



Assessing Compliance with the WHO Surgical Safety Checklist in Rwanda and Malawi: A Mixed-Methods Study of Systemic and Behavioural Barriers

JC Allen Ingabire^{1*}, Faustin Ntirenganya¹, Alphonsine Imanishimwe¹, Emmanuel Munyaneza¹, Isae Ncogoza¹, Georges Bucyibaruta², Rashid Ngalawango³, Zaithwa Matemvu, Vanessa Msosa³

Correspondence: JC Allen Ingabire, ijea2000@gmail.com, +250788549975

Abstract

Introduction: The WHO Surgical Safety Checklist (WHO SSC) is a low-cost, high-impact tool shown to improve surgical outcomes and enhance safety culture, particularly in low- and middle-income countries (LMICs). Despite its effectiveness, adherence remains inconsistent across resource-constrained settings. This study evaluated WHO SSC availability and compliance in Rwandan and Malawian hospitals, identifying systemic and behavioural factors influencing implementation.

Methods: A prospective observational study and cross-sectional staff survey were conducted in 28 referral and district hospitals in Rwanda and Malawi. Surgical cases were selected using stratified random sampling, and checklist adherence was assessed via structured observation across the three checklist phases. Theatre staff completed questionnaires on checklist familiarity, training, and team dynamics. Statistical analysis included descriptive methods and generalised linear models to identify predictors of checklist availability and use.

Results: Of 602 surgical procedures observed, checklist availability was significantly higher in referral hospitals (62%) than in district hospitals (30%), and in elective (56%) versus emergency surgeries (38%). Availability was lower in Rwanda (31%) compared to Malawi (69%) ($p < 0.01$), yet Rwandan hospitals demonstrated superior adherence across all phases: Sign-In (estimate = 29.4, $p < 0.01$), Time-Out (15.8, $p < 0.01$), and Sign-Out (15.2, $p < 0.01$). Team presence during Time-Out increased checklist use eleven-fold (OR: 11.8, 95% CI: 6.56–21.33). Familiarity with the checklist and 5–10 years of experience also improved compliance.

Discussion: Despite broad awareness, checklist use in LMICs remains inconsistent due to logistical barriers and workforce dynamics. Targeted training, increased checklist availability, and digital tools may strengthen implementation and enhance surgical safety in under-resourced settings.

1 Surgery Department, University Teaching Hospital of Kigali, University of Rwanda, Rwanda

2 Center for Equity in Global Surgery, University of Global Health Equity, Rwanda

3 Department of Surgery, Kamuzu Central Hospital, Malawi

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Introduction

In LMICs such as Rwanda and Malawi, where healthcare resources are often stretched thin, the checklist's potential to improve surgical outcomes is particularly compelling¹. Research highlights that sustained use of the checklist not only improves clinical metrics but also fosters better communication within surgical teams, enhances adherence to standard practices like antibiotic prophylaxis, and bolsters the overall safety culture in hospitals^{2,3}. Moreover, these benefits come with a favourable return on investment, making the checklist a cost-effective intervention for under-resourced healthcare systems⁴.

Despite its proven efficacy, the adoption of the WHO checklist varies significantly across countries. In high income and very high human development index (HDI) nations, compliance exceeds 90%, while in low-HDI settings, utilization drops to approximately one-third⁵. Factors such as limited checklist availability, inadequate training, and resistance due to negative perceptions contribute to this disparity⁶. For instance, in Malawi, while a majority of healthcare workers are aware of the checklist, its usage remains inconsistent, highlighting gaps in both infrastructure and attitude¹.

Rwanda and Malawi offer important case studies for understanding these challenges. Rwanda has made significant strides in healthcare delivery, including implementing the checklist in district hospitals, yet struggles with sustaining adherence due to workforce shortages and logistical barriers^{7,8}. Similarly, Malawi faces challenges with low uptake, despite healthcare workers being familiar with the tool, indicating the need for targeted strategies to address both systemic and behavioural barriers.

