Quality of life and mortality from a nephrologist's view: a prospective observational study
Seung Seok Han1, Ki Woong Kim2, Ki Young Na1,4, Dong-Wan Chae1,3,4, Yon Su Kim1,3, Suhnggwon Kim1,3 and Ho Jun Chin*1,3,4

Address: 1Department of Internal Medicine, Seoul National University College of Medicine, Seoul, Korea, 2Department of Psychiatry, Seoul National University College of Medicine, Seoul, Korea, 3Kidney Research Institute, Seoul National University College of Medicine, Seoul, Korea and 4Department of Internal Medicine, Seoul National University Bundang Hospital, Gyeonggi-do, Korea
Email: Seung Seok Han - hansway@medimail.co.kr; Ki Woong Kim - kwkimmd@snu.ac.kr; Ki Young Na - kyna@snubh.org; Dong-Wan Chae - cdw1302@snubh.org; Yon Su Kim - yonsukim@snu.ac.kr; Suhngwon Kim - skimim@plaza.snu.ac.kr; Ho Jun Chin* - mednep@snubh.org
* Corresponding author

Abstract

Background: Although health-related quality of life (HRQOL) is a potential independent predictor of mortality, nephrologists have shown little interest in HRQOL with respect to mortality in chronic kidney disease (CKD). The aim of this article is to evaluate the impact of HRQOL on mortality in the elderly, who are likely to develop or already have CKD.

Methods: Among 1,000 randomly sampled participants aged more than 65 years (sourced from the Korean Longitudinal Study on Health and Ageing), 944 subjects were evaluated for HRQOL. HRQOL was assessed using a 36-item Short-Form health survey (SF36). A cumulative survival rate was calculated according to tertiles of SF36 scores and classified by the presence of CKD (estimated GFR <60 ml/min/1.73 m²).

Results: Among 944 subjects, 46.6% had CKD. CKD patients had lower total and physical component scores compared with subjects without CKD. The 3-year cumulative survival rate was 90.0% (non-CKD vs. CKD: 92.6% vs. 87.4%, \( P = 0.005 \) by log rank test). After adjusting for multiple variables, a reduced SF36 score (physical and mental components) was a strong predictor of all-cause mortality. Physical components were consistently able to predict mortality after CKD classification, but mental components were statistically significant only in the CKD group.

Conclusion: In addition to traditional risk factors of mortality, nephrologists should be aware of HRQOL as a predictor of mortality and should make efforts to improve HRQOL in CKD patients.
CKD in the elderly has increased to nearly half of the population aged 70 years and older [3], and the incidence among the elderly in Korea is similar [4]. Therefore, the problems associated with CKD need to be appropriately managed to reduce the burden of CKD in the aging society.

The ability to predict future morbidity and mortality is a key to reduce the burden of CKD. To this end, monitoring a patient's functional and subjective status of well-being, collectively known as health-related quality of life (HRQOL), is of particular importance in CKD patients [4-7]. Traditional risk factors (e.g., atherosclerosis, smoking, and diabetes mellitus) for mortality had been considered important in the elderly with or without CKD [8,9]; however, it is currently thought that traditional risk factors do not account for all reported mortality [10]. Recently, HRQOL, comprising physical, mental, and social health, is recognized as an important predictor of mortality in elderly individuals or patients with end-stage renal disease [5,7,11,12]. However, nephrologists have shown little interest in the role that HRQOL plays in mortality in CKD patients [13].

The 36-item Short-Form health survey (SF36) has been validated as a QOL assessment tool for a wide variety of patients, including CKD patients [14-16]. Here, we evaluate HRQOL using the SF36 and assess the impact of HRQOL on mortality in the elderly, who are likely to develop or already have CKD.

