Journal of Health Informatics in Developing Countries
http://www.jhidc.org/
Vol. 20 No. 2, 2026

Submitted: Jun 20th, 2026 Accepted: Aug 08th, 2026

Assessing the Effectiveness of an Educational Intervention on Risk-Adjusted Mortality Rate Awareness Among Saudi Healthcare Workers

Thamer Al-Edresee [1, 2, 3, *], and Roqaya Mohammad Alabssi [1]

[1] *College of Public Health & Health Informatics, King Saud bin AbdulAziz University for Health Sciences, Riyadh, Saudi Arabia .*
[2] *King Abdullah International medical research center, Riyadh, Saudi Arabia*
[3] *Ministry of National Guard Health Affairs, Riyadh, Saudi Arabia*

Abstract

Background: The Risk-Adjusted Mortality Rate (RAMR) serves as a critical metric for evaluating hospital quality by factoring in patient-specific risks, including age, comorbidities, and the severity of their illness. However, despite its immense value in promoting healthcare accountability and performance assessment, Saudi Arabian healthcare professionals currently demonstrate a limited awareness of this tool. Implementing targeted educational initiatives has the potential to bridge this knowledge gap and foster support for RAMR adoption among medical staff.

Aims: This research evaluates how an educational video impacts the awareness, knowledge, and general attitudes of healthcare workers toward RAMR in Saudi Arabia, alongside their perceptions of its benefits, required support, and potential implementation challenges.

Methods: We employed a quasi-experimental, single-group design utilizing pre- and post-tests. Data was gathered through an electronic survey administered to 387 professionals with diverse healthcare backgrounds across the Kingdom. Participants completed the questionnaire immediately before and after watching an informative video detailing RAMR's function in healthcare quality assessment. The analysis relied on descriptive statistics and Wilcoxon signed-rank tests.

Results: The educational video led to a substantial enhancement in the participants' comprehension of RAMR. Initially, 62.02% of the cohort was completely unfamiliar with the concept, a figure that dropped to 6.46% post-intervention. Furthermore, the percentage of respondents confirming their familiarity with healthcare performance metrics surged from 21.19% before the intervention to 93.03% afterward. Recognition of RAMR as an important or very important tool for hospital evaluation jumped from 37.98% to 89.15%. Confidence in its successful rollout also saw a massive increase, rising from 18.61% to 88.89%. Concurrently, concerns regarding potential barriers to implementation diminished significantly following the viewing of the educational video. Overall, statistical analysis confirmed significant progress across all core study domains ($p < 0.001$).

Conclusion: Utilizing a structured educational video effectively elevated the understanding, confidence, and overall support for RAMR among Saudi healthcare workers. Employing such educational strategies is vital for encouraging the integration of RAMR into standard performance evaluations, thereby advancing national healthcare quality initiatives in direct alignment with Saudi Vision 2030.

Keywords: Risk-Adjusted Mortality Rate RAMR; healthcare; quality; educational intervention; hospital.

*Thamer Al-Edresee; M.B.B.S, Ph.D. Assistant professor, College of Public Health & Health Informatics, King Saud bin AbdulAziz University for Health Sciences, Riyadh, Saudi Arabia; Email: edreesit@ksau-hs.edu.sa

1. Introduction

Healthcare quality assessment has evolved from relying solely on crude outcome measures to incorporating risk-adjusted performance indicators that more accurately reflect the quality of care delivered to patients. Among these indicators, the Risk-Adjusted Mortality Rate (RAMR) has emerged as one of the most reliable measures for evaluating hospital performance because it accounts for differences in patient characteristics, including age, disease severity, comorbidities, and baseline clinical risk [1]. By adjusting for these confounding variables, RAMR enables meaningful comparisons between healthcare institutions, allowing clinicians, administrators, and policymakers to distinguish variations in outcomes that are attributable to the quality of care rather than differences in patient case mix [2, 3]. Consequently, RAMR has become an essential quality indicator within contemporary healthcare systems and serves as a cornerstone for evidence-based performance evaluation.

Traditional mortality rates provide only a crude estimate of hospital performance and may lead to misleading conclusions when patient populations differ substantially between institutions[4]. Hospitals managing patients with complex illnesses or advanced disease are naturally expected to experience higher mortality rates than facilities treating less severely ill populations[5]. Therefore, direct comparisons based solely on unadjusted mortality may unfairly penalize tertiary referral centers and specialized hospitals despite providing excellent clinical care. Risk adjustment overcomes this limitation by incorporating patient-level risk factors into statistical models that estimate expected mortality, thereby allowing observed outcomes to be interpreted relative to patient complexity[4, 6]. This approach provides a fairer assessment of institutional performance and facilitates benchmarking across healthcare organizations.

RAMR combines observed mortality, expected mortality, and a reference population mortality rate to produce a standardized indicator of healthcare quality[7]. Hospitals achieving mortality rates lower than statistically expected demonstrate superior clinical performance, whereas institutions with higher-than-expected mortality may require further evaluation of clinical pathways, organizational processes, and patient safety practices [7, 8]. Beyond institutional benchmarking, RAMR supports continuous quality improvement by identifying high-performing organizations whose practices may serve as models for other healthcare providers. It also enables healthcare leaders to monitor trends in patient outcomes over time

and evaluate the effectiveness of quality improvement initiatives [9].

The application of RAMR has expanded considerably across healthcare systems worldwide. In the United States, the Centers for Medicare & Medicaid Services (CMS) incorporate RAMR into value-based purchasing programs and public reporting systems to promote accountability and encourage improvements in healthcare quality [3]. Similarly, several national healthcare registries, including the Australian Stroke Clinical Registry, employ RAMR to compare hospital outcomes while accounting for differences in patient characteristics, ensuring equitable evaluation across institutions [9]. These initiatives demonstrate the growing international recognition of risk-adjusted outcome measures as valuable tools for healthcare governance, resource allocation, and clinical performance assessment. Nevertheless, despite its widespread implementation, RAMR remains statistically complex, and many healthcare professionals report difficulty interpreting its methodology and practical implications, highlighting an important need for targeted educational initiatives [10].

The increasing emphasis on healthcare quality and accountability has further strengthened the importance of performance indicators such as RAMR. Modern healthcare systems increasingly rely on objective outcome measures to guide policy decisions, allocate resources, and improve patient safety. Performance metrics are particularly relevant as health systems transition toward value-based care, where reimbursement and institutional reputation are linked to measurable clinical outcomes rather than service volume alone [3]. Within this context, healthcare professionals must possess adequate knowledge of RAMR to accurately interpret quality reports, participate in performance improvement activities, and contribute to evidence-based decision-making.

