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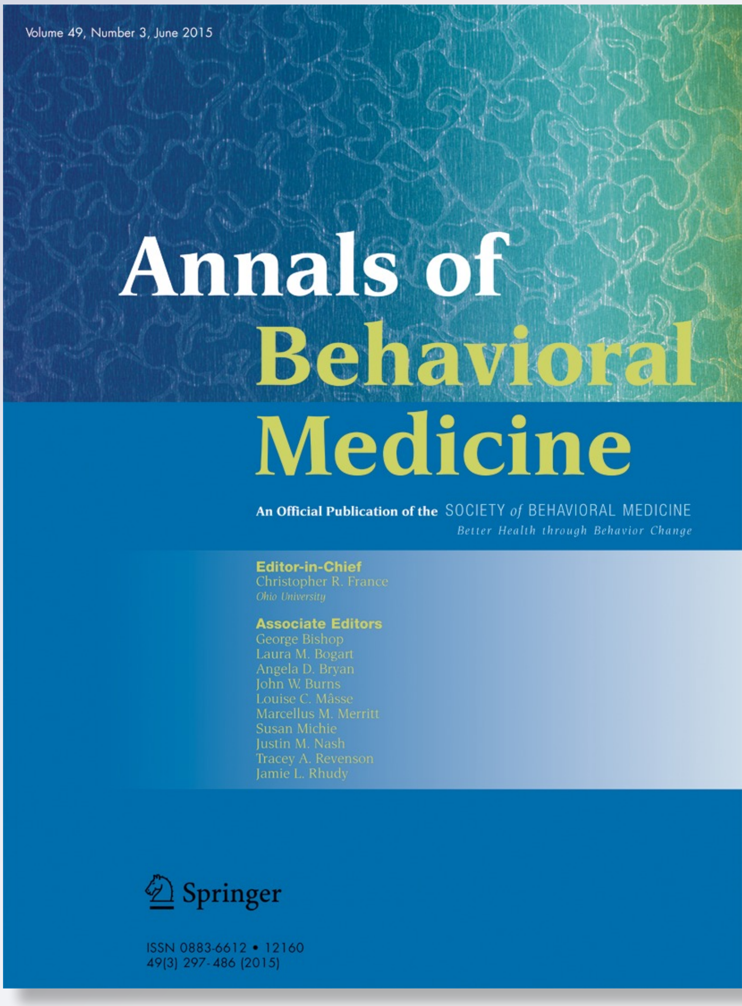

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ORIGINAL ARTICLE

Differential Predictors of Acute Post-Surgical Pain Intensity After Abdominal Hysterectomy and Major Joint Arthroplasty

Patrícia R. Pinto, PhD · Teresa McIntyre, PhD · Vera Araújo-Soares, PhD · Patrício Costa, PhD · Armando Almeida, PhD

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Abstract
Background Psychological factors have a significant role in post-surgical pain, and their study can inform pain management.
Purpose The aims of this study are to identify psychological predictors of post-surgical pain following abdominal hysterectomy (AH) and major joint arthroplasty (MJA) and to investigate differential predictors by type of surgery.
Method One hundred forty-two women undergoing AH and 110 patients undergoing MJA were assessed 24 h before (T1) and 48 h after (T2) surgery.
Results A predictive post-surgical pain model was found for AH and MJA yielding pre-surgical pain experience and pain catastrophizing as significant predictors and a significant interaction of pre-surgical optimism and surgery type. Separate regression models by surgery type showed that pre-surgical optimism was the best predictor of post-surgical pain after MJA, but not after AH.
Conclusions Findings highlight the relevance of psychological predictors for both surgeries and the value of targeting specific psychological factors by surgery type in order to effectively manage acute post-surgical pain.

Keywords Acute post-surgical pain · Abdominal hysterectomy · Major joint arthroplasty · Pre-surgical pain catastrophizing · Pre-surgical optimism · Pre-surgical psychological pain interventions

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Introduction

Acute pain is the most commonly anticipated and expected problem after surgery [1]. Unless properly treated, acute post-surgical pain creates needless suffering, delays the healing process, raises post-operative morbidity and mortality, increases hospital stay and costs of care [2], and is also a risk factor for the development of chronic post-surgical pain [3]. Nevertheless, even with the most recent advances in research and the establishment of new guidelines and standards for treatment, acute post-surgical pain continues to be undermanaged [2].

The gate control theory [4] and the neuromatrix theory [5] of pain argue that pain is a multidimensional subjective experience resulting from complex interactions between sensory-discriminative, motivational-affective, and cognitive-evaluative dimensions. Accordingly, psychological factors, either affective or cognitive, can either exacerbate or inhibit the experience of pain [6]. In fact, in the field of surgical pain, affective and cognitive variables have emerged as consistent predictors of acute and chronic post-surgical pain, exerting at least moderate effects on these outcomes [7].

Within the motivational-affective dimensions, anxiety and depression have been intensely investigated [8–10], and within the cognitive-evaluative dimensions, pain catastrophizing has been the most researched variable [8, 11, 12], albeit with conflicting results. Pain catastrophizing is defined as a cognitive variable which involves the magnification of the threat value of pain, as well as feelings of helplessness and pessimism in the ability to deal with it [13, 14]. Although affective and cognitive factors are interrelated, pain catastrophizing has emerged as the strongest psychological factor associated with pain experience [13, 14]. For instance, Sullivan and colleagues [15] found that despite the strong relationship between pain catastrophizing, depression, and pain-related fears of movement, only pain catastrophizing predicted pain intensity. Another study revealed that amongst surgical fear, optimism, and pain catastrophizing, only the latter predicted post-surgical pain intensity [16]. Other studies have reported a larger influence of pain catastrophizing on post-surgical pain [8, 15, 17, 18] than other cognitive or affective variables. These results are not surprising given the expected influence pain catastrophizing can have on attention shift and consequently, pain perception [13, 14]. Another important psychological construct to consider in the prediction of post-surgical pain is optimism. The literature has focused predominantly on negative psychological constructs, with fewer studies targeting positive psychological variables that could function as buffers or adaptive coping strategies, such as optimism [19–21]. Dispositional optimism corresponds to a generalized expectation that good things will happen [22]. Despite the recent efforts in examining the influence of optimism on pain outcomes, these have been mainly confined to non-surgical clinical and experimental research [23]. One of the few studies on optimism and surgical pain recently revealed that pre-surgical optimism was the best predictor of pain after major joint arthroplasties, above and beyond clinical factors [20].

Given that each type of surgery carries different threats and specific personal issues to deal with [24, 25], it is possible that the experience of acute pain after each type of surgery may be influenced by specific psychological risk factors. However, the differential impact of psychological factors on post-surgical pain associated with different surgeries has been overlooked. Previous studies investigating post-surgical pain predictors have focused upon surgery type as a covariate or a potential predictor [12, 16, 21, 25] or have measured the amount of pain in different surgical procedures [26, 27]. However, they did not investigate whether the same set of predictors could distinctly or similarly associate and predict acute pain in distinct surgeries. We are aware of only one surgical pain study with a similar aim, yet directed at chronic post-surgical pain [28].

