

Gender and Geographic Disparities in Access to Kidney Replacement Therapy in South-Western Italy (Campania): A Population-Based Study

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Abstract

This study examined patterns of kidney replacement therapy (KRT) in Italy, emphasizing disparities linked to gender and place of residence. Using population-level administrative records from Campania between 2015 and 2018, we analyzed the use of haemodialysis, peritoneal dialysis, kidney transplantation, and associated mortality. Across the study period, 11,713 individuals in Campania were receiving KRT. Annual prevalence ranged from 1000 to 1015 patients per million (pmp) for haemodialysis, 115 to 133 pmp for peritoneal dialysis, and 2081 to 2245 pmp for kidney transplantation. New cases of haemodialysis occurred at 160–185 pmp annually, while kidney transplant incidence ranged from 59 to 191 pmp per year. Mortality rates varied by modality, with haemodialysis at 12.8–14.2%, peritoneal dialysis at 5.2–13.8%, and transplant recipients at 2.4–3.3%. Cox regression identified age, type of KRT, suburban residence, and yearly incidence of new dialysis as significant predictors of mortality. Regarding access to kidney transplantation, female sex, older age, suburban residence, and recent dialysis initiation were associated with lower transplant rates. Overall, these results highlight notable inequalities in KRT delivery, indicating that both gender and residential location influence survival and access to kidney transplantation in this population.

Keywords: Epidemiology, Dialysis, Kidney replacement Treatment

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Introduction

Globally, the use of kidney replacement therapy (KRT) is rising in parallel with the increasing prevalence of end-stage kidney disease [1-3]. KRT imposes considerable social and economic burdens, as patients undergoing these treatments continue to experience high morbidity and mortality [1-3]. Reliable epidemiological information on KRT and patient outcomes is crucial for planning effective care pathways. To address this need, many high-income

countries have established KRT registries [4,5]. In Italy, the Italian Society of Nephrology (Società Italiana di Nefrologia) has maintained a national KRT Registry for over 25 years [6]. However, the Registry remains incomplete, as only a subset of regional sections consistently provides comprehensive data [7]. Administrative health databases have proven effective for constructing disease registries, including for chronic kidney disease (CKD) [8,9], and similar approaches have been applied to Italian regional datasets [10,11]. The present study leverages administrative data from the

Campania region in southern Italy to examine the epidemiology of KRT and to explore whether gender and place of residence contribute to disparities in access to kidney care [12–16].

Materials and Methods

In Italy, KRT delivered through the national health system includes haemodialysis, peritoneal dialysis, and kidney transplantation [6]. Acute kidney failure requiring temporary dialysis—either haemodialysis or peritoneal dialysis—is managed as in-patient care in public or private hospitals. Chronic haemodialysis may be delivered on an outpatient basis at hospitals or accredited private clinics affiliated with the national health system. Chronic peritoneal dialysis and follow-up care for kidney transplant recipients can be provided in hospitals either as day-surgery or during hospitalization, depending on clinical needs.

The Italian healthcare system is organized by regional authorities, which are further divided into local health authorities. The Campania region comprises seven local authorities: one covering Naples (Napoli 1), two for the surrounding suburban areas (Napoli 2 nord and Napoli 3 sud), and one for each of the remaining provinces (Avellino, Benevento, Caserta, and Salerno). This study used administrative records from all Campania health authorities, covering haemodialysis, peritoneal dialysis, and kidney transplantation. Non-residents were excluded. Data were collected for 2014–2018 from hospital discharge records, outpatient specialty visits, and drug prescription databases. Mortality data were obtained from the local civil registry. All datasets were linked in a fully anonymized manner. Extracted information included KRT type, sex, date of birth, date of entry into the database, date of death (if applicable), and local health authority of residence.

Prevalence and incidence

KRT prevalence for 2015–2018 was defined as follows:

- Haemodialysis: identified from hospital discharge or outpatient nephrology records with code V560 or ICD-9-CM codes 39951–59;
- Peritoneal dialysis: identified from hospital discharge codes V451 or 54981–82 and/or prescription codes F00001678-73, LPB5262G-64G, LPB96564, LPB5268, or LCE8280-81;
- Kidney transplant: identified from hospital discharge codes V420 or 99681 and/or outpatient nephrology code 897.

