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Original Article

# Excess mortality among patients on dialysis: Comparison with the general population in Korea

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## Abstract

**Background**: Although patients with end-stage renal disease (ESRD) experience excess mortality compared with the general population, the standardized mortality ratio (SMR) for Korean patients on dialysis has not yet been investigated. In this study, we evaluated the SMR among all Korean ESRD patients on maintenance dialysis in 2009 and 2010, and compared it according to age categories, sex, and dialysis modality.
**Methods:** We used data from all patients on maintenance dialysis between January 1, 2009 and December 31, 2010 in Korea using the database of the Korean Health Insurance Review and Assessment Service, and the SMR was determined by calculating of the ratio between the number of actual deaths and expected deaths.
**Results:** A total of 45,568 patients in 2009 and 48,170 patients in 2010 were included in the analysis. The overall age- and sex-adjusted SMR was 10.3 [95% confidence interval (CI), 10.0–10.6] in 2009 and 10.9 (95% CI, 10.7–11.2) in 2010. The SMR for females was much higher than for males. The SMR gradually decreased with increasing age groups. The overall SMR for maintenance hemodialysis patients was lower than that of peritoneal dialysis patients.
**Conclusion:** The SMR among Korean ESRD patients is likely to be higher than in other countries. Further evaluation is needed to attempt to improve the outcomes.



## Introduction

Dialysis therapy has been considered a standard option for patients with end-stage renal disease (ESRD) unless kidney transplantation is possible. Since the process of separating solutes *in vitro* using semipermeable membranes was invented and the word “dialysis” was coined [1], great advances have

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been made in this technology. In Korea, the first report of 14 ESRD patients was published in 1967, and it described the short-term results of dialysis treatment [2]. The prevalence of ESRD patients is increasing rapidly due to the expansion of the elderly population and an increase in the incidence of diabetes, and in 2010, 46,818 patients were known to be on maintenance hemodialysis (HD) or peritoneal dialysis (PD) [3]. In addition, there were 4,560,457,000 cases of HD, and 373,958,629,000 Korean Won were claimed for the reimbursement of HD in 2010 [4].

In order to collect nationwide data on dialysis therapy, the Korean Society of Nephrology (KSN) launched an official registry program in 1985, and in the annual report of mortality data, the overall 5-year survival rate of male patients undergoing dialysis was 65.3% and that of female patients was 68.0% [3]. The registry, however, includes only approximately two-thirds of the patients undergoing dialysis in Korea because not all the dialysis centers participated in enrollment for the registry [5]. The mortality rate for the whole ESRD population therefore needs to be determined.

When designing an epidemiological study, the issue of confounding needs to be considered as well as interaction. Age and sex have always been treated as important confounding risk factors in clinical studies. The methods of "standardization" are an effective way to deal with major confounding factors whereby a standard population is chosen. By comparing the specificity of a study population to that of a standard population, the effect of the particular distribution of the confounding variable, such as age and sex, in the study population is negated [6].

In the present study, we investigated mortality rates among all Korean ESRD patients on maintenance dialysis in 2009 and 2010. In addition, we compared mortality rates between dialysis patients and the whole general population by calculating the standardized mortality ratio (SMR) according to age categories, sex, and dialysis modality.

## Methods

### *Data source and study population*

All data used in the present study were obtained from the Korean Health Insurance Review and Assessment Service (HIRA) database. In Korea, all citizens are obliged to join the National Health Security System as a mandatory social insurance program. In 2007, 96% of citizens were covered by the National Health Insurance Scheme, which is financed by contributions from those insured and government subsidies, and the remaining 4% of citizens were covered by a separate program called Medical Aid, which is a public assistance program that provides minimum livelihood assistance to low-income households [7]. Under these programs, all claims for dialysis-associated medical services submitted by health care providers are reviewed by the HIRA [7,8]. Using the HIRA database, we were able to identify every ESRD patient among the entire South Korean population and analyze the data for all ESRD patients on dialysis therapy.

For the analysis of the mortality rate among dialysis patients, we initially identified all patients on maintenance dialysis between January 1, 2009 and December 31, 2010 in Korea. Patients who were younger than 20 years or who survived fewer than 90 days from the date of dialysis initiation were excluded.

Patients who had started HD were identified by the occurrence of a new claim for the payment code of HD: O7020 or O7021; patients who had started PD were identified by the simultaneous occurrence of new claims for the payment code of PD: O7061, O7062, O7071, or O7072, and for the drug code of PD solutions specified in the National Health Insurance Claims Database. The death of a dialysis patient in 2009 and 2010, respectively, was defined as a case in which the discharge form in the claims data was classified as death or there were no records of a hospital visit over 180 days, regardless of the type of care center. The crude mortality rate was a measure of the number of deaths divided by that of a population per year. The number and mortality rate of the entire population in 2009 and 2010 were obtained from Statistics Korea [9].

### *Statistical analysis*

All statistical analyses were performed using SAS version 9.3 (SAS Institute, Cary, NC, USA). To compute indirect standardization by a typical method, we implemented two-stage processes in the following manner. First, in order to obtain the expected number of deaths in dialysis patients, we multiplied the mortality rate of the national population as a standard population by the prevalence of dialysis patients. By default, 10-year-old age-sex-specific death rates in the standard population were applied to the dialysis patients with the same unit as a study population. Second, the SMR was determined by calculating the ratio between the number of observed deaths (e) and expected deaths (E). Let $e_i$ be the number of events in the $i$th age group of a study population. The events are deaths in this study. Let $p_i$ be the size of the $i$th age group of the study population and the superscript $\omega$ denote the whole population. Here, $\rho_i^{(\omega)} = e_i^{(\omega)}/p_i^{(\omega)}$. is the event rate in the $i$th age group for the whole population. The formula of the SMR can be represented as follows [10,11]:

$$\mathrm{E} = \sum \rho_i^{(\omega)} p_i = \sum \left( \frac{e_i^{(\omega)}}{P_i^{(\omega)}} \right) p_i$$

$$\mathrm{SMR} = \frac{\textit{Observed deaths}}{\textit{Expected deaths}} = \frac{e}{\mathrm{E}}$$

The 95% confidence interval (CI) of the SMR was calculated using the method presented by Vandenbroucke [12], and its formula is defined as follows:

$$\text{Lower CI of SMR} = \frac{\left(\sqrt{\textit{Observed deaths}} - 1\right)^2}{\textit{Expected deaths}}$$

$$\text{Upper CI of SMR} = \frac{\left(\sqrt{\textit{Observed deaths} + 1} + 1\right)^2}{\textit{Expected deaths}}$$

## Results

### *Baseline characteristics*

In total, 45,568 patients in 2009 and 48,170 patients in 2010 who received dialysis due to ESRD were included in this study (Table 1). The mean age of prevalent patients on maintenance dialysis was 57.8 ± 13.3 years in 2009 and 58.4 ± 13.4 years in