Detection of malnutrition and sarcopenia risk in patients with advanced lung cancer using the R-MAPP tool

José P. Suárez-Llanos*[1], Cristina Lorenzo González[1], Barbara Cánovas Gaillemin[2], Idoia Morilla Ruíz[3], Ángel Luis Hernández Herrera[1], Gerardo Moreno Segura[2], Verónica Serrano Pecos[4], David Martín Iglesias[5], Luis Miguel Luengo Pérez[4]

[1]Hospital Universitario Nuestra Señora de Candelaria, Instituto de Investigación Sanitaria de Canarias (IISC), Santa Cruz de Tenerife, Spain
[2]Hospital Universitario de Toledo, Toledo, Spain
[3]Hospital Universitario de Navarra, Instituto de Investigación Sanitaria de Navarra (IdiSNA), Pamplona, Spain
[4]Hospital Universitario de Badajoz, Badajoz, Spain
[5]Hospital Virgen de la Luz de Cuenca, Cuenca, Spain

***Corresponding author:**
José P. Suárez-Llanos PhD, MD
Hospital Universitario
Nuestra Señora de Candelaria
carretera del Rosario 145
38010, Santa Cruz
de Tenerife, Spain
E-mail: pablua@hotmail.com

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Abstract

Introduction: Malnutrition and sarcopenia are frequent in advanced lung cancer, worsening outcomes and quality of life. Early detection and intervention are essential. This study assessed the effectiveness of R-MAPP in detecting malnutrition and sarcopenia risk compared to standard clinical practice.

Material and methods: A prospective, randomized, multicenter study of 65 advanced lung cancer patients assigned to R-MAPP or standard care was performed. R-MAPP integrates MUST and SARC-F with clinical data. Outcomes included risk identification, weight, quality of life (EQ-5D-5L), and handgrip strength. Analyses were adjusted for baseline imbalances (alcohol use, chemotherapy).

Results: The R-MAPP group identified 42.4% of patients at risk vs. 3.1% in the control group ($p < 0.001$). After adjustment, R-MAPP markedly increased the likelihood of detecting at-risk patients (adjusted OR = 21.2, 95% CI: 2.6–175.4, $p = 0.005$). No significant differences were observed in weight (4.94 kg, 95% CI: –4.59–14.48, $p = 0.30$) or quality of life (–8.45 VAS points, 95% CI: –22.62–5.71, $p = 0.23$), although both remained stable despite a higher chemotherapy rate in the intervention group.

Conclusions: R-MAPP effectively identifies patients at risk of malnutrition and sarcopenia in advanced lung cancer, supporting early intervention in complex clinical settings. Although further studies are needed to assess its long-term impact and diagnostic performance, R-MAPP is a practical, efficient tool for risk screening rather than diagnostic confirmation in routine oncology care. However, as this was a pilot study without a formal sample size calculation, secondary outcomes should be interpreted as exploratory only. This also applies to the wide confidence interval observed for the primary outcome.

Key words: malnutrition, sarcopenia, advanced lung cancer, nutritional screening, R-MAPP.

Introduction

Advanced lung cancer is one of the most impactful oncological diseases in terms of incidence, mortality, and social burden. According to recent data, it remains the leading cause of cancer-related deaths worldwide, with a high proportion of diagnoses occurring at advanced stages, significantly limiting therapeutic options and long-term survival [1]. In this context, nutritional complications such as malnutrition and sarcopenia emerge as critical factors that worsen patient prognosis by increasing morbidity and compromising both quality of life and treatment efficacy [2].

Malnutrition in cancer patients is linked to various factors, including the adverse effects of oncological therapies, disease-induced metabolic changes, and reduced food intake due to cancer-associated anorexia. This condition affects up to 40% of patients, particularly those with advanced solid tumors such as lung cancer [3]. Nutritional deterioration directly impacts patients' ability to complete treatment cycles, increasing the frequency of toxicities associated with chemotherapy and immunotherapy [4].

Sarcopenia, characterized by the progressive loss of muscle mass and function, is associated with a higher risk of falls, fractures, reduced functional capacity, and poorer tolerance to oncological treatments [5] This condition further complicates the clinical picture, contributing to the development of cachexia and overall patient deterioration [6].

However, despite the clear clinical relevance of malnutrition and sarcopenia, early diagnosis remains a challenge. The coexistence of sarcopenic obesity, often observed in oncology patients, complicates the detection of muscle mass loss, as it may be masked by an elevated body mass index (BMI) [7]. Traditional clinical evaluations are frequently insufficient to identify at-risk patients, especially in settings with limited resources or high care demands. This underscores the need for innovative, accessible, and cost-effective tools that enable comprehensive assessments and facilitate early intervention [8].