A patient was classified as receiving dialysis if undergoing haemodialysis and/or peritoneal dialysis. When multiple treatments were recorded in the same year, the treatment with lower frequency was prioritized: peritoneal dialysis

over haemodialysis, and kidney transplantation over any dialysis modality. Prevalence data from 2014 were used solely to define 2015 incidence and were not otherwise reported.

De novo incidence of KRT for 2015–2018 included patients without KRT in the previous year, based on the same codes used for prevalence. Patients who received a transplant following dialysis or resumed dialysis after transplant failure were not counted in the de novo incidence.

Outcomes

For each year, patients receiving KRT were evaluated for three main outcomes: whether they were hospitalized, whether they died, and, for survivors, the type of KRT they continued the following year. Patients who did not appear in either the subsequent year's KRT records or the mortality database were classified as “missing.” It should be noted that for patients prevalent in 2018, follow-up regarding KRT type in the next year or missing status could not be determined, as data for 2019 were not available.

Statistical analysis

KRT prevalence and incidence from 2015 to 2018 were expressed as absolute counts (N), percentages, and patients per million population (pmp). Population denominators for Campania were sourced from the Italian National Institute of Statistics [17]. Prevalence estimates at the regional level were presented with 95% confidence intervals (95% CI) to facilitate comparisons with other studies. Graphical representations focused on 2017 to allow alignment with published data from other Italian regions (excluding Campania) (7), while results for 2015, 2016, and 2018 are included in the Supplementary Material.

Associations with mortality and access to kidney transplantation were explored using Cox proportional hazards models. Mortality analyses encompassed all KRT patients, whereas analyses of transplant access included only dialysis patients, excluding those already transplanted at initial database entry. Follow-up time for mortality analyses was calculated from 1 January 2015 (or date of database entry, if later) to either date of death or 31 December 2018 for survivors. For transplant analyses, follow-up spanned from 1 January 2015 (or entry date) to the date of transplantation or 31 December 2018 for patients who did not receive a transplant. Key variables in the models included sex, age at entry, KRT modality, local health authority of residence, and the incidence of new dialysis cases from 2015–2018, accounting for differences between short-term (≤ 4 years) and longer-term KRT. The two Naples suburban health authorities were combined to compare outcomes with the urban Naples area. Proportional hazards assumptions were tested both

visually and statistically. Hazard ratios (HR) with 95% CI are reported. Analyses were performed using Stata 15 MP and/or SPSS-19.

Results

Prevalence and incidence

From 2015 to 2018, 11,713 Campania residents were receiving KRT. The majority were men, aged 45 years or older, and lived in urban or suburban Naples (Supplementary Table S1).

Prevalence figures, shown in **Table 1**, indicate that overall KRT ranged from 1375 to 1414 pmp. Haemodialysis prevalence was 1000–1015 pmp, peritoneal dialysis 115–133 pmp, and kidney transplant 2081–2245 pmp. Only overall KRT and kidney transplant prevalence showed an increasing trend over the years through 2018. Cumulative patient numbers from 2015 to 2018 were 8236 for haemodialysis, 237 for peritoneal dialysis, and 3240 for kidney transplantation. Notably, over 98% of haemodialysis patients received treatment at private outpatient facilities throughout the study period.

Table 1. Prevalence and de novo incidence of kidney replacement treatment among residents of Campania by calendar year: absolute counts (N) and count per million population (pmp) with 95%CI

