Original Article

Nutritional Risk Screening in patients with chronic kidney disease

Rongshao Tan MD[1], Jianting Long MD, PhD[2], Shi Fang MD[3], Haiyan Mai MD[3], Wei Lu MD[3], Yan Liu MD, PhD[4], Jianrui Wei MD[1], Feng Yan MD[5]

[1]*Department of Nutrition, Institute of clinical nutrition, Guangzhou Red Cross Hospital, Jinan University, Guangzhou, China*
[2]*Department of Medicinal Oncology, the First Affiliated Hospital, SUN Yat-Sen University, Guangzhou, China*
[3]*Department of Clinical Nutrition, the First Affiliated Hospital, SUN Yat-Sen University, Guangzhou, China*
[4]*Department of Nephrology, Guangzhou Red Cross Hospital, Jinan University, Guangzhou, China*
[5]*Department of Nutrition, the First Affiliated Hospital of Guangzhou Medical University, Guangzhou, China*

Knowledge concerning nutritional status of patients with chronic kidney disease (CKD) is limited. Nutritional Risk Screening-2002 (NRS-2002) has been used to evaluate the nutritional aspects of patients according to the recommendation of European Society for Clinical Nutrition and Metabolism. Here we aim to assess the prevalence and characteristics of nutritional risk in CKD patients by using NRS-2002. NRS-2002 scores of 292 CDK patients were recorded in first 24 hours subsequent to their admission to hospital. All patients have never been on dialysis. BMI, weight and various biochemical parameters were also characterized for these patients. Possible correlations between these parameters and NRS-2002 score were investigated. The overall prevalence of nutritional risk was 44.9% (53.6% in CKD stage 4-5 patients and 38.3% in stage 1-3 patients). Statistically significant differences were found in serum Albumin, Haemoglobin B, and lymphocyte counts between patients with or without increased nutritional risk. Under the situation that attending physicians were completely unaware of NRS-2002 scores, only 35.1% of the patients at risk received nutritional support. The nutritional risk status was associated with CKD stages but independent from primary diagnosis type. More attention should be paid to the nutritional status in CKD patients (including early stage patients). We recommended using NRS-2002 for nutritional risk assessment among non-dialysis CKD patients in routine clinical practice.

Key Words: nutrition, nutritional risk screening 2002, chronic kidney disease, nutritional support, malnutrition

INTRODUCTION

Chronic kidney disease (CKD), characterized by progressive loss in renal function, is a growing health problem. The total number of CKD patients has markedly increased during the last 30 years.[1] Specially, in China, the overall prevalence of CKD has reached 10.8%.[2] Moreover, a systematic review of 26 studies found a prevalence of CKD from 23.4% to 35.8% in patients older than 64 years.[3] Therefore, CKD should be considered a public health priority.

Malnutrition is highly prevalent and in CKD patients. The risk of mortality is inversely correlated to nutritional status[4,5] and good nutritional status among patients with CKD is associated with reduction of comorbidities. Since malnutrition is potentially reversible with appropriate nutritional support, early identification of high nutritional risk patients to ensure early diagnosis of malnutrition may facilitate effective treatment. However, the nutritional status of CKD patients is still often neglected. Moreover, limited previous studies on nutritional risk screening of CKD patients are mostly focus on hemodialysis patients[6,7] or patients in advanced stages (stage 4 and 5).[8] Investigations on nutritional risk screening across all stages of CKD are still lacking.

Nutritional Risk Screening 2002 (NRS-2002) is a simple, practical and patient-friendly tool that enables the detection of nutritional risk within 24 hours after admission in hospitalized patients. It is recommended by the European Society for Clinical Nutrition and Metabolism (ESPEN) to screen adults.[9] One multicenter, prospective study involving 26 hospital departments (including the Dept. of Nephrology) from more than 10 countries identified nutritional risk defined by the NRS-2002 as an independent predictor of poor clinical outcome.[10] NRS-2002 has been put to good use for nutritional risk screening in hospitals in both China and the United States. Here we aim to quantify the prevalence of nutritional risk among

Corresponding Author: Dr Yan Liu, Department of Nephrology, Guangzhou Red Cross Hospital, Guangzhou, China, No. 396 Tongfuzhong Road, Guangzhou, Guangdong, 510020, China.
Tel: 86-18928900385; Fax: 86-20-34403835
Email: yanliu1587@outlook.com
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non-dialysis CKD patients at different stages (including stage 1-5) by using NRS-2002. In addition, the effects of CKD stage and primary diagnosis type on pronounced nutritional risk were also studied.

