ORIGINAL ARTICLE

Mediating Role of Safety Climate in The Associations Between Safety Culture, Safety Education and Training, Reporting Attitudes with Medical Errors in Riyadh Hospitals

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ABSTRACT

Introduction: Medical errors pose significant challenges to healthcare systems globally. In Saudi Arabia, the alarming rise in medical error incidents since 2016 has eroded trust in the healthcare system, highlighting inadequacies in current policies and practices. This study investigated how safety climate mediates the relationship between safety culture, safety education and training attitudes, and reporting attitudes on medical errors among healthcare professionals in Riyadh public hospitals. **Materials and Methods**: This cross-sectional study collected data from 403 healthcare professionals across four Riyadh public hospitals. Descriptive analysis was conducted using SPSS, while AMOS was used for structural equation modelling. **Results**: Healthcare professionals perceiving stronger safety culture (b=0.53, p<0.001) and reporting attitudes (b=0.44, p<0.001) were more likely to commit medical errors, while those with positive safety education and training attitudes (b=-0.21, p<0.001) recorded fewer errors. Safety climate partially mediated relationships between safety culture and medical errors (p<0.001) and between safety education/training attitudes and medical errors (p<0.001), but not between reporting attitudes and medical errors (p=0.068). **Conclusion**: Safety climate crucially mediates the translation of organizational safety factors into medical error outcomes. Healthcare organizations should simultaneously develop strong safety cultures, positive safety climates, effective training programs, and non-punitive reporting systems to enhance organizational learning and improve patient safety outcomes in Saudi Arabian healthcare settings.
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Keywords: Patient Safety, Medical Errors, Safety Climate, Healthcare Professionals, Saudi Arabia, Structural Equation Modelling

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INTRODUCTION

The growing emphasis on patient safety globally reflects significant concerns about the substantial societal costs of medical errors, which often result in adverse events. Medical errors significantly impact morbidity and mortality rates worldwide (1,2). The World Health Organization reports that one in ten patients in high-income countries suffer injuries due to medical errors, calling them a severe threat to individuals and public health globally (3). In the Kingdom of Saudi Arabia (KSA), a report on the frequency of medical errors indicated increased incidents from 2016 to 2020 (4,5). In 2018 alone, the legal health committees of the KSA Ministry of Health (5) registered 1,097 cases of medical errors. The cost of medical errors extends beyond financial implications, eroding trust in the healthcare system and diminishing satisfaction among healthcare providers and patients (6). The inadequacy of current healthcare policies and practices to mitigate these risks is apparent, necessitating immediate and urgent action to safeguard patient safety and well-being. Considering these challenges, the current study investigates the relationship between safety culture, safety education and training attitude, and reporting attitude with

medical errors within healthcare settings. Additionally, by examining whether safety climate mediates these relationships, the study also aims to provide insights into how safety culture, safety education and training attitude, and reporting attitude influence medical error occurrences.

Safety culture in healthcare organizations encompasses values, attitudes, and behaviors that define an organization's approach to health and safety management (7,8). Research demonstrates that certain organizational safety cultural elements–particularly adequate staffing, consistent handoffs, and effective teamwork–correlate negatively with medical errors (9,10), while coordination and communication failures predict adverse outcomes. The Saudi Arabian healthcare context presents unique challenges due to its multinational workforce and multilingual environment (11). Singer and Vogus (12) and Weaver et al. (13) recommended further empirical examination of the influence of safety culture on medical error in the country, given previously reported mixed findings. These mixed findings refer to variations in how safety culture is operationalized and measured, as well as inconsistent associations between safety culture components and error rates across different hospitals and regions. Such discrepancies highlight the need to critically analyze the contextual factors and potential mediators, such as safety climate, that might explain these variations. Future research should also consider thorough investigation of safety culture as a crosscutting contextual factor that can moderate the effectiveness of other patient safety practices, such as implementation of rapid response systems. The strength of evidence for patient safety culture would be improved if theoretical models guiding these investigations are explicitly articulated and empirically validated.

