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# Heterogeneous influences of emotional disturbances on multi-domain quality of life after anterior cervical spine surgery: A prospective study

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### Highlights

- More than 1/3 (38%) patients reported significant anxious symptoms after C-spine surgery.
- Depression and anxiety were significantly associated with post-operative quality of life.
- Patients who scored more than 17 on the pre-operative BAI reported more unfavorable post-operative quality of life.

### Abstract

#### Objective

Quality of life (QoL) has been identified as one of the most important outcome measurements following [cervical spine surgery](#). The contributing factors to post-operative QoL remain limited. This study thus aimed to prospectively examine the QoL and related pre-operative emotional factors in patients who underwent anterior cervical spine surgery.

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A total of 124 patients who underwent anterior cervical spine surgery were recruited. All participants were prospectively evaluated for their QoL and 2 aspects of emotion, depression and anxiety, before and after surgery, respectively.

## Results

Pre-operatively, 13% of patients showed signs of depression and 31% of patients reported symptoms of anxiety. Post-operatively 14% of patients reported depression, but 41% reported symptoms of anxiety. A significant association between depression, anxiety and different domains of QoL were identified, and specific cut-off points of pre-operatively depressive and/or anxiety levels to predict unfavorable post-operative QoL were further established.

## Conclusions

This [prospective study](#) demonstrated specific emotional factors, specifically depression and anxiety, influence patients' QoL following surgery. These results suggest clinicians should also monitor patients' [emotional adjustments](#) with their physical conditions.

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## Keywords

Cervical; Spinal surgery; Anxiety; Depression; Quality of life

## 1. Introduction

[Spinal surgery](#) is one of the most common surgical procedures in developed countries [1]. In the United States between 1990 and 2001, a 220% increase in the number of lumbar fusion procedures has been reported [1]. Similarly, the nationwide health statistics in Taiwan reported that more than thirty thousand patients received spinal surgery in 2011 [2]. In addition to symptoms directly attributable to lesions of the spinal cord (e.g., [limb weakness](#) and numbness), quality of life (QoL) has been recently employed to subjectively evaluate clinical outcomes following spinal surgery [[3], [4], [5]]. Chaichana et al. [3] evaluated 67 patients undergoing [discectomy](#) for a single-level [herniated lumbar disc](#), and reported a significant improvement in QoL by 12-months postoperatively. Fujimori et al. [4] reported similar findings, more than 80% of patients with [ossification](#) of the [posterior longitudinal ligament](#) (OPLL) reported both satisfaction with the results of surgery and a significant improvement in their QoL.

Although spinal surgery may improve patient QoL, recent evidence has suggested that specific [psychosocial factors](#) may also profoundly influence self-reporting by patients of postoperative well-being [6,7]. Skolasky et al. [6] reported that depressive symptoms were observed but significantly reduced at 6 months after spinal surgery. Moreover, Li et al. [7] recently reported

patients undergoing cervical total disc replacement.

To date, most studies [[8], [9], [10], [11]] have focused on assessing QoL after lumbar surgery rather than following [cervical spine](#) procedures. Although several recent studies have begun to address the relationship between emotional factors and the QoL after cervical spine surgery [7,12], the relationship between QoL assessment and specific emotional factors, including depression and anxiety, remain unclear. For example, Elsamadicy et al. [13] compared clinical outcomes between patients with and without depressive disorders after cervical spinal surgery. They found treatment with antidepressants before surgery significantly improved patients' post-operative functional disability. However, Mayo et al. [14] examined the associations between mental health and post-operative outcomes in 52 patients who underwent [anterior cervical discectomy and fusion](#). An association between pre-operative mental health status to post-operative clinical outcomes was not demonstrated. To resolve above controversy, this [prospective study](#) thus sought to directly evaluate simultaneous influences of specific [emotional disturbances](#), depression and anxiety, on different domains of post-operative QoL in patients undergoing cervical spine surgery.

