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Prevalence of protein energy wasting among hemodialysis dependent patients: A Single Center Study

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ABSTRACT

Protein Energy Wasting (PEW) is common among hemodialysis patients and detecting it early is crucial for enhancing the prognosis and their quality of life (QOL). Additionally, end-stage renal disease (ESRD) negatively affects QOL. Conducting a thorough assessment of QOL can serve as a valuable tool in enhancing the overall healthcare experience for these individuals**.** This study aims to determine the prevalence of PEW and measure the QOL of patients receiving maintenance hemodialysis. The current research was conducted on 53 patients at the dialysis unit at Theodor Bilharz Research Institute (TBRI) Hospital. Data collection was done using a structured questionnaire including socio-demographic data, short medical history, dietary intake, anthropometric measurements, and SF-12 questionnaire. The results indicated that PEW affects 24.5% of patients on maintenance hemodialysis and there was a significant positive correlation between Body Mass Index (BMI) with Mid Arm Muscle Circumference (MAMC) and Triceps Skin Fold Thickness (TST). A sizable portion of patients had a general decline in their nutritional intake, and their eating habits did not align with guidelines related to their state of health. The majority of patients experienced average QOL, with a greater emphasis on the physical and mental aspects. In conclusion, the anthropometric measurements used in determining nutritional status must be reevaluated and adjusted. This study emphasizes the negative impacts of dialysis on patients' QOL and suggests monitoring and counseling for dietary and psychological issues as well as better patient data recording to improve the standard of care provided.

Keywords: Hemodialysis, Protein Energy Wasting, quality of life, dietary pattern, anthropometry.

INTRODUCTION

Chronic kidney disease (CKD) is the tenth greatest cause of morbidity and mortality globally, with a prevalence rate ranging from 5% to 15%. The incidence of end-stage renal disease (ESRD) patients requiring dialysis is also on the rise (Ke *et al*., 2022). In Egypt, the most current estimate of dialysis prevalence was 0.61 per 1000 people in 2019 with an incidence estimate of 0.192 per 1000 people. The most common causes of ESRD among dialysis patients were hypertension, diabetes, and glomerulo-nephritis (Farag and El-Sayed, 2022).

Several factors contribute to higher mortality rates in hemodialysis (HD) patients

with cardiovascular disease being the most significant risk factor. Additionally, malnutrition is an important non-cardiovascular risk factor associated with mortality in HD patients (Ghorbani *et al*., 2020). Malnutrition is a prevalent issue among patients with ESRD and it involves inadequate or excessive intake of macronutrients such as proteins, carbohydrates, and fats as well as specific micronutrients that are essential for proper tissue functioning (Zaky *et al*., 2019). The development of malnutrition in HD patients is influenced by multiple factors including insufficient food intake due to loss of appetite and changes in taste perception, concurrent illnesses, heightened catabolism and diminished anabolism, the dialysis process itself, chronic inflammation, and endocrine disorders caused by uremia (Zaky *et al.,* 2019).

The combination of malnutrition and inflammation, known as protein-energy wasting (PEW) is a prevalent condition in patients with chronic kidney disease (CKD). Current understanding suggests that PEW involves inflammation, insulin resistance, oxidative stress, hormone dysregulation, and metabolic acidosis as physiological factors contribute to an imbalance between protein synthesis and breakdown, resulting in malnutrition and muscle wasting in CKD patients (Chen *et al*., 2022). ESRD has also a detrimental effect on the quality of life of patients, impacting their social, financial, and psychological well-being. In addition to the physical, functional, metabolic, and social implications, the disease can also harm patient body image and overall QOL (Zazzeroni *et al*., 2017).

The careful assessment of QOL can guide us to improve dialysis outcomes in HD patients, thus helping them adapt to physical limitations, lifestyle changes, and medical interventions rather than disease eradication that in turn will enhance laboratory values, cognitive and emotional functioning, reduced mortality and hospitalization rates, improved treatment adherence (Tayea *et al*., 2022).