Addressing these gaps requires prioritizing increased checklist accessibility, continuous education and training for surgical teams, and fostering a culture that prioritizes safety protocols⁹. Insights from Rwanda and Malawi offer valuable lessons for developing scalable, context-specific solutions to ensure the WHO Surgical Safety Checklist achieves its life-saving potential in resource-constrained settings. This study aimed to assess the usage and compliance of the WHO SSC in Rwanda and Malawi, identify factors affecting its implementation, and provide actionable strategies to overcome barriers and enhance its adoption in LMICs.

Methods

Study Design

This study employed a prospective observational design, combined with a cross-sectional survey, to evaluate usage and compliance with the WHO Surgical Safety Checklist (WHO SSC) across hospitals in Rwanda and Malawi. All hospitals participated voluntarily and included both referral (tertiary) and district (rural) facilities, ensuring a broad representation of healthcare settings. Within each hospital, a stratified random sampling strategy was used to select surgical cases, proportionally representing elective and emergency procedures as well as subspecialties in general surgery, obstetrics and gynaecology, and orthopaedics. Data collection took place over a one-week period in June 2020 and involved both direct observation of surgical cases and structured surveys of operating theatre staff.

Study Population and Sampling

Hospitals were categorised by level of care and available resources. Referral hospitals represented large, specialised centres equipped with advanced surgical infrastructure and functioning as training institutions. District hospitals were smaller facilities providing general surgical care and typically served as the first point of referral for lower-level health centres, particularly in rural areas.

Surgical cases were stratified according to procedure type (elective or emergency), surgical specialty (general surgery, obstetrics and gynaecology, orthopaedics, and trauma), and hospital level (referral or district), to ensure representative sampling across different clinical settings.

The survey component included theatre staff members involved in surgical care, including theatre nurses, anaesthetists, and surgeons. Participants were selected using simple random sampling to ensure equitable representation across staff roles.

Data Collection

Data collection was conducted in two phases. First, trained nurses directly observed surgical procedures to assess adherence to the WHO SSC across its three phases: Sign-In, Time-Out, and Sign-Out. A structured observation checklist was used to document patient demographics, procedure type (elective or emergency), and checklist completion. This real-time observation enabled analysis of checklist use in various clinical contexts.



Second, a structured questionnaire was administered to theatre staff. The survey gathered information on familiarity with the WHO SSC, training and qualifications relevant to checklist use, and team dynamics, including which roles initiated the checklist. It also explored perceived barriers and facilitators to checklist adherence. Demographic data such as years of experience, qualifications, and training frequency were collected to examine individual and systemic influences on compliance.

Outcome Measures

The primary outcome was defined as compliance with the WHO SSC, measured by the proportion of checklist items completed across its three phases—Sign-In, Time-Out, and Sign-Out—for each surgical case. Checklist availability was defined as the physical presence of the checklist in the operating theatre, regardless of use. This distinction allowed the study to assess both logistical barriers (absence of the checklist) and behavioural barriers (presence but non-use).

Secondary outcomes included factors associated with checklist compliance, such as hospital type, procedure type, and country. Additional analyses explored the relationship between team dynamics, staff training, and compliance; barriers to checklist implementation; and variation in adherence across the three checklist phases.

Data Management and Analysis

All data were securely entered into REDCap, a web-based data management platform. Statistical analysis was conducted using R software. Descriptive statistics were used to summarise participant demographics, compliance rates, and survey findings. Associations between categorical variables, such as staff roles, qualifications, and checklist familiarity, were evaluated using Cramér's V. Generalised linear models (GLMs) were used to identify predictors of checklist availability, adherence across checklist phases, and influencing factors at both the individual and team levels. Comparisons were made across countries, hospital types, and surgical procedures, with statistical significance set at $p < 0.05$.

Ethical Considerations

Ethical approval was obtained from institutional review boards in both Rwanda and Malawi. Written informed consent was obtained from all staff survey participants. Observational data were fully anonymised, and ethical protocols were followed throughout to protect participant confidentiality and maintain data integrity.

