Original Article

Korean J Transplant 2023;37:29-40
https://doi.org/10.4285/kjt.22.0049

KJT
KOREAN JOURNAL OF TRANSPLANTATION

pISSN 2671-8790
eISSN 2671-8804

Changes in socioeconomic status and patient outcomes in kidney transplantation recipients in South Korea

Sehoon Park[1,*], Jina Park[2,*], Jihoon Jeong[3], Yunyoung Jang[3], Yong Chul Kim[3], Dong Ki Kim[3,4], Kook-Hwan Oh[3], Kwon Wook Joo[3,4], Yon Su Kim[1,3,4], Hajeong Lee[3]

[1]Department of Biomedical Science, Seoul National University College of Medicine, Seoul, Korea
[2]Department of Biostatistics, Korea University College of Medicine, Seoul, Korea
[3]Department of Internal Medicine, Seoul National University Hospital, Seoul National University College of Medicine, Seoul, Korea
[4]Kidney Research Institute, Seoul National University, Seoul, Korea

Background: Socioeconomic status is an important factor affecting the accessibility and prognosis of kidney transplantation. We aimed to investigate changes in kidney transplant recipients' socioeconomic status in South Korea and whether such changes were associated with patient prognosis.
Methods: This retrospective nationwide observational cohort study in South Korea included kidney transplant recipients between 2007 and 2016. South Korea provides a single-insurer health insurance service, and information on the socioeconomic status of the recipients is identifiable through the claims database. First, a generalized linear mixed model was used to investigate changes in recipients' socioeconomic status as an outcome. Second, the risk of graft failure was analyzed using Cox regression as another outcome to investigate whether changes in socioeconomic status were associated with patient prognosis.
Results: Among the 15,215 kidney transplant recipients included in the study, economic levels (defined based on insurance fee percentiles) and employment rates declined within the first 2 years after transplantation. Beyond 2 years, the employment rate increased significantly, while no significant changes were observed in economic status. Patients whose economic status did not improve 3 years after kidney transplantation showed a higher risk of death than those whose status improved. When compared to those who remained employed after kidney transplantation, unemployment was associated with a significantly higher risk of death-censored graft failure.
Conclusions: The socioeconomic status of kidney transplant recipients changed dynamically after kidney transplantation, and these changes were associated with patient prognosis.

Keywords: Kidney transplant; Social class; Recipient; Prognosis; Allografts

Received October 21, 2022
Revised February 4, 2023
Accepted March 3, 2023

Corresponding author: Hajeong Lee
Department of Internal Medicine, Seoul National University Hospital, Seoul National University College of Medicine, 101 Daehak-ro, Jongno-gu, Seoul 03080, Korea
E-mail: mdhjlee@gmail.com
*These authors contributed equally to this work.

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HIGHLIGHTS

- The socioeconomic status of end-stage kidney disease patients changed significantly after kidney transplantation.
- Within a short period after kidney transplantation, recipients' economic grades declined and unemployment rates increased.
- Although economic status did not significantly change in the later periods posttransplantation, the employment rate increased.
- Changes in socioeconomic status were associated with patient prognosis.

INTRODUCTION

Kidney transplantation (KT) improves the quality of life and survival of patients with kidney failure [1]. The transplanted kidney can function normally and without rejection under long-term immunosuppression. Therefore, successful KT requires sophisticated long-term medical management to mitigate the risks of infectious, malignant, and metabolic complications associated with immunosuppressive treatment and delicate short-term surgical management. Therefore, shared decision-making and proper medical compliance are essential for KT and are closely associated with the prognosis of KT recipients [2].

Socioeconomic status is a crucial non-medical factor that may affect medical conditions, such as nutritional status, general health status, and particularly medical compliance in KT recipients, and is associated with the accessibility and prognosis of KT [3,4]. Previous reports have suggested the importance of socioeconomic disparities in patients with kidney failure regarding the various levels of access to KT [3-6]. In addition, poor socioeconomic status in KT recipients is a risk factor for graft failure [7-9].

Previous studies have also investigated changes in socioeconomic status after KT, particularly focusing on the employment rate [10-12]. A large-scale meta-analysis of cross-sectional and cohort studies summarized that the overall employment rate of KT recipients before and after transplantation remained low, at 36.9% and 38.2% in the pre- and posttransplantation periods, respectively [13]. Another large cohort study analyzing 29,809 KT recipients in the United States reported that 23.1% of KT recipients received private insurance while employed, and those who only received public health insurance had a lower employment rate (<10%), which did not improve after KT [14]. Considering the previous studies indicating that socioeconomic status may be an important factor that dynamically changes after KT, an additional study investigating the individual-level socioeconomic changes associated with KT and their potential impact on the posttransplant prognosis is warranted.

