Linguistic and Cultural Adaptation and Italian Validation of the Renal iNUT, a Nutrition Screening Tool for Hospitalized Patients with Chronic Kidney Disease

Articoli originali

Sara Morales Palomares[1,2*], Silvia Cappelletti[2*], Gaetano Ferrara[2,3], Stefano Mancin[2], Giovanni Cangelosi[2,4], Giada Vrenna[2], Mauro Parozzi[2,5], Domenica Gazineo[2,6], Marco Sguanci[2], Mattia Bozzetti[7*], Elena Sandri[8*]
***These authors contributed equally**


Giovanni Cangelosi

AI tools were used to support language editing and translation, but not for content generation. No AI-generated content was included without human review and revision.

1 Department of Pharmacy, Health and Nutritional Sciences (DFSSN), University of Calabria, 87036 Rende Italy
2 Italian Society of Nephrology Nurse (SIAN), Via Capotesta 1/30, 07026 Olbia, Italy
3 Department of Biomedicine and Prevention, University of Rome Tor Vergata, Viale Montpellier 1, 00128 Rome, Italy
4 School of Pharmacy, Experimental Medicine and "Stefani Scuri" Public Health Department, University of Camerino, Via Madonna delle Carceri 9, 62032 Camerino (MC), Italy
5 Medicine and Surgery Department, University of Parma, Via Gramsci 14, 43126 Parma, Italy
6 Governo Clinico e Qualità, IRCCS Azienda Ospedaliero-Universitaria di Bologna, Via Giuseppe Massarenti 9, 40138, Bologna, Italy
7 Direction of Health Professions, ASST Cremona, Viale Concordia 1, 26100 Cremona, Italy
8 Faculty of Medicine and Health Sciences, Catholic University of Valencia San Vicente Martir, 46001 Valencia, Spain

Corresponding author:
Dr. Giovanni Cangelosi
School of Pharmacy, Polo Medicina Sperimentale e Sanità Pubblica,
62032 Camerino, Italy
E-mail: giovanni01.cangelosi@unicam.it

ABSTRACT

Background/aim. Malnutrition is a frequent and serious issue among patients with chronic kidney disease (CKD), often leading to worse clinical outcomes. The Renal Inpatient Nutrition Screening Tool (Renal iNUT), originally developed in the United Kingdom, provides a quick and renal-specific method for screening hospitalized CKD patients. While a Spanish version has been adapted, no validated Italian translation is currently available. This study set out to translate and culturally adapt the Renal iNUT for application in Italian clinical contexts, as well as to evaluate its psychometric properties.

Methods. The adaptation followed the methodological approach described by Sousa and Rojjanasrirat, proceeding through seven structured phases to secure conceptual, linguistic, and cultural equivalence. After a pilot phase with healthcare professionals, the tool was administered to hospitalized patients with CKD to assess both inter- and intra-rater reliability.

Results. Feedback from the pilot testing indicated that the Italian Renal iNUT was clear, intuitive, and easy for clinicians to use in daily practice. Psychometric testing confirmed good intra-rater reliability [Intraclass Correlation Coefficients (ICC) = 0.83; 95% Confidence Interval (CI) 0.69 – 0.91] and excellent inter-rater reliability (ICC = 0.90; 95% CI 0.82–0.95). Total scores remained stable across repeated measurements [median = 2.0; Interquartile Range (IQR) 1.0 – 3.0/2.5].

Conclusions. Overall, the Italian version of the Renal iNUT demonstrated strong reliability and practical usability, supporting its use for nutritional screening in patients with CKD. Its implementation may help promote standardized nutritional screening and early nutritional interventions in Italian hospital settings, ultimately improving the quality of care and patient outcomes for individuals with CKD.

KEYWORDS: Chronic kidney disease, nutritional screening of malnutrition, Renal Inpatient Nutrition Screening Tool (Renal iNUT), cross-cultural adaptation, validity and reliability, Italy

