

Development, validation, and results of a national endoscopy safety attitudes questionnaire (Endo-SAQ)



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ABSTRACT

Background and study aims Safety attitudes are linked to patient outcomes. The Joint Advisory Group on Gastrointestinal Endoscopy (JAG) identifies the need to improve our understanding of safety culture in endoscopy. We describe the development and validation of the Endo-SAQ (endoscopy safety attitudes questionnaire) and the results of a national survey of staff attitudes.

Methods Questions from the original SAQ were adapted to reflect endoscopy-specific content. This was refined by an expert group, followed by a pilot study to assess acceptability. The refined Endo-SAQ (comprising 35 questions across six domains) was disseminated to endoscopy staff across the UK and Ireland. Outcomes were domain scores and the percentage of positive responses (score $\geq 75/100$) per domain. Descriptive and comparative analyses were performed. Binary logistic regression identified staff and service factors associated with positive scores. Validity and reliability of Endo-SAQ were assessed through psychometric analysis.

Results After expert review, four questions in the preliminary Endo-SAQ were adjusted. Sixty-one participants undertook the pilot study with good acceptability. A total of 453 participants completed the refined Endo-SAQ. There were positive responses in teamwork, safety climate, job satis-

faction, and working conditions domains. Endoscopists had significantly more positive responses to stress recognition and working conditions than nursing staff. JAG accreditation was associated with positive scores in safety climate and job satisfaction domains. Endo-SAQ met thresholds of construct validity and reliability.

Conclusions Endoscopy staff had largely positive safety attitudes scores but there were significant differences across domains and staff. There is evidence for the validity and reliability of Endo-SAQ. Endo-SAQ could complement current measures of patient safety in endoscopy and be used in evaluation and research.

Introduction

Safety culture reflects the values, beliefs, attitudes and perceptions of an organization and its members about safety [1]. It is important to understand safety culture as it is inherently linked to patient outcomes and wellbeing [2]. Safety attitudes refer specifically to the perceptions of individuals toward safety. “Low” safety attitudes scores among healthcare staff have been associated with increased rates of patient readmission, length of stay, and adverse events [3]. Conversely over time, “higher” safety attitude scores have been linked to reduced all-patient harm and lower adjusted mortality rates [4]. Within gastrointestinal endoscopy specifically, one group identified a correlation between lower safety attitude scores in nurses and higher rates of error in practice [5]. Measuring safety attitudes appears to improve our understanding of safety culture within organizations. This can help to identify areas to improve upon, as outlined in the National Health Service patient safety strategy [6].

There are a wide range of tools to measure safety attitudes in healthcare: the safety attitudes questionnaire (SAQ) [7], hospital survey on patient safety culture [8], Manchester patient safety culture assessment tool (MaPSaF) [9], and safety climate survey (SCSu) [10]. The SAQ appears to be the most widely used and validated safety attitudes tool [11]. The SAQ consists of questions aligned to six domains: teamwork, safety climate, job satisfaction, stress recognition, perceptions of management, and working conditions. Domains reflect factors that are relevant to safety attitudes. A number of institutions have adapted the SAQ for use in specific circumstances, for example, in different countries and medical speciality types [12, 13, 14, 15, 16].

The Joint Advisory Group on Gastrointestinal Endoscopy (JAG) safety strategy identifies the need to improve our understanding of safety culture in endoscopy [17]. Currently, there is no specific tool to measure safety culture in endoscopy. Such a tool could complement the current quality assurance processes for endoscopy services, including the global rating scale (GRS) and accreditation of endoscopy services [18]. This paper describes development and validation of a novel tool to measure safety attitudes in endoscopy, the Endo-SAQ. In addition, we report outcomes from the first survey of safety attitudes in endoscopy staff from across the UK and Ireland.

Methods

Study design

The study design was informed by similar studies of SAQ adaptation and assessment [7, 12, 13, 14, 15, 16]. Contemporary validity frameworks were used as a theoretical basis for the study design [19]. The study was split into two phases to fully address the research objectives. Phase 1 was a pilot study to develop the Endo-SAQ and assess content validity and acceptability. Phase 2 was a national cross-sectional study using the refined Endo-SAQ to collect responses for analysis of safety attitudes. Psychometric evaluation was used to assess the internal structure and reliability of the tool.