Results

Demographic Characteristics of Observed Cases

A total of 602 surgical cases were observed, with near-equal representation from Malawi and Rwanda. Obstetrics and gynaecology accounted for the majority of procedures, followed by general surgery and orthopaedics. The patient population was predominantly female, with a female-to-male ratio of 2.66:1. The median patient age was 25.5 years (IQR: 17–36), and the mean age was 27.62 years (95% CI: 25.97–29.27). These findings reflect a high burden of obstetric and gynaecological surgeries and a young patient demographic.

Factors Associated with WHO SSC Availability

Checklist availability varied significantly by hospital type, surgical specialty, procedure urgency, and country. District hospitals were less likely to have the WHO SSC available compared to referral hospitals (OR: 0.30, 95% CI: 0.19–0.46, $p < 0.01$). Availability was also lower for obstetrics and gynaecology cases compared to general surgery (OR: 0.56, 95% CI: 0.32–0.98, $p = 0.043$), while orthopaedics showed a non-significant trend towards reduced availability (OR: 0.61, 95% CI: 0.32–1.17, $p = 0.133$). Emergency surgeries were more likely to have checklist availability than elective cases, though this finding was not statistically significant (OR: 1.53, 95% CI: 0.93–2.54, $p = 0.098$). Notably, checklist availability was significantly lower in Rwanda than in Malawi (OR: 0.42, 95% CI: 0.27–0.64, $p < 0.01$). These findings indicate considerable variation in structural access to the checklist across clinical and geographical settings (Table 1).

Disparities in Checklist Availability by Setting

Visual analysis of checklist availability (Figure 1) confirmed these disparities. Referral hospitals demonstrated higher checklist availability than district hospitals (62% vs 30%), while elective procedures showed better availability than emergency cases (56% vs 38%). General surgery cases most commonly had the checklist in use, whereas obstetrics and gynaecology procedures contributed most to cases without it. Rwanda had significantly greater checklist availability than Malawi, highlighting key contextual differences in implementation.

Factors Influencing Checklist Use Across Phases

Adherence to the WHO SSC varied across the three checklist phases. District hospitals demonstrated higher adherence during the "Sign Out" phase compared to referral hospitals (Estimate = 8.585, $p < 0.01$), with



no significant differences for "Sign In" or "Time Out." Emergency surgeries showed lower adherence during the "Time Out" phase (Estimate = -9.590, $p = 0.02$) compared to elective surgeries. Orthopaedic cases had reduced adherence during "Sign In" (Estimate = -9.977, $p = 0.02$) and a borderline increase during "Sign Out" (Estimate = 8.752, $p = 0.05$). Hospitals in Rwanda had significantly higher adherence across all checklist phases compared to those in Malawi, with estimates of 29.365 ($p < 0.01$) for "Sign In", 15.786 ($p < 0.01$) for "Time Out", and 15.171 ($p < 0.01$) for "Sign Out". Interestingly, the mere availability of the checklist did not significantly influence adherence in any phase ($p > 0.4$), suggesting other underlying behavioural or systemic factors (Figure 2).

professional experience overall, with a greater proportion reporting 5–10 years of service. Familiarity with the WHO SSC was notably higher in Rwanda than in Malawi, and a greater proportion of Rwandan staff had received formal training on checklist use. Theatre nurses were the most frequent initiators of the checklist in both settings, although anaesthetists had a more prominent initiating role in Rwanda. Educational attainment also differed, with more diploma holders in Malawi and more bachelor's degree holders in Rwanda. Missing survey data were more frequent in Malawi, which may reflect logistical differences in data collection processes (Table 2).