In this context, the Remote Malnutrition and Sarcopenia Primary Practice (R-MAPP) tool represents a promising solution. This instrument integrates validated screening methods, such as the Malnutrition Universal Screening Tool (MUST) and the SARC-F scale (Strength, Assistance with walking, Rise from chair, Climb stairs, and Falls), to efficiently identify the risk of malnutrition and sarcopenia in routine clinical practice [9]. R-MAPP could be particularly valuable for oncology patients. Unlike tools such as NRS-2002 or PG-SGA, R-MAPP requires less time and clinical input, making it more practical in high-demand or resource-limited environments. Its streamlined format avoids the need for extensive dietary histories or lengthy interviews. R-MAPP also stands out for its capability to perform remote evaluations, leveraging digital platforms that broaden its applicability, even among populations with limited access to specialized healthcare services [10]. Additionally, it has received recognition from international organizations, such as the European Society for Clinical Nutrition and Metabolism (ESPEN), as a strategic tool to optimize nutritional management in chronic patients [11].

The primary objective of this study was to assess the effectiveness of the R-MAPP tool in detecting the risk of malnutrition and sarcopenia in patients with advanced lung cancer, compared to standard clinical practice. Specifically, it aimed to determine whether its implementation could facilitate the early identification of at-risk patients and support tailored nutritional and physical interventions. Through this work, the study seeks not only to validate the clinical utility of R-MAPP but also to generate robust evidence supporting its integration into daily clinical practice, emphasizing its potential to optimize the comprehensive management of advanced lung cancer patients in resource-constrained settings with increasing healthcare demands.

Material and methods

Design and subjects

A prospective, randomized, multicenter, controlled study was conducted involving adult patients diagnosed with advanced lung cancer. Participants were allocated to intervention and control groups using a 1 : 1 randomization process that ensured allocation concealment through sealed, opaque envelopes. A computer-generated block randomization sequence without stratification was used, and the block size was not disclosed to investigators or recruiters to prevent potential selection bias. The study was carried out across five nationally recognized hospitals.

Inclusion criteria required participants to be newly diagnosed adults (≥ 18 years) with confirmed stage IV lung cancer, just prior to initiating chemotherapy or immunotherapy cycles. Eligible participants were also required to have an estimated life expectancy of six months or more and the ability to comprehend the study's objectives and provide informed consent.

Exclusion criteria included prior participation in nutritional intervention programs or specific treatments for malnutrition risk within the past six months, a Karnofsky Performance Status score below 60, a history of previous oncological processes, or the presence of other significant condi-

tions that could independently justify malnutrition or sarcopenia unrelated to lung cancer (e.g., recent surgery, trauma, or active inflammatory disease).

Measuring instruments and data collection

This study used validated instruments to comprehensively assess the nutritional status and sarcopenia risk of the selected patients, supplemented by specific tools for collecting clinical and demographic data. The primary diagnostic tool was R-MAPP, which comprises two main components: the MUST and the SARC-F scale. The MUST evaluates malnutrition risk based on body mass index (BMI), the percentage of involuntary weight loss, and a score associated with acute diseases. The SARC-F scale includes five items measuring strength, walking assistance, the ability to rise from a chair, stair climbing, and falls, providing a score to identify sarcopenia risk [12, 13].

Additionally, a Jamar dynamometer was used to measure the grip strength of the dominant arm. In this procedure, three consecutive measurements were taken, with the highest value recorded as the reference. The maximum value was used rather than the arithmetic mean, as it best reflects the participant's voluntary peak performance and is commonly applied in functional assessments to avoid underestimation due to initial submaximal effort. Quality of life was assessed using the EQ-5D-5L questionnaire, administered at both baseline and the end of follow-up [14].

Clinical and demographic data were extracted from patients' medical records, including information on age, sex, weight, height, BMI, prior illnesses, comorbidities, TNM staging, and oncological treatments. Data on lifestyle habits, such as tobacco and alcohol use, were also collected, along with information on pharmacotherapy, including corticosteroid use. Baseline and final evaluations were performed for both groups.

Intervention

In the intervention group, the process began by identifying eligible patients during clinical consultations in oncology units. Once inclusion and exclusion criteria were verified, patients were invited to participate in the study with a detailed explanation of its objectives and procedures. After providing written informed consent, each patient was assigned a unique code to ensure data confidentiality.

At the initial visit, baseline assessments were conducted using the R-MAPP tool, along with objective measurements of grip strength. Anthropometric and clinical data, such as age, sex, comorbidities, functional status, and quality of life, were also collected.

Patients who screened positive (MUST score ≥ 2 or SARC-F score ≥ 4) received a personalized intervention plan. This plan included specific dietary recommendations based on ESPEN guidelines and a tailored physical exercise program designed to meet individual needs. The exercises focused on improving muscle strength and functionality, and patients were given instructions on proper execution. Follow-up reviews were conducted every two months to monitor adherence and adjust the plan as needed.

In the control group, patients underwent standard nutritional evaluations and management according to routine clinical practice, without the use of the R-MAPP tool. Data collection for both groups was managed using an electronic case report form (eCRF). Data were entered directly into the eCRF by trained clinical personnel. To ensure data integrity, the research team performed regular monitoring of completeness and accuracy. Outcome assessors were not involved in group allocation, and statistical analysis was performed independently after database lock.

Outcomes measures

The outcome measures in this study were designed to assess the impact of the R-MAPP tool on the early detection of malnutrition and sarcopenia risk, as well as the effectiveness of the implemented interventions. These measures were categorized into primary and secondary outcomes, focusing on clinical, functional, and quality-of-life aspects.

