or two of these items were classified as pre-frail.¹

Slowness was assessed in a five-meter-long corridor, along which the patient walked at their own pace, without running. The ratio between distance and time (meters/second) was calculated.¹⁷ A walking time of six seconds or longer (<0.83 m/s) was selected as the optimal cut-off point for frailty.⁶

Weakness was assessed by handgrip strength,¹⁸ according to the recommendation of the American Society of Hand Therapists.¹⁹ When the participants were ready, they were asked to hold the hydraulic dynamometer (Model HS5001-SAEHAN Corporation, Korea) with their dominant hand and to perform maximum isometric effort, maintaining it for about 5 seconds. The mean of three attempts for their dominant hand was compared to reference values, according to sex and body mass index (kg/m^2).¹

Low physical activity was assessed by the Duke Activity Status Index, a 12-item questionnaire used to assess the activities of daily living.²⁰ Each item has a specific weight based on metabolic cost (MET). The participants identified activities which they were able to perform. The final score ranges from zero to 58.2 points. The cut-off point of 4 METs, classified as a poor functional capacity, was considered to characterize frailty.²¹

Exhaustion was assessed by asking patients the questions: (1) *Last week, how often did you feel like everything you did was an effort?* (2) *Last week, how often did you feel like you could not get going?* It was considered *often* when the answer was equal to or more than three days and *not often* when the answer was fewer than three days. Exhaustion was

considered to be present when the answer to both questions was *often*.⁶ Lastly, the criterion for unintentional weight loss was based on self-reported or measured weight, which was not due to dieting or exercising in the previous year. The cut-off point of 4.5 kg or more was considered for frailty.⁶

Maximal inspiratory pressure

Inspiratory muscle strength was assessed by manovacuometry, according to the recommendation of the American Thoracic Society.²² At least three reproducible maneuvers were performed using a digital pressure manometer (MVD300 - Globalmed, Brazil). The highest value was recorded for data analysis as long as it did not exceed the second-highest value by 10%.²² Maximal inspiratory pressure < 40 cmH₂O was selected as the cut-off point for inspiratory muscle weakness.²³

Postoperative assessment

Data on morbidity in the postoperative period was obtained from the patients' clinical records considering the following items: extracorporeal circulation time (cut-off point of 120 minutes), use of vasopressor (yes or no), mean arterial pressure (MAP) < 60 mmHg or > 120 mmHg, need for red blood cell (RBC) transfusion (yes or no), the occurrence of cardiac arrhythmia and/or heart arrest (yes or no), presence of intra-aortic balloon pump (yes or no), antibiotic use (yes or no), extubation time (≤ 8 hours, between 9-12 hours or > 12 hours), length of stay in the intensive care unit (ICU) (total days), and length of postoperative stay (total days), which includes the period between surgery and hospital discharge. In-hospital mortality due to clinical complications was also recorded.

Statistical analysis

The continuous data are presented as mean ± standard deviation (SD) or median and interquartile range (p25-p75), according to the normality of the data. Categorical data are presented in counts and relative frequencies. For continuous variables, normality was tested by the Shapiro-Wilk test. One-way ANOVA with Bonferroni post-hoc test was used to compare normally distributed variables between frailty categories. Asymmetric variables were analyzed using the Kruskal-Wallis test and Dunn's multiple comparisons test with adjustment by Bonferroni. For categorical variables, Pearson's chi-squared or Fisher's exact tests were used. The association between postoperative morbimortality variables and MIP was evaluated by the Spearman test.

Afterwards, age, sex, and MIP, which were significantly associated ($p < 0.05$) with frailty, were introduced into multiple regression models to find the independent association between frailty and postoperative variables. The multiple Poisson regression model with robust variances was performed for categorical variables and multiple linear regression through the generalized linear model method with a gamma distribution for continuous variables. All analyses were generated in IBM SPSS Statistics software, Version 20.0 (IBM Corp., Armonk, NY, USA), with a significance level of $p < 0.05$.

