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Interdialytic weight gain and associated factors in patients undergoing hemodialysis treatment

Ganho de peso interdialítico e fatores associados em pacientes em tratamento hemodialítico

Abstract

Objective: Estimate the prevalence of interdialytic weight gain (IDWG) and assess its correlation with sociodemographic, anthropometric, clinical, and biochemical indicators in patients undergoing hemodialysis. ***Methods***: A cross-sectional study was carried out with adult and elderly patients of both sexes referred to a hemodialysis center. Data collection consisted of the application of a structured questionnaire, measurement of anthropometric parameters, and analysis of medical records. Associations between variables were assessed using simple and multiple linear regression models. Data analysis was performed using Stata 13.1 software. ***Results***: A total of 123 patients were evaluated, the majority of which were male (63.4%), aged over 40 years (66.6%), and of low socioeconomic status (50.4%). The prevalence of excessive IDWG among study participants was 10.5% and was negatively associated with increased age (β = −0.019; 95% CI: −0.037; −0.006). Positive associations were observed between IDWG and increased waist circumference (β = 0.022; 95% CI: 0.003; 0.041), hemodialysis treatment time (expressed in months) (β = 0.017; 95% CI: 0.009; 0.026), and increased serum creatinine concentration (β = 0.091; 95% CI: 0.016; 0.166). ***Conclusion***: It was found that IDWG was greater in younger patients and was positively associated with waist circumference, hemodialysis treatment time, and serum creatinine concentration. These findings demonstrate the importance of multi-professional interventions to improve the quality of life of patients undergoing hemodialysis.

Keywords: Renal dialysis. Nutritional status. Weight gain.

Resumo

Objetivo: Estimar a prevalência do ganho de peso interdialítico (GPI) e verificar sua correlação com indicadores sociodemográficos, antropométricos, clínicos e bioquímicos em pacientes em tratamento hemodialítico. ***Métodos***: Realizou-se estudo transversal com pacientes adultos e idosos, de ambos os sexos, cadastrados em uma unidade de hemodiálise. A coleta de dados foi realizada a partir da aplicação de questionário estruturado, aferição de medidas antropométricas e análise dos prontuários. As associações entre as variáveis foram verificadas utilizando-se modelos de regressão linear simples e múltipla. A análise dos dados foi realizada com o auxílio do *software* Stata 13.1. ***Resultados***: Foram avaliados 123 pacientes, com predominância do sexo masculino (63,4%), faixa etária superior a 40 anos (66,6%) e nível socioeconômico baixo (50,4%). A prevalência de GPI excessivo entre os participantes do estudo foi de 10,5% e associou-se de forma negativa com o aumento da idade (β= -0,019; 95% IC: -0,037; -0,006). Foram observadas associações positivas entre o GPI e

o aumento da circunferência da cintura (β= 0,022; 95% IC: 0,003; 0,041), o tempo de hemodiálise dado em meses (β= 0,017; 95% IC: 0,009; 0,026) e o aumento da concentração sérica de creatinina (β= 0,091; 95% IC: 0,016; 0,166). *Conclusão*: Constatou-se que o GPI foi maior em pacientes mais jovens e se associou de forma positiva à circunferência da cintura, ao tempo em hemodiálise e à concentração sérica de creatinina. Esses achados demonstram a importância de intervenções multiprofissionais para que pacientes submetidos à hemodiálise apresentem melhor qualidade de vida.

Palavras-chave: Diálise Renal. Estado Nutricional. Ganho de Peso.

INTRODUCTION

Chronic kidney disease (CKD) is associated with high morbidity and mortality, which increase with progression to end-stage kidney disease. CKD complications include cardiovascular disease, premature death, cancers, cognitive decline, anemia, and bone disorders.[1,2] Early diagnosis can prevent disease aggravation; however, late diagnosis may lead to the need for dialysis or transplantation.[3,4] Reduction of renal function and indication for hemodialysis impart important changes to patients' life habits, such as daily use of medication and control of food and water intake.[5]

