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Nutritional Status and the Role of Clinical Pharmacists in Hemodialysis Patients: An Anthropometric Study from Tripoli

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Abstract:

Malnutrition is a frequent and serious complication in patients on maintenance hemodialysis (MHD), leading to increased morbidity and mortality. Despite its clinical significance, nutritional status in this population is often underassessed and undertreated. Integrating clinical pharmacists into the multidisciplinary team offers an opportunity to improve patient outcomes through counseling, dietary monitoring, and collaborative care. This cross-sectional study included 100 adult end-stage renal disease (ESRD) patients undergoing MHD at the Tripoli Center for Dialysis to assess nutritional status using anthropometric and functional parameters—body mass index (BMI), mid-arm circumference (MAC), triceps skinfold thickness (TSFT), mid-arm muscle circumference (MAMC), and handgrip strength (HGS)—and to highlight potential clinical pharmacy contributions. Among participants (53% males, 47% females; mean age 50.4 ± 12 years), 55% had normal nutrition, 35% were mildly to moderately malnourished, and 10% were severely malnourished. Protein depletion (MAMC) occurred in 32%, and HGS weakness in 16%. Age and HGS predicted mild to moderate malnutrition, while height, weight, BMI, and TSFT predicted severe malnutrition. BMI and HGS were associated with age, and HGS correlated with gender. These findings demonstrate that malnutrition is highly prevalent among hemodialysis patients in Tripoli, underscoring the need for routine anthropometric assessment and the active involvement of clinical pharmacists to ensure early detection and optimization of patient care and outcomes.

Keywords: Hemodialysis, Malnutrition, Nutritional assessment, Anthropometry, Clinical pharmacist, End-stage renal disease.

الحالة التغذوية ودور الصيادلة السريريين لدى مرضى الغسيل الكلوي: دراسة أنثروبومترية من طرابلس

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الملخص

يُعدّ سوء التغذية من المضاعفات الشائعة والخطيرة لدى مرضى الغسيل الكلوي الدوري(MHD) ، إذ يؤدي إلى ارتفاع معدلات المراضة والوفيات. ورغم أهميته السريرية، غالبًا ما يتم إغفال تقييم الحالة التغذوية في هذه الفئة من المرضى أو معالجتها بشكل غير كافٍ. ويُشكّل دمج الصيدلي السريري ضمن الفريق الطبي متعدد التخصصات فرصةً لتحسين نتائج المرضى من خلال التثقيف الغذائي، والمتابعة الغذائية، والرعاية التعاونية. شملت هذه الدراسة المقطعية 100 مريض بالغ مصاب بالفشل الكلوي في المرحلة النهائية (ESRD) يخضعون للغسيل الكلوي الدوري في مركز طرابلس للغسيل الكلوي، وذلك لتقييم الحالة التغذوية باستخدام مؤشرات أنثروبومترية ووظيفية تشمل: مؤشر كتلة الجسم(BMI) ، محيط منتصف العضد(MAC) ، سُمك طية الجلد ثلاثية الرؤوس(TSFT) ، محيط عضلة منتصف العضد(MAMC) ، وقوة القبضة اليدوية(HGS) ، بالإضافة إلى تسليط الضوء على إسهامات الصيدلة السريرية المحتملة. من بين المشاركين (53% ذكور، 47% إناث؛ متوسط العمر 50.4 ± 12 سنة)، كان 55% في حالة تغذوية طبيعية، و35% يعانون من سوء تغذية بدرجة خفيفة إلى متوسطة، و10% يعانون من سوء تغذية شديد. لوحظ استنفاد البروتين (MAMC) في 32%، وضعف قوة القبضة في 16%. تنبأ العمر وقوة القبضة بحدوث سوء تغذية خفيف إلى متوسط، بينما تنبأت كل من الطول والوزن ومؤشر كتلة الجسم وسُمك طية الجلد بسوء التغذية الشديد. وارتبط كل من مؤشر كتلة الجسم وقوة القبضة بالعمر، كما ارتبطت قوة

القبضة بالنوع الاجتماعي. توضح هذه النتائج أن سوء التغذية منتشر بشكل مرتفع بين مرضى الغسيل الكلوي في طرابلس، مما يؤكد الحاجة إلى إجراء تقييم أنثروبومتري روتيني وإشراك الصيادلة السريريين بفعالية لضمان الاكتشاف المبكر وتحسين رعاية المرضى ونتائجهم.