Results

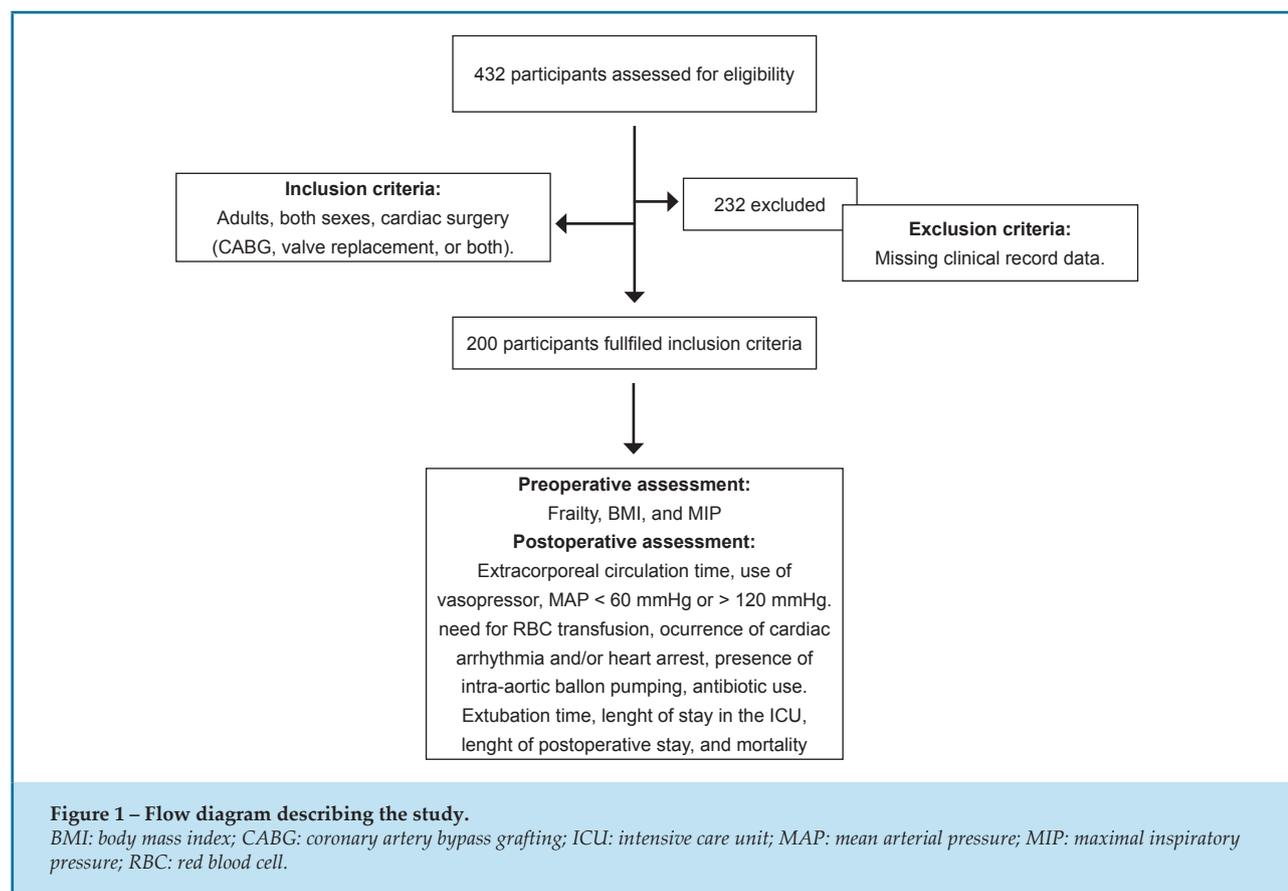
Participant characteristics

According to our inclusion criteria, a total of 432 patients were eligible for the study; 232 patients were excluded due to missing data in their clinical records. The study flow diagram is shown in Figure 1. The majority of patients were male (68.5%), with a mean age of 65.7 ± 7.2 years (from 48 to 87 years old), classified as overweight (45%) and non-frail (63.5%). Forty-three (21.5%) patients undergoing cardiac surgery were younger than 60 years old.

The median postoperative follow-up time was 8 (7-11) days. The pre and postoperative clinical characteristics of the sample were summarized in Table 1. Coronary artery bypass grafting was the most prevalent surgery (68.5%), followed by valve replacement surgery (19%) and by the association of CABG and valve replacement (12%). MIP was below 40 cmH₂O in 22 (11%) individuals.

