BMC Nephrology

RESEARCH

Open Access

Employment before and after initiation of dialysis or kidney transplantation– a Danish nationwide registry-based cohort study

Rasmus Kirkeskov Carlsen[1,2,3*], Lilli Kirkeskov[4], Margit S. Riis[5], Rikke K. Jacobsen[5], Frederikke Hørdam Gronemann[5], Merete Osler[5,6], Janne Petersen[5,7] and Niels Henrik Buus[1]

Abstract

Background Patients treated with chronic dialysis or kidney transplantation have difficulties in maintaining employment. We aimed to estimate employment rates among dialysis and kidney transplant patients from 3 years before to 3 years after initiating dialysis or undergoing transplantation.

Methods All first-time dialysis and kidney transplantation patients aged 18–65 years in Denmark from 2005 to 2019 were identified using the Danish Nephrological Register and linked with information about social security benefits. Each dialysis or kidney transplant patient was matched with 3 references.

Results In total, 4,469 patients undergoing dialysis (median age 55 years, 65% males) and 2,294 patients receiving kidney transplants (median age 49 years, 64% males) were included together with 13,262 and 6,790 matched references, respectively. The employment rate was 11% when initiating dialysis compared to 61% for the reference group. Kidney transplantation patients had an employment rate of 20% compared to 67% for the reference group. At all time points (3 years before, 1 year before, at the time of intervention, 1 year after, and 3 years after) both dialysis and kidney transplant patients had lower employment rates compared to references ($P < 0.001$). There was only a partial return to work after transplantation. Employment rates increased in ESKD patients in the period 2005–2019, however, the increase was not different from corresponding reference groups.

Conclusions Employment rates in ESKD patients are very low and decline long before initiation of dialysis or kidney transplantation. Of concern, kidney transplantation only leads to a small increase in employment. There has been no improvement in the employment of ESKD patients from the period 2005–2009 to 2015–2019.

Keywords End-stage kidney disease, Employment, Dialysis, Kidney transplantation, Cohort study

*Correspondence:
Rasmus Kirkeskov Carlsen
rasm.carl@midt.rm.dk
[1]Department of Renal Medicine, Aarhus University Hospital, Palle Juul-Jensens Boulevard 35, Aarhus N 8200, Denmark
[2]Medical Department, Viborg Regional Hospital, Viborg, Denmark
[3]Department of Transplantation Medicine, Oslo University Hospital, Oslo, Norway
[4]Department of Social Medicine, University Hospital Bispebjerg-Frederiksberg, Copenhagen, Denmark
[5]Center for Clinical Research and Prevention, University Hospital Bispebjerg-Frederiksberg, Copenhagen, Denmark
[6]Section of Epidemiology, Department of Public Health, University of Copenhagen, Copenhagen, Denmark
[7]Section of Biostatistics, Department of Public Health, University of Copenhagen, Copenhagen, Denmark

Background

End-stage kidney disease (ESKD) has a major impact on the quality of life and affects the ability to be employed. People with chronic diseases are at increased risk for premature labour force exit including long-term unemployment and early retirement [1]. In recent decades, treatment options for ESKD have improved, including home haemodialysis, improved peritoneal dialysis options, and enhanced survival following kidney transplantation [2]. Despite this progress, inability to work remains a major problem [3–6].

In a recent meta-analysis, we found that employment rates among patients with ESKD below 65 years were notably low: 26.3% (10.5–59.7%) for those in dialysis, 36.9% (25–86%) for patients awaiting kidney transplantation, and 38.2% (14.2–85%) post-transplantation, as compared to an overall employment rate in the Organization for Economic Co-operation and Development (OECD) countries of 69% [6, 7]. Employment rates among ESKD patients, however, vary considerably between countries and continents, influenced by numerous factors such as age [8, 9], gender [10–12], ethnicity [9, 13, 14], educational level [11, 12, 15], dialysis modality [11, 16], and the presence of comorbidities such as diabetes [8, 17] or depression [8, 18].

Most previous studies in this field are cross-sectional and without a relevant reference group. In addition, employment rates are mainly based on self-reported work ability or labour market attachment, or the studies included patients above the age of normal retirement pension. Furthermore, very few investigations have compared employment rates before and after the initiation of dialysis or transplantation. Lastly, several studies have reported no data on time from intervention at the time of employment status. Therefore, there is a need for larger studies investigating employment among ESKD patients compared with an appropriate background population. Combining several national databases, all prevalent ESKD patients in Denmark over a 15-year period are investigated, rendering it possible to establish accurate employment rates and changes over time from 2005 to 2019.

The purpose of the present nationwide study is to describe the employment rate before and after initiation of dialysis and kidney transplantation in Denmark compared with the general Danish population, and secondly to investigate the employment rate between time periods from 2005 to 2009 to 2015–2019. We hypothesize that ESKD impairs working ability, resulting in low employment rates and that kidney transplantation improves the employment rate. Secondly, we hypothesize that improvement in the treatment of ESKD has increased patients' employment rates from 2005 to 2009 to 2015–2019.

