EMPIRICAL RESEARCH QUANTITATIVE

The impact of safety culture, quality of care, missed care and nurse staffing on patient falls: A multisource association study

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Abstract

Aims: To examine the association between nursing unit safety culture, quality of care, missed care and nurse staffing levels, and inpatient falls using two data sources: incidence of falls and nurses' perceptions of fall frequency in their units. The study explores the association between the two sources of patient falls and identifies if nurses' perceptions of patient fall frequency reflect the actual patient falls recorded in the incident management system.

Background: Inpatient falls are associated with severe complications that result in extended hospitalisation and increased financial consequences for patients and healthcare services.

Design: A multi-source cross-sectional study guided by the STROBE guidelines.

Methods: A purposive sample of 33 nursing units (619 nurses) from five hospitals completed an online survey from August to November 2021. The survey measured safety culture, quality of care, missed care, nurse staffing levels and nurses' perceptions of patient fall frequency. In addition, secondary data on falls from participating units between 2018 and 2021 were also collected. Generalised linear models were fitted to examine the association between study variables.

Results: Nursing units with strong safety climate and working conditions and lower missed care were associated with lower rates of falls using both data sources. Nurses' perceptions of the frequency of falls in their units were reflective of the actual incidence rate of falls, but the association was not statistically significant.

Conclusion: Nursing units with a strong safety climate and better collaborations between nurses and other professionals, including physicians and pharmacists, were associated with lower incidents of patient falls.

Relevance to Clinical Practice: This study provided evidence for healthcare services and hospital managers to minimise patient falls.

1 | INTRODUCTION

Patient falls represent a significant threat to patient outcomes and should be minimised to keep patients safe. Falls with injuries, such as fractures, are serious health issues and may also cause other adverse patient outcomes, such as pressure injuries or hospital-acquired infections (Kim et al., 2022). The World Health Organization (2021) estimates that 684,000 fatal falls occur annually, making falls the second greatest cause of accidental death globally. Despite the prevalence of patient falls in healthcare settings, the Centers for Disease Control and Prevention view them as preventable events (Centers for Disease Control and Prevention, 2020). Even though falls can be prevented using targeted interventions, preventing inpatient falls in acute care settings remains a significant challenge for healthcare managers (Morris et al., 2022). Nurses are in close contact to patients; therefore, their attitudes towards safety are essential in reducing and preventing patient falls.

2 | BACKGROUND

Safety culture can be described as the individuals' values and beliefs regarding what is essential in healthcare settings and their attitudes and behaviour towards the appropriate and inappropriate actions and the management role in the rewards and punishments for better patient safety (Kakemam et al., 2021). Strong safety culture is associated with a higher quality of care and better patient outcomes (Lee et al., 2019). Considering nurses represent the largest proportion of healthcare workers (Sim et al., 2019), examining the safety culture within nursing units and the association with patient falls is essential for patient safety and better healthcare services.

A systematic review by Alanazi et al. (2022) included seven studies that examined patient falls, and only three reported significant associations between nurses' positive safety attitudes and a reduction in patient falls. Two recent studies have also demonstrated a limited association between safety attitudes sub-scales and nurses' perceptions of patient fall frequency (Kakemam et al., 2021; Yesilyaprak & Demir Korkmaz, 2023). Safety culture is a complex concept, and it is unclear which factors influence patient falls. Therefore, this study examined safety culture and identified which sub-scales of the safety attitudes questionnaire (SAQ) are associated with patient falls in the Saudi Arabian context.

> **What does this paper contribute to the wider global clinical community?**
>
> - Nursing units with a strong safety climate and safety behaviour reported lower incidence rates of falls and less frequent nurses' perceptions of falls occurrence.
> - Higher hospital quality of care and lower missed care across nursing units were associated with lower falls rate and nurses' perceptions of falls with injury frequency.
> - A positive association between the incidence rate of falls and nurses' perceptions of the frequency of falls, falls with injury and falls without injury was identified, but the association was not statistically significant.

Nurse staffing and nurses' attitudes towards quality and missed care are critical for patient safety. However, evidence of their association with falls remains unclear. For example, Hessels et al. (2019) found no association between missed care and falls. A systematic review by Recio-Saucedo et al. (2018) reported that only two out of four studies found significant associations between missed care and patient falls. Tuinman et al. (2021) reported mixed results on the relationship between staffing levels and patient falls. A more recent study by Nantsupawat et al. (2022) reported higher numbers of patients per nurse were associated with higher missed care and increased adverse events; however, there was no significant association between missed care and patient falls. Nhongo et al. (2022) recommended that more research on staffing levels and falls is needed. Therefore, the association between staffing levels, missed care and falls requires further investigation.

Patient falls are commonly examined using two sources of data: incident and survey data (Alanazi et al., 2022). Incident data from incident management systems are widely considered to be the gold standard for identifying patient falls (Brown & Wolosin, 2013; Taylor et al., 2012). However, non-reporting can be an issue with this method and nurses' perceptions of fall frequency in their unit are also considered a reliable measure (Sim et al., 2018). This study will collect patient falls data from both sources and investigate whether nurses' perceptions of fall frequency align with the actual number of reported falls.

Donabedian's (1988) conceptual framework was used to understand the relationship between safety culture, quality of care,

missed care, staffing levels and patient falls. This framework assesses healthcare quality using a three-part approach: structure, process and outcomes. Structural components, such as quality of care and staffing levels within the unit, may affect the process of nursing care through nursing unit safety culture and missed care. Both structural and process components have the potential to influence patient outcomes, including patient falls.

