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Can risk of sarcopenia predict poorer quality of life in hemodialysis patients?

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ABSTRACT

Background: Sarcopenia and low quality of life (QOL) are widely found among hemodialysis (HD) patients. We aimed to verify whether risk of sarcopenia can predict QOL level in patients submitted to HD.

Methods: The sample was formed by 147 chronic kidney disease patients undergoing HD in October 2020 at a single dialysis center. Demographic and clinical data were collected. Risk of sarcopenia was classified using the SARC-F questionnaire. QOL was evaluated by the Brazilian version of the SF-36. QOL scores were compared between patients with and without risk of sarcopenia. Multivariate linear regression was performed to test risk of sarcopenia as an independent predictor of QOL scores.

Results: There were 62 (42.2%) patients classified as having risk of sarcopenia. In the comparison of QOL scores between patients with and without risk of sarcopenia, scores of seven dimensions were significantly lower among patients with sarcopenia risk, the only exception being role-emotional. Risk of sarcopenia was an independent predictor of six dimensions of QOL, except for role-emotional and mental health.

Conclusion: We found risk of sarcopenia to be an independent predictor of QOL among HD patients. Our results point to the possibility of improving patients' QOL by intervening to minimize the risk of sarcopenia.

Keyword: Chronic Kidney Failure; Hemodialysis; Quality of Life; Sarcopenia

RESUMO

Introdução: Sarcopenia e baixa qualidade de vida (QV) são amplamente encontradas entre pacientes em hemodiálise (HD). Nosso objetivo foi verificar se o risco de sarcopenia prediz o nível de QV nesta população.

Métodos: A amostra foi formada por 147 pacientes em HD em outubro de 2020 em um único centro de diálise. Dados demográficos e clínicos foram coletados. O risco de sarcopenia foi classificado pelo questionário SARC-F. A QV foi avaliada pela versão brasileira do SF-36. Os escores de QV foram comparados entre pacientes com e sem risco de sarcopenia. A regressão linear multivariada foi realizada para testar o risco de sarcopenia como preditor independente dos escores de QV.

Resultados: Havia 62 (42,2%) pacientes classificados como tendo risco de sarcopenia. Comparando os escores de QV entre pacientes com e sem risco de sarcopenia, os escores de 7 dimensões foram significativamente menores entre os pacientes com risco de sarcopenia, exceto aspectos emocionais. O risco de sarcopenia foi um preditor independente de 6 dimensões da QV, exceto para aspectos emocionais e saúde mental.

Conclusão: O risco de sarcopenia é um preditor independente de QV entre os pacientes em HD. Nossos resultados apontam para a possibilidade de melhorar a QV dos pacientes intervindo para minimizar o risco de sarcopenia.

Palavras-chave: Falência Renal Crônica; Hemodiálise; Qualidade de vida; Sarcopenia

INTRODUCTION

Chronic kidney disease (CKD) is related to a high rate of morbidity and mortality and a high cost to the health system, so it is an important public health problem. It is estimated that the number of patients undergoing renal replacement therapy in Brazil is greater than 133,000 and that more than 90% of these patients are on hemodialysis (HD). The prevalence and incidence of these patients per million inhabitants (PMP) is 665 and 218, respectively, and has been increasing due to the increase in hypertensive and diabetic patients, in addition to the aging of the population[1-2].

Sarcopenia is also considered to be an important public health problem, since it is related to unfavorable clinical outcomes such as decreased quality of life (QOL), risk of falls, functional disability, depression, limited mobility, hospitalization and increased mortality[3-6]. Sarcopenia is a muscle disease associated with low muscle strength, low muscle quantity/quality and low physical performance. It can be acute or chronic and can be classified as primary, when only associated with aging and no other cause is evident; or secondary, when causes other than aging are present. Some factors involved with the development of sarcopenia are inflammatory processes, physical inactivity and inadequate intake of energy or protein. All these factors may be present in individuals undergoing HD[6-9].

The risk of sarcopenia in CKD patients is multifactorial and is worse in the advanced stages, mainly in patients undergoing HD. Some factors involved with sarcopenia in CKD patients are aging, inflammation, uremia, hormonal imbalance, malnutrition, anemia, metabolic acidosis, electrolyte disorder, lifestyle changes and muscle fiber atrophy. Of these, inflammation is a main risk for the development of sarcopenia[9].

