UHASSELT

KNOWLEDGE IN ACTION

Faculteit Geneeskunde en Levenswetenschappen

master in systeem- en procesinnovatie in de gezondheidszorg

Masterthesis

Evolutie van de patiëntveiligheidscultuur op intensieve zorgen en spoedgevallen in algemene ziekenhuizen in België

Isabelle Hauke

Scriptie ingediend tot het behalen van de graad van master in systeem- en procesinnovatie in de gezondheidszorg

PROMOTOR :

Prof. dr. Ward SCHROOTEN

2024
2025

UHASSELT

KNOWLEDGE IN ACTION

www.uhasselt.be
Universiteit Hasselt
Campus Hasselt:
Martelarenlaan 42 | 3500 Hasselt
Campus Diepenbeek:
Agoralaan Gebouw D | 3590 Diepenbeek

UHASSELT

KNOWLEDGE IN ACTION

Faculteit Geneeskunde en Levenswetenschappen

master in systeem- en procesinnovatie in de gezondheidszorg

Masterthesis

Evolutie van de patiëntveiligheidscultuur op intensieve zorgen en spoedgevallen in algemene ziekenhuizen in België

Isabelle Hauke

Scriptie ingediend tot het behalen van de graad van master in systeem- en procesinnovatie in de gezondheidszorg

PROMOTOR :

Prof. dr. Ward SCHROOTEN

Inhoudsopgave

Woord vooraf

Het schrijven van deze masterproef vormt het sluitstuk van een leerrijk traject binnen de opleiding tot master in systeem- en procesinnovatie in de gezondheidszorg. Deze masterproef weerspiegelt mijn sterke interesse in kwaliteitsvolle zorg en patiëntveiligheid, thema's die centraal staan in mijn dagelijkse praktijk als adjunct-hoofdverpleegkundige op de Cardiale Intensieve Zorgen (CIZ) en Medium Care. Vanuit deze rol ervaar ik dagelijks het belang van een veilige en ondersteunende werkomgeving voor zorgverleners en patiënten.

In de eerste plaats wil ik mijn promotor, Professor Ward Schrooten, bedanken voor zijn deskundige begeleiding en bereikbaarheid tijdens dit project. Vervolgens dank ik de onderzoekers en de Universiteit Hasselt, die instonden voor het verzamelen en beheren van de nationale data over patiëntveiligheidscultuur. Zonder hun inzet en engagement was dit onderzoek niet mogelijk geweest.

Dank ook aan mijn collega's en leidinggevenden binnen het Ziekenhuis Oost-Limburg voor de opportuniteit en ondersteuning om deze opleiding tot een goed einde te mogen brengen. Tot slot ben ik mijn familie dankbaar voor hun aanmoediging en steun tijdens deze uitdagende combinatie van studie, werk en privéleven. Een bijzonder woord van dank gaat uit naar mijn partner, Dr. Vincent Raymaekers, voor zijn waardevolle input en kritische blik.

Met deze masterproef hoop ik een bescheiden bijdrage te leveren aan de inzichting in de evolutie van de patiëntveiligheidscultuur op de diensten intensieve zorgen en spoedgevallen in de Belgische ziekenhuiszorg.

Isabelle Hauke

Abstract

Background: Patient safety culture (PSC) is crucial in preventing harm, especially in high-risk settings like intensive care units (ICUs) and emergency departments (EDs). These departments face unique challenges such as time pressure, high workload, and complex care. In Belgium, PSC has been monitored since 2007 using the Hospital Survey on Patient Safety Culture (HSPSC). This study aimed to assess the evolution of patient safety culture in Belgian acute care hospitals between 2005 and 2024, with a focus on ICU and ED settings.

Methods: A cross-sectional study was conducted using HSPSC survey data from 106 Belgian hospitals, containing 11 615 respondents. Descriptive statistics, chi-square tests, and multivariable logistic mixed-effects models were used to analyze trends and associations. Positive dimensional scores (≥3 on a 5-point scale) were used to indicate favorable safety perceptions.

Results: Overall, PSC improved over time, particularly in dimensions such as management support, feedback and communication about errors and supervisor expectations. However, persistent concerns were observed in staffing and nonpunitive response to errors. ICU staff consistently reported more positive perceptions than ED staff. Head nurses and nurse aides showed more favorable attitudes than nurses. Multivariable analysis showed that adequate staffing (OR = 2.64) and strong management support (OR = 1.88) were significantly associated with positive safety perceptions, while ED staff had lower odds for both outcome dimensions.

Conclusion: Despite notable progress, key challenges remain in Belgian EDs and ICUs, particularly regarding staffing and nonpunitive culture. Differences across roles and departments highlight the need for targeted, context-specific interventions. Continuous national measurement efforts remain essential to monitor and improve PSC in acute care settings.

Keywords: Patient safety culture, Hospital Survey on Patient Safety Culture, Intensive Care Unit, Emergency Department, Staffing, Management Support, Belgium, Mixed-effects model

Introduction

According to the World Health Organization (WHO) patient safety is defined as 'the absence of preventable harm to a patient and reduction of risk of unnecessary harm associated with health care to an acceptable minimum'. Approximately 1 in 10 patients experiences harm in healthcare, resulting in over 3 million deaths each year due to unsafe care (1). Therefore, patient safety has become a cornerstone of qualitative care within healthcare systems worldwide (2). It emphasizes the development of systems and practices to minimize errors, adverse events and safety risks (1). Intensive care units (ICUs) and emergency departments (EDs) are prone to safety issues due to their complexity of care, urgent care needs and rapid decision-making. Studies report that adverse events, such as medication errors and communication failures occur at higher rates in these departments compared to other hospital units (3, 4).

The Institute of Medicine (IOM) emphasized the significant impact of preventable adverse events and identified "safety culture" as a fundamental factor to minimize harm to patients. A patient safety culture (PSC) enables healthcare organizations to effectively learn from incidents and implement preventive strategies (5). The importance of patient safety has gained increasing recognition in recent years. There have been efforts from the WHO Global Patient Safety Action Plan and national patient safety programs to improve safety culture (1). The Belgian federal government has implemented a national program aimed at improving quality and patient safety in hospitals since 2007. This initiative uses the Hospital Survey on Patient Safety Culture (HSPSC) to evaluate and benchmark patient safety culture over time (6). Belgian hospitals can contribute their data to a database managed by the University of Hasselt (UHasselt). From this database, benchmark reports are provided and scientific research is conducted. Previous results revealed significant variability in safety perception across healthcare settings, particularly in ICUs and EDs, where staffing shortages, communication barriers and insufficient management support have been identified as contributors to safety risks (6).

Despite these efforts, the incidence of adverse events remains significant. Concerning ICUs and EDs, studies have shown that up to 20% of patients experience some form of adverse event during their hospital stay, ranging from medication errors to procedural complications (7). Furthermore, systemic issues such as inadequate staffing, communication barriers and workflow interruptions increase these risks (8). Recent literature suggests that while improvements have been observed, challenges remain, definitely in acute departments where rapid decision-making and teamwork are critical (9, 10).

Effective management creates a climate where staff feel valued, supported, and empowered to report safety concerns (11). In contrast, inadequate management and insufficient staffing contributes to burnout and higher error rates compromising patient safety and outcomes (12). Nurses in ICUs and EDs are vulnerable to high stress levels in case of workloads and lack of support, which negatively impacts their ability to deliver safe care (13). Furthermore, a supportive management style is associated with higher rates of incident reporting and improved staff morale, which are important for patient safety (14). Staffing challenges have been identified as a critical factor influencing patient safety in ICUs and EDs. Studies highlight that low nurse-to-patient ratios are associated with increased mortality and adverse events, particularly in acute care departments (15-18). In addition, Rogers et al. reported errors and near errors are more likely to occur when nurses work more than twelve hours, especially when performing overtime (19).

The interaction between management support and staffing on patient safety perceptions and event reporting in ICUs and EDs remains underexplored. Therefore, the aim of this study is to examine the evolution of patient safety culture in acute Belgian hospitals over time in ICU and ED experiences among head nurses, nurses and nurse aids. Additionally, the study aims to explore how perceived management support and staffing levels influence overall patient safety perceptions and the frequency of event reporting in these high-risk departments.

Methods

Study design and outcome

This cross-sectional follow-up study investigates the evolution of patient safety culture among head nurses, nurses and nurse aids in acute Belgian hospitals from 2005 to 2024. The study includes respondents from the Emergency Department (ED) and Intensive Care Unit (ICU) from acute care hospitals in Belgium. Five measurement periods were defined: 2005–2008, 2009–2014, 2015–2019, 2020–2021 and 2022–2024. The shorter intervals reflect disruptions in regular data collection activities caused by the COVID-19 pandemic. Participating hospitals were invited through a national patient safety improvement initiative coordinated by a neutral academic institution, in collaboration with the Belgian Federal Government. A validated version of the HSPC in Dutch of French was used (20). Only data from hospitals located in Brussels, Flanders, or Wallonia were included. Hospitals from Grand Duchy of Luxembourg, psychiatric institutions and long-term care hospitals were excluded.

