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Employment Status and Work Functioning among Kidney Transplant Recipients

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Abstract

Background and objectives To date, employment figures of kidney transplant recipients in Europe are inconsistent. Additionally, little is known about work functioning of employed kidney transplant recipients and work functioning trajectories before and after transplantation.

Design, setting, participants, & measurements Data from the ongoing TransplantLines Biobank and Cohort study and from community-dwelling employed adults were used. Health-related work functioning of kidney transplant recipients was assessed with the Work Role Functioning Questionnaire 2.0 and compared with potential kidney donors and community-dwelling employed adults.

Results We included 668 kidney transplant recipients of working age (59% men, age 51±11 years) at median 3 (interquartile range, 2–10) years after transplantation, 246 potential kidney donors of working age (43% men, age 53±9 years), and 553 community-dwelling employed adults (70% men, age 45±11 years). The proportion of employed kidney transplant recipients was lower compared with potential kidney donors (56% versus 79%). If employed, the work functioning score of kidney transplant recipients was slightly lower compared with employed potential kidney donors yet higher compared with community-dwelling employed adults (medians 91 [interquartile range, 76–98], 94 [interquartile range, 85–99], and 88 [interquartile range, 79–95], respectively). Backward linear regression analyses revealed that lower educational level, having a kidney from a deceased donor, presence of tingling or numbness of hands or feet, presence of concentration/memory problems, presence of anxiety, and presence of severe fatigue were independently associated with lower work functioning among kidney transplant recipients. Additional subgroup analyses showed that work functioning scores were lower before transplantation than at 12 months after transplantation (83 [interquartile range, 66–93] versus 92 [interquartile range, 88–98], respectively; $P=0.002$).

Conclusions Stable employed kidney transplant recipients report to function well at work. In addition, this study shows that self-reported work functioning is higher after successful kidney transplantation compared with before transplantation.

Clinical Trial registry name and registration number: TransplantLines Biobank and Cohort study, NCT03272841

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Introduction

Work is important because it provides income, but also, work provides social contacts, day filling and structure, and social status. Work therefore importantly contributes to quality of life (1–4). Although the proportion of employed kidney transplant recipients is generally considered relatively low, employment figures of stable kidney transplant recipients in Europe are inconsistent, with reported percentages ranging from 21% to 71% (5,6). In addition, little is known about work functioning among employed kidney transplant recipients. It is important to gain more insight into this topic because low work functioning could result in sickness absence, work disability, and unemployment (7–10).

Work functioning is a concept at the intersection of a person's health and work performance. It reflects the ability of a person to meet work demands given a mental or physical health state, and it goes beyond the simple dichotomy of working or not working by assessing experiences in the work role (11–15). We hypothesized that work functioning is lower among kidney transplant recipients compared with the general working population due to the potential negative effect of their vulnerable health status together with common neurologic and mental side effects of drugs and the high prevalence of severe fatigue in this population (16–18). To date, it is unknown whether these factors are indeed associated with work functioning limitations in

kidney transplant recipients. Identification of potential determinants is important to develop targeted interventions to improve work functioning of kidney transplant recipients and to help them stay at work.

Besides the individual perspective, being employed and being able to function well at work are important from societal and economic perspectives. After all, the majority of patients with kidney failure of working age receive a kidney transplant in Europe, and the number of kidney transplant recipients will likely continue to increase worldwide in the next decades (19,20). Improving work functioning can therefore help save societal costs for work disability and save costs for sickness absence and at-work productivity loss (8).

In this study, we therefore aimed to investigate the proportion of employed kidney transplant recipients in comparison with controls. In addition, we assessed work functioning among employed kidney transplant recipients in comparison with controls and aimed to identify potential work-related and clinical targets to improve work functioning of kidney transplant recipients. Finally, we investigated the trajectory of work functioning before and after transplantation.

Materials and Methods

Study Design

Data from the ongoing, prospective TransplantLines Biobank and Cohort study, collected between June 2015 and May 2021 at the University Medical Center Groningen (UMCG) in The Netherlands, were used (21). All adult solid organ transplant recipients and donors were invited to participate. The study was approved by the Medical Ethics Review Board of UMCG (METc 2014/077) and adheres to the UMCG Biobank Regulation. The participation rate of this cohort was 81%, and 80% of the included participants filled in the Work Role Functioning Questionnaire (WRFQ). We included kidney transplant recipients with a functioning allograft approximately 1 year or longer after transplantation and potential kidney donors, who served as controls in the first comparator group. For the second comparator group, data from a previously published external dataset of community-dwelling employed adults were used (12). Participants were recruited from several companies and organizations in diverse work settings in The Netherlands *via* multiple approaches. All participants provided written informed consent on enrollment. The clinical and research activities being reported are consistent with the Principles of the Declaration of Istanbul as outlined in the Declaration of Istanbul on Organ Trafficking and Transplant Tourism and the World Medical Association Declaration of Helsinki.

Employment Status and Work Functioning

Work-related data were obtained by self-formulated questions. Work functioning was measured using the validated WRFQ version 2.0 (12). The 27-item WRFQ measures the extent to which physical and emotional problems affected the ability to perform the work role in the past 4 weeks for a broad variety of work demands. Response options range on a five-point Likert scale. There was also an answer option of "does not apply to my job." Scores were calculated by taking the mean of the answers ×25, resulting in a percentage between zero and 100, which is the percentage persons can fulfill their work role in a week; a higher score therefore indicates better work functioning. The answer "does not apply to my job" was coded as missing. The score for a (sub-)scale was set to missing if >20% of the answers were missing (12,13).

Patient-Reported Outcome Measures

Side effects of immunosuppressive therapy were assessed using the Modified Transplant Symptom Occurrence and Symptom Distress Scale 59 Revised Questionnaire, of which all neurologic- and mental-related side effects were selected (17). Side effects were reported as present when participants experience the side effect regularly, almost always, or always. Fatigue was measured with the Checklist Individual Strength 20 Revised Questionnaire (22,23). A score ≥35 on the subscale "fatigue severity" was indicative of severe fatigue (23).

Other Variables

Clinical data were extracted from electronic patient records. Medication use was verified in a visit in which anthropometric measurements were also performed (21). Body mass index was calculated by dividing body weight by height squared. Laboratory parameters were measured using routine laboratory methods. The eGFR was calculated with the Chronic Kidney Disease Epidemiology Collaboration equation (24). Diabetes mellitus was defined according to the criteria of the American Diabetes Association, and anemia was defined according to the criteria of the World Health Organization (25,26). Educational level was assessed by questionnaires asking for the highest degree of education and was categorized as low (level 0, 1, or 2), moderate (level 3 or 4), or high (level 5 or 6) according to the International Standard Classification of Education (27).