Phase 1: Development of the Endo-SAQ

The previously validated SAQ [7] was used as a framework to construct the Endo-SAQ. Permission was sought to adapt the original SAQ (University of Texas). The SAQ is the most widely used safety culture tool and is short and easy to complete with good replicability [11]. Questions within the SAQ were adapted by the core research team to reflect endoscopy-specific content. Adapted questions were kept within their original domain classifications as outlined previously.

An expert group undertook an independent rating exercise to assess content validity. Experts were defined by those with extensive, national-level experience in safety and quality assurance in endoscopy from both clinical and nursing backgrounds. Experts were asked to score the adapted questions for relevance and clarity on a scale of 1 to 4 (1 = not relevant/clear, 4 = very relevant/very clear). The Content Validity Index (CVI) was calculated at the item level (I-CVI) and scale level (S-CVI). An I-CVI > 0.79 and S-CVI > 0.90 are the accepted thresholds that indicate ‘good’ content validity [20].

A pilot study was conducted in which the Endo-SAQ was administered to all staff at a single tertiary UK endoscopy unit. Outcomes measured were domain scores (calculated out of 100), time to completion, and acceptability as recorded through user comments.

Phase 2: Measuring outcomes and validation of the Endo-SAQ

Following the pilot, the refined Endo-SAQ was distributed across the UK and Ireland (see online supplementary file). The survey was hosted on a dedicated online platform (Qualtrics XM) and a link sent electronically to all JAG-registered endoscopy services and members of the British Society of Gastroenterology (BSG) and BSG Nurses Association (BSGNA). Each organization advertised the survey, including open advertisement

on social media platforms. Any individual who worked within an endoscopy unit was eligible to participate, with no relevant predefined exclusion criteria. Two rounds of advertising were conducted to promote survey uptake, as well as financial incentives for completion. As this was an open survey, sampling was conducted on a voluntary response basis. The survey period was 10 weeks.

Outcome measures were mean domain scores and percentage of positive responses (PPR) per domain (defined as percentage of domain scores ≥ 75) as per the original SAQ [7]. Psychometric outcomes were related to construct validity, including convergent and divergent validity, and reliability measures as described below.

Statistical analysis

Sample size

The estimated total workforce of UK endoscopy is 21,500 [21]. Based on this and accepting a confidence level of 95% and 5% margin of error, the estimated sample size required was 378 [22]. This sample number would theoretically be representative of the endoscopy workforce.

Domain ratings and scores

A complete case analysis approach was used. Baseline demographic variables were subject to descriptive statistics. Ratings are presented as mean and standard deviation (SD) as per the custom for SAQ analysis. Friedman's test was used to assess differences across domain scores and post-hoc comparisons performed using Wilcoxon signed-rank tests. Binary logistic regression, using a forward selection method, was performed to identify factors related to positive score results. Independent variables entered into the analysis were based on factors that may have relationship with positive scores. Final model results are presented as odds ratios (ORs) and 95% confidence intervals (CI). Staff subgroup analyses were performed using Kruskal-Wallis test with post-hoc pairwise comparisons subject to the Bonferroni correction. This adjusts *P* values to control for the family-wise error rate (probability of at least one type 1 error) where multiple comparisons were made on the same groups. Statistical significance is indicated by *P* < 0.05 unless otherwise stated.

Psychometric analysis

Confirmatory factor analysis (CFA) was conducted as a measure of construct validity to assess the relationship between variables (question items) and factors (domains) in a predetermined factor structure. Model goodness-of-fit, which assesses consistency of this relationship, is presented as the Comparative Fit Index (CFI), Tucker-Lewis-Index (TLI), Standardized Root Mean Square Residual (SRMR) and Root Mean Square Error of Approximation (RMSEA) [23]. Factor loadings for each variable were also calculated as part of CFA. These represent the specific correlations between variables and factors. The average variance extracted (AVE) was calculated based on factor loadings. AVE is a measure of how much variation in variables is due to the related factor and used as a marker of convergent

validity [24]. Pearson's correlation coefficient was used to assess relationship between factors. The square root of a factor's AVE ($\sqrt{\text{AVE}}$) was used as a marker of discriminant validity ($\sqrt{\text{AVE}}$ should be greater than the correlation between the factor and any other factor). Reliability analysis included Cronbach's alpha and composite reliability (CR). Ceiling and floor effects were calculated as the percentage of participants who rated all items in a domain at maximum scores (ceiling) or minimum scores (floor).

