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Modality transition on renal replacement therapy and quality of life of patients: a 10-year follow-up cohort study

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Abstract

Purpose Despite advance in renal replacement therapy (RRT), patients with chronic end-stage renal disease (ESRD) face various limitations, and renal transplantation (Tx) is the treatment that impacts most on quality of life (QoL). This study aimed to assess changes in QoL in a cohort of ESRD dialysis patients.

Methods Sociodemographic, clinical, nutritional, lifestyle, and QoL data were collected from 712 patients at baseline (time 1) and after 10 years of follow-up (time 2) for patients surviving. The QoL was assessed through the 36-Item Short Form Health Survey (SF-36) and the multiple linear regression model was used to analyze the factors associated with change in QoL.

Results A total of 205 survivors were assessed and distributed into three groups according to current RRT (Dialysis–Dialysis, Dialysis–Tx, and Dialysis–Tx–Dialysis). At time 1, only age was significantly different among groups; at time 2, transplant patients sustained greater social participation, job retention, and improvement in SF-36 scores. The factors associated with change in QoL were more time on dialysis interfering negatively on physical functioning ($p=0.002$), role-physical limitations ($p=0.002$), general health ($p=0.007$), social functioning ($p=0.02$), role-emotional ($p=0.003$), and physical components ($p=0.002$); non-participation in social groups at times 1 and 2 reducing vitality ($p=0.02$) scores; and having work at time 2, increasing vitality ($p=0.02$) and mental health ($p=0.02$) scores.

Conclusions QoL was shown to be dynamic throughout the years of RRT, transplantation being the treatment with more benefits to the ESRD. More time on dialysis and limited social and occupational routine were associated with a reduction in QoL.

Keywords Quality of life · End-stage renal disease · Chronic kidney disease · Renal replacement therapy

Introduction

Despite advance in renal replacement therapy (RRT) and increased survival, patients with chronic end-stage renal disease (ESRD) face various physical, mental, and social limitations resulting from disease progression and complexity of treatments [1, 2]. Living with ESRD symptoms and comorbidities, along with the need to cope with psychosocial stressors, have a direct impact on quality of life (QoL) [3–5].

Some studies showed lower QoL for ESRD patients when compared to the general population, and deterioration is associated with different factors such as sex, age, number of comorbidities, nutritional status, clinical parameters, compliance with treatment, and mental health [6–12]. Length of treatment and RRT modality are also described as risk factors, given the longer a patient stays on dialysis, the greater the likelihood of comorbidities and physical aggravation. On

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the other hand, renal transplantation (Tx) results in improved clinical and emotional status, as well as longer survival and lower costs [2, 8–16].

Several complications of ESRD patients are triggered by a poorer QoL, such as an increased risk for hospitalization, mortality, or loss of renal graft [10, 11, 17]. Reduced QoL scores are also associated with impaired mental functioning and vitality, making them important contributing factors to mental disorders, like depression and anxiety [11, 18]. These mental disorders are associated with different conditions that lead to worse health outcomes, besides being related to unhealthy behaviors, such as alcohol intake and smoking, inadequate eating, sedentary lifestyle, and non-compliance to treatment [18–20]. These events increase the risk of clinical complications and consequent use of hospital emergency services and increased health expenditures [21].

In recent years, there has been a growing interest in understanding the QoL of patients with ESRD. However, there are scarce data in the literature attempting to assess change in QoL during RRT transition modalities, as well as its associated factors [8, 15, 16]. Most of the studies are cross sectional, with a small number of participants and short follow-up period, or they compare groups of patients on different RRT [8, 14]. Thus, it is essential to perform longitudinal studies with a long follow-up period, and preferably with patients under the same treatment modality, in order to understand QoL dynamics between dialysis and Tx, and to identify the major potentially modifiable determinants to attain better health outcomes [8, 10, 15, 16].

Based on the abovementioned, our assumption is that the QoL of ESRD patients varies according to duration and modality of RRT, and the best scores are obtained after the Tx or less time on dialysis. The objectives of the study were (1) to assess changes in QoL in a non-concurrent prospective cohort of incident dialysis patients with ESRD; (2) to check the effects of the transition in RRT modalities on QoL; and (3) to investigate the main factors associated with QoL and its development.

Methods

Study design

A longitudinal, 10-year follow-up study, with a retrospective (January 2006 to January 2008) and a prospective (January 2008 to May 2017) component in a cohort of RRT patients, from ten dialysis services of the Brazilian public health system, in the city of Belo Horizonte, Minas Gerais, Brazil [22] (Fig. 1) was conducted. The Research Ethics Committee of the *Universidade Federal de Minas Gerais* approved the research protocol (opinion 1.747.336/2016) and all participants signed the informed consent form.

Population

The initial cohort included all patients aged 18 years or older, who started dialysis between January 1, 2006 and January 1, 2008, with at least 3 months of treatment and no history of Tx, presenting physical and cognitive conditions to answer the questions, and who signed the informed consent form. Based on the medical records of the dialysis units, all patients who met the inclusion criteria for the study were contacted by the interviewers and invited to participate in the interviews. Out of 23876 patients, 748 were considered eligible for the survey and 36 refused to participate. Therefore, 712 patients comprised the initial cohort sample, and 205 surviving patients after a 10-year follow-up were assessed in this study.