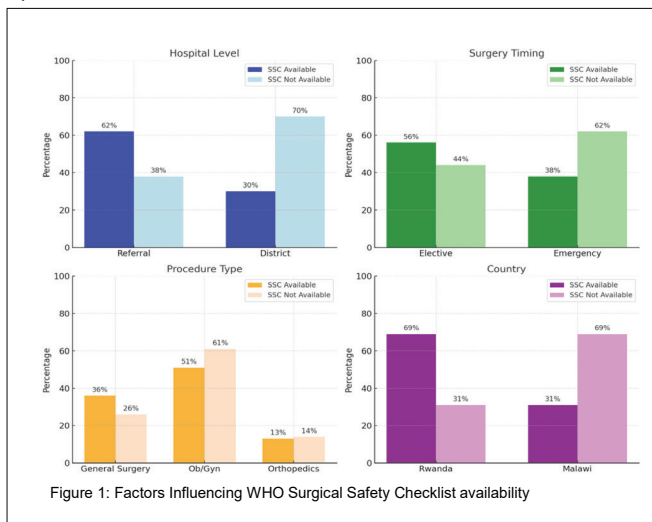


Figure 1: Factors Influencing WHO Surgical Safety Checklist availability

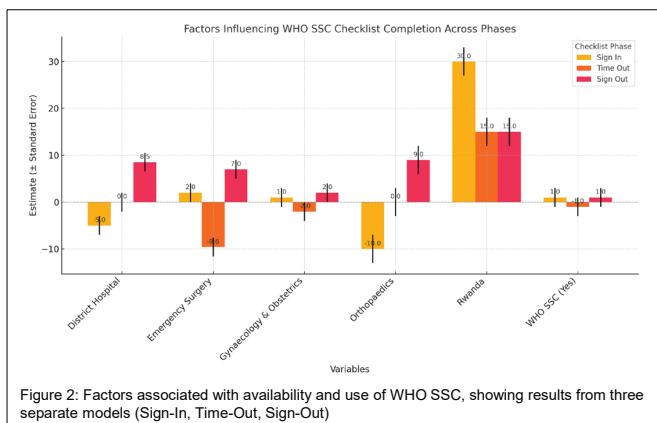


Figure 2: Factors associated with availability and use of WHO SSC, showing results from three separate models (Sign-In, Time-Out, Sign-Out)

Surgical Staff Characteristics and Checklist Familiarity

Descriptive analysis of theatre staff revealed differences between Malawi and Rwanda. The distribution of staff roles was similar, with theatre nurses comprising half of the respondents in both countries. Anaesthetists were more common in Malawi, while surgeons were more prevalent in Rwanda. Staff in Rwanda had more

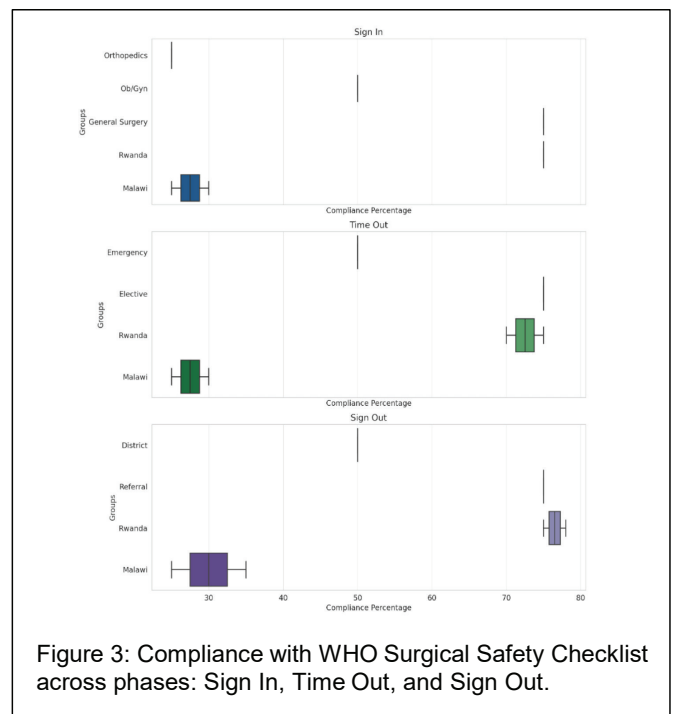


Figure 3: Compliance with WHO Surgical Safety Checklist across phases: Sign In, Time Out, and Sign Out.

