

Institutionalizing Enhanced Recovery After Surgery and Changes in Patient Safety Culture: A 5-Year Longitudinal Study of Multidisciplinary Colorectal Surgical Teams

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Abstract

Background

Enhanced Recovery After Surgery (ERAS) is a multidisciplinary care model that requires sustained coordination across perioperative teams. Although ERAS has been widely evaluated in terms of clinical outcomes, less is known about how its transition from voluntary participation to standardized institutional practice is associated with patient safety culture over time. This study examined longitudinal changes in patient safety culture during five years of ERAS implementation and institutionalization in multidisciplinary colorectal surgical teams.

Methods

This retrospective longitudinal program evaluation used de-identified, aggregated unit-level results from the Taiwan Patient Safety Culture Survey collected annually from 2019 to 2023 at a medical center in Taiwan. The dataset contained respondent numbers and positive response rates for Teamwork Climate, Job Satisfaction, Working Conditions, and Resilience for each available unit-year across multidisciplinary perioperative teams (Anesthesiology, Operating Room, Surgical Ward, Physiotherapy, and Nutrition). Analyses were descriptive because individual responses and item-level positive-response counts were unavailable; percentages were not converted into estimated counts and no inferential tests were performed.

Results

Longitudinal patterns varied across units, domains, and years. In Anesthesiology, Resilience changed from 11.9% in 2019 to 41.2% in 2023 and Working Conditions from 59.3% to 84.0%. Operating Room Working Conditions changed from 30.4% to 39.7%. Surgical Ward Resilience changed from 4.6% to 8.3%, with a temporary peak of 58.6% in 2022. Nutrition Teamwork Climate changed from 60.4% to 89.2%. Physiotherapy Teamwork Climate was 100.0%, 100.0%, 91.7%, 75.9%, and 98.2% from 2019 through 2023, respectively. Complete four-domain trajectories for all multidisciplinary units are reported in Table 1.

Conclusions

ERAS institutionalization was accompanied by heterogeneous changes in patient safety culture across multidisciplinary colorectal surgical units. Higher 2023 values in several unit-domain measures coexisted with substantial year-to-year fluctuation and declines in others. These findings describe organizational trends and do not establish individual change, statistical significance, or causal effects of ERAS. Prospective multicenter studies with individual-level and implementation data are needed.

Trial Registration:

Not applicable.

Introduction

Patient safety culture is an essential organizational foundation for high-quality healthcare delivery, reflecting how healthcare professionals perceive teamwork, communication, working conditions, and institutional commitment to safety [1, 2]. A positive safety culture is particularly critical in complex perioperative environments, where safe patient care depends on close coordination among diverse clinical disciplines [3, 4]. Previous research using the Safety Attitudes Questionnaire (SAQ) has demonstrated the vital role of teamwork climate and safety climate in understanding healthcare professionals' perceptions of organizational safety across acute care settings [5, 6]. However, substantial differences in safety culture perceptions across professional groups—especially between surgeons, anesthesiologists, and perioperative nurses—have also been widely reported, highlighting the necessity for structured organizational strategies that facilitate communication, mutual respect, and shared responsibility across disciplinary boundaries [7–9].

Enhanced Recovery After Surgery (ERAS) provides an ideal context in which to examine such multidisciplinary organizational evolution. Originally conceptualized to attenuate surgical stress and accelerate postoperative rehabilitation [10], ERAS has evolved into a comprehensive, multimodal care pathway requiring synchronized participation across surgery, anesthesiology, nursing, nutrition, physiotherapy, and allied health services [11, 12]. Although ERAS has been extensively validated in terms of clinical benefits, including reduced postoperative complications and shortened length of stay [12, 13], successful implementation depends heavily on overcoming entrenched professional silos and establishing reliable interdisciplinary workflows [14, 15]. Structured interprofessional communication tools, including Team Resource Management (TRM) principles and the standardized ISBAR (Introduction, Situation, Background, Assessment, Recommendation) framework, have been shown to enhance situational awareness, reduce ambiguity, and bridge interdisciplinary communication gaps [16, 17]. From a health services perspective, institutionalizing ERAS transforms it from a set of discrete clinical elements into a broader organizational framework for multidisciplinary care delivery [15, 18].