Methods

Design

This is a registry-based cohort study with a matched reference group, investigating employment rates in dialysis and/or transplantation patients in the period 2005–2019. Index time was defined as the first initiation of either dialysis or kidney transplantation. As most transplantation patients take sickness leave during the peri- and postoperative period, employment status at index time was based on their status four weeks before transplantation. This study adheres to the STROBE and RECORD checklists.

Ethics

The study adheres to the tenets of the Declaration of Helsinki. The study only includes pseudonymized registry data and therefore does not require review of an ethics committee or consent from participants according to Danish Law (Scientific Ethical Committees Act § 14, part 2). The study was reviewed and approved of Statistics Denmark (project number 708072/MMK).

Study population

The study populations were defined as patients initiating chronic dialysis treatment (dialysis cohort) or having kidney transplantation (transplantation cohort) based on registrations in the Danish Nephrological Register (*Dansk Nefrologisk Selskabs Landsregister*, DNSL) between 2005 and 2019. Inclusion criterion was age 18–65 years. Exclusion criteria were patients not included in the Civil Registration System (CPR) three years before and after index time or no entry in the DREAM database (Danish Register for Evaluation of Marginalization). A patient can enter both the dialysis cohort and the transplantation cohort.

Almost all patients were matched with three references from the background population (> 97% of the study population), and all patients were matched with at least one reference. The reference group was matched by year of birth, gender, and latest known municipality.

Outcome

Employment was classified as being without social benefits registered in DREAM. Unemployment was defined as receiving social benefits or being on sick leave. Permanently out of the workforce was defined as early retirement or pension (specific DREAM codes are listed in Supplementary Table 1).

The primary outcome was the employment rates at five different time points for the dialysis cohort or transplantation cohort: 3 years before, 1 year before, at the initiation of dialysis or transplantation, 1 year and 3 years after. The secondary outcome was differences in employment rate over 3 time periods; 2005–2009, 2010–2014, and

2015–2019, for respectively dialysis or transplantation patients compared to the reference group.

Data collection

Data was linked between 4 databases: DNSL, DREAM, Statistics Denmark, and the Danish National Patient Register.

DNSL, as a part of the Danish Clinical Quality Program– National Clinical Registries (RKKP), includes all patients with ESKD since 1990 and contains information on dialysis modality, changes between dialysis modalities and time of kidney transplantation. As no private nephrology clinics exist in Denmark, DNSL covers the entire population.

The DREAM register includes all citizens who have received transfer income since 1991 and reports weekly on which benefits have been paid. Because of changes in the DREAM register, we excluded patients or controls if they had no entry in DREAM. People who never received any state transfer payment before their death and died before 2008 were not registered in DREAM. After 2008 all Danish people with any monthly income from either state transfers or regular wage had been registered in the DREAM database.

Statistics Denmark provided information concerning socio-economic conditions, including education and income. In addition, this database includes information such as ethnic background and municipality of residence.

The Danish National Patient Register contains information about contacts at Danish hospitals, including dates of contacts and diagnosis codes according to the International Classification of Diseases, Tenth Revision (ICD-10).

Classifications

In the registries, ethnicity is reported as Danish if the person, regardless of birthplace, has at least one parent who is born in Denmark and is a Danish citizen, or if the person was born in Denmark regardless of the parent's status. A person is reported as immigrated if born outside of Denmark, none of the parents are born in Denmark and registered with Danish citizenship.

The following ICD-10 diagnoses were used: DE10-14 for diabetes, DI109 and DI151 for hypertension, DI20-25 for ischemic heart disease, and DF31-DF33 for affective disorders. The validity and sensitivity of identifying ischemic heart disease and diabetes is high using ICD codes in Denmark, is low regarding hypertension and unknown when identifying affective disorders [19].

Based on a random sample of the Danish population matched on index year and age at index year, income quartiles were estimated, and each patient's income was evaluated in relation to these quartiles.

Statistical analysis

Data were analysed using SAS Enterprise Guide version 8.3 Update 7 (8.3.7.202) (64-bit). The distribution of characteristics at index time was presented by numbers (percentages) and differences between patients and the reference group were assessed by chi-square tests.

Employment rates are presented in Sankey diagrams demonstrating proportions for each group (patients and controls) and how proportions change from one time point (only) to the adjacent time point (i.e., it is not possible to follow one patient from the first bar to the last).

Employment rates at index time were presented for three groups having year of index in 2005–2009, 2010–2014 or 2015–2019. Changes in employment were assessed with logistic regression analyses and differences between patients and controls were assessed by an interaction.

