

## Nutritional Status among Hospitalized Chronic Kidney Disease Patients in Chittagong Medical College Hospital

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### Abstract

**Background:** Despite being underdiagnosed, malnutrition is a Chronic Kidney Disease (CKD) consequence that has been shown to impact prognosis and quality of life. It is linked to mortality and a quick development to End-Stage Renal Disease (ESRD). Death and the rate of ESRD progression will be slowed down by early detection and therapy. Data regarding the dietary health of patients with Chronic Kidney Disease (CKD) are scarce in Bangladesh. This study sought to ascertain the frequency and pattern of malnutrition among CKD patients receiving hospital care.

**Materials and methods:** It was a hospital-based cross-sectional observational study, conducted at the Department of Nephrology and Medicine of Chittagong Medical College Hospital for a six-month period from April 2017 to September 2017. Ninety-seven hospitalized CKD patients were selected purposively as per set inclusion and exclusion criteria. Nutritional status was assessed by Body Mass Index (BMI) Mid-Upper Arm Circumference (MUAC) Triceps Skinfold Thickness (TSF) Arm Muscle Circumference (AMC) and serum albumin.

**Results:** The mean age of the population was 49.15 years (SD  $\pm$  14.16) with male and female ratio being 1.85:1.

More than 90% were in stage 5 of CKD. Based on the diagnostic criteria applied, the patients' frequency of malnutrition varied greatly, ranging from 15.5% to 97.9% of the population. It was highest by the AMC criteria in 97.9% of the patients, followed by 92.8% by TSF, 80.4% by MUAC, 56.7% by serum albumin and 15.5% by BMI.

**Conclusion:** Undernutrition is really common among chronic kidney disease patients in Bangladesh.

**Key words:** Chronic kidney disease; Hepcidin; Hb; Iron profile; Serum creatinine; C-Reactive Protein (CRP).

### Introduction

Chronic Kidney Disease (CKD) can be defined by the indicators of renal insufficiency like proteinuria, changes in kidney structure detected by imaging or increased serum creatinine.<sup>1</sup> Globally, CKD is now acknowledged as a public health problem. Globally trend of CKD is decreasing in developed countries like Australia, the USA, and European countries but in the developing countries, the picture was exactly the opposite.<sup>1</sup> Worldwide, an estimated 200 million people suffer from CKD, and the estimated prevalence was 13.4% among whom about 80% were in stages 3 to 5.<sup>1</sup> On the other hand, the reported prevalence in South Asian countries ranged between 17.2-29.9% during 2013-14.<sup>2-7</sup> According to the National Kidney Foundation of Bangladesh, the prevalence of CKD is 16- 18% in Bangladesh.<sup>8</sup> CKD is a big concern for developing countries including Bangladesh because of the increasing prevalence, high health expenditure, and low socioeconomic condition.<sup>5</sup>

Oliveira et al. stated that Malnutrition has been shown in multiple studies to affect 23%-76% of Hemodialysis patients (HD) and 18%-50% of patients on peritoneal dialysis.<sup>9</sup> Liman et al. used several indicators, including Subjective Global Assessment (SGA) weight change over a six-month follow-up period, BMI, TSF, MUAC, and blood albumin, to examine the baseline nutritional condition of 62 patients with chronic renal disease. The dietary condition of individuals

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undergoing HD was compared to that of those who have not yet started HD. 54.8% of the patients under study met the SGA criteria for malnutrition, 41.9% met the requirements based on weight loss during six months, 48.4% met the MUAC criteria, 17.7% met the BMI criteria, 85.5% met the TSF criteria, 24.2% met the serum albumin criteria and 69.4% met two or more criteria.<sup>10</sup>

Therefore, there is a dietary basis for CKD or at least a significant nutritional contribution to it. Patients with CKD experience changes in their nutritional status due to several reasons, including metabolic disorders. food depletion is linked to several factors, including low appetite, insufficient food intake, insulin resistance, infection, and oxidative stress.<sup>11</sup> Moreover, these individuals typically exhibit Protein-Energy Wasting (PEW) particularly as the disease nears its end.<sup>12</sup>