الكلمات المفتاحية: الغسيل الكلوي، سوء التغذية، التقييم التغذوي، القياسات الأنثروبومترية، الصيدلي السريري، الفشل الكلوي في المرحلة النهائية.

Introduction

Chronic kidney disease (CKD) is a major contributor to morbidity and mortality worldwide [1]. Patients with end-stage renal disease (ESRD) require maintenance hemodialysis (MHD) to sustain life. For an adult ESRD patient, the minimum dose of MHD is four-hour sessions three times per week. In some circumstances, such as in older patients, those with low body weight or small stature, twice-weekly sessions may be used. In low- and middle-income countries, some centers perform twice-weekly MHD mainly due to limited availability of dialysis machines and financial constraints [2]. ESRD patients undergoing MHD face emotional, financial, and physical challenges, including dependency on caregivers, logistic barriers, and high rates of depression [2].

The incidence and prevalence of CKD are rising steadily, and this disease is associated with body wasting and malnutrition [3]. Malnutrition is a significant concern in CKD, impacting patients' nutritional status and overall health. In developing countries, malnutrition is often related to socioeconomic conditions, while in developed countries it typically occurs within the context of chronic illness [4]. Patients on MHD are particularly at risk due to the catabolic effects of dialysis, poor appetite from uremia, nutrient losses through the dialysis membrane, inflammation, and metabolic acidosis, which may lead to protein-energy wasting (PEW) syndrome [3,5,6].

Even after initiation of dialysis, many factors leading to body wasting persist, including dietary restrictions, poor appetite, malabsorption, medications, and variation in meal timing due to dialysis schedules [7]. Nutrient losses during dialysis, elevated protein catabolism, and inflammatory cytokines further contribute to nutritional deficiency [3]. Gastrointestinal symptoms such as dyspepsia and indigestion can reduce calorie intake [8]. Nutritional assessment is therefore critical for providing dietary guidance, and can be performed using anthropometric measurements, bio-impedance, subjective global assessment (SGA), and the mini nutritional assessment (MNA) [9].

Diet plays a crucial role in CKD management. Medical nutrition therapy, including monitoring protein, calcium, phosphorus, potassium, and sodium intake, can slow disease progression and prevent malnutrition [10]. High protein intake may increase intraglomerular pressure, causing glomerular hyperfiltration and damage; hence, a low-protein diet of 0.6–0.8 g/kg/day is often recommended [11]. Electrolyte imbalances, including hyperkalemia, hyperphosphatemia, hypocalcemia, and metabolic acidosis, must also be managed [12].

PEW, defined as decreased body stores of protein and energy fuels, is a critical outcome of these factors [1]. Nutritional assessment supports management of dietary restrictions, prevention of PEW, optimization of dialysis adequacy, and enhancement of quality of life [7–9,13]. Anthropometric measurements, such as body mass index (BMI), mid-arm circumference (MAC), mid-arm muscle circumference (MAMC), triceps skinfold thickness (TSFT), and handgrip strength (HGS), are practical, non-invasive methods to assess nutritional status in hemodialysis patients [15–17]. TSFT below 60% indicates severe fat depletion, 60–90% indicates mild-to-moderate depletion, and above 90% indicates adequate fat reserves. MAMC below 90% signals protein depletion [20].

The role of the clinical pharmacist in managing hemodialysis patients is increasingly recognized. Pharmacists contribute to nutritional care, adherence support, and monitoring of therapy-related complications, thereby improving clinical outcomes [4,14].

This research aims to assess nutritional status in hemodialysis patients using anthropometric measurements in a cost-effective, novel approach in Libya. The study evaluates nutritional monitoring and care, patient benefits from dialysis, quality of life outcomes, and explores potential contributions from clinical pharmacists in patient management [4,14].

Methodology

This prospective, unicenter, cross-sectional study was conducted at the central hemodialysis center in Tripoli, Libya, with the primary objective of evaluating the nutritional status of adult patients with end-stage renal disease (ESRD) undergoing maintenance hemodialysis (MHD).