Statistical Analyses

Data distribution was visually assessed using quantile-quantile plots and histograms. Normally distributed data were presented as mean±SD, non-normally distributed data were presented as median (interquartile range [IQR]), and categorical data were presented as number (valid percentage). Differences in WRFQ scores between groups were assessed using Mann–Whitney *U* tests. Differences between repeated measurements of work functioning were assessed using Wilcoxon signed rank tests.

Linear regression analyses with work functioning (WRFQ total score) as the dependent variable were performed to assess potential associations with work-related and clinical variables. We tested for interactions with age, sex, and eGFR. To examine which variables were independently associated with work functioning, forward selection of baseline variables according to the preceding univariable linear regression analyses was performed (P for inclusion $=0.20$) and followed by stepwise backward linear regression analyses (P for exclusion $=0.05$).

Results of linear regression analyses are presented as adjusted differences, referring to the number of SDs a dependent variable differs per SD higher value of the independent variable, together with 95% confidence intervals. To meet the assumptions of linear regression analyses, the WRFQ total score was transformed using the formula

$\log_{10}$(maximal score +1− WRFQ total score)x−1. Other variables were $\log_2$ transformed where necessary. All statistical analyses were performed using the Statistical Package for the Social Sciences, version 25.0 (IBM Corp., Armonk, NY). A two-sided P=0.05 was regarded as statistically significant in all analyses.

In sensitivity analyses, a comparison of the WRFQ total scores while not excluding scores of participants who answered "not applicable to my job" to >20% of the questions was performed. In addition, regression analyses were repeated with this alternative WRFQ total score.

Results

Sample Characteristics

WRFQ data were available for 930 of 1155 kidney transplant recipients, 327 of 406 potential kidney donors, and of 553 community-dwelling employed adults from a previously published external dataset. Kidney transplant recipients who filled in the questionnaires more frequently received a kidney from a living donor and were more frequently preemptively transplanted compared with kidney transplant recipients who did not fill in the questionnaires (Supplemental Table 1). No differences in sex, age, body mass index, and eGFR were observed. After exclusion of participants above the increasing retirement age (Supplemental Table 2) (n=336) and students (n=7), a total of 668 kidney transplant recipients, 246 potential kidney donors, and 553 community-dwelling employed adults remained (Figure 1). In total, 59% of the kidney transplant recipients was men, and mean age was 51±11 years. Median time after transplantation was 3 (IQR, 2–10) years, and mean eGFR was 53±18 ml/min per 1.73 m^2. The prevalence of men was lower among potential kidney donors (43%) and higher among community-dwelling employed adults (70%). Mean age was higher among potential kidney donors (53±9 years) and lower among community-dwelling employed adults (45±11 years). The educational levels of kidney transplant recipients and potential kidney donors were comparable. Kidney transplant recipients more frequently had a low educational level compared with community-dwelling employed adults. More detailed characteristics are presented in Tables 1 and 2.

Employment Figures

Work-specific characteristics are presented in Supplemental Table 3. A total of 56% of the kidney transplant recipients were employed compared with 79% of the potential kidney donors. The proportions of employed kidney transplant recipients were 62% among men and 48% among women. Most employed kidney transplant recipients had a permanent contract (72%), worked >32 h/wk (58%), and had mentally demanding tasks (44%). Sickness absence at the time of inclusion was reported by 8% of employed kidney transplant recipients, and 17% of the employed kidney transplant recipients received a supplementary disability pension. Among the 295 unemployed kidney transplant recipients, 71% received a disability pension. Characteristics of kidney transplants recipients and potential kidney donors per employment status are presented in Supplemental Table 4.

Work Functioning

Characteristics of employed kidney transplant recipients for whom a WRFQ total score was available for primary analyses (n=316), for whom the WRFQ total score was set as missing because participants answered "not applicable to my job" to >20% of the questions (n=46), and without a WRFQ total score because of missing data (n=11) were very similar (Supplemental Table 5). The WRFQ total score of employed kidney transplant recipients was slightly lower compared with employed potential kidney donors (91 [IQR, 76–98] versus 94 [IQR, 85–99]; P=0.006) yet higher compared with community-dwelling employed adults (91 [IQR, 76–98] versus 88 [IQR, 79–95]; P=0.03). The WRFQ score indicates the percentage of time a participant can fulfill his or her work role. For instance, among kidney transplant recipients, the 75th percentile of the WRFQ was 76, which indicates that 75% of the employed kidney transplant recipients were able to fulfill their work role for ≥76% of their working time, translating to almost 4 days in a full workweek. Results for each separate question of the WRFQ are presented in Supplemental Table 6. According to previously published cutoff values (28), 24% of the kidney transplant recipients reported low work functioning, 23% of the kidney transplant recipients reported medium work functioning, and 53% of the kidney transplant recipients reported high work functioning.

Among kidney transplant recipients, work scheduling demands were met a median of 94% (IQR, 63%–100%) of the work time, output demands were met a median of 88% (IQR, 63%–100%) of the work time, physical demands were met a median of 100% (IQR, 88%–100%) of the work time, mental and social demands were met a median of 96% (IQR 82%–100%) of the work time, and flexibility demands were met a median of 95% (IQR 85%–100%) of the work time. Comparisons of these scores with scores of control groups are presented in Figure 2 and Supplemental Table 7.

Associations with Work Functioning in Employed Kidney Transplant Recipients

Working hours per week, working tasks, age, sex, and immunosuppressive drugs were not associated with work functioning (Table 2). Being moderately educated was more strongly positively associated with work functioning than being highly educated. β-blocker use was negatively associated with work functioning, just like almost all patient-reported outcome measures, of which severe fatigue showed the strongest negative association with work functioning followed by concentration/memory problems, restlessness/nervousness, muscle weakness, and depressive feelings. Backward linear regression analyses showed that lower educational level, having a kidney from a deceased donor, presence of tingling or numbness of hands or feet, presence of concentration/memory problems, presence of anxiety, and presence of severe fatigue were independently associated with lower work functioning.