Safety education and training provide healthcare professionals with the necessary knowledge and skills to identify and mitigate safety risks (14). Woodward et al. (14) indicate that lack of risk awareness significantly contributes to medical errors, with education identified as a fundamental mitigation strategy. Despite advances in safety education and training strategies, challenges persist in enforcement and long-term behavior change (15), making the overall effectiveness of educational interventions in reducing medical errors inconclusive (16). It is important to clarify that safety education aims to develop knowledge, critical thinking, and understanding to prepare individuals for broad challenges, whereas training is more targeted, focusing on specific skills for particular clinical tasks (UNESCO).

Reporting attitudes pertain to healthcare professionals' perceptions and dispositions toward disclosing errors or adverse events within clinical settings (17). Transparency and error reporting constitute crucial elements of healthcare accountability and system efficacy, with Saudi Arabia experiencing increasing medical error lawsuits, particularly in obstetrics (27%) and general surgery (17%) (17,18). Significant discrepancies were found between healthcare professionals' stated beliefs about reporting importance and actual reporting practices, with 43% admitting they would not report errors to avoid punishment (17). In comparison, 60% believe guaranteed confidentiality would improve reporting rates (17). Nonetheless, studies have demonstrated that accountability and reporting culture are fundamental building blocks for patient safety and quality improvement (12, 19). In practice, a positive reporting attitude involves prompt, honest self-reporting of mistakes or near misses, as well as peer reporting, within an environment that encourages learning rather than blame.

Safety climate represents the immediate employees' perceptions and attitudes toward the organization's safety policies, procedures, and practices (20). In contrast, safety culture encompasses the overarching beliefs, values, and safety norms that permeate the entire organization. The safety climate of individual units within a hospital collectively contributes to the overall safety culture of the institution. Each unit may have its unique safety climate influenced by factors such as leadership, communication practices, and teamwork dynamics. However, these individual climates collectively shape the broader safety culture of the hospital. Safety climate is a critical mediating mechanism between organizational safety factors and medical error outcomes in healthcare settings. James et al. (21) and Zabin.et.al (32) claimed that safety climate could either strengthen or weaken the relationship between safety culture measures and error rates depending on the level of restrictiveness. This mediating role extends to safety education and training initiatives, where effective programs incorporating leadership involvement, feedback mechanisms, and continuous reinforcement positively influence safety climate perceptions studies such as Clarke et.al (25) and Sarvadikar et al. (22), which then affect medical error rates. Regarding reporting attitude, non-punitive safety climates with robust communication channels increase error reporting while punitive environments suppress it (24). These relationships between organizational safety factors and department-specific safety climates (22), how unit-level climate variations ultimately determine whether broader cultural values, educational programs, and reporting systems successfully translate into reduced medical errors.

The "enabling" aspect the role of a positive culture in fostering an environment where safety is prioritized through clear communication, training, and policies that promote awareness and prevention of errors. As such, healthcare organizations empower their staff to remain vigilant and proactive in identifying and mitigating risks, which is crucial for reducing medical errors. The "enacting" and "elaborating" components of the framework build on the initial safety culture by

encouraging continuous action and learning. Enacting safety means translating policies into day-to-day practices, such as adhering to safety checklists and protocols and maintaining open lines of communication among healthcare providers. Elaborating involves refining these practices based on new insights, experiences, and data related to medical errors. This continuous improvement process enables organizations to adapt to evolving challenges and ensures that safety measures are dynamic and responsive. Rashman et al. (27) further proposed that enabling, enacting, and elaborating are most effective in reducing hospital errors when mediated by contextual variables such as safety climate. By applying this framework in research on medical errors, scholars can evaluate healthcare organizations' implementation of safety cultures and identify factors that contribute to effective error prevention. Based on these arguments, the following conceptual model is proposed (Figure 1). Despite all this, there remains a gap in understanding the complex interplay between safety culture, safety education and training attitudes, reporting attitudes, and safety climate in relation to medical errors in the context of Saudi Arabian healthcare systems. This study aims to address this gap by examining the mediating role of safety climate in the relationship between safety culture, safety education and training attitudes, and reporting attitudes with medical errors among healthcare professionals in Riyadh public hospitals.

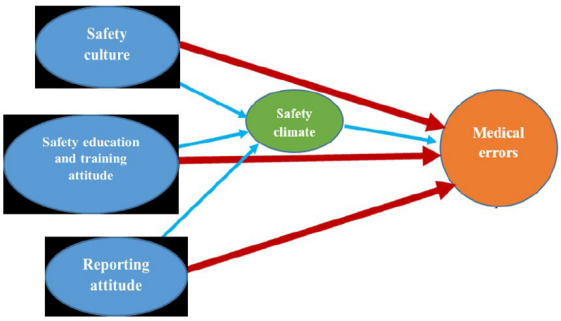

Figure 1: Conceptual model.