Results

Study population

From 1st January 2005 to 31st December 2019 a total of 4,469 patients initiated chronic dialysis and were matched with 13,262 references, including only patients of working age (47% of all dialysis patients regardless of age). A total of 2,294 patients received their first kidney transplantation between 2005 and 2019 and were matched with 6,790 references (Fig. 1).

Patient characteristics compared with the corresponding matched reference group are presented in Table 1. Dialysis patients had a median age of 55 (quartile range 16) years at the initiation of dialysis, whereas transplanted patients had a median age of 49 (quartile range 18) years at the time of transplantation. Approximately two-thirds of both dialysis and transplanted patients were males. Dialysis patients received haemodialysis in 65% of the cases. Seventy-nine per cent of transplanted patients had received dialysis before transplantation and 21% had pre-emptive transplantation. Of transplanted patients previously receiving dialysis, 64% received haemodialysis.

Both dialysis and transplant patients had a higher proportion of immigrants and both groups generally had shorter education and lower income compared with their respective references. As expected, ESKD patients had a higher proportion of comorbidities compared with respective references, including higher occurrence of diabetes, hypertension, and ischemic heart disease, and the dialysis patients were more often diagnosed with affective disorders. The cause of ESKD was missing in 25–30% of cases while the known causes of ESKD had similar distributions among dialysis and transplanted patients.

Employment rates

The employment rates are presented in Table 2 and as Sankey diagrams in Fig. 2A-D as proportions at 3 years

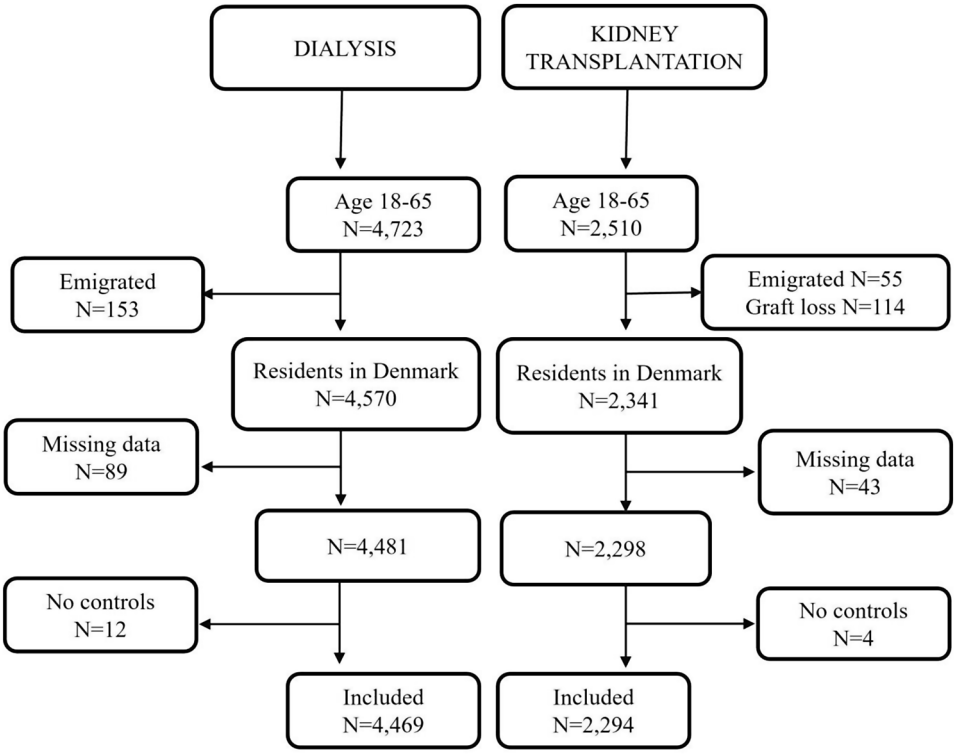

Fig. 1 Flowchart of inclusion and exclusion of either dialysis or kidney transplant patients. Inclusion and exclusion are presented downwards with primarily all patients in either dialysis or kidney transplantation of working age (years) in the study period 2005–2019; then excluded patients who emigrated and in the transplantation cohort patients with primary graft loss without data on first transplantation or graft loss same date as first transplantation; then excluded patients in the transplant group with an immediate graft loss after transplantation; then excluded patients without data in the DREAM registry; then excluded patients without available controls and finally the study population

before, 1 year before, index time, 1 year after, and 3 years after; for dialysis and transplantation patients and corresponding controls, respectively. The coloured connections between two adjacent bars in the Sankey diagram demonstrate that a large proportion of patients and the reference group remain in the same work affiliation category.

At all time points, employment rates were much lower among both dialysis and transplantation patients as compared to their respective references and with higher proportions of sickness leave or being permanently out of work (Table 2). This includes a significantly lower employment rate three years before dialysis or transplantation compared to the respective reference ($P<0.001$). Dialysis patients had a high proportion of death with 25% dying within 3 years after initiation of dialysis compared to only 2% of controls.

