Research Article

COMPARATIVE VALIDATION OF THE CDQP-4 QUESTIONNAIRE FOR THE DIAGNOSIS OF PRE-CACHEXIA

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Abstract

Pre-cachexia is an early stage of progressive nutritional deficiency in patients with oncological diseases. Failure to diagnose and treat pre-cachexia in a timely manner leads to the development of cachexia, which can be the cause of death in 20% of cancer patients. Consequently, pre-cachexia is considered a life-threatening condition that requires early detection. Existing diagnostic methods lack sufficient sensitivity, specificity, reliability, and discriminatory power to distinguish pre-cachexia from cachexia and related conditions. The purpose of this article is to compare the diagnostic competence, reliability, discriminatory power, consistency, and other characteristics of the Comprehensive Diagnostic Questionnaire for Pre-cachexia-4 (CDQP-4), which we developed. Statistical analysis revealed several advantages of the CDQP-4, including a sensitivity of 87.6%, a specificity of 89.3%, and a diagnostic classification capacity (AUC = 0.92), outperforming reference scales such as MNA-SF (72.4%, 68.7%, 0.76), MUST (64.2%, 62.4%, 0.68), and NRS-2002 (69.8%, 65.3%, 0.71). The overall diagnostic accuracy of the CDQP-4 (90.6%) was superior to that of the ECOG, MNA-SF, PG-SGA, and EORTC QLQ-C30 scales (all ≤79.2%). The diagnostic accuracy of the CDQP-4 questionnaire for pairs of adjacent states—normal vs. pre-cachexia (0.912), pre-cachexia vs. cachexia (0.894), and normal vs. sarcopenia (0.876)—was the highest when compared to the corresponding values for the ECOG and MNA-SF scales. Furthermore, the CDQP-4 demonstrated the greatest sensitivity to clinical changes in patients' status (improvement or deterioration), as well as excellent reliability, internal consistency, reproducibility, and a well-balanced structure. Thus, the CDQP-4 questionnaire serves as an effective and promising tool for diagnosing pre-cachexia in clinical practice.

Keywords: pre-cachexia, interleukin-6, inflammation, sarcopenia, cancer

1. Introduction

One of the most pressing issues in cancer patients is cachexia, which is a multifactorial wasting syndrome characterized by unintentional and pronounced weight loss (including the loss of muscle mass). It occurs in 20–85% of cancer patients and accounts for 20% of fatal outcomes (Chen et al., 2024; Tamayo-Torres et al., 2024). Such a high mortality rate necessitates the search for early precursors of cachexia in order to initiate treatment as early as possible to arrest its progression.

Diagnosing pre-cachexia proves challenging due to the lack of an effective tool for distinguishing between pre-cachexia and cachexia, as well as between pre-cachexia and a normal metabolic state. In real-world clinical practice, the 2011 international expert consensus guidelines are used for these purposes, defining a weight loss of more than 5% over 12 months as a diagnostic criterion for cachexia. Consensus was reached that cachexia develops in stages: from pre-cachexia to cachexia, and subsequently to refractory cachexia *(Fearon et al., 2011). Each stage has its own distinct characteristics:*

- ***Pre-cachexia*** *– weight loss ≤5%, accompanied by anorexia and metabolic changes;*
- ***Cachexia*** *– weight loss >5%, or BMI <20 kg/m² and weight loss >2%, or sarcopenia and weight loss >2%, frequently associated with reduced food intake and/or systemic inflammation;*

- ***Refractory cachexia*** *– cachexia of varying severity, cancer characterized by predominant catabolic processes and unresponsiveness to anticancer therapy, low performance status, and a life expectancy within 3 months (Laviano et al., 2015).*

As these clinical forms progress, patients' quality of life, including their sense of well-being, declines significantly (Kasvis et al., 2019). To deliver equivalent etiopathogenetic and symptomatic therapy, the influence of various factors on the development of this pathology is analyzed.