Despite increasing recognition of the interplay between patient safety culture, implementation fidelity, and resilient healthcare systems [19, 20], empirical evidence regarding the long-term organizational and cultural changes accompanying ERAS institutionalization remains sparse. In particular, little is known about how safety culture dimensions evolve as an ERAS program transitions from an early voluntary, champion-led initiative into standardized institutional practice [18, 21], or how multidisciplinary teams sustain safety culture during major healthcare system disruptions such as the COVID-19 pandemic [22, 23]. To address these knowledge gaps, we conducted a five-year longitudinal evaluation (2019–2023) of patient safety culture across multidisciplinary colorectal surgical teams at a medical center in Taiwan. This study aimed to examine longitudinal trajectories in teamwork climate, job satisfaction, working

conditions, and organizational resilience across core perioperative and allied health teams during progressive ERAS institutionalization.

Methods

Study Design and Setting

This study employed a retrospective longitudinal program evaluation to examine changes in patient safety culture during the implementation and progressive institutionalization of an Enhanced Recovery After Surgery (ERAS) program. The study was conducted at a medical center in Taiwan and covered a five-year period from 2019 to 2023. The year 2019 served as the baseline period, followed by progressive implementation and standardization of the colorectal ERAS pathway from 2020 through 2023.

Participants

The study population comprised healthcare professionals from multidisciplinary units involved in perioperative colorectal care, including Anesthesiology, the Operating Room, Surgical Ward, Physiotherapy, and Nutrition. Table 1 presents all four domains for these multidisciplinary units across the five-year period. Annual respondent numbers are reported for every available unit-year.

Survey data were analyzed at the unit level using de-identified, aggregated results from the Taiwan Patient Safety Culture Survey. No individually identifiable participant information was included in the study dataset.

ERAS Implementation and Institutionalization

During the study period, the ERAS program progressively transitioned from a voluntary, interest-based initiative to a standardized institutional care pathway. The implementation strategy emphasized multidisciplinary coordination and standardization across the perioperative continuum and incorporated three major organizational components:

Horizontal Information Connectivity: Clinical care processes were standardized across participating departments to improve continuity of information and coordination throughout the perioperative pathway.

Team Resource Management (TRM): TRM principles were incorporated into interdisciplinary communication and multidisciplinary case discussions to promote teamwork, shared situational awareness, and communication across professional groups [9,16].

Standardized Communication Framework: The ISBAR (Introduction, Situation, Background, Assessment, Recommendation) framework was incorporated into patient handoffs and clinical reporting to facilitate structured and consistent communication across care transitions [17].

Together, these components supported the progressive institutionalization of ERAS as a multidisciplinary perioperative care model rather than an intervention dependent primarily on voluntary individual participation [15,18].

Data Source and Patient Safety Culture Measures

Data were obtained from the Taiwan Patient Safety Culture Survey (TPSCS), administered by the Joint Commission of Taiwan (JCT) and conducted within the hospital as part of routine patient safety and quality improvement activities. The survey instrument was not developed for the present study. The TPSCS was established using an authorized Chinese adaptation of the Safety Attitudes Questionnaire (SAQ); the Chinese SAQ and its application in a nationwide Taiwanese survey have been published previously [6]. The JCT subsequently expanded the survey framework in 2014 by adding Resilience and Work-life Balance domains to the original SAQ-based domains [26]. Thus, the contemporary TPSCS is based on, but should not be treated as identical to, the originally published Chinese SAQ. The study dataset was a hospital-authorized export of de-identified unit-level summaries rather than individual survey records.

The analytical source contained four domain-level positive response rates: Teamwork Climate, Job Satisfaction, Working Conditions, and Resilience. The presentation focuses on units directly representing the multidisciplinary perioperative pathway.

Positive response rates were supplied as aggregated annual unit-level percentages. The dataset also reported the number of respondents for each unit-year, but did not include individual responses, item-level positive-response counts, respondent identifiers, or a stable cohort linkage across years.