The evolution of positive dimensional scores over five distinct measurement periods are analyzed. Next, differences in patient safety culture are evaluated between departments (ICU en ED) as well as between different staff functions (head nurses, nurses and nurse aids). Positive dimensional scores are compared across these subgroups to identify systematic differences. Baseline characteristics will be assessed for the association with a positive perception of patient safety. Finally, the relationship between staffing (D07) and hospital management support (D08) and the two outcome dimensions are analyzed.

Data collection

Data were sourced from validated patient safety culture surveys administered in Belgian hospitals. The Hospital Survey on Patient Safety Culture (HSPSC) is a validated instrument developed by the Agency for Healthcare Research and Quality and was used to measure safety culture. The participating hospitals used a validated version of the HSPSC in Dutch or French. The HSPSC measures patient safety culture on 12 dimensions on patient safety, covering 42 items. These dimensions include teamwork, communication, staffing, reporting culture and management support for patient safety. Each of these items are rated on a 5-point Likert scale, ranging from 'strongly disagree' to 'strongly agree,' with a neutral midpoint ('neither'), or from 'never' to 'always,' with an intermediate option ('sometimes') (6).

Hospitals distributed the surveys internally, either electronically or on paper, over a 13-week timeframe. A standardized protocol was provided, including detailed guidance on participant recruitment, data collection procedures, and response monitoring to optimize data quality. All questionnaires were distributed anonymously (6).

Data management and statistical analysis

Responses to the survey were processed by calculating the mean dimensional scores for each respondent on a scale ranging from 1 to 5. To facilitate interpretation, these mean scores were dichotomized into binary outcomes. Scores higher than 3 were recoded as 'positive towards patient safety' and scores of 3 and below 3 were considered as 'negative towards patient safety.

To assess safety culture at the hospital level, summary positive dimensional scores were computed by determining the proportion of respondents who expressed a positive perception of patient safety within each of the 12 dimensions evaluated in the survey.

All statistical analyses were conducted using R 4.2.1. A p-value < 0.05 was considered statistically significant. Although differences in dimensional scores may reach statistical significance, small difference are unlikely to be of practical relevance. Therefore, in line with the guidance from the AHRQ, we considered a difference of at least 5 percentage to be clinically relevant (21).

Mean positive dimensional scores were calculated for each period, staff function and department. 95% confidence intervals (CI) were calculated to describe the range of variation. Chi-square tests were used for to make categorical comparisons of the positive dimensional scores.

Multivariable logistic regression (mixed models) was performed to estimate odds ratios (ORs) for the likelihood of reporting a positive perception for each dimension separately (using a reversed model building). These models included hospital as a random effect to account for clustering of responses within institutions (mixed-effects modeling).

Lastly, the influence of staffing (D07) and management support (D08) on outcome variables was assessed in a separate logistic regression model, adjusting for other dimensions using a reversed model building approach to identify key predictors of overall safety perception and event reporting.

Results

Descriptive statistics

Hospital and respondent characteristics

A total of 106 acute Belgian hospitals participated in the national patient safety culture surveys using the Hospital Survey on Patient Safety Culture (HSPSC) between 2005 and 2024. Participation varied across time periods, with the number of participating hospitals ranging from 5 in 2020–2021 to 94 in 2009–2014. In recent years, participation was limited to hospitals in Flanders, with no representation from Brussels or Wallonia in the most recent periods (2020–2024). The hospitals' characteristics for each period are presented in Table 1.

The total number of unique respondents across all survey rounds was 11615. Most respondents were nurses (90.2%), followed by head nurses (6.2%) and nurse aides (3.6%). Most respondents worked in intensive care units (63.5%), with the remainder in emergency departments (36.5%). Respondents were experienced professionals with most participants indicating over six years of work experience both in the hospital and in their current specialty. Furthermore, over 97% reported direct patient contact, and the majority worked full-time (between 20 and 39 hours per week). The respondent characteristics for each time are presented in Table 1.

Missing data

Missing data were minimal across survey items and respondent characteristics. For most variables, the proportion of missing responses remained below 2%. Data were handled as missing at random.

Measurements over time

The number of measurements (repetitive participations) from participating varied substantially (Table 2). Twenty percent of hospitals only performed one measurement in their hospital. The remaining hospitals contributed to multiple measurement periods, enabling trend analysis over time. A percentage of 38.2% of hospitals participated in three measurement periods, while 20.9% contributed to two. Only six hospitals contributed to all five measurement periods between 2005 and 2024.

	Number of acute hospitals
Number of measurements	
Only 1 measurement	22 (20%)
2 Measurements	23 (20,9%)
3 Measurements	42 (38,2%)
4 Measurements	17 (15,5%)
5 Measurements	6 (5,5%)

Table 2 Number of measurements per acute hospital.

	2005-2008	2009-2014	2015-2019	2020-2021	2022-2024	Total (Unique)
Participating acute hospitals						
Total number of acute hospitals	85	93	91	5	13	106
Per region						
Brussel	6 (7.1%)	10 (10.8%)	9 (9.9%)	-	-	10 (9.4%)
Vlaanderen	56 (65.9%)	55 (59.1%)	58 (63.7%)	5 (100%)	13 (100%)	62 (32.1%)
Wallonië	23 (27.1%)	28 (30.1%)	24 (26.4%)	-	-	10 (9.4%)
Per province						
Antwerpen	17 (20%)	15 (16.1%)	9 (9.9%)	-	2 (15.4%)	18 (17%)
Brussel	6 (7.1%)	10 (10.8%)	9 (9.9%)	-	-	10 (9.4%)
Henegouwen	10 (11.8%)	11 (11.8%)	8 (8.8%)	-	-	16 (15.1%)
Limburg	10 (11.8%)	9 (9.7%)	11 (12.1%)	1 (20%)	1 (7.7%)	11 (10.4%)
Luik	6 (7.1%)	11 (11.8%)	9 (9.9%)	-	-	9 (8.5%)
Luxemburg	2 (2.4%)	3 (3.2%)	3 (3.3%)	-	-	3 (2.8%)
Namen	3 (3.5%)	2 (2.2%)	2 (2.2%)	-	-	3 (2.8%)
Oost-Vlaanderen	16 (18.8%)	14 (15.1)	18 (19.8%)	1 (20%)	5 (38.5%)	14 (13.2%)
Vlaams-Brabant	2 (2.4%)	4 (4.3%)	6 (6.6%)	-	1 (7.7%)	5 (4.7%)
Waals-Brabant	1 (1.2%)	1 (1.1%)	2 (2.2%)	-	-	2 (1.9%)
West-Vlaanderen	12 (14.1%)	13 (14%)	14 (15.4%)	3 (60%)	4 (30.8%)	15 (14.2%)
Respondents						
Total number of respondents	3645	4068	3305	269	328	11615
Staff position						
Head nurse	213 (5.8%)	239 (5.9%)	203 (6.1%)	33 (12.3%)	27 (8.2)	715 (6.2%)
Nurse	3274 (89.8%)	3683 (90.5%)	2998 (90.7%)	231 (85.9%)	296 (90.2)	10482 (90.2%)
Nurse aid	158 (4.3%)	146 (3.6%)	104 (3.1%)	5 (1.9%)	5 (1.5)	418 (3.6%)
Department						
ICU	2282 (62.6%)	2559 (62.9%)	2124 (64.3%)	176 (65.4%)	231 (70.4%)	7372 (63.5%)
ED	1363 (37.4%)	1509 (37.1%)	1181 (35.7%)	93 (34.6%)	97 (29.6%)	4243 (36.5%)
Work experience hospital						
< 1 year	203 (5.6%)	178 (4.4%)	146 (4.4%)	8 (3%)	21 (6.4%)	556 (4.8%)
1 to 5 years	816 (22.4%)	1070 (26.3%)	816 (24.7%)	57 (21.2%)	68 (20.7%)	2828 (24.3%)
6 to 10 years	805 (22.1%)	683 (16.8%)	590 (17.9%)	46 (17.1%)	42 (12.8%)	2166 (18.6%)
11 to 15 years	519 (14.2%)	610 (15%)	466 (14.1%)	44 (16.4%)	38 (11.6%)	1677 (14.4%)
16 to 20 years	566 (15.5%)	475 (11.7%)	346 (10.5%)	30 (11.2%)	34 (10.4%)	1451 (12.5%)