## 2. Materials and methods

### 2.1. Participants

Between January 2013 through July 2015, a total of 124 patients diagnosed with [cervical spondylosis](#) (34% female, 66% male), were screened by the research staff at our medical center. All participants agreed to participate in this study and provided written informed consent. All protocols were approved by the Research Ethics Committee of our Institution. Cervical spondylosis was assessed in all [study participants](#) and surgically corrected by a neurosurgeon based on [neuroimaging](#) information that showed an absence of [cerebrospinal fluid](#) (CSF) signal with or without spinal cord edema and/or spinal atrophy at the level of the [cervical spine](#) using sagittal T2-weighted [magnetic resonance imaging](#) (MRI). Demographic data is presented in [Table 1](#) (mean age = 56.3 years; mean educational level = 12.93 years).

Table 1. Patients' demographical information.

	Participants (N = 124)
<b>Sex (% of female)</b>	34
<b>Age (mean ± standard deviation)</b>	56.25 ± 10.72 (range: 30–80)
<b>Formal education years (mean ± standard deviation)</b>	12.80 ± 3.59 (range: 5-18)
<b>Time for evaluation (days after surgery, mean ± standard deviation)</b>	124.19 ± 65.56 (range: 39–491)
<b>Cervical Spondylosis</b>	

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<b>Myelopathy</b>	N = 81 (65%)
<b>Radiculopathy</b>	N = 36 (29%)
<b>Myelopathy + Radiculopathy</b>	N = 7 (6%)

N: number of participants.

## 2.2. QoL measures

The Taiwanese version of the World Health Organization short-form QoL instrument [15] was used to evaluate QoL. The WHOQOL-BREF is a 5-point [Likert scale](#), which consists of 28 items and can be further subdivided into 5 specific domains (Physical Health, Psychological, [Social Relationship](#), Environmental and Global Factors). The Taiwanese WHOQOL-BREF has been shown to possess good reliability and acceptable validity.

## 2.3. Assessment of emotional factors

In this study, the Beck's [Depression Inventory II](#) – Chinese version (BDI-II) [16] was used to evaluate symptoms of clinical depression. This inventory utilizes a 21-item and 4-point Likert scale, which requires the patient to evaluate their emotional status for two weeks post-surgery. The BDI-II has been shown to have good reliability and validity [16], and may be used to assess the severity of clinical depression (Normal = BDI-II score < 14; Mildly depressive = BDI-II score between 14–19; Moderately depressive = BDI-II score between 20–28; and Severely depressive = BDI-II score between 29–63).

Clinical anxiety was evaluated by the [Beck Anxiety Inventory](#) – Chinese version (BAI) [17]. The BAI uses a 21-item and 4-point Likert scale, whose reliability and validity has also been documented [17]. Patients were required to rate their anxiety symptoms during the first week post-surgery. Anxiety severity may also be classified using the total BAI score (Normal = A BAI score < 8; Mildly anxious = BAI score between 8–15; Moderately anxious = BAI score between 16–25; and Severely anxious = BAI score between 26–63).

## 2.4. Study protocol

All participants were evaluated for emotional factors and QoL (1) prior to surgery and (2) at 4 months post-surgery (mean = 129 ± 70.10 days).

## 2.5. Data analysis

According to the published criteria for the BDI-II test, all patients were further subdivided into depressive (BDI-II score  $\geq 14$ ) and non-depressive (BDI-II score < 14) groups. Similarly, patients were subdivided into anxious (BAI  $\geq 8$ ) and non-anxious (BAI < 8) groups based on the published criteria for the BAI test. For QoL, patients were subdivided into two categories representing (1) “favorable” outcome (the score of each domain of QoL  $\geq 11$ ) or (2) “unfavorable” outcome (the score of each domain of QoL < 11). A one-way analysis of variance (ANOVA) was

with “favorable vs. unfavorable” post-operative QoL. In addition, repeated measures ANOVA with Bonferroni correction (type I error  $\alpha$  was set at 0.05) was used to compare pre- and post-operative BDI-II, BAI, and QoL scores. The association between pre- and post-operative emotions and post-operative QoL were analyzed using a Spearman’s rho correlation coefficient. Finally, the receiving operating curve (ROC) was used to establish a cut-off point for depressive and/or anxious levels to predict post-operative favorable QoL. Commercially available software (SPSS version 17.0; SPSS, Inc; Chicago, IL) was employed for statistical analyses.