Since psychological factors (affective or cognitive) are amenable to modification or management through appropriate psychological interventions, it is worthwhile to identify predictors for each type of surgery. This could inform the development of pre-surgical psychological interventions to better manage surgical pain. For instance, the predictive models tested would aid in identifying patients at risk for higher acute pain intensity, and in targeting these patients early on, preferably prior to surgery. The aim of this study is to identify affective and cognitive psychological predictors of acute post-surgical pain intensity following different types of surgery: abdominal hysterectomy and major joint arthroplasty. The psychological predictors under study were pre-surgical anxiety and depression (affective), pre-surgical pain catastrophizing, and optimism (cognitive). Additionally, the study seeks to explore whether type of surgery moderates the associations between psychological variables and post-surgical pain. The reason underlying the choice of these types of surgery, abdominal hysterectomy and major joint arthroplasty, was that abdominal surgery and orthopedic surgery of major joints are considered to be amongst the most painful operations [9, 26]. Additionally, abdominal hysterectomy is the most common gynecologic surgery performed in women in Western countries [29]. Major joint arthroplasties are also amongst the most commonly performed surgeries worldwide, due to the aging population and the subsequent rise in the prevalence of knee and hip osteoarthritis [30]. Ultimately, we hope the results will inform the design of pre-surgical psychological pain interventions directed at abdominal hysterectomy and major joint arthroplasty patients.

The following specific hypotheses were tested: (1) It is expected that psychological factors will play a significant role in acute post-surgical pain for both abdominal hysterectomy and major joint arthroplasty. In accordance with the literature on the relations between pre-surgical anxiety, depression, pain catastrophizing, optimism, and pain [7–9, 20], we expect that anxiety, depression, and pain catastrophizing will have positive correlations with pain outcomes whereas optimism will be negatively correlated with the latter; (2) due to the distinct nature of these surgeries, we expect to find differential psychological predictors for each type of surgery (abdominal hysterectomy versus major joint arthroplasty). Based on previous findings regarding these surgeries [18, 20], we hypothesize that pain catastrophizing and optimism will have a differential role in the prediction of acute pain, with the former being more predictive of pain after abdominal hysterectomy and the latter more associated with pain after major joint arthroplasty (type of surgery moderator effect). In terms of the affective variables assessed, anxiety and depression, it is hypothesized that they will not differentially predict acute pain after abdominal hysterectomy and major joint arthroplasty since their predictive role has been established regardless of the type of surgery [3, 7, 9].

Methodology

Participants and Procedure

This study was conducted in a central hospital in northern Portugal. Ethical approval was granted by the Hospital Research Ethics Committee, and all participants were informed about the study and then read and signed the written informed consent form.

This study is part of an ongoing large prospective cohort study investigating persistent post-surgical pain prevalence among abdominal hysterectomy and major joint arthroplasty. For the purposes of present analyses, wherein the focus is on acute post-surgical pain, data concerning the assessments performed 24 h prior (T1) and 48 h after (T2) surgery were retained, with both assessments being performed in the hospital by a trained psychologist.

Abdominal Hysterectomy

Abdominal hysterectomy refers to the surgical removal of the uterus. It is indicated for women with benign disorders such as uterine fibroids, prolapse, endometriosis, or pelvic pain; it is also indicated for malign disease such as premalignant changes in cervix and endometrium, and cancer [31]. Inclusion criteria were age between 18 and 75 years and the ability to understand consent procedures and questionnaire materials. Exclusion criteria were hysterectomy due to malign conditions or emergency hysterectomies. In the current study, only abdominal hysterectomies (n=142) were included in order to rule out the surgical approach as a potential confounding factor. Amongst the latter, the incision type was pfannenstiel (n=119) or vertical (n=23).

Major Joint Arthroplasty

Major joint arthroplasty is a surgical procedure designed to remove damaged cartilage and bone from around the major joints and replace it with a prosthesis. In the present study, the site of arthroplasty was either the knee or the hip. Inclusion criteria were being 18 to 80 years old, being able to understand consent procedures and questionnaire materials, no psychiatric or neurologic pathology (e.g., psychosis and dementia), and undergoing total knee or hip arthroplasty for diagnosis of coxarthrosis and gonarthrosis only (osteoarthrosis). Arthroplasties performed due to fractures were excluded, as well as hemiarthroplasties, revision, and emergency arthroplasties. A sample of 110 patients was assessed at both T1 and T2 points (52 total knee arthroplasties and 58 total hip arthroplasties) thus being enrolled in current analyses.

Measures

All instruments and study procedures were previously piloted in a similar sample of patients (20 for abdominal hysterectomy and 12 for major joint arthroplasty) for evaluation of their acceptability, feasibility, and comprehensibility. To assess the variables under study, the Portuguese versions of the following questionnaires were administered:

Pre-Surgical Assessment

1. Socio-Demographic and Clinical Data Questionnaire. It included questions on age, education, residence, marital status, professional status, household, parity, previous pre-surgical pain, pain due to other causes, previous surgeries, height, weight, surgical diagnosis, disease onset, comorbidities, and use of psychotropic drugs (e.g., antidepressants or anxiolytics).
2. Brief Pain Inventory–short form (BPI-SF) [32]. It was only used with those patients presenting pre-surgical pain. The BPI-SF measures pain intensity, on an 11-point numerical rating scale (NRS—from 0 or "no pain" to 10 or "worst pain imaginable"), pain analgesics, perception of analgesics relief (0–100 %), pain interference in daily activities, and pain location.
3. Hospital Anxiety and Depression Scale (HADS) [33]. It consists of two seven-item subscales which measure anxiety (abdominal hysterectomy, α=0.79; major joint arthroplasty, α=0.80) and depression (abdominal hysterectomy, α=0.80; major joint arthroplasty, α=0.71) symptomatology amongst patients in non-psychiatric hospital settings. Subscale scores vary between 0 and 21, with higher scores representing higher levels of anxiety and depression.
4. Life Orientation Test–revised (LOT-R) [34]. It evaluates the personality trait optimism through eight items. In this study, three items were used (abdominal hysterectomy, α=0.94; major joint arthroplasty, α=0.96), corresponding to a subscale of optimism with scores ranging from 0 to 12, higher values being associated with more optimism.
5. "Pain Catastrophizing scale" of the Coping Strategies Questionnaire–Revised Form (CSQ-R) [35]. This subscale has six items (abdominal hysterectomy, α=0.86; major joint arthroplasty, α=0.93) that assess pain catastrophizing. To generate the total subscale score, the sum of the item scores was calculated, with subscale scores varying between 6 and 30. Higher scores indicate greater use of this specific coping strategy.

Post-Surgical Assessment

Primary Outcome Measure: Acute Pain Intensity Patients were asked to rate their worst and average pain level within the first 48 h after surgery, on an 11-point numerical rating scale (from the BPI-SF), already described. For the purposes of the current analyses, a composite measure was calculated, resulting from the sum and mean (average taken by dividing by two) of the worst and the average pain level, assessed using the average of these two scores.

This procedure has been used in other studies that also use composite measures or a pain intensity index [8, 16, 36]. We believe that this measure is more useful and broadest as an outcome, since a combination of measures is a good strategy to diminish error and increase reliability [37].

Clinical Variables Clinical data related to surgery (description of surgical procedure; uterus weight and height for hysterectomy sample; surgical incision for the hysterectomy sample and site of arthroplasty for the arthroplasty sample), anesthesia (type of anesthesia; ASA score: physical status classification of the American Society of Anesthesiologists), and analgesia (analgesic protocols and provision of rescue analgesia) were retrieved from medical records.

Statistical Analyses

Data were analyzed using the Statistical Package for the Social Sciences (SPSS; version 19.0 software). The internal consistency of responses to the questionnaires was assessed using the Cronbach's alpha coefficient [38]. Descriptive statistics were computed on pre-surgical, surgical, and post-surgical sample characteristics to define each surgical group. In addition, *t* tests (for continuous variables, normal distribution was assessed through Kolmogorov-Smirnov test and/or through skewness and kurtosis absolute values) and chi-squared tests (χ^2, for nominal variables) were performed, comparing patients undergoing abdominal hysterectomy and major joint arthroplasty. Due to the gender discrepancy between the two surgery groups and its potential influence on these comparisons, the abdominal hysterectomy sample was also compared with the major joint arthroplasty female subsample alone.