In this study, we studied nationwide KT events in South Korea (hereinafter, Korea) to investigate the clinical significance of changes in the socioeconomic status of KT recipients. Korea has a universal healthcare system with a single insurer, generally covering the medical fees related to KT. The claims database of Korea collects information on all insured medical services and the socioeconomic status of the recipients, making it suitable for such a study. We hypothesized that socioeconomic status would change after KT and that socioeconomic changes may be associated with the prognosis of KT recipients.

METHODS

This study was approved by the Institutional Review Board of Seoul National University Hospital (IRB No. E-2105-094-1219). This review board waived the requirement for informed consent because the study used retrospectively collected claims data from the National Health Insurance Service database, which are anonymous [15]. The study protocol was in accordance with the Declaration of Helsinki and the Declaration of Istanbul.

Study Setting

This was a nationwide observational cohort study that retrospectively collected claims data. The nationwide claims data include information on all insured medical services provided to all Korean nationals, as the Korean population is covered by a mandatory single insurer [15]. In Korea, dialysis patients and KT recipients receive special insurance support covering most (>90%) fees for insured medical services related to kidney failure, including life-long immunosuppression maintenance. As KT is an insured medical service designated by a unique procedure code, all KT events occurring throughout the

https://doi.org/10.4285/kjt.22.0049

country are identifiable in the database. In addition, health insurance enrollment status includes information on annual financial percentiles based on the insurance fee, which is determined by annual income and possessed estate or property. The workplace-independent enrollment status can be acquired based on individuals' status as being employed in a regular workplace; thus, the employment status of covered individuals is available in the data. Finally, as mortality data based on death certificates and information on return to dialysis or re-transplantation are identifiable by specific codes, graft failure outcomes can be defined. These characteristics have been utilized in our previous studies investigating the clinical significance of economic or occupational status related to KT [3,4].

Study Population

In the claims database, we identified 15,229 KT recipients who underwent transplantation between 2007 and 2016. We excluded 14 recipients who underwent multi-organ transplantation, leaving 15,215 KT recipients as the study population (Fig. 1).

Study Outcomes

We first assessed changes in socioeconomic status as the primary outcome, including the economic and employment status of the KT recipients. Next, we assessed the risk of graft failure as the secondary outcome, including allograft function failure and mortality events, using changes in socioeconomic status as the exposure variable.

Ascertainment of Socioeconomic Status

The national claims database provides information on economic status, identifiable as 21 grades based on insurance fee percentiles [3]. The insurance fee is based on one's income and assets; thus, this information has been used in studies focusing on economic status. The lowest economic state grade was the "aided" group, as the people in it had their insurance fees waived because of their poor economic status after qualification by a government organization. Therefore, the government paid most of the

