

Review

Measurement and risk adjustment of the perioperative mortality rate in low and middle income countries: a scoping review.

Oluwatosin Gabriel Afolabi, MBBS, MRCS¹, Damilola Timothy Ishola, MBBS², Mayowa Emmanuel Oluwajuyigbe, MBBS³, Adedamola Benjamin Adegbamigbe, MBBS¹

¹ Surgery, Federal Teaching Hospital Ido-Ekiti, Nigeria., ² Internal Medicine, Federal Teaching Hospital Ido-Ekiti, Nigeria, ³ Surgery, Federal Teaching Hospital Ido-Ekiti, Nigeria

Keywords: Perioperative mortality rate, Risk adjustment, global surgery, Low and middle income countries, scoping review, Surgical outcomes

<https://doi.org/10.62186/001c.166085>

Academic Medicine & Surgery

Objective

The perioperative mortality rate (POMR) is one of the core indicators endorsed by the Lancet Commission on Global Surgery, yet its value for comparing surgical safety across settings depends on how it is defined, measured and adjusted for differences in case-mix. This scoping review mapped the literature on the measurement and risk adjustment of POMR in low- and middle-income countries (LMICs), and identified the resulting evidence gaps.

Methods

The review followed the Arksey and O'Malley framework with the Levac refinements and was reported in accordance with the PRISMA extension for Scoping Reviews. Five electronic databases (MEDLINE via PubMed, Embase via Ovid, Scopus, the Cochrane Library and Web of Science) were searched from inception, supplemented by citation searching and grey literature, with no date or language restriction. Eligible sources reported the definition, measurement, reporting or risk adjustment of POMR in adult or paediatric surgical populations in one or more LMICs. Records were deduplicated in Rayyan. Two reviewers independently screened titles/abstracts and full texts, with inter-rater agreement quantified using Cohen's kappa; disagreements were resolved by discussion with a third reviewer. Data were charted on a standardised form and synthesised narratively.

Results

Of 1,812 records identified across five databases (PubMed 894, Scopus 461, Embase via Ovid 365, Web of Science 73, Cochrane Library 19), 978 duplicates were removed, leaving 834 unique records. Title and abstract screening excluded 798 records ($\kappa = 0.786$, substantial agreement), leaving 36 reports for full-text assessment. Twenty-nine sources met the inclusion criteria ($\kappa = 0.906$, almost perfect agreement); seven were excluded, most commonly for high-income-only data without disaggregated LMIC results or for representing an overlapping cohort already captured by a more complete source. Four recurring themes emerged: heterogeneous numerator, denominator, and follow-up definitions that limited comparability; predominance of crude, in-hospital estimates with sparse and unevenly reported case-mix adjustment; feasibility of parsimonious, locally derived risk-adjustment models built on routinely available variables; and persistently uncommon standardised national reporting of POMR, even where indicator collection was otherwise feasible.

1. INTRODUCTION

Surgical conditions account for an estimated one-third of the global burden of disease; however, approximately five billion people lack access to safe, timely, and affordable surgical and anaesthesia care, with the greatest deficits concentrated in low- and middle-income countries (LMICs).^{1,2} As access to surgery expands, the safety of that

care becomes a central concern because increasing volume without attention to quality risks converting unmet need into avoidable harm. Each year hundreds of millions of operations are performed worldwide, and a substantial and unequally distributed share of postoperative deaths occurs in resource-constrained settings.³

To make surgical system performance measurable, the Lancet Commission on Global Surgery proposed six indica-

tors, of which the perioperative mortality rate (POMR) is the principal measure of the safety of surgical and anaesthetic care.^{1,4} POMR is broadly understood as the proportion of patients who die following a surgical procedure within a defined period, and it has been incorporated into global indicator sets used by the World Health Organization and the World Bank.⁴ Its appeal lies in its conceptual simplicity and its relevance to patients, providers, and policy-makers alike.

However, the usefulness of POMR as a comparative metric depends on consistency in three respects: the numerator (which deaths are counted), the denominator (which procedures or admissions are counted), and the time window over which deaths accrue. Earlier work demonstrated wide variation in these choices across the LMIC literature, with in-hospital death and operative patients being the most common but far from universal definitions.⁵ Crude POMR conflates the safety of care with the underlying risk of the population treated, so that hospitals serving sicker or more urgent patients may appear to perform poorly, even when care is appropriate. In high-income settings, validated tools incorporating the American Society of Anesthesiologists (ASA) physical status, urgency and procedure type are used to adjust for case-mix, but these instruments are not always transferable to LMIC populations, whose risk profile, disease presentation and data availability differ.^{6,7}

Although several reviews have summarised POMR values across procedures, the literature specifically concerned with how POMR is measured and risk-adjusted in LMICs has not previously been mapped comprehensively, and the evidence base has expanded substantially in the years since the most recent systematic synthesis.⁵ A recently published systematic review of all six Lancet Commission indicators confirms that perioperative mortality remains the least completely reported of the six, with usable national estimates available for only a minority of World Bank-classified countries and no country-level benchmark yet set for the indicator, in contrast to the other five.⁸ That review, however, addresses whether POMR is reported at the national level, not how it is defined, measured, or risk-adjusted where primary data exist, which is the specific gap this scoping review addresses. Understanding the methods, definitions, and data systems in use and the gaps between them is a prerequisite for credible benchmarking and embedding POMR within routine information systems. Therefore, this scoping review aimed to map the evidence on the measurement and risk adjustment of POMR in LMICs, characterise the definitions and analytical approaches reported, and identify priorities for standardisation and future research.

2. METHODS

2.1. PROTOCOL AND DESIGN

We conducted a scoping review using the framework described by Arksey and O'Malley and subsequently refined by Levac et al, comprising identification of the research question, identification of relevant sources, source selec-

tion, charting of the data, and collating, summarising and reporting the results.^{9,10} Reporting followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR).¹¹ A scoping design was chosen because the objective was to map the range and nature of measurement approaches rather than to estimate a pooled effect. The protocol for this scoping review was registered on the Open Science Framework (registration DOI: <https://doi.org/10.17605/OSF.IO/UG57Z>), and the review was conducted in accordance with the registered protocol.

2.2. REVIEW QUESTION AND ELIGIBILITY CRITERIA

The review addressed the question: how is the perioperative mortality rate defined, measured, reported and risk-adjusted in low- and middle-income countries? Sources were eligible if they reported on the definition, measurement, reporting or risk adjustment of POMR in adult or paediatric surgical or anaesthetic populations in one or more LMICs, as classified by the World Bank. Primary observational studies, multinational cohort studies, methodological and conceptual papers, consensus statements, situational analyses and reviews were eligible; for multinational cohorts spanning high-income and LMIC sites, only the disaggregated LMIC-specific data were charted. Sources were excluded if they were conducted exclusively in high-income settings without disaggregated LMIC data, did not report or address POMR, were conference abstracts or protocols without retrievable data, were editorials or commentaries without primary or synthesised data, or reported an overlapping cohort already represented by a more complete source. No language or date restriction was applied. Framework and methodology citations (Arksey and O'Malley, Levac, PRISMA-ScR, and equivalent guidance) are cited throughout the manuscript but are not themselves counted among the included sources, consistent with their role as methodological rather than substantive evidence.

2.3. INFORMATION SOURCES AND SEARCH

To identify relevant literature, we searched five electronic databases from inception to June 2026: MEDLINE (via PubMed), Embase (via Ovid), Scopus, the Cochrane Library, and Web of Science. The search combined terms for perioperative or postoperative mortality and surgical case fatality with terms for measurement, definition, risk adjustment and case-mix, and terms for low- and middle-income countries and named world regions, combined with the Boolean operator AND across three concept blocks (Appendix 1). The electronic search was supplemented by citation searching of included sources (backward and forward) and by hand-searching of grey literature, including reports from global surgery bodies. The complete, database-specific search strategies are provided in Appendix 1 for reproducibility.