MATERIALS AND METHODS

Patients

Consecutive patients from the First Affiliated Hospital of SUN Yat Sen University (n=143), the First Affiliated Hospital of Guangzhou Medical University (n=118), and Guangzhou Red Cross Hospital (n=31) were approached to participate in our study from April to June 2010. All patients were diagnosed according to the Kidney Disease Outcome Quality Initiative (K/DOQI) clinical practice guidelines.[11] Signed informed consent was obtained from all subjects. A total of 292 adult patients (≥18 years) were included. Eligibility criteria were as follows: evidence of kidney damage due to chronic kidney disease; no requirement of dialysis within the preceding 3 months. Subjects with other disorders/conditions (e.g. organ transplantation, coma, and previous surgery) that might potentially affect malnutrition were excluded. Patients subjected to surgery within 24 h after admissions were also excluded. The study was approved by the Ethics Committee of all three teaching hospitals (Register No. S054, Clinical trial register No. NCT00289380). The study was performed in accordance with the ethical standards laid down in the Declaration of Helsinki.

Nutritional Risk Screening

NRS-2002 screening and data collection were conducted as previously published.[12,13] Briefly, the total nutritional risk score (NRS-2002 score) was calculated according to the NRS-2002 scoring system, endorsed by ESPEN.[14] All NRS-2002 scores were recorded for all patients within 24 hours after admission. The first component of the questionnaire assesses the nutritional status according to three items: Body Mass Index (BMI, <18.5, 18.5-20.5, and >20.5 kg/m^2), weight loss history (over 5% in 3 months, over 5% in 2 months or over 5% in 1 month) and reduced food intake as a proportion in the preceding week (0%-25%, 25%-50%, 50%-75% and >75%). The second component assesses disease severity. The third component assesses age: all subjects over 70 years would be given an additional weighting. Primary data were collected in the form of a questionnaire. The corresponding authors from each of the teaching hospitals collected data in accordance to the items in the NRS-2002. Each patient was interviewed separately by two of the dieticians specifically trained to perform NRS-2002 screening, resulting in two independent sets of answers. Disagreements between the two interviewers were submitted for discussion by a committee consisted of the deans of the Dept. of Clinic Nutrition of each of the three hospitals. Patients were given a third interview by one of the members from the committee if a consensus could not be reached. The total NRS-2002 score (range 0-7) is the sum of the nutritional status score, the disease severity score and the age adjustment score. Patients with a NRS-2002 score of ≥3 were considered as nutritionally at risk.

Anthropometrics

Weight and height were measured by using calibrated standing scale. Barefoot height was measured to the nearest 0.5 cm at 6:00-8:00 am. Weight was scaled to the nearest 0.2 kg when the patient was wearing patient uniform only and after at least 8 hours of fasting. Both height and weight were measured by nurses and documented in medical records. BMI was calculated using the standard formula (kg/m^2).

Biochemical parameters

Blood samples were drawn from all participants after an overnight fast upon admission. White blood cells (WBC), neutrophils and lymphocytes were counted. Serum albumin was measured using the bromcresol green method with a normal reference range of 35 to 50 g/L. Serum C-reactive protein (CRP) was measured using immuneturbidimetry with a normal reference range of <8 mg/L. Haemoglobin B (HB) was determined using the sodium lauryl sulfate (SLS)-haemoglobin method with a normal reference range of 120 to 160 g/L. Serum creatinine (CREA) was measured using the sarcosine oxidase method with a normal reference range of 53 to 115 μmol/L. Blood Urea Nitrogen (BUN) was measured using the urease method with a normal reference range of 2.9 to 8.6 mmol/L. Glomerular filtration rate was estimated by the MDRD (Modification of Diet in Renal Disease) equation modified specific for the Chinese population: c-eGFR (mL/min per 1.73 m^2) =186 × $Pcr^{-1.154}$ × $age^{-0.203}$ × 0.742 (if female) × 1.233 (if Chinese).[15]

Nutritional support

The application of nutritional support during day 1 to day 14 after admission was recorded. Whether the patients need nutritional support was decided by attending physicians who were completely unaware of NRS-2002 scores. The nutritional support plans can be divided into two categories: (1) parenteral nutrition: a combination of amino acids, glucose, fat and multivitamins with nonprotein calories of at least 15 kcal/kg·d; (2) enteral nutrition: oral nutrient supplements and tube feeding providing patients with calories of at least 15 kcal/kg·d. Patients who received the aforementioned nutritional support for at least 3 days were considered nutritionally supported.