Comparisons of frailty categories for participant characteristics and postoperative morbimortality

The mean age of patients in pre-frail and frail categories was greater ($p = 0.002$) when compared to non-frails. Considering sex, the prevalence of frail and pre-frail patients was greater for women than men ($p < 0.001$). However, there was no difference between frailty categories according to body mass index (BMI). Red blood cell transfusion ($p = 0.003$) and occurrence of arrhythmia ($p = 0.038$) were more prevalent in pre-frail and frail patients. The extubation time over 12 hours was also more prevalent in frail than non-frail patients ($p = 0.034$). Maximal inspiratory pressure below 40 cmH₂O ($p < 0.001$) and length of postoperative stay ($p = 0.019$) were more prevalent in frail patients than non-frail ones. Finally, there was no difference between frailty categories and the following outcomes: extracorporeal circulation time,



vasopressor use, MAP alterations, cardiac arrest, death, antibiotic use, and length of stay in the ICU (Table 1).

Associations between MIP and postoperative morbimortality

Inspiratory muscle weakness was associated with RBC transfusion since 59.1% of the individuals with MIP < 40 cmH₂O needed blood transfusion compared to 28.7% of individuals with MIP > 40 cmH₂O (p=0.004). MIP was also associated with a longer postoperative stay. The median was 21.5 (16.5-33.8) days for patients with MIP < 40 cmH₂O vs. 18 (14.0-22.0) days for those patients with MIP > 40 cmH₂O (p=0.020). There was no association between MIP and the other morbimortality variables.

Multiple regression models

Frailty was not associated with postoperative variables in multiple regression models when adjusted by age, sex, and MIP. Instead, the regression analysis revealed that age was an independently determinant for MAP (p=0.025), RBC transfusion (p=0.014), extubation time (p<0.001), length

of stay in the ICU (p=0.005), and length of postoperative stay (p=0.015). Female sex was also an independently determinant for RBC transfusion (p=0.002) (Table 2).

Discussion

The present study showed a prevalence of 36% in frailty and pre-frailty in the preoperative period of cardiac surgery, which was higher for older patients and for women. However, frailty assessed by the Fried phenotype, was not a predictor for postoperative outcomes in multiple regression models when adjusted by age, sex, and MIP. Only age was an independent predictor for postoperative morbidity in a short-term inpatient follow-up.

Most of our sample patients were older than 60 years, male, with overweight/obesity. Coronary artery bypass grafting was the most prevalent type of cardiac surgery. These characteristics were similar to previous reports.²⁴⁻²⁶ The prevalence of frailty varies among studies according to age group and the frailty classification tool.²⁷ We found 14% of frailty in middle age and older adults, assessed by Fried phenotype, and 22.5% of pre-frailty. Bäck et

Table 1 – Baseline and postoperative clinical characteristics according to frailty categories