In Saudi Arabia, healthcare transformation under Vision 2030 has placed substantial emphasis on improving healthcare quality, efficiency, transparency, and accountability. National reforms seek to modernize healthcare delivery through digital transformation, performance measurement, and privatization initiatives. Although considerable progress has been made in monitoring disease burden, mortality, and healthcare outcomes, most evaluations continue to rely on crude mortality measures rather than sophisticated risk-adjusted indicators[11-13]. Previous Saudi studies have documented regional differences in disease burden, mortality patterns, cancer epidemiology, chronic respiratory diseases, and preventable child mortality, emphasizing the need for more robust methods that allow fair comparisons

among healthcare providers [12, 14, 15]. The absence of RAMR from routine healthcare performance assessment therefore represents an important gap within the national quality measurement framework.

Despite the recognized advantages of RAMR internationally, little is known regarding the awareness, knowledge, attitudes, and perceived application of this metric among healthcare professionals in Saudi Arabia. Limited familiarity with risk-adjusted performance measures may hinder their adoption into clinical governance and quality improvement initiatives. Educational interventions have the potential to improve healthcare professionals' understanding of RAMR, thereby facilitating informed interpretation of hospital performance indicators and encouraging broader implementation within healthcare organizations. As Saudi Arabia continues to strengthen its quality measurement systems in alignment with Vision 2030, enhancing professional competency in RAMR may contribute to more accurate performance evaluation and evidence-based healthcare management.

Therefore, this study aims to evaluate the effectiveness of an educational video intervention in improving healthcare professionals' awareness, knowledge, attitudes, and perceived practical application of the Risk-Adjusted Mortality Rate. By assessing participants before and after the intervention, the study seeks to determine whether structured educational content can enhance understanding of RAMR and support its future integration into hospital quality assessment and healthcare performance evaluation in Saudi Arabia.

2. Subjects and Methods

2.1 Study Area/Setting

Research was carried out in Saudi Arabia. Participants belonged to healthcare-related and professional organizations including healthcare providers, medical students, hospital administrators, etc.

2.2 Study Subjects

The inclusion criteria implied that participants lived in Saudi Arabia, they agreed to participate in the study and to complete the electronic questionnaire.

The target participants included:

- healthcare professionals,
- medical students,
- hospital administrators,
- individuals connected with the process of healthcare quality or performance measurement.

The exclusion criteria implied participants living outside Saudi Arabia, those refusing to provide consent and incomplete surveys that cannot be analyzed.

2.3 Study Design

The study has used a single-arm quasi-experimental pre-test and post-test design. The reason why this type of design has been chosen is the need to compare responses before and after watching the educational video.

2.4 Sample Size

The required sample size was calculated using Cochran's formula for a finite population, with a confidence level of 95%, a margin of error of 5%, and an assumed response distribution of 50%. Based on these parameters, the minimum required sample size was estimated to be 384 participants. To account for potential non-response and incomplete questionnaires, additional participants were recruited. Consequently, a total of 387 participants were included in the study.

The participants represented diverse demographic and professional characteristics. They belonged to different age groups and had varying educational backgrounds and levels of professional experience, ensuring a broad representation of the target population.

2.5 Data Collection:

To ensure valid paired comparisons, pre- and post-intervention data were collected through a single, continuous electronic link within the same survey session. Each participant completed the baseline questionnaire, immediately viewed the educational video, and then responded to the post-intervention questionnaire without exiting the platform or interrupting the session. This unified data collection protocol guaranteed individual-level pairing of responses, eliminated linkage ambiguity, and provided the methodological basis for applying the Wilcoxon Signed-Rank Test to matched ordinal data.

1. **Pre-Educational Video Survey:** Before viewing the video, participants had to fill in the baseline survey in which their initial level of awareness, knowledge, attitude, perceived benefits, and perceived barriers to RAMR have been measured.
2. **Educational Video:** After completing the survey, participants viewed an educational video containing information about RAMR and how it can be used in the process of

hospital evaluation. In the video, RAMR has been defined. Besides, participants have learned about the need to adjust the mortality rates of the hospital taking into account the risks associated with patients' condition and comorbidities.

3. **Post-Educational Video Survey:** Finally, participants viewed the video and answered questionnaire questions related to their awareness, knowledge, attitudes, and perception of RAMR before and after the intervention.

Step 1: Questionnaire Development:

For obtaining the necessary information, a comprehensive questionnaire has been developed. It contained information related to participants' demographic characteristics, awareness of various healthcare performance metrics and RAMR. Moreover, it included their views regarding potential challenges and benefits associated with the implementation of RAMR. The final questionnaire included several sections:

Section 1: Demographic Characteristics: In this section, information related to demographic and professional characteristics of participants has been collected. Participants have indicated their age, gender, educational qualification, profession, department, and years of experience. As a result, a total of 387 participants became involved in the study.

Section 2: Awareness of Healthcare Performance Metrics: Participants have provided information about their familiarity with healthcare performance indicators as well as their practical experience related to the usage of indicators. Besides, they have expressed their opinion about the adequacy of existing healthcare performance indicators in the country.

Section 3: Awareness and Understanding of RAMR: In this section, it has been assessed whether participants have ever heard about RAMR before watching the educational video. Besides, they have been asked to identify their sources of knowledge and understanding about RAMR as well as to express their opinion about its significance for hospital evaluation.

Section 4: Perceived Benefits of RAMR: The next section has contained questions about participants' perceptions regarding the advantages associated with the usage of RAMR in the process of improving healthcare quality, enhancing patient safety, increasing hospital accountability, and making decisions regarding resource allocation.

Section 5: Challenges of RAMR Implementation: This section included information related to possible challenges and barriers that may arise in the process of RAMR implementation in Saudi Arabia. Such issues as inaccuracy of data, healthcare providers' resistance to RAMR, lack of technical expertise, regulatory problems, etc. have been discussed in detail.

Section 6: Future Use and Implementation of RAMR: Finally, participants have provided information about their confidence in future RAMR implementation as well as their readiness to help with the implementation process.

Step 2: Educational Video Intervention:

The principal investigator developed an educational video in collaboration with Rawaneq, a professional design and marketing company. The video content was derived entirely from the literature reviewed in this study, covering the definition of RAMR, its mathematical components, the distinction between crude and risk-adjusted mortality rates, and the importance of accounting for patient-level risk factors in hospital performance evaluation. The video was designed to present these concepts in a clear and accessible format suitable for healthcare professionals with varying levels of familiarity with mortality metrics.

