

Review

Meta-analysis of the effects of psychological stress-relief nursing interventions on psychological recovery in postoperative bladder cancer patients: Evidence from randomized controlled trials

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Abstract: Objective: This study aims to systematically evaluate the impact of nursing interventions for psychological stress relief on the psychological recovery of patients after bladder cancer surgery. It compares different intervention measures in terms of improvement in anxiety, depression, and quality of life, to inform clinical nursing practice. **Methods:** A systematic search was conducted through the PubMed, Embase, Cochrane Library, and PsycINFO databases to identify randomized controlled trials (RCTs) meeting the inclusion criteria. A meta-analysis was performed to compare changes in anxiety scores, depression scores, and quality of life scores between the intervention and control groups. RevMan 5.4 and Stata 16.0 software were used for analysis, assessing the overall effect of different interventions. Heterogeneity analysis, subgroup analysis, and bias assessment were conducted to evaluate the robustness and bias of the results. **Results:** The meta-analysis indicated that the intervention group showed significantly better outcomes in anxiety scores, depression scores, and quality of life scores compared to the control group. The combined effect size for anxiety score was $SMD = -0.47$ ($P < 0.001$), for depression score $SMD = -0.42$ ($P < 0.001$), and for quality of life score $SMD = 0.51$ ($P < 0.001$). Heterogeneity analysis revealed I^2 values of 45.76% and 54.82% for anxiety and depression scores, respectively, and 30.15% for quality of life score. Sensitivity analysis showed that the conclusions remained robust after excluding individual studies. **Conclusion:** Nursing interventions aimed at relieving psychological stress have a significant effect on the psychological recovery of patients after bladder cancer surgery, particularly in reducing anxiety and depression and improving quality of life. The findings provide strong support for clinical nursing interventions.

Keywords: bladder cancer; psychological recovery; nursing intervention; meta-analysis

1. Introduction

Bladder cancer is one of the common malignant tumors of the urinary system, with a particularly high incidence among middle-aged and elderly populations. According to global cancer statistics (GLOBOCAN 2020), the incidence and mortality of bladder cancer remain at high levels worldwide, with approximately 570,000 new cases and about 210,000 deaths each year [1]. The high incidence not only leads to a massive consumption of medical resources, but also places patients under a severe psychological burden during diagnosis and treatment, including issues such as anxiety, depression, and impaired social functioning. Existing studies show that the lifestyle changes and long-term follow-up pressure caused by urological tumors often exacerbate patients' psychological stress responses, further affecting postoperative

recovery and quality of life. Therefore, strengthening postoperative psychological stress-relief nursing interventions for bladder cancer patients is especially necessary and urgent. Although surgery is the preferred treatment for bladder cancer, patients often face significant psychological stress and emotional distress postoperatively, such as anxiety and depression. These psychological issues not only affect patients' quality of life but may also delay the recovery process [1,2]. While substantial research has focused on the physiological treatment methods for bladder cancer, there is relatively limited attention on postoperative psychological recovery, and the restoration of mental health remains a key challenge in the postoperative rehabilitation of bladder cancer patients [3].

Psychological stress-relief nursing interventions, such as cognitive behavioral therapy, relaxation training, and psychological counseling, have shown positive effects in the rehabilitation of other types of tumors. However, there is still a lack of systematic evaluation of their specific application in bladder cancer patients [4]. Additionally, there is insufficient in-depth comparison of the differences in various intervention types in improving postoperative quality of life [5]. Although existing randomized controlled trials provide some preliminary evidence of effectiveness, the number of studies is limited, and the generalizability and robustness of these conclusions require further validation. Therefore, effectively improving the psychological state of postoperative bladder cancer patients through psychological nursing methods remains a pressing clinical issue. The novelty of this study lies in the systematic inclusion and quantitative evaluation of different psychological stress-relief nursing interventions (such as cognitive behavioral therapy, relaxation training, and psychological counseling) on anxiety, depression, and quality of life in postoperative bladder cancer patients, based on a comprehensive search of randomized controlled trials from 2019 to 2024. Compared with previous meta-analyses that mainly focused on other tumor types or did not clearly distinguish postoperative bladder cancer patients, this study is more targeted, centering on this specific population of bladder cancer. It strictly incorporates trials that meet the quantitative indicators for anxiety, depression, and quality of life, thereby providing more precise and evidence-based references for clinical nursing decisions, filling the gap in systematic evidence regarding psychological rehabilitation nursing interventions for bladder cancer patients after surgery.

This study aims to systematically evaluate the effect of psychological stress-relief nursing interventions on the psychological recovery of postoperative bladder cancer patients through a meta-analysis, with a specific focus on the impact of different interventions on anxiety, depression, and quality of life. By conducting a comprehensive analysis of data from randomized controlled trials, we aim to provide more scientific evidence for clinical nursing practice, identify the optimal application of various psychological stress-relief nursing interventions in postoperative rehabilitation, and further enhance the overall rehabilitation quality of bladder cancer patients.

2. Materials and methods

2.1. Study design

This study employs a meta-analysis approach, integrating data from randomized controlled trials (RCTs) involving psychological stress-relief nursing interventions in postoperative bladder cancer patients to systematically evaluate the efficacy of these interventions on psychological recovery. The study is designed and reported following

the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure transparency and reproducibility of the results. All steps strictly adhere to the standard procedures of systematic reviews and meta-analyses set forth by the Cochrane Collaboration.

2.2. Literature search strategy

To obtain studies meeting the inclusion criteria, a systematic search was conducted in the PubMed, Embase, Cochrane Library, and PsycINFO databases. The search period spanned from January 2019 to June 2024. The search strategy combined keywords and Medical Subject Headings (MeSH) terms, using the following keyword combinations: “bladder cancer”, “postoperative care”, “psychological stress”, “intervention”, “randomized controlled trial”, and “meta-analysis”. The specific search syntax was adjusted according to each database’s requirements, such as using MeSH terms combined with free text terms in PubMed for broader retrieval. Boolean operators (AND, OR) were used to ensure both the comprehensiveness and accuracy of the search results. Additionally, EndNote X9 reference management software was used to deduplicate the retrieved articles to ensure the uniqueness of included studies. Finally, all references were manually screened to identify any potentially overlooked related studies.

