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RESEARCH

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The relationship between sarcopenia, nutritional status, physical function, and quality of life in elderly cancer patients: a path analysis

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Abstract

Objective This study investigates the associations between sarcopenia and quality of life in elderly cancer patients, with nutritional status and physical function as potential mediators. It also explores the interactions among sarcopenia, nutritional status, and physical function.

Methods A cross-sectional study was conducted among 275 elderly cancer patients. Sarcopenia was assessed using the criteria of the European Working Group on Sarcopenia in Older People 2 (EWGSOP2). Nutritional status was evaluated using the Nutritional Risk Screening 2002 (NRS-2002) tool, along with serum albumin, prealbumin levels, and body mass index (BMI). Physical function was assessed using the 6-minute walk distance (6MWD), gait speed, and Timed Up and Go (TUG) test. All functional indicators were standardized into z-scores. Quality of life (QOL) was measured using the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire-Core 30 (EORTC QLQ-C30). Structural equation modeling (SEM) was used to analyze the relationships among sarcopenia, nutritional status, physical function, and QOL.

Results Multivariate analysis indicated that sarcopenia, nutritional status, and physical function together explained 54% of the variance in quality of life. Path analysis showed significant associations through the following pathways: (1) Sarcopenia → Nutritional status → quality of life (22.0%); (2) Sarcopenia → Physical function → quality of life (17.07%); (3) Sarcopenia → Nutritional status → Physical function → quality of life (6.09%).

Conclusion Sarcopenia, nutritional status, and physical function are significantly associated with quality of life in elderly cancer patients. Physical function mediates the associations between both sarcopenia and nutritional status. Early detection and comprehensive interventions targeting sarcopenia, nutrition, and physical function are essential

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for improving patient outcomes. Future strategies should be individualized to address the complex needs of this population.

Clinical trial number Not applicable

Keywords Elderly cancer patients, Sarcopenia, Nutritional status, Physical function, Quality of life, Path analysis

Introduction

The global population is aging rapidly, leading to a rising number of elderly individuals diagnosed with cancer. This demographic shift presents significant challenges to healthcare systems, as older cancer patients are particularly vulnerable due to age-related physiological decline and the cumulative burden of cancer and its treatment. According to the International Agency for Research on Cancer, China reported 2.92 million new cancer cases and 1.98 million cancer-related deaths among individuals aged 60 and above in 2022, accounting for over 60% of new diagnoses and nearly 77% of total cancer mortality nationwide [1, 2]. With advancing age, cancer patients often experience declines in physical function, nutritional status, and overall health, contributing to reduced quality of life (QOL) [3, 4]. As the elderly cancer population continues to grow, it is increasingly critical to understand and address the complex, interrelated factors influencing their QOL to improve clinical outcomes and enhance patient well-being.

Sarcopenia, a geriatric syndrome marked by progressive loss of skeletal muscle mass, strength, and physical function, affects over 40% of elderly cancer patients [5, 6], with particularly high prevalence among those with gastric, lung, and colorectal cancers [6]. It is associated with an increased risk of postoperative complications, poor treatment outcomes, and elevated mortality rates [7]. Sarcopenia also impairs daily functioning and self-care, contributing significantly to the decline in QOL [8]. For example, Bossi et al. (2021) [9] reported that QOL scores declined with increasing severity of sarcopenia. Sarcopenia frequently coexists with malnutrition, and the interaction between these conditions accelerates physical and functional decline [10]. Recent studies highlight the effectiveness of combined nutritional and exercise interventions in counteracting sarcopenia and enhancing QOL [11, 12]. Uchida et al. (2023) demonstrated that individualized nutritional support paired with resistance training significantly improved muscle mass and physical performance in older cancer patients [11]. Similarly, Souza et al. (2024) found that multimodal interventions targeting both nutrition and physical activity enhanced physical function and reduced symptom burden [12]. Malnutrition exacerbates sarcopenia through mechanisms such as metabolic disturbances, chronic inflammation, and impaired nutrient absorption—particularly in patients undergoing cancer treatments [13, 14]. These changes contribute to progressive muscle wasting, slower gait speed, reduced endurance, and increased vulnerability to functional decline [15]. Deterioration in physical capacity also negatively impacts social participation, psychological well-being, and self-esteem [16, 17]. The synergistic effects of sarcopenia and malnutrition severely impair muscle strength and endurance, resulting in a marked reduction in QOL [18, 19]. Therefore, early screening and comprehensive interventions targeting both nutritional deficiencies and physical inactivity are essential to mitigate these adverse effects and improve outcomes in elderly cancer patients.

Although previous studies have reported associations between sarcopenia, nutritional status, physical function, and QOL, the mechanisms underlying these interactions remain insufficiently understood. Much of the existing research focuses on individual variables in isolation, often neglecting their interrelated effects. To address this gap, the present study employs path analysis to explore the complex relationships among sarcopenia, nutritional status, and physical function, and their collective influence on QOL. By examining both direct and indirect pathways, this study aims to generate robust evidence to support the development of targeted, multifaceted intervention strategies.

Materials and methods

Study design and participants

This cross-sectional study recruited elderly cancer patients based on defined inclusion and exclusion criteria. Eligible participants were: (1) aged 65 years or older; (2) pathologically diagnosed with a malignancy (e.g., lung, gastric, colorectal, or breast cancer); (3) capable of providing informed, voluntary consent; and (4) able to perform basic activities of daily living without severe cognitive or psychiatric impairments that could compromise assessment validity. Exclusion criteria were: (1) acute disease exacerbation or unstable vital signs; (2) severe neuromuscular disorders; (3) receipt of interventional nutritional therapy or intensive rehabilitation within the previous three months; and (4) significant language or hearing impairments impeding participation or accurate assessment.

The required sample size was calculated based on Structural Equation Modeling (SEM) guidelines, with a minimum of 10 participants per estimated parameter in the path model [20]. Allowing for a 15% attrition rate, a final sample size of no fewer than 200 patients was targeted.

Measures

This study assessed a range of demographic, clinical, and functional variables in elderly cancer patients recruited between January and September 2024 from the Cancer Prevention and Treatment Institute of Chengdu and the Department of Oncology at Chengdu Fifth People's Hospital, China.