2.4. SELECTION AND CHARTING

All studies were imported into Rayyan software, automatically screened for duplicates, and managed by two independent reviewers (O.G.A. and D.T.I.).¹² Two reviewers (O.G.A. and D.T.I.) independently screened titles and abstracts against the eligibility criteria; inter-rater agreement was quantified using Cohen's kappa and interpreted using the categories of Landis and Koch, in which values of 0.61–0.80 indicate substantial agreement and 0.81–1.00 indicate almost perfect agreement.¹³ The full texts of potentially eligible records were then assessed independently by the two reviewers (M.E.O. and A.B.A.), with a third reviewer (O.G.A.) adjudicating disagreements at both stages. If two or more included sources reported overlapping or nested patient populations from the same institution and overlapping enrolment periods, the most complete source was retained, and the overlapping source was excluded, with the relationship documented in the charting table.

Data were charted on a piloted standardised form capturing the country and income classification, study design and population, the numerator and denominator used to construct POMR, the follow-up window, the reported POMR, the risk factors and case-mix variables recorded, the risk-adjustment method applied, and the data source or collection tool used. Consistent with the scoping review methodology, a formal appraisal of the risk of bias was not performed. Findings were collated and summarised narratively and tabulated, organised around the measurement, risk adjustment, data systems, and reporting themes that emerged from the charted data.

3. RESULTS

3.1. SEARCH AND SELECTION

The five database searches yielded 1,812 records: 894 from PubMed, 461 from Scopus, 365 from Embase (via Ovid), 73 from Web of Science and 19 from the Cochrane Library. After removal of 978 duplicates in Rayyan, 834 unique records remained for title and abstract screening. Screening at this stage excluded 798 records, with substantial inter-rater agreement between the two independent reviewers ($\kappa = 0.786$), leaving 36 reports for full-text retrieval and assessment. All 36 reports were retrieved in full text. Following full-text assessment, with almost perfect inter-rater agreement ($\kappa = 0.906$), 29 sources met the inclusion criteria and were charted; 7 were excluded. The included sources comprised multinational prospective cohort studies, single-country and single-institution cohorts, methodological and consensus papers, and national situational analyses, spanning sub-Saharan Africa, South Asia, Latin America, East Asia and the Pacific.

Of the seven exclusions, two were superseded or overlapping reports of evidence already captured more completely elsewhere: an earlier, smaller-scope conference report by Ng-Kamstra and colleagues (2015) was superseded by the same group's full systematic review, which is included; and two single-hospital Ethiopian cohorts (Tarekegn et al,

2020; Endeshaw et al, 2023) were excluded because their enrolment windows were fully nested within a more complete report from the same institution (Endeshaw et al, 2024), which is included. Three were excluded for reporting exclusively high-income data without a disaggregated LMIC subset, despite titles or framing suggesting resource-limited applicability: Fecho et al (2008), and two related papers by Anderson and colleagues (2012, 2014), all derived and validated on United States datasets. The remaining exclusion, a 2026 systematic review of all six Lancet Commission indicators (Anyomih et al), addressed national reporting completeness rather than the measurement or risk-adjustment methodology of POMR itself, and is instead cited as background in the Introduction and Discussion.

3.2. CHARACTERISTICS OF THE INCLUDED EVIDENCE

Of the 29 included sources, 19 were single-country or single-institution primary studies, six were multinational prospective cohort studies spanning 14–82 countries, and four were methodological, consensus, or indicator-evaluation papers without a discrete primary cohort. The study designs were predominantly observational, comprising 17 prospective cohorts, 5 retrospective cohorts or database analyses, 1 cluster-randomised controlled trial (nested within a multinational cohort infrastructure), and 6 secondary analyses of national administrative or health information system data. Geographically, sub-Saharan Africa was the most heavily represented region (14 sources, spanning Uganda, Kenya, Ethiopia, Rwanda, South Africa, and pan-African multinational cohorts), followed by Latin America (5 sources, all Colombia and Brazil), with single sources each from India, Mongolia, and the Pacific island states, and three sources drawing on humanitarian or conflict-affected settings across the Democratic Republic of Congo, Central African Republic, and South Sudan. No eligible sources were identified from Southeast Asia or the Middle East and North Africa, a gap discussed further below.

Follow-up windows for the primary numerator varied widely and were often only partially standardised, even within multinational cohorts: 24-hour, 48-hour, 7-day, 14-day, 28-day and 30-day windows were all used, sometimes in combination within a single study to allow comparison across time horizons. Six sources relied on secondary analysis of national administrative or health-information-system datasets, which permitted large denominators but consistently reported non-risk-adjusted, procedure-code-derived estimates with limited capacity for case-mix adjustment; this administrative-data limitation is discussed further in Section 4.3. Two clusters of sources shared an underlying data infrastructure while addressing distinct analytic questions: the African Surgical Outcomes Study (ASOS) cohort underpins both the primary outcomes report and the derivation of the ASOS Surgical Risk Calculator,^{6,7} and the Mulago National Referral Hospital paediatric surgical database (Kampala, Uganda, 2014–2018) underpins both a minimum-dataset risk-adjustment model and an evaluation of episodic versus continuous data-collection feasibility.^{14,15} These pairings are noted in [Table 2](#)

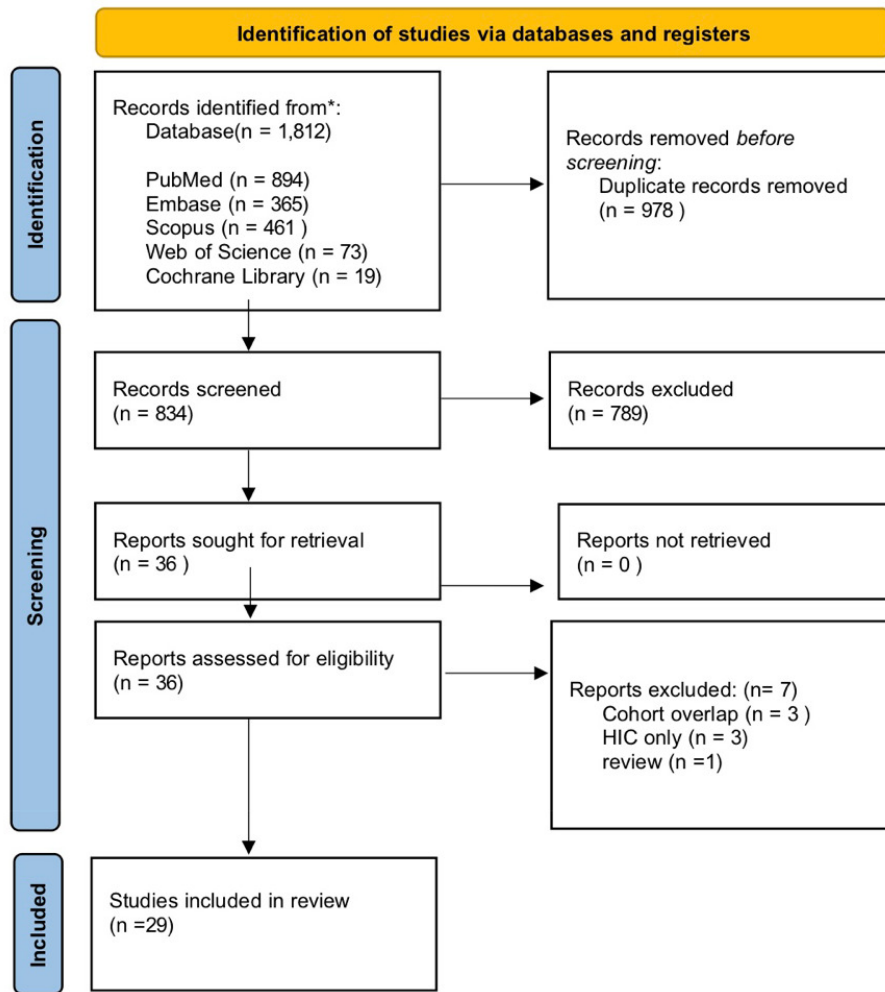


Figure 1. PRISMA-ScR flow diagram of study identification and selection.

so that patient totals are not inadvertently double-counted when the evidence is synthesised.

