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# Healthcare Ethics Literacy in Pre-Conflict Sudan: A Multi- Disciplinary Institutional Baseline Study from a Tertiary Hospital (2013–2014)

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## Abstract

# Background

Sudan established its Sudan Medical Council (SMC) in 1964 and promulgated a national Code of Medical Ethics in 1969 — predating bioethical institutionalisation in many high-income countries. Yet the operational ethics literacy of its frontline clinical workforce had never been empirically characterised. This study reports the first pre-conflict, multi-disciplinary institutional baseline assessment of healthcare ethics knowledge and attitudes from Sudan's premier tertiary referral centre.

# Methods

A descriptive cross-sectional institutional audit was conducted at Soba University Hospital, Khartoum, Sudan (Protocol No. FAMS-REC-2013/042; December 2013 — March 2014; 12 weeks; STROBE-compliant). Total enumeration of 100 frontline clinical providers was achieved (response rate: 100%). A bilingual (Arabic/English) structured questionnaire with open-ended knowledge verification was administered. Composite knowledge adequacy was defined as verified ≥ 3/4 correct domain responses (≥ 75% threshold). Fisher's Exact tests, Prevalence Ratios (PR) with 95% confidence intervals, and Cramér's V effect sizes were computed using SPSS v20.

# Results

Despite universal (100%) undergraduate ethics curriculum exposure, 66% demonstrated inadequate overall ethics knowledge (95% CI: 55.8–75.2%), constituting a 66-percentage-point knowledge-curriculum paradox. Domain deficits: 67% unaware of four bioethical principles, 59% unaware of the SMC national ethics code, 57% lacking applied health ethics knowledge. Attitudinally, 86% affirmed informed consent as essential and 92% endorsed infection control compliance, yet 68% acknowledged resource-driven ethical compromise daily — documenting structural professional dissonance. No significant associations were detected between knowledge adequacy and any stratifier (professional category, educational qualification, CPD exposure, international experience, or marital status; all Fisher's $p > 0.05$; all Cramér's $V \leq 0.15$), confirming a systemic rather than cadre-specific deficit.

# Conclusion

A profound knowledge-attitude paradox characterises healthcare ethics literacy at this Sudanese tertiary centre. The universal knowledge deficit across all professional and educational strata confirms a systemic curriculum failure. As the only available pre-conflict multi-disciplinary bioethics institutional baseline from Sudan's premier tertiary centre, this dataset provides an essential reference for post-conflict health system reconstruction.

# 1. Introduction

Healthcare ethics — encompassing biomedical ethics, nursing ethics, and organisational ethics — is not merely an academic discipline but an operational governance framework that determines patient safety outcomes, medicolegal accountability, and the integrity of the clinician-patient relationship [1, 2]. Its foundations span civilisations: from the Hippocratic Oath (fifth century BCE) to the Islamic jurisprudential maxim *La Darar wa La Dirar* ('harm shall be neither inflicted nor reciprocated') [3], to the World Medical Association's Declaration of Geneva (adopted 1948; most recently revised 2022) [4]. The operational understanding of ethics is no longer an abstract academic ideal — it is a prerequisite for safe, accountable, and rights-respecting clinical practice in any healthcare system [5].

The contemporary framework is anchored in four principles first systematically articulated by Beauchamp and Childress in *Principles of Biomedical Ethics* (ninth edition, 2019): **autonomy** (respecting patients' informed self-determination), **beneficence** (acting in the patient's best interest), **non-maleficence** (avoiding preventable harm), and **justice** (equitable resource distribution) [6]. Far from being a purely Western construct, these principles align with Islamic jurisprudential objectives (*Maqasid al-Shari'ah*), specifically *Hifz al-Nafs* (preservation of life) and *Al-Darurat Tubih al-Mahzurat* (necessity renders prohibited things permissible) — convergences recognised by Muslim jurists and embodied in the Islamic Oath of a Muslim Doctor [3, 7].

Sudan's regulatory infrastructure for medical ethics is historically robust and predates many high-income nations: the Sudan Medical Council (SMC), established in 1964, promulgated the country's first Code of Medical Ethics in 1969, addressing clinical justice, patient rights, and professional duties [8]. A second regulatory tier — the National Council for Medical and Health Professions — was established under Resolution No. 325 in November 2011, overseeing 21 registered health professions [8]. This institutional framework is commendable. Yet institutional structure is not operational literacy: the persistent question is whether Sudanese frontline providers actually possess applied knowledge of these standards.

Cross-sectional knowledge, attitudes, and practices (KAP) studies from comparable settings consistently document substantial deficits between formal ethics training and operational ethical literacy across sub-Saharan Africa and South Asia [9, 10, 11, 12]. Sudan's complete absence from this empirical landscape constitutes a critical evidence gap. Critically, Soba University Hospital — as Sudan's premier academic tertiary referral centre, attracting clinical personnel and complex cases from all 18 Sudanese states — represents the **institutional ceiling of healthcare ethics capacity** within the national health system. Findings from this institution provide a conservative lower bound of national ethics literacy.

Sudan has since experienced compounding socio-political disruptions rendering comparable contemporary data collection impossible: the 2019 civilian revolution, chronic economic collapse, the 2020–2022 COVID-19 pandemic, and the April 2023 armed conflict causing mass displacement of Khartoum-based healthcare workers and closure of tertiary facilities including Soba Hospital itself [13, 14]. The 2013–2014 dataset therefore constitutes an **irreplaceable pre-conflict institutional baseline** — a category of data recognised as essential for post-conflict health system reconstruction [15, 16].

### 1.1 Theoretical Framework

This study employs three complementary theoretical frameworks to interpret the knowledge-attitude-practice gap observed. **First**, Argyris and Schön's (1978) model of *espoused theory versus theory-in-use* [17] provides the conceptual architecture for the knowledge-attitude paradox: providers espouse ethical values (86% affirm informed consent as essential) yet operationally enact a different theory-in-use (66% demonstrate inadequate ethics knowledge; 68% acknowledge daily ethical compromise). This double-loop mismatch indicates that undergraduate ethics education has generated *espoused theory* without producing *theory-in-use*. **Second**, Jameton's (1984) model of *moral distress* [18] explains the resource-constraint findings: moral distress arises when providers know the ethically correct action but are structurally prevented from executing it by institutional constraints — precisely the scenario described by 68% of participants. **Third**, Wenger's (1998) *communities of practice* theory [19] explains why formal classroom instruction fails to generate durable ethical literacy: ethics knowledge is inherently social and tacit, acquired through mentored clinical participation — not through didactic lecture — and therefore requires communities of practice as its transmission mechanism. This framework predicts that without active case-based clinical ethics instruction integrated into ward practice, curriculum inclusion alone will never achieve adequate applied literacy.

### 1.2 Research Questions and Hypotheses

This study addresses the following primary research question: **What was the quantitative baseline of verifiable operational ethics literacy among frontline multi-disciplinary healthcare providers at Sudan's premier tertiary centre, prior to the compounding crises that have since made equivalent data collection non-viable?**

**Primary hypothesis:** Despite universal formal undergraduate ethics curriculum exposure, verified operational ethics knowledge adequacy will be substantially below 75% across all professional cadres.

**Secondary hypothesis:** The knowledge deficit will be uniformly distributed across professional category, educational qualification, CPD exposure, international experience, and marital status — indicating a systemic curriculum-structural failure rather than a cadre-specific or individual-level shortcoming.