Follow-up

Data were collected on two occasions. Baseline (T.1) occurred between January and April 2008, from interviews during dialysis sessions and the second collection (T.2) was performed between January and May 2017. All patients included in the first phase of the study were invited to participate again in the interviews that also occurred during hemodialysis (HD) sessions, or at follow-up visits of peritoneal dialysis or transplanted patients. The individuals who refused to take part, recovered renal function, or were transferred for ESRD follow-up in another city were excluded from follow-up. A structured questionnaire examining socioeconomic, clinical, nutritional, lifestyle, and QOL (SF-36) questions was applied in both interviews by medical undergraduate students working at the transplant centers. The interviewers were intensively trained in research, interviewing methods, and in the use and purpose of the SF-36 by the project researchers. The patients received a copy of the SF-36 questionnaire to follow along the survey period.

Assessment and measures

Data collected in the study were related to:

- *Sociodemographic and treatment characteristics*: obtained through a structured interview and by consulting patient charts at participating units. Covariates selected were *sociodemographic* (sex, age, ethnicity, marital status, schooling, occupation, and income); *clinical variables* (dialysis time, graft loss, number of medications); and *life habits*: social activities (participation in unions, associations, organizations, and diverse groups, such as seniors, men/women, religious, and political

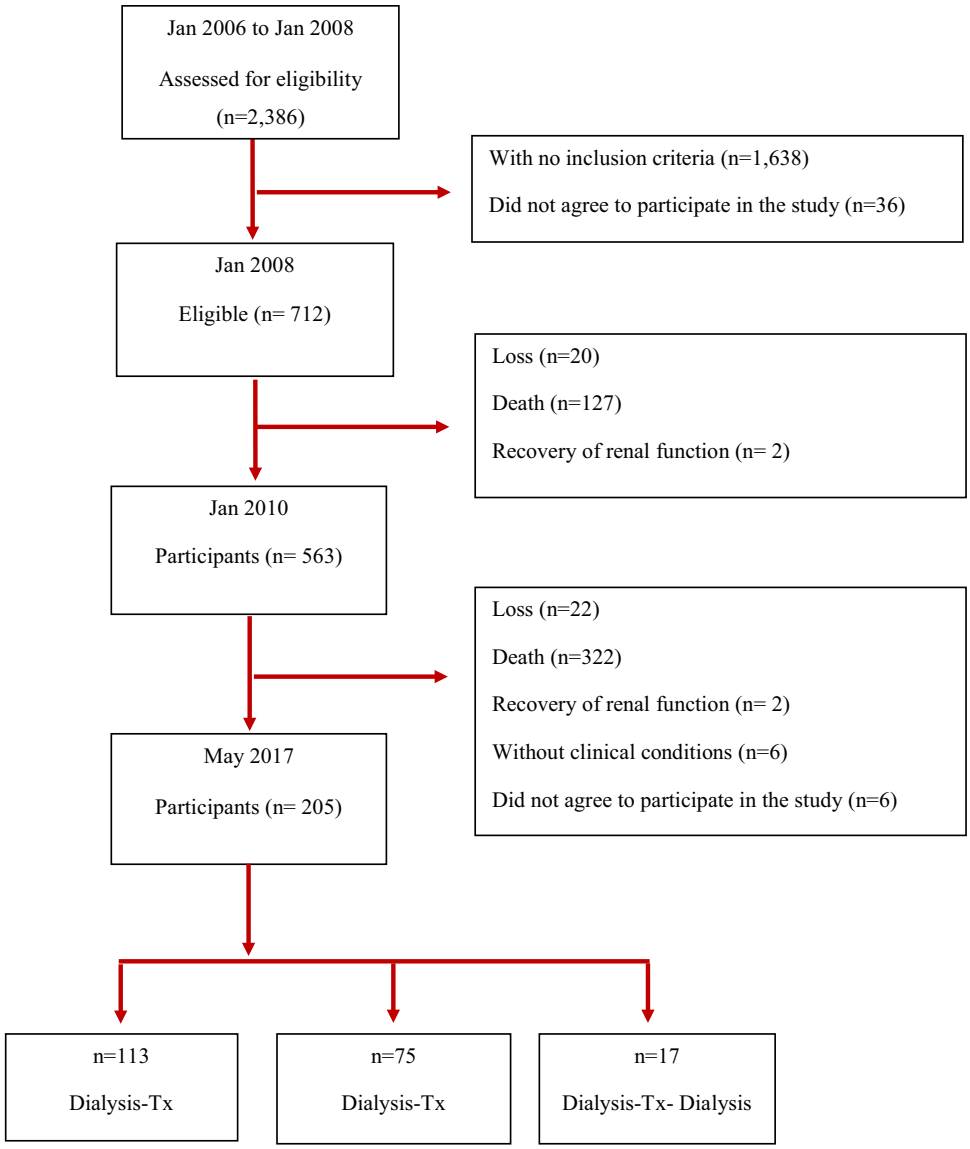

Fig. 1 Flowchart of the study design

groups) and recreational activities (parties, clubs, soccer stadiums, and gatherings with family/friends).