3.3. DEFINING AND MEASURING THE PERIOPERATIVE MORTALITY RATE

Heterogeneity in the construction of POMR was the most consistent finding across the included studies. The numerator varied between deaths occurring in the operating room, deaths before hospital discharge, and deaths within fixed windows of 24 hours, 48 hours, 7 days, 28 days or 30 days.⁵ The denominator was most often the number of operative patients or procedures, but admission episodes were sometimes used, which materially changes the rate when patients undergo multiple procedures; a four-site comparison spanning New Zealand, Australia, South Africa and Papua New Guinea showed that substituting procedures for admissions as the denominator shifted POMR by 7–70%, and that in-hospital ascertainment underestimated true 30-day POMR by approximately one third at the New Zealand site.¹⁶ A humanitarian-surgery analysis across seven Médecins Sans Frontières-supported hospitals in the Democratic Republic of Congo, Central African Republic and South Sudan applied two numerator definitions in parallel, death within 2 days of admission and death within 30 days,

and found materially different rates for each, with children at consistently higher risk than adults on both definitions.²⁹ An Utstein consensus process subsequently defined the data points required to construct POMR and related indicators at basic, intermediate and full levels of maturity, providing a reference standard against which national reporting can be judged, although only 21% of the consensus meeting's participants were drawn from low- or middle-income countries.²³

Across multinational cohort studies, the dominant pattern was a low-risk surgical population by conventional measures, yet a disproportionately high mortality. In a 7-day international cohort of elective inpatient surgery across 27 countries, patients in the eight non-high-income settings had a lower baseline risk profile but outcomes that were no better than, and frequently worse than, higher-income comparators, with death after a complication being a key driver.³⁷ A multicentre study of breast, colorectal and gastric cancer surgery across 82 countries found that 30-day mortality and death after major complications were substantially higher in the 51 non-high-income countries in the cohort, and that the capacity to rescue patients from complications, rather than disease stage alone, explained much of the excess.³⁹ A prospective study of emergency abdominal surgery across 58 countries, stratified by Human

Table 2. Characteristics of included studies (n = 29).

Author (Year)	Country / Region	Study design	Sample size	Surgical population	Definition of POMR	Follow-up period	Risk-adjustment variables	Principal findings
Ng-Kamstra et al (2018) ⁵	83 LMICs (multinational)	Systematic review & meta-analysis	985 studies; 1,020,869 patients	All surgical specialties	In-hospital death (55.3% of studies); operative patients as denominator (96.2%)	Variable / often undefined	ASA reported in 11.3% of studies	Standardised definition and risk-stratification absent from LMIC literature
Ariyaratnam et al (2015) ¹⁶	South Africa & Papua New Guinea (LMIC sites of 4)	Multi-site retrospective database analysis	1,362,635 admissions / 1,514,242 procedures (all sites)	All surgical admissions	In-hospital vs 30-day; procedures vs admissions compared as denominator	In-hospital to 30 days	Age, admission urgency	Denominator choice altered POMR by 7–70%; in-hospital underestimated 30-day POMR by ~1/3
Anderson et al (2017) ¹⁷	Uganda (Mbarara)	Prospective vs retrospective validation study	8,515 operations/year	All surgical patients	30-day, in-hospital	30 days	Age, urgency (limited)	Prospective POMR 2.4% vs retrospective 1.5%; logbooks feasible but undercount
Sileshi et al (2017) ¹⁸	Kenya (Kijabe)	Prospective cohort, provider-driven electronic tool	8,419 / 11,875 eligible cases captured	All surgical patients	24-h, 48-h, 7-day cumulative	7 days	Procedure type; inverse-probability weighting for missingness	7-day POMR 1.53%; electronic tool feasible but missingness a major bias source
Biccard et al / ASOS (2018) ⁷	25 African countries	Multinational prospective cohort	11,422 patients; 247 hospitals	Adult inpatient surgery	In-hospital mortality	7-day recruitment window	ASA, age, comorbidity (descriptive)	In-hospital mortality 2.1%; twice the global average despite low-risk profile
Kluyts et al / ASOS calculator (2018) ⁶	25 African countries (ASOS subset)	Risk-model derivation and validation	8,799 patients; 168 hospitals	Adult inpatient surgery	In-hospital mortality / severe complications (composite)	Concurrent with ASOS	Age, ASA, indication, urgency, severity, procedure type	AUROC 0.805; region-specific tool outperformed imported instruments
Pérez Rivera et al / CoISOS (2024) ¹⁹	Colombia	Multicentre prospective cohort	3,807 patients; 54 hospitals	Adult surgical patients	POMR (elective and emergency)	7-day recruitment; inpatient stay	ASA, procedure complexity, Clavien-Dindo grade	POMR 1.9% (elective 0.7%, emergency 3.0%); higher than prior secondary-data estimates
Degu et al (2023) ²⁰	Ethiopia (Addis Ababa)	Retrospective cross-sectional	3,295 patients	General, paediatric, neuro- and cardiothoracic surgery	30-day mortality	30 days	ASA, emergency status, timing of death	POMR 4.5%; 69.5% of deaths by postoperative day 7; ASA ≥3 linked to earlier death
Newton et al (2020) ²¹	Kenya (24 hospitals)	Prospective cohort	6,005 paediatric cases	Paediatric surgical patients	24-h / 48-h / 7-day cumulative	7 days	ASA, night/ weekend surgery, checklist use, hospital level	7-day POMR 1.7%; primary-level hospitals highest risk; checklist non-use modifiable
Hanna et al (2020) ²²	Colombia	National situational analysis (secondary data)	National, 2016 data	All operative patients	All-cause, non-risk-adjusted, 30-day	30 days	None (explicitly non-risk-adjusted)	Median POMR 0.74%; established as baseline for future risk-adjustment work