Dialysis and transplantation patients with respective controls were divided into subgroups corresponding to year of index time in the time periods 2005–2009, 2010–2014, and 2015–2019 (Table 3). There was a trend towards increasing employment rates at index time in both patient groups as well as in the reference group in the period 2015–2019 as compared to the previous periods, using logistic regression. This trend was significant in all groups, including dialysis patients ($P=0.001$) and transplantation patients ($P=0.009$). However, the changes were not significantly different between time periods among dialysis patients ($P=0.10$) or transplanted patients ($P=0.10$) from the reference group, i.e., the interaction term in logistic regression between patient/reference and year group was not significant.

Discussion

The present study investigates employment rates in cohorts of dialysis and kidney transplant patients using complete national register-based information and with large population-based reference groups for comparison. The main findings are low employment rates in dialysis and kidney transplant patients respectively, already three years before intervention, at the initiation, and one and three years after initiation. The low employment rates at initiation are especially low when compared to matched references and did not improve more in patients than references from the period 2005–2009 to 2015–2019.

This study is novel compared to previous studies, which mainly used self-reported data concerning employment. Also, this seems to be the first study comparing employment rates at time points: before, at the time of initiation of dialysis or kidney transplantation, and the following

Table 1 Characteristics of patients with end-stage kidney disease initiating dialysis or kidney transplantation and their corresponding references from the background population

	Dialysis		Kidney transplantation	
	Patients	**Reference**	**Patients**	**Reference**
Total				
N	4,469	13,262	2,294	6,790
Age (years)				
18–35	512 (11%)	1,485 (11%)	446 (19%)	1,291 (19%)
36–45	664 (15%)	1,971 (15%)	482 (21%)	1,431 (21%)
46–55	1,162 (26%)	3,460 (26%)	668 (29%)	1,991 (29%)
56–65	2,131 (48%)	6,346 (48%)	698 (30%)	2,077 (31%)
Sex				
Male	2,888 (65%)	8,567 (65%)	1,464 (64%)	4,337 (64%)
Female	1,581 (35%)	4,695 (35%)	830 (36%)	2,453 (36%)
Period				
2005	1,673 (37%)	4,978 (38%)	645 (28%)	1,908 (28%)
2010	1,489 (33%)	4,410 (33%)	834 (36%)	2,469 (36%)
2015	1,307 (29%)	3,874 (29%)	815 (36%)	2,413 (36%)
Ethnicity	$P < 0.0001$		$P = 0.003$	
Immigrated	481 (11%)	1165 (9%)	266 (12%)	640 (9%)
Danish	3,988 (89%)	12,097 (91%)	2,028 (88%)	6,150 (91%)
Education	$P < 0.0001$		$P < 0.0001$	
Basic schooling	1,947 (45%)	4,235 (33%)	882 (39%)	2,183 (33%)
Vocational training	1,651 (38%)	5,112 (39%)	856 (38%)	2,483 (37%)
College graduate	577 (13%)	2,626 (20%)	386 (17%)	1,401 (21%)
University degree or higher	160 (4%)	1,043 (8%)	114 (5%)	601 (9%)
Income	$P < 0.0001$		$P < 0.0001$	
< p25	1,932 (43%)	3,584 (27%)	733 (32%)	1,906 (28%)
[p25-p50]	1,161 (26%)	2,981 (22%)	618 (27%)	1,495 (22%)
[p50-p75]	791 (18%)	3,034 (23%)	495 (22%)	1,524 (22%)
> p75	585 (13%)	3,663 (28%)	448 (20%)	1,865 (27%)
Dialysis modality				
Haemodialysis	2,893 (65%)		1,146 (64%)	
Peritoneal dialysis	1,576 (35%)		656 (36%)	
Waiting time for transplantation (months)				
Living donor			949	
< 12			699 (54%)	
12–24			253 (19%)	
> 24			353 (27%)	
Time on dialysis (months)				
< 12			537 (23%)	
12–24			454 (20%)	
> 24			811 (35%)	
Pre-emptive			492 (21%)	
Diabetes	$P < 0.0001$		$P < 0.0001$	
Yes	1,622 (36%)	407 (3%)	526 (23%)	159 (2%)
No	2,847 (64%)	12,855 (97%)	1,768 (77%)	6,631 (98%)
Affective disorder	$P < 0.0001$		$P = 0.216$	
Yes	97 (2%)	90 (1%)	17 (1%)	35 (1%)
No	4,372 (98%)	13,172 (99%)	2,277 (99%)	6,755 (99%)
Hypertension	$P < 0.0001$		$P < 0.0001$	
Yes	2,293 (51%)	638 (5%)	1,295 (56%)	246 (4%)
No	2,176 (49%)	12,624 (95%)	999 (44%)	6,544 (96%)
Ischemic heart disease	$P < 0.0001$		$P < 0.0001$	
Yes	707 (16%)	394 (3%)	363 (16%)	171 (3%)

