BMJ Open

Risk factors and protective factors of acute postoperative pain: an observational study at a German university hospital with cross-sectional and longitudinal inpatient data

Jenny Riecke ,[1] Simon Felix Zerth ,[1] Ann-Kristin Schubert,[2] Thomas Wiesmann,[3] Hanns-Christian Dinges,[2] Hinnerk Wulf,[2] Christian Volberg[2,4]

To cite: Riecke J, Zerth SF, Schubert A-K, *et al*. Risk factors and protective factors of acute postoperative pain: an observational study at a German university hospital with cross-sectional and longitudinal inpatient data. *BMJ Open* 2023;**13**:e069977. doi:10.1136/bmjopen-2022-069977

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2022-069977).

Received 29 November 2022
Accepted 24 April 2023

[1]Department of Clinical Psychology and Psychotherapy, University of Marburg, Marburg, Germany
[2]Department of Anesthesiology & Intensive Care Medicine, Philipps University Marburg Faculty of Medicine, Marburg, Germany
[3]Diakonie-Klinikum Schwäbisch Hall, Schwäbisch Hall, Germany
[4]Research Group Medical Ethics, University of Marburg, Marburg, Germany

Correspondence to
Dr Christian Volberg;
christian.volberg@uni-marburg.de

ABSTRACT

Objectives Surgical fear is one of the most important psychological risk factors for postoperative pain, but less is known about the contribution of protective factors. This study investigated somatic and psychological risk and resilience factors of postoperative pain and validated the German version of the Surgical Fear Questionnaire (SFQ).

Setting University Hospital of Marburg, Germany.

Design Single-centre observational study and cross-sectional validation study.

Participants Data for validating the SFQ were obtained from a cross-sectional observational study (N=198, mean age 43.6 years, 58.8% female) with persons undergoing different kinds of elective surgery. A sample of N=196 (mean age 43.0 years, 45.4% female) undergoing elective (orthopaedic) surgery was analysed to investigate somatic and psychological predictors of relevant acute postsurgical pain (APSP).

Outcome measures Participants completed preoperative and postoperative assessments at postoperative days 1, 2 and 7. Presurgical pain, age, gender, pain expectation, surgical setting, physical status, anaesthesia, surgical fear, pain catastrophising, depression, optimism and self-efficacy were examined as predictors.

Results Confirmatory factor analysis confirmed the original two-factor structure of the SFQ. Correlation analyses indicated good convergent and divergent validity. Internal consistency (Cronbach's α) was between 0.85 and 0.89. Blockwise logistic regression analyses for the risk of APSP revealed outpatient setting, higher preoperative pain, younger age, more surgical fear and low dispositional optimism as significant predictors.

Conclusions The German SFQ is a valid, reliable and economical instrument with which the important psychological predictor surgical fear can be assessed. Modifiable factors that increase the risk of postoperative pain were higher pain intensity before surgery and being fearful about negative consequences of the surgery whereas positive expectations seem to buffer against postsurgical pain.

Trial registration numbers DRKS00021764 and DRKS00021766.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The study is characterised by its longitudinal design and the multidimensional (somatic, demographic and psychological) assessment of potential risk factors of postoperative pain.
⇒ A strength of the study is the integration of both psychological resilience and risk factors of postoperative pain.
⇒ A limitation is the retrospective assessment of pain.

INTRODUCTION

All over the globe, the number of surgeries is significantly increasing. In 2012, 312.9 million operations were performed worldwide, which was an increase of 34% over 8 years.[1] A US national survey showed that about 86% of patients undergoing surgery had postsurgical pain[2 3] and a Norwegian population-based study found that 40% experienced persistent pain 3 months after surgery.[4] Moderate to severe acute postsurgical pain (APSP) was experienced by 41% at the day of surgery and 30% on the first postoperative day (POD) in a large-scale survey of surgical inpatients.[5] Even minor surgeries are associated with high levels of postoperative pain.[6] Surgical pain is defined as pain that increases or develops after a surgery indicating its temporal relationship.[7] Due to the high incidence of postsurgical pain and burden of postsurgical pain, pain relief has been declared as one of the fundamental human rights.[8]

Thus, there is an urgent need to optimise postoperative pain management,[9] which is a clear prerequisite for improving recovery and reducing the risk of postsurgical complications.[10] Severe surgical-related pain is a major factor associated with prolonged hospital stay, immobility and postoperative chronic pain.[11–14] The fact that 'every chronic pain was once acute' was highlighted by Katz and