Statistical analysis

Statistical analysis was performed with SPSS (Statistical Package for Social Sciences, Chicago, IL, USA), version 17.0. Descriptive data were presented in percentages, or mean±SD. Values normally distributed were further analyzed using the Student's t-test. Values with an abnormal distribution were analyzed using the Mann–Whitney U test. ANOVA was used for the comparison of means among different groups. The Chi-square analysis was used for the comparison of rates among different groups. A p value <0.05 was considered statistically significant.

RESULTS

Study population

A total of 292 patients (145 men and 147 women) were included in this study. Figure 1 presents the recruitment process. Demographic and biochemical characteristics of

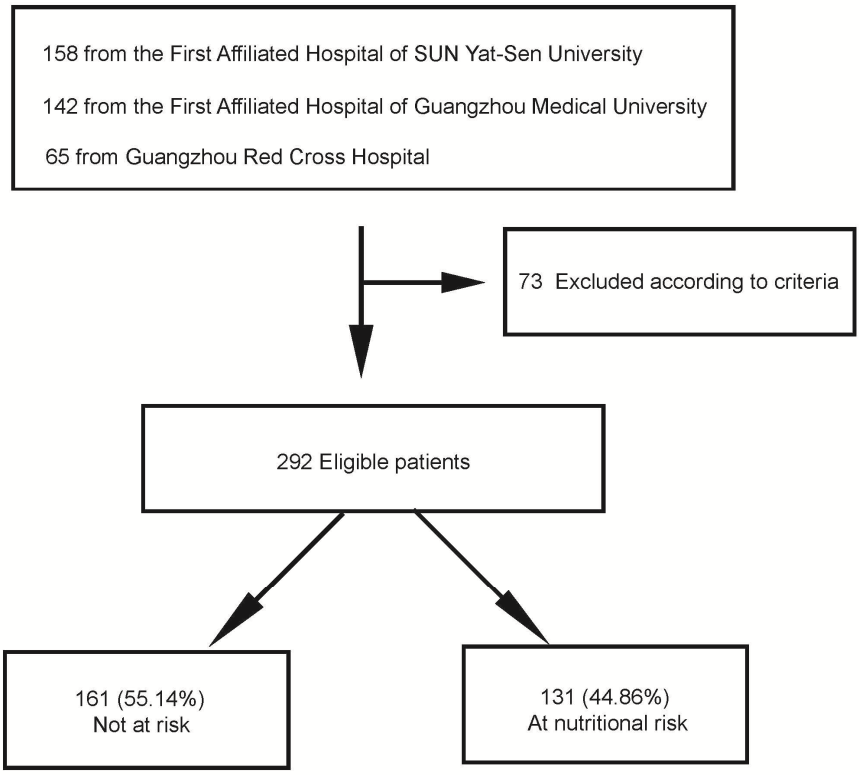

Figure 1. Flow-chart: the recruitment process

the patients are detailed in Table 1. At the study entry, the mean (standard deviation) of the men and women were 55.1 (19.5) and 53.2 (21.1) years old, respectively. There was no significant difference in age between men and women patients in general (t=0.828, p=0.408). With deteriorating kidney function, serum CRP level was found to be consistently elevated, while the level of serum albumin descended from stage 1 to stage 4 CKD. HB and lymphocyte count decreased consistently.

General characteristics

According to NRS-2002 screening results, the prevalence of nutritional risk (NRS-2002 ≥3) was 44.9% (Table 2). Age of the patients at nutritional risk is generally higher than those without nutritional risk (p=0.007), suggesting that the prevalence of nutritional risk increased with age. As might be expected based on the NRS-2002 scoring system, the occurrence of nutritional risk was associated with BMI and weight (p<0.001).

It is recommended that a combination of valid and complementary measures rather than any single measure alone be used for evaluation of protein energy malnutrition and nutritional status in order to achieve greater sensitivity and specificity. Many biochemical parameters have been proposed as a means of evaluating nutritional status for dialysis patients, including albumin, serum creatinine, total lymphocyte count and standard biochemistry.[16] The correlation between NRS-2002 score and these biochemical parameters were also investigated to check their potential relationship. Statistically significant differences were found in serum Albumin, HB, and lymphocyte counts between the two sub-populations, while no statistical differences were found in serum CRP, WBC, neutrophil counts, kidney function parameters, or length of hospital stay.