In recent years, active research has focused on the relationship between biomarkers and cachexia or pre-cachexia. In their review, E. Tamayo-Torres et al. highlight key pathogenetic mechanisms of cachexia, such as impaired protein metabolism, inflammation, oxidative stress, and mitochondrial dysfunction. Particular emphasis is placed on the role of systemic inflammation and interleukin-6 (IL-6), which suppresses protein synthesis (by inhibiting the PI3K/AKT/mTOR signaling pathway) and induces mitochondrial dysfunction and muscle atrophy (by activating FOXO family proteins) (Tamayo-Torres et al., 2024). Even at the pre-cachexia stage, elevated levels of C-reactive protein, tumor necrosis factor-alpha (TNF-α), and fibrinogen, alongside decreased serum albumin concentrations, are observed (Op den Kamp et al., 2012). Staging scales and classifiers developed in recent years to diagnose cachexia stages (non-cachexia → pre-cachexia → cachexia → refractory cachexia) most commonly utilize the following predictors: inflammatory markers (including C-reactive protein); weight loss (including lean body mass); markers and indices of muscle mass loss (severity of sarcopenia); symptom burden; food intake (anorexia); quality of life; physical/functional capacity; and survival time (Argilés et al., 2011; Wesseltoft-Rao et al., 2015; Vigano et al., 2017; Zhou et al., 2018; Wiegert et al., 2021).

In a recent study, machine learning was tested for diagnosing cachexia by analyzing several parameters: the C-reactive protein-to-albumin ratio (CAR), high-density lipoprotein (HDL) levels, dietary changes, mid-upper arm circumference, handgrip strength, and serum creatinine levels. Two logistic regression models demonstrated the best AUC (Area Under the ROC Curve) values: 0.830 for diagnosing cachexia and 0.701 for diagnosing pre-cachexia (Chen et al., 2024). Furthermore, a radiation-induced cachexia staging scale was developed to diagnose different phases of this condition and differentiate patient management strategies. The authors concluded that a decline in functional capacity is a decisive criterion for transitioning between cachexia stages (Yi et al., 2022).

Recently, at the Bukhara State Medical Institute (Republic of Uzbekistan) and the State Autonomous Healthcare Institution of the Tyumen Region "Multifunctional Clinical Medical Center of the Russian Federation," the Comprehensive Diagnostic Questionnaire for Pre-cachexia-4 (CDQP-4) was developed and tested, with its validation results published in an open-access journal (Mamedov et al., 2025). Statistically significant correlations were established between pre-cachexia and elevated levels of IL-6 (r=0.819), TNF-α (r=0.782), and C-reactive protein (r=0.782). Testing the questionnaire on 287 women with stage IV malignant neoplasms of the reproductive organs demonstrated high sensitivity (92.4%), specificity (88.6%), and diagnostic accuracy (90.5%).

The aim of the present study was the comparative validation of the CDQP-4 questionnaire against scales commonly used in clinical practice to diagnose cachexia: MNA-SF, MUST, and NRS-2002. In a separate section, CDQP-4 was compared with the ECOG, PG-SGA, and EORTC QLQ-C30 scales as reference tools for functional and nutritional status.

2. Materials And Methods

This study compared the diagnostic, functional, and nutritional parameters of the CDQP-4 scale with those of reference scales. A detailed description of testing the CDQP-4 questionnaire in 287 women with reproductive system tumors and hormone-producing tumors was provided in our previous publication (Mamedov et al., 2025).

2.1. The CDQP-4 Questionnaire

Briefly, the CDQP-4 questionnaire consists of 2 parts: Part A for self-completion by the patient; and Part B for completion by the attending physician, which contains an "anthropometry" block reflecting weight loss, a "laboratory parameters" block including albumin, C-reactive protein, TNF-α, and IL-6, and a "functional status" block comprising total ECOG scale scores, thigh muscle thickness via ultrasound, and handgrip dynamometry results. The total score ranges from 0 to 150 points. Interpretation of CDQP-4 results: 0–45 points – low risk of pre-cachexia; 46–90 points – moderate risk of pre-cachexia; 91–150 points – high risk / established pre-cachexia.