### 3. Results

#### 3.1. Pre-operative and post-operative depression, anxiety, and QoL (Figs. 1 and 2)

All patients were subdivided into 3 groups: **myelopathy** (MY), **radiculopathy** (RA) and myelopathy plus radiculopathy groups (MY + RA), since different pre-operative **neuropathology** might be present in patients with **cervical spondylosis**. A total of 65% of patients were in the MY group, 29% in the RA group, and 6% in the MY + RA group. However, no significant differences between demographic variables (age:  $F = 1.45$ ,  $p = .24$ ; formal educational years:  $F = .09$ ,  $p = .91$ ) and **emotional disturbances** before (BDI-II:  $\chi^2 = 2.07$ ,  $p = .36$ ; BAI:  $\chi^2 = 1.02$ ,  $p = .60$ ) and after (BDI-II:  $\chi^2 = .99$ ,  $p = .61$ ; BAI:  $\chi^2 = .36$ ,  $p = .83$ ) cervical **spinal surgery** were found among the 3 groups.

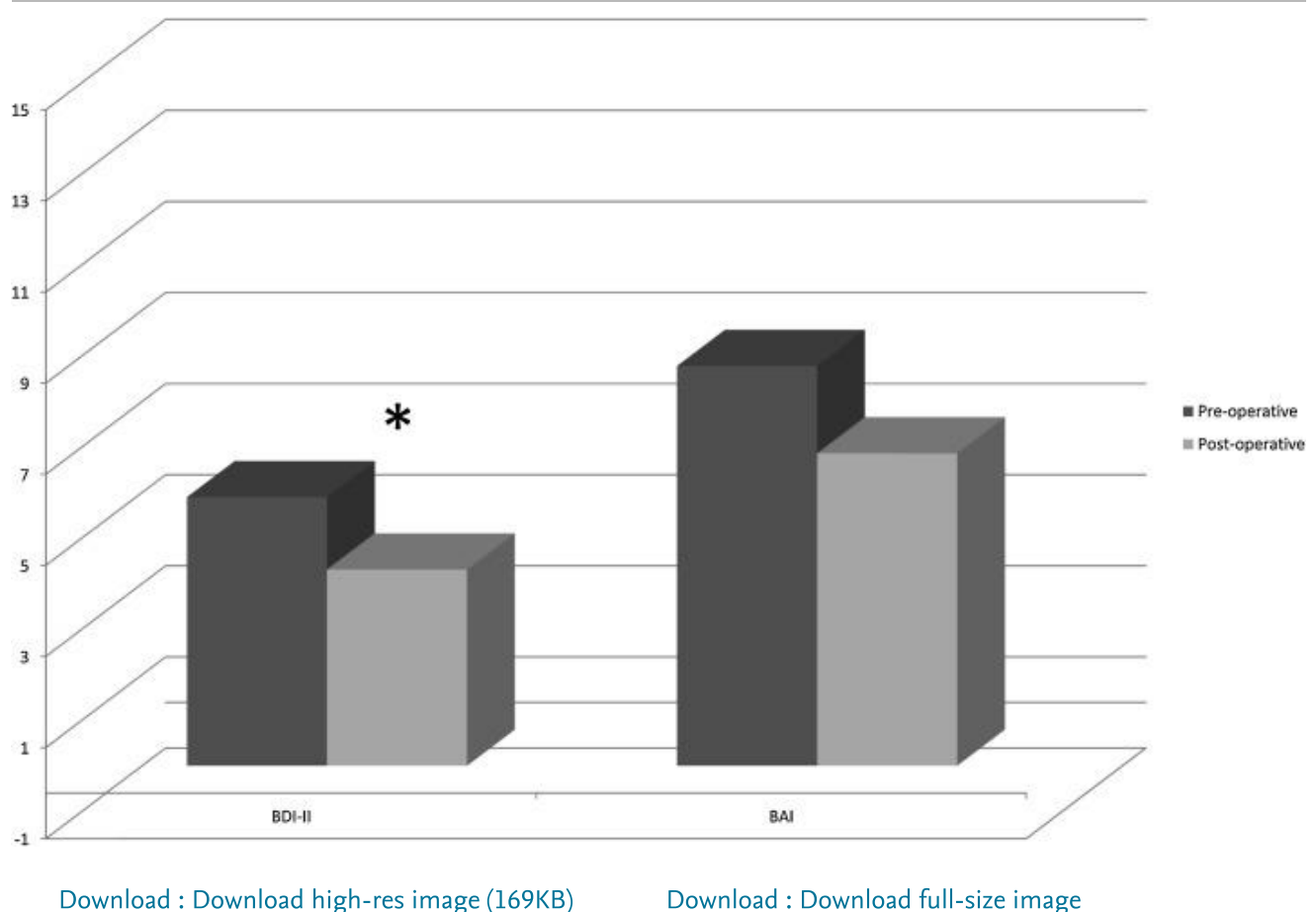


Fig. 1. Pre- and post-operative depression and anxiety.