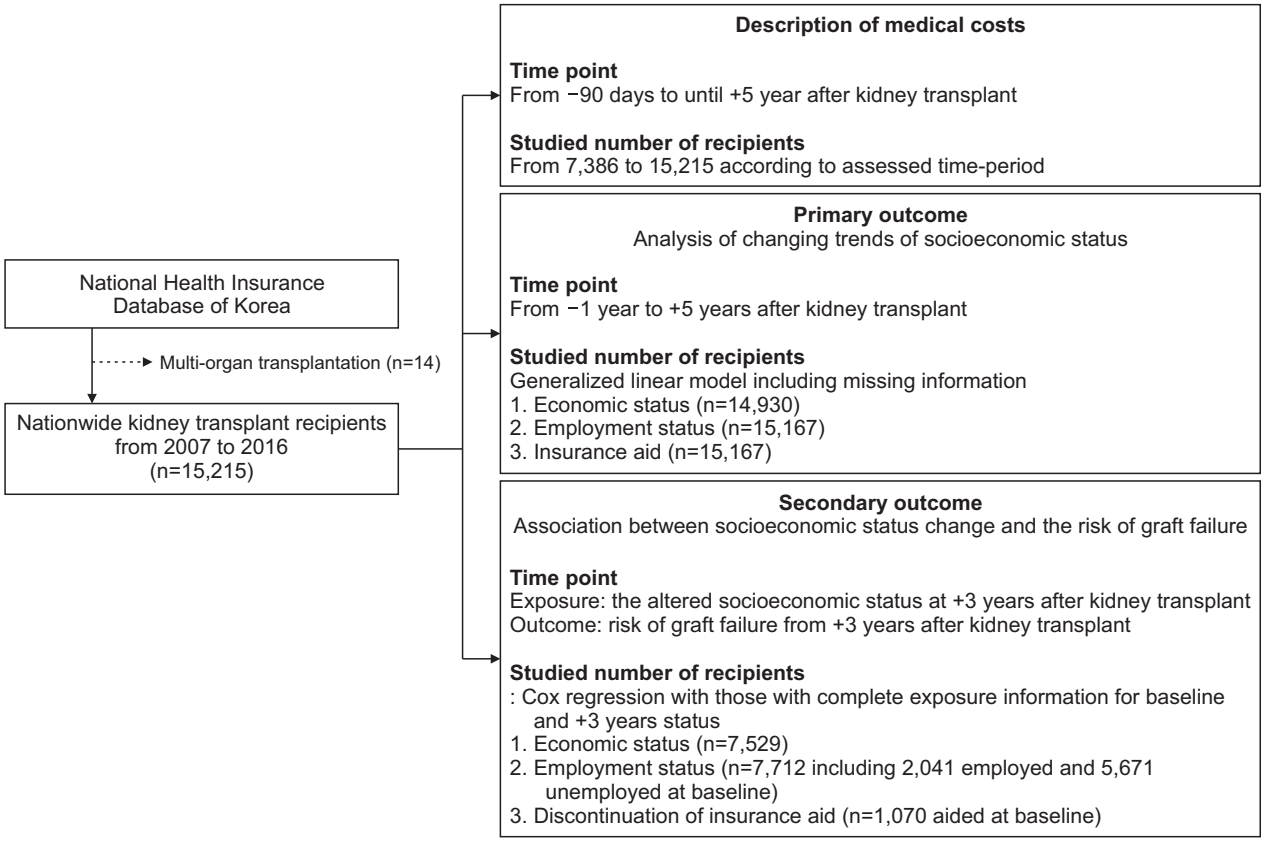

Fig. 1. Study flowchart.

insured medical fees for the individuals in the aided group because of their unemployment and poverty; this group comprised approximately 2% to 3% of the Korean population.

Employment status is identifiable by the insurance enrollment status; those who are employed in a regular workplace receive "workplace-independent" insurance, while those who are dependent on employees receive "workplace-dependent" insurance [4]. Otherwise, Koreans are enrolled in "community" health insurance or the aforementioned "aided" group. We defined the baseline socioeconomic status 1 year before KT to define the index status prior to KT because the information from the year of KT was a mixture of pre- and posttransplant periods.

Ascertainment of Patient Prognosis

The prognostic outcome was graft failure, which was defined as a composite of death-censored graft failure (DCGF) and death with functioning graft (DWFG) events. DCGF was defined as re-initiation of dialysis or retransplantation, and DWFG included mortality events without a history of DCGF. Dialysis or transplantation events were identified using procedural claims codes or unique codes for dialysis patients, and death events were identified using national death registries that collected all death certificates in Korea. These events were identified as of the end of 2016.

Other Data Collection

We collected data on the demographic, medical, socioeconomic status, and medical costs of the study population. The details are described in Supplementary Material 1.

Statistical Analysis

To investigate whether there was a significant change in socioeconomic status after KT, we modeled the socioeconomic status according to a time (year) variable using a generalized linear mixed model and assessed the time trend using time exposure with socioeconomic status outcome variables. The assessed outcomes were economic grade, socioeconomic deprivation as determined by the receipt of insurance aid, and employment status.

We first assessed the changes in socioeconomic status from the year before KT to 5 years after KT. Next, as the change in socioeconomic status may vary according to the period after KT, we assessed the changes from 1 year before KT to 1 year after KT. The changes from 1 year to 5 years after KT were also assessed. In addition to a univariable generalized linear mixed model, we constructed a multivariable model adjusted for age, sex, diabetes, hypertension, previous dialysis type, dialysis vintage, and whether the KT case was desensitized. In addition, a sub-

Table 1. Baseline characteristics of all kidney transplantation recipients from 2007 to 2016 (n=15,215)

Characteristic	Value
Age (yr)	48.0 (38.0–55.0)
Sex	
Male	9,004 (59.2)
Female	6,194 (40.8)
Prior kidney replacement therapy type	
Preemptive	4,852 (31.9)
Hemodialysis	6,639 (43.6)
Peritoneal dialysis	2,788 (18.3)
Both (hemodialysis and peritoneal dialysis)	936 (6.2)
Dialysis duration	
Preemptive (none or <3 mo)	4,852 (31.9)
≥3 mo & <1 yr	2,721 (17.9)
≥1 yr & <3 yr	2,731 (17.9)
≥3 yr & <5 yr	2,159 (14.2)
≥5 yr	2,752 (18.1)
Pretransplant diabetes	4,954 (32.6)
Pretransplant hypertension	13,191 (86.7)
Desensitization	2,456 (16.1)
Plasmapheresis	395 (2.6)
Rituximab	438 (2.9)
Both	1,623 (10.7)
Income grade (one grade per 5 percentiles, 0 to 20)	12 (4–17)
Income quartile	
<25th	4,302 (28.8)
26–50th	2,403 (16.1)
51–75th	3,373 (22.6)
76–100th	4,852 (32.5)
Insurance aid	2,086 (13.7)
Employed	4,086 (26.9)
Place of residence	
Rural	4,382 (28.9)
Urban	10,785 (71.1)

Values are presented as median (interquartile ranges) or number (%). The total study population had some missing information. There were 17 patients with missing information for age and sex. Economic grades were available for 14,930 individuals. Insurance enrollment types, which were used to define the state of employment or insurance aid, were available in 15,167 recipients.

https://doi.org/10.4285/kjt.22.0049

group analysis was conducted by dividing the total study population into economic grades (≥50th or <50th percentiles at the time of KT).