Adherence to adequate fluid intake is usually measured by interdialytic weight gain (IDWG).[6] According to the Clinical Practice Guideline for Hemodialysis Adequacy,[7] the IDWG should be 4.0–4.5% of dry weight at most. Some studies indicate that the mean IDWG is 2.5 to 3.0 kg.[8,9] IDWG is inversely associated with age (the younger the individual, the higher the IDWG), sex (IDWG is directly associated with women), dialysis time, and nutritional status (when individuals present some degree of malnutrition).[6] Research has shown that IDWG values greater than 4% in combination with malnutrition may indicate a poor prognosis, requiring a specific approach in clinical practice for possible improvement in results.[5,10]

Excessive IDWG is associated with risk factors for all-cause mortality, as well as cardiovascular and respiratory complications and increased morbidity.[10-12] Furthermore, high IDWG has a secondary association with excessive fluid and/or food intake.[10]

Given the above, it is relevant to identify whether factors that were previously related to IDWG in the literature are repeated in this sample unit for the proposal of actions that may improve the quality of life of patients. This study aimed to estimate the prevalence of IDWG and assess its correlation with sociodemographic, anthropometric, clinical, and biochemical indicators in patients undergoing hemodialysis treatment.

Methods

Study design

This is a cross-sectional study conducted in a hemodialysis center in western Bahia State, Brazil.

Population and sample

The study included a convenience sample of 123 patients of both sexes undergoing hemodialysis treatment on a thrice-weekly regimen, with each session lasting between 3.5 and 4 h. All patients who met the inclusion criteria were invited to participate in the study.

Inclusion criteria were age equal to or greater than 18 years, being registered in the center, and undergoing chronic hemodialysis treatment. There was no limit for treatment duration. Pregnant individuals, patients who were unable to respond to the questionnaire, and those unable to perform anthropometric or body composition measurements were excluded from the study.

Procedures

The research project was approved by the Human Research Ethics Committee at the Federal University of Western Bahia, Brazil (protocol no. 3,838,122). Data were collected from June 2018 to December 2019 through application of a structured questionnaire containing sociodemographic questions, measurement of anthropometric and body composition parameters, and analysis of clinical and biochemical information from medical records. All stages of data collection were performed by trained individuals after patients had signed an informed consent form.

The following sociodemographic variables were collected: sex, (dichotomized as male and female), marital status (categorized into married/partnered and single/divorced/separated/widowed), age (expressed in completed years and categorized into less than 40 years and equal to or more than 40 years), level of education (categorized into illiterate, primary education, and secondary education/vocational school/higher education), and socioeconomic status. Socioeconomic status was assessed according to criteria from the Brazilian Association of Research Companies (ABEP)[13] and classified into socioeconomic classes A and B (high), C (middle), and D and E (low), based on the purchasing power of goods and services and allow assigning a socioeconomic score to each individual.[13]

Anthropometric and body composition variables were measured after a hemodialysis session. Dry weight was measured with a portable digital electronic scale (TANITA®, model BF683W, maximum capacity of 150 kg, sensitivity of 50 g). Height was measured with a fixed stadiometer (WELMY®, model W300, maximum length of 2.5 m, resolution of 0.1 cm). The body mass index (BMI) was calculated as the ratio of dry weight in kilograms to height in meters squared.[14]

IDWG was calculated as the difference between pre-hemodialysis weight and post-hemodialysis weight. An IDWG ≤ 2.5 kg was considered acceptable.[15]

Circumference measurements were taken in triplicate with a flexible and inelastic tape measure (Sanny®, São Paulo, Brazil) divided into centimeters. Waist circumference was measured at the midpoint between the iliac crest and the last rib. Patients were instructed to breathe in a relaxed manner, let their arms hang loose at their sides, stand with their feet together, and distribute their weight evenly on both feet.[16] Neck circumference was measured just below the laryngeal prominence, with the head in the Frankfurt plane. Arm circumference was measured at the midpoint between the acromion and olecranon.

Body fat percentage was estimated by electrical bioimpedance (A-310, Biodynamics Corporation, USA). For body composition assessment, patients were asked to remove any metal objects and lie down. Electrodes were placed on the hands and feet.