>21 years	702 (19.3%)	1017 (25%)	930 (28.1%)	84 (31.2%)	125 (38.1%)	2858 (24.6%)
Missing	34 (0.9%)	35 (0.9%)	11 (0.3%)	-	-	80 (0.7%)
Work experience current hospital work area/unit						
< 1 year	289 (7.9%)	261 (6.4%)	226 (6.8%)	15 (5.6%)	27 (8.2%)	818 (7%)
1 to 5 years	1022 (28%)	1252 (30.8%)	928 (28.1%)	81 (30.1%)	78 (23.8%)	3362 (28.9%)
6 to 10 years	915 (25.1%)	756 (18.6%)	646 (19.5%)	57 (21.2%)	45 (13.7%)	2419 (20.8%)
11 to 15 years	513 (14.1%)	631 (15.5%)	462 (14%)	42 (15.6%)	40 (12.2%)	1688 (14.5%)
16 to 20 years	461 (12.6%)	439 (10.8%)	356 (10.8%)	24 (8.9%)	41 (12.5%)	1321 (11.4%)
>21 years	422 (11.6%)	702 (17.3%)	669 (20.2%)	50 (18.6%)	97 (29.6%)	1940 (16.7%)
Missing	23 (0.6%)	27 (0.7%)	18 (0.5%)	-	-	68 (0.6%)
Working hours						
<20h/week	174 (4.8%)	185 (4.5%)	143 (4.3%)	12 (4.5%)	1 (0.3%)	515 (4.4%)
20-39h/week	2607 (71.5%)	2833 (69.6%)	2261 (68.4%)	176 (65.4%)	236 (72%)	8113 (69.8%)
40-59h/week	763 (20.9%)	906 (22.3%)	778 (23.5%)	73 (27.1%)	85 (25.9%)	2605 (22.4%)
60-79h/week	50 (1.4%)	77 (1.9%)	62 (1.9%)	6 (2.2%)	3 (0.9%)	198 (1.7%)
>80h/week	12 (0.3%)	26 (0.6%)	25 (0.8%)	2 (0.7%)	3 (0.9%)	68 (0.6%)
Missing	39 (1.1%)	41 (1%)	36 (1.1%)	-	-	116 (1.0)
Direct patient contact						
Yes	3546 (97.3%)	3968 (97.5%)	3219 (97.4%)	264 (98.1%)	320 (97.6%)	22317 (97.4%)
No	50 (1.4%)	44 (1.1%)	25 (0.8%)	5 (1.9%)	1 (0.3%)	125 (1.1%)
Missing	49 (1.3%)	56 (1.4%)	61 (1.8%)	-	7 (2.1%)	173 (1.5%)
Work experience current specialty or profession						
< 1 year	145 (4%)	129 (3.2%)	118 (3.6%)	12 (4.5%)	19 (5.8%)	423 (3.6%)
1 to 5 years	683 (18.7%)	887 (21.8%)	722 (21.8%)	52 (19.3%)	63 (19.2%)	2407 (20.7%)
6 to 10 years	840 (23%)	670 (16.5%)	566 (17.1%)	51 (19%)	47 (14.3%)	2174 (18.7%)
11 to 15 years	546 (15%)	660 (16.2%)	462 (14%)	47 (17.5%)	34 (10.4%)	1749 (15.1%)
16 to 20 years	602 (16.5%)	531 (13.1%)	378 (11.4%)	21 (7.8%)	32 (9.8%)	1564 (13.5%)
>21 years	768 (21.1%)	1120 (27.5%)	956 (28.9%)	85 (31.6%)	128 (39%)	3057 (26.3%)
Missing	61 (1.7%)	71 (1.7%)	103 (3.1%)	1 (0.4%)	5 (1.5%)	241 (2.1%)

Table 1 Hospital and respondent characteristics.

Positive dimensional scores on safety culture dimensions

The overall evolution of positive dimensional scores on patient safety culture dimensions over the five measurement periods is shown in Table 3. In most dimensions, the mean positive dimensional scores of respondents with a positive perception increased over time. Regarding the outcome dimensions, a modest but significant improvement was observed in '*Overall perceptions of safety'* (O01), visualized in Figure 1, which increased from 0.51 in 2005–2008 to 0.60 in 2022–2024 (p = 0.004). However, *the 'Frequency of event reporting'* (O02), visualized in Figure 2, remained low across all periods, improving only slightly from 0.40 to 0.34 (p < 0.001).

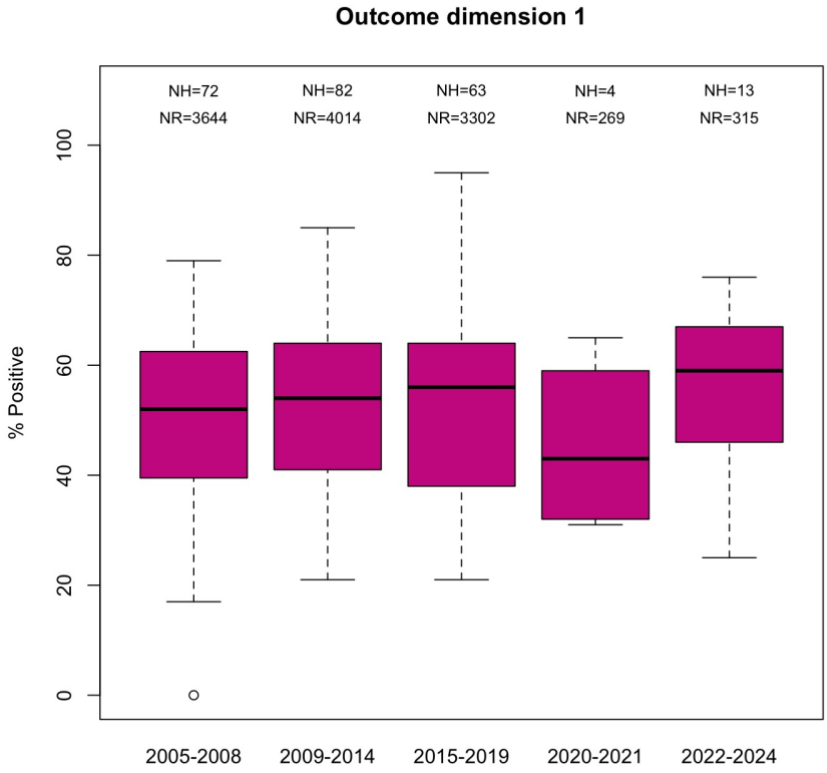


Figure 1 Evolution in positive dimensional scores for overall positive perception of patient safety (outcome dimension 1) among nurses, head nurses and nurse aids in the ICU and ED across different time periods in Belgian acute hospitals (2005–2024). NH = number of hospitals, NR = number of respondents.

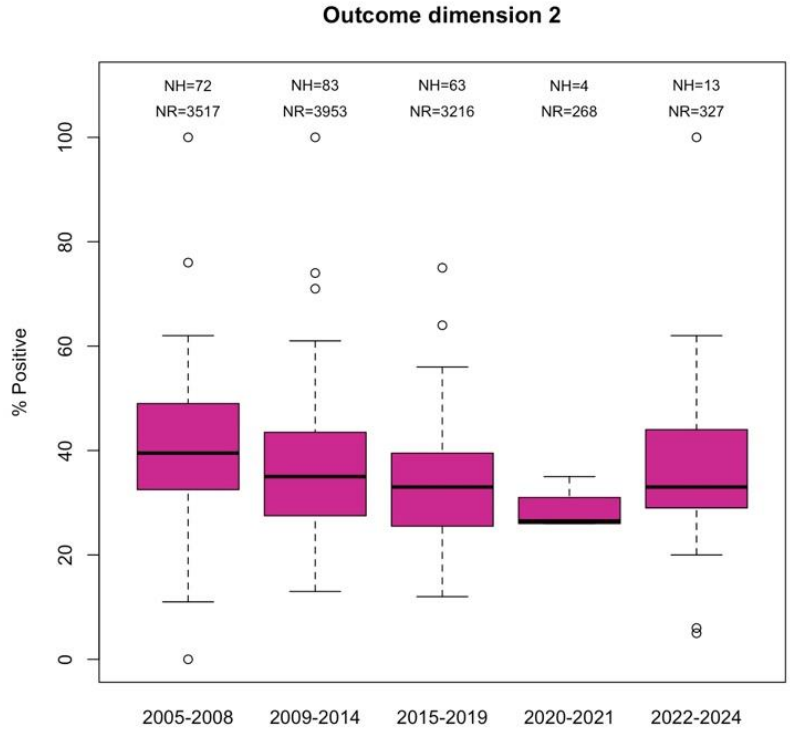


Figure 2 Evolution in positive dimensional scores for overall positive perception of patient safety (outcome dimension 1) among nurses, head nurses and nurse aids in the ICU and ED across different time periods in Belgian acute hospitals (2005–2024). NH = number of hospitals, NR = number of respondents.

The overall perception of patient safety culture within hospitals has gradually improved over time, with significant increases observed in dimensions such as management support, communication about errors, and supervisor expectations, while teamwork within units consistently remained strong. In contrast, progress in some dimensions remained limited, as shown in Table 3.

For example, the dimension *'Supervisor/manager expectations and actions promoting safety'* (D01) rose from 0.71 in 2005–2008 to 0.80 in 2022–2024. Similarly, *'Feedback and communication about error'* (D05) improved from 0.51 to 0.64 over the same period. *'Hospital management support for patient safety'* (D08) also showed a strong increase from 0.32 to 0.54. The dimension *'Teamwork within units'* (D03) consistently received high scores across all time points, ranging from 0.78 to 0.85. These evolutions were statistically significant ($p < 0.001$), suggesting a gradual improvement in the patient safety climate within hospitals.

Head nurses consistently reported the highest positive scores across patient safety culture dimensions, whereas nurses generally scored the lowest. Head nurses generally reported more positive perceptions on dimensions like teamwork and communication openness, while nurse aides scored highest on outcome measures such as event reporting and overall safety perceptions. This is shown in Table 4.