The second analysis investigated the association between changes in socioeconomic status and patient prognosis. The changes in 3 years after KT compared to the state before KT were categorized as an increase or decrease in economic grades and loss of employment or new employment. An increase in economic grade was defined as movement towards an upper quartile of the economic grade percentiles, and a decrease in economic grade was defined inversely. Although this outcome could not distinguish between voluntary or involuntary events, loss of employment was defined as an event when an employed individual no longer received employment-independent insurance after KT. New employment was defined as an instance in which a recipient who was unemployed prior to KT was identified as being employed 3 years after KT. The exposure was regressed to DCGF, death, and graft failure prognosis using a Cox proportional hazard model. In addition to a univariable model, a multivariable model was constructed and adjusted for the aforementioned variables. As the exposure period was defined as 3 years after KT, the follow-up was initiated 3 years after KT. Moreover, those who experienced DCGF or DWFG or were censored within this 3-year period were excluded from the analysis.

The complete-case method was used to deal with missing information. Those with complete information on exposure, outcome, and covariates were included in each analysis. All statistical analyses were performed using R ver. 4.0.3 (R Foundation), and statistical significance was determined using two-sided P-values (<0.05).

RESULTS

Baseline Characteristics

The median age at KT was 48 years, and 59.2% of the recipients were men (Table 1). KT recipients who lived in urban areas comprised 71.1% of the study population. Regarding baseline socioeconomic status, the median economic grade was the 56–60th percentile of the nation. In addition, 26.9% of the recipients were employed. Before KT, 13.7% of the recipients received insurance aid due to their socioeconomically deprived state.

Medical Costs

Regarding the medical costs for insured medical services during the peritransplant period (Table 2), the period with the highest total costs was from 30 days before to 30 days after the KT date. Subsequently, medical costs gradually decreased over time. A similar trend was identified when we separately assessed the medical fees paid by the recipients and the fees covered by the insurance service.

Changing Trends in Socioeconomic Status

From the year before and up to 5 years after KT, a significant trend was observed for the economic grades of the recipients to decrease over time (Fig. 2, Table 3, Supplementary Table 1). However, the employment rate increased significantly, reaching 31.9% 5 years after KT, while the proportion of those who received insurance aid decreased to 12.1% 5 years after KT. The above trends were also significant in the multivariable models adjusted for age, sex, history of diabetes or hypertension before KT, duration or type of dialysis prior to KT, and whether KT was desensitized.

Table 2. Medical costs for insured medical services during the peritransplant period

Period	No. of recipients with available information	Total costs for insured medical services	Costs paid by recipients	Costs covered by health insurance service
≥−90 day & <−30 day	15,145	3,681 (2,635–4,578)	416 (179–706)	3,273 (2,159–4,024)
≥−30 day & <30 day	15,215	17,347 (14,689–21,078)	2,012 (1,531–2,616)	15,636 (13,090–18,954)
≥30 day & <1 yr	14,850	9,280 (6,978–12,640)	972 (491–1,529)	8,280 (6,180–11,315)
≥1 yr & <2 yr	12,709	7,325 (5,559–9,853)	748 (346–1,126)	6,539 (4,950–8,854)
≥2 yr & <3 yr	10,841	6,559 (4,910–8,870)	660 (304–971)	5,884 (4,392–7,991)
≥3 yr & <4 yr	9,053	6,147 (4,543–8,287)	613 (294–907)	5,483 (4,066–7,473)
≥4 yr & <5 yr	7,386	5,826 (4,172–8,063)	581 (259–880)	5,197 (3,724–7,259)

The costs are presented as median (interquartile range) in dollars ($). The costs were converted to dollars by applying a rate of 1,200 Korean won=1 US dollar.