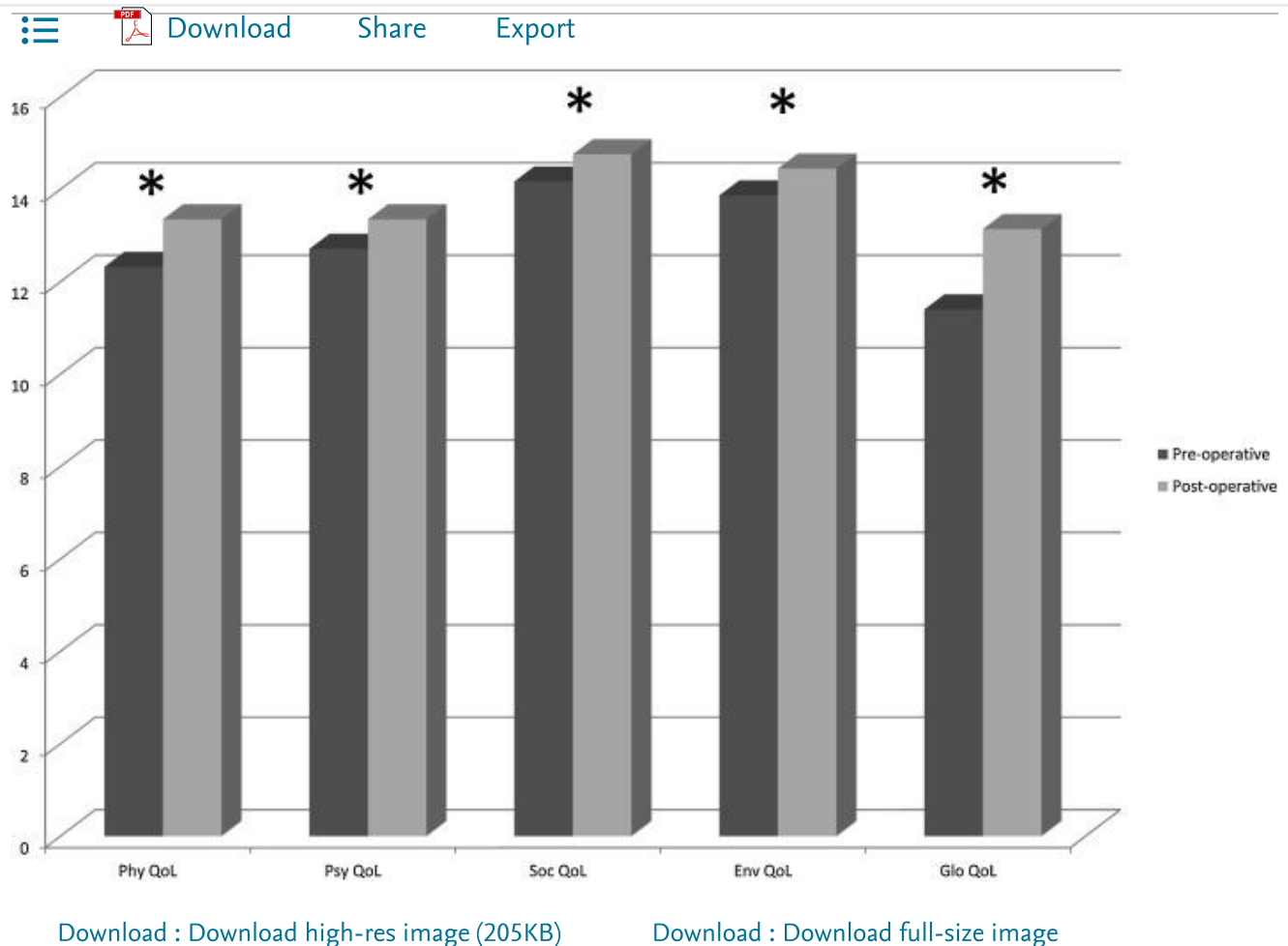


Fig. 2. Pre- and post-operative quality of life.

Accordingly, the following analyses were based on reports from all patients rather than from specific neuropathology groups: 12.5% of patients reported experiencing depressive symptoms and 30.9% reported experiencing symptoms of anxiety pre-operatively. Following surgery, 13.7% of patients continued to experience problems with clinical depression, while 40.5% continued to report difficulties with anxiety. No significant differences were found between the pre- and post-operative BDI-II scores ( $F = .48, p = .49$ ) and BAI ( $F = .98, p = .33$ ).

Most post-operative QoL domains showed a significant improvement when compared with pre-operative scores (physical:  $F = 7.10, p = .01$ ; social:  $F = 5.26, p = .026$ ; environmental:  $F = 4.11, p = .048$ ; global:  $F = 7.81, p = .007$ ), with the exception of the psychological domain ( $F = 1.96, p = .167$ ).

### 3.2. The association between emotional factors and QoL (Tables 2 and 3)

Two possible associations between emotions and QoL were evaluated. Analyses of pre-operative QoL and emotions showed that pre-operative anxiety ( $r = -.40, p < .001$ ) and depression ( $r = -.29, p = .015$ ) were significantly correlated with pre-operative global QoL. The