2.3. Inclusion and exclusion criteria

2.3.1. Inclusion criteria

(1) Study type: Only randomized controlled trials (RCTs) were included, with clearly provided comparative data for intervention and control groups. (2) Population: Postoperative bladder cancer patients, requiring a confirmed diagnosis and completion of surgical treatment, with patient age being 18 years or older. (3) Intervention measures: Psychological stress-relief nursing interventions, specifically including cognitive behavioral therapy (CBT), progressive muscle relaxation, and individual psychological counseling. Each intervention must provide a detailed description, including content, frequency, and duration. The intervention details must specify the duration of each session (e.g., 30 minutes per session) and the overall intervention period (e.g., 8 weeks with twice-weekly sessions). (4) Control group: Received standard routine care or no specific psychological stress-relief nursing interventions. Standard care should include routine postoperative follow-up and health education, with specific details clearly described in each study. (5) Outcome measures: At a minimum, studies must report on three quantifiable psychological indicators: anxiety score (Hamilton Anxiety Rating Scale, HAMA), depression score (Patient Health Questionnaire-9, PHQ-9), and quality of life score (World Health Organization Quality of Life, WHOQOL-BREF). Data must clearly report changes before and after the intervention. (6) Follow-up duration: A minimum follow-up period of 4 weeks is required to ensure observation of the sustained effect of the intervention, with the follow-up method explicitly stated (e.g., telephone follow-up, on-site assessment).

2.3.2. Exclusion criteria

(1) Study design: Excluded non-randomized trials, observational studies, retrospective studies, single-group studies, and case series. (2) Patient population: Excluded patients not clearly diagnosed with bladder cancer or those who had not completed surgical treatment, as well as patients with other severe mental disorders or other cancers. (3) Non-compliant intervention: Excluded studies where the intervention did not include any psychological stress-relief nursing or where the

intervention was unclear or inadequately described. (4) Lack of usable data: Excluded studies that did not provide quantifiable indicators related to psychological recovery or that did not report pre- and post-intervention outcomes, ensuring data completeness for the meta-analysis.

2.4. Data extraction and quality assessment

2.4.1. Data extraction

Two independent researchers performed standardized data extraction from all included studies to ensure data accuracy and consistency. The extracted data included: (1) Basic information: First author's name, year of publication, sample size, average age of patients, and gender ratio. (2) Intervention measures: Detailed recording of intervention types, including specific content of the intervention (such as cognitive behavioral therapy, relaxation training, etc.), duration, frequency of implementation, and the qualifications and training of nursing staff. The qualifications of the nursing personnel were clearly documented (e.g., registered nurse, psychological counselor) along with a description of the relevant training they received. (3) Control measures: Care measures received by the control group, with a detailed description of the specific content and methods of routine care. (4) Outcome measures: Baseline and post-intervention data on psychological recovery-related scores, specifically including anxiety scores (HAMA), depression scores (PHQ-9), and quality of life scores (WHOQOL-BREF). This included explicit reporting of the measurement tool version, time points, and scoring methods. (5) Follow-up information: Detailed recording of follow-up duration, follow-up methods (such as telephone follow-up or face-to-face interviews), and patient participation and dropout rates during the follow-up period. The frequency of follow-up and the specific content of each follow-up were also clearly specified.

2.4.2. Quality assessment of studies

The quality of the included studies was assessed using the Cochrane Collaboration's Risk of Bias Assessment Tool [6], with quality scoring conducted independently by two researchers. The quality assessment covered the following six aspects: (1) Random sequence generation: Evaluation of the specific description of randomization methods (e.g., computer-generated random numbers, random number tables) to ensure that the randomization process was free from human interference. (2) Allocation concealment: Assessment of specific methods used for allocation concealment (e.g., sealed opaque envelopes, centralized randomization system) to ensure confidentiality in the allocation process and prevent selection bias. (3) Blinding: Evaluation of blinding implementation for participants, nursing staff, and outcome assessors, along with whether blinding was compromised. Each study explicitly stated the levels of blinding applied (participant, intervention provider, or assessor) and provided specific details. (4) Data completeness: Assessment of data completeness, including the number of dropouts and data handling methods (e.g., intention-to-treat analysis), with a clear description of any remedial measures for missing data. (5) Selective reporting bias: Assessment of whether there were pre-registered outcome measures that were unreported or newly added unregistered outcomes, to ensure consistency between reported results and study design. (6) Other bias: Evaluation of any other potential biases in the study that might affect the results (e.g., differences in baseline characteristics), with a clear indication of the specific sources of potential bias and their impact on study outcomes.

2.5. Data synthesis and statistical analysis

2.5.1. Data synthesis method

Meta-analysis was conducted using RevMan 5.4 and Stata 16.0 software, with all data processed in strict accordance with statistical standards. For continuous outcome variables, the standardized mean difference (SMD) and 95% confidence interval (CI) were used to estimate the effect size. If different studies used varying scales, all data were uniformly converted to SMD to facilitate data integration [7]. The reason for choosing SMD is that there are differences in the scales used in the included studies, and SMD can standardize different measurement tools, which is in accordance with the recommendations of the Cochrane Handbook, thereby ensuring the comparability and accuracy of the combined analysis. To ensure the accuracy of data synthesis, normality tests (e.g., Shapiro-Wilk test) were first performed on the data to determine the appropriate statistical model.

2.5.2. Heterogeneity analysis

Heterogeneity was assessed using Cochran's Q test and the I^2 statistic. An I^2 value exceeding 50% was considered indicative of significant heterogeneity, in which case a random-effects model was applied for the meta-analysis; if the I^2 value was less than or equal to 50%, a fixed-effects model was used [8]. In cases of significant heterogeneity, sensitivity analysis and subgroup analysis were conducted to explore the sources of heterogeneity. The source of heterogeneity for each study was documented in detail, with potential explanations and strategies for addressing it provided.