Study design

A structured questionnaire was utilized to collect data on dietary habits, health status, and clinical parameters, while a comprehensive anthropometric assessment was performed to objectively quantify nutritional status. Anthropometric measurements included body mass index (BMI), triceps skinfold thickness (TSFT), mid-arm circumference (MAC), mid-arm muscle circumference (MAMC), and handgrip strength (HGS), following standardized procedures [1,2].

Sample selection

Adult ESRD patients receiving MHD either twice or thrice weekly, with each session lasting four hours, were recruited using convenience sampling. Exclusion criteria included patients with overt edema or significant physical disabilities affecting the non-fistula arm, which could interfere with accurate anthropometric assessment. Demographic and clinical data—including age, sex, dialysis duration and frequency, and clinical signs of malnutrition such as edema or skin changes—were recorded using a pre-prepared proforma.

Anthropometric evaluation

Anthropometric evaluation was performed with patients seated comfortably, elbows flexed at 90°, and forearms in neutral position. Height and weight were measured to calculate BMI using the standard formula: BMI = weight (kg)/height (m^2). Mid-arm circumference was measured using a flexible measuring tape, while TSFT was assessed using skinfold calipers. MAMC was calculated with the formula: MAMC = MAC (cm) – π × TSFT (mm)/10 (where π= mathematical constant, approximately **3.1416)** [3]. Handgrip strength of the non-fistula arm was measured with a mechanical dynamometer, taking three readings and recording the best value. Standard reference ranges were applied to classify nutritional status: BMI of 18.1–24.9 kg/m^2 as normal, MAMC ≥25.3 mm for men and ≥23.2 mm for women as normal, TSFT ≥12.5 mm for men and ≥16.5 mm for women as adequate, and HGS ≥27 kg for men and ≥16 kg for women as normal [4,5]. TSFT below 60% of the reference value indicated severe fat depletion, 60–90% indicated mild to moderate depletion, and above 90% indicated adequate fat reserves. Similarly, MAMC below 90% of the reference value was considered indicative of protein depletion [4]. Body fat percentage was estimated using age- and sex-specific caliper reference charts.

Statistical analysis

Data were entered and analyzed using Microsoft Excel and SPSS version 29. Descriptive statistics were reported as mean ± standard deviation (SD) for normally distributed continuous variables and median with interquartile range (IQR) for non-normally distributed variables. Categorical variables were summarized as frequencies and percentages. Intergroup comparisons were performed using Mann-Whitney U test or Kruskal-Wallis test with Tukey's post-hoc analysis for continuous variables, and Pearson chi-square test for categorical variables. Relationships between continuous variables were assessed using Pearson or Spearman correlation coefficients as appropriate. Multinomial regression analysis was applied to estimate odds ratios (OR) for potential risk factors, and receiver operating characteristic (ROC) curve analysis was employed to evaluate the utility of independent parameters in predicting nutritional status, using MAMC as the reference standard. A P-value ≤ 0.05 was considered statistically significant.

Throughout the study, the clinical pharmacist played an integral role in coordinating anthropometric assessments, reviewing patients' nutritional intake and laboratory data, providing education on dietary management, and interpreting results to guide clinical decision-making, thereby ensuring a comprehensive approach to optimizing nutritional care in this vulnerable population [1,6].

Ethics Approval and Consent to Participate

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. The research protocol and consent form were reviewed and approved by the Institutional Scientific Committee for Research of the Department of Pharmacology and Clinical Pharmacy, Faculty of Pharmacy, University of Tripoli, Libya (Approval code: UOT/2021). Written informed consent was obtained from all participants prior to enrollment.

Results

Participant Characteristics

A total of 100 hemodialysis patients were recruited, including 53% males and 47% females. The mean age was 50.4 ± 12 years, ranging from 18 to 73 years. Each patient underwent maintenance hemodialysis for 4 hours per session, three times per week. The mean height and weight were 164.8 ± 9.2 cm and 74.2 ± 16.7 kg, respectively. Age distribution showed that 17% of patients were 18–35 years, 19% were 36–50 years, 54% were 51–65 years, and 10% were 66–73 years. BMI categorization revealed that 3% were underweight, 37% had normal BMI, 30% were overweight, 23% had obesity grade I, and 7% had obesity grade II or III. Detailed demographics are presented in Table 1.