		Calendar Year			
		2015	2016	2017	2018
Prevalence	N	8057	8173	8218	8167
	pmp (95%CI)	1375 (1302–1447)	1397 (1324–1470)	1407 (1334–1481)	1414 (1340–1487)
KRT	N	5861	5939	5853	5806
	pmp (95%CI)	1000 (938–1062)	1015 (953–1078)	1002 (940–1064)	1005 (943–1067)
Haemodialysis	N	115	133	125	116
	pmp (95%CI)	20 (11–28)	23 (13–32)	21 (12–30)	20 (11–29)
Peritoneal dialysis	N	2081	2101	2240	2245
	pmp (95%CI)	355 (318–392)	359 (322–396)	384 (345–422)	389 (350–427)
Kidney transplant	N	1022	1088	1121	958
	pmp (95%CI)	174 (148–200)	186 (159–213)	192 (165–219)	166 (141–191)
Incidence	N	993	1035	1079	922
	pmp (95%CI)	169 (144–195)	177 (151–203)	185 (158–211)	160 (135–184)
Haemodialysis	N	29	53	42	36
	pmp (95%CI)	5 (1–9)	9 (3–15)	7 (2–12)	6 (1–11)
Peritoneal dialysis	N	159	191	187	172
	pmp (95%CI)	27 (17–37)	33 (21–44)	32 (21–43)	30 (19–40)
Kidney transplant *	N				
	pmp (95%CI)				

Notes: The total population of Campania for the years 2015 through 2018 was 5,861,529; 5,850,850; 5,839,084; and 5,777,616, respectively. *Among patients who were receiving dialysis in the previous year (excluding pre-emptive kidney transplants). KRT refers to kidney replacement therapy.

The lower part of **Table 1** indicates that, between 2015 and 2018, the annual incidence of de novo KRT ranged from 166 to 192 pmp. Specifically, new haemodialysis cases occurred at 160–185 pmp, new peritoneal dialysis cases at 29–53 pmp, and new kidney transplants at 159–191 pmp. Overall, the incidence of de novo KRT during this period fluctuated without displaying a clear temporal trend across the different treatment types.

Influence of gender and age

KRT prevalence increased with advancing age for both sexes across all modalities, including haemodialysis and kidney transplantation (**Figure 1** and Supplementary

Figures S1–S3). The highest prevalence of KRT and haemodialysis was observed in individuals aged 75 years or older, while kidney transplant prevalence peaked among those aged 55–64. Peritoneal dialysis remained uncommon across all age groups, with prevalence under 100 pmp, and was the most frequent dialysis modality only in patients younger than 18 years (Figure S4). Over time, the age at which KRT and haemodialysis peaked shifted: earlier for males starting in 2015 and later for females by 2018 (Figures S1–S3). For patients aged 35 years and above, both haemodialysis and kidney transplantation were generally more prevalent in men than in women.

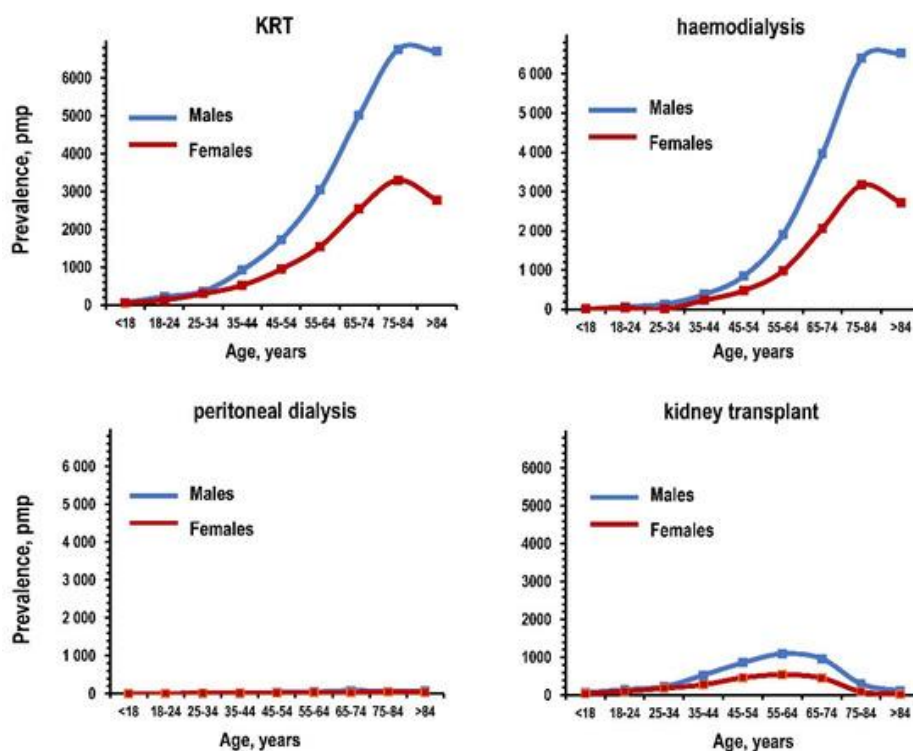


Figure 1. Age- and sex-specific prevalence of kidney replacement therapy, haemodialysis, peritoneal dialysis, and kidney transplantation in Campania residents during 2017, expressed as patients per million population (pmp). Notes: blue line represents males; red line represents females. KRT: kidney replacement therapy