Most scholars agree that there isn't just one indicator of a patient's nutritional condition in CKD patients., and consequently, it is important to assess a variety of nutritional markers simultaneously, such as clinical, biophysical, and biochemical measures. A routine nutritional assessment should include a clinical evaluation of muscle mass, subcutaneous fat, and weight loss history. The majority of studies have evaluated patients' nutritional status using the Body Mass Index (BMI) Triceps Skinfold Thickness (TSF) Mid-Upper Arm Circumference (MUAC) and Mid-Arm Muscle Circumference (MAMC).<sup>13-15</sup>

The most often utilized laboratory parameters for regular evaluation of nutritional status are albumin, transferrin and other liver-derived protein concentrations in plasma.<sup>13</sup> However, anthropometry is becoming more widely utilized in renal centers since it is a legitimate and valuable clinical tool for determining the protein-energy nutritional status of patients with chronic kidney disease and it is also an easy, safe, practical and affordable procedure. Anthropometry, which includes height, body weight, percentage of standard body weight (The patient's present weight expressed as a percentage of ideal weight), BMI, TSF, MUAC and AMC, helps determine the patient's degree of adiposity and lean mass.<sup>9</sup>

In general, malnutrition increases the risk of premature death, an increased number of hospitalizations, loss of physical functional capacity, depression, worsening quality of life, more complex clinical management and increased health care costs translating into a substantial economic burden for health systems. A significant portion of patients with renal failure experience malnutrition, which is linked to higher rates of morbidity and mortality in this population. Studies that have solely assessed the dietary condition of patients with Chronic Kidney Disease (CKD) in Bangladesh are scarce. Thus, current data is necessary to raise awareness about malnutrition and the effects of low nutritional status in these patient populations. Thus, research is required to ascertain the nutritional condition of patients with Chronic Kidney Disease (CKD) in our context. The findings of this study could be useful in developing and executing intervention plans to provide well-functioning healthcare systems and improve the quality of life for individuals with chronic kidney disease.

### Materials and methods

We conducted this analytical cross-sectional study in the Department of Nephrology and Medicine of Chittagong Medical College Hospital (CMCH) from April 2017 to September 2017.

The study population included the CKD patients admitted into the CMCH during the study period. We included the adult patients (18 years and above) who was diagnosed as CKD patients and provided written consent. We excluded the patients with any malignancy, Congestive cardiac failure, chronic liver disease, chronic obstructive pulmonary disease, and tuberculosis.

We collected data from 97 eligible patients according to our sample size which was calculated considering the prevalence of under nutrition among hospitalized CKD patients of 0.5, 95% confidence interval and 80% of power. These participants were recruited through the convenience sampling method.

Data collection methods and instruments: The data was collected using a semi-structured questionnaire. After collecting the socio-demographic data

anthropometric assessments including height and weight for calculating the Body Mass Index (BMI) Mid Upper Arm Circumference (MUAC) Triceps Skin Fold Thickness (TSF) and Mid-Arm Circumference (MAC) of the patients were done using appropriate techniques. For laboratory investigations 3 cc of venous blood was collected and sent to the pathology department of CMCH. Every patient's information was captured once during their inpatient stay, or at the onset of the research if they were already in the hospital. No patient was included more than once, and no patient follow-up was carried out.

The statistical analysis was carried out by using the Statistical Package for Social Sciences (SPSS -23). Continuous variables were statistically described in terms of measures of central deviation. Qualitative or categorical variables were described as frequencies and proportions. Data were presented in appropriate tables and graphs. The diagnostic accuracy of the anthropometric indices was calculated considering serum albumin as a reference test.

The ethical approval was obtained from the Chittagong Medical College Ethical Review Committee. The participants provided informed written consent when they agreed to participate in this study. The purpose and procedure of this study were explained to them, and the issue of confidentiality and anonymity were ensured. In addition, they were given the right not to answer any question if they felt they were to do so and to withdraw from the study whenever it was deemed necessary by them.

## Results

Among the 97 study participants, only 19.6% were below 40 years of age while most of the participants were male with a male-to-female ratio of 1.85:1. About one-third (34%) were illiterate. All the women except two were housewives, however, about a third of the male participants were farmers. The majority of the respondents were from low (56.7%) or lower-middle-class (33.0%) families. Table 1 summarizes the sociodemographic characteristics of the participants.