2.1 | Aims

1. To describe the incidence of patient falls and nurses' perceptions of the frequency of patient falls in nursing units in five Ministry of Health (MOH) hospitals in Saudi Arabia.
2. To examine the influence of nursing unit safety culture, quality of care, missed care and nurse staffing levels on patient falls.
3. To explore the relationship between the incidence of patient falls as reported in administrative data and nurses' perceptions of the frequency of patient falls as reported in a cross-sectional survey.

3 | METHODS

3.1 | Design

A cross-sectional study was conducted in five hospitals and collected existing secondary data on falls from a MOH administrative dataset for the period between 2018 and 2021. The report of the study followed the guidelines recommended by the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE). This study is part of a doctoral project that aims to investigate the relationship between nurses' safety attitudes and nursing-sensitive patient outcomes (Alanazi et al., 2023).

3.2 | Participants

Five acute public MOH hospitals were purposively selected to participate in this study. Hospitals had a minimum capacity of 200 beds and were from two regions in Saudi Arabia, three from the Riyadh region and two from the Eastern region. Hospital units that reported patient outcomes data on falls to the MOH dataset were included. Each participating unit was classified into one of the four categories: intensive care unit (ICU), medical, surgical or mixed medical-surgical. Nurses working in these units between August 2021 and November 2021 were invited to complete a cross-sectional survey. Nurses were eligible to participate if they had worked for at least 3 months at the current hospital, were able to read and understand English and worked within a participating unit. Emergency departments, maternity units, palliative care units, operating theatres, recovery and outpatient departments were excluded from participating in the study as these units do not report patient falls to the MOH database.

Data from patients who had experienced a fall reported within the incident management system from the ICU, medical, surgical and mixed medical-surgical units in the five hospitals were included in this study. Data on patient fall incidents for the years 2018, 2019, 2020 and 2021 were requested from the MOH dataset.

3.3 | Ethical considerations

Ethical approval was obtained from the Human Research Ethics Committee (HREC) of the University of Wollongong, Australia, on 29 June 2021 (Approval No. 2021/214). Other ethical approvals from Saudi Arabia were sought from the Ministry of Health (Approval No. 1443–206207), King Saud Medical City (Approval No. H1RI-18-Jul21-01), and King Fahad Medical City (Approval No. 21-296E).

3.4 | Data collection

An electronic survey was developed and advertised via a single-page poster with a QR code and placed on the announcement board in each participating unit. Nurses in participating units received an email, with a reminder 2 weeks later, containing a link to the questionnaire with information about the study. Once nurses scanned or accessed the survey, full instructions were given, including processes for consenting to participate in the study. Nurses had to identify the hospital and ward where they worked on the landing page of the survey, and therefore only eligible nurses were able to participate. In addition, 4 years of existing data on patient falls for the same units were requested from the MOH. Data were analysed, and the incident rates per 1000 inpatient days were calculated for each nursing unit.

3.5 | Study variables

3.5.1 | Nurse characteristics

Nurses' demographic data included age, gender, nationality, years of experience, qualifications, shift duration and details about nurses' work patterns.

3.5.2 | Safety culture

Nursing units' safety culture was measured using the SAQ. The SAQ is a validated instrument developed by Sexton et al. (2006) and is widely used to collect individual and group-level attitudes towards six safety-related sub-scales (Churruca et al., 2021). The internal reliability of each sub-scale in this study ranged from .772 for teamwork to .894 for job satisfaction. The overall SAQ scale had a Cronbach's alpha of .956 in this study. The SAQ sub-scales originally included: teamwork climate, safety climate, job satisfaction, stress recognition, perceptions

of management and working conditions. This study categorised the perception of management sub-scale into two different sub-scales, unit and hospital management, and calculated the safety behaviour sub-scale, which has been used in a recent study (Dickens et al., 2021) and the overall SAQ score. The stress recognition sub-scale was not included in the overall score as the subscale negatively correlated with other sub-scales and does not fit into the overall safety attitudes construct measured by the SAQ (Churruca et al., 2021). Therefore, in this study, 39 items from the SAQ were used to report the eight sub-scales. Responses were recorded on a five-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*), and the average score of each sub-scale was calculated. Responses were converted to a percentage ([mean of item − 1]*25), and a score of 75 or greater indicated a positive safety culture (Taylor et al., 2012).

3.5.3 | Quality of care

Nurses' perceptions of quality of care were assessed using questions from RN4CAST and have been used in many nursing studies over the past decade (Lee et al., 2018; Sermeus et al., 2011; Smith et al., 2020). This study used three items to assess the quality of care in nursing units and hospitals. Nurses were asked to rate the overall quality of care provided in their unit and hospital. Responses were recorded on a four-point Likert scale (1=*poor*, 2=*fair*, 3=*good* and 4=*excellent*), then were dichotomised into a binary variable unfavourable (0=*poor and fair*) and favourable (1=*good and excellent*). The proportion of nurses who rated the quality of care as favourable was calculated for each unit.

3.5.4 | Missed care

Missed care, also referred to as 'care left undone', was examined using questions from a validated instrument developed by the Basel Extent of Rationing of Nursing scale (Schubert et al., 2008). The questions have been used extensively in nursing research and were informed by previous studies, including RN4CAST (Ball et al., 2018; Nantsupawat et al., 2022; Sermeus et al., 2011). Nurses in this study were provided with a list of 13 essential activities and asked to select all care that was missed on their most recent shift. The Cronbach's alpha value for the 13 items of missed care in this study was .91. Missed care in each nursing unit was summarised as the proportion of nurses who missed at least one nursing activity.