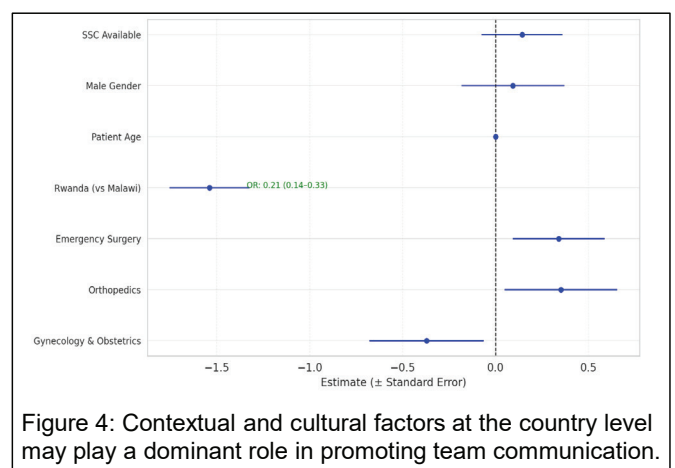


Figure 4: Contextual and cultural factors at the country level may play a dominant role in promoting team communication.



Table 1: Generalised Linear Model testing factors associated with WHO SSC availability in the operating room

		Estimate ± standard error	z-value	p-value	OR (95% CI)
	Intercept	2.188 ± 0.266	8.217	<0.01	8.92 (5.37 - 15.28)
Hospital level	Referral Hospital				
	District Hospital	-1.215 ± 0.225	-5.412	<0.01	0.30 (0.19 - 0.46)
Surgery timing	Elective				
	Emergency	0.426 ± 0.257	1.656	0.098	1.53 (0.93 - 2.54)
Procedures	General Surgery				
	Gynaecology & Obstetrics	-0.574 ± 0.283	-2.025	0.043	0.56 (0.32 - 0.98)
	Orthopaedics	-0.494 ± 0.329	-1.503	0.133	0.61 (0.32 - 1.17)
Country	Malawi				
	Rwanda	-0.879 ± 0.225	-3.912	<0.01	0.42 (0.27 - 0.64)

Table 2: Descriptive variables of interviewed staff

Characteristics	Malawi	Rwanda	Cramer's V
Position			0.04
Theatre nurse	50% (n=171)	50% (n=145)	
Anaesthetist	36.3% (n=124)	26.2% (n=76)	
Surgeon	13.7% (n=47)	23.8% (n=69)	
Working experience			0.07
< 5 years	53.2% (n=177)	47.9% (n=139)	
5-10 years	23.7% (n=79)	30.0% (n=87)	
10 years	23.1% (n=77)	22.1% (n=64)	
Familiarity with SSC			0.26
Yes	73.4% (n=251)	93.8% (n=272)	
No	26.7% (n=91)	0.62% (n=18)	
Trained to use the SSC			0.15
Yes	30.1% (n=103)	49.7% (n=144)	
No	69.9% (n=239)	50.3% (n=146)	
Initiator of SSC			0.06
Theatre Nurse	71.3% (n=231)	49.7% (n=144)	
Anaesthetist	1.0% (n=32)	29.0% (n=84)	
Surgeon	18.8% (n=61)	21.4% (n=62)	
Qualification			0.14
Diploma	64.3% (n=182)	54.8% (n=159)	
Bachelor	22.6% (n=64)	40.0% (n=116)	
Postgraduate	13.1% (n=37)	3.4% (n=10)	
Missing Values	17.3% (n=59)	1.7% (n=5)	

SCC: Surgical Safety Checklist

Table 3: Determinants of WHO Surgical Safety Checklist use: The role of team dynamics, experience, and familiarity.