Repeated Measurements of Work Functioning in Employed Kidney Transplant Recipients

Baseline characteristics of kidney transplant recipients for whom pretransplantation work functioning data were

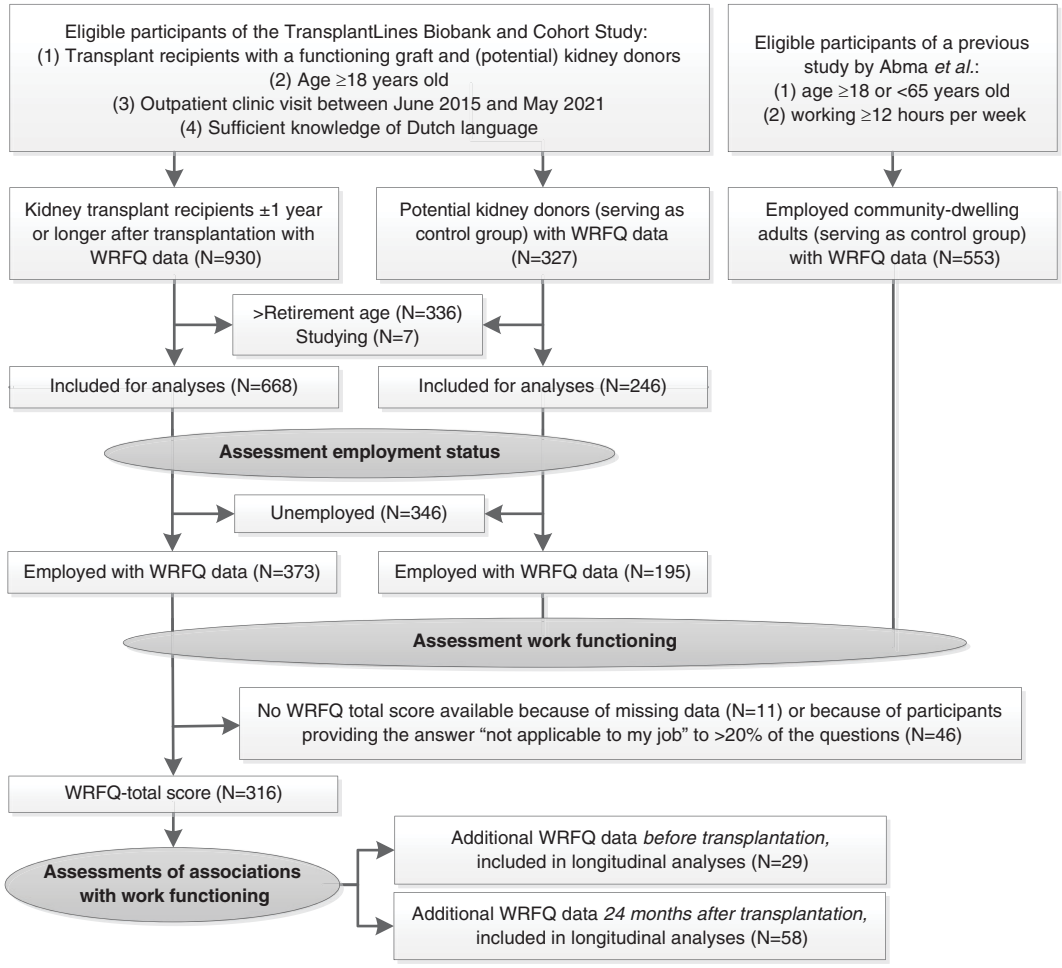

Figure 1. | **Participants flow chart.** WRFQ, Work Role Functioning Questionnaire.

available were generally comparable with those for whom pretransplantation work functioning data were not available, with the exception of the proportion of preemptive transplantations, which was higher among the kidney transplant recipients for whom pretransplantation work functioning data were available (Supplemental Table 8). WRFQ total scores shortly before transplantation were lower than at 12 months after transplantation (83 [IQR, 66–93] versus 92 [IQR, 88–98], respectively; $P=0.002$; $n=29$), indicating that work functioning improves after transplantation (Figure 3). Among the 11 patients with the lowest WRFQ scores before transplantation, five patients were on dialysis at the time of filling in the questionnaire. In addition, among the ten patients for whom the WRFQ score decreased or did not change, nine had undergone a preemptive transplantation. Baseline characteristics of employed kidney transplant recipients with work functioning data at 12 and 24 months are presented in Supplemental Table 9. No difference in WRFQ total scores was found between 12 and 24 months after transplantation (90 [IQR, 78–95] versus 89 [IQR, 76–99]; $P=1.0$; $n=56$).

Sensitivity Analyses

Not excluding work functioning scores of participants who answered "not applicable to my job" to >20% of the questions, the 25th percentile of WRFQ total score of kidney transplant recipients was lower, but the median and 75th percentile remained similar (91 [IQR, 73–98]). In these analyses, the score of kidney transplant recipients was numerically lower when compared with potential kidney donors (94 [IQR, 85–99]; $P=0.002$) and numerically higher but statistically not different when compared with community-dwelling employed adults (88 [IQR, 79–95]; $P=0.20$). Results of univariable regression analyses were generally comparable. Backward regression analyses showed that lower educational level, presence of concentration/memory problems, and presence of severe fatigue were independently associated with lower work functioning, similar to the primary analyses (Supplemental Table 10).

Discussion

The proportion of employed stable kidney transplant recipients was 56%. Despite the prevalent side effects of immunosuppressive therapy and the high prevalence of fatigue, employed stable kidney transplant recipients report to function well at work. Educational level, donor type, tingling or numbness of hands or feet, concentration/memory problems, anxiety, and severe fatigue were

Table 1. Characteristics of kidney transplant recipients, potential kidney donors, and community-dwelling employed adults in The Netherlands

Variables	Kidney Transplant Recipients, *n*=668	Potential Kidney Donors, *n*=246	Community-Dwelling Employed Adults, *n*=553
Baseline variables			
Men, *n* (%)	391 (59)	105 (43)	388 (70)
Age, yr	51±11	53±9	45±11
Educational level, *n* (%)			
Low	225 (34)	78 (32)	77 (14)
Moderate	264 (40)	94 (38)	215 (40)
High	168 (26)	74 (30)	247 (46)
Primary kidney disease, *n* (%)			
Unknown	92 (14)	n/a	n/a
Inflammatory disease	220 (33)	n/a	n/a
Congenital and hereditary kidney disease	185 (28)	n/a	n/a
Kidney vascular disease, excluding vasculitis	53 (8)	n/a	n/a
Diabetic kidney disease	51 (8)	n/a	n/a
Other	67 (10)	n/a	n/a
Time after transplantation, yr	3 [2–10]	n/a	n/a
Preemptive transplantation, *n* (%)	254 (38)	n/a	n/a
eGFR, ml/min per 1.73 m^2	53±18	87±14	—
Work-specific characteristics			
Employed, *n* (%)	373 (56)	195 (79)	553 (100)
Men	241 (62)	86 (82)	377 (100)
Women	132 (48)	109 (77)	165 (100)

Normally distributed data are presented as mean±SD, non-normally distributed data are presented as median (IQR), and categorical data are presented as number (valid percentage). Data regarding educational level were missing in 11 (2%) of the kidney transplant recipients, and data regarding age, educational level, and eGFR were missing in 25 (4%), 14 (3%), and 553 (100%) of the community-dwelling employed adults, respectively. n/a, not applicable; —, not measured; IQR, interquartile range.

independently associated with lower self-reported work functioning among kidney transplant recipients. Analyses in a subgroup of employed patients with kidney failure showed that self-reported work functioning was higher after successful kidney transplantation.

