RESEARCH

Assessing the accuracy of the revised Cardiac Risk Index compared to the American Society of Anaesthesiologists physical status classification in predicting Pulmonary and Cardiac complications among non-cardiothoracic surgery patients at Muhimbili National Hospital: a prospective cohort study

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Abstract

Background The Revised Cardiac Risk Index (RCRI) and the American Society of Anaesthesiologists (ASA-PS) classification system are two commonly used tools for preoperative risk assessment. This study aimed to assess the accuracy of RCRI compared to the ASA-PS classification system in preoperative risk assessment for pulmonary and cardiac problems among non-cardiothoracic surgery patients admitted at Muhimbili National Hospital (MNH).

Methods This was a prospective cohort study design conducted from August 2022 to April 2023 among 184 patients of 18 years and above admitted at MNH for elective non-cardiothoracic surgery. Data Analysis was conducted using STATA software version 16. Means and standard deviations were used to summarize continuous data. Frequencies and percentages were used to summarize categorical data. The logistic regression and ROC curve analysis were used to determine the correlation between variables.

Results The majority of patients (43.3%) had an RCRI score of 1 point, and 39.9% were classified as ASA class 1. Patients in ASA classes 3 and 4 had higher odds of developing cardiac and pulmonary complications (AUC = 0.75 and 0.77, respectively). Patients with an RCRI score of 2 or ≥ 3 points were also more likely to experience cardiac and pulmonary complications (AUC = 0.73 and 0.72, respectively). There was no significant difference in the predictive ability of the two tools. Both RCRI and ASA-PS classification systems were equally effective in predicting these complications.

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Conclusion Both the RCRI and the ASA-PS classification system demonstrated good predictive ability for cardiac and pulmonary complications among patients undergoing non-cardiothoracic surgery.

Keywords RCRI, ASA-PS, Preoperative risk assessment, Cardiac complications, Pulmonary complications

Background

There are significant numbers of patients who are developing postoperative cardiopulmonary complications following a non-cardiothoracic surgery [1].

Depending on the type of operation performed, the reported incidence after major non-cardiothoracic surgery ranges from 4 to 20% [2]. To reduce the occurrence or prevalence of postoperative pulmonary complications (PPCs) a thorough understanding of the patient conditions that increase the risk of developing PPCS, as well as the effective interventions available to mitigate the impact of pre-existing patient conditions on the development of Postoperative pulmonary complications, is required. Preoperative Planned Intensive care unit (ICU) admission after surgery must be considered and a Reliable risk stratification tool will be a key issue.

Currently, surgeons' estimates of a patient's surgical risk before surgery differ greatly. Surgical risk calculators are infrequently utilized, despite their reliability [3] Due to differences in the definition of PPCs, the overall incidence of postoperative pulmonary complications among patients undergoing non-cardiothoracic surgery ranges from 2 to 19%. Postoperative pulmonary complications affect 10–30% of patients who require general anesthesia, and they can be more hazardous than a thromboembolic phenomenon, infectious complications. An estimate of the burden of post-operative cardiac complications is equally important as on the burden of pulmonary complications has been stated [2].

To reduce the incidence or prevalence of postoperative pulmonary complications, it is necessary to have a thorough understanding of the patient's health status to increase the risk of developing PPCs, as well as the effective interventions that can be used to mitigate the impact of preexisting patient health status on the development of Postoperative pulmonary complications [4].

Currently, little is known about the risk stratification tools used in our setting especially at MNH which serves as the National referral facility for all health facilities in the country. The ASA-PS categorization and the RCRI were both found to be accurate predictors of Perioperative Myocardial Infarction. At present, MNH surgeons do not have a risk assessment tool to evaluate patients before surgery. However, the anesthesiologist team uses the ASA-PS to screen patients throughout the perioperative period. Studies have shown that in the majority of Perioperative Myocardial Infarction events, 72.7% of incidents happened within 48 h of surgery [5].

This study aimed at comparing the effectiveness and reliability of the two risk stratification tools namely: the ASA-PS classification system and the RCRI during the initial preoperative cardiac and pulmonary evaluation, which involved an attempt to stratify the risk category for pulmonary and cardiac problems among non-cardiothoracic surgery patients attending MNH.