Statistical Analysis

Descriptive statistics were used to summarize annual unit-level positive response rates from 2019 through 2023. All available values are reported as percentages with the corresponding unit-year respondent number. Trends were evaluated by direction, magnitude, and year-to-year variability across the complete observed trajectories.

The dataset consisted of unit-level aggregated domain rates rather than individual-level responses or item-level positive-response counts. Accordingly, the reported percentages were not converted into estimated respondent counts, and Chi-square tests and p-values were not calculated. The analysis emphasizes the direction, magnitude, and year-to-year variability of longitudinal unit-level patterns; it does not estimate individual change or causal effects of ERAS implementation.

Ethical Considerations

This study involved the secondary analysis of highly aggregated, de-identified unit-level administrative data collected as part of routine institutional patient safety and quality improvement activities. The study received exempt approval from the Institutional Review Board of the Cathay General Hospital (CGH IRB

No. CGH-P115050). The requirement for informed consent was waived because only highly aggregated, de-identified unit-level administrative data were used, and the researchers had access to neither individual responses nor personally identifiable information. The study was conducted in accordance with relevant institutional guidelines and regulations and with the principles of the Declaration of Helsinki and the International Council for Harmonisation Good Clinical Practice (ICH-GCP) guidelines.

Results

3.1 Overall Longitudinal Trends in Patient Safety Culture

Across 2019-2023, the four patient safety culture domains showed heterogeneous longitudinal patterns rather than uniform improvement (Figures 1 and 2; Table 1). Within the same unit, domains often moved in different directions. Complete annual trajectories were therefore retained rather than limiting the presentation to selected favorable endpoints.

By 2023, some measures exceeded their 2019 levels, whereas others were lower. Interpretation therefore uses all annual observations and emphasizes within-unit heterogeneity without inferential endpoint testing.

3.2 Changes in Core Perioperative Units

In Anesthesiology, Teamwork Climate was 78.0%, 96.0%, 62.0%, 61.8%, and 77.8% from 2019 to 2023. Job Satisfaction was 70.7%, 83.3%, 59.6%, 34.6%, and 82.1%; Working Conditions were 59.3%, 56.4%, 77.4%, 54.2%, and 84.0%; and Resilience was 11.9%, 9.5%, 31.0%, 9.8%, and 41.2%. The four domains followed distinct, nonmonotonic trajectories.

In the Operating Room, Teamwork Climate declined from 60.9% in 2019 to 17.1% in 2022 before reaching 41.1% in 2023. Job Satisfaction was 39.1%, 50.0%, 43.9%, 13.8%, and 24.3%; Working Conditions were 30.4%, 38.6%, 33.3%, 11.0%, and 39.7%; and Resilience was 8.7%, 18.2%, 8.9%, 2.9%, and 28.8% from 2019 through 2023.

In Surgical Ward, Teamwork Climate was 72.7%, 23.5%, 80.0%, 92.9%, and 20.8% from 2019 through 2023. Job Satisfaction was 63.6%, 26.5%, 60.0%, 90.0%, and 18.1%; Working Conditions were 54.6%, 17.6%, 80.0%, 87.1%, and 16.7%; and Resilience was 4.6%, 5.9%, 8.0%, 58.6%, and 8.3%. The 2022 peak was temporary and did not represent a sustained endpoint increase.

These core-unit results demonstrate pronounced domain-, unit-, and year-specific variability. They do not support a single common trajectory across the perioperative pathway. Because the dataset contained aggregated domain rates, these differences are reported descriptively without p-values.

