

ВЛИЯНИЕ СИСТЕМНОЙ ФОТОДИНАМИЧЕСКОЙ ТЕРАПИИ НА КАЧЕСТВО ЖИЗНИ ПАЦИЕНТОВ С МЕТАСТАТИЧЕСКИМ РАКОМ ПРЕДСТАТЕЛЬНОЙ ЖЕЛЕЗЫ

К.Т. Казбеков¹, Н.А. Шаназаров¹, С.В. Зинченко², А.Т. Казбекова³, В.В. Бенберин¹

¹Больница Медицинского центра Управления делами Президента Республики Казахстан, Астана, Республика Казахстан

²Казанский (Приволжский) федеральный университет, Казань, Россия

³Медицинский Университет Астана, Астана, Республика Казахстан

Резюме

Качество жизни является важным интегральным показателем эффективности лечения онкологических пациентов и отражает субъективное физическое, психологическое и социальное благополучие. Данные о влиянии системной фотодинамической терапии на качество жизни пациентов с метастатическим раком предстательной железы ограничены. Целью исследования являлось изучение влияния системной фотодинамической терапии на показатели качества жизни у пациентов с метастатическим раком предстательной железы. Проведено проспективное продольное исследование с участием 14 пациентов, со средним возрастом 69 лет. Качество жизни оценивали до и после лечения с использованием опросника QOL-CS. Надёжность шкал определяли с помощью коэффициента α Кронбаха. Для сравнения показателей до и после лечения использовали парный t-критерий Стьюдента с расчётом размера эффекта (Cohen's d). Опросник QOL-CS продемонстрировал высокую надёжность ($\alpha = 0,91$). После лечения выявлено статистически значимое улучшение по физическому, психологическому и социальному доменам, а также по интегральному показателю качества жизни ($p < 0,001$), при больших величинах эффекта (Cohen's d $> 1,8$). Изменения показателей духовного благополучия не достигли статистической значимости ($p = 0,134$). Системная фотодинамическая терапия ассоциируется с клинически значимым улучшением качества жизни пациентов с метастатическим раком предстательной железы.

Ключевые слова: системная фотодинамическая терапия, качество жизни, рак предстательной железы, QOL-CS.

Контакты: Казбеков К.Т., e-mail: kazbekovkt@gmail.com

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IMPACT OF SYSTEMIC PHOTODYNAMIC THERAPY ON QUALITY OF LIFE IN PATIENTS WITH METASTATIC PROSTATE CANCER

Kazbekov K.T.¹, Shanazarov N.A.¹, Zinchenko S.V.², Kazbekova A.T.³, Benberin V.V.¹

¹Medical Center Hospital of the President's affairs Administration of the Republic of Kazakhstan, Astana, Republic of Kazakhstan

²Kazan Federal University, Kazan, Russia

³Astana Medical University, Astana, Republic of Kazakhstan

Abstract

Quality of life is an important integrative indicator of treatment effectiveness in oncology and reflects patients' subjective physical, psychological, and social well-being. Data regarding the impact of systemic photodynamic therapy on quality of life in patients with metastatic prostate cancer remains limited. The aim of this study was to evaluate the effect of systemic photodynamic therapy on quality-of-life outcomes in patients with metastatic prostate cancer. A prospective longitudinal study was conducted involving 14 patients with a mean age of 69 years. Quality of life was assessed before and after treatment using the Quality of Life-Cancer Survivor (QOL-CS) questionnaire. Internal consistency of the scales was evaluated using Cronbach's alpha. Changes in quality-of-life scores were analyzed using the paired Student's t-test, and effect sizes were calculated using Cohen's d. The QOL-CS questionnaire demonstrated high reliability ($\alpha = 0.91$). After treatment, statistically significant improvements were observed in the physical, psychological, and social domains, as well as in the overall

quality-of-life score ($p < 0.001$), with large effect sizes (Cohen's $d > 1.8$). Changes in spiritual well-being did not reach statistical significance ($p = 0.134$). Systemic photodynamic therapy is associated with clinically meaningful improvements in quality of life among patients with metastatic prostate cancer.

