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Pre-Kidney Transplant Lower Extremity Impairment and Post-Transplant Mortality

Running Title: Lower Extremity Impairment & Post-KT Mortality

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Abbreviations: Short Physical Performance Battery (SPPB), Kidney Transplant (KT), End-Stage Renal Disease (ESRD), Body Mass Index (BMI), Hepatitis C Virus (HCV), Panel Reactive Antibody (PRA), Cold Ischemic Time (CIT), Expanded Criteria Donor (ECD), Donation after Cardiac Death (DCD)

ABSTRACT

Prediction models for post-kidney transplant (KT) mortality have had limited success (C-statistics≤0.70). Adding objective measures of potentially modifiable factors may improve prediction and, consequently, KT survival through intervention. The short physical performance battery (SPPB) is an easily administered objective test of lower extremity function consisting of three parts (balance, walking speed, chair stands), each with scores of 0-4, for a composite score of 0-12, with higher scores indicating better function. SPPB performance and frailty (Fried frailty phenotype) were assessed at admission for KT in a prospective cohort of 719 KT recipients at Johns Hopkins Hospital (8/2009-6/2016) and University of Michigan (2/2013-12/2016). The independent associations between SPPB impairment (SPPB composite score≤10) and composite score with post-KT mortality were tested using adjusted competing risks models treating graft failure as a competing risk. The 5-year post-KT mortality for impaired recipients was 20.6% compared to 4.5% for unimpaired recipients (P<0.001). Impaired recipients had a 2.30-fold (aHR:2.30,95%CI:1.12–4.74,P=0.02) increased risk of post-KT mortality compared to unimpaired recipients. Each one-point decrease in SPPB score was independently associated with a 1.19-fold (95%CI:1.09–1.30,P<0.001) higher risk of post-KT mortality. SPPB-derived lower extremity function is a potentially highly useful and modifiable objective measure for pre-KT risk prediction.

INTRODUCTION

Post-kidney transplant (KT) survival models have moderate predictive ability, with C-statistics generally below 0.70 for the standard models using the Scientific Registry of Transplant Recipients such as the estimated post-transplant survival (EPTS) score (1, 2). The Kidney Allocation System uses the EPTS to prioritize candidates; however, its limited predictive ability warrant including additional components for improved risk prediction. By including subjective components, candidates may select their responses based on what they believe may be most likely to get them a kidney sooner. Completely objective tests would avoid candidate bias and potentially allow for improved prediction of mortality. Furthermore, if the test measures a modifiable risk factor like lower extremity function, there is the potential to improve post-KT survival through intervention.

Previous work has demonstrated the utility of frailty as a successful predictor of several important outcomes among KT recipients such as delayed graft function, longer length of stay, early hospital readmission, immunosuppression intolerance, and mortality (3-7). However, frailty, a phenotype of decreased physiologic reserve distinct from comorbidity and disability, relies on several subjective components such as self-reported exhaustion and self-reported low physical activity. A completely objective physical assessment would avoid these issues resulting in improved risk prediction, clinical and policy decision-making related to the selection of KT candidates, and care of high-risk patients.

The short physical performance battery (SPPB) is a well-validated and objective physical assessment tool of lower extremity function, which was developed among community-dwelling older adults (8-10). The SPPB is an objective assessment of lower extremity impairment, a potentially modifiable factor, and is associated with many important health outcomes including mortality, quality of life, and functional decline in older adults (10-12). Given the strong association between frailty and mortality in KT recipients and the similarities between the components of the two assessments (i.e., walking speed), we hypothesized that the SPPB may

also be strongly associated with post-KT mortality (13, 14). Furthermore, lower extremity impairment may be more relevant than grip strength given the limitations of measuring grip strength among ESRD patients with fistulas or grafts.

The goals of this study were to: (1) quantify the independent association between SPPB-derived lower extremity function and mortality among KT recipients, and (2) compare the SPPB's association with and prediction of post-KT mortality with that of frailty. We hypothesized that recipients with poor performance on the SPPB at admission for KT would be at higher risk of post-KT mortality and that the SPPB would perform similarly to frailty in strength of association with and prediction of mortality. In addition, the SPPB would provide a completely objective testing modality and a potentially modifiable risk factor.