Materials and Methods

Study Design and Location

This cross-sectional study was conducted in four public hospitals in Riyadh, Saudi Arabia, between September 2022 and September 2023. The current study focused specifically on public hospitals in Riyadh due to access permissions and the centralized nature of healthcare policy implementation. The hospitals were selected from two health clusters in Riyadh. The clusters represent a group of hospitals in a network of integrated healthcare providers operating under a single administrative structure. It offers medical professionals internal mobility prospects to treat patients within the same cluster. The main criteria that make up these clusters are geographic location, the number of patients served, the capacity of hospitals, and integrated access to healthcare (28). Two hospitals were selected from Cluster One (i.e., King Saud Medical City and Imam bin Abdurrahman Hospital and two others from Cluster Two (i.e., King Fahd Medical City and Prince Mohammad bin Abdul Aziz Hospital). The location of these hospitals represents the geographical location of the two clusters located in the northern and southern parts of Riyadh.

Study Population and Sampling

The sample size was calculated using the web tool by Soper (30), which determined a minimum sample size of 542 participants based on anticipated effect size (0.3), desired statistical power level (0.8), number of latent variables (5), number of observed variables (41), probability level (0.05), and non-response rate (20%). The sample size for each hospital was determined using a proportionate-to-size ratio. It was calculated using this formula: the number of healthcare professionals in each hospital divided by the total number of healthcare professionals in all four hospitals multiplied by 542. Table 1 depicts the final number of respondents from each hospital to be recruited for this study. The inclusion criteria were as follows: Saudi healthcare professionals employed in public hospitals in Riyadh City. Exclusion criteria were part-time healthcare professionals and those with less than three years of experience. Eligible candidates were recruited using simple random sampling via a list provided by each hospital administration.

Table I: Number of respondents from each hospital

No.	Hospitals	Number of employees	Sample (n) from each hospital
1.	Imam bin Abdurrahman hospital	200	48
2.	Prince Mohammad bin Abdul Aziz hospital	300	72
3.	King Saud medical city	800	193
4	King Fahd medical city	950	229

Study Variables

Questionnaires for the present research study were adopted from past studies. The instrument has been validated by four expert panels from Malaysia and Saudi Arabia. Experts in the relevant field were also consulted to ensure content validity. Furthermore, the questionnaire underwent face validity testing and was administered to 55 healthcare professionals who were not part of the study. The measurement instruments were designed on a 5-point Likert scale from 1 being "Strongly Disagree" to 5 being "Strongly Agree". The instruments were distributed in English. The questionnaires consisted of 5 sections: socio-demographic factors (i.e., age, gender, occupation, working experience, and education level), safety culture (29), safety education and training (30), reporting attitudes (31), and safety climate (32).

The safety culture questionnaire contained nine items measuring healthcare professionals' perceptions of safety culture in their workplace. The higher the score, the better the perception of respondents of the safety culture

at the workplace. The safety education and training attitudes questionnaire (six items) was used as a proxy for predicting healthcare professionals' likelihood of participating in safety education and training programs. Previous research has shown a strong correlation between attitude and behavior, indicating that attitude can be a reliable predictor of behavior, particularly when individuals have control over their actions (33,34). The higher the score, the better the attitude of the healthcare professionals towards safety education and training. The reporting attitude questionnaire was an eight-item tool that assessed the attitudes of healthcare professionals toward reporting medical errors. Reversing the score for Questions 1, 2, 3, 7, and 8, a high score (> 20) would signal a good attitude of the healthcare professionals to report medical errors. The safety climate questionnaire had nine items designed to measure perceptions of safety climate in the workplace, where a higher score corresponds to better respondents' perceptions of the safety climate at the workplace. These instruments demonstrated good reliability, with Cronbach's alpha values ranging from 0.735 to 0.928. Data on medical errors for each healthcare professional were obtained from the hospital administrative record.

Ethical approval was obtained from the Medical Review and Ethics Committee of Universiti Putra Malaysia. Informed consent was obtained from all participants prior to data collection. The questionnaires were administered in person, and participants were assured confidentiality and anonymity.