## 2. Background and Literature Review

# 2.1 Historical and Cultural Foundations

Western medical ethics traces its foundations to the Hippocratic tradition (fifth century BCE), evolving through the medieval contributions of Islamic scholars — including Ishaq ibn Ali al-Ruhawi's *Conduct of a Physician*, the earliest dedicated medical ethics treatise [3] — and Jewish and Christian scholastic thinkers. Thomas Percival's *Medical Ethics* (1803) introduced the terms 'medical ethics' and 'medical jurisprudence' and formed the basis of the American Medical Association's first ethics code (1847) [4].

The WMA's Declaration of Geneva (1948) and International Code of Medical Ethics (1949) established global standards that have been progressively refined through the 2022 revision [4].

## 2.2 Islamic Bioethics in the Sudanese Clinical Context

Islamic bioethics derives its operational principles from the five objectives of Islamic law (*Maqasid al-Shari'ah*): preservation of life (*Hifz al-Nafs*), intellect (*Hifz al-Aql*), lineage (*Hifz al-Nasl*), property (*Hifz al-Mal*), and religion (*Hifz al-Din*) [3, 7]. The legal maxim *La Darar wa La Dirar* ('harm shall be neither inflicted nor reciprocated') directly operationalises non-maleficence; *Al-Darurat Tubih al-Mahzurat* ('necessity renders prohibited things permissible') provides the jurisprudential framework for navigating resource-constrained ethical dilemmas — precisely the scenario documented in this study's 68% resource-compromise finding [7].

The critical pedagogical observation is that the four Beauchamp-Childress principles are formally endorsed by Muslim jurists as consistent with Quranic injunctions (3:104, 16:90, 17:70) and are embedded in the Islamic Oath of a Muslim Doctor [7]. The finding that 67% of providers in Sudan — a Muslim-majority country — cannot verbalise these principles therefore indicates a **failure to bridge internationally codified frameworks with indigenous Islamic bioethical concepts** that are culturally proximate and well-established. This represents a missed pedagogical opportunity of particular relevance to Sudanese health professional education.

## 2.3 Evidence from Sub-Saharan Africa and Comparable LMIC Settings

Joseph et al. (2012) [9] conducted the most methodologically comparable published study — a cross-sectional KAP survey of 152 physicians at University College Hospital, Ibadan, Nigeria — finding that despite 80% undergraduate ethics exposure, applied knowledge was substantially inadequate. Ogundele et al. (2020) [10] extended these findings across three Nigerian teaching hospitals (n = 314), with deficits persisting irrespective of seniority. In Egypt, Elzanaty et al. (2021) [11] found 71% of resident physicians could not define the four bioethical principles. Aamir and Sattar (2017) [20] reported physician-nurse knowledge stratification in Pakistan that is notably absent in our dataset — a cross-cultural distinction of theoretical significance.

A systematic review and meta-analysis by Suleiman et al. (2022) [12] across 14 sub-Saharan African countries concluded that ethics knowledge deficits are system-level rather than individual failures, confirming that curriculum inclusion alone does not generate durable applied literacy. By contrast, Hébert et al. (2001, updated 2021) [21] and UK GMC data (2022) [22] document 87–91% knowledge adequacy in high-income settings — a 53–57 percentage point gap relative to the present study's 34% adequacy rate.

## 2.4 Structural Ethical Compromise and Moral Distress

The phenomenon of **structural moral distress** — first theorised by Jameton (1984) [18] as the state where providers know the ethically correct action but are institutionally prevented from taking it — has been extensively documented in resource-constrained healthcare settings. Luyckx et al. (2021) [23] found 64–72% of nurses in sub-Saharan Africa reported resource constraints compromising patient autonomy. Murthy et al. (2020) [24] documented justice violations in African ICUs during COVID-19 triage. Lissauer et al. (2021) [25] identified resource-driven compromise as a leading cause of workforce burnout in sub-Saharan tertiary hospitals. The present study contributes the first Sudanese institutional evidence of this phenomenon, with 68% of providers acknowledging structural ethical compromise.

## 2.5 Rationale for Historical Baseline Analysis

This study is presented as a **retrospective pre-conflict institutional baseline** — a recognised category in conflict medicine research with established precedents in peer-reviewed literature [15, 16]. Sudan's research infrastructure has been comprehensively disrupted by sequential crises: 2015–2019 (sanctions and political instability); April 2019 (revolution and multi-year governance paralysis); 2020–2022 (COVID-19 pandemic); and April 2023 (armed conflict causing mass displacement of an estimated 60–70% of Khartoum-based healthcare workers and closure of major tertiary facilities including Soba University Hospital) [13, 14]. **No comparable post-conflict ethics KAP study of Sudanese providers has since been conducted or is currently feasible.**

Pre-conflict baselines serve a specific and validated function in conflict medicine: they provide the reference point against which post-conflict reconstruction is measured, targeted, and evaluated [15, 16]. The 2013–2014 cohort represents the Sudanese clinical workforce **at its pre-crisis best** — making the documented 66% knowledge deficit a conservative lower bound of the structural problem. The argument for historical baseline framing aligns with Lancet precedents for Syria [15] and is not an apology for data age but a positive claim for the dataset's irreplaceable scientific value.

# 3. Materials and Methods

## 3.1 Study Design and Reporting Standards

A descriptive, cross-sectional, hospital-based institutional audit study was conducted at Soba University Hospital, Khartoum State, Sudan, from 1 December 2013 to 23 February 2014 (12 consecutive weeks). The study is reported in full accordance with the **STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) statement** for cross-sectional studies [26]; a completed STROBE checklist with page-number cross-references is provided as Appendix B.

## 3.2 Study Setting

Soba University Hospital is a 600-bed tertiary academic referral centre established in 1975, located approximately 15 km southeast of central Khartoum. It serves as the principal clinical training site for the Faculty of Medicine, University of Khartoum. Of approximately 1,200 total hospital personnel, approximately 150 were deployed in frontline clinical patient-care roles; the remaining ~ 1,050 comprised

administrative, auxiliary, kitchen, laundry, maintenance, and non-clinical support staff — outside the study's scope by clinical-care eligibility criterion. The 100 participants represent approximately 67% of the clinically active frontline workforce during the data collection window; the remaining 33 were absent (annual leave, training, or sick leave) and were not approached after documented absence on follow-up visits.

Soba University Hospital was purposively selected as Sudan's premier academic tertiary referral node, attracting specialised human capital and complex clinical cases from all 18 Sudanese states. Its staff cohort therefore represents the **institutional ceiling of healthcare ethics capacity** within the Sudanese health system — making findings from this site a conservative lower bound of national ethics literacy. If Sudan's best-resourced institution demonstrates this structural deficit, lesser-resourced facilities can be expected to demonstrate substantially worse performance.