- *Comorbidities*: The Charlson Comorbidity Index (CCI) was used to assess severity of comorbidity. This score comprises 19 comorbidity conditions, with weights varying from 1 to 6. The higher the total score, the more severe is the clinical condition [23]. The comorbidities included in the score and weighted indices were (1) myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic pulmonary disease, connective tissue disease, ulcer, mild liver disease, diabetes; (2) hemiplegia, moderate or severe renal disease, diabetes with target-organ damage, any tumors, leukemia, lymphoma; (3) moderate or severe liver disease; (4) metastatic solid tumor, AIDS.
- *Nutritional assessment* performed using the Subjective Global Assessment (SGA) method, which is based on the clinical and physical history of the patient and allows classification in three levels: nourished, suspected malnutrition, and severe malnutrition [24].
- *Quality of life (QoL)* The validated Portuguese version of the 36-Item Short Form Health Survey (SF-36) was used [25–27]. The SF-36 is a tool that assesses general health status and QoL based on eight domains (physical functioning, role-physical, bodily pain, general health, vitality, social functioning, role-emotional, mental health) and two components (physical dimension and mental dimension). Scores range from 0 to 100, in that the nearest to 100 indicates higher QoL. The eight dimensions and the physical and mental components are reported in normalized scores, calculated using the US general population norms. The T scores are normalized to a distribution with a mean of 50 points and a standard deviation of 10 points.

Statistical analysis

All analyses compared groups. Frequencies were calculated for the categorical variables for the descriptive analysis. Mean and standard deviation were used for quantitative variables if the assumption of normality could be considered valid; if not, median and interquartile ranges were used. ANOVA followed by the Tukey test (in the case of normality) and Kruskal–Wallis test followed by the Mann–Whitney test with Bonferroni correction (in the case of non-normality) were used to compare quantitative variables. The Chi-square or Fisher's exact tests were used for the categorical variables. To study the factors associated with change in QoL between times 1 and 2, the variables whose association test with the SF-36 scores presented $p < 0.20$ in the univariate analysis were incorporated into the multiple linear regression model, which was adjusted for age, sex, treatment transition group, and baseline SF36 score. The assumptions about the errors of the linear regression model were verified by graphical analysis of the residues. The Statistical Package for Social Science (SPSS) version 16.0 was used, 95% confidence intervals were calculated, and differences were considered significant when $p < 0.05$.

Results

Sample characteristics

Of the 712 patients who started follow-up, 449 (58.4%) died, 4 (0.5%) recovered renal function, and 44 (10.3%) were considered losses due to moving out of the city or because they were not found. In the second collection phase, 12 (1.8%) patients were excluded from the study due to refusal or unfavorable clinical conditions to participate in the interview. Thus, 205 patients were re-assessed and distributed into three groups for the study, according to RRT in January 2017: 113 patients remained on dialysis during the 10-year follow-up (Dialysis–Dialysis), 75 underwent transplant (Dialysis–Tx), and 17 returned to dialysis after renal graft loss (Dialysis–Tx–Dialysis). The main causes for renal graft loss were rejection (52.9%) and infection (29.4%). The major diseases related to the CCI were diabetes (24.8%), congestive heart failure (20.9%), and chronic pulmonary disease (18.4%). Considering baseline characteristics, only age was significantly different among groups ($p < 0.001$); the remaining characteristics showed no distinction in sociodemographic, clinical, and SF36 data (Table 1).

Characteristics of the sample after follow-up

After 10 years of follow-up, the groups that changed their treatment in relation to the baseline RRT showed differences in sociodemographic, clinical, and SF36 characteristics (Tables 2, 3). Compared with the Dialysis–Dialysis group, Dialysis–Tx presented a higher proportion of patients who retained both work ($p = 0.002$) as the main activity, and wages ($p = 0.01$) as source of income, at times 1 and 2. In contrast, the only source of income for the Dialysis–Dialysis group were social benefits (disability pension, illness, or social welfare) at both collection points ($p = 0.03$), or only at the second ($p = 0.002$). In relation to social activities, the Dialysis–Tx group continued participating more in phases 1 and 2 when compared to the Dialysis–Dialysis ($p = 0.001$) and Dialysis–Tx–-Dialysis ($p = 0.02$) groups. The mean time on dialysis was shorter in Dialysis–Tx patients compared to Dialysis–Dialysis ($p = 0.001$) and Dialysis–Tx–Dialysis ($p = 0.001$) patients; the same was observed between Dialysis–Dialysis and Dialysis–Tx–Dialysis, the latter presenting less time on dialysis ($p = 0.001$).

Quality of life

SF36 scores showed differences during treatment transitions in the 10 years of follow-up, and the Dialysis–Tx group showed a greater gain in QoL in the physical component summary ($p = 0.001$), and in almost all domains, except for *bodily pain* and *mental health* that revealed no significance (Table 3). There was no difference in the mental component summary between the groups. The difference in scores between times 1 and 2 was higher in the Dialysis–Tx group compared to the others in *physical functioning* ($p < 0.001$), *general health* ($p < 0.001$), *social functioning* ($p = 0.006$), *role-emotional* ($p = 0.002$), and in the *physical components* ($p = 0.001$) domains. Transplanted patients also presented a greater positive difference in *limitations due to role-physical* ($p = 0.008$) and *vitality* ($p = 0.003$) compared to those only on dialysis (Table 3) (Fig. 2).