Key words: systemic photodynamic therapy, quality of life, prostate cancer, QOL-CS.

Contacts: Kazbekov K.T., e-mail: kazbekovkt@gmail.com

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Introduction

Quality of life (QOL) is a multidisciplinary health-related concept that has been used in medicine for more than four decades. It has become an integral component of modern clinical practice and is widely regarded as an individual's subjective assessment of overall well-being [1]. The term "quality of life" in relation to patients first appeared in Index Medicus in 1977 [2]. In 1982, R.M. Kaplan and J.W. Bush introduced the concept of "health-related quality of life" (HRQOL), referring specifically to quality of life as it relates to health status [3, 4].

According to the World Health Organization (WHO), health is defined as a state of complete physical, social, and psychological well-being rather than merely the absence of disease. In this framework, the WHO defines QOL as an individual's subjective perception of their position in life, in relation to their culture, value systems, and relationships with the surrounding environment. The WHOQOL instruments (WHOQOL-100 and WHOQOL-BREF) enable standardized assessment of physical, psychological, social, and environmental well-being, providing a valid and reliable approach to measuring QOL in both clinical and population-based studies [5].

In 1990, at a joint conference of the U.S. National Cancer Institute (NCI) and the American Society of Clinical Oncology (ASCO), QOL was recognized as the second most important endpoint after overall survival and was considered more informative than objective tumor response in assessing treatment outcomes [6].

In modern medicine, improving patients' QOL has become a primary goal of medical care and one of the key criteria for treatment evaluation, thereby driving the development of new diagnostic and therapeutic approaches for malignant neoplasms, including prostate cancer [4].

These developments have necessitated the establishment of a unified methodological framework for QOL assessment. Despite ongoing discussions regarding the diversity of available measurement instruments, a key methodological requirement is the appropriate selection of instruments capable of objectively capturing an individual's physical, spiritual, psychological, and social well-being. Standardized questionnaires represent the

primary instruments for this purpose. These instruments must meet strict psychometric standards, and only when such criteria are satisfied can the resulting data be considered reliable and meaningful. A questionnaire may be defined as a structured method of data collection in social research that involves obtaining written responses from a defined population through questions relevant to the research problem [7].

Currently, more than 400 QOL questionnaires have been developed worldwide. In oncology practice, several cancer-specific instruments are most commonly used, including the American Functional Assessment of Cancer Therapy-General (FACT-G), the European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire-Core 30 (EORTC QLQ-C30), and the Quality of Life-Cancer Survivor (QOL-CS). In addition, other instruments are occasionally employed, such as the Rotterdam Symptom Checklist (RSC), the Functional Living Index-Cancer (FLIC), the Cancer Inventory of Problem Situations (CIPS), and the Cancer Rehabilitation Evaluation System (CARES). Measures assessing physical functioning, symptom burden, and pain are also commonly used, including the Karnofsky Performance Index (KPI), the McGill Pain Questionnaire (MPQ), the Symptom Distress Scale (SDS), visual analogue scales such as the Spitzer Quality of Life Index (SQLI), the Linear Analogue Self-Assessment Scale (LASA), the Quality of Life Tool (QOLT), and the BREAST-Q [4, 8, 9].

S.A. Muslov et al. (2022) conducted a QOL assessment among 100 patients with prostate cancer at baseline using the EORTC QLQ-PR25 module, applying both classical test theory and modern Rasch model-based approaches. Both methods demonstrated high internal consistency (Cronbach's $\alpha = 0.81$) and strong correlations between the two approaches ($r = 0.93-0.97$). The overall QOL score ranged from 76% to 79%, supporting the validity and comparability of these measurement methods in patients with prostate cancer [10].