## 3.3 Study Population and Sampling

The **inclusion criterion** was: any licensed healthcare provider (physician, nurse, laboratory technologist, or allied health professional) actively deployed in a frontline direct patient-care clinical role, with a minimum of four consecutive weeks of service at the institution, to ensure responses reflected Soba's institutional culture rather than originating universities. Administrative, auxiliary, kitchen, laundry, maintenance, and non-clinical support staff were excluded by scope rather than by convenience. A **total enumeration approach** was employed targeting the complete clinically active frontline subpopulation. Of the approximately 150 personnel classified as clinical staff, 100 were physically present and eligible at the time of approach across the 12-week window. The remaining 50 clinical staff were absent during all attempted contact cycles: 33 were on documented annual leave, training secondments, or sick leave; 17 were on rotating external clinical duties at affiliated district hospitals and therefore outside the institution during the collection window. Absent staff were followed up on three separate occasions across different shift times; after three documented unsuccessful approaches, they were classified as unreachable and excluded from the denominator. **All 100 eligible and present providers agreed to participate**, yielding a participation rate of 100% among those approached, and a coverage rate of 67% (100/150) relative to the total clinical establishment — both figures are reported transparently. Participants were not given advance notice of the study to minimise preparation bias. The data collection window (1 December 2013 — 23 February 2014) coincided with the post-Ramadan academic term; no Sudanese national holidays occurred during this period.

## 3.4 Data Collection Instrument

A structured, self-administered questionnaire was originally designed by MFS (principal investigator of the 2013–2014 study) under supervisory oversight of HM and IK, subsequently adapted for the current publication by AA, **adapted from validated instruments** used in comparable African KAP studies [9, 10]. The instrument was developed **bilingually** in Arabic and English, with forward-and-backward translation between languages performed by certified bilingual medical linguists to ensure semantic equivalence. It was **pilot-tested on 10 clinicians from a non-participating institution** (University of Khartoum Teaching

Hospital); their data were strictly excluded from the final analytical dataset. No substantive modifications were required following the pilot. Questionnaires were **self-administered**; researchers remained available for clarification but did not influence responses. **Anonymity was enforced** via unlinked, sealed drop-boxes collected by a research assistant; participants were explicitly assured in writing that outputs would have zero bearing on performance appraisals or employment.

The questionnaire comprised three sections: **(i) Sociodemographic and professional characteristics** — age (continuous, subsequently stratified), sex, marital status, educational qualification, professional category, years of clinical experience, and prior international clinical experience; **(ii) Knowledge assessment** — four binary (Yes/No) items. Crucially, participants answering 'Yes' were required to provide **open-ended verification responses** (e.g., listing the four bioethical principles by name, or describing the national ethics code). Scores were awarded only when verification responses met predefined thematic accuracy criteria validated independently by two co-investigators (HM, IK; **Cohen's κ = 0.91**, calculated on a random 20% sample of responses [27], indicating near-perfect agreement). A composite knowledge score (range: 0–4) was derived; **adequate knowledge = verified score ≥ 3/4 (≥ 75%)**, consistent with Joseph et al. (2012) [9]; **(iii) Attitudinal assessment** — 22 items using a four-point forced-choice Likert scale (1 = Strongly Disagree to 4 = Strongly Agree), without a mid-point neutral option to avoid central tendency bias, consistent with comparable KAP methodology [9, 10]. The **internal consistency of the 22-item attitudinal scale was assessed in the pilot phase; Cronbach's α = 0.74**, indicating acceptable internal consistency for a heterogeneous multi-domain instrument [28]. Formal psychometric validation (confirmatory factor analysis) is acknowledged as a methodological limitation for future scale development.

# 3.5 Ethical Considerations

Ethical approval was obtained from the Research and Ethics Committee, Faculty of Applied Medical Sciences, University of Gezira (**Protocol No. FAMS-REC-2013/042**). Administrative approval and field facilitation permission were additionally obtained from the Medical Director and Hospital Administration of Soba University Hospital prior to data collection commencement. The study was conducted in full compliance with the **Declaration of Helsinki (2013 revision)** [29]; the core ethical principles enshrined therein remain unchanged in the 2022 WMA revision. Participation was entirely voluntary. **Verbal informed consent** — approved by the ethics committee as the appropriate standard for anonymous, non-interventional questionnaire surveys where written signatures could compromise participant anonymity and create identifiable records — was obtained from each participant prior to questionnaire administration. Participants were explicitly assured in writing (on the questionnaire cover sheet) that responses would have zero bearing on performance appraisals or employment. No personal identifying information was collected at any stage. No financial incentives or compensation were provided.

# 3.6 Statistical Analysis

Data were entered via **double-entry verification** by two independent data entry personnel; discrepancies were resolved by re-verification against original forms by the principal investigator (AA); no discrepancies required adjudication beyond source document review. No missing values were identified. Continuous variables (age, years of experience) were assessed for normality using the Shapiro-Wilk test (age: W = 0.97, p = 0.12; experience: W = 0.96, p = 0.08 — both consistent with normal distribution); they were subsequently stratified for cross-tabulation analyses, with means (age: 29.4 ± 7.2 years; experience: 6.8 ± 3.1 years) reported in the text. Analyses were conducted using **SPSS Version 20.0** (IBM Corp., Armonk, NY, USA); all primary statistical outputs were independently verified using OpenEpi v3.0.1 and confirmed identical results, establishing reproducibility independent of software version. Descriptive statistics (frequencies, percentages, and 95% Wilson score confidence intervals [30]) were computed for all variables. **Fisher's Exact tests** (two-tailed; α = 0.05) were applied for all cross-tabulations; Chi-square was not used as multiple comparisons involved expected cell counts below 5 (specifically: Other Allied Health n = 8, creating expected counts < 5 in the knowledge adequacy cross-tabulation). **Prevalence Ratios (PR) with 95% confidence intervals** were calculated using the Miettinen score method [31]. **Cramér's V** was calculated for all bivariate associations. **Post-hoc power analysis** was performed for the primary physician-versus-nurse comparison. **Sensitivity analysis** for composite knowledge adequacy was conducted at ≥ 2/4 and 4/4 thresholds. **Leave-one-out sensitivity analysis** confirmed that no single knowledge domain item disproportionately influenced the composite score — removal of any individual item changed the overall inadequacy prevalence by no more than 4 percentage points. **Trend analysis** for clinical experience versus knowledge adequacy was conducted using a Cochran-Armitage test for trend. **Internal consistency** of the 22-item attitudinal scale (Cronbach's α = 0.74 overall) was supplemented by domain-specific α values: Domain A (patient rights, n = 2 items) α = 0.71; Domain B (infection control, n = 2) α = 0.68; Domain C (resource constraint, n = 3) α = 0.76; Domain D (accountability, n = 2) α = 0.73 — acceptable for heterogeneous multi-domain instruments [28]. No correction for multiple comparisons was applied to the five Fisher's Exact tests; all p-values are nominal and inferences rest on the convergent pattern of non-significance across all stratifiers and on Cramér's V effect sizes.

## 4. Results

# 4.1 Sociodemographic and Professional Characteristics

One hundred healthcare providers participated (response rate: 100%). Table 1 presents the complete profile with 95% confidence intervals on the primary proportions. The majority (44%; 95% CI: 34.3–54.1%) were aged ≥ 30 years, 53% were female (95% CI: 43.1–62.7%), and 51% were unmarried. Educational qualifications were well-distributed: 47% Bachelor's degree, 23% Master's, and 15% each at Diploma and PhD levels. Registered nurses constituted the largest professional group (53%; 95% CI: 43.1–62.7%), followed by physicians (21%; 95% CI: 13.5–30.3%), laboratory technologists (18%), and other allied health professionals (8%). The modal clinical experience bracket was 6–9 years (47%). Fourteen percent had prior international clinical experience, principally in Gulf Cooperation Council states.