2.2. Reference Scales

The following reference scales were used:

- **MNA-SF** – Mini Nutritional Assessment Short-Form (scored from 0 to 14 points, where 0 indicates malnutrition, 14 indicates normal nutritional status, and <12 points indicates a high risk of malnutrition) (Kaiser M.J. et al., 2009).
- **MUST** – Malnutrition Universal Screening Tool (from 0 to 6 points, where 0 indicates low risk of malnutrition, and ≥2 points indicates high nutritional risk requiring dietary intervention) (Stratton et al., 2004).
- **NRS-2002** – Nutritional Risk Screening (from 0 to 6 points, where <3 points indicates low nutritional risk, and ≥3 points indicates high nutritional risk requiring nutritional support) (Kondrup et al., 2003).
- **ECOG** – Eastern Cooperative Oncology Group Performance Status (from 0 to 5 points, where 0 means the patient is fully active, and 5 indicates death) (Oken et al., 1982).
- **PG-SGA** – Patient-Generated Subjective Global Assessment (nutritional assessment where 0 points indicates no nutritional intervention is required, and ≥9 points indicates a critical need for intensive intervention) (Bauer et al., 2002).
- **EORTC QLQ-C30** – The European Organization for Research and Treatment of Cancer Quality of Life Questionnaire-C30 (overall quality of life score across functional and symptom scales from 0 to 100 points, where a higher score indicates a worse quality of life) (Aaronson et al., 1993).

2.3. Evaluation Parameters

The test and reference scales were evaluated based on sensitivity, specificity, diagnostic accuracy, discriminatory power, responsiveness to changes in patient status, reliability, validity, completion time, and ease of interpretation. The SPSS software package was used for statistical analysis.

3. Results And Discussion

3.1. Diagnostic Characteristics of Screening Instruments

The results of the comparative study regarding sensitivity, specificity, AUC (Area Under the ROC Curve), completion time, and complexity of interpretation are presented in Table 1.

Table 1. Diagnostic characteristics of questionnaires in pre-cachexia screening

Questionnaire / Scale	AUC (0–1)	Sensitivity, %	Specificity, %	Completion Time, min	Interpretation Complexity
CDQP-4	0.92	87.6	89.3	10–15	Low
MNA-SF	0.76	72.4	68.7	5–7	Moderate
MUST	0.68	64.2	62.1	3–5	High
NRS-2002	0.71	69.8	65.3	5–7	Moderate

In our series, CDQP-4 demonstrated an AUC of 0.92—a level classified as "outstanding discrimination" according to the Hosmer–Lemeshow classification—whereas MNA-SF and NRS-2002 remained in the "acceptable/fair" range (0.68–0.76). The difference in AUC between CDQP-4 and each of the reference instruments was statistically significant ($p<0.05$ according to the non-parametric DeLong test with multiple comparison correction), which we verified separately given the large number of parallel tests.

3.2. Comparison of Diagnostic Accuracy Between CDQP-4 and Reference Scales

The measurements of sensitivity, specificity, and diagnostic accuracy for the CDQP-4 questionnaire exceeded the corresponding results for the reference scales (Table 2).

Table 2. Comparative diagnostic accuracy of instruments (pre-cachexia vs. cachexia)

Questionnaire / Scale	Se, %	Sp, %	Accuracy, %	AUC	p (vs. CDQP-4, AUC)
CDQP-4	92.4	88.7	90.6	0.936	–
ECOG	78.3	72.5	75.4	0.754	0.04
MNA-SF	69.6	65.2	67.4	0.674	0.03
PG-SGA	81.5	76.8	79.2	0.792	0.05
EORTC QLQ-C30	75.2	70.6	72.9	0.726	0.02

The p-values in this table refer to the comparison of the AUC of each reference instrument with that of CDQP-4. The results above indicate that CDQP-4 outperforms every reference scale in terms of sensitivity (Se), specificity (Sp), diagnostic accuracy, and integrated diagnostic capacity (AUC). Key differences remained statistically significant even after applying a conservative correction for multiplicity.