Collected data included age, gender, cancer type and stage, treatment modality, and medical history. Sarcopenia was evaluated based on the criteria of the European Working Group on Sarcopenia in Older People 2 (EWGSOP2) [21]. Muscle mass was measured using Dual-Energy X-ray Absorptiometry (DXA), muscle strength via handgrip strength, and physical function through gait speed and the Timed Up and Go (TUG) test. Nutritional status was assessed using the Nutritional Risk Screening tool (NRS-2002) [22], in conjunction with serum albumin, prealbumin levels, and body mass index (BMI). Physical function was assessed using the 6-minute walk distance (6MWD), gait speed, and TUG time. To generate a composite indicator, each measure was standardized (z-scores), TUG scores were reverse-coded so that higher values indicated better function, and the average of the three was used to reflect overall physical function [23]. Quality of life (QOL) was measured using the European Organization for Research and Treatment of Cancer (EORTC) Quality of Life Questionnaire-Core 30 (QLQ-C30) [24, 25], which assesses multiple domains including physical, psychological, and social functioning. This comprehensive evaluation was designed to provide a holistic understanding of the health status and functional capacity of elderly cancer patients, thereby offering evidence to support the development of tailored clinical interventions aimed at improving patient outcomes.

Data analysis

Descriptive statistics, including means, standard deviations, and proportions, were used to summarize participants' demographic characteristics and assessment variables. Group differences in continuous variables were examined using independent samples t-tests, while categorical variables were compared using chi-square (χ^2) tests. Univariate analyses were conducted to compare quality of life (QOL) scores between non-sarcopenic and sarcopenic patients, as well as across categories of nutritional status and physical function, using t-tests or one-way ANOVA where appropriate. Pearson's correlation analysis was performed to assess bivariate associations among the primary study variables, including sarcopenia, nutritional status, physical function, and QOL.

To identify independent predictors of QOL, multiple stepwise linear regression analyses were conducted with sarcopenia, nutritional status, and physical function indicators (i.e., six-minute walk distance, gait speed, and timed up-and-go test) as the main independent variables. To control for potential confounding, a set of demographic and clinical covariates—including age (continuous), marital status (coded as married = 1, others = 0), education level (years of schooling), household income (categorized as low, middle, or high), cancer stage (I–IV), and cancer type (dummy-coded with breast cancer as the reference group)—were included in the regression models. Multicollinearity was examined using the Variance Inflation Factor (VIF), and all model assumptions were assessed using appropriate diagnostic tests.

In addition, path analysis was performed using structural equation modeling (SEM) to explore both direct and indirect pathways linking sarcopenia, nutritional status, physical function, and QOL. The SEM model incorporated the same set of covariates to adjust for confounding effects and improve estimation accuracy. Model fit was evaluated using the Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA). All statistical analyses were conducted using SPSS version 26.0 (IBM Corp., Armonk, NY, USA), and SEM was performed with SPSS Amos version 26.0.

Results

Demographic and clinical characteristics

As shown in Table 1, significant differences were observed between the sarcopenia and non-sarcopenia groups in terms of both demographic and clinical characteristics. Specifically, differences were found in age, marital status, education level, household income, cancer type, and treatment modality (all $p < 0.05$). Patients with sarcopenia were generally older, had lower educational attainment and income levels, and were more likely to have gastrointestinal malignancies and advanced-stage cancer. In addition, the sarcopenia group exhibited significantly lower values for height, weight, body mass index (BMI), handgrip strength, physical function scores, skeletal muscle mass, and other related functional and nutritional indicators compared to those without sarcopenia.

Nutritional status and physical function in elderly cancer patients

As shown in Table 2, significant differences were observed between the sarcopenia and non-sarcopenia groups in terms of nutritional risk scores, serum albumin and prealbumin levels, and distribution of Body Mass Index (BMI) categories ($P < 0.01$). Patients in the sarcopenia group demonstrated significantly poorer physical function compared to those in the non-sarcopenia group.

Table 1 Comparison of baseline characteristics between sarcopenia and non-sarcopenia groups in elderly cancer patients (Mean ± SD)

Characteristic	Sarcopenia Group (*n* = 166)	Non-Sarcopenia Group (*n* = 109)	t-value/ Chi-square (χ^2)	*p*-value
Gender			2.56	0.11
Male	55%	48%		
Female	45%	52%		
Age (years)	75.4 ± 7.4	70.3 ± 5.9	4.32	< 0.01
Marital Status			8.46	0.03
Married	70%	50%		
Unmarried	30%	50%		
Education Level			6.02	0.02
High school or above	45%	65%		
Below high school	55%	35%		
Income Level			9.12	0.01
Annual income < 30,000	60%	40%		
Annual income ≥ 30,000	40%	60%		
Disease Type			7.32	0.02
Digestive system cancers	50%	35%		
Respiratory system cancers	30%	40%		
Breast cancer	20%	25%		
Disease Stage			6.15	0.05
Stage I	20%	30%		
Stage II	35%	45%		
Stage III	30%	20%		
Stage IV	15%	5%		
Treatment Method			10.45	0.01
Surgery	50%	65%		
Radiotherapy/ Chemotherapy	30%	20%		
Targeted therapy	10%	10%		
Immunotherapy	10%	5%		
Anthropometric Measurements				
Height (m)	1.58 ± 0.07	1.62 ± 0.08	-3.78	< 0.01
Weight (kg)	50.2 ± 6.5	62.3 ± 8.1	-13.62	< 0.01
Body Mass Index (BMI, kg/m^2)	20.1 ± 1.8	23.8 ± 2.4	-13.72	< 0.01
Handgrip Strength (kg)	18.7 ± 5.4	27.3 ± 6.8	-11.39	< 0.01
6-Metre Walk Speed (m/s)	0.8 ± 0.2	1.2 ± 0.3	-10.67	< 0.01
Limb Skeletal Muscle Mass (kg)	15.6 ± 2.3	20.4 ± 2.9	-15.66	< 0.01
Skeletal Muscle Index (SMI, kg/m^2)	5.7 ± 0.8	7.8 ± 0.9	-19.43	< 0.01
Upper Arm Circumference (cm)	22.3 ± 3.1	26.4 ± 3.5	-10.33	< 0.01
Calf Circumference (cm)	29.5 ± 2.8	34.2 ± 3.1	-12.89	< 0.01
Waist Circumference (cm)	78.4 ± 7.6	85.2 ± 8.4	-7.44	< 0.01