Introduction

Chronic kidney disease (CKD) is becoming increasingly common and now affects around 10–11% of adults worldwide [1]. Among its many complications, malnutrition is one of the most relevant, as it strongly influences both disease progression and the patient's overall well-being [2, 3]. According to recent systematic reviews, the global prevalence of malnutrition in CKD varies widely depending on clinical setting, disease stage, and the criteria or tools used to assess it [4]. Malnutrition in CKD has a multifactorial origin, resulting from several overlapping biological and clinical mechanisms [5]. A reduced dietary intake, often related to anorexia, nausea, or gastrointestinal symptoms, is one of the most common contributors. Metabolic and hormonal disturbances linked to chronic inflammation and the accumulation of uremic toxins further aggravate protein-energy wasting and muscle catabolism [6]. Changes in taste and smell perception can also lessen appetite and dietary variety, while dietary restrictions prescribed to control electrolyte or mineral imbalance, multiple medications, and the effects of repeated hospitalizations all play a role [7, 8]. Taken together, these factors not only raise the likelihood of malnutrition but also have a negative impact on patients' overall clinical course. Individuals who are malnourished often respond less effectively to treatment, experience longer hospital stays, and are more likely to be readmitted, leading to greater healthcare costs [9]. As a result, their quality of life tends to decline, and long-term outcomes are poorer [10]. This issue becomes even more evident with advancing age and progressive kidney impairment, which highlights how essential regular nutritional screening and timely interventions are in this population [11]. To provide a clearer framework for describing nutrition-related disorders in CKD, the International Society of Renal Nutrition and Metabolism (ISRNM) proposed the concept of protein–energy wasting (PEW), a condition characterized by the loss of body protein and energy stores caused by metabolic and inflammatory disturbances [12]. Recent meta-analyses have shown that PEW occurs across all stages of CKD, with particularly high prevalence among dialysis patients [13]. In those undergoing hemodialysis, identifying nutritional risk and applying targeted interventions have been associated with improved outcomes [14], whereas persistent loss of appetite remains a powerful predictor of both hospitalization and mortality [15]. Common anthropometric indicators such as body mass index (BMI), triceps skinfold thickness (TSF), and mid-arm muscle circumference (MAMC) are often used to estimate nutritional status [16–18]. However, validated screening tools are still rarely applied in everyday practice [19]. The 2020 Kidney Disease Outcomes Quality Initiative (KDOQI) guidelines stress the need for more research to define optimal combinations of nutritional indicators for early detection and to standardize screening approaches for non-dialysis CKD populations [20]. In response to these needs, Jackson et al. developed the Renal Inpatient Nutrition Screening Tool (Renal iNUT), a concise screening instrument that showed high sensitivity and specificity when compared with the Subjective Global Assessment (SGA) [21]. Although the SGA remains the recognized gold standard for evaluating nutrition-related morbidity and mortality [22], the Renal iNUT offers clear advantages in terms of speed and usability, particularly for CKD inpatients [5, 9]. Its concise structure allows quick identification of at-risk patients and facilitates timely nutritional support [19]. The Renal iNUT has already been translated and validated in Spanish-speaking settings, confirming its reliability and ease of use [23]. Yet, no validated Italian version is currently available. Developing one could help healthcare professionals perform more consistent and standardized nutritional screening in Italian hospitals. Ultimately, an Italian adaptation might promote earlier dietary interventions, strengthen the integration of clinical nutrition within CKD care, and contribute to better long-term patient outcomes. Addressing this gap is crucial, since malnutrition continues to be a frequent but often underestimated complication that significantly impacts prognosis, complication rates, and quality of life in people with CKD.

Aim

This study aimed to translate, culturally adapt, and psychometrically validate the Renal iNUT tool for application in Italian hospital settings.

Methods

Study Design and Setting

This single-centre study focused on the translation, cultural adaptation, and psychometric validation of the Renal iNUT tool into Italian, following formal authorization from the original developers [21]. Briefly, the Renal INUT is a kidney-specific screening instrument developed to identify hospitalized patients with CKD who are at risk of malnutrition. It consists of a small set of items exploring key domains that are particularly relevant in this population: current BMI or clinical appearance of malnutrition, recent unintentional weight loss, changes in usual appetite and food intake, and the use of oral nutritional supplements. For each domain, predefined response options associated with nutritional risk are scored as positive, and the total number of "at-risk" responses generates an overall risk score (range 0–4), with higher scores reflecting a higher risk of malnutrition. This score is used to classify patients as low risk (0), at risk (1) or in need of dietetic referral (≥ 2). The tool also includes a brief follow-up section for weekly re-screening during hospitalization, in which weight, BMI and changes in appetite and food intake since admission are reassessed. The Renal iNUT is designed to be completed by ward nurses at the bedside in a few minutes using routinely available clinical information and a brief patient interview. The study followed a seven-phase cross-cultural adaptation protocol adapted from Sousa and Rojjanasrirat [24], ensuring rigorous methodology to preserve the conceptual, semantic, and cultural integrity of the tool. Phases 1–3 were conducted between March and April 2025, Phases 4–5 in May 2025, and Phases 6–7 from June to August 2025. Each phase is described below, to ensure the tool's cultural and linguistic relevance and its applicability in clinical practice.

Ethical Considerations

The study was approved by the Bioethics Committee of Bologna (protocol no. 0390138). All participants provided written informed consent in accordance with the principles outlined in the Declaration of Helsinki. They were clearly informed about the voluntary nature of their participation and their right to withdraw at any stage without any negative consequences.

Translation and Cultural Adaptation Process

The Italian adaptation of the Renal iNUT followed a structured seven-phase process designed to ensure both linguistic accuracy and cultural relevance.

Translation of the Original Tool into Italian

During the first phase, two independent bilingual translators, both fluent in English and Italian, produced separate translations of the original tool. One translator specialized in healthcare terminology and was familiar with the conceptual basis of the questionnaire, while the other focused more on everyday language to maintain clarity and accessibility. This phase resulted in two Italian versions (IT1 and IT2), each reflecting a slightly different linguistic register.

Reconciliation of Translated Versions

In the next phase, an independent translator compared IT1 and IT2 to reconcile differences and produce a single harmonized version. Any inconsistencies were discussed and resolved to achieve the best possible balance between conceptual precision and linguistic naturalness. The resulting

version was labeled Preliminary Italian Version 1 (PI-V1).

Blind Back-Translation

The reconciled Italian text was then translated back into English by two translators whose native language was English and who had no prior knowledge of the original instrument. This "blind" back-translation aimed to highlight any discrepancies or shifts in meaning that might have occurred during the translation process.

Multidisciplinary Committee Review

After the back-translation, a multidisciplinary panel composed of a methodologist, nephrology specialists, and all translators involved reviewed the materials side by side. The committee examined both semantic and conceptual equivalence, resolving any discrepancies and refining the Italian version to ensure it was consistent with the original content. This stage led to the creation of a pre-final Italian version of the Renal iNUT.

Content Validity Assessment

The pre-final version was then reviewed by the expert panel to evaluate item clarity, cultural appropriateness, and clinical relevance. The experts verified that all items maintained the intended meaning of the original version and that the instructions and response options were suitable for use in the Italian healthcare context.

