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Original/*Otros*

Inflammatory, nutritional and clinical parameters of individuals with chronic kidney disease undergoing conservative treatment

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Abstract

Introduction: **due to the relevance of inflammation in individuals with chronic kidney disease (CKD), inflammation should be taken into account in the interpretation of the clinical-nutritional status.**

Objective: **assess the association between inflammation, nutritional and clinical parameters in patients with CKD.**

Materials and methods: **92 patients with CKD. C-reactive protein (CRP) was used as an inflammation marker. Assessed nutritional parameters were anthropometry and biochemical exams. Evaluated clinical parameters were comorbidities, CKD characteristics, lipid profile, lipid-lowering agents, urea, creatinine and total leukocytes. Comparisons between two groups (with or without inflammation) were performed using Student's t-test or chi-square test.**

Results: **15 (16.3%) patients had CRP above ≥ 10mg/L and were considered with inflammation. In the group with inflammation, 05 (33%) had hypoalbuminemia as compared with 05 (6.5%) in the group without inflammation (p = 0.002). Lipid values were lower in the group with inflammation, with mean total cholesterol 171 (± 41.2) mg/dL and mean LDL-C 95 (± 31.2) mg/dL as compared with the group without inflammation, which had and a mean total cholesterol 198 (± 46) mg/dL and mean LDL-C 124 (± 40.1) mg/dL, p = 0,038 and p = 0.011, respectively. No other statistically significant differences between groups were found.**

Conclusion: **inflammation was associated with changes in the total cholesterol and LDL levels and with an increased incidence of hypoalbuminemia. We suggest that serum albumin levels should only be used to assess nutritional status in the absence of inflammation and**

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INFLAMACIÓN, ESTADO CLÍNICO Y NUTRICIONAL DE PACIENTES RENALES CRÓNICOS EN TRATAMIENTO CONSERVADOR

Resumen

Introducción: **la inflamación es un problema frecuente en pacientes con enfermedad renal crónica (ERC) y se debe relacionar con el estado clínico y nutricional de estos.**

Objetivo: **evaluar si existe una asociación entre la inflamación y los parámetros clínicos y nutricionales en los pacientes con ERC.**

Material y métodos: **fueron evaluados 92 pacientes con ERC. Se utilizó la proteína C reactiva (PCR) como marcador de la inflamación. Los parámetros nutricionales evaluados fueron antropometría y exámenes bioquímicos. Los parámetros clínicos evaluados fueron comorbilidades, características de la ERC, perfil lipídico, hipolipemiantes, urea, creatinina y leucocitos totales. Para analizar las diferencias entre los grupos (con o sin inflamación) se utilizó el test t de Student o el test de Chi-cuadrado.**

Resultados: **15 pacientes (16,3%) presentaban PCR ≥ 10,0 mg/dL y tenían inflamación. De estos, 05 (33%) tuvieron hipoalbuminemia, en comparación con 05 (6,5%) en el grupo sin inflamación (p = 0,002). Los valores de lípidos fueron inferiores en el grupo con inflamación, con colesterol total medio de 171 mg/dL (± 41,2) e LDL-C médio de 95 mg / dL (± 31,2) en comparación con aquellos sin inflamación con medias de 198 mg / dL (± 46) y 124 mg/dL (± 40,1), respectivamente. No se encontraron otras diferencias significativas entre los grupos.**

Conclusión: **la inflamación se ha asociado con modificaciones en el colesterol total, LDL e hipoalbuminemia. Se concluye que la albúmina sérica solo se debe utilizar para evaluar el estado nutricional en ausencia de inflamación. El nivel de PCR es un marcador sensible de la**

CRP levels ought to be considered in nutritional status interpretation in patients with CKD.

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Key words: *Chronic kidney disease. C-reactive protein. Inflammation. Nutritional status. Hypoalbuminemia.*

inflamación y debe ser empleado en la interpretación del estado nutricional en pacientes con ERC.

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Palabras clave: *Enfermedad renal crónica. Proteína C reactiva. Inflamación. Estado nutricional. Hipoalbuminemia.*

Introduction

In patients with chronic kidney disease (CKD), inflammation contributes to the pathogenesis of atherosclerosis and is a predictor of cardiovascular events and increased mortality rate[1]. Clinical reports suggest that inflammatory mediators may induce anorexia, anemia, muscle proteolysis, and reduced protein production, resulting in hypoalbuminemia and malnutrition[2].