Table 1. Four-domain longitudinal positive response rates in multidisciplinary ERAS units, 2019-2023

Unit	Domain	2019 % (n)	2020 % (n)	2021 % (n)	2022 % (n)	2023 % (n)
Anesthesiology	Teamwork Climate	78.0 (59)	96.0 (66)	62.0 (79)	61.8 (116)	77.8 (70)
	Job Satisfaction	70.7 (59)	83.3 (66)	59.6 (79)	34.6 (116)	82.1 (70)
	Working Conditions	59.3 (59)	56.4 (66)	77.4 (79)	54.2 (116)	84.0 (70)
	Resilience	11.9 (59)	9.5 (66)	31.0 (79)	9.8 (116)	41.2 (70)
Operating Room	Teamwork Climate	60.9 (23)	56.8 (44)	44.6 (57)	17.1 (73)	41.1 (74)
	Job Satisfaction	39.1 (23)	50.0 (44)	43.9 (57)	13.8 (73)	24.3 (74)
	Working Conditions	30.4 (23)	38.6 (44)	33.3 (57)	11.0 (73)	39.7 (74)
	Resilience	8.7 (23)	18.2 (44)	8.9 (57)	2.9 (73)	28.8 (74)
Surgical Ward	Teamwork Climate	72.7 (22)	23.5 (18)	80.0 (25)	92.9 (36)	20.8 (26)
	Job Satisfaction	63.6 (22)	26.5 (18)	60.0 (25)	90.0 (36)	18.1 (26)
	Working Conditions	54.6 (22)	17.6 (18)	80.0 (25)	87.1 (36)	16.7 (26)
	Resilience	4.6 (22)	5.9 (18)	8.0 (25)	58.6 (36)	8.3 (26)
Nutrition	Teamwork Climate	60.4 (17)	86.0 (12)	44.4 (22)	68.3 (17)	89.2 (21)
	Job Satisfaction	58.3 (17)	86.0 (12)	66.7 (22)	44.2 (17)	81.9 (21)
	Working Conditions	88.1 (17)	60.0 (12)	55.6 (22)	55.0 (17)	49.2 (21)
	Resilience	9.1 (17)	18.0 (12)	1.4 (22)	9.2 (17)	32.4 (21)
Physiotherapy	Teamwork Climate	100.0 (19)	100.0 (19)	91.7 (19)	75.9 (22)	98.2 (21)
	Job Satisfaction	100.0 (19)	100.0 (19)	94.4 (19)	85.2 (22)	64.9 (21)
	Working Conditions	100.0 (19)	100.0 (19)	94.1 (19)	81.5 (22)	86.8 (21)
	Resilience	9.0 (19)	10.0 (19)	61.1 (19)	38.9 (22)	8.8 (21)

Values are aggregated positive response rates, % (unit-year n). Percentages are domain-level summaries and were not treated as individual positive-response counts; no significance tests were performed.

3.3 Changes Across Patient Safety Culture Domains in Allied Health Units

In Nutrition, Teamwork Climate was 60.4%, 86.0%, 44.4%, 68.3%, and 89.2% from 2019 through 2023. Job Satisfaction was 58.3%, 86.0%, 66.7%, 44.2%, and 81.9%; Working Conditions were 88.1%, 60.0%, 55.6%, 55.0%, and 49.2%; and Resilience was 9.1%, 18.0%, 1.4%, 9.2%, and 32.4%.

In Physiotherapy, Teamwork Climate was 100.0%, 100.0%, 91.7%, 75.9%, and 98.2% from 2019 through 2023. Job Satisfaction was 100.0%, 100.0%, 94.4%, 85.2%, and 64.9%; Working Conditions were 100.0%, 100.0%, 94.1%, 81.5%, and 86.8%; and Resilience was 9.0%, 10.0%, 61.1%, 38.9%, and 8.8%.

Figure 2 displays all four domains for the two allied health units. The Nutrition and Physiotherapy trajectories illustrate that a high Teamwork Climate value in 2023 did not imply improvement in every domain.

Together, the results reinforce the importance of complete within-unit, four-domain trajectories. The measures reflect unit-level perceptions of teamwork and resilience and should not be interpreted as direct evidence that professional silos were eliminated or that the same individuals changed their views over time.

Discussion

The principal finding of this five-year study was that ERAS institutionalization coincided with heterogeneous changes across all four measured patient safety culture domains in the core multidisciplinary units. Several 2023 values were higher than their 2019 values, including Anesthesiology Working Conditions and Resilience, Operating Room Working Conditions and Resilience, and Nutrition Teamwork Climate and Resilience. Other measures were unchanged or lower, and substantial intervening variation was common. The findings therefore represent descriptive organizational time trends rather than uniform improvement, individual longitudinal change, or causal effects of ERAS.