To determine the meaningfulness of the differences (practical significance), since statistical significance (*p* value) is dependent on group size, the associated effect sizes and 95 % confidence intervals were also computed. They were expressed as Hedge's *g* for continuous variables and Pearson's *phi* (∅) coefficient for nominal variables, due to distinct sample sizes of the two surgery groups. Hedge's *g score* above 0.80 is usually considered a large effect, between 0.50 and 0.70 a medium effect and between 0.20 and 0.40 a small effect size [39]. The interpretation of Pearson's *phi* (φ) coefficient is analogous to the correlation coefficient, expressing the strength of association between two variables.

In order to assess concurrent and prospective relations amongst study variables, Pearson correlation coefficients were calculated among continuous variables and point-biserial correlation coefficients between dichotomous and continuous variables.

The primary outcome variable in this study is "acute post-surgical pain," assessed as a continuous variable (pain intensity, numerical rating scale 0–10). First, in order to examine the effects of psychological factors on acute post-surgical pain for both abdominal hysterectomy and major joint arthroplasty (hypothesis 1), a regression model was performed whereby age, previous pain experience, surgery type, and the psychological factors under analysis were used as predictors. Second, as we sought to evaluate whether pre-surgical factors have different relationships to post-surgical pain depending on type of surgery (hypothesis 2), we considered a moderator approach. To explore moderation effects, the predictor variables were mean-centered in order to avoid multicollinearity problems. The resulting hierarchical regression model tested whether the surgery type moderated associations between each psychological parameter and acute post-surgical pain (hypothesis 2). Model variables were entered in three blocks: (a) type of surgery; (b) psychological variables—anxiety, depression, pain catastrophizing, and optimism; and (c) product terms between type of surgery and each psychological variable. Given the obtained results, we proceeded with regression analyses separately for each type of surgery (hypothesis 2). For each regression model, demographic and clinical factors were controlled as covariates and kept similar for both models. In the first block of both regression equations, demographic variables (sex and age, just age for abdominal hysterectomy) were entered. Pre-surgical clinical variables were inserted in the second block; surgical-related variables were added in the third block; and psychological variables were included in the last blocks. Multicollinearity was analyzed through the variance inflation factor value (VIF) and the tolerance coefficients for each variable, which were established as being below 2 and greater than 0.60, respectively.

Results

Socio-Demographic, Clinical, and Psychological Measures by Surgery Type

Compared to patients with abdominal hysterectomy, patients undergoing major joint arthroplasty were older [t (250)=15.041; $p<0.001$)], had lower education [χ^2 (1, n=252)=37.064; $p<0.001$], and tended to be unemployed [χ^2 (1, n=252)=55.263; $p<0.001$] (Table 1). The magnitude of the differences was particularly meaningful for age (g=1.908). With exception of marital status, these results were similar when the comparisons were performed between the

Table 1 Socio-demographic, clinical and psychological measures by type of surgery

Measures	Abdominal hysterectomy (n=142)	Major joint arthroplasty (n=110; n♀=73)	t/χ^2	p value	Effect size[b]	95 % CI
Patient baseline characteristics (T1)						
Socio-demographic indicators						
Age (years)	49.5 (8.22)	**64.9 (7.81)** 66.2 (7.21)	**15.04** 14.64	**<0.001** <0.001	**1.908** 2.108	**[1.610, 2.209]** [1.770, 2.444]
Education (≤4 years of education)	91 (64.5 %)	**106 (96.4)** 71 (97.3 %)	**37.06** 28.00	**<0.001** <0.001	**0.384** 0.362	**[0.279, 0.440]** [0.251, 0.402]
Marital status (married)[a]	122 (85.9 %)	**84 (76.4 %)** 49 (67.1 %)	**3.790** 10.46	**0.052** 0.001	**0.123** 0.221	**[−0.011, 0.248]** [0.071, 0.363]
Professional status (employed)	77 (54.2 %)	**10 (9.1 %)** 4 (5.6 %)	**55.26** 48.11	**<0.001** <0.001	**0.469** 0.474	**[0.357, 0.549]** [0.363, 0.531]
Clinical—general indicators						
Disease onset / duration (months)	40.8 (50.2)	**113.0 (110.1)** 121.4 (110.2)	**6.460** 5.934	**<0.001** <0.001	**0.821** 0.855	**[0.561, 1.079]** [0.562, 1.146]
BMI (kg/m^2)	28.8 (4.66)	**29.8 (4.95)** 30.1 (5.07)	**1.614** 1.749	**0.108** 0.074	**0.205** 0.252	**[−0.045, 0.454]** [−0.032, 0.534]
Previous surgeries (yes)	102 (71.8 %)	**93 (84.5 %)** 63 (87.5 %)	**6.474** 6.644	**0.011** 0.010	**0.161** 0.176	**[0.028, 0.271]** [0.033, 0.278]
Psychotropic use (yes)[a]	42 (29.6 %)	**39 (35.5 %)** 35 (47.9 %)	**0.982** 7.076	**0.322** 0.008	**0.062** 0.181	**[−0.068, 0.193]** [0.037, 0.323]
Clinical—pre-surgical pain indicators						
Intensity (worst level)	3.89 (3.25)	**7.01 (2.07)** 7.58 (1.92)	**9.250** 10.40	**<0.001** <0.001	**1.175** 1.498	**[0.905, 1.443]** [1.186, 1.808]
Intensity (average level)	2.50 (2.13)	**4.43 (1.23)** 4.64 (1.32)	**9.018** 9.033	**<0.001** <0.001	**1.145** 1.301	**[0.876, 1.413]** [0.996, 1.604]
Intensity (composite measure)	3.20 (2.61)	**5.72 (1.49)** 6.11 (1.43)	**9.685** 10.55	**<0.001** <0.001	**1.230** 1.519	**[0.958, 1.500]** [1.206, 1.830]
Pain due to other causes (yes)	92 (64.8 %)	**67 (60.9 %)** 55 (76.4 %)	**0.201** 2.989	**0.654** 0.084	**0.028** 0.118	**[−0.102, 0.160]** [−0.027, 0.242]
Psychological variables						
HADS: anxiety	7.50 (4.46)	**5.38 (4.10)** 6.08 (4.19)	**−3.869** −2.252	**<0.001** 0.025	**0.491** 0.324	**[0.248, 0.742]** [0.055, 0.603]
HADS: depression	2.44 (3.10)	**1.96 (2.84)** 2.44 (3.19)	**−1.265** −0.012	**0.207** 0.991	**0.161** 0.002	**[0.000, 0.403]** [0.000, 0.011]
CSQ-R: pain catastrophizing	11.4 (5.62)	**10.8 (6.09)** 12.1 (6.52)	**−0.706** 0.861	**0.481** 0.390	**0.090** 0.124	**[0.000, 0.329]** [−0.159, 0.406]
LOT-R: optimism[a]	6.96 (3.33)	**8.05 (3.12)** 7.55 (3.33)	**2.641** 1.229	**0.009** 0.220	**0.336** 0.177	**[0.084, 0.586]** [−0.106, 0.460]
Pain 48 h after surgery (T2)						
Acute pain intensity—worst	5.61 (2.79)	**6.51 (2.48)** 7. 15 (2.18)	**2.652** 4.435	**0.009** <0.001	**0.337** 0.639	**[0.086, 0.587]** [0.350, 0.926]
Acute pain intensity—average	3.35 (1.53)	**3.84 (1.43)** 4.18 (1.17)	**2.625** 4.484	**0.009** <0.001	**0.333** 0.646	**[0.083, 0.584]** [0.357, 0.933]
Acute pain intensity—composite	4.48 (2.01)	**5.18 (1.75)** 5.67 (1.44)	**2.933** 4.978	**0.004** <0.001	**0.373** 0.717	**[0.121, 0.623]** [0.427, 1.005]

Continuous variables are presented as mean (SD); categorical variables are presented as n (%); bold=major joint arthroplasty total sample (n=110); normal=major joint arthroplasty subsample of women (n=73)

T1 24 h before surgery, *T2* 48 h after surgery, *BMI* body mass index, *HADS* Hospital Anxiety and Depression Scale, *CSQ-R* Coping Strategies Questionnaire–Revised, *LOT-R* Life Orientation Test–Revised

[a] Variables in which the significant differences (p value) between abdominal hysterectomy sample and the total major joint arthroplasty sample changed when the former was compared with the major joint arthroplasty female subsample

[b] Hedge's g for continuous variables and Pearson's phi (φ) coefficient for nominal variables

abdominal hysterectomy sample and the major joint arthroplasty women subsample only.