**Methods**

**Study Participants**

The present study was designed as a population-based, prospective cohort study of health, aging, and common geriatric diseases in a population aged ≥65 years in Seongnam-si, a satellite city of Seoul, Korea. The study design was described in detail elsewhere as an element of the Korean Longitudinal Study on Health and Aging (KLoSHA) [17]. The baseline phase of KLoSHA began in September 2005. The KLoSHA includes two cohorts, one selected from the total population of Seongnam-si (931,019 individuals) and a 6.6% sample of the population aged ≥65 years. For the elderly sample (Sample-RE), a simple random sample (1,118 individuals, 1.81%) was selected from a list of 61,730 residents aged ≥65 years as of August 1, 2005. The sampled subjects were invited to participate in the study by letter and telephone. Of the 1,118 candidates, 698 agreed to participate in the baseline KLoSHA study. For the “oldest old age” sample (Sample-OO), all individuals aged ≥85 years in Seongnam-si (3,136 persons) were contacted by letter and telephone, and 302 agreed to participate in the KLoSHA. We enrolled the Sample-OO in addition to the Sample-RE. All participants were Korean. From a random sample of 1,000 participants, we evaluated 944 who had examined the SF36.

All assessments were performed at the Seoul National University Bundang Hospital in Gyeonggi-do, Korea. An independent ethics committee at each participating institution (SNUBH) approved the study protocol (B-0508/023-003). The study was conducted in accordance with the Declaration of Helsinki.

**Measurements and Definitions**

The investigated clinical parameters included age, sex, ever-drinking, ever-smoking, and a history of hypertension, diabetes mellitus, coronary heart disease (CHD), or cerebrovascular accident (CVA). Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured after participants had rested for at least 3 minutes. Numerous laboratory measurements were obtained. Serum measurements included hemoglobin, glucose, total protein, albumin, total cholesterol, triglyceride, high-density lipoprotein (HDL) cholesterol, and creatinine (Cr) levels. Urine measurements included a dipstick test for albumin and measurement of red blood cell (RBC) counts per high-power field by light microscopy. Glomerular filtration rate (GFR) was calculated for 932 participants using the Modification of Diet in Renal Disease (MDRD) Study equation [18].

Patients with one of the following were classed as hypertensive: SBP ≥140 mmHg, DBP ≥90 mmHg, or use of antihypertensive medication, irrespective of BP. Diabetes mellitus was defined as a fasting glucose level ≥126 mg/dL or the use of hypoglycemic agents. CHD was defined as self-reported history of angina pectoris, acute myocardial infarction, percutaneous coronary intervention, or coronary artery bypass operation. Proteinuria was defined as albumin ≥1+ and hematuria as an RBC count >5 per high-power field. CKD was defined as an estimated GFR <60 ml/min/1.73 m² [19].

The HRQOL of subjects was assessed using the Korean version of the SF36 [14,20]. It consists of 36 questions, 35 of which are included on eight multi-item scales: Physical Functioning, Role--Physical, Bodily Pain, General Health, Vitality, Social Functioning, Role--Emotional, and Mental Health. The SF36 assesses physical and mental health components. All-cause mortality data were obtained from the Ministry of Public Administration and Security’s national database in June 2009.

**Statistical analysis**

All analyses were performed using SPSS software (SPSS version 16.0, Chicago, IL, USA). Data were presented as mean/standard deviations (SD) for continuous variables and as proportions for categorical variables. Demographic and clinical data were described and compared between CKD and non-CKD groups. Differences were analyzed
using the $\chi^2$ test for categorical variables and the Student’s $t$ test for non-categorical variables. All subjects were divided into three groups according to tertiles of SF36 scores. The unadjusted hazard ratios for all-cause mortality were calculated by the Cox proportional hazard model (model 1), and adjustments were made (model 2). Variables included for adjustments were age, gender, and others that had $P$ values of less than 0.05 in univariate analyses. The hazard ratio for all-cause mortality was calculated after classifying subjects according to the presence of CKD. A $P$ value of less than 0.05 was considered significant.