Pre-Test of the Pre-Final Version

The pre-final version was pilot-tested with a group of 15 healthcare professionals, including nephrology nurses, dietitians, and physicians, working at Azienda Socio Sanitaria Territoriale (ASST) Lariana – Fermo della Battaglia, Como (Italy). Participants gave written informed consent and were asked to comment on the clarity of the instructions, the relevance of the items, and the ease of completing the questionnaire. Their feedback was incorporated to make minor adjustments and finalize the tool for clinical application.

Psychometric Testing

The final phase focused on evaluating the psychometric properties of the Renal iNUT tool in a representative sample of hospitalized patients with CKD. Healthcare professionals, including physicians and nurses from nephrology and internal medicine wards, were tasked with using the tool to assess the nutritional risk of patients. This phase was critical in determining the tool's reliability and validity in clinical practice by assessing its consistency and accuracy across various patient scenarios.

Sample size for phase 7

The expected reliability for this study was based on the previously published validation of the Renal iNUT tool, which reported a Cohen's kappa of 0.74 (95% CI [0.58, 0.90]), indicating substantial agreement. Assuming a similar level of agreement, an expected Intraclass Correlation Coefficients (ICC) of approximately 0.74 was considered. A simulation-based a priori power analysis indicated that for expected (ICC) values around 0.7–0.8, a sample of 30–40 patients with two raters is sufficient to obtain reliable and precise estimates, with a 95% confidence interval width of approximately 0.3 [25]. Accordingly, the inclusion of n = 35 patients in the present study can be regarded as adequate to assess inter- and intra-rater reliability.

Data collection for phase 7

Data were collected between June and August 2025 in the tertiary nephrology department of ASST Lariana, Fermo della Battaglia (Como, Italy). Before data collection began, the participating

healthcare professionals received specific training on how to administer and score the Renal iNUT, ensuring a uniform application of the tool across assessors. Patients diagnosed with CKD were recruited consecutively at the time of hospital admission, after signing written informed consent. The Renal iNUT was then administered by two independent raters following a structured schedule designed to test both intra- and inter-rater reliability:

Rater 1 (T0): Initial nutritional assessment performed at the time of patient admission.

Rater 1 (T6h): Repeat evaluation 6 hours later by the same professional to assess consistency within the same operator.

Rater 2 (T24h): Independent evaluation conducted within 24 hours of admission by another professional to assess inter-rater consistency.

All scores were assigned strictly according to the standardized Renal iNUT criteria to ensure objective and comparable evaluations of nutritional risk.

An overview of the entire process of translation, cultural adaptation, and validation is presented in Figure 1.

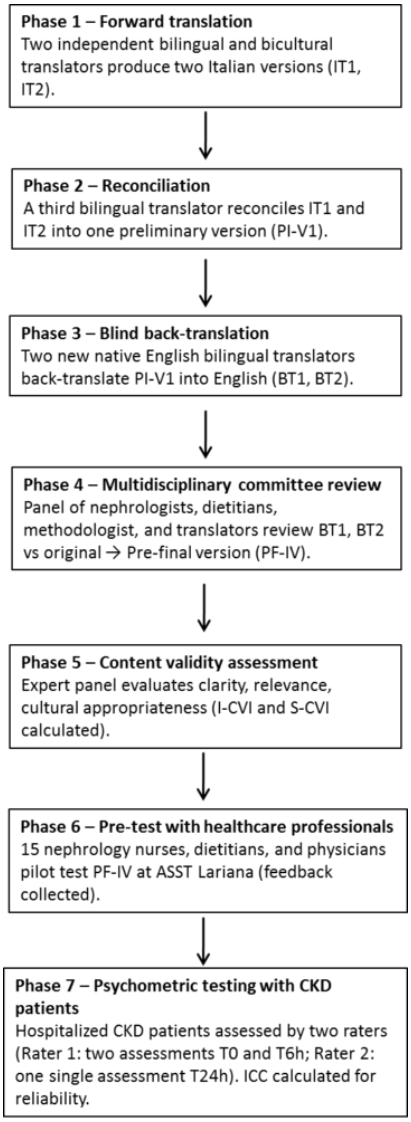

Figure 1. Flow diagram of the seven-phase cross-cultural adaptation and validation process of the Renal iNUT tool into Italian. Legend. CKD: Chronic Kidney Disease; ICC: Intraclass Correlation Coefficients; ASST: Azienda Socio Sanitaria Territoriale; PI-V1: Preliminary Italian Version 1; PF-IV: pre-final Italian version; BT1: Back Translation 1; BT2: Back Translation 2; I-CVI: Item-Content Validity Index; S-CVI: Scale-Content Validity Index.

Statistical Analysis

Descriptive statistics were produced for both demographic and clinical variables. Because continuous data were not normally distributed, they are presented as medians with interquartile ranges (IQR). Categorical variables, such as item-level responses, are expressed as absolute frequencies and percentages. Test–retest reliability (agreement between T0 and T6 h) was examined using the intraclass correlation coefficient [ICC (3, 1)] calculated through a two-way mixed-effects model (absolute agreement, single measures). Inter-rater reliability (agreement between T6 h and T24 h assessments) was analyzed with ICC (2,1) using a two-way random-effects model under the same agreement assumptions. Ninety-five-percent confidence intervals (CIs) were reported for all ICCs and interpreted according to conventional cut-offs: < 0.50 = poor, 0.50–0.75 = moderate, 0.75–0.90 = good, and > 0.90 = excellent reliability [26]. All analyses were conducted using R, version 4.5.0.

Results

The results of this study are presented according to the seven phases outlined in the Methods section, each representing a critical step in the linguistic and cultural adaptation and validation of the Renal iNUT tool for use in Italian clinical settings.