Data Analysis

Data were analysed using SPSS version 25 and AMOS version 28. Descriptive statistics were used to describe the socio-demographic characteristics and study variables. The Maximum Likelihood (ML) estimation method was selected for the Confirmatory Factor Analysis (CFA) to examine the underlying measurement models for all variables. To assess for common method bias due to the self-reported nature of the data, Harman's single-factor test was performed. All items were entered into an exploratory factor analysis using a principal component method. The results indicated that the first factor accounted for only 21.7% of the total variance, well below the 50% threshold. This suggests that common method bias was unlikely to have significantly influenced the findings. Structural equation modelling (SEM) was then conducted to examine the mediating role of safety climate in the relationship between safety culture, safety education and training attitudes, and reporting attitudes with medical errors. The mediation analysis utilized the bootstrap procedure with 5000 resampling iterations. Model fit was assessed using the following indices: chi-square/degrees of freedom (χ^2/df < 5.0), root mean square error of approximation (RMSEA < 0.08), goodness of fit index (GFI > 0.90), normed fit index (NFI > 0.90), comparative fit index (CFI > 0.90), and Tucker-Lewis index (TLI > 0.90).

Results

Out of 550 respondents approached during data collection, only 403 responses met the inclusion criteria and were used in the analysis (response rate 73.3%). The median age of respondents was 37 years. The sample comprised 66% females and 34% males. Most participants (63%) were nurses, while 37% were physicians. Of these, 65% had a bachelor's degree, 20% had a master's degree, 12% had a PhD, and 3% had other qualifications. About 26% of respondents had 3-5 years of working experience, 31% had 6-10 years, 31% had 11-20 years, and 12% had more than 20 years of experience (Table 2).

Table II: Demographic of respondents (N=403)

Sociodemographic Characteristic	Mean (SD)	Frequency	Percentage
Age	37 (8)		
Gender			
Male		137	34
Female		266	66
Occupation			
Nurse		254	63
Physician		149	37
Educational qualification			
Bachelors		263	65
Masters		81	20
Ph.D.		47	12
Others		12	3
Work experience			
3-5 years		103	26
6-10 years		125	31
11-20 years		126	31
21-25 years		32	8
More than 25 years		17	4

Measurement Model

Confirmatory factor analysis was performed to validate the measurement models for all variables. To assess the reliability and validity of the measurement model, composite reliability (CR) and average variance extracted (AVE) were calculated for each construct. The CR values indicated acceptable internal consistency, with Safety Culture at 0.768, Safety Education and Training Attitude at 0.906, Reporting Attitude at 0.712, and Safety Climate at 0.935, each exceeding the recommended threshold of 0.70. In terms of convergent validity, AVE values were also examined. Results showed AVE values of 0.311 for Safety Culture, 0.618 for Safety Education and Training Attitude, 0.277 for Reporting Attitude, and 0.617 for Safety Climate. Although the AVE values for Safety Culture and Reporting Attitude were slightly below the conventional cut-off of 0.50, the high CR

scores indicate that the constructs still demonstrate adequate convergent validity. Additionally, all the factor loadings were found to be statistically significant and demonstrated acceptable fit indices after appropriate modifications (Table 3).

Table III: Measurement models

Variables	χ^2/df	RMSEA	GFI	NFI	CFI	TLI
Safety culture	4.43	0.09	0.95	0.91	0.93	0.90
Safety education & training	3.81	0.08	0.98	0.99	0.99	0.98
Reporting attitude	4.62	0.09	0.97	0.94	0.95	0.90
Safety climate	3.43	0.09	0.96	0.97	0.98	0.96

Note. χ2 = chi-square; df = degrees of freedom; RMSEA = root mean square error of approximation; GFI = goodness of fit index; NFI = normed fit index; CFI = comparative fit index; TLI = Tucker-Lewis index