The results of a study conducted with individuals with CKD suggested that inflammation can lead to the misinterpretation of nutritional markers as a result of muscle proteolysis, particularly anthropometric indicators of body composition. Inflammation can also alter biochemical markers, including serum albumin, hemoglobin, transferrin and ferritin levels[3].

Due to the relevance of inflammation in individuals with CKD, inflammation should be taken into account in the interpretation of the clinical-nutritional status of patients and in the development of therapeutic interventions[2]. C-reactive protein (CRP) has been widely used as a serum marker of inflammation and is considered a reliable biomarker of inflammation and atherosclerotic cardiovascular disease[4,5,3].

The relationship between inflammation and nutritional and clinical parameters is not well understood in CKD patients not undergoing dialysis. Therefore, the aim of the present study was to establish whether a relationship exists between inflammatory markers and nutritional and clinical parameters in CKD patients undergoing conservative treatment.

Materials and methods

Design and sampling

The present cross-sectional study was conducted in a university hospital nutrition and nephropathy outpatient clinic, between September 2012 and November 2013. The study included clinically stable, from both genders, adult (≥ 20 and < 60 years old) and elderly adult (≥ 60 years old) outpatients with glomerular filtration rates (GFRs) between 15 and 89 ml/min/1.73 m^2.

The exclusion criteria were as follows: admission to a hospital within the past month, limb amputation, malignant disease, chronic infectious disease, acquired immunodeficiency syndrome, history of dialysis or transplantation, use of immunosuppressant drugs, acute kidney failure, severe liver failure, leukocytosis (defined as total leukocit count higher than 10.000 cells/mm^3) and terminal CKD.

Data collection

Data collection was standardized and performed by previously trained nutrition trainees and nutritionists.

Anthropometric measurements included body weight and height, as recommended by the World Health Organization[8]. Body height and weight were used to calculate the body mass index (BMI), which was evaluated using the cutoff points suggested by the WHO[9] for adults and older adults, based on the classification recommended by Nutrition Screening Initiative (NSI)[10]. For adult patients, four skinfolds measurements were summed, and for elderly patients, the tricipital skinfold measurement alone was taken. Corrected arm muscle area was calculated for adult patients, whereas arm muscle circumference was calculated for elderly patients[11]. Waist circumference (WC) was calculated for all patients[12].

All biochemical tests were performed in the hospital laboratory. Hemoglobin, total protein serum levels and albumin serum levels, urea, creatinine, lipid profile and CPR levels were evaluated. The albumin serum levels were measured by bromocresol green method. Inflammation was evaluated through the measurement of CRP levels by turbidimetry, and the patients were defined as inflamed if CRP ≥ 10 mg/L[6]. Serum urea levels were measured enzymatically and the serum creatinine levels were measuring using the modified Jaffe method. The lipid profile included measurements of total cholesterol (TC), cholesterol fractions and triglycerides (TG), following the recommendations of the National Cholesterol Education Program[13]. The serum TC and TG levels were measured by means of an automated enzymatic method using a colorimetric assay. The high-density lipoprotein (HDL) level was measured by means of the direct method, and the low-density lipoprotein (LDL) and very low-density lipoprotein (VLDL) levels were estimated using the Friedewald equation[14].

Clinical data were collected from patients' charts and included time since CKD diagnosis in months, estimated GFR, presence of diabetes mellitus and use of hypolipidemic drugs. Demographic data, such as age and gender, and behavioral data, including smoking and physical activity level, were also evaluated.

Statistical Analysis

For statistical analysis, the Kolmogorov–Smirnov test was used to determine if the data followed a normal (parametric) or non-normal (non-parametric) distribution. The data were expressed as the mean and standard deviation or as the median and interquartile range in the case of the continuous variables and as percentages in the case of the categorical variables.

Comparisons between two groups (with or without inflammation) were performed using Student's t-test in the case of parametric data and the Mann-Whitney test in the case of non-parametric data. Proportions were compared by means of the chi-square or Fisher's exact test.

The significance level was set to 5% ($p \leq 0.05$) in all of the analyses. The analyses were performed using the statistical package SPSS version 20.0®.

The study protocol was approved by the research ethics committee.