**Table I** Socio-demographic characteristics of the patients (n=97)

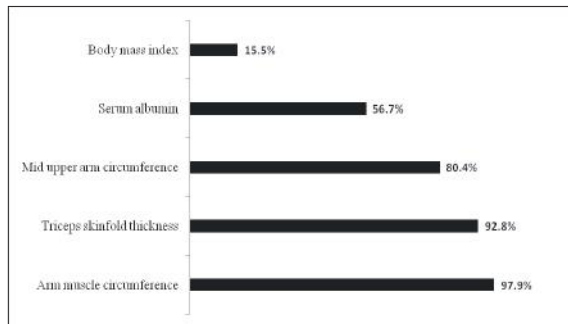
Characteristics	Frequency (n) / Mean	Percentage (%) / Standard Deviation
Age	49.2	±14.2
Sex		
Male	63	64.9
Female	34	35.1
Education		
Illiterate	33	34.0
Primary	33	34.0
Secondary	26	26.8
Higher Secondary and above	5	5.2
Occupation		
Housewife	32	32.9
Farmer	22	22.7
Industrial worker/laborer	16	16.5
Business	13	13.4
Service	10	10.3
Others	4	4.1
Economic condition		
Low	55	56.7
Lower middle class	32	33.0
Upper middle class	10	10.3

Out of 97 CKD patients, the majority of the patients (88, 90.7%) were in stage 5. Only seven patients were in stage 4 and two were in stage 3. Among these patients, only 15 (15.5%) were classified as undernourished when Body Mass Index (BMI) was used as a criterion. In the case of Mid Upper Arm Circumference (MUAC) the proportion of malnutrition was found to be 80.4%. In this study, 90 (92.8%) CKD patients were found to be malnourished while using the triceps skin fold as a criterion. This percentage was 97.9% for Arm Muscle circumference and 56.7% when serum albumin was considered as the criterion. Table 2 presents the nutrition parameters and nutritional status in detail and Figure 1 presents the prevalence of malnutrition using different parameters.

**Table II** Distribution of nutrition parameters in CKD patients by sex (n=97)

Characteristics	Female (n=34)	Male (63)	Total
Body Mass Index	20.9 ± 2.8	22.0 ± 3.7	21.6 ± 3.4
<18.5 kg/m <sup>2</sup>	5 (14.7%)	10 (15.9%)	15 (15.5%)
18.5-22.9 kg/m <sup>2</sup>	25 (73.5%)	34 (54.0%)	59 (60.8%)
23-24.9 kg/m <sup>2</sup>	3 (8.8%)	5 (7.9%)	8 (8.2%)
25-29.9 kg/m <sup>2</sup>	0 (0%)	12 (19.0%)	12 (12.4%)
≥30 kg/m <sup>2</sup>	1 (2.9%)	2 (3.2%)	3 (3.1%)

Characteristics	Female (n=34)	Male (63)	Total
Mid Upper Arm Circumference (MUAC) cm	20.5 ± 3.0	22.5 ± 2.8	21.8 ± 3.0
Normal	6 (17.6%)	13 (20.6%)	19 (19.6%)
Malnutrition	28 (82.4%)	42 (66.7%)	70 (72.2%)
Severe malnutrition	0 (0%)	8 (12.7%)	8 (8.2%)
Triceps Skin Fold Thickness cm	9.5 ± 2.7	8.1 ± 3.1	8.6 ± 3.4
Normal	2 (5.9%)	5 (7.9%)	7 (7.2%)
Malnutrition	9 (26.5%)	20 (31.7%)	29 (29.9%)
Severe malnutrition	23 (67.6%)	38 (60.3%)	61 (62.9%)
Arm Muscle Circumference cm	17.3 ± 2.4	19.9 ± 2.4	19.1 ± 2.7
Normal	0 (0%)	2 (3.2%)	2 (2.1%)
Malnutrition	33 (97.1%)	61 (96.8%)	94 (96.9%)
Severe malnutrition	1 (2.9%)	0 (0%)	1 (1.0%)
Serum Albumin, mg/dl	3.4 ± 0.4	3.3 ± 0.5	3.3 ± 0.5
Normal (≥3.5 mg/dl)	16 (47.1%)	26 (41.3%)	42 (43.3%)
Malnutrition (<3.5 mg/dl)	18 (52.9%)	37 (58.7%)	55 (56.7%)