Structural model

Results from the structural model demonstrated acceptable fit indices (χ^2/df= 4.794, RMSEA= 0.07, GFI= 0.923, NFI= 0.790, CFI= 0.985, TLI= 0.790), the Normed Fit Index (NFI) and Tucker-Lewis Index (TLI), are well below the conventional thresholds for acceptable model fit (typically > 0.90 or > 0.95), were made to the original confirmatory factor analysis (CFA) model, error covariance were added between items showing high and the final SEM was tested, demonstrated improved goodness-of-fit relative . . Statistically significant estimates were observed across all pathways (p<0.05). Specifically, safety culture (SCU) (b= 0.53, p< 0.001), safety education and training (SET) (b= -0.21, p< 0.001), and reporting attitude (RS) (b= 0.44, p< 0.001) were statistically correlated with medical errors (ME), Path analysis showed that all primary relationships were statistically significant (p < 0.05). Additionally, SCU and safety climate (SC) were positively correlated (b= 0.49, p= 0.01), suggesting that an increase in safety culture score by one unit leads to a corresponding 0.49-point increase in the perception of safety climate at the workplace. The model also shows that SET and SC were positively correlated (b= 0.870, p= 0.02), where an increase in safety education and training score by one unit increases the safety climate score by 0.87. RS and SC had a positive correlation as well (b= 0.170, p= 0.01), where a one-unit increase in the reporting attitude score leads to a 0.17 rise in the safety climate score. Furthermore, the correlation between SC and ME is significant (b= 0.06, p= 0.04). This shows that a higher safety climate score is linked to an increased likelihood of medical error occurrences. These outcomes underscore the significant relationship and impact of safety culture, safety education and training attitude, and reporting attitude on medical errors and safety climate. It also highlights the relationship between safety climate and medical error occurrence in public hospitals in Riyadh.

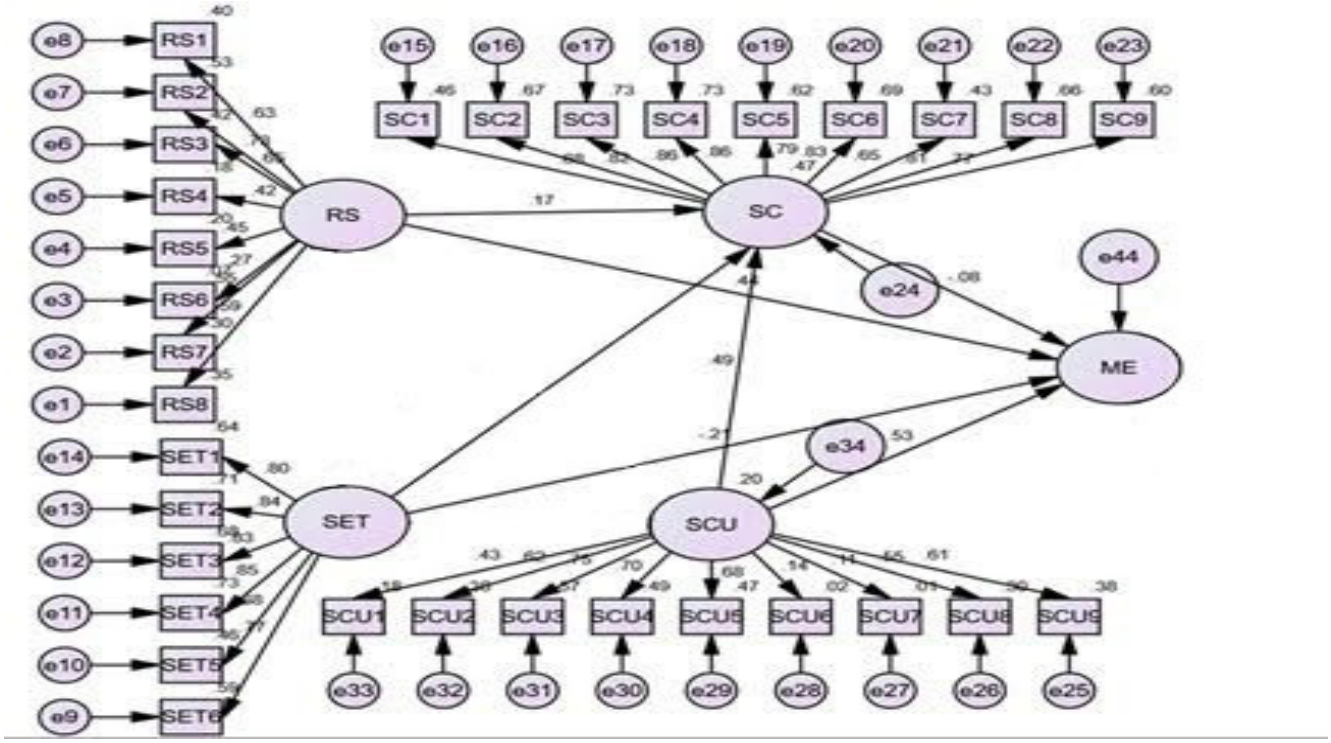

Figure 2: Structural model.