Seltzer who described the development of chronic postsurgical pain as a transitional process.[12] Consequently, the stratification of potential risk factors for postoperative pain is of particular importance.[15] Several studies showed that preoperative pain is a strong predictor of postsurgical pain.[16–19] Younger age and female sex were found to be significant sociodemographic risk factors.[17 18 20] Within a biopsychosocial framework of pain the multidimensional risk stratification becomes evident.[15] In a recent review, Giusti *et al* demonstrated the importance of psychological and psychosocial factors on postsurgical pain.[21] They concluded that state anxiety was the strongest predictor. Surgery-related fear is one of the well-known risk factors related both to (severe) acute and chronic postoperative pain.[16 17 22] Fear of surgery is associated with increased disability, reduced recovery and increased analgesic nonadherence after day surgery.[23 24] Therefore, the sound assessment of surgery-related fear is essential to identify patients at risk and could provide valuable information for developing specific educational or therapeutic interventions before surgery.[25] Other significant psychological predictors of APSP were pain catastrophising, optimism, expectation of pain, neuroticism, negative affect and depression.[26] The authors concluded that both risk and protective factors are important to cope with postoperative pain.[26] Consistently, more researchers call for a greater integration of positive outcomes and advocate for a resilience approach to better understand (mal) adaption to pain.[27] Resilience has been defined as response to different types of stressful events, which could be surgery and is a distinct process from risk.[28] In the present paper, we focused on psychological resilience resources of individuals, undergoing elective surgery, such as the trait of dispositional optimism and self-efficacy. There is evidence that higher levels of optimism were associated to lower levels of pain intensity.[29 30]

Accordingly, the current paper aimed to investigate the joint role of sociodemographic, somatic and psychological risk and protective factors for relevant (moderate) acute postoperative pain in order to develop a more comprehensive understanding of possible causes of APSP and potential targets for psychosocial interventions. Further, we wanted to validate the German version of the Surgical Fear Questionnaire (SFQ) to offer a short but precise measurement scale for this important psychological factor.

METHODS

Data collection

This study is a prospective open-label observational study, which was conducted at the University Hospital of Marburg, Germany. Measurements were taken both preoperatively and postoperatively. Postoperative assessments were done at: POD 1 (24 hours after surgery), POD 2 (48 hours after surgery) and 1 week after surgery (POD 7) with questions being asked about the mean level of pain during the first 48 hours and the mean intensity for the whole week after surgery. Adult patients scheduled for orthopaedic surgery of the upper or lower extremity with American Society of Anesthesiologists (ASA) physical status I–IV were screened for inclusion criteria from May 2020 to January 2021. In total we included N=243 participants (sample 1). For the validation of the German version of the SFQ an additional sample of N=198 patients undergoing heterogeneous surgeries was investigated (sample 2). Participants answered the questionnaires while they waited for their pretreatment consultation at the anaesthesia clinic. The upcoming surgery took place within a week of this assessment at the latest. Data collection of the second group was from October 2020 to January 2021. The study was prospectively registered in the German Clinical Trials Register (DRKS00021764 and DRKS00021766).

Translation and cultural adaption

The original authors Theunissen and Peters gave us their permission to translate and validate the SFQ.[25] The translation and cross-cultural adaption followed the guidelines of Beaton *et al*.[31] At first two forward translations from English into German were performed. Second, we compared both versions and created a combined version. Then an uninformed native speaker again back translated this version. A revised prefinal version was administered to a few patients who were about to undergo a planned surgery. The German and the back-translated versions of the questionnaire were discussed and adapted by a team of clinical psychologists (German version, see online supplemental file 1).

Measures

Preoperative assessment

Sociodemographic variables were age, gender, level of education, marital status and employment situation. Surgical-related variables were setting (ambulatory vs inpatient), surgical site (arm vs leg), duration of surgery, ASA status and anaesthetic technique (regional (RA), general anaesthesia (GA) or combination of RA and GA). Pain-related questions included preoperative pain intensity and pain duration related to the operation. As recommended by the Initiative on Methods, Measurement and Pain Assessment in Clinical Trials[32] pain intensity was assessed with an 11-point Numerical Rating Scale (NRS; 0=no pain, 10=worst imaginable pain).[32] In addition, we asked patients about their expectations of postoperative pain intensity directly after the surgery and during the course of postoperative recovery using the same NRS.

Various psychological questionnaires were used to assess psychological predictors of surgery-related pain (sample 1). Surgical fear was assessed with the SFQ, which is a self-rating scale measuring both short-term and long-term surgery-related fears. Each subscale consists of 4 items which are scored on an 11-point NRS ranging from 0 (not at all afraid) to 10 (very afraid). This results in a total score of 0–80. Several validation studies with large sample sizes yielded high internal consistency for

the whole scale and both subscales and showed good convergent and divergent validity.[25] To examine convergent validity of the SFQ, we assessed state anxiety with the short version of the State-Trait Anxiety Inventory (STAI-SKD).[33] Five items are answered on a 4-point Likert scale from 1 (not at all) to 4 (very). The German version proved to be a valid and reliable instrument to assess state anxiety in health psychological settings. The Pain Catastrophising Scale (PCS)[34 35] and the depression subscale of the Patient Health Questionnaire (PHQ-9)[36 37] were provided to evaluate the divergent validity of the SFQ. In addition, we investigated pain-related disability with the Pain Disability Index, which is a seven-item questionnaire measuring pain-related disability in various areas of daily living.[38 39] Positive predictors were captured by the revised Life Orientation Test (LOT-R) measuring dispositional optimism[40 41] and the General Self-Efficacy Scale (GSES).[42]

Postoperative assessment

The type of anaesthesia was not regulated by the study protocol. The choice of technique and agents was an individual decision by the anaesthesiologist and patient.

For upper limb surgery, patients could choose between GA and axillary brachial plexus block. For lower limb surgery between GA, spinal anaesthesia or a combination of GA and popliteal sciatic nerve block.