In 2007, a study showed that the proportion of employed Dutch kidney transplant recipients was 52% (29). Since then, general transplant care has improved (20). In addition, the proportion of preemptive transplantations has increased, which hypothetically results in fewer patients losing their jobs because of frequent dialysis, which greatly affects daily lives (30). Despite these improvements and the increased proportion of preemptive transplantations, the proportion of employed kidney transplant recipients has improved only slightly to 56% in this study. An explanation could be that some kidney transplant recipients changed their priorities after kidney transplantation and focused more on other things in life rather than work. Nevertheless, these study findings confirm that the proportion of employed kidney transplant recipients in The Netherlands is generally between 50% and 60%.

In extension of previous studies among kidney transplant recipients that only investigated dichotomous work outcomes, we additionally investigated self-reported work functioning in this population. This novel work outcome provides insight into how transplant recipients function at work, what barriers they experience, and how much time they are actually productive in their work time (12). Contrary to our expectations, self-reported work functioning among kidney transplant recipients was good in comparison with our control groups and with other populations, including shift workers; university workers; and patients with musculoskeletal pain, cancer, or endometriosis (13,31,32). This may have been achieved by alterations at work to create a good balance between working capacity and workload. An alternative explanation can be a response shift; recipients may compare their work functioning with the pretransplant period, in which they likely functioned worse at work because of the (treatment of) kidney failure, or they get used to their decreased work functioning (33). The results in our study are highly encouraging, and they demonstrate a clear message to employers that kidney transplant recipients can function very well at work. These findings can therefore help to reduce any stigmas regarding work and work functioning after kidney transplantation. It is important to note that the observed work functioning can only be determined for employed kidney transplant recipients, who were generally younger and healthier compared with the unemployed transplant recipients in our study. Work functioning may, therefore, be worse among unemployed kidney transplant recipients if they would get a job.

Results of regression analyses indicate that work functioning is multifactorial and that a combination of good physical and mental status is important to function well at work. Besides physical and mental health, job type also seems to influence work functioning, as educational level, which likely reflects the type of job, was also independently

Table 2. Characteristics and associations with work functioning of employed kidney transplant recipients

Variables	Employed Kidney Transplant Recipients, n=373	Work Functioning (Work Role Functioning Questionnaire Total Score[a])		
		Included in Analyses, n=316	Adjusted Difference (95% Confidence Interval)	
			Univariable Linear Regression	Stepwise Backward Linear Regression[b]
Work-specific characteristics, *n* (%)				
Working per week, h				
>32	210 (58)	186 (60)	Reference	
20–32	87 (24)	78 (25)	−0.06 (–0.17 to 0.06)	
12–20	35 (10)	28 (9)	−0.05 (–0.17 to 0.06)	
<12	31 (9)	18 (6)	0.01 (–0.10 to 0.13)	
Working tasks				
Mentally demanding tasks	162 (44)	141 (45)	Reference	
Physically demanding tasks	91 (25)	73 (23)	−0.05 (–0.17 to 0.07)	
Both	116 (31)	101 (32)	−0.07 (–0.19 to 0.05)	
Educational level				
Low	93 (25)	73 (23)	Reference	Reference
Moderate	165 (45)	141 (45)	0.19 (0.05 to 0.33)	0.28 (0.15 to 0.41)
High	110 (30)	98 (31)	0.14 (–0.00 to 0.28)	0.20 (0.07 to 0.33)
Demographics				
Men, *n* (%)	241 (65)	206 (65)	−0.03 (–0.14 to 0.08)	
Age, yr	48±11	48±10	−0.04 (–0.16 to 0.07)	
Body mass index, kg/m^2	26.9±4.3	26.9±4.4	−0.05 (–0.16 to 0.06)	
Diabetes, *n* (%)	68 (18)	58 (18)	−0.06 (–0.17 to 0.05)	
Time after transplantation, yr[c]	3 [2–11]	3 [2–11]	−0.03 (–0.14 to 0.08)	
Preemptive transplantation, *n* (%)	162 (43)	132 (42)	−0.04 (–0.15 to 0.07)	
Living donor, *n* (%)	258 (69)	220 (70)	−0.07 (–0.18 to 0.04)	−0.14 (–0.25 to –0.04)
Laboratory measurements				
Hemoglobin, g/dl	14.2±1.8	14.2±1.8	−0.07 (–0.18 to 0.04)	
Albumin, g/dl	4.4±0.3	4.4±0.3	0.10 (–0.01 to 0.21)	—
eGFR, ml/min per 1.73 m^2	54±17	54±17	0.06 (–0.06 to 0.17)	
Medication use, *n* (%)				
Prednisolone	361 (97)	307 (97)	−0.04 (–0.15 to 0.08)	
Calcineurin inhibitor	303 (81)	261 (83)	0.05 (–0.06 to 0.16)	
Proliferation inhibitor	322 (86)	272 (86)	−0.01 (–0.12 to 0.10)	
mTOR inhibitor	15 (4)	13 (4)	−0.04 (–0.15 to 0.07)	
β-blockers	182 (49)	155 (49)	−0.12 (–0.23 to –0.01)	—
Antidepressants	13 (3)	10 (3)	−0.07 (–0.18 to 0.04)	
Patient-reported outcome measures, *n* (%)				
Trembling hands	101 (27)	87 (27)	−0.03 (–0.14 to 0.08)	
Tingling or numbness of hands or feet	41 (11)	34 (11)	−0.21 (–0.32 to –0.10)	−0.15 (–0.26 to –0.05)
Feeling of warmth in hands or feet	45 (12)	38 (12)	−0.08 (–0.19 to 0.03)	—
Muscle weakness	50 (13)	39 (12)	−0.24 (–0.35 to –0.13)	—
Muscle cramps	38 (10)	34 (11)	−0.13 (–0.24 to –0.02)	—
Dizziness	36 (10)	30 (10)	−0.19 (–0.30 to –0.08)	—
Headaches	34 (9)	25 (8)	−0.07 (–0.19 to 0.04)	—
Depressive feeling	20 (5)	19 (6)	−0.24 (–0.34 to –0.13)	—
Concentration/memory problems	42 (11)	38 (12)	−0.27 (–0.37 to –0.16)	−0.19 (–0.30 to –0.09)
Sleep difficulties	62 (17)	51 (16)	−0.16 (–0.27 to –0.05)	—
Nightmares	7 (2)	7 (2)	−0.09 (–0.20 to 0.02)	—
Anxiety	8 (2)	8 (3)	−0.19 (–0.30 to –0.09)	−0.11 (–0.22 to –0.01)
Restlessness/nervousness	37 (10)	32 (10)	−0.25 (–0.35 to –0.14)	—
Mood swings	41 (11)	38 (12)	−0.22 (–0.33 to –0.11)	—
Severe fatigue	83 (22)	71 (23)	−0.29 (–0.39 to –0.18)	−0.23 (–0.34 to –0.12)

Normally distributed data are presented as mean±SD, non-normally distributed data are presented as median (IQR), and categorical data are presented as number (valid percentage). Results of linear regression are presented as adjusted differences, referring to the number of SDs the transformed work functioning score changes per SD increase of the independent variable. Variables had no missing values, or <3% were missing. —, excluded in backward linear regression analyses; mTOR, mammalian target of rapamycin; IQR, interquartile range.