The primary outcome of the study was the proportion of patients identified as being at risk of malnutrition or sarcopenia, determined using the predefined cutoff points of the R-MAPP tool. This measure was pivotal in evaluating the tool's diagnostic accuracy and its ability to detect at-risk individuals in a timely manner.

Secondary outcomes included a broad range of variables aimed at capturing the changes in patients' health and well-being over the course of the study. Anthropometric and functional changes, such as variations in body weight and BMI between the baseline and final assessments, were closely monitored. Grip strength was also evaluated, with the highest value from three consecutive measurements of the dominant arm recorded as the reference.

Additionally, quality of life was assessed using the EQ-5D-5L questionnaire, administered at both baseline and the end of the study. This provided a comprehensive view of how the interventions affected patients' perceived health and daily functioning. Together, these outcome measures offered a robust framework to evaluate the clinical utility of R-MAPP and the benefits of early intervention in patients with advanced lung cancer.

Data analysis

Given the exploratory nature of the study and the recruitment limitations encountered, particularly in the context of the COVID-19 pandemic, the trial was conducted as a pilot study. As such, no formal sample size calculation was included in the final protocol, and the study was primarily intended to generate preliminary data to inform the design of future, adequately powered investigations. Therefore, a descriptive analysis was conducted to summarize the factors and measurement variables used in the study. Frequencies and percentages were calculated for qualitative data, while means, standard deviations (SD), medians, and interquartile ranges were reported for quantitative variables. Tables and figures were generated to facilitate a clearer understanding of the data.

To evaluate the primary outcome, a univariate analysis was performed, focusing on the proportion of patients at risk of malnutrition or sarcopenia in both groups. This analysis included hypothesis testing using Pearson's χ^2 estimator, along with the calculation of odds ratios (OR) and their corresponding 95% confidence intervals (CI). In cases where baseline imbalances were identified, multivariate logistic regression models were employed to adjust for potential confounding factors. Due to the limited sample size and exploratory nature of this pilot study, stratified randomization and subgroup analyses were not performed, as they could have introduced additional imbalances. Relevant baseline differences were adjusted for using multivariate models.

Secondary outcome variables, such as changes in weight, BMI, grip strength, and quality of life, were analyzed using Student's *t*-test for independent samples when assumptions of normality and homoscedasticity were met. If these assumptions were violated, non-parametric tests, such as the Mann-Whitney *U* test, were applied. Additionally, repeated measures analyses were conducted to evaluate baseline-to-final changes within each group and to compare these changes between groups for detecting significant differences.

All analyses considered *p*-values below 0.05 to be statistically significant, with results presented alongside 95% confidence intervals. Two-tailed testing was employed throughout, and in cases of follow-up losses, an intention-to-treat approach was adopted. The "last observation carried forward" (LOCF) method was used to impute missing data for continuous measures.

Results

A total of 65 participants were included in the study, randomly and evenly distributed between the intervention group (n = 33) and the control group (n = 32) (Fig. 1). Baseline characteristics of the participants were generally similar across groups. However, significant imbalances were observed in alcohol consumption (p = 0.005) and chemotherapy treatment (p = 0.030), both of which were more prevalent in the intervention group. The mean age of the participants was 64.8 years (SD = 8.8), with a baseline BMI of 25.9 kg/m² (SD = 4.6). Initial grip strength averaged 24.7 kg (SD = 9.2) across the entire cohort. A detailed summary of the baseline characteristics of the study population is provided in Table I.

Univariate analysis

The univariate analysis revealed that the R-MAPP tool identified a significantly higher proportion of patients at risk of malnutrition or sar-