GA was induced using intravenous propofol, fentanyl and rocuronium if necessary. Balanced or total intravenous anaesthesia was maintained with desflurane or propofol (target bispectral index values between 35 and 55) and intermittent fentanyl as required.

All peripheral nerve blocks were performed ultrasound guided single shot with 30–40 mL of a mixture containing 10 mL of 0.2% ropivacaine and 30 mL of 1% prilocaine. For spinal anaesthesia, 3.0–3.5 mL 0.5% bupivacaine isobaric was used.

Standard basic postoperative analgesia was administered as follows: ibuprofen 600 mg four times a day, metamizole 1000 mg four times a day or paracetamol 1000 mg four times a day. For rescue analgesia patients received an oxycodone+naloxone combination and/or intravenous morphine or piritramide on demand, following local standard operating procedures for postoperative pain.

After surgery, all patients went to the postanaesthesia care unit. Research assistants visited all patients at POD 1 or contacted them by phone, if patients underwent ambulatory surgery (POD 1). Pain intensity ratings were scored on an 11-point NRS for every 3 hours during the first 24 hours after surgery by the patient. We calculated the mean pain intensity out of these scores. We defined relevant APSP as at least moderate pain >4.[17 43] Further, we assessed quality of recovery (QOR) with the QOR-15 Questionnaire which is a 15 item scale to assess patient comfort in the perioperative period with 5 dimensions: psychological support, physical comfort, emotional state, physical independence and pain.[44 45] The Global Surgical Recovery (GSR) Index was used as a generic one-item scale measuring to what extent patients feel recovered from surgery.[46] The scale ranges from 0%, meaning not recovered at all, to 100%, meaning fully recovered. One week after surgery, patients were contacted by telephone and were asked about their pain, treatment satisfaction and recovery (GSR) during the last week. Patients retrospectively scored their mean pain intensity for the first 48 hours (POD 2) after surgery and the mean pain intensity for the whole week with an NRS (POD 7).

Statistical analyses

Psychometric properties of the German SFQ were examined with standard item analysis, including item difficulties and item-total correlations and the internal consistency (Cronbach's α). Cronbach's α is based on the average correlations of items within a test.[47] Values between 0.7 and 0.95 are proposed to be good.[48] To investigate whether the factor structure corroborated the original version, a confirmatory factor analysis (CFA) was conducted. For CFA improvement, goodness of fit criteria were minimum fit function χ^2, the root mean square error of approximation (RMSEA, <0.05 very good fit, 0.05–0.08 good fit[49]), the Comparative Fit Index (CFI, >0.95 very good fit[49]) and the standardised root mean square residual (SRMR, <0.06 good fit[50]). Construct validity was analysed using Pearson correlation coefficients, following the criteria recommended by Fisseni.[51] Accordingly, the SFQ should show high positive correlations ($r \geq 0.6$) with other questionnaires measuring anxiety (STAI). To fulfil criteria for divergent validity, the SFQ should show low positive correlations ($r \leq 0.4$) with pain intensity, pain catastrophising and depression. Blockwise logistic regression analysis was used to analyse the dichotomous variables relevant to moderate postsurgical pain (sample 1). In step 1, surgery-related variables (site, setting) were entered. Sociodemographic variables (age, gender) were entered in step 2. Step 3 included preoperative pain intensity, ASA and anaesthetic technique. Psychological variables (pain expectation, SFQ, PCS, PHQ-9, LOT-R, GSES) were entered in step 4.

All statistical analyses were performed with the Statistical Package for Social Science (IBM SPSS V.27[52]), for the CFA AMOS V.27 was used; p values <0.05 were considered significant.

Patient and public involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

RESULTS

Longitudinal data were available of N=243 participants (sample 1), of which 47 participants had to be excluded due to attrition or because they had missing data in relevant predictor variables. The cross-sectional validation study consisted of N=198 participants (sample 2). Patient

Table 1 Patient characteristics

Variables	APSP sample (sample 1) N=196	Validation sample (sample 2) N=198
Age (years)*	43.0±16.7	43.6±24.7
(Preoperative) pain (0–10)*	3.39±2.33	2.99±2.79
Preoperative excitement (0–10)*	N/A	4.61±5.56
Gender, n (% female)	89 (45.4)	114 (58.8)
Occupational status, n (%)		
Working	119 (60.7)	137 (70.6)
Apprentice	37 (18.9)	9 (4.6)
Not working	6 (3.1)	5 (2.6)
Retirement pension	17 (8.7)	23 (11.9)
Disability pension	9 (4.6)	11 (5.7)
ASA status, n (%)		
ASA I	90 (45.9)	N/A
ASA II	83 (42.3)	N/A
ASA III	22 (11.2)	N/A
ASA IV	1 (0.5)	N/A
Surgical site, n (%)		
Upper extremities	95 (48.5)	N/A
Lower extremities	101 (51.5)	N/A
Surgical setting, n (%)		
Ambulatory	89 (45.4)	N/A
In-patient	107 (54.6)	N/A
Anaesthesia type, n (%)		
General	92 (46.9)	N/A
Regional	88 (44.9)	N/A
Combined	16 (8.2)	N/A

*Values are presented as means (±SD).
ASA, American Society of Anesthesiologists; ASAP, acute postsurgical pain; N/A, not applicable;

characteristics are presented in table 1 (for descriptive information of all variables, see online supplemental table 1). The middle-aged longitudinal sample (sample 1, N=196) showed a mild pain intensity before surgery (0–4 on an 11-point NRS). GA was used in 47% of the patients, RA were applied in 45% of the cases and 8% received a combination.