Results

Among 92 patients evaluated, 50 (54)% were male and elderly, 71 (77%) were sedentary e 06 (6,5%) were smokers The median CRP value was 2.5 mg/L [0.1-7.0mg/L]. 15 (16.3%) patients had CPR ≥ 10mg/L and were considered with inflammation, 77 (83.7%) had CPR < 10mg/L and were considered without inflammation. In the group exhibiting inflammation, 09 (60%) of the participants were male, the mean age was 63.4 (±10.3) years old, 10 (66.7%) were elderly and sedentary patients, and 02 (13.3%) were smokers. Statistically significant differences were not detected between the groups with respect to the demographic and behavioral characteristics.

In the nutritional parameters analysis, 05 (33.3%) in the inflammation group as compared with 05 (6.5%) in the group without inflammation had serum albumin level was < 3.8 mg/dL ($p = 0.002$). Anthropometric indicators, BMI and body composition were not different between groups. The mean WC values were not different between groups. Half of patients with inflammation had increased WC as compared with 41.7% in the group without inflammation (Table II).

Lipid values were lower in the inflammation group, with mean total cholesterol 171 mg/dL (± 41.2) and mean LDL-C 95 mg/dL (± 31.2) as compared with non-inflammation group, which had a mean total cholesterol 198 mg/dL (± 46) and mean LDL-C 124 mg/dL (± 40.1) ($p = 0.038$ and $p = 0.011$, respectively). 09 (60%) of patients with inflammation were using hypolipidemic drugs.

No other statistically significant differences between groups were found.

Discussion

The prevalence of chronic inflammation is high among individuals with CKD, including patients not undergoing dialysis, and is strongly associated with morbidity and mortality[15]. Several factors influence this association, including with the presence of uremia, metabolic acidosis and infection[6].

CRP is the most frequently used markers of inflammation and is associated with an increased risk of cardiovascular disease and mortality in the overall population and among individuals with CKD[3]. In the present study, 16.3% of the participants exhibited CRP ≥ 10 mg/L, which indicates that predialytic patients may exhibit inflammation. A Swedish study that applied the same CRP cutoff value as the present study reported that the prevalence of inflammation was 36% among the 300 CKD participants[16]. These findings suggest that inflammation might contribute to the clinical and nutritional complications exhibited by this population of patients.

An association between nutritional parameters and inflammatory markers has been reported in both the overall population as well as among individuals undergoing dialysis[17,18]. However, few studies have investigated this association in CKD patients undergoing conservative treatment.

We did not detect any association between CRP and BMI, which is consistent with the results of a study conducted in India involving 100 CKD patients under-

Table I
Demographic and behavioral characteristics of individuals wilh chronic kidney disease with or wilhout inj/ammation undergoing conservative treatment

Variables	*Total 92 (100%)*	*Inflammation*		P *Value*
		Yes 15	*No 77 (83.7%)*	
Male gender	50 (54.3)	09 (60)	41 (53.2)	0.631
Older adults	50 (54.3)	10 (66.7)	40 (51.9)	0,295
Sedentary behavior	71 (77.2)	10 (66.7)	61 (79.2)	0.320
Smokers	06 (65)	02 (13.3)	04 (5.2)	0.252

X^2 test.

Table II
Nutritional characteristics of individuals with chronic kidney disease with or without inflammation undergoing conservative treatment

Variables	*Total 92 N*	*Inflammation*		P *Value*
		Yes 15 (16.3%)	*No 77 (83.7%)*	
BMI (kg/m²)[2]	25.3 (4.8)	25.1 (4.9)	25.3 (4.8)	0.886
Waist circumference (cm)[2]	91.7 (13.4)	94.9 (16.4)	91.0 (12.8)	0.328
Muscle tissue (cm)[1]	33 (35.9)	05 (33.3)	28 (36.4)	0.823
Adipose tissue (mm)[1]	40 (44.4)	05 (33.3)	35 (46.7)	0.343
Arm circumference[1]	32 (35.2)	07 (46.7)	25 (32.9)	0.307
Total proteins (g/dl)[1]	7.6 (0.65)	7.6 (0.74)	7.6 (0.74)	0.909
Albumin (g/dl)[3]	4.2 (4.1-4.5)	4.2 (3.7-4.6)	4.3 (4.1-4.5)	0,345
Hipoalbuminemia (%)[1]	10 (10.9)	05 (33.3)	05 (6.5)	0.002
Hemoglobin (g/dl)[2]	11.8 (1.8)	11.3 (2.4)	11.9 (1.7)	0.265

[1]Percent, X^2 test; [2]mean and standard deviatiau, *Student's* t-test, [3]median aud interquartile range, *Mann-Whitney* test.

going conservative treatment[15]. In individuals undergoing dialysis, inflammation may activate catabolic pathways, thereby causing a reduction in lean body mass[19]. In the present study, we did not observe association between inflammation and insufficient muscle mass in CKD patients not undergoing dialysis.