3.5.5 | Staffing

Nurse staffing levels were calculated as the patient-to-nurse ratio by collecting the total number of patients and nurses in each unit in the most recent shift. This approach is widely used in nursing research and can be a reliable method for estimating staffing levels (Ausserhofer et al., 2013; Nantsupawat et al., 2022; Sermeus et al., 2011). For analysis at the unit level, patient-to-nurse ratios

were calculated for each nurse's response, and the average patient load per nurse was reported for each nursing unit.

3.5.6 | Falls

The incidence of patient falls was the primary outcome of this study. Patient falls data for the full years 2018, 2019, 2020 and 2021 for the participating units were requested from the MOH dataset. Data were provided in an Excel spreadsheet. Data were then shared with the quality departments in each hospital for validation to ensure data on falls had been correctly attributed to participating units. The final validated data set had a total of 214 fall incidents that occurred during 680,118 inpatient days in 33 nursing units. The incident rate of patient falls was calculated using the total number of falls divided by the total number of in-patient days multiplied by 1000 patient days for each nursing unit (Cina-Tschumi et al., 2009).

3.5.7 | Nurses' perception of the frequency of falls

Nurses' perception of the frequency of overall patient falls, patient falls with injury and patient falls without injury were estimated using a seven-point Likert scale ranging from '1 = never' to '7 = daily'. The responses were dichotomised to form a binary variable for analyses: 0='never happened' (*never and several times per year*) and 1='had happened' (*at least once per month; several times per month; at least once per week; several times per week and daily*) (Van Bogaert et al., 2014). Nurses' perceptions of the frequency of adverse events have been used extensively in international studies and reported to be reliable and valid measures (Kakemam et al., 2021; Lee et al., 2018).

3.6 | Data analysis

Data analysis was performed using IBM SPSS Statistics (version 28.0). Missing value analysis was used to identify the proportion and pattern of missing data across all variables. The percentage of missing data ranged from .2% to 5.0%, and it was found that the data were not missing completely at random. Thus, a multiple imputation approach was used to replace missing data for SAQ items (2.1%) (Boussat et al., 2021). For nurse staffing questions, missing data were managed using the approach described by Al-Ghraiybah et al. (2023). A variety of descriptive analyses were performed and included frequencies for categorical variables and means and standard deviations for continuous variables. Medians and interquartile ranges (IQR) were used to describe skewed data. Analysis of variance (ANOVA) was used to examine differences in the results of the study across hospitals (Table S1). The results demonstrated significant associations between hospitals and nursing unit types and variations in safety culture subscales, quality of care, missed care

and staffing level; however, the study did not directly investigate the differences in these study variables, as this was beyond the scope of this study but is reported in Tables S1–S9.

Bivariate correlation was used to assess the strength of the correlation between the study variables. Generalised linear models (GLMs) were fitted to examine the association between safety culture, quality of care, missed care, staffing and patient falls. Before fitting the GLM, the assumptions of normality and homoscedasticity were checked, and gamma with log link approach was deemed to be the most appropriate (Ng & Cribbie, 2017). Nursing units with zero falls rate ($n = 3$) were excluded from models as these values were invalid for the gamma probability distribution. Models were controlled for nursing unit type, hospital size, years of experience and qualification of nurses as they are known to impact on nursing-sensitive patient outcomes (Ausserhofer et al., 2013). The association was considered significant at $p < .05$.

4 | RESULTS

4.1 | Demographics

A total of 33 nursing units from five MOH hospitals in two different regions in Saudi Arabia participated in this study. Of the 898 potential participants, 619 responded to an online survey and identified their working unit with an average unit response rate of 68.9% (range: 33%–100%). The average age of nurses was 33.7 years (SD = 5.76), and the average experience as a nurse was 9.2 years (SD = 4.92). The majority of nurses were non-Arabic ($N = 463$, 74.8%), female ($N = 517$, 83.5%) and had a bachelor's degree or higher ($N = 543$, 87.7%). Table 1 provides a summary of participant characteristics.

4.2 | Nursing unit safety culture

The overall SAQ score and the subscale scores for nursing units by type, ICU or ward, are shown in Table 2. The average overall SAQ scores in ICU ranged from 65.8 (SD = 9.12) in hospital B to 57.7 (13.18) in hospital C. The average overall SAQ score in wards ranged from 63.5 (SD = 11.83) in hospital A to 57.7 (11.84) in hospital B. The highest-rated score for individual sub-scales in ICUs was observed for teamwork climate (Mean = 78.6, SD = 11.63), job satisfaction (Mean = 75.2, SD = 15.03) and safety behaviour (Mean = 73.1, SD = 14.23) in hospital B. The lowest score was for working conditions (Mean = 46.3, SD = 25.06) in hospital C and hospital management (Mean = 46.5, SD = 17.85) and working conditions (Mean = 46.5, SD = 18.65) in hospital A. The highest-rated score for individual subscales in wards was for safety behaviour (Mean = 70.1, SD = 15.15), safety climate (Mean = 69.9, SD = 14.79) and teamwork climate (Mean = 67.4, SD = 15.39) in hospital A. The lowest score in wards was for the working conditions (Mean = 45.6, SD = 24.14) in hospital C and stress recognition (Mean = 46.8, SD = 21.16) in hospital D. Only ICU units in hospital B recorded a positive safety culture score of 75 or higher in teamwork climate and job satisfaction subscale.