**Figure 1** Prevalence of malnutrition by different parameters in CKD patients (n=97)

To assess the reliability of BMI in comparison to serum albumin in the classification of nutritional status of CKD patients' concordance was found in 51 (52.6%) cases. There was a slight agreement between the two tests as evidenced by the kappa value. To assess the reliability of MUAC in comparison to serum albumin was found in 56 (57.73%) cases. For TSF, the concordance was found in 54 (55.7%) cases and this value was 56.7% for AMC. The details of the diagnostic reliability in comparison to albumin are presented in Table III.

**Table III** Diagnostic reliability of different nutritional parameters in comparison to serum albumin

Criteria	Sensitivity	Specificity	Positive predictive	Negative predictive	Diagnostic accurac
			value	value	
BMI	21.8	92.8	80.0	47.6	52.6
MUAC	83.6	23.8	59.0	52.6	57.7
TSF	92.7	7.1	56.7	42.9	55.7
AMC	98.2	2.4	56.9	50.0	56.7

## Discussion

The study participants' average age was 49.15 years, with a standard deviation of 14.16 years. This is comparable to a study carried out in Dhaka Medical College Hospital (DMCH), Bangladesh, where the average age was 47.3 years, with a standard deviation of 15.4 years, in Nepal 46.9 years with SD ± 17.9 years and in India 42.3 years with SD ± 12.5 years respectively.<sup>17,18,3</sup> However, this is not the case for a study done in the Kingdom of Saudi Arabia, where the average age was 37.4 years with a standard deviation of 11.3 years.<sup>18</sup> In this study, the age group of 50–59 years old had a higher prevalence of CKD (32%), which is comparable to the results of a study conducted at DMCH, where the age group of 40–49 years old had a higher prevalence.<sup>16</sup> This study's male-predominant sex distribution is consistent with research from Bangladesh, India, and Nepal.<sup>3,16-17</sup> Nevertheless, a higher prevalence was seen in females in certain other studies carried out in Western nations like Australia and the USA.<sup>19-20</sup> This demonstrates the prevalence of men in this region of the world seeking medical attention.

In the present study, 34% of the study participants were illiterate, 34% had primary level education or below, and the rest had at least secondary educational qualification SSC and above. The majority of the respondents were from low (56.7%) or lower middle class (33.0%). These findings align with a study conducted in DMCH.<sup>16</sup> Similar findings were also reported in a study in Taiwan.<sup>21</sup> However, in countries like Bangladesh, this pattern of education, occupation and socio-economic status is expected since usually, the people from the lowest quintile visit these public hospitals for care.

In the current study, most of the respondents (90.7%) were in stage 5 of CKD, 7.2% in stage 4 and 2.1% in stage 3 which is nearly similar to the study conducted in DMCH<sup>15</sup> where 76.7% of CKD patients in stage-5, 16% in stage-4 and 7.3% in stage-3. It does not, however, closely resemble the NHANES III population-based study, which found that just 0.4% of participants had CKD in stages 4 and 5, and that more than 5% had CKD in stages 1 through 3.<sup>16,22</sup>