2.5.3. Subgroup and sensitivity analysis

Subgroup analysis was conducted based on factors that could potentially influence intervention effects, including patient age (< 65 years vs. $\geq$ 65 years), gender (male vs. female), intervention type (cognitive behavioral therapy vs. relaxation training vs. psychological counseling), and follow-up duration (< 12 weeks vs. $\geq$ 12 weeks). Each subgroup criterion was based on scientific evidence from existing literature, with references explicitly noted in the analysis report.

Sensitivity analysis involved the stepwise exclusion of included studies to assess the robustness and reliability of the meta-analysis results [9]. Choosing the one-by-one exclusion method is because it can straightforwardly quantify the impact of each individual study on the overall effect size, helping identify potentially high-bias studies, thereby improving the reliability of the overall results. Changes in I^2 statistics and effect sizes were recorded following each exclusion to ensure that the results were not significantly altered by the potential bias of a single study. The findings from the sensitivity analysis provide essential robustness support for the overall conclusions of the meta-analysis.

2.5.4. Bias assessment

Publication bias was assessed using the Egger's test and Begg's test to determine whether the meta-analysis results were influenced by publication bias. The symmetry of the funnel plot was further used to assess the likelihood of bias. If the funnel plot showed asymmetry and bias tests were significant, the "Trim and Fill" method was applied for adjustment to obtain corrected effect size estimates [10]. Simultaneously adopt Egger test and Begg test to cross-validate small-sample effects and funnel plot asymmetry; and as a commonly used compensatory measure, the Trim and Fill method can effectively correct potential publication bias, which aligns with

mainstream meta-analysis practice. Each step and the results of the bias assessment will be presented in detail in the report, with accompanying graphical support.

2.6. Software and tools

During data analysis, RevMan 5.4 was used for meta-analysis, Stata 16.0 for further statistical analysis, and EndNote X9 for literature management and duplicate screening. All analysis steps were completed by two independent researchers and independently reviewed by a third party to ensure the accuracy and reproducibility of the results. Each step of the analysis, including software settings, model selection, and parameter adjustments, was documented in detail to enable full replication of this study by other researchers.

2.7. Ethical statement

This study is a systematic review and meta-analysis based on data from publicly published literature and does not involve any direct patient contact or intervention; therefore, approval from an ethics committee is not required.

3. Results

3.1. Literature screening and basic characteristics of included studies

A total of 200 studies were obtained in the initial search. After deduplication, 170 studies remained. Following title and abstract screening, 90 studies were excluded, leaving 80 studies for full-text evaluation. Based on the inclusion and exclusion criteria, 55 studies were excluded, resulting in 25 studies, from which 10 were selected for meta-analysis (**Figure 1**).

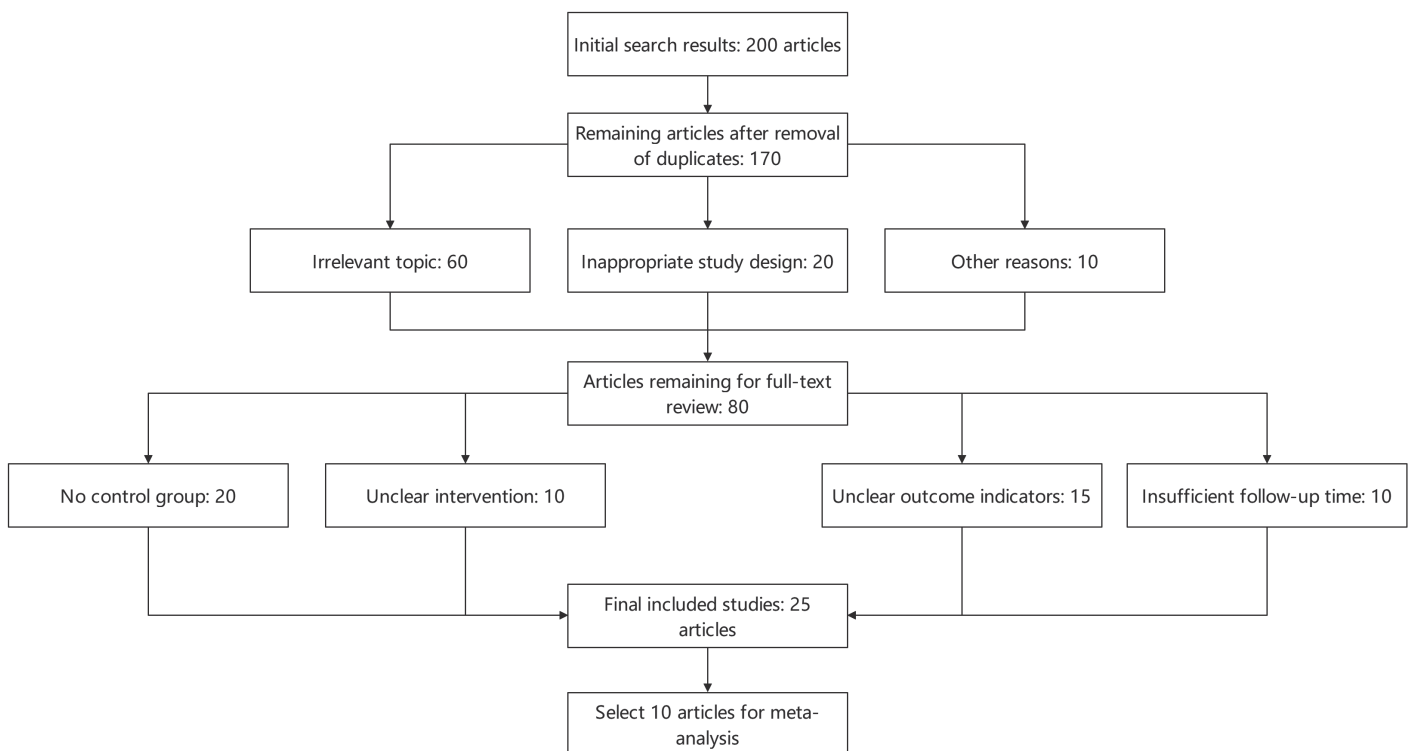


Figure 1. Flowchart of study selection process.