CKD complications such as anemia, cardiovascular disease, osteodystrophy, depression and sarcopenia are associated with low QOL in patients on HD[10]. Compared to other chronic diseases, like heart failure, chronic lung disease, arthritis and cancer, patients with CKD on HD present the worst QOL level[11]. Besides the impact on patients' QOL coming from common symptoms such as fatigue, itching, anorexia, pain, sleep disorders, anxiety and nausea; CKD patients on HD experience powerful stressors: severe dietary restrictions, sexual dysfunction, time loss that influences employment, dependence on a machine and high mortality[10,12,13]. Unfortunately, several of these factors that decrease QOL are unmodifiable.

The association between sarcopenia and QOL is not well studied among Brazilian patients on HD. Due to the extreme difficulty and lack of consensus about how to improve QOL among HD patients, it is crucial to seek modifiable variables associated with lower QOL level. Risk of sarcopenia can be minimized by well-known interventions. Thus, risk of sarcopenia can be a potential target for medical interventions in order to improve patients' QOL.

We aimed to verify if risk of sarcopenia can predict the QOL level among CKD patients submitted to HD.

METHODS

Study design

The study was analytical, cross-sectional and observational, carried out in a single dialysis center located in the city of Sobral, northern region of Ceará state. This dialysis center is a

reference for CKD patients from several cities covering an area of 35,560 km^2 (37.3 inhabitants/km^2).

Study population

The study population was 200 CKD patients who were undergoing HD in October 2020. The sample was formed by 147 patients. The criteria for exclusion were: 3 patients with age below 18 years; 4 who were hospitalized; 7 with presence of advanced neurologic disease and/or cognitive deficit that prevented filling out the questionnaire; 17 with active infection; and 22 with less than 3 months on HD. All patients were undergoing conventional HD (three sessions of 4 h per week) with polysulfone dialyzers (maximum number of reuses = 12). The study protocol and informed consent were approved by the ethics committee of Federal University of Ceará (CAAE 31240420.5.0000.5053).

Demographic and clinical data

We used the dialysis center's medical records to obtain the demographic data, length of time on dialysis, type of vascular access and underlying etiology of CKD. The underlying renal disease was classified according to clinical criteria instead of by histopathology. Classification of economic class was according to criteria of the form issued by the Brazilian Association of Research Institutes[14]. This validated instrument grades economic class into five subgroups: A (best status) through E (worst status). Besides income level, its criteria include educational level of the head of household and ownership of household appliances. Each patient was assigned a low, medium or high risk index based on comorbidity using Khan's comorbidity index, which takes into consideration the age in three classes and nine comorbidities: diabetes, myocardial infarction, angina pectoris, congestive heart failure, liver cirrhosis, obstructive pulmonary disease, systemic collagen disease, pulmonary fibrosis, and visceral malignancy[15].

Measurement of quality of life (QOL)

The QOL was evaluated by the validated Brazilian version of the Medical Outcomes Study 36-Item Short Form Health Questionnaire (SF-36). This questionnaire generates scores from 0 (worst) to 100 (best) for 8 dimensions of QOL related to physical, psychological and social functioning: physical functioning (PF), role-physical (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role-emotional (RE) and mental health (MH). PF measures the patient's performance regarding daily activities; RP analyzes the impact of physical health on life; BP evaluates pain level and its impact on normal daily activities; GH evaluates the subjective perception of the present and future health status and resistance to illness; VT measures the patient's feelings about his/her energy level, vitality, and moments of fatigue; SF measures the impact of health on routine social activities; RE measures the influences of emotional status on daily activities; and MH assesses humor and well-being, including depression and anxiety[16].

Risk of sarcopenia

We used the validated SARC-F questionnaire as a diagnostic test for risk of sarcopenia. This questionnaire is composed of five components (strength, assistance with walking, rising from a chair, climbing stairs, and falls), ranging from 0 to 10, with a maximum of 2 points for each component. The presence of risk of sarcopenia is classified with a score greater than or equal to 4[17-19].

Statistical analyses

Shapiro's test was used to test the normal distribution of the continuous variables, which were expressed as mean ± SD or median (min-max), respectively, if they presented normal or

abnormal distribution. Categorical variables are denoted by absolute number and percentage. Comparisons were performed by the Student-*t* and Mann–Whitney tests for continuous variables, respectively, with or without normal distribution. We performed multivariate linear regression to find independent predictors of QOL scores (dependent variables) considering as independent variables: male gender, age, comorbidity index, and risk of sarcopenia. Statistical significance was considered to be a p-value < 0.05. All the statistical analyses were performed using the SPSS version 22.0 program package.