3.3. Discriminatory Power of CDQP-4 and Reference Scales

Given that the progression of nutritional deficiency in cancer patients occurs gradually, we calculated discriminant AUC values for transitional states: normal → pre-cachexia; pre-cachexia → cachexia; and normal → sarcopenia (Table 3).

Table 3. Discriminatory power of CDQP-4 and reference scales (AUC for pairs of states)

Questionnaire / Scale	Normal vs. Pre-cachexia (AUC)	Pre-cachexia vs. Cachexia (AUC)	Normal vs. Sarcopenia (AUC)
CDQP-4	0.912	0.894	0.876
ECOG	0.752	0.685	0.698
MNA-SF	0.678	0.642	0.656

The AUC values presented in the table, reflecting the integrated diagnostic capacities of the scales, demonstrate the superiority of the CDQP-4 questionnaire over its reference counterparts in capturing transitions between different stages of cachexia development. Furthermore, CDQP-4 is also more effective in evaluating the transition from normal muscular status to sarcopenia.

3.4. Determination of Sensitivity to Changes in Nutritional and Functional Status

The sensitivity (responsiveness) of the CDQP-4 questionnaire to changes in nutritional and functional status was evaluated against the MNA-SF (nutritional status) and ECOG (functional status) scales, measured as the score difference responding to clinical change (Table 4).

Table 4. Sensitivity to changes in clinical status

Questionnaire / Scale	Improvement (ΔM±SD)	Deterioration (ΔM±SD)	Stability (ΔM±SD)
CDQP-4	+2.3±0.4	−3.7±0.6	+0.5±0.2
ECOG	+1.6±0.3	−2.9±0.5	+0.3±0.1
MNA-SF	+1.2±0.2	−2.4±0.4	+0.2±0.1

The results presented in the table show the mean score change corresponding to shifts in a patient's condition (improvement/deterioration). Thus, the response "step" to changes in the CDQP-4 questionnaire is larger than in the reference scales with comparable variability, indicating superior responsiveness and making it a convenient tool for monitoring patients' conditions.

3.5. Assessment of Reliability and Validity

To validate the CDQP-4 questionnaire, a set of parameters was utilized: internal consistency via Cronbach's alpha, test-retest reliability, split-half reliability, and ICC (Intraclass Correlation Coefficient). SPSS and MedCalc software packages were used for analysis; confidence intervals for Cronbach's α and ICC were determined using standard software procedures (Table 5).

Table 5. Reliability indicators of CDQP-4

Indicator	Value	95% CI
Cronbach's alpha (α)	0.892	0.871–0.913
Test-retest (total score, r)	0.876	0.852–0.901
Split-half (Spearman–Brown)	0.884	0.863–0.905
ICC (total score)	0.896	0.862–0.924

All obtained α values exceed the 0.80 threshold, which corresponds to good internal consistency and is recommended for questionnaires used in clinical practice. This indicates strong internal consistency among the CDQP-4 items and confirms that all items specifically measure pre-cachexia/cachexia. Moreover, high test-retest and ICC values demonstrate excellent test reproducibility. Upon retesting after 14±2 days in patients without significant clinical

changes, the total CDQP-4 score remained virtually unchanged.

3.6. Discussion

The development of pre-cachexia poses a serious challenge in oncology, as median survival is substantially reduced in these patients (11.2 months vs. 18.7 months, p<0.001) compared to patients without pre-cachexia (Martin et al., 2019). Progressive protein-energy malnutrition can be driven not only by the oncological process itself but also by comorbid conditions. Timely staging of cachexia in cancer patients and identifying its earliest phases provide an excellent opportunity to initiate treatment that prevents further progression of nutritional deficiency. Nevertheless, pre-cachexia is rarely diagnosed due to mild symptoms and a lack of patient complaints. Laboratory markers—including total protein, albumin, transferrin, etc.—as well as diagnostic scales are frequently used for the early detection of worsening malnutrition (Leiderman et al., 2024).