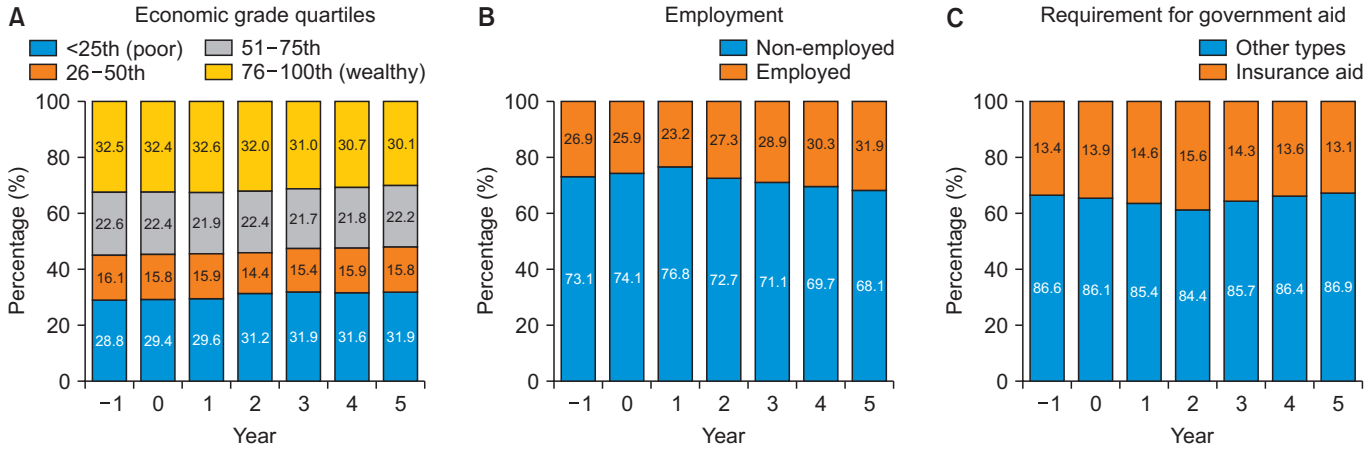

Fig. 2. Time trends of insurance fee percentiles, the proportion of employed individuals, and those who required government aid for their insurance coverage. The socioeconomic status in the year before kidney transplant to +5 years after the kidney transplantation year are presented. (A) The economic grades are identified as 21 ordinal categories covering 5 percentiles each, and the quartile groups are presented for simplification. (B) The employed individuals included those who were enrolled in the national health insurance through workplace insurance system, which indicates the recipients were employed at a regular workplace. (C) The group with insurance aid comprised those who were socioeconomically deprived, and their insurance fees and medical service costs were mostly covered by the government after approval for the qualification.

Table 3. Changes in the socioeconomic status of KT recipients from prior to KT until 5 years after KT

Outcome variable	Beta		Adjusted beta	
	Mean (SE)	P for trend	Mean (SE)[a]	P for trend
Baseline to 5 yr after KT				
Economic grade[b]	−0.09 (0.01)	<0.001	−0.09 (0.01)	<0.001
Employed	0.19 (0.01)	<0.001	0.19 (0.01)	<0.001
Aided group	−0.14 (0.02)	<0.001	−0.13 (0.02)	<0.001
Baseline to 2 yr after KT				
Economic grade[b]	−0.10 (0.01)	<0.001	−0.10 (0.01)	<0.001
Employed	−0.09 (0.02)	<0.001	−0.07 (0.02)	0.001
Aided group	0.29 (0.04)	<0.001	0.30 (0.04)	<0.001
From 2 yr to 5 yr after KT				
Economic grade[b]	−0.03 (0.02)	0.130	−0.03 (0.02)	0.150
Employed	0.40 (0.03)	<0.001	0.40 (0.03)	<0.001
Aided group	−1.40 (0.08)	<0.001	−1.37 (0.08)	<0.001

P for trend values were calculated by regressing the time variable to the outcome variable in a generalized linear mixed model.
KT, kidney transplantation; SE, standard error.
[a]The multivariable analysis was adjusted for age, sex, diabetes, hypertension, previous dialysis types, dialysis vintage, and whether the KT case was desensitized; [b]One grade per 5 percentiles, and the total number of grades was 21 (aided insurance group as grade 0).

However, the above trends appeared differently when we split the time frames into two periods: (1) from the year before KT until 2 years after KT, and (2) from 2 years to 5 years after KT. The income grades decreased during the first 2 years, consistent with the overall trend described above. However, within 2 years of KT, the proportion of employed individuals significantly decreased, while the proportion of those who received insurance aid increased. When the changes in the latter period were investigated, there was no longer a significant change in the economic grade of the recipients, both in the univariable and multivariable model results. However, from

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2 years after KT onward, the proportion of employed recipients increased significantly, while the proportion of those who required insurance aid decreased. Similarly, the proportion of the individuals in the aided group decreased, indicating that a greater proportion of the population was no longer socioeconomically deprived in the later period.