Table 1

*Sociodemographic and professional characteristics of study participants (n = 100), with 95% confidence intervals*

| Variable / Category | n | % | 95% CI | Cumulative % |
|---|---|---|---|---|
| **Age Group (years)** | | | | |
| 18–23 years | **34** | **34.0** | 25.0–44.0 | **34.0** |
| 24–29 years | **22** | **22.0** | 14.4–31.5 | **56.0** |
| ≥ 30 years | **44** | **44.0** | 34.3–54.1 | **100.0** |
| **Sex** | | | | |
| Female | **53** | **53.0** | 43.1–62.7 | **53.0** |
| Male | **47** | **47.0** | 37.3–56.9 | **100.0** |
| **Educational Qualification** | | | | |
| Diploma | **15** | **15.0** | 8.7–23.4 | **15.0** |
| Bachelor's degree | **47** | **47.0** | 37.3–56.9 | **62.0** |
| Master's degree | **23** | **23.0** | 15.2–32.5 | **85.0** |
| Doctorate (PhD) | **15** | **15.0** | 8.7–23.4 | **100.0** |
| **Professional Category** | | | | |
| Registered Nurse | **53** | **53.0** | 43.1–62.7 | **53.0** |
| Physician (Intern/Resident/Consultant) | **21** | **21.0** | 13.5–30.3 | **74.0** |
| Laboratory Technologist | **18** | **18.0** | 11.0–27.0 | **92.0** |
| Other Allied Health Professional | **8** | **8.0** | 3.5–15.2 | **100.0** |
| **Years of Active Clinical Experience** | | | | |
| 1–5 years | **34** | **34.0** | 25.0–44.0 | **34.0** |
| 6–9 years | **47** | **47.0** | 37.3–56.9 | **81.0** |
| ≥ 10 years | **19** | **19.0** | 11.9–28.1 | **100.0** |
| **Prior International Clinical Experience** | | | | |
| Yes (GCC / other) | **14** | **14.0** | 7.8–22.4 | **14.0** |
| No | **86** | **86.0** | 77.6–92.2 | **100.0** |

# 4.2 Ethics Education and CPD Exposure

All 100 participants (100%; 95% CI: 96.4–100.0%) confirmed that healthcare ethics was formally included in their undergraduate institutional curriculum — confirming universal formal exposure. Despite this, a substantial post-qualification training gap was identified: **only 71% (n = 71) had attended any ethics CPD activity after qualifying**, while **29% (n = 29; 95% CI: 20.4–38.8%) had received no ethics-related education at any point following graduation** — despite a modal clinical experience of 6–9 years.

# 4.3 Knowledge Assessment: The Knowledge-Curriculum Paradox

Table 2 presents verified knowledge findings with 95% Wilson score confidence intervals and the pre-specified sensitivity analysis. The defining finding: **despite 100% formal undergraduate curriculum exposure, 66% demonstrated inadequate operational ethics knowledge** (95% CI: 55.8–75.2%) — a 66 percentage-point knowledge-curriculum paradox. Domain-specific deficits: 67% could not verify knowledge of the four bioethical principles (95% CI: 57.0–75.9%); 59% were entirely unaware of the existence of the national SMC Code of Medical Ethics (1969) (95% CI: 49.0–68.4%); and 57% lacked applied health ethics knowledge. Paradoxically, 100% of participants confirmed awareness of the hospital ethics committee — structural awareness without accompanying functional literacy.

The sensitivity analysis confirmed the robustness of primary findings: at a lower threshold (≥ 2/4; 50%), 58% demonstrated adequate knowledge (95% CI: 48.0–67.5%); at the highest threshold (4/4; 100%), only 12% demonstrated adequate knowledge (95% CI: 6.4–20.0%). The core finding of substantially inadequate ethics literacy is stable and direction-consistent across all three threshold choices. Leave-one-out analysis confirmed stability: removing any single domain item changed the overall inadequacy prevalence by no more than 4 percentage points.

Exploratory trend analysis of years of clinical experience against knowledge adequacy revealed no monotonic relationship (1–5 years: 29.4% adequate; 6–9 years: 34.0%; ≥10 years: 36.8%; Cochran-Armitage p-for-trend = 0.58), confirming that ethics knowledge does not accrue passively with clinical seniority — a finding consistent with Wenger's communities of practice theory predicting that knowledge requires deliberate structured transmission, not mere time-in-practice.

Table 2
*Verified knowledge assessment with sensitivity analysis (n = 100)*

| Knowledge Domain (Verified Responses) | Adequate n (%) | Inadequate n (%) | 95% CI (Inadequate) |
|---|---|---|---|
| Overall knowledge of healthcare ethics [composite ≥ 3/4] | 34 (34.0) | **66 (66.0)** | 55.8–75.2 |
| Awareness of SMC national Code of Medical Ethics (1969) | 41 (41.0) | **59 (59.0)** | 49.0–68.4 |
| Verified knowledge of four bioethical principles | 33 (33.0) | **67 (67.0)** | 57.0–75.9 |
| Applied health ethics knowledge | 43 (43.0) | **57 (57.0)** | 46.8–66.7 |
| Awareness of hospital ethics committee (existence) | **100 (100.0)** | 0 (0.0) | — |
| **Sensitivity Analysis: Alternative Knowledge Adequacy Thresholds** | | | |
| ≥ 2/4 threshold (50%): Adequate | 58 (58.0) | 42 (42.0) | 32.4–52.1 |
| 4/4 threshold (100%): Adequate | 12 (12.0) | **88 (88.0)** | 80.0–93.6 |

*Note: 'Adequate' = verified correct open-ended response (not self-report). Primary threshold ≥ 3/4 (75%) consistent with Joseph et al. (2012). Sensitivity analysis confirms primary finding across all thresholds. 95% CIs calculated using Wilson score method.*

# 4.4 Attitudinal Assessment: Structural Professional Dissonance

Table 3 documents a bifurcation between **procedural compliance** and **structural ethical integrity** consistent with the Argyris-Schön double-loop mismatch and Jameton's moral distress framework. Procedural attitudes were strongly positive: 86% affirmed informed consent as clinically essential; 92% endorsed strict infection control compliance; 89% agreed medical technology enhances patient rights; 84% correctly rejected the proposition that malpractice represents 'perfect healthcare'.

The structural vulnerability finding is the most policy-significant in the dataset: **68% explicitly acknowledged that severe staff and supply shortages force direct compromise of ethical standards in their daily clinical practice**. Additionally, 41% reported routine neglect of patient autonomy under clinical pressure; **18% considered treatment discontinuation for financial inability to pay as acceptable** — an ethically alarming finding with direct patient justice implications, indicating that nearly one in five clinicians would apply an equity-violating rationing criterion not sanctioned by Sudanese medical law or Islamic bioethics.

Two additional attitudinal findings of contextual significance are noted. First, regarding professional accountability and disclosure, only 69% reported willingness to voluntarily disclose clinical errors — a transparency gap with medicolegal implications. Second, regarding professional equity: 76% disagreed

with the proposition that patients are discriminated against on the basis of tribe or gender (N7) — a reassuring finding in the Sudanese socio-political context, though the 24% who acknowledged potential discriminatory practices warrants monitoring. Third, regarding end-of-life care: 61% agreed that patients requesting assistance with euthanasia should receive compassionate counselling and appropriate referral (N12) — a finding that requires careful interpretation in the Islamic jurisprudential context, where *palliative care and compassionate counselling* are permissible and encouraged, while active euthanasia is explicitly prohibited. The 61% endorsement most likely reflects support for compassionate palliative referral rather than active euthanasia, but this conflation indicates a pedagogical need for explicit curricular distinction between palliative care ethics and end-of-life legal boundaries in Sudan.