Translation and expert review (phases 1–5)

Phases 1–5 resulted in an Italian version of the Renal iNUT that was conceptually consistent with the original tool and suitable for use in Italian clinical settings. In phases 1–3, two independent forward translations were produced and reconciled into a single Italian draft, which was then blindly back-translated into English. Comparison of the back-translations with the original version showed good conceptual overlap, with no major discrepancies in meaning. During the multidisciplinary committee review (phase 4), nephrology experts, dietitians, a methodologist and the translators introduced only minor linguistic refinements to improve clarity and idiomatic flow, while preserving the original content and structure of the tool. In phase 5, content validity indices met a priori benchmarks I-CVI: Item-Content Validity Index (I-CVI) ≥ 0.78 and Scale-Content Validity Index (S-CVI) ≥ 0.80, indicating that the items were judged as clear, relevant and culturally appropriate by the expert panel and could be retained in the Italian version without substantial modification.

Pre-test with healthcare professionals (phase 6)

In phase 6, the pre-final Italian version (PF-IV) of the Renal iNUT was pre-tested with 15 healthcare professionals (nephrology nurses, dietitians and physicians) working in nephrology and internal medicine wards. Overall, participants considered the tool easy to understand, clinically relevant, and straightforward to administer. They also reported that it could be completed quickly and integrated into routine clinical assessments without affecting workflow, although the exact administration time was not formally measured in this study. Their feedback led to a few minor wording and layout adjustments, but no substantial changes to item content, resulting in the final Italian version used for psychometric testing (Supplementary File 1).

Phase 7: Psychometric Testing

Sample characteristics

A total of 35 hospitalized patients with CKD participated in psychometric testing. The median age of the sample was 71.4 years (IQR 56.7–80.9), and the median BMI was 23.6 kg/m² (IQR 21.2–25.6).

Renal-iNUT Scores

Across repeated assessments, total Renal iNUT scores remained stable, with median values of 2.0 at

T0 (IQR 1.0–3.0), 2.0 at T6 h (IQR 1.0–2.0), and 2.0 at T24 h (IQR 1.0–2.5). The observed range was 0–4 at all time points (Table 1).

Item-level responses were consistent over time (Table 2). The domains most frequently endorsed were Food Intake (60.0% at T0; 48.6% at T6 h; 45.7% at T24 h) and Appetite (54.3%; 48.6%; 51.4%), followed by Weight Loss (37.1%; 40.0%; 38.2%). The items Malnutrition/BMI ≤ 20 (≈ 17%) and Nutritional Supplements (≈ 11–17%) appeared less frequently. Overall, these findings indicate a consistent response pattern across all assessment points.

Timepoint	n	Median (IQR)	Min	Max
T0	35	2.0 (1.0–3.0)	0	4
T6h	35	2.0 (1.0–2.0)	0	4
T24h	35	2.0 (1.0–2.5)	0	4

Table 1. Total scores. Legend: n = number of participants; IQR = Interquartile Range; Min = Minimum; Max = Maximum; T0 = first evaluation; T6h = 6h evaluation; T24h = 24h evaluation. Note: Median (IQR) and range values for total Renal iNUT scores across the three assessment time points (T0, T6h, and T24h) in 35 hospitalized patients with chronic kidney disease (CKD).

Item	T0 n (%)	T6h n (%)	T24h n (%)
Weight loss (involuntary)	13 (37.1%)	14 (40.0%)	13 (38.2%)
Malnutrition or BMI ≤ 20	6 (17.6%)	6 (17.1%)	6 (17.1%)
Nutritional supplements	4 (11.4%)	6 (17.1%)	5 (14.3%)
Food intake	21 (60.0%)	17 (48.6%)	16 (45.7%)
Appetite	19 (54.3%)	17 (48.6%)	18 (51.4%)

Table 2. Item response frequencies at T0, T6h, and T24h (only observed categories). *Legend: BMI: body mass index; n = number of participants; T0 = first evaluation; T6h = 6h evaluation; T24h = 24h evaluation.* Note: Frequencies and percentages of positive responses for each Renal iNUT item across the three assessment time points (T0, T6h, and T24h) in 35 hospitalized patients with CKD.

Reliability

Intra-rater Reliability (T0 vs T6h)

Intraclass correlation coefficients (ICC [3, 1]) for item-level agreement ranged from 0.78 to 1.00. The ICC for the total score was 0.83 (95% CI 0.69–0.91), indicating good reproducibility within the same rater (Table 3).

Item	ICC	95% CI (Lower)	95% CI (Upper)	n
Item 1	0.82	0.67	0.91	35
Item 2	1.00	1.00	1.00	34
Item 3	0.78	0.60	0.88	35
Item 4	0.79	0.63	0.89	35
Item 5	0.78	0.60	0.88	35
Total	0.83	0.69	0.91	35

Table 3. Intraclass Correlation Coefficients [ICC (3, 1)] for Items and Total Score Between T0 and T6h. Legend: ICC = Intraclass correlation coefficients; n = number of participants; CI = Confidence Interval. Note: Intraclass correlation coefficients (ICC [3, 1]) and 95% confidence intervals (CI) for item-level and total scores obtained by the same rater at two time points (T0 and T6h).

Inter-rater reliability (T6h vs T24h)

Item-level ICC (2,1) values ranged from 0.83 to 1.00. The ICC for the total score was 0.90 (95% CI 0.82–0.95), indicating excellent agreement between different raters (Table 4).