[a]To meet the assumptions of linear regression analyses, the Work Role Functioning Questionnaire total score was transformed using the formula $\log_{10}$(maximal score +1− Work Role Functioning Questionnaire total score)x−1.

[b]Analyses in the final model were performed in 303 employed kidney transplant recipients. The R^2 of the final model was 22.4%.

[c]$\log_2$ transformed.

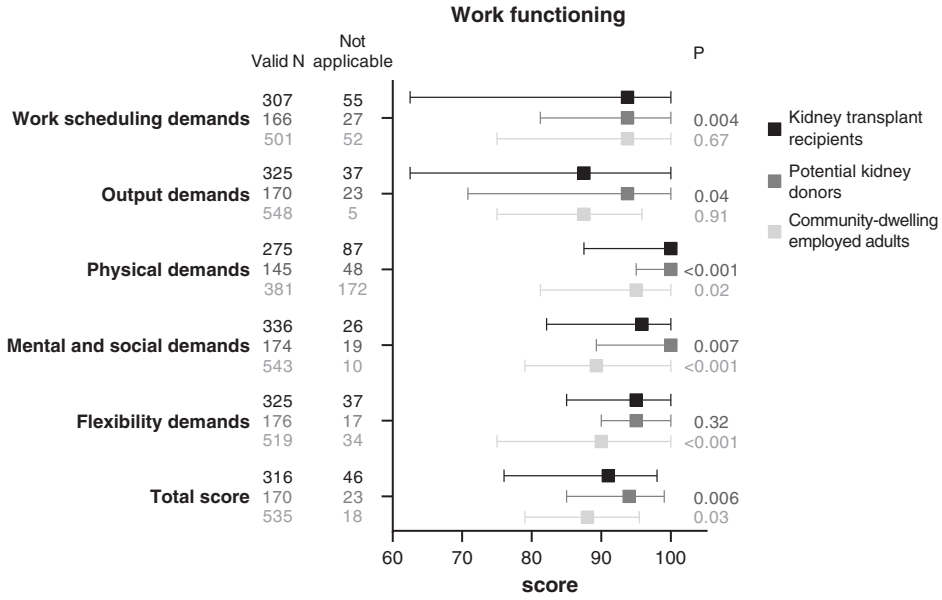

Figure 2. | Differences in work functioning scores as assessed by the work role functioning questionnaire (WRFQ) between kidney transplant recipients, potential kidney donors, and community-dwelling employed adults. A lower score indicates worse work functioning. Differences between kidney transplant recipients and comparator groups were assessed using Mann–Whitney *U* tests.

associated with work functioning. Weekly working hours, age, and use of specific immunosuppressive medication were not associated with work functioning. It must be noted that a large proportion of the work functioning values of kidney transplant recipients remains unexplained by the identified variables.

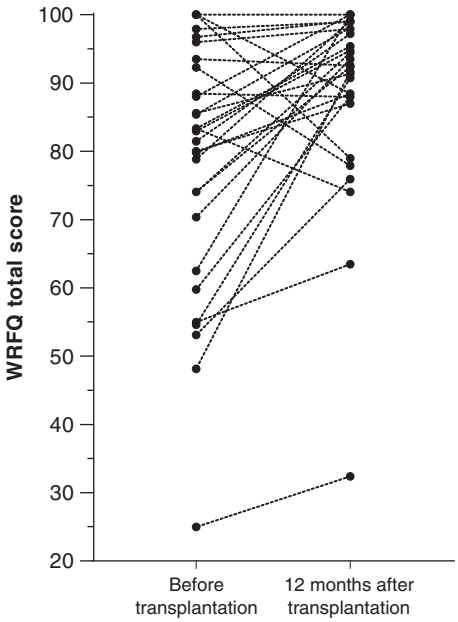

Figure 3. | Work Role Functioning Questionnaire total scores before and 12 months after transplantation of 29 employed kidney transplant recipients. Self-reported work functioning was higher after transplantation in the vast majority of kidney transplant recipients. Four patients reported lower work functioning after transplantation (more than five points lower) compared with before transplantation.

Strengths of this study are the use of a well-defined cohort with extensive data regarding clinical parameters, medication use, and health and functional outcomes. In addition, the availability of serial measurements in a subgroup of patients provided novel insights into the trajectories of work functioning after transplantation. However, there are limitations that we acknowledge. First, because of the observational study design, no conclusions regarding causal relationships can be drawn. Second, we could not exclude the possibility of a selection bias favoring healthier recipients. Indeed, kidney transplant recipients who filled in the questionnaires more frequently received a kidney from a living donor and were more frequently preemptively transplanted compared with those who did not fill in the questionnaires. However, we were able to include a large population of stable kidney transplant recipients in their working age and reached a high response rate to questionnaires (34). Third, no data were available on the causes of unemployment and on how many of the kidney transplant recipients were unemployed pretransplantation. Fourth, potential kidney donors may have personality and health characteristics that differ from the general population, making them less suitable as a comparator group. Fifth, repeated measurements were available in a subset of kidney transplant recipients, which increases the possibility of a selection and response bias in these analyses. Finally, this single-center study only included patients from the northern part of The Netherlands, which calls for prudence when extrapolating these findings to other areas.

In conclusion, the proportion of employed stable kidney transplant recipients is 56%. Stable employed kidney transplant recipients report to function very well at work. In addition, this study shows that self-reported work functioning is higher after successful kidney transplantation compared with before kidney transplantation.

Disclosures

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Author Contributions

S.J.L. Bakker, U. Bültmann, T.J. Knobbe, D. Kremer, and A. Visser conceptualized the study; F.I. Abma, C. Annema, S.J.L. Bakker, T.J. Knobbe, and D. Kremer were responsible for data curation; S.J.L. Bakker was responsible for investigation; T.J. Knobbe was responsible for formal analysis; F.I. Abma, S.J.L. Bakker, T.J. Knobbe, D. Kremer, and A. Visser were responsible for methodology; S.J.L. Bakker was responsible for project administration; F.I. Abma was responsible for validation; T.J. Knobbe was responsible for visualization; S.J.L. Bakker was responsible for funding acquisition; S.J.L. Bakker, U. Bültmann, and A. Visser provided supervision; T.J. Knobbe and D. Kremer wrote the original draft; and C. Annema, S.J.L. Bakker, S.P. Berger, U. Bültmann, G.J. Navis, S.F. van der Mei, and A. Visser reviewed and edited the manuscript.