Hand grip strength was measured on the side opposite to the arteriovenous fistula after a hemodialysis session. Measurements were taken in triplicate using a hydraulic dynamometer (SAEHAN®, model SH5001, Saehan Corporation). Patients were instructed to sit with the arm adducted and the elbow flexed at 90º, without any support.[17]

Clinical variables, including hemodialysis treatment time (in months) and serum albumin, creatinine, and pre-dialysis urea levels, were obtained from medical records.

Statistical analysis

Normality of distribution was assessed by the Shapiro–Wilk test. Results are presented as absolute and relative frequencies, mean, standard deviation, and range. Associations between independent variables and IDWG were analyzed using linear regression models. Variables with $p < 0.20$ in the bivariate analysis were considered for the construction of a multiple linear model, and those with $p < 0.05$ were retained. Analyses were performed using Stata version 13.1.

RESULTS

Of the patients included in this study (n = 123), 63.4% were male, 63.4% reported being married or having a partner, 66.7% were aged 40 years or older (46.8 ± 14.2 years), 55.3% reported having completed elementary school, and 50.5% had low socioeconomic status (Table 1).

Table 1. Sociodemographic characteristics of patients referred to a hemodialysis center in western Bahia State, Brazil, 2020.

Variable	*n*	%
Sex		
Male	78	63.4
Female	45	36.6
Marital status		
Married/partnered	78	63.4
Single/divorced/separated/widowed	45	36.6
Age group (years)		
<40	41	33.3
≥40	82	66.7
Level of education		
Illiterate	11	8.9
Primary education	68	55.3
Secondary education/vocational school/higher education	44	35.8
Socioeconomic status		
High (A and B)	11	8.9
Middle (C)	50	40.6
Low (D and E)	61	50.5

Socioeconomic status was defined according to ABEP.[13]

The mean IDWG was 2.5 ± 1.3 kg. The prevalence of excessive IDWG among study participants was 10.5%.

Table 2 shows the mean, standard deviation, and range of anthropometric, body composition, clinical, and biochemical data of study participants. The mean BMI was 24.0 ± 5.0 kg/m^2, arm circumference was 29.0 ± 5.1 cm, neck circumference was 36.1 ± 3.7 cm, and waist circumference was 87.5 ± 13.0 cm. The mean body fat percentage of hemodialysis patients was 25.6 ± 11.4%, and the mean hand grip strength was 29.5 ± 20.3 kg. The mean hemodialysis treatment time was 25.6 ± 38.7 months. The mean serum albumin level was 3.5 ± 0.6 mg/dL; serum creatinine level, 8.2 ± 3.3 mg/dL; and pre-dialysis urea level, 155.9 ± 47.4 mg/dL.

Table 2. Anthropometric, body composition, clinical, and biochemical characteristics of patients with chronic kidney disease undergoing hemodialysis in western Bahia, Brazil, 2020.

Item	Female patients		Male patients		Total		Range
	Mean	SD	Mean	SD	Mean	SD	P_{25}; P_{75}
Interdialytic weight gain (kg)	2.4	1.2	2.5	1.2	2.5	1.3	1.5; 3.4
Body mass index (kg/m^2)	25.2	6.2	23.4	4.2	24.0	5.0	20.7; 27.5
Arm circumference (cm)	30.0	6.1	28.5	4.5	29.0	5.1	25.0; 32.5
Neck circumference (cm)	33.8	2.9	37.6	3.5	36.1	3.7	34.0; 38.0
Waist circumference (cm)	89.3	14.5	86.5	12.0	87.5	13.0	78.0; 97.0
Body fat (%)	33.4	9.9	21.0	9.5	25.6	11.7	17.0; 32.6
Hand grip strength (kgf)	18.8	11.5	36.0	21.6	29.5	20.3	16.0; 40.0
Hemodialysis treatment time (months)	35.3	51.5	19.9	27.5	25.6	38.7	5.0; 30.0
Serum albumin (mg/dL)	3.4	0.4	3.5	0.6	3.5	0.57	3.2; 3.9
Serum creatinine (mg/dL)	6.9	2.2	9.6	3.5	8.2	3.0	6.0; 10.0
Pre-dialysis serum urea (mg/dL)	150.0	44.7	156.5	49.1	155.9	47.4	127.0; 189.0

SD, standard deviation; P_{25}, 25th percentile; P_{75}, 75th percentile

Table 3 shows the determinants of IDWG, as assessed by simple and multiple linear regression analysis. Negative associations were found between patients with higher IDWG and older age, revealing that the younger the age, the greater the IDWG ($p = 0.042$). Positive associations were observed between high IDWG and high waist circumference ($p = 0.019$), hemodialysis treatment time ($p < 0.001$), and serum creatinine concentration ($p = 0.017$).