Determining accuracy will help in identifying patients at risk and aid in better preparation in handling predicted post-operative adverse events and thereby reduce mortality.

Methods

Design and setting of the study

This is a prospective cohort study conducted from August 2022 to April 2023 at the Department of Surgery of MNH, using quantitative techniques. The accuracy of the RCRI was compared to that of the ASA-PS classification system in preoperative stratification for postoperative cardiac and pulmonary complications among patients with non-cardiothoracic surgical conditions.

MNH is a tertiary National Referral and University Teaching Hospital with a capacity of 1500 beds and a weekly outpatient volume of 2000 patients. The Department of General Surgery has a bed capacity of 461 beds, with an average of 17,736 admissions per year. Per year, respectively 5,350 and 782 elective major and minor surgeries, and 816 and 75 emergency major and minor surgeries are done.

Target population

Study participants were patients aged 18 years and above who have been admitted for elective non-cardiothoracic surgery at MNH under the Department of Surgery during the study period.

Selection criteria

The study involved patients who underwent major non-cardiothoracic surgery and are over the age of 18 years.

Sample size and data collection

The sample size was estimated using Fischer's formula ($n = z^2*P*Q/d^2$) in a simple population, assuming that the incidence (P) of Pulmonary and Cardiac complications among non-cardiothoracic surgery patients is 14%, within a 95% confidence interval (z = 1,96) and 5% marginal error (d). Thus the sample size was 184. Data were collected by filling the structured questionnaires through interviews with patients in the wards and the follow-up

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after surgery was made to determine their outcome. Investigations like ECG, ECHO, and plain chest X-rays were reviewed by blinded cardiologists and radiologists respectively. The documented results of these investigations' findings were used for this study.

Pre-operative patient's information collected included: patients demographics, description of procedures and indications, anesthetic approach, type of stratification tool used, physiologic data collected during surgery and duration of surgery, complications, and deaths before discharge from the hospital.

The primary attending team was notified whenever related complications were found in the study group because they were responsible for ordering an appropriate investigation and appropriate intervention for these patients; this was done to avoid any potential conflicts of interest. Patients were monitored post-operatively whether they developed cardiac and pulmonary complications or not. The follow-up period ended when a patient was discharged from the ward.

Operational definitions

Cardiac dysfunction is a complex clinical syndrome described as a failure to meet the systematic demands of circulation as a result of a functional or structural cardiac abnormality that affects ventricular filling or ejection fraction [6].

Pulmonary dysfunction is a clinical syndrome that occurs when the lungs fail to sufficiently oxygenate arterial blood and/or avoid carbon dioxide retention. When arterial oxygen is less than 60mmHg and arterial carbon dioxide is more than 50mmHg, this occurs [7].

The American Society of anesthesiologists (ASA) physical status classification Method is a risk stratifying system used primarily by anesthesiologists to help forecast preoperative hazards. It is also used to evaluate a patient's preoperative comorbid disorders. In forecasting perioperative risks, the classification system is utilized in conjunction with other characteristics such as the type of operation, frailty, and level of deconditioning [8].

The revised cardiac risk index (RCRI) is a tool that can be used to predict a patient's risk of perioperative cardiac problems. It is a preoperative prediction tool that is used to determine if there is a link between preoperative characteristics such as the patient's age, operation type, comorbidity at the time of diagnosis, or laboratory data and the likelihood of cardiac problems in non-cardiothoracic surgery patients [6].

Data analysis

Data analysis was conducted by using STATA software version 16. Means and standard deviations were used to summarize continuous data, while frequencies and percentages were used to summarize categorical data.

Sensitivity and specificity were calculated from the postoperative outcome as either having postoperative cardiopulmonary complications or not. The risk variables for postoperative cardiopulmonary problems in non-cardiothoracic surgery patients were determined using logistic regression. To determine if there was a difference in accuracy between these tools, ROC analysis was performed.

Results

Incidence of PPCs

Out of 184 patients who underwent non-cardiac surgery at MNH, PPCs were encountered among 9 patients, i.e. 4,9%.