Although central obesity is associated with inflammation, insulin resistance, dyslipidemia and oxidative stress among CKD patients[20], in the present study we did not observe any relationship between high CRP levels and WC. The mean WC in the group with inflammation was higher than the group without inflammation (94.9 cm (±16.4) vs. 91.0 cm (±12.8); respectively); however, the difference was not statistically significant. Contrary to the results of the present study, Chen and colleagues (2013) reported a positive association between WC and CRP[21]. CRP was also found to be positively associated with WC in a group of 44 individuals with stage 3 or 4 CKD[18]. Outpatient nutritional follow-up may have contributed to the results of the present study, as dietary pattern can influence inflammation[22].

Table III
Clinical characteristics of individuals with chronic kidney disease with or without inflammation undergoing conservative treatment

Variables	*Total 92*	*Inflammation*		P *Value*
		Yes 15 (16.3%)	*No 77 (83.7%)*	
Diabetes (%)[1]	38 (41.3)	05 (33.3)	33 (42.9)	0.493
CKD duration (mounths)[3]	48 (12-120)	72 (12-144)	42 (12-105)	0.409
eGFR (ml/min)[2]	39.7 (19.5)	43.5 (23.3)	38.9 (18.7)	0.408
CKD estages 3 and 4 (%)[1]	81 (88.0)	13 (86.7)	68 (88.3)	1.000
Total cholesterol (mg/dl)[2]	194.3 (46.2)	171.7 (41.2)	198.7 (46.0)	0.038
LDL (mg/dl)[2]	119.5 (40.0)	95.8 (31.2)	124.1 (40.1)	0.011
HDL (mg/dl)[2]	45.4 (13.9)	44.6 (14.1)	45.6 (13.9)	0.801
TG (mg/dl)[3]	131 (95.5-183)	197)	183)	0.979
TG/HDL ratio[3]	3.3 (1.8-5.0)	3.7 (1.7-5.7)	3.2 (1.8-5.0)	0.97
Use of hypolidemic drugs (%)[1]	41 (44.6)	09 (60)	32 (41.6)	0.189
Urea (mg/dl)[2]	80.5 (42.1)	81.2 (44.3)	80.4 (42.0)	0.943
Creatinine (mg/dl)[2]	2.02 (1.1)	1.8 (1.0)	2.0 (1.1)	0.523
Leukocyte count (/mm³)[2]	6829.2 (1855.6)	(1932.8)	(1850.3)	0.627

[1]Percent, X^2 test; [2]mean and standard deviatiau, *Student's* t-test; [3]median aud interquartile range, *Mann-Whitney* test.

With respect to clinical parameters, the frequency of hypoalbuminemia (serum albumin < 3.8 mg/ml) was higher in the group with inflammation. Abraham et al, 2009, reported similar results, with higher CRP levels among the participants with lower serum albumin levels[15]. Furthermore, other studies have reported an association between increased levels of CRP and a reduction in the serum albumin concentration[23],[24].

The National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF/KDOQI) recommends that the routine assessment of the nutritional status should be based on the serum albumin level[25]. Nevertheless, some studies have found that serum albumin levels decrease in individuals with inflammation[26,27].

Our results support an association between inflammation and hypoalbuminemia. In individuals with CKD, hypoalbuminemia is mainly associated with inflammation and thus does not necessarily indicate dietary inadequacy[27]. Therefore, serum albumin is considered a poorly sensitive marker of malnutrition[26]. Inflammation induces earlier changes in the albumin level than does malnutrition, and early albumin changes exhibit a negative correlation with changes in CRP[26], as confirmed by the present study.

One study of individuals with CKD did not detect a strong correlation between nutritional status and serum albumin[28]. The serum albumin levels were considered to a weak and limited predictor of nutritional status and were poorly correlated with other markers, such as global subjective assessment and handgrip strength[28].

