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THE EFFECT OF DESIGNING AND IMPLEMENTING AN ELECTRONIC SCHEDULING SYSTEM ON JOB SATISFACTION AND SAFETY CULTURE AMONG STAFF NURSES: A QUASI-EXPERIMENTAL STUDY

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Abstract

Background: Nursing scheduling is a critical management function in 24-hour healthcare services because it influences workload distribution, perceived fairness, staff well-being, and patient safety. Manual scheduling is often time-consuming, prone to errors, and may limit transparency and staff participation. This study was conducted to assess the effect of designing and implementing an electronic scheduling system on staff nurses' satisfaction with scheduling and patient safety culture. **Methods:** A quasi-experimental pre-post study was conducted among 95 staff nurses working in surgical wards at Main Mansoura University Hospital, Egypt. The intervention involved designing and implementing an electronic scheduling system for duty rosters, shift requests, schedule changes, leave requests, and schedule visibility. Data were collected before implementation and three months after implementation using a structured scheduling satisfaction questionnaire and the Hospital Survey on Patient Safety Culture. Descriptive statistics, paired tests, chi-square tests, effect sizes, and Pearson correlation analysis were used. **Results:**A total of 95 nurses participated. Statistically significant improvements were observed across all scheduling satisfaction dimensions after implementation ($p<0.001$). The total satisfaction score increased from 59.15 ± 3.46 to 106.34 ± 8.10, with a 47.19-point improvement ($t = -48.85$, $p<0.001$, Cohen's $d = 7.58$). Safety culture also improved across all composites. The overall positive response rate increased from 15.7% before implementation to 50.3% three months after implementation, representing a 34.6 percentage-point gain ($p<0.001$, Cohen's $d = 4.36$). Post-implementation satisfaction was strongly and positively correlated with safety culture ($r = 0.742$, $p<0.001$). **Conclusions:** Designing and implementing an electronic scheduling system substantially improved staff nurses' satisfaction and contributed positively to patient safety culture. Electronic scheduling may support nursing management by enhancing transparency, communication, perceived fairness, and workload organization. Further controlled, multicenter, and longer follow-up studies are recommended to confirm the sustainability and generalizability of these effects.

Keywords: Electronic Scheduling; Staff Nurses; Nurse Satisfaction; Patient Safety Culture; Shift Scheduling; Quasi-Experimental Study.

BACKGROUND

Efficient nurse scheduling is essential for safe and continuous healthcare delivery. In hospitals that operate 24 hours a day, scheduling decisions affect staffing adequacy, workload distribution, continuity of care, and the ability of nurses to recover between shifts. Recent evidence indicates that electronic and self-rostering systems can improve

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roster efficiency, staff satisfaction, empowerment, work-life balance, retention, and organizational efficiency when compared with traditional manual approaches [1]. Evidence on self-rostering and predictable shift patterns further suggests that schedule redesign can improve nurses' work-life balance, job satisfaction, and quality of life [2,3].

Nurse scheduling is complex because managers must balance hard constraints, such as adequate staff coverage, skill mix, legal or institutional rules, and patient care requirements, with soft constraints, such as nurses' preferences, fairness, flexibility, and requested days off. Structured scheduling approaches increasingly integrate nurses' preferences, fairness rules, and optimization methods to enhance transparency and participation. Goal programming and other optimization approaches have also shown that considering workload fairness and individual preference satisfaction can improve nurses' perceptions of fairness and preference fulfilment [4]. More recent robotic process automation applications demonstrate the potential of electronic scheduling tools to integrate scheduling routines into hospital workflows and improve work-life balance [5].

Scheduling is also closely linked to job satisfaction. Qualitative evidence describes scheduling as a central determinant of nurses' satisfaction inside and outside work, because schedules influence sleep, family life, health, autonomy, and turnover intentions [6]. From a nursing-management perspective, transparent scheduling processes may reduce perceptions of favoritism, support equitable shift distribution, and provide nurses with more timely access to roster information and schedule-change procedures.