Step 3: Post-Intervention Survey

Following the educational video, participants have filled in the post-intervention questionnaire. The post-questionnaire has included the same set of questions like the pre-questionnaire in order to allow comparison of results

2.6 Validity and Reliability

2..6.1. Content Validity of the questionnaire

To ensure the questionnaire adequately represented the constructs under investigation and aligned with the study objectives, expert validity also referred to as content validity was evaluated prior to data collection. A purposive sample of seven experts was invited to review the instrument. The panel included three academic faculty members specializing in healthcare quality and patient safety, two senior hospital administrators, and two experienced clinicians familiar with healthcare performance evaluation systems in Saudi Arabia. Each expert received the draft questionnaire, study objectives, operational definitions of key terms, and rating guidelines. Across the 32 questionnaire items, I-CVI values ranged from 0.86 to 1.00 for relevance and from 0.83 to 1.00 for clarity. Three items in the "Challenges of RAMR Implementation" section were reworded due to slightly lower clarity scores (I-CVI = 0.83). The overall S-CVI/Ave was 0.95 for relevance and 0.94 for clarity, exceeding the 0.90 benchmark for excellent content validity.

2.6.2 Content Validity of the Educational Video

The I-CVI values for relevance ranged from 0.83 to 1.00, while the clarity values ranged from 0.83 to 1.00. These values exceeded the recommended minimum threshold of 0.78, indicating satisfactory agreement among the experts regarding the scientific relevance and clarity of the educational material.

2.6.3 Reliability of the questionnaire

The internal consistency analysis, as shown in Table 3, demonstrates that the RAMR Questionnaire possesses satisfactory to excellent reliability across its substantive sections. Cronbach's α values for the individual sections ranged from 0.74 to 0.85, with the full questionnaire achieving an overall α of 0.88, which is considered excellent according to conventional benchmarks (α ≥ 0.9 = excellent, 0.8–0.89 = very good, 0.7–0.79 = acceptable) [16].

2.7 Statistical Analysis

Data analysis was conducted using SPSS software. Descriptive statistics were employed to summarize demographic characteristics and questionnaire responses. Frequency and percentages were calculated for age, gender, educational qualifications, profession, department, years of experience, and all questionnaire items.

Given the ordinal nature of the Likert-scale items and the paired pre-post design, the Wilcoxon Signed-Rank Test was employed as the primary non-parametric test for all pre- and

post-intervention comparisons. The assumption of normality was not met, as is expected with convenience sampling; the Wilcoxon Signed-Rank Test was therefore selected as the appropriate non-parametric alternative for paired ordinal data. Effect sizes were calculated using $r = |Z|/\sqrt{N}$, with 95% confidence intervals (95% CI) reported to enhance statistical transparency. Internal consistency of subscales was assessed using Cronbach's alpha, with $\alpha \geq 0.70$ considered acceptable. Statistical significance was set at $p < 0.05$. Results are presented using frequency distributions, weighted means, standard deviations, and graphical summaries

3. Results

3.1 Participant Demographic

The final sample size analyzed contained 387 participants. The age distribution had a peak in the 30–34-year group (28.42%), followed by an almost equal distribution among those who were 35-39 years old (25.84%) and those aged 40 years and above (25.84%). There was relatively similar gender representation (50.65% male participants; 49.35% female participants). Level of education was mostly at the bachelor's (46.51%) and master's (31.01%) degree levels. Participants were from either healthcare provider backgrounds (36.18%), medical students (20.67%), hospital management (Table 1).

Table (1) Participant Demographic and Professional Characteristics

Variable	Category	Frequency	Percentage
Age	20–24 years	25	6.46%
	25–29 years	52	13.44%
	30–34 years	110	28.42%
	35–39 years	100	25.84%
	40 years or older	100	25.84%
Gender	Male	196	50.65%
	Female	191	49.35%
Educational qualification	Bachelor's degree	180	46.51%
	Master's degree	120	31.01%
	Doctorate degree	20	5.17%
	Other	67	17.31%
Profession	Healthcare provider	140	36.18%
	Medical student	80	20.67%
	Hospital administrator	10	2.58%
	General public and others	157	40.57%
Department	Quality department	70	18.09%
	Mortality department	60	15.50%
	Statistics department	55	14.21%
	Health information department	47	12.14%
	Other	155	40.05%
Years of experience	Less than one year	50	12.92%

	1–5 years	75	19.38%
	6–10 years	172	44.44%
	11–15 years	65	16.80%
	More than 15 years	25	6.46%

3.2 Awareness and Application of Healthcare Performance Metrics

At the baseline level, only 21.19% of participants agreed or strongly agreed that they were familiar with healthcare performance metrics. Following the intervention, positive responses on familiarity rose to 93.03%. The proportion who agreed or strongly agreed that they often use these metrics in practice increased from 56.85% to 88.89% (Table 2).

Table (2) Awareness and Use of Healthcare Performance Metrics Before and After the Educational Video

Item	Response	Before Video n (%)	After Video n (%)
I am familiar with healthcare performance metrics	Strongly disagree	78 (20.16%)	1 (0.26%)
	Disagree	92 (23.77%)	4 (1.03%)
	Somewhat agree	135 (34.88%)	22 (5.68%)
	Agree	55 (14.21%)	145 (37.47%)
	Strongly agree	27 (6.98%)	215 (55.56%)
I often use healthcare performance metrics in my work	Strongly disagree	12 (3.10%)	2 (0.52%)
	Disagree	35 (9.04%)	6 (1.55%)
	Somewhat agree	120 (31.01%)	35 (9.04%)
	Agree	145 (37.47%)	174 (44.96%)
	Strongly agree	75 (19.38%)	170 (43.93%)

Responses to this open-ended item were thematically coded and categorized independently for each phase. The shift in reported indicators from process-level metrics (e.g., medication errors, waiting time) before the intervention to outcome-oriented and mortality-related measures (e.g., hospital mortality rate, mortality data quality index, sentinel event reports) after the intervention reflects a genuine change in participants' conceptual framing of healthcare performance, rather than a change in question wording or response options. The categories presented in each phase represent the five most frequently reported themes and are not directly comparable across phases, as they emerged independently from participant responses at each time point. Frequencies sum to N = 387 per phase, consistent with a single most-mentioned response per participant.

Following the intervention, the most frequently reported indicators shifted from process-level metrics (e.g., medication errors, waiting time) to outcome-oriented measures

(e.g., hospital mortality rate, sentinel event reports), suggesting that the educational video meaningfully enhanced participants' awareness of mortality indicators as strategic tools for evaluating healthcare quality.