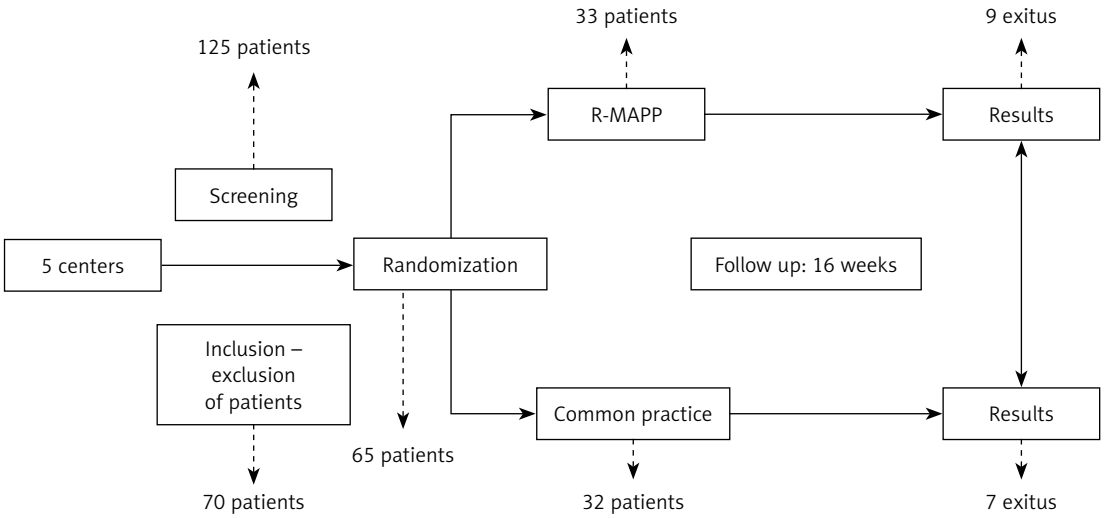


Figure 1. Study design and patient flowchart across study phases

copenia compared to standard clinical practice. In the intervention group, 42.4% of patients (14 out of 33) were identified as being at risk (MUST ≥ 2 or SARC-F ≥ 4), whereas only 3.1% (1 out of 32) of patients in the control group reached these thresholds. This difference was statistically significant ($p < 0.001$), underscoring the superior ability of the R-MAPP tool to detect at-risk cases that went unnoticed with standard methods. A detailed comparison of these results is presented in Figure 2.

Multivariate analysis

Given the significant baseline imbalances observed in variables such as alcohol consumption and chemotherapy treatment, a multivariate logistic regression analysis was conducted to adjust for these potential confounding factors. In the adjusted model, the intervention group continued to demonstrate a significantly higher likelihood of identifying patients at risk of malnutrition or sarcopenia, with an adjusted odds ratio (OR) of 21.2 (95% CI: 2.6–175.4, $p = 0.005$). This finding supports the use of R-MAPP as a tool to improve early identification of patients at risk, although it should not be interpreted as confirmation of a clinical diagnosis. Nonetheless, the possibility of residual confounding due to unmeasured variables cannot be entirely ruled out. A detailed summary of the adjusted results is presented in Table II.

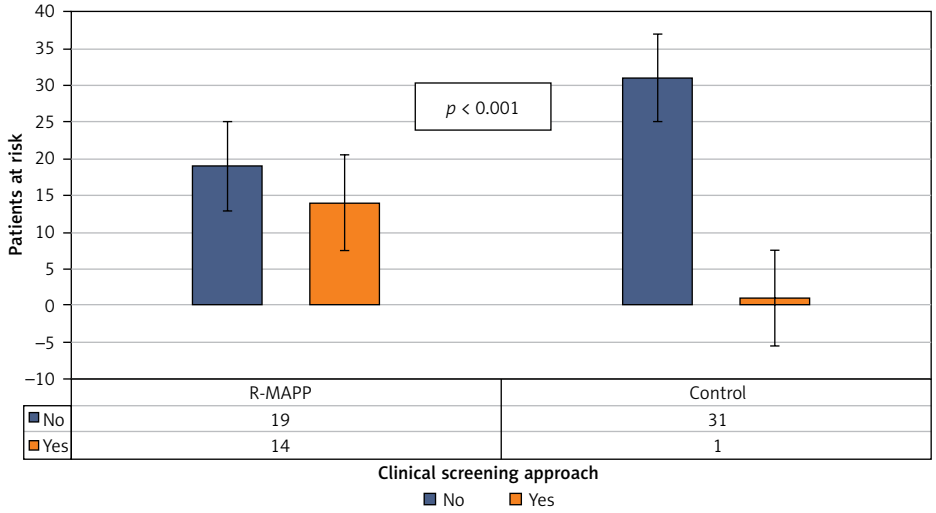
Secondary outcomes

Body weight: At the end of the follow-up period, the intervention group exhibited better weight maintenance compared to the control group, with a mean difference of 4.94 kg (95% CI: –4.59–14.48). However, this difference was not statistically significant ($p = 0.30$). Additional analysis using the LOCF method to impute missing data for patients without final measurements confirmed similar results, also failing to reach statistical significance ($p = 0.58$). Although the difference in weight maintenance was not statistically significant, a higher proportion of patients

Table I. Baseline characteristics of studied sample

Variable	Total	R-MAPP	Control	*P*-value
Sex (male), *n* (%)	35 (53.8)	19 (57.6)	16 (50)	0.540
Age, mean (SD)	64.77 (8.82)	64.76 (8.65)	64.78 (9.14)	0.991
Height, mean (SD)	164.20 (9.07)	164.36 (9.63)	164.03 (8.60)	0.884
Weight, mean (SD)	70.60 (14.15)	71.55 (16.24)	69.62 (13.22)	0.601
BMI, mean (SD)	25.90 (4.57)	26.41 (4.91)	25.38 (4.21)	0.367
Controlled diabetes, *n* (%)	6 (9.2)	2 (6.3)	4 (12.5)	0.672
Diagnosis, n (%)				
Small cell carcinoma	8 (12.3)	4 (12.1)	4 (12.5)	0.927
Adenocarcinoma	44 (67.7)	23 (69.7)	21 (65.6)	
Squamous	13 (20)	6 (18.2)	7 (21.9)	
Staging, *n* (%)				
Stage IIIA	2 (3.1)	–	2 (6.3)	0.495
Stage IIIC	1 (1.6)	–	1 (3.1)	
Stage IVA (M1a)	21 (32.8)	11 (33.3)	10 (21.3)	
Stage IVA (M1b)	9 (14.1)	5 (15.2)	4 (12.5)	
Stage IVB	31 (48.4)	17 (51.5)	4 (12.5)	
Alcohol consumption, *n* (%)	7 (10.8)	–	7 (21.9)	0.005*
Smoking, *n* (%)	22 (33.8)	9 (27.3)	13 (40.6)	0.217
Corticotherapy, *n* (%)	15 (23.1)	7 (21.2)	8 (25)	0.717
Chemotherapy, *n* (%)	51 (79.7)	29 (87.9)	22 (68.8)	0.030*
Immunotherapy, *n* (%)	38 (59.4)	19 (57.6)	19 (59.4)	1.000
Radiotherapy, *n* (%)	6 (9.5)	1 (3)	5 (16.6)	0.104
Karnofsky, mean (SD)	86.41 (13.02)	86.56 (13.35)	86.25 (12.89)	0.922
Grip strength, mean (SD)	24.69 (9.19)	26.81 (10.34)	22.48 (7.36)	0.061