Effects of CKD stage and primary diagnosis type on nutritional risk

We also checked whether the prevalence of nutritional risk was affected by CKD stage or primary diagnosis. As shown in Table 3, increased nutritional risk were found with deteriorating kidney function (p=0.034). Over half (51.1%) of the patients at nutritional risk were at CKD stage 4-5. However, the prevalence of nutritional risk was independent from the primary diagnosis for the hospitalization (p>0.05).

Nutritional support status

To check whether the patients at risk received proper nutritional support, we also recorded their nutritional support status during day 1 to day 14 after admission. Under the situation that attending physicians were completely unaware of NRS-2002 scores, only 35.1% of the patients at risk received nutritional support (Table 4). In general, parenteral nutrition was more likely to be used in "at risk" patients than enteral nutrition (31.3% vs 7.6%). For all patients at nutritional risk, only 12.5% of the early stage (stage 1-2) patients received nutritional support while the percentage for advanced stage (stage 4-5) patients was nearly a half (46.3%).

DISCUSSION

Current knowledge on existence of nutritional risk in CKD patients (especially stage 1-3) is limited. Here we investigated characteristics of nutritional risk screening performed in different stages of CKD patients.

Table 1. Characteristics of the study population

	Stage 1 CKD (n=39)	Stage 2 CKD (n=44)	Stage 3 CKD (n=84)	Stage 4 CKD (n=58)	Stage 5 CKD (n=67)	Total (n=292)
Age (yrs)	32.6±12.6	49.2±20.7	57.7±20.0	62.6±18.5	56.1±18.3	53.7±20.6
Men, % (n)	28.2 (11)	43.2(19)	54.8(46)	55.2(32)	55.2 (37)	49.7(145)
Weight (kg)	56.8±12.2	58.6±14.7	60.2±11.6	58.8±12.5	57.2±11.9	58.5±12.5
BMI (kg/m^2)	21.4±3.62	22.6±4.91	23.1±3.88	22.1±3.86	22.3±3.86	22.4±4.04
Albumin (g/L)	42.8±5.91	37.3±6.56	32.3±7.33	31.1±7.82	33.9±8.07	34.6±8.20
CRP (mg/L)	2.90±8.75	12.2±33.8	16.2±39.1	17.1±27.6	12.5±20.4	13.4±30.1
WBC ($\times10^9$/L)	6.31±1.77	8.13±3.53	8.41±3.84	8.71±4.06	7.20±3.09	7.87±3.54
HB (g/L)	125±22.1	128±16.9	117±25.2	109±22.3	88.9±23.5	112±26.6
Neutrophils ($\times10^9$/L)	3.43±1.31	5.46±6.32	4.75±3.30	5.21±3.83	4.49±3.44	4.71±3.89
Lymphocyte ($\times10^9$/L)	2.02±0.72	1.96±1.02	1.67±0.95	1.66±1.14	1.32±0.72	1.68±0.95
CREA (umol/L)	63.2±14.2	77.7±14.4	114±31.1	186±60.8	558±252	218±227
BUN (mmol/L)	4.14±1.45	5.12±2.12	7.30±2.66	15.4±16.6	28.1±29.7	12.9±18.4
c-eGFR (mL/min/1.73 m^2)	144±44.7	108±25.1	73.7±27.4	41.6±14.5	14.1±8.96	68.3±49.8
LOS (length of stay)	15.0±7.45	16.7±10.3	21.7±14.6	19.8±17.8	21.7±12.8	19.7±13.8

BMI: body mass index; CRP: C-reactive protein; WBC: white blood cell; HB: haemoglobin B; CREA: creatinine; BUN: blood urea nitrogen; c-eGFR: estimated glomerular filtration rate specifically for Chinese.