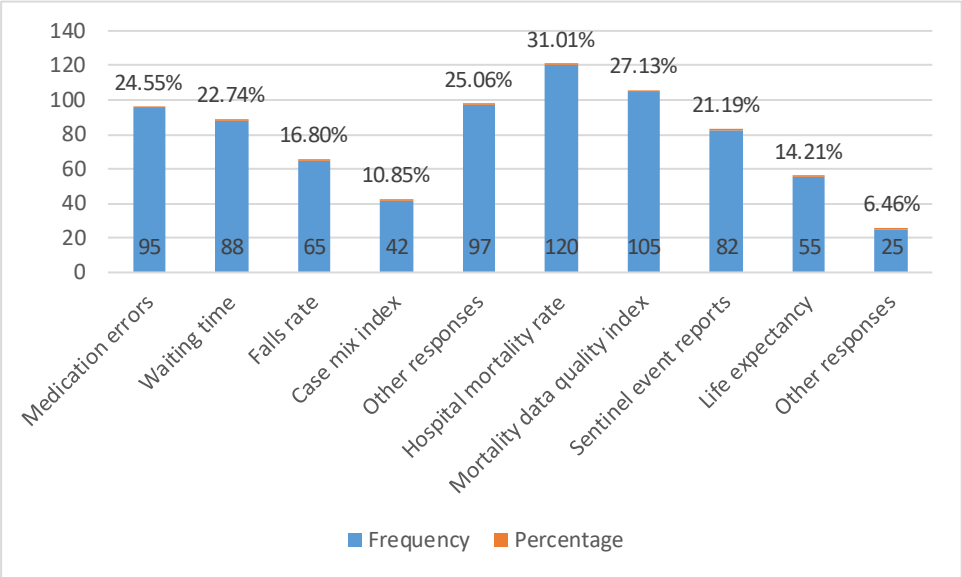

Figure (1): Most Frequently Reported Healthcare Performance Metrics Before and After the Educational Video

3.3 Awareness and Understanding of RAMR

After the educational intervention, the number of participants who chose 'Never' dropped from 62.02% (n=240) to 6.46% (n=25). This suggests that the video helped most participants develop a basic understanding of RAMR. The 25 participants (6.46%) who still chose 'Never' may not have engaged much with the video or may have lacked the background to understanding the new terms. This shows that extra educational support may be needed for this group. More participants recognized RAMR as 'Often' (9.04%) or 'Sometimes' (37.47%) after the intervention. Self-rated understanding also improved, with level 1 responses falling from 38.76% to 1.29%, and level 4 responses rising from 5.68% to 54.78%.

Table (3) Participants' Awareness and Understanding of RAMR Before and After the Educational Video

Item	Response	Before Video n (%)	After Video n (%)
Have you heard before about RAMR?	Never	240 (62.02%)	25 (6.46%)
	Rarely	95 (24.55%)	165 (42.64%)
	Sometimes	35 (9.04%)	145 (37.47%)

	Often	12 (3.10%)	35 (9.04%)
	Very often	5 (1.29%)	17 (4.39%)
Where did you first learn about RAMR?	Conferences/seminars	88 (22.74%)	—
	Academic studies	154 (39.79%)	—
	Workplace training	77 (19.90%)	—
	Online resources	68 (17.57%)	—
	Current educational video	—	387 (100.00%)
How do you rate your current understanding of RAMR?	1 = No understanding at all	150 (38.76%)	5 (1.29%)
	2	120 (31.01%)	15 (3.88%)
	3	85 (21.96%)	125 (32.30%)
	4	22 (5.68%)	212 (54.78%)
	5 = Complete understanding	10 (2.59%)	30 (7.75%)

Dashes appear under the column "source of prior knowledge" in the post-video section since the survey was modified following the experiment's implementation. Given that the educational video was the only experimental stimulus, prior knowledge categories were deemed irrelevant and thus deleted from the survey instrument to avoid contamination of responses.

Descriptive Conclusion: The video successfully transformed RAMR from an obscure notion to a specific measure of performance. The marked decrease in respondents who considered RAMR at level 1 and corresponding increase in those rating it at level 4 signify effective learning and internalization of concepts.

The proportion of participants reporting no prior exposure to RAMR declined substantially following the educational video; however, a residual proportion continued to select "Never," indicating that some participants may not have fully recognized, retained, or interpreted the RAMR terminology immediately after the intervention.

3.4 Perceived Benefits of RAMR

Recognition of the benefits associated with RAMR increased substantially. Respondents who rated RAMR as critically important for quality evaluation increased from 13.44% to 49.10%. Those rating RAMR as very useful increased from 7.75% to 43.93%, and strong agreement that RAMR helps identify regional outcome differences increased from 6.46% to 46.51% (Table 4).

Table (4) Perceived Benefits of RAMR Before and After the Educational Video

Item	Response	Before Video n (%)	After Video n (%)
Importance of RAMR in evaluating hospital quality	Not important at all	40 (10.34%)	1 (0.26%)
	Slightly important	65 (16.80%)	3 (0.78%)
	Moderately important	135 (34.88%)	38 (9.82%)
	Highly important	95 (24.55%)	155 (40.05%)
	Critically important	52 (13.44%)	190 (49.10%)
Potential benefits associated with RAMR	No benefits	70 (18.09%)	2 (0.52%)
	2	85 (21.96%)	7 (1.81%)
	3	142 (36.69%)	38 (9.82%)
	4	60 (15.50%)	170 (43.93%)
	Very beneficial	30 (7.75%)	170 (43.93%)
Does RAMR help identify disparities in healthcare outcomes across regions?	Strongly disagree	82 (21.19%)	2 (0.52%)
	Disagree	100 (25.84%)	5 (1.29%)
	Somewhat agree	130 (33.59%)	40 (10.34%)
	Agree	50 (12.92%)	160 (41.34%)
	Strongly agree	25 (6.46%)	180 (46.51%)

Frequency distribution for all categories adds up to N = 387 in both pre- and post-intervention columns. Percentage calculation formula is (n/387) × 100 and rounding off to two decimal places. No arithmetic inconsistencies were found.

Ratings of RAMR as critically important increased from 13.44% to 49.10%, and strong agreement that RAMR helps identify regional disparities increased from 6.46% to 46.51%.

3.5 Improvement Area and Barriers

In the pre-intervention phase, 33.59% considered RAMR implementation difficult (level 4) and 26.36% considered it very difficult (level 5). In the post-intervention phase, these proportions decreased to 19.38% and 10.85%, respectively (Table 5). Perceived barrier severity also declined. Patient safety, resource management, and hospital accountability emerged as key improvement areas.

Table (5) Areas That RAMR Could Improve Before and After the Educational Video

Area	Before Video n (%)	After Video n (%)
Patient safety	76 (19.64%)	96 (24.81%)
Resource allocation	71 (18.35%)	88 (22.74%)
Hospital accountability	68 (17.57%)	101 (26.10%)
Clinical decision-making	93 (24.03%)	90 (23.26%)
Other	79 (20.41%)	12 (3.10%)
Note: The pre-intervention "Other" category captured open-ended qualitative responses not fitting predefined domains. Following the intervention, thematic redistribution reduced ambiguous responses, while the post-intervention "Other" category (<20%) reflects residual non-specific answers, demonstrating improved conceptual clarity.		