General characteristics

Demographic and clinical characteristics

The mean age of the study participants was 51 ± 15 years, and the majority were female (57.6%). The most common pre-existing conditions were hypertension (35.6%), diabetes mellitus (22.8%), and chronic obstructive pulmonary disease (COPD) (17.4%).

Accuracy of RCRI and ASA-PS in predicting cardiac complications

The results showed that patients in ASA-PS class 4 had significantly higher odds of developing cardiac complications (OR=11.53; 95%; CI=1.13-117.15; p=0.039). The ROC curve analysis showed that ASA-PS had a good discriminative ability for identifying patients at high risk of cardiac complications with an AUC of 0.75.

The study found that patients with an RCRI score of 3 or higher had significantly higher odds of developing cardiac complications (OR=18.0; 95% CI=1.71-189.02; at a p-value of 0.016). The ROC curve analysis showed that the RCRI had a good discriminative ability for identifying patients at high risk of cardiac complications with an AUC of 0.73.

Accuracy of RCRI AND ASA-PS in predicting pulmonary complications

The study found that patients in ASA-PS class 3 and 4 had significantly higher odds of developing pulmonary complications (OR=10.01; 95% CI=2.59–38.75; p=0.001 and OR=11.04; 95% CI=2.56–47.68; p=0.001, respectively). The ASA-PS also had a good discriminative ability for identifying patients at high risk of pulmonary complications with an AUC of 0.77.

The study also found that patients with an RCRI score of 2 or ≥3 had significantly higher odds of developing pulmonary complications (OR=8.86; 95% CI=2.41–32.48; p=0.001 and OR=6.30; 95% CI=1.35–29.33; p=0.019, respectively). The ROC curve analysis showed that the RCRI had the good discriminative ability for

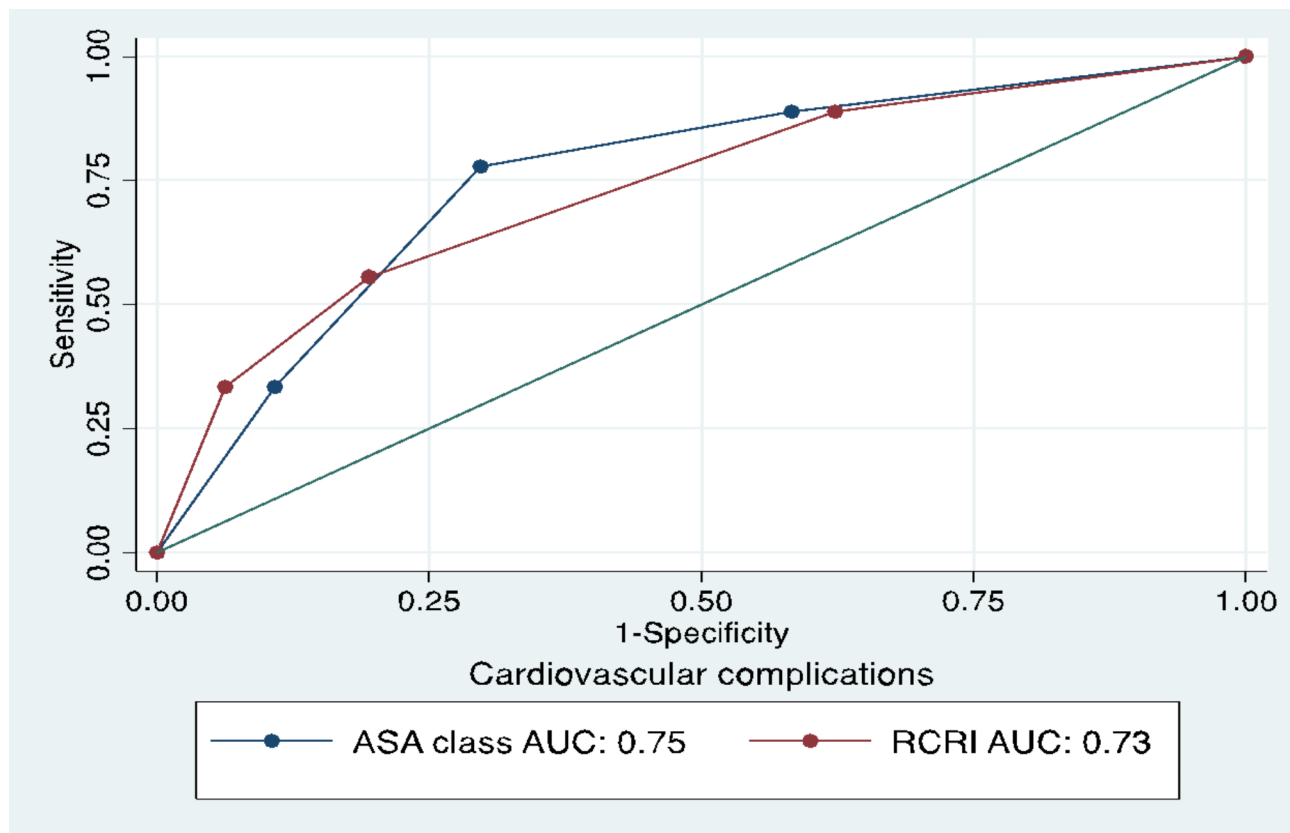Chrisant *et al. BMC Surgery*   (2024) 24:263