Diagnostic scales and questionnaires developed over recent decades are not comprehensive, universal instruments capable of specifically identifying pre-cachexia. Specialized screening tools (such as MUST, NRS-2002, PG-SGA, etc.) were designed to detect and assess already established nutritional deficiency. They fail to capture early, metabolically reversible changes characteristic of pre-cachexia. Consequently, while they detect observable weight loss, the core manifestations of emerging nutritional deficiency (early satiety, anorexia, systemic inflammatory processes, and progressive muscle mass loss) elude these tools. The definition of pre-cachexia proposed by the international consensus (Fearon et al., 2011) relies on clinical, anthropometric data, and appetite evaluation, which introduces a degree of subjectivity and insufficient sensitivity at the earliest stages of metabolic disturbances. Most modern scales and questionnaires often lack clear quantitative cutoff values, unified terminology, and standardized biomarker panels, negatively impacting their sensitivity and specificity for pre-cachexia. Virtually no studies or scales exist that can clearly discriminate between pre-cachexia and cachexia. As a result, pre-cachexia is often identified retrospectively once full-blown cachexia has already developed, depriving clinicians of the optimal "window of opportunity" to halt metabolic derangements.

There is an urgent need for a highly sensitive and highly specific classifier for the various stages of cachexia, including its earliest phases. Our newly developed Comprehensive Diagnostic Questionnaire for Pre-cachexia (CDQP-4) demonstrated outstanding capability in detecting pre-cachexia, clearly demarcating this state from both earlier (normal) and later (cachexia) stages of progressive nutritional deficiency. In our primary publication on CDQP-4 (Mamedov et al., 2025), the full content of the questionnaire—comprising 25 questions with response options scored from 0 to 6 points—was detailed. CDQP-4 incorporates virtually all major pathogenetic markers and signs of pre-cachexia assessed via laboratory, instrumental, and anthropometric methods, alongside patient-reported outcomes. Through their responses, patients self-assess their eating behavior, functional status, physical activity, psycho-emotional state, and symptoms. Combining subjective and objective data within a single questionnaire enables the collection and statistical integration of the maximum possible number of features characteristic of incipient nutritional deficiency. This renders the assessment highly sensitive (92.4%), specific (88.6%), and diagnostically accurate (90.5%), significantly outperforming reference scales such as MNA-SF, MUST, and NRS-2002, as demonstrated in the present study. Each laboratory marker used showed a high degree of correlation with CDQP-4 (p<0.001) and was assigned a weighting coefficient within the composite biomarker index for diagnosing pre-cachexia. Although the time required to complete CDQP-4 was longer than that of reference questionnaires, its interpretation was straightforward and left no room for misinterpretation.

Comparing CDQP-4 parameters with functional scales (ECOG, MNA-SF, PG-SGA, EORTC QLQ-C30) also revealed the superiority of the former in terms of sensitivity, specificity, and diagnostic accuracy. Furthermore, CDQP-4 achieved the highest Area Under the ROC Curve (AUC=0.926) among all compared methods, corresponding to an outstanding level of diagnostic efficacy. Among all reference counterparts, the PG-SGA scale showed the best results (Se=81.5%, Sp=76.8%, Accuracy=79.2%, AUC=0.792), yet the difference in diagnostic efficacy (AUC) compared to CDQP-4 reached statistical significance (p=0.05). The MNA-SF scale exhibited the lowest informativeness (Se=69.6%, Sp=65.2%, Accuracy=67.4%, AUC=0.674), which is explained by the fact that this tool was originally designed for a geriatric patient population. The ECOG (AUC=0.754, p=0.04) and EORTC QLQ-C30 (AUC=0.726, p=0.02) scales were also substantially inferior to CDQP-4: as instruments designed to assess functional status and quality of life, they do not include nutritional deficiency markers specific to pre-cachexia/cachexia and, consequently, differentiate poorly between pre-cachexia and cachexia. The advantage of CDQP-4 in this context was evident because its structure was specifically tailored to pre-cachexia criteria, accounting for both clinical-anamnestic information (anorexia, weight loss, sarcopenia, etc.) and laboratory/instrumentally determined metabolic changes absent from reference screening scales.

