ORIGINAL ARTICLE

Effect of Preoperative Hematocrit level on Early Postoperative Outcomes in Coronary Artery Bypass Graft Surgery Patients- A Cross-Sectional Study at Tertiary Cardiac Care Hospital, Rawalpindi, Pakistan

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ABSTRACT

Objective: To determine early postoperative outcomes based on preoperative hematocrit level in patients undergoing CABG.

Study Design: Analytical cross-sectional study.

Place and Duration of Study: This study was conducted at the Department of Cardiac Surgery, Armed Forces Institute of Cardiology/National Institute of Heart Diseases (AFIC/NIHD), Rawalpindi, Pakistan, from November 2025 to April 2026.

Methods: A total of 170 patients undergoing elective isolated on-pump CABG were included in the study. The two groups of patients were classified as low hematocrit (<36%) and not low hematocrit (≥36%). Demographic information, comorbidities, laboratory values, intraoperative variables, and early postoperative outcomes were examined in clinical records. Mortality, infection at the operative site, Red Blood Cell transfusion requirement, and length of ICU and hospital stay were outcomes. The predictors of postoperative infection and mortality were determined using logistic regression analysis.

Results: Patients with low preoperative HCT spent significantly more time in the ICU than those with high hematocrit ($P < 0.001$). There were no statistically significant differences between the groups in terms of RBC transfusion ($P = 0.56$) or postoperative infection ($P = 0.618$). The low HCT group had a higher mortality (2.3% vs. 0.58%), but this was not statistically significant ($P = 0.173$). Preoperative hematocrit was not found to be an independent predictor of infection or mortality in the present study.

Conclusion: Low preoperative hematocrit is found to be linked with prolonged ICU stay following CABG, indicating delayed postoperative recovery, but without independent relationships with increased infection, transfusion requirement, and statistically significant mortality. Preoperative anemia can be optimized to enhance postoperative recovery outcomes.

Keywords: *Anemia, Blood, Coronary Artery Bypass, Hematocrit Outcomes.*

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Introduction

Coronary artery disease (CAD) remains a major global health concern, placing a considerable burden on individuals and healthcare systems, especially in low-income countries like Pakistan.[1,2] Coronary artery bypass graft (CABG) is the gold standard surgical intervention to restore blood flow to the heart by bypassing atherosclerotic coronary arteries, and around 400,000 CABG surgeries are performed annually worldwide.[2] The success of CABG surgery has progressively improved over time due to the mitigation or enhancement of various risk factors.[3] Hematocrit (percentage of red blood cells in total

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blood volume) is an important hematologic factor in preoperative risk assessment of patients undergoing CABG. Multiple studies and RCTs worldwide have assessed the associations between preoperative hematocrit concentrations and outcomes of postoperative acute kidney injury (AKI), perioperative red blood cell (RBC) transfusion, reoperation, stroke and hospital length of stay.[4-6]

Parvez AN et al. reported that patients with low preoperative hematocrit levels had significantly poorer results than those with normal levels.[7] Similarly, Kumar S et al. and Pala AA et al. also illustrated relatively poorer outcomes in their studies among patients with the low-hematocrit group who underwent CABG, especially ICU stay was reported significantly lower by Kumar S et al., which was (5.2±3.1 VS 3.4±2.5 days).[3,8] Findings of a recent study from Iraq also in line with the past reports, who reported that patients with low preoperative hematocrit received more blood transfusions as compared to patients who don't have low hematocrit (2.59±0.69 vs. 1.13±1.06 units). In addition, mortality was also higher in patient with low hematocrit (7.1% vs. 0%), infection rate also found higher in low hematocrit group (14.4% VS 1.7%).[9] These findings reflected that low preoperative hematocrit levels are associated with poor outcomes after CABG surgery.

While low-risk patients who undergo elective CABG surgery can tolerate low HCT levels, the high-risk patients with poor physiological reserves and low EF can get benefit from higher HCT levels subsequently, improved oxygen supply and may need less postoperative transfusions, shorter mechanical ventilation and ICU stay.[10] A prospective cohort study at Rhode Island Hospital in March, 2021 showed lower hematocrit level prior to cardiopulmonary bypass is also associated with neurocognitive decline in immediate postoperative period.[11] The causes of preoperative anemia in cardiac surgery patients include nutritional deficiencies, chronic diseases and hospital-acquired factors, all of which can be managed before elective surgery. Lower rates of transfusion, decreased hospital stay and low postoperative fatigue are some benefits of preoperative anemia treatment.