Item	ICC (2,1)	95% CI (Lower)	95% CI (Upper)	n
Item 1	0.94	0.88	0.97	34
Item 2	1.00	1.00	1.00	35
Item 3	0.90	0.80	0.95	35
Item 4	0.83	0.69	0.91	35
Item 5	0.83	0.69	0.91	35
Total	**0.90**	**0.82**	**0.95**	35

Table 4. ICC (2,1) (two-way random, absolute agreement) between T6h and T24h. Legend: ICC = Intraclass correlation coefficients; n = number of participants; CI = Confidence Interval. Note: Intraclass correlation coefficients (ICC [2, 1]) and 95% confidence intervals (CI) for item-level and total scores obtained by two different raters at T6h and T24h.

Discussion

This study set out to translate, culturally adapt, and psychometrically validate the Renal iNUT for use in Italian hospital settings, filling an important gap in renal-specific nutritional screening.

Malnutrition remains a common and complex complication in chronic kidney disease (CKD) [1, 2]. It contributes to higher morbidity, longer hospital stays, frequent readmissions, and rising healthcare costs [9]. Because of this, identifying nutritional risk early is essential to initiate prompt and effective interventions [27, 28]. The Renal iNUT was created to offer a concise, kidney-specific screening tool that combines anthropometric and dietary dimensions such as appetite, food intake, and oral nutritional supplement (ONS) use. These elements are highly relevant in CKD, where nutritional deterioration is often worsened by polypharmacy, uremic toxin buildup, gastrointestinal disturbances, and taste changes like dysgeusia, all of which reduce dietary intake [7, 8, 29]. By integrating these features, the tool allows for a more focused and clinically meaningful evaluation of nutritional risk. The process of translation, cultural adaptation, and validation followed a rigorous seven-phase protocol that has already been successfully applied in international studies [30]. This approach ensured that the Italian version maintained semantic alignment with the original tool while remaining appropriate for clinical use within the Italian healthcare system. The procedure included bilingual forward and back translations, review by a multidisciplinary committee, and an expert evaluation of each item's clarity and cultural fit. Both the I-CVI and the S-CVI were above the recommended cutoffs, confirming the strength and reliability of the adapted version. Feedback gathered from 15 healthcare professionals, including nephrologists, dietitians, and nurses, confirmed that the Italian Renal iNUT was clear, practical, and easy to apply, with only minor wording adjustments required. Psychometric testing in a sample of 35 hospitalized CKD patients further supported its reliability, showing excellent reproducibility: intra-rater reliability (T0 vs T6 h) reached an ICC of 0.83 (95% CI 0.69–0.91), and inter-rater reliability (T6 h vs T24 h) achieved 0.90 (95% CI 0.82–0.95) [26]. These results are particularly noteworthy considering the difficulties inherent in assessing nutrition among CKD patients, where factors such as hydration status, inflammation, and metabolic alterations often interfere with anthropometric and biochemical measurements [31, 32]. From a clinical standpoint, the stable score distributions across repeated assessments, median 2.0 with consistent domain responses, underline the tool's reliability for longitudinal monitoring. This is important because malnutrition in CKD is not static; it fluctuates with disease progression, dialysis regimens, comorbid conditions, and hospitalization episodes [33].

When compared with more general screening instruments such as the MUST [34] or the SGA [22], the Renal iNUT demonstrates several advantages [24, 35]. Traditional screening tools often rely heavily on body weight or BMI, yet these indicators can mask nutritional risk when patients present

with fluid overload, sarcopenia, or protein–energy wasting [36]. The Renal iNUT offers a broader view: by including dietary intake, appetite, and the use of ONS, it captures CKD-specific conditions such as fluid imbalance and appetite loss, providing a more realistic picture of a patient's nutritional status [24, 30]. Another advantage of the tool is the structured training offered to the professionals who use it. When staff receive standardized instruction, differences between observers tend to decrease, making the tool more consistent across units and professional roles [37, 38]. Incorporating this training into routine clinical practice could support wider and more reliable adoption of the Renal iNUT in nephrology settings [39]. The tool's usefulness extends beyond nutritional screening alone. In older adults with CKD, malnutrition frequently overlaps with frailty, falls, longer hospital stays, and higher mortality rates [40]. Detecting nutritional risk early, through a CKD-specific tool like the Renal iNUT, can complement frailty assessments and help promote a more integrated and patient-centered model of care [24, 35]. Because nutritional decline and inflammation are closely linked, using the Renal iNUT alongside inflammatory or metabolic biomarkers may also enhance risk stratification and prognostic assessment [24, 41]. On a broader level, applying validated nutritional screening tools in a systematic way can contribute to shorter hospitalizations, fewer readmissions, and lower healthcare costs [42]. Embedding the Renal iNUT into standard care pathways could therefore benefit both patients and health systems [24]. Finally, as clinical nutrition becomes increasingly digitalized, there are growing opportunities to connect validated instruments like the Renal iNUT with electronic health records, mobile apps, and telemedicine systems. These integrations allow for real-time data entry, automatic scoring, and faster communication among multidisciplinary teams, ultimately supporting more efficient and coordinated nutritional care [43, 44]. In this context, artificial intelligence (AI) also holds promise: predictive algorithms trained on large clinical datasets could enhance risk prediction, personalize dietary strategies, and monitor trends over time. For CKD patients, whose nutritional trajectories often change rapidly, the combination of standardized screening instruments such as the Renal iNUT with AI-based technologies could represent a meaningful step toward precision nutrition and improved quality of care [45].