**Results**

**Baseline characteristics of participants**

Table 1 shows the patient baseline characteristics. Of the 944 participants, 424 (44.9%) were male and 520 (55.1%) were female. The mean age was 76 years (range, 65-98 years). The proportions with hypertension and diabetes were 71.1% and 20.9%, respectively. The mean creatinine level was 1.12 mg/dL and the mean GFR was 61.1 ml/min/1.73 m$^2$. Among the participants, 46.6% had a GFR of less than 60 ml/min/1.73 m$^2$; 8 (0.9%) had a GFR of 15-30 ml/min/1.73 m$^2$, and 2 (0.2%) had a GFR of less than 15 ml/min/1.73 m$^2$. The physical component score was significantly lower in CKD patients than in non-CKD subjects.

**Table 1: Demographics of participants responding to the baseline Short Form with 36 questions**

|                     | CKD (-) (n = 488) | CKD (+) (n = 444) | Total subjects (n = 944) |
|---------------------|-------------------|-------------------|-------------------------|
| Age‡               | 74.8/8.2          | 77.4/8.9          | 76.0/8.6                |
| Male gender (%)‡    | 52.9              | 36.5              | 45.1                    |
| Hypertension (%) ‡  | 68.0              | 74.4              | 71.1                    |
| Diabetes mellitus (%) | 20.9            | 20.5              | 20.9                    |
| CHD (%)†           | 4.7               | 10.6              | 7.6                     |
| CVA (%)            | 9.2               | 11.0              | 10.1                    |
| Ever-drinking (%)‡  | 45.5              | 32.4              | 39.2                    |
| Ever-smoking (%) * | 43.1              | 35.7              | 39.6                    |
| SBP (mmHg)         | 132.6/17.8        | 132.2/18.3        | 132.5/18.1              |
| DBP (mmHg)         | 82.8/10.2         | 82.5/11.0         | 82.7/10.6               |
| Serum findings     |                   |                   |                         |
| Hemoglobin (g/dL)‡ | 13.9/1.6         | 13.6/1.4          | 13.7/1.5                |
| Glucose (mg/dL)†   | 111.0/28.0        | 106.4/20.9        | 108.9/25.1              |
| Total protein (g/dL)| 7.4/0.47         | 7.5/0.46          | 7.5/0.46                |
| Albumin (g/dL)     | 4.09/0.27         | 4.09/0.22         | 4.09/0.24               |
| Total cholesterol (mg/dL) ‡ | 199.5/37.5  | 205.7/37.6        | 202.7/37.9              |
| Triglyceride (mg/dL) | 131.1/88.8      | 137.8/29.2        | 135.0/82.1              |
| HDL cholesterol (mg/dL) | 60.8/16.0   | 59.5/14.8         | 60.2/15.4               |
| Creatinine (mg/dL)‡ | 0.98/0.15        | 1.27/0.41         | 1.12/0.34               |
| eGFR (ml/min/1.73 m$^2$)‡ | 70.2/8.7     | 51.0/8.1          | 61.1/12.8               |
| Proteinuria (%)    | 7.4              | 9.4               | 8.4                     |
| Hematuria (%)      | 9.9              | 11.3              | 10.8                    |
| SF36 score         |                   |                   |                         |
| Physical functioning| 56.9/27.89       | 50.6/29.60        | 53.9/28.88              |
| Role—physical†     | 71.1/28.46       | 65.3/32.70        | 68.4/30.67              |
| Bodily pain        | 63.1/28.11       | 59.3/31.64        | 61.3/29.89              |
| General health     | 43.8/21.85       | 42.7/22.05        | 43.3/21.94              |
| Vitality           | 52.3/20.56       | 50.6/21.87        | 51.5/21.20              |
| Social functioning | 79.5/23.55       | 76.4/26.80        | 78.0/25.18              |
| Role—emotional     | 81.4/26.00       | 78.3/29.36        | 79.9/27.68              |
| Mental health      | 68.6/19.52       | 67.6/20.84        | 68.1/20.15              |
| PCS†               | 55.8/13.3        | 53.1/14.6         | 54.5/14.0               |
| MCS                | 52.2/10.1        | 51.1/11.0         | 51.7/10.5               |
| Median follow-up (interquartile, months) | 39 (35–42) | 39 (35–41) | 39 (35–42) |

GFR was not estimated in twelve subjects.