Supplemental Material

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SUPPLEMENTAL MATERIAL

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Supplemental Table 1. Characteristics of participants who filled in the questionnaire and participants who did not fill in the questionnaires.

	Participants who filled in the questionnaires	**Participants who did not fill in the questionnaires**	**P**
Kidney Transplant recipients, *n* (%)	**930 (81)**	**225 (19)**	**n/a**
Male sex, *n* (%)	564 (61)	137 (61)	0.9
Age, years	56 ± 13	55 ± 15	0.4
Body mass index, kg/m^2	27.3 ± 4.7	27.5 ± 5.0	0.6
Time after transplantation, years	3 [2 to 10]	2 [1 to 7]	0.011
Pre-emptive transplantation, *n* (%),	338 (36)	65 (29)	0.035
Living donor, n (%)	520 (57)	91 (44)	<0.001
eGFR, mL/min/1.73m^2	51 ± 18	50 ± 19	0.4
Potential kidney donors, *n* (%)	**327 (81)**	**79 (19)**	**n/a**
Male sex, *n* (%)	145 (44)	42 (53)	0.2
Age, years	57 ± 11	54 ± 13	0.05
Body mass index, kg/m^2	26.5 ± 3.5	26.1 ± 3.5	0.4
eGFR, mL/min/1.73m^2	85 ± 13	87 ± 16	0.2

Data are presented as number (valid %). Variables had no missing values or <5% was missing. Significance of differences between groups were assessed using independent samples T-tests, Mann-Whitney U tests and Chi Square test depending on data distribution.

Supplemental Table 2. Increasing retirement age in The Netherlands.

Birth date[1]	Retirement age
≤09-30-1950	65 year
>09-30-1950	65 year and 6 months
>06-30-1951	65 years and 9 months
>03-31-1952	66 years
>12-31-1952	66 years and 4 months

[1]: Birth date is presented as month-day-year. Reference: Tax and Customs Administration of The Netherlands.

Supplemental Table 3. Work-specific characteristics of kidney transplant recipients, potential kidney donors and community-dwelling employed adults.

Work specific characteristics	Kidney transplant recipients N=668	Potential kidney donors N=246	Community-dwelling employed adults N=553
Employed, *n* (%)	373 (56)	195 (79)	553 (100)
Contract type, *n* (%)			
Temporary contract	21 (6)	15 (8)	31 (11)
Permanent contract	267 (72)	144 (74)	237 (86)
Other	84 (23)	36 (18)	7 (3)
Working hours per week, *n* (%)			
>32 hours	210 (58)	118 (61)	476 (87)
20 to 32 hours	87 (24)	53 (27)	58 (11)
12 to 20 hours	35 (10)	15 (8)	9 (2)
<12 hours	31 (9)	7 (4)	4 (0.7)
Working tasks[1], *n* (%)			
Mentally demanding tasks	162 (44)	68 (35)	156 (37)
Physically demanding tasks	91 (25)	49 (25)	257 (62)
Both	116 (31)	78 (40)	5 (1)
Sickness absence[2], *n* (%)	30 (8)	8 (4)	
0% of contract hours	13 (44)	5 (63))	-
0 to 50% of contract hours	9 (31)	1 (13)	-
>50% of contract hours	7 (24)	2 (25)	-
Disability pension[2], *n* (%)	62 (17)	1 (0.5)	-
Unemployed	295 (44)	51 (21)	n/a
Disability pension, *n* (%)	209 (71)	8 (16)	n/a

[1]: working tasks were self-reported by kidney transplant recipients and potential kidney donors, and scored by an investigator based on job description for community-dwelling employed adults. [2]: data were not assessed among community-dwelling employed adults. Data are presented as number (valid %). Data regarding disability pension were missing in 41 (8%) kidney transplant recipients, and data regarding contract type, working hours per week and working tasks were missing in 278 (50%), 6 (1%) and 135 (24%) community-dwelling employed adults. Other variables had no missing values or <4% was missing.

Supplemental Table 4. Characteristics of kidney transplant recipients and potential kidney donors per employment status.

	Unemployed	Employed
Kidney Transplant recipients, *n* (%)	**295 (44)**	**373 (56)**
Male sex, *n* (%)	150 (51)	241 (65)
Age, years	54 ± 10	48 ± 11
Body mass index, kg/m^2	28 ± 6	27 ± 4
Educational level, *n* (%)		
Low	132 (46)	92 (25)
Moderate	99 (34)	165 (45)
High	58 (20)	110 (30)
Time after transplantation, years	3 [2 to 9]	3 [2 to 11]
Pre-emptive transplantation, *n* (%)	92 (31)	162 (43)
Living donor, n (%)	148 (50)	258 (69)
eGFR, mL/min/1.73m^2	51 ± 20	54 ± 17
Potential kidney donors, *n* (%)	**51 (21)**	**195 (79)**
Male sex, *n* (%)	19 (37)	86 (44)
Age, years	57 ± 8	51 ± 8
Body mass index, kg/m^2	27 ± 4	26 ± 4
Educational level, *n* (%)		
Low	24 (47)	54 (28)
Moderate	16 (31)	78 (40)
High	11 (22)	63 (32)
eGFR, mL/min/1.73m^2	83 ± 12	88 ± 14

Normally distributed data are presented as means ± standard deviation (SD), non-normally distributed data as median [interquartile range], and categorical data as number (valid %). Data regarding education level were missing in 11 kidney transplant recipients, respectively. No data regarding Abbreviations: eGFR, estimated glomerular filtration rate.

Supplemental Table 5. Characteristics of employed kidney transplant recipients of which a WRFQ total score was available for primary analyses, of which the WRFQ total score was set at missing because participants answered 'not applicable to my job' to >20% of the questions and without a WRFQ total score because of missing data.

	Employed kidney transplant recipients		
	With a WRFQ total score N=316	**Without a WRFQ total score because participants answered to >20% of the questions "not applicable to my job" N=46**	**Without a WRFQ total score because of missing data N=11**
Baseline variables			
Male sex, *n* (%)	206 (65)	26 (57)	9 (82)
Age, years	48 ± 10	49 ± 12	53 ± 7
Body mass index, kg/m^2	26.9 ± 4.4	26.9 ± 4.2	26.0 ± 2.4
Time after transplantation, years	3 [2 to 11]	4 [2 to 9]	2 [2 to 12]
Pre-emptive transplantation, *n* (%)	132 (42)	27 (59)	3 (27)
Living donor, *n (%)*	220 (70)	32 (70)	6 (55)
eGFR, mL/min/1.73m^2	54 ± 17	54 ± 16	49 ± 27

Normally distributed data are presented as means ± standard deviation, non-normally distributed data as median [interquartile range], and categorical data as number (valid %).