Table 3. Simple and multiple linear regression coefficients, confidence intervals, and *p*-values for interdialytic weight gain in patients with chronic kidney disease in western Bahia State, Brazil, 2020

Variable	β	95% CI	*p*	Adj. β	95% CI	*p*
Age (years)	−0.019	−0.035; 0.003	0.015	−0.019	−0.037; −0.006	0.042
Marital status	−0.402	−0.865; 0.061	0.088			
Level of education	0.034	−0.334; 0.403	0.853			
Socioeconomic status	0.179	−0.176; 0.535	0.321			
Body mass index (kg/m^2)	0.002	−0.041; 0.047	0.907			
Arm circumference (cm)	0.063	0.020; 0.106	0.004			
Neck circumference (cm)	0.044	−0.017; 0.106	0.154			
Waist circumference (cm)	0.013	−0.004; 0.030	0.130	0.022	0.003; 0.041	0.019
Body fat (%)	−0.017	−0.037; 0.002	0.083			
Hand grip strength (kgf)	0.001	−0.009; 0.012	0.790			
Hemodialysis treatment time (months)	0.006	0.005; 0.012	0.032	0.017	0.009; 0.026	<0.001
Serum albumin (mg/dL)	0.270	−0.160; 0.701	0.216			
Serum creatinine (mg/dL)	0.115	0.036; 0.193	0.005	0.091	0.016; 0.166	0.017
Pre-dialysis serum urea (mg/dL)	0.004	−0.004; 0.009	0.074			

CI, confidence interval; β, beta coefficient from simple linear regression; adj. β, adjusted beta coefficient; *p*, *p*-value from multiple linear regression analysis at $p \leq 0.05$. Variables were adjusted for each other in the final model.

DISCUSSION

In the present study, it was found that IDWG was negatively associated with age and positively associated with waist circumference, hemodialysis treatment time, and serum creatinine concentration in patients undergoing hemodialysis treatment in western Bahia State, Brazil.

Our findings showed that IDWG was higher in younger patients, in agreement with previous studies. In a cohort of 44,114 patients undergoing dialysis treatment, it was found that an increase in IDWG was directly associated with higher mortality. Furthermore, the authors identified that the younger the age of patients, the higher the IDWG.[18] A prospective cross-sectional study with 134 patients on hemodialysis, lasting five years, also identified that age had an inverse correlation with IDWG.[19] Researchers followed-up 309 patients on hemodialysis for three months and identified that IDWG was lower in older patients.[20]

These findings can be explained by the fact that sensation of thirst decreases with increasing age, resulting from brain dysfunction and decreased osmoreceptor sensitivity in older individuals.[21] However, assessment of water consumption in a given population is subjective and limited, given that consumption levels are not measured accurately; only estimated values can be obtained. Moreover, the metabolic rate of younger individuals influences food and water consumption, which are determining factors for IDWG.[22]

Waist circumference was positively associated with IDWG, demonstrating that individuals with higher visceral or subcutaneous fat tend to have higher IDWG.[23] A meta-analysis with 170,765 patients found that high IDWG values potentiate the occurrence of intradialytic hypotension, a very recurrent complication in patients undergoing hemodialysis, associated with the occurrence of cardiovascular events and mortality.[24] A cross-sectional study with 344 individuals over 18 years of age observed the prevalence of abdominal obesity in more than half of the patients, who were found to follow the general trend of excess abdominal adiposity, as observed in previous epidemiological studies.[14,25] Thus, the presence of excess weight, especially in the abdominal region, increases the risk of complications in patients with CKD.