P < 0.05, † P < 0.01, ‡ P < 0.001

Abbreviations: CKD: chronic kidney disease; CHD: coronary heart disease; CVA: cerebrovascular accident; SBP: systolic blood pressure; DBP: diastolic blood pressure; HDL: high-density lipoprotein; eGFR: estimated glomerular filtration rate; SF36: 36-item Short-Form health survey; PCS: physical component summary score; MCS: mental component summary score.
During the 3-year follow-up period (0-45 months), 104 subjects (11.0%) died. Among the clinical and laboratory parameters in Table 1 (excluding the SF36 scores), the mortality rate was associated with age (52.3% older vs. 47.7% younger by a median age of 73 years: OR 5.97 (3.50-10.20), \( P < 0.001 \), ever-smoking (+39.6% vs. -60.4%: OR 1.60 (1.08-2.35), \( P = 0.018 \), proteinuria (+6.4% vs. -91.6%: OR 2.08 (1.20-3.61), \( P = 0.009 \), serum levels of hemoglobin (1 g/dL increase: OR 0.83 (0.74-0.94), \( P = 0.002 \), total protein (1 g/dL increase: OR 0.50 (0.33-0.75), \( P = 0.001 \), albumin (1 g/dL increase: OR 0.17 (0.10-0.27), \( P < 0.001 \), total cholesterol (1 mg/dL increase: OR 0.99 (0.99-0.96), \( P = 0.004 \), HDL cholesterol (1 mg/dL increase: OR 0.98 (0.97-1.00), \( P = 0.007 \), and estimated GFR (CKD vs. non-CKD: OR 1.74 (1.17-2.58), \( P = 0.006 \). These variables were used for adjustments in multivariate analyses. The 3-year cumulative survival rate was 90.0% (non-CKD group vs. CKD group: 92.6% vs. 87.4%, \( P = 0.005 \) by the log rank test).

**Influence of health-related quality of life on all-cause mortality**

Each 10-unit increase on the eight scales was associated with decreased all-cause mortality in study participants after adjustment for multiple variables (Table 2). Univariate analysis showed that groups with high scores of SF36 components (except general health) had greater survival rates than groups with low scores. This trend remained consistent after adjustment (model 2).

We divided subjects into two groups on the basis of presence of CKD. Figure 1 and Figure 2 show the Kaplan-Meier curve according to tertiles of SF36 scores and the presence of CKD. Cumulative survival rates according to physical and mental component scores were further separated by the presence of CKD (\( P < 0.001 \) in Figure 1 and Figure 2 by the log rank test). By multivariate analysis (Table 3), the physical component score was associated with all-cause mortality, irrespective of CKD. The mental component score was significantly correlated with all-cause mortality in the CKD group; however, the correlation was only marginally significant in the non-CKD group.

**Discussion**

Clinicians focus on newer risk factors (e.g., inflammation, oxidative stress, and epigenetic change) as well as traditional risk factors (e.g., atherosclerosis, smoking, and diabetes mellitus) when assessing mortality risk in patients with CKD [21]. It is essential to evaluate non-typical risk factors because the aging society is more heavily con-