The mediation analysis revealed that SC partially mediated the relationship between safety culture and medical errors (p< 0.001), as well as between safety education and training attitudes and medical errors (p< 0.001). However, safety climate did not significantly mediate the relationship between reporting attitudes and medical errors (p= 0.068). The direct, indirect, and total effects of the mediation model (Figure 2) are present in Table 4.

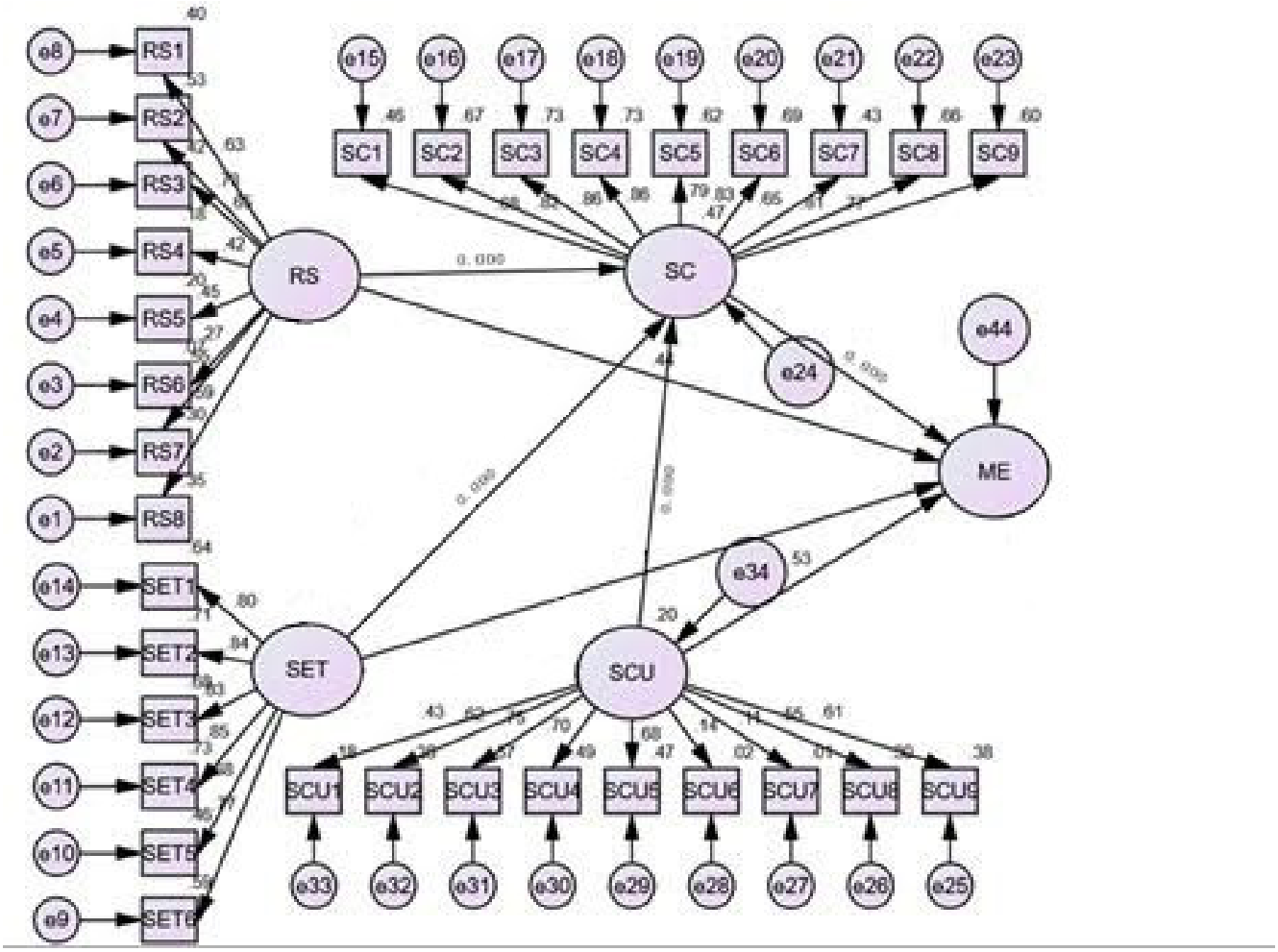

Figure 3: Mediation model.