Linear regression analyses revealed that the main factors associated with the change in SF36 scores, considering all patients, were more time on dialysis, negatively impacting the domains of *physical functioning* (β, −0.201; 95% CI, −0.327; −0.076), *limitations due to role-physical* (β, −0.336, 95% CI, −0.550; −0.121), *general health* (β, −0.163; 95% CI, −0.282; −0.045), *social functioning* (β, −0.172; 95 CI, −0.317; −0.026), *role-emotional* (β, −0.347 95% CI, −0.574; −0.120), and in the *physical* components (β, −0.081; 95% CI, −0.132; −0.03); non-participation in social groups at time 1 and 2, reducing the QoL scores in *vitality* (β, −10.352; 95% CI, −19.403; −1.30) domains; and being employed at time 2, that raised the scores for *vitality* (β, 14.173; 95% CI, 1.464; 26.881) and *mental health* (β, 12.388; 95% CI, 1.482; 23.294) (Table 4).

Seventy-five percent of data were complete. The declaration of current income was the category with more

Table 1 Baseline and follow-up sociodemographic and clinical characteristics of treatment transition groups

Variables	Dialysis–dialysis ($n=113$)		Dialysis–Tx ($n=75$)		Dialysis–Tx–dialysis ($n=17$)		p value
	T1	T2	T1	T2	T1	T2	
Sociodemographic							
Age	48.9 ± 13.1	–	42.8 ± 11.1	–	38.0 ± 11.9	–	*< 0.001*
Sex (female)	56 (49.6)	–	33 (44.0)	–	8 (47.1)	–	0.75
Skin color (brown/black)	72 (63.7)	–	46 (61.3)	–	13 (76.5)	–	0.56
Married/de facto relationship	70 (61.9)	61 (54.0)	50 (66.7)	53 (70.7)	9 (52.9)	11 (64.7)	0.54
Schooling							
Illiterate	10 (8.8)	5 (4.4)	1 (1.3)	0	0	0	0.13
Up to 9 years	66 (58.4)	63 (55.8)	40 (53.3)	36 (48.0)	8 (47.1)	8 (47.1)	
10 to 12 years	28 (24.8)	33 (29.2)	23 (30.7)	27 (36.0)	7 (41.2)	7 (41.2)	
Over 12 years	9 (8.0)	12 (10.6)	11 (14.7)	12 (16.0)	2 (11.8)	2 (11.8)	
Has a job	18 (15.9)	14 (12.4)	18 (24.0)	26 (34.7)	3 (17.6)	4 (23.5)	0.38
Number of minimum wages	2.7 ± 2.7	3.2 ± 3.8	4.8 ± 7.0	4.0 ± 4.1	2.3 ± 1.7	2.8 ± 1.8	0.10
Source of income							
Work	13 (14.8)	12 (11.4)	14 (21.9)	23 (35.9)	4 (28.6)	2 (14.3)	0.43
Benefit	75 (85.2)	93 (88.6)	50 (78.1)	41 (64.1)	10 (71.4)	12 (85.7)	
Clinical							
Time on dialysis (months)	14.6 ± 8.3	–	13.5 ± 7.8	–	14.9 ± 8.9	–	0.64
CCI	3.2 ± 2.4	1.9 ± 1.4	2.0 ± 1.2	2.9 ± 1.7	2.8 ± 1.6	1.7 ± 1.4	0.41
Number of medications	5.3 ± 2.3	5.8 ± 3.0	5.7 ± 2.1	7.5 ± 3.2	5.9 ± 2.7	5.5 ± 2.9	0.35
SGA (well nourished)	98 (86.7)	98 (88.3)	66 (88.0)	73 (97.3)	15 (88.2)	16 (94.1)	0.8
Transfer of health service (yes)	–	30 (26.5)	–	33 (40.0)	–	5 (29.4)	0.05
Habits							
Recreational activities (yes)	89 (78.8)	69 (61.1)	63 (84.0)	60 (80.0)	13 (76.5)	12 (70.6)	0.61
Social group (yes)	35 (31.0)	41 (36.3)	30 (40.0)	41 (54.7)	4 (23.5)	3 (17.6)	0.28
SF-36 scores							
Physical components	40.9 ± 9.4	35.4 ± 10.5	44.0 ± 8.3	44.9 ± 9.5	44.3 ± 11.2	37.1 ± 10.2	0.45
Physical functioning	65.1 ± 26.3	50.3 ± 27.7	68.5 ± 21.5	73.2 ± 24.3	74.7 ± 23.1	58.5 ± 24.6	0.32
Role-physical	44.1 ± 41.9	39.6 ± 41.2	50.0 ± 41.1	68.0 ± 41.4	51.4 ± 43.7	38.2 ± 36.5	0.58
Bodily pain	67.5 ± 27.5	52.1 ± 29.8	74.9 ± 25.4	66.2 ± 23.9	72.3 ± 28.2	52.3 ± 25.4	0.19
General health status	60.6 ± 21.2	50.3 ± 23.2	61.5 ± 20.1	68.8 ± 21.9	62.2 ± 17.8	47.5 ± 23.8	0.9
Mental components	51.1 ± 10.5	49.0 ± 11.6	48.5 ± 12.2	52.4 ± 10.3	50.2 ± 11.6	46.6 ± 9.3	0.07
Vitality	65.8 ± 20.4	52.9 ± 22.1	63.8 ± 24.1	64.0 ± 21.4	66.4 ± 19.0	54.1 ± 18.5	0.9
Social functioning	75.6 ± 25.3	71.3 ± 27.9	73.9 ± 27.1	85.3 ± 22.6	76.4 ± 27.5	66.9 ± 29.6	0.9
Role-emotional	63.6 ± 41.3	56.8 ± 45.4	62.1 ± 40.6	84.0 ± 32.1	68.6 ± 36.2	51.0 ± 47.3	0.9
Mental health	75.5 ± 20.4	69.6 ± 20.0	71.1 ± 21.4	72.9 ± 20.3	74.5 ± 21.2	67.7 ± 14.5	0.33