Validation of the SFQ

Participants showed moderate levels of surgical fear with a mean score of 26.53 (SD=15.39) ranging from 0 to 67 for the whole scale. Five participants (2.6%) scored the possible minimum score of 0 and no one scored the possible highest score. The subscale score for fear of short-term consequences was a bit higher (M=15.52) as the fear of long-term consequences of surgery (M=11.00) (see table 2). Regarding skewness (>7) and kurtosis (>2), all items did not exceed the critical values.

We found good internal consistency rates, with Cronbach's α 0.89 for the whole scale and α=0.85 for both subscales assessing short-term and long-term consequences. The total item-scale correlations ranged from r_{itc}=0.56 (item 4) to r_{itc}=0.72 (item 5) (table 2).

We tested the two-factor structure of the original version with a CFA. The fair to good model fit was comparable to the original version by Theunissen *et al*:[25] χ^2/df ratio=4.79, CFI=0.913, RMSEA=0.140 (90% CI 0.112 to 0.170), SRMR=0.068.

The SFQ showed a high positive correlation (r=0.7) with the state anxiety index proving criterion validity. Correlations with divergent constructs like depression (PHQ-9), optimism (LOT-R), PCS and pain intensity were generally lower and ranged from r=0.24 to r=0.42 (see table 3).

Predictor analysis

The outcome variable of clinically relevant acute postoperative pain was operationalised as pain >4 on an 11-point NRS.[43] 32.7% of participants experienced clinically relevant APSP at POD 1, 28.1% at POD 2 and 43.9% at POD 7 (sample 1, N=196).

We performed separate blockwise multiple logistic regression analyses for the risk of moderate postoperative pain for each POD (see online supplemental table 2 for detailed results).

Significant surgical and somatic predictors for POD 1 were surgical setting and preoperative pain. An ambulatory setting and higher preoperative pain intensity increased the risk of relevant APSP. Psychological factors associated with relevant surgical related pain on POD 1 were short-term surgical fear and dispositional optimism. The final model of POD 2 was significant but not the last block including the psychological variables (p=0.092). Acute postoperative pain after 7 days was predicted by age and dispositional optimism. After the second block the model was not significant (p=0.063) and with block three the model became significant (p=0.047) but the block was not (p=0.148). Accordingly, age and anaesthetic technique could not be interpreted as significant predictors of APSP at POD 7. Positive expectations seem to decrease the risk of moderate postoperative pain, whereas younger age increased the risk of APSP. For the independent variables surgical site, gender, ASA-grade, anaesthetic technique, long-term fear, expected pain, catastrophising and self-efficacy no associations with relevant postoperative pain were found.

DISCUSSION

The objective of this study was to investigate various somatic and psychological risk and protective factors of acute postoperative pain. A further issue was to establish the validity and reliability of the German version of the SFQ. Therefore, we used two data sets of a cross-sectional (N=198, sample 2) and a prospective (N=196, sample 1) observation study with patients undergoing elective surgeries.

Table 2 Item means, SD, item difficulties, item-whole correlations and α if removed

Item	M	SD	Difficulty	Item-whole correlation*	α if removed
Short term	15.53	8.71	0.39†	0.91†	–
1. I am afraid of the operation.	2.75	2.46	0.27	0.78	0.87
2. I am afraid of the anaesthesia.	3.15	2.72	0.31	0.67	0.87
3. I am afraid of the pain after the operation.	2.43	2.36	0.24	0.61	0.87
4. I am afraid of the unpleasant side effects (like nausea) after the operation.	2.67	2.51	0.27	0.68	0.88
Long term	11.00	8.35	0.27	0.89	–
5. I am afraid my health will deteriorate because of the operation.	4.11	2.60	0.41	0.72	0.87
6. I am afraid the operation will fail.	3.58	2.74	0.36	0.64	0.88
7. I am afraid that I won't recover completely from the operation.	4.19	2.59	0.42	0.82	0.87
8. I am afraid of the long duration of the rehabilitation after the operation.	3.64	2.63	0.36	0.59	0.87

*Item-whole correlations with the respective subscales.
†Values in these rows denote the means for the subscale.

Somatic factors increasing the risk of relevant acute postoperative pain were higher preoperative pain intensity and an outpatient surgical setting. Also, younger age increased the risk of APSP. Our results provide further evidence for the importance of psychological factors in postoperative pain.

Psychological variables added to the predictive power for POD 1 and POD 7. A consistent psychological risk factor was short-term surgical fear being associated with APSP. Positive expectations expressed by dispositional optimism seem to be protective against the development of acute postoperative pain. Regarding the validation of the German SFQ, CFA confirmed the two-factor model of the questionnaire (subscale 1: fear of immediate consequences of surgery, subscale 2: fear of the long-term consequences). The two- factor solution revealed a fair model fit except for RMSEA with good Cronbach's α levels over 0.8. These results are comparable to validation studies in other countries.[53 54] Further analyses demonstrated a good validity and reliability of the German version.