METHODS

Study Design

This was a prospective, longitudinal cohort study of 719 English-speaking KT recipients 18 years or older at the Johns Hopkins Hospital, Baltimore, Maryland, from August 2009 to June 2016 (N=645) and the University of Michigan, Ann Arbor, Michigan, from February 2013 to December 2016 (N=74). KT recipients enrolled in this cohort were not different from those who were not enrolled on important factors such as age (P=0.19), sex (P=0.43), race (P=0.56), time on dialysis (P=0.10), peripheral vascular disease (P=0.17), cerebrovascular disease (P=0.92), COPD (P=0.27), hypertension (P=0.79), pre-transplant malignancy (P=0.33), or donor type (P=0.45); participants in the study were more likely to be diabetic (32% vs. 27%; P=0.02). SPPB was measured at the time of hospital admission for KT as described below. Recipient factors (age, sex, race, education, BMI, hepatitis C virus [HCV] status, preemptive KT, years on dialysis, previous KT, cause of end-stage renal disease [ESRD], diabetes status, history of cancer, cardiovascular disease and lung disease), transplant factors (panel reactive antibody [PRA], ABO incompatibility, HLA mismatches, and cold ischemic time [CIT], live vs. decease donor KT), and donor factors (age, sex, race, donation after cardiac death [DCD], deceased expanded criteria

[ECD], hypertension, diabetes, HCV status, and creatinine) were collected. Active cancer was a contraindication for KT, so no recipients had active cancer before KT in our cohort.

Frailty was measured at the time of admission for KT using the Fried frailty phenotype, which has been previously described in other studies of KT recipients (3, 5-7, 15-20). Briefly, the Fried frailty phenotype consists of 5 components: shrinking (self-report of unintentional weight loss of more than 10 lbs in the last year), weakness (grip-strength below a gender and BMI-based cutoff), exhaustion (self-report), low activity (kcals/week below cutoff), and slowed walking speed (time to walk 15 feet being below an established gender and height-based cutoff). One point is given for the presence of each of these and a score of 3 or higher was used to define a recipient as frail. The Johns Hopkins and University of Michigan Institutional Review Boards approved this study and all participants provided informed consent.

Short Physical Performance Battery (SPPB)

The SPPB was measured at admission for KT by trained research assistants and consists of three objective physical assessments (standing balance, walking speed, and repeated chair stands) of lower extremity function, each with a score ranging from 0 to 4, for a summed composite score ranging from 0 to 12. The test takes approximately 5 to 10 minutes to complete. For the balance portion, recipients are asked to stand and remain in several progressively more difficult positions (side-by-side, semi-, and full-tandem stances) for 10 seconds each. For the walking speed test, recipients' usual walking speed is measured as they walk an 8-foot course. Finally, for the chair stand portion, recipients are asked to fold their arms across their chest and rise from a chair five times as quickly as possible. A full description of administration and scoring has been detailed elsewhere (10).

SPPB and Mortality

Cumulative incidence of mortality was estimated using a Kaplan-Meier approach. The independent association between SPPB impairment and post-KT mortality was assessed with a competing risks survival regression model based on the Fine and Gray proportional subhazards

model treating graft failure as a potential competing risk and adjusting for age, sex, race, BMI, years on dialysis, cause of ESRD, donor type (living vs. deceased), diabetes status, cardiovascular disease (including any ischemic heart disease, cerebrovascular disease, or peripheral vascular disease), and lung disease (21). Cancer was not included in models given that there were only 5 patients with cancer in the analytic sample. These factors were included in our adjusted models based on previous literature and due to their likely importance to SPPB and mortality. SPPB impairment was empirically defined as an SPPB score of ≤10, as a dichotomous cutoff of 10 resulted in the highest model quality (lowest Akaike Information Criterion). Proportional hazards were confirmed visually by graphing the log-log plot of survival and statistically using Schoenfeld residuals (P=0.85). The independent association between each one-point increase in SPPB score with post-KT mortality, and the association between each individual SPPB component (balance, walking speed, and chair stands) and post-KT mortality, were assessed using competing risks models treating graft failure as a potential competing risk adjusted for the same recipient and transplant factors as above.

Effect Heterogeneity of SPPB and Mortality

Effect modification of the association between SPPB score and post-KT mortality by recipient age, sex, race, diabetes status, and frailty status was tested using a Wald test. We used the same approach to test for effect modification using impairment instead of SPPB score.

SPPB, Age, and Mortality

We further divided the unimpaired and impaired groups based on an age cutoff of ≥65 years, a clinically relevant and commonly used cutoff for older adults, creating four age-impairment groups: younger-unimpaired, younger-impaired, older-unimpaired, and older impaired. We then quantified the independent association between combined age-impairment group and mortality using an adjusted competing risks models treating graft failure as a potential competing risk as described above.

SPPB, Frailty, and Mortality

We compared the predictive abilities of SPPB impairment with the established predictive abilities of frailty using Cox proportional hazards models including the same factors in the models described above. SPPB impairment and frailty were each separately added to the base model and C-statistics were calculated for each. A linear combination test assessing whether or not there was a significant difference between the two C-statistics was performed.