Table 1. Association between Age Groups and Anthropometric Measurements (n=100)

Anthropometric Measurement	≤35 yrs (n=17)	36–50 yrs (n=19)	51–65 yrs (n=54)	>65 yrs (n=10)	P-value
TSFT <60%	0	4 (21.1%)	5 (9.3%)	1 (10%)	0.072
60–90%	3 (17.6%)	5 (26.3%)	21 (38.9%)	6 (60%)	
≥90%	14 (82.4%)	10 (52.6%)	28 (51.9%)	3 (30%)	
MAMC <90%	5 (29.4%)	6 (31.6%)	17 (31.5%)	4 (40%)	0.949
≥90%	12 (70.6%)	13 (68.4%)	37 (68.5%)	6 (60%)	
HGS <Normal	2 (11.8%)	7 (36.8%)	5 (9.3%)	2 (20%)	0.043
Normal	15 (88.2%)	12 (63.2%)	49 (90.7%)	8 (80%)	
BMI Underweight (<18)	2 (11.8%)	1 (5.3%)	0	0	0.015
Normal (18.1–24.9)	10 (58.8%)	8 (42.1%)	15 (27.8%)	4 (40%)	
Overweight (25–29.9)	3 (17.6%)	3 (15.8%)	20 (37%)	4 (40%)	
Obesity Grade I (30–34.9)	0	7 (36.8%)	14 (25.9%)	2 (20%)	
Obesity Grade II & III (≥35)	2 (11.8%)	0	5 (9.3%)	0	

Anthropometric Measurements
Assessment using anthropometric measures showed that 35% of patients had mild to moderate fat depletion, 10% had severe fat depletion, and 55% had adequate fat reserves, based on TSFT. MAMC indicated sufficient protein stores in 68% of patients, while 32% exhibited protein depletion. HGS evaluation revealed that most patients had normal muscle strength, with 16% demonstrating weakness. Detailed anthropometric measurements are provided in Table 2.

Table 2. Association between Gender and Anthropometric Measurements (n=100)

Anthropometric Measurement	Male (n=53)	Female (n=47)	P-value
TSFT <60%	5 (9.4%)	5 (10.6%)	0.278
60–90%	15 (28.3%)	20 (42.6%)	
≥90%	33 (62.3%)	22 (46.8%)	
MAMC <90%	20 (37.7%)	12 (25.5%)	0.192
≥90%	33 (62.3%)	35 (74.5%)	
HGS Normal	50 (94.3%)	34 (72.3%)	0.005
>Normal	3 (5.7%)	13 (27.7%)	
BMI Underweight (<18)	2 (3.8%)	1 (2.1%)	0.577
Normal (18.1–24.9)	23 (43.4%)	14 (29.8%)	
Overweight (25–29.9)	13 (24.5%)	17 (36.2%)	
Obesity Grade I (30–34.9)	11 (20.8%)	12 (25.5%)	
Obesity Grade II & III (≥35)	4 (7.5%)	3 (6.4%)	

Association between Age Groups and Anthropometric Measurements
Chi-square analysis revealed a significant association between age and BMI (P=0.015) as well as HGS (P=0.043) (Table 3). Younger patients (≤35 years) predominantly had normal BMI, whereas overweight and obese patients were mainly in the 51–65-year age group. A decline in handgrip strength was observed with increasing age, reflecting potential age-related loss of muscle mass and protein intake deficits. TSFT and MAMC did not show statistically significant differences across age groups.

Table 3. Correlation between Age and Anthropometric Measurements

Variable	Pearson Correlation	P-value
Height	0.83	0.412
Weight	0.306**	0.002
BMI	0.310**	0.002
MAMC	-0.120	0.233
TSFT	0.275**	0.010
Body Fat %	0.120	0.235

Note: ***P*<0.01 significant.

Association between Gender and Anthropometric Measurements
No significant associations were observed between gender and TSFT, MAMC, or BMI. However, HGS was significantly higher in males compared to females (P=0.005) (Table 4).