Table 1 (continued)

	Dialysis		Kidney transplantation	
	Patients	**Reference**	**Patients**	**Reference**
No	3,762 (84%)	12,868 (97%)	1,931 (84%)	6,619 (97%)
Cause of end-stage kidney disease				
Chronic glomerulonephritis	473 (15%)		429 (25%)	
Cystic kidney disease	282 (9%)		252 (15%)	
Systemic disease	1,365 (43%)		535 (31%)	
Chronic pyelonephritis / nephrolithiasis	142 (4%)		81 (5%)	
Interstitial nephropathy	147 (5%)		62 (4%)	
Uraemia without specification	494 (16%)		266 (15%)	
Other hereditary kidney disease	75 (2%)		46 (2%)	
Other	188 (6%)		53 (3%)	
Missing	1,303		570	

Age is presented from initiation of dialysis or transplantation. Income is reported as the closest proximity to quartiles of a previously calculated distribution, Patients and the reference groups are compared using chi-square tests

Table 2 Employment rates 3 years before, 1 year before, at index time, 1 year after, and 3 years after initiation of dialysis or kidney transplantation

	Dialysis		Kidney transplantation	
	Patients	**Reference**	**Patients**	**Reference**
3 years prior to index time	$P<0.001$		$P<0.001$	
Employed	41%	69%	46%	69%
Unemployed	24%	16%	29%	19%
Permanently out of work	35%	15%	24%	12%
1 year prior to index time	$P<0.001$		$P<0.001$	
Employed	33%	64%	30%	68%
Unemployed	24%	16%	35%	18%
Permanently out of work	43%	20%	35%	14%
At index time	$P<0.001$		$P<0.001$	
Employed	11%	61%	20%	67%
Unemployed	40%	15%	39%	18%
Permanently out of work	48%	24%	41%	15%
1 year after index time	$P<0.001$		$P<0.001$	
Employed	11%	58%	28%	65%
Unemployed	27%	14%	28%	17%
Permanently out of work	51%	28%	42%	18%
Dead	11%	1%	2%	1%
3 years after index time	$P<0.001$		$P<0.001$	
Employed	12%	51%	28%	60%
Unemployed	15%	12%	23%	16%
Permanently out of work	49%	35%	44%	23%
Dead	25%	2%	5%	1%

Index time is defined as time of initiation of first dialysis or transplantation (4 weeks prior)

years. Our hypothesis of low employment rates among ESKD patients was confirmed, though with a surprisingly large difference between patients and the matched references already three years before intervention. It is of concern that kidney transplantation only marginally increases employment rates.

In the present study, employment rates among dialysis and transplantation patients are considerably lower as compared to data from our previous meta-analysis which represented all published studies until 2020 [6]. However, concerning dialysis patients, the results from the meta-analysis were primarily driven by 2 cross-sectional studies from the United States. One study represents 36,646 dialysis patients wait-listed for transplantation with 34.5% working full-time and the other dialysis cohort with 105,636 patients with an employment rate of 18.9% [20, 21]. Only one previous study has assessed employment among Danish ESKD patients and based on self-reporting in a small cohort of 150 haemodialysis patients, 22% were employed [22]. Likewise, data regarding employment among transplanted patients in the meta-analysis are highly influenced by 2 large cohort studies from the United States including 47,123 patients one year after transplantation, of which 38.1% worked full-time and 71,976 patients with an employment rate of 32.1% [23, 24].

The much lower employment rates in our study may be explained by study design as well as differences in socioeconomic conditions and healthcare systems between the United States and Europe. Self-reporting in previous studies may overestimate working abilities and therefore induce a bias and even large cohort studies may not represent the average of all ESKD patients from a country. The cause of ESKD could also be important and a high proportion of diabetes patients would tend to reduce employment due to more comorbidity [6].

The increase in employment among dialysis as well as transplanted patients in the period 2015–2019 suggests