Recreational activities and social group: participation in some social activity at least once a month. Values for categorical variables are given as number (percentage); values for continuous variables, as mean ± standard deviation. Continuous variables, presumed to have a normal distribution, were compared by the t test; for other quantitative variables, the Mann–Whitney test was used to make comparisons in the group. The Chi-square or Fisher's exact tests were used for the categorical variables

CCI Charlson Comorbidity Index, *SGA* Subjective Global Assessment, *SF-36* 36-Item Short Form Health Survey

p value calculated by analyses of baseline data

missing data. In the remaining categories, data completeness varied from 90 to 100%. The graphical analysis of the residuals of models did not show violation of normality assumptions and heteroscedasticity of the errors.

Discussion

The present study has shown that patients on RRT are subject to changes in QoL in general, as well as in their

Table 2 Differences in sociodemographic and clinical characteristics between T2–T1 of treatment transition groups

Variables	Dialysis–dialysis ($n=113$)	Dialysis–Tx ($n=75$)	Dialysis–Tx–dialysis ($n=17$)	p value
Schooling (T1/T2)				
No change	100 (88.5)	68 (90.7)	17 (100)	0.40
Increase	13 (11.5)	7 (9.3)	0	
Married/de facto relationship (T1–T2)				
Yes/yes	55 (48.7)	43 (57.3)	6 (35.3)	0.06
No/no	39 (34.5)	17 (22.7)	5 (29.4)	
Yes/no	14 (12.4)	6 (8.0)	2 (11.8)	
No/yes	5 (4.4)	9 (12.0)	4 (23.5)	
Number of minimum wages (T2–T1)	0.0 ± 1.9	0.1	0.9 ± 1.4	0.23
Has a job (T1–T2)				
Yes/yes	9 (8.0)^{A}	13 (17.3)^{B}	3 (17.6)^{A,B}	*0.02*
No/no	90 (79.6)	44 (58.7)	13 (76.5)	
Yes/no	9 (8.0)	6 (8.0)	0	
No/yes	5 (4.4)	12 (16.0)	1 (5.9)	
Work as source of income (T1–T2)				
Yes/yes	63 (78.8)^{A}	30 (57.7)^{B}	9 (81.8)^{A,B}	*0.03*
No/no	4 (5.0)^{A}	10 (19.2)^{B}	2 (18.2)^{A,B}	
Yes/no	6 (7.5)^{A}	2 (3.8)^{B}	0 ^{A,B}	
No/yes	7 (8.8)	10 (19.2)	0 ^{A,B}	
Recreational activities (T1–T2)				
Yes/yes	57 (50.4)	51 (68.0)	1 (5.9)	0.12
No/no	12 (10.6)	3 (4.0)	9 (52.9)	
Yes/no	32 (28.3)	11 (14.7)	4 (23.5)	
No/yes	12 (10.6)	10 (13.3)	3 (17.6)	
Social group (T1–T2)				*0.02*
Yes/yes	23 (20.4)^{A}	20 (26.7)^{B}	1 (5.9)^{A}	
No/no	60 (53.1)	22 (29.3)	11 (64.7)	
Yes/no	12 (10.6)	12 (16.0)	3 (17.6)	
No/yes	18 (15.9)	21 (28.0)	2 (11.8)	
CCI	−1.0	−1.0	-1.1 ± 1.6	0.40
Number of medications	0.0	1.8 ± 3.9	-0.3 ± 4.3	0.06
SGA (well nourished)				
Yes/yes	86 (77.5)	64 (85.3)	14 (82.4)	0.58
No/no	2 (1.8)	2 (2.7)	0	
Yes/no	10 (9.0)	0	1 (5.9)	
No/yes	13 (11.7)	9 (12.0)	2 (11.8)	
Time in dialysis (months)	120.0 ± 7.9^{A}	37.0^{B}	98.6 ± 24.1^{C}	*< 0.001*

Values for categorical variables are given as number (percentage); values for continuous variables, if presumed to have a normal distribution, were summarized by mean ± SD. For other quantitative variables, median was used as a summary measure. For multiple comparisons, the Kruskal Wallis test (continuous variables) and the Fisher's test (categorical variables using all categories) were used. In each line, equal letters indicate groups statistically equal; different letters indicate groups statistically different

CCI Charlson Comorbidity Index, *SGA* Subjective Global Assessment

habits and lifestyle, which in turn are associated with how long they are kept on dialysis or the type of current treatment modality. Data from the study showed that, at T1, there were no differences in sociodemographic, clinical characteristics, and mean time on dialysis in the cohort. Differences were only observed throughout the follow-up, in which part of the patients changed treatment modality and began to present better results after transplantation. The literature has agreed that Tx, compared to other treatment modalities, offers patients with ESRD better clinical conditions and the possibility of independence from the restrictions imposed by dialysis, favoring the