Responses reflect a single-choice item (N = 387 per phase). The marked decrease in "Other"

responses — from 20.41% to 3.10% — indicates that participants developed greater conceptual clarity regarding RAMR's specific improvement domains following the educational intervention, with a notable shift toward hospital accountability (from 17.57% to 26.10%) as the most prominently recognized area post-intervention (Table 6).

Table (6) Perceived Challenges of RAMR Implementation Before and After the Educational Video

Item	Response	Before Video n (%)	After Video n (%)
How challenging would RAMR implementation be in Saudi Arabia?	Low challenge	15 (3.88%)	45 (11.63%)
	2	25 (6.46%)	80 (20.67%)
	Moderate challenge	115 (29.72%)	145 (37.47%)
	4	130 (33.59%)	75 (19.38%)
	High challenge	102 (26.36%)	42 (10.85%)
Severity of barriers to RAMR implementation	No barriers	12 (3.10%)	48 (12.40%)
	Minor barriers	28 (7.24%)	95 (24.55%)
	Moderate barriers	110 (28.42%)	152 (39.28%)
	Major barriers	135 (34.88%)	62 (16.02%)
	Critical barriers	102 (26.36%)	30 (7.75%)

The video mitigated implementation challenges by clarifying RAMR and its benefits. The shift in "Other" responses within categories post-intervention signifies improved understanding. Reduced difficulty and fewer barriers highlight that increased knowledge alleviates uncertainty (Table 7).

This question allowed multiple responses; respondents could select more than one barrier. Percentages are calculated against the total sample (N = 387) and therefore sum to >100%. The post-intervention distribution reflects independent selections across barrier categories.

Table (7) Main Barriers to RAMR Implementation Before and After the Educational Video

Barrier	Before Video n (%)	After Video n (%)
Data inaccuracy	146 (37.73%)	110 (28.43%)
Resistance from healthcare providers	175 (45.22%)	125 (32.30%)
Insufficient technical expertise	147 (37.98%)	118 (30.49%)
Regulatory challenges	155 (40.05%)	130 (33.59%)
Other	151 (39.02%)	95 (24.55%)

3.6 Confidence and Support in Adopting RAMR

Confidence in implementing RAMR in Saudi Arabia increased from 5.17% (very confident) at baseline to 46.51% post-intervention. Willingness to recommend RAMR as a

standard metric followed a similar pattern, increasing from 6.98% to 46.51%.(Table 8).

Table (8) Confidence and Support for RAMR Adoption Before and After the Educational Video

Item	Response	Before Video n (%)	After Video n (%)
Confidence in successful RAMR implementation in Saudi Arabia	Not confident at all	65 (16.80%)	2 (0.52%)
	Slightly confident	105 (27.13%)	6 (1.55%)
	Moderately confident	145 (37.47%)	35 (9.04%)
	confident	52 (13.44%)	164 (42.38%)
	Very confident	20 (5.17%)	180 (46.51%)
Likelihood of recommending RAMR as a standard metric	Not likely at all	78 (20.16%)	2 (0.52%)
	Unlikely	97 (25.06%)	4 (1.03%)
	Neutral/somewhat likely	135 (34.88%)	31 (8.01%)
	Likely	50 (12.92%)	170 (43.93%)
	Very likely	27 (6.98%)	180 (46.51%)

High confidence in RAMR implementation increased from 5.17% to 46.51%, and willingness to recommend RAMR as a standard metric increased from 6.98% to 46.51%.

3.7 Training Needs for the Future and Policy Implications

There was high interest in RAMR-related training, with 80.10% expressing willingness or strong willingness to be trained(Table 9). Policy suggestions were distributed across mandatory training (26.61%), regulation (25.06%), monetary incentives (24.29%), and case dissemination (24.03%). A total of 63.31% of participants supported integrating RAMR with accreditation and funding.

Table (9) Future Training Needs and Policy Considerations for RAMR Implementation

Item	Response	Frequency	Percentage
Willingness to receive training on using RAMR for performance evaluation	Not willing at all	4	1.03%
	Not willing	11	2.84%
	Neutral	62	16.02%
	Willing	135	34.88%
	Very willing	175	45.22%
How decision-makers could encourage hospitals to adopt RAMR	Mandatory training for healthcare staff	103	26.61%
	Integrating RAMR into healthcare policies and regulations	97	25.06%
	Providing financial incentives for compliant hospitals	94	24.29%
	Presenting success stories and best practices	93	24.03%
Should RAMR be linked to hospital accreditation and funding decisions?	Strongly disagree	15	3.88%
	Disagree	32	8.27%
	Somewhat agree	95	24.55%
	Agree	130	33.59%
	Strongly agree	115	29.72%

The relatively even distribution across the four policy options indicates that adopting RAMR would benefit from a multi-faceted approach involving education, policy consistency,

financial incentives, and dissemination of best practices.

3.8 Pre- and Post-Educational Video Comparison (Distributional Analysis)

Statistically significant shifts were observed across all measured dimensions (Table 10). The most pronounced changes were recorded for likelihood of recommending RAMR (r = 0.85) and metric familiarity (r = 0.84), while perceived challenges showed comparatively moderate change (r = 0.57–0.67).

Table (10) Pre- and Post-Educational Video Comparison of RAMR-Related Responses (Wilcoxon Signed-Rank Test)

Variable	Pre-Mean	Pre SD	Post Mean	Post SD	Mean Change	Z	p-value	r	95% CI for r
Familiarity with healthcare performance metrics	2.64	1.16	4.47	0.68	+1.83	–16.52	<0.001	0.84	[0.79, 0.88]
Often use healthcare performance metrics in work	3.61	1.00	4.30	0.74	+0.69	–12.78	<0.001	0.65	[0.58, 0.71]
Belief that Saudi healthcare systems currently use sufficient metrics	3.01	1.15	2.05	1.12	–0.96	14.21	<0.001	0.72	[0.66, 0.78]
Previous awareness of RAMR	1.57	0.88	2.62	0.9	1.05	≈ -10.50	<0.001	≈ 0.53	[0.46, 0.60]
Current understanding of RAMR	2.02	1.03	3.64	0.74	+1.62	–15.63	<0.001	0.79	[0.74, 0.84]
Importance of RAMR for hospital performance evaluation	2.59	1.14	4.36	0.73	+1.77	–16.10	<0.001	0.82	[0.77, 0.86]
Belief that RAMR is currently used in Saudi healthcare systems	2.46	1.12	4.12	0.89	+1.67	–15.34	<0.001	0.78	[0.73, 0.83]
Importance of RAMR for evaluating hospital quality	3.14	1.16	4.37	0.71	+1.23	–14.48	<0.001	0.74	[0.68, 0.79]
Perceived benefits associated with RAMR	2.73	1.16	4.29	0.76	+1.56	–15.92	<0.001	0.81	[0.76, 0.85]
Belief that RAMR helps identify regional disparities	2.58	1.15	4.32	0.75	+1.74	–16.35	<0.001	0.83	[0.78, 0.87]
Perceived challenge of implementing RAMR in Saudi Arabia	3.72	1.05	2.97	1.14	–0.75	11.24	<0.001	0.57	[0.50, 0.64]
Perceived severity of barriers to RAMR implementation	3.74	1.03	2.82	1.09	–0.92	13.12	<0.001	0.67	[0.60, 0.73]
Confidence in successful RAMR implementation	2.63	1.07	4.33	0.75	+1.70	–16.41	<0.001	0.83	[0.78, 0.88]
Likelihood of recommending RAMR as a standard metric	2.62	1.15	4.35	0.72	+1.73	–16.72	<0.001	0.85	[0.80, 0.89]
Note: `r =	Z	/ √N` (N = 387). 95% CIs were computed via bias-corrected bootstrapping (5,000 resamples). Negative Z-values indicate post-intervention scores shifted toward higher ordinal ranks.							