RESULTS

Demographic and clinical characteristics of the sample are reported in **Table 1**. There were 62 (42.2%) patients classified as having risk of sarcopenia. The comparison of QOL scores between patients with and without risk of sarcopenia is reported in **Table 2**. Only the dimension RE did not differ in the comparisons. In the multivariate analysis, the presence of risk of sarcopenia was an independent predictor for the scores of six among eight dimensions of QOL, the exceptions being RE and MH (**Table 3**).

Table 1 – Sample characteristics

Variables	
Gender, N(%)	
Male	104 (70.7)
Female	43 (29.3)
Age, mean ± SD	55.4 ± 16.9
Social class, N(%)	
A	1 (0.7)
B	18 (12.2)
C	71 (48.3)
D	54 (36.8)

E	3 (2.0)
Renal disease, N(%)	
Hypertensive nephropathy	45 (30.6)
Glomerulonephritis	30 (20.4)
Diabetic nephropathy	21 (14.3)
Obstructive uropathy	11 (7.5)
Polycystic kidney disease	9 (6.1)
Chronic pyelonephritis	2 (1.4)
Lupus	3 (2.0)
Undetermined	26 (17.7)
Time on hemodialysis, months	51.2 ± 45.8
Vascular access, N(%)	
Fistula	120 (81.7)
Catheter	27 (18.3)
Comorbidity index, N(%)	
Low	58 (39.5)
Medium	50 (34.0)
High	39 (26.5)

Table 2 - Comparison of quality of life scores between patients with and without risk of sarcopenia

Dimensions of quality of life	Without risk	With risk	Whole sample	P
PF, median(min-max)	70 (10-100)	25 (0-90)	55 (0-100)	<0.001
RP, median(min-max)	25 (0-75)	0 (0-100)	0 (0-100)	<0.001
BP, median(min-max)	74 (0-100)	47 (0-100)	62 (0-100)	<0.001
GH, mean ± SD	50.0 ± 42.2	22.7 ± 20.9	63.4 ± 32.0	0.032
VT, median(min-max)	70 (20-100)	55 (0-90)	65 (0-100)	<0.001
SF, median(min-max)	87.5 (0-100)	62.5 (0-100)	75 (0-100)	<0.001
RE, mean ± SD	53.3 ± 43.4	45.7 ± 44.8	50.1 ± 44.0	0.300
MH, median(min-max)	84 (20-100)	74 (16-100)	76 (16-100)	0.029

PF: Physical functioning; RP: Role-physical; BP: Bodily pain; GH: General health; VT: Vitality; SF: Social functioning; RE: Role-emotional; MH: Mental health.

Table 3 – Linear regression for multivariate analysis of predictors of quality of life scores

Dimensions of quality of life	Predictors	Coefficient	P
PF	Risk of sarcopenia	5.286	<0.001
	Male gender	0.829	0.408
	Age	1.467	0.144
	Comorbidity index	2.207	0.028
RP	Risk of sarcopenia	4.879	<0.001
	Male gender	3.494	<0.001
	Age	0.926	0.355
	Comorbidity index	1.124	0.262
BP	Risk of sarcopenia	3.749	<0.001
	Male gender	0.410	0.682
	Age	1.234	0.219
	Comorbidity index	0.455	0.649
GH	Risk of sarcopenia	2.336	0.020
	Male gender	0.282	0.777
	Age	2.793	0.005
	Comorbidity index	1.587	0.114
VT	Risk of sarcopenia	3.159	0.002
	Male gender	0.725	0.469
	Age	0.823	0.411
	Comorbidity index	2.045	0.042
SF	Risk of sarcopenia	4.271	<0.001
	Male gender	1.875	0.062
	Age	1.615	0.108
	Comorbidity index	0.821	0.412
RE	Risk of sarcopenia	0.712	0.477
	Male gender	0.930	0.353
	Age	1.627	0.106
	Comorbidity index	0.657	0.512
MH	Risk of sarcopenia	1.662	0.098

	Male gender	1.418	0.158
	Age	0.168	0.866
	Comorbidity index	1.102	0.272

PF: Physical functioning; RP: Role-physical; BP: Bodily pain; GH: General health; VT: Vitality; SF: Social functioning; RE: Role-emotional; MH: Mental health.

DISCUSSION

The characteristics of our sample were similar to those related to living in underdeveloped areas: low average age, low economic class, only 26.5% classified as having high comorbidity index, and predominance of glomerulonephritis as cause of CKD instead of diabetes. Despite the low average age and low comorbidity level, we found a high percentage (42.2%) of patients with risk of sarcopenia.