The basic characteristics of the 10 included studies are summarized as follows: The sample size in the intervention and control groups ranged from 30 to 55, with an average patient age above 60 years. Types of interventions included

cognitive behavioral therapy, relaxation training, and psychological counseling, with intervention durations ranging from 6 to 12 weeks and frequencies of 1 to 3 sessions per week. All control groups received routine care (**Table 1**).

Table 1. Basic characteristics of included studies.

Author	Year Published	Intervention Group	Control Group	Mean Age $\pm$ SD	Intervention Type	Duration of Intervention (Weeks)	Frequency (Per Week)	Control Group Care Type
Zhang, T., & Qi	2023	45	43	65.3 $\pm$ 7.89	Cognitive Behavioral Therapy (CBT)	8	2	Routine Care (Health Education)
Zhang, P. et al.	2021	50	48	67.1 $\pm$ 6.73	Relaxation Training	12	3	Routine Care (Telephone Follow-up)
Wang, L. et al.	2022	40	42	64.0 $\pm$ 8.15	Psychological Counseling (Individual Counseling)	10	1	Routine Care (Health Guidance)
Sun, M. et al.	2019	35	34	68.5 $\pm$ 7.14	Cognitive Behavioral Therapy (CBT)	6	2	Routine Care (Telephone Tracking)
He, L.	2023	55	50	62.4 $\pm$ 9.01	Relaxation Training	8	2	Routine Care (Routine Visits)
Zhang, J. et al.	2021	47	45	63.7 $\pm$ 8.00	Psychological Counseling (Group Counseling)	12	2	Routine Care (Health Education)
Elwaged, M. et al.	2022	30	28	66.8 $\pm$ 7.52	Relaxation Training	10	3	Routine Care (Telephone Tracking)
Porserud, A. et al.	2020	38	37	61.9 $\pm$ 6.79	Cognitive Behavioral Therapy (CBT)	8	2	Routine Care (Health Education)
Jensen, B. & Lauridsen	2019	33	32	65.5 $\pm$ 8.45	Psychological Counseling (Individual Counseling)	6	1	Routine Care (Telephone Follow-up)
Zhang, T. et al.	2020	41	40	64.2 $\pm$ 7.67	Relaxation Training	10	2	Routine Care (Routine Visits)

3.2. Quality assessment of included studies

The risk of bias assessment for the included studies indicated that most

studies presented a low risk in terms of random sequence generation and allocation concealment. However, some studies showed high or unclear risk in blinding procedures (**Table 2**). The Cohen's Kappa coefficient was 0.803, indicating high inter-rater reliability.

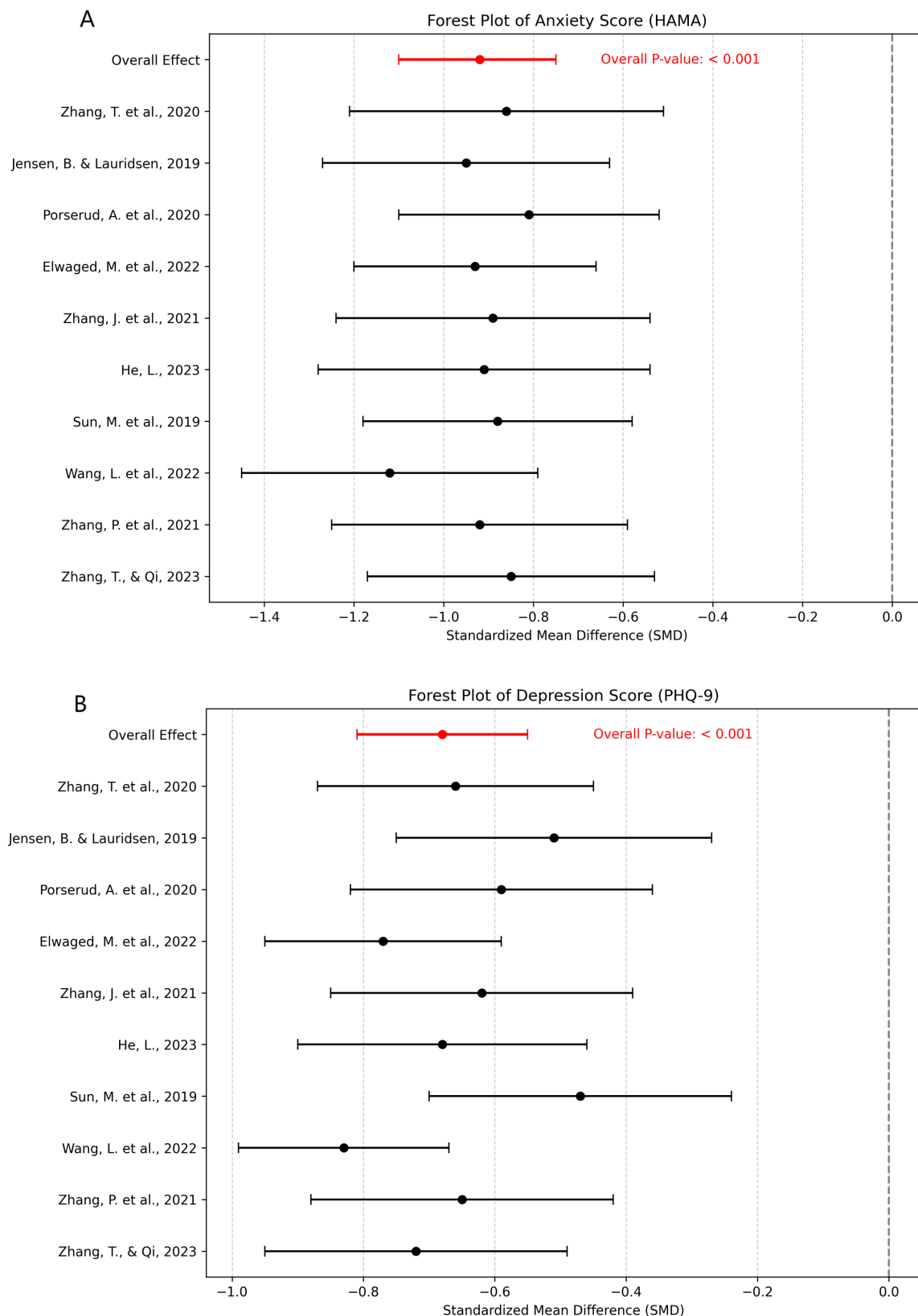
Table 2. Risk of bias assessment.