relationship between post-operative QoL and pre-/post-operative emotions demonstrated that only pre-operative anxiety was significantly associated with post-operative environmental ( $r = -.29, p = .030$ ) and

to be significantly associated with post-operative global QoL (depression:  $\rho = -.36$ ,  $p = .002$ ; anxiety:  $\rho = -.50$ ,  $p < .001$ ), while anxiety was significantly correlated with post-operative psychological ( $\rho = -.26$ ,  $p = .030$ ), social ( $\rho = -.29$ ,  $p = .016$ ), and environmental ( $\rho = -.40$ ,  $p = .001$ ) QoL domains.

Table 2. Correlations between pre-operative emotions and quality of life.

	Emotions		Quality of life				
	BDI-II	BAI	PHY	PSY	SOC	ENV	GLO
<b>BDI-II</b>	.						
<b>BAI</b>	.72**	.					
<b>PHY</b>	-.14	-.27*	.				
<b>PSY</b>	-.20	-.29**	.68**	.			
<b>SOC</b>	-.06	-.19	.55**	.69**	.		
<b>ENV</b>	-.15	-.11	.48**	.64**	.69**	.	
<b>GLO</b>	-.32**	-.43**	.60**	.73**	.58**	.51**	.

Scores represent the Spearman's rho coefficient; BDI-II: Beck Depression Inventory – 2<sup>nd</sup> edition; BAI: Beck Anxiety Inventory; PHY: physical domain of Quality of life; PSY: psychological domain of Quality of life; SOC: social domain of Quality of life; ENV: environmental domain of Quality of life; GLO: global domain of Quality of life.

\*

$p < .05$ .