Table 4. Correlation between Gender and Handgrip Strength (HGS)

Variable	Spearman's rho	P-value
Gender	0.299**	0.002

Correlation Analyses

Pearson correlation analysis showed weak but significant positive correlations between age and weight, BMI, and TSFT (*P*<0.01), while no significant correlation was observed with MAMC or body fat percentage (Table 5). Spearman's rho analysis indicated a weak positive correlation between gender and HGS (P=0.002) (Table 6).

Table 5. Nutritional Status According to TSFT

Characteristic	Total (n=100)	Normal (n=55)	Mild–Moderate (n=35)	Severe (n=10)	P-value
Age, y	50.41 ±12.6	49.8 ±12.1	55.11 ±12.2	50.7 ±9.8	0.016
Height, cm	164.8 ±9.2	165.8 ±9.1	163.5 ±9.0	164 ±10.6	0.47
Weight, kg	74.2 ±16.7	74.2 ±16.8	73.7 ±17.2	76.3 ±15.8	0.84
BMI, kg/m²	27.4 ±5.49	26.9 ±5.69	27.7 ±5.51	29.8 ±3.8	0.21
MAC, cm	23.6 ±6.5	22.6 ±7.2	24.7 ±6.1	24.8 ±3.8	0.33
MAMC, cm	24.1 ±4.5	24.8 ±4.3	24.14 ±4.8	20.06 ±2.5	0.004
BF%	28.6 ±5.16	29.8 ±12.1	31.1 ±12.2	30.7 ±9.8	0.977

Table 6. Nutritional Status According to MAMC

Characteristic	Total (n=100)	Normal (n=68)	Severe (n=32)	P-value
Age, y	50.41 ±12.6	50.9 ±12.8	50.03 ±12.4	0.84
Height, cm	164.8 ±9.2	164.1 ±9.0	166 ±9.3	0.30
Weight, kg	74.2 ±16.7	72.1 ±16.5	78.8 ±16.6	0.041
BMI, kg/m²	27.4 ±5.49	26.7 ±5.5	28.8 ±5.0	0.065
MAC, cm	23.6 ±6.5	23.3 ±6.5	24.1 ±6.7	<0.001
MAMC, cm	24.1 ±4.5	26.3 ±3.6	19.3 ±4.6	<0.001
TSFT, mm	30.0 ±44.1	33.5 ±47.7	28.7 ±5.2	0.010

Nutritional Status Classification

Based on TSFT, patients were classified into normal nutrition (55%), mild to moderate malnutrition (35%), and severe malnutrition (10%) (Table 7). MAMC-based classification identified 68% of patients as having normal protein reserves, while 32% were severely malnourished. MAMC showed a significant inverse relationship with severe malnutrition (P=0.004). Weight, MAC, and TSFT were significantly associated with MAMC-defined malnutrition (P=0.041, <0.001, 0.010, respectively).

Table 7. Predictors of Nutritional Status (Multinomial Regression)

Variable	Mild–Moderate Malnutrition OR (95% CI)	P-value	Severe Malnutrition OR (95% CI)	P-value
Age	1.069 (1.019–1.121)	0.006	0.992 (0.899–1.095)	0.878
Gender	1.898 (0.422–8.533)	0.131	1.759 (0.183–16.91)	0.625
Height, cm	0.764 (0.547–1.066)	0.113	2.101 (1.271–3.474)	0.004
Weight, kg	1.289 (0.897–1.852)	0.170	0.414 (0.226–0.759)	0.004
BMI, kg/m²	0.479 (0.181–1.271)	0.139	11.162 (2.099–59.3)	0.005
HGS	0.218 (0.049–0.970)	0.045	6.56 (0.068–632.3)	0.420
MAC, cm	1.039 (0.950–1.136)	0.404	1.028 (0.826–1.281)	0.803
MAMC, cm	0.947 (0.836–1.074)	0.397	0.767 (0.530–1.111)	0.160
TSFT, mm	0.996 (0.991–1.001)	0.145	0.951 (0.916–0.988)	0.009

Predictors of Nutritional Status

Multinomial regression analysis showed that age (OR = 1.07; 95% CI: 1.02–1.12; p = 0.006) and handgrip strength (HGS) (OR = 0.22; 95% CI: 0.05–0.95; p = 0.045) were significant predictors of mild to moderate malnutrition. Severe malnutrition was independently associated with height (OR = 2.10; 95% CI: 1.45–3.04), weight (OR = 0.41; 95% CI: 0.22–0.76), body mass index (BMI) (OR = 11.16; 95% CI: 3.52–35.36), and triceps skinfold thickness (TSFT) (OR = 0.95; 95% CI: 0.92–0.98) (all p < 0.01). Gender, mid-arm circumference (MAC), and mid-arm muscle circumference (MAMC) were not significant predictors of malnutrition in this cohort.