Author (Year)	Country / Region	Study design	Sample size	Surgical population	Definition of POMR	Follow-up period	Risk-adjustment variables	Principal findings
Davies et al / Utstein (2021) ²³	Multinational consensus (21% LMIC representation)	Consensus / Delphi methodological report	Not applicable	Not applicable	Formal tiered definition (basic / intermediate / full data points)	Not applicable	Not applicable	Reference standard for constructing POMR and related indicators
Biccard et al / ASOS-2 (2021) ²⁴	33 African countries	Cluster-randomised controlled trial	28,892 patients; 332 hospitals	Adult surgical patients (risk-stratified)	30-day in-hospital mortality	30 days	ASOS Risk Calculator score ≥ 10 (stratification variable)	No mortality benefit from enhanced surveillance (1.3% vs 1.3%); low-risk 0.2% vs high-risk 5.6%
Massenburg et al (2017) ²⁵	Brazil	National descriptive / modelling study	National, 2014 data	All operative patients	POMR via procedure codes	Annual	None	POMR 1.71%; substantial geographic disparity in workforce density
Ullrich et al (2023) ¹⁵	Uganda (Mulago, Kampala)	Database feasibility study (episodic vs continuous)	3,578 cases (2014–2018 database)	Paediatric surgical patients	In-hospital mortality	Variable / episodic sampling	None (feasibility focus)	POMR 14%; episodic sampling reliably estimated POMR vs continuous collection
Holmer et al (2019) ²⁶	194 WHO member states	Global indicator evaluation (secondary compilation)	Global	All operative patients	LCoGS definition (in-hospital deaths / total procedures)	Not applicable	Not applicable	Only 9 of 194 countries had usable POMR data, versus 154 for workforce density
Torborg et al / ASOS-Paeds (2024) ²⁷	31 African countries	Multinational prospective cohort	8,625 children; 249 hospitals	Paediatric surgical patients (<18y)	30-day mortality	14-day recruitment; 30-day outcome	ASA, procedure category (descriptive)	POMR 2.3%; 11-fold higher than high-income comparator
Firth et al (2025) ²⁸	Uganda (Mbarara)	Retrospective registry cohort	7,170–7,177 patients (42 months)	Adult surgical patients	In-patient POMR	42 months (Aug 2013–Jan 2017)	Procedure type, ASA, HIV status, urgency, referral distance, age	POMR 5.3–5.5%; full multivariable risk-adjustment model
Davies JF et al / MSF (2016) ²⁹	DR Congo, Central African Republic, South Sudan	Multi-hospital retrospective analysis	14,482 patients; 7 hospitals	Surgical inpatients (conflict-affected settings)	Dual definition: POMR2 (2-day) and POMR30 (30-day)	2 and 30 days	Age group, procedure type	POMR 305.28/1,000 admissions; children at higher risk than adults
Rickard et al (2016) ³⁰	Rwanda (Kigali, CHUK)	Prospective cohort	180 deaths over 12 months	Adult and paediatric surgical patients	Death during operative hospital stay	12-month period	Age group, urgency, procedure	POMR 6.5%; 49% of deaths in recovery room; 35% within first postoperative day
Endeshaw et al (2024) ³¹	Ethiopia (Bahir Dar)	Prospective cohort, propensity-score matched	3,030 patients	Adult non-cardiac surgery	28-day mortality	28 days	Comorbidity burden (propensity-score matching)	POMR 3.10%; comorbid 6.29% vs non-comorbid 2.12% (ATT +2.52 percentage points)

Author (Year)	Country / Region	Study design	Sample size	Surgical population	Definition of POMR	Follow-up period	Risk-adjustment variables	Principal findings
Mansourati et al (2018) ³²	India (4 urban hospitals)	Prospective trauma cohort	2,986 patients	Adult trauma surgical patients	48-hour and 30-day mortality	30 days	Procedure type (generalised linear mixed model)	48-h mortality 6.0%; 30-day mortality 23.1%, indicating substantial late mortality burden
Nunez et al (2022) ³³	Mongolia	National situational analysis (retrospective, 11 years)	National, 2006–2016	All operative patients	In-hospital mortality	Annual, 2006–2016	None	In-hospital mortality fell 0.27%→0.14%, partly attributable to a coding change
Guest et al (2017) ³⁴	14 South Pacific countries (LMIC subset)	Multi-country collaborative situational analysis	13 of 14 countries reporting POMR	All operative patients	7-day POMR (bellwether-hospital review)	6-month collection period	None	POMR range 0.11–1.0%; some countries had no pre-existing national reporting system
Arya et al (2016) ³⁵	Global (commentary)	Methodological / conceptual commentary	Not applicable	Not applicable	Discusses LCoGS numerator/denominator definition	Not applicable	Not applicable	Draws a cautionary parallel with the maternal mortality ratio's standardisation history
Samper et al (2022) ³⁶	Colombia	National granular secondary-data analysis	National, 2016 data	All operative patients	30-day, non-risk-adjusted POMR	30 days	Procedure-, patient- and hospital-level stratification	Aggregate POMR 0.87%; service-line-specific variation identified
Ullrich et al (2022) ¹⁴	Uganda (Mulago, Kampala)	Database-derived model development (minimum dataset)	3,194 patients (2014–2018 database)	Paediatric ward admissions	Inpatient mortality	5-year database period	Diagnosis, procedure, district (3-variable minimal model)	3-variable model AUROC 0.915, comparable to full model
ISOS Group (2016) ³⁷	8 non-high-income of 27 countries (LMIC subset)	Multinational prospective cohort	474 hospitals total (LMIC subset charted)	Adult elective inpatient surgery	In-hospital mortality; failure-to-rescue	7-day recruitment	Complication occurrence (failure-to-rescue)	Similar/worse outcomes in LMIC sites despite lower baseline risk
GlobalSurg Collaborative (2016) ³⁸	Middle- and low-HDI tertiles (of 58 countries)	Multinational prospective cohort	10,745 patients; 357 centres	Emergency abdominal surgery	24-hour and 30-day mortality	30 days	HDI tertile, safety-checklist use	Adjusted 30-day mortality OR 2.78 (middle-HDI) and 2.97 (low-HDI) vs high-HDI
GlobalSurg Collaborative (2021) ³⁹	Upper-middle and lower-middle/low-income of 82 countries (LMIC subset)	Multinational prospective cohort	6,852 LMIC patients of 15,958 total; 428 hospitals	Breast, colorectal and gastric cancer surgery	30-day mortality / major complication	30 days	Disease stage, complications, hospital infrastructure	Death after complication highest in LMICs; rescue capacity, not stage, explained the excess

Development Index tertile rather than World Bank income classification, similarly reported a stepwise increase in adjusted 30-day mortality from high- to low-HDI settings (adjusted odds ratio 2.78 for middle-HDI and 2.97 for low-HDI settings).³⁸

3.4. RISK ADJUSTMENT AND CASE-MIX

Risk adjustment was reported far less often than crude rates, and where case-mix variables were captured, ASA physical status, age, urgency and procedure type were the most informative, with ASA physical status repeatedly associated with mortality across adult and paediatric LMIC cohorts.^{21,30} Several investigators demonstrated that adequate adjustment is feasible with a parsimonious set of routinely available variables. In a 42-month registry-derived cohort from a Ugandan regional referral hospital, in-hospital POMR was independently associated with procedure type, ASA rating, urgency, HIV serostatus, referral distance and age in a full multivariable model.²⁸ A related analysis of a paediatric surgical database at a separate Ugandan referral hospital showed that a three-variable model (diagnosis, procedure and district) achieved discrimination (AUROC 0.915) comparable with a model using the full variable set (AUROC 0.932), indicating that high data-collection burden is not a prerequisite for useful adjustment.¹⁴

Region-specific tools outperformed instruments imported from high-income settings. The ASOS Surgical Risk Calculator, derived from a 25-country African cohort, used age, ASA physical status, indication, urgency, severity and type of surgery, and showed good discrimination for in-hospital mortality and severe complications (AUROC 0.805) in African patients, in whom existing high-income tools were not valid because the pattern of risk differed.^{6,7} Single-institution cohorts reinforced the same predictor set: at a major Rwandan referral hospital, POMR was 6.5% and was associated with age under 5 years and emergency urgency, with nearly half of deaths occurring in the postoperative recovery room and 35% within the first postoperative day³⁰; in an Indian trauma cohort across four urban hospitals, 48-hour mortality was 6.0% but rose to 23.1% by 30 days, indicating substantial late perioperative mortality not captured by early-window definitions alone³²; and in an Ethiopian tertiary hospital, ASA status of 3 or higher was independently associated with earlier postoperative death, with 69.5% of all perioperative deaths occurring within the first postoperative week.²⁰ A propensity-score-matched analysis at a separate Ethiopian hospital found that comorbidity burden was independently associated with a 2.52 percentage-point higher absolute risk of 28-day perioperative death after adjustment for confounders.³¹ These findings recurred across the literature: the variables that drive risk in LMIC populations, including HIV status, advanced presentation and limited postoperative surveillance, are not fully captured by tools developed elsewhere.