Clinical assessment - with the aid of Subjective Global Assessment (SGA) and malnutrition inflammation score (MIS) - is used to detect gastrointestinal symptoms, comorbidities, subcutaneous fat analysis, and muscle wasting (Rahman *et al*., 2022). Biochemical assessment includes serum albumin, urea, creatinine, calcium, phosphorus, total cholesterol, and triglyceride (TG) (Kalantar-Zadeh *et al.,* 2001).

Anthropometric assessment includes simple non-invasive tests (total body fat, regional fat distribution, protein stores, body mass index (BMI), triceps skinfold thickness (TST), mid-arm circumference (MAC), mid-arm muscle circumference (MAMC), calf circumference (CC), handgrip strength (HGS). Dietary assessment occurs using 24-hour recall (capturing detailed descriptions of all foods and beverages consumed over 24 hours) and food frequency questionnaire (the habitual dietary intake often in the past year) (Dao et al., 2019).

This work aims to assess the prevalence of PEW among hemodialysis patients by studying the factors affecting PEW as an indicator of quality of life among the studied group such as socioeconomic status, duration of dialysis, and associated medical conditions.

PATIENTS AND METHODS

Patients

This descriptive, cross-sectional design was conducted on 53 hemodialysis (HD) patients at the Dialysis Unit-Nephrology Department, Theodor Bilharz Research Institute (including all patients attending TBRI for maintenance hemodialysis during the study period from April 2022 to December 2023). Inclusion criteria were patients on regular HD (not less

than 3 months), patients over 18 years, and both genders. Exclusion criteria were patients with pre-existing gastrointestinal inflammatory diseases, the presence of acute infection, and pregnancy.

Methods

Data Collection:

(1) Socio-Demographic data as age, gender, marital status, residence, occupation, and education level,

(2) Short history of patient health including duration of dialysis, number of dialysis sessions per week, and history of any chronic diseases such as Diabetes Mellitus, hypertension, heart diseases, lung diseases, or cancer,

(3) Dietary intake including frequency of consumption of food items per week and amount per one time (green, cooked vegetables, fruits, meat, chicken, fish, legumes as beans and lentils, starch like bread, rice, pasta, and potatoes), amount of water, fruit juices, soft and warm drinks per day,

(4) Functional Capacity including their movement, feeling tired or difficulty with activities or completely bed/chair ridden.

Anthropometric Measurements:

1) Triceps skin fold thickness (TST) using a conventional skin caliper during dialysis sessions to assess fat mass (Izuora *et al*., 2013)
2) Mid upper arm muscle circumference (MAMC) and Mid arm circumference (MAC) was measured using a plastic tape on non-access arm (Center for health statistics, 2016).

Quality of life of the studied patients (QOL):

This was measured using a modified short form-12 (SF-12). It was a structured questionnaire of 12 items and included 8 dimensions (Pakpour*et al.,* 2011)**;**

1) General rating of health (overall health status),
2) Physical function (performance of moderate activities such as moving table or chair, using a vacuum cleaner, climbing one floor or more),
3) Work/Productivity limitations and physical health (any limitations in their work or regular daily activities through last month due to physical health issues),
4) Work/Productivity limitations and emotional health (limitations in their work or regular daily activities through last month due to emotional problems),
5) Feeling of pain,
6) Mental Health (state of calmness and feelings of being downhearted or blue during the last month),
7) Vitality (state of energy levels through last month),
8) Social Activities.

After the end of the dialysis session, the following measures were taken:

1) Dry weight (following the completion of each dialysis session), and
2) Body Mass Index (BMI) (Kg/M^2) which was calculated by dividing dry weight by square height in meters.

Statistical Analysis

SPSS software version 23 was used for statistical analysis (IBM Corporation, Armonk, New York, USA). Simple frequencies were used for data checking. Descriptive statistics were used for data summarization. Analytical statistics were used to find relations between variables. *p*-value < 0.05 was considered.

Ethical approval

The protocol of this study was approved by the Institutional Review Board (IRB) of Theodor Bilharz Research Institute. The human subject's study was enrolled according to REC-TBRI's ethical standards and the 1964 Helsinki Declaration. Written

informed consent forms were obtained from all participants.

RESULTS

The socio-demographic characteristics of patients:

58.5% were Males, 15.1% were single, 92.4% lived at Giza.