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Fig. 1 A ROC curve analysis comparing the accuracies of ASA-PS classification and RCRI score in predicting cardiac complications among non-cardio-thoracic surgery patients at MNH

Table 1 Comparison of the accuracies between ASA-PS classification and RCRI score in predicting cardiac complications among non-cardiothoracic surgery patients

Tool	Observations	AUC (95% Confidence interval)	*p*-value
ASA PS Classification	184	0.75 (0.59–0.91)	
			0.817
RCRI score	184	0.73 (0.56–0.91)	

Key; RCRI revised cardiac risk index, ASA PS American Society of anesthesiologist physical status, AUC; -Area under the curve

identifying patients at high risk of pulmonary complications with an AUC of 0.72.

Comparison of the accuracies between RCRI & ASA-PS in predicting cardiac complications

The ROC curve analysis (Fig. 1) showed that both ASA-PS and RCRI had almost similar AUC values (0.75 and 0.73, respectively), suggesting that these tools have similar discriminative abilities for identifying patients at high risk of cardiac complications. However, there was no statistically significant difference in accuracy between the two tools (*p*=0.817) (Table 1).

Comparison of the accuracies between RCRI & ASA-PS in predicting pulmonary complications

The ROC curve analysis (Fig. 2) showed that both ASA-PS and RCRI had nearly similar AUC values (0.76 and 0.71, respectively), suggesting that these tools have similar discriminative abilities for identifying patients at high risk of pulmonary complications. However, there was no statistically significant difference in accuracy between the two tools (*p*=0.469) (Table 2).

This study found that both ASA-PS and RCRI are accurate tools for predicting cardiac and pulmonary complications in patients undergoing non-cardiothoracic surgery. However, there was no statistically significant difference in accuracy between the two tools. The study also found that patients with higher ASA-PS and RCRI scores were more likely to develop cardiac and pulmonary complications. This suggests that these tools can be used to identify patients who are at high risk of complications and who may benefit from additional monitoring or interventions.