		2005-2008	2009-2014	2015-2019	2020-2021	2022-2024	p-value*
Positive dimensional score per patient safety culture dimension (95% CI)							
D01	Supervisor/manager expectations and actions promoting patient safety	0.71 (0.69-0.72)	0.73 (0.72-0.74)	0.73 (0.71-0.74)	0.80 (0.75-0.85)	0.80 (0.76-0.84)	p<0.001
D02	Organizational learning—Continuous improvement	0.64 (0.62-0.65)	0.70 (0.69-0.72)	0.73 (0.72-0.75)	0.72 (0.66-0.77)	0.71 (0.66-0.76)	p<0.001
D03	Teamwork within units	0.78 (0.76-0.79)	0.83 (0.82-0.84)	0.85 (0.84-0.86)	0.84 (0.80-0.88)	0.85 (0.81-0.89)	p<0.001
D04	Communication openness	0.66 (0.64-0.68)	0.70 (0.689-0.71)	0.70 (0.68-0.71)	0.64 (0.58-0.70)	0.68 (0.63-0.73)	p=0.001
D05	Feedback and communication about error	0.51 (0.49-0.52)	0.51 (0.49-0.52)	0.56 (0.54-0.57)	0.56 (0.50-0.62)	0.64 (0.59-0.69)	p<0.001
D06	Nonpunitive response to error	0.42 (0.40-0.43)	0.44 (0.43-0.46)	0.42 (0.40-0.44)	0.42 (0.36-0.48)	0.46 (0.41-0.52)	P=0.088
D07	Staffing	0.42 (0.40-0.43)	0.44 (0.43-0.46)	0.41 (0.40-0.43)	0.39 (0.34-0.45)	0.53 (0.47-0.58)	p<0.001
D08	Hospital management support for patient safety	0.32 (0.30-0.33)	0.39 (0.37-0.40)	0.47 (0.45-0.49)	0.42 (0.37-0.48)	0.54 (0.48-0.59)	p<0,001
D09	Teamwork across hospital units	0.43 (0.41-0.44)	0.44 (0.421-0.45)	0.48 (0.46-0.49)	0.52 (0.46-0.58)	0.49 (0.44-0.54)	p<0.001
D10	Hospital handoffs and transitions	0.46 (0.44-0.47)	0.44 (0.43-0.46)	0.45 (0.43-0.47)	0.44 (0.38-0.50)	0.49 (0.44-0.54)	p=0.438
Positive dimensional score per outcome dimension (95% CI)							
O01	Overall perceptions of safety	0.51 (0.50-0.53)	0.51 (0.50-0.53)	0.51 (0.50-0.53)	0.54 (0.48-0.60)	0.60 (0.55-0.66)	P=0.004
O02	Frequency of event reporting	0.40 (0.39-0.42)	0.36 (0.34-0.37)	0.34 (0.32-0.35)	0.32 (0.26-0.38)	0.34 (0.20-0.39)	p<0.001

*Table 3 Positive dimensional score per patient safety dimension per time period. Clinically significant differences were indicated in green for improvement (>5%) and red for a decline (>5%) (21). *Chi-quare test.*

	Head nurse	Nurse	Nurse aid	p-value*
Positive dimensional score per patient safety culture dimension (95% CI)				
D01 Supervisor/manager expectations and actions promoting patient safety	0.81 (0.78-0.84)	0.72 (0.71-0.73)	0.80 (0.76-0.83)	p<0.001
D02 Organizational learning—Continuous improvement	0.85 (0.82-0.87)	0.68 (0.67-0.69)	0.67 (0.63-0.72)	p<0.001
D03 Teamwork within units	0.90 (0.88-0.92)	0.82 (0.81-0.82)	0.79 (0.75-0.82)	p<0.001
D04 Communication openness	0.90 (0.88-0.92)	0.67 0.66-0.68)	0.74 (0.69-0.78)	p<0.001
D05 Feedback and communication about error	0.69 (0.66-0.73)	0.51 (0.50-0.52)	0.65 (0.60-0.69)	p<0.001
D06 Nonpunitive response to error	0.65 (0.62-0.69)	0.42 (0.41-0.43)	0.38 0.34-0.43)	p<0.001
D07 Staffing	0.48 (0.44-0.51)	0.42 (0.41-0.43)	0.41 (0.37-0.46)	p=0.123
D08 Hospital management support for patient safety	0.57 (0.53-0.60)	0.38 (0.37-0.39)	0.56 (0.51-0.61)	p<0.001
D09 Teamwork across hospital units	0.55 (0.51-0.58)	0.44 (0.43-0.45)	0.51 (0.47-0.56)	p<0.001
D10 Hospital handoffs and transitions	0.44 (0.41-0.48)	0.45 (0.44-0.46)	0.53 (0.48-0.58)	p=0.004
Positive dimensional score per outcome dimension (95% CI)				
O01 Overall perceptions of safety	0.53 (0.50-0.57)	0.52 (0.52-0.53)	0.62 (0.57-0.66)	p<0.001
O02 Frequency of event reporting	0.39 (0.35-0.43)	0.36 (0.35-0.37)	0.51 (0.46-0.56)	p<0.001

*Table 4 Positive dimensional score per patient safety dimension per staff position. *Chi-square test.*

	ICU	ED	p-value*
Positive dimensional score per patient safety culture dimension (95% CI)			
D01 Supervisor/manager expectations and actions promoting patient safety	0.74 (0.73-0.75)	0.70 (0.69-0.71)	p<0.001
D02 Organizational learning—Continuous improvement	0.73 (0.72-0.74	0.63 (0.61-0.64)	p<0.001
D03 Teamwork within units	0.84 (0.84-0.85)	0.78 (0.77-0.79)	p<0.001
D04 Communication openness	0.70 (0.69-0.71)	0.66 (0.65-0.68)	p<0.001
D05 Feedback and communication about error	0.54 (0.53-0.56)	0.50 (0.48-0.51)	p<0.001
D06 Nonpunitive response to error	0.48 (0.46-0.49)	0.35 (0.33-0.36)	p<0.001
D07 Staffing	0.48 (0.47-0.49)	0.33 (0.31-0.34)	p<0.001
D08 Hospital management support for patient safety	0.42 (0.41-0.43)	0.35 (0.34-0.37)	p<0.001
D09 Teamwork across hospital units	0.50 (0.49-0.51)	0.36 (0.35-0.38)	p<0.001
D10 Hospital handoffs and transitions	0.48 (0.47-0.49)	0.40 (0.38-0.41)	p<0.001
Positive dimensional score per outcome dimension (95% CI)			
O01 Overall perceptions of safety	0.60 (0.59-0.62)	0.39 (0.37-0.40)	p<0.001
O02 Frequency of event reporting	0.38 (0.37-0.39)	0.33 (0.32-0.34)	p<0.001

*Table 5 Positive dimensional score per patient safety dimension per department t. *Student-t test.*

A comparison between ICU and ED respondents revealed that ICU staff reported more favorable perceptions of patient safety culture in contrast to the ED staff (Table 5). Clinically significant differences (>5 %) were found across all dimensions, except for dimension D01, D02 and D05. The positive dimensional scores for dimension 7 compared between the ICU and ED nurses is visualized in Figure 3. Additional comparative boxplots are added in the additional files.

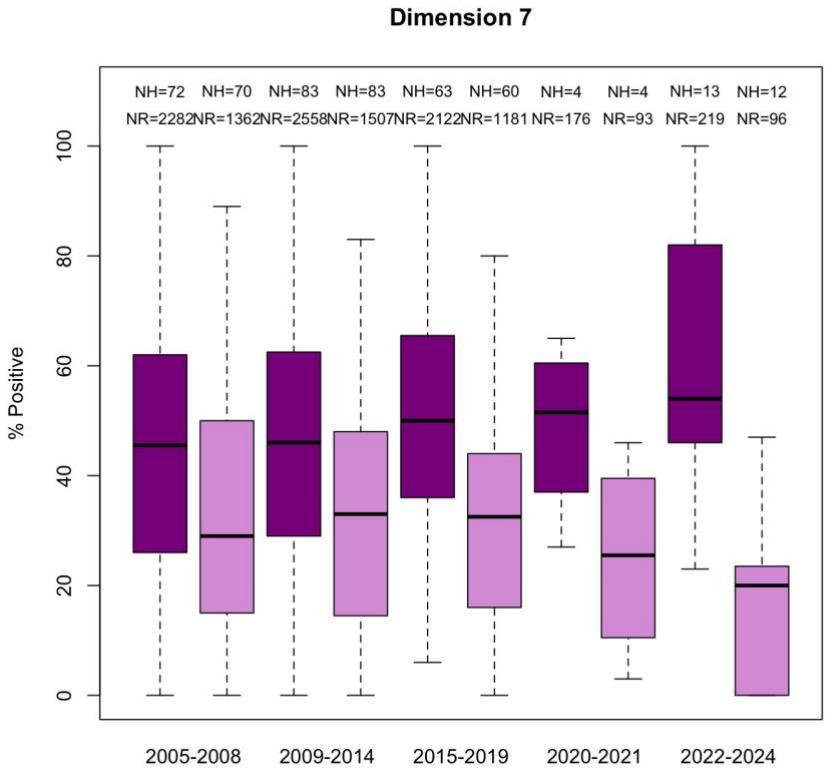


Figure 3 Evolution of positive dimensional scores regarding staffing (Dimension 7) for ICU (dark purple) versus the ED (light purple) across different time periods in Belgian acute hospitals (2005–2024). NH = number of hospitals, NR = number of respondents.