Supplemental Table 6. Results per question of the Work Role Functioning Questionnaire 2.0 of 362 kidney transplant recipients.

			Kidney transplant recipients					
			Response, n (valid %)[1]					
In the past four weeks, I found it difficult to…	Sub scale	'not applicable to my job (%)'	0	1	2	3	4	Mean
get going easily at the beginning of the work day	WSD	18 (5)	20 (6)	31 (9)	24 (7)	81 (24)	188 (55)	3.12
start on your job as soon as you arrived at work	WSD	19 (5)	48 (14)	26 (8)	8 (2)	34 (10)	227 (66)	3.07
go your work without stopping to take extra breaks or rest	WSD	27 (7)	22 (7)	47 (14)	19 (6)	65 (19)	182 (54)	3.01
stick to a routine or schedule	WSD	28 (8)	31 (9)	30 (9)	17 (5)	44 (13)	212 (64)	3.13
work fast enough	OD	26 (7)	30 (9)	38 (11)	22 (7)	55 (16)	191 (57)	3.01
finish work on time	OD	33 (9)	18 (6)	24 (7)	15 (5)	61 (19)	211 (64)	3.29
do your work without making mistakes	OD	19 (5)	18 (5)	24 (7)	7 (2)	73 (21)	221 (64)	3.33
satisfy the people who judge your work	OD	46 (13)	25 (8)	30 (10)	7 (2)	37 (12)	217 (69)	3.24
feel a sense of accomplishment in your work	OD	12 (3)	43 (12)	46 (13)	28 (8)	57 (16)	176 (50)	2.79
feel you have done what you are capable of doing	OD	14 (4)	55 (16)	55 (16)	16 (5)	42 (12)	180 (52)	2.68
lift, carry, or move objects at work weighing more than 10 pounds	PD	103 (28)	8 (3)	13 (5)	10 (4)	29 (15)	189 (73)	3.38
sit, stand, or stay in one position for longer than 15 min while working	PD	25 (10)	9 (3)	16 (5)	17 (5)	40 (12)	245 (75)	3.52
repeat the same motion over and over again while working	PD	86 (24)	2 (0.7)	13 (5)	16 (6)	45 (16)	200 (73)	3.55
bend, twist, or reach while working	PD	59 (16)	2 (0.7)	15 (5)	15 (5)	44 (15)	227 (75)	3.58
use hand-held tools or equipment	PD	42 (12)	5 (2)	7 (2)	7 (2)	18 (6)	283 (88)	3.77
keep your mind on your work	MSD	6 (2)	13 (4)	23 (7)	9 (3)	93 (26)	218 (61)	3.35
do work carefully	MSD	4 (1)	18 (5)	23 (6)	5 (1)	66 (18)	246 (69)	3.39
concentrate on your work	MSD	8 (2)	12 (3)	18 (5)	14 (4)	100 (28)	210 (59)	3.35
work without losing your train or thought	MSD	10 (3)	11 (3)	18 (5)	13 (4)	97 (28)	213 (61)	3.37
easily read or use your eyes when working	MSD	26 (7)	7 (2)	27 (8)	13 (4)	87 (26)	202 (60)	3.34
speak with people in-person, in meetings or on the phone	MSD	28 (8)	8 (2)	15 (5)	9 (3)	52 (16)	250 (75)	3.56
control your temper around people when working	MSD	23 (6)	15 (4)	13 (3)	8 (2)	39 (12)	264 (88)	3.55
set priorities in my work	FD	21 (6)	8 (2)	18 (5)	12 (4)	66 (19)	237 (70)	3.48
handle changes in my work	FD	23 (6)	6 (2)	16 (5)	13 (4)	69 (20)	235 (69)	3.51
process incoming information, for example e-mails, in time	FD	62 (17)	5 (2)	11 (4)	10 (3)	60 (20)	214 (71)	3.56
perform multiple tasks at the same time	FD	32 (9)	5 (2)	21 (6)	19 (6)	82 (25)	203 (62)	3.38
be proactive, show initiative in my work	FD	13 (4)	16 (5)	12 (3)	14 (4)	30 (9)	277 (79)	3.55

[1]: 0=difficult all the time, 1=difficult most of the time, 2=difficult half of the time, 3=difficult some of the time, 4=difficult none of the time.

Supplemental Table 7. Results for sub scores and total scores of the Work Role Functioning Questionnaire 2.0 in kidney transplant recipients, potential kidney donors and community-dwelling adults.

Work role functioning questionnaire	Mean ± SD	Median [IQR]	N (%)
Kidney transplant recipients			
Work scheduling demands	78 ± 29	94 [63 to 100]	n/a
Output demands	76 ± 28	88 [63 to 100]	n/a
Physical demands	90 ± 18	100 [88 to 100]	n/a
Mental and social demands	86 ± 22	96 [82 to 100]	n/a
Flexibility demands	88 ± 20	95 [85 to 100]	n/a
Total score	84 ± 19	91 [76 to 98]	n/a
Low work functioning, *n* (%)	n/a	n/a	75 (24)
Medium work functioning, *n* (%)	n/a	n/a	74 (23)
High work functioning, *n* (%)	n/a	n/a	168 (53)
Potential kidney donors			
Work scheduling demands	85 ± 25	94 [81 to 100]	n/a
Output demands	83 ± 23	94 [71 to 100]	n/a
Physical demands	94 ± 16	100 [95 to 100]	n/a
Mental and social demands	91 ± 17	100 [89 to 100]	n/a
Flexibility demands	91 ± 16	95 [90 to 100]	n/a
Total score	89 ± 15	94 [85 to 99]	n/a
Low work functioning, *n* (%)	n/a	n/a	20 (12)
Medium work functioning, *n* (%)	n/a	n/a	37 (22)
High work functioning, *n* (%)	n/a	n/a	113 (66)
Community-dwelling employed adults			
Work scheduling demands	83 ± 22	94 [75 to 100]	n/a
Output demands	81 ± 21	88 [75 to 96]	n/a
Physical demands	87 ± 20	95 [81 to 100]	n/a
Mental and social demands	85 ± 17	89 [79 to 100]	n/a
Flexibility demands	84 ± 21	90 [75 to 100]	n/a
Total score	84 ± 16	88 [79 to 95]	n/a
Low work functioning, *n* (%)	n/a	n/a	98 (18)
Medium work functioning, *n* (%)	n/a	n/a	195 (36)
High work functioning, *n* (%)	n/a	n/a	242 (45)

Low work functioning was defined as a work role functioning questionnaire total score <75. Medium work functioning was defined as a score between 75 and 89, and high work functioning was defined as a score ≥90. Abbreviations: IQR, interquartile range; SD, standard deviation.