Another clinical aspect addressed in this study was hemodialysis treatment time, a factor associated with IDWG. It is reported in the literature that, over the years of dialysis treatment, patients tend to have lower diuresis,[26,27] which may directly impact IDWG. Furthermore, patients undergoing hemodialysis find it difficult to maintain nutritional treatment in the long term, directly impacting quality of life, given that treatment is lifelong and dietary restriction is a complementary factor.[28]

Serum creatinine, an important biochemical indicator in CKD, showed a positive association with IDWG. Serum creatinine concentration is related to nutritional status, protein reserves, muscle mass, and dietary intake of protein sources. However, in patients with kidney problems, other factors influence creatinine concentration, such as age, sex, ethnic group, dialysis frequency, and residual renal function. Some studies have shown that low serum creatinine levels are highly predictive of mortality in hemodialysis patients.[29,30]

In a study with 44,114 patients, it was found that reductions in serum creatinine concentrations were associated with lower IDWG. In this same group of patients, it was also identified that reduction in serum pre-albumin and potassium, which were associated with lower IDWG, increased mortality.[18] A study with 309 stable patients on hemodialysis identified a direct correlation of serum creatinine with IDWG.[31] Therefore, it is essential to align nutritional behaviors with the goal of reducing IDWG without, however, causing a negative impact on nutritional status.[22]

Malnourishment is associated with IDWG. Patients experiencing this condition commonly have higher IDWG.[6] Such a finding highlights the need for nutritional education of patients undergoing hemodialysis treatment regarding their dietary restrictions. A reduction in salt intake and sodium-rich foods is crucial to reduce thirst, one of the

strategies for controlling IDWG.[32] Greater integration of a multi-professional team becomes necessary for monitoring and promoting awareness of patients and family members regarding weight gain control, contributing to treatment adherence.

Some limitations of the present study should be highlighted, such as the inclusion of participants with two months of hemodialysis treatment, a phase in which hypervolemia and low treatment efficiency are common, as well as the non-assessment of patients' water consumption. The strengths of this study include the fact that data were collected by a trained team, allowing for minimized inter-individual variability and ensuring greater reliability. This is the first study to identify factors associated with IDWG in patients treated in the western region of Bahia State, Brazil.

CONCLUSION

IDWG was positively associated with clinical (e.g., hemodialysis treatment time and serum creatinine level) and anthropometric (e.g., waist circumference) parameters. IDWG was found to be inversely associated with age.

These findings demonstrate the importance of multi-professional interventions to ensure that patients undergoing hemodialysis have a better quality of life. It is worth noting that survival and mortality in patients on hemodialysis are directly associated with IDWG; more research is needed on associations with sociodemographic and economic factors, given that there are few discussions on the topic in the literature.

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REFERENCES

1. Stevenson JK, Campbell ZC, Webster AC, Chow CK, Tong A, Craig JC, et al. eHealth interventions for people with chronic kidney disease. Cochrane Database Syst Rev 2019; 8(8): CD012379. https://doi.org/10.1002/14651858.
2. Stevens PE, Levin A. Improving Global Outcomes ChronicKidney Disease Guideline Development Work Group M. Evaluation and management of chronic kidney disease: synopsis of the kidney disease: improving global outcomes 2012 clinical practice guideline. Ann Intern Med. 2013; 158: 825-830. https://doi.org/10.7326/0003-4819-158-11-201306040-00007.
3. De Oliveira CM, Dos Santos EBA, Ferreira LR, Bermudez BEBV, Tizzot EA, Júnior CAM. A importância do médico de atenção primária no rastreamento e diagnóstico precoce da doença renal crônica. Rev. Ciênc. Saúde. 2019; 9(2): 4. https://doi.org/10.21876.
4. Peritoneal Dialysis Adequacy 2006 Work Group. Clinical practice guidelines for peritoneal adequacy, update 2006. Am J Kidney Dis 2006; 48: S91-S97. https://doi.org/10.1053/j.ajkd.2006.05.016.
5. Dantas LG, de Seixas Rocha M, Junior JAM, Paschoalin EL, Paschoalin SR, Cruz CMS. Non-adherence to Haemodialysis, Interdialytic weight gain and cardiovascular mortality: a cohort study. BMC nefrology. 2019; 20 (1): 402. https://doi.org/10.5935/0101-2800.20150050.
6. Nerbass FB, Morais JG, Santos RG, Krüger TS, Koene TT, Filho HA. Factors related to interdialytic weight gain in hemodialysis patients. J Bras Nefrol. 2011;33(3):300-305. https://doi.org/10.1590/S0101-28002011000300005.
7. Ikizler TA, Burrowes JD, Byham-Gray LD, Campbell KL, Carrero JJ, Chan W, et al. KDOQI Clinical Practice Guideline for Nutrition in CKD: 2020 Update. Clin J Am Soc Nephrol. 2020; 76(3): S1-S107. https://doi.org/10.1053/j.ajkd.2020.05.006.