Cardiovascular morbidity and mortality are not associated with hypoalbuminemia or inflammation[29]. In a retrospective cohort including 452,000 CKD patients from 25 countries across five continents, most deaths were due to cardiovascular disease, and the patients who died exhibited a gradual reduction in their serum albumin levels and an increase in their CRP levels[30].

Other studies have reported that hypoalbuminemia and increased CRP are strong predictors of clinical prognosis and mortality[29],[31]. Clinical parameters, including the results of biochemical tests, can reveal clinical abnormalities in CKD patients sufficiently early to being interventions[30].

CKD is characterized by dysregulated lipid metabolism, oxidative stress, inflammation and dyslipidemia[32]. Inflammation is inversely correlated with cholesterol levels[33], consistent with the results of the present study. However, in the present study, 60% of the participants with inflammation were treated therapeutically with statins, which may have promoted a reduction in the TC and LDL levels. Statins are able to reduce the CRP and LDL levels as well as morbidity and mortality due to cardiovascular disease and are able to delay the progression of CKD[34].

Based on the results described above, we conclude that the clinical and nutritional parameters assessed in the present study ought to be evaluated in conjunction with inflammatory parameters. Most of those indicators are widely available and can be used in clinical practice.

References

1. Locatelli F, Canaud B, Eckardt KU, Stenvinkel P, Wanner C, Zoccali C. Oxidative stress in end-stage renal disease: an emerging threat to patient outcome. Nephrol Dial Transplant. 2003;18 (7):1272-1280.
2. Gabay C, Kushner I. Acute-phase proteins and other systemic responses to inflammation. *N Engl J Med*. 1999; 340 (6): 448–454.
3. Kalantar-Zadeh K, Block G, McAllister CJ, Humphreys MH, Kopple JD. Appetite and inflammation, nutrition, anemia, and clinical outcome in hemodialysis patients. *Am J Clin Nutr*. 2004; 80 (2): 299–307.
4. Pearson T, Mensah G, Alexander R, et al. Markers of Inflammation and Cardiovascular Disease: Application to Clinical and Public Health Practice: A Statement for Healthcare Professionals From the Centers for Disease Control and Prevention and the American Heart Association. *Circulation*. 2003; 107:499-511.
5. Yeun JY, Kaysen GA. C-reactive protein, oxidative stress, homocysteine, and troponin as inflammatory and metabolic predictors of atherosclerosis in ESRD. *Curr Opin Nephrol Hypertens*. 2000; 9 (6):621-30.
6. Meuwese CL, Stenvinkel P, Dekker FW et al. Monitoring of inflammation in patients on dialysis: forewarned is forearmed. *Nat Rev Nephrol*. 2011; 7: 166–176.
7. Kyle, U G, et.al, Bioeletrical impedance analysis – part I: review of principles and methods. *Clinical Nutrition*. 2004; 23,1226-1243.
8. WHO, World Health Organization. Physical Status: The Use and Interpretation of Anthropometry. Report of a WHO Expert Committee. Geneva. 1995; 439p.
9. WHO, World Health Organization. Preventing and Managing the Global Epidemic. Report of a WHO Consultation on Obesity. Geneva: WHO, 1998.
10. Nutrition Screening Initiative. Interventions manual for professionals caring for older Americans. Washington, DC: Nutrition Screening Initiative, 1992.
11. Frisancho A.R. New norms of upper limb fat and muscle areas for assessment of nutritional status. *Am J Clin Nutr*. 1981; 34: 2540-2545.
12. World Health Organization. Obesity: preventing and managing the global epidemic. Report of a WHO Consultation. Geneva, World Health Organization; 1998. Technical Report Series, 894p.
13. NCEP. National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) final report. Circulation 2002;106:3143-421.
14. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clin Chem 1972; 18: 499–502.
15. Abraham G, Sundaram V, SundaramV, et al. C-Reactive Protein, a Valuable Predictive Marker in Chronic Kidney Disease. *Saudi J Kidney Dis Transpl*. 2009; 20(5):811-815.
16. Suliman ME, Quereshi AR, Stenvinkel P, et al. Inflammation contributes to low plasma amino acid concentrations in patients with chronic kidney disease. *Am J Clin Nutr* 2005; 82:342–9.
17. Alvarado MAR, Roitz CS. Relación entre los niveles séricos de la proteína C reactiva y medidas antropométricas; una revisión sistemática de los estudios realizados en Suramérica [Relationship between serum levels of C-reactive protein and anthropometric measurements: A systematic review of studies in South America]. *Nutr. Hosp*. 2012; 27 (4).