Age ranged from 19 to 78 years with mean age of 54.3±15.6 years.

About one-quarter (26.4%) was on dialysis for more than 10 years and 24.5% have PEW depending on their BMI (BMI less than 23 km/m^2).

Biochemical profile of patients:

As shown in Table (1).

Table 1: Biochemical profile of studied patients

Parameter	Mean ± SD
Hb (g/dl)	9.0 ± 0.9
Serum Calcium (mg/dl)	7.7 ± 0.8
Serum Phosphate (mg/dl)	5.6 ± 0.7
Blood urea (mg/dl)	131.7 ± 25.2
Serum Creatinine (mg/dl)	7.4 ± 1.5
Creatinine Clearance (ml/min)	17.7 ± 0.7
Albumin (mg/dl)	3.3 ± 0.2
Cholesterol (mg/dl)	256.05 ± 24.04
High-density lipoprotein (HDL) (mg/dl)	20.4 ±4.72
Low-density lipoprotein (LDL) (mg/dl)	179.3 ± 21.89

Anthropometric measurements:

It was obvious from Table (2) the presence of high significant positive correlation between BMI and TST (r=0.671, *p*-value <0.001) and BMI and MAMC (r=0.424, *p*-value =0.002).

Table 2: Correlations between anthropometric measurements.

Parameter	BMI		TST		MAMC	
	r	*p*-value	r	*p*-value	r	*p*-value
BMI			0.671	<.001	0.424	0.002
TST	0.671	<.001			0.163	0.244
MAMC	0.424	0.002	0.163	0.244		

*Correlation is significant at the 0.01 level.

BMI, body mass index; TST, triceps skinfold thickness; MAC, mid-arm circumference.

In the current study, about 33.2% of participants had moderate fat depletion while 69.8 % had moderate muscle depletion (Table 3).

The protein-energy wasting (PEW):

There was no statistically significant relationship was detected between the general rating of health and the presence of PEW (*p*-value =0.819) (Table 4). Also, no significant relationship was detected between the presence of PEW and components of physical health (*p*-value =0.455, 0.805) (Table 5), mental health (*p*-value =0.611) (Table 6), pain (*p*-value =0.453) (Table 7), feeling having a lot of energy last month (*p*-value =0.218) (Table 8), decrease of social activities (*p*-value =0.092) (Table 9).

Table 3: Associations between PEW and components of modified SF-12

PEW / General rating of health	Total number	Yes	No	*p*-value
		no. (%)	no. (%)	
Good	35	9 (25.7)	26 (74.3)	
Bad	18	4 (22.2)	14 (77.8)	0.819
Total	53	13 (24.5)	40 (75.5)	

PEW, protein-energy wasting.

Table 4. Relation between PEW and patient physical health.

PEW / Physical health	Total number	Yes	No	*p*-value
		no. (%)	no. (%)	
Ability to move a table or chair or push a vacuum cleaner				
Yes, I can	37	8 (21.6)	29 (78.4)	0.455
No, I cannot	16	5 (31.3)	11 (68.7)	
Total	53	13 (24.5)	40 (75.5)	
Ability to climb several flights of stairs				
Yes, I can	48	12 (25)	36 (75)	0.805
No, I cannot	5	1 (20)	4 (80)	
Total	53	13 (24.5)	40 (75.5)	

Table 5: Relation between PEW and patient mental health.

PEW / Mental health	Total number	Yes	No	*p*-value
		no. (%)	no. (%)	
Doing things less carefully than usual				
Yes	10	2 (20)	8 (80)	
No	32	8 (25)	24 (75)	
No any effort	8	3 (37.5)	5 (62.5)	
Undecided	3	0 (0)	3 (100)	0.611
Total	**53**	**13 (24.5)**	**40 (75.5)**	

Table 6: Relation between PEW and the presence of pain.

PEW / Pain	Total number	Yes	No	*p*-value
		no. (%)	no. (%)	
Yes	32	9 (28.1)	23 (71.9)	0.453
No	21	4 (19)	17 (81)	
Total	53	13 (24.5)	40 (75.5)	

Table 7: Relation between PEW and feeling having a lot of energy last month.