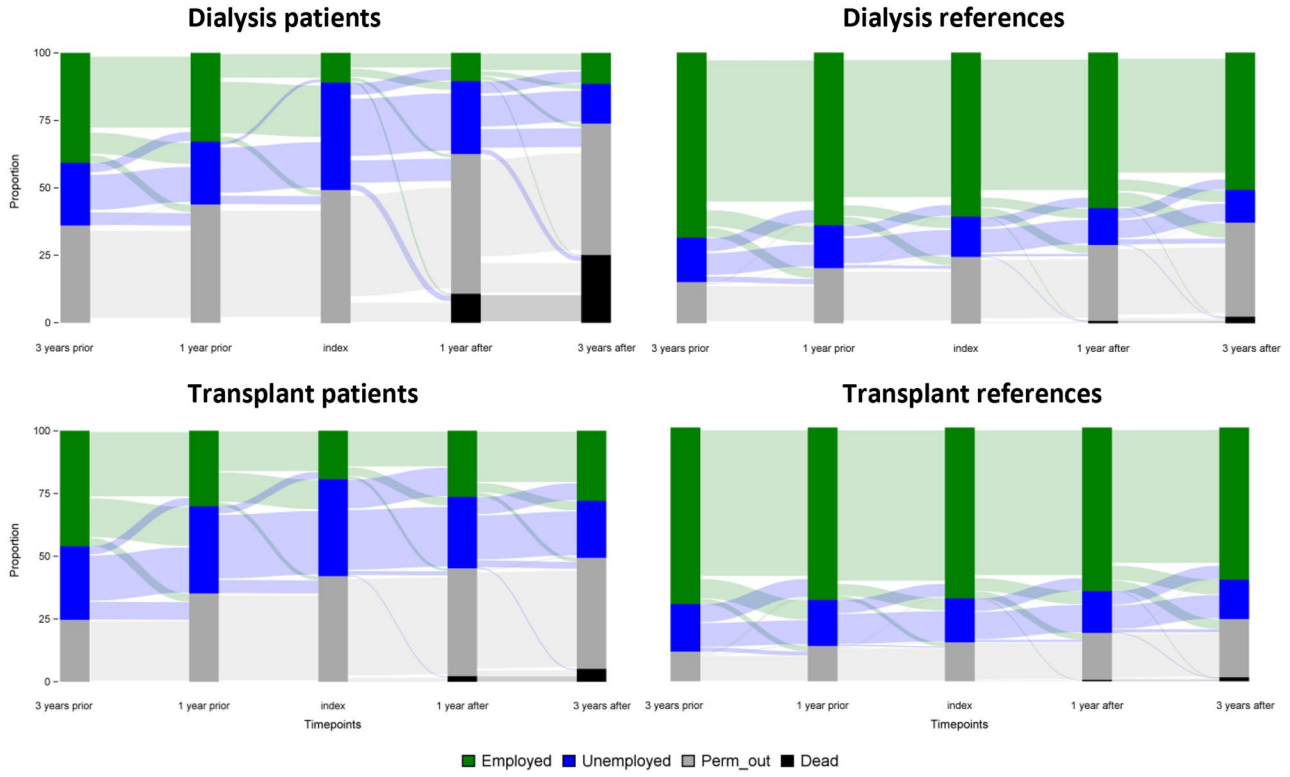

Fig. 2 **A**–**D**. Sankey diagram. Employment rates before, at initiation of dialysis or transplantation, and after intervention compared to reference group. Each bar represents a standstill proportion of people employed (green), unemployed (blue), permanently out of work (grey) or dead (black) at a certain time point, counting from left to right: three years before index, one year before index, at index, one year after index, and three years after index. Index time is defined as time of initiation of first dialysis or transplantation

Table 3 Employment rates at index time in 3 time periods

	Dialysis		Kidney transplantation	
	Patients*	Reference*	Patients*	Reference*
2005–2009	153 (9%)	2,963 (60%)	115 (18%)	1,289 (68%)
2010–2014	172 (12%)	2,644 (60%)	149 (18%)	1,634 (66%)
2015–2019	177 (14%)	2,507 (65%)	189 (23%)	1,651 (68%)

Index time is defined as time of initiation of first dialysis or transplantation (4 weeks prior) presented in the three different five-year periods. *$P < 0.05$ for trend of employment according to index time

that employment among ESKD patients is dependent on the same economic circumstances as for the general population which also increased in this period [25]. However, despite significant improvements in treatment options and prognosis of ESKD [2–6] in the period from 2005 to 2019, this is not reflected in relative employment rates for ESKD patients, indicating insufficient focus on this aspect in Danish dialysis and transplantation centres.

An important finding in our dataset is a large decline in employment during the years before the initiation of renal replacement therapy. This information shows that initiatives in maintaining employment should take place in the early stages of chronic kidney disease and not wait until patients need replacement therapy. It is well-known that ESKD populations have a large burden of somatic comorbidities which is also a marked feature in the presented Danish population. Both somatic and social factors are related to unemployment in ESKD patients. These include comorbidities such as diabetes [13, 18], cardiovascular [23] and affective disorders [8]. Social conditions including the educational level [11, 12, 15] are very important but often overlooked and require focus many years before the onset of ESKD. For patients undergoing kidney transplantation, pre-transplant employment is very important for continuous affiliation to the labour market [4, 8, 13, 26], which points to the importance of pre-emptive transplantation, more living donor transplantations, and the avoidance of a long time on waiting lists.

Strengths and limitations

The main strengths of this study are the use of a nationwide cohort comprising all Danish patients on chronic renal replacement therapy over a 15-year period as well as an independent outcome assessment from the DREAM database, thus avoiding bias associated with self-reporting. Another strength is the use of a matched control group enabling us to clearly identify differences in both health-related and socio-economic conditions between ESKD patients and the background population considering changes over time.