Table IV: Mediation effect of safety climate on relationship between independent variables and medical errors

Pathways	Beta	95% confidence interval		p. value
		Lower bound	Upper bound	
Direct model SCU→ME	0.21			<0.001
Mediation model SCU→SC→ME	0.16	0.14	0.28	<0.001
Direct model SET→ME	-0.56			<0.001
Mediation model SET→SC→ME	-0.41	-0.86	-0.29	<0.001
Direct model RS→ME	0.04			<0.001
Mediation model RS→SC→ME	0.07	-0.12	0.09	0.068

Note: SCU = Safety Culture; SET = Safety Education and Training Attitudes; RS = Reporting Attitudes; SC = Safety Climate; ME = Medical Errors.

Discussion

The current research examined the mediating effects of safety climate on the relationship between safety culture, safety education and training attitudes, and reporting attitudes on medical errors among healthcare professionals in Riyadh public hospitals.

Safety culture with medical errors

Our results revealed that healthcare professionals who perceived a stronger safety culture were paradoxically more likely to report medical errors. This unexpected relationship can be explained by several factors identified in previous research. Hammoudi et al. (35) and Shehata et al. (36) found that healthcare environments with more developed safety cultures often have better error detection and reporting systems, leading to higher documented error rates that may not necessarily reflect higher actual error occurrence. It also aligns with findings from Cohen et al. (37), who noted that error reports are often poor indicators of individual competence and that nurses who report errors tend to be more conscientious and safety-minded. Wakefield et al. (38) found that environments emphasizing safety culture encouraged more transparent error reporting rather than indicating more frequent errors. This phenomenon is widely recognized in the patient safety literature as the "reporting paradox" or detection bias, whereby improvements in safety culture create conditions for greater openness and willingness to report errors, near misses, and system failures. In such climates, staff feel psychologically safe and supported, which promotes voluntary reporting and transparency. Thus, the higher number of reported medical errors in our study may reflect enhanced detection and reporting mechanisms rather than a real increase in adverse events. These findings underscore the complex nature of interpreting error data in the context of organizational culture. Future studies should incorporate objective performance indicators such as EHR-based safety triggers or incident audits to disentangle reporting behavior from actual clinical error rates and better assess the true impact of safety culture improvements.

Safety education and training attitude with medical errors

The study also demonstrates that healthcare professionals with more positive attitudes toward safety education and training were significantly less likely to commit medical errors. This finding corroborated previous research by Halbach and Sullivan (39), who found that medical officers with positive attitudes toward patient safety education were more likely to engage in error-prevention behaviors and showed greater awareness of safety practices. The strong inverse relationship between safety attitudes and error occurrence found in our study is also consistent with work by El-Gendi et al. (40), who found that positive safety attitudes correlated with reduced medication errors in Egyptian hospitals. The protective effect of positive safety education and training attitudes appears to operate through multiple mechanisms. Frager (41) found that both cognitive and affective components of attitudes toward errors are important predictors of safety behaviors. When these components are aligned (high affective-cognitive consistency), the relationship between attitudes and safety behaviors is strengthened. This may help explain the protective effect found in our study, as professionals with positive education and training attitudes likely had alignment between their cognitive understanding of safety importance and their emotional commitment to safety practices. However, it is important to note that positive education and training attitudes alone may not be sufficient for error prevention. As demonstrated by Waterman et al. (42), even physicians with positive attitudes can experience significant stress and negative emotions after errors occur, which could impact future performance if not addressed adequately through supportive organizational systems. De Feijter et al. (43) found that while positive attitudes toward safety education were beneficial, perceived behavioral control and social norms also played crucial roles in determining whether safety knowledge would be effectively implemented.