From a Voluntary Initiative to an Institutionalized Model of Care

A central feature of the ERAS implementation process in this study was its transition from a voluntary, interest-based initiative to a standardized institutional care pathway. ERAS requires coordinated participation across surgery, anesthesiology, nursing, nutrition, physiotherapy, and other perioperative services [11, 12]. Such multidisciplinary programs may be difficult to sustain when coordination depends primarily on individual enthusiasm and informal working relationships, particularly when implementation barriers persist across professional and departmental boundaries [14]. In the literature on healthcare innovation and implementation science, relying solely on clinical champions without embedding practices into organizational routines frequently leads to intervention decay over time [18, 21].

In the present setting, progressive standardization of perioperative processes, incorporation of Team Resource Management (TRM) principles, and structured ISBAR communication provided a common framework for multidisciplinary participation [9, 16, 17]. Improvements in Working Conditions and other safety culture measures during the study period are consistent with the possibility that institutionalization helped embed multidisciplinary coordination into routine practice. Rather than depending solely on individual champions, standardized processes may provide greater continuity in how teams communicate, coordinate responsibilities, and manage perioperative care.

These findings extend the interpretation of ERAS beyond its traditional focus on clinical outcomes. From a health services perspective, ERAS may also function as an organizational model through which evidence-based practices, multidisciplinary roles, and communication processes are incorporated into routine care delivery [15, 18].

Standardization and Organizational Resilience

Anesthesiology Resilience reached 41.2% in 2023 compared with 11.9% in 2019, but varied substantially in the intervening years. Surgical Ward Resilience was 4.6% in 2019 and 8.3% in 2023, with a temporary peak of 58.6% in 2022. In both units, the accompanying Teamwork Climate, Job Satisfaction, and Working Conditions trajectories further demonstrate that no single domain summarizes the unit's organizational experience. Resilient healthcare emphasizes the capacity of complex sociotechnical systems and clinical teams to absorb strain, adapt, and maintain essential functions under fluctuating conditions [19, 20].

One possible explanation for these findings is that standardized care processes may increase predictability within complex perioperative environments. When team members work within shared clinical pathways and structured communication processes, they develop clearer expectations regarding patient trajectories, professional responsibilities, handoffs, and escalation processes. TRM and ISBAR may further support shared situational awareness and mental models across professional and hierarchical boundaries [7–9, 16, 17]. These organizational structures could reduce ambiguity and provide teams with a more consistent framework for responding to changing clinical demands.

However, the present study did not directly measure the mechanisms underlying changes in resilience. The observed association between ERAS institutionalization and Resilience should therefore be interpreted cautiously. Measures of implementation fidelity, workload, communication quality, leadership, and other organizational factors would be needed to determine how standardized multidisciplinary pathways may influence resilience.

Integration of Allied Health Professionals

The allied health findings also show domain-specific variation. Nutrition Teamwork Climate increased from 60.4% in 2019 to 89.2% in 2023, while Working Conditions decreased from 88.1% to 49.2%. Physiotherapy Teamwork Climate was 100.0% in 2019 and 98.2% in 2023, with lower intermediate values in 2021 and 2022; Job Satisfaction declined from 100.0% to 64.9%, and Resilience was 9.0% in 2019 and

8.8% in 2023 after higher intermediate values. These contrasting trajectories argue against using one favorable domain as a proxy for overall organizational improvement.

Perioperative nutritional optimization and early functional mobilization are recognized as indispensable core pillars of modern ERAS protocols [11, 12, 24, 25]. Incorporating these evidence-based interventions into a standardized perioperative pathway provides allied health professionals with structured, visible, and clearly delineated clinical responsibilities within the surgical continuum. Previous studies have documented marked perceptual disparities in teamwork and safety culture between physicians and allied health providers [4, 7]. The present findings suggest that institutionalized multidisciplinary pathways can provide an organizational foundation that reinforces the active integration and recognized value of allied health professionals in perioperative care.