Model items	Odd Ratio	Confidence Interval	P-value
Familiarity			
Yes	2.23	1.02 - 5.20	0.052
Position			
Anaesthetist	0.88	0.52 - 1.51	0.652
Surgeon	0.98	0.57 - 1.70	0.945
Training about SSC			
Yes	1.41	0.94 - 2.14	0.100
Working experience in theatre			
5-10 years	1.64	1.01 - 2.69	0.045
>10 years	1.25	0.74 - 2.11	0.400
Initiator of SSC			
Anaesthetist	1.1	0.66 - 1.87	0.696
Surgeon	0.98	0.58 - 1.67	0.939
Qualification			
Diploma	0.95	0.58 - 1.54	0.828
Postgraduate	0.34	0.16 - 0.73	0.006
Presence of team during time out			
Yes	11.8	6.56 - 21.33	<0.001



Determinants of Checklist Use

Multivariable analysis indicated that moderate experience (5–10 years) was significantly associated with checklist use (OR: 1.64, 95% CI: 1.01–2.69, $p = 0.045$), while those with over 10 years of experience did not demonstrate a significant association. Familiarity with the checklist was positively associated with its use, although this was borderline significant (OR: 2.23, 95% CI: 1.02–5.20, $p = 0.052$). The presence of the full surgical team during the "Time Out" phase was the strongest predictor of checklist use (OR: 11.80, 95% CI: 6.56–21.33, $p < 0.01$). Staff with postgraduate qualifications were significantly less likely to use the checklist (OR: 0.34, 95% CI: 0.16–0.73, $p = 0.006$). Staff position, training, and diploma-level qualifications were not significantly associated with checklist use. These findings underscore the importance of team presence and practical experience in driving checklist adherence (Table 3).

Compliance Across Checklist Phases

Compliance with the WHO SSC showed substantial variation across the three phases. Rwanda consistently demonstrated higher overall adherence, with a median compliance rate of approximately 75% across all phases, compared to 25% in Malawi. General surgery and elective cases had the highest compliance levels, whereas orthopaedic procedures and emergency cases had the lowest. Referral hospitals outperformed district hospitals, both in median compliance and consistency of adherence. These results highlight specific areas, particularly Malawi, district hospitals, emergency cases, and orthopaedics, where targeted interventions are needed to improve checklist compliance (Figure 3).

Team Member Self-Introduction

Analysis of team member self-introduction revealed a strong association with country. Staff in Rwanda were significantly more likely to complete self-introductions during the checklist process (OR: 0.21, 95% CI: 0.14–0.33), compared to those in Malawi. No significant associations were found between self-introduction compliance and other variables, including procedure type, timing, patient age or sex, or checklist availability. These findings suggest that contextual and cultural factors at the country level may play a dominant role in promoting this key component of team communication (Figure 4).

Discussion

The study on the usage and compliance with the WHO

Surgical Safety Checklist (WHO SSC) in Rwanda and Malawi offers a comprehensive perspective on the challenges and opportunities associated with implementing global health interventions in resource-limited settings. The findings highlight critical systemic and behavioural barriers, such as limited access to the checklist, insufficient training, and persistent negative perceptions among healthcare workers, which collectively hinder consistent adherence. These barriers are not unique to these settings but are representative of broader challenges observed across low-HDI nations¹⁰. Despite these hurdles, the study underscores the checklist's potential to significantly enhance surgical outcomes, foster better communication within teams, and establish a robust culture of safety, even in under-resourced environments.

The observations align with findings from broader literature that demonstrate the checklist's capacity to reduce surgical complications and promote adherence to best practices. For instance, Treadwell et al. and Kwok et al. highlight similar benefits in diverse settings, reinforcing the universal applicability of the checklist⁹. However, this study provides a unique lens by focusing on the localized challenges of LMICs, where infrastructure gaps and workforce shortages exacerbate implementation difficulties. The disparities in checklist adoption rates between low-HDI and high-HDI settings, approximately 33% versus over 90% as reported by the WHO in 2022, reflect a critical need for tailored approaches⁵. Addressing these challenges requires not only material support, such as providing sufficient copies of the checklist, but also strategies aimed at cultural transformation, including ongoing education and behaviour change interventions¹².