Discussion
Incidence of PPCs
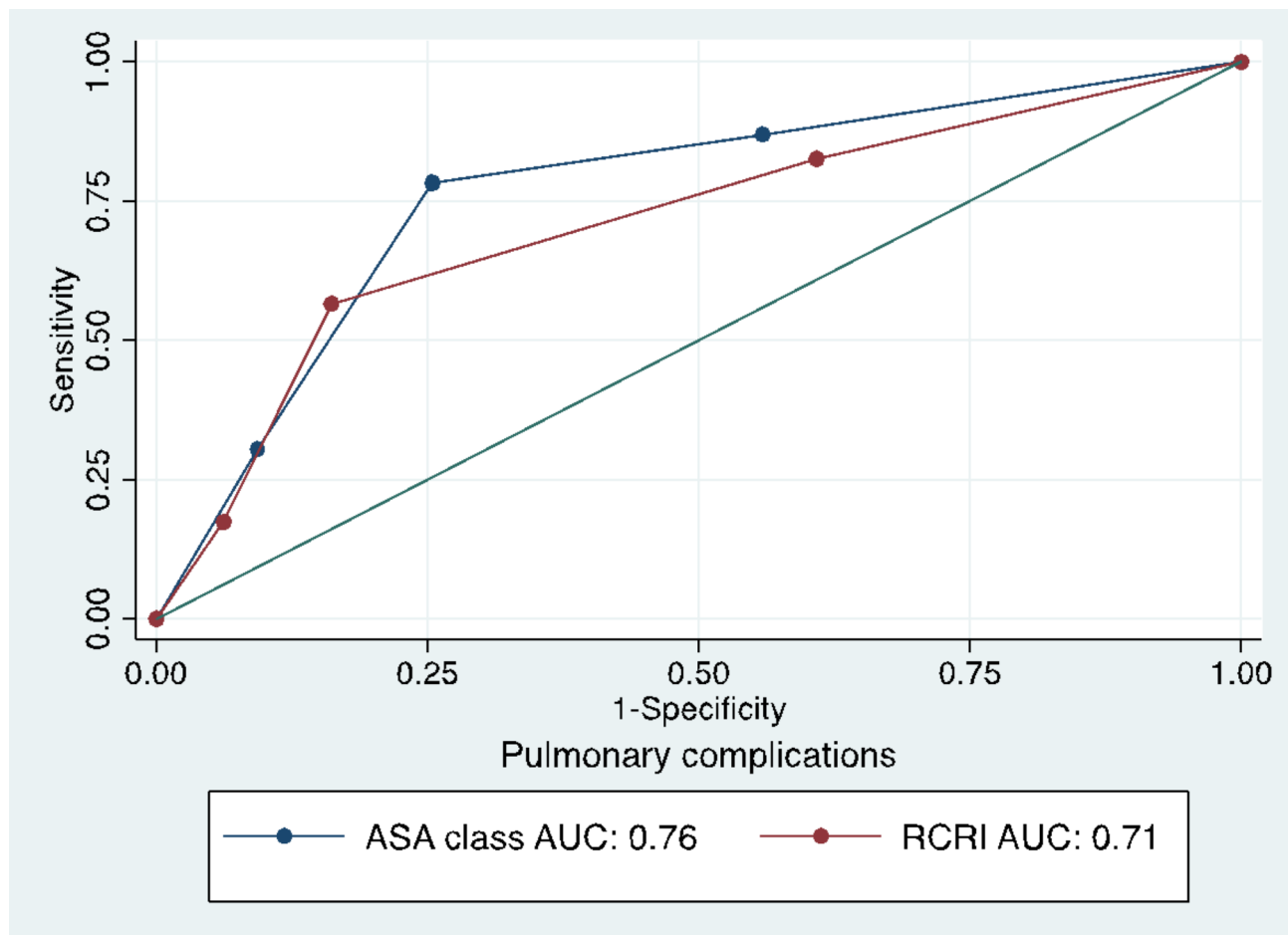The cardiopulmonary complications were found in 4,9% of patients who underwent non-cardiac surgery.

Fig. 2 A ROC curve analysis comparing the accuracies of ASA-PS classification and RCRI score in predicting pulmonary complications among non-cardiothoracic surgery patients at MNH

Table 2 Comparison of the accuracies of ASA PS classification and RCRI score in predicting pulmonary complications among non-cardiothoracic surgery patients at MNH

Tool	Observations	AUC (95% Confidence interval)	p-value
ASA PS Classification	184	0.76 (0.66–0.87)	
			0.469
RCRI score	184	0.71 (0.59–0.83)	

Key; RCRI revised cardiac risk index, ASA PS American Society of anesthesiologist physical status, AUC; -Area under the curve

This incidence, although relatively low, is comparable to 4 to 20% mentioned in literature. This could be explained by the preoperative selection and preparation of the surgical at MNH.