Variables	Overall (n=200)	Frail (n=28)	Pre-frail (n=45)	Non-frail (n=127)	p-value
Age, years	65.7 ± 7.2	68.6 ± 8.1 ^a	67.6 ± 7.3 ^a	64.4 ± 6.6	0.002
Sex- n (%)					<0.001
Men	137 (68.5)	13 (9.5) ^a	24 (17.5) ^a	100 (73.0) [†]	
Women		15.0 (23.8) ^{a*}	21.0 (33.3) ^{a*}	27.0 (42.9)	
BMI, kg/m ² - n (%)					0.656
Underweight/Normal	65 (32.5)	8 (12.3)	17 (26.2)	40 (61.5)	
Overweight	90 (45.0)	11 (12.2)	20 (22.2)	59 (65.6)	
Obese	45 (22.5)	9 (20.0)	8 (17.8)	28 (62.2)	
MIP, cmH ₂ O- n (%)					<0.001
≥40	178 (89.0)	18 (10.1)	40 (22.5) ^b	120 (67.4) ^b	
<40	22 (11.0)	10 (45.5) [†]	5 (22.7) ^b	7 (31.8) ^b	
Postoperative morbidity- n (%)					
Extracorporeal circulation time, min					0.126
<120	183 (91.5)	27 (96.4)	38 (84.4)	118 (92.9)	
>120	17 (8.5)	17 (3.6)	1 (15.6)	9 (7.1)	
Vasopressor use	175 (87.5)	24 (85.7)	37 (82.2)	114 (89.8)	0.442
MAP <60 or >120 mmHg	76 (38.0)	13 (46.4)	20 (44.4)	43 (33.9)	0.278
RBC transfusion	64 (32.0)	14 (50.0) ^a	20 (44.4) ^a	30 (23.6)	0.003
Occurrence of arrhythmia	51 (25.5)	11 (39.3) ^a	15 (33.3) ^a	25 (19.7)	0.038
Cardiac arrest	13 (6.5)	2 (7.1)	5 (11.1)	6 (4.7)	0.358
Intra-aortic balloon pumping	9 (4.5)	0 (0)	4 (8.9)	5 (3.9)	0.154
Death	8 (4.0)	2 (7.1)	3 (6.7)	3 (2.4)	0.303
Antibiotic use	32 (16.0)	9 (32.1)	6 (13.6)	17 (13.4)	0.052
Length of postoperative stay, days	8 (7-11)	9 (7-13)	9 (7-14) ^b	7 (7-9) ^b	0.019
Length of stay in the ICU, days	2.0 (2-4)	2.5 (2-4)	3.0 (2-4)	2.0 (2-3)	0.207
Extubation time, hours					0.034
≤8	59 (29.5)	5 (17.9)	8 (17.8)	46 (36.2) ^c	
9-12	90 (45.0)	12 (42.9)	22 (48.9)	56 (44.1)	
>12	51 (25.5)	11 (39.3)	15 (33.3)	25 (19.7) ^b	

Continuous variables expressed as mean ± SD or median [interquartile range (p25-p75)]. Categorical variables expressed as numbers (%). BMI: body mass index; ICU: intensive care unit; MAP: mean arterial pressure; MIP: maximal inspiratory pressure; RBC: red blood cell. ^a Difference from non-frail (p<0.05). ^b Difference from frail (p<0.05). ^c Difference from pre-frail (p<0.05). [†] Difference for the variable in the same frailty category (p<0.05).

Table 2 – Multiple regression analysis for the interaction between postoperative variables and frailty

Postoperative variables	PR	ß	95% CI	P
Vasopressor use				
Age	1.006		0.999 – 1.013	0.102
Female sex	1.064		0.967 – 1.171	0.204
MIP<40 cmH ₂ O	1.039		0.889 – 1.214	0.630
Pre-frailty	0.882		0.761 – 1.022	0.096
Frailty	0.902		0.759 – 1.071	0.239
MAP <60 or >120 mmHg				
Age	1.028		1.003 - 1.053	0.025*
Female sex	1.320		0.910 - 1.914	0.144
MIP<40 cmH ₂ O	1.254		0.803 – 1.960	0.320
Pre-frailty	1.099		0.726 – 1.665	0.654
Frailty	1.038		0.640 – 1.682	0.881
RBC transfusion				
Age	1.034		1.007 – 1.062	0.014*
Female sex	1.969		1.272 – 3.047	0.002*
MIP<40 cmH ₂ O	1.345		0.833 – 2.171	0.225
Pre-frailty	1.378		0.849 – 2.239	0.195
Frailty	1.345		0.799 – 2.264	0.264
Occurrence of arrhythmia				
Age	1.027		0.994 – 1.061	0.106
Female sex	1.099		0.676 – 1.786	0.705
MIP<40 cmH ₂ O	1.345		0.726 – 2.492	0.347
Pre-frailty	1.486		0.827 – 2.672	0.186
Frailty	1.568		0.823 – 2.987	0.171
Cardiac arrest				
Age	1.031		0.958 – 1.111	0.412
Female sex	0.631		0.199 – 2.001	0.435
MIP< 40cmH ₂ O	2.597		0.685 – 9.847	0.160
Pre-frailty	2.181		0.635 – 7.487	0.215
Frailty	1.063		0.202 – 5.594	0.942
Intra-aortic balloon pumping				
Age	1.003		0.933 – 1.079	0.929
Female sex	0.440		0.094 – 2.062	0.298
MIP< 40cmH ₂ O	4.238		0.992 – 18.101	0.051
Pre-frailty	2.262		0.545 – 9.390	0.261
Frailty	1.318		0.258 – 6.733	0.740
Death				
Age	1.074		0.985 – 1.170	0.107
Female sex	0.502		0.122 – 2.067	0.340
MIP< 40cmH ₂ O	0.956		0.168 – 5.422	0.959
Pre-frailty	2.548		0.416 – 15.600	0.312
Frailty	2.486		0.390 – 15.850	0.335
Antibiotic use				
Age	1.041		0.992 – 1.093	0.101
Female sex	0.949		0.460 – 1.958	0.887
MIP< 40cmH ₂ O	1.098		0.442 – 2.732	0.840
Pre-frailty	0.899		0.336 – 2.409	0.833
Frailty	1.968		0.863 – 4.491	0.108