4.3 | Quality of care, missed care and staffing

Data on hospital and unit quality of care, nurse staffing and care left undone are presented in Table 3. Hospital quality of care was rated as favourable by participants, with hospital D being rated most highly in ICU (73.1%) and wards (67.4%). Participants rated the unit quality of care as favourable in the five hospitals. The highest proportions were in ICU units in hospital B (79.3%) and wards in hospital A (79.7%). Quality of care in the unit on the last shift was rated as favourable by participants, with ICU units in hospital D (79.5%) and wards in hospital A (83.6%) having the highest ratings. Nurses who reported care activities missed on their last shift in ICU ranged from an average of 58.6% in hospital B to 87.3% in hospital A. The percentage of nurses who reported at least one care activity was missed in wards ranged from an average of 65.6% in hospital A to 92.6% in hospital C. For nurse staffing levels, the patient-to-nurse ratio across ICU units was 1.5 (SD = .09) in hospital A to 2.4 (SD = 1.20) in hospital D. The average number of patients per nurse in inpatient units was 4.4 (SD = .54) in hospital A to 7.3 (SD = 1.89) in hospital C.

4.4 | Patient falls

Incidence rates of patient falls and nurses' perceptions of the frequency of patient falls are presented in Table 4. For the primary outcome, 214 falls were reported in 33 nursing units between 2018 and 2021. The number of reported falls per nursing unit varied considerably, ranging from 0 to 32 falls. The number of falls across the 4 years was highest in 2018 with 1.77 falls per 1000 inpatient days, and lowest in 2021 with 1.13 falls per 1000 inpatient days. Over the 4 years, the fall rate ranged from .00 to 1.14 per 1000 inpatient days, with ICU units recording the lowest fall rate (Median = .04 per 1000 inpatient days) and mixed medical-surgical wards recording the highest rate (Median = .39 per 1000 inpatient days).

Approximately 10% (IQR = 5%–20%) of nurses reported that falls frequently happened in their ward at least once per month. The frequency of falls without injury (Median = 10%, IQR = 0%–21%) was higher than falls with injury (Median = 8%, IQR = 0%–15%). Nurses working in surgical units reported a higher frequency of patient falls (Median = 13%, IQR = 0%–42%).

4.5 | Association between safety culture, quality of care, missed care, staffing and patient falls

GLMs were fitted between 15 independent variables, including SAQ, quality of care, missed care, nurse staffing and four different outcomes; incidence rate of patient falls, nurses' perceptions of overall

TABLE 1 Nurses' characteristics (n=619).

Variable	All hospitals N=619 Mean (SD)	Hospital A N=214 Mean (SD)	Hospital B N=69 Mean (SD)	Hospital C N=104 Mean (SD)	Hospital D N=129 Mean (SD)	Hospital E N=103 Mean (SD)
Age (years)	33.7 (5.76)	34.4 (4.21)	34.1 (5.35)	34.4 (6.75)	33.3 (7.30)	31.7 (5.23)
Experience (years)	9.2 (4.92)	10.4 (3.63)	9.3 (5.55)	9.4 (5.77)	8.4 (5.75)	7.5 (4.21)
	Frequency (%)					
Gender						
Male	84 (13.6)	53 (24.8)	7 (10.1)	9 (8.7)	11 (8.7)	4 (3.9)
Female	517 (83.5)	152 (71.0)	61 (88.4)	91 (87.5)	89.9 (91.3)	97 (94.2)
Background						
Arabic	154 (24.9)	18 (8.4)	40 (58.0)	39 (37.5)	39 (30.2)	18 (17.5)
Non-Arabic	463 (74.8)	195 (91.1)	29 (42.0)	65 (62.5)	89 (69.0)	85 (82.5)
Qualification						
Diploma	76 (12.3)	2 (.9)	20 (29.0)	19 (18.3)	27 (20.9)	8 (7.8)
Bachelor or higher	543 (87.7)	212 (99.1)	49 (71.0)	85 (81.7)	102 (79.1)	95 (92.2)
Shift duration						
8h	204 (33.0)	15 (7.0)	12 (17.4)	61 (58.7)	51 (39.5)	65 (63.1)
12h	402 (64.9)	195 (91.1)	56 (81.2)	40 (38.5)	77 (59.7)	34 (33.0)
Job category						
In charge\Head nurse	138 (22.3)	63 (29.4)	17 (24.6)	33 (31.7)	13 (10.1)	12 (11.7)
Staff nurse	480 (77.5)	150 (70.1)	52 (75.4)	71 (68.3)	116 (89.9)	91 (88.3)
Job status						
Temporary	57 (9.2)	5 (2.3)	6 (8.7)	10 (9.6)	22 (17.1)	14 (13.6)
Permanent	555 (89.7)	207 (96.7)	61 (88.4)	92 (88.5)	107 (82.9)	88 (85.4)

Abbreviation: SD, standard deviation.

falls, falls with injury and falls without injuries (Table 5). Since bivariate correlation results indicated multicollinearity between individual SAQ subscales ($r=.60-.87$), each subscale was modelled separately using the same control variables for each outcome. Of the 15 variables, 9 were associated with the incidence of patient falls, 6 with the nurse's perceptions of falls, 10 with falls with injury and six with falls without injury.