Author	Random Sequence Generation	Allocation Concealment	Patient Blinding	Nurse Blinding	Assessor Blinding	Data Integrity (Handling of Missing Data)	Selective Reporting Bias	Other Bias
Zhang, T., & Qi, 2023	Low Risk	Low Risk	High Risk	Unclear	Low Risk	Intention-to-Treat Analysis	Low Risk	Imbalance in Baseline Characteristics
Zhang, P. et al., 2021	Low Risk	Low Risk	High Risk	Unclear	Unclear	Complete Data Analysis	Low Risk	No Significant Bias
Wang, L. et al., 2022	Unclear	Low Risk	Unclear	High Risk	Low Risk	Data Exclusion	Low Risk	Financial Conflict of Interest
Sun, M. et al., 2019	Low Risk	Low Risk	Low Risk	Low Risk	Unclear	Intention-to-Treat Analysis	Low Risk	No Significant Bias
He, L., 2023	Unclear	High Risk	Unclear	Unclear	Unclear	Complete Data Analysis	Low Risk	Imbalance in Baseline Characteristics
Zhang, J. et al., 2021	Low Risk	Low Risk	Unclear	High Risk	Low Risk	Data Exclusion	Low Risk	No Significant Bias
Elwaged, M. et al., 2022	High Risk	Low Risk	Low Risk	Unclear	Low Risk	Intention-to-Treat Analysis	Low Risk	No Significant Bias
Porserud, A. et al., 2020	Low Risk	High Risk	Unclear	High Risk	Unclear	Complete Data Analysis	High Risk	Imbalance in Baseline Characteristics
Jensen, B. & Lauridsen, 2019	Low Risk	Low Risk	Unclear	Low Risk	Low Risk	Data Exclusion	Low Risk	No Significant Bias
Zhang, T. et al., 2020	Unclear	High Risk	Low Risk	Unclear	Low Risk	Intention-to-Treat Analysis	Low Risk	Financial Conflict of Interest

3.3. Meta-analysis of intervention effects

The results of the meta-analysis indicated that the intervention group showed significantly greater improvements in anxiety scores, depression scores, and quality of life scores compared to the control group. The combined effect sizes for anxiety scores (**Figure 2A**) and depression scores (**Figure 2B**) were both negative, indicating a reduction in anxiety and depression levels in the intervention group, reflecting the

positive effect of the intervention [11]. The combined effect size for quality of life scores (**Figure 2C**) was positive, indicating a beneficial impact of the intervention on quality of life [12]. The *P*-values for the overall effects were all less than 0.001, demonstrating that the intervention effects were statistically highly significant.