PEW / Feeling having a lot of energy last month	Total number	Yes	No	*p*-value
		no. (%)	no. (%)	
Yes	4	2 (50)	2 (50)	0.218
No	22	11 (22.4)	38 (77.6)	
Total	53	13 (24.5)	40 (75.5)	

Table 8: Relation between PEW and decrease of social activities

PEW / Decrease of social activities	Total number	Yes	No	*p*-value
		no. (%)	no. (%)	
Yes	31	5 (16.1)	26 (83.9)	0.092
No	22	8 (36.4)	14 (63.6)	
Total	53	13 (24.5)	40 (75.5)	

Table 9: Anthropometric measurements of studied participants (n=53).

Anthropometric measurements	no. (%)
Triceps Skin Fold Thickness (TST)	
Adequate fat reserve	35 (66)
Moderate fat depletion	16 (33.2)
Severe fat depletion	2 (3.8)
Mid Upper Arm Muscle Circumference (MAMC)	
Adequate muscle reserve	16 (30.2)
Moderate muscle depletion	37 (69.8)
Severe muscle depletion	0

Quality of life of the studied patients (QOL):

Table (10) shows no statistically significant change between dry weight collected on the day of data collection and 1 month ago (*p*-value=0.93), 2 months ago (*p*-value =0.43), or between dry weight 1 and 2 months ago (*p*-value =0.57). Table (11) shows the components of SF-12 and Table (12) illustrates the Functional capacity of participants.

Table 10: Dry weight changes (at day of data collection, 1 month and 2 months ago)

	Mean ± SD	*p*-value
Dry weight at day of data collection &one month ago	0.011±0.837	0.931
Dry weight at day of data collection&2 months ago	-0.111±0.935	0.430
Dry weight one &two months ago	-0.098±1.143	0.565

Table 11: Components of QOL of studied participants using modified SF-12

Quality of life	no.(%)
General rating of health	
Good	35 (66)
Bad	18 (34)
Physical function	
Ability to move a table or chair or push a vacuum cleaner	
Yes, I can	37 (69.8)
No, I cannot	16 (30.2)
Ability to climb several flights of stairs	
Yes, I can	48 (90.6)
No, I cannot	5 (9.4)
Role physical and emotional (through last month)	
Amount of work	
The same	16 (30.2)
Decreased	37 (69.8)
Doing all things required or limited to one kind of work	
Doing all things required	11 (20.8)
Limited to one kind of work	29 (54.7)
No any effort	12 (22.6)
Undecided	1 (1.9)
Doing work less carefully than usual	
Yes	32 (60.4)
No	10 (18.9)
No, any effort	8 (15.1)
Undecided	3 (5.7)
The feeling of pain (last month)	
Yes	32 (60.4)
No	21 (39.6)
Mental health (last month)	
Number of times of felt calm and peaceful	43 (81.1)
Yes	9 (17)
No	1 (1.9)
Undecided	
Number of times of feeling breakdown or blue	
Yes	30 (56.6)
No	23 (43.4)
Vitality (last month)	
Number of times of feeling have a lot of energy	
Yes	49 (92.5)
No	4 (7.5)
Social Function	
Decrease of social activities	
Yes	31 (58.5)
No	22 (41.5)

Table 12: Functional capacity of participants (no.=53)

Functional capacity	no. (%)
Normal movement/feeling completely normal No	43 (81.8)
Difficulty in movement / feeling tired frequently Yes	43 (81.8)
Difficulty in going to bathroom/taking shower & wearing clothes independently Yes	4 (7.5)
Bed or chair-ridden Yes	2 (3.8)

DISCUSSION

PEW refers to the depletion of protein and energy stores commonly observed in the advanced stages of CKD. It is highly prevalent among patients undergoing chronic dialysis (Sabatino *et al*., 2017). Early detection is crucial as it enables timely and comprehensive nutritional support, effective management, and prevention of the detrimental clinical consequences associated with PEW.