Specifically, they had shorter 6-minute walk distances, slower gait speeds, and longer Timed Up and Go (TUG) times, indicating impaired mobility and functional capacity. These deficits were also associated with significantly

Table 2 Nutritional status and physical function assessment results of elderly cancer patients

Indicator	Sarcopenia Group (*n* = 166)	Non-Sarcopenia Group (*n* = 109)	t-value / Chi-square value	*p*-value
Nutritional Status				
NRS-2002 Score (points)	3.8 ± 0.9	2.7 ± 0.8	10.27	< 0.01
Serum Albumin (g/L)	34.2 ± 3.8	38.6 ± 3.5	-9.72	< 0.01
Serum Prealbumin (mg/L)	180.4 ± 20.7	220.5 ± 25.6	-14.18	< 0.01
BMI Classification (n, %)		X^2 = 22.34	< 0.01	
< 18.5 (Underweight)	53 (31.9%)	6 (5.5%)		
18.5–23.9 (Normal Weight)	91 (54.8%)	48 (44.0%)		
≥ 24.0 (Overweight/ Obese)	22 (13.3%)	55 (50.5%)		
Physical Function				
6-Minute Walking Distance (m)	320.4 ± 45.8	420.1 ± 50.7	-15.34	< 0.01
Gait Speed (m/s)	0.85 ± 0.14	1.05 ± 0.12	-11.93	< 0.01
TUG Time (seconds)	12.8 ± 2.1	8.6 ± 1.7	17.45	< 0.01

Table 3 Comparison of quality of life between non-sarcopenic and sarcopenic elderly cancer patients

Item	Non-sarcopenic (*n* = 109)	Sarcopenic (*n* = 166)	F/t Value	*P* Value
Overall Quality of Life Score	78.5 ± 8.2	72.4 ± 7.6	32.45	< 0.001
Physical Function Score (BFI)	24.3 ± 4.5	20.8 ± 4.1	28.12	< 0.001
Psychological Function Score (PFI)	26.1 ± 3.9	23.5 ± 3.7	29.77	< 0.001
Social Function Score (SFI)	28.1 ± 4.2	25.3 ± 4.4	23.58	< 0.001
Fatigue Score (FA)	12.5 ± 2.8	15.3 ± 3.0	30.11	< 0.001
Pain Score (PA)	10.2 ± 2.4	12.7 ± 2.6	26.49	< 0.001

Note: Values are expressed as mean ± standard deviation. Sarcopenia was defined based on muscle mass (measured via DXA) and physical performance (handgrip strength, gait speed, and TUG test). Statistical comparisons were performed using independent samples t-tests

lower overall quality of life scores compared to the non-sarcopenia group ($P < 0.05$).

Comparison of quality of life between non-sarcopenic and sarcopenic elderly cancer patients

As shown in Table 3, significant differences in quality of life (QOL) and related functional domains were observed between non-sarcopenic and sarcopenic elderly cancer patients ($p < 0.001$ for all comparisons). The non-sarcopenic group demonstrated consistently higher scores in overall QOL (78.5 ± 8.2), physical function (BFI), psychological function (PFI), and social function (SFI), compared to patients with sarcopenia. In contrast, patients with sarcopenia reported significantly higher fatigue (FA) and pain (PA) scores, indicating greater symptom burden. These results suggest that sarcopenia is associated

Table 4 Correlations between sarcopenia, nutritional status, physical function, and quality of life in elderly cancer patients

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Sarcopenia	1										
2. Nutritional Status	-0.68**	1									
3. 6-Minute Walking Distance	-0.65*	0.48**	1								
4. Gait Speed	-0.72**	0.46	0.78**	1							
5. TUG Time	-0.66**	0.52	0.74**	0.85*	1						
6. Total Quality of Life Score	-0.68**	0.58**	0.72**	0.82*	0.88*	1					
7. Physical Function Score (BFI)	-0.62**	0.54**	0.68**	0.80*	0.84	0.90**	1				
8. Psychological Function Score (PFI)	-0.61**	0.53**	0.65**	0.74**	0.80*	0.83**	0.86**	1			
9. Social Function Score (SFI)	-0.55**	0.50**	0.67*	0.75*	0.78**	0.80**	0.83**	0.80**	1		
10. Fatigue Score (FA)	-0.60**	0.51*	0.68**	0.76**	0.82**	0.85*	0.88**	0.83**	0.80*	1	
11. Pain Score (PA)	-0.62*	0.52*	0.66**	0.78**	0.82*	0.85*	0.89**	0.79*	0.75*	0.78*	1

Note: **$P<0.01$, *$P<0.05$

Table 5 Stepwise multivariate regression analysis of sarcopenia, nutritional status, physical function, and covariates on quality of life

Layer	Independent Variable	B	Standard Error (SE)	β	t-value	*p*-value	R^2	Adjusted R^2
Model 1	Sarcopenia	-0.35	0.08	-0.32	-4.50	$p<0.01$	0.12	0.10
Model 2	Nutritional Status (NRS-2002)	0.26	0.06	0.23	4.67	$p<0.01$	0.15	0.14
Model 3	Physical Function							
	6-Minute Walking Distance	0.04	0.01	0.35	5.60	$p<0.01$	0.20	0.19
	Gait Speed	0.12	0.03	0.30	4.00	$p<0.01$	0.17	0.16
	TUG Time (seconds)	-0.10	0.02	-0.32	-5.00	$p<0.01$	0.14	0.13
Model 4	Covariates[1]	—	—	—	—	—		
Overall Model							0.58	0.54

Note: All variables were standardized before entry. Physical function indicators were added in parallel in Model 3

Covariates[1] include age, marital status, education, household income, cancer type, and cancer stage. These covariates were included in Model 4 to control for potential confounding effects. Multicollinearity was assessed using VIF (< 2), and no violations of regression assumptions were detected (Durbin–Watson = 1.95).

with poorer outcomes across multiple dimensions of health-related quality of life.