Regarding gender as a sociodemographic factor associated with postoperative pain, preceding study results are conflicting.[18 20 55] In our study, gender was not an independent predictor of postoperative pain. Corresponding to preceding findings younger age was associated with moderate postoperative pain on POD 7.[17 20]

Our results of presurgical pain are in line with preceding studies, which identified preoperative pain intensity as one of the most important predictors of postsurgical pain.[16–19] Further somatic factors such as anaesthetic technique and ASA grade did not predict APSP. Our sample had mainly mild diseases without substantive functional limitations as over 80% of the patients had an ASA grade of 1 or 2. This kind of ceiling effect might explain the results. Further, no difference between regional and general techniques emerged on postoperative pain. However, a former study

Table 3 Means and SD of clinical variables and their correlations with the SFQ subscales (sample 2)

Outcome	M	SD	Correlation with SFQ-S	Correlation with SFQ-L	Correlation with SFQ total
SFQ (0–80)	26.53	15.39	0.91**	0.90**	1
SFQ-S (0–40)	15.53	8.71	1	0.63**	0.91**
SFQ-L (0–40)	11.00	8.35	0.63**	1	0.90**
STAI (5–20)	9.81	3.29	0.68**	0.59**	0.70**
Pain intensity (0–10)	2.99	2.79	0.22**	0.20*	0.24**
PHQ-9 (0–27)	5.00	4.41	0.34**	0.41**	0.42**
LOT-R (0–40)	25.92	4.54	−0.22**	−0.13	−0.20**
PCS (0–52)	10.60	11.26	0.33**	0.36**	0.38**

*p<0.05, **p<0.01.
LOT-R, revised life orientation test; PCS, Pain Catastrophising Scale; PHQ-9, Patient Health Questionnaire; SFQ, Surgical Fear Questionnaire; SFQ-S, subscale SFQ; STAI, State-Trait Anxiety Inventory.

found a protective effect for RA on postoperative pain on the day of surgery but not on later days.[17] As patients could choose which anaesthesia they get, a selection bias might have influenced these results.

Patients undergoing ambulatory surgery had a significantly higher risk of having moderate postoperative pain within 24 hours after surgery. Besides various benefits of an outpatient setting, moderate to severe pain is common which in turn is a frequent cause of delayed discharge and recovery.[56] This may have several reasons, for example, at home patients might be more active which in turn leads to more pain. Therefore, effective analgesic treatment at the hospital is important.[57] Additionally, clinicians should provide information about pain medications and its management within educational interventions.[58] An important prerequisite for effective educational programmes is a sound preoperative assessment of pain and associated psychological factors such as anxiety and surgical related fears.[21 58] Accordingly, reliable and valid generic instruments are needed to cover the most important targets of preoperative informational interventions. This study provides a validated German version of the SFQ. The SFQ is an economical instrument with a total of eight items, hence allowing a concise assessment with little associated effort for patients and clinicians. It is suitable for general use in clinical practice and research including a broad range of short and long-term surgery-related fears.[25]

Our longitudinal data showed that short-term fear as a psychological risk factor was predictive of APSP on POD 1 and POD 2 but not on POD 7. Similar results were found in a preceding study where short-term fear was associated with postoperative pain only at POD 1.[13] Fears about surgery-related long-term consequences seem to play a minor role in our data. This could be due to the surgical procedures, which were mainly routine elective surgeries with short duration of rehabilitation. Further, fear of immediate consequences seems to be associated with elevated APSP whereas long-term fears are more important in the prediction of chronic postoperative pain.[13] Future studies might investigate these differentiated effects between short-term and long-term fears also regarding the transitions between acute, persistent and chronic postoperative pain.

The present results revealed that despite surgery-related fears, which can be regarded as future-oriented anticipatory states,[59] positive future expectancies also influenced postoperative pain. Participants with dispositional optimism showed less postsurgical pain at 24 hours and 1 week after surgery. Optimism is defined as generalised favourable expectancies about the future.[40] Anticipating good outcomes seems to protect against pain whereas being fearful and thus anticipating bad outcomes increases pain. Both factors include expectations, which are described as future-directed cognitions referring to the likelihood of specific events or experiences.[60] A meta-analysis confirmed that postsurgical health outcomes are predicted by patients' expectations, underpinning the necessity to optimise these expectancies in presurgical interventions.[61]

There is promising evidence that targeting patients expectations in a psychological preoperative intervention improved outcome in heart surgery.[62] Patient education is important both for preventing and reducing fears in patients undergoing surgery.[63] Other psychological factors (catastrophising, depression, self-efficacy) were not predictive of APSP. Contrarily, evidence from a meta-analysis revealed pain catastrophising as the strongest psychological risk factor of postoperative pain.[26] On the one hand this could be explained by low levels of catastrophising in our study. Further, pain catastrophising seems to be predictive of postoperative pain at later POD.[64] Former studies found that resilience factors were predictive of more favourable recovery in postsurgical pain, while risk factors were predictive of poorer pain recovery.[65] One can speculate that trait-like constructs such as optimism, which is often conceptualised as a positive generalised expectation[40] may buffer short-term surgical-related fears. It is also possible that there exists a difference in rumination and catastrophising between long-term and short-time history of preoperative pain and that the used PCS was not the right instrument to measure the psychological predictors in our study, as we only included patients with a short-time history of acute pain. Thus, it is important to choose the psychological instruments according to the preoperative pain history and it would be interesting to investigate those interaction effects between risk and resilience factors.