Subgroup Analysis of Changing Trends in Socioeconomic Status According to Economic Grades

The trends of socioeconomic changes were prominently different according to the baseline economic status (Supplementary Table 2). In those with high above-median income grades, the economic grades consistently decreased. The requirement for insurance aid increased until 2 years after KT and decreased afterward. The employment rate increased after KT, particularly 2 years after surgery and onwards.

In those with low baseline economic grades, economic improvement consistently occurred throughout the follow-up period. In addition, the requirement for insurance aid significantly decreased, particularly after 2 years post-KT, along with a significant increase in employment rate in the period.

Association between Changes in Socioeconomic Status and Patient Prognosis

There were 7,748 KT recipients who were not censored or did not experience graft failure within 3 years after KT (Fig. 1). The characteristics of the study subjects included in the secondary analysis were similar to the total KT recipients; they had a median age of 45 years, 58.3% were men, and 39.1% were preemptive KT cases. Among them, 7,529 had complete information for economic status and 7,712 for health insurance enrollment status, respectively, both in baseline and 3 years after KT. The characteristics of the 7,529 recipients with follow-up information are presented in Supplementary Table 3 to provide a general description of the population included in the survival analysis. In addition, 2,041 patients were employed at baseline and were assessed for loss of employment status, while 5,671 were unemployed at baseline and were assessed for new employment. In total, 1,070 recipients received insurance aid at baseline.

Regarding changes in economic status (Table 4), individuals who remained in the same economic quartile showed a higher risk of death than those whose economic grade improved. Those who had worsening economic status showed similarly higher hazard ratios for the risk of death, though the statistical significance remained marginal. Regarding the DCGF outcome, the risks remained constant regardless of changes in economic grades, resulting in a non-significant finding in the composite graft failure outcome results.

When we tracked individuals who were employed before KT, we discovered that those who became unemployed within 3 years after KT showed a significantly higher risk of DCGF than those who remained employed. Furthermore, although the patient death outcome results were non-significant, the risks of composite graft failure were significantly higher in those who became unemployed. In the analysis of those who were unemployed at baseline, becoming newly employed was associated with lower hazard ratios for graft failure than remaining unemployed, though the results remained marginally significant in the regression models.

Among those who received aided health insurance due to their poor socioeconomic status before KT, those who were able to leave the aided group showed significantly lower risks of DCGF than those who remained in the aided group. Additionally, such an improvement in socioeconomic status was associated with a significantly lower risk of composite graft failure.

DISCUSSION

In this nationwide observational study, we observed a significant change in socioeconomic status after KT. In Korea, within a short period after KT, recipients' economic grades declined and unemployment rates increased, and an increased number of recipients required government aid for their health insurance coverage. However, while there was no significant change in economic grades in the later period, the employment rate increased and the proportion of recipients receiving insurance aid decreased. Furthermore, changes in socioeconomic status were associated with patient prognosis. Recipients whose economic grades improved showed lower risks of death, and those who became unemployed experienced higher risks of DCGF.

As KT requires a voluntary donation from others, not all patients with kidney failure can receive it, and a sizable proportion of kidney failure patients die while on the waiting list [1,6,16]. The remaining hurdles for

Table 4. Associations between changes in socioeconomic status during 3 years after kidney transplantation and patient outcomes

Assessed status (outcome and exposure)	No. with exposure	No. with outcome	HR (95% CI)	P-value	Adjusted HR (95% CI)[a]	Adjusted P-value
Changes in economic status[b] (n=7,529)						
DCGF						
Higher economic	1,440	92	Reference	-	Reference	-
Same economic	4,400	320	1.13 (0.90–1.43)	0.29	1.13 (0.90–1.43)	0.29
Lower economic	1,689	114	1.04 (0.79–1.37)	0.77	1.04 (0.79–1.37)	0.79
DWFG						
Higher economic	1,440	23	Reference	-	Reference	-
Same economic	4,400	116	1.65 (1.05–2.58)	0.03	1.58 (1.01–2.48)	0.04
Lower economic	1,689	45	1.64 (0.99–2.71)	0.05	1.64 (0.99–2.71)	0.05
Graft failure						
Higher economic	1,440	110	Reference	-	Reference	-
Same economic	4,400	422	1.26 (1.02–1.55)	0.03	1.23 (1.00–1.52)	0.05
Lower economic	1,689	146	1.12 (0.87–1.43)	0.38	1.10 (0.86–1.41)	0.44
Loss of employment[c] (n=2,041)						
DCGF						
Remained employed	1,549	61	Reference	-	Reference	-
Loss of employment	492	35	1.84 (1.21–2.78)	0.004	1.95 (1.27–2.97)	0.002
DWFG						
Remained employed	1,549	22	Reference	-	Reference	-
Loss of employment	492	10	1.38 (0.65–2.91)	0.40	1.33 (0.62–2.84)	0.46
Graft						
Remained employed	1,549	79	Reference	-	Reference	-
Loss of employment	492	39	1.57 (1.07–2.31)	0.02	1.63 (1.10–2.41)	0.01
Being newly employed[d] (n=5,671)						
DCGF						
Remained	4,987	398	Reference	-	Reference	-
Newly employed	684	44	0.82 (0.60–1.13)	0.23	0.77 (0.56–1.06)	0.11
DWFG						
Remained	4,987	144	Reference	-	Reference	-
Newly employed	684	11	0.58 (0.3–1.06)	0.08	0.70 (0.38–1.30)	0.26
Graft						
Remained	4,987	521	Reference	-	Reference	-
Newly employed	684	54	0.77 (0.58–1.02)	0.07	0.76 (0.57–1.01)	0.06
Discontinuation of insurance aid[e] (n=1,070)						
DCGF						
Remained in aided	798	110	Reference	-	Reference	-
No longer in aided	272	22	0.53 (0.34–0.84)	0.007	0.46 (0.29–0.73)	0.001
DWFG						
Remained in aided	798	34	Reference	-	Reference	-
No longer in aided	272	7	0.56 (0.25–1.26)	0.16	0.54 (0.23–1.23)	0.14
Graft						
Remained in aided	798	139	Reference	-	Reference	-
No longer in aided	272	25	0.47 (0.31–0.72)	<0.001	0.43 (0.28–0.66)	<0.001