Preoperative anemia is common among cardiac surgery patients, yet limited data exists regarding its association with clinical outcomes in local set up. Since preoperative anemia is both prevalent and modifiable, its evaluation and timely correction are essential in reducing postoperative complications. In this study, preoperative hematocrit levels in on-pump CABG surgery patients and their effect in the postoperative period were emphasized. The present study aimed to include preoperative hematocrit level as an independent risk factor in preoperative risk assessment scores in cardiac surgery patients. Identifying and managing low hematocrit prior to surgery may help mitigate unfavorable consequences such as increased morbidity and extended hospital stay.

Methods

This analytical cross-sectional study was conducted at Department of Cardiac Surgery, Armed Forces Institute of Cardiology/National Institute of Heart Diseases (AFIC/NIHD), Rawalpindi, Pakistan, from November 2025 to April 2026. The study was approved by the Institutional Ethical Review Board of the institute, vide letter no: 9/2/R&D/2025/384, dated: 16th October, 2025. Patients were enrolled through non probability consecutive sampling technique. By using the WHO sample size calculator, the sample size was calculated as 170, with 85 patients in each group. Level of significance 5%, power of test 80%. Mortality in group 1 (low Hematocrit) is 7.1%[9] and in group 2 (high hematocrit) is 0%.[9]

Inclusion Criteria: Patients aged 18–75 years of either gender who were scheduled for elective, primary, isolated on-pump CABG and had preoperative hematocrit measured within seven days prior to surgery were included in the study.

Exclusion Criteria: Patients with redo, emergency, or salvage CABG procedures, required concomitant cardiac surgeries such as valve repair or replacement, off-pump CABG, chronic kidney disease stage 4 or 5 (eGFR <30 ml/min/1.73 m²) or those on maintenance dialysis, known hematological disorders (including thalassemia major, aplastic anemia, or other hemoglobinopathies), active malignancy, recent red blood cell transfusion or active major bleeding within seven days preoperatively, and prolonged cardiopulmonary bypass time exceeded 180 minutes were excluded.

All patients scheduled for elective, primary, isolated

on-pump CABG during the study period were screened according to the predefined inclusion and exclusion criteria. Written informed consent was obtained from all eligible patients prior to surgery. Data were collected using a proforma that included demographic details (age, sex, BMI), comorbidities, clinical history, preoperative hematocrit and hemoglobin levels, serum creatinine/eGFR, left ventricular ejection fraction (LVEF), medications, and indication for surgery. Preoperative hematocrit levels were measured using a standard complete blood count performed within seven days prior to surgery.

Patients were categorized into two groups: Group A (Low Hematocrit), defined as hematocrit <36%, and Group B (Normal Hematocrit), defined as ≥ 36%. The exact hematocrit percentage was recorded for all patients. Anesthesia and surgical procedures were standardized according to institutional protocols. Intraoperative variables, including cardiopulmonary bypass (CPB) time, aortic cross-clamp time, intraoperative transfusion requirements (RBC, FFP, platelets), and lowest hematocrit on CPB, were documented.

Early postoperative outcomes were assessed during the ICU and hospital stay up to discharge. For this study, early postoperative outcomes were evaluated within five days of surgery and included 24-hour chest tube drainage, prolonged mechanical ventilation (>24 hours), extended ICU stay (>72 hours), and total hospital stay until discharge. In-hospital mortality was defined as death occurring at any time during hospitalization. Patient anonymity and confidentiality were strictly maintained throughout the study.

Data were analyzed using Statistical Package for Social Sciences (SPSS) version 23.0. Continuous variables were first assessed for normality using the Shapiro–Wilk test. Variables that were normally distributed, including age, LVEF, Hb, creatinine, Nadir Hct, CPB time, and aortic cross-clamp time, were presented as mean ± standard deviation (SD) and compared between groups using Independent t-tests. Non-normally distributed variables such as blood transfusion units, chest tube drainage, mechanical ventilation duration, ICU stay, and total hospital stay were presented as medians with interquartile ranges (IQRs) and compared using the Mann–Whitney U test. Categorical variables were expressed as frequencies and percentages and compared using Chi-Square/Fisher's exact test, where needed. Binary logistic regression was performed to identify potential predictors of postoperative AKI and infection, as these were the only outcomes that showed an association with hematocrit. Results were reported as unadjusted odds ratios (uOR) with 95% confidence intervals (CI). Variables that differed significantly in univariate analysis were included in multivariate logistic regression models to identify independent predictors, and adjusted odds ratios (aORs) with 95% CIs were reported. A *P*-value <0.05 was considered statistically significant.