Table 3 Differences in SF-36 scores (T2–T1) of treatment transitions groups

Variables	Dialysis–dialysis ($n=113$)	Dialysis–Tx ($n=75$)	Dialysis–Tx–dialysis ($n=17$)	p value
Physical components	-5.2 ± 12.2^{A}	1.0 ± 11.2^{B}	-7.1 ± 12.8^{A}	*0.001*
Physical functioning	-14.8 ± 29.4^{A}	5.1 ± 29.9^{B}	-16.1 ± 25.8^{A}	*< 0.001*
Role-physical	$0.0\ (-100.0;\ 100.0)^{A}$	$0.0\ (-100.0;\ 100.0)^{B}$	$0.0\ (-100;\ 75.0)^{A,B}$	*0.01*
Bodily pain	$-17.5\ (-100.0;\ 78.0)$	$-11.0\ (-70.0;\ 50.0)$	$-12.0\ (-69.0;\ 72.0)$	0.30
General health status	-10.5 ± 23.3^{A}	7.5 ± 26.0^{B}	-14.7 ± 25.9^{A}	*< 0.001*
Mental components	$-2.4\ (-33.1;\ 28.8)$	$1.5\ (-22.7;\ 40.2)$	$-5.9\ (-21.8;\ 19.3)$	0.02
Vitality	-13.3 ± 26.7^{A}	0.2 ± 26.8^{B}	$-12.3 \pm 22.5^{A,B}$	*0.003*
Social functioning	$0.0\ (-75.0;\ 87.5)^{A}$	$6.2\ (-62.5;\ 87.5)^{B}$	$-12.5\ (-62.5;\ 50.0)^{A}$	*0.006*
Role-emotional	$0.0\ (-100.0;\ 100.0)^{A}$	$0.0\ (-100.0;\ 100.0)^{B}$	$0.0\ (-100.0.0;\ 66.6)^{A}$	*0.002*
Mental health	-6.1 ± 21.9	1.8 ± 23.3	-6.8 ± 19.3	0.04

Continuous variables, presumed to have a normal distribution, were summarized by mean ± SD and compared by the Anova and Tukey's *post hoc* test. For other quantitative variables, median (interquartile range) was used as a summary measure, and the Kruskal–Wallis test and Mann–Whitney test (with Bonferroni correction) to make comparisons in the groups. In each line, equal letters indicate groups statistically equal; different letters indicate groups statistically different

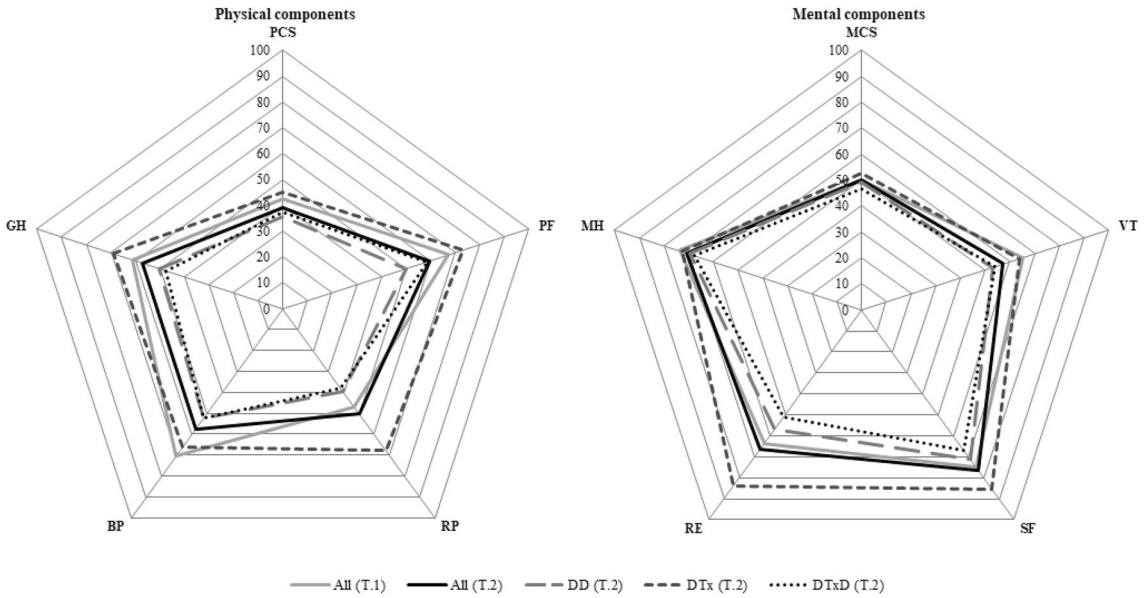

Fig. 2 Mean SF-36 of 205 patients at T1 and T2. *PF* Physical functioning, *RP* role-physical, *BP* bodily pain, *GH* general health status, *VT* vitality, SF social functioning, *RE* role-emotional, *MH* mental health, *PCS* physical components, *MCS* mental components (MCS)

reestablishment of a life closer to the one previous to illness [1, 8, 28–30].