This survey's total respondents had a BMI of 60.8%, whereas 15.5% had a BMI below normal. This is comparable to a study conducted in Bangladesh, where 54.0% of respondents had a normal BMI, 34.0% were overweight, and 12.0% had a BMI below normal.<sup>16</sup> However, research conducted in Saudi Arabia found that 60.7% of those with CKD were overweight.<sup>18</sup> In our study, the corresponding figure of overweight, obesity and morbid obesity was 8.2%, 12.4% and 3.1% respectively. The variations in these studies' diagnostic criteria and study subjects' status as maintenance dialysis patients could account for the variation in prevalence. The majority of research evaluating nutritional status was done on patients on HD maintenance. Oliveria et al. discovered that there was only regular (Kappa = 0.264) concordance in the nutritional diagnosis between the traditional subjective global assessment (SGA) and BMI (cutoff point of 18.5 kg/m<sup>2</sup>). Conversely, at a BMI cutoff value of 22.0 kg/m<sup>2</sup>, there was a moderate concordance across the approaches (Kappa = 0.503), indicating that this cutoff point would be better suitable for nutritional assessment.<sup>9</sup> In our study the cutoff point for BMI was <18.5 kg/m<sup>2</sup>. Possibly, this is the reason why we could not show strong concordance between BMI and Serum Albumin. Mid-Upper Arm Circumference (MUAC) reflects protein deposits. It can be easily applied and not subject to examiner-dependent errors. Overall, 78 (81%) CKD patients were malnourished while 8 (8.2%) were severely malnourished using the MUAC criteria in the present study. However, Triceps Skinfold Thickness (TSF) and Arm Muscle Circumference (AMC) were poor techniques for assessing nutritional status, showing a high prevalence of malnutrition even in individuals whose BMI and blood albumin levels were considered normal.<sup>9</sup> Similar to the high prevalence of malnutrition as observed in the current study Oliveria et al. also noticed a higher prevalence with MAUC, TSF and AMC in comparison to serum albumin and BMI criteria.<sup>9</sup> To assess the reliability of BMI, MUAC, TSF and AMC in comparison to serum albumin in the classification of nutritional status of CKD patients, there was slight agreement in all anthropometric assessments as evidenced by kappa value. Among these four anthropometric

indices, MUAC has the highest (57.73%) diagnostic accuracy, followed by AMC (56.7%), TSF (55.67%) and BMI (52.58%) considering the serum albumin as a reference test.

From the above discussion, it is evident that the prevalence of malnutrition varied widely between studies. Besides the uniformity of the study subjects the lack of reference patterns considering age and sex could be attributable for these differences. In addition, the interpretation of anthropometric data may be impaired by the intra-observer variability, which was 4.7% for AMC and 22.6% for TSF.<sup>9</sup> Nevertheless, as a simple, safe, practical and cost-effective method anthropometric indices are used widely in CKD and other hospitalized patients along with the biochemical markers.

### Limitations

One of the main limitations of this study was that this was a single-centre study. However, the centre is a tertiary-level hospital and accommodates referred patients from many hospitals in the region. Secondly, the sample size was relatively small. But, since we did not opt for multivariable analysis, the sample size was sufficient to provide statistical power for the descriptive statistics of our study. Finally, our study will not be generalizable to all CKD patients since we could recruit stage 3-5 patients only.

### Conclusion

Our study suggests that undernutrition is really common among CKD patients in Bangladesh. This study warrants the need for anthropometric measurement of such patients. Moreover, in such resource-poor settings, precise measurement can save a lot of money as well and reduce the out-of-pocket expenditure of the people.

### Recommendations

The current study reveals that anthropometric measures can be helpful for nutritional assessments of the patients. Further studies with larger sample size and more diverse group of population should be conducted to identify the current status. Moreover, the healthcare provider should be trained to take anthropometric measures for their patients which, in turn, would also help them in the clinical practice.

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### Contribution of the authors

NN-Conception, design, data collection, manuscript writing & final approval.

MSU-Interpretation of data, critical revision & final approval.

MK-Data analysis, drafting & final approval.

SH-Study design, critical revision & final approval.

MQI-Data collection, critical revision & final approval.

TK-Data collection, drfting & final approval.

MKH-Data collection, drfting & final approval.

MAKC-Study design, data analysis, manuscript writing & final approval.

SC-Data collection, critical revision & final approval.

PKD-Conception, study design, critical revision & final approval.

### Disclosure

The authors declared no conflict of interest.

### References

1. Lozano R, Naghavi M, Foreman K et al. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: A systematic analysis for the Global Burden of Disease Study 2010. *Lancet*. 2013; 380: 2095–2128.
2. Roy S. Determinants of healthcare expenditure on human capital and economic growth in Bangladesh: a longitudinal data analysis from 1995–2010. *Asian J Pharm Res Health Care*. 2014; 6: 6–10.
3. Singh AK, Farag YM, Mittal BV et al. Epidemiology and risk factors of chronic kidney disease in India—results from the SEEK (Screening and Early Evaluation of Kidney Disease) study. *BMC Nephrol*. 2013; 14: 114.
4. Sharma SK, Dhakal S, Thapa L et al. Community-based screening for chronic kidney disease, hypertension and diabetes in Dharan. *JNMA J Nepal Med Assoc*. 2013; 52: 205–212.
5. Jafar TH, Schmid CH, Levey AS. Serum creatinine as marker of kidney function in South Asians: a study of reduced GFR in adults in Pakistan. *J Am Soc Nephrol*. 2005; 16: 1413–1419.