The main limitation of the study is the lack of eGFR and corresponding Chronic Kidney Disease (CKD) stages at all time points. We expect all or nearly all patients to be CKD stage 5 at the time of intervention, but we cannot exclude the possibility of differences especially at time points before or after index time when comparing to other countries. We identified hypertension and affective disorders using ICD-10 codes, which have respectively low and unknown sensitivity in Denmark with possible underestimations of the diagnoses. We decided to focus only on the first initiation of dialysis and/or transplantation, respectively, for each patient, and the effects of multiple transplantations or multiple returns to dialysis treatment on employment cannot be estimated from the data.

Implications and perspective

There is great potential for improving employment rates in patients with renal replacement therapy. The most important intervention is probably work-related prevention prior to unemployment, or early at diagnosis of end-stage renal disease, through education and clinical and social support for patients to stay in work. Though there has been an increase in employment rates in ESKD patients in the fifteen-year study period 2005–2019, the increase is not different from corresponding control groups, and this indicates no progress in maintaining ESKD patients at work despite improvements in the treatment of ESKD.

Conclusion

Employment rates in ESKD patients are very low compared to matched references and decline long before the initiation of dialysis or kidney transplantation. Of concern, kidney transplantation only leads to a small increase in employment. There has been no improvement in the employment of ESKD patients from the period 2005–2009 to 2015–2019.

Abbreviations

CKD	Chronic Kidney Disease
CPR	Civil Person Registration
DNSL	Dansk Nefrologisk Selskabs Landsregister
DREAM	Danish Register for Evaluation of Marginalization
ESKD	End-stage kidney disease
ICD-10	International Classification of Diseases, Tenth Revision
OECD	Organization for Economic Co-operation and Development
RKKP	Regionernes Kliniske Kvalitetsudviklingsprogram

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12882-025-03969-9.

Supplementary Material 1

Acknowledgements

None.

Author contributions

RC, LK, and NHB designed the outline of the study, refined by JP, MO, MR, RJ, and FG. MR, RJ, and FG performed data acquisition and analysis. RC drafted the primary manuscript. All authors reviewed and approved the manuscript before submission.

Funding

The study was supported by the Augustinus Foundation, project number 19-2123.

Data availability

Because of the sensitivity of the data used, no dataset with microdata or pseudonymised data can be shared in concordance with Danish law and guidelines from the Danish Health Data Authority. Macrodata and information on data collection from registries and using data from registries are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

The study adheres to the tenets of the Declaration of Helsinki. The study only includes pseudonymized registry data and therefore does not require review of an ethics committee or consent from participants according to Danish Law (Scientific Ethical Committees Act § 14, part 2). The study was reviewed and approved of Statistics Denmark (project number 708072/MMK).

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 27 September 2024 / Accepted: 17 January 2025
Published online: 30 January 2025

References

1. van Rijn RMRS, Brouwer S, Burdorf A. Influence of poor health on exit from paid employment: a systematic review. Occup Environ Med. 2014;71:295–301.
2. Kramer A PM, Noordzij M, Stel VS, Andrusev AM, Aparicio-Madre MI, Arribas Monzón FE, Åsberg A, Barbullushi M, Beltrán P, Bonthuis M, Caskey FJ, Castro de la Nuez P, Cernevskis H, De Meester J, Finne P, Golan E, Heaf JG, Hemmelder MH, Ioannou K, Kantaria N, Komissarov K, Korejwo G, Kramar R, Lassalle M, Lopot F, Macário F, Mackinnon B, Pálsson R, Pechter Ü, Piñera VC, Santiuste de Pablos C, Segarra-Medrano A, Seyahi N, Slon Roblero MF, Stojceva-Taneva O, Vazelov E, Winzeler R, Ziginskiene E, Massy Z, Jager KJ. The European Renal Association - European Dialysis and Transplant Association (ERA-EDTA) Registry Annual Report 2016: a summary. Clin Kidney J. 2019;12:702–20.
3. D'Egidio VMA, Ciaccio D, Sestili C, Cocchiara RA, Del Cimmuto A, La Torre G. Return to work after kidney transplant: a systematic review. Occup Med. 2019;69:412–8.
4. Eppenberger LH-MP, Dickenmann M. Back to work? Socioeconomic status after kidney transplantation. Swiss Med Wkly. 2015;145:1–8.
5. Chisholm-Burns MAES, Spivey CA, Kaplan B. Health-related quality of life and employment among renal transplant recipients. Clin Transpl. 2012;26:411–7.
6. Kirkeskov LCR, Lund T, Buus NH. Employment of patients with kidney failure treated with dialysis or kidney tranplantation - a systematic review and meta-analysis. MBMC Nephrol. 2021;22:1–17.
7. OECD. Employment rate (indicator). https://dataoecd.org/emp/employment-ratehtm 2020. Assessed on 11. May 2023.
8. Danuser BSA, Studer R, Koller M, Wild P. Employment 12 months after kidney transplantation: an in-depth bio-psycho-social analysis of the Swiss transplant cohort. PLoS ONE. 2017;12:1–17.
9. Sangalli VDJ, Doppalapudi SB, Costa G, Neri L. Work ability and labor supply after kidney transplantation. Am J Nephrol. 2014;40:353–61.