A.A. Zhuravlev et al. (2025) adapted the Functional Assessment of Cancer Therapy-Prostate (FACT-P) questionnaire for Russian-speaking patients with prostate cancer, confirming high reliability ($\alpha = 0.78-0.89$) and validity. The Russian-language version showed good clinical utility for

QOL assessment in both clinical practice and oncological research [9].

The validation of the "Universal QOL Questionnaire for Patients with Prostate Cancer" demonstrated its high reliability and validity. The instrument enables the assessment of urinary, bowel, sexual, and hormonal functions, as well as patients' social and emotional well-being before and after treatment, making it a valuable tool for guiding therapeutic decisions and for clinical research [11].

Specific QOL assessment instruments complement traditional indicators of morbidity and mortality, providing researchers and clinicians with valuable means of evaluating the impact of cancer and its treatment. However, their psychometric refinement and cross-cultural adaptation remain subjects of ongoing development [12].

A comprehensive analysis of methodological approaches to measuring QOL in medicine, drawing on both classical test theory and modern latent variable models, as well as reviews of historical perspectives, psychometric properties of questionnaires, and applications of traditional and novel assessment methods across various clinical settings, underscores the importance of accurate QOL measurement in clinical research and health-care practice [13].

Drawing on international experience in QOL assessment, researchers at the City of Hope National Medical Center (California, USA) developed the QOL-CS questionnaire to measure QOL in patients with different types of cancer. The instrument comprises 41 items grouped into four domains: physical, social, psychological, and spiritual well-being. It is regarded as one of the most comprehensive instruments for evaluating changes across multiple dimensions of QOL in patients with cancer and has been validated in several countries [14, 15, 16].

Quality of life assessment in prostate cancer

Individual QOL assessment is conducted across all stages of medical care and has important prognostic value, facilitating prediction of disease course and outcomes while supporting informed treatment decision-making. Longitudinal evaluation enables monitoring of therapeutic effectiveness, comparison of different treatment modalities and pharmacological interventions, and broad application in the development of prognostic, rehabilitation, and palliative care programs, as well as in treatment standardization and pharmacoeconomic research [2, 17].

The development of new approaches to QOL assessment in patients with urological malignancies plays a key role in both clinical research and routine practice. An analysis of 17 original studies employing instruments such as EPIC-26/CP, EORTC QLQ-C30/PR25, FACT-P, PROMIS, and FoP-Q-SF demonstrated that QOL in patients with prostate cancer is influenced by a complex interplay of clinical, anatomical, and psychosocial factors [10, 18, 19].

The primary goal of prostate cancer treatment is not only to maximize survival but also to maintain a high QOL. Prostate cancer is frequently detected at an early stage and often presents as a low-risk disease. An increasing number of patients opt for active surveillance, which reduces treatment-related morbidity and helps preserve QOL [11, 20].

A favorable prognosis in prostate cancer has been associated with greater patient engagement in daily life and active participation in social activities, better disease awareness, partial independence from others, minimal emotional limitations in role functioning, and overall better social functioning, as well as positive worldviews and a perceived sense of control over life circumstances [21].

Treatment strategies for prostate cancer are heterogeneous and often aggressive. Advanced prostate cancer has a significant impact on patients' QOL. In routine clinical practice, impairments such as reduced physical functioning, generalized weakness, bone pain due to metastatic involvement, and urinary dysfunction are frequently underestimated. In the absence of overt clinical symptoms, the disease often presents predominantly with psychological distress, particularly depression and anxiety [1, 22].

QOL in patients with prostate cancer is strongly associated with disease stage, treatment modalities, and overall disease severity, highlighting the clinical importance of comprehensive patient assessment when selecting optimal treatment strategies [23].

The management of prostate cancer in elderly patients is closely linked to disease duration and QOL considerations, necessitating comprehensive geriatric assessment to individualize treatment strategies. Patients with prostate cancer, particularly those over 80 years of age, require multidisciplinary management involving not only oncologists but also clinical psychologists, geriatric specialists, and, when necessary, social services. QOL in older patients declines with advancing disease stage, while urinary dysfunction becomes more pronounced. The greatest improvement in urinary symptoms has been observed following palliative transurethral resection of the prostate, whereas the highest QOL scores are reported after radical prostatectomy. Assessment of both QOL and urinary function may serve as prognostic markers in prostate cancer staging [24, 25].