Regarding the pre-surgical clinical variables (Table 1), major joint arthroplasty patients were more likely to have been diagnosed for a longer period of time with the condition leading to surgery (understandably so) [t (145.0)=6.460; $p<0.001$] and had been subjected to more previous surgeries than abdominal hysterectomy women [χ^2 (1, n=252)=6.474; $p=0.011$]. Regarding pre-surgical pain, major joint arthroplasty patients reported higher pre-surgical pain intensity, both at worst [t (241.7)=9.250; $p<0.001$] and average level [t (232.8)=9.018; $p<0.001$], with those differences being substantial (g=1.111 and g=1.072, respectively). When comparing abdominal hysterectomy women only with major joint arthroplasty women, outcomes were similar except for psychotropic use, with a significant difference found (χ^2 (1, n=215)=7.076; $p=0.008$) in the direction of a higher use by major joint arthroplasty women.

Regarding baseline psychological variables, Table 1 reveals that abdominal hysterectomy women were significantly more anxious [t (250)=−3.869; $p<0.001$; g=0.491] than major joint arthroplasty patients, with this difference attenuating when only major joint arthroplasty women were considered [t (213)=−2.252; $p=0.025$; g=0.335]. Furthermore, women submitted to abdominal hysterectomy were less optimistic than patients undergoing major joint arthroplasty [t (250)=2.641; $p=0.009$; g=0.335], with this difference losing its significance when considering only the major joint arthroplasty women subsample.

Table 1 also reveals that after surgery, patients submitted to major joint arthroplasty reported higher acute pain intensity, both at its worst [t (250)=2.652; $p=0.009$] or on average [t (250)=2.625; $p=0.009$], when compared with abdominal hysterectomy women. The associated effect sizes (g=0.337 and g=0.328, respectively) were low but became medium when the comparison was performed only with major joint arthroplasty women (g=0.590 and g=0.583, respectively).

Inter-Correlations of Baseline Pre-Surgical (T1) and Surgical Factors and Acute Post-Surgical Pain (T2) for the Total Sample

Table 2 shows inter-correlations of the main baseline pre-surgical (T1) and surgical factors and acute post-surgical pain (T2), for the total sample. Age was not associated with acute post-surgical pain intensity. In terms of pre-surgical pain-related variables, pain intensity (r=0.34, $p<0.001$) and pain due to other causes (r_{pb}=0.24, $p<0.001$) were significantly correlated with post-surgical pain intensity.

Concerning psychological variables, pre-surgical anxiety (r=0.22, $p<0.001$), depression (r=0.24, $p<0.001$), and pain catastrophizing (r=0.34, $p<0.001$) were positively and significantly correlated with acute post-surgical pain. Albeit with lower magnitude, optimism (r=−0.12, $p=0.05$) was also associated with the outcome. The type of surgery, whether it was an abdominal hysterectomy versus a major joint arthroplasty, was also significantly correlated with post-surgical pain (r_{pb}=−0.18, $p=0.004$), with the latter showing a stronger association.

Psychological Predictors of Acute Post-Surgical Pain Intensity for Both Abdominal Hysterectomy and Major Joint Arthroplasty

A single hierarchical regression analysis (Table 3) was performed in order to test hypothesis 1, regarding the predictive role of psychological factors on acute post-surgical pain for both abdominal hysterectomy and major joint arthroplasty. The results confirmed that hypothesis 1 showed a significant joint effect of psychological variables on post-surgical pain

Table 2 Pearson and point-biserial correlation coefficients between baseline pre-surgical (T1) and surgical factors, and post-surgical pain intensity at T2 after abdominal hysterectomy (n=142) and major joint arthroplasty (n=110)

	2	3	4	5	6	7	8	9
1. Post-surgical pain	0.05	0.34***	0.24***	0.22***	0.24***	0.34***	−0.12*	−0.18**
2. Age	–	0.22***	0.03	−0.32***	−0.05	−0.07	0.09	−0.69***
3. Pre-surgical pain		–	0.16*	0.01	0.03	0.16*	0.14*	−0.50***
4. Pain other causes			–	0.24***	0.13*	0.24***	−0.19*	0.03
5. HADS: anxiety				–	0.54***	0.54***	−0.43***	24.0***
6. HADS: depression					–	0.47***	−0.49***	0.08
7. CSQ-R: pain catastrophizing						–	−0.38***	0.05
8. LOT-R: optimism							–	−0.17**
9. Type of surgery								–

T1 24 h before surgery, *T2* 48 h after surgery, *HADS* Hospital Anxiety and Depression Scale, *CSQ-R* Coping Strategies Questionnaire–Revised, *LOT-R* Life Orientation Test–Revised

*$p<0.05$; **$p<0.01$; ***$p<0.001$

Table 3 Hierarchical multiple regression model for post-surgical pain intensity 48 h after abdominal hysterectomy or major joint arthroplasty (total sample)

Variables	*t*	*β*	*sr*	R^2	ΔR^2	ΔF
Block 1					0.002	0.575
Age[a]	0.758	0.048	0.048			
Block 2					0.153	22.228***
Pre-surgical pain intensity[b]	5.258***	0.320	0.308			
Pain due to other causes[c]	3.234***	0.192	0.190			
Block 3					0.006	1.676
Type of surgery[d]	−1.295	−0.121	−0.076			
Final model				0.237		
Block 1						
Age[a]	−1.106	−0.091	−0.062			
Block 2						
Pre-surgical pain intensity[b]	3.244***	0.226	0.182			
Other previous pain states[c]	2.376*	0.143	0.134			
Block 3						
Type of surgery[d]	−1.742†	−0.157	−0.098			
Block 4					0.077	6.060***
HADS: anxiety	0.155	0.012	0.009			
HADS: depression	1.458	0.107	0.082			
CSQ-R: pain catastrophizing	2.962**	0.211	0.167			
LOT-R: optimism	−0.081	−0.006	−0.005			

HADS Hospital Anxiety and Depression Scale, *CSQ-R* Coping Strategies Questionnaire–Revised (pain catastrophizing subscale), *LOT-R* Life Orientation Test–Revised

†$p \leq 0.10$; *$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$

[a] Continuous variable, in years

[b] Continuous variable, numerical rating scale 0–10 from Brief Pain Inventory–short form (BPI-SF)

[c] Dichotomous variable: 0=no; 1=yes

[d] Dichotomous variable: 0=major joint arthroplasty; 1=hysterectomy

(ΔF=6.060, p<0.001), explaining 7.7 % of the variance in the outcome. Depression and pain catastrophizing contributed the most to the explained variance, with higher depression and pain catastrophizing being associated with more acute post-surgical pain report. Pain catastrophizing was the only significant unique psychological predictor of pain post-surgery (t (241)=2.962, β=0.211, p=0.003) for abdominal hysterectomy and major joint arthroplasty jointly. Hypothesis 2 tested whether surgery type moderated associations between each psychological parameter and acute post-surgical pain (Table 4). This hypothesis was only partially supported since optimism was the only psychological variable revealing a significant interaction with surgery type in the prediction of post-surgical pain (t (242)=3.755, β=0.402, p<0.001). Pain catastrophizing, which had been a significant predictor for both surgeries in the previous model, did not interact with surgery type.