\*\*

$p < .01$ .

Table 3. Correlations between pre-/post-operative emotions and post-operative quality of life.

	Emotions				Post-operative quality of life				
	Pre BDI-II	Pre BAI	Post BDI-II	Post BAI	PHY	PSY	SOC	ENV	GLO
<b>Pre BDI-II</b>	.								
<b>Pre BAI</b>	.72**	.							

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	Pre BDI-II	Pre BAI	Post BDI-II	Post BAI	PHY	PSY	SOC	ENV	GLO	
Post BDI-II	.55 <sup>**</sup>	.49 <sup>**</sup>								
Post BAI	.48 <sup>**</sup>	.48 <sup>**</sup>	.82 <sup>**</sup>							
PHY	.07	-.10	-.19	-.21						
PSY	-.08	-.14	-.22	-.26 <sup>*</sup>	.74 <sup>**</sup>					
SOC	-.05	-.22	-.17	-.30 <sup>**</sup>	.66 <sup>**</sup>	.75 <sup>**</sup>				
ENV	-.08	-.29 <sup>*</sup>	-.26 <sup>*</sup>	-.41 <sup>**</sup>	.50 <sup>**</sup>	.66 <sup>**</sup>	.73 <sup>**</sup>			
GLO	-.21	-.42 <sup>**</sup>	-.36 <sup>**</sup>	-.51 <sup>**</sup>	.58 <sup>**</sup>	.68 <sup>**</sup>	.71 <sup>**</sup>	.66 <sup>**</sup>		

Scores represent the Spearman's rho coefficient; Pre BDI-II: Pre-operative evaluations of Beck Depression Inventory – 2<sup>nd</sup> edition; Pre BAI: Pre-operative evaluations of Beck Anxiety Inventory; Post BDI-II: Post-operative evaluations of Beck Depression Inventory – 2<sup>nd</sup> edition; Post BAI: Post-operative evaluations of Beck Anxiety Inventory; PHY: physical domain of Quality of life; PSY: psychological domain of Quality of life; SOC: social domain of Quality of life; ENV: environmental domain of Quality of life; GLO: global domain of Quality of life.

\*

$p < .05$ .

\*\*

$p < .01$ .

Differences in emotional complaints between patients with “favorable” and “unfavorable” post-operative QoL were also demonstrated (Table 4). Patients with “unfavorable” post-operative physical QoL scores showed significantly higher levels of post-operative depression ( $F = 5.14$ ,  $p = .026$ ), while patients with “unfavorable” post-operative psychological and global QoL scores showed significantly higher levels of both post-operative depression (psychological:  $F = 7.03$ ,  $p = .010$ ; global:  $F = 17.06$ ,  $p < .001$ ) and anxiety (psychological:  $F = 8.70$ ,  $p = .004$ ; global:  $F = 28.65$ ,  $p < .001$ ). Patients with “unfavorable” post-operative global QoL also showed significantly higher pre-operative levels of depression ( $F = 6.59$ ,  $p = .012$ ) and anxiety ( $F = 11.13$ ,  $p = .001$ ), while patients with “unfavorable” post-operative environmental QoL showed significantly higher pre-operative levels of depression ( $F = 4.00$ ,  $p = .049$ ). The ROC analysis further revealed that patients who scored  $> 17$  on the BAI pre-operatively would more easily report unfavorable post-operative social QoL (ROC area=.92,  $p = .047$ ; sensitivity =1.00, specificity =.83) and environmental QoL (ROC area=.95,  $p = .009$ ; sensitivity =1.00, specificity =.85). In addition, patients who scored  $> 8$  on the BAI pre-operatively (ROC area=.80,  $p = .001$ ; sensitivity =.75, specificity =.72) or scored  $> 5$  on the BDI-II pre-operatively (ROC area=.68,  $p = .043$ ; sensitivity =.69, specificity =.65) would more easily report unfavorable post-operative global QoL.