The accuracy of the ASA –PS in predicting pulmonary complications among non-cardiothoracic surgery patients
The findings from our study demonstrate that the ASA-PS exhibited good DA in predicting pulmonary complications with an AUC of 0.77. This indicates that the ASA class has a moderate to high level of accuracy in predicting the occurrence of pulmonary complications among non-cardiothoracic surgery patients. Patients categorized as ASA class 3 or 4 are at significantly higher risk, and healthcare providers should pay particular attention to their preoperative evaluation, perioperative management, and postoperative care to mitigate the risk of pulmonary complications.

The results of this study are consistent with previous studies conducted across different surgical disciplines that have consistently demonstrated the reliability of the ASA physical status classification system and its potential to predict postoperative outcomes. It has been noted that compared to individual comorbidity indices, the ASA physical status classification system exhibits better predictive power, particularly in terms of short-term postoperative mortality [9].

The accuracy of the ASA-PS in predicting cardiac complications among non-cardiothoracic surgery patients

The findings of our study demonstrate that the ASA PS class exhibited good DA in predicting cardiac complications with an area under the curve (AUC) of 0.75. These findings suggest that patients classified as ASA class 4 are at significantly higher risk of experiencing cardiac complications. Healthcare providers should take particular care in the preoperative assessment, perioperative management, and postoperative care of these patients to mitigate the risk of cardiac complications.

These findings are also consistent with a systematic review of 77 published studies involving 165,705 patients, which found that the ASA physical status is a better predictor of postoperative mortality in settings with lower rather than higher death rates [10] These findings are significant as they demonstrate the higher accuracy of the ASA physical status in predicting post-operative risks for non-cardiothoracic surgery patients.

The accuracy of the RCRI score in predicting pulmonary complications among non-cardiothoracic surgery patients

The study findings showed that the RCRI exhibited good DA in predicting pulmonary complications with an AUC of 0.72. Patients with RCRI scores of 2 points and ≥3 points were significantly more likely to experience pulmonary complications and should be closely monitored and appropriate measures should be taken to mitigate the risk of pulmonary complications.

These findings are consistent with previous studies across various surgical specialties that have shown the predictive ability of the RCRI in postoperative morbidity, including elective orthopedic surgery where patients with an mRCRI score≥3 points had increased non-cardiac morbidity and longer hospital stays [11].

The accuracy of the revised Cardiac Risk Index in predicting cardiac complications among non-cardiothoracic surgery patients

These findings support the utility of the RCRI as an effective risk stratification tool for predicting cardiac complications. Patients with higher RCRI scores, particularly those with scores of ≥3 points, should receive increased attention in terms of preoperative evaluation, perioperative management, and postoperative care to mitigate the risk of cardiac complications.

These results align with prior research conducted in different surgical fields, demonstrating the predictive capacity of the Revised Cardiac Risk Index (RCRI) in post-operative complications. For instance, in elective orthopedic surgery, it was observed that patients with an mRCRI score of ≥3 points experienced higher rates of non-cardiac morbidity and prolonged hospital stays [11].

Our study supports the use of the Revised Cardiac Risk Index (RCRI) as a valuable risk stratification tool for predicting cardiac complications among non-cardiothoracic surgery patients admitted at Muhimbili National Hospital.

The difference in accuracy between revised Cardiac Risk Index and the ASA physical status classification system

In this study, we aimed to compare the accuracy of two risk stratification tools, the ASA physical status classification system and the Revised Cardiac Risk Index (RCRI), in predicting cardiac and pulmonary complications among non-cardiothoracic surgery patients at Muhimbili National Hospital. The results of our study demonstrated that patients with a score of ≥3 using the RCRI score were more likely to experience cardiac and pulmonary complications, and this outcome was statistically significant. However, we found no significant difference in predicting cardiac and pulmonary complications between the two risk stratification tools.

Our findings are consistent with previous studies that have demonstrated the reliability of the ASA physical status classification system in predicting post-operative outcomes across various surgical specialties. When compared to individual comorbidity indices, the ASA physical status classification system has been shown to have better predictive power in terms of short-term postoperative mortality. Furthermore, the ASA physical status classification system was found to be a promising and simple tool that can be routinely used in the operating room to predict operative risks for both elective and emergency surgeries, compared to other tools such as Charlson and POSSUM [12, 13].