Patient safety culture represents shared values, beliefs, and practices that support safe care, open communication, learning from errors, and non-punitive responses to mistakes. The World Health Organization emphasizes patient safety cultureand health-worker safety as essential components of eliminating avoidable harm in healthcare [7]. The Agency for Healthcare Research and Quality Hospital Survey on Patient Safety Culture version 2.0 provides a structured method for assessing 10 safety culture composites using percent-positive responses [8]. Stronger patient and workforce safety culture is associated with teamwork, leadership support, event reporting, communication, and safer organizational learning [9].

The link between scheduling and safety culture may operate through several mechanisms. Poorly balanced schedules, staff shortages, fatigue, and excessive workload can contribute to job stress and burnout, which in turn may weaken patient safety culture and increase the likelihood of missed care or errors [10,11]. Studies in Middle Eastern settings also highlight the importance of staffing, management support, handoffs, and response to error for safety culture and job satisfaction [12,13]. Moreover, missed nursing care is negatively associated with nurses' job satisfaction, and low registered nurse staffing is linked to poorer patient outcomes [14,15]. Therefore, scheduling systems that improve transparency, staffing visibility, and workload organization may have benefits beyond administrative efficiency.

Despite growing international evidence on electronic rostering, self-rostering, and optimized scheduling, limited evidence is available from Egyptian university hospitals on

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whether designing and implementing an electronic scheduling system can improve staff nurses' satisfaction and patient safety culture in real clinical settings. So, this study was conducted to address this gap in surgical wards at Main Mansoura University Hospital.

METHODS

Aim

This study was conducted to assess the effect of designing and implementing an electronic scheduling system on staff nurses' satisfaction with scheduling and patient safety culture

Study Design

A quasi-experimental design was used. This design was appropriate because the study aimed to assess changes in outcomes before and after implementation of an electronic scheduling intervention in a real clinical setting where random assignment was not feasible.

Setting

The study was conducted in the surgical wards of the main building of Main Mansoura University Hospital, Egypt. The hospital is an 1860-bed university hospital providing a wide range of healthcare services.

Participants and Sample

The study population included 100 staff nurses working in the selected surgical wards. A convenience sampling technique was used. The minimum required sample size was calculated using Slovin's formula at a 95% confidence level and 5% margin of error: $n = N / (1 + N \times e^2)$, where $N = 100$ and $e = 0.05$; therefore, $n = 80$. A total of 95 staff nurses participated, yielding a 95% response rate.

Data Collection Tools

First, a personal characteristics and work-related data sheet was developed by the researcher to collect demographic and employment information, including gender, age, marital status, qualification, years of nursing experience, work schedule, ability to take breaks, staff shortage frequency, peak workload time, preferred work schedule model, and night-duty preference.

Second, staff nurses' satisfaction with scheduling was measured using a structured questionnaire developed by the investigator based on relevant literatureon scheduling satisfaction, electronic rostering, self-rostering, predictable shift patterns, and nurse scheduling preferences [1-3,6]. The questionnaire included 44 items grouped into 13 dimensions: influence on scheduling, work quality and flexibility, work-life balance, fairness and transparency, team collaboration, workload and productivity, recovery and competence, professional growth, fatigue and burnout, scheduling adaptability, communication and coordination, overall satisfaction, and intention to quit. Responses were rated on a 3-point Likert scale from 1 (to a small extent) to 3 (to a large extent), with

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higher scores indicating greater satisfaction. Total scores were categorized as low (44-73), moderate (74-103), or high (104-132) satisfaction.

The satisfaction questionnaire was reviewed by five experts from the Faculty of Nursing for content validity. Required modifications were made to improve clarity, relevance, and coverage of the intended dimensions. Reliability testing showed high internal consistency, with Cronbach's alpha = 0.89.

Third, patient safety culture was assessed using the Hospital Survey on Patient Safety Culture, developed by the Agency for Healthcare Research and Quality [8]. The tool assesses core patient safety culture composites, including teamwork within units, staffing and work pace, organizational learning, response to error, supervisor/manager support, communication about error, communication openness, reporting patient safety events, hospital management support, and handoffs and information exchange. Items were rated on a five-point Likert scale. Percent-positive responses were calculated according to AHRQ scoring guidance, including reverse coding of negatively worded items where applicable [8]. In this study, composite scores below 50% were interpreted as "significant improvement needed," scores from 50% to 74% as "needs improvement," and scores of 75% or higher as "strong."