Table 2. Patients characteristics according to studied groups of increased nutritional risk

	NRS <3 (n=161, 55.14%)	NRS ≥3 (n=131, 44.86%)	*p* value
Age (yrs)	50.7±18.3	57.4±22.6	0.007
Men, %	53.4	45.0	0.16
Weight (kg)	63.4±11.4	49.5±8.80	<0.001
BMI(kg/m^2)	24.0±3.53	19.4±3.10	<0.001
Albumin (g/L)	36.1±7.65	32.7±8.49	0.001
CRP (mg/L)	10.2±26.2	17.1±34.0	0.10
WBC ($\times10^9$/L)	7.74±3.32	8.03±3.80	0.49
HB (g/L)	116±27.3	107±24.8	0.004
Neutrophils ($\times10^9$/L)	4.76±4.15	4.64±3.56	0.79
Lymphocytes ($\times10^9$/L)	1.87±1.08	1.43±0.70	<0.001
CREA (umol/L)	202±213	238±243	0.17
BUN (mmol/L)	11.1±13.1	15.2±23.2	0.05
c-eGFR (mL/min/1.73m^2)	71.2±45.1	64.8±55.0	0.28
LOS	19.6±15.5	19.9±11.4	0.83

Data are shown as mean±SD.
BMI: body mass index; CRP: C-reactive protein; WBC: white blood cell; HB: haemoglobin B; CREA: creatinine; BUN: blood urea nitrogen; c-eGFR: estimated glomerular filtration rate specifically for Chinese; LOS: length of stay.

Table 3. Influence of age, CKD stage and primary diagnosis type on nutritional risk status

	Nutritional risk status		*p* value
	NRS-2002 <3 n (%)	NRS-2002 ≥3 n (%)	
CKD stage			0.034
1-2	51 (31.7)	32 (24.4)	
3	52 (32.3)	32 (24.4)	
4-5	58 (36.0)	67 (51.1)	
Primary diagnosis			0.340
ANCA-associated glomerulonephritis	2 (1.2)	2 (1.5)	
Chronic glomerulonephritis	21 (13)	9 (6.9)	
Diabetic nephropathy	25 (15.5)	22 (16.8)	
Gouty nephropathy	4 (1.4)	1 (0.3)	
Hypertensive nephropathy	20 (12.4)	28 (21.4)	
IgA nephropathy	11 (6.8)	6 (4.6)	
Nephropathy syndrome	21 (13.0)	12 (9.2)	
Obstructive nephropathy	6 (3.7)	8 (6.1)	
Polycystic kidney disease (PKD)	1 (0.6)	1 (0.8)	
Systemic lupus erythematosus (SLE)	9 (5.6)	4 (3.1)	
Urinary system infection	10 (6.2)	6 (4.6)	
Other chronic renal disease	31 (19.3)	32 (24.4)	

Table 4. Nutritional support in CKD patients at nutritional risk

	Nutritional support	Parenteral nutrition	Enteral nutrition
Total (131)	35.1% (46/131)	31.3% (41/131)	7.6% (10/131)
Stage 1-2	12.5% (4/32)	9.4 % (3/32)	3.1% (1/32)
Stage 3	34.4% (11/32)	31.3% (10/32)	9.4 % (3/32)
Stage 4-5	46.3% (31/67)	41.8% (28/67)	9.0% (6/67)

Increased nutritional risk was found in 131 of the studied patients (44.9%). For patients at advanced stages (stage 4-5), the percent was 53.6% (67/125), which is comparable to the prevalence reported from previous studies on patients with end stage renal disease with maintenance hemodialysis.[17-19] For patients at stage 1-3, the prevalence was significantly less than that of advanced stage patients. However, 38.3% (64/167), which is not negligible, of these patients were at nutritional risk, suggesting that the nutritional status of the patients at early stage should also be paid attention to. In the current study, under the situation that attending physicians were completely unaware of NRS-2002 scores, only 35.1% of the patients at risk received nutritional support (Table 4), suggesting that the nutritional risk of CKD patients is still often underestimated or neglected. Therefore, we recommend that routine evaluation of the prevalence of nutritional risk in non-dialysis CKD patients, including early stage patients, should be carried out in clinical practice. Appropriate nutritional support should be provided for those patients under nutritional risk.

The correlation between NRS-2002 score and biochemical parameters, which have been proposed as a means of evaluating nutritional status,[16] was also investigated to check their potential relationship. Statistically significant differences were found in serum albumin, HB, and lymphocyte counts between the patients with and without increased nutritional risk. Serum albumin is one of the most important markers of protein energy malnutrition (PEM) in patients with CKD, based largely on the statistical association between diminished serum albumin and mortality or morbidity.[16] HB levels and lymphocyte counts may also be associated with the mortality in patients with CKD.[20,21] It was reported that lymphocyte proliferation and function are impaired by protein malnutrition.[22] Correlation between NRS-2002 based nutritional risk and these important biochemical parameters suggested that NRS-2002 is suitable in the nutritional assessment in CKD patients.