In recent years, accumulating evidence suggests a close association between prostate cancer and cardiovascular disease, with psychological disorders and QOL emerging as important prognostic factors. Patients with newly diagnosed prostate cancer and concomitant ischemic heart disease exhibit higher levels of depression, greater anxiety, and poorer QOL scores on general health perception and mental health subscales compared with those without ischemic heart disease [26].

QOL in patients with prostate cancer is substantially affected by sexual dysfunction, emotional disturbances,

and pain, particularly at advanced stages of the disease. Studies evaluating QOL following radical treatment have shown that a considerable proportion of patients experience functional impairments and a decline in overall well-being. Only approximately 17% of patients reported high QOL scores, underscoring the significant impact of both the disease and its treatment on daily functioning and psychological well-being. Preservation of the neurovascular bundles during radical prostatectomy has been associated with improved sexual function outcomes, while comprehensive QOL assessment facilitates treatment optimization by balancing survival benefits against treatment-related adverse effects [27, 28].

In the context of ongoing healthcare digitalization, emerging approaches to QOL assessment in prostate cancer enable optimization of treatment and rehabilitation strategies, facilitate longitudinal monitoring of patients' clinical status, and promote individualized therapy. Digital solutions and personalized assessment tools further enhance tracking of treatment-related adverse effects, thereby improving the overall effectiveness of patient care [29].

Photodynamic therapy in prostate cancer and its impact on quality of life

International clinical experience with photodynamic therapy (PDT) has demonstrated considerable efficacy for both radical and palliative management of malignancies across various anatomical sites. PDT may be used either as a standalone modality or in combination with surgery and radiotherapy. In certain clinical situations, including patient refusal of surgery or contraindications to surgical intervention, it may represent the only feasible antitumor treatment option [4].

PDT is a modern therapeutic modality based on the interaction of three key components: a photosensitizer, light of a specific wavelength, and molecular oxygen. This approach enables selective destruction of tumor cells while simultaneously stimulating immune responses. As a minimally invasive, tissue-preserving technique, PDT has been increasingly adopted in recent years in oncology.

PDT consists of two main stages and involves administration of a photosensitizer followed by localized irradiation of the target area. Its mechanism of action is based on selective accumulation of the photosensitizer in tumor cells and its activation by light of a specific wavelength, resulting in the generation of reactive oxygen species and tumor cell destruction. The efficacy and safety of PDT are ensured by precise selection of both the light source and the photosensitizer, allowing selective targeting of pathological tissues while minimizing damage to surrounding healthy cells.

Upon light activation of the photosensitizer, reactive oxygen species and free radicals are generated, resulting in oxidative damage to tumor cells, disruption of cellular membranes and intracellular structures, and ultimately

cell death. Concurrently, PDT activates antitumor immune responses by stimulating phagocytosis and cell-mediated immunity, thereby facilitating the elimination of residual malignant cells and reducing the risk of disease recurrence.

Systemic photodynamic intravenous laser blood irradiation enhances therapeutic effectiveness by improving the rheological and functional properties of blood, activating both cellular and humoral immunity, and increasing oxygen transport capacity together with antioxidant and bactericidal activity. Collectively, these effects promote a systemic immune response [30, 31].

In prostate cancer, QOL assessment plays a key role in selecting optimal treatment strategies that balance therapeutic efficacy with minimal adverse effects. Studies indicate that combined treatment approaches provide better pain control and improved emotional well-being. Longitudinal QOL evaluation before and after treatment enables therapy to be tailored according to urinary, sexual, hormonal, and psychological functioning [32].