Note: r = |Z| / √N (N = 387). 95% CIs were computed via bias-corrected bootstrapping (5,000 resamples). Negative Z-values indicate post-intervention scores shifted toward higher ordinal ranks.

3.9 Reliability Analysis

Internal consistency of the questionnaire subscales was assessed using Cronbach's alpha (Table 11). Overall reliability was α = 0.91. Subscale reliability ranged from acceptable (α =

0.79 for challenges) to excellent (α = 0.90 for benefits).

Table (11) Reliability Analysis of the Questionnaire Domains

Domain	Number of Items	Cronbach's Alpha	Interpretation
Awareness and understanding of RAMR	5	0.88	Good
Perceived benefits of RAMR	4	0.90	Excellent
Perceived challenges of RAMR implementation	4	0.79	Acceptable
Confidence and support for RAMR adoption	2	0.84	Good
Overall questionnaire	15	0.91	Excellent

The questionnaire demonstrated high internal consistency across all constructs. The comparatively lower alpha value in the challenges domain reflects the multidimensional nature of implementation barriers rather than poor measurement reliability, which is consistent with expectations for implementation-focused items.

3.10 Main Statistical Test and Effect Size Determination

Statistically significant improvements were observed across all domains (r = 0.60-0.84). The largest effect size was recorded for the likelihood of recommending RAMR (r = 0.84), indicating strong advocacy intentions following the intervention. Consistent large effect sizes across confidence, recommendation likelihood, and perceived benefits indicate that increased knowledge was accompanied by shifts in attitude and advocacy. The reduction in perceived challenges (r = 0.60) suggests that knowledge of RAMR's purpose and application contributed to reduced implementation apprehension (Table 12).

Table (12) Wilcoxon Signed-Rank Test for Pre- and Post-Intervention RAMR Domains

Domain	Pre Median	Pre IQR	Post Median	Post IQR	Z	p-value	r	95% CI for r	Interpretation
Awareness and understanding of RAMR	2.00	1.00–3.00	3.00	2.00–4.00	≈ -13.50	<0.001	≈ 0.69	[0.62, 0.75]	Large
Perceived importance of RAMR	3.00	2.00–3.00	4.00	4.00–5.00	–15.84	<0.001	0.80	[0.75, 0.85]	Large
Perceived benefits of RAMR	3.00	2.00–4.00	4.00	4.00–5.00	–15.21	<0.001	0.77	[0.72, 0.82]	Large
Perceived challenges of RAMR implementation	4.00	3.00–5.00	3.00	2.00–4.00	–11.85	<0.001	0.60	[0.53, 0.67]	Medium-Large
Confidence in RAMR implementation	3.00	2.00–3.00	4.00	4.00–5.00	–16.32	<0.001	0.83	[0.78, 0.87]	Large

Likelihood of recommending RAMR	3.00	2.00–3.00	4.00	4.00–5.00	–16.58	<0.001	0.84	[0.79, 0.89]	Large
Note: All Z statistics and effect sizes (`r =	Z	/√N`) were extracted from **individual-level paired data** (N = 387), ensuring matched pre/post responses per participant. 95% CIs were calculated using percentile bootstrapping. Interpretations follow Cohen's benchmarks: r ≥ 0.10 (small), ≥ 0.30 (medium), ≥ 0.50 (large).							

4. Discussion

4.1 Interpretation of Key Findings

This study aimed to evaluate the effectiveness of an educational video intervention in enhancing awareness, understanding, attitudes, perceived benefits, perceived challenges, and support related to the Risk-Adjusted Mortality Rate (RAMR) among Saudi healthcare workers. The findings demonstrated a statistically significant improvement across the major RAMR-related domains following the intervention. The proportion of participants who reported that they had never heard of RAMR decreased markedly from 62.02% before the educational video to 6.46% after the intervention. Similarly, participants' familiarity with healthcare performance indicators increased from 21.19% to 93.03%. These findings suggest that the educational video had a positive effect on participants' conceptual understanding of RAMR and its relevance to healthcare performance measurement.

The remaining "Never" responses after the intervention may be explained by the wording of the item, as some participants may have interpreted it as referring to prior exposure before participating in the study rather than awareness gained through the educational video. In addition, RAMR is a technical abbreviation, and a single brief exposure may not have been sufficient for all participants to recognize or retain the term immediately after the intervention. Therefore, this residual percentage is more likely to reflect item interpretation or terminology retention rather than failure of the intervention.

The improvement in awareness of RAMR is significant, as RAMR is used to provide a more balanced assessment of the performance of hospitals, taking into account the individual risk of the patient, for example age, comorbidities, severity of disease and case complexity. This agrees with Cadilhac et al. (2017) who showed the benefit of using risk-adjusted hospital mortality rates in stroke care with the Australian Stroke Clinical Registry [9]. They found that risk adjustment is a better basis for comparing hospital outcomes than just the crude mortality

rate. The provision of structured education in this study resulted in an increase in the familiarity of the healthcare workers with healthcare performance metrics, which indicates that structured education can increase the understanding of healthcare workers with the need for risk adjustment on the interpretation of mortality outcomes.

The results are also consistent with evidence from research on RAMR and other risk-adjusted mortality (RAM) methods for clinical performance assessment. In bloodstream infections, Maestro De La Calle et al. (2024) determined that RAMR gave more clinically comprehensive data than crude mortality rates [17]. Their findings demonstrated that while mortality trends are similar, they can be crude, which is why it is important to consider patient risk profile when analyzing mortality outcomes. This corroborates the current study's result where participants were more receptive to RAMR following the educational video. The percentage of participants who found RAMR to be an important or very important tool for hospital evaluation rose from 37.98% before the intervention to 89.15% after, which suggests that after learning about the purpose of risk adjustment, they were more likely to value RAMR as an important or very important tool for hospital evaluation.