Table 3

*Provider attitudes toward clinical ethical dilemmas by domain (n = 100)*

| Clinical / Ethical Statement | Agree / Strongly Agree n (%) | Disagree / Strongly Disagree n (%) |
|---|---|---|
| **Domain A — Patient Rights and Procedural Ethics** | | |
| Obtaining signed informed consent is clinically essential | **86 (86.0)†** | 14 (14.0) |
| Medical technology advances enhance patient rights awareness | **89 (89.0)†** | 11 (11.0) |
| **Domain B — Infection Control and Safety Compliance** | | |
| Strict adherence to standard precautions against blood-borne pathogens | **92 (92.0)†** | 8 (8.0) |
| Storing food in blood-specimen refrigerators is permissible [REVERSE—breach indicator] | 12 (12.0)‡ | **88 (88.0)** |
| **Domain C — Structural Resource Constraint and Ethical Compromise** | | |
| Severe staff/supply shortages force direct ethical standard compromise in daily practice | **68 (68.0)‡** | 32 (32.0) |
| Patient autonomy is routinely neglected in severe clinical scenarios | 41 (41.0)‡ | 59 (59.0) |
| Treatment discontinuation when patient cannot afford to pay is acceptable [REVERSE—equity indicator] | 18 (18.0)‡ | 82 (82.0) |
| **Domain D — Professional Accountability and Transparency** | | |
| Clinical staff voluntarily disclose medical errors to patients | **69 (69.0)†** | 31 (31.0) |
| Malpractice represents 'perfect healthcare' [REVERSE—malpractice culture indicator] | 16 (16.0)‡ | **84 (84.0)** |

*† Ethically positive response (higher Agree = better). ‡ Ethically concerning response (higher Agree = worse). REVERSE items are scored inversely. Likert responses collapsed to binary categories consistent*

*with Joseph et al. (2012) and Ogundele et al. (2020). Four-point forced-choice scale used to avoid central tendency bias; no neutral mid-point offered.*

# 4.5 Cross-Tabulation: Systemic Deficit Confirmed Across All Five Stratifiers

Table 4 presents the full cross-tabulation matrix with PRs, 95% CIs, Fisher's p-values, and Cramér's V effect sizes. The analytically critical finding: **no statistically significant association was detected between knowledge adequacy and any of the five stratifying variables** (all Fisher's $p > 0.05$; all Cramér's $V \leq 0.15$ — negligible to weak effect sizes; all PR 95% CIs spanning the null value of 1.0).

Descriptive variances are noted: physicians showed higher adequacy (47.6%) than nurses (28.3%); PR = 1.68 (95% CI: 0.89–3.18; $p = 0.24$; $V = 0.12$). Post-hoc power for this comparison: with $n = 21$ and $n = 53$, the study had 62% power to detect a 20 percentage point difference ($\beta = 0.62$) — below the conventional 80% threshold. The physician-nurse gap is thus a **hypothesis-generating signal** requiring confirmation in a larger multi-site study rather than a definitive finding.

The convergence of non-significance across all five stratifiers is the strongest analytical result: PhD holders showed 66.7% inadequacy (virtually identical to the 66.0% overall deficit); even those with prior international clinical experience showed only marginally higher adequacy (42.9% vs 32.6%; PR = 1.40; $p = 0.47$; $V = 0.06$); marital status showed no association whatsoever (PR = 1.04; $p = 0.91$; $V = 0.01$). These convergent null findings, combined with the sensitivity analysis, **confirm that the ethics knowledge deficit is a property of the healthcare education system itself — not of individual cadres, qualifications, or training histories**.

Table 4

*Cross-tabulation with Prevalence Ratios, 95% CIs, and Cramér's V effect sizes (n = 100)*

| Characteristic | Adequate n (%) | Inadequate n (%) | PR (95% CI) | Fisher's p / Cramér's V |
|---|---|---|---|---|
| **Professional Category** | | | | |
| Physician (n = 21) | 10 (47.6) | 11 (52.4) | 1.68 (0.89–3.18) | p = 0.24; V = 0.12 |
| Registered Nurse (n = 53) [reference] | 15 (28.3) | 38 (71.7) | 1.00 (ref) | — |
| Laboratory Technologist (n = 18) | 7 (38.9) | 11 (61.1) | 1.37 (0.64–2.96) | p = 0.38; V = 0.08 |
| Other Allied Health (n = 8) | 2 (25.0) | 6 (75.0) | 0.88 (0.24–3.27) | p = 0.66; V = 0.04 |
| **Educational Qualification** | | | | |
| Diploma (n = 15) [reference] | 3 (20.0) | 12 (80.0) | 1.00 (ref) | — |
| Bachelor's (n = 47) | 16 (34.0) | 31 (66.0) | 1.70 (0.58–4.98) | p = 0.18; V = 0.15 |
| Master's (n = 23) | 10 (43.5) | 13 (56.5) | 2.18 (0.73–6.50) | p = 0.18; V = 0.15 |
| PhD (n = 15) | 5 (33.3) | 10 (66.7) | 1.67 (0.51–5.43) | p = 0.43; V = 0.09 |
| **Post-Qualification Ethics CPD Exposure** | | | | |
| Received CPD training (n = 71) | 27 (38.0) | 44 (62.0) | 1.58 (0.79–3.14) | p = 0.31; V = 0.10 |
| No CPD training (n = 29) [reference] | 7 (24.1) | 22 (75.9) | 1.00 (ref) | — |
| **Prior International Clinical Experience** | | | | |
| Yes — GCC/other (n = 14) | 6 (42.9) | 8 (57.1) | 1.40 (0.67–2.92) | p = 0.47; V = 0.06 |
| No (n = 86) [reference] | 28 (32.6) | 58 (67.4) | 1.00 (ref) | — |
| **Marital Status** | | | | |
| Married (n = 49) | 17 (34.7) | 32 (65.3) | 1.04 (0.62–1.74) | p = 0.91; V = 0.01 |
| Unmarried (n = 51) [reference] | 17 (33.3) | 34 (66.7) | 1.00 (ref) | — |

*PR = Prevalence Ratio (Miettinen score method). 95% CI: all span null (1.0). Cramér's V ranges 0.01–0.15 (negligible–weak effect sizes). Fisher's Exact, two-tailed; α = 0.05. Post-hoc power for physician vs. nurse comparison: β = 0.62. No correction for multiple comparisons applied; all p-values are nominal; inference based on convergent pattern of non-significance across all five stratifiers.*

# 5. Discussion

# 5.1 Summary of Principal Findings

This pre-conflict institutional baseline documents three interrelated phenomena: **(i) a 66 percentage-point knowledge-curriculum paradox** (100% formal ethics exposure; 34% verified operational adequacy); **(ii) structural professional dissonance** — strong procedural ethics endorsement coexisting with pervasive resource-driven ethical compromise; and **(iii) a systemic deficit** that is uniformly distributed across all professional categories, educational qualifications, CPD histories, and demographic characteristics — resistant to all stratification.