4.5.1 | Incidence of patient falls

Six of the eight safety attitudes sub-scales and the overall SAQ score were found to have a negative impact on the incidence of patient falls (See Table 5). The top three predictors were the overall SAQ score, working conditions and perception of hospital management. Higher overall SAQ scores ($\beta=-1.699$, CI [-1.699, $-.748$], $p=<.001$), improved working conditions ($\beta=-1.429$, CI [-2.058, $-.801$], $p=<.001$) and positive perceptions of hospital management ($\beta=-1.414$, CI [-1.905, $-.922$], $p=<.001$) were associated with lower incidence rates of patient falls. Strong hospital quality of care ratings were associated with lower incidence of patient falls ($\beta=-1.456$, CI [-2.258, $-.655$], $p=<.001$). Higher proportions of missed care were

associated with higher rates of patient falls ($\beta=1.269$, CI [.340, 2.199], $p=.007$).

4.5.2 | Nurses' perceptions of patient fall frequency

Only two of the eight safety attitudes sub-scales and the overall SAQ score were statistically significant predictors of nurses' perceptions of the frequency of overall patient falls, and patient falls without injury. Higher scores of safety climate were negatively associated with the frequency of overall falls ($\beta=-1.309$, [CI -2.541, $-.077$], $p=.037$) and falls without injury ($\beta=-1.425$, CI [-2.612, $-.238$], $p=.019$). Nursing units with strong safety behaviour reported less frequent overall falls ($\beta=-.802$, CI [-1.515, $-.089$], $p=.027$) and falls without injury ($\beta=-.847$, CI [-1.545, $-.148$], $p=.017$). Hospital and unit ratings for quality and quality of care on the most recent shift were also negatively associated with less frequent overall falls and falls without injury. The highest associations were found between the hospital quality of care and overall falls ($\beta=-1.789$, CI [-3.139, $-.439$], $p=.009$) and falls without injury ($\beta=-1.955$, CI [-3.438, $-.473$], $p=.010$). Nursing units with higher proportions of missed care related to 'adequate patient surveillance' reported higher frequency

TABLE 2 Average scores of nursing units' safety culture per hospital.

	Hospital A Mean (SD)		Hospital B Mean (SD)		Hospital C Mean (SD)		Hospital D Mean (SD)		Hospital E Mean (SD)	
	ICU n=83	Wards n=131	ICU n=31	Wards n=38	ICU n=47	Wards n=57	ICU n=80	Wards n=49	ICU n=39	Wards n=64
Overall SAQ score	58.0 (11.88)	63.5 (11.83)	65.8 (9.12)	57.7 (11.84)	57.7 (13.18)	58.8 (12.99)	62.5 (14.55)	59.1 (16.16)	61.8 (12.24)	59.1 (13.22)
Teamwork climate	63.5 (16.48)	67.4 (15.39)	78.6 (11.63)	59.7 (19.21)	62.9 (15.41)	61.5 (15.94)	64.2 (16.36)	61.1 (17.40)	67.4 (12.57)	61.4 (14.85)
Safety climate	64.0 (13.29)	69.9 (14.79)	72.0 (10.08)	59.0 (14.96)	59.7 (18.76)	62.3 (15.96)	65.8 (14.96)	64.1 (16.92)	65.7 (14.92)	65.1 (14.69)
Job satisfaction	60.1 (22.20)	67.9 (19.27)	75.2 (15.03)	62.3 (17.31)	67.2 (20.98)	67.0 (19.06)	68.4 (23.10)	62.6 (24.22)	64.4 (16.23)	64.0 (19.80)
Unit management	57.4 (16.10)	63.6 (14.59)	64.4 (15.21)	59.9 (12.60)	54.9 (14.33)	58.7 (21.07)	62.9 (17.57)	59.4 (20.27)	62.8 (17.91)	58.1 (18.76)
Hospital management	46.5 (17.85)	55.1 (18.07)	54.2 (19.24)	57.3 (15.94)	51.7 (17.76)	51.2 (20.63)	61.8 (19.69)	56.2 (22.10)	58.2 (18.58)	53.6 (21.78)
Stress recognition	65.7 (26.14)	62.7 (23.52)	52.7 (24.37)	49.1 (19.28)	56.8 (22.46)	62.1 (20.59)	50.6 (21.25)	46.8 (21.16)	56.1 (23.14)	52.0 (21.15)
Working conditions	46.5 (18.65)	53.8 (19.77)	54.6 (21.71)	52.5 (17.22)	46.3 (25.06)	45.6 (24.14)	58.2 (22.78)	56.9 (23.80)	52.7 (16.15)	52.3 (20.46)
Safety behaviour	62.2 (16.58)	70.1 (15.15)	73.1 (14.23)	61.1 (21.69)	65.7 (19.95)	64.3 (18.95)	67.2 (20.74)	62.4 (23.64)	68.0 (17.26)	66.7 (19.01)

Abbreviation: SD, standard deviation.

of overall falls (β=1.709, CI [.599, 2.820], p=.003) and falls without injury (β=1.799, CI [.734, 2.864], p=<.001).

Four of the eight safety attitudes sub-scales and the overall SAQ score negatively predicted nurses' perceptions of patient falls with injury. Safety climate was the strongest predictor of nurses reporting fewer falls with injury (β=−.908, CI [−1.567, −.249], p=.007). Hospital, unit and shift quality of care were also negatively associated with a lower frequency of falls, with shift quality of care being the strongest predictor (β=−1.021, CI [−1.807, −.234], p=.011). Nursing units with higher numbers of missed care activities also had a higher incidence of patient falls with injury (β=1.019, CI [.343, 1.694], p=.003). In addition, a higher patient load per nurse was positively associated with a higher frequency of falls with injury (β=.200, CI [.087, .314], p=<.001).