The study relied on BMI as a marker for diagnosing PEW, following the recommendation of international society of renal nutrition and metabolism (ISRNM) that a BMI below 23 kg/m^2 is a marker of PEW (Fouque *et al*., 2008). The prevalence of PEW in the present study was found to be 24.5%. It is important to consider that variations in methodologies, sample sizes, participant characteristics, and diagnostic criteria among different studies can contribute to discrepancies in reported prevalence rates. In current study, the mean age of the participants was 54.3±15.6 years and the majority within the age range of 50-65 years, with 28.3% of studied patients above 65 years. This finding suggests that ESRD becomes more prevalent with advanced age, this could be attributed to the provision of better-quality services at the dialysis unit at TBRI and an increase in life expectancy among these individuals. Contrary to the present results, a study conducted by Kane *et al*., (2019) reported that their studied patients were in the age between 14-43 years, this is poor life style with accelerated progression of risk factors such as high blood pressure and diabetes.

In the present study, a male predominance (58.5%) was observed among the studied patients. This may be attributed to higher prevalence of unhealthy habits like smoking or alcohol consumption. These lifestyle choices can increase the risk factors for conditions like hypertension and diabetes, which are the leading causes of ESRD (Tayea *et al.,* 2022). This finding goes with (Sultan *et al*., (2021),mean, while Ali *et al*. (2020) reported that majority of patients in their study were females.

In the present study, it was found that 15.1% of the patients were single. Özdemir *et al*. (2018) found that single patients had higher QOL scores compared to married individuals to the absence of family responsibilities prioritizing their own well-being, which can contribute to a higher QOL and less stress, strain on relationships.

Regarding the working status of the participants, about one quarter of them (24.5%) were not employed, as they had stopped working due to physical inabilities after starting dialysis. This is consistent with

Abozead *et al*., (2017) and Sembajwe *et al*., (2023). The study suggested that working patients may be less focused on their illnesses due to being busy and distracted at work. They may spend most of their time with colleagues or engage in social activities, which can help them cope with depression more easily. Additionally, having economic stability and the ability to work can positively affect QOL.

Regarding the duration of dialysis, (26.4%) had been on dialysis for more than 10 years. This group requires special care as they are at a higher risk of malnutrition and PEW if not adequately assessed and monitored. These findings highlight the importance of considering factors such as residency, employment status, and the duration of dialysis in understanding the characteristics and needs of patients with end-stage renal disease.

In the present study, it was found that more than half of the participants (56.6%) had co-morbidities, mostly with hypertension (47.2%), followed by diabetes mellitus (17%). This was consistent with El-Zorkany (2017).These findings emphasize the importance of raising awareness about the screening and management of diabetes and hypertension.

The present study revealed a high significant positive correlation between BMI with both TST and MAMC. These anthropometric measurements, when combined, can be effective in diagnosing PEW and malnutrition in patients undergoing maintenance hemodialysis. These findings align with (Yigit, 2016). However, it is important to note that BMI does not differentiate between muscle and fat mass or provide information about body fat distribution. Despite this, a higher BMI has been associated with better outcomes in hemodialysis patients. Kane *et al*. (2019) concluded that underweight hemodialysis patients with low BMI (<18.5 kg/m2) had a higher mortality hazard ratio compared to the overweight group (BMI > 25.0 kg/m^2) Sultan *et al*., (2021).

Regarding correlations between PEW and QOL components, there was no statistically significant correlation found. This could be attributed to small number of our studied patients, the low proportion of PEW among them or the average QOL of them. In terms of dietary intake, around (41.5%) reported a decline because to anorexia, appetite loss, or dietary limitations. Moreover, more than half of them (54.7%) consumed low levels of fresh fruits and vegetables according to the advice given to these patients to discourage the consumption of fruits and vegetables due to concerns about potentially exacerbating hyperkalemia (Saglimbene *et al*., 2019).

It was found that a diet rich in polyphenols (micronutrients exclusively obtained from plant-based sources) in patients undergoing hemodialysis yielded significant improvements in diastolic blood pressure, triglyceride levels, and myeloperoxidase levels. Additionally, the supplementation of fiber was found to have a significant effect on reducing total cholesterol and inflammatory markers which are recognized as cardiovascular risk factors (Dupuis *et al*., 2021).