6. Perkovic V, Cass A, Patel AA et al. High prevalence of chronic kidney disease in Thailand. *Kidney Int*. 2008; 73: 473–479.

7. Anand S, Khanam MA, Saquib J et al. High prevalence of chronic kidney disease in a community survey of urban Bangladeshis: A cross-sectional study. *Global Health*. 2014; 10: 9.

8. National Kidney Foundation, T. KDOQI Clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. 2002. [http://www.kidney.org/professionals/KDOQI/guidelines\\_ckd/](http://www.kidney.org/professionals/KDOQI/guidelines_ckd/).

9. Oliveira CMC, Marcos Kubrusly M, Mota RS, da Silva CAB. Malnutrition in chronic kidney failure: What is the best diagnostic method to assess? *J Bras Nefrol*. 2010;32(1):55-68.

10. Liman HM, Anteyi EA, Oviyasu E. Prevalence of malnutrition in chronic kidney disease : A study of patients in a tertiary hospital in Nigeria. *Sahel Med J*. 2012;18 Suppl.SI: 8-11.

11. Chung S, Koh ES, Shin SJ & Park CW. Malnutrition in patients with chronic kidney disease. *Open journal of internal medicine*. 2012;2: 89-99.

12. Ikizler TA, et al. 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 international*. 2013;84 (6): 1096-1107.

13. Stevenkel P, Barany P, Chung SH, Lindholm B, Heimbürger O. A comparative analysis of nutritional parameters as predictors of outcome in male and female ESRD patients. *Nephrol Dial Transplant*. 2002;17:1266-1274.

14. Henn A and Cano N J M. Nutritional problems in adult patients with stage 5 chronic kidney disease on dialysis (Both haemodialysis and peritoneal dialysis). *Nephrol Dial Transplant*. 2010;3:109-117.

15. De Mutsert R, Snidjer MB, Van Der Sman de Beer F, et al. Association between body mass index and mortality is similar in the haemodialysis population and the general population at high age and equal duration of follow up. *J Am Soc Nephrol*. 2007;18:967-974.

16. Haq MN, Rahman L, Miah MZI, Gazi EA, Baroi SC. Epidemiological Pattern of Renal Insufficiency among the Patients of Nephrology Unit of Dhaka Medical College Hospital, Dhaka, Bangladesh. *Faridpur Med. Coll. J*. 2013;8(2):80-84.

17. Chhetri PK, Manandhar DN, Bhattarai SP, Pahari LR, Shrestha R. Risk factors of Renal Disease). *Nep Med Coll J*. 2008; 10 (1):8-10

18. Abdulkareem OA, Youssef MKF, Abdulla AAS, Dujanah M, Fayez A, Ali A, et al. Epidemiology of Chronic Kidney Disease in the Kingdom of Saudi Arabia. *Saudi J Kidney Dis Transplant*. 2010; 21 (6):1066-1072.

**19.** Chadban S, Briganti E, Kerr P. Prevalence of kidney damage in Australian adults: The AusDiab kidney Study. *J Am Soc Nephrol.* 2003;14:S131-S138.

**20.** Weinhandl E, Constantini E, Everson S, Gilbertson D, Li S, Solid C, et al. Peer kidney care initiative 2014 report: Dialysis care and outcomes in the United States. *Am J Kidney Dis.* 2015;65 Suppl 1:S1–140.

**21.** High CCH, Shang-Jyh H, Chi-Pang W, Hsing-Yi C, Ted C, RueiShiang S, et al. Prevalence and Low Awareness of CKD in Taiwan: A Study on the Relationship Between Serum Creatinine and Awareness From a Nationally Representative Survey. *Am J Kidney Dis.* 2006; 48:727-738.

**22.** Jones CA, Mcquillan GM, Kusek JW. Serum creatinine levels in the US population: Third National Health and Nutrition Examination Survey. *Am J Kidney Dis.* 1998, 32:992-999.