Correlation between sarcopenia, nutritional status, physical function, and quality of life in elderly cancer patients

Table 4 presents the correlations between sarcopenia, nutritional status, physical function, and quality of life, including its various subdomains (e.g., physical function, psychological function, social function, fatigue, and pain scores) in elderly cancer patients. The findings reveal a significant negative correlation between the sarcopenia and all quality of life dimensions, with the strongest associations observed in physical function (r = -0.62, $p<0.01$) and physical performance (r = -0.65, $p<0.01$). The most pronounced positive correlations are found between nutritional status and overall quality of life ($r=0.58$, $p<0.01$) and physical function ($r=0.54$, $p<0.01$).

Multivariate regression analysis of sarcopenia, nutritional status, physical function, and covariates on quality of life

As shown in Table 5, a stepwise multivariate linear regression analysis was conducted to examine the effects of sarcopenia, nutritional status, physical function, and sociodemographic and clinical covariates on quality of life (QOL) in elderly cancer patients. In Model 1, sarcopenia alone was entered as the independent variable and was found to be a significant negative predictor of QOL ($\beta = -0.32$, $t = -4.50$, $p<0.01$), explaining approximately 12% of the variance ($R^2 = 0.12$).

In Model 2, the inclusion of nutritional status (NRS-2002) significantly improved the model ($\beta=0.23$, $p<0.01$), increasing the explained variance to 15%. In Model 3, physical function indicators—six-minute walk distance ($\beta=0.35$), gait speed ($\beta=0.30$), and timed up-and-go (TUG) test time ($\beta = -0.32$)—were subsequently added. All were statistically significant ($p<0.01$), and their inclusion further improved the model's explanatory power (Adjusted R^2 up to 0.20), indicating that better physical function is associated with higher QOL.

In Model 4, a set of covariates was included to adjust for potential confounding effects, including age, marital status, educational level, household income, cancer type, and cancer stage. While individual coefficients are not shown in the table for brevity, several covariates were statistically significant and contributed meaningfully to the final model. The fully adjusted model demonstrated a strong overall fit ($F=34.21$, $p<0.001$), with no multicollinearity issues ($VIF<2$) and acceptable residual independence (Durbin–Watson = 1.95). The final model explained 58% of the variance in QOL (R^2 = 0.58; Adjusted R^2 = 0.54), indicating that sarcopenia, nutritional status, physical function, and relevant demographic and clinical characteristics are all independent and significant predictors of QOL in this population.

Structural equation modeling of sarcopenia, nutritional status, physical function, and quality of life

To further explore the direct and indirect relationships among sarcopenia, nutritional status, physical function, and quality of life (QOL) in elderly cancer patients, a structural equation model (SEM) was constructed based on prior regression results and theoretical assumptions. Demographic and clinical covariates that significantly differed between sarcopenic and non-sarcopenic groups—namely age, marital status, education level, household income, cancer stage, and cancer type—were included in the model as control variables to adjust for potential confounding effects.

As shown in Fig. 1, the SEM demonstrated a good overall fit to the data, with the following fit indices: χ^2/df = 1.78 (χ^2 = 1.78, df = 1), GFI = 0.92, AGFI = 0.89, NFI = 0.93, RFI = 0.91, IFI = 0.95, TLI = 0.97, CFI = 0.98, and RMSEA = 0.045. These values meet commonly accepted thresholds for model adequacy, indicating that the model fits the observed data well. The final model supported the hypothesized pathways. Sarcopenia was found to have both direct and indirect effects on QOL, mediated through nutritional status and physical function. Specifically, sarcopenia was negatively associated with nutritional status and physical function, both of which, in turn, were positively associated with QOL. These findings highlight the complexity of the mechanisms linking physical decline to quality of life, suggesting that interventions targeting nutrition and physical performance may partially mitigate the adverse impact of sarcopenia on overall well-being in elderly cancer patients.

As shown in Table 6, path analysis indicated that sarcopenia was directly associated with quality of life (β = -0.45) and indirectly associated through three mediating pathways. The first indirect path (Ind1) involved nutritional status and QOL (β = -0.18, -0.51 * 0.35), accounting for 22.0% of the total association. The second path (Ind2) included physical function and QOL (β = -0.14, -0.46 * 0.31), contributing 17.07%. The third path (Ind3) involved nutritional status → physical function → QOL (β = -0.05, -0.51 * 0.32 * 0.31), accounting for 6.09%. Mediating effects were tested using a bias-corrected nonparametric percentile bootstrap method with 5,000 resamples. The 95% confidence interval for the total indirect association between sarcopenia and QOL was (-0.58, -0.21), which did not include zero, indicating a statistically significant indirect relationship. The 95% CIs for all three indirect paths and their comparative differences also excluded zero. Among them, the pathway through nutritional status alone (Ind1) had the largest proportion of the total association. After including mediators in the model, the direct path from sarcopenia to QOL accounted for 54.87%, and the combined indirect paths accounted for 45.13%.

Discussion

This study found that the prevalence of sarcopenia among elderly cancer patients was as high as 60.3%, consistent with findings from both domestic and international