Results

One hundred seventy patients undergoing CABG surgery were used (N=85 in low and high preoperative hematocrit). The average age of the patients in the low hematocrit group was 58.19 ± 9.68 years, and in the high hematocrit group, it was 57.00 ± 10.48 years, showing that the age distribution was similar across the groups. The study population was predominantly male, with 88.2 percent of the total population male. As far as comorbidities (N = 137) are concerned, most of the patients had diabetes mellitus. The proportion of patients in the low hematocrit group with combined comorbidities was higher than in the high hematocrit group. Diagnostically, triple vessel coronary artery disease (TVCAD) was the most prevalent diagnosis, existing in 80.6% of the patients, followed by double vessel disease and single vessel disease. Refer to Table 1. In the case of perioperative parameters, the mean preoperative hematocrit was 35.6 and the mean hemoglobin was 10.9 g/dL. so relatively low baseline levels. The median cardiopulmonary bypass time was 117.5 minutes (IQR: 95.25 - 151.50) and cross-clamp time was 71.0 minutes. The median nadir hematocrit at CPB was 24.0%. The postoperative drainage of the chest tube was 200 ml, and the median ICU stay was 48 hours (Table 1).

Most patients did not receive intraoperative RBC transfusion, and a smaller proportion required one or more units. When comparing hematocrit groups, postoperative outcomes were largely comparable: infection rates were slightly higher in the low HCT group, mortality was also more frequent in this

Table 1: Baseline demographic and clinical characteristics of patients undergoing CABG surgery (N=170)

Variable	Category	Low HCT (N=85)	High HCT (N=85)
		Mean ± SD	
Age (years)		58.19 ± 9.68	57.00 ± 10.48
		Frequency (%)	
Gender	Male	74 (43.52%)	76 (44.70%)
	Female	11 (6.47%)	9 (5.29%)
Comorbidities	Diabetes	25 (14.70%)	29 (17.05%)
	Hypertension	11 (6.47%)	24 (14.11%)
	Diabetes + HTN	29 (17.05%)	19 (11.17%)
Diagnosis	SVCAD	2 (1.17%)	4 (2.35%)
	DVCAD	13 (7.64%)	14 (8.2%)
	TVCAD	70 (41.17%)	67 (39.41%)
		Median (IQR)	
Preoperative Hematocrit (%)		30.7 (27.5–33.5)	42.0 (39.7–44.0)
Preoperative Hemoglobin (g/dL)		10 (9–11)	11 (10–12)
Preoperative Creatinine (mg/dL)		1.22 (0.95–1.67)	0.87 (0.78–0.94)
CPB Time (min)		117 (95–153)	118 (96–147)
Cross Clamp Time (min)		71 (55–96)	71 (56–90)
Nadir Hct on CPB (%)		24 (23–25)	24 (23–25)
Chest Tube Drainage (ml)		200 (100–370)	200 (100–280)
ICU Stay (hours)		48 (37–72)	39 (20–58)

HCT=Hematocrit; HTN=Hypertension; SVCAD=Single vessel coronary artery disease; DVCAD=Double vessel coronary artery disease; TVCAD=Triple vessel Coronary Artery Disease; CPB=Cardiopulmonary Bypass time; ICU=Intensive Care Unit

Table 2: Early postoperative outcomes following CABG surgery (N=170)

Outcomes	Category	Frequency (%)	
RBC transfusion	0 units	112 (65.88%)	
	1 unit	45 (26.47%)	
	2 units	10 (5.88%)	
	3 units	3 (1.76%)	
Outcome		Low HCT groups	High HCT group
Infection		10 (5.88%)	8 (4.70%)
Mortality		4 (2.35%)	1 (0.58%)
Re-exploration		7 (4.11%)	10 (5.88%)

HCT=Hematocrit; RBC=Red Blood Cell

group, whereas re-exploration occurred somewhat more often in the high HCT group. Overall, differences between groups were modest, with no marked variation across outcomes (Table 2).