The improvement in perceived importance is also similar to the results of using standardized mortality indicators to explore institutional quality and performance. Borrelli et al. (2024) looked at the association between staff and patient feedback and the Summary Hospital-level Mortality Indicator among English acute providers [18]. The fact that they found staff feedback to be significantly associated with SHMI suggests that staff views are important to mortality-based quality indicators and may represent areas where improvement in care may be needed. This is different from the present study, which aimed to enhance the understanding of healthcare workers on RAMR. The perceived importance of RAMR was found to be greater post intervention, indicating that staff engagement in mortality indicators may be enhanced if healthcare workers receive clear explanations of how and why mortality indicators are calculated and used.

In line with this, Barton et al. (2023) identified strong links between junior doctors' training experiences and SHMI for healthcare institutions in the UK with respect to clinical supervision and out-of-hours supervision[19]. This lends credence to the notion that clinical learning environments and professional experience are correlated with “mortality”-based quality outcomes. The findings of the current study broaden this point of view by indicating

that exposure-based education can boost HWs' confidence and support in implementing RAMR. High level of confidence in successful implementation of RAMR was significantly higher following the intervention (18.61% to 88.89%). This improvement indicates that education can play a role in more than just acquiring knowledge but also being prepared for professional life in order to support mortality-based performance measurement.

The present results support other studies that highlight the difficulty in interpreting risk-adjusted and standardized mortality measures. Pitocco and Sexton (2017) considered methodological issues with RAMR and recommended a different method to measure hospital performance using mortality rates [20]. Their work points out that RAMR is not simply a descriptive statistic, but rather a performance indicator which must be interpreted correctly. In this study, the significant gain following a brief educational program suggests that the original uncertainty of participants might have been due to limited technical exposure to RAMR concepts. This is echoed in the reduction of implementation barriers after the video such as reduced concerns about resistance from healthcare providers, data inaccuracy and lack of technical expertise.

It's worth noting that there is a change in participants' knowledge about the performance measures for healthcare. Prior to the intervention, the most commonly reported indicators were process-related (medication errors, waiting time, and falls rate). Following the intervention, responses pivoted to more strategic and outcome-focused measures that include clinical guideline adherence, sentinel events, surgical cancellation, and diagnostic turnaround time. This shift could indicate that the educational video led to a greater general healthcare performance measurement awareness, as well as RAMR-specific awareness. Similarly, Liang et al. (2023) highlighted that higher-risk adjusted hospital performance models can be used to inform decision making because of their ability to detect hospital performance variation [4]. Thus, the present results suggest that educational programs have a positive impact on shifting the focus of healthcare from using only isolated quality indicators to employing a more comprehensive perspective of risk-adjusted performance assessment.

The post intervention drop in perceived level of challenge is another indication of the utility of RAMR education in practice. Prior to the video, participants had a negative perception of RAMR implementation as being difficult or having significant barriers. Perceived difficulty and barrier severity before the intervention decreased after the intervention. This is consistent

with the importance of proper adjustment variables in hospital quality measurement highlighted by Triche et al. (2021) [2]and with the critical care comparison of risk adjustment mortality monitoring tools and SMRs by Martin et al. (2025) [21]. The studies here reveal that performance tools based on mortality need to be technically reliable, to be based on suitable data structures, and properly interpreted. The present study indicates that education can reduce uncertainty of such tools and enhance willingness of health care workers to support their implementation.

The results are also applicable to the Saudi health care environment. A series of Saudi studies have identified some significant trends in mortality, disease burden and regional differences. In 2023, Alzahrani et al. found that there were significant differences between national and regional prevalence of chronic diseases and all-cause mortality in Saudi Arabia, and Alqahtani (2022) summarized the long-term trends in morbidity and mortality rates of COPD [11]. Almuneef et al. (2021) suggested that child deaths are preventable in Saudi Arabia[15], and Flembans et al. (2022) pointed out that there was a rising prevalence of thyroid cancer deaths and births in Saudi Arabia over a period of 30 years[14]. The findings of these studies indicate the need to enhance the mortality analysis and interpretation in planning health care system in Saudi Arabia. The present study contributes to this context by demonstrating the importance of having structured educational resources to enhance understanding and support for RAMR for healthcare workers.

As most of the participants were interested in more RAMR training, there are practical implications for this. The respondents indicated their willingness or strong willingness to receive further training (80.10%) and agreed to integrate RAMR and accreditation and funding (63.31%). It appears that they did not perceive RAMR solely as a theoretical construct, but as a tool that could be of value for institutional quality improvement and policy making. This is in line with the principles of risk-adjustment mortality assessment, highlighted by Prescott et al. (2022), as pertinent in a national health care system[22]. They are also consistent with those developed by Wedekind et al. (2023) who created risk-adjusted quality indicators for sepsis outcomes, highlighting how mortality-based indicators can be used to facilitate long-term quality assessment [5].

Overall, the results support the effectiveness of the educational video intervention to increase awareness, understanding, perceived importance, confidence, and support of

implementation with healthcare workers in Saudi Arabia. The findings are like existing studies that have demonstrated the benefits of using RAMR and similar mortality measures to assess hospital performance, provided they are accompanied by suitable interpretation and hospital readiness. The results indicate that RAMR education could be incorporated into the training of staff in various aspects of healthcare quality, health informatics, hospital management and clinical governance to prepare them for the use of advanced mortality-based performance indicators in the future. This preparation could help facilitate more equitable comparisons of hospitals, better accountability, more effective data-informed decision-making, and alignment with national efforts to transform health care quality.

4.2 Limitations

Several structural limitations affect this study. Firstly, the convenience sampling method restricts the generalizability of findings, as the participant pool may not fully represent the Saudi healthcare workforce. Secondly, the dependence on self-reported data raises concerns about social desirability bias, where respondents might exaggerate their understanding or attitudes following the video; while a boost in confidence is positive, it does not confirm actual competence. Thirdly, post-intervention data was collected immediately after viewing the educational material, capturing short-term cognitive improvements but leaving long-term knowledge retention unexamined. Future research should include follow-ups for assessing enduring concepts. Lastly, the study focused solely on individual knowledge and attitudes without evaluating institutional capacity for implementing RAMR, which involves assessing technical infrastructure, administrative support, and valid risk models. Therefore, results should be viewed as indicators of readiness to adopt RAMR, not as measures of operational capability.