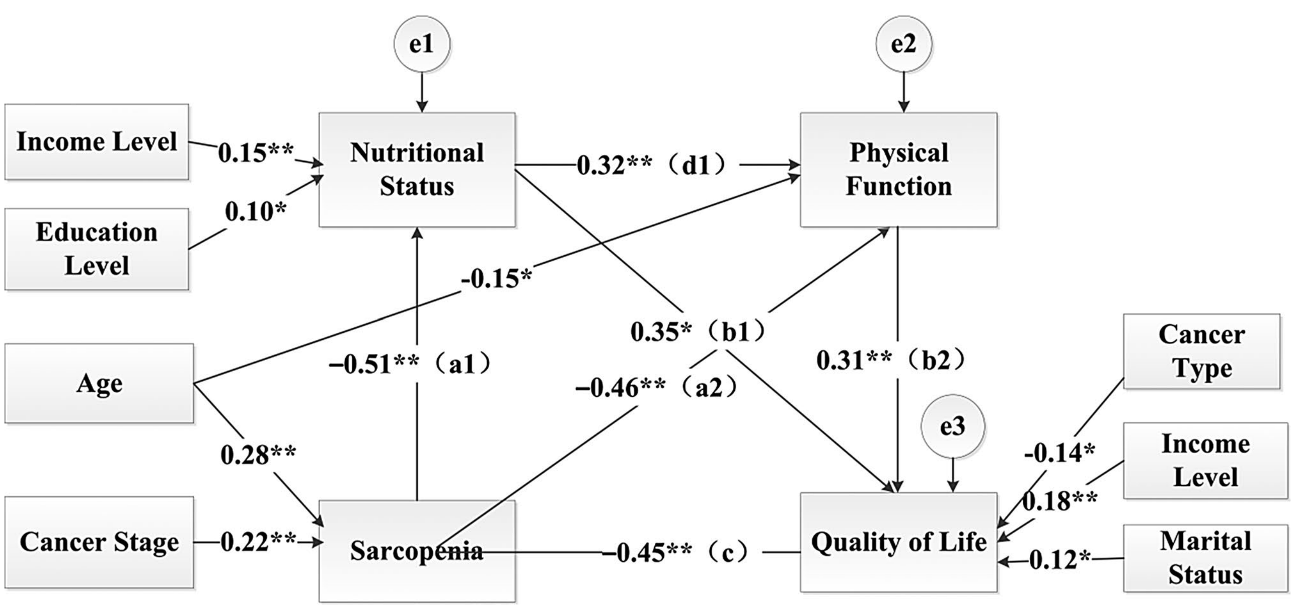

Fig. 1 Structural equation modeling of sarcopenia, nutritional status, physical function, and quality of life. Note: path coefficients are standardized. **$p < 0.01$, * $p < 0.05$

Table 6 Path analysis results showing direct and indirect associations of sarcopenia with quality of life through nutritional status and physical function

	Pathway Point	Estimate 95% Confidence Interval (CI%)		Effect Size (%)
		Lower limit	upper limit	
Ind1: Sarcopenia → Nutritional Status → Quality of Life (a1 * b1)	-0.17	-0.30	-0.15	22.0
Ind2: Sarcopenia → Physical Function → Quality of Life (a2 * b2)	-0.14	-0.28	-0.10	17.07
Ind3: Sarcopenia → Nutritional Status → Physical Function → Quality of Life	-0.05	-0.11	-0.01	6.09
(a1 * d1 * b2)	-0.45	-0.85	-0.32	54.87
Direct: Sarcopenia → Quality of	-0.37	-0.58	-0.21	45.13
Life (c)	-0.82	-0.98	-0.52	
Total Indirect Effect (Ind = Ind1 + Ind2 + Ind3)				
Total Effect (Total = Ind + Direct)				

Note: The table presents the path analysis results, with point estimates, 95% confidence intervals (CIs), and effect sizes for the indirect and direct effects of sarcopenia, nutritional status, and physical function on quality of life. The indirect effects through different pathways (Ind1, Ind2, Ind3) and the total indirect and direct effects are presented with their respective confidence intervals and percentages

studies [25–27]. Sarcopenia has significant clinical implications in this population, as it adversely affects functional status and overall health. Malnutrition is a key contributor to sarcopenia and is closely associated with reduced levels of serum albumin and prealbumin, which are commonly observed in cancer patients. Our findings align with previous studies by Erdoğan et al. (2024), Almouaalamy (2023), and Sahin et al. (2024) [28–30], which also reported a significant correlation between low albumin levels and sarcopenia, suggesting that improving nutritional status is a critical strategy in managing sarcopenia among elderly cancer patients.

Maintaining physical function is also considered essential in preventing or delaying the progression of sarcopenia. Yang Lihong et al. (2024) [31] reported that elderly cancer patients with impaired physical function experienced a more rapid decline in muscle mass and a higher risk of sarcopenia. Our findings further emphasize the need to incorporate physical function preservation into sarcopenia management strategies to slow its progression and improve overall patient outcomes.

We also found a significant negative association between sarcopenia and quality of life (QOL) in elderly cancer patients. Yalcin et al. (2023) [32] demonstrated that sarcopenia is closely linked to diminished QOL, particularly in terms of physical function and the ability to perform daily activities. The loss of muscle strength and decline in self-care ability associated with sarcopenia directly impact patients' daily living. Notably, we further identified a moderating role of nutritional status in the relationship between sarcopenia and QOL: patients with higher nutritional scores tended to report better QOL. This supports previous research indicating that proper nutritional interventions can significantly enhance the quality of life in cancer patients [33, 34]. By improving nutritional intake, patients are better able to maintain muscle strength, slow muscle loss, and enhance physical performance, ultimately improving overall well-being. Regression analysis confirmed that sarcopenia negatively predicts QOL (β = -0.32, $p < 0.01$), consistent with findings by Jensen et al. (2023) [35], who noted that sarcopenia contributes to reduced physical function, decreased daily activity capacity, and worsened psychological health, including increased anxiety and depression. Ge Xueqing et al. (2023) [36] also highlighted that severe sarcopenia is strongly associated with both physical and psychological decline, leading to reduced independence and further deterioration in QOL.

Mechanistically, sarcopenia interacts with frailty, malnutrition, and declining physical capacity in a vicious cycle, accelerating deterioration in quality of life. Several studies have revealed that sarcopenia affects the health status of cancer patients through various pathways. Nipp et al. (2018) [37] found that sarcopenia was associated with lower QOL and increased symptoms of depression. Martínez-Herrera et al. (2022) [38] reported that patients with sarcopenia or sarcopenic obesity exhibited poorer physical performance and greater fatigue, which reduced activity levels and further accelerated muscle loss. A 2023 systematic review and meta-analysis [39] also confirmed that sarcopenia significantly decreases health-related QOL. These findings suggest that sarcopenia may reduce nutritional intake and metabolic function, exacerbate frailty, and impair daily and psychological functioning.

In addition, to place our findings in a broader context, we compared our results with previous studies conducted among community-dwelling older adults. For example, Zhang et al. (2023) demonstrated that in community-living older adults, frailty and physical function mediated the impact of nutritional status on QOL [40]. Bartha et al. (2021) found that physical performance played a significant mediating role between sarcopenia and life satisfaction among healthy elderly individuals [41]. Similarly, Choi et al. (2022) reported that muscle mass influenced mental QOL indirectly via physical function in a general aging population [42]. These findings indicate that the structural pathways linking sarcopenia, nutrition, physical function, and QOL may be broadly applicable across elderly populations. However, elderly cancer patients differ from the general older population in important ways, including treatment-related cachexia, inflammation, and reduced exercise tolerance. As such, our results underscore the unique challenges and intervention priorities faced by this clinical subgroup.