Limitations and implications

A limitation of this study is the retrospective pain evaluation for POD 2 which might have led to distorted memory effects. It is recommended to better use direct pain assessment even if retrospective evaluation is common. Further, we might have neglected other potential predictors such as social context or support. In regard to persistent postoperative pain there is evidence that the perception of social support predicts postoperative pain.[21] Future studies should consider the social aspects of pain as pain is inherently a social experience.[66] Our longitudinal sample was quite young (M=43), and participants mainly had good physical status with mild symptoms as reflected by low ASA grades between 1 and 2. This may limit the generalisability of our study results. Postoperative pain might be higher in more disabled patients with more severe surgical procedures. Due to the concept of the study, we solely focused on pain as outcome measure while neglecting other relevant outcomes such as quality of life or recovery, which might be especially valuable in the context of resilience factors.

Our study results underline that preoperative pain assessment is essential as presurgical pain is a clear predictor of postoperative pain. Educational preoperative interventions would benefit from providing information about pain management especially in the context of an outpatient setting. Our findings may inform clinicians

about the importance of a multidimensional and targeted screening with both somatic and psychological factors. Moreover, as optimism seems to be protective against postoperative pain, resilience factors may be equally important to consider in preoperative prevention interventions and screenings.[65]

CONCLUSIONS

This study showed that both risk and resilience factors are important predictors of postoperative pain and should be addressed in presurgical screenings and interventions. The German version of the SFQ has proven to economically assess surgery-related fears with good psychometric properties.

Acknowledgements The authors thank all clinical and research staff members of the Department of Anesthesiology and Intensive Care Medicine at Philipps-University Marburg for their assistance with patient recruitment and premedication. We thank B Pfeffer for assisting in patient recruitment, logistical organisation and data collection. We would like to express our special thanks to J Stemmann, L Mohme, A Schneider, T Streb and F Niebeling for assisting and engaging in data collection. Further, we thank T Koch, G Nebeling and R Axt for their assistance in study organisation.

Contributors JR: conceptualisation, drafting the paper, data analysis, guarantor of the study; SFZ: drafting the manuscript; CV: conceptualisation, data acquisition, supervision, writing revision, guarantor of the study; A-KS, H-CD, TW and HW: data acquisition, conceptualisation. All authors discussed the results and revised the manuscript.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests TW received honorarium for lectures from Pajunk, Vygon, Teva ratiopharm. HW received honorarium for lectures from Gruenenthal, Edwards, Sintetica, Pajunk and Medtronic. All other authors declare that they have no conflicts of interests.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by Local ethics committee of the University Hospital of Marburg, ID: Study 24/20. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request. A request can be made to the corresponding author.

ORCID iDs

Jenny Riecke http://orcid.org/0000-0002-2683-7541
Simon Felix Zerth http://orcid.org/0009-0001-7869-6349