Given the above results, we proceeded with conducting separate regression analyses for abdominal hysterectomy and major joint arthroplasty, with demographic and clinical correlates for each surgery type entered in the first blocks and “optimism” entered last in the models. The results of the multiple hierarchical regression analysis for abdominal hysterectomy are presented in Table 5. Age was inserted in the first block, showing a predictive role (t (139)=−3.179, β= −0.260, p=0.002) and explaining 6.8 % of the variance in post-surgical pain intensity. In the second block, pre-surgical pain and pain due to other causes were added, as the only pre-surgical clinical variables significantly associated with the dependent variable, both emerging as significant predictors (t (137)=2.240, β=0.190, p=0.027; t (137)=2.277, β=0.185, p=0.024, respectively) and accounting for an additional 8.4 % of the variance. Surgical incision type was entered in the third block, showing the predictive role of pfannenstiel incision (t (136)=2.189, β=0.173, p=0.030) and adding 2.9 % to the explained variance of the outcome. Optimism, entered in the last block (Table 5), did not reach significance, adding 0 % to the explained variance. In the final model, which explained 18.0 % of the variance, pre-surgical pain intensity was only marginally significant (t (135)=1.854, β=0.159, p=0.066) ,

Table 4 Hierarchical multiple regression results regarding for the test of moderation effects of type of surgery concerning the impact of psychological variables on acute post-surgical pain intensity 48 h after abdominal hysterectomy ($n=142$) or major joint arthroplasty ($n=110$) (total sample)

Variables	t	β	R^2	ΔR^2	ΔF
Block 1				0.032	8.304**
Type of surgery[a]	−2.882**	−0.179			
Block 2			0.168	0.136	10.058***
HADS: anxiety	1.059	0.083			
HADS: depression	1.214	0.092			
CSQ-R: pain catastrophizing	3.766***	0.272			
LOT-R: optimism	0.354	0.025			
Final model			0.216		
Block 1					
Type of surgery[a]	−3.740***	−0.223			
Block 2					
HADS: anxiety	0.125	0.015			
HADS: depression	0.055	0.007			
CSQ-R: pain catastrophizing	1.679†	0.176			
LOT-R: optimism	−2.723**	−0.299			
Block 3				0.048	3.719**
HADS: anxiety × type of surgery[b]	0.758	0.090			
HADS: depression × type of surgery[b]	0.825	0.098			
CSQ-R: pain Catastrophizing × type of surgery[b]	1.138	0.117			
LOT-R: optimism × type of surgery[b]	3.755***	0.402			

HADS Hospital Anxiety and Depression Scale, *CSQ-R* Coping Strategies Questionnaire–Revised (pain catastrophizing subscale), *LOT-R* Life Orientation Test–Revised

†$p\leq0.10$; **$p\leq0.01$; ***$p\leq0.001$

[a] Dichotomous variable: 0=major joint arthroplasty; 1=hysterectomy

[b] Interaction terms between each psychological variable and type of surgery

although age ($t\,(135)=-2.626$, $\beta=-0.216$, $p=0.010$), pain due to other causes ($t\,(135)=2.279$, $\beta=0.185$, $p=0.024$), and surgical incision type ($t\,(135)=2.176$, $\beta=0.173$, $p=0.031$) remained significant predictors.

For the prediction of post-surgical pain intensity after major joint arthroplasty (Table 6), both sex and age were inserted in the first block. Sex yielded significant results ($t\,(107)=4.223$, $\beta=0.384$, $p<0.001$), and this block explained 16.1 % of the variance in post-surgical pain. Pre-surgical pain intensity was entered next, along with pain due to other causes, but only the latter reached significance ($t\,(105)=2.184$, $\beta=0.208$, $p=0.031$), accounting for an additional 6.5 % of the variance. In the third block, site of arthroplasty was entered and was a significant predictor ($t\,(104)=2.145$, $\beta=0.193$, $p=0.034$), adding 3.3 % to the explained variance of the outcome. Optimism was added as the last block, constituting a significant predictor ($t\,(103)=-3.461$, $\beta=-0.297$, $p=0.001$) and explaining an additional 7.7 % of the variance. This final model explained 33.6 % of the variance with pre-surgical pain becoming a significant predictor ($t\,(102)=2.407$, $\beta=0.211$, $p=0.018$).

Discussion

To our knowledge, this is the first study aiming to compare different types of surgery regarding demographic, clinical, and psychological acute pain predictors. It aimed to identify specific psychological risk factors for acute post-surgical pain, after abdominal hysterectomy and major joint arthroplasties, in order to inform the development of pre-surgical psychological pain interventions for improving post-surgical pain management.

Findings confirmed the role of pre-surgical emotional and cognitive psychological factors in acute post-surgical pain. Anxiety, depression, and pain catastrophizing were important factors across surgeries, although pain catastrophizing was the strongest and only unique psychological predictor. Optimism emerged as the only differential predictor according to type of surgery (moderator effect). More specifically, pre-surgical optimism, a personality trait, was the best predictor of acute post-surgical pain intensity in major joint arthroplasty, along with pre-surgical pain. In abdominal hysterectomy, this model could not be reproduced.

Table 5 Hierarchical multiple regression model for pre-surgical and surgical predictors of post-surgical pain intensity 48 h after abdominal hysterectomy (n=142)

Variables	t	β	R^2	ΔR^2	ΔF
Block 1				0.068	10.105**
Age[a]	−3.373***	−0.274			
Block 2				0.084	6.743**
Pre-surgical pain intensity[b]	2.240*	0.190			
Pain due to other causes[c]	2.277*	0.185			
Block 3				0.029	4.793*
Surgical incision[d]	2.189*	0.173			
Final model			0.180		
Block 1					
Age[a]	−2.626**	−0.216			
Block 2					
Pre-surgical pain intensity[b]	1.854†	0.159			
Other previous pain states[c]	2.279*	0.185			
Block 3					
Surgical incision[d]	2.176*	0.173			
Block 4				0.000	0.000
LOT-R: optimism	−0.013	−0.001			

T1 24 h before surgery, *T2* 48 h after surgery, *LOT-R* Life Orientation Test–Revised

†$p\leq0.10$; *$p\leq0.05$; **$p\leq0.01$; ***$p\leq0.001$

[a] Continuous variable, in years

[b] Continuous variable, numerical rating scale 0–10 from Brief Pain Inventory–short form (BPI-SF)

[c] Dichotomous variable: 0=no; 1=yes

[d] Dichotomous variable: 0=vertical incision, 1=pfannenstiel incision

Instead, an integrative predictive model was found, revealing the simultaneous role of age, other previous pain states and surgical incision type, and a marginal role of pre-surgical pain intensity.

Present findings highlight the relevance of addressing psychological risk factors, at pre-surgery, for both major joint arthroplasty and abdominal hysterectomy. They also suggest that there may be some specific psychological risk factors according to type of surgery that can be targeted in order to more effectively reduce acute post-surgical pain, such as optimism for major joint arthroplasty.