Given the multifactorial nature of sarcopenia, its management requires integrated, multidimensional strategies. Nutritional intervention should be central to improving muscle mass and overall health among cancer patients. Individualized nutritional support must ensure adequate protein intake, energy balance, and sufficient micronutrient supplementation to combat malnutrition and prevent muscle degradation. Specifically, protein intake should be prioritized, targeting 1.2–1.5 g/kg/day of high-quality protein, along with adequate caloric consumption and supplementation of key nutrients such as vitamin D and omega-3 fatty acids. Recent studies suggest that protein intake in the range of 1.2–1.5 g/kg/day is optimal for maintaining muscle mass in older cancer patients [43, 44]. Vitamin D supplementation (800–1000 IU/day) and omega-3 fatty acids (approximately 3 g/day) have been shown to improve muscle mass, strength, and physical function in elderly cancer patients. Proper nutritional management forms the foundation for reversing the negative impact of sarcopenia on physical function and quality of life (QOL) [45, 46].

Exercise interventions also play a vital role in sarcopenia management [47]. Resistance training, performed 2–3 times per week, has been shown to significantly improve muscle mass, strength, and physical function in elderly cancer patients [48, 49]. A 2024 network meta-analysis demonstrated that resistance training significantly improves lean muscle mass and lower limb strength, while combined aerobic and resistance exercise effectively reduces fat mass [50]. Additionally, a recent review highlighted that both aerobic and resistance exercises can alleviate side effects of cancer treatment, improve metabolic health, and enhance overall patient well-being [51]. Combining these targeted nutritional and exercise approaches can significantly mitigate the progression of sarcopenia and improve QOL in this vulnerable population. These findings suggest that tailored exercise programs can enhance physical capacity, metabolic function, and QOL.

Papadopetraki et al. (2023) [52] proposed that a combination of nutritional supplementation and structured exercise training could facilitate functional recovery, mitigate the effects of sarcopenia, and enhance quality of life. To address the complexity of sarcopenia, malnutrition, and functional decline, a multidisciplinary management model is essential. Such a model should integrate oncologists, nutritionists, physical therapists, and rehabilitation specialists to develop comprehensive, individualized care plans for patients [53–55].

This study has several limitations. First, due to its cross-sectional design, causal relationships among sarcopenia, nutritional status, physical function, and quality of life (QOL) cannot be established. Future longitudinal studies are needed to elucidate the temporal dynamics and causal pathways among these variables. Second, the sample was drawn from a single geographic region, which may introduce regional selection bias and limit the generalizability of the findings. Multicenter studies with larger and more diverse samples are recommended to validate and extend our results.

Third, although this study targeted an Asian (Chinese) population, the EWGSOP2 criteria were used instead of the AWGS2019 criteria. This constitutes a limitation of the study design, and the prevalence and severity of sarcopenia in this study may have been either over- or underestimated. Future research should consider adopting regionally validated diagnostic standards such as AWGS2019 to enhance accuracy and comparability within Asian populations.

Fourth, the path analysis relied solely on observed variables, without accounting for latent variables or measurement errors, which may affect the robustness and generalizability of the model. Future research could apply structural equation modeling (SEM) with latent constructs to more accurately depict the underlying relationships. Finally, this study focused primarily on sarcopenia, nutritional status, and physical function in relation to QOL. Future research should also consider incorporating psychological well-being, social support, and comorbidities to develop a more holistic and personalized approach to health management in elderly cancer patients.

Conclusion

In summary, this study employed structural equation modeling to examine the associations between sarcopenia, nutritional status, physical function, and quality of life (QOL) in elderly cancer patients. The findings revealed that sarcopenia is associated with QOL both directly and indirectly, with nutritional status and physical function acting as significant mediators. These results highlight the importance of early identification and management of sarcopenia, as well as the promotion of adequate nutrition and maintenance of physical function. To improve QOL in this population, future interventions should adopt a comprehensive, multifactorial management approach that integrates nutritional support, physical rehabilitation, and clinical monitoring throughout the continuum of cancer care.

Abbreviations

6MWD	Six-minute walk distance
AGFI	Adjusted goodness-of-fit index
Alb	Albumin
BFI	Physical function index
BMI	Body mass index
CFI	Comparative fit index
FA	Fatigue

GFI	Goodness-of-fit index
GS	Gait speed
IFI	Incremental fit index
NFI	Normed fit index
NRS-2002	Nutritional Risk Screening 2002
PA	Pain
PFI	Psychological function index
Pre-Alb	Prealbumin
QOL	Quality of life
RFI	Relative fit index
RMSEA	Root mean square error of approximation
SEM	Structural equation modeling
SFI	Social function index
TLI	Tucker–Lewis index
TUG	Timed up and go test
VIF	Variance inflation factor

Supplementary Information

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Supplementary Material 1

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Author contributions

Liyi Wang is listed as a contributing author of the study. Liyi Wang, Xuejun Dai, and Jiao Ai contributed equally to this work. The conception of the study was carried out by Liyi Wang, Xuejun Dai, Jiao Ai, and Lang He. The study design was developed by Liyi Wang, Xuejun Dai, and Jiao Ai. The execution of the study involved Liyi Wang, Xuejun Dai, Jiao Ai, Xiaojuan Li, and Aihua Deng. Data collection, analysis, and interpretation were conducted by Liyi Wang, Xuejun Dai, Jiao Ai, Xiaojuan Li, Aihua Deng, Lang He, Xiaomei Yang, Ying Zhang, and Dujuan Tian. The original draft of the manuscript was written by Liyi Wang. Critical revision of the manuscript was done by Liyi Wang, Xuejun Dai, Jiao Ai, Xiaojuan Li, and Aihua Deng. The final version of the manuscript was approved by all coauthors.

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Data availability

Sequence data that support the findings of this study have been deposited in the Mendeley Data. Find some help on our Data availability statements page. You can view it here: https://data.mendeley.com/datasets/y5g4vs372n/1.

Declarations

Ethics approval and consent to participate

This study complies with the Declaration of Helsinki. All patients and their families signed informed consent forms, adhering to the principle of voluntary anonymity and fairness, and the study was approved by the Ethics Committee of Chengdu Fifth People's Hospital (Ethics No: 2023-033(K)-01), and all participants provided written informed consent. This study is not a clinical trial study.

Consent for publication

Written informed consent for publication of the study findings was obtained from all participants or their legal guardians.