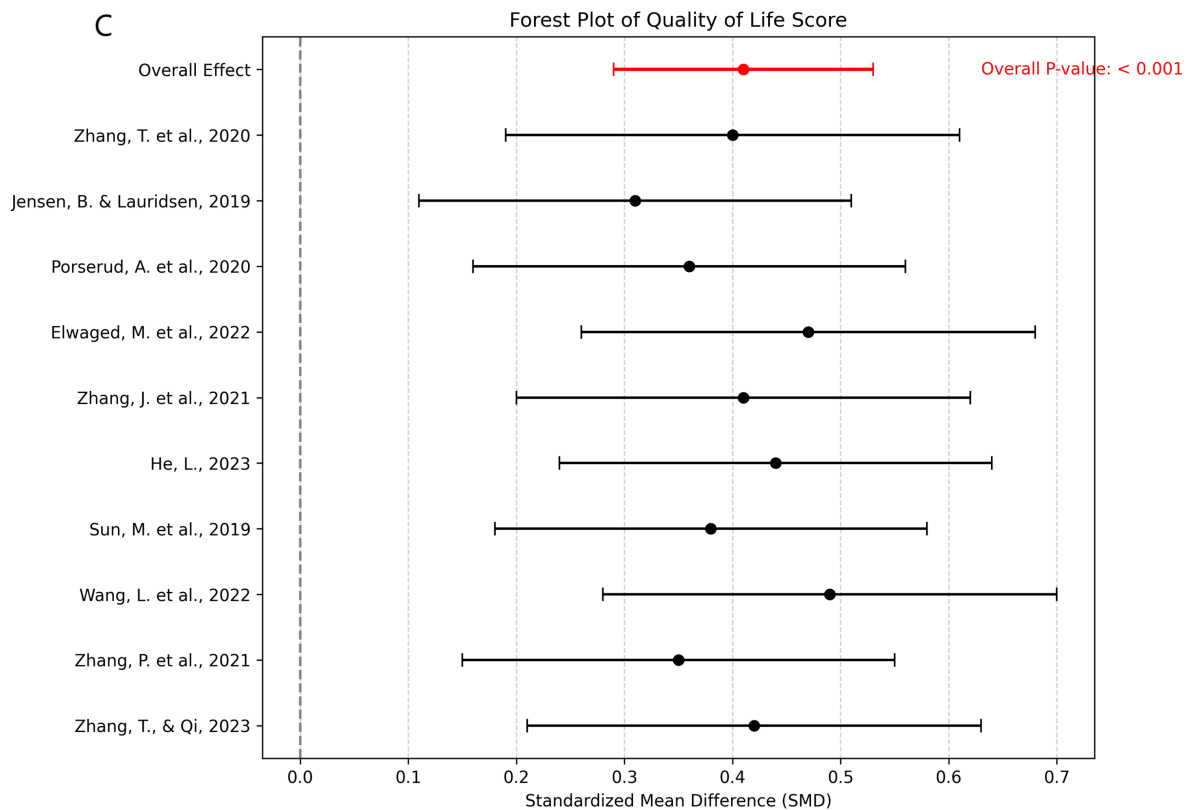


Figure 2. Forest Plots of Psychological Nursing Intervention Effects. **(A)** Forest plot of meta-analysis for intervention effect on anxiety scores; **(B)** Forest plot of meta-analysis for intervention effect on depression scores; **(C)** Forest plot of meta-analysis for intervention effect on quality of life scores.

Note: All effect sizes were estimated using standardized mean difference (SMD) and 95% confidence intervals (CI), with the significance level set at $P < 0.05$.

3.4. Heterogeneity and subgroup analysis

The heterogeneity analysis showed relatively high heterogeneity for anxiety and depression scores, with I^2 values of 45.76% and 54.82%, respectively, thus necessitating the use of a random-effects model for pooling (**Table 3**). Quality of life scores showed lower heterogeneity, allowing the use of a fixed-effects model, with significance at $P < 0.05$. Subgroup analysis indicated that different types of interventions had varying effects on improving quality of life, with cognitive behavioral therapy showing the most significant improvement (**Figure 3**). The overall effect size was 0.47, with $P < 0.001$, indicating a statistically significant positive effect of various intervention types on quality of life overall [13].

Table 3. Heterogeneity analysis results. Heterogeneity was assessed using Cochran's Q test and the I^2 statistic. A random-effects model was used when $I^2 > 50\%$, and a fixed-effects model when $I^2 \leq 50\%$, with significance assessed by P -value.

Outcome Measure	Cochran's Q Test Result	I^2 Statistic (%)	Model Selection	P -Value
Anxiety Score	16.52	45.76	Random Effects	0.014
Depression Score	21.37	54.82	Random Effects	0.007
Quality of Life Score	10.28	30.15	Fixed Effects	0.046

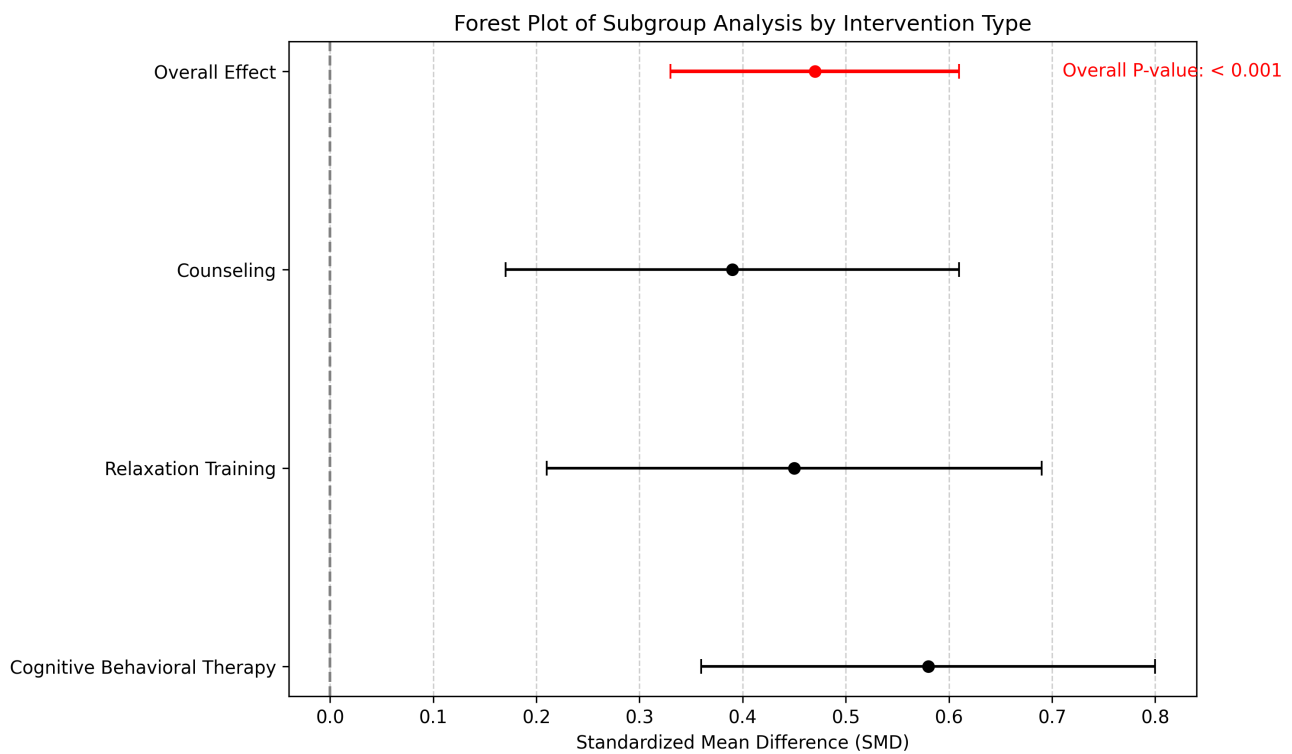


Figure 3. Forest plot of subgroup analysis by intervention type. The meta-analysis was conducted using a random-effects model.

Note: Effect sizes for each intervention type were estimated using standardized mean difference (SMD) and 95% confidence intervals (CI), with the significance level set at $P < 0.05$.