Future studies should also investigate how Renal iNUT scores relate to objective markers of nutritional status, such as serum albumin, inflammatory biomarkers, muscle strength, and body composition parameters, as well as to clinically meaningful outcomes including length of stay, readmissions, and mortality. Such evidence would provide a more comprehensive understanding of the clinical value of the tool and further support its use in routine nephrology practice.

Limitations

This study presents several limitations that should be acknowledged. First, it was carried out in a single Italian hospital, and therefore the findings may partly reflect local dietary habits, healthcare practices, and organizational models. While this setting enhances the cultural fit of the adaptation, it may restrict the broader applicability of the results to other regions or healthcare systems. The study sample was relatively small (n = 35). Although this number met the predefined requirements for estimating ICCs with adequate precision, it may not fully represent the diversity of the CKD population. Moreover, the short retest intervals (6–24 hours) helped to minimize clinical changes between assessments but could have introduced some degree of memory or learning bias among raters. Furthermore, we did not formally record the time required to complete each Renal iNUT assessment, and we were therefore unable to quantify its impact on workflow. In addition, we did not systematically collect biochemical and functional indicators of nutritional status (e.g., serum albumin, muscle strength, or muscle mass), which prevented us from evaluating the concurrent validity of the Renal iNUT against objective clinical markers. Finally, this investigation focused primarily on content validity and reliability. Other psychometric properties, such as construct,

concurrent, and predictive validity, were not examined here and should be evaluated in future, larger-scale studies.

Relevance to clinical practice

The Italian adaptation of the Renal iNUT provides a fast, kidney-specific tool for detecting malnutrition in CKD patients and addresses a clear gap in daily clinical practice. By including key parameters such as appetite, food intake, and ONS use, the instrument captures nutritional risk more accurately than generic screening tools, which may fail in the presence of fluid overload or altered body composition. The Renal iNUT uses a standardized scoring system that helps nephrologists, dietitians, and nurses communicate more effectively and work toward a shared nutritional plan. The tool is easy to use, requires only a short period of training, and can be repeated several times during a patient's hospital stay. This practicality makes it particularly useful for detecting early signs of nutritional decline and for triggering timely interventions aimed at preventing protein–energy wasting, reducing complications, and shortening recovery times. Thanks to its solid reproducibility, the Renal iNUT can be applied consistently from admission to discharge, ensuring continuity in the monitoring of nutritional status. Integrating the tool into electronic health records (EHRs) would make its use even smoother, automatic data capture and follow-up could be handled directly within the system. Beyond simplifying daily practice, this would enable real-time clinical decisions and generate valuable information for tracking hospital malnutrition at a national level. These datasets could in turn help health authorities refine care pathways and design more effective nutrition-related policies. In the near future, combining Renal iNUT data with artificial intelligence-based analytical platforms may further improve risk prediction and support more personalized nutritional care for patients with CKD. In summary, the Italian adaptation of the Renal iNUT stands out as a practical and reliable tool, one that promotes consistent screening, strengthens collaboration across disciplines, and contributes to better outcomes in nephrology care.

Conclusion

The Italian adaptation of the Renal iNUT resulted in a tool that remains true to the original version while being fully attuned to the linguistic and cultural characteristics of the Italian healthcare environment. Every domain, wording choice, and response option was carefully reviewed to reflect local dietary habits and clinical practice, making the instrument directly relevant to Italian patients and professionals. Clinically, having a renal-specific screening tool is a real step up from generic instruments. By focusing on appetite, actual food intake, and use of ONS, the Renal iNUT offers a more nuanced and sensitive picture of nutritional risk in CKD. Crucially, it can flag malnutrition even when usual markers, weight or BMI, are misleading because of fluid overload or altered body composition. Beyond accuracy, the tool helps standardize assessment across wards and roles, and it makes communication between nephrologists, dietitians, and nurses more consistent, bringing nutritional monitoring firmly into multidisciplinary CKD care. Because it is concise and easy to administer, it can be used routinely during a hospital stay to catch early decline and trigger timely action. Introducing a validated, kidney-specific screener into the Italian system addresses a clear gap: with malnutrition common in CKD and tightly linked to poor outcomes, the Renal iNUT could support earlier detection, better quality of care, and reductions in complications, length of stay, and costs. In summary, the Italian Renal iNUT is both a practical clinical tool and a step forward in nephrology care, promoting more proactive, standardized, and patient-centered nutritional management.