All statistical calculations were performed using SPSS v25 (IBM, Armonk, New York, United States) and MPlus v8.6 (Muthen & Muthen, Los Angeles, California, United States).

Ethics statement

This study conforms to standards of care to survey participants as set out in the Helsinki Declaration. Data were anonymized and responses could not be attributed to an individual or specific service. This study was registered as a service evaluation with London North West Healthcare research and development department (SE19.031_ARC).

Results

Phase 1

The preliminary Endo-SAQ consisted of 36 question items split into six domains. Domains were unchanged from the original SAQ. Five independent expert raters (three endoscopists, one clinical endoscopist and one senior nurse) scored items for clarity and relevance. Four items had an I-CVI < 0.79, indicating the need for revision and resulting in question rewording. Additionally, one item was removed on review of experts' comments. Overall, S-CVI for both clarity and relevance was > 0.90 (see online supplementary file).

Overall, 61 participants completed the pilot survey (completion rate 88.4%). All domain scores were over 60 (out of 100). The PPR per domain varied, with "perception of management" and "working conditions" both scoring < 40. The median survey completion time was six minutes (IQR 4–9). Responses from participants were generally favorable with comments supporting the importance of questions and ease of use. Lack of anonymity was raised in one comment (participants were asked to provide email addresses for prize draw) and therefore the format of the survey was changed to address this.

Phase two

Demographics

In total, 516 participants accessed the Endo-SAQ of whom 453 completed all questions (completion rate of 87.8%). ► **Table 1** shows the breakdown of participant characteristics.

Domain ratings and scores

Mean domain rating and scores were calculated. The higher a rating or score, the more positive the response e.g., higher job satisfaction. The PPR was additionally calculated for each domain. ► **Table 2** summarizes these findings.

► **Table 1** Participant and service characteristics by number and percentage (within each demographic category).

Category	N (%)
Sex	
Male	153 (33.8)
Female	297 (65.6)
Non-binary/third gender	1 (0.2)
Prefer not to say	2 (0.4)
Age	
18–24	5 (1.1)
25–34	58 (12.8)
35–44	122 (26.9)
45–54	157 (34.7)
55–64	98 (21.6)
65 and older	13 (2.9)
Years in role	
<6 months	21 (4.6)
6 to 11 months	28 (6.2)
1 to 2 years	69 (15.2)
3 to 4 years	69 (15.2)
5 to 10 years	107 (23.6)
11 to 20 years	101 (22.3)
21 years or more	58 (12.8)
Role	
Administrator/non-clinical manager	34 (7.5)
Decontamination Technician	3 (0.7)
Endoscopist–Clinical (including nurse)	55 (12.1)
Endoscopist–Consultant	125 (27.6)
Endoscopist–Medical Trainee	15 (3.3)
Endoscopist–Other	9 (2)
Endoscopist–Surgical Trainee	4 (0.9)

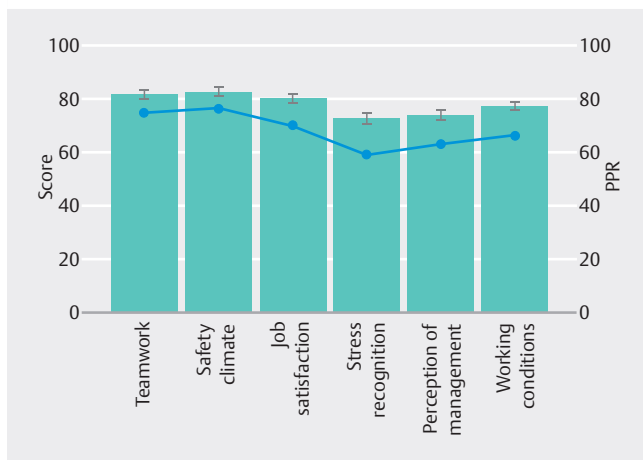
► **Table 1** (Continuation)