18. Carvalho LK, Silva MIB, Vale BS, et al. Annual variation in body fat is associated with systemic inflammation in chronic kidney disease patients Stages 3 and 4: a longitudinal study. *Nephrol Dial Transplant*. 2012; 27: 1423–1428.
19. Wang X H & Mitch W E. Mechanisms of muscle wasting in chronic kidney disease. *Nat. Rev. Nephrol*. 2014; 10, 504–516.
20. Ramos LF, Shintani A, Ikizler TA *et al*. Oxidative stress and inflammation are associated with adiposity in moderate to severe CKD. *J Am Soc Nephrol* 2008; 19: 593–599.
21. Chen S, Liu H, Liu X, Li Y, Li M, Yan Lianga et al. Central Obesity, C-Reactive Protein and Chronic Kidney Disease: A Community- Based Cross-Sectional Study in Southern China. *Kidney Blood Press Res*. 2013; 37:392-401.
22. Lee Y, Kang D, Lee As. Effect of dietary patterns on serum C-reactive protein level. *Nutr Metab Cardiovasc Dis*. 2014; 24 (9):1004-11.
23. Kim Y, Molnar MZ, Rattanasompattikul M, Hatamizadeh P, Benner D, Kopple JD. Relative contributions of inflammation and inadequate protein intake to hypoalbuminemia in patients on maintenance hemodialysis. *Int Urol Nephrol*. 2013; 45:215–227.
24. Raafat M, Metwaly A, Khalik AA, Abu-Zikri N, Madkour M, Hussein N. Inflammatory and Nutritional Biomarkers: Role as Non -Traditional Risk Factors for Cardiovascular Morbidity in Patients with Chronic Kidney Disease. *Life Science Journal*. 2012; 9 (2).
25. Clinical practice guidelines for nutrition in chronic renal failure. K/DOQI, National Kidney Foundation. *Am J Kidney Dis*. 2000*;* 35: S1– S140.
26. Friedman AF, Fadem SZ. Reassessment of Albumin as a Nutritional Marker in Kidney Disease. *J Am Soc Nephrol*. 2010; 21: 223–230.
27. Kaysen GA, Dubin JA, Muller Hans-Georg, et al. Inflammation and reduced albumin synthesis associated with stable decline in serum albumin in hemodialysis patients. *Kidney International*. 2004; 65, 1408–1415.
28. Gama-Axelsson T, Heimburger O, Stenvinkel P, Barany P, Lindholm B, Qureshi AR. Serum Albumin as Predictor of Nutritional Status in Patients with ESRD. *Clin J Am Soc Nephrol*. 2012; 7: 1446–1453.
29. Teixeira Nunes F, de Campos G, Xavier de Paula SM, et al. Dialysis adequacy and nutritional status of hemodialysis patients. *Hemodial Int* 2008; 12(1):45–51.
30. Usvyat LA, Barth C, Bayh I, et al. Interdialytic weight gain, systolic blood pressure, serum albumin, and C-reactive protein levels change in chronic dialysis patients prior to death. *Kidney International* 2013; 84: 149–157.
31. de Mutsert R, Grootendorst DC, Indemans F, Boeschoten EW, Krediet RT, Dekker FW. Netherlands Cooperative Study on the Adequacy of Dialysis-II Study Group. Association between serum albumin and mortality in dialysis patients is partly explained by inflammation, and not by malnutrition. 2009;19 (2):127-35.
32. Vaziri ND, Norris K. Lipid disorders and their relevance to outcomes in chronic kidney disease. *Blood Purif*. 2011; 31: 189–96.
33. Liu Y, Coresh J, Eustace JA, et al. Association Between Cholesterol Level and Mortality in Dialysis Patients Role of Inflammation and malnutrition. *JAMA*. 2004; 291:451-459.
34. Deng J, Wu Q, Liao Y, Huo D, Yang Z. Effect of statins on chronic inflammation and nutrition status in renal dialysis patients: A systematic review and meta-analysis. *Nephrology*. 2012; 17, 545–551.