The investigation of the discriminatory power of CDQP-4 compared to reference scales showed that CDQP-4 consistently outperforms reference tools in differentiating pairs of states: normal vs. pre-cachexia; pre-cachexia vs. cachexia; and normal vs. sarcopenia. When discriminating between normal status and pre-cachexia, CDQP-4 achieved a peak AUC of 0.912, whereas the next highest value lagged significantly behind for ECOG (0.752) and was even lower for MNA-SF (0.678), corresponding to acceptable and poor discrimination, respectively. When differentiating pre-cachexia from cachexia as adjacent stages of a single pathological continuum, CDQP-4 maintained high resolving power (AUC=0.894), substantially outperforming ECOG (AUC=0.685) and MNA-SF (AUC=0.642), which underscores the inadequacy of reference scales in distinguishing between these two states. Differentiating normal status from sarcopenia also highlighted the advantages of CDQP-4 (AUC=0.876) against the less impressive figures of the reference scales (ECOG AUC=0.698 and MNA-SF AUC=0.656). Notably, in the normal vs. sarcopenia pair, the gap in AUC values between CDQP-4 and the reference scales was narrower, aligning with the partial overlap between the metabolic phenotypes of sarcopenia and nutritional deficiency. Overall, the data indicate the absence of a pronounced "blind spot" in CDQP-4, as the AUC never dropped below 0.87 in any discrimination task.

Analysis of the CDQP-4 questionnaire's responsiveness to patient dynamics confirmed its advantages in monitoring nutritional and functional status. During both clinical improvement and deterioration, the absolute magnitude of score change on the CDQP-4 questionnaire was markedly greater than on the ECOG and MNA-SF scales. Meanwhile, score variations in clinically stable patients were negligible and comparable across all evaluated scales. The larger response "step" of CDQP-4 coupled with comparable variability reflects its heightened sensitivity to genuine changes in patient status, making CDQP-4 particularly convenient for routine monitoring and evaluating the efficacy of therapeutic interventions.

Reliability assessments of the CDQP-4 questionnaire using Cronbach's α coefficient, test-retest scores, Spearman–Brown split-half values, and intraclass correlation coefficients (ICC) demonstrate that the questionnaire possesses strong internal consistency, test-retest stability, structural balance, and excellent inter-session reproducibility of the total score. The stability of CDQP-4 scores over an interval of 14±2 days confirms the practical suitability of our developed scale for diagnosing pre-cachexia.

4. Conclusion

The conducted study enabled a comprehensive characterization of the diagnostic competencies of our newly developed CDQP-4 questionnaire and proved its superiority over reference instruments. Comparative analysis established that existing screening scales (MUST, NRS-2002, MNA-SF, PG-SGA) and functional status/quality-of-life questionnaires (ECOG, EORTC QLQ-C30) are substantially inferior to CDQP-4 not only in sensitivity and specificity, but also in diagnostic efficacy, including discriminatory power across all studied pairs of states: normal vs. pre-cachexia; pre-cachexia vs. cachexia; and normal vs. sarcopenia. High responsiveness of CDQP-4 to changes in patients' clinical status was noted, alongside high reliability, internal consistency, excellent reproducibility, and structural balance. Taken together, these findings provide strong grounds to consider the CDQP-4 questionnaire an effective, clinically applicable tool for diagnosing pre-cachexia.