| SF36 survey                          | Model 1a | Model 2b |
|--------------------------------------|----------|----------|
|                                      | HR (95% CI) | \( P \) value | HR (95% CI) | \( P \) value |
| 10-unit increase in SF36 components  |          |          |
| Physical functioning                  | 0.78 (0.72--0.83) | <0.001 | 0.81 (0.75--0.89) | <0.001 |
| Role—physical                        | 0.85 (0.81--0.90) | <0.001 | 0.90 (0.85--0.96) | 0.001 |
| Bodily pain                          | 0.90 (0.85--0.96) | 0.002 | 0.92 (0.86--0.99) | 0.020 |
| General health                       | 0.93 (0.85--1.02) | 0.123 | 0.90 (0.82--1.00) | 0.052 |
| Vitality                             | 0.85 (0.77--0.93) | <0.001 | 0.88 (0.79--0.98) | 0.018 |
| Social functioning                   | 0.83 (0.78--0.90) | <0.001 | 0.87 (0.81--0.93) | <0.001 |
| Role—emotional                      | 0.84 (0.80--0.89) | <0.001 | 0.88 (0.83--0.93) | <0.001 |
| Mental health                        | 0.85 (0.78--0.93) | 0.001 | 0.83 (0.75--0.91) | <0.001 |
| Physical component summary score     |          |          |
| Tertile 1 (<49.4)                    | I (Reference) |          | I (Reference) |          |
| Tertile 2 (49.4--61.7)               | 0.46 (0.30--0.72) | 0.001 | 0.54 (0.33--0.87) | 0.011 |
| Tertile 3 (>61.7)                    | 0.25 (0.14--0.43) | <0.001 | 0.35 (0.19--0.64) | 0.001 |
| Mental component summary score       |          |          |
| Tertile 1 (<49.0)                    | I (Reference) |          | I (Reference) |          |
| Tertile 2 (49.0--57.0)               | 0.68 (0.44--1.05) | 0.082 | 0.63 (0.40--1.01) | 0.055 |
| Tertile 3 (>57.0)                    | 0.36 (0.21--0.61) | <0.001 | 0.39 (0.22--0.70) | 0.001 |

a Unadjusted model.

bModel adjusted for age, gender, ever-smoking, proteinuria, serum levels of hemoglobin, total protein, albumin, cholesterol, HDL cholesterol, and estimated GFR.

Abbreviations: SF36: 36-item Short-Form health survey; HR: hazard ratio; CI: confidence interval.
fronted with various non-traditional co-morbidities. In the present study, we evaluated the relationship between HRQOL, as measured by the SF36, and all-cause mortality in an elderly population with or without CKD. Both physical and mental components, including each health component, affected all-cause mortality in elderly subjects. This trend was consistent for individuals with CKD. To the best of our knowledge, although HRQOL is known to be related to mortality in patients with end-stage renal disease, no report has been published on the correlation between HRQOL and mortality in patients with CKD. This issue should be kept in mind by nephrologists who may otherwise not be interested in the QOL of CKD patients.

The SF36 is an approved test that is applicable to healthy elderly individuals as well as CKD patients [14-16]. Han et al. also used the SF36 for assessing HRQOL in elderly Koreans (n = 219, aged 73.7 years) [22]. The SF36 scores for each component were similar between Han’s cohort and our study cohort, but scores of social functioning, role emotional, and mental health were higher in our cohort. Recently, Mujais et al. reported HRQOL in CKD patients using the Kidney Disease Quality of Life (KDQOL) questionnaire, which combines the generic SF36 instrument with a kidney disease-specific instrument [23]. In their study, the mean physical and mental component scores for stage 3 CKD patients were 40 and 51, respectively. Although comparison between two cohorts is impossible

Table 3: Stratified analysis of all-cause mortality by the presence of chronic kidney disease

| SF36 survey                        | CKD (-) (n = 488) | P value | CKD (+) (n = 444) | P value |
|------------------------------------|-------------------|---------|-------------------|---------|
| Physical component summary score   |                   |         |                   |         |
| Tertile 1 (<49.4)                  | 1 (Reference)     |         | 1 (Reference)     |         |
| Tertile 2 (49.4--61.7)             | 0.44 (0.21--0.92) | 0.029   | 0.54 (0.28--1.05) | 0.068   |
| Tertile 3 (>61.7)                  | 0.23 (0.09--0.60) | 0.003   | 0.44 (0.20--0.98) | 0.045   |
| Mental component summary score     |                   |         |                   |         |
| Tertile 1 (<49.0)                  | 1 (Reference)     |         | 1 (Reference)     |         |
| Tertile 2 (49.0--57.0)             | 0.67 (0.33--1.37) | 0.273   | 0.51 (0.27--0.99) | 0.041   |
| Tertile 3 (>57.0)                  | 0.41 (0.16--1.05) | 0.051   | 0.35 (0.17--0.74) | 0.006   |