Outcome measures supported these differences. ICU respondents reported significantly higher *'Overall perceptions of safety'* (O01) (0.60) compared to ED respondents (0.39), and a slightly higher *'Frequency of event reporting'* (O02) (0.38 versus 0.33, respectively). This consistent discrepancy between departments underscores the structural and operational challenges that EDs face, which may impede the development of a robust safety culture.

Mixed Model Analysis

A multivariable mixed model (logistic regression) with the participating hospital as a random effect was used to assess the likelihood of reporting positive safety for dimension 7 and 8 and the outcome dimensions using a reversed model building. Table 6 gives an overview of the odds ratio for a positive dimensional score for the variables included in the mixed model.

Across the time periods, the odds ratios (ORs) for D07 and D08 generally declined in more recent years. For example, the odds to have a positive dimensional score on management support (D08) peaked in 2015–2019 (OR = 2.277) compared to 2005-2008. The odds for event reporting (Outcome 2) were significantly lower for all periods compared to 2005-2008.

Working in the emergency department was associated with lower odds for a positive dimensional score on staffing problems (D07: OR = 0,52) and lower odds for perceiving strong management support (D08: OR = 0.732). ED staff also had significantly lower odds for positive safety perception

(Outcome 1: OR = 0.36) and only modest odds for event reporting (Outcome 2: OR = 0.78), compared to ICU staff.

Experience-related variables (work experience in hospital and in the department) revealed variable effects. In general, longer experience was not consistently associated with higher odds of positive dimensional scores. In contrast higher workload, represented by weekly working hours, was associated with lower odds on positive dimensional scores in management support (OR=0.69) and overall positive safety perception (OR=0.65).

Staff position was a strong determinant, nurse aides had the highest odds of positive perceptions across all dimensions (D07: OR = 1.60; D08: OR = 2.47; Outcome 1: OR = 1.67; Outcome 2: OR = 1.84), followed by head nurses.

Variable	Dimension 7	Dimension 8	Outcome 1	Outcome 2
Period				
2005-2008	1	1	1	1
2009-2014	1.05 (0.95 – 1.17)	**1.44 (1.28 – 1.61)**	**1.13 (1.01 – 1.26)**	**0.79 (0.71 – 0.88)**
2015-2019	1.04 (0.92 – 1.17)	**2.28 (2.01 – 2.57)**	1.12 (0.99 – 1.26)	**0.74 (0.66 – 0.83)**
2020-2021	1.03 (0.71 – 1.50)	**1.52 (1.06 – 2.17)**	0.80 (0.54 – 1.13)	**0.63 (0.44 – 0.90)**
2022-2024	**1.71 (1.28 – 2.29)**	**1.65 (1.23 – 2.21)**	0.82 (0.61 – 1.11)	**0.65 (0.49 – 0.86)**
Department				
Intensive Care Unit	1	1	1	1
Emergency department	**0,52 (0.47 – 0.56)**	**0.73 (0.67 – 0.80)**	**0.36 (0.33 – 0.40)**	**0.78 (0.72 – 0.85)**
Work experience hospital				
< 1 years	1	1	-	-
1 to 5 years	0.86 (0.62 – 1?17)	**0.61 (0.44 – 0.83)**	-	-
6 to 10 years	0.75 (0.54 -1.04)	**0.59 (0.42 – 0.82)**	-	-
11 to 15 years	**0.67 (0.47 – 0.94)**	0.75 (0.53 – 105)	-	-
16 to 20 years	**0.67 (0.48 – 0.95)**	0.77 (0.54 – 1.08)	-	-
>21 years	**0.71 (0.50 – 0.99)**	0.89 (0.63 – 1.26)	-	-
Work experience current hospital work area/unit				
< 1 year	1	1	1	-
1 to 5 years	**0.70 (0.54 – 0.91)**	**0.70 (0.54 – 0.91)**	**0.72 (0.58 – 0.90)**	-
6 to 10 years	**0.69 (0.52 – 0.92)**	**0.61 (0.45 – 0.81)**	**0.64 (0.51 – 0.81)**	-
11 to 15 years	0.75 (0.56 – 1.01)	**0.63 (0.47 – 0.85)**	**0.68 (0.53 – 0.87)**	-
16 to 20 years	0.74 (0.54 – 1.00)	**0.63 (0.46 – 0.86)**	**0.72 (0.55 -0.93)**	-
> 21 years	**0.74 (0.48 – 0.89)**	**0.71 (0.52 – 0.97)**	**0.77 (0.59 – 0.99)**	-
Working hours				
< 20h per week	1	1	1	-

20 to 39h per week	1.06 (0.87 – 1.28)	0.84 (0.69 – 1.02)	0.93 (0.76- 1.13)	-
40 to 59 h per week	**0.72 (0.58 – 0.88)**	**0.69 (0.55 – 0.85)**	0.82 (0.66 – 1.01)	-
60 to 79h per week	0.73 (0.51 – 1.05)	0.77 (0.53 – 1.11)	**0.65 (0.45 – 0.93)**	-
>80h per week	0.85 (0.49 – 1.47)	0.73 (0.42 – 1.27	0.75 (0.43 – 1.29)	-
Staff position				
Nurse				
Head nurse	**1.60 (1.36 – 1.90)**	**2.30 (1.94 – 2.73)**	**1.20 (1.01 – 1.43)**	**1.18 (1.01 – 1.39)**
Nurse aid	0.99 (0.81 – 1.24)	**2.47 (1.98 – 3.06)**	**1.67 (1.33 – 2.09)**	**1.84 (1.48 – 2.28)**
Work experience current profession				
< 5 years	-	-	1	1
1 to 5 years	-	-	0.79 (0.59 – 1.06)	**0.78 (0.62 – 0.97)**
6 to 10 years	-	-	**0.68 (0.50 – 0.92)**	**0.59 (0.48 – 0.74)**
11 to 15 years	-	-	**0.54 (0.39 – 0.73)**	**0.64 (0.51 – 0.80)**
16 to 20 years	-	-	**0.62 (0.44 – 0.84)**	**0.71 (0.56 – 0.89)**
> 21 years	-	-	**0.62 (0.45 – 0.85)**	**0.79 (0.63 – 0.98)**

Table 6 Odds ratios (ORs) and 95% CI from a multivariable mixed-effects logistic regression model assessing dimension 7 (D07, Staffing), dimension 8 (D08, Hospital management support for patient safety), outcome 1 (O01 Overall perception of patient safety) and outcome 2 (O02 Frequency of event reporting).

Outcome dimensions and the influence of staffing and management support

A separate multivariable mixed model examined the influence of a positive dimensional score on staffing (D07) and hospital management support (D08) on the outcome dimensions taking all dimensions into consideration. Two models were fitted using reversed model building. For the overall perception of safety, both D07 (OR = 2.64) and D08 (OR = 1.88) were significantly associated with positive perceptions. For frequency of event reporting, D07 showed a modest association (OR = 0.82), while D08 did not significantly influence reporting behavior. Results are summarized in Table 7.

Variable	Outcome 1	Outcome 2
Dimension 1	1.76 (1,58 – 1.95)	1.24 (1.11 – 1.38)
Dimension 2	1.77 (1.61 – 1.96)	1.30 (1.17 – 1.44)
Dimension 3	1.46 (1.30 – 1.65)	-
Dimension 4	-	1.32 (1.19 – 1.47)
Dimension 5	1.45 (1.32 – 1.59)	2.25 (2.05 – 2.47)
Dimension 6	1.62 (1.47 – 1.77)	1.19 (1.09 – 1.30)
Dimension 7	2.6 (2.40 – 2.89)	0.82 (0.75 – 0.90)
Dimension 8	1.88 (1.71 – 2.07)	-
Dimension 9	1.22 (1.11 – 1.35)	1.13 (1.03 – 1.24)
Dimension 10	1.68 (1.53 – 1.84)	1.31 (1.19 – 1.43)

Table 7 Odds ratios (ORs) and 95% CI from a multivariable mixed-effects logistic regression model assessing outcome 1 (O01 Overall perception of patient safety) and outcome 2 (O02 Frequency of event reporting).

Discussion

This study offers a comprehensive overview of the evolution of patient safety culture (PSC) in 106 Belgian acute care hospitals over a nearly two-decade period, focusing specifically on ICU and ED settings. The findings demonstrate a general improvement in positive safety perceptions across most dimensions of the Hospital Survey on Patient Safety Culture (HSPSC), particularly in domains related to management support, supervisor expectations, and communication about error. These improvements likely reflect the impact of national safety initiatives and the increasing integration of safety culture in hospital policies over the past two decades. Over time the most notable progress was seen in the positive dimensional score for hospital management support for patient safety (D08), which increased from 0.32 to 0.54 over the study period, and in feedback and communication about error (D05), which rose from 0.51 to 0.64. These findings are aligned with international efforts such as the WHO Global Patient Safety Action Plan, which emphasizes leadership commitment and organizational learning as pillars of safety culture transformation (1). Similarly, Singer et al. (2009) noted a positive correlation between safety climate and safety performance, particularly when leadership is perceived as supportive (22).