Although there is limited evidence suggesting differences in accuracy between the two risk stratification tools, our study contributes to the growing body of evidence that both RCRI and ASA physical status are significant predictors of cardiac and pulmonary postoperative complications among non-cardiothoracic surgery patients, with no observed difference in accuracy. This information can be valuable in clinical decision-making and can aid in identifying high-risk patients who may require closer monitoring and more aggressive interventions to prevent post-operative complications. Further studies are needed to validate our findings and to explore the potential benefits of combining these two risk stratification tools to improve accuracy in predicting postoperative outcomes.

However, we recommend surgeons to contemplate the adoption of the RCRI as a preoperative risk assessment tool for non-cardiothoracic surgery patients, as one of the preoperative assessment protocols. Traditionally, the ASA-PS Classification System has been utilized for anesthesia-related risk assessment. However, this study

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indicates that the RCRI offers a valuable alternative that accurately predicts pulmonary and cardiac complications before surgery in non-cardiothoracic patients.

The utilization of the RCRI would enable surgeons to employ a tool specifically designed for their patient population, tailored to their unique requirements. This has the potential to enhance patient outcomes and safety by facilitating more precise risk assessment and informed decision-making throughout patient management and perioperative care.

It should be acknowledged that although both the RCRI and ASA PS exhibit favorable discriminative ability, they may not encompass all the factors that contribute to the occurrence of cardiac and pulmonary complications. The subjective nature of the ASA classification system introduces the possibility of inter-observer variability, and there are additional factors, such as specific comorbidities or procedural intricacies, that may influence the development of pulmonary complications but are not accounted for by the ASA class. Thus, to improve the accuracy of predicting pulmonary complications, it may be beneficial to integrate supplementary risk assessment tools or adopt a more comprehensive approach to risk stratification.

Conclusion

Both the RCRI and the ASA-PS classification system demonstrated good predictive ability for cardiac and pulmonary complications among patients undergoing non-cardiothoracic surgery. The RCRI can be used as a preoperative risk assessment tool for non-cardiothoracic surgery patients. However, the moderately high accuracy rate of both RCRI and ASA scores along with the monocentric aspect of this study should motivate to conduct further studies to validate one preoperative risk assessment tool for non-cardiac surgery more efficient in predicting PPCs.

Abbreviations

ACC	American College of Cardiology
ACP	American College of Physicians
APACHE	Acute Physiology and Chronic Health Evaluation
ASA	American Society of Anesthesiologists
AUC	Area under the curve
CHF	Congestive Heart Failure
COPD	Chronic Obstructive Pulmonary Disease
DRC	Democratic Republic of the Congo
ESC	European Society of Cardiologists
ICU	Intensive Care Unit
Los	Length of Stay
MI	Myocardial infarction
MNH	Muhimbili National Hospital
MUHAS	Muhimbili University of Health and Allied Sciences
POSSUM	Physiologic and Severity Score for the Enumeration of Mortality and Morbidity
PPC	Post-operative Pulmonary Complications
RCRI	Revised Cardiac Risk Index
ROC	Receiver operating characteristics
UOM	Université Officielle de Mbujimayi

WHO   World Health Organization

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12893-024-02536-7.

Supplementary Material 1

Data availability
All data generated or analyzed during this study are included in this published article and its supplementary information file. However, the datasets used and/or analysed during the current study are still available from the corresponding author on reasonable request.

Declarations

Ethics declarations and consent to participate
This study was presented to the ethical committee of Muhimbili University of Health and Allied Sciences and the ethical clearance was granted by the MUHAS Research Ethics Committee (Ref No: DA.282/298/01.C/1393, ethical clearance number MUHAS–REC– 10-2022-1393. Permission for Data collection was granted from the research and consultancy unit of MNH (Ref. No.: MNH/TRCU/Perm/2022/064). All ethical principles were respected during the study period. For confidentiality, the patients' names were not written on the data collection tools after obtaining informed consent. Confidentiality, anonymity, protection of privacy for personal information were granted.

Consent for publication
All participants gave written informed consent for their personal or clinical details along with any identifying images to be published in this study.

Competing interests
The authors declare no competing interests.

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