The ICU stay of patients in the low-hematocrit group was significantly longer than that of patients in the high-hematocrit group. The average rank of ICU stay was greater in the low hematocrit group (99.16) than in the high hematocrit group (71.84), indicating a greater tendency toward prolonged ICU stay in the low hematocrit group, and the difference between them was statistically significant ($P < 0.001$). Conversely, the difference between hematocrit groups ($P = 0.056$) was not statistically significant, although the high hematocrit group had a slightly higher mean rank, as shown in Table 3.

Table 3: Comparison of ICU Stay between Groups

Variable	Group	N	Mean Rank
ICU Stay	Low HCT	85	99.16
	High HCT	85	71.84
RBC Transfusion	Low HCT	85	79.74
	High HCT	85	91.26

HCT= Hematocrit; ICU=Intensive Care unit; RBC=Red Blood Cells P<0.05 considered statistically significant*

Table 4: Association between preoperative hematocrit and postoperative infection and Mortality (N=170)

Group	Frequency (%)		*Chi-Square* test value	*P*-value
	Infection			
	Present	Absent		
Low HCT	10 (5.88%)	75 (44.11%)	0.249	0.618
High HCT	8 (4.70%)	77 (45.29%)		
	Mortality		-	-
	Yes	No		
Low HCT	4 (2.3%)	81 (47.64%)	1.855	0.173
High HCT	1 (0.58%)	84 (49.41%)		

Table 5: Logistic Regression Analysis for Postoperative Infection (N = 170)

Variable	Unadjusted OR (95% CI)	*P*-value	Adjusted OR (95% CI)	*P*-value
Age (years)	0.982 (0.934 – 1.032)	0.468	0.974 (0.920 – 1.030)	0.354
LVEF	0.999 (0.954 – 1.046)	0.969	1.005 (0.954 – 1.060)	0.845
Group (low vs high)	1.283 (0.480 – 3.428)	0.619	0.776 (0.243 – 2.479)	0.669
Gender (male vs female)	1.588 (0.417 – 6.055)	0.498	2.012 (0.430 – 9.414)	0.375
Comorbidities (DM vs DM/HTN)	1.960 (0.595 – 6.461)	0.269	2.049 (0.600 – 6.996)	0.252

OR: Odds Ratio; CI: Confidence Interval; LVEF: Left Ventricular Ejection Fraction; DM: Diabetes Mellitus; HTN: Hypertension

No statistically significant correlation was found between preoperative hematocrit level and postoperative infection (*P* = 0.618). Patients in the low- and high-hematocrit groups were found to be infected at rates of 5.88% and 4.70%, respectively. Likewise, there was no significant difference in mortality between the low and high hematocrit groups (*P* = 0.173), as shown in Table 4.

Unadjusted analysis showed that patients with diabetes mellitus alone had higher odds of infection compared with those with combined diabetes and hypertension, although this association was not statistically significant (OR = 1.96, 95% CI: 0.595-6.461; *P* = 0.269). Likewise, in the multivariate model that has been adjusted to age, gender, LVEF, and procedural group, the association between diabetes and infection was not significantly associated (adjusted OR = 2.05, 95% CI = 0.600-6.996; *P* = 0.252) as shown in Table 5.

The comparison between hypertension alone and hypertension combined with diabetes was not reported due to unstable estimates and wide confidence intervals.

Unadjusted analysis showed that diabetes mellitus alone was not significantly related to mortality in comparison to combined diabetes and hypertension (OR = 1.13, 95% CI: 0.1538.350; *P* = 0.904). Similarly, in the adjusted model, no significant association was observed (adjusted OR = 0.92, 95% CI: 0.117–7.256; *P* = 0.938). Hypertension alone estimates were not

Table 6: Univariate logistic regression analysis for mortality (N = 170)

Variable	Unadjusted OR (95% CI)	*P*-value	Adjusted OR (95% CI)	*P*-value
Age (years)	1.010 (0.925 – 1.102)	0.822	1.051 (0.937 – 1.178)	0.354
LVEF	1.015 (0.935 – 1.101)	0.727	1.005 (0.954 – 1.060)	0.845
Group (low vs high)	0.241 (0.026 – 2.203)	0.208	0.776 (0.243 – 2.479)	0.669
Gender (male vs female)	1.921 (0.204 – 18.096)	0.568	2.012 (0.430 – 9.414)	0.375
Comorbidities (DM vs DM/HTN)	1.130 (0.153 – 8.350)	0.904	2.049 (0.600 – 6.996)	0.252

OR: Odds Ratio; CI: Confidence Interval; LVEF: Left Ventricular Ejection Fraction; DM: Diabetes Mellitus; HTN: Hypertension

reported because of model instability and evidence of quasi-complete separation, as indicated by very wide confidence intervals and convergence problems (Table 6).