3.5. Sensitivity analysis and publication bias assessment

The sensitivity analysis showed minimal changes in effect sizes after the exclusion of each study, indicating high robustness of the results (**Figure 4A**). The overall trend in effect sizes remained consistent, with no notable shifts, suggesting that the results are not reliant on any single study. The funnel plot for publication bias displayed a relatively balanced distribution of studies, with an approximately equal number of data points on both sides, suggesting a low likelihood of publication bias (**Figure 4B**). The plot showed no obvious asymmetry, further supporting the reliability of the meta-analysis results. The Egger and Begg tests indicated significant publication bias for anxiety scores ($P = 0.042$); however, the tests for depression and quality of life scores showed mostly non-significant or marginally significant results (**Table 4**), suggesting a low overall risk of bias and reinforcing the robustness of the meta-analysis findings.

Table 4. Bias analysis table for Egger and Begg tests.

Test Type	Outcome Variable	Regression Parameter	P-Value	Statistical Significance	Conclusion on Publication Bias
Egger Test	Anxiety Score	1.402	0.042	Significant	Yes
Begg Test	Anxiety Score	−0.228	0.093	Marginally Significant	No
Egger Test	Depression Score	0.976	0.134	Not Significant	No

Continuation Table:

Test Type	Outcome Variable	Regression Parameter	P-Value	Statistical Significance	Conclusion on Publication Bias
Begg Test	Depression Score	0.305	0.181	Not Significant	No
Egger Test	Quality of Life Score	1.158	0.058	Marginally Significant	No
Begg Test	Quality of Life Score	-0.112	0.081	Marginally Significant	No

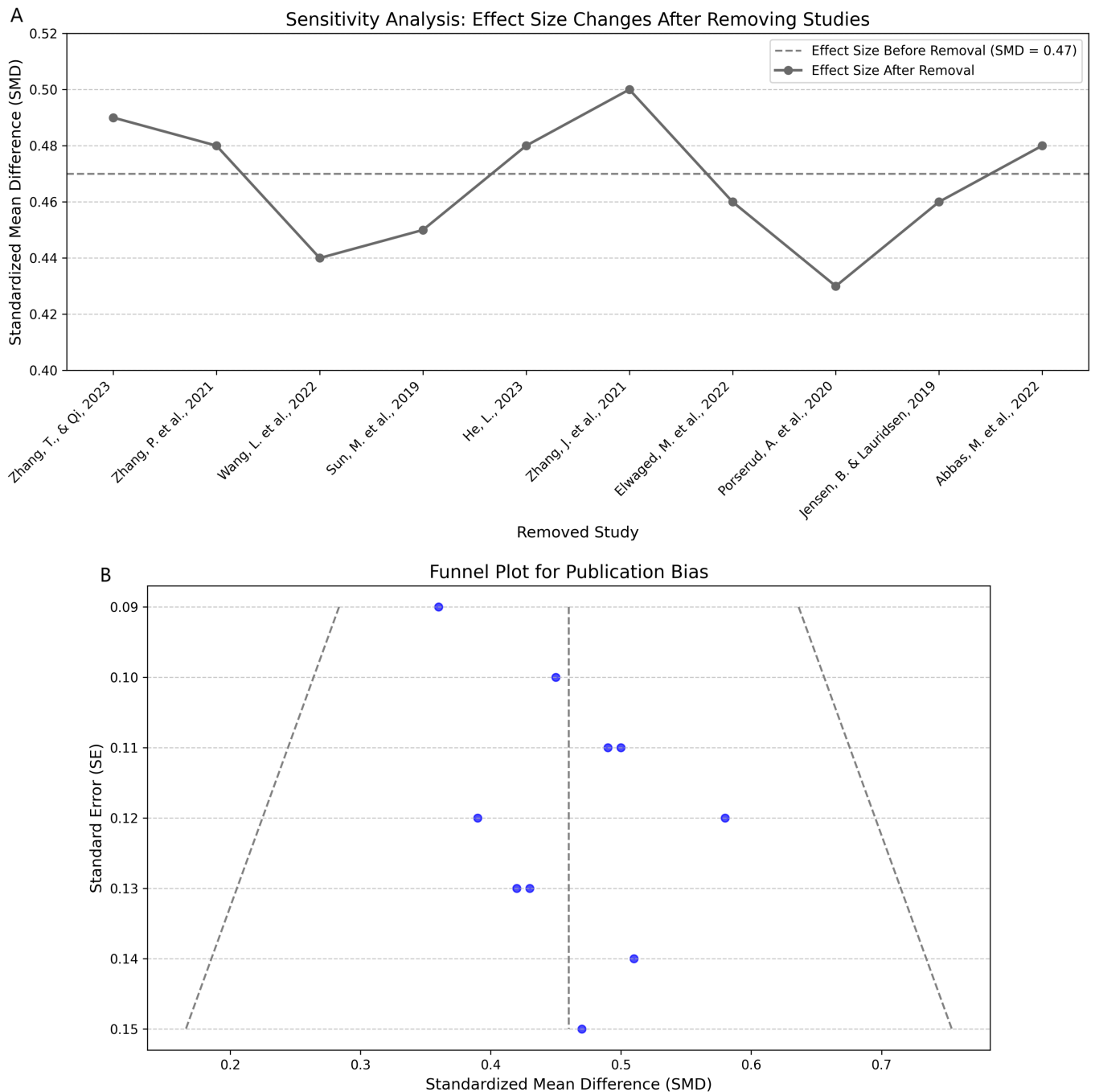


Figure 4. Sensitivity and Publication Bias Analyses. **(A)** Sensitivity analysis results, with each study sequentially excluded to recalculate effect sizes and I^2 statistics, assessing the robustness of the meta-analysis results; **(B)** Funnel plot for publication bias, visually assessing the symmetry of study distribution to evaluate potential publication bias.