Nevertheless, the survey measured unit-level perceptions of Teamwork Climate rather than professional integration itself. The results should not be interpreted as direct evidence that ERAS eliminated professional silos. They instead provide descriptive evidence of changing teamwork perceptions among allied health units during the period of ERAS institutionalization.

Patient Safety Culture and Resilience During the COVID-19 Period

The five-year observation period encompassed the COVID-19 pandemic. Several measures reached lows or highs during 2022, but the direction was not consistent across units or domains. For example, Operating Room measures were generally low in 2022, whereas Surgical Ward Teamwork Climate, Job Satisfaction, Working Conditions, and Resilience were all at their observed peaks. The pandemic period was therefore contextual rather than evidence of a common response.

The recovery of several measures in 2023 is compatible with the broader concept of organizational resilience [19, 20], but the aggregated observational data do not identify the mechanisms responsible. Recent studies investigating healthcare workforce safety culture during the pandemic have emphasized that robust interprofessional support systems and structured operational workflows are critical for mitigating provider burnout and preserving patient safety culture during prolonged crises [22, 23]. Established multidisciplinary workflows and structured communication may have provided organizational support, although this interpretation remains a hypothesis.

Changes in pandemic burden, staffing, workload, respondent composition, institutional policies, leadership initiatives, and other unmeasured factors may have contributed to the observed patterns. The COVID-19 period should therefore be treated as contextual information rather than evidence that ERAS protected the organization from disruption.

Implications for Health Services and Quality Improvement

The findings have implications for the implementation and evaluation of multidisciplinary care pathways. ERAS has traditionally been assessed using patient-level outcomes such as postoperative complications

and length of stay [11–13]. The present study suggests that organizational outcomes—including teamwork, working conditions, and staff perceptions of resilience—may provide complementary measures of how multidisciplinary care pathways become embedded within healthcare organizations.

From this perspective, institutionalizing ERAS involves more than standardizing individual clinical interventions. It also provides an organizational platform for establishing shared workflows, structured communication, and multidisciplinary participation across the perioperative continuum [15, 18]. Incorporating patient safety culture measures into long-term ERAS evaluation may therefore help healthcare organizations assess not only whether clinical protocols are implemented, but also how implementation is experienced by the professionals responsible for delivering care.

This perspective is particularly relevant to healthcare organizations seeking to transition quality improvement initiatives from reliance on individual champions toward sustainable organizational processes [18, 21]. Nevertheless, the extent to which the findings are transferable to other institutions requires further investigation.

Limitations

This study has several limitations. First, it was conducted at a single medical center, and organizational structures, staffing models, ERAS implementation strategies, and patient safety culture may differ across healthcare settings. The generalizability of the findings should therefore be evaluated in multicenter studies.

Second, this was a retrospective longitudinal program evaluation without a contemporaneous control group. Although changes in several patient safety culture domains were observed during the progressive institutionalization of ERAS, causal attribution to the ERAS program cannot be established. Other temporal changes, including staffing, workload, institutional quality improvement activities, leadership initiatives, and the changing impact of the COVID-19 pandemic, may have influenced the observed trends.

Third, the analysis was based on de-identified, aggregated unit-level domain rates rather than individual responses or item-level positive-response counts. Annual respondent numbers were available, but they could not validly be used to reconstruct individual outcome counts or support Chi-square testing. Individual changes could not be tracked, respondent composition could differ by year, and clustering within units could not be modeled. The findings should therefore be interpreted as descriptive unit-level temporal patterns.

Fourth, patient safety culture measures reflect healthcare professionals' perceptions and do not directly measure objective patient outcomes or implementation fidelity. Future studies should examine whether longitudinal changes in patient safety culture are associated with clinical outcomes such as postoperative complications, readmissions, length of stay, and other indicators of ERAS performance.

Finally, future multicenter prospective studies incorporating individual-level longitudinal data, implementation measures, and clinical outcomes would help clarify the mechanisms through which institutionalized multidisciplinary pathways may influence patient safety culture and organizational resilience.