Design and implementation of the electronic scheduling system

The system was implemented for three months before post-implementation data collection. The electronic scheduling system was designed and developed by a programmer based on requirements identified by the researcher and the clinical workflow of the surgical wards. The system was developed to support comprehensive nurse staffing by managing duty rosters, staff shift requests, schedule changes, leave requests, and schedule visibility. The system considered hard constraints, such as required staffing coverage and shift rules, and soft constraints, such as staff preferences and fairness in shift allocation

Data collection procedure

Baseline data were collected before implementation of the electronic scheduling system. The system was then introduced to the selected wards, and nurses were oriented to its use. Post-implementation data were collected three months after implementation using the same study tools.

Statistical analysis

Descriptive statistics were used to summarize participants' demographic and work-related characteristics. Means and standard deviations were calculated for continuous variables, and frequencies and percentages were calculated for categorical variables. Paired statistical tests were used to compare pre- and post-implementation satisfaction and safety culture scores. Chi-square tests were used for categorical comparisons. Cohen's d was calculated to estimate effect sizes. Pearson correlation analysis was used to examine relationships between satisfaction, safety culture, age, and years of

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experience. Receiver operating characteristic analysis was used for discriminative analysis. Statistical significance was set at $p<0.05$.

RESULTS

Survey Response

Almost all eligible nurses (n = 95) responded to the distributed survey link, yielding a 95% response rate.

Table 1 presents the demographic characteristics of the participating nurses. The majority of participants were female (77.9%), with a mean age of 35.23 ± 6.36 years and mean nursing experience of 7.73 ± 5.07 years. Most participants were married (91.6%) and held Bachelor's degrees (60.0%).Regarding work patterns, nearly all nurses (96.8%) worked rotating shifts that included night duties. A total of 89.5% of nurses reported frequent or constant staff shortages. Additionally, 86.3% indicated they could only sometimes take breaks during their shifts, while 13.7% rarely or never had the opportunity to take breaks.

Table 1: Socio-Demographics of Study Participants

Variable	Category	n	(%)
Gender	Female	74	77.90%
	Male	21	22.10%
Age (years)	Mean ± SD	35.23 ± 6.36	
	<30	28	29.50%
	30-34	22	23.20%
	35-39	22	23.20%
	≥40	23	24.20%
Experience In Nursing Profession	Mean ± SD	7.73 ± 5.07	
	<5	38	40.00%
	05-Sep	24	25.30%
	≥10	33	34.70%
Marital Status	Married	87	91.60%
	Unmarried	8	8.40%
Qualification	Bachelor's	57	60.00%
	Master's	20	21.10%
	Diploma	18	18.90%
Work Schedule	Rotating (including night)	92	96.80%
	Day only (including evening)	3	3.20%
Ability to Take Breaks	Sometimes	82	86.30%
	Rarely or never	13	13.70%
Frequency of Staff Shortages	Frequently	46	48.40%
	Constantly	39	41.10%
	Never	10	10.50%
Peak Workload Time	Morning	62	65.30%
	Midday	33	34.70%
Preferred Work Schedule Model	Rotating shifts	56	58.90%
	Fixed schedule	39	41.10%
Night Duty Preferences	No	95	100.00%

Nurses' Satisfaction with Electronic Scheduling Syste

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Table 2 shows statistically significant improvement in all satisfaction dimensions after implementation of the electronic scheduling system ($p<0.001$), with large to very large effect sizes. The total satisfaction score increased from 59.15 ± 3.46 to 106.34 ± 8.10 ($t = -48.85$, $p<0.001$, Cohen's $d = 7.58$), representing a 47.19-point improvement.