References

1. Leiderman I.N., Medvedev A.Yu., Eremeeva O.G., Zukov R.A. (2024). Problems of early diagnosis and correction of protein-energy malnutrition in patients at high surgical and anesthetic risk in abdominal surgery: a literature review. *Annals of Critical Care*, 3, 96–113. doi.org. (In Russian).
2. Mamedov U.S., Gaisina E.A., Rakhimov N.M. (2025). Validation of a Diagnostic Precachexia Questionnaire Using an Integral Biomarker Index in Women with Oncological Pathology. *Problems of Biology and Medicine*, 6(166), 138–145. (In Russian).
3. Aaronson, N.K., Ahmedzai, S., Bergman, B., Bullinger, M., Cull, A., Duez, N.J., Filiberti, A., Flechtner, H., Fleishman, S.B., de Haes, J.C., et al. (1993). The European Organization for Research and Treatment of Cancer QLQ-C30: a quality-of-life instrument for use in international clinical trials in oncology. *J Natl Cancer Inst.*, 85(5), 365–376. doi: 10.1093/jnci/85.5.365.
4. Argilés, J.M., López-Soriano, F.J., Toledo, M., Betancourt, A., Serpe, R., Busquets, S. (2011). The cachexia score (CASCO): a new tool for staging cachectic cancer patients. *J Cachexia Sarcopenia Muscle*, 2(2), 87–93. doi: 10.1007/s13539-011-0027-5.