Discussion

Malnutrition remains a common and clinically significant problem among patients undergoing maintenance hemodialysis, with profound effects on morbidity, mortality, and quality of life. In our study, 35% of patients exhibited mild-to-moderate malnutrition, and 10% severe malnutrition based on TSFT, while 32% showed protein depletion according to MAMC. These findings are consistent with previous reports indicating that protein-energy wasting affects a substantial proportion of hemodialysis patients worldwide [1–3]. The prevalence observed in our cohort aligns with Sahathevan et al., who reported malnutrition in 30–40% of Malaysian hemodialysis patients [2], and highlights the ongoing global challenge of maintaining adequate nutritional status in this population.

Age-related changes in body composition were evident in our analysis. Older patients had higher prevalence of overweight and obesity but demonstrated reduced handgrip strength, indicating sarcopenic changes despite higher BMI. This paradoxical coexistence of fat accumulation with muscle depletion has been described previously [5,7], emphasizing that BMI alone is insufficient to assess nutritional health in dialysis patients. Functional measures such as HGS provide a practical and sensitive indicator of muscle mass and strength and correlate with clinical outcomes [10].

Anthropometric parameters including TSFT and MAMC proved valuable in identifying fat and protein depletion. Approximately 35% of our patients had mild-to-moderate fat depletion, while protein depletion was noted in 32% based on MAMC. These findings underscore the importance of combining multiple anthropometric indices for accurate nutritional assessment, as recommended by the American Society for Parenteral and Enteral Nutrition (ASPEN) and KDOQI guidelines [14,20]. The correlation between MAMC and TSFT with malnutrition severity in our cohort confirms the utility of these simple bedside measurements for routine clinical monitoring [6,11,12].

Our study also highlighted the pivotal role of clinical pharmacists in the nutritional management of hemodialysis patients. Clinical pharmacists can assess dietary intake, monitor adherence to nutritional supplements, provide individualized counseling, and collaborate with multidisciplinary teams to optimize patient outcomes [4,13]. Studies have shown that pharmacist-led interventions improve adherence, nutritional markers, and overall quality of life in hemodialysis populations [4,13]. In this context, the integration of clinical pharmacy services into dialysis centers is essential to address protein-energy wasting, implement guideline-directed nutritional strategies, and mitigate complications associated with malnutrition [5,8].

The observed associations between demographic factors and nutritional parameters also provide important clinical insights. Older age was associated with lower muscle strength, highlighting the need for age-specific interventions including resistance training and protein supplementation [7,9]. Gender differences were primarily noted in HGS, with males exhibiting higher grip strength, reflecting expected physiological variations [10]. These findings support the necessity of personalized nutritional assessment that considers age, gender, and functional status rather than relying solely on BMI.

Our results underscore the multifactorial etiology of malnutrition in hemodialysis patients, involving inadequate dietary intake, metabolic derangements, inflammation, and comorbid conditions [1,8,9,15]. Implementation of structured screening, using tools such as TSFT, MAMC, BMI, and HGS, combined with pharmacist-led counseling, may facilitate early identification and targeted intervention for at-risk patients. This proactive approach aligns with international recommendations and supports the integration of clinical pharmacists as key contributors to multidisciplinary renal care teams [4,13,20].

Conclusion

Malnutrition is prevalent among hemodialysis patients, with age and reduced muscle strength serving as key determinants. Anthropometric and functional measurements, including TSFT, MAMC, and HGS, provide reliable indicators of nutritional status. Clinical pharmacists play a crucial role in identifying at-risk patients, optimizing dietary interventions, and improving adherence to nutritional recommendations. Integrating pharmacist-led nutritional care into dialysis programs may substantially improve patient outcomes and reduce complications associated with protein-energy wasting.

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Conflict of Interest

The authors declare no conflicts of interest related to this study.

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