Conclusion

Over five years of progressive ERAS implementation and institutionalization, the four measured patient safety culture domains showed heterogeneous trajectories across multidisciplinary colorectal surgical units. Several measures were higher in 2023 than at baseline, while others were unchanged or lower and marked year-to-year fluctuation was common.

The findings support considering organizational outcomes alongside clinical outcomes when evaluating long-term ERAS implementation. However, they do not establish individual-level change, statistical significance, or a causal effect of ERAS. Structured multidisciplinary practices such as Team Resource Management and ISBAR communication remain plausible organizational supports that require direct evaluation.

ERAS may therefore be viewed as a potential organizational framework for embedding multidisciplinary collaboration into routine care, but this interpretation should remain provisional. Multicenter prospective studies integrating individual-level safety culture data, implementation fidelity, organizational context, and patient outcomes are needed to test the proposed mechanisms and generalizability.

Declarations

Ethics approval and consent to participate: This study involved the secondary analysis of highly aggregated, de-identified unit-level administrative data collected as part of routine institutional patient safety and quality improvement activities. The study received exempt approval from the Institutional Review Board of the Cathay General Hospital (CGH IRB No. CGH-P115050). The requirement for informed consent was waived because only highly aggregated, de-identified unit-level administrative data were used, and the researchers had access to neither individual responses nor personally identifiable information. The study was conducted in accordance with relevant institutional guidelines and regulations and with the principles of the Declaration of Helsinki and the International Council for Harmonisation Good Clinical Practice (ICH-GCP) guidelines.

Consent for publication: Not applicable.

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions: L.P.H. conceived and designed the study, led the ERAS implementation and institutionalization, coordinated multidisciplinary research activities, contributed to data acquisition and interpretation, and drafted the manuscript. S.L.G. contributed to study supervision, interpretation, and critical revision. S.C.C. contributed to clinical implementation of the colorectal ERAS pathway, data interpretation, and critical revision. T.S.Y., C.S.W., and S.O.L. contributed to data interpretation and critical revision. All authors read and approved the final manuscript.

Availability of data and materials: The data analyzed in this study were obtained from hospital-authorized, de-identified unit-level administrative records from the Taiwan Patient Safety Culture Survey. The data are not publicly available because access is subject to institutional authorization and data governance requirements. Further information regarding data access may be available from the corresponding author upon reasonable request and with permission from Cathay General Hospital.