No significant difference was detected between different primary diagnosis types (Table 3), suggesting that the nutritional risk of CKD patients was independent from their primary diagnoses for hospitalization.

Limitations of this study must be addressed. We only used NRS-2002 to evaluate the nutritional risk of the patients. Evaluation results of other tools, such as Malnutrition Inflammation Score (MIS)[23] and Subjective Global Assessment (SGA),[24] were not involved in this study. However, the resulting prevalence in advanced stage patients in this study is comparable to the results of previous studies using other tools.[6,17] In addition, association of NRS-2002 risk status with previously proposed important biochemical parameters for evaluating nutritional status further support its usability. Of note, Velasco et al compared four nutritional screening tools in the detection of nutritional risk in hospitalized patients and drew a conclusion that NRS-2002 should be used to screen for nutritional status in the hospital setting.[25] In one multicenter, prospective study involving 26 hospital departments from more than 10 countries showed that patients defined by NRS-2002 as “at risk” had more complications, higher mortality and longer lengths of hospital stay than ‘not at-risk’ patients. It was believed that nutritional risk was an independent predictor of poor clinical outcome.[10] NRS-2002 is user-friendly and it could be completed in a few minutes. Furthermore, most patients were comfortable

with the questions and were willing to participate in the interview or measurement processes.[26] Therefore, NRS-2002 is an appropriate nutritional assessment tool for hospitalized CKD patients and our results provided reliable understanding of the prevalence of nutritional risk in CKD patients across different stages.

In conclusion, using NRS-2002, we evaluated the prevalence of nutritional risk in different stages of CKD patients. Increased nutritional risk was found in 44.9% of the studied patients. Statistically significant differences were found in serum Albumin, HB, and lymphocyte counts between patients with or without increased nutritional risk. Under the situation that attending physicians were completely unaware of NRS-2002 scores, only 35.1% of the patients at risk received nutritional support. More attention should be paid to the nutritional status in CKD patients (including early stage patients). We recommended using NRS-2002 for nutritional risk assessment among non-dialysis CKD patients during in routine clinical practice.

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AUTHOR DISCLOSURES

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Original Article

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Rongshao Tan MD[1], Jianting Long MD, PhD[2], Shi Fang MD[3], Haiyan Mai MD[3], Wei Lu MD[3], Yan Liu MD, PhD[4], Jianrui Wei MD[1], Feng Yan MD[5]

[1]Department of Nutrition, Institute of clinical nutrition, Guangzhou Red Cross Hospital, Jinan University, Guangzhou, China
[2]Department of Medicinal Oncology, the First Affiliated Hospital, SUN Yat-Sen University, Guangzhou, China
[3]Department of Clinical Nutrition, the First Affiliated Hospital, SUN Yat-Sen University, Guangzhou, China
[4]Department of Nephrology, Guangzhou Red Cross Hospital, Jinan University, Guangzhou, China
[5]Department of Nutrition, the First Affiliated Hospital of Guangzhou Medical University, Guangzhou, China

慢性肾脏病患者的营养风险筛查研究

目前人们对于慢性肾脏病患者（CKD）的营养状况了解非常有限。根据欧洲临床营养与代谢协会推荐，营养风险筛查标准 NRS-2002 已被广泛应用于评估其他疾病患者的营养风险。本研究旨在利用 NRS-2002 评估 CKD 患者的营养风险。我们针对 292 例未经过透析的 CDK 患者进行了 NRS-2002 评估，记录了他们的体重指数（BMI）和各种生化指标，并对 NRS-2002 评分与各种指标之间的相关性进行了分析。在所有样本中，处于营养风险状态的患者比例为 44.9%（CKD 4-5 级患者中比例为 53.6%，1-3 级为 38.3%）。血清白蛋白、血红蛋白 B 和淋巴细胞计数与患者的营养风险状态显著相关。在主治医师未得知 NRS-2002 评分的状况下，仅有 35.1%存在营养风险的患者接受了营养支持治疗。患者的营养风险状况与其初诊类型无关。本研究结果表明，临床实践中应该重视 CKD 患者（包括早期病人）的营养状况，及时给予营养治疗。我们建议针对非透析的 CKD 患者使用 NRS-2002 进行营养风险评估。

关键词：营养状况、营养风险筛查 2002、慢性肾病、营养支持、营养失调