The age-related pattern of de novo KRT and haemodialysis showed increasing incidence with advancing age, reaching a peak in individuals aged 75 years and older for both men and women (Figure 2 and Supplementary Figures S5–S7). Peritoneal dialysis incidence remained low across all age groups, below 50 pmp in both sexes. Kidney transplantation incidence increased with age, peaking at 45–54 years in men and 55–

64 years in women. For patients aged 35 years and above, new KRT and haemodialysis cases were generally higher in men compared to women. These patterns were similar in other study years, although peak prevalence for KRT and haemodialysis gradually shifted toward older age groups (Figures S5–S7). In contrast, kidney transplant incidence declined with increasing age in both sexes (Figure S8).

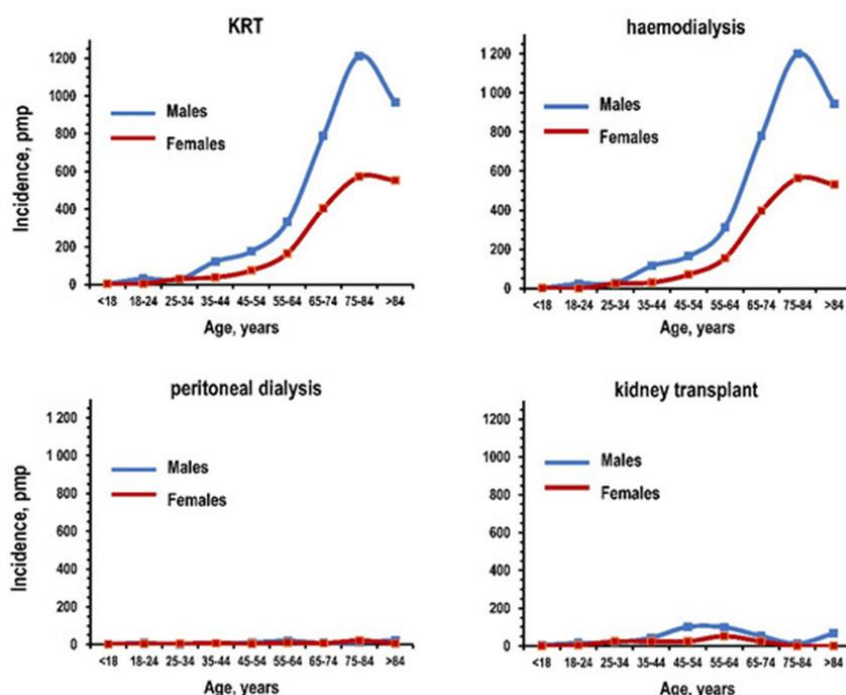


Figure 2. Distribution of newly diagnosed cases of kidney replacement therapy, haemodialysis, peritoneal dialysis, and kidney transplantation by age and sex among Campania residents in 2017, expressed as patients per million population (pmp). Blue lines indicate males; red lines indicate females. KRT: kidney replacement therapy

Patient outcomes

Figure 3 illustrates the outcomes of prevalent KRT patients, stratified by modality: haemodialysis, peritoneal dialysis, and kidney transplantation. The upper panels summarize events occurring within the same calendar year, specifically death and hospitalization. The lower panels depict the type of KRT received and the proportion of missing records in the subsequent year.

Mortality within a given year varied by treatment type: 12.8%–14.2% for haemodialysis, 5.2%–13.8% for peritoneal dialysis, and 2.4%–3.3% for transplant recipients. Hospital admissions were reported in 35.2%–36.5% of haemodialysis patients, whereas all peritoneal dialysis and transplant patients were hospitalized during the year.