Competing interests

The authors declare no competing interests.

Contribution of the paper

What is already known

Sarcopenia is a common condition among elderly cancer patients and is associated with declines in physical function and quality of life.

Nutritional status plays a critical role in the management of sarcopenia and the maintenance of physical function in this population.

Although the relationships among sarcopenia, nutritional status, physical function, and quality of life have been investigated, the underlying mechanisms remain inadequately understood.

What this paper adds

This study presents a comprehensive path analysis that elucidates the direct and indirect relationships among sarcopenia, nutritional status, physical function, and quality of life in elderly cancer patients. The results underscore the mediating role of physical function in the link between sarcopenia and quality of life. These findings provide valuable insights into the importance of early detection and targeted interventions for sarcopenia—particularly those aimed at improving nutrition and physical function—to enhance quality of life in this population.

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References

1. Ju W, Zheng R, Zhang S, et al. Cancer statistics in Chinese older people, 2022: current burden, time trends, and comparisons with the US, japan, and the Republic of Korea. Sci China Life Sci. 2023;66(5):1079–91. https://doi.org/10.1007/s11427-022-2218-x. Epub 2022 Dec 15. PMID: 36543994.
2. Zheng RS, Chen R, Han BF et al. [Cancer incidence and mortality in China, 2022]. Zhonghua Zhong Liu Za Zhi. 2024;46(3):221–231. Chinese. https://doi.org/10.3760/cma.j.cn112152-20240119-00035. PMID: 38468501.
3. Wang X, Song C, Li W, et al. Survey and analysis of nutritional status and quality of life in inpatients with malignant tumors. Cancer Prev Treat. 2023;36(1):8–17.
4. Ebob-Anya BA, Bassah N. Psychosocial distress and the quality of life of cancer patients in two health facilities in Cameroon. BMC Palliat Care. 2022;21(1):96. https://doi.org/10.1186/s12904-022-00981-w.