Following vascular-targeted photodynamic therapy, most patients with low-risk localized prostate cancer reported no decision regret, with only 9.7% reporting significant regret due to local recurrence or tumor progression. Overall QOL remained stable, indicating good tolerability and minimal invasiveness of the procedure [33].

O.E. Popovkina et al. (2022) report on the development of photodynamic diagnostic and therapeutic approaches at the A. Tsyb Medical Radiological Research Center, highlighting advances in photosensitizer application, optimization of treatment parameters, and the implementation of focal, interstitial, and systemic photodynamic therapy in clinical oncology practice. These findings highlight the potential of PDT as both a diagnostic and therapeutic modality in contemporary oncology [34].

Systemic photodynamic therapy (SPDT) for localized low-risk prostate cancer has demonstrated a high rate of negative biopsy results at 6 months, good tolerability, and preservation of QOL, with only moderate effects on erectile and urinary function. In a European prospective study, SPDT reduced disease progression and prolonged time to progression compared with active surveillance. Adverse events were predominantly mild to moderate and transient, indicating good tolerability and supporting the potential of this approach as a promising focal therapy option [35].

QOL analysis using the QOL-CS questionnaire in patients with advanced cancer demonstrated that SPDT improves patient outcomes. QOL assessment serves as an important prognostic indicator and aids in individualizing treatment by guiding the selection of optimal therapeutic strategies [36].

The importance of QOL assessment as a sensitive endpoint in the management of metastatic prostate cancer highlights its value in detecting changes in functional and

emotional well-being during therapy and in informing optimal treatment strategies [37].

The aim of the study was to evaluate the effect of systemic photodynamic therapy on QOL outcomes in patients with metastatic prostate cancer.

Materials and methods

The study was conducted at the Center for Photodynamic Therapy of the Medical Center Hospital of the President's affairs Administration of the Republic of Kazakhstan from 2024 to 2025. Patients with metastatic prostate cancer were enrolled. The mean age of the participants was 69 years. None of the participants had cognitive impairment, which ensured their ability to independently complete the questionnaires. Written informed consent was obtained from all patients prior to study initiation and treatment.

This prospective longitudinal study assessed QOL indicators at baseline (before treatment initiation) and after completion of systemic photodynamic therapy.

Changes in QOL parameters were evaluated over time relative to baseline values. This design enabled objective evaluation of the treatment effect on patients' subjective well-being. The study design is illustrated in Fig. 1.

Subjective evaluation of overall health and psychological well-being was performed in patients with metastatic prostate cancer before initiation of systemic photodynamic therapy and after treatment completion to assess QOL related outcomes.

QOL assessment and analysis were performed using the Quality of Life/Cancer Survivor (QOL-CS) questionnaire, which comprises 41 items and has been adapted and validated for use in clinical research. The instrument enables comprehensive evaluation of patients' physical, psychological, social, and functional well-being.

Scores were calculated on a 0-10 scale, where 0 indicated the worst outcome and 10 the best. Items 1-7, 9, 16-27, 29-34, and 38 were reverse-scored.

Internal consistency of the QOL-CS questionnaire scales was assessed using Cronbach's alpha. Values of $\alpha > 0.70$ were considered indicative of acceptable reliability of the instrument.

Statistical analysis was performed using parametric methods. Normality of QOL score distribution variables was assessed using the Shapiro-Wilk test. Differences in QOL scores before and after treatment were evaluated using the paired Student's t-test. Results are presented as mean $\pm$ standard deviation ($M \pm SD$). To assess the clinical significance of the observed changes, effect size was additionally calculated using Cohen's d.

A p-value < 0.05 was considered statistically significant.

Results

Based on a processed data, internal consistency of the QOL-CS questionnaire domains was assessed using Cronbach's alpha after reverse scoring of relevant items and calculation of domain scores. The obtained coefficients were comparable to those reported in the original validation study by B.R. Ferrell et al. (2003) in a cohort of cancer survivors [15, 16].