Supplemental Table 8. Characteristics of employed kidney transplant recipients with and without additional work functioning data before transplantation.

	Employed kidney transplant recipients with a WRFQ total score	
	With an additional WRFQ total score before Tx N=29	**Without an additional WRFQ total score before Tx N=287**
Baseline variables		
Male sex, *n* (%)	22 (76)	184 (64)
Age[1], years	50 ± 9	48 ± 10
Pre-emptive transplantation, *n* (%)	18 (62)	114 (40)
Time after transplantation, years	n/a	5 [2 to 12]
eGFR[1], mL/min/1.73m^2	58 ± 11	53 ± 17
Work functioning		
WRFQ total score before tx	83 [66 to 93]	n/a
WRFQ total score 12 months after tx	92 [88 to 98]	n/a

[1]: at 12 months after transplantation for participants with an additional WRFQ total score before tx. Normally distributed data are presented as means ± standard deviation, non-normally distributed data as median [interquartile range], and categorical data as number (valid %). Abbreviations: Tx, transplantation; WRFQ, work role functioning questionnaire.

Supplemental Table 9. Baseline characteristics and work functioning of kidney transplant recipients 12 and 24 months after transplantation.

	Employed kidney transplant recipients with WRFQ data 12 and 24 months after Tx N=56
Baseline variables	
Male sex, *n* (%)	37 (66)
Age 24 months after transplantation, years	50 ± 10
Pre-emptive transplantation, *n* (%)	32 (57)
eGFR 24 months after transplantation, mL/min/1.73m^2	60 ± 15
Work functioning	
WRFQ total score 12 months after transplantation	90 [78 to 95]
WRFQ total score 24 months after transplantation	89 [76 to 99]

Normally distributed data are presented as means ± standard deviation, non-normally distributed data as median [interquartile range], and categorical data as number (valid %). Abbreviations: Tx, transplantation; WRFQ, work role functioning questionnaire.

Supplemental Table 10. Associations with work functioning of employed kidney transplant recipients including work functioning total scores of participants who answered 'not applicable to my job' to >20% of the questions.

	WRFQ total score, including work functioning total scores of participants who answered 'not applicable to my job' to >20% of the questions	
	Univariable linear regression	Stepwise backwards linear regression[2]
Variables	Adjusted differences (95% CI)	Adjusted differences(95% CI)
Work-specific characteristics		
Working hours per week, *n* (%)		
>32 hours	*reference*	
20 to 32 hours	-0.05 (-0.16 to 0.06)	~
12 to 20 hours	-0.09 (-0.19 to 0.02)	~
<12 hours	0.01 (-0.10 to 0.12)	~
Working tasks, *n* (%)		
Mentally demanding tasks	*reference*	
Physically demanding tasks	-0.08 (-0.20 to 0.04)	~
Both	-0.03 (-0.15 to 0.08)	~
Educational level, *n* (%)		
Low	*reference*	*reference*
Moderate	0.19 (0.07 to 0.32)	0.21 (0.09 to 0.34)
High	0.12 (-0.00 to 0.25)	0.13 (0.01 to 0.26)
Demographics		
Male sex, *n* (%)	-0.04 (-0.15 to 0.06)	
Age, years	-0.03 (-0.13 to 0.07)	
Body mass index, kg/m^2	-0.02 (-0.12 to 0.09)	
Diabetes, *n* (%)	-0.02 (-0.12 to 0.09)	
Time after transplantation, years[3]	-0.03 (-0.13 to 0.08)	
Pre-emptive transplantation, *n* (%)	-0.04 (-0.15 to 0.06)	
Living donor, *n* (%)	-0.05 (-0.15 to 0.06)	
Laboratory measurements		
Hemoglobin, g/dL	0.03 (-0.07 to 0.14)	
Albumin, g/dL	0.10 (-0.01 to 0.20)	~
eGFR, mL/min/1.73m^2	0.08 (-0.03 to 0.18)	~
Medication use		
Prednisolone, *n* (%)	0.08 (-0.03 to 0.18)	
Calcineurin inhibitor, *n* (%)	0.06 (-0.05 to 0.16)	
Proliferation inhibitor, *n* (%)	-0.01 (-0.11 to 0.10)	
mTOR inhibitor, *n* (%)	-0.10 (-0.20 to 0.01)	
Beta-blockers, *n* (%)	0.01 (-0.09 to 0.11)	~
Antidepressants, *n* (%)	-0.03 (-0.13 to 0.08)	
Patient-reported outcome measures		
Trembling hands, *n* (%)	0.01 (-0.10 to 0.11)	
Tingling or numbness of hands or feet, *n* (%)	-0.18 (-0.28 to -0.08)	~
Feeling of warmth in hands or in feet, *n* (%)	-0.06 (-0.17 to 0.04)	
Muscle weakness, *n* (%)	-0.24 (-0.34 to -0.13)	-0.13 (-0.24 to -0.03)
Muscle cramps, *n* (%)	-0.13 (-0.24 to -0.03)	~
Dizziness, *n* (%)	-0.19 (-0.30 to -0.09)	~
Headaches, *n* (%)	-0.11 (-0.22 to -0.01)	~

Depressive feeling, *n* (%)	-0.22 (-0.32 to -0.12)	-0.13 (-0.23 to -0.02)
Concentration/memory problems, *n* (%)	-0.23 (-0.33 to -0.12)	-0.16 (-0.26 to -0.05)
Sleep difficulties, *n* (%)	-0.14 (-0.25 to -0.04)	~
Nightmares, *n* (%)	-0.07 (-0.17 to 0.03)	~
Anxiety, *n* (%)	-0.17 (-0.27 to -0.07)	~
Restlessness/nervousness, *n* (%)	-0.21 (-0.31 to -0.11)	~
Mood swings, *n* (%)	-0.19 (-0.29 to -0.08)	~
Severe fatigue, *n* (%)	-0.25 (-0.35 to -0.15)	-0.18 (-0.28 to -0.07)

[1]: WRFQ total score was available in 361 employed kidney transplant recipients. To meet the assumptions of linear regression analyses, the total WRFQ score was transformed using the formula: $\log_{10}$(maximal score+1- WRFQ total score)x-1. **[2]:** Analyses in the final model were performed in 350 employed kidney transplant recipients. The R^2 of the final model was 16.2%. [3]**:** Log_2 transformed. ~: excluded during stepwise backwards linear regression analyses. Results of linear regression are presented as adjusted differences, referring to the number of standard deviations the transformed work functioning score changes per standard deviation increase of the independent variable. Variables had no missing values or <3% was missing. Abbreviations: eGFR, estimated glomerular filtration rate; WRFQ, work role functioning questionnaire.