After 10 years on RRT, the likelihood of remaining employed at T1 and T2 was higher for the Dialysis–Tx patient group. The opposite was observed between patients in the Dialysis–Dialysis and Dialysis–Tx–Dialysis groups. As time went by, a greater proportion of patients did not retain their jobs or even had no work activity, remaining exclusively dependent on income derived from social benefits. Job retention and re-employment was low among dialytic patients as shown in the retrospective study conducted by Muehrer et al. comprising 102,104 working-age patients from the United States Renal Data System, 6 months prior to beginning dialysis; the data showed a high unemployment rate, compared to the general population, with a rising trend with increase in years on dialysis. The main factors associated were presence of comorbidities and physical and functional disability [31]. In a meta-analysis on the psychosocial status and lifestyle of young adults on RRT, in contrast to healthy peers, young people with ESRD were more likely to be unemployed and financially dependent on the family, especially those who were on dialysis, compared with those transplanted [9]. Regarding this fact, patient lifestyle after Tx is believed to considerably change due to the absence of the rigorous routine of dialysis sessions, which limit free time for occupational

Table 4 Associated factors for the physical and mental dimensions and their domains in T2 considering all patients

Models	*β*	95% CI	*p* value
SF36 domains			
Physical functioning			
Time on dialysis (months)	−0.201	−0.327; −0.076	0.002
Role-physical			
Time on dialysis (months)	−0.336	−0.550; −0.121	0.002
General health status			
Time on dialysis (months)	−0.163	−0.282; −0.045	0.007
Vitality			
Has a job (No/yes)**	14.173	1.464; 26.881	0.02
Social group (No/no)*	−10.352	−19.403; −1.30	0.02
Social functioning			
Time on dialysis (months)	−0.172	−0.317; −0.026	0.02
Role-emotional			
Time on dialysis (months)	−0.347	−0.574; −0.120	0.003
Mental health			
Has a job (No/yes)**	12.388	1.482; 23.294	0.02
SF36 dimensions			
Physical components			
Time on dialysis (months)	−0.081	−0.132; −0.030	0.002

Multivariate linear regression analysis adjusted to age, sex, transfer of health service, baseline SF-36 scores, and actual RRT

CI confidence interval

*Reference category: Social group (Yes/yes)

**Reference value: Has a job (Yes/yes)

activities, or by greater freedom from physical restrictions, such as care with arteriovenous fistula, which prevents patients still on dialysis to have certain professions [32]. In addition to the specificities of RRT, patients improved their general health after successful transplantation, gaining greater vitality and well-being, and presenting less oppressive symptoms common to dialysis patients, such as fatigue, cramps, insomnia, pain, and headache, which are important sources of stress and limit work performance [8, 30, 32].

Dialysis–Tx patients also presented greater inclusion and longevity in social activities at T1 and T2 as compared to Dialysis–Dialysis and Dialysis–Tx–Dialysis, which shows that Tx also favors attainment of a socially active life routine. In general, ESRD patients reduce recreational or social activities after beginning treatment. Even though this decline is in part attributed to clinical status, the RRT modality plays an important role. The greatest loss is found in patients undergoing dialysis treatment, due to the weekly schedule of dialysis sessions and food impositions [33]. A systematic review of the literature comparing the participation in social activities among ESRD adults showed that transplanted patients experienced better possibilities of social insertion, whereas patients on HD or peritoneal dialysis (PD) did not present differences in comparison to one another [34].

In the present study, QoL scores showed variations throughout the follow-up, with an improvement in physical components and in the SF36 domains in the Dialysis–Tx group, except for *bodily pain and mental health*, while in Dialysis–Dialysis and Dialysis–Tx–Dialysis variation went in the opposite direction, with reduction in QoL in general. Despite the notable gain in QoL in the transplant recipient group, this was mainly observed in relation to the physical items, due to the improvement in clinical parameters, nutritional status, and dialysis-independence [14, 35]. Favorable physical performance consequently provides patients with positive changes to other aspects, including gains in physical functioning, vitality, emotional, and social status, as well as in the return to daily routine activities [2, 13–15, 36, 37]. However, even with the evident success achieved with Tx, QoL is still lower than in the general population [8, 36, 38]. Some studies show that, as opposed to what occurs with the physical component, the mental one does not present difference in the group of dialytic patients [17, 35, 39]. It is believed that, because it is still the case of being a chronic patient and under complex and continuous treatment, transplant patients face several challenges that directly affect mental health, such as living with feelings of uncertainty and fear related to graft survival, infections, hospitalizations, and return to dialysis; constant self-surveillance and surveillance of others regarding self-care; following a complex drug regimen, with possible coexistence with immunosuppressive side effects and changes in body image [14, 30, 36, 38, 40]. Such situations raise the risk for the onset of depression and anxiety, psychological disorders are very prevalent in the population with ESRD that interfere negatively on QoL domains, representing independent variables for a worse perception of health in general [3, 18, 19, 41, 42].