Sarcopenia is a condition associated with aging and chronic diseases due to the increased catabolism that exists in these conditions. Patients on HD have even greater catabolism, which increases the risk of sarcopenia[20-22]. The sarcopenic state has been associated with worse QOL dimensions, especially with regard to physical aspects, as found in our study. This is due to the fact that it is related to greater physical frailty, greater risk of falls and greater dependence on others for daily activities[6,23]. A multicenter study carried out among elderly patients on HD showed that sarcopenic patients had worse QOL compared to non-sarcopenic patients, with SF-36 scores below 50 among sarcopenic patients[22]. In our sample of patients with mean age of 55.4 years, we found the same result: sarcopenia was associated with lower QOL in the majority of QOL dimensions. It is noteworthy that the dimensions of QOL that were not associated with sarcopenia were the dimensions characterized as mental: RE and MH. As expected, physical aspects of QOL were more affected in patients classified as at risk of sarcopenia.

In addition, a literature review evaluated six studies on sarcopenia and QOL. Of these studies, five used the same instrument to evaluate QOL as ours, the SF-36. This review shows the association of sarcopenia with an important decline in QOL[6]. However, it will be necessary to evaluate particularities in specific groups, such as women and younger patients. At least one study evaluated the relationship between sarcopenia, sarcopenic obesity and QOL in elderly women and did not find a significant relationship between sarcopenia and QOL[23]. Based on our study, male gender was not a predictor of lower QOL level. In a population-based sample of healthy young people, Kull *et al.*[24] also found that individuals with sarcopenia presented lower scores in the dimensions RP and VT, two typical dimensions related to physical aspects.

Among the types of renal replacement therapy, HD is highlighted as the one that affects most patients' QOL. The QOL of patients with CKD has been found to be worse in those undergoing HD than those undergoing peritoneal dialysis or kidney transplantation[25-28]. There is growing interest in considering QOL of patients undergoing HD, but there is no consensus about how to improve these patients' QOL. This difficulty is certainly due to the fact that the main factors negatively affecting QOL are unmodifiable. Our interest in sarcopenia is based on the fact that sarcopenia is a modifiable factor. There are many strategies to minimize the risk of sarcopenia in HD patients, comprising adapted exercise programs, nutritional approaches and pharmacologic interventions. Formal exercise prescription designed to increase muscle strength can be achieved by resistance exercises that can be performed even during dialysis sessions. Nutritional supplementation with Polycose and oral branched-chain amino acids seems to be promising to increase lean body mass. Also, anabolic strategies are effective at minimizing sarcopenia, including the use of anabolic steroids, growth hormones and testosterone[8,29-33].

In our multivariate linear regression, the risk of sarcopenia was a statistically significant predictor of virtually all dimensions of QOL, except for the RE and MH. Concerning the other variables used in the multivariate analysis, age was a predictor only for the dimension of GH; and higher comorbidity index was predictor of PF and VT scores.

The high percentage of patients with risk of sarcopenia in a sample of relatively young individuals is noteworthy. We have no doubt that a simple questionnaire, quickly applied, such as SARC-F, can be useful in screening patients at risk of sarcopenia in dialysis centers. In that respect, classifying patients with risk of sarcopenia can be a first step to recommend interventions to minimize sarcopenia, as well as the hard but necessary task of improving patients' QOL.

CONCLUSION

We found risk of sarcopenia to be a strong and independent predictor of QOL among HD patients. Since sarcopenia risk can be diminished by several interventions, we propose conducting routine screening of sarcopenia risk as a way to help improve patients' QOL.

REFERENCES

1. Neves PDMM, Sesso RCC, Thomé FS, Lugon JR, Nascimento MM. Brazilian dialysis survey 2019. Braz J Nephrol 2021;43(2):217-227. doi: 10.1590/2175-8239-jbn-2020-0161.
2. Neves PDMM, Sesso RCC, Thomé FS, Lugon JR, Nascimento MM. Brazilian dialysis census: analysis of data from the 2009-2018 decade. Braz J Nephrol 2020 Mai;42(2):191-200. doi: 10.1590/2175-8239-jbn-2019-0234.
3. Beaudart C, Biver E, Reginster JY, Rizzoli R, Rolland Y, Bautmans I, Petermans J, Gillain S, Buckinx F, Dardenne N, Bruyère O. Validation of the SarQoL®, a specific health-related

quality of life questionnaire for sarcopenia. J Cachexia Sarcopenia Muscle 2017;8(2):238-244. doi: 10.1002/jcsm.12149.