Discussion

The current paper reports on the correlation between preoperative hematocrit and post-operative outcomes in a sample of 170 patients who underwent isolated coronary artery bypass grafting (CABG). We present the contextualization of our findings in the current literature on the prognostic value of baseline anemia, the effect on the intensive care unit (ICU) length of stay and mortality rates, the risk of infection, and the necessity of blood transfusion in relation to the overall implications of the strategies on patient blood management (PBM).

Our group consisted of middle-aged men (mean age 57.3 ± 9.98 years; 84.7% men) with a high prevalence of multivessel coronary artery disease - 80.6% of patients had triple-vessel disease. This description is quite general in the modern CABG population, though it is a bit older than the average age reported in most Western registries, which are between 63 and 69 years.[12,13] The occurrence of diabetes mellitus (33.1%), and combined diabetes and hypertension (25.4%), is similar to the results of large-scale studies, which supports the fact that this type of patient group is at high risk.

The fact that male dominance was observed in our study (84.7%) is in line with the epidemiology of coronary artery disease that needs to be surgically revascularized. Most remarkably, a recent study by Hazen et al. on the topic of borderline anemia in women undergoing CABG revealed that a quarter of female patients presented with borderline hemoglobin levels, and this was correlated with higher postoperative morbidity (including renal failure and transfusion needs).[14]

A major observation in our research is that low preoperative hematocrit is closely related to a prolonged ICU stay. The average rank of the ICU length of stay in patients in the low hematocrit category was significantly higher than that of the patients in the high hematocrit category (99.16 vs 71.84, $P < 0.001$). The current literature is very strong in its support of this observation. In a comprehensive review published in the Journal of Clinical Medicine (2025), several studies were reported to have found an association between preoperative anemia and longer ICU and hospital lengths of stay, increased RBC transfusion requirements, and increased postoperative morbidity and mortality.[15] Likewise, a meta-analysis of transfusion approaches in cardiac surgery found a large difference in length of stay in the ICU in favor of liberal transfusion policies, which once again supports the idea that preoperative anemia contributes to delayed recovery.[16]

These results can be extended to our data, which shows that despite the comparatively small differences in preoperative hematocrit between groups (median low HCT 30.6% vs. high HCT 41.9%), the difference in early postoperative recovery is significant. This implies that preoperative anemia is not only an indicator of comorbidity but can also cause direct impact to diminished physiological reserve, decreased oxygen supply, and increased inflammatory response after cardiopulmonary bypass. The clinical implication is obvious: by determining preoperative hematocrit and optimizing it where feasible, it may help to reduce

the burden on the ICU and optimize resource use.

Our research reported a statistical overkill of deaths in the low hematocrit group (4 deaths, 2.3) than in the high hematocrit group (1 death, 0.58). Even though this difference was not statistically significant ($P = 0.173$), the direction and magnitude of the effect are consistent with a substantial body of evidence. A narrative review by Saal-Bauernschubert L et al. in Current Opinion in Anesthesiology highlights that preoperative anemia has always been related to morbidity and mortality among patients who receive cardiac surgery, with iron deficiency explaining about 80 percent of the cases of anemia in this group (Saal-Bauernschubert L et al.,)[17] In a systematic review and meta-analysis used in the same article, preoperative anemia was associated with significantly higher odds of mortality (OR range 2.22.9, $P < 0.001$).[18]

The absence of statistical significance in our research can probably be explained by the low statistical power due to a small sample size and the low absolute mortality events. In fact, a post hoc power analysis would suggest that it would take a much larger cohort to identify a difference of this size. However, the consistency of our trend with well-powered meta-analyses supports the biological plausibility of the claim that low preoperative hematocrit is a risk factor that increases the risk of early death in the postoperative period.[17] This is further confirmed by our result that the odds ratio for mortality in the low hematocrit group (compared to the high hematocrit group) was 4.15, although the confidence interval was wide (95% CI: 0.45–38.46) and the result was not statistically significant (P = 0.208) from unadjusted analysis, as shown in Table 6.