4.6 | Association between the rate of patient falls, and nurses' perception of the frequency of patient falls

GLMs were conducted to examine the association between the two sources of patient fall data while controlling for nursing unit type, hospital size and nursing experience. The association between the incidence of patient falls and nurses' perceptions of the frequency of overall falls (β=.164, CI [−.045, 2.590], p=.058), falls without injury (β=.163, CI [−.062, 2.620], p=.062) and falls with injury (β=.874, CI [−.346, 2.094], p=.160) was not statistically significant (See Table 5). The directions of the association between the incidence rate of patient falls and the three outcomes of nurses' perceptions of fall frequency were positive, indicating higher nurses' perceptions of the frequency of falls may likely reflect the actual incidence of patient falls.

5 | DISCUSSION

The study examined the association between nursing unit safety culture, quality and missed care, nurse staffing levels and patient falls collected from two sources. In addition, the study also explored the relationship between the two sources of falls; the incidence rate of patient falls and nurses' perceptions of the frequency of patient falls. The study supports the framework proposed by Donabedian (1988), which emphasises the importance of structure, process and outcomes. Patient outcomes, such as patient falls, are influenced by the processes of nursing care, such as safety culture. Specifically, this study found that nursing units with a strong safety culture, good working conditions and effective collaboration between healthcare providers were associated with lower rates of patient falls. There was a positive relationship between nurses' perceptions of the frequency of falls, falls with injury, and falls without injury and the incidence rate of falls; however, the association was not statistically significant.

TABLE 3 Descriptive summary of the quality of care, missed care and staffing across nursing units per hospital.

	Hospital A		Hospital B		Hospital C		Hospital D		Hospital E	
	ICU n = 78	Wards n = 128	ICU n = 29	Wards n = 33	ICU n = 45	Wards n = 54	ICU n = 78	Wards n = 43	ICU n = 36	Wards n = 63
Frequency (%)										
Hospital quality of care (favourable)	33 (42.3)	73 (57.0)	20 (69.0)	16 (48.5)	22 (48.9)	32 (59.3)	57 (73.1)	29 (67.4)	25 (69.4)	40 (63.5)
Unit quality of care (favourable)	41 (51.6)	102 (79.7)	23 (79.3)	18 (54.5)	26 (57.8)	35 (64.8)	58 (74.4)	31 (72.1)	26 (72.2)	44 (69.8)
Unit last shift quality of care (favourable)	45 (57.7)	107 (83.6)	22 (75.9)	25 (75.8)	31 (68.9)	37 (68.5)	62 (79.5)	31 (72.1)	27 (75.0)	47 (74.6)
Missed care	69 (87.3)	84 (65.6)	17 (58.6)	28 (82.4)	38 (82.6)	50 (92.6)	49 (61.3)	29 (65.9)	26 (70.3)	44 (69.8)
Mean (SD)										
Staffing (patients per nurse)	1.5 (.09)	4.4 (.54)	1.7 (.10)	6.0 (1.01)	1.8 (.10)	7.3 (1.89)	2.4 (1.20)	5.0 (.74)	2.1 (.05)	4.7 (.78)

Abbreviation: SD, standard deviation.

The study found that the rate of patient falls varied significantly between nursing units, with a mean falls rate of .25 falls per 1000 patient days. While this rate is lower than that reported in previous research (Bouldin et al., 2013; Toyabe, 2015), there are several possible reasons why this study found a lower falls rate than the other studies. One possible explanation is the study sample. Our study included a lower proportion of medical wards, and medical wards are known to have a higher falls rate than surgical and critical care units. Bouldin et al. (2013) have reported a higher falls rate of 4.03 per 1000 patient days in medical units compared to 2.76 per 1000 patient days in surgical units. Under-reporting of falls may also explain the low incidence rate of falls in our study. Under-reporting of falls is a known issue in healthcare settings and can lead to an underestimation of falls rates (Cina-Tschumi et al., 2009; Toyabe, 2015). A 3-month prevalence study in a university hospital in Saudi Arabia reported a falls rate of 2.4% of admitted patients (*n* = 27 falls) in medical and surgical wards (Innab, 2022). The findings of this study suggest that patient falls may be under-reported in MOH hospitals in Saudi Arabia, which is supported by the nurse perception data indicating that some nurses reported falls occurring 'at least once per month' to 'daily' in their wards. To address the under-reporting issue, multiple data sources, including real-time observational data, may be needed (Toyabe, 2015). Accurate reporting of falls rates and developing effective prevention strategies are crucial to improve patient safety.

The present study contributes to the literature on the relationship between safety culture and patient falls in nursing units. Specifically, the findings suggest that nursing units with a strong safety climate, job satisfaction, unit and hospital management support, working conditions and safety behaviour experienced fewer patient falls. Similarly, nursing units with a strong safety climate and safety behaviour were associated with lower nurses' perceptions of the frequency of falls. However, previous studies have reported inconsistent findings regarding the association between nursing unit safety culture and patient falls (Ausserhofer et al., 2013; Brown & Wolosin, 2013; Hessels et al., 2019; Taylor et al., 2012). The discrepancies in the results could be attributed to differences in the settings and the sample size of nursing units, the nature of the data and the analysis used in their study.

One of the noteworthy findings of the present study is that nursing units with strong collaboration between nurses, staff physicians and pharmacists were associated with fewer falls incidents and lower nurses' perceptions of the frequency of falls. Given that nurses are the primary providers of hospital care, their perception of safety culture is crucial in preventing patient falls. Therefore, better collaboration between healthcare providers could play a vital role in enhancing patient safety and reducing the incidence of falls in nursing units.