	Post-operative quality of life									
	Physical		Psychological		Social		Environmental		Global	
	FAV	UNFAV	FAV	UNFAV	FAV	UNFAV	FAV	UNFAV	FAV	UNFAV
<b>Pre-operative</b>										
<b>BDI-II</b>	6.16 (5.41)	7.45 (8.29)	6.21 (5.77)	7.40 (7.94)	6.03 (5.58)	8.55 (9.05)	5.87 (5.60)	8.77 (8.64)	4.91 (4.54)	8.76 <sup>**</sup> , a (8.07)
<b>BAI</b>	8.48 (8.56)	12.13 (11.60)	8.75 (8.75)	11.77 (11.54)	8.86 (8.96)	12.71 (12.01)	8.50 (8.50)	13.35 <sup>*</sup> , a (12.39)	6.60 (7.25)	13.79 <sup>**</sup> , a (11.24)
<b>Post-operative</b>										
<b>BDI-II</b>	4.05 (4.60)	8.09 <sup>*</sup> , a (10.26)	4.05 (5.07)	9.00 <sup>**</sup> , a (10.20)	5.03 (6.50)	7.40 (11.65)	5.08 (6.47)	6.60 (12.08)	3.15 (4.29)	9.83 <sup>**</sup> , a (9.12)
<b>BAI</b>	6.47 (7.25)	9.45 (10.09)	5.79 (6.24)	11.85 <sup>**</sup> , a (11.33)	7.09 (7.92)	10.20 (12.03)	6.88 (7.72)	12.33 (12.31)	4.34 (4.76)	13.88 <sup>**</sup> , a (10.22)

scores represent means, and scores in the parenthesis represent standard deviation; BDI-II: [Beck Depression Inventory](#) – 2<sup>nd</sup> edition; BAI: [Beck Anxiety Inventory](#); FAV: favorable post-operative quality of life; UNFAV: unfavorable post-operative quality of life;

a

represents a significant difference of scores on BDI-II and/or BAI between patients with favorable and unfavorable post-operative quality of life.

\*

$p < .05$ .

\*\*

$p < .01$ .

## 4. Discussion

### 4.1. Pre-operative and post-operative depression and anxiety

Our results revealed that 13% and 31% of patients reported symptoms of pre-operative depression and anxiety, respectively. These observations are consistent with those of previously published studies [6,12]. Skolasky et al. [6] explored the relationship between pain and depressive

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symptom of remarkable pre-operative depression. Recently, Alvin et al. [12] demonstrated that 33% of patients undergoing cervical posterior fusion procedures had taken antidepressants prior to surgery, while 23% had taken [anxiolytics](#). Although symptoms of clinical depression appear to be more predominant in North American and Western European studies, several studies from Asia have shown a somewhat different pattern. Li et al. [7] evaluated 85 patients with [cervical spondylosis](#) who underwent a cervical [total disc replacement](#) (CTDR) and found that 14.1% and 24.7% of patients reported pre-operative symptoms of clinical depression and anxiety, respectively. The results of the present study indicated that symptoms of anxiety may exceed those of depression in Asian patients undergoing cervical [spinal surgery](#).

Although our results did not reveal that depressive and anxious [symptomatology](#) significantly improve after surgery, but indicated that only 14% of our patients reported symptoms of [post-operative depression](#), with a greater percentage (41%) reporting symptoms of post-operative anxiety. Our observations are supported, in part, by those of previous studies [7,12]. Alvin et al. [12] evaluated depressive symptoms at 1-year post-surgery in 88 patients who underwent cervical posterior fusion (CPF) using the [Patient Health Questionnaire – 9](#) (PHQ-9) [18]. A significant improvement in depressive symptoms following surgery was identified. Li et al. also reported that symptoms of anxiety and depression significantly improved at 1-week post-surgery, and further revealed this improvement persisted up to 2 years post-operatively. Although our study demonstrated a significant improvement in symptoms of depression following surgery, improvement in the symptoms of anxiety was not observed. One possible factor underlying the lack of consistency between our results and those published in previous reports may be due to our use of a different scale to evaluate symptoms of anxiety (i.e., the BAI permits the evaluation of up to 3 clinical anxiety domains which were not evaluated in previous studies). Fujimori et al. [4] used the Hospital Anxiety/Depression Scale (HAD) [19] to evaluate emotional problems of surgical patients, while Li et al. [7] utilized a self-rating scale to examine these symptoms (the Zung Depression/Anxiety Scale) [20,21]. Although the assessment scales used previously to evaluate surgical outcomes and emotional factors focused primarily on symptoms of anxiety, the BAI scale used in the present study, was able to evaluate novel [somatic](#) and cognitive aspects of the post-surgical emotional response, which appear more central to the manifestation of clinical anxiety in patients undergoing cervical spine surgery [22].