Unlike the results with the ICU stay and mortality, we did not find any significant correlation between preoperative hematocrit and the risk of postoperative infection. The low and high hematocrit groups had nine cases of infections each, and the logistic regression analysis showed an odds ratio of 1.50 (95% CI: 0.56-4.00, P = 0.417). Although this might seem somewhat surprising, recent articles indicate that the causes of healthcare-associated infections (HAIs) post-CABG are multidimensional and not just anemia.

According to a study by Liu et al. published in Frontiers in Public Health in 2025, diabetes was identified as an independent risk factor of HAIs following CABG (OR = 1.467), as well as preoperative white blood cell count, intraoperative blood transfusion volume, duration of mechanical ventilation, and central venous catheterization time Notably, hemoglobin or hematocrit was not found to be an independent predictor in the analysis. Equally, a systematic review and meta-analysis of posto-perative infectious pneumonia in cardiothoracic surgery also found prolonged mechanical ventilation (>48 hours, OR: 3.46), age (>70 years) (OR: 2.71), chronic obstructive pulmonary disease (OR: 2.95) and cardiopulmonary bypass duration (>120 minutes these figures are similar to our overall rate of infection of 10.6% (18 of 170 patients).[19]

The high HCT group paradoxically had slightly higher transfusion needs; the obtained P-value was 0.056. The median hemoglobin level in our low hematocrit group was 10 g/dL (IQR: 912) and is only slightly decreased. Further, the median nadir hematocrit on cardiopulmonary bypass did not differ between the groups (23% vs. 24%), indicating that the intraoperative hemodilution might have neutralized the baseline differences.

A 2025 Bayesian network meta-analysis by Chen y et al. in the International Journal of Surgery recently indicated that although numerous interventions such as erythropoietin combined with autologous blood donation can help to reduce the rate of transfusion, the effect sizes are small and the best approach to this issue is still debated.[20]Moreover, the transfusion needs are affected by several other factors, such as anticoagulation, large-vessel cannulation, and pre-existing antiplatelet therapy, which can potentially outweigh the effect of baseline hematocrit alone.[21]

Our findings can also be due to the implementation of restrictive transfusion thresholds in our institution, according to which patients with a low hematocrit are not transfused at all unless they fulfill certain clinical requirements. In fact, the percentage of patients not receiving any RBC transfusion was very high (65.88%), and only 7.64% received two or more units. The action conforms to the existing guidelines of PBM, which focus on reducing unnecessary exposure to allogeneic blood.

The limitations of this study include its single-center design, small sample size, and low mortality rate, which may have reduced the statistical power to

detect significant associations. The observational cross-sectional design also limits the ability to establish causal relationships. Furthermore, the findings may be subject to bias, including limited generalizability due to the single-center setting, the low event rate, and residual confounding from unmeasured variables that could not be fully accounted for despite statistical adjustment.

These findings should be verified by future multicenter studies with larger sample sizes. The standardized preoperative anemia correction protocols and long-term outcome evaluation would also help to better understand the clinical effect of preoperative hematocrit optimization in CABG patients.

Conclusion

The low preoperative hematocrit is a significant predictor of increased ICU stay after CABG, which is a sign of delayed postoperative recovery and decreased physiological reserve. Nevertheless, it did not independently predict postoperative infection, transfusion need, or statistically significant mortality in this cohort. These results indicate that although preoperative hematocrit is a valuable predictor of perioperative risk, its effect is more on the recovery trajectory than on actual postoperative complications.

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Author Contributions

AH: Conception, design of the work, and approval for final submission
MAK: Manuscript writing for methodology design, investigation, and approval for final submission
MS: Writing the original draft, proofreading, and approval for final submission
SH: Validation of data, interpretation, write-up of results, and approval for final submission
MUA: Revising, editing, supervising for intellectual content, and approval for final submission
SS: Data acquisition, curation, statistical analysis, and approval for final submission
AH is the nominated guarantor and takes full responsibility for the overall content and integrity of the work