BIBLIOGRAPHY

1. Kovesdy CP. Epidemiology of chronic kidney disease: an update 2022. Kidney Int Suppl. 2022;12(1):7-11. https://doi.org/10.1016/j.kisu.2021.11.003
2. Price SR, Wang XH. Protein-energy wasting in chronic kidney disease: mechanisms responsible for loss of muscle mass and function. Kidney Res Clin Pract. 2025;44(5):726-740. https://doi.org/10.23876/j.krcp.24.214
3. Narasaki Y, Rhee CM, Kalantar-Zadeh K, Rastegar M. Why protein-energy wasting leads to faster progression of chronic kidney disease. Curr Opin Nephrol Hypertens. 2025;34(1):55-66. https://doi.org/10.1097/MNH.0000000000001035
4. Zhao L, Chen S, Ren L, et al. Prevalence and Diagnosis of Malnutrition in Patients with Chronic Kidney Disease: Evaluating the Value of NRS2002 and SGA Scores. Kidney Blood Press Res. 2025;50(1):513-522. https://doi.org/10.1159/000546832
5. Xi WZ, Wu C, Liang YL, Wang LL, Cao YH. Analysis of malnutrition factors for inpatients with chronic kidney disease. Front Nutr. 2023;9:1002498. https://doi.org/10.3389/fnut.2022.1002498
6. Gomariz-Ruiz J, Pérez-Cruzado D, Gutiérrez-Sánchez D. Cluster of symptoms in kidney failure: A systematic review. Heliyon. 2024;11(1):e41556. https://doi.org/10.1016/j.heliyon.2024.e41556
7. Sguanci M, Ferrara G, Palomares SM, et al. Dysgeusia and Chronic Kidney Disease: A Scoping Review. J Ren Nutr. 2024;34(5):374-390. https://doi.org/10.1053/j.jrn.2024.04.005
8. Morales Palomares S, Parozzi M, Ferrara G, Andreoli D, Godino L, Gazineo D, et al. Olfactory Dysfunctions and Chronic Kidney Disease: A Scoping Review. J Ren Nutr. 2025;35(1):4-14. https://doi.org/10.1053/j.jrn.2024.06.007
9. Schuetz P, Seres D, Lobo DN, Gomes F, et al. Management of disease-related malnutrition for patients being treated in hospital. Lancet. 2021;398:1927-1938. https://doi.org/10.1016/S0140-6736(21)01451-3
10. Luo Y, Huang H, Wang Q, Lin W, Duan S, et al. An Exploratory Study on a New Method for Nutritional Status Assessment in Patients with Chronic Kidney Disease. Nutrients. 2023;15:2640. https://doi.org/10.3390/nu15112640
11. Piccoli GB, Cederholm T, Avesani CM, Bakker SJL, Bellizzi V, Cuerda C, et al. Nutritional status and the risk of malnutrition in older adults with chronic kidney disease – implications for low protein intake and nutritional care: A critical review endorsed by ERN-ERA and ESPEN. Clin Nutr. 2023;42:443-457. https://doi.org/10.1016/j.clnu.2023.01.018
12. Ikizler TA, Cano NJ, Franch H, Fouque D, Himmelfarb J, Kalantar-Zadeh K, et al. Prevention and treatment of protein energy wasting in chronic kidney disease patients: a consensus statement by the International Society of Renal Nutrition and Metabolism. Kidney Int. 2013;84:1096-1107. https://doi.org/10.1038/ki.2013.147
13. Carrero JJ, Thomas F, Nagy K, Arogundade F, Avesani CM, Chan M, et al. Global Prevalence of Protein-Energy Wasting in Kidney Disease: A Meta-analysis of Contemporary Observational Studies From the International Society of Renal Nutrition and Metabolism. J Ren Nutr. 2018;28:380-392. https://doi.org/10.1053/j.jrn.2018.08.006
14. Sabatino A, Regolisti G, Karupaiah T, Sahathevan S, Singh BKS, Khor BH, et al. Protein-energy wasting and nutritional supplementation in patients with end-stage renal disease on hemodialysis. Clin Nutr. 2017;36:663-671. https://doi.org/10.1016/j.clnu.2016.06.007
15. Burrowes JD, Larive B, Chertow GM, Cockram DB, Dwyer JT, Greene T, et al. Self-reported appetite, hospitalization and death in haemodialysis patients: findings from the Hemodialysis (HEMO) Study. Nephrol Dial Transplant. 2005;20:2765-2774. https://doi.org/10.1093/ndt/gfi132
16. Cederholm T, Barazzoni R, Austin P, Ballmer P, Biolo G, et al. ESPEN guidelines on definitions and terminology of clinical nutrition. Clin Nutr. 2017;36:49-64. https://doi.org/10.1016/j.clnu.2016.09.004
17. Oladele CO, Unuigbe E, Chukwuonye II, Obi EC, Ohagwu KA, Oladele G, et al. Assessment of Nutritional Status in Patients with Chronic Kidney Disease in Nigeria. Saudi J Kidney Dis Transpl. 2021;32:445-454. https://doi.org/10.4103/1319-2442.335457
18. Chang PK, Chen WL, Wu LW. Mid-arm muscle circumference: A significant factor of all-cause and cancer mortalities in individuals with elevated platelet-to-lymphocyte ratio. PLoS One. 2018;13:e0208750. https://doi.org/10.1371/journal.pone.0208750
19. Fiaccadori E, Sabatino A, Barazzoni R, Carrero JJ, et al. ESPEN guideline on clinical nutrition in hospitalized patients with acute or chronic kidney disease. Clin Nutr. 2021;40:1644-1668. https://doi.org/10.1016/j.clnu.2021.01.028
20. Ikizler TA, Burrowes JD, Byham-Gray LD, et al. KDOQI Clinical Practice Guideline for Nutrition in CKD: 2020 Update. Am J Kidney Dis. 2020;76(suppl 1):S1-S107. https://doi.org/10.1053/j.ajkd.2020.05.006
21. Jackson HS, MacLaughlin HL, Vidal-Diez A, Banerjee D. A new renal inpatient nutrition screening tool (Renal iNUT): a multicenter