3.5. DATA SYSTEMS AND FEASIBILITY OF MEASUREMENT

Measurement was constrained by data infrastructure as much as by methodology. Where electronic records were absent, existing operating theatre logbooks captured the great majority of operations and deaths and provided a simple, reproducible and inexpensive route to the required variables at a Ugandan referral hospital, although they limited the depth of risk adjustment possible and modestly undercounted prospectively observed POMR (1.5% retrospective versus 2.4% prospective).¹⁷ A provider-driven electronic data-collection tool implemented at a Kenyan hospital captured 8,419 of 11,875 eligible cases and used inverse-probability weighting to correct for the resulting missingness, generating a 7-day POMR estimate of 1.53% while highlighting data completeness as a major source of potential bias.¹⁸ A separate evaluation of the same Ugandan paediatric database used to derive the minimum-dataset model (section 3.4) found that episodic, periodic sampling could reliably estimate a 14% baseline POMR without continuous surveillance, offering a pragmatic option for settings without registries.¹⁵

Paediatric cohorts in Kenya and across Africa used purpose-built electronic forms to establish baseline rates and identify modifiable factors. A 24-hospital Kenyan cohort of 6,005 paediatric cases found a 7-day cumulative POMR of 1.7%, with non-use of the surgical safety checklist and after-hours surgery among the modifiable factors identified, and with primary-level hospitals carrying the highest risk.²¹ The subsequent ASOS-Paeds study extended this approach across 31 African countries and 249 hospitals, recruiting 8,625 children and documenting a 30-day mortality of 2.3%, eleven-fold higher than a high-income comparator in crude, unadjusted terms.²⁷ At the regional level, a 14-country South Pacific collaboration collecting the Lancet Commission indicators found that POMR could be reported by 13 of 14 participating countries using retrospective review of bellwether-hospital records, but that several countries, including Fiji, had no pre-existing national process for POMR reporting and required a bespoke one-off data-collection exercise to generate the estimate.³⁴

3.6. NATIONAL REPORTING AND STANDARDISATION

National-level cohort studies confirmed both the feasibility and the value of standardised collection. ASOS recruited more than eleven thousand patients across twenty-five African countries and established that surgical patients in Africa die at roughly twice the global average despite a younger, lower-risk profile, with most deaths occurring on the ward after surgery.⁷ The subsequent ASOS-2 cluster-randomised trial, which stratified 28,892 patients across 332 hospitals by ASOS Surgical Risk Calculator score, tested enhanced postoperative surveillance for high-risk patients but did not reduce 30-day in-hospital mortality overall (1.3% in both arms), underlining that measurement must be coupled with effective and resourced rescue pathways.²⁴ Comparable national and single-institution cohorts in Colombia generated primary POMR estimates using

prospective, purpose-built data collection across 54 hospitals, reporting an overall POMR of 1.9% (0.7% elective, 3.0% emergency) that was higher than earlier estimates derived from the same country's secondary administrative data.¹⁹

Despite this, standardised national reporting of POMR remained uncommon. An evaluation of all six global surgery indicators across 194 World Health Organization member states found that only 9 countries had usable perioperative mortality data, compared with 154 countries reporting workforce density, the starkest data gap among the six indicators.²⁶ National situational analyses in Colombia, Brazil and Mongolia were each able to calculate POMR from administrative data, but did so using differing definitions, follow-up periods and levels of granularity: Colombia's national health information system yielded a median POMR of 0.74% in one secondary analysis and an aggregate figure of 0.87% with service-line stratification in a second, independent analysis of the same underlying 2016 dataset^{22, 36}; Brazil's national procedure-coded data yielded a POMR of 1.71% alongside substantial geographic disparity in surgical workforce density²⁵; and an 11-year retrospective analysis in Mongolia found in-hospital mortality declining from 0.27% to 0.14%, a change the authors partly attributed to a coding revision rather than a genuine improvement in safety, illustrating how measurement artefacts can be mistaken for outcome change in the absence of standardised definitions.³³ A conceptual commentary drawing an explicit parallel between POMR and the maternal mortality ratio observed that even a comparatively mature, decades-old indicator with an ostensibly simple numerator and denominator has faced persistent challenges in international comparability, a cautionary precedent for POMR's own standardisation effort.³⁵ The recurring message across the charted sources was that the indicator is collectable in settings at all levels of development, but that the absence of standard reporting items prevents its potential as a comparative benchmark from being realised.

4. DISCUSSION

4.1. PRINCIPAL FINDINGS

This scoping review mapped 29 sources concerned with the measurement and risk adjustment of POMR in LMICs and identified four connected findings. First, POMR is constructed inconsistently, with variation in the numerator, denominator and follow-up window that limits comparability across studies and countries.^{5,16,23,29} Second, most estimates are crude and in-hospital or administratively derived, and risk adjustment for case-mix is the exception rather than the rule, even though ASA physical status, urgency and procedure type are strong and routinely obtainable predictors.^{21,30} Third, where investigators have applied risk adjustment, parsimonious and locally derived models perform well and are feasible with data already present in clinical records, while tools imported from high-income settings transfer poorly.^{6,7,14} Fourth, standardised national reporting of POMR remains rare even in settings where indicator collection has been demonstrated to be lo-

gistically feasible, indicating that the binding constraint is as much institutional and political as it is technical.^{26,34}

4.2. IMPLICATIONS FOR MEASUREMENT STANDARDISATION

These findings have practical implications. The conceptual attraction of POMR is undermined when a single hospital can report materially different rates depending on whether deaths are counted in theatre, before discharge or at 30 days, and whether the denominator is procedures or admissions.¹⁶ Adoption of the data points defined through the Utstein consensus process, the explicit statement of the numerator, denominator and time window with every estimate, and the tracking of a defined basket of common procedures would each improve comparability without imposing unrealistic data demands.²³ Because in-hospital ascertainment systematically underestimates mortality when post-discharge deaths are missed, the chosen window should be reported transparently and, where possible, extended through follow-up, as demonstrated by the parallel numerator approach adopted in the humanitarian-surgery literature.^{16,29}

4.3. IMPLICATIONS FOR RISK ADJUSTMENT

Risk adjustment deserves particular emphasis. Crude comparison penalises hospitals that treat sicker and more urgent patients, which describes many referral facilities in LMICs, and may distort resource allocation if used naively for benchmarking.^{21,30,32} The evidence reviewed suggests a pragmatic path: a small, objective minimum dataset, anchored on ASA physical status, age, urgency, procedure type and a limited set of context-relevant comorbidities such as HIV status, can support adjustment that is both feasible and locally valid.^{14,28} Region-specific instruments such as the ASOS Surgical Risk Calculator illustrate that calculators built on local data outperform transplanted tools, and that calibration to the local population matters more than model complexity.^{6,7} The neutral result of the ASOS-2 trial is a reminder that better measurement is necessary but not sufficient, and that identifying high-risk patients yields benefit only when rescue pathways are resourced.²⁴ A further, related limitation is that secondary analyses of national administrative datasets, while valuable for establishing baseline national estimates, were consistently unable to support case-mix adjustment because the underlying coded data lacked clinical granularity; this is a structural limitation of administrative-data approaches rather than a deficiency of any individual study, and argues for embedding a minimum clinical dataset within routine information systems rather than relying on procedure codes alone.^{22,25,33,36}