REFERENCES

1 Weiser TG, Haynes AB, Molina G, *et al*. Estimate of the global volume of surgery in 2012: an assessment supporting improved health outcomes. *The Lancet* 2015;385:S11.
2 Gan TJ, Habib AS, Miller TE, *et al*. Incidence, patient satisfaction, and perceptions of post-surgical pain: results from a US national survey. *Curr Med Res Opin* 2014;30:149–60.
3 Maier C, Nestler N, Richter H, *et al*. Qualität Der schmerztherapie in deutschen krankenhäusern. *Dtsch Arztebl* 2010;107:607–14.
4 Johansen A, Romundstad L, Nielsen CS, *et al*. Persistent postsurgical pain in a general population: prevalence and predictors in the Tromsø study. *Pain* 2012;153:1390–6.
5 Sommer M, de Rijke JM, van Kleef M, *et al*. The prevalence of postoperative pain in a sample of 1490 surgical inpatients. *Eur J Anaesthesiol* 2008;25:267–74.
6 Gerbershagen HJ, Aduckathil S, van Wijck AJM, *et al*. Pain intensity on the first day after surgery. *Anesthesiology* 2013;118:934–44.
7 Werner MU, Kongsgaard UE. I. defining persistent post-surgical pain: is an update required? *Br J Anaesth* 2014;113:1–4.
8 Lippe PM, Brock C, David J, *et al*. The first national pain medicine Summit -- final summary report. *Pain Med* 2010;11:1447–68.
9 Kehlet H. Recovery —bedfellows that can not be ignored. *Pain* 2018;159:S1.
10 Kehlet H, Dahl JB. Anaesthesia, surgery, and challenges in postoperative recovery. *Lancet* 2003;362:1921–8.
11 Beloeil H, Sulpice L. Peri-Operative pain and its consequences. *Journal of Visceral Surgery* 2016;153:S15–8.
12 Katz J, Seltzer Z. Transition from acute to chronic postsurgical pain: risk factors and protective factors. *Expert Rev Neurother* 2009;9:723–44.
13 Peters ML, Sommer M, de Rijke JM, *et al*. Somatic and psychologic predictors of long-term unfavorable outcome after surgical intervention. *Ann Surg* 2007;245:487–94.
14 Kehlet H, Jensen TS, Woolf CJ. Persistent postsurgical pain: risk factors and prevention. *Lancet* 2006;367:1618–25.
15 Schug SA, Bruce J. Risk stratification for the development of chronic postsurgical pain. *PR9* 2017;2:e627.
16 Sommer M, de Rijke JM, van Kleef M, *et al*. Predictors of acute postoperative pain after elective surgery. *Clin J Pain* 2010;26:87–94.
17 Gramke H-F, de Rijke JM, van Kleef M, *et al*. Predictive factors of postoperative pain after day-case surgery. *Clin J Pain* 2009;25:455–60.
18 Yang MMH, Hartley RL, Leung AA, *et al*. Preoperative predictors of poor acute postoperative pain control: a systematic review and meta-analysis. *BMJ Open* 2019;9:e025091.
19 Bruce J, Thornton AJ, Scott NW, *et al*. Chronic preoperative pain and psychological robustness predict acute postoperative pain outcomes after surgery for breast cancer. *Br J Cancer* 2012;107:937–46.
20 Gerbershagen H, PogatzkiZahn E, Peelen L, *et al*. Risk factors for moderate-severe postoperative pain. *Eur J Anaesthesiol* 2014;120:1237–45.
21 Giusti EM, Lacerenza M, Manzoni GM, *et al*. Psychological and psychosocial predictors of chronic postsurgical pain: a systematic review and meta-analysis. *Pain* 2021;162:10–30.
22 Theunissen M, Peters ML, Bruce J, *et al*. Preoperative anxiety and catastrophizing: a systematic review and meta-analysis of the association with chronic postsurgical pain. *Clin J Pain* 2012;28:819–41.
23 Peters ML, Sommer M, van Kleef M, *et al*. Predictors of physical and emotional recovery 6 and 12 months after surgery. *Br J Surg* 2010;97:1518–27.
24 Stessel B, Theunissen M, Marcus MA, *et al*. Prevalence and predictors of patient nonadherence to pharmacological acute pain therapy at home after day surgery: a prospective cohort study. *Pain Pract* 2018;18:194–204.
25 Theunissen M, Peters ML, Schouten EGW, *et al*. Validation of the surgical fear questionnaire in adult patients waiting for elective surgery. *PLoS One* 2014;9:e100225.
26 Sobol-Kwapinska M, Bąbel P, Plotek W, *et al*. Psychological correlates of acute postsurgical pain: a systematic review and meta-analysis. *Eur J Pain* 2016;20:1573–86.
27 Goubert L, Trompetter H. Towards a science and practice of resilience in the face of pain. *Eur J Pain* 2017;21:1301–15.
28 Sturgeon JA, Zautra AJ. Resilience: a new paradigm for adaptation to chronic pain. *Curr Pain Headache Rep* 2010;14:105–12.
29 Hood A, Pulvers K, Carrillo J, *et al*. Positive traits linked to less pain through lower pain catastrophizing. *Pers Individ Dif* 2012;52:401–5.
30 Treharne GJ, Kitas GD, Lyons AC, *et al*. Well-Being in rheumatoid arthritis: the effects of disease duration and psychosocial factors. *J Health Psychol* 2005;10:457–74.