Psychological Predictors of Acute Pain for Both Abdominal Hysterectomy and Major Joint Arthroplasty

All the psychological factors under analysis were significant correlates of post-surgical pain intensity and jointly predicted acute pain across both surgeries, which fit into the gate control theory [4] and the neuromatrix theory [5] of pain. These theories argue that pain is a multidimensional subjective experience resulting from complex interactions between sensory-discriminative, motivational-affective, and cognitive-evaluative dimensions. Accordingly, it was not surprising that all psychological factors under study, either affective or cognitive, had a significant influence on acute pain across surgeries exacerbating (anxiety, depression, and pain catastrophizing) or inhibiting (optimism) the experience of pain [6]. It is important to note that these psychological variables added unique variance to the role of pre-surgical pain variables in the explanation of pain post-surgery. Additionally, pre-surgical pain intensity was significantly correlated with pain catastrophizing and optimism, suggesting shared variance and a combined effect on post-surgical pain.

Within the motivational-affective dimensions, the predictive role of anxiety and depression has already been established regardless of the type of surgery [3, 7, 9]. Within the cognitive-evaluative dimensions, pain catastrophizing [8, 12, 15, 17, 18] and optimism [19–21] have also been reported as exerting a significant influence on post-surgical pain.

In the current study, for both surgery types, pain catastrophizing emerged as the only unique psychological predictor of acute pain intensity post-surgery, corroborating the results of previous studies [8, 16–18]. Actually, pain catastrophizing has been identified as the most important and consistent predictor of pain, both in surgical and non-surgical contexts [3, 7, 13, 14].

Table 6 Hierarchical multiple regression model for pre-surgical and surgical predictors of post-surgical pain intensity 48 h after major joint arthroplasty (n=110)

Variables	t	β	R^2	ΔR^2	ΔF
Block 1				0.161	10.238***
Sex[a]	4.223***	0.384			
Age[b]	0.615	0.056			
Block 2				0.065	4.403*
Pre-surgical pain intensity[c]	1.807†	0.167			
Pain due to other causes[d]	2.184*	0.208			
Block 3				0.033	4.603*
Site of arthroplasty[e]	2.145*	0.193			
Final model			0.336		
Block 1					
Sex[a]	1.679†	0.163			
Age[b]	0.622	0.053			
Block 2					
Pre-surgical pain intensity[c]	2.407*	0.211			
Other previous pain states[d]	1.165	0.108			
Block 3					
Site of arthroplasty[e]	1.818†	0.156			
Block 4				0.077	11.978***
LOT-R: optimism[f]	−3.461***	−0.297			

T1 24 h before surgery, *T2* 48 h after surgery, *LOT-R* Life Orientation Test–Revised

†$p \leq 0.10$; *$p \leq 0.05$; ***$p \leq 0.001$

[a] Dichotomous variable: 0=men, 1=women

[b] Continuous variable, in years

[c] Continuous variable, numerical rating scale 0–10 from Brief Pain Inventory–short form (BPI-SF)

[d] Dichotomous variable: 0=no, 1=yes

[e] Dichotomous variable: 0=hip, 1=knee

[f] Continuous variable

Differential Predictors of Abdominal Hysterectomy and Major Joint Arthroplasty

The hypothesized differential prediction of pain post-surgery by emotional and cognitive pre-surgical variables was only supported for optimism. The results seem to suggest that in terms of psychological factors, anxiety and depression, and pain catastrophizing operate jointly to impact post-surgical pain for both abdominal hysterectomy and major joint arthroplasty patients. This seems to indicate that there is an emotional-cognitive set of core psychological factors that need to be attended to independently of surgery type.

However, the separate analyses per type of surgery also indicate that there may be specific psychological factors for certain types of surgery. This was the case for optimism in major joint arthroplasty. The diseases underlying the surgeries targeted here are distinct and consequently may be perceived differently by patients. The diseases underlying arthroplasties are usually perceived by patients as being chronic, entailing several limitations and having a strong impact on quality of life, which might explain why optimism arose as a main predictor. Overall, dispositional optimism, a generalized expectation that good things will happen [22], has been identified as a significant predictor of positive outcomes in a variety of health- and disease-related conditions [22, 23, 40]. Given that arthroplasties arise as the last and only solution for certain impairments, it is plausible that those patients who are optimistic will face the surgical experience in a more positive frame of mind, focusing less on its negative aspects, such as acute post-surgical pain [40]. This could affect their pain perception, probably because they would be less attentive to pain stimuli [23, 41], focusing on their hopeful medium-term life improvements rather than on temporary but necessary present difficulties, and consequently more keen to accept pain as a part of the short-term post-surgical period. Indeed, it has been suggested that persons with higher levels of optimism may be more prone to report greater hopefulness and pain acceptance, with both being linked to better pain outcomes [42–44]. This perspective could also lead optimistic patients to engage in more adaptive coping strategies, such as positive reinterpretation, acceptance, and reliance on problem-focused coping [45].

Although there were no specific psychological predictors for abdominal hysterectomy, a different set of demographic and clinical predictors (e.g., age, pre-surgical pain) emerged for this type of surgery versus major joint arthroplasty, further supporting the idea that each type of surgery carries different threats and specific personal issues to deal with [24, 25]. Abdominal hysterectomy refers to the surgical removal of the uterus and is indicated for women with benign disorders, such as uterine fibroids, endometriosis, or pelvic pain. Although it is also indicated for malign disease, these were not included in the current study, to avoid dealing with the strong emotional cancer-related issues. On the other hand, major joint arthroplasty is mostly performed amongst individuals who present chronic long-term diseases, such as osteoarthritis and similar inflammatory and degenerative diseases. These chronic illnesses have a stronger impact on the individual's quality of life than the benign conditions that lead to abdominal hysterectomy. It is likely that the differences found in predictors of acute post-surgical pain for these two types of surgery may be due in part to the different types of underlying illnesses, both in terms of patient perceptions of the illness characteristics (e.g., duration and symptoms), as well as the impact that the illness may have in the person's life.

Regarding the abdominal hysterectomy sample, the aim of surgery was usually to improve symptoms associated with gynecologic disorders, with pre-surgical pain being an issue for most (70 % of sample) but not all of the patients, which was not the case of major joint arthroplasty (100 % had pre-surgical pain). Moreover, generally those women undergoing hysterectomy had a pre-surgical life without significant disease-associated functional impairments, likely perceiving surgery as something not as vital to improve their quality of life as osteoarthritis patients, which might explain why optimism did not come up as a significant predictor. For these women, other factors, such as the fear of losing their uterus and the impact of surgery on fertility, body image, and sexuality [31, 46, 47] may influence their perception of the surgical procedure (e.g., as being a potential threat on reproduction or sexuality). Indeed, in the current study, younger women, for whom negative consequences would be more salient, were more likely to report higher levels of post-surgical pain. Pre-surgical pain experience and surgical incision (pfannenstiel) also revealed a significant predictive role on post-surgical pain after abdominal hysterectomy, which is in line with previous results. [18, 48].

The findings of the current study indicate that for different types of surgery (in this case, abdominal hysterectomy and major joint arthroplasty), specific demographic, clinical, and psychological predictors may explain variations in acute post-surgical pain. This finding is novel and can have important clinical implications. Previous studies that explored risk factors for post-surgical pain, either acute or chronic, took into account surgery type as a covariate or a potential predictor [12, 16, 21, 25]. Other studies measured the amount of pain in different surgical categories, such as abdominal, orthopedic, or other types of surgery [26, 27]. The present study had a different aim, to test whether the same set of psychological predictors could distinctly or similarly associate with acute pain post-surgery, in different types of surgery. The unique work similar to ours that we are aware of is the recent publication of Masselin-Dubois and colleagues [28], although centered on chronic post-surgical pain and using total knee arthroplasty and breast surgery as the surgeries being compared. They found common predictive factors by type of surgery, which is in line with the core psychological set of predictors found in this study across abdominal hysterectomy and major joint arthroplasty. The novel contribution of our study is the finding of optimism as a differential psychological predictor for major joint arthroplasty and the set of distinct demographic and clinical predictor for abdominal hysterectomy versus major joint arthroplasty. Both of these findings have important clinical implications as explained later.