Looking at the following year, most haemodialysis patients (over 78.8%) remained on the same therapy, with fewer than 0.3% switching to peritoneal dialysis and 2.0%–3.8% receiving a kidney transplant. Among peritoneal dialysis patients, more than 48.8% continued on the same treatment, under 11.4% transitioned to haemodialysis, and 7.5%–12.0% underwent transplantation. Patients with functioning kidney transplants largely remained transplanted (over 82.0%), with less than 4.3% moving to haemodialysis and fewer than 0.2% to peritoneal dialysis.

The proportion of patients with missing follow-up data in the subsequent year was highest among peritoneal dialysis patients (10.4%–15.8%), followed by kidney transplant recipients (9.9%–11.0%), and lowest among haemodialysis patients (2.0%–3.8%).

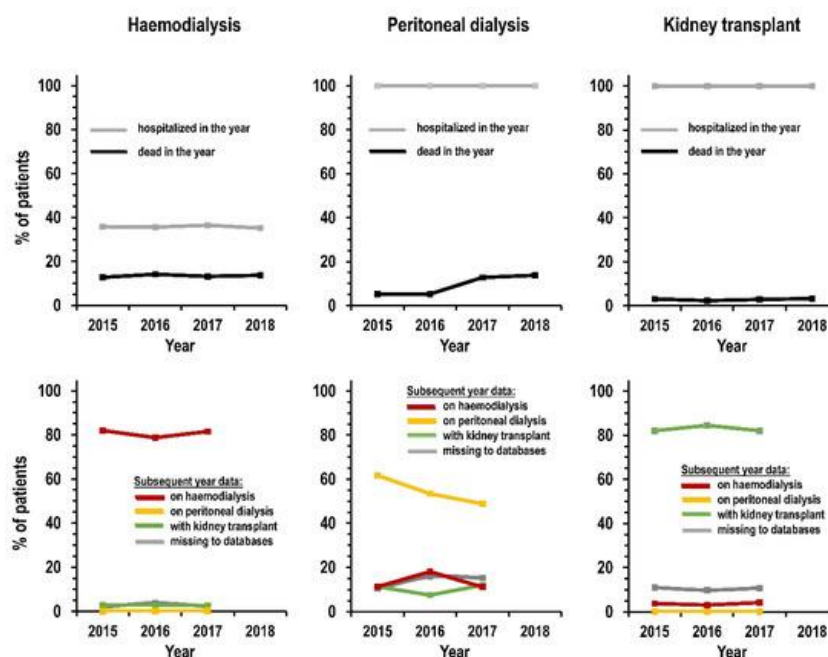


Figure 3. Yearly prevalence (%) of different kidney replacement therapy modalities. Notes: Upper panels show patients experiencing at least one hospitalization within the year (grey line) or death during the year (black line). Lower panels indicate KRT status in the following year: continued haemodialysis (red line), continued peritoneal dialysis (yellow line), kidney transplantation without dialysis (green line), or missing from the KRT and mortality records (grey line)

Factors associated with mortality and kidney transplantation

Over the 2015–2018 period, the overall annual mortality rate was 11.7% for all KRT patients (31,221 patient-years), with modality-specific rates of 16.5% for haemodialysis (19,669 patient-years), 11.7% for peritoneal dialysis (624 patient-years), and 3.2% for kidney transplant recipients (10,927 patient-years). Differences in mortality across KRT types were highly significant (log-rank $\chi^2 = 1063$, $p < 0.001$).

Cox regression analysis (**Table 2**) revealed that kidney transplantation was associated with a 59% lower risk of all-cause mortality compared with haemodialysis ($p < 0.001$). Factors independently linked to higher mortality included older age at database entry ($p < 0.001$), residence in Naples suburban areas or in Avellino province relative to urban Naples ($p = 0.007$ and $p = 0.044$, respectively), and initiation of new dialysis between 2015 and 2018 ($p = 0.037$). When analyses were stratified by KRT type, results among transplant recipients indicated that female

patients had a lower mortality risk ($p < 0.041$, Table S2, Supplementary Material).