Category	N (%)
Endoscopy Nurse	141 (31.1)
Healthcare Assistant	18 (4)
Other	37 (8.2)
Porter	1 (0.2)
Bowel Cancer Screening Practitioner	11 (2.4)
Sector	
NHS/public sector	421 (92.9)
Independent/private sector	32 (7.1)
Work in Bowel Cancer Screening* service?	
Yes	373 (82.3)
Work in JAG accredited service?	
Yes	367 (81.0)
Region	
East Midlands	27 (6)
East of England	38 (8.4)
Greater London	78 (17.2)
North East	39 (8.6)
North West	48 (10.6)
Northern Ireland	18 (4)
Republic of Ireland	14 (3.1)
Scotland	13 (2.9)
South East	40 (8.8)
South West	37 (8.2)
Wales	25 (5.5)
West Midlands	52 (11.5)
Yorkshire and the Humber	24 (5.3)

*In the UK and Ireland, Bowel Cancer Screening services are those that provide an accredited screening service for bowel cancer

► **Table 2** Domains by mean ratings, calculated score (out of 100) and percentage of positive responses (PPR)

Domain	Rating (mean ± SD)	Calculated score (mean ± SD)	PPR (%)
Teamwork	4.28 ± 0.78	81.92 ± 19.47	75.70
Safety climate	4.31 ± 0.72	82.84 ± 17.97	77.30
Job satisfaction	4.21 ± 0.81	80.19 ± 20.22	72.85
Stress recognition	3.91 ± 0.89	72.83 ± 22.20	59.82
Perception of management	3.96 ± 0.93	74.08 ± 23.25	62.30
Working conditions	4.1 ± 0.67	77.52 ± 16.81	66.00



► **Fig. 1** Dual axes plot of mean domain scores (bars) and percentage of positive responses (PPR; black dots and line) for each domain.

The highest rated domain was safety climate (mean score 82.84; PPR 77.30) and lowest rated domain was stress recognition (mean score 72.83; PPR 59.82). Variation in domain scores is demonstrated in ► **Fig. 1**.

There was a statistically significant difference in domain scores across all domains ($\chi^2(5) = 182.5, P < 0.001$). Post-hoc analysis highlighted significant differences in scores across all domains except between teamwork and safety climate ($P = 0.059$) and stress recognition and perception of management ($P = 0.489$). To understand these differences further, a breakdown of mean ratings per question was reviewed. ► **Table 3** shows the mean rating per question with results in order of highest to lowest rating per domain.

The three lowest rated questions (mean < 3.50) were related to staffing levels, morale in the endoscopy unit and frequency of communication breakdowns and subsequent delays in care.

Logistic regression

Binary logistic regression was carried out to identify staff and service factors associated with positive scores (defined as score ≥ 75) in each domain. Job role was refined into three subcategories: endoscopists, nursing roles including healthcare assistants and non-clinical staff (administrators, porters and decontamination technicians) to carry out the analysis. Independent variables in this model were service factors: region, sector, presence of bowel cancer screening (BCS), JAG accreditation status and staff factors: gender, role, age, and years in role. An overview of results can be seen in ► **Table 4**.

In terms of service factors, JAG accreditation was associated with positive scores in safety climate (OR 1.92, CI 1.13–3.27, $P = 0.02$) and job satisfaction (OR 2.09, CI 1.27 – 3.46, $p = 0.004$) domains. Region was a significant factor in teamwork ($p = 0.03$) and perception of management domains ($P = 0.01$). There was no impact of sector type or presence of BCS on scores. The endoscopist role was associated with positive scores in the stress recognition domain (OR 2.23, CI 1.12–4.46, $P = 0.02$) compared to non-clinical roles. Female sex was associated with

lower domain scores (rated items lower) in teamwork (OR 0.57, CI 0.34–0.95, $P = 0.03$), safety climate (OR 0.51, CI 0.31–0.85, $P = 0.01$), job satisfaction (OR 0.63, CI 0.39–0.99, $P = 0.047$) and working conditions (OR 0.35, CI 0.22–0.55, $P < 0.001$) domains. There was no effect of participant age or years in role.

Staff subgroup analysis

Staff were split into three subcategories: endoscopists, nursing roles including healthcare assistants, and non-clinical staff (administrators, porters etc.) to carry out subgroup analysis. Domain scores and PPR were assessed between these groups (► **Table 5**).

Post-hoc pairwise testing identified endoscopists scored items in the safety climate domain higher than non-clinical staff (PPR 81.5% vs 65.0%; $P = 0.04$) as well as stress recognition (PPR 67.8% vs 50.0%; $P = 0.01$). Endoscopists also rated items significantly higher than nursing staff in stress recognition (PPR 67.8% vs 53.7%; $P = 0.02$) and working conditions (PPR 72.0% vs 57.5%; $P = 0.03$).