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Figures

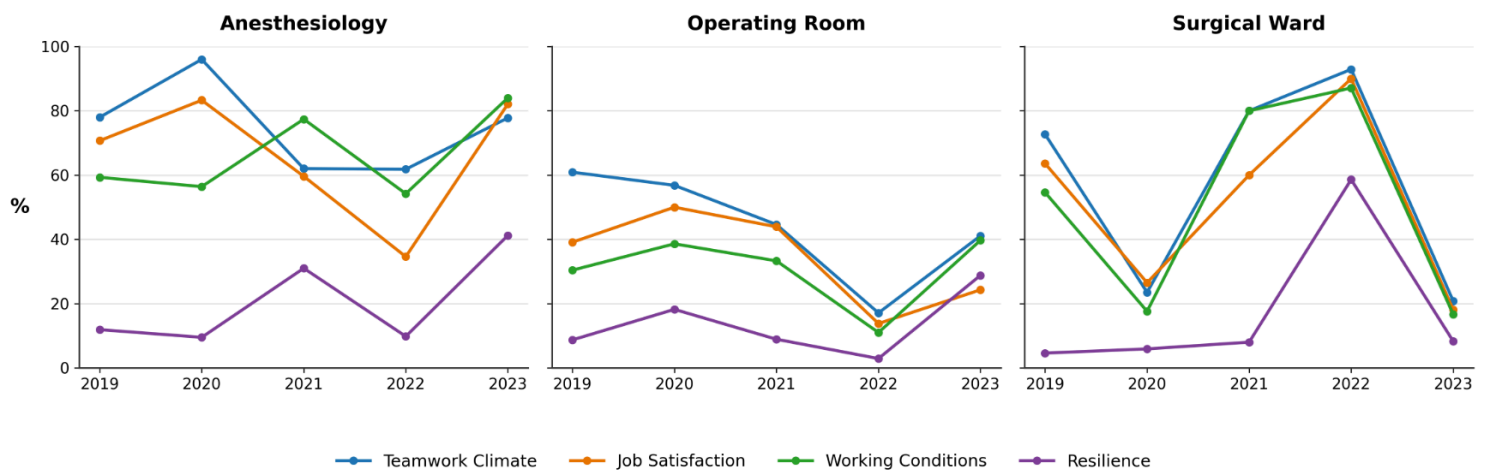


Figure 1

Longitudinal unit-level patient safety culture measures in core perioperative units, 2019-2023. Each panel presents all four available domains for Anesthesiology, the Operating Room, and Surgical Ward. Lines represent annual aggregated positive response rates and do not represent repeated observations of the same individuals.

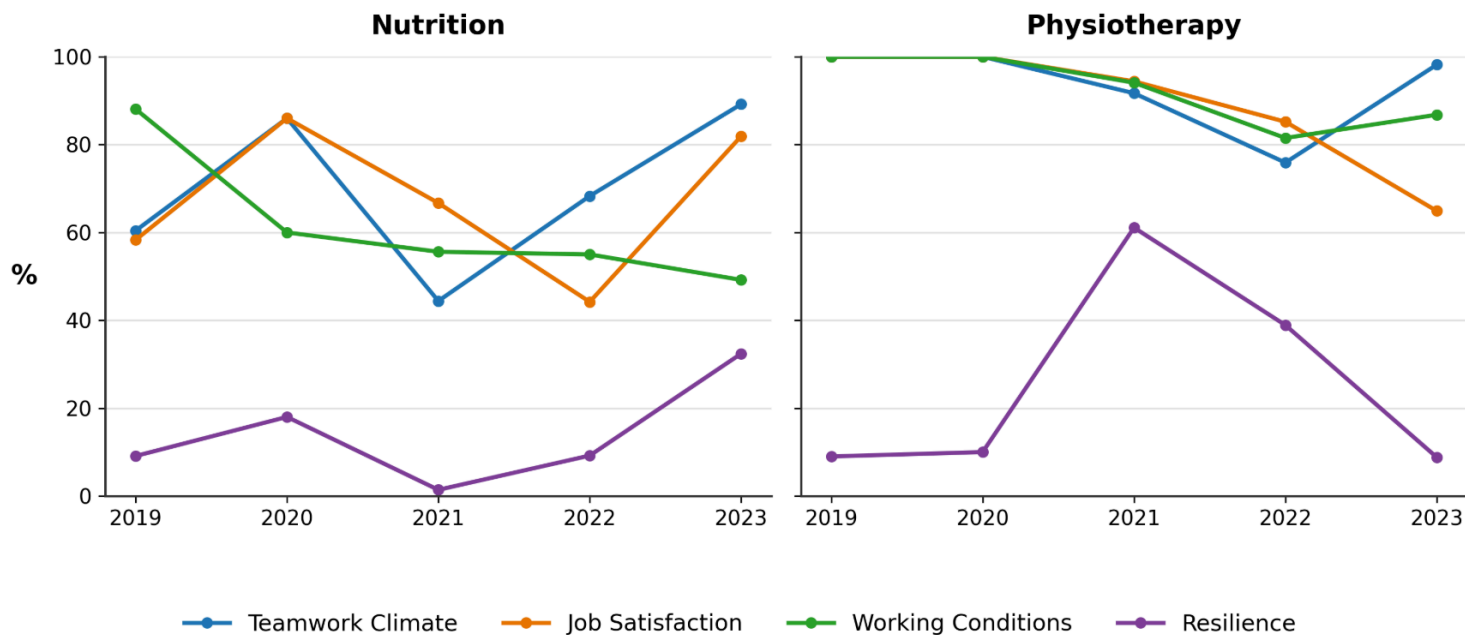


Figure 2

Longitudinal patient safety culture measures in allied health units, 2019-2023. Each panel presents all four domains for Nutrition and Physiotherapy. Lines represent descriptive annual aggregated unit-level positive response rates.