In this article, after a 10-year follow-up, more time on dialysis treatment was the main factor associated with the reduction in QoL scores, especially in the domains related to the physical component such as *physical functioning, limitations due to role-physical and general health, besides role-social and role-emotional* corresponding to the mental component. These results were also observed by Von Der Lippe et al. (2014), who at the end of a 5-year follow-up of a cohort with 128 dialysis patients, observed that those transplanted achieved better SF36 scores in physical, social, vitality, and general health aspects, with dialysis time being one of the predictors [8]. The same was also observed in another cohort with 262 ESRD patients after 7 years of follow-up; in this study, Griva *et al*. showed that QoL was associated with a change in the modality of RRT, with a higher score of the SF36 after Tx, but with a reduction in the score in the presence of renal graft loss and return to dialysis [15]. Despite the

progress in dialysis techniques in past decades, which has increased the survival of those who depend on it, it has not yet been possible to eliminate their adverse effects on the health status and physical deterioration of ESRD patients [1, 35]. Dialytic patients have a high burden of disease or comorbidity, including an increased risk for heart, bone and vascular disorders [43, 44]. In a review article comparing the relevant clinical results between Tx and dialysis, it was shown that, regardless of the modality, dialysis increased the risk for cardiovascular events, hospitalizations, and mortality [1]. Patients on dialysis also presented worsening of their nutritional status, including low albumin and uncontrolled levels of phosphorus, potassium, and calcium, which are important causes for physical deterioration and risk of death [45].

Participation in social groups and work retention were also associated with QoL results after 10 years of follow-up, mainly in the *vitality and mental health* domains. However, data on renal patients exploring these topics are scarce, mainly from studies with longitudinal design. Generally speaking, there are innumerous benefits of social activities for the promotion of emotional well-being, as well as for QoL improvement, including feelings of satisfaction, perception of freedom of choice, feeling of belonging, and integration in and expansion of social network [46]. Social support is considered as one of the main protective characteristics of social and leisure activities, being essential for coping with the disease and treatment challenges, as well as for the maintenance of the emotional status of ESRD patients. A prospective study evaluated the predictors for poorer health status in 150 elderly on dialysis and showed social dissatisfaction and the lower sense of community belonging were essential risk factors for perceived negative health status or death after 1-year follow-up [47].

Among social activities, work also represents an important benefit to the patient, not only because it is an essential foundation for the construction of identity and the sense of belonging to society, but also for promoting recognition and personal fulfillment, directly impacting on interpersonal relations and mental health. In the case of ESRD, inclusion in work activities also preserves the capacity to maintain control and continuity of a life routine that is similar to the one previous to illness, maintaining financial independence and more active behaviors, including care with health and renal treatment. Chisholm-Burns et al. (2011) examined the relation between QoL and employment among 82 renal transplant patients and found that those who were employed had higher SF12 scores [48]. Return to society plays an important role in the QoL of patients on RRT, and retention of employment is one of the main facilitators [49]. Occupational status contributes to better rehabilitation, as well as to improved economic and emotional status, benefiting self-esteem and QoL [31].

Some limitations of the present study need to be addressed. First of all, consideration should be given to not evaluating the clinical and uremic parameters at different times of data collection and, therefore, the impossibility of comparing the progression of renal status and QoL scores during follow-up. These data would have had major relevance in our study, due to the association between QoL and glomerular filtration rate, as well as other clinical parameters already demonstrated in previous studies. Second, at the end of the study, we had 74 losses due to not finding individuals or unavailable data at the initial dialysis unit, after patient transfer to another RRT center. During the 10 years of follow-up, some of the participating clinics were closed and incorporated into larger dialysis centers, and others reopened after a long period of inactivity. Third, the possible presence of survival bias, since participants represented alive patients and with a probable better health condition and QoL compared with the deceased during the follow-up. Within the survival bias, we also considered the best clinical condition patients were likely to present when transplanted during the follow-up period, as compared to those remaining on dialysis. Fourth, the use of face-to-face interviews to respond to SF36, since directly interviewing patients may have influenced the results, as they tend to be more positive when asked, rather than filling out the form.

Conclusion

Our findings revealed that the QoL of the ESRD patients on RRT presents variability over the years of treatment, with changes in opposite directions according to modality transition. Even though it did not match the general population, the best QoL scores were achieved after successful transplantation. Longer stay on dialysis was the main factor associated with lower QoL, followed by the presence of a limited daily life routine, including non-participation in social and work activities. In terms of RRT, Tx proved to be the most beneficial treatment for patients, including greater preservation of physical health, QoL, and socially more active behaviors. Data on QoL as well as psychosocial factors over time are still scarce, and mostly come from cross-sectional and small sample studies. Thus, future investigations are recommended in order to provide a closer and more appropriate understanding of the reality of this group of patients and to identify their major risk and protection factors.

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Author Contributions Study conception and design: DCSB, MLC, ELM, IAR; data collection: DCSB, ELM, DPM, THMN, MLC; data analysis and interpretation: DCSB, ELM, DPM, THMN, MLC; statistical analysis: DCSB, ELM, IAR, DPM, MLC; supervision or mentoring: ELM, IAR, MLC. All authors contributed significant intellectual content during the preparation and revision of this manuscript and take full responsibility for the overall work, ensuring proper investigation and clarification of issues regarding the accuracy or integrity of any part of this work.

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Compliance with ethical standards

Conflict of interest DCSB, ELM, IAR, DPM, THMN, MLC declares that she has no conflict of interest. All authors have no other relevant financial interests to declare.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The Institutional Review Board (IRB) at the Federal University of Minas Gerais—UFMG, approved the study (decision 397/2006 and 59817316.7.0000.5149/2016) and informed consent was obtained from all individual participants included in the study. This article does not contain any studies with animals performed by any of the authors.

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