Despite overall improvements, several dimensions continued to score below desirable thresholds. Nonpunitive response to error (D06) and staffing (D07) remained particularly weak, with mean positive dimensional scores consistently below 0.50, except for a late increase in staffing scores in the 2022–2024 period. These results are in line with findings from Wagner et al. (2013) and Halligan & Zecevic (2011), who emphasized that fear of blame and chronic understaffing hinder open communication and incident reporting (23, 24).

Staffing was also a central determinant of safety outcomes. Multivariable logistic regression confirmed that higher perceptions of adequate staffing (D07) were strongly associated with better overall safety perception (O01, OR = 2.64). Furthermore, a higher staffing perception is negatively associated with event reporting (outcome 2) (OR = 0.82), indicating that better staffing perception leads to lower likelihood of reporting events. A positive dimensional score on management support (O08) is associated with a better overall safety perception (OR= 1,88). In a recent systematic review Drennan et al. (2024) demonstrated that lower nurse staffing levels in EDs are consistently linked to delayed care delivery, overcrowding, and adverse events such as increased cardiac arrest rates (25). The international ED survey by Petrino et al. (2023) similarly identified staffing shortages and poor management support as key barriers to patient safety in over 100 countries (26).

ICU respondents reported significantly more favorable safety perceptions than ED respondents across all dimensions. The most pronounced gaps were observed in hospital management support (ICU: 0.42 vs. ED: 0.35), staffing (0.48 vs. 0.33) and overall safety perception (0.60 vs. 0.39). The multilevel model confirmed that working in the ED was associated with lower odds of positive safety perception (OR = 0.36) and management support (OR = 0.73). In contrast, the odds for reporting staffing problems was 1.71. The consistently lower scores in EDs point to structural and cultural barriers such as staffing shortages, limited management support and a punitive atmosphere, which may hinder safety improvements. The European Society for Emergency Medicine has stressed the need for system-level reforms in EDs to address such vulnerabilities (26). In addition, Petrino et al. highlighted that most health professionals identify the ED as an environment with specific safety issues. The main factors appeared to be a shortage of personnel during busy periods, overcrowding due to boarding, and a perceived lack of support from hospital management (26).

Clear differences emerged between staff functions. Head nurses reported the highest positive scores across nearly all dimensions, especially in teamwork (D03), communication openness (D04), and management support (D08). Nurse aides reported the highest outcome scores, including overall safety perception and event reporting, while nurses consistently scored the lowest. These role-based discrepancies may reflect differences in hierarchical perspective, leadership involvement, and reporting expectations. Taylor et al. (2015) emphasized that frontline staff, such as nurses, often

have less influence on organizational decisions and may experience greater disillusionment with safety processes (27).

This study has several limitations. First, participation varied considerably across the measurement periods, with only Flemish hospitals participating in the most recent years (2020–2024). This limits the generalizability of the findings to the entire Belgian hospital landscape, as no data were collected from hospitals in Brussels or Wallonia during these periods. The number of participating hospitals and respondents varied greatly over time. Due to the COVID-19 pandemic there is a particularly low participation in the last two measurement periods. This reduces the robustness of the trend analysis in recent years.

Second, this study relied entirely on self-reported perceptions using the Hospital Survey on Patient Safety Culture (HSPSC). While the HSPSC is a validated instrument, it measures staff perceptions rather than objective patient safety outcomes. This makes the findings susceptible to response bias and limits the ability to confirm whether improvements in perceptions translate into actual improvements in patient outcomes. Furthermore, the analysis focused on broad trends without evaluating the effectiveness of specific interventions implemented in individual hospitals. Although improvements were observed over time, the study design does not allow for conclusions about which safety improvement strategies or management practices were most effective.

While multivariable analyses controlled for staff function, department and experience, other potentially important factors—such as hospital size, patient complexity, leadership style, resource availability, and staff training programs—were not examined. This limits the understanding of how these organizational factors may have influenced patient safety culture.

Based on the findings and limitations of this study, several recommendations can be made. First, efforts should be directed toward ensuring broader and more consistent participation of hospitals across all Belgian regions, including Brussels and Wallonia. This would strengthen the representativeness of patient safety culture assessments on a national level. Furthermore, the structural and cultural barriers identified in emergency departments, particularly related to staffing shortages, lack of management support, and limited openness in communication, require targeted interventions. Hospital leadership should prioritize the development of supportive management practices and promote a nonpunitive safety culture that encourages open reporting and learning from errors, especially in departments that consistently report lower safety perceptions. To support continuous improvement, it is essential that hospitals maintain regular participation in safety culture assessments over time. Sustained participation would allow for meaningful longitudinal analyses and enable benchmarking across multiple measurement periods.

Conclusion

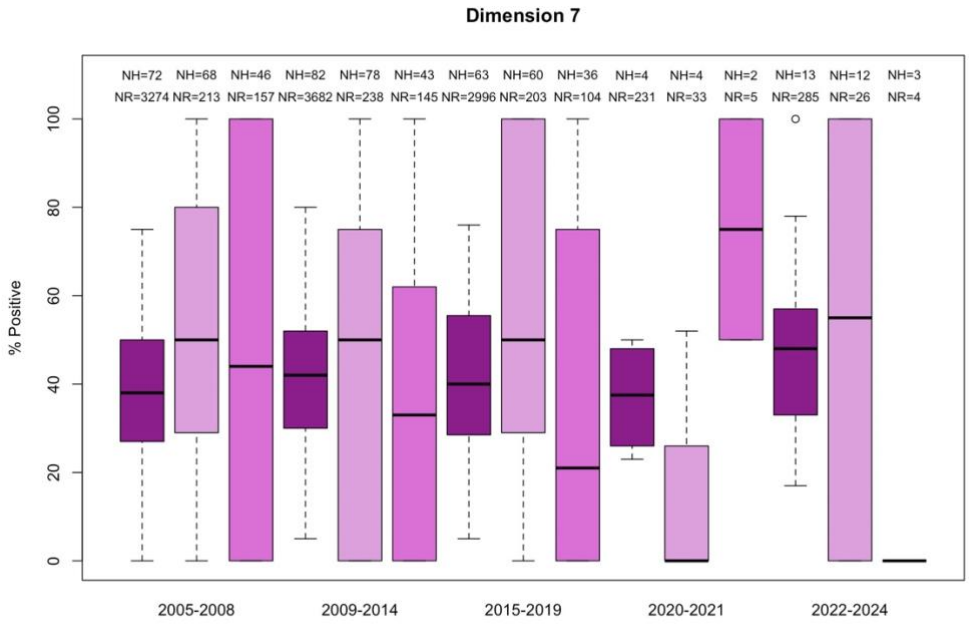
This study showed that the patient safety culture in Belgian acute care hospitals has generally improved in intensive care units and emergency departments over the past two decades. Positive evolutions were observed in several dimensions, such as management support, supervisor expectations, and communication about errors. Nevertheless, the results indicate that certain dimensions, including nonpunitive response to error and staffing, remain areas of concern with relatively low scores. Differences between departments were observed, with intensive care units reporting more favorable safety perceptions compared to emergency departments. Additionally, differences were found between professional roles, with head nurses and nurse aides reporting more positive perceptions than nurses. These findings provide insight into the evolution of safety culture in Belgian hospitals and highlight areas that may require further attention in future improvement efforts.