Table 2: Nurses' Satisfaction with Electronic Scheduling System

Dimension	Pre-Implementation		Post-Implementation (After 3 Months)		t-test	P-value
	Mean	SD	Mean	SD		
Influence on Scheduling	1.29	0.25	2.29	0.36	-21.8	<0.001
Quality of Work	1.28	0.25	2.36	0.32	-23.6	<0.001
Recovery and Competence	1.31	0.27	1.99	0.43	-12.73	<0.001
Quality of Nursing Work Life	1.32	0.25	2.5	0.31	-28.43	<0.001
Work-Life Conflict	2.44	0.41	1.56	0.42	12.93	<0.001
Flexibility in scheduling	1.27	0.22	2.45	0.48	-22.24	<0.001
Scheduling Efficiency	1.3	0.24	2.6	0.28	-39.6	<0.001
Fairness and Transparency	1.31	0.22	2.75	0.25	-41.22	<0.001
Team Collaboration	1.26	0.26	2.77	0.27	-39.87	<0.001
Workload Perception	1.28	0.2	2.34	0.4	-23.49	<0.001
Productivity	1.26	0.27	2.41	0.57	-16.88	<0.001
Overall Satisfaction with current schedule	1.3	0.26	2.68	0.34	-31.38	<0.001
Intention to Quit*	1.93	0.35	2.56	0.43	-11.36	<0.001
TOTAL SATISFACTION	59.15	3.46	106.34	8.1	-48.85	<0.001

Satisfaction Levels Before and After Implementation

Table 3 illustrates the distribution of satisfaction levels before and after implementation. Before implementation, all nurses (100%) had low satisfaction. After implementation, no nurses remained in the low category; 31.6% had moderate satisfaction and 68.4% had high satisfaction.

Table 3: Satisfaction Levels Before and After Implementation (N = 95)

Satisfaction Level	Pre-Implementation		Post-Implementation (After 3 Months)		P-value	χ^2
	n	%	n	%		
Low (44-73)	95	100	0	0		
Moderate (74-103)	0	0	30	31.6	<0.001	*190*
High (104-132)	0	0	65	68.4		
Total	95	100	95	100		

$p<0.001$

Safety Culture

Table 4 showed improvements in safety culture across all composites following the electronic scheduling implementation. Overall safety culture increased from 15.7%

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positive responses pre-implementation to 50.3% post-implementation, a 34.6 percentage point increase ($p<0.001$, Cohen's d = 4.36). The overall safety culture moved from the "Significant Improvement Needed" category (scores below 50%) to the "Needs Improvement" category (50-74% range).

All improvements were statistically significant ($p<0.001$), with large to very large effect sizes (Cohen is d ranging from 1.67 to 6.24).

Table 4: Safety Culture Composites Pre- and Post-Implementation (N = 95)

Composite	Pre-Implementation % Positive	3 months post Implementation % Positive	Difference	P-value	Cohen's d
Teamwork Within Units	36.50%	53.00%	16.50%	<0.001	1.84
Staffing and Work Pace	20.30%	57.90%	37.60%	<0.001	4.11
Organizational Learning -	3.50%	52.60%	49.10%	<0.001	5.83
Response to Error	15.50%	64.20%	48.70%	<0.001	5.47
Supervisor/Manager Support	6.00%	47.70%	41.80%	<0.001	4.98
Communication About Error	11.20%	35.80%	24.60%	<0.001	2.91
Communication Openness	23.20%	44.50%	21.30%	<0.001	2.34
Reporting Patient Safety Events	7.90%	22.10%	14.20%	<0.001	1.67
Hospital Management Support	15.10%	51.90%	36.80%	<0.001	4.12
Handoffs and Information Exchange	17.90%	73.30%	55.40%	<0.001	6.24
OVERALL SAFETY CULTURE	15.70%	50.30%	34.60%	<0.001	4.36

Safety Culture Category Distribution Pre- and Post-Implementation

Table 5 shows the distribution of safety culture categories following implementation of the electronic scheduling system. Before implementation, all 10 safety culture composites were rated below 50%, placing them in the "significant improvement needed" category.

Three months after implementation, the safety culture profile improved: 6 out of 10 composites (60%) moved from "significant improvement needed" to the "needs improvement" category (50-74%). Four composites (40%) remained below 50% but showed numerical improvement. No composites reached the "strong" category (≥75%); however, the overall shift toward higher scores was statistically significant ($p<0.001$).