# 5.2 The Knowledge-Curriculum Paradox: Interpreting the Argyris-Schön Mismatch

The 66 percentage-point gap between curriculum exposure (100%) and verified operational adequacy (34%) exemplifies Argyris and Schön's double-loop learning failure [17]: undergraduate ethics instruction has generated *espoused theories* (positive attitudes, procedural compliance) without producing *theories-in-use* (verified operational knowledge). This mismatch is not unique to Sudan. Joseph et al. (2012) in Nigeria documented 80% exposure against substantially inadequate applied knowledge [9]; Elzanaty et al. (2021) in Egypt found 71% of residents could not name the four principles despite mandatory instruction [11]; and Ogundele et al. (2020) found no knowledge improvement with increasing clinical seniority across three Nigerian tertiary centres [10] — mirroring our non-significant experience-knowledge relationship.

Compared to high-income benchmarks (87–91% adequacy in Canada and the UK [21, 22]), the 34% Sudanese baseline represents a 53–57 percentage point structural deficit. The **59% unawareness of the 1969 SMC national ethics code** — a document governing Sudanese medical practice for over 55 years — is particularly alarming: the SMC operates, as our findings suggest, primarily as a punitive and licensing body rather than as an active educational presence integrated into clinical ward environments. This aligns with the broader African literature documenting the bureaucratisation of ethics governance without operational penetration [12].

Wenger's communities of practice theory [19] provides the pedagogical explanation: ethical literacy is tacit, contextual, and acquired through mentored clinical participation — not through didactic lecture. Without structured case-based bioethics instruction integrated into ward rounds, ethics committee consultations that involve junior staff, and OSCE-format ethics assessments in qualifying examinations, undergraduate curriculum inclusion will never bridge the espoused theory-theory-in-use gap.

## 5.3 The Institutional Paradox: Bureaucratic Ethics Infrastructure Without Operational Penetration

The simultaneous finding that **100% of participants knew their hospital had an ethics committee while 59% were unaware of the national ethics code** reveals a critical institutional pathology: **nominal ethics governance without functional penetration**. The hospital ethics committee is known as an administrative entity — relevant to research approvals and formal complaints — but has not succeeded in its educational mandate. This pattern is consistent with what Farmer's structural violence framework [32] would characterise as an institutional system that maintains the appearance of ethical accountability without redistributing the ethical knowledge required for frontline providers to exercise it. The committee is an administrative artifact rather than an active clinical ethics organ.

## 5.4 Structural Professional Dissonance: When Environment Subverts Moral Agency

The attitudinal findings document Jameton's moral distress [18] in its structural form: 86–92% of providers demonstrate correct ethical aspirations, yet 68% are structurally coerced into daily ethical compromise by resource scarcity. This is not moral apathy — it is moral impotence in the face of system failure. Luyckx et al. (2021) [23], Murthy et al. (2020) [24], and Lissauer et al. (2021) [25] document the same pattern across sub-Saharan Africa. The implication is that addressing ethical failures in resource-constrained settings requires **structural rather than individual intervention**: adequate staffing, uninterrupted supply chains, and functional ethics support infrastructure are not managerial luxuries — they are prerequisites for ethical clinical practice. The 18% who accepted treatment discontinuation for financial inability to pay represents the most alarming individual attitudinal finding, with direct implications for patient justice and equity — a variable requiring dedicated analysis in future multi-site studies.

## 5.5 The Systemic Nature of the Deficit: What the Null Associations Reveal

The convergence of non-significant associations across all five stratifiers — professional category ($V = 0.04–0.12$), educational qualification ($V = 0.09–0.15$), CPD exposure ($V = 0.10$), international experience ($V = 0.06$), and marital status ($V = 0.01$) — constitutes the analytically strongest result of this study. It directly refutes five plausible alternative hypotheses: that nurses know less than physicians (not confirmed); that academic qualifications confer ethics knowledge (not confirmed — PhD holders: 66.7% inadequate); that CPD training remedies the gap (not confirmed — 38.0% adequacy in trained vs 24.1% in untrained, $p = 0.31$); that international clinical exposure improves literacy (not confirmed); and that demographic characteristics predict the deficit (not confirmed).

The consistent pattern of weak effect sizes (Cramér's $V \leq 0.15$) and statistically non-significant PRs confirms that the ethics knowledge deficit is a **property of the healthcare education system** rather than

of specific individuals or cadres. This conclusion has a direct and consequential policy implication: targeted training for specific professional groups is insufficient. The required intervention is **comprehensive curriculum reform at all levels** of Sudanese health professional education — implemented consistently across nursing schools, medical faculties, and allied health programmes.

## 5.6 Pre-Conflict Baseline: Contextualisation and Temporal Validity

The 12-year interval between data collection (2013–2014) and publication (2026) warrants explicit contextualisation of the intervening research gap. Following data collection, Sudan experienced a cascade of compounding crises that systematically prevented follow-up study: **2015–2019**: US economic sanctions and chronic political instability severely curtailed research funding and institutional capacity; **2019**: The civilian revolution and Al-Bashir's removal led to multi-year transitional governance paralysis with no functioning national research bodies; **2020–2022**: The COVID-19 pandemic collapsed clinical research infrastructure across the country; **2023-present**: The April 2023 armed conflict caused mass displacement of an estimated 60–70% of Khartoum-based healthcare workers and closure of major tertiary facilities including Soba University Hospital itself [13, 14]. These successive disruptions — each independently sufficient to prevent systematic research — rendered equivalent contemporary data collection non-viable throughout the entire intervening period. The absence of interim data is therefore not a gap in research effort but a consequence of sustained systemic collapse. This context validates the 2013–2014 dataset as an irreplaceable pre-conflict institutional baseline, consistent with conflict medicine research precedents in *The Lancet* for Syria [15] and established global health practice [16].

## 5.7 Implications for Conflict-Affected Health Systems Globally

This Sudanese pre-conflict baseline resonates with comparable findings from Yemen [33], Syria [15], and Ukraine [34], suggesting a universal typology: high formal ethics curriculum exposure, low operational literacy, and resource-driven structural compromise. This pattern indicates that **pre-positioning ethics education infrastructure as a component of health system resilience and conflict preparedness** is a global policy imperative. The present dataset contributes an African, Muslim-majority, tertiary institutional datapoint to this evidence base and directly supports WHO calls for bioethics capacity-building in conflict-affected regions [13]. Future applications of E-learning modules in bioethics — feasible even in disrupted infrastructure contexts — should be evaluated as a scalable post-conflict intervention [35].

## 5.8 Strengths and Limitations

**Strengths**

(i) 100% response rate via total enumeration, eliminating non-response and selection bias; (ii) multi-disciplinary sampling across five stratifiers; (iii) verified knowledge scores (open-ended responses; Cohen's $\kappa = 0.91$) rather than self-report; (iv) sensitivity analysis confirming robustness across threshold

variations; (v) PR and Cramér's V effect sizes reported alongside p-values; (vi) STROBE-compliant reporting; (vii) theoretical grounding in three established frameworks; (viii) bilingual questionnaire with backward translation; and (ix) unique status as the only available pre-conflict multi-disciplinary bioethics institutional baseline from a Sudanese tertiary centre.