Psychometric analysis

Confirmatory factor analysis The structure of Endo-SAQ is formed from a combination of question items (variables) and predefined domains (factors) based on the original SAQ. The first step of CFA is to assess how well this model fits. Generally, good model fit indicates variables correlate well with factors. ► **Table 6** shows goodness-of-fit information for this model.

All tests of model fit met generally accepted thresholds [23, 25, 26], indicating that the question items of Endo-SAQ are reflected appropriately in the domains they are assigned to. This was verified by reviewing factor loadings and AVE within the model. All factor loadings in this model were > 0.5 and significant ($P < 0.05$), the calculated AVE was > 0.5 for all factors, which is considered acceptable [27] (see online supplementary file for further detail including assessment of discriminant validity).

Internal consistency All Endo-SAQ domains scored 'acceptable' or above based on Cronbach's alpha (> 0.8) and CR (> 0.7).

Ceiling and floor effects Ceiling effects were noted across teamwork (23.2%), safety climate (19.4%), job satisfaction (16.8%), and perception of management (15.5%) domains, which were all above the proposed threshold of 15% [28]. No floor effects were observed.

Discussion

Key findings

The Endo-SAQ is the first survey of safety attitudes across the endoscopy workforce in the UK and Ireland. Overall, the results suggest largely positive safety attitudes of staff with four of six domains having mean scores above 75. However, there were significant differences between domain scores, indicating variability in perceptions of safety.

Teamwork and safety climate were the highest rated domains and closely linked with no significant difference in scores. Overall, there were positive perceptions about overt patient safety issues reflecting the increasing awareness of endos-

► **Table 3** Mean rating per question in order from highest to lowest per domain.

Domain	Item no	Question	Rating (mean ± SD)
Teamwork	3	I have the support I need from other colleagues to care for patients	4.46 ± 0.86
	4	It is easy for staff here to ask questions when there is something that they do not understand	4.44 ± 0.87
	1	In this endoscopy unit, it is difficult to speak up if I perceive a problem with patient care*	4.26 ± 1.16
	2	Disagreements in this endoscopy unit are addressed appropriately (i. e. not who is right, but what is best for the patient)	4.12 ± 1.13
	5	The endoscopy staff members here work together as a well-coordinated team	4.11 ± 1.06
Safety climate	8	I know how and where to direct questions regarding patient safety in this endoscopy unit	4.65 ± 0.74
	6	I would feel safe being treated here as a patient	4.62 ± 0.75
	7	Patient safety issues are handled appropriately in this endoscopy unit	4.47 ± 0.88
	11	I am encouraged by my colleagues to report any patient safety concerns I may have	4.39 ± 0.94
	13	My suggestions about patient safety would be discussed and acted upon if I expressed them to senior staff	4.25 ± 0.98
	12	The culture in this endoscopy unit encourages learning from the errors of others	4.19 ± 1.05
	9	I receive appropriate feedback about my performance	4.11 ± 1.09
	10	In this endoscopy unit, it is difficult to discuss errors openly*	3.82 ± 1.34
Job satisfaction	17	I am proud to work in this endoscopy unit	4.49 ± 0.87
	14	I like my job	4.48 ± 0.84
	15	Working here is like being part of a large team	4.31 ± 0.98
	16	This is a good place to work	4.31 ± 0.95
	18	Morale in this endoscopy unit is high	3.45 ± 1.21
Stress recognition	20	I am less effective at work when fatigued	4.17 ± 0.93
	21	I am more likely to make errors in tense or hostile situations	4.00 ± 1.13
	19	If my workload becomes excessive, my performance is impaired	3.88 ± 1.04
	22	Fatigue impairs my performance during emergency/high-demand situations	3.59 ± 1.18
Perception of management	24	Endoscopy unit management doesn't knowingly compromise patient safety	4.27 ± 1.12
	25	Endoscopy unit management is doing a good job	3.96 ± 1.16
	23	Endoscopy unit management supports my daily efforts	3.96 ± 1.11
	26	Colleagues in difficulty are dealt with constructively by our endoscopy unit	3.90 ± 1.11
	27	I get adequate, timely info about events that might affect my work, from endoscopy unit management	3.74 ± 1.20
Working conditions	32	I experience good working relationships with nurses in this endoscopy unit	4.60 ± 0.71
	34	I experience good working relationships with other staff in this endoscopy unit	4.57 ± 0.75
	33	I experience good working relationships with endoscopists in this endoscopy unit	4.50 ± 0.75
	31	All trainees/students in my discipline (e. g. endoscopy, nursing, admin, porter, decon) are adequately supervised	4.25 ± 0.99
	30	All the necessary information for cases is routinely available to me	4.14 ± 1.00
	29	This endoscopy unit does a good job of training new staff	3.91 ± 1.14
	35	Communication breakdowns that lead to delays in delivery of care are common*	3.49 ± 1.30
	28	The levels of staffing in this endoscopy unit are sufficient to handle the number of patients	3.34 ± 1.36