10. Imanishi YFS, Karaboyas A, Bruce M, Robinson BM, Ronald L, Pisoni RL, Nomura T, Akiba T, Akizawa T, Kurokawa K, Saito A, Fukuhara S, Inaba M. Associations of employment status and educational levels with mortality and hospitalization in the dialysis outcomes and practice patterns study in Japan. PLoS ONE. 2017;12:1–11.
11. Kutner NGZR, Huang Y, Johansen KL. Depressed mood, usual activity level, and continued employment after starting dialysis. Clin J Am Soc Nephrol. 2010;5:2040–5.
12. Huang BLB, Xu L, Wang Y, Cao Y, Yan P, Chen J. Low employment and low willingness of being reemployed in Chinese working-age maintained hemodialysis patients. Ren Fail. 2017;39:607–12.
13. Eng MZJ, Cambon A, Marvin MR, Gleason J. Employment outcomes following successful renal transplantation. Clin Transpl. 2012;26:242–6.
14. Bohlke MMS, Gomes RH, Terhorst L, Rocha M, Poli de Figueiredo CE, Sesso R, Irigoyen MC. Predictors of employment after successful kidney transplantation– a population-based study. Clin Transpl. 2008;22:405–10.
15. Curtin RBOE, Sacksteder P, Friedman A. Differences between employed and nonemployed dialysis patients. Am J Kidney Dis. 1996;27:533–40.
16. Ghani ZRH, Jarl J. The effect of peritoneal dialysis on labor market outcomes compared with institutional hemodialysis. Perit Dial Int. 2019;39:59–65.
17. Matas AJLW, McHugh L, Gillingham K, Payne WD, Dunn DL, Gruessner RW, Sutherland DE, Najarian JS. Employment patterns after successful kidney transplantation. Transplantation. 1996;61:729–33.
18. Nour NHC, Ross H. Factors related to participation in paid work after organ transplantation: perceptions of kidney transplant recipients. J Occup Rehabil. 2015;25:38–51.
19. Schmidt M, Schmidt SA, Sandegaard JL, Ehrenstein V, Pedersen L, Sørensen HT. The Danish National Patient Registry: a review of content, data quality, and research potential. Clin Epidemiol. 2015;7:449– 90. Epub 20151117. https://doi.org/10.2147/CLEP.S91125. PubMed PMID: 26604824; PubMed Central PMCID: PMC4655913.
20. Kasiske BL, London W, Ellison MD. Race and socioeconomic factors influencing early placement on the kidney transplant waiting list. J Am Soc Nephrol. 1998;9(11):2142–7. https://doi.org/10.1681/ASN.V9112142. PubMed PMID: 9808103.
21. Kutner N, Bowles T, Zhang R, Huang Y, Pastan S. Dialysis facility characteristics and variation in employment rates: a national study. Clin J Am Soc Nephrol. 2008;3(1):111–6. https://doi.org/10.2215/CJN.02990707. PubMed PMID: 18178781; PubMed Central PMCID: PMC2390987.
22. Molsted S, Aadahl M, Schou L, Eidemak I. Self-rated health and employment status in chronic haemodialysis patients. Scand J Urol Nephrol. 2004;38(2):174–8. 10.1080/00365590310020015. PubMed PMID: 15204389.
23. Petersen E, Baird BC, Barenbaum LL, Leviatov A, Koford JK, Shihab F et al. The impact of employment status on recipient and renal allograft survival. Clin Transplant. 2008;22(4):428– 38. Epub 20080225. https://doi.org/10.1111/j.1399-0012.2008.00803.x. PubMed PMID: 18312443.
24. Tzvetanov I, D'Amico G, Walczak D, Jeon H, Garcia-Roca R, Oberholzer J et al. High rate of unemployment after kidney transplantation: analysis of the United network for organ sharing database. Transplant Proc. 2014;46(5):1290-4. Epub 20140515. https://doi.org/10.1016/j.transproceed.2014.02.006. PubMed PMID: 24836836.
25. Employment DMo. Men and women on the labor market 2021 2022 [cited 2024 February 9]. Available from: https://bm.dk/arbejdsomraader/udgivelser/rapporter-publikationer/2022/maend-og-kvinder-paa-arbejdsmarkedet-2021/
26. Tzvetanov IDAG, Walczak D, Jeon H, Garcia-Roca R, Oberholzer J, Benedetti E. E. High rate of unemployment after kidney transplantation: Analysis of the United Network for Organ Sharing Database. Transplant Proc. 2014;46:1290-4.

Publisher's note