*BMI – body mass index, Karnofsky – Karnofsky Performance Scale, p-value – probability value, R-MAPP – Remote Malnutrition and Sarcopenia Primary Practice, SD – standard deviation. *Statistically significant differences at a 95% confidence level ($p < 0.05$). P-values derived from χ^2/Fisher's exact tests for categorical variables and Student's t-test (or Mann-Whitney U test when non-normal) for continuous variables.*



Statistical comparison using χ^2 test. Adjusted logistic regression showed an OR = 21.2 (95% CI: 2.6–175.4, p = 0.005).

Figure 2. Comparison of risk detection rates for malnutrition and sarcopenia: R-MAPP vs. standard clinical practice in advanced lung cancer patients

Table II. Univariate and multivariate regression for the R-MAPP or control group variable adjusting for confounding factors

Variable	B	OR	95% CI		*P*-value
Group	3.129	22.842	2.776	187.954	0.004*
Variable	**B**	**OR (a)**	**95% CI**		***P*-value**
Alcohol	–19.312	0.00	0.00	–	0.998
Chemotherapy	–0.675	0.573	0.509	5.335	0.490
Group	3.054	21.211	2.565	175.404	0.005*

*B – coefficient estimate in logistic regression, CI – confidence interval, OR – odds ratio, OR (a) – adjusted odds ratio, p-value – probability value. *Statistically significant differences at a 95% confidence level (p < 0.05). P-values derived from univariate and multivariate logistic regression models.*

in the intervention group underwent chemotherapy, a treatment commonly associated with weight loss. In this context, the early intervention using the R-MAPP tool may have partially mitigated these adverse effects.

Quality of life: No statistically significant differences in quality-of-life scores were observed between the groups. In the intervention group, the mean difference in subjective evaluation (VAS) was –8.45 points (95% CI: –22.62–5.71) compared to the control group (p = 0.23). This difference may also have been influenced by the higher proportion of patients receiving chemotherapy in the intervention group. Additionally, the substantial variability observed between groups in this analysis may have limited the detection of significant differences, emphasizing the need to interpret these findings cautiously. Detailed results for both outcomes are presented in Table III.

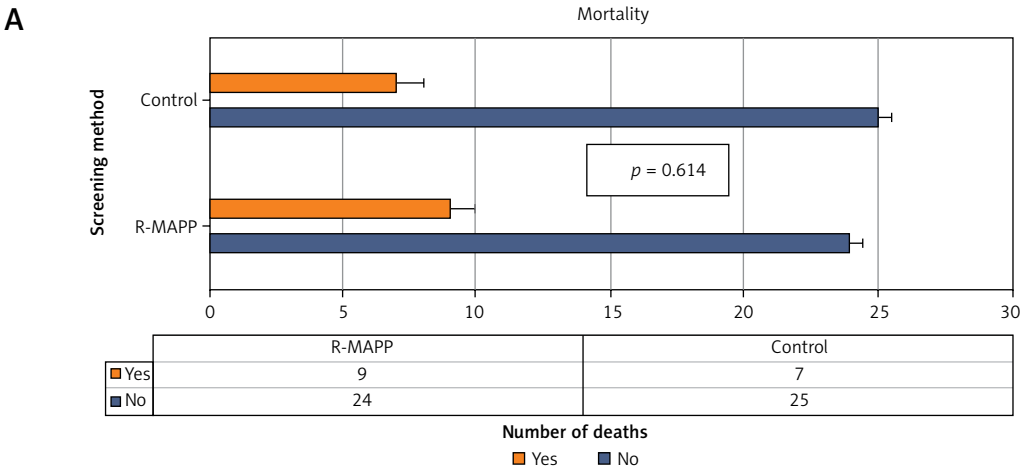
Additional results

No statistically significant differences were observed between the groups regarding mortality (p = 0.61) or hospital readmissions (p = 0.46) during the study period. A detailed comparison of these results is presented in Figure 3. In the intervention group, 41.2% of patients assessed with the MUST tool maintained unchanged scores between pre- and post-treatment measurements. Meanwhile, 23.5% showed a decrease of one point, and 5.9% experienced an increase of three points, reflecting a heterogeneous response to the implemented interventions. However, a considerable proportion of patients achieved stabilization