*Questions are negatively phrased and therefore ratings were reverse scored in order to be comparable to other questions on a positive scale.

► **Table 4** Binary logistic regression using forward selection method to identify factors associated with positive scores for each domain. The variables included in the final models for each domain are displayed with odds ratios (OR) and 95% CI.

Domain	Variables in final model	OR (95% CI)	P value
Teamwork	<i>Region</i>		0.03
	East Midlands	REF	
	East of England	0.06 (0.01–0.47)	
	Greater London	0.12 (0.02–0.95)	
	North East	0.10 (0.01–0.86)	
	North West	0.19 (0.02–1.59)	
	Northern Ireland	0.03 (0.003–0.26)	
	Republic of Ireland	0.12 (0.01–1.17)	
	Scotland	0.08 (0.01–0.86)	
	South East	0.23 (0.03–2.02)	
	South West	0.18 (0.02–1.56)	
	Wales	0.13 (0.01–1.13)	
	West Midlands	0.34 (0.04–2.98)	
	Yorkshire and the Humber	0.07 (0.01–0.63)	
	<i>Gender</i>		
Female	0.57 (0.34–0.95)	0.03	
Safety climate	<i>JAG accredited?</i>		
	Yes	1.92 (1.13–3.27)	0.02
	<i>Gender</i>		
Female	0.51 (0.31–0.85)	0.01	
Job satisfaction	<i>JAG accredited?</i>		
	Yes	2.09 (1.27–3.46)	0.04
	<i>Gender</i>		
Female	0.63 (0.39–0.99)	0.047	
Stress recognition	<i>Role</i>		0.01
	Admin	REF	
	Nursing	1.22 (0.62–2.43)	0.57
	Endoscopist	2.23 (1.12–4.46)	0.02
Perception of management	<i>Region</i>		0.02
	East Midlands	REF	
	East of England	0.17 (0.05–0.60)	
	Greater London	0.22 (0.07–0.70)	
	North East	0.20 (0.06–0.70)	
	North West	0.37 (0.11–1.26)	
	Northern Ireland	0.09 (0.02–0.37)	
	Republic of Ireland	0.64 (0.12–3.36)	
	Scotland	0.28 (0.06–1.30)	
	South East	0.49 (0.14–1.76)	
	South West	0.26 (0.07–0.89)	
	Wales	0.26 (0.07–0.99)	
	West Midlands	0.52 (0.15–1.79)	
Yorkshire and the Humber	0.17 (0.05–0.66)		
Working conditions	<i>Gender</i>		
	Female	0.35 (0.22–0.55)	<0.001

► **Table 5** Domain scores and percentage of positive responses for different staff subgroups. SD = standard deviation, PPR = percentage of positive responses.

Domain		Staff subgroups			P value
		Non-clinical (n = 40)	Nursing (n = 201)	Endoscopists (n = 211)	
Teamwork	Mean Score ± SD	78.88 ± 19.10	80.15 ± 21.86	84.10 ± 16.78	0.26
	PPR (%)	77.5	69.7	81.0	–
Safety climate	Mean Score ± SD	78.44 ± 18.55	81.30 ± 19.00	85.06 ± 16.57	0.02
	PPR (%)	65.0	75.1	81.5	–
Job satisfaction	Mean Score ± SD	75.63 ± 26.87	79.25 ± 20.61	81.85 ± 18.23	0.50
	PPR (%)	72.5	68.7	76.8	–
Stress recognition	Mean Score ± SD	65.63 ± 23.17	70.93 ± 22.37	76.18 ± 21.31	0.002
	PPR (%)	50.0	53.7	67.8	–
Perception of management	Mean Score ± SD	74.88 ± 25.03	73.46 ± 24.97	74.41 ± 21.21	0.75
	PPR (%)	70.0	62.2	60.7	–
Working conditions	Mean Score ± SD	74.9 ± 17.13	74.36 ± 18.8	80.98 ± 13.90	0.002
	PPR (%)	57.5	61.2	72.0	–

► **Table 6** Model fit information for Endo-SAQ. Accepted thresholds for each test are included for interpretation.