Reporting attitude with medical errors

Our study found that healthcare professionals with positive attitudes toward error reporting were significantly more likely to report medical errors. As Unal and Seren (44) noted, healthcare professionals who maintain positive attitudes toward error reporting tend to be more aware of and attentive to identifying potential medical errors performed by either themselves or their colleagues, leading to higher reported rates—not necessarily higher actual error occurrence. Sarvadikar et al. (45) discovered that healthcare professionals' perceptions and reporting behaviors varied significantly based on their attitudes toward errors—those with more positive attitudes toward reporting documented both major and minor incidents, while those with negative attitudes primarily reported only severe cases. This differential reporting behavior may explain the positive association between reporting attitudes and medical errors found in our study. Moreover, several organizational factors were reported to moderate the relationship between attitudes and error reporting. Soydemir et al. (46) identified that administrative support, feedback systems, and a blame-free culture were critical elements that enabled healthcare professionals with positive reporting attitudes to engage in reporting behaviors. Without these systemic supports, even those with favorable attitudes toward reporting may be deterred by fear of individual/legal accusations or adverse administrative reactions.

Safety climate as a mediator

The current study found that safety climate partially mediated the relationship between safety culture and medical errors and between safety education and training attitudes and medical errors. These findings suggest that safety climate serves as an important pathway through

which safety culture and safety education and training attitudes influence medical errors. The mediating role of safety climate in the relationship between safety culture and medical errors aligns with previous research by Weng et al. (47), who found that safety climate dimensions, particularly teamwork climate and working conditions, served as significant mediators between management leadership practices and safety outcomes in intensive care units. It supports that safety culture works through climate-related mechanisms to influence frontline safety behaviors and outcomes. Similarly, the mediating role of safety climate in the relationship between safety education and training attitudes and medical errors is consistent with findings by Huang et al. (48), who demonstrated that safety climate mediated the relationship between management commitment to safety training and injury outcomes. This suggests that the organizational context and climate in which training is implemented significantly influence its effectiveness in reducing errors. The partial mediation observed in our study indicates that while safety climate is an important pathway, safety culture and safety education and training attitudes also have direct effects on reducing medical errors. This implies that organizations seeking to reduce medical errors should focus on developing a strong safety culture and implementing effective safety education and training programs while fostering a favorable safety climate.

Limitations of the Study

This study has several limitations that should be acknowledged. First, all data were self-reported by healthcare professionals, which may be subject to recall bias and social desirability bias. Second, the study was conducted exclusively in four public hospitals within Riyadh, which may limit the generalizability of the findings to other regions or to public healthcare settings in Saudi Arabia. Healthcare delivery structures, professional cultures, and patient demographics may differ significantly in other areas of the country. Third, the study did not account for potential confounding variables such as department type, workload, prior training, or institutional leadership styles, all of which may influence safety-related perceptions and behaviors. Fourth, there is a very high degree of confidentiality in handling or copying any paper information or reliable recordings of data classified as highly confidential. The researcher is content with recording the data manually in detail. Future research should consider incorporating these variables as control factors or covariates to refine the precision of the analysis.

Conclusions

Our study provides valuable insights into the complex relationships between safety culture, safety education and training attitudes, reporting attitudes, safety climate, and medical errors in healthcare settings. The findings demonstrate that organizations should develop a strong safety culture to reduce medical errors effectively. There is also an urgent need to invest in comprehensive safety education and training programs for healthcare professionals. Stronger safety cultures and positive reporting attitudes are associated with higher reported error rates, likely reflecting better error detection and reporting systems rather than actual increased error occurrence. This underscores the importance of fostering open, non-punitive reporting cultures to enhance learning from errors and improve patient safety. Additionally, safety climate plays a crucial mediating role in the relationship between organizational safety factors and medical errors, highlighting the importance of considering direct and indirect pathways when developing strategies to reduce medical errors.

These findings have important implications for healthcare organizations and policymakers seeking to enhance patient safety and reduce medical errors. Developing comprehensive strategies that address organizational (safety culture, safety climate) and individual (safety education and training attitudes, reporting attitudes) factors is essential for creating safer healthcare environments. Future research should explore the temporal dynamics of these relationships through longitudinal studies and investigate the specific mechanisms through which safety climate mediates the relationship between organizational safety factors and medical errors.

Institutional Review Board Statement:

The study was conducted in accordance with ethical clearance and approval by the Ethics Committee for Research In-volving Human Subjects (JKEUPM) (http://www.tncpi.upm.edu.my/faildokumen). Reference number: JKEUPM-2022-518.

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