In the original study, the authors reported high internal consistency for the overall QOL score ($\alpha = 0.93$), as well as high Cronbach's alpha values for the individual domains: physical ($\alpha = 0.77$), psychological ($\alpha = 0.89$), social ($\alpha = 0.81$) and spiritual well-being ($\alpha = 0.71$).

In the present study, the overall QOL-CS score demonstrated high reliability ($\alpha = 0.91$), consistent with the original validation findings and confirming the robustness of the instrument.

Internal consistency indices for the physical ($\alpha = 0.88$) and psychological well-being ($\alpha = 0.91$) domains indicated high reliability and were comparable to those reported in the original validation study. In contrast, Cronbach's alpha values for the social ($\alpha = 0.49$) and spiritual ($\alpha = 0.29$) domains were lower. Similar reductions in internal consistency

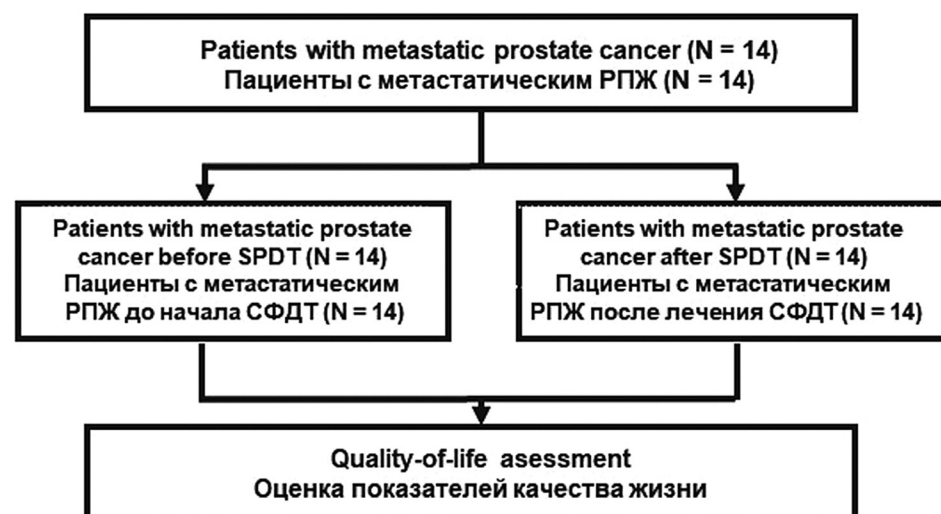


Рис. 1. Дизайн исследования.
Fig. 1. Study design.

tency have been reported in subsequent studies and are commonly attributed to the conceptual heterogeneity of these scales, which encompass diverse aspects of social adaptation and spiritual experience.

Overall, the findings confirm the psychometric reliability of the QOL-CS questionnaire and are consistent with those of the original validation study.

Normality of quantitative variables distribution was assessed using the Shapiro-Wilk test separately for each QOL

Таблица 1

Проверка гипотезы о нормальности распределения показателей качества жизни (QOL-CS) до и после лечения (критерий Шапиро-Уилка)

Table 1
Shapiro-Wilk test for normality of quality-of-life (QOL-CS) scores before and after treatment

Домен QOL-CS QOL-CS Domain	W, до лечения W, before treatment (n = 14)	p	W, после лечения W, after treatment (n = 14)	p
Физическое благополучие Physical well-being	0.955	0.647	0.960	0.727
Психологическое благополучие Psychological well-being	0.939	0.404	0.943	0.452
Социальное благополучие Social well-being	0.890	0.080	0.930	0.308
Духовное благополучие Spiritual well-being	0.962	0.753	0.950	0.552
Общий показатель Overall score	0.957	0.677	0.904	0.128

Таблица 2

Сравнение показателей качества жизни (QOL-CS) до и после лечения (парный t-критерий Стьюдента, с коррекцией Бонферрони)

Table 2
Comparison of QOL-CS scores before and after treatment using paired Student's t-tests with Bonferroni correction