In this study, nurses' perceptions about quality and missed care were found to be associated with the incidence of falls and their perceptions of the frequency of falls. While Nantsupawat et al. (2022) did not find a significant association between higher levels of missed care and nurse-reported patient falls, our study showed that nursing

	All units (N = 33 units)	ICUs (N = 6 units)	Wards (N = 27 units)
	Median (IQR)	Median (IQR)	Median (IQR)
Falls rate (per 1000 IPDs*)	.25 (.13–.47)	.04 (.00–.09)	.28 (.21–.48)
	(n = 587 nurses)	(n = 266 nurses)	(n = 321 nurses)
Nurses reported falls			
Overall	10% (2%–21%)	11% (6%–14%)	10% (0%–25%)
With injury	8% (0%–15%)	8% (6%–13%)	8% (0%–17%)
Without injury	10% (0%–21%)	9% (6%–15%)	10% (0%–25%)

TABLE 4 Distribution of patient falls across nursing units.

Abbreviations: IPDs, inpatient days; IQR, interquartile ranges.

units with higher ratings for hospital quality of care and lower levels of missed care were associated with lower incidence of falls and reduced nurses' perceptions of the frequency of falls with injury in their unit. Furthermore, nursing units with higher levels of missed 'adequate patient surveillance' were associated with higher percentages of nurses reporting falls with and without injury occurring in their unit during the last year. A similar study by Ball et al. (2018) also reported higher ratings of nursing missed care in nursing units with higher incidence rates of falls. These findings suggest missed care has a significant impact on patient outcomes, and the reasons why nurses left care undone could be related to structural elements, such as staffing levels, where nurses handle more patients and are, therefore, unable to complete all tasks. Staffing levels have previously been associated with higher missed care and lower quality of care (Nantsupawat et al., 2022).

Nurse staffing has been identified as a crucial factor in reducing the incidence of patient falls in healthcare facilities. While our study did not find a significant relationship between staffing levels and patient falls recorded in the administrative data, we observed that a higher number of patients per nurse was associated with a higher percentage of nurses reporting patient falls with injury had occurred 'at least once per month' to 'daily' in their unit. This finding is supported by previous research indicating that an increase in the number of nurses is associated with a reduction in falls among hospitalised patients (Bowden et al., 2019; Kalisch et al., 2012). However, the association between nursing staffing and falls is not always consistent (Griffiths et al., 2016; Shin et al., 2019; Tuinman et al., 2021). One possible explanation for this inconsistency is the varied methods used to measure nurse staffing and patient falls. Nurse staffing can be measured using different sources, such as nursing hours per patient day, nurses' reported data and hospital administrative data (Shin et al., 2019; Twigg et al., 2021). Moreover, the unit type and the study setting, such as long-term facilities or acute care hospitals, may also influence the relationship between nurse staffing and patient falls.

In this study, there was no statistically significant relationship observed between incidence data and nurses' perceptions of falls frequency. In contrast, a previous study by Cina-Tschumi et al. (2009) reported a significant relationship between nurse-estimated falls and the incidence rate of falls. The discrepancy between the findings

may be attributed to differences in the methods and analyses employed in both studies. Specifically, Cina-Tschumi et al. (2009) used the mean of ordinal variables in each unit to examine the correlation, while in our study, we used binary variables of falls by dichotomising based on whether falls occurred or not in each unit, as recommended by previous research (Han et al., 2020; Kakemam et al., 2021; Van Bogaert et al., 2014). In addition, Cina-Tschumi et al. (2009) analysed the rate of fall for the period of 1 year, while in our study, we used 4 years of fall data due to the impact of the COVID-19 pandemic on healthcare during the study period.

Despite the lack of a statistically significant association between nurses' perceptions of falls frequency and incidence data in our study, we found a positive association between the two sources of this data. The positive association between the two sources of patient falls was supported by the relationship between safety attitudes sub-scales, quality of care and falls incidence. Nursing units with a strong safety climate, safety behaviour, and high hospital and unit quality of care were more likely to have decreased nurses' perceptions of falls frequency and incidence of falls. Therefore, nurses' perceptions of the frequency of patient falls may accurately reflect the actual incidence of patient falls. Considering the impact of falls on patients and the underreporting of falls, further research is needed to examine the accuracy of the relationship between nurses' perceptions of falls frequency and the incidence of falls.

5.1 | Limitations

Despite our study's strengths, several limitations have been identified. This study was a cross-sectional survey; thus, causal relationships cannot be determined. In addition, the sample and setting of the study were limited to five MOH hospitals in two regions of Saudi Arabia and, therefore, may not be generalisable to other settings or regions. The study used an existing source from the administrative dataset to gather data on the incidence of patient falls, and thus, we do not have any way of quantifying missing data or under-reported falls. In addition, no risk adjustments have been conducted. However, to the best of our knowledge, this is the first study that reported the incidence of falls over a 4-year period in Saudi Arabia. Further research should be undertaken to investigate

TABLE 5 Association between independent predictors and patient falls - GLMs.