Extubation time, hours			
Age	1.052	1.023 – 1.083	0.000*
Female sex	1.225	0.763 – 1.966	0.401
MIP<40 cmH ₂ O	1.095	0.594 – 2.018	0.772
Pre-frailty	1.342	0.760 – 2.369	0.310
Frailty	1.451	0.783 – 2.691	0.237
Length of postoperative stay, days			
Age	0.017	0.003 – 0.031	0.015*
Female sex	0.013	-0.169 – 0.195	0.889
MIP<40 cmH ₂ O	0.247	-0.130 – 0.635	0.199
Pre-frailty	0.133	-0.124 – 0.391	0.310
Frailty	-0.092	-0.337 – 0.153	0.461
Length of stay in the ICU, days			
Age	0.031	0.010 – 0.053	0.005*
Female Sex	-0.035	-0.322 – 0.253	0.813
MIP<40 cmH ₂ O	0.228	-0.282 – 0.737	0.381
Pre-frailty	0.124	-0.294 – 0.541	0.562
Frailty	-0.289	-0.635 – 0.057	0.101

Multiple regression models adjusted by age, sex, and MIP. Male sex, MIP \geq 40 cmH₂O and Non-frail: reference categories. PR: prevalence ratio for categorical variables; β - Regression coefficient for continuous variables. CI: confidence interval. ICU: intensive care unit; MAP: mean arterial pressure; MIP: maximal inspiratory pressure; RBC: red blood cell. * Significant association between adjustment criteria and postoperative variables ($p < 0.05$).

al.,²⁸ found 25% of frail patients in 604 individuals over 65 years, considering a comprehensive frailty tool, that includes the Fried criteria, physical performance, and laboratory tests.²⁹ Despite the prevalence differences, there were similar results among our study and previous studies.^{28,30} Prospective observational studies also demonstrated that frail and pre-frail patients had a higher prevalence of postoperative complications, such as atrial fibrillation,²⁸ prolonged ventilation,^{28,30} transfusion requirements,²⁸ and increased length of stay.^{28,30}

Contrary to expected, Fried's frailty alone was not enough to predict morbimortality. Some studies have already shown more robust, integrative, and comprehensive tools that are based on many factors,^{29,31} since frailty has many etiological pathways.³² In addition, it is important to note that our follow-up time after surgery was short (i.e., from 7 to 11 days), unlike other studies that had follow-up equal or longer than 30 days.^{9,10,28} In a previous prospective study, which assessed frailty in 594 older patients who underwent cardiac and non-cardiac elective surgery,³³ even after adjusting for cardiovascular risk factors and characteristics of patients, frailty remained as an independent predictor of surgical complications and length of stay. A possible explanation for these divergent results could be differences in sample age and surgical procedures; longer postoperative follow-up time (i.e., 30 days); and a stricter cut-off point for frailty, as in four or five Fried items.³³

We chose to include 43 participants below 60 years, since frailty is not a condition limited by age. In the scenario of cardiac surgery, the presence of cardiovascular diseases and others comorbidities could be responsible for the frail condition. However, similar to other studies, frail and pre-frail participants were older.³⁴ Even though frailty may be a better predictor than age per se, chronological age was the only factor independently associated with morbimortality in our study. A positive association was found between age and MAP alterations, which could indicate hemodynamic instability in older patients in the perioperative setting. In addition, our data demonstrated an association between age and RBC transfusion, agreeing with the previous study.³⁵ Age was also associated with extubation delay, length of stay in the ICU, and length of postoperative stay. In fact, patients who experience delayed extubation will have longer ICU and hospital length of stay, as well as a consequently higher treatment costs and lower quality of life.³⁶ In a large prospective cohort of almost half a million people from 37 to 73 years, frailty and pre-frailty were associated with age, female sex, obesity and underweight, smoking, socioeconomic deprivation, and infrequent alcohol intake.³⁷ In fact, the prevalence of multimorbidity and frailty increases with age, but neither is limited to the elderly.³⁷