#### 4.2. The association between emotions and QoL

Results suggest that specific pre- or post-operative QoL domains are significantly associated with pre-operative depression and anxiety, and further established cut-off points for pre-operative depressive and/or anxious levels to predict unfavorable post-operative QoL. These findings supported observations reported in previously published studies [7,12,13,23]. Li et al. [7] examined the association between age, the level of neurological functions, the level of pain, depression, and anxiety in patients post-operatively over a 2-year period. A significant correlation between post-operative QoL and depression, together with a significant relationship between QoL and anxiety, was reported. Alvin and colleagues [12] also confirmed the association between [emotional disturbances](#) and QoL, and further determined that both pre-operative QoL and post-operative depressive symptoms significantly influence post-operative QoL. Adogwa et

outcome within 1 year post cervical spinal surgery, and found that [post-operative pain](#) scores were significantly reduced in patients with pre-operative anxiety disorders only when they received viable management strategies for this psychiatric symptomatology.

Four aspects of our findings support the current understanding of patients' QoL following surgery, as well as to add more informative ideas regarding the relationship between emotions and QoL in patients undergoing cervical spine surgery. Firstly, not only the [affective disorders](#) [13,23] but negative emotional status is detrimental to patients' QoL after cervical spinal surgery. Secondly, different QoL domains can be influenced by different emotional complaints (e.g., post-operative psychological and social domains of QoL were more strongly associated with concurrent symptoms of anxiety, while pre-operative anxiety was observed to negatively influence the environmental and global domains of QoL). Thirdly, both pre- and post-operative depression and anxiety were found to significantly influence multi-domain post-operative QoL. Lastly, the specific cut-off points for BAI and BDI-II were indicated to directly predict the unfavorable QoL after cervical spinal surgery, which may help clinicians provide patients with the tools to manage adverse effects such as negative emotions post-operative.

Taken together, these results suggest that in addition to physical and psychological concerns, depression and anxiety also appear to be critical factors underlying a patient's perception of their post-operative physical environment and available social supports. These novel observations could not have been revealed using conventional measures of health-related QoL, such as the [SF-36](#). Our results suggest that both pre- and post-operative emotional evaluation and interventions are warranted, despite the possibility of post-surgical recovery from depression.

### 4.3. Limitations

Although the associations between specific pre- and post-operative emotional disturbances and post-operative QoL have been directly shown in this [prospective study](#), several methodological weaknesses may exist. Firstly, the cause of emotional disturbances was not clearly evaluated in this study. For example, D'angelo et al. [24] revealed that pre-operative trait anxiety rather than anxious status was significantly associated with the persistence of pain after lumbar spinal surgery. Secondly, some clinical outcomes were not measured in this study, such as pain status, neck disability evaluations, etc. Lastly, the follow-up period after cervical spinal surgery might be short since a few researchers [12,23,24] have tried to explore the outcomes within 1 year after surgery.

## 5. Conclusions

This study prospectively evaluated the association between emotional complaints and QoL in patients subjected to [cervical spine surgery](#). Symptoms of anxiety seemed to be more prevalent post-operatively, and both depression and anxiety were found to markedly and significantly influence specific domains of post-operative QoL. Specifically, patients who scored more than 17 on the BAI had significantly higher reported unfavorable post-operative outcomes. Accordingly,

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## Declarations of interest

None.

## Acknowledgments

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