The findings also draw parallels with Kapira et al. in Malawi, where awareness of the checklist did not consistently translate to utilisation¹. This emphasizes the insufficiency of mere familiarity; successful implementation requires systemic changes that address logistical constraints and foster positive attitudes¹³. The strategies employed in Madagascar, such as targeted workforce education and logistical support, serve as promising examples of localised solutions¹⁴. Nevertheless, questions remain regarding the scalability and sustainability of these interventions, a gap that has also been noted in other LMIC-focused studies¹⁵.

A noteworthy aspect of this research is its potential to inform broader global health practices. By comparing the challenges and successes in Rwanda and Malawi with those observed in other LMICs, the study underscores the importance of localised adaptations for global health interventions. This aligns with systematic reviews like



those by Treadwell et al., which advocate for interventions designed with an acute awareness of contextual needs³. The findings also highlight the importance of technological integration, such as digital or mobile-based checklists, to overcome logistical barriers and promote consistent use.

While the study effectively captures the immediate impacts of implementing the WHO SSC, it would benefit from longitudinal follow-ups to assess the durability of current interventions. Such data would provide valuable insights into whether the observed improvements in safety culture and team communication are sustained over time. Additionally, exploring behavioural frameworks to address resistance and attitudinal barriers could yield actionable strategies for increasing adherence rates. In the broader context, the findings offer a critical reminder that the success of global health interventions hinges on their adaptability to local contexts. By identifying both challenges and opportunities, the study contributes to the growing body of evidence that underscores the value of context-specific solutions in achieving global health goals.

This article brings a fresh perspective by focusing on the adoption and compliance challenges of the WHO Surgical Safety Checklist (WHO SSC) in two under-resourced settings, Rwanda and Malawi, highlighting unique contextual barriers such as logistical constraints and workforce shortages. Unlike many studies that broadly assess checklist efficacy, this work provides a detailed examination of systemic and behavioural obstacles in LMICs, offering localised insights for improving implementation strategies. However, this study has limitations. It relies on cross-sectional data, which limits the ability to assess causality or capture changes in checklist adherence over time. Consequently, it may not fully reflect long-term effects of interventions or evolving adherence patterns. Additionally, some subgroups, such as specific surgical specialties and emergency cases, had small sample sizes, reducing statistical power and limiting generalisability. Future research should prioritise longitudinal or mixed-methods studies to evaluate the sustainability and long-term impact of checklist implementation strategies. Moreover, incorporating innovative approaches, such as digital checklist systems, may help address logistical challenges, improve data accuracy, and enhance usability, particularly in resource-constrained environments.

This study reaffirms the critical role of the WHO Surgical Safety Checklist (WHO SSC) as a cornerstone of surgical safety, demonstrating its potential to significantly improve outcomes and strengthen safety culture even in resource-constrained settings like Rwanda and Malawi. However,

it also reveals that systemic and behavioural barriers, such as inadequate training, logistical challenges, and entrenched perceptions, limit the checklist's full impact in these contexts. The findings underscore the importance of tailoring implementation strategies to local realities, emphasising capacity-building, sustained education, and cultural shifts within surgical teams. Furthermore, the study highlights the value of adopting innovative solutions, such as digital and mobile-based checklists, to address logistical and accessibility challenges. While the results provide valuable localised insights, they also underscore the broader applicability of the lessons learned to other low-HDI nations facing similar challenges. Future research should prioritise longitudinal studies to evaluate the sustainability of these interventions, while also exploring scalable, context-sensitive technologies that can adapt to the evolving demands of healthcare systems in resource-limited settings. By addressing these gaps, the WHO SSC can fulfil its promise as a transformative tool for advancing surgical safety and equity in global health.

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GAIT statement¹⁶ for Generative AI use: Generative AI was used solely for minor language editing in this manuscript. No content generation, data analysis, or substantive rewriting was performed. The authors take full responsibility for the accuracy and integrity of the work.

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