4.4. IMPLICATIONS FOR HEALTH INFORMATION SYSTEMS AND NATIONAL REPORTING

The review also highlights that measurement is ultimately a question of health information systems. Logbooks, provider-entered electronic tools and periodic episodic col-

lection each offer routes to credible estimates in the absence of mature registries, and national and multinational cohort studies show that coordinated prospective measurement is achievable across many countries simultaneously.^{7, 15,17,18} The persistent finding that POMR is reported for only a minority of countries, and that even where national estimates exist they are rarely risk-adjusted, indicates that the binding constraint is institutional and political rather than purely technical, and that integration of surgical metrics into national health information systems should be treated as a policy priority.²⁶ This conclusion is reinforced by the observation, drawn from a recently published systematic review of all six Lancet Commission indicators, that perioperative mortality has the weakest national reporting coverage of the six and remains the only one without an agreed country-level benchmark, underscoring that the standardisation gap this review documents is not an artefact of a limited evidence base but a genuine and, on the latest evidence, still-widening gap in the global surgery indicator agenda.⁸

4.5. LIMITATIONS

This review has some limitations. As a scoping review, it mapped the nature and range of the evidence and did not formally appraise the methodological quality of the included sources or pool estimates; therefore, the findings describe the literature rather than quantify POMR. The synthesis was narrative, and the thematic structure, while grounded in the charted data, reflects interpretive choices. Although the search was broad and multi-database with no language restriction, relevant grey literature and national reports not indexed in the searched sources may have been missed, and the rapidly evolving global surgery literature means that recent national analyses may not yet be captured. Notably, no eligible source was identified from Southeast Asia or the Middle East and North Africa, and this regional gap should be interpreted as an evidence gap rather than an indication that measurement activity is absent from those regions. Finally, the heterogeneity of definitions across sources, which is itself a central finding, made direct comparison of reported rates inappropriate and limited the conclusions that could be drawn regarding absolute mortality.

5. CONCLUSION

The perioperative mortality rate is a collectable and policy-relevant indicator of surgical safety in low- and middle-income countries; however, its value for benchmarking is currently limited by inconsistent definitions and the scarcity of risk adjustment. The evidence indicates that a minimum standardised reporting dataset, comprising an explicitly stated numerator, stated denominator, fixed follow-up interval, defined basket of tracked procedures, minimum set of case-mix variables anchored on ASA physical status, age, urgency, and procedure type, and a recommended reporting format, would substantially strengthen comparability without imposing unrealistic data demands on resource-con-

strained settings. Embedding these elements within routine health information systems and coupling measurements with resource rescue pathways are the principal priorities for translating POMR from a headline figure into a tool for improving surgical outcomes.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable. This study is a scoping review of previously published literature and did not involve human participants, human data or human tissue.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA AND MATERIALS

All data generated or analysed during this review are included in this published article and its appendix. The charting form and complete search strategies (Appendix 1) are available from the corresponding author on reasonable request.

COMPETING INTERESTS

The authors declare that they have no competing interests.

FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

AUTHORS' CONTRIBUTIONS

Conceptualization: Oluwatosin Gabriel Afolabi (Lead). Data curation: Oluwatosin Gabriel Afolabi (Lead), Damilola Timothy Ishola (Supporting), Mayowa Emmanuel Oluwajuyigbe (Supporting), Adedamola Benjamin Adegbamigbe (Supporting). Investigation: Oluwatosin Gabriel Afolabi (Lead), Damilola Timothy Ishola (Supporting), Adedamola Benjamin Adegbamigbe (Supporting). Methodology: Oluwatosin Gabriel Afolabi (Lead), Damilola Timothy Ishola (Supporting), Mayowa Emmanuel Oluwajuyigbe (Supporting), Adedamola Benjamin Adegbamigbe (Supporting). Project administration: Oluwatosin Gabriel Afolabi (Lead). Resources: Oluwatosin Gabriel Afolabi (Lead), Mayowa Emmanuel Oluwajuyigbe (Supporting), Adedamola Benjamin Adegbamigbe (Supporting). Supervision: Oluwatosin Gabriel Afolabi (Lead), Damilola Timothy Ishola (Supporting), Mayowa Emmanuel Oluwajuyigbe (Supporting), Adedamola Benjamin Adegbamigbe (Supporting). Validation: Oluwatosin Gabriel Afolabi (Lead), Damilola Timothy Ishola (Supporting), Mayowa Emmanuel Oluwajuyigbe (Supporting), Adedamola Benjamin Adegbamigbe (Supporting). Writing – original draft: Oluwatosin Gabriel Afolabi (Lead), Damilola Timothy Ishola (Supporting), Mayowa Emmanuel Oluwajuyigbe (Supporting), Adedamola Benjamin Adegbamigbe (Supporting). Writing

– review & editing: Oluwatosin Gabriel Afolabi (Lead), Damilola Timothy Ishola (Supporting), Mayowa Emmanuel Oluwajuyigbe (Supporting), Adedamola Benjamin Adegbamigbe (Supporting). Formal Analysis: Damilola Timothy Ishola (Lead), Mayowa Emmanuel Oluwajuyigbe (Supporting). Visualization: Damilola Timothy Ishola (Lead), Mayowa Emmanuel Oluwajuyigbe (Supporting), Adedamola Benjamin Adegbamigbe (Supporting).

ACKNOWLEDGEMENTS

None.

Submitted: June 06, 2026 EDT. Accepted: July 30, 2026 EDT.

Published: August 04, 2026 EDT.



This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CCBY-4.0). View this license's legal deed at <http://creativecommons.org/licenses/by/4.0> and legal code at <http://creativecommons.org/licenses/by/4.0/legalcode> for more information.