validation study. Clin Nutr. 2019;38:2297-2303. https://doi.org/10.1016/j.clnu.2018.10.002
22. Bigogno FG, Fetter RL, Avesani CM. Aplicabilidade da avaliação global subjetiva e malnutrition inflammation score na avaliação do estado nutricional na doença renal crônica. J Bras Nefrol. 2014;36:236-240. https://doi.org/10.5935/0101-2800.20140034
23. Romano-Andrioni B, Martín Lleixà A, Carrasco-Serrano M, et al. Nueva herramienta de cribado nutricional para pacientes hospitalizados con enfermedad renal crónica: traducción, adaptación transcultural del iNUT Renal al castellano y comparación con cuestionarios clásicos. Nutr Hosp. 2023;40:1192-1198. https://doi.org/10.20960/nh.04538
24. Sousa VD, Rojjanasrirat W. Translation, adaptation and validation of instruments or scales for use in cross-cultural health care research: a clear and user-friendly guideline. J Eval Clin Pract. 2011;17:268-274. https://doi.org/10.1111/j.1365-2753.2010.01434.x
25. Mokkink LB, de Vet H, Diemeer S, Eekhout I. Sample size recommendations for studies on reliability and measurement error: an online application based on simulation studies. Health Serv Outcomes Res Method. 2023;23:241-265. https://doi.org/10.1007/s10742-022-00293-9
26. Koo TK, Li MY. A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research. J Chiropr Med. 2016;15:155-163. https://doi.org/10.1016/j.jcm.2016.02.012
27. Reber E, Gomes F, Vasiloglou MF, Schuetz P, Stanga Z. Nutritional Risk Screening and Assessment. J Clin Med. 2019;8:1065. https://doi.org/10.3390/jcm8071065
28. Mahmood S, Jalal Z, Hadi MA, et al. Prevalence of non-adherence to antihypertensive medication in Asia: a systematic review and meta-analysis. Int J Clin Pharm. 2021;43:486-501. https://doi.org/10.1007/s11096-021-01236-z
29. Chao CT, Lin SH. Uremic Toxins and Frailty in Patients with Chronic Kidney Disease: A Molecular Insight. Int J Mol Sci. 2021;22:6270. https://doi.org/10.3390/ijms22126270
30. Ersoy Söke N, Karademir E, Bayrak E, et al. Turkish version of the renal inpatient nutrition screening tool: validity and reliability for haemodialysis patients. Br J Nutr. 2025;133:231-238. https://doi.org/10.1017/S0007114524003192
31. Ruperto M, Barril G. Clinical Significance of Nutritional Status, Inflammation, and Body Composition in Elderly Hemodialysis Patients—A Case–Control Study. Nutrients. 2023;15(24):5036. https://doi.org/10.3390/nu15245036
32. Nogueira Á, Álvarez G, Barril G. Impact of the Nutrition–Inflammation Status on the Functionality of Patients with Chronic Kidney Disease. Nutrients. 2022;14:4745. https://doi.org/10.3390/nu14224745
33. Robayo Herrera LM, Pérez Roldán LC, Padrones López B, et al. Factors associated with malnutrition in the very elderly with chronic kidney disease. Nephrol Dial Transplant. 2024;39(suppl 1):gfae069–1458–1619. https://doi.org/10.1093/ndt/gfae069.1458
34. Elia M. The 'MUST' Report. BAPEN; 2003. Available from: https://www.bapen.org.uk/reports/must/the-must-report/
35. Kosters CM, van den Berg MGA, van Hamersvelt HW. Sensitive and practical screening instrument for malnutrition in patients with chronic kidney disease. Nutrition. 2020;72:110643. https://doi.org/10.1016/j.nut.2019.110643
36. Serón-Arbeloa C, Labarta-Monzón L, Puzo-Foncillas J, et al. Malnutrition Screening and Assessment. Nutrients. 2022;14:2392. https://doi.org/10.3390/nu14122392
37. Broadley I, White R, Jaffee A. Nutrition training for medical professionals: where do we begin? Br J Cardiol. 2022;29(4):28. https://doi.org/10.5837/bjc.2022.028
38. Tang Y, Wen X, Tang X, et al. Nutritional nursing competence of clinical nurses and its influencing factors: a cross-sectional study. Front Nutr. 2024;11:1449271. https://doi.org/10.3389/fnut.2024.1449271
39. Anderson CAM, Nguyen HA. Nutrition education in the care of patients with chronic kidney disease and end-stage renal disease. Semin Dial. 2018;31(2):115-121. https://doi.org/10.1111/sdi.12681
40. Molinari P, Caldiroli L, Abinti M, Nardelli L, Armelloni S, Cesari M, et al. Frailty Is Associated with Malnutrition–Inflammation Syndrome in Older CKD Patients. Nutrients. 2024;16(16):2626. https://doi.org/10.3390/nu16162626
41. Anand N, SCC, Alam MN. The Malnutrition Inflammation Complex Syndrome-The Micsing Factor in the Perio-Chronic Kidney Disease Interlink. J Clin Diagn Res. 2013;7(4):763-767. https://doi.org/10.7860/JCDR/2013/5329.2907
42. Inciong JFB, Chaudhary A, Hsu HS, et al. Economic burden of hospital malnutrition: A cost-of-illness model. Clin Nutr ESPEN. 2022;48:342-350. https://doi.org/10.1016/j.clnesp.2022.01.020
43. Roberts S, Marshall AP, Bromiley L, Hopper Z, et al. Patient-Led, Technology-Assisted Malnutrition Risk Screening in Hospital: A Feasibility Study. Nutrients. 2024;16(8):1139. https://doi.org/10.3390/nu16081139
44. Trujillo EB, Shapiro AC, Stephens N, Johnson SJ, Mills JB, Zimmerman AR, et al. Monitoring Rates of Malnutrition Risk in Outpatient Cancer Centers Utilizing the Malnutrition Screening Tool

Embedded into the Electronic Health Record. J Acad Nutr Diet. 2021;121(5):925-930. https://doi.org/10.1016/j.jand.2020.11.007

45. Palomares SM, Ferrara G, Sguanci M, Gazineo D, et al. The Impact of Artificial Intelligence Technologies on Nutritional Care in Patients with Chronic Kidney Disease: A Systematic Review. J Ren Nutr. 2025;S1051-2276(25)00126-8. https://doi.org/10.1053/j.jrn.2025.06.002