8. Campos MIX. Influência dos fatores clínicos, bioquímicos e do consumo alimentar sobre o ganho de peso interdialítico de pacientes submetidos à hemodiálise no município da Vitória de Santo Antão-PE. Vitória de Santo Antão (PE): Universidade Federal de Pernambuco; 2018.

9. Thomé EGDR, Brandolt CDS, Proença CDDC, Breitsameter G. Ganho de peso interdiálise e a relação com o cuidado. In: Semana de Enfermagem; 2019 maio 15 a 17; Hospital de clinicas de Porto Alegre: Escola de enfermagem da UFRGS. Porto Alegre; 2019

10. Brandão HFC, Saraiva MBM, de Sousa BS, de Almeida SS, Souza EDS, Melo HCM, Tomyia MTO. Estado nutricional e sua associação com risco cardiovascular no paciente em tratamento hemodialítico. Brazilian Journal of Development. 2021; 7(2):11712-11728.https://doi.org/10.34117/bjdv7n2-003

11. Bossola M, Pepe G,Vulpio C. The Frustrating Attempt to Limit the Interdialytic Weight Gain in Patients on Chronic Hemodialysis: New Insights Into an Old Problem. J Ren Nutr. 2018; 28(5): 293-30. https://doi.org/10.1053/j.jrn.2018.01.015.

12. Kurita N, Hayashino Y, Yamazaki S, Akizawa T, Akiba T, Saito A, et al. Revisiting interdialytic weight gain and mortality association with sérum albumin interactions: the Japanese dialys is out comesand practice pattern study. J Ren Nutr. 2017; 27(6): 421-429. https://doi.org/10.1053/j.jrn.2017.05.003.

13. Cabrera C, Brunelli SM, Rosenbaum D, Anum E, Ramakrishnan K, Jensen DE, et al. A retrospective, longitudinal study estimating the association between interdialytic weight gain and cardiovascular events and death in hemodialysis patients. BMC nephrology. 2015; 16(1): 113.

14. Brasil, Critério de Classificação Econômica; Filiadas, B E. ABEP: Associação Brasileira de Empresas de Pesquisa. 2016.

15. Fouque D, Vennegoor M, ter Wee P, Wanner C, Basci A, Canaud B, et al. EBPG guideline on nutrition. Nephrol Dial Transplant 2007;22:ii45-87. https://doi.org/10.1093/ndt/gfm020

16. World Health Organization. Obesidade: prevenção e gerenciamento da epidemia global: Relatório de uma consulta da OMS (Série de relatórios técnicos da OMS 894). 1998. Disponível em<https://www.who.int/nutrition/publications/obesity/WHO_TRS_894/en/>

17. Abeso. Diagnóstico e tratamento da obesidade em criança e adolescentes. 2016; Ed, 4, 129-158.

18. Innes EV. Hand grip strength testing: a review of the literature. Aust Occup Ther J 1999; 46(3): 120-140. https://doi.org/10.1046/j.1440-1630.1999.00182.x.

19. Szczech LA, Reddan DN, Klassen PS, Coladonato J, Chua B, Lowrie EG, et al. Interactions between dialysis-related volume exposures, nutritional surrogates and mortality among ESRD patients. Can J Kidney Health Dis. 2003; 18(8): 1585-1591. https://doi.org/10.1093/ndt/gfg225.