Table 2. Cox regression analyses on mortality and access to kidney transplant (dependent variables) among residents in the Campania region on kidney replacement treatment from 2015 to 2018: uni- and multivariate HR (95%CI), bold character for HR significantly $\neq 1$

Dependent variable: mortality (n patients = 11,713, n events = 3666)		
Independent variables	Uni-variate HR (95%CI)	multi-variate HR (95%CI)
Female gender, y - n = 1-0	1.05 (0.98-1.12)	0.95 (0.89-1.02)
Age at entry in datafile, years	1.06 (1.06-1.06)	1.05 (1.05-1.05)
Type of KRT		
Haemodialysis	4.06 (3.61-4.56)	1 (reference)
Peritoneal dialysis, y - n = 1-0	0.80 (0.64-1.01)	0.88 (0.70-1.10)
Kidney transplant, y - n = 1-0	0.19 (0.17-0.21)	0.41 (0.37-0.47)
Local authority of residence		
City of Naples	0.94 (0.86-1.02)	1 (reference)
Suburban areas of Naples*	1.05 (0.98-1.12)	1.13 (1.03-1.24)
Avellino	1.22 (1.08-1.37)	1.15 (1.01-1.32)
Benevento	1.09 (0.93-1.27)	1.05 (0.89-1.25)
Caserta	1.02 (0.93-1.12)	1.09 (0.97-1.22)
Salerno	0.88 (0.81-0.96)	1.00 (0.90-1.11)
De novo incidence of dialysis, y - n = 1-0	1.54 (1.43-1.66)	1.08 (1.01-1.17)
Dependent variable: kidney transplant (n patients = 8473, n events = 549)		
Independent variables	Uni-variate HR (95%CI)	multi-variate HR (95%CI)
Female gender, 1-0	0.82 (0.70-0.95)	0.79 (0.67-0.92)
Age at entry in datafile, years	0.94 (0.93-0.94)	0.94 (0.93-0.94)
Type of KRT		
Haemodialysis	0.26 (0.20-0.34)	1 (reference)
Peritoneal dialysis, y - n = 1-0	2.42 (1.84-3.19)	1.22 (0.91-1.63)
Local authority of residence		
City of Naples	1.05 (0.88-1.26)	1 (reference)
Suburban areas of Naples *	0.99 (0.85-1.15)	0.80 (0.65-0.98)
Avellino	0.91 (0.68-1.23)	0.88 (0.63-1.23)
Benevento	1.22 (0.87-1.71)	1.24 (0.86-1.79)
Caserta	1.03 (0.84-1.26)	0.83 (0.64-1.06)
Salerno	0.93 (0.76-1.12)	0.79 (0.62-1.01)
De novo incidence of dialysis **, y - n = 1-0	0.65 (0.54-0.79)	0.59 (0.49-0.71)

*The suburban areas of Napoli 2 nord and Napoli 3 sud were combined for analysis. **Incidence data cover the period 2015-2018. KRT: kidney replacement therapy.

During the four-year period from 2015 to 2018, the annual rate of kidney transplantation was 2.6 percent (21,234 patient-years). Cox regression analysis identified several independent factors associated with a lower likelihood of receiving a kidney transplant: female sex ($p = 0.002$), older age at entry into the database ($p < 0.001$), residence in the suburban areas of Naples compared with urban Naples ($p = 0.033$), and initiation of new dialysis between 2015 and 2018 ($p < 0.001$). No significant association was observed for type of dialysis or residence in other provinces ($p > 0.06$).

Discussion

This research represents the first comprehensive evaluation of KRT epidemiology in the Campania region, a region previously underrepresented or absent in national and European KRT registry reports. Between 2015 and 2018, KRT prevalence ranged from approximately 1,300 to 1,400 patients per million population (pmp), and

incidence ranged from 160 to 190 pmp. These rates are in the mid-range of European registry data [5] and align with findings from other Italian regions [7,10]. Haemodialysis delivered through private ambulatory clinics was by far the most frequently used modality. Peritoneal dialysis was relatively uncommon among adults but predominated in pediatric patients. Overall annual mortality among KRT recipients was roughly 11%, consistent with reports from other Italian cohorts [7,10,18], and was independently influenced by age, KRT type, place of residence, and recent initiation of dialysis. The yearly kidney transplant rate was approximately 3%, with gender, age, residence, and recent dialysis initiation serving as independent correlates.