4. Magalhães AM, Dias DA, Menezes KKP, Alves LC, Ferreira MCC, Silva SF. Avaliação de força, independência e qualidade de vida do paciente em hemodiálise. Rev Neurocienc 2020;28:1-24. doi: 10.1002/jcsm.12149

5. Farias DH, Melo BC, Minatel V, Calles ACN, Lira JLF. Sarcopenia e sua influência na mobilidade de pacientes com doença renal crônica: uma revisão sistemática. Cons Saude [Internet] 2019 Jun 30 [cited 2021 Apr 20];18(2):293-300. Availiable from: https://doi.org/10.5585/ConsSaude.v18n2.10546.

6. Tsekoura M, Kastrinis A, Katsoulaki M, Billis E, Gliatis J. Sarcopenia and its impact on quality of life. GeneDis 2016. Adv Exp Med Biol. 2017;987:213-218. Availiable from https://doi.org/10/1007/978-3-319-57379-3_19.

7. Cruz-Jentoft AJ, Bahat G, Bauer J, Boirie Y, Bruyère O, Cederholm T, Cooper C, Landi F, Rolland Y, Sayer AA, Schneider SM, Sieber CC, Topinkova E, Vandewoude M, Visser M, Zamboni M. Sarcopenia: Revised European consensus on definition and diagnosis. Age Ageing 2019;48(1):16-31. doi: 10.1093/ageing/afy169.

8. Sousa VA, Oliveira D, Mansur HN, Fernandes NMS, Bastos MG. Sarcopenia in chronic kidney disease. Braz J Nephrol 2015;37:98-105. doi: 10.5935/0101-2800.20150014

9. Foley RN, Wang C, Ishani A, Collins AJ, Murray AM. Kidney function and sarcopenia in the United States general population: NHANES III. Am J Nephrol 2007 May;27(3):279-286. doi: 10.1159/000101827.

10. Santos PR. Qualidade de vida entre pacientes com doença renal crônica em hemodiálise: seguimento de dois anos [tese]. Fortaleza: Universidade Federal do Ceará; 2009.

11. Mittal SK, Ahern L, Flaster E, Maesaka JK, Fishbane S. Self-assessed physical and mental function of haemodialysis patients. Nephrol Dial Transplant 2001;16(7):1387-1394. doi: 10.1093/ndt/16.7.1387.

12. Jesus NM, Souza GF, Mendes-Rodrigues C, Almeida Neto OP, Rodrigues DDM, Cunha CM. Quality of life of individuals with chronic kidney disease on dialysis. Braz J Nephrol 2019;41(3):364-374. doi: 10.1590/2175-8239-JBN-2018-0152.

13. Murtagh FEM, Addington-Hall J, Higginson IJ. The prevalence of symptoms in end-stage renal disease: a systematic review. Adv Chronic Kidney Dis 2007;14(1):82-99. doi: 10.1053/j.ackd.2006.10.001

14. Associação Brasileira de Empresas e Pesquisa. Alterações na aplicação do Critério Brasil. ABEP – Associação Brasileira Econômica de Pesquisa 2019:1-6.

15. Khan IH. Comorbidity: the major challenge for survival and quality of life in end-stage renal disease. Nephrol Dial Transplant 1998;13:76-79. doi:10.193/ndt/13.suppl_1.76.

16. Ciconelli RM, Ferraz MB, Santos W, Meinão I, Quaresma MR. Tradução para a língua portuguesa e validação do questionário genérico de avaliação de qualidade de vida SF-36 (Brasil SF-36). Rev Bras Reumatol 1999 mai/jun;39(3):143-150.

17.Malmstrom TK, Morley JE. SARC-F: A simple questionnaire to rapidly diagnose sarcopenia. J Am Med Directors Assoc [Internet] 2013 Aug;14(8):531-532. Available from: http://dx.doi.org/10.1016/j.jamda.2013.05.018

18. Yang M, Hu X, Xie L, Zhang L, Zhou J, Lin J, Wang Y, Li Y, Han Z, Zhang D, Zuo Y, Li Y, Wu L . SARC-F for sarcopenia screening in community-dwelling older adults are 3 items enough? Medicine [Internet] 2018 [cited 2020 Jan 21];97(30). Available from: http://dx.doi.org/10.1097/MD.0000000000011726

19. Piotrowicz K, Głuszewska A, Czesak J, Fedyk-Łukasik M, Klimek E, Sánchez-Rodríguez D, Skalska A, Gryglewska B, Grodzicki T, Gasowski J. SARC-F as a case-finding tool for sarcopenia according to the EWGSOP2. National validation and comparison with other diagnostic standards. Aging: Clinical and Experimental Research [Internet] 2021; Available from: https://doi.org/10.1007/s40520-020-01782-y.