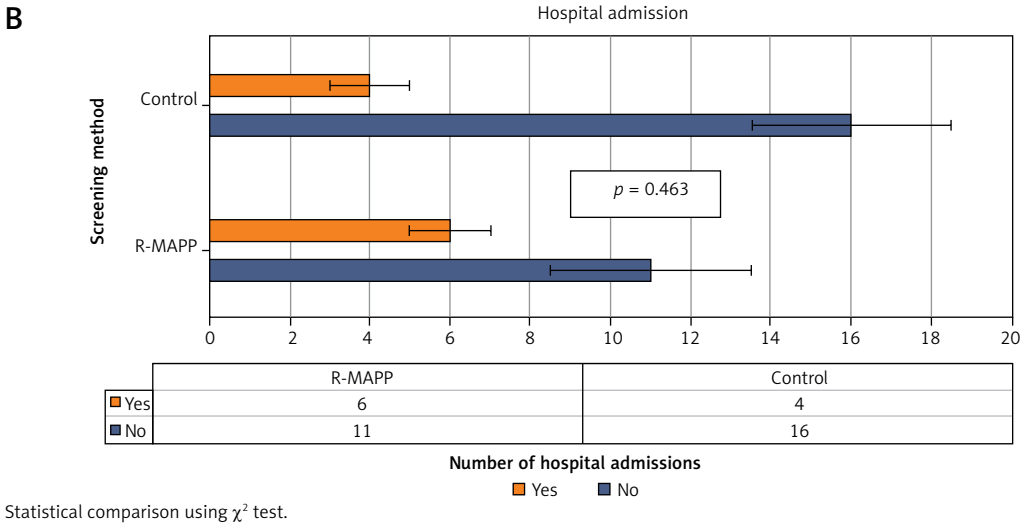
Table III. Quantitative secondary outcomes: differences in pre-post changes in weight and quality of life between R-MAPP group and control group

Outcome	Difference	95% CI		*P*-value
Weight (pre-post)	4.49	–4.593	14.477	0.300
Quality of life (pre-post)	–8.452	–22.618	5.714	0.234

P-values derived from independent samples t-test.



Statistical comparison using χ^2 test.



Statistical comparison using χ^2 test.

Figure 3. A – Comparison of mortality rates between R-MAPP and standard clinical practice groups. **B** – Hospital admission rates in patients screened with R-MAPP vs. standard clinical practice

or improvement in malnutrition risk during follow-up.

Similarly, 82.4% of patients in the intervention group assessed with the SARC-F scale maintained stable scores throughout the study. This finding suggests functional stability, even in the face of potential adverse effects from treatments such as chemotherapy. These results highlight the potential of the R-MAPP tool to support the maintenance of nutritional and functional parameters in patients with advanced lung cancer.

Discussion

The findings of this study, supported by a robust design that provides a high level of evidence, demonstrate that the R-MAPP tool is significantly more effective than standard clinical practice in identifying patients at risk of malnutrition and sarcopenia in advanced lung cancer. This result is particularly relevant in a clinical context where these conditions are highly prevalent and have a profoundly negative impact on patient prognosis and quality of life.

While the differences in certain secondary variables, such as body weight and quality of life, did not reach statistical significance, their interpretation requires consideration of the higher proportion of patients in the intervention group undergoing chemotherapy – a factor known to exacerbate nutritional and functional adverse effects. Limited statistical power for these variables may also have contributed to the lack of significant findings. In this context, the observed stability in these measures within the intervention group over the follow-up period may represent an indirect benefit of the R-MAPP tool, as it enables the early implementation of nutritional and functional strengthening strategies. Nevertheless, these findings should be interpreted as exploratory and hypothesis-generating, rather than definitive conclusions.

These findings highlight the tool's potential to mitigate the negative impacts of aggressive

cancer treatments, offering a proactive approach to managing malnutrition and sarcopenia risk in a population particularly vulnerable to these complications. However, the wide confidence interval around the primary outcome suggests variability in the effect estimate, likely influenced by the relatively small sample size. This finding should be interpreted with caution, although the direction and magnitude of the association remain clinically relevant. In addition, the relatively small sample size, particularly in the intervention group, may limit the generalizability of the findings and highlight the need to replicate the study in larger, more representative patient populations. Furthermore, while the R-MAPP intervention included educational materials on nutrition and physical activity, no formal assessment of patient adherence was conducted. This limits the ability to evaluate how behavioral changes may have influenced outcomes.

Malnutrition is a critical issue in cancer patients, with prevalence rates reaching up to 80% in certain cancers, such as lung, pancreatic, and head and neck cancers [15]. The causes of malnutrition in this population include insufficient dietary intake due to anorexia or treatment-related side effects (e.g., nausea, mucositis, vomiting) and tumor-induced metabolic alterations, such as accelerated catabolism and insulin resistance [16]. These changes reduce the availability of essential nutrients and negatively impact the body's ability to maintain physiological function [17].