REFERENCES

1. Meara JG, Leather AJM, Hagander L, et al. Global Surgery 2030: evidence and solutions for achieving health, welfare, and economic development. *Lancet*. 2015;386(9993):569-624. doi:[10.1016/S0140-6736\(15\)60160-X](https://doi.org/10.1016/S0140-6736(15)60160-X)
2. Alkire BC, Raykar NP, Shrimel MG, et al. Global access to surgical care: a modelling study. *Lancet Glob Health*. 2015;3(6):e316-e323. doi:[10.1016/S2214-109X\(15\)70115-4](https://doi.org/10.1016/S2214-109X(15)70115-4)
3. Weiser TG, Haynes AB, Molina G, et al. Size and distribution of the global volume of surgery in 2012. *Bull World Health Organ*. 2016;94(3):201-209F. doi:[10.2471/BLT.15.159293](https://doi.org/10.2471/BLT.15.159293)
4. Watters DA, Hollands MJ, Gruen RL, et al. Perioperative mortality rate (POMR): a global indicator of access to safe surgery and anaesthesia. *World J Surg*. 2015;39(4):856-864. doi:[10.1007/s00268-014-2638-4](https://doi.org/10.1007/s00268-014-2638-4)
5. Ng-Kamstra JS, Arya S, Greenberg SLM, et al. Perioperative mortality rates in low-income and middle-income countries: a systematic review and meta-analysis. *BMJ Glob Health*. 2018;3(3):e000810. doi:[10.1136/bmjgh-2018-000810](https://doi.org/10.1136/bmjgh-2018-000810). PMID:29989045
6. Kluyts HL, le Manach Y, Munlemvo DM, et al. The ASOS Surgical Risk Calculator: development and validation of a tool for identifying African surgical patients at risk of severe postoperative complications. *Br J Anaesth*. 2018;121(6):1357-1363. doi:[10.1016/j.bja.2018.08.005](https://doi.org/10.1016/j.bja.2018.08.005). PMID:30442264
7. Biccadd BM, Madiba TE, Kluyts HL, et al. Perioperative patient outcomes in the African Surgical Outcomes Study: a 7-day prospective observational cohort study. *Lancet*. 2018;391(10130):1589-1598. doi:[10.1016/S0140-6736\(18\)30001-1](https://doi.org/10.1016/S0140-6736(18)30001-1). PMID:29306587
8. Anyomih TTK, Agbeko AE, Aregawi AB, et al. Systematic review of the Lancet Commission on Global Surgery indicators with quality assessment of modelled estimates. *BJS*. 2026;113(3):znaf289. doi:[10.1093/bjs/znaf289](https://doi.org/10.1093/bjs/znaf289)
9. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol*. 2005;8(1):19-32. doi:[10.1080/1364557032000119616](https://doi.org/10.1080/1364557032000119616)
10. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. *Implement Sci*. 2010;5:69. doi:[10.1186/1748-5908-5-69](https://doi.org/10.1186/1748-5908-5-69)
11. Tricco AC, Lillie E, Zarin W, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med*. 2018;169(7):467-473. doi:[10.7326/M18-0850](https://doi.org/10.7326/M18-0850)
12. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan—a web and mobile app for systematic reviews. *Syst Rev*. 2016;5:210. doi:[10.1186/s13643-016-0384-4](https://doi.org/10.1186/s13643-016-0384-4)
13. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics*. 1977;33(1):159-174. doi:[10.2307/2529310](https://doi.org/10.2307/2529310)
14. Ullrich SJ, Kisa P, Muzira A, et al. Pediatric surgical quality improvement in low- and middle-income countries: what data to collect? *Surgery*. 2022;171(4):1067-1072. doi:[10.1016/j.surg.2021.09.010](https://doi.org/10.1016/j.surg.2021.09.010). PMID:35078626
15. Ullrich SJ, Kisa P, Muzira A, et al. Improving surgical research capacity in low- and middle-income countries: can episodic data collection reliably estimate perioperative mortality? *Ann Surg*. 2023;277(3):e714-e718. doi:[10.1097/SLA.0000000000005105](https://doi.org/10.1097/SLA.0000000000005105). PMID:34334654
16. Ariyaratnam R, Palmqvist CL, Hider P, et al. Toward a standard approach to measurement and reporting of perioperative mortality rate as a global indicator for surgery. *Surgery*. 2015;158(1):17-26. doi:[10.1016/j.surg.2015.03.024](https://doi.org/10.1016/j.surg.2015.03.024). PMID:25958067
17. Anderson GA, Ilcisin L, Abesiga L, et al. Surgical volume and postoperative mortality rate at a referral hospital in Western Uganda: measuring the Lancet Commission on Global Surgery indicators in low-resource settings. *Surgery*. 2017;161(6):1710-1719. doi:[10.1016/j.surg.2017.01.009](https://doi.org/10.1016/j.surg.2017.01.009). PMID:28259351
18. Sileshi B, Newton MW, Kiptanui J, et al. Monitoring anesthesia care delivery and perioperative mortality in Kenya utilizing a provider-driven novel data collection tool. *Anesthesiology*. 2017;127(2):250-271. doi:[10.1097/ALN.0000000000001713](https://doi.org/10.1097/ALN.0000000000001713). PMID:28657959
19. Pérez Rivera CJ, Lozano-Suárez N, Velandia-Sánchez A, et al. Colombian surgical outcomes study insights on perioperative mortality rate, a main indicator of the Lancet Commission on Global Surgery: a prospective cohort study. *Lancet Reg Health Am*. 2024;38:100862. doi:[10.1016/j.lana.2024.100862](https://doi.org/10.1016/j.lana.2024.100862). PMID:39253707

20. Degu S, Kejela S, Zeleke HT. Perioperative mortality of emergency and elective surgical patients in a low-income country: a single institution experience. *Perioper Med (Lond)*. 2023;12(1):49. doi:[10.1186/s13741-023-00341-z](https://doi.org/10.1186/s13741-023-00341-z). PMID:37715264
21. Newton MW, Hurt SE, McEvoy MD, et al. Pediatric perioperative mortality in Kenya: a prospective cohort study from 24 hospitals. *Anesthesiology*. 2020;132(3):452-460. doi:[10.1097/ALN.0000000000003070](https://doi.org/10.1097/ALN.0000000000003070). PMID:31809324
22. Hanna JS, Herrera-Almario GE, Pinilla-Roncancio M, et al. Use of the six core surgical indicators from the Lancet Commission on Global Surgery in Colombia: a situational analysis. *Lancet Glob Health*. 2020;8(5):e699-e710. doi:[10.1016/S2214-109X\(20\)30090-5](https://doi.org/10.1016/S2214-109X(20)30090-5). PMID:32353317
23. Davies JI, Gelb AW, Gore-Booth J, et al. Global surgery, obstetric, and anaesthesia indicator definitions and reporting: an Utstein consensus report. *PLoS Med*. 2021;18(8):e1003749. doi:[10.1371/journal.pmed.1003749](https://doi.org/10.1371/journal.pmed.1003749). PMID:34415914
24. Biccard BM, du Toit L, Lesosky M, et al. Enhanced postoperative surveillance versus standard of care to reduce mortality among adult surgical patients in Africa (ASOS-2): a cluster-randomised controlled trial. *Lancet Glob Health*. 2021;9(10):e1391-e1401. doi:[10.1016/S2214-109X\(21\)00291-6](https://doi.org/10.1016/S2214-109X(21)00291-6). PMID:34418380
25. Massenburg BB, Saluja S, Jenny HE, et al. Assessing the Brazilian surgical system with six surgical indicators: a descriptive and modelling study. *BMJ Glob Health*. 2017;2(2):e000226. doi:[10.1136/bmjgh-2016-000226](https://doi.org/10.1136/bmjgh-2016-000226). PMID:28589025
26. Holmer H, Bekele A, Hagander L, et al. Evaluating the collection, comparability and findings of six global surgery indicators. *Br J Surg*. 2019;106(2):e138-e150. doi:[10.1002/bjs.11061](https://doi.org/10.1002/bjs.11061). PMID:30570764
27. Torborg A, Meyer H, Elfiky M, et al. Outcomes after surgery for children in Africa (ASOS-Paeds): a 14-day prospective observational cohort study. *Lancet*. 2024;403(10435):1482-1492. doi:[10.1016/S0140-6736\(24\)00103-X](https://doi.org/10.1016/S0140-6736(24)00103-X). PMID:38527482
28. Firth PG, Musinguzi N, Mushagara R, et al. Risk-adjustment of perioperative mortality rate measurement in a low-income country. *Anesth Analg*. 2025;141(6):1380-1388. doi:[10.1213/ANE.0000000000007475](https://doi.org/10.1213/ANE.0000000000007475). PMID:40310756
29. Davies JF, Lenglet A, van Wijhe M, Ariti C. Perioperative mortality: analysis of 3 years of operative data across 7 general surgical projects of Médecins Sans Frontières in Democratic Republic of Congo, Central African Republic, and South Sudan. *Surgery*. 2016;159(5):1269-1278. doi:[10.1016/j.surg.2015.12.022](https://doi.org/10.1016/j.surg.2015.12.022). PMID:26883163
30. Rickard JL, Ntakiyiruta G, Chu KM. Associations with perioperative mortality rate at a major referral hospital in Rwanda. *World J Surg*. 2016;40(4):784-790. doi:[10.1007/s00268-015-3308-x](https://doi.org/10.1007/s00268-015-3308-x). PMID:26546186
31. Endeshaw AS, Dejen ET, Kumie FT. The effect of comorbidity on 28-day perioperative mortality rate among non-cardiac surgical patients in Northwest Ethiopia: a prospective cohort study using propensity score matching. *BMC Public Health*. 2024;24(1):3139. doi:[10.1186/s12889-024-20678-4](https://doi.org/10.1186/s12889-024-20678-4). PMID:39533259
32. Mansourati M, Kumar V, Khajanchi M, et al. Mortality following surgery for trauma in an Indian trauma cohort. *Br J Surg*. 2018;105(10):1274-1282. doi:[10.1002/bjs.10862](https://doi.org/10.1002/bjs.10862). PMID:29665031
33. Nunez JM, Nellerme J, Davis A, et al. Establishing a baseline for surgical care in Mongolia: a situational analysis using the six indicators from the Lancet Commission on Global Surgery. *BMJ Open*. 2022;12(7):e051838. doi:[10.1136/bmjopen-2021-051838](https://doi.org/10.1136/bmjopen-2021-051838). PMID:35863828
34. Guest GD, McLeod E, Perry WRG, et al. Collecting data for global surgical indicators: a collaborative approach in the Pacific Region. *BMJ Glob Health*. 2017;2(4):e000376. doi:[10.1136/bmjgh-2017-000376](https://doi.org/10.1136/bmjgh-2017-000376). PMID:29225948
35. Arya S, Ng-Kamstra J, Meara JG, Langer A. Tracking perioperative mortality and maternal mortality: challenges and opportunities. *Lancet Glob Health*. 2016;4(7):e440-e441. doi:[10.1016/S2214-109X\(16\)30082-1](https://doi.org/10.1016/S2214-109X(16)30082-1). PMID:27185468
36. Samper AFG, Herrera-Almario GE, Tulloch D, et al. A granular analysis of service delivery for surgical system strengthening: application of the Lancet indicators for policy development in Colombia. *Lancet Reg Health Am*. 2022;10:100217. doi:[10.1016/j.lana.2022.100217](https://doi.org/10.1016/j.lana.2022.100217). PMID:36777688
37. International Surgical Outcomes Study group. Global patient outcomes after elective surgery: prospective cohort study in 27 low-, middle- and high-income countries. *Br J Anaesth*. 2016;117(5):601-609. doi:[10.1093/bja/aew316](https://doi.org/10.1093/bja/aew316). PMID:27799174
38. GlobalSurg Collaborative. Mortality of emergency abdominal surgery in high-, middle- and low-income countries. *Br J Surg*. 2016;103(8):971-988. doi:[10.1002/bjs.10151](https://doi.org/10.1002/bjs.10151). PMID:27145169