Key limitations of this study include the lack of data on the underlying cause of end-stage kidney disease, patient comorbidities, and precise KRT initiation dates—particularly for patients receiving KRT for five years or longer. Ethnicity data were not collected; however, this is

a minor concern as foreign residents represent less than 9% of the Italian population [17].

Several observations support the conclusion that chronic dialysis comprised at least 93 percent of all dialysis cases in this study. First, haemodialysis accounted for over 95% of KRT modalities apart from kidney transplant. Second, more than 98 percent of haemodialysis patients were treated in private ambulatory clinics, where acute or temporary dialysis is not provided. Cases labeled as “missing” in the subsequent-year databases may reflect a mixture of temporary dialysis for acute kidney injury, relocation outside Campania, or coding errors. Compared with haemodialysis, missing cases were two to three times more common among peritoneal dialysis patients and kidney transplant recipients, suggesting that coding errors were relatively rare in private outpatient clinics, which rely on accurate reporting for reimbursement.

Analysis of KRT in the year following initial treatment showed that haemodialysis remained the predominant modality for patients who required dialysis after kidney transplant failure, consistent with current prevalence and incidence data and reports from northeastern Italy [18]. Transitions from peritoneal dialysis to haemodialysis were considerably more frequent than the reverse.

Year-to-year fluctuations in prevalence and incidence partially explain interregional variability in KRT rates. From 2015 to 2018, KRT prevalence increased slightly more when expressed per million population (+2.8%) than in absolute numbers (+1.3%), reflecting the gradual decline in the Campania population over this period (see **Table 1** footnote). Data from the Italian Dialysis and Transplantation Registry showed an upward trend in KRT incidence until 2011, followed by stabilization [7]; the current findings suggest that temporal trends may vary by region. The elevated KRT prevalence in Campania was entirely attributable to haemodialysis among individuals aged ≥ 45 years, while prevalence curves for kidney transplant were similar to national registry data and lower for peritoneal dialysis (Figure S8, Supplementary Material).

Mortality was independently higher in dialysis patients as age increased compared to kidney transplant recipients and among patients with newly initiated dialysis, consistent with prior studies [18,19]. While female sex is generally associated with lower mortality even in advanced chronic kidney disease [20], in this study gender was linked to mortality only among kidney transplant recipients and not among dialysis patients. These findings suggest that dialysis may negate the survival advantage typically seen in females with reduced kidney function. The observed higher mortality among dialysis patients living in suburban areas highlights the potential impact of socioeconomic factors on outcomes and indicates disparities between urban and suburban populations [12].

To date, the influence of socioeconomic status on dialysis mortality has been studied mainly outside Europe [21]. The current data could not explore whether socioeconomic factors affect comorbidities or timing of KRT initiation due to the absence of this information.

Independent predictors of reduced access to kidney transplantation included female sex, older age, suburban residence, and newly initiated dialysis. Associations with older age and KRT initiation are consistent with findings from large registries [4,5]. Notably, the link between female sex and lower transplant access has not previously been reported in Europe or Italy, though it has been observed in the US and Canada [13,15]. This gender disparity may reflect multiple factors, including unequal enrollment on transplant lists, higher prevalence of transplant contraindications in women, or gender bias at transplant centers. Similarly, the lower likelihood of transplantation for patients living in suburban areas reinforces the notion of social inequities in KRT, aligning with the higher mortality observed in this group.

From a practical standpoint, these findings can inform the planning and organization of medical and social support for KRT patients by providing robust data on prevalence, incidence, and outcomes. The novel observation—at least in the Italian and European context—of increased mortality and reduced access to kidney transplantation among suburban dialysis patients highlights significant social disparities. This is further emphasized by the lower transplant access observed in female patients.

Conclusions

In conclusion, this study presents the first detailed assessment of KRT epidemiology in Campania, Italy’s third most populous region in the southwest. Both prevalence and incidence were within the intermediate ranges reported in European registries. Among KRT patients, age, timing of KRT initiation, and treatment modality were independent predictors of mortality and kidney transplant access. Evidence of socioeconomic disparities was suggested by the findings that female sex and suburban residence were associated with both higher mortality and reduced likelihood of receiving a kidney transplant.

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