Table 5: Safety Culture Category Distribution Pre- and Post-Implementation (N = 95)

Safety Culture Category	Pre (n) (Composites)	Pre %	Post (n) (Composites)	Post %	P-value
Significant Improvement Needed (<50%)	10	100	4	40	<0.001*
Needs Improvement (50-74%)	0	0	6	60	
Strong (≥75%)	0	0	0	0	
Total Composites	10	100	10	100	

*Chi-square test

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Relationship between Variables

Table 6 shows the correlation analysis among key variables before implementation of the electronic scheduling system. There were no statistically significant correlations between total satisfaction score and safety culture (r = 0.184, p = 0.074), satisfaction and age (r = 0.123, p = 0.234), or satisfaction and experience (r = 0.156, p = 0.132). The only statistically significant correlation was between age and years of nursing experience (r = 0.845, p<0.001).

Table 6: Correlation Between Electronic Schedule Satisfaction, Patient Safety Culture, And Demographic Characteristics Before Implementing The Program (N = 95)

Variable	Total Satisfaction	Safety Culture	Age	Experience
Total Satisfaction Score	1	0.184	0.123	0.156
		(p=0.074)	(p=0.234)	(p=0.132)
Total Safety Culture Score	0.184	1	0.091	0.078
	(p=0.074)		(p=0.382)	(p=0.451)
Age (years)	0.123	0.091	1	0.845***
	(p=0.234)	(p=0.382)		(p<0.001)
Experience (years)	0.156	0.078	0.845***	1
	(p=0.132)	(p=0.451)	(p<0.001)	

r = Pearson correlation, ***p<0.001

Table 7 shows a statistically significant post-implementation correlation between satisfaction and safety culture (r = 0.742, p<0.001), compared with a non-significant pre-implementation correlation (r = 0.184, p = 0.074). The age-experience correlation remained significant (r = 0.845, p<0.001).

Table 7: Correlation between Electronic Schedule Satisfaction, Patient Safety Culture, and Demographic Characteristics after Implementing the Program (N = 95)

Variable	Total Satisfaction	Safety Culture	Age	Experience
Total Satisfaction Score	1	0.742***	0.134	0.168
		(p<0.001)	(p=0.196)	(p=0.104)
Total Safety Culture Score	0.742***	1	0.178	0.156
	(p<0.001)		(p=0.083)	(p=0.130)
Age (years)	0.134	0.178	1	0.845***
	(p=0.196)	(p=0.083)		(p<0.001)
Experience (years)	0.168	0.156	0.845***	1
	(p=0.104)	(p=0.130)	(p<0.001)	

r = Pearson correlation, ***p<0.001

Discriminative Analysis and Reliability

Figure 1 shows the discriminative performance of total satisfaction, total safety culture, and the combined model. Satisfaction demonstrated excellent discrimination (AUC = 0.94, cut-off = 95), safety culture demonstrated good discrimination (AUC = 0.86, cut-off = 42%), and the combined model showed the strongest performance (AUC = 0.96).

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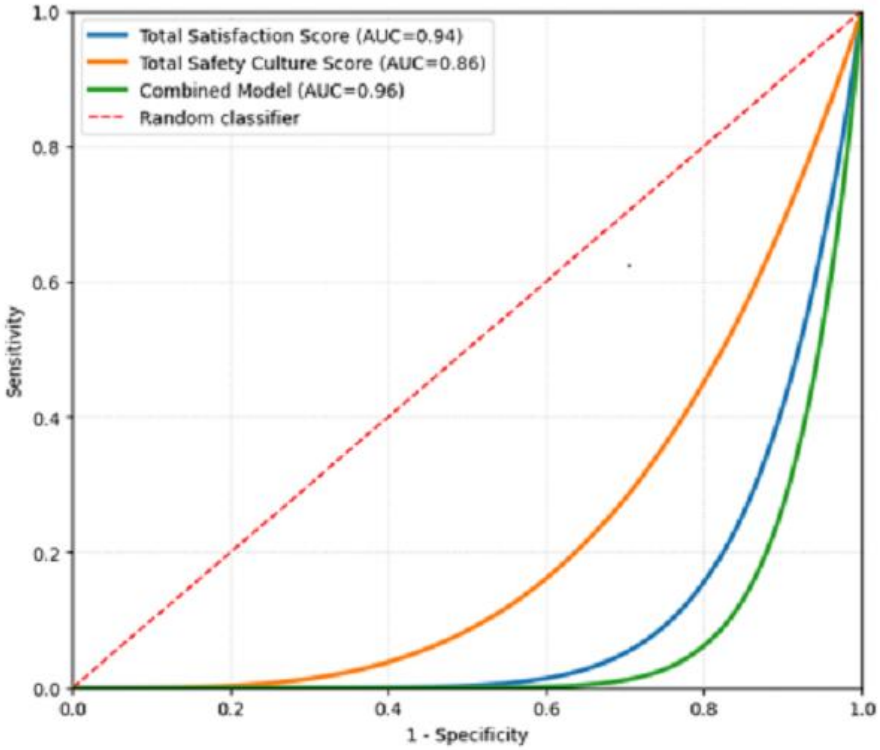