31 Beaton DE, Bombardier C, Guillemin F, *et al*. Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine (Phila Pa 1976)* 2000;25:3186–91.
32 Dworkin RH, Turk DC, Farrar JT, *et al*. Core outcome measures for chronic pain clinical trials: IMMPACT recommendations. *Pain* 2005;113:9–19.
33 Englert C, Bertrams A, Dickhäuser O. Entwicklung Der fünf-item-kurzskala STAI-SKD Zur messung von zustandsangst. *Zeitschrift Für Gesundheitspsychologie* 2011;19:173–80.
34 Meyer K, Sprott H, Mannion AF. Cross-Cultural adaptation, reliability, and validity of the German version of the pain catastrophizing scale. *J Psychosom Res* 2008;64:469–78.
35 Sullivan MJL, Bishop SR, Pivik J. The pain catastrophizing scale: development and validation. *Psychological Assessment* 1995;7:524–32.
36 Gräfe K, Zipfel S, Herzog W, *et al*. Screening psychischer störungen MIT dem „ gesundheitsfragebogen für patienten (PHQ-D)''. ergebnisse Der deutschen validierungsstudie. *Diagnostica* 2004;50:171–81.
37 Kroenke K, Spitzer RL. The PHQ-9: a new depression diagnostic and severity measure. *Psychiatric Annals* 2002;32:509–15.
38 Tait RC, Chibnall JT, Krause S. The pain disability index: psychometric properties. *Pain* 1990;40:171–82.
39 Dillmann U, Nilges P, Saile H, *et al*. Behinderungseinschätzung bei chronischen schmerzpatienten. *Schmerz* 1994;8:100–10.
40 Scheier MF, Carver CS. Optimism, coping, and health: assessment and implications of generalized outcome expectancies. *Health Psychol* 1985;4:219–47.
41 Glaesmer H, Hoyer J, Klotsche J, *et al*. Die Deutsche version des life-orientation-tests (LOT-R) zum dispositionellen optimismus und pessimismus. *Zeitschrift Für Gesundheitspsychologie* 2008;16:26–31.
42 Jerusalem M, Schwarzer R. Skala Zur allgemeinen selbstwirksamkeitserwartung. skalen Zur erfassung von lehrer- und schülermerkmalen dokumentation Der psychometrischen verfahren Im rahmen Der wissenschaftlichen begleitung des modellversuchs selbstwirksame schulen. In: . 1999: 999. 1–4.
43 Jensen MP, Chen C, Brugger AM. Interpretation of visual analog scale ratings and change scores: a reanalysis of two clinical trials of postoperative pain. *J Pain* 2003;4:407–14.
44 Kahl U, Gebhardt N, Brodersen K, *et al*. Validation of a translated quality of recovery-15 questionnaire in German patients undergoing elective noncardiac surgery. *Br J Anaesth* 2021;127:e161–3.
45 Stark PA, Myles PS, Burke JA. Development and psychometric evaluation of a postoperative quality of recovery score: the qor-15. *Anesthesiology* 2013;118:1332–40.
46 Kleinbeck SV. Self-Reported at-home postoperative recovery. *Res Nurs Health* 2000;23:461–72.
47 Cronbach LJ. Coefficient alpha and the internal structure of tests. *Psychometrika* 1951;16:297–334.
48 Terwee CB, Bot SDM, de Boer MR, *et al*. Quality criteria were proposed for measurement properties of health status questionnaires. *J Clin Epidemiol* 2007;60:34–42.
49 Hu L, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal* 1999;6:1–55.
50 Schreiber JB, Nora A, Stage FK, *et al*. Reporting structural equation modeling and confirmatory factor analysis results: a review. *The Journal of Educational Research* 2006;99:323–38.
51 Fisseni HJ. *Lehrbuch zur psychologischen Diagnostik: mit Hinweisen zur Intervention (2., überarbeitete und erweiterte Aufl*. Göttingen: Hogrefe-Verlag, 1997.
52 Released ICorp. *IBM SPSS Statistics for Windows, Version 27.0*. Armonk, NY: IBM Corp, 2020.
53 Yang G, Zang X, Ma X, *et al*. Translation, cross-cultural adaptation, and psychometric properties of the Chinese version of the surgical fear questionnaire. *J Perianesth Nurs* 2022;37:386–92.
54 Bağdigen M, Karaman Özlü Z. Validation of the Turkish version of the surgical fear questionnaire. *J Perianesth Nurs* 2018;33:708–14.
55 Mamie C, Bernstein M, Morabia A, *et al*. Are there reliable predictors of postoperative pain? *Acta Anaesthesiol Scand* 2004;48:234–42.
56 Pavlin DJ, Chen C, Penaloza DA, *et al*. Pain as a factor complicating recovery and discharge after ambulatory surgery. *Anesth Analg* 2002;95:627–34,
57 Chauvin M. State of the art of pain treatment following ambulatory surgery. *Eur J Anaesthesiol Suppl* 2003;28:3–6.
58 Chou R, Gordon DB, de Leon-Casasola OA, *et al*. Management of postoperative pain: a clinical practice guideline from the American pain Society, the American Society of regional anesthesia and pain medicine, and the American Society of anesthesiologists' Committee on regional anesthesia, executive Committee, and administrative Council. *The Journal of Pain* 2016;17:131–57.
59 Grupe DW, Nitschke JB. Uncertainty and anticipation in anxiety: an integrated neurobiological and psychological perspective. *Nat Rev Neurosci* 2013;14:488–501.
60 Kube T, Rozenkrantz L, Rief W, *et al*. Understanding persistent physical symptoms: conceptual integration of psychological expectation models and predictive processing accounts. *Clin Psychol Rev* 2020;76:101829.
61 Auer CJ, Glombiewski JA, Doering BK, *et al*. Patients' expectations predict surgery outcomes: a meta-analysis. *Int J Behav Med* 2016;23:49–62.
62 Rief W, Shedden-Mora MC, Laferton JAC, *et al*. Preoperative optimization of patient expectations improves long-term outcome in heart surgery patients: results of the randomized controlled psy-heart trial. *BMC Med* 2017;15:4.
63 Wilson CJ, Mitchelson AJ, Tzeng TH, *et al*. Caring for the surgically anxious patient: a review of the interventions and a guide to optimizing surgical outcomes. *Am J Surg* 2016;212:151–9.
64 Pavlin DJ, Sullivan MJL, Freund PR, *et al*. Catastrophizing: a risk factor for postsurgical pain. *Clin J Pain* 2005;21:83–90.
65 Beeckman M, Hughes S, Van der Kaap-Deeder J, *et al*. Risk and resilience predictors of recovery after spinal fusion surgery in adolescents. *Clin J Pain* 2021;37:789–802.
66 Karos K, Meulders A, Vlaeyen JWS. Pain as a threat to the social self. *Pain* 2018;159:1.