Goodness-of-fit (tests of model fit)	Value	Accepted threshold
Comparative Fit Index (CFI)	0.97	> 0.95
Tucker-Lewis-Index (TLI)	0.97	> 0.95
Standardised Root Mean Square Residual (SRMR)	0.045	< 0.05
Root Mean Square Error of Approximation (RMSEA)	0.049	< 0.05
90% CI for RMSEA	0.045, 0.053	
Probability RMSEA ≤ .05	0.67	> 0.05

copy staff toward incident reporting, checklist completion, and learning from safety incidents [29]. Job satisfaction was also rated highly (mean score 80.19, PPR 72.85%), with participants acknowledging pride in working in their units and liking their job. Scores related to working conditions as well as supervision reflected positive perceptions of working relationships among staff. Conversely, stress recognition (mean score 72.83, PPR 59.82%) and perception of management (mean score 74.08, PPR 62.30%) were the lowest rated domains. Question items that scored the least in each domain reflected issues around staffing, communication breakdown, receiving information from management, ability to openly discuss errors, management of colleagues in difficulty, the awareness of stress on performance, and morale. These are areas for potential improvement; however, no item had overall negative perceptions (rating of 1 or 2 on 5-point Likert scale).

It is interesting to note that Endo-SAQ participants had higher domain scores than those in the original SAQ study [7]. Here, domain scores were less than 75 in all domains across the six

SAQ versions used. In addition, domain scores observed in subsequent SAQ studies of operating theater, maternity, acute medical unit, and generic healthcare staff were lower than those in our study (see online supplementary file). There are limitations of comparing scores across specialty types but these data do provide some context to our results and may reflect the influence JAG has on safety within endoscopy [17].

Staff perceptions

Subgroup analysis identified significant differences in safety attitudes based on staff role type. Endoscopists were more likely to have positive scores in safety climate and stress recognition when compared to non-clinical staff. In addition, they had significantly greater positive responses in the stress recognition and working conditions domains compared to nursing staff. There may be a variety of reasons for this. Training, supervision, and staffing are areas where endoscopists, nursing and non-clinical staff have differing experiences. Nursing staff, for example, may be impacted more by absence, sickness and staffing

issues than other role types [21]. Interestingly, a study of safety attitudes among endoscopy nurses in the United States identified lower stress recognition scores when compared to our nursing group [5]. Clearly perceptions of how a person manages stress and individual stressors will differ between roles. Differences may reflect better awareness of managing high-demand situations in clinical settings compared to non-clinical settings. It is important to note that the burden on all staff has increased, driven by increased activity, particularly in the era of COVID-19 [30]. While there is recognition of the need to support clinical training and maintain quality of endoscopy, the effects on non-clinical staff may not be as well acknowledged.

Service and personal factors

Factors related to an endoscopy service appear to influence safety attitudes. Services that were JAG accredited were over twice as likely to have positive scores in safety climate and job satisfaction domains compared to unaccredited services. Accreditation standards are focused on raising the quality and safety of endoscopy, and therefore, may increase awareness of these issues among an accredited service's staff [18]. Interestingly, there was no effect of BCS status or sector type on scores.

One clear finding was the impact of gender on perceptions of safety. When controlling for other factors including role, female sex was associated with lower scores in teamwork, safety climate, job satisfaction, and working conditions domains. A study of safety attitudes among operating room staff found similar findings, identifying that women had less favorable perceptions of job satisfaction and working conditions than men [31]. The authors surmise that these differences occur due to general attitudinal differences between sexes. These issues need to be studied further but may relate to non-technical skills around leadership and followership, managing hierarchy and effective communication. Differences in attitudes may also be a symptom of pre-existing gender inequality in the workplace. For example, women may feel they have less influence within the endoscopy environment, and therefore, perceive working conditions differently [32]. A key step to reducing gender inequality in endoscopy is acceptance and awareness of it. Female individuals tend to make up the predominant proportion of the wider endoscopy workforce, and therefore, awareness of differences in safety attitudes of endoscopy team members is vital. Development of diversity, equity, and inclusion measures is key to reducing gender inequality. Practical measures may include increased representation in mentorship, a more flexible working environment, engagement in allyship, and promotion of self-advocacy [33].