| | Incidence data (primary outcome) | | | Nurse-reported frequency of falls (secondary outcome) | | | | | | | | |
| | Incidence of falls (n=30 units) | | | Overall falls (n=33 units) | | | Falls with injury (n=33 units) | | | Falls without injury (n=33 units) | | |
Variables	β	95% CI	p	β	95% CI	p	β	95% CI	p	β	95% CI	p
Overall SAQ	-1.699	-1.699, -.748	<.001	-.972	-2.078, .266	.124	-.639	-1.333, .056	.071	-1.086	-2.354, .183	.093
Teamwork climate	-.600	-1.433, .233	.158	-.790	-1.612, .033	.060	-.536	-.984, -.089	.019	-.825	-1.698, .048	.064
Safety climate	-1.163	-2.293, -.033	.044	-1.309	-2.541, -.077	.037	-.908	-1.567, -.249	.007	-1.425	-2.612, -.238	.019
Job satisfaction	-.663	-1.258, -.068	.029	-.330	-1.116, .456	.410	-.126	-.559, .307	.568	-.443	-1.216, .329	.261
Perceptions of unit management	-1.026	-1.999, -.053	.039	-.078	-1.282, 1.126	.899	-.786	-1.013, .403	.398	-.184	-1.443, 1.075	.774
Perception of hospital management	-1.414	-1.905, -.922	<.001	-.184	-1.192, .823	.720	-.287	-.795, .220	.213	.371	-.925, 1.667	.575
Stress recognition	.368	-.390, 1.125	.342	-.064	-1.116, .987	.905	.422	-.111, .955	.121	-.682	-1.642, .278	.164
Working condition	-1.429	-2.058, -.801	<.001	-.554	-1.365, .257	.181	-.506	-.990, .022	.040	-.516	-1.458, .427	.283
Safety behaviour	-1.033	-1.580, -.846	<.001	-.802	-1.515, -.089	.027	-.420	-.841, -.001	.050	-.847	-1.545, -.148	.017
Hospital quality of care	-1.456	-2.258, -.655	<.001	-1.789	-3.139, -.439	.009	-.835	-1.573, -.097	.027	-1.955	-3.438, -.473	.010
Unit quality of care	-.601	-1.562, .359	.220	-1.555	-2.618, -.491	.004	-1.004	-1.613, -.395	.001	-1.666	-2.764, -.569	.003
Unit quality of care (last shift)	-.619	-1.873, .636	.334	-1.727	-3.081, -.374	.012	-1.021	-1.807, -.234	.011	-1.598	-3.043, -.154	.030
Overall missed care	1.269	.340, 2.199	.007	1.393	-.091, 2.877	.066	1.019	.343, 1.694	.003	1.382	-.286, 3.015	.104
Missed adequate patient surveillance	.342	-.901, 1.586	.589	1.709	.599, 2.820	.003	.887	.238, 1.537	.007	1.799	.734, 2.864	<.001
Staffing	.008	-.154, .170	.925	.095	-.146, .336	.439	.200	.087, .314	<.001	.121	-.143, .385	.368
Incidence of patient falls	-	-	-	.164	-.045, 2.590	.058	.874	-.346, 2.094	.160	.163	-.062, 2.620	.062

Abbreviations: β, beta; CI, confidence interval; adjusted for - incidence rate (nursing unit type, hospital size and experience) and nurses reported falls (nursing unit type, hospital size and qualification).

the prevalence of patient falls, such as retrospective chart review, in acute care hospitals in Saudi Arabia and explore the barriers to reporting falls among nurses.

6 | CONCLUSION

The current findings provide insight into the complex relationship between safety culture, missed care, nursing staffing and patient falls in nursing units. The results suggest that nursing units with a strong safety climate, working conditions and safety behaviours and higher ratings of hospital quality of care are associated with a lower incidence rate of falls and reduced nurses' perceptions of the frequency of falls in their unit over the last year. Higher levels of missed care and increased patient-to-nurse ratios were associated with higher nurses' perceptions of the frequency of patient falls with injury in their units. Although the positive relationship between nurses' perceptions of falls frequency and falls incidence rates was not statistically significant, it highlights the potential value of nurses' perceptions in identifying the occurrence of patient falls. Future research using longitudinal and quasi-experimental designs is needed to establish causal relationships between safety culture factors such as teamwork, staffing levels and falls. This will enable healthcare organisations to develop evidence-based interventions to improve patient safety and reduce the incidence of falls in healthcare settings.

7 | RELEVANCE TO CLINICAL PRACTICE

The findings of this study have significant implications for clinical practice. Hospitals and healthcare managers can use this information to improve patient safety and reduce falls incidents. Strategies that promote a strong safety climate, working conditions, safety behaviours and collaborations between interdisciplinary team members in nursing units may reduce the incidence of patient falls. Nursing units with higher levels of job satisfaction and support from both unit and hospital management were more likely to record a lower incidence rate of patient falls. Improving nurse staffing levels and fostering collaboration between healthcare workers could lead to a reduction in the workload, which in turn can alleviate pressure on nursing staff and minimise missed care. These measures can ultimately contribute to a safer and more effective healthcare environment and improve the quality of care for patients.

AUTHOR CONTRIBUTIONS

All authors: made substantial contributions to the conception and design, or acquisition of data or analysis and interpretation of data. **FKA**: involved in data collection and analysis, and initial draft writing. **FKA, JS, SL and LM**: involved in drafting the manuscript or revising it critically for important intellectual content. **FKA, JS, SL and LM**: approved the final version to be submitted for publication. **All authors**: have agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the article are appropriately investigated and resolved.

CONFLICT OF INTEREST STATEMENT

No conflict of interest has been declared by the author(s).

DATA AVAILABILITY STATEMENT

The primary dataset collected and analysed during the current study is available from the corresponding author on request. Secondary data are not available due to privacy/ethical restrictions imposed by the data custodian.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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