As the changes during 3 years after transplant were the exposures, follow-up was initiated at 3 years after transplant and those who were censored or experienced the outcome before reaching the time were not included in the analysis. Graft failure outcome was the composition of death-censored graft failure and death with functioning graft events.

HR, hazard ratio; CI, confidence interval; DCGF, death-censored graft failure; DWFG, death with functioning graft.

[a]Multivariable analysis was adjusted for age, sex, diabetes, hypertension, previous dialysis types, dialysis vintage, and whether the kidney transplantation case was desensitized; [b]Baseline economic status was categorized as quartile levels, and the exposure status was defined by comparing the quartile levels to those at 3 years after transplantation; [c]Loss of employment status was assessed among those who were employed at baseline; [d]Newly employed status was assessed among those who were not employed at baseline; [e]The assessment of discontinuation of insurance aid was performed among those who were receiving insurance aid due to their socioeconomically deprived status at baselines.

https://doi.org/10.4285/kjt.22.0049

kidney failure patients to receive KT are related to their underlying medical health and socioeconomic status as measured by wealth, employment, or education [3,4,6,17]. Previous studies have highlighted that disparities in accessing KT may exist due to poor economic or employment status [3-6,18,19]. In addition, these disparities might have widened in recent years, as poor people might have benefited less from recent advances in medical interventions aimed at removing obstacles to KT (e.g., desensitization) [3].

In addition, as KT or donation causes substantial changes in the functional capacity of recipients or donors, there may be some socioeconomic changes after KT. In our previous study, we found some adverse effects on the socioeconomic status of living donors, which were particularly prominent in the immediate period after donation [20]. On the recipients' side, few studies have investigated changes in the socioeconomic status of recipients with successive assessments of their economic or employment status [10]. Regarding this objective, our study has particular strengths: (1) we assessed nationwide kidney transplant events using a large number of samples; (2) we analyzed objective data on economic or employment status extracted from the claims database; (3) we assessed socioeconomic changes for up to 5 years after KT; and (4) we observed associations between changes in socioeconomic status and patient prognosis.

Our study, which included recent KT recipients in Korea, found that the overall employment rate of KT recipients was comparable to that reported previously [13]. We also observed significant changes in recipients' economic and employment status, which varied according to the period after KT. In the first 2 years, economic and employment status deteriorated slightly as the economic grade declined and the proportion of unemployed or aided recipients increased. This negative economic impact might have been related to financial burdens, which are particularly evident in the period shortly after KT. Changes in the employment rate may be primarily due to recipients voluntarily seeking sick leave out of caution for their immunosuppressed status or postoperative care. Alternatively, some recipients might have involuntarily lost working capacity because of possible complications (e.g., delayed graft function or acute rejection) after KT. However, we observed an increasing employment rate after the immediate period and a decreasing proportion of recipients who required government aid for their insurance coverage, indicating an overall trajectory of improving employment status after KT. As it is anticipated that patients with kidney failure will regain functional capacity as the graft functions, these results may indicate that KT would consequently benefit the recipients' working ability.

Notably, an overall benefit of KT on socioeconomic status occurred in those with low baseline economic status, whereas the opposite pattern was identified in recipients who were wealthier. The functional benefit of KT, when compared to dialysis, might have been accentuated in the poor group, as poorer individuals generally received KT after a longer period of dialysis [3]. For the group with a high baseline economic status, their high income may have been more vulnerable to being affected by the event of end-stage kidney disease itself, and KT might not have been sufficient to ameliorate the functional impairment related to the illness. Alternatively, the richer group might have been more likely to seek a job with a low work burden even if the income was low or might have been more likely to consider retirement.