Psychometric evaluation

Endo-SAQ is based on a multidimensional scale in which question items are grouped into domains that reflect different components of safety attitudes (the overall construct). The results demonstrate good content validity and acceptability following refinement in the pilot study. Based on the CFA, the six-factor model, derived from the original SAQ, demonstrates good model fit [23]. Measures of convergent validity were within acceptable thresholds. The statistical measures of reliability

conducted met accepted thresholds, but high ceiling effects were noted in four of six domains. This has a potential impact on the reliability of results and can contribute to incorrectly represented data. Overall, results of the psychometric analyses suggest acceptable validity and reliability, similar to other studies assessing SAQ adaptation [12, 13, 14, 15, 16].

Strengths and limitations

Implementation of our study design and methodology is justified by similar SAQ studies [12, 13, 14, 15, 16]. In addition, the use of a pilot study to ensure feasibility of a larger study and acceptability to participants is a key strength of our work. However, there are several important limitations in interpreting the data presented. Surveys may be inherently biased through self-selection and non-response. Responses were received from a broad selection of participants; however, only a fraction of the entire endoscopy workforce is represented. This can impact on the generalizability of results. Participation was encouraged through use of an open platform, long response period, and incentives; however, some staff groups did not engage as much as others. This can introduce selection bias, potentially explaining the largely positive outcomes, and limit true "representativeness" of the endoscopy workforce. An alternative approach, for example through direct recruitment of participants, would not have been feasible in this setting. However, future studies involving Endo-SAQ could address this in smaller-scale settings. Finally, despite the guarantee of anonymity, the nature of the questions may have led to sensitivity bias, impacting the reliability of the data.

We acknowledge that not all factors presented within the logistic regression model will have the same causal interpretation. However, our aim was to look at factors that may be associated with positive scores and not necessarily predictive capabilities of individual factors. As such, interpretation of ORs should be performed with caution. Finally, although validity is assessed through a variety of methods, this is limited to the content and internal structure of the Endo-SAQ. Other forms of validity, such as responsiveness to change, were not measured in this study. Future application of the Endo-SAQ should aim to address these areas, for example, through correlation of Endo-SAQ outcomes with other measures of patient safety and unit activity, including complication rates, staffing levels, and procedural volume.

Safety culture in endoscopy: Endo-SAQ in practice

Safety culture sits alongside other facets of patient safety, such as risk management informing safer healthcare systems. Understanding safety culture within endoscopy units may uncover areas of concern that are not otherwise reported. Practically, Endo-SAQ could be integrated into annual endoscopy team surveys and could complement more "traditional" measures of patient safety in endoscopy such as 30-day mortality and incident reviews. Endo-SAQ outcomes could be used as a platform for promoting discussion around strengths and weaknesses within a service to support a variety of improvements through local endoscopy governance processes. Services could also use the Endo-SAQ in evaluating the impact of interventions on safety

over time. The recent SACRED (selection, acceptance, complications, reconnaissance, envelopment and documentation) performance measures are an example of a team-centered intervention [34]. Endo-SAQ could be helpful in evaluating safety interventions such as this over a period of time. From a research perspective, Endo-SAQ could be used to assess safety attitudes internationally, aiming to understand safety attitudes on a global scale.

Conclusions

This study describes the first overview of safety attitudes in the UK and Ireland endoscopy workforce. We have adapted and developed a tool to measure the safety attitudes of endoscopy staff. Staff have generally positive perceptions of safety in endoscopy, but there are areas for potential improvement, particularly understanding impacts of stress and perceptions of management. Endo-SAQ can reliably detect safety attitudes and differences between groups, with evidence supporting its validity. This tool could be used to complement existing quality assurance processes in endoscopy.

Conflict of Interest

HA is Chief Scientific Officer of Pre-emptive Medicine and Health Security at Flagship Pioneering. AD is Executive Chair of Pre-emptive Medicine and Health Security at Flagship Pioneering. SR, MM, SM, ER, MB, PB, MC, MR, HA, CH & STG declare no competing interests.

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