In addition to being older, the prevalence of frailty was higher in women. According to the male-female health-survival paradox, although women live longer

than men, they tend to have a poorer health status. A combination of biological, behavioral, and social factors seems to underpin this paradox.³⁸ It is suggested that women have a greater physiological reserve than men, enabling women to develop more deficits in multiple organ systems without succumbing to death.^{32,38} Also, our data demonstrated that female sex was independently associated with RBC transfusion, as in other studies which showed that women have a higher bleeding tendency³⁹ and are more likely to be transfused than men.⁴⁰ Considering the obtained results, the higher prevalence of frailty in women and older adults demonstrates a greater vulnerability of these individuals, especially when RBC transfusion was done. Thus, this population should be prioritized when interventions are planned.

Finally, it was also expected that preoperative inspiratory muscle weakness could lead to poorer postoperative outcomes, since cardiac surgery may lead to respiratory dysfunction and ventilatory muscle impairment.¹⁵ Our data showed a greater prevalence of inspiratory muscle weakness (MIP below 40 cmH₂O) in frail patients. Nevertheless, after adjustments, MIP was not a predictor of postoperative morbimortality, possibly because MIP assesses the strength of ventilatory muscles and does not consider abnormalities in gas exchange and other ventilatory mechanical variables, which the surgical trauma itself can impair. Thus, it can be speculated that MIP seems to be an unsatisfactory predictor, since it has a high sensitivity but a low specificity.⁴¹ It can therefore be concluded that other variables, or even a cutoff point different from that used here, may in fact lead to different results, which should be considered in future research.

By contrast, respiratory muscle dysfunction was associated with postoperative prolonged mechanical ventilation in a prospective assessment of 151 patients who had undergone heart valve surgery.⁴² This disagreement between these studies could be addressed by differences in the cut-off points used for MIP (40 cmH₂O *vs.* 70 cmH₂O). In addition, maximal expiratory pressure values were combined with a respiratory rate above 15 rpm to characterize respiratory muscle dysfunction.⁴²

Some limitations of this study should be pointed out. This study failed to identify the comorbidities preoperatively. Hypertension, heart failure, chronic obstructive pulmonary disease, anemia, and other comorbidities could contribute to frailty syndrome and morbimortality outcomes. The retrospective design limited the access to relevant information for confounding factors. As a study strength, our results may

help future studies make decisions about which frailty assessment tool to use for middle-aged and older adults undergoing cardiac surgery.

Conclusions

Frailty was more prevalent in older adults and women undergoing cardiac surgery. Frail patients also had a higher prevalence of inspiratory muscle weakness. Nevertheless, MIP was not a predictor of postoperative morbimortality. Frailty assessed by the Fried phenotype was not a predictor of postoperative morbimortality, considering a short postoperative time at the hospital. Instead, age was the most important independent factor associated with postoperative morbidity following cardiac surgery, in middle-aged and older Brazilian adults.

Author Contributions

Conception and design of the research: Nascimento DM, Santos FV. Acquisition of data: Santos FV, Rover MC, Moura MS, Leão BM. Analysis and interpretation of the data: Nascimento DM, Botton CE. Statistical analysis: Nascimento DM, Botton CE. Writing of the manuscript: Nascimento DM, Botton CE. Critical revision of the manuscript for intellectual content: Nascimento DM, Botton CE, Schaan BD.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Sources of Funding

There were no external funding sources for this study.

Study Association

This study is not associated with any thesis or dissertation work.

Ethics approval and consent to participate

This study was approved by the Ethics Committee of the Santa Casa de Misericórdia de Porto Alegre under the protocol number 2.306.582. All the procedures in this study were in accordance with the 1975 Helsinki Declaration, updated in 2013. Informed consent was obtained from all participants included in the study.

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