Limitations of the Study

In terms of external validity, this is a single site and single country study, and thus, the generalization of the results to other populations should be considered with caution. Regarding internal validity, surgical, anesthetic, and analgesic procedures within each type of surgery could not be compared due to the specific features and different clinical nature of each surgery, as well as to their different standardized guidelines which determine distinct anesthetic and analgesic protocols. The small sample size of the present study is also a limitation preventing the drawing of definitive conclusions. There is need for more evidence from larger studies in order to replicate these findings.

Moreover, by directly comparing hysterectomies with arthroplasties, we are aware of a potential confounding effect associated with the variable sex, which has previously showed a significant association with surgical pain [15, 49]. Nevertheless, in an attempt to circumvent this issue, the abdominal hysterectomy sample was compared both with the total major joint arthroplasty sample and with the women major joint arthroplasty subsample.

Clinical Practice Implications

The common set of psychological predictors found for abdominal hysterectomy and major joint arthroplasty patients indicates that pre-surgical psychological screening and intervention directed at emotional (e.g., anxiety) and cognitive factors (pain catastrophizing) is a key component of surgical patient care. Based on current findings, pre-surgical psychological interventions should address emotional factors and pain catastrophizing cognitions. These interventions within a cognitive-behavioral therapy framework should aim, for instance, at challenging and substituting those negative cognitions with positive pain coping self-statements [50, 51], as well as be focused on techniques aimed at reducing pre-surgical anxiety, such as relaxation or distraction [52]. Depression is another aspect to be considered, especially in longstanding conditions, such as major joint arthroplasty, which are likely to carry with them feelings of hopelessness, and affect several sources of self-esteem (e.g., work and family).

The most novel implication of the present findings is to highlight the relevance of targeting specific risk factors according to type of surgery in order to more effectively reduce acute post-surgical pain. This knowledge might feed into acute pain clinical practice by shifting the focus of assessment and intervention practice toward recognizing the relevance of pre-surgical screening and surgical preparation of patients. Pre-surgical pain intensity was found to be associated with pain catastrophizing and optimism. Therefore, a careful evaluation of pre-surgical pain intensity, together with cognitive factors, may have a synergistic effect in reducing post-surgical pain. Previous studies have already shown that targeting and intervening in a key psychological predictor of surgical pain (e.g., pain catastrophizing) proved to have positive effects on the latter [50, 51].

The specific predictive models found for abdominal hysterectomy and major joint arthroplasty may guide the design of pre-surgical interventions. In terms of differential predictors, age was an important factor in the prediction of abdominal hysterectomy post-surgical pain, indicating that younger women are at higher risk and, therefore, need to be targeted for psychological and clinical preparation. Regarding major joint arthroplasty, preliminary evidence indicates that optimism is especially important for the prediction of pain. Even though optimism is typically described as a trait [40, 53] and thus might be less amenable to clinical intervention than emotional factors and pain catastrophizing, there are studies which have shown the success of interventions on the augmentation of optimism levels [54–58]. A specific example is the “best possible self” technique [56–58], a positive future thinking and imagery technique, focused on optimism induction, which showed to increase optimism levels and thereby also led to diminished pain sensitivity in a cold pressor task [57]. This best possible self imagery exercise entails a writing and visualization exercise [56–58] and corroborates recent findings [59] which show that dispositional optimism is associated with the capacity to create vivid positive mental imagery of the future. It thus emphasizes that fostering positive future imagery could be a suitable intervention to promote optimism levels, with expected implications for post-surgical pain control and management.

Although needing replication, current findings of common as well as differential psychological predictors of acute post-surgical pain in abdominal hysterectomy and major joint arthroplasty encourage further research on testing predictive models of post-surgical pain in other types of surgery, which include demographic, clinical, and psychological factors. These models could inform more effective and comprehensive intervention development directed at post-surgical pain management.

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References

1. Apfelbaum J, Chen C, Mehta S, Gan T. Postoperative pain experience: Results from a national survey suggest postoperative pain continues to be undermanaged. *Anesth Analg*. 2003; 97: 534-540.
2. Schug SA. The Global Year Against Acute Pain. *Anaesth Intensive Care*. 2011; 39: 11-14.
3. Macintyre PE, Schug SA, Scott DA, Visser EJ, Walker SM. *Working Group of the Australian and New Zealand College of Anaesthetists and Faculty of Pain Medicine. Acute pain management: Scientific evidence*. 3rd ed. Melbourne: Australian and New Zealand College of Anaesthetists and Faculty of Pain Medicine; 2010.
4. Melzack R. Pain – an overview. *Acta Anaesthesiol Scand*. 1999; 43: 880-884.
5. Melzack R. From the gate to the neuromatrix. *Pain Suppl*. 1999; 6: S121-S126.
6. Tracey I, Mantyh PW. The cerebral signature for pain perception and its modulation. *Neuron*. 2007; 55: 377-391.
7. Burns JW, Moric M. Psychosocial factors appear to predict postoperative pain: Interesting, but how can such information be used to reduce risk? *Tech Reg Anesth Pain Manag*. 2011; 15: 90-99.
8. Granot M, Ferber SG. The roles of pain catastrophizing and anxiety in the prediction of postoperative pain intensity: A prospective study. *Clin J Pain*. 2005; 21: 439-445.
9. Ip HYV, Abrishami A, Peng PWH, Wong J, Chung F. Predictors of postoperative pain and analgesic consumption: A qualitative systematic review. *Anesthesiology*. 2009; 111: 657-677.
10. Rakel BA, Blodgett NP, Zimmerman MB, et al. Predictors of postoperative movement and resting pain following total knee replacement. *Pain*. 2012; 153(11): 2192-2203.
11. Theunissen M, Peters ML, Bruce J, Gramke HF, Marcus MA. Preoperative anxiety and catastrophizing: A systematic review and meta-analysis of the association with chronic postsurgical pain. *Clin J Pain*. 2012; 28(9): 819-841.