References

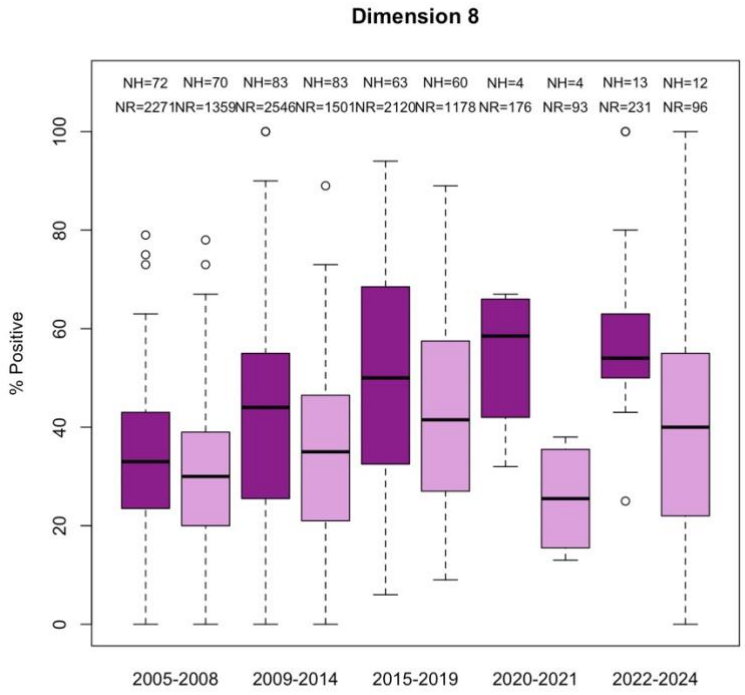
1. World Health Organisation Patient Safety 2023 [Available from: https://www.who.int/health-topics/patient-safety#tab=tab_1.
2. Azyabi A, Karwowski W, Davahli MR. Assessing Patient Safety Culture in Hospital Settings. Int J Environ Res Public Health. 2021;18(5).
3. Vincent C. Patient Safety: 2nd edition. Patient Safety: 2nd edition. 2010.
4. Mitchell PH. Advances in Patient Safety
Defining Patient Safety and Quality Care. In: Hughes RG, editor. Patient Safety and Quality: An Evidence-Based Handbook for Nurses. Rockville (MD): Agency for Healthcare Research and Quality (US); 2008.
5. Alsalem G, Bowie P, Morrison J. Assessing safety climate in acute hospital settings: a systematic review of the adequacy of the psychometric properties of survey measurement tools. BMC Health Serv Res. 2018;18(1):353.
6. Vlayen A, Hellings J, Barrado LG, Haelterman M, Peleman H, Schrooten W, et al. Evolution of patient safety culture in Belgian acute, psychiatric and long-term care hospitals. Safety in Health. 2015;1(1):2.
7. Pronovost P, Needham D, Berenholtz S, Sinopoli D, Chu H, Cosgrove S, et al. An intervention to decrease catheter-related bloodstream infections in the ICU. N Engl J Med. 2006;355(26):2725-32.
8. Donchin Y, Gopher D, Olin M, Badihi Y, Biesky M, Sprung CL, et al. A look into the nature and causes of human errors in the intensive care unit. Crit Care Med. 1995;23(2):294-300.
9. Huang DT, Clermont G, Kong L, Weissfeld LA, Sexton JB, Rowan KM, et al. Intensive care unit safety culture and outcomes: a US multicenter study. Int J Qual Health Care. 2010;22(3):151-61.
10. Singer SJ, Gaba DM, Falwell A, Lin S, Hayes J, Baker L. Patient safety climate in 92 US hospitals: differences by work area and discipline. Med Care. 2009;47(1):23-31.
11. de Lima Silva Nunes R, de Camargo Silva AEB, de Lima JC, Carvalho DE, Bernardes CA, Sousa TP, et al. Factors influencing the patient safety climate in intensive care units: cross-sectional study. BMC Nurs. 2021;20(1):125.
12. Aiken LH, Clarke SP, Sloane DM, Sochalski J, Silber JH. Hospital nurse staffing and patient mortality, nurse burnout, and job dissatisfaction. Jama. 2002;288(16):1987-93.
13. Institute of Medicine Committee on Quality of Health Care in A. In: Kohn LT, Corrigan JM, Donaldson MS, editors. To Err is Human: Building a Safer Health System. Washington (DC): National Academies Press (US)
Copyright 2000 by the National Academy of Sciences. All rights reserved.; 2000.
14. Flin R, Burns C, Mearns K, Yule S, Robertson EM. Measuring safety climate in health care. Qual Saf Health Care. 2006;15(2):109-15.
15. Recio-Saucedo A, Pope C, Dall'Ora C, Griffiths P, Jones J, Crouch R, et al. Safe staffing for nursing in emergency departments: evidence review. Emergency Medicine Journal. 2015;32(11):888-94.
16. West E, Barron DN, Harrison D, Rafferty AM, Rowan K, Sanderson C. Nurse staffing, medical staffing and mortality in Intensive Care: An observational study. International Journal of Nursing Studies. 2014;51(5):781-94.
17. Hsu Y-J, Chang BH, Thompson DA, Marsteller JA. Impact of Nursing Staffing on Patient Outcomes in Intensive Care Unit. The journal of nursing care. 2013;2:1-6.
18. Needleman J, Buerhaus P, Mattke S, Stewart M, Zelevinsky K. Nurse-staffing levels and the quality of care in hospitals. N Engl J Med. 2002;346(22):1715-22.
19. Rogers AE, Hwang WT, Scott LD, Aiken LH, Dinges DF. The working hours of hospital staff nurses and patient safety. Health Aff (Millwood). 2004;23(4):202-12.
20. Vlayen A, Hellings J, Claes N, Abdou EA, Schrooten W. Measuring safety culture in belgian psychiatric hospitals: validation of the dutch and French translations of the hospital survey on patient safety culture. J Psychiatr Pract. 2015;21(2):124-39.
21. Sorra J FT, Dyer N, Nelson D, Khanna K. Hospital Survey on Patient Safety Culture: 2012 User Comparative Database Report. Agency for Healthcare Research and Quality (US); 2012. Report No.: AHRQ Publication No. 12-0017.
22. Singer S, Lin S, Falwell A, Gaba D, Baker L. Relationship of safety climate and safety performance in hospitals. Health Serv Res. 2009;44(2 Pt 1):399-421.
23. Wagner LM, Capezuti E, Rice JC. Nurses' perceptions of safety culture in long-term care settings. J Nurs Scholarsh. 2009;41(2):184-92.
24. Halligan M, Zecevic A. Safety culture in healthcare: a review of concepts, dimensions, measures and progress. BMJ Qual Saf. 2011;20(4):338-43.

25. Drennan J, Murphy A, McCarthy VJC, Ball J, Duffield C, Crouch R, et al. The association between nurse staffing and quality of care in emergency departments: A systematic review. Int J Nurs Stud. 2024;153:104706.
26. Petrino R, Tuunainen E, Bruzzone G, Garcia-Castrillo L. Patient safety in emergency departments: a problem for health care systems? An international survey. Eur J Emerg Med. 2023;30(4):280-6.
27. Taylor JA, Dominici F, Agnew J, Gerwin D, Morlock L, Miller MR. Do nurse and patient injuries share common antecedents? An analysis of associations with safety climate and working conditions. BMJ Qual Saf. 2012;21(2):101-11.

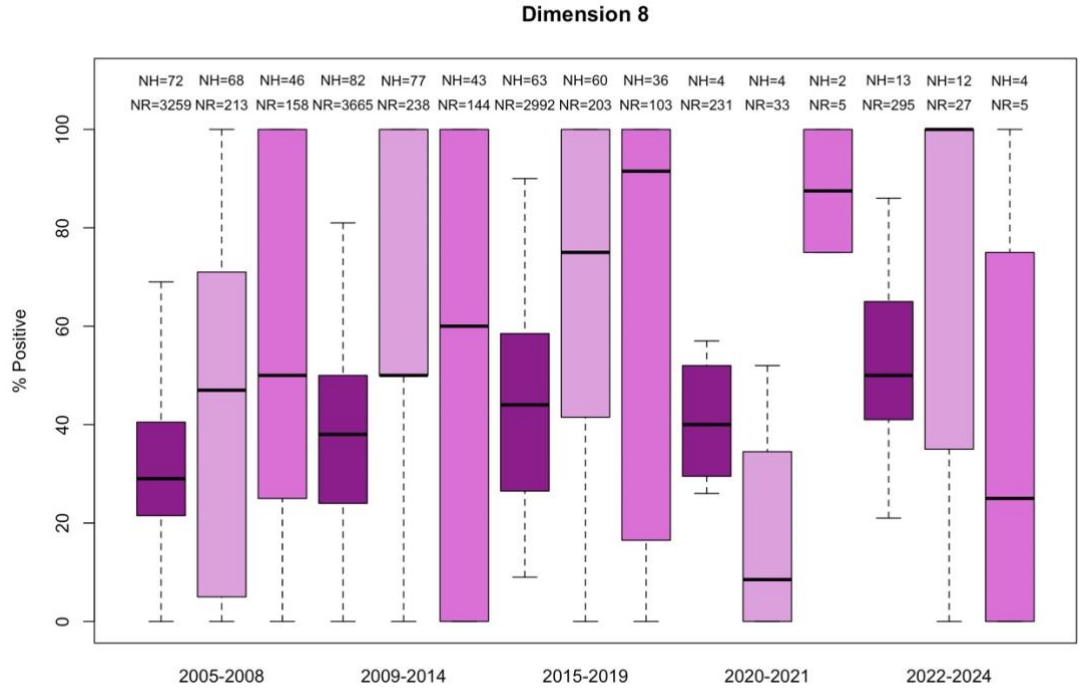
Additional files



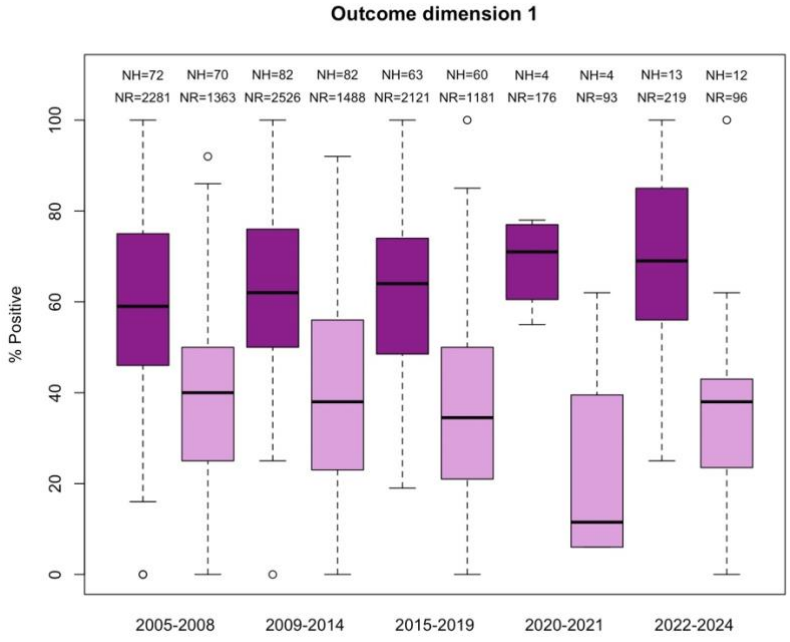
Supplemental figure 1 Evolution of positive dimensional scores regarding staffing (Dimension 7) for head nurses (light purple), nurses (dark purple) and nurse aids (purple) across different time periods in Belgian acute hospitals (2005–2024). NH = number of hospitals, NR = number of respondents.