39. GlobalSurg Collaborative, National Institute for Health Research Global Health Research Unit on Global Surgery. Global variation in postoperative mortality and complications after cancer surgery: a multicentre, prospective cohort study in 82 countries. *Lancet*. 2021;397(10272):387-397. doi:[10.1016/S0140-6736\(21\)00001-5](https://doi.org/10.1016/S0140-6736(21)00001-5). PMID:33485461

APPENDIX 1. COMPLETE ELECTRONIC SEARCH STRATEGIES

Searches were conducted across MEDLINE (via PubMed), Embase (via Ovid), Scopus, the Cochrane Library and Web of Science from database inception to June 2026, with no language . Each database was searched using three concept blocks combined with the Boolean operator AND; blocks were run as separate history lines and combined at the end to avoid smart-quote and truncation-symbol encoding errors specific to each platform.

A1.1. MEDLINE (PUBMED)

```
# 1: ("Hospital Mortality"[Mesh] OR "perioperative mortality"[tiab] OR "postoperative mortality"[tiab] OR "surgical mortality"[tiab] OR "operative mortality"[tiab] OR POMR[tiab] OR "surgical case fatality"[tiab] OR "perioperative death*" [tiab] OR "postoperative death*" [tiab])
# 2: ("Risk Adjustment"[Mesh] OR measur*[tiab] OR definition*[tiab] OR "risk adjust*" [tiab] OR "case mix" [tiab] OR "case-mix" [tiab] OR "risk stratification" [tiab] OR benchmark*[tiab] OR indicator*[tiab] OR "ASA physical status" [tiab] OR "minimum dataset" [tiab] OR "data collection" [tiab] OR reporting [tiab])
# 3: ("Developing Countries"[Mesh] OR "low and middle income" [tiab] OR "low-income" [tiab] OR "middle-income" [tiab] OR "developing countr*" [tiab] OR "resource-limited" [tiab] OR "resource limited" [tiab] OR "resource-poor" [tiab] OR LMIC*[tiab] OR Africa*[tiab] OR Asia*[tiab] OR "Latin America*" [tiab] OR "sub-Saharan" [tiab] OR Caribbean[tiab] OR Oceania[tiab] OR Pacific[tiab])
# 4: #1 AND #2 AND #3 (894 records retrieved)
```

A1.2. SCOPUS (ADVANCED SEARCH)

```
TITLE-ABS-KEY ( ( "perioperative mortality" OR "postoperative mortality" OR "surgical mortality" OR "operative mortality" OR "POMR" OR "surgical case fatality" OR "perioperative death*" OR "postoperative death*" ) AND ( measur* OR definition* OR "risk adjust*" OR "case mix" OR "case-mix" OR "risk stratification" OR benchmark* OR indicator* OR "ASA physical status" OR "minimum dataset" OR "data collection" OR reporting ) AND ( "low and middle income" OR "low-income" OR "middle-income" OR "developing countr*" OR "resource-limited" OR "resource limited" OR "resource-poor" OR LMIC* OR Africa* OR Asia* OR "Latin
```

```
America*" OR "sub-Saharan" OR Caribbean OR Oceania OR Pacific ) ) (461 records retrieved)
```

A1.3. EMBASE (OVID), COCHRANE LIBRARY AND WEB OF SCIENCE

The following plain-text concept blocks were adapted to each platform's native syntax (Ovid line-by-line combination for Embase and the Cochrane Library; TS= field tag for Web of Science) to avoid encoding failures with MeSH mapping and truncation symbols across these interfaces.

```
Concept 1: "perioperative mortality" OR "postoperative mortality" OR "surgical mortality" OR "operative mortality" OR "POMR" OR "surgical case fatality" OR "perioperative death" OR "perioperative deaths" OR "postoperative death" OR "postoperative deaths"
Concept 2: measurement OR measuring OR definition OR definitions OR "risk adjustment" OR "risk adjusted" OR "case mix" OR "case-mix" OR "risk stratification" OR benchmark OR benchmarking OR indicator OR indicators OR "ASA physical status" OR "minimum dataset" OR "data collection" OR reporting
Concept 3: "low and middle income" OR "low income" OR "middle income" OR "developing country" OR "developing countries" OR "resource-limited" OR "resource limited" OR "resource-poor" OR LMIC OR LMICs OR Africa OR African OR Asia OR Asian OR "Latin America" OR "Latin American" OR "sub-Saharan" OR Caribbean OR Oceania OR Pacific
Combine: (Concept 1) AND (Concept 2) AND (Concept 3)
```

Embase (via Ovid): 365 records retrieved. Web of Science (TS=): 73 records retrieved. Cochrane Library: 19 records retrieved.

A1.4. SUPPLEMENTARY SOURCES

The electronic search was supplemented by backward and forward citation searching of all included sources, and by hand-searching of grey literature from global surgery bodies (the Lancet Commission on Global Surgery secretariat, World Health Organization Global Index Medicus, and national surgical, obstetric and anaesthesia plan repositories).