12. 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.
13. Quartana PJ, Campbell CM, Edwards RR. Pain catastrophizing: A critical review. *Expert Rev Neurother*. 2009; 9: 745-758.
14. Sullivan MJL, Thorn B, Haythornthwaite JA, et al. Theoretical perspectives on the relation between catastrophizing and pain. *Clin J Pain*. 2001; 17: 52-64.
15. Sullivan M, Tanzer M, Stanish W, et al. Psychological determinants of problematic outcomes following Total Knee Arthroplasty. *Pain*. 2009; 143: 123-129.
16. Sommer M, Geurts JW, Stessel B, et al. Prevalence and predictors of postoperative pain after ear, nose, and throat surgery. *Arch Otolaryngol Head Neck Surg*. 2009; 135(2): 124-130.
17. Papaioannou M, Skapinakis P, Damigos D, et al. The role of catastrophizing in the prediction of postoperative pain. *Pain Med*. 2009; 10(8): 1452-1459.
18. Pinto P, McIntyre T, Almeida A, Araújo-Soares V. The mediating role of pain catastrophizing in the relationship between presurgical anxiety and acute postsurgical pain after hysterectomy. *Pain*. 2012; 153: 218-226.
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(6): 937-946.
20. Pinto PR, McIntyre T, Ferrero R, Almeida A, Araujo-Soares V. Predictors of acute post-surgical pain and anxiety following primary total hip and knee arthroplasty. *J Pain*. 2013; 14(5): 502-515.
21. Peters ML, Sommer M, de Rijke JM, et al. Somatic and psychological predictors of long-term unfavorable outcome after surgical intervention. *Ann Surg*. 2007; 245: 487-494.
22. Rasmussen HN, Scheier MF, Greenhouse JB. Optimism and physical health: A meta-analytic review. *Ann Behav Med*. 2009; 37: 239-256.
23. Goodin BR, Bulls HW. Optimism and the Experience of Pain: Benefits of Seeing the Glass as Half Full. *Curr Pain Headache Rep*. 2013; 17(5): 1-9.
24. Johnston M. Emotional and cognitive aspects of anxiety in surgical patients. *Commun Cogn*. 1987; 20: 245-260.
25. Kalkman CJ, Visser K, Moen J, Bonsel GJ, Grobbee DE, Moons KGM. Preoperative prediction of severe postoperative pain. *Pain*. 2003; 105: 415-423.
26. Meissner W, Mescha S, Rothaug J, et al. Quality Improvement in Postoperative Pain Management - Results From the QUIPS Project. *Dtsch Ärzteblatt Int*. 2008; 105(50): 865-870.
27. Coll AM, Ameen J. Profiles of pain after day surgery: Patients' experiences of three different operation types. *J Adv Nurs*. 2006; 53(2): 178-187.
28. Masselin-Dubois A, Attal N, Fletcher D, et al. Are Psychological Predictors of Chronic Postsurgical Pain Dependent on the Surgical Model? A Comparison of Total Knee Arthroplasty and Breast Surgery for Cancer. *J Pain*. 2013; 14(8): 854-864.
29. Recker DC, Perry PM. Postsurgical pain syndromes: Chronic pain after hysterectomy and cesarean section. *Tech Reg Anesth Pain Manag*. 2011; 15: 133-139.
30. Vilardo L, Shah M. Chronic pain after hip and knee replacement. *Tech Reg Anesth Pain Manag*. 2011; 15: 110-115.
31. Schwartz S, Williams D. Psychological aspects of gynecologic surgery. *J Gynecol Oncol*. 2002; 7: 268-279.
32. Cleeland C, Ryan KM. Pain assessment: Global use of the Brief Pain Inventory. *Ann Acad Med Singap*. 1994; 23: 129-138.
33. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. *Acta Psychiatr Scand*. 1983; 67: 361-370.
34. Scheier MF, Carver CS, Bridges MW. Distinguishing Optimism From Neuroticism (and Trait Anxiety, Self-Mastery, and Self-Esteem): A Reevaluation of the Life Orientation Test. *J Pers Soc Psychol*. 1994; 67(6): 1063-1078.
35. Riley JL, Robinson ME. CSQ: Five factors or fiction? *Clin J Pain*. 1997; 13: 156-162.
36. Jensen MP, Hu X, Potts SL, Gould EM. Single versus composite measures of pain intensity: Relative sensitivity for detecting treatment effects. *Pain*. 2013; 154(4): 534-538.
37. Spadoni GF, Stratford PW, Solomon PE, Wishart LR. The evaluation of change in pain intensity: A comparison of the P4 and single-item numeric pain rating scales. *J Orthop Sports Phys Ther*. 2004; 34(4): 187-193.
38. Cronbach LJ. Coefficient alpha and the internal structure of tests. *Psychometrika*. 1951; 16: 297-334.
39. Cohen J. *Statistical power analysis for the behavioural sciences*. 2nd ed. Hillsdale: Lawrence Erlbaum Associates; 1988.
40. Carver CS, Scheier MF, Segerstrom SC. Optimism. *Clin Psychol Rev*. 2010; 30(7): 879-889.
41. Affleck G, Tennen H, Apter A. Optimism, pessimism, and daily life with chronic illness. In: Chang EC, ed. *Optimism and pessimism: Implications for theory, research, and practice*. Washington: American Psychological Association; 2001: 147-168.
42. Snyder CR, Berg C, Woodward JT, et al. Hope against the cold: Individual differences in trait hope and acute pain tolerance on the cold pressor task. *J Pers*. 2005; 73: 287-312.
43. McCracken LM, Eccleston C. A prospective study of acceptance of pain and patient functioning with chronic pain. *Pain*. 2005; 118: 164-169.
44. McCracken LM, Vowles KE. A prospective analysis of acceptance of pain and values-based action in patients with chronic pain. *Health Psychol*. 2008; 27: 215-220.
45. Scheier MF, Weintraub JK, Carver CS. Coping with stress: Divergent strategies of optimists and pessimists. *J Pers Soc Psychol*. 1986; 51: 1257-1264.
46. Ayoubi JM, Fanchin R, Monrozies X, Imbert P, Reme JM, Pons JC. Respective consequences of abdominal, vaginal, and laparoscopic hysterectomies on women's sexuality. *Eur J Obstet Gynecol Reprod Biol*. 2003; 111: 179-182.
47. Dragisic KG, Milad MP. Sexual functioning and patient expectations of sexual functioning after hysterectomy. *Am J Obstet Gynecol*. 2004; 190: 1416-1418.
48. Loos MJ, Scheltinga MR, Mulders LG, Roumen RM. The Pfannenstiel incision as a source of chronic pain. *Obstet Gynecol*. 2008; 111(4): 839-846.
49. Singh JA, Gabriel S, Lewallen D. The impact of gender, age, and preoperative pain severity on pain after TKA. *Clin Orthop Relat Res*. 2008; 466(11): 2717-2723.
50. Riddle D, Keefe F, Ang D, et al. A phase III randomized three-arm trial of physical therapist delivered pain coping skills training for patients with total knee arthroplasty: The KASTPain protocol. *BMC Musculoskelet Disord*. 2012; 13(1): 149-170.
51. Riddle DL, Keefe FJ, Nay WT, McKee D, Attarian DE, Jensen MP. Pain coping skills training for patients with elevated pain catastrophizing who are scheduled for knee arthroplasty: A quasi-experimental study. *Arch Phys Med Rehabil*. 2011; 92(6): 859-865.
52. Bruehl S, Chung OY. Psychological Interventions for Acute Pain. In: Hadjistavropoulos T, Craig KD, eds. *Pain: Psychological Perspectives*. Mahwah: Lawrence Erlbaum Associates; 2004: 245-269.
53. Scheier MF, Carver CS. Optimism, coping, and health: Assessment and implications of generalized outcome expectancies. *Health Psychol*. 1985; 4: 219-47.
54. Antoni MH, Lehman JM, Kilbourn KM, et al. Cognitive-behavioral stress management intervention decreases the prevalence of depression and enhances benefit finding among women under treatment for early-stage breast cancer. *Health Psychol*. 2001; 20: 20-32.
55. Fosnaugh J, Geers AL, Wellman JA. Giving off a rosy glow: The manipulation of an optimistic orientation. *J Soc Psychol*. 2009; 149(3): 349-64.

56. Hanssen MM, Peters ML, Vlaeyen JW, Meevissen Y, Vancleef LM. Optimism lowers pain: Evidence of the causal status and underlying mechanisms. *Pain*. 2012; 154: 53-58.
57. Meevissen Y, Peters ML, Alberts HJ. Become more optimistic by imagining a best possible self: Effects of a two week intervention. *J Behav Ther Exp Psychiatry*. 2011; 42(3): 371-378.
58. Peters ML, Flink IK, Boersma K, Linton SJ. Manipulating optimism: Can imagining a best possible self be used to increase positive future expectancies? *J Posit Psychol*. 2010; 5(3): 204-211.
59. Blackwell SE, Rius-Ottenheim N, Schulte-vanMaaren Y, et al. Optimism and mental imagery: A possible cognitive marker to promote well-being? *Psychiatry Res*. 2013; 206: 56-61.