Model adjusted for age, gender, ever-smoking, proteinuria, serum levels of hemoglobin, total protein, albumin, cholesterol, HDL cholesterol, and estimated GFR.

Abbreviations: CKD, chronic kidney disease; SF36, 36-item Short-Form health survey; HR, hazard ratio; CI, confidence interval.

Figure 1
Survival curves classified by the presence of chronic kidney disease: physical component score. The Kaplan-Meier curve is assessed in participants according to the physical component score. Tertiles in physical component score: T1, <49.4; T2, 49.4--61.7; T3, >61.7.

Figure 2
Survival curves classified by the presence of chronic kidney disease: mental component score. The Kaplan-Meier curve is assessed in participants according to the mental component score. Tertiles in mental component score: T1, <49.0; T2, 49.0--57.0; T3, >57.0.
The importance of HRQOL in patients with end-stage renal disease is well known. DeOreo et al. examined the SF36 score in 1,000 patients who underwent hemodialysis [28]; the median values of the physical and mental component scores were 37 and 47, respectively. It was revealed that a low SF36 score, particularly a low physical component score, was associated with increased hospitalization and mortality rates. Kalantar-Zadeh et al. also measured SF36 scores in 65 end-stage renal disease patients and found a correlation with hospitalization and mortality; the mental component score and total score had the strongest correlations [5]. Furthermore, these researchers revealed that serum albumin and hemoglobin levels were associated with SF36 scores. However, few studies have investigated CKD patients with reduced renal function (GFR less than 60 ml/min/1.73 m²). The present study showed that elderly CKD patients had lower HRQOL scores than subjects without CKD; this reduced HRQOL score was strongly associated with increased all-cause mortality after adjustment for traditional risk factors and chemical markers. Furthermore, as shown in Figure 1 and Figure 2, HRQOL further separated the mortality rate according to the presence of CKD. In this regard, we should treat HRQOL and CKD equally.

Although our results are informative, our study is not without limitations. First, because all participants in our cohort were elderly Asian individuals, our results may not be applicable to other ethnic groups or adults aged <65 years with CKD. Indeed, Lopes et al. have reported differences in HRQOL among various ethnic groups undergoing hemodialysis [29]. Second, the MDRD equation has not yet been investigated in the Korean population and may not be appropriate for the elderly population. Third, HRQOL was measured only once at the start of the present prospective research; therefore, our data do not show changes during the follow-up period. Fourth, HRQOL was higher than expected (mean value: 54.5 in the physical component; 51.7 in the mental component). However, the purpose of our study was not to evaluate the cut-off point of the SF36 score. Rather, we sought to understand an independent correlation between HRQOL and mortality in CKD patients.

**Conclusion**
The present study demonstrated that HRQOL was a strong predictor of all-cause mortality in an elderly Asian population, including subjects with CKD. Although the present study does not reveal the mechanism by which the subjective HRQOL is correlated with the objective outcome of mortality, it would be reasonable to try to improve HRQOL in the elderly and CKD patients to reduce mortality. This is a responsibility of clinicians that will be more important in the aging society as the prevalence of CKD increases. Further studies are needed to ascertain how interventions to increase HRQOL can reduce mortality rates in CKD patients.

**Competing interests**
The authors declare that they have no competing interests.

**Authors’ contributions**
SSH participated in the design of the study and performed the statistical analysis. SSH also wrote this paper. KWK
participated in the design of the study. KYN collected data and performed the statistical analysis. DWC helped to draft the manuscript. YSK collected data. SK participated in the design of the study and finally approved this paper to be submitted. All authors read and approved this paper.