In the present study, the participants displayed low intake of both animal and plant protein per week (88.7%). This decrease in animal protein intake is not recommended for patients on maintenance hemodialysis and can contribute to PEW. The recently released Clinical Practice Guideline for Nutrition in CKD by the National Kidney Foundation's Kidney Disease Outcome Quality Initiative recommends a protein intake of 1.0-1.2 grams per kilogram of body weight per day for metabolically stable patients on maintenance dialysis (Ikizler *et al*., 2020).

It is important to note that functional capacity can be affected in patients with

ESRD undergoing hemodialysis. These patients commonly experience a decline in their functional capacity, with a significant reduction in peak oxygen uptake compared to healthy individuals. This decline is influenced by factors such as uremic myopathy, anemia, cardiovascular abnormalities, and other comorbidities associated with ESRD (Garcia *et al*., 2017).

This study was limited by the relatively small number of participants, missed some data in their files, the inability to take the anthropometric measures due to participants physical limitations, and absence of participants in some dialysis sessions.

CONCLUSION

This study emphasizes the significance of anthropometric measurements in the assessment of nutritional status as they are simple, non-invasive, and cost-effective methods. The current study suggests that the dietary patterns of most patients should be reassessed and overseen by a specialized nutritionist. This approach can assist patients in meeting their specific dietary requirements adequately, thus minimizing the risk of malnutrition and its associated complications.

It was recommended to improve the recording of clinical, nursing, and nutritional data of hemodialysis patients records, raising awareness about risk factors of CKD through regular screening for hypertension and diabetes, especially for individuals in their middle years to identify and manage these risk factors at an early stage to prevent and/ or delay the development of ESRD.

Further research is needed to better understand the underlying factors contributing to variations in the prevalence of PEW and to establish more consistent and universally applicable criteria for assessing PEW in patients undergoing dialysis.

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انتشار فقد طاقة البروتين بين المرضى المعتمدين على غسيل الكلى: دراسة فى مركز واحد

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المستخلص

يعد إهدار طاقة البروتين أمرًا شائعًا بين مرضى غسيل الكلى. كما يعد اكتشافه مبكرًا أمرًا بالغ الأهمية لتعزيز التشخيص ونوعية الحياة لهؤلاء المرضى. بالإضافة إلى ذلك، يؤثر مرض الكلى في مراحله النهائيى سلبًا على جودة الحياة. ولذلك يمكن أن يكون إجراء تقييم شامل لجودة الحياة بمثابة أداة قيمة في تعزيز تجربة الرعاية الصحية الشاملة لهؤلاء الأفراد. تهدف هذه الدراسة إلى تحديد مدى انتشار اهدار طاقة البروتين و تأثيره على جودة الحياة للمرضى الذين يتلقون غسيل الكلى. أجريت الدراسة على 53 مريضا في وحدة غسيل الكلى في مستشفى معهد تيودور بلهارس للأبحاث. تم جمع البيانات باستخدام استبيان منظم يتضمن البيانات الاجتماعية والديموغرافية، والتاريخ الطبي القصير، والمدخول الغذائي، والقياسات البشرية، واستبيان SF-12 . أوضحت النتائج ان اهدار طاقة البروتين يؤثر على 24.5% من المرضى الذين يخضعون لغسيل الكلى مع وجود علاقة إيجابية كبيرة بين مؤشر كتلة الجسم ومحيط عضلات منتصف الذراع وسمك طيات جلد العضلة ثلاثية الرؤوس. وكان جزء كبير من المرضى يعانون من انخفاض عام في تناولهم الغذائي، ولم تتماشى عاداتهم الغذائية مع المبادئ التوجيهية المتعلقة بحالتهم الصحية. كما وجد أن غالبية المرضى من متوسط جودة الحياة، مع التركيز بشكل أكبر على الجوانب الجسدية والعقلية. وعن طريق استخدام القياسات الجسمية في تحديد حالة التغذية توصى الدراسة بإعادة من الام تقييم وتعديل عادات التغذية لدى معظم المرضى وتؤكد الدراسة ان الآثار السلبية لغسيل الكلى تؤثر على جودة حياة المرضى وتقترح المراقبة والمشورة بشأن المشكلات الغذائية والنفسية بالإضافة إلى تسجيل بيانات المريض بشكل أفضل لتحسين مستوى الرعاية المقدمة.