Figure 1: Discriminative Analysis and Reliability

DISCUSSION

The current study aimed to assess the effect of designing and implementing an electronic scheduling system on staff nurses' satisfaction with scheduling and patient safety culture in surgical wards at Main Mansoura University Hospital. The findings showed substantial and statistically significant improvements in all satisfaction dimensions and in all patient safety culture composites three months after implementation. From the researchers' point of view, these findings indicate that electronic scheduling is not only an administrative tool but also a nursing-management intervention that can improve transparency, fairness, communication, and organization of work.

Improvement in Staff Nurses' Satisfaction with Scheduling

Regarding nurses' satisfaction with scheduling, the current study revealed a dramatic improvement in total satisfaction score after implementation. Before implementation, all nurses were classified as having low satisfaction. After implementation, no nurses remained in the low category; approximately one-third achieved moderate satisfaction and more than two-thirds achieved high satisfaction. This improvement may be related to the system's ability to make rosters more visible, organize leave and shift-change requests, reduce uncertainty, and promote perceived fairness in shift allocation.

This result is in agreement with the mixed-method systematic review by O'Connell et al., which concluded that electronic and self-rostering systems generally have positive effects

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on staff satisfaction, control, empowerment, work-life balance, retention, and healthcare efficiency [1]. The finding is also consistent with Webster and Archibald, who reported that self-rostering can enhance nurses' work-life balance and job satisfaction [2], and with Jung and Kim, who found that pattern-based schedules were associated with higher job satisfaction and quality of life compared with traditional rotating schedules [3].

On the same line, Rerkjirattikal et al. showed that goal programming approaches that consider workload fairness and individual preferences can improve nurses' perceptions of fairness and preference satisfaction [4]. Similarly, the qualitative study by Stimpfel et al. described scheduling as central to nurses' job satisfaction and emphasized the importance of flexibility, transparency, equity, and autonomy in scheduling practices [6]. From the researchers' point of view, the improvement in the current study might be related to the system's ability to accommodate individual preferences, ensure transparent scheduling processes, and provide nurses with greater autonomy and flexibility in managing their work schedules.

Enhancement of Patient Safety Culture

Regarding patient safety culture, the current study showed a meaningful improvement in the overall positive response rate, increasing from 15.7% before implementation to 50.3% three months after implementation. Although the overall category moved only from "significant improvement needed" to "needs improvement," the size of change was large and all composites improved significantly. From the researchers' point of view, this improvement may be explained by better staffing visibility, clearer communication about duty rosters, and reduced ambiguity around shift exchanges and leave requests.

The improvement in staffing and work pace, handoffs and information exchange, organizational learning, and response to error is particularly important. These dimensions are relevant to the AHRQ patient safety culture framework, which emphasizes communication, teamwork, reporting, learning, and management support as core components of safety culture [8]. The result is also consistent with global patient safety priorities that call for high-reliability health systems, open learning cultures, and health-worker safety as foundations for safe patient care [7].

This finding is supported by Zabin et al., who concluded that job stress and related factors such as fatigue, workload, burnout, and difficult working conditions can negatively affect patient safety culture among nurses [10]. Li et al. also reported in a systematic review and meta-analysis that nurse burnout is associated with lower patient safety climate, more adverse safety indicators, lower patient satisfaction, and lower quality of care [11]. Therefore, an electronic scheduling intervention that reduces scheduling stress and improves workload organization may indirectly support safety culture.