Acknowledgements
This work was supported by an independent Research Grant (IRG) from Pfizer Global Pharmaceuticals (grant no. 06-06-039) and a Grant for developing Seongnam Health Promotion Program for the Elderly from Seongnam City Government in Korea (grant no. 800-2003021).

References
1. World population data sheet of the population reference book of Seoung Genere. WHO: 2004.
2. Yearbook of Health and Welfare Statistics Seoul, Korea. Korea Ministry of Health and Welfare Statistics 2003.
3. Coresh J, Selvin E, Stevens LA, Manzi J, Kusek JW, Epping P, Van Lente F, Levey AS. Prevalence of chronic kidney disease in the United States. JAMA 2007, 298(17):2039-2047.
4. Chin HJ, Song YR, Lee JJ, Lee SB, Kim KW, Na KY, Kim S, Chae DW. Moderately decreased renal function negatively affects the health-related quality of life among the elderly Korean population: a population-based study. Nephrol Dial Transplant 2008, 23(9):2810-2817.
5. Kalantar-Zadeh K, Kopp JD, Block G, Humphreys MH. Association among SF36 quality of life measures and nutrition, hospitalization, and mortality in hemodialysis. J Am Soc Nephrol 2001, 12(12):2797-2806.
6. Mapes DL, Lopes AA, Satayathum S, McCullough KP, Goodkin DA, Locatielli F, Fukuhara S, Young EW, Kurokawa K, Saito A, et al. Health-related quality of life as a predictor of mortality and hospitalization: the Dialysis Outcomes and Practice Patterns Study (DOPPS). Kidney Int 2003, 64(4):339-349.
7. Kalantar-Zadeh K, Unruh M. Health related quality of life in patients with chronic kidney disease. Int Urol Nephrol 2005, 37(2):367-378.
8. Sytkowski PA, D’Agostino RB, Belanger A, Kannel WB. Sex and time trends in cardiovascular disease incidence and mortality: the Framingham Heart Study, 1950-1989. Am J Epidemiol 1996, 143(4):338-350.
9. Collins AJ, Hanson G, Umen A, Kjellstrand C, Keshaviah P. The association of physical activity with mortality among end-stage renal disease patients entering hemodialysis and the impact on long-term mortality. Am J Kidney Dis 1995, 15(5):422-432.
10. Hennekens CH. Increasing burden of cardiovascular disease: current knowledge and future directions for research on risk factors. Circulation 1998, 97(11):1095-1102.
11. Dorr DA, Jones SS, Burns L, Donnelly SM, Brunker CP, Wilcox A, Clayton PD. Use of health-related, quality-of-life metrics to predict mortality and hospitalizations in community-dwelling seniors. J Am Geriatr Soc 2006, 54(4):667-673.
12. Bernard SL, Kincade JE, Konrad TR, Arcury TA, Rabiner DJ, Wemons A, DeFriese GH, Ory MG. Predicting mortality from community surveys of older adults: the importance of self-rated functional ability. J Gerontol B Psychol Sci Soc Sci 1997, 52(3):515-163.
13. Perlman RL, Finkelstein FO, Liu L, Rays E, Kiser M, Eisle E, Burrows-Hudson S, Messana JM, Levin N, Rajagopalan S, et al. Quality of life in chronic kidney disease (CKD): a cross-sectional analysis in the Renal Research Institute-CKD study. Am J Kidney Dis 2005, 45(4):588-666.
14. Wang JF, Kosinski M, Keller SK, eds: SF-36 Physical and Mental Health Sumary Scales: A User’s Manual. Boston: The Health Institute; 1994.
15. Garratt AM, Ruta DA, Abdalla MI, Buckingham JK, Russell IT. The SF36 health survey questionnaire: an outcome measure suitable for routine use within the NHS? BMJ 1993, 306(6890):1440-1444.