Sarcopenia, like malnutrition, results from a combination of inadequate nutrition, systemic inflammation, and metabolic alterations. The prevalence of sarcopenia in oncology patients is also alarmingly high, reaching up to 70% in certain cases. This condition is associated with an increased incidence of treatment-related toxicities, prolonged hospital stays, and early mortality [5]. The improved detection rate observed may be attributed to the structured combination of nutritional and functional screening components (MUST and SARC-F), as well as to the digital format of R-MAPP, which minimizes variability in data entry and enhances the consistency of screening across care settings.

In patients undergoing aggressive treatments, sarcopenia exacerbates therapy-related adverse effects by disrupting drug metabolism and reducing the patient's functional capacity. This diminished functionality often limits their ability to complete treatment regimens, directly impacting clinical outcomes [18]. These findings further emphasize the critical need for early identification and management of sarcopenia risk in oncology care, underscoring the relevance of tools such as R-MAPP to address these multifaceted challenges and improve patient outcomes comprehensively [19]. However, the study was not powered to detect statistically significant differences in secondary outcomes such as weight or quality of life, and these results should therefore be interpreted as exploratory.

It is evident that early identification and multidisciplinary intervention are fundamental in managing malnutrition and sarcopenia risk in oncology patients undergoing aggressive treatments [15, 20]. Malnutrition risk assessment, using widely recognized tools such as the NRS-2002 or skeletal muscle mass index, plays a pivotal role in identifying at-risk patients and prioritizing targeted interventions [21].

Early nutritional support, including supplementation with proteins and essential amino acids, has proven effective in mitigating muscle mass loss and improving tolerance to oncological treatments [22]. Furthermore, individualized physical rehabilitation programs enhance muscle strength, improve functionality, and contribute to the comprehensive management of these conditions [23].

The integration of these strategies into clinical practice optimizes treatment tolerance, enhances quality of life, and extends survival, particularly in patients with greater metabolic and functional vulnerability [22]. This underscores the importance of combining early screening tools such as R-MAPP with evidence-based nutritional and physical interventions to improve outcomes in this high-risk population [24].

In this context, the R-MAPP tool, recognized by the ESPEN, emerges as a valuable resource. By integrating validated tools such as the MUST and the SARC-F scale, it could be particularly useful for patients with advanced cancer, where metabolic and functional complications are common. Its preventive approach enables the early implementation of nutritional and physical strategies while facilitating personalized interventions, ultimately impacting clinical outcomes positively. The R-MAPP tool combines ease of use, screening accuracy, and the potential to improve clinical outcomes in oncology patients, positioning it as a strategic asset in clinical practice [11].

The results of our study support this premise, demonstrating that R-MAPP identifies a significantly higher proportion of patients at risk of malnutrition and sarcopenia compared to standard clinical practice. In the intervention group, 42.4% of patients were identified as at risk, compared to only 3.1% in the control group. This finding is particularly relevant in the management of patients with advanced cancer, emphasizing the value of R-MAPP as a tool that combines diagnostic sensitivity with clinical applicability [25]. However, no external reference standard was used to confirm

the presence of malnutrition or sarcopenia risk, as the study was designed to evaluate screening performance in clinical practice rather than diagnostic accuracy. The higher detection rate should therefore be interpreted as improved case identification rather than definitive diagnosis.

It is worth noting that, in this study, the MUST item "Are you currently unwell?" was not automatically scored positively for all patients unless there was an acute complication or at the discretion of the evaluating physician or patient. Otherwise, all patients would have received at least one point in the MUST nutritional screening, leading to substantially higher malnutrition risk percentages in both groups. This methodological decision highlights the importance of clinical judgment in applying screening tools and interpreting results [26].

Early screening not only enables the implementation of preventive strategies but also contributes to stabilizing critical variables such as quality of life, even in patients undergoing aggressive treatments such as chemotherapy, where a more pronounced functional decline would typically be expected [27]. These findings highlight the impact of R-MAPP on improving the comprehensive management of oncology patients in complex clinical settings [28].

In older patients with advanced lung cancer, nutrition assumes a central role not only as a supportive strategy but also as an integral therapeutic intervention. Malnutrition states significantly contribute to the progression of sarcopenia, directly impairing patients' ability to complete oncological treatments, including chemotherapy and immunotherapy [2]. In this context, the evidence provided by our study supports the routine use of R-MAPP in daily clinical practice. By systematically integrating nutritional and functional screening, R-MAPP enhances the capacity to address these challenges proactively.

Moreover, the accessible design of the R-MAPP tool facilitates its implementation in outpatient settings or even for remote monitoring, adapting seamlessly to the care realities of older patients with multiple comorbidities. Its simplicity, minimal resource requirements, and digital format support its integration into routine clinical workflows, even in high-demand environments. Although a formal cost-effectiveness analysis was not conducted, R-MAPP requires no additional equipment or staffing, suggesting good economic viability. In our experience, patient adherence to the tool was high, further reinforcing its feasibility in real-world settings. This adaptability underscores its utility as a versatile and impactful tool for improving outcomes in this vulnerable population [10]. It is also possible that a longer follow-up period could reveal delayed effects on body weight and quality of life, especially in patients undergoing multiple cycles of chemotherapy or immunotherapy.