However, the finding that some composites remained below 50% after implementation indicates that electronic scheduling alone is not sufficient to build a strong safety culture. Safety culture requires continued leadership support, non-punitive response to error, open communication, and active reporting systems. This interpretation is consistent with

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regional evidence showing that teamwork may score relatively high while staffing, response to error, and communication still need improvement [12].

The relationship between scheduling satisfaction and safety culture

The current study found no statistically significant correlation between satisfaction and safety culture before implementation, but a strong positive correlation after implementation. This suggests that once scheduling processes became more organized, transparent, and accessible, nurses' satisfaction became more closely linked with their perceptions of the safety environment. In other words, improvement in scheduling satisfaction may have been accompanied by improvement in teamwork, communication, handoffs, and management support.

This result is in line with evidence that safety culture dimensions, including staffing, hospital management support, and handoffs, are associated with job satisfaction and intention to leave among healthcare workers [13]. It is also supported by evidence that missed nursing care is negatively associated with job satisfaction [14], and that lower registered nurse staffing is linked to poorer patient outcomes [15]. From the researchers' point of view, the electronic system may have acted as a practical link between workforce management and safety culture by improving the way staff availability, preferences, and scheduling constraints were managed.

Strengths and Limitations

This study has several strengths. It addressed a practical nursing-management problem in a real clinical setting and evaluated both staff-related and safety-related outcomes. The study used pre- and post-implementation assessment, included a high response rate, and reported effect sizes in addition to statistical significance. The system was designed according to actual ward scheduling needs, which increases its practical relevance.

The study also has limitations. First, the quasi-experimental one-group design does not allow full control of external factors that may have influenced outcomes. Second, the study was conducted in surgical wards in one university hospital, which may limit generalizability. Third, outcomes were measured three months after implementation; therefore, the long-term sustainability of improvements is unknown. Fourth, satisfaction and safety culture were assessed using self-reported questionnaires, which may be affected by response bias. Finally, the study did not directly measure patient clinical outcomes, nurse turnover, absenteeism, or objective scheduling errors.

Implications for Practice and Policy

The findings suggest that hospital and nursing administrators should consider electronic scheduling as part of broader workforce-management and patient-safety strategies. Electronic scheduling systems should be designed to include transparent rules, staff preference submission, shift-change tracking, leave management, fair allocation of difficult shifts, and real-time roster visibility. Training and technical support should be provided to nurses and nurse managers during implementation. Policy makers and

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nursing leaders should also integrate electronic scheduling with safe staffing policies, fatigue management, and safety culture improvement programs.

CONCLUSIONS

Designing and implementing an electronic scheduling system significantly improved staff nurses' satisfaction with scheduling and contributed positively to patient safety culture among nurses working in surgical wards at Main Mansoura University Hospital. The improvement was observed across all satisfaction dimensions and all safety culture composites. The strong post-implementation correlation between satisfaction and safety culture suggests that transparent and organized scheduling may support both workforce well-being and safer care environments. Electronic scheduling should be considered a valuable nursing-management tool, but it should be integrated with leadership support, safe staffing policies, and continuous safety culture initiatives to achieve sustained improvement.

Abbreviations

AHRQ: Agency for Healthcare Research and Quality; AUC: Area under the curve; HSOPS/HSOPSC: Hospital Surveyon Patient Safety Culture; ORCID: Open Researcher and Contributor ID; ROC: Receiver operating characteristic; SD: Standard deviation; WHO: World Health Organization.

Declarations

Ethics Approval, Consent to Participate, And Research Regulations

The study was conducted in accordance with relevant guidelines and regulations and the principles of the Declaration of Helsinki. Ethical approval was obtained from the Research Ethics Committee, Faculty of Nursing, Cairo University (09/04/2025). Administrative approval was obtained from Main Mansoura University Hospital. Written informed consent was obtained from all participating nurses before data collection. Participation was voluntary, and confidentiality and anonymity were maintained throughout the study.

Consent for Publication

Not applicable. The manuscript does not contain any individual person's identifiable data, images, or videos.

Competing interests

The authors declared that they have no competing interests.

Availability of Data and Materials

The datasets generated and/or analysed during the current study are not publicly available due to privacy and ethical restrictions but are available from the corresponding author on reasonable request.