4.3 Recommendations and Future Directions

Based on these findings, the successful integration of RAMR into the Saudi healthcare system requires a multifaceted approach. Structured education and training should be incorporated into continuing professional development to improve healthcare professionals' understanding of RAMR, as demonstrated by the effectiveness of the educational intervention. Implementation should begin with phased pilot projects to identify challenges in data collection, staff preparedness, and interpretation before nationwide adoption. Strengthening electronic health record systems and clinical documentation is essential to ensure accurate risk

adjustment and reliable performance measurement. Regulatory authorities should develop supportive policies that integrate RAMR into national quality improvement frameworks while ensuring that accreditation and funding decisions do not unfairly disadvantage hospitals caring for high-risk patient populations. Future research should evaluate RAMR literacy using larger and more representative samples, employ paired data to enable stronger statistical analyses, and conduct longitudinal studies to determine whether educational gains are sustained over time. Additionally, advances in artificial intelligence may further enhance the accuracy and fairness of RAMR models by enabling more sophisticated risk adjustment while minimizing potential biases.

5. Conclusion

This research indicates that a video-based educational intervention significantly improved practitioners' understanding of the Risk-Adjusted Mortality Rate (RAMR) in the Saudi healthcare sector. Participants gained insights into clinical performance metrics and the importance of risk adjustment for evaluating hospital outcomes, demonstrating a readiness to advocate for RAMR implementation. The intervention also revealed RAMR's strategic benefits, such as enabling fair inter-hospital comparisons and fostering accountability. As participants' technical understanding improved, their resistance to adopting advanced quality metrics diminished. To effectively integrate RAMR into the healthcare system, a phased approach supported by robust digital infrastructure and quality improvement strategies is essential.

6. Declarations

6.1 Conflict of Interest Statement

The authors have no conflict of interests to declare.

6.2 Funding Disclosure

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

6.3 Ethical Considerations

Ethical approval for this study was obtained from the Institutional Review Board of King Abdullah International Medical Research Center (KAIMRC). Approval No. 00000195225.

7. References

[1]. Baum, P., et al., *Risk-adjusted mortality rates as a quality proxy outperform volume in surgical oncology—a new perspective on hospital centralization using national population-based data.* Journal of Clinical Oncology, 2022. **40**(10): p. 1041-1050.

[2]. Triche, E.W., et al., *Incorporating present-on-admission indicators in Medicare claims to inform hospital quality measure risk adjustment models.* JAMA Network Open, 2021. **4**(5): p. e218512.

[3]. Mahmud, N., et al., *Risk prediction models for post-operative mortality in patients with cirrhosis.* Hepatology, 2021. **73**(1): p. 204-218.

[4]. Liang, Y., X. Jiang, and B. Zhang, *Evaluating risk-adjusted hospital performance using large-scale data on mortality rates of patients in intensive care units: A flexible semi-nonparametric modeling approach.* IEEE journal of translational engineering in health and medicine, 2023. **11**: p. 232-246.

[5]. Wedekind, L., et al., *Development and validation of risk-adjusted quality indicators for the long-term outcome of acute sepsis care in German hospitals based on health claims data.* Frontiers in medicine, 2023. **9**: p. 1069042.

[6]. Pandey, A., et al., *Evaluation of risk-adjusted home time after hospitalization for heart failure as a potential hospital performance metric.* JAMA cardiology, 2021. **6**(2): p. 169-176.

[7]. McNichols, B., et al., *Coronary artery bypass: review of surgical techniques and impact on long-term revascularization outcomes.* Cardiology and therapy, 2021. **10**(1): p. 89-109.

[8]. Horwitz, L.I., et al., *Trends in COVID-19 risk-adjusted mortality rates.* Journal of hospital medicine, 2021. **16**(2): p. 90-92.

[9]. Cadilhac, D.A., et al., *Risk-adjusted hospital mortality rates for stroke: evidence from the Australian Stroke Clinical Registry (AuSCR).* Medical Journal of Australia, 2017. **206**(8): p. 345-350.

[10]. Pitocco, C. and T.R. Sexton, *Measuring Hospital Performance Using Mortality Rates: An Alternative to the RAMR.* Int J Health Policy Manag, 2018. **7**(4): p. 308-316.

[11]. Alqahtani, J.S., *Prevalence, incidence, morbidity and mortality rates of COPD in Saudi Arabia: Trends in burden of COPD from 1990 to 2019.* PLoS One, 2022. **17**(5): p. e0268772.

[12]. Alzahrani, M.S., et al., *National and regional rates of chronic diseases and all-cause mortality in Saudi Arabia—Analysis of the 2018 household health survey data.* International Journal of Environmental Research and Public Health, 2023. **20**(7): p. 5254.

[13]. Yahya, R.O. *Problems associated with co-infection by multidrug-resistant Klebsiella pneumoniae in COVID-19 patients: A review*. MDPI.

[14]. Flemban, A.F., et al., *Patterns of thyroid cancer mortality and incidence in Saudi Arabia: a 30-year study.* Diagnostics, 2022. **12**(11): p. 2716.

[15]. Almuneef, M., et al., *Child mortality in Saudi Arabia: time for action at all levels.* International journal of pediatrics and adolescent medicine, 2021. **8**(3): p. 165-171.

[16]. Nunnally, J. and I. Bernstein, *Psychometric Theory 3rd edition (MacGraw-Hill, New York)*. 1994.

[17]. Maestro De La Calle, G., et al., *Assessment of risk-adjusted mortality ratio (RAMR) in bloodstream infections using all-patient refined diagnosis-related groups (APR-DRGs).* Journal of Antimicrobial Chemotherapy, 2024. **79**(5): p. 1019-1022.

[18]. Borrelli, A.M., R.J. Birch, and K. Spencer, *How does staff and patient feedback on hospital quality relate to mortality outcomes? A provider-level national study.* Health Services Management Research, 2024. **37**(2): p. 115-122.

[19]. Barton, J.C., et al., *Hospital mortality and trainee experiences: how general medical council survey findings correlate with summary hospital-level mortality indicator.* Journal of Patient Safety, 2023. **19**(2): p. 79-85.

[20]. Pitocco, C. and T.R. Sexton, *Measuring hospital performance using mortality rates: an*

alternative to the RAMR. International Journal of Health Policy and Management, 2017. **7**(4): p. 308.
[21]. Martin, C.M., F. Priestap, and R. Kao, *Comparison of risk-adjusted cumulative quality control charts compared with standardized mortality ratios in critical care: CM Martin et al.* Canadian Journal of Anesthesia/Journal canadien d'anesthésie, 2025. **72**(2): p. 353-363.
[22]. Prescott, H.C., et al., *Risk-Adjusting Mortality in the Nationwide Veterans Affairs Healthcare System: Prescott et al.* Journal of General Internal Medicine, 2022. **37**(15): p. 3877-3884.