16. Diaz-Buxo JA, Lowrie EG, Lew NL, Zhang H, Lazarus JM. Quality of life evaluation using Short Form 36: comparison in hemodialysis and peritoneal dialysis patients. Am J Kidney Dis 2000, 35(2):293-300.
17. Park HJ, Lim S, Lim J, Kim K, Han M, Yoon IY, Kim J, Chang Y, Chang CB, Chin HJ, et al. An Overview of the Korean Longitudinal Study on Health and Aging. Psychiatry Invest 2007, 4:84-95.
18. Levey AS, Bosch JP, Lewis JB, Greene T, Rogers N, Roth D. A more accurate method to estimate glomerular filtration rate from serum creatinine: a new prediction equation. Modification of Diet in Renal Disease Study Group. Ann Intern Med 1999, 130(4):461-470.
19. K/DQI clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. Am J Kidney Dis 2002, 39(2 Suppl 1):S1-66.
20. Nam BH, Lee SW. Testing the validity of the Korean SF-36 Health Survey. J Korean Society Health Statistics 2003, 28:3-24.
21. Garcia-Lopez E, Carrero JJ, Sullman ME, Lindholm B, Stenvinkel P. Risk factors for cardiovascular disease in patients undergoing peritoneal dialysis. Perit Dial Int 2007, 27(Suppl 2):S205-209.
22. Han CW, Lee EJ, Iwata T, Kataoka H, Kohzuki M. Development of the Korean version of Short-Form 36-Item Health Survey: health related QOL of healthy elderly people and elderly patients in Korea. Tohoku J Exp Med 2004, 203(3):189-194.
23. Mujas SK, Story K, Bourlietelle J, Takano T, Soroka S, Franken C, Mendelssohn D, Finkelstein FO. Health-related quality of life in CKD patients: correlated and evolution over time. Clin J Am Soc Nephrol 2009, 4(8):1293-1301.
24. Maddox GL, Douglass EB. Self-assessment of health: a longitudinal study of elderly subjects. J Health Soc Behav 1973, 14(1):87-93.
25. Rakowski W, Mor V. The association of physical activity with mortality among older adults in the Longitudinal Study of Aging (1984-1988). J Gerontol 1992, 47(4):M122-129.
26. Kimmel PL, Weihs K; Petersen RA. Survival in hemodialysis patients: the role of depression. J Am Soc Nephrol 1993, 4(1):12-27.
27. Kimmel PL, Peterson RA, Weihs KL, Simmons SJ, Alleyne S, Cruz I, Veis IY. Multiple measurements of depression predict mortality in a longitudinal study of chronic hemodialysis outpatients. Kidney Int 2000, 57(5):2093-2098.
28. DeOreo PB. Hemodialysis patient-assessed functional health status predicts continued survival, hospitalization, and dialysis-attendance compliance. Am J Kidney Dis 1997, 30(2):204-212.
29. Lopes AA, Bragg-Gresham JL, Satayathum S, McCullough K, Pifer T, Goodkin DA, Mapes DL, Young EW, Wolfe RA, Held PJ, et al. Health-related quality of life and associated outcomes among hemodialysis patients of different ethnicities in the United States: the Dialysis Outcomes and Practice Patterns Study (DOPPS). Am J Kidney Dis 2003, 41(3):605-615.

Pre-publication history
The pre-publication history for this paper can be accessed here:

http://www.biomedcentral.com/1471-2369/10/39/prepub

Publish with BioMed Central and every scientist can read your work free of charge

"BioMed Central will be the most significant development for disseminating the results of biomedical research in our lifetime." Sir Paul Nurse, Cancer Research UK

Your research papers will be:

- available free of charge to the entire biomedical community
- peer reviewed and published immediately upon acceptance
- cited in PubMed and archived on PubMed Central
- yours — you keep the copyright

Submit your manuscript here:
http://www.biomedcentral.com/info/publishing_adv.asp