5. Jiang S, Kang L. Conceptual definition of sarcopenia: interpretation of the Delphi consensus from the global sarcopenia leaders initiative. Chin J Geriatr. 2024;43(8):971–5.
6. Keller K. Sarcopenia. WIEN MED WOCHENSCHR. 2018;169(7–8):157–72. https://doi.org/10.1007/s10354-018-0618-2.
7. Cavusoglu C, Tahtaci G, Dogrul RT, et al. Predictive ability of the G8 screening test to determine probable sarcopenia and abnormal comprehensive geriatric assessment in older patients with solid malignancies. BMC Geriatr. 2021;21(1):574. https://doi.org/10.1186/s12877-021-02544-9.
8. Huang Z, Wang Y, Zhu L, et al. Analysis of sarcopenia status and its influencing factors in patients with Gastrointestinal malignant tumors. J Nurs. 2023;38(5):50–3.
9. Bossi P, Delrio P, Mascheroni A, Zanetti M. The spectrum of malnutrition/cachexia/sarcopenia in oncology according to different Cancer types and settings: A narrative review. Nutrients. 2021;13(6):1980. https://doi.org/10.3390/nu13061980. PMID: 34207529; PMCID: PMC8226689.
10. Shimizu A, Yamamoto M, Tanabe H. Malnutrition and sarcopenia in older adults: impact on physical performance and quality of life. Geriatr Gerontol Int. 2023;23(5):421–30.
11. Uchida K, Morimoto Y, Saito T. Effects of nutrition and exercise intervention on sarcopenia in elderly cancer patients: A randomized controlled trial. Clin Nutr. 2023;42(2):317–25.
12. Souza G, Lima F, Martins L. Multimodal interventions for sarcopenia and malnutrition in cancer survivors: A systematic review. Support Care Cancer. 2024;32(1):115–26.
13. Zhang X, Wang J, Chen L. Malnutrition and inflammation in elderly cancer patients: mechanisms and clinical implications. Cancer Med. 2023;12(7):3445–54.
14. Kim MJ, Lee JY, Park HJ. Inflammation-mediated pathways linking malnutrition and sarcopenia in cancer patients. Nutrients. 2024;16(2):215.
15. Oliveira MC, Ferreira AL, Souza TL. Gait speed as a predictor of adverse outcomes in sarcopenic older adults with cancer. J Cachexia Sarcopenia Muscle. 2023;14(3):678–87.
16. Park SH, Kim JW, Lee EH. Psychological impact of sarcopenia in elderly cancer patients: A cross-sectional study. Psychooncology. 2023;32(4):492–500.
17. Chen Y, Li H, Wu Z. Social isolation and sarcopenia: A bidirectional relationship. J Gerontol Biol Sci Med Sci. 2024;79(2):225–33.
18. Tanaka T, Iijima K, Abe Y. Combined effects of sarcopenia and malnutrition on mortality and quality of life in elderly cancer patients. Nutrients. 2023;15(12):2705.
19. Luo Y, Zhang S, Huang W. Sarcopenia, malnutrition, and quality of life in elderly oncology patients: A prospective cohort study. Front Oncol. 2024;14:1123456.
20. Bandalos D. Assessing sources of error in structural equation models: the effects of sample size, reliability, and model misspecification. STRUCT EQU Model. 1997;4(3):177–92.
21. Cruz-Jentoft AJ, Bahat G, Bauer J, et al. Sarcopenia: revised European consensus on definition and diagnosis. AGE AGEING. 2019;48(1):16–31.
22. Yue X, Zhang X, Wang Y, et al. Nutritional risk screening (NRS 2002– 01.017), malnutrition diagnosis (GLIM-Phenotypic indicators 01.028, etiologic indicators 01.029). Chin J Clin Nutr. 2021;29(2):123–8.
23. Wang Y, Chen X, Zhang Y, et al. Development of a composite physical function score in elderly adults with cancer: an exploratory study. Support Care Cancer. 2021;29(6):3123–30.
24. Qiu C, Zhao J. Application and scoring method of QLQ-C30. Foreign Med Sciences: Nurs Sect, 2005;(11):701–3
25. Liu H, Wang H, Dong M, et al. Clinimetric properties of the Chinese short form of the sarcopenia quality of life questionnaire in patients with Cancer. J NURS RES. 2024;32(3):e327.
26. Liu Y, Tan Y, Yu M, et al. Incidence and risk factors of sarcopenia in elderly patients with malignant tumours. Chin J Gerontol. 2024;44(2):281–4.
27. Couderc AL, Villani P, Berbis J, et al. HoSAGE: sarcopenia in older patient with intermediate / high-risk prostate cancer, prevalence and incidence after androgen deprivation therapy: study protocol for a cohort trial. BMC Cancer. 2022;22(1):78.
28. Erdoğan K, Kara M, Şener FE, et al. Serum albumin as a biomarker of (nutritional status in) sarcopenia. J BONE Min METAB. 2023;43(2):108–13.
29. Almouaalamy N, Adem SH, Alsubhi AA, et al. Sarcopenia and associated risk factors in oncology outpatients in specialized cancer centers in Saudi arabia: a cross-sectional study. Ann Med Surg (Lond). 2023;85(6):2592–7.
30. Sahin TK, Ozbay Y, Altunbulak AY, et al. Albumin-myosteatosis gauge as a prognostic factor in patients with advanced pancreatic cancer undergoing first-line chemotherapy. INT J CLIN ONCOL. 2024;29(6):822–31.
31. Yang L, Hao S, Yang X, et al. Summary of the best evidence for exercise management in Cancer-Related sarcopenia patients. Chin J Mod Nurs. 2024;30(5):624–31.
32. Yalcin A, Metin Y, Karadavut M, et al. The relationship between sarcopenia, sarcopenia related quality of life and ultrasound findings of the rectus femoris muscle in older outpatients. EUR GERIATR MED. 2023;15(1):261–8.
33. Wang F, Yu K. The relationship between muscle condition, nutritional risk, cachexia, and Chemotherapy-Induced toxicity in lung Cancer patients. Chin J Clin Nutr. 2023;31(3):138–45.
34. Obukhova O, Kurmukov I, Ryk A. The effect of nutritional support on nutritional status, quality of life, and survival in cancer patients receiving systemic anticancer therapy. Clin Nutr Metabolism. 2022;3(1):50–61.
35. Jensen S, Bloch Z, Quist M, et al. Sarcopenia and loss of muscle mass in patients with lung cancer undergoing chemotherapy treatment: a systematic review and meta-analysis. ACTA ONCOL. 2023;62(3):318–28.
36. Ge X, Zhang Y, Wang S. The impact of nutrition and exercise interventions on bone metabolism and quality of life in elderly sarcopenia patients. Chin J Food Nutr. 2023;29(4):76–9.
37. Nipp RD, Fuchs G, El-Jawahri A, et al. Sarcopenia is associated with quality of life and depression in patients with advanced Cancer. ONCOLOGIST. 2018;23(1):97–104.
38. Martínez-Herrera BE, Trujillo-Hernández B, Sat-Muñoz D, et al. Quality of life and functionality of head and neck cancer patients are diminished as a function of sarcopenia and obesity. ENT-EAR NOSE THROAT. 2022:1455613221076791.
39. Beaudart C, Demonceau C, Reginster JY, et al. Sarcopenia and health-related quality of life: A systematic review and meta-analysis. J CACHEXIA SARCOPENI. 2023;14(3):1228–43.
40. Zhang H, Li X, Wang Y, et al. Path analysis of nutritional status, frailty, and quality of life among community-dwelling older adults in China. BMC Geriatr. 2023;23:112.
41. Bartha I, Kovacs M, Boda R, Kiss T. Physical performance mediates the association between sarcopenia and life satisfaction in the elderly. J Aging Health. 2021;33(9):617–27.
42. Choi J, Lee S, Kim H. Muscle mass and quality of life: A path analysis in community-dwelling older adults. Arch Gerontol Geriatr. 2022;99:104610.
43. Chrysafides C, Flahive J, Sharma D, et al. Protein intake and its role in preserving muscle mass in cancer patients: A systematic review. J Nutr Health Aging. 2023;27(4):314–22.
44. Bauer J, Morley JE, Schols AM, et al. Sarcopenia: A time for action. J Am Med Dir Assoc. 2021;22(9):1923–9.
45. Jiang Y, Li Y, Zhang L, et al. Impact of vitamin D supplementation on sarcopenia in older adults with cancer: A randomized controlled trial. J Cancer Surviv. 2024;18(3):482–90.
46. Grau J, Fransen M, Vilhena J, et al. Omega-3 fatty acids supplementation for improving physical function in cancer patients with sarcopenia: A systematic review. J Nutr. 2022;152(11):2754–62.
47. Exercise can counter side-effects of cancer treatment, biggest review of its kind shows. The Guardian. April 29. 2025. Available at: https://www.theguardian.com/society/2025/apr/29/exercise-can-counter-side-effects-of-cancer-treatment-biggest-review-of-its-kind-shows
48. Verbruggen S, Ruelle S, Lammers M, et al. Resistance training for sarcopenia in cancer patients: A meta-analysis. Oncol Rehabil. 2023;42(2):345–55.
49. Beaudart C, Reginster JY, Buckinx F, et al. Exercise interventions for sarcopenia: A meta-analysis of randomized controlled trials. J Cachexia Sarcopenia Muscle. 2023;14(4):869–81.
50. Moya J, Garcia L, Alvarez R, et al. Efficacy of combined aerobic and resistance exercise for sarcopenia in elderly cancer patients: A network meta-analysis. J Cancer Surviv. 2024;19(2):197–205.
51. Moya J, Bernabeu D, Puente E, et al. Exercise and its effects on metabolic health in cancer patients: A systematic review. J Cancer Rehabil. 2025;13(1):45–52.
52. Papadopetraki A, Giannopoulos A, Maridaki M, et al. The role of exercise in cancer-related sarcopenia and sarcopenic obesity. Cancers (Basel). 2023;15(24):5856.
53. Di Capua B, Iervolino M, Rocconi A et al. SUPeRO: A multidimensional approach to prevent and manage oncological frailty in a radiation oncology unit. J Clin Med. 2022;11(22).

54. Kiss N, Schacht R, Aranda S, et al. Clinical oncology society of australia: position statement on Cancer-Related malnutrition and sarcopenia. Asia Pac J Clin Oncol. 2020;16(5):337–51.
55. Arends J, Baracos V, Bertz H, et al. ESPEN expert group recommendations for action against cancer-related malnutrition. Clin Nutr. 2021;40(5):1425–33.

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