The ease of use of the R-MAPP tool as a screening instrument stands out compared to other tools commonly employed in this domain. For instance, while the NRS-2002 is widely used and supported by international guidelines, its application requires detailed information about the patient's medical and dietary history. This can pose challenges in settings with limited resources or for patients with restricted access to comprehensive care [29].

A similar limitation is seen with the Patient-Generated Subjective Global Assessment (PG-SGA). Although this tool is highly specific and sensitive, it relies on exhaustive interviews and requires significant time investment from healthcare professionals [21]. In contrast, the R-MAPP tool integrates validated instruments in a streamlined and efficient manner, making it particularly well suited for use in diverse clinical contexts, including those with limited resources or high patient volumes. This balance of simplicity, accuracy, and adaptability highlights its practical advantage in the early detection and management of malnutrition and sarcopenia risk in oncology patients.

Advanced techniques such as bioimpedance analysis offer precise data on body composition, including muscle mass, fat, and total body water, and have the potential to provide detailed insights and longitudinal monitoring. However, the need for specialized equipment and high costs limit their feasibility as an initial screening tool in clinical departments or institutions with restricted resources [30].

Similarly, imaging-based methods such as CT or MRI stand out for their high precision in assessing skeletal muscle mass and other functional parameters. Despite their accuracy, their technical complexity, associated costs, and the requirement for specialized personnel pose significant challenges to their integration into daily clinical practice. These methods are therefore typically reserved for specific cases or research studies [31, 32]. While R-MAPP does not replace objective methods such as CT or BIA, its low-cost implementation and ease of use make it a pragmatic option for early risk screening in real-world oncology settings.

Recently, nutritional ultrasound has emerged as a novel approach for assessing muscle mass, particularly in the rectus femoris and abdominal subcutaneous fat tissue. However, this technique demands clinical expertise and a considerable amount of execution time, which may not be feasible for routine screening purposes [33]. These limitations further emphasize the practicality and accessibility of the R-MAPP tool, which balances efficiency, ease of use, and clinical relevance, mak-

ing it a superior choice for initial nutritional and functional risk screening in oncology patients.

In this context, the R-MAPP tool offers a balanced solution, combining the precision of validated methods with a simplicity of use that makes it accessible even in resource-limited settings. Its ability to effectively integrate nutritional and functional screening in oncology patients allows for the early identification and management of conditions such as malnutrition and sarcopenia risk, optimizing clinical outcomes without the logistical and economic challenges associated with other tools [10]. It should also be noted that no formal assessment of inter-rater reliability was conducted, although the simplicity of the R-MAPP tool and the use of written instructions aimed to minimize variability in its application.

As with any clinical study, our work has a number of limitations that should be acknowledged. First, as this was a pilot trial, no formal sample size calculation was performed. This limits the statistical power to detect differences in secondary outcomes, which should therefore be considered exploratory and hypothesis-generating. In addition, the wide confidence interval observed for the primary outcome reflects substantial uncertainty. In small pilot studies, effect estimates are often unstable and prone to inflation, particularly when the number of events is limited. Accordingly, while the direction of the effect is consistent with the expected benefit of R-MAPP, the magnitude of the odds ratio should be interpreted with caution until confirmed in larger, adequately powered trials. Finally, the lack of comparison with gold-standard diagnostic tools such as CT or bioimpedance analysis limits the validation of R-MAPP's accuracy. This raises the possibility of misclassification bias, as some patients flagged as "at risk" may not meet diagnostic criteria, while others with underlying sarcopenia or malnutrition may remain undetected. Moreover, the absence of formal adherence measurement to nutritional and exercise recommendations limits the ability to establish whether the observed stability in weight and quality-of-life outcomes reflects actual behavior change. Although the randomized design helps mitigate systematic bias, future studies should incorporate adherence assessments to clarify the mechanisms underlying these effects.

In summary, this study provides robust evidence supporting the effectiveness of the R-MAPP tool for the early screening of malnutrition and sarcopenia risk in patients with advanced lung cancer, establishing a strong foundation for its integration into daily clinical practice. The ability of R-MAPP to identify at-risk patients and facilitate tailored interventions can significantly contribute to optimizing the comprehensive management of these patients, particularly in challenging clinical contexts, such as those involving intensive chemotherapy treatments.

While further research is needed to assess its long-term impact on clinical outcomes, the current findings endorse R-MAPP as an effective and accessible strategy for improving the care and prognosis of oncology patients. Its practicality, precision, and adaptability underscore its value as a key resource for enhancing patient outcomes and addressing critical needs in oncology care, warranting future validation in broader cancer populations and with extended follow-up. Importantly, while R-MAPP facilitates the early identification of patients potentially vulnerable to malnutrition and sarcopenia, its role should be understood as a screening instrument rather than a substitute for diagnostic evaluations such as imaging or body composition analysis. On the other hand, the results obtained in this study should be regarded as exploratory and hypothesis-generating, pending confirmation in larger, adequately powered studies.

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Ethical approval

The study was approved by the Bioethics Committee. Approval number: CHUNSC_2020_101.

Conflict of interest

The authors declare no conflict of interest.

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