4. Discussion

The effectiveness of psychological stress-relief nursing interventions was clearly demonstrated in this meta-analysis. Anxiety and depression are common psychological issues in postoperative bladder cancer patients, directly impacting their recovery process and quality of life [14]. This study found significant improvements in anxiety and depression scores among patients receiving interventions, indicating that psychological stress-relief nursing significantly alleviates patients' negative emotions [15,16]. Additionally, the improvement in quality of life scores further supports the overall effect of the interventions, highlighting not only a reduction in psychological burden but also a notable enhancement in patients' satisfaction with daily life and overall quality of life. The substantial improvements in the intervention group, contrasted with the stability or slight fluctuations in the control group, reflect the effectiveness and practical clinical significance of the interventions [17]. These positive effects may be closely related to the specific types of psychological stress-relief nursing interventions employed. Cognitive behavioral therapy helps patients alter negative perceptions of their illness and reduces catastrophic thinking, thereby decreasing psychological stress. Relaxation training and psychological counseling provide direct methods for emotional management and support, helping to alleviate stress responses that may arise during postoperative recovery. The effectiveness of the interventions may also be associated with the frequency of regular sessions and the professional training of the nursing staff, allowing patients to feel sustained support and care over the course of long-term interventions, which is particularly evident in the improvement of quality of life [18]. Overall, these interventions provide multi-dimensional support—psychological, behavioral, and emotional—enhancing patients' coping abilities and improving their psychological recovery after surgery. This underscores the necessity and efficacy of psychological stress-relief nursing in the rehabilitation process for postoperative bladder cancer patients. From the perspective of clinical nursing and psycho-oncology practice, these interventions not only directly alleviate patients' negative emotions but also provide a clear intervention pathway for the postoperative nursing team. For example, a multidisciplinary collaboration mechanism can be introduced in the ward, enabling professional nursing staff, psychological counselors, and oncologists to jointly carry out personalized psychological nursing programs, thereby enhancing patients' treatment compliance and proactivity in disease management. This not only meets the need for comprehensive psychological support in psycho-oncology, but also lays the foundation for subsequent research to verify the feasibility and long-term effectiveness of multidimensional intervention models.

In terms of quality of life improvement, different psychological stress-relief nursing interventions exhibited varying effects. This study found that cognitive behavioral therapy (CBT) had the most significant impact on enhancing patients' quality of life [19,20]. By altering patients' negative perceptions of the disease and coping mechanisms for negative emotions, CBT clearly plays a crucial role in helping patients better adapt to life after surgery. This intervention helps patients gain a deeper understanding of their illness. By actively adjusting their mindset, they can achieve lasting improvements in quality of life [21]. Meanwhile, relaxation training and psychological counseling also show positive effects on quality of life. These interventions may be less impactful than CBT, but they provide more direct physiological and emotional support. As a result, they offer a clear advantage in alleviating stress and improving mood, especially in the short term [22]. The

effectiveness of these different forms of interventions suggests that in clinical nursing, the choice of intervention should be tailored to meet the individual needs of each patient, and a combination of various methods may be necessary to achieve a more comprehensive effect [23]. Diverse intervention strategies not only accommodate the different psychological states and needs of patients but also maximize the lasting impact of the intervention through different approaches. Future research should further evaluate the long-term effects of these methods to determine how best to optimize the combination and frequency of interventions, ensuring that each patient receives the most appropriate psychological support.

In this meta-analysis, the Egger and Begg tests were used to assess the potential for publication bias, and the results indicated a certain degree of publication bias in anxiety scores. This suggests that studies on anxiety relief interventions may exhibit some bias due to a preference for publishing positive results. However, the bias tests for depression scores and quality of life scores were mostly non-significant or only marginally significant, indicating greater stability in these areas [24]. Overall, the impact of publication bias is limited, and the study findings remain highly credible. Heterogeneity analysis revealed some variability in the study results for anxiety and depression scores, suggesting that these outcome variables were affected by potential heterogeneity across different studies [25]. To address this heterogeneity, a random-effects model was applied to integrate the studies, aiming to mitigate the influence of differences across studies on the overall conclusion. Quality of life scores showed low heterogeneity; thus, a fixed-effects model was used, which helps more accurately reflect the true effect of the interventions. Sensitivity analysis was conducted by sequentially excluding included studies to evaluate the robustness of the overall results. The analysis showed that the exclusion of any single study had a limited impact on the overall effect, further enhancing the robustness and reliability of the study's conclusions. In summary, the main conclusions of this meta-analysis were not significantly affected by bias or heterogeneity, demonstrating the broad applicability and scientific validity of psychological stress-relief nursing interventions for postoperative psychological recovery in bladder cancer patients.

5. Study limitations and future research directions

This study systematically evaluated the effects of psychological stress-relief nursing interventions on the psychological recovery of postoperative bladder cancer patients, with findings indicating a significant positive impact on recovery. However, some limitations exist. The sample size included was relatively limited, especially within certain subgroups, which may impact the generalizability and reliability of the results. Additionally, some of the included studies presented a risk of bias in areas such as randomization, allocation concealment, and blinding, and these inconsistencies may weaken the internal validity of the study's conclusions. The meta-analysis indicated a degree of publication bias in anxiety scores, suggesting that the current conclusions may rely too heavily on published positive results. Future studies should include more unpublished data to reduce bias and ensure objectivity and completeness of the findings. Further research should focus on increasing the sample size and the number of high-quality randomized controlled trials, particularly those that systematically compare the long-term effects of different interventions. This will provide more targeted evidence and guidance for clinical nursing, ultimately enhancing the psychological recovery outcomes for patients.

Author contributions: Conceptualization, YZ and HZ; methodology, YC; formal

analysis, YC; investigation, YZ; resources, YC; writing—original draft preparation, YZ; writing—review and editing, HZ; supervision, YC. All authors have read and agreed to the published version of the manuscript.

Ethical approval: This study is a meta-analysis based on publicly available literature. Ethical approval was not required as no individual patient data or direct interventions were involved.

Informed consent statement: Not applicable.

Consent to publish: The manuscript has neither been previously published nor is under consideration by any other journal. The authors have all approved the content of the paper.

Conflict of interest: The authors declare no conflict of interest.

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