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Authors' contributions

SES conceived the study, developed the intervention requirements, collected the data, performed the initial analysis, and drafted the manuscript.

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MI and ES supervised the study design, reviewed the data collection tools, contributed to interpretation of the findings, and critically revised the manuscript.

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Authors' information

Supplementary material

References

1) O'Connell M, Barry J, Hartigan I, Cornally N, Saab MM. The impact of electronic and self-rostering systems on healthcare organisations and healthcare workers: a mixed-method systematic review. J Clin Nurs. 2024;33(7):2374-2387. doi:10.1111/jocn.17114.

2) Webster B, Archibald D. Self-rostering, work-life balance and job satisfaction in UK nursing: a literature review. Nurs Manag (Harrow). 2022;29(6):27-32. doi:10.7748/nm.2022.e2048.

3) Jung YJ, Kim H. Job Satisfaction, Quality of Life, and Turnover Intention Among Nurses: A Comparative Study of Pattern-Based and Rotating Shift Schedules. Healthcare (Basel). 2025;13(20):2551. doi:10.3390/healthcare13202551.

4) Rerkjirattikal P, Huynh VN, Olapiriyakul S, Supnithi T. A goal programming approach to nurse scheduling with individual preference satisfaction. Math Probl Eng. 2020;2020:2379091. doi:10.1155/2020/2379091.

5) Jung SY, Seo HE, Hong SH, Doo EY. Development of a nurse scheduling program using robotic process automation in Korea. Health Informatics J. 2026. doi:10.1177/14604582251414581.

6) Stimpfel AW, Leep-Lazar K, Mercer M, DeMarco K. "Scheduling is everything": a qualitative descriptive study of job and schedule satisfaction of staff nurses and nurse managers. West J Nurs Res. 2025;47(10):912-923. doi:10.1177/01939459251330280.

7) World Health Organization. Global Patient Safety Action Plan 2021-2030: towards eliminating avoidable harm in health care. Geneva: World Health Organization; 2021.

8) Sorra J, Yount N, Famolaro T, Gray L, Sorra J. AHRQ Hospital Survey on Patient Safety Culture Version 2.0: User's Guide. Rockville, MD: Agency for Healthcare Research and Quality; 2021. AHRQ Publication No. 19(21)-0076.

9) Murray J, Sorra J, Famolaro T. Ensuring patient and workforce safety culture in healthcare. AHRQ Patient Safety Network; 2023. https://psnet.ahrq.gov/perspective/ensuring-patient-and-workforce-safety-culture-healthcare. Accessed 6 Jun 2026.

10) Zabin LM, Abu Zaitoun RS, Sweity EM, de Tantillo L. The relationship between job stress and patient safety culture among nurses: a systematic review. BMC Nurs. 2023;22:39. doi:10.1186/s12912-023-01198-9.

11) Li LZ, Yang P, Singer SJ, Pfeffer J, Mathur MB, Shanafelt T. Nurse burnout and patient safety, satisfaction, and quality of care: a systematic review and meta-analysis. JAMA Netw Open. 2024;7(11):e2443059. doi:10.1001/jamanetworkopen.2024.43059.

12) Al Muharraq EH, Alallah SM, Alkhayrat SA, Jahlan AG. Exploring the perception of safety culture among nurses in Saudi Arabia. BMC Nurs. 2024;23:697. doi:10.1186/s12912-024-02077-7.

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DOI: 10.5281/zenodo.23416075

13) Al-Surimi K, Almuhaysin A, Ghailan KY, Shaheen NA. Impact of patient safety culture on job satisfaction and intention to leave among healthcare workers: evidence from middle east context. Risk Manag Healthc Policy. 2022;15:2435-2451. doi:10.2147/RMHP.S390021.

14) Algin A, Yesilbas H, Kantek F. The relationship between missed nursing care and nurse job satisfaction: a systematic review and meta-analysis. West J Nurs Res. 2024;46(12):1051-1062. doi:10.1177/01939459241292038.

15) Dall'Ora C, Saville C, Rubbo B, Turner L, Jones J, Griffiths P. Nurse staffing levels and patient outcomes: a systematic review of longitudinal studies. Int J Nurs Stud. 2022;134:104311. doi:10.1016/j.ijnurstu.2022.104311.