20. López-Gómez JM, Villaverde M, Jofre R, Rodriguez-Benítez P, Pérez-García R. Interdialyticweightgain as a markerofbloodpressure, nutrition, andsurvival in hemodialysispatients. Kidney int. 2005; 67: S63-S68. https://doi.org/10.1111/j.1523-1755.2005.09314.x.

21. Ifudu O, Uribarri J, Rajwani I, Vlacich V, Reydel K, Delosreyes G, et al. Relation between interdialytic weight gain, body weight and nutrition in hemodialysis patients. Clin J Am Soc Nephrol. 2002; 22(4): 363-368. https://doi.org/10.1159/000065228.

22. Stachenfeld NS, Di Pietro Loretta, Nadel ER, Mack GW. Mechanismo fatte nuated thirst in aging: role of central volume receptors. Am J Physiol Regul Integr Comp Physiol. 1997; 272(1): R148-R157. https://doi.org/10.1152/ajpregu.1997.272.1.R148.

23. Ferraz SF, Freitas ATVDS, Vaz IMF, Campos MIVAM, Peixoto MDRG, Pereira ERS. Estado nutricional e ganho de peso interdialítico de pacientes com doença renal crônica em hemodiálise. J Bras Nefrol. 2015; 37(3): 306-314. https://doi.org/10.5935/0101-2800.20150050.

24. Holland H. Estado nutricional e composição corporal de pacientes em hemodiálise, segundo ganho de peso interdialítico. Ribeirão Preto (São Paulo): Universidade de São Paulo; 2016.

25. Kuipers J, Verboom LM, Ipema KJ, Paans W, Krijnen WP, Gaillard CA, et al. The prevalence of intradialytic hypotension in patients on conventional hemodialysis: A systematic review with meta-analysis. Clin J Am Soc Nephrol. 2019; 49(6): 497-506. https://doi.org/10.1159/000500877.

26. Freitas ATVDS, Vaz IMF, Ferraz SF, Peixoto MDRG, Campos MIVM, Fornés NS. Prevalência e fatores associados à obesidade abdominal em pacientes em hemodiálise em Goiânia-GO. J Bras Nefrol. 2013; 35(4): 265-272. https://doi.org/10.5935/0101-2800.20130045.

27. Brener ZZ, Kotanko P, Winchester JF, Thijssen S, Bergman M. Clinical benefit of preserving residual renal function in dialysis patients: an update for clinicians. Am J Med Sci. 2010; 339(5): 453-456. https://doi.org/10.1097/MAJ.0b013e3181cf7d5b.

28. Wang AYM, Woo J, Wang M, Sea MMM, Sanderson JE, Lui SF, et al. Important differentiation of factors that predict outcome in peritoneal dialysis patients with different degrees of residual renal function. Can J Kidney Health Dis 2005; 20(2): 396-403. https://doi.org/10.1093/ndt/gfh331.

29. Silva LMD, Bueno CD. Adesão ao tratamento dietoterápico sob a ótica dos pacientes com doença renal crônica em hemodiálise. Nutrire Rev. Soc. Bras. Aliment. Nutr 2014:276-283.

30. Owen WF. C-reactiveprotein as an outcome predictor for maintenance hemodialysis patients. Kidney int. 1998; 54(2): 627-636. https://doi.org/10.1046/j.1523-1755.1998.00032.x.

31. Ifudu O, Uribarri J, Rajwani I, Vlacich V, Reydel K, Delosreyes G, Friedman EA. Relation between interdialytic weight gain, body weight and nutrition in hemodialysis patients. Am J Nephrol. 2002;22(4):363-8. https://doi.org/10.1159/000065228.

32. Pifer TB, Mccullough KP, Port FK, Goodkin DA, Maroni BJ, Held PJ, et al. Mortality risk in hemodialysis patients and changes in nutritional indicators: DOPPS. Kidney int. 2002; 62(6): 2238-2245. https://doi.org/10.1046/j.1523-1755.2002.00658.x

Contributors

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