5. Bauer, J., Capra, S., Ferguson, M. (2002). Use of the scored Patient-Generated Subjective Global Assessment (PG-SGA) as a nutrition assessment tool in patients with cancer. *Eur J Clin Nutr.*, 56(8), 779–785. doi: 10.1038/sj.ejcn.1601412.
6. Chen, Y., Liu, C., Zheng, X., Liu, T., Xie, H., Lin, S.Q., Zhang, H., Shi, J., Liu, X., Wang, Z., Deng, L., Shi, H. (2024). Machine learning to identify precachexia and cachexia: a multicenter, retrospective cohort study. *Support Care Cancer*, 32(10), 630. doi: 10.1007/s00520-024-08833-4.
7. Fearon, K., Strasser, F., Anker, S.D., Bosaeus, I., Bruera, E., Fainsinger, R.L., Jatoi, A., Loprinzi, C., MacDonald, N., Mantovani, G., Davis, M., Muscaritoli, M., Ottery, F., Radbruch, L., Ravasco, P., Walsh, D., Wilcock, A., Kaasa, S., Baracos, V.E. (2011). Definition and classification of cancer cachexia: an international consensus. *Lancet Oncol.*, 12(5), 489–495. doi: 10.1016/S1470-2045(10)70218-8.
8. Kaiser, M.J., Bauer, J.M., Ramsch, C., Uter, W., Guigoz, Y., Cederholm, T., Thomas, D.R., Anthony, P., Charlton, K.E., Maggio, M., Tsai, A.C., Grathwohl, D., Vellas, B., Sieber, C.C. (2009). Validation of the Mini Nutritional Assessment short-form (MNA-SF): a practical tool for identification of nutritional status. MNA-International Group. *J Nutr Health Aging*, 13(9), 782–788. doi: 10.1007/s12603-009-0214-7.
9. Kasvis, P., Vigano, M., Vigano, A. (2019). Health-related quality of life across cancer cachexia stages. *Ann Palliat Med.*, 8(1), 33–42. doi: 10.21037/apm.2018.08.04.
10. Kondrup, J., Rasmussen, H.H., Hamberg, O., Stanga, Z. (2003). Nutritional risk screening (NRS 2002): a new method based on an analysis of controlled clinical trials. *Clin Nutr.*, 22(3), 321–336. doi: 10.1016/s0261-5614(02)00214-5.
11. Laviano, A., Koverech, A., Mari, A. (2015). Cachexia: clinical features when inflammation drives malnutrition. *Proc Nutr Soc.*, 74(4), 348–354. doi: 10.1017/S0029665115000117.
12. Martin, L., Senesse, P., Gioulbasanis, I., Antoun, S., Bozzetti, F., Deans, C., Strasser, F., Thoresen, L., Jagoe, R.T., Chasen, M., Lundholm, K., Bosaeus, I., Fearon, K.H., Baracos, V.E. (2019). Diagnostic criteria for the classification of cancer-associated weight loss. *Journal of Clinical Oncology*, 37(14), 1142–1150. doi: 10.1200/JCO.2014.56.1894.
13. Oken, M.M., Creech, R.H., Tormey, D.C., Horton, J., Davis, T.E., McFadden, E.T., Carbone, P.P. (1982). Toxicity and response criteria of the Eastern Cooperative Oncology Group. *Am J Clin Oncol.*, 5(6), 649–655. PMID: 7165009.
14. Op den Kamp, C.M., Langen, R.C., Minnaard, R., Kelders, M.C., Snepvangers, F.J., Hesselink, M.K., Dingemans, A.C., Schols, A.M. (2012). Pre-cachexia in patients with stages I-III non-small cell lung cancer: systemic inflammation and functional impairment without activation of skeletal muscle ubiquitin proteasome system. *Lung Cancer*, 76(1), 112–117. doi: 10.1016/j.lungcan.2011.09.012.
15. Stratton, R.J., Hackston, A., Longmore, D., Dixon, R., Price, S., Stroud, M., King, C., Elia, M. (2004). Malnutrition in hospital outpatients and inpatients: prevalence, concurrent validity and ease of use of the 'malnutrition universal screening tool' ('MUST') for adults. *Br J Nutr.*, 92(5), 799–808. doi: 10.1079/bjn20041258.
16. Tamayo-Torres, E., Garrido, A., de Cabo, R., Carretero, J., Gómez-Cabrera, M.C. (2024). Molecular mechanisms of cancer cachexia. Role of exercise training. *Mol Aspects Med.*, 99, 101293. doi: 10.1016/j.mam.2024.101293.
17. Vigano, A.A.L., Morais, J.A., Ciutto, L., Rosenthall, L., di Tomasso, J., Khan, S., Olders, H., Borod, M., Kilgour, R.D. (2017). Use of routinely available clinical, nutritional, and functional criteria to classify cachexia in advanced cancer patients. *Clin Nutr.*, 36(5), 1378–1390. doi: 10.1016/j.clnu.2016.09.008.
18. Wesseltoft-Rao, N., Hjermstad, M., Ikdahl, T., Dajani, O., Ulven, S.M., Iversen, P.O., Bye, A. (2015). Comparing two classifications of cancer cachexia and their association with survival in patients with unresected pancreatic cancer. *Nutr Cancer*, 67(3), 472–480. doi: 10.1080/01635581.2015.1004728.
19. Wiegert, E.V.M., de Oliveira, L.C., Calixto-Lima, L., Chaves, G.V., Silva, Lopes M.S., Peres, W.A.F. (2021). New cancer cachexia staging system for use in clinical practice. *Nutrition*, 90, 111271. doi: 10.1016/j.nut.2021.111271.
20. Yi, H., Wang, Y., Liang, Q., Li, X., Chen, C., Mao, X. (2022). R-CSS: A clinically applicable score to classify cachexia stages in patients with cancer undergoing intensity-modulated radiation therapy. *Asia Pac J Oncol Nurs.*, 10(1), 100164. doi: 10.1016/j.apjon.2022.100164.
21. Zhou, T., Wang, B., Liu, H., Yang, K., Thapa, S., Zhang, H., Li, L., Yu, S. (2018). Development and validation of a clinically applicable score to classify cachexia stages in advanced cancer patients. *J Cachexia Sarcopenia Muscle*, 9(2), 306–314. doi: 10.1002/jcsm.12275.