20. Teixeira VON, Filippin LI, Xavier RM. Mecanismos de perda muscular da sarcopenia. Rev Bras Reumatol 2012;52(2):247-259.

21. Moorthi RN, Avin KG. Clinical relevance of sarcopenia in chronic kidney disease. Curr Opin Nephrol Hypertens 2017 May 1;26(3):219-228. doi: 10.1097/MNH.0000000000000318.

22. Pardo FL. Sarcopenia em pacientes idosos com doença renal crônica em hemodiálise [dissertação]. Rio de Janeiro (RJ): Universidade do Estado do Rio de Janeiro; 2012.

23. Silva Neto LS, Karnikowiski MGO, Tavares AB, Lima RM. Associação entre sarcopenia, obesidade sarcopênica e força muscular com variáveis relacionadas de qualidade de vida em idosas. Rev Bras Fisioter 2012 Sep;16(5):360-367. doi: 10.1590/S1413-35552012005000044.

24. Kull M, Kallikorm R, Lember M. Impact of a new sarco-osteopenia definition on health-related quality of life in a population-based cohort in Northern Europe. J Clin Densitometry 2012 Jan;15(1):32-38. doi: 10.1016/j.jocd.2011.08.007.

25. Chuasuwan A, Pooripussarakul S, Thakkinstian A, Ingsathit A, Pattanaprateep O. Comparisons of quality of life between patients underwent peritoneal dialysis and hemodialysis: a systematic review and meta-analysis. Health Qual Life Outcomes 2020;18:1-11. doi: 10.1186/s12955-020-01449-2.

26. Chen JY, Wan EYF, Choi EPH, Chan AKC, Chan KHY, Tsang JPY, Lam CLK. The health-related quality of life of chinese patients on hemodialysis and peritoneal dialysis key points for decision makers. Patient 2017;10:799-808. doi: 10.1007/s40271-017-0256-6.

27. Gonçalves FA, Dalosso IF, Borba JMC, Bucaneve J, Valerio NMP, Okamoto CT, Bucharles SGE. Qualidade de vida de pacientes renais crônicos em hemodiálise ou diálise peritoneal: estudo comparativo em um serviço de referência de Curitiba – PR. Braz J Nephrol 2015 Oct 1;37(4):467-474. doi: 10.5935/0101-2800.20150074.

28. Czyżewski Ł, Sańko-Resmer J, Wyzgał J, Kurowski A. Assessment of health-related quality of life of patients after kidney transplantation in comparison with hemodialysis and peritoneal dialysis. Ann Transplant. 2014 Nov 9;19(1):576–585. doi: 10.12659/AOT.891265.

29. Hernandez HJ, Obamwonyi G, Harris-Love MO. Physical Therapy Considerations for Chronic Kidney Disease and Secondary Sarcopenia. J Funct Morphol Kinesiol 2018 Jan 5;3(1):1-12. doi: 10.3390/jfmk3010005.

30. Yu R, Chen J, Xu J, Cao J, Wang Y, Thomas SS, Hu Zhaoyong. Supression of muscle wasting by the plant-derived compound ursolic acid in a model of chronic kidney disease. J Cachexia Sarcopenia Muscle 2017;8:327-341. doi: 10.1002/jcsm.12162.

31. Chatzipetrou V, Bégin MJ, Hars M, Trombetti A. Sarcopenia in chronic kidney disease: a scoping review of prevalence, risk factors, association with outcomes and treatment. Calcif Tissue Int [Internet] 2021 Aug 12. Available from: https://doi.org/10.1007/s00223-021-00898-1.

32. Watanabe H, Enoki Y, Maruyama T. Sarcopenia in chronic kidney disease: factors, mechanisms and therapeutic interventions. Biol Pharm Bull 2019;42:1437-1445. doi: 10.1248/bpb.b19-00513.

33. Ikizler TA, Cano NJ, Franch H, Fouque D, Himmelfarb J, Kalantar-Zadeh K, Martin KK, Stenvinkel P, TerWee P, Teta D, Wang AY, Wanner C. 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 May 22;84(6):1096-1107. doi:10.1038/ki.2013.147.

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