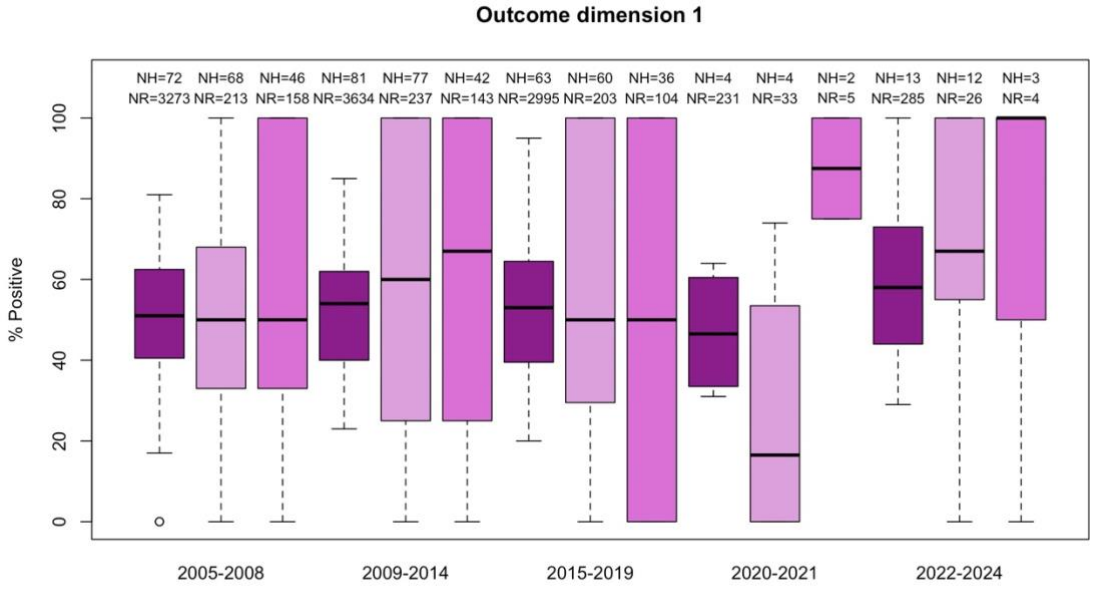
Supplemental figure 2 Evolution of positive dimensional scores regarding management (Dimension 8) for ICU (dark purple) versus the ED (light purple) across different time periods in Belgian acute hospitals (2005–2024). NH = number of hospitals, NR = number of respondents.



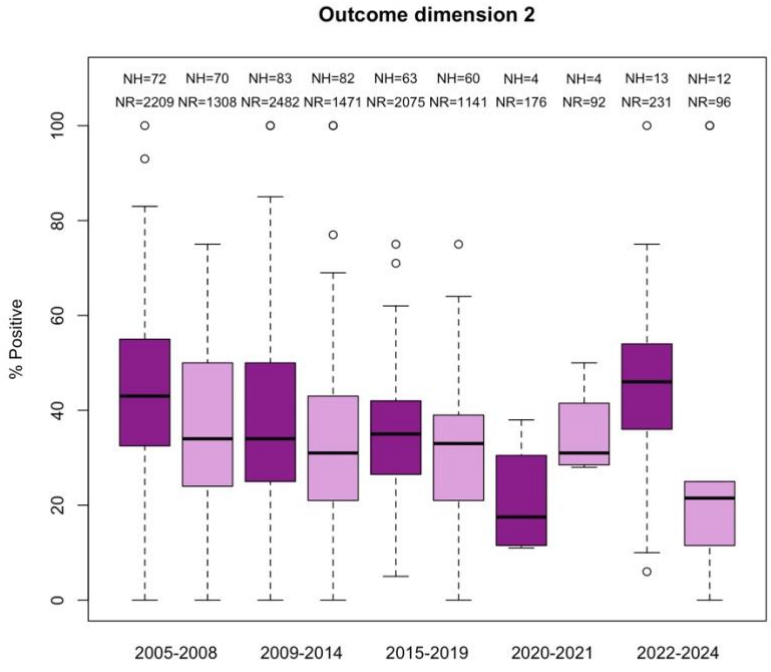
Supplemental figure 3 Evolution of positive dimensional scores regarding management (Dimension 8) for head nurses (light purple), nurses (dark purple) and nurse aids (purple) across different time periods in Belgian acute hospitals (2005–2024). NH = number of hospitals, NR = number of respondents.



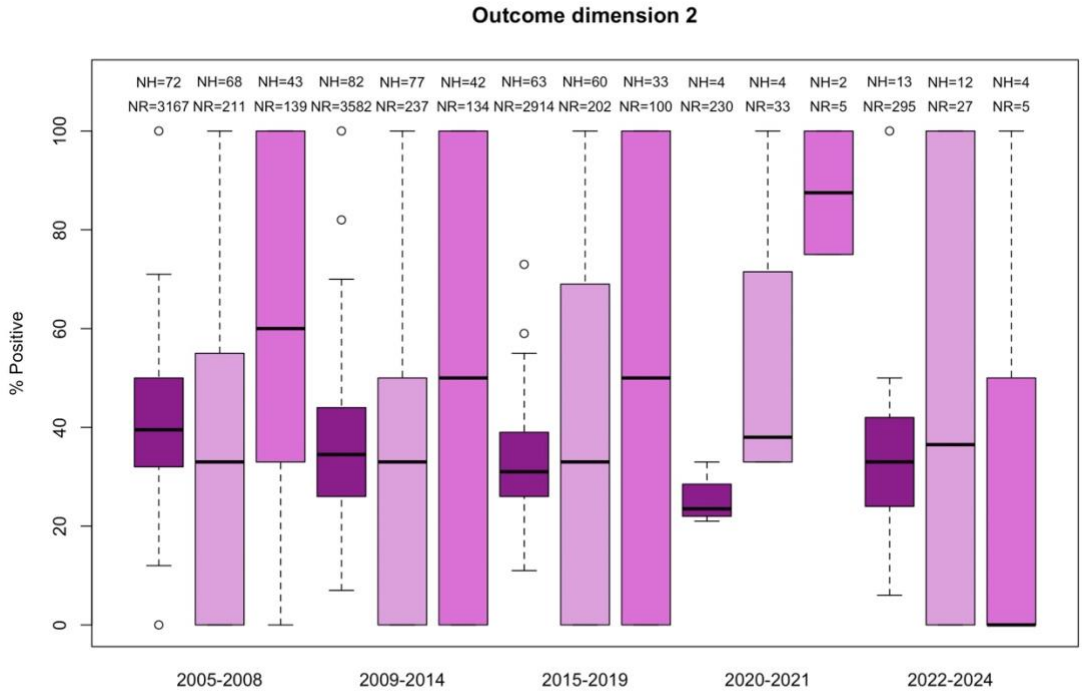
Supplemental figure 4 Evolution of positive dimensional scores regarding overall perception of patient safety (Outcome Dimension 1) for ICU (dark purple) versus the ED (light purple) across different time periods in Belgian acute hospitals (2005–2024). NH = number of hospitals, NR = number of respondents.



Supplemental figure 5 Evolution of positive dimensional scores regarding overall perception of patient safety (Outcome Dimension 1) for head nurses (light purple), nurses (dark purple) and nurse aids (purple) across different time periods in Belgian acute hospitals (2005–2024). NH = number of hospitals, NR = number of respondents.



Supplemental figure 6 Evolution of positive dimensional scores regarding overall frequency of event reporting (Outcome Dimension 2) for ICU (dark purple) versus the ED (light purple) across different time periods in Belgian acute hospitals (2005–2024). NH = number of hospitals, NR = number of respondents.



Supplemental figure 7 Evolution of positive dimensional scores regarding frequency of event reporting (Outcome Dimension 2) for head nurses (light purple), nurses (dark purple) and nurse aids (purple) across different time periods in Belgian acute hospitals (2005–2024). NH = number of hospitals, NR = number of respondents.