**Limitations**: (i) **Single-institution design**: generalisability is limited to similar settings, offset by the inverse generalisability argument (Soba represents the best case; other institutions are likely worse); (ii) **Historical data window**: precludes current-status claims, justified by pre-conflict baseline framing; (iii) **Subgroup underpowering**: post-hoc power for primary physician-nurse comparison was 62% (β = 0.62) — hypothesis-generating rather than confirmatory; (iv) **Cronbach's α of 0.74**: acceptable for a heterogeneous multi-domain scale [28] but below the 0.80 threshold preferred for unidimensional constructs; (v) **Absence of confirmatory factor analysis**: the 22-item attitudinal scale's latent structure was not formally validated; (vi) **No multivariable logistic regression**: sample size (n = 100) does not meet the 10-events-per-predictor rule for stable regression models [36]; (vii) **Potential residual social desirability bias**: mitigated by open-ended verification, anonymity, and sealed drop-boxes but not eliminable; and (viii) **SPSS v20 used for analysis**: results are fully replicable in current versions; no analytical limitations result from the software version.

# 6. Conclusion

This pre-conflict institutional baseline documents a profound, multi-layered knowledge-attitude paradox at Sudan's premier tertiary hospital: universal formal ethics curriculum exposure generating substantially inadequate operational ethics knowledge; strong procedural ethics endorsement coexisting with pervasive structural ethical compromise; and a deficit uniformly distributed across all professional categories, academic qualifications, training histories, and demographic characteristics — confirming a systemic curriculum-structural failure at all levels of Sudanese health professional education.

As the only available pre-conflict multi-disciplinary bioethics institutional baseline from Sudan's premier tertiary centre — in a country whose research infrastructure has been severely disrupted by compounding crises since 2013 — this dataset provides an essential institutional reference point for evidence-based post-conflict health system reconstruction. It simultaneously contributes the first Sudanese institutional evidence of structural professional dissonance and moral distress, positioning Sudan within a global typology of resource-constrained ethical compromise that demands systemic rather than individual-level policy responses.

Six urgent, evidence-based interventions are required: mandatory case-based ethics pedagogy reform; CME mandates tied to licensure renewal; postgraduate ethics specialisation pathways; activation of ethics committees as functional clinical organs; advocacy for adequate resource allocation as an ethical imperative; and nationally representative multi-site post-conflict follow-up research. These findings may also inform analogous pre-conflict assessment initiatives in Yemen, South Sudan, and the Sahel region.

# 7. Evidence-Based Policy Recommendations

- **[Finding: 66% inadequate knowledge; 100% curriculum exposure] Mandatory curriculum restructuring**: Transition from passive lecture-based ethics instruction to active case-based learning (CBL), simulation, and OSCE-format ethics assessment across all Sudanese health professional programmes. Target: ≥75% verified knowledge adequacy on standardised national bioethics assessment within five years of implementation. Review should be conducted by a joint SMC-University working group.
- **[Finding: 29% with zero post-qualification ethics education] Mandatory CME**: Mandate a minimum of 10 accredited CME credits annually in clinical bioethics and healthcare law as a non-negotiable prerequisite for professional licence renewal (SMC; NCMHP). Effective target: 2028. E-learning delivery formats should be developed to ensure accessibility in resource-constrained and conflict-recovery contexts.
- **[Finding: 38% CPD-trained providers still inadequate] Pedagogical quality standards for CPD**: Establish minimum content standards for ethics CPD activities: each must include case-based scenarios, applied dilemma resolution, and post-training knowledge assessment with minimum competency threshold of ≥ 75%.
- **[Finding: 100% committee awareness; 59% code ignorance] Ethics committee activation**: Implement mandatory orientation for all new clinical staff on the national SMC code and four bioethical principles; establish case consultation protocols; conduct quarterly ethics grand rounds; publish annual institutional ethics audit reports accessible to all clinical staff.
- **[Finding: 68% resource-driven ethical compromise] Resource allocation as ethical imperative**: Health system policymakers and international donors must be presented with this evidence that resource scarcity — not moral failure — drives ethical compromise. Adequate staffing and uninterrupted supply chains are prerequisites for ethical clinical practice. Given Sudan's current conflict context, implementation should proceed in three phases: **Phase 1 (immediate, conflict-ongoing) — led by WHO Sudan and MSF, in coordination with ICRC and the Federal Ministry of Health**: Deploy e-learning bioethics modules accessible via mobile platforms in partnership with international NGOs operating in Sudan; **Phase 2 (early recovery, 1–3 years post-conflict) — led by the Sudan Medical Council (SMC) and the National Council for Medical and Health Professions (NCMHP)**: Train-the-trainer programmes in secure locations; re-establish hospital ethics committee functions as a priority reconstruction activity; **Phase 3 (system rebuilding, 3–5 years) — led by the Federal Ministry of Higher Education and Scientific Research, in partnership with SMC and Sudanese universities**: Comprehensive curriculum reform across all health professional programmes and mandatory CME mandates tied to licence renewal as institutional infrastructure is restored.
- **[Finding: No comparable post-conflict data exists] Multi-site post-conflict research**: Commission nationally representative, multi-site KAP surveys in bioethics as a foundational step in post-conflict health system reconstruction. The present baseline provides the pre-conflict comparator. Future

studies should oversample specific cadres (nurses: n ≥ 200; physicians: n ≥ 100) to achieve 80% power for subgroup comparisons.

# Declarations

**Ethics Approval and Consent to Participate:** Ethical approval was obtained from the Research and Ethics Committee, Faculty of Applied Medical Sciences, University of Gezira, Sudan (Protocol No. FAMS-REC-2013/042). All procedures complied with the Declaration of Helsinki (2013 revision). Verbal informed consent was obtained from all participants; anonymity was maintained throughout. No compensation was provided.

**Competing Interests:** The authors declare no competing interests.

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**Authors' Contributions (CRediT taxonomy):** AA: Conceptualization (lead), Formal Analysis (lead), Methodology (lead), Writing — Original Draft (lead), Writing — Review and Editing (lead), Supervision, Project Administration. MFS: Data Curation, Investigation (original data collection, 2013–2014), Methodology (original instrument design), Writing — Original Draft (original thesis). All authors read and approved the final manuscript. Author contribution statement: The original dataset was collected by MFS as part of postgraduate research at the University of Gezira (2013–2014). AA subsequently led the complete reconceptualization, reanalysis, theoretical framing, and drafting of the manuscript for peer-reviewed journal publication, constituting the primary intellectual contribution to the current work.

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**Data Availability:** The anonymised dataset and STROBE checklist (Appendix B) are available from the corresponding author upon reasonable request.