Домен QOL-CS QOL-CS Domain	n	M, до лечения M, before treatment	M, после лечения M, after treatment	t-критерий Стьюдента Student's t-test	p	d Коэна Cohen's d
Физическое благополучие Physical well-being	14	2.79	3.48	8.322	<0.001	2.224
Психологическое благополучие Psychological well-being	14	1.69	2.37	8.677	<0.001	2.319
Социальное благополучие Social well-being	14	2.88	3.37	6.790	<0.001	1.815
Духовное благополучие Spiritual well-being	14	5.03	5.22	1.598	0.134	0.427
Общий показатель Overall score	14	3.10	3.61	8.228	<0.001	2.199

domain and the overall score before and after treatment. According to analysis, no statistically significant deviations from normality were observed for any QOL domain (physical, psychological, social, and spiritual) or for the total QOL-CS score ($p > 0.05$). These findings indicate no evidence to reject the assumption of normal distribution of the data (Table 1).

Accordingly, parametric statistical methods were applied for subsequent analysis of differences in QOL scores before and after treatment.

Differences in quality-of-life scores before and after treatment were analyzed using the paired Student's t-test.

Statistically significant improvements were observed in the physical, psychological, and social domains, as well as in the overall QOL-CS score ($p < 0.001$). These differences remained significant after adjustment for multiple comparisons. Large effect sizes were observed across these domains (Cohen's $d > 1.8$), indicating substantial clinical significance.

Changes in spiritual well-being did not reach statistical significance ($p = 0.134$), with a small-to-moderate effect size (Cohen's $d = 0.43$) (Table 2).

Thus, treatment was associated with statistically significant improvements in physical, psychological, social, and overall QOL scores, indicating the clinical relevance of these changes. No statistically significant changes were observed in spiritual well-being. Overall, these findings support the effectiveness of treatment in improving key aspects of patients' quality of life.

Discussion

In the present study, QOL in patients with metastatic prostate cancer was comprehensively assessed before and after SPDT using the QOL-CS questionnaire. The findings confirm the instrument's psychometric reliability and sensitivity to clinically meaningful treatment-related changes,

supporting its use for longitudinal QOL assessment in this patient population.

Analysis of internal consistency demonstrated high Cronbach's alpha values for the overall QOL-CS score and for the physical and psychological well-being domains, consistent with the original validation findings and indicating item homogeneity. Lower alpha values for the social and spiritual domains are in line with previous reports and likely reflect the conceptual heterogeneity of these scales, which encompass diverse aspects of social adaptation and existential experience, as well as the limited sample size.

Assessment of normality revealed no statistically significant deviations from normal distribution for any domain or for the overall QOL score, either before or after treatment, supporting the use of parametric statistical methods. Application of the paired Student's t-test demonstrated significant improvements in the physical, psychological, social domains, and overall QOL-CS score. These changes were accompanied by large effect sizes, indicating their clinical relevance.

In contrast to the aforementioned domains, changes in spiritual well-being did not reach statistical significance, which may reflect the relative stability of spiritual and existential aspects of quality of life and their lower sensitivity to

short-term clinical interventions. Overall, the findings support the effectiveness of the treatment in improving the main dimensions of patients' quality of life and underscore the importance of incorporating QOL assessment into the comprehensive evaluation of treatment outcomes.

Conclusion

The study demonstrated that SPDT in patients with metastatic prostate cancer was associated with statistically and clinically significant improvements in QOL scores, particularly in the physical, psychological, social, and overall QOL-CS domains. The magnitude of these effects supports their clinical relevance.

The QOL-CS questionnaire demonstrated high psychometric reliability and sensitivity to clinically meaningful changes, supporting its use for assessing QOL dynamics during treatment. The absence of statistically significant changes in spiritual well-being highlights the relative stability of this domain and underscores the need for further investigation using additional or alternative instruments.

These findings underscore the importance of incorporating QOL assessment into the overall evaluation of treatment outcomes in patients with advanced prostate cancer and may help optimize therapeutic and supportive interventions aimed at improving QOL in this population.

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