A bidirectional mechanism could explain the association between socioeconomic changes after KT and patient prognosis. Poor medical status 3 years after transplantation might have been a reason for the worse prognosis in the later periods because worsening of the socioeconomic status may indicate relatively poor graft function or health status of the recipients; however, this information could not be obtained from the claims database. Alternatively, poor socioeconomic status 3 years after transplantation might have adversely affected patients' medical behavior (e.g., medication compliance or seeking medical services) [21], which might have led to worse patient outcomes. As direct measurements of graft function are unavailable in the claims database, which lacks laboratory information, a future study that includes detailed medical and social information is required to reveal the mechanism of the relationship between posttransplant socioeconomic status and prognosis. The current study suggests that clinicians should monitor changes in recipients' socioeconomic status, as these changes may be related to graft prognosis, or those who suffer from poor outcomes may also have socioeconomic difficulties.

The differences between the associations of socioeconomic status with DCGF or DWFG may be explained at a hypothesis level. DCGF is more directly related to suboptimal immunosuppression; thus, being unemployed might have affected the regular lifestyle of the recipients and lowered general compliance to maintenance immunosuppression. Conversely, as DWFG is strongly asso-

ciated with cardiovascular, infection, or malignancy-related complications, poor economic status might have adversely affected patients' behavior in terms of actively seeking medical interventions for related comorbidities, causing a higher risk of mortality. However, as the causes of DCGF and DWFG are heterogeneous and overlap [22,23], additional research would be necessary to understand the reason for these differences in prognostic consequences related to changes in KT recipients' socioeconomic status.

This study had several limitations. First, due to the retrospective and observational nature of this study, there are possibilities of unmeasured confounding effects or reverse causation. Therefore, the primary findings of this study are limited to the observed associations, and a mechanistic explanation or the direction of the effects should be investigated in future studies. Second, because of the characteristics of the claims database, laboratory measurements or detailed medical histories relevant to KT (e.g., graft function or living/deceased donor information) were not included. In addition, as socioeconomic status was defined by claims information, some employment positions (e.g., part-time work or a workplace not providing proper workplace health insurance) might not have been included in the current study. Third, as socioeconomic status is primarily affected by the social environment in a nation, findings from Korea may not be generalized to other countries. Lastly, some follow-up information was missing, and this might have affected the study results in an undetermined manner.

In conclusion, KT recipients in Korea experienced significant socioeconomic changes after transplantation. Posttransplant changes in socioeconomic status were associated with patient prognosis. Healthcare providers may consider recipients' economic or employment status as an important factor that dynamically changes after KT and that may affect their posttransplant prognosis.

ACKNOWLEDGMENTS

Conflict of Interest
No potential conflict of interest relevant to this article was reported.

Funding/Support
This study analyzed the database from National Health Insurance Service of Korea. This study was supported by the Korea Health Technology R&D Project through the Korea Health Industry Development Institute (KHIDI), funded by the Ministry of Health & Welfare, Republic of Korea (Grant HI18C1604). The funder had no role in performing the study and the study was performed independently by the authors. This study utilized the database of the National Health Insurance Service of Korea. This study was also supported by research grant from the Korean Society for Transplantation (2023-00-01001-002).

ORCID
Sehoon Park https://orcid.org/0000-0002-4221-2453
Jina Park https://orcid.org/0000-0002-7410-1985
Jihoon Jeong https://orcid.org/0000-0002-5554-4238
Yunyoung Jang https://orcid.org/0000-0003-2248-132X
Yong Chul Kim https://orcid.org/0000-0003-3215-8681
Dong Ki Kim https://orcid.org/0000-0002-5195-7852
Kook-Hwan Oh https://orcid.org/0000-0001-9525-2179
Kwon Wook Joo https://orcid.org/0000-0001-9941-7858
Yon Su Kim https://orcid.org/0000-0003-3091-2388
Hajeong Lee https://orcid.org/0000-0002-1873-1587

Author Contributions
Data curation: SP, JP, JJ, YJ, YCK. Formal analysis: SP, JP. Funding acquisition: DKK, KHO, KWJ, YSK, HL. Methodology: SP, YCK, DKK, HL. Project administration: SP, JP, JJ, HL. Visualization: JP, YJ. Writing–original draft: SP, JP, HL. Writing–review & editing: all authors. All authors read and approved the final manuscript.

Supplementary Materials
Supplementary materials can be found via https://doi.org/10.4285/kjt.22.0049.

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https://doi.org/10.4285/kjt.22.0049