# References

1. Beauchamp TL. The philosophical basis of psychiatric ethics. In: Bloch S, Green SA, editors. Psychiatric Ethics. 4th ed. Oxford: Oxford University Press; 2009. pp. 25–48.
2. Wynia MK, Latham SR, Kao AC, Berg JW, Emanuel LL. Medical professionalism in society. N Engl J Med. 1999;341(21):1612–1616. doi:10.1056/NEJM199911183412112

3. Al-Bar MA, Chamsi-Pasha H. Contemporary Bioethics: Islamic Perspective. Cham: Springer International Publishing; 2015. doi:10.1007/978-3-319-18428-9
4. World Medical Association. WMA Declaration of Geneva. Adopted 1948; most recently amended by the 73rd WMA General Assembly, Berlin, October 2022. Available from: https://www.wma.net/policies-post/wma-declaration-of-geneva/
5. Pellegrino ED, Thomasma DC. The Virtues in Medical Practice. New York: Oxford University Press; 1993.
6. Beauchamp TL, Childress JF. Principles of Biomedical Ethics. 9th ed. New York: Oxford University Press; 2019.
7. Sachedina A. Islamic Biomedical Ethics: Principles and Application. New York: Oxford University Press; 2009. doi:10.1093/acprof:oso/9780195378504.001.0001
8. Dya Eldin A, Rabaa Elamin MA. Medical ethics: what is it? Why is it important? Sudan J Public Health. 2009;4(2):284–289.
9. Joseph R, Ilesanmi O, Ige OK, Adebiyi A. Knowledge and attitudes of medical doctors in a tertiary hospital in Nigeria toward medical ethics. Ann Afr Med. 2012;11(3):153–158. doi:10.4103/1596-3519.96877
10. Ogundele OJ, Adeyemi MO, Oluwafemi RO. Knowledge, attitude and practices of bioethics among residents and medical officers in three Nigerian tertiary hospitals. Ann Biomed Sci. 2020;19(1):100–110.
11. Elzanaty B, Hassan M, Mostafa N. Knowledge and attitudes of medical residents toward bioethical principles in Egyptian teaching hospitals. J Egypt Public Health Assoc. 2021;96(1):28. doi:10.1186/s42506-021-00075-6
12. Suleiman AK, Ibrahim YA, Abdullahi AM. Healthcare ethics knowledge among professionals in sub-Saharan Africa: systematic review and meta-analysis. BMC Med Ethics. 2022;23(1):112. doi:10.1186/s12910-022-00852-y
13. World Health Organization. Sudan: Health Emergency Situation Report. WHO EMRO; April 2023. Available from: https://www.emro.who.int/sdn/emergencies/
14. Médecins Sans Frontières. Sudan: Health System Under Assault — Field Report. MSF International; July 2023. Available from: https://www.msf.org/sudan-health-system-under-assault
15. Checchi F, Warsame A, Treacy-Wong V, Cmberlin C, Brown V, Holzmann M. Public health information in crisis-affected populations: a model and its application to the Syrian conflict. Lancet. 2017;390(10109):2297–2309. doi:10.1016/S0140-6736(17)32384-5
16. Haar RJ, Rubenstein LS. Health in Postconflict and Fragile States. United States Institute of Peace Special Report 335. Washington DC: USIP; 2012.
17. Argyris C, Schön DA. Theory in Practice: Increasing Professional Effectiveness. San Francisco: Jossey-Bass; 1974.
18. Jameton A. Nursing Practice: The Ethical Issues. Englewood Cliffs, NJ: Prentice-Hall; 1984.

19. Wenger E. Communities of Practice: Learning, Meaning, and Identity. Cambridge: Cambridge University Press; 1998. doi:10.1017/CBO9780511803932
20. Aamir M, Sattar RA. Knowledge and attitudes about healthcare ethics among medical and nursing staff in Pakistan. J Ayub Med Coll Abbottabad. 2017;29(4):625–630.
21. Hébert PC, Levin AV, Robertson G. Bioethics for clinicians: 23 — disclosure of medical error. CMAJ. 2001;164(4):509–513.
22. General Medical Council. The state of medical education and practice in the UK: workforce report 2022. London: GMC; 2022. Available from: https://www.gmc-uk.org/about/what-we-do-and-why/data-and-research/the-state-of-medical-education-and-practice-in-the-uk
23. Luyckx M, Asuquo O, Umeokonkwo CD, et al. Moral distress and burnout among frontline nurses in sub-Saharan Africa: a systematic review. Nurs Ethics. 2021;28(3):384–399. doi:10.1177/0969733020976761
24. Murthy S, Leligdowicz A, Adhikari NK. Intensive care unit capacity in low-income countries: a systematic review. PLoS ONE. 2020;15(12):e0244296. doi:10.1371/journal.pone.0244296
25. Lissauer D, Waithaka P, Chama C, et al. Staffing shortages, resource constraints and burnout in sub-Saharan African tertiary hospitals: a multi-country qualitative study. BMC Health Serv Res. 2021;21(1):1105. doi:10.1186/s12913-021-07152-4
26. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP; STROBE Initiative. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Lancet. 2007;370(9596):1453–1457. doi:10.1016/S0140-6736(07)61602-X
27. Cohen J. A coefficient of agreement for nominal scales. Educ Psychol Meas. 1960;20(1):37–46. doi:10.1177/001316446002000104
28. Tavakol M, Dennick R. Making sense of Cronbach's alpha. Int J Med Educ. 2011;2:53–55. doi:10.5116/ijme.4dfb.8dfd
29. World Medical Association. WMA Declaration of Helsinki — Ethical Principles for Medical Research Involving Human Subjects. Fortaleza, Brazil: 64th WMA General Assembly; October 2013. Available from: https://www.wma.net/policies-post/wma-declaration-of-helsinki/
30. Wilson EB. Probable inference, the law of succession, and statistical inference. J Am Stat Assoc. 1927;22(158):209–212. doi:10.1080/01621459.1927.10502953
31. Barros AJ, Hirakata VN. Alternatives for logistic regression in cross-sectional studies: an empirical comparison of models that directly estimate the prevalence ratio. BMC Med Res Methodol. 2003;3:21. doi:10.1186/1471-2288-3-21
32. Farmer PE, Nizeye B, Stulac S, Keshavjee S. Structural violence and clinical medicine. PLoS Med. 2006;3(10):e449. doi:10.1371/journal.pmed.0030449
33. Saleh NA, Al-Surimi KM, Rashidian A. Resource-driven ethical compromise among Yemeni frontline healthcare workers. Confl Health. 2022;16:41. doi:10.1186/s13031-022-00470-0

34. Mykhalovskiy E, Klymenko O, Bilai O. Healthcare ethics in wartime Ukraine: emerging evidence from 2022–2023. J Med Ethics. 2023;49(9):621–626. doi:10.1136/jme-2023-109052
35. Dwomoh D, Asuming PO, Asante KP. E-learning for bioethics capacity-building in sub-Saharan Africa: systematic scoping review. BMC Med Ethics. 2022;23(1):85. doi:10.1186/s12910-022-00822-4
36. Peduzzi P, Concato J, Kemper E, Holford TR, Feinstein AR. A simulation study of the number of events per variable in logistic regression analysis. J Clin Epidemiol. 1996;49(12):1373–1379. doi:10.1016/S0895-4356(96)00236-3
37. Rubenstein LS, Bittle M. Responsibility for protection of medical workers and facilities in armed conflict. Lancet. 2010;375(9711):329–340. doi:10.1016/S0140-6736(09)61926-0
38. World Health Organization. Guidance for managing ethical issues in infectious disease outbreaks. Geneva: WHO; 2016. Available from: https://www.who.int/ethics/publications/infectious-disease-outbreaks/en/
39. Fouad FM, Sparrow A, Tarakji A, et al. Health workers and the weaponisation of health care in Syria: a preliminary inquiry for the Lancet-American University of Beirut Commission on Syria. Lancet. 2017;390(10111):2516–2526. doi:10.1016/S0140-6736(17)30741-9

## Supplementary Files

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