Sensitivity Analysis of SPPB and Mortality

The robustness of the associations between SPPB performance (composite score, impairment) and mortality were assessed by additionally adjusting for transplant (HLA mismatches, CIT > 24h) and donor (expanded criteria donor, creatinine > 1.5) factors in the full model (age, sex, race, BMI, years on dialysis, cause of ESRD, donor type, diabetes status, cardiovascular disease, and lung disease) described above.

Statistical Analysis

A P value < 0.05 was considered significant. All analyses were performed using Stata (version 14; StataCorp, College Station, TX).

RESULTS

Study Population

Of 719 KT recipients participating in our study, the mean age was 51.6 (SD=14.2, range: 18.7-86.0), 37.7% were female, 38.8% were African American, and 37.7% received live donor kidneys. The median follow-up time was 2.0 years (IQR: 0.7-3.0, max: 10.0) with 128 (17.8%) recipients having a follow-up of 5 years or more.

Pre-KT SPPB

At admission for KT, the median SPPB score was 11 (IQR: 9-12) and 336 (46.7%) KT recipients were SPPB impaired (Table 1) (Figure 1). Among unimpaired individuals, the median composite,

walk, chair, and balance scores were 12 (IQR: 11-12), 4 (IQR: 4-4), 4 (IQR: 3-4), and 4 (IQR: 4-4), respectively. Among impaired individuals, the median composite, walk, chair, and balance scores were 9 (IQR: 8-10), 4 (IQR: 3-4), 2 (IQR: 1-2), and 4 (IQR: 3-4), respectively.

Impaired recipients were significantly older (56.3 vs. 47.5 years, P<0.001), had higher BMI (28.3 vs. 26.7, P<0.001), were on dialysis for longer (3.4 vs. 2.7 years, P<0.001), were more likely to be diabetic (36.0% vs. 18.0%, P<0.001) and had different distributions of race (P=0.003) and cause of ESRD (P<0.001) (Table 1). Those with SPPB impairment were less likely to have received a 0 HLA mismatched kidney (2.1% vs. 8.6%, P<0.001) and a live donor KT (28.6% vs. 45.7%, P<0.001), and were more likely to have had >24 hours of CIT (48.2% vs. 30.3%, P<0.001), an expanded criteria donor (8.3% vs. 2.4%, P<0.001), and a donor with a creatinine >1.5 (29.8% vs. 20.4%, P=0.004).

SPPB and Mortality

SPPB impaired recipients had a significantly higher cumulative incidence of post-KT mortality compared to unimpaired recipients (P=0.001) (Figure 2). SPPB impaired recipients had a 1-year mortality of 4.1% (compared to 1.5% for unimpaired recipients) and a 5-year mortality of 20.6% (compared to 4.5%) (Table 2). When further stratified by age, the impaired group consistently had higher mortality in nearly every age stratum. For example, impaired recipients ≥65 years had a 5-year mortality of 27.1 % compared to 8.5% for unimpaired individuals ≥65 years (Table 2).

In the adjusted full model, SPPB impaired recipients experienced a 2.30-fold (95% CI: 1.12–4.74, P=0.02) greater risk of post-KT mortality (Table 3) and a C-statistic of 0.76. SPPB composite score showed an adjusted 1.19-fold (95% CI: 1.09–1.30, P<0.001) higher risk of mortality for each one-point decrease in SPPB score (worse function) and a C-statistic of 0.78 in the full model. One-point decreases in balance, walking speed, and chair stand score (worse function)

were associated with adjusted 1.50-fold (95% CI: 1.22-1.86, P<0.001), 1.21-fold (95% CI: 0.89-1.65, P=0.22), and 1.28-fold (95% CI: 1.02-1.60, P=0.04) increases in post-KT mortality risk.

Effect Heterogeneity of SPPB and Mortality

No differences in the association between SPPB impairment status and post-KT mortality were found by age (interaction P=0.81), race (interaction P=0.54), sex (interaction P=0.44), or diabetes status (interaction P=0.28). No differences in the association between SPPB composite score and post-KT mortality were found by age (interaction P=0.60), race (interaction P=0.46), sex (interaction P=0.16), or diabetes status (interaction P=0.42).

SPPB, Age, and Mortality

A total of 336 (46.7%) participants were <65 years and SPPB unimpaired, 241 (33.5%) were <65 years and impaired, 47 (6.5%) were ≥65 years and unimpaired, and 95 (13.2%) were ≥65 years and impaired. Compared to the younger-unimpaired group, the younger-impaired group had a 2.34-fold (95% CI: 1.06–5.17, P=0.04) higher risk of death, the older-unimpaired group had a 0.90-fold (95% CI: 0.16–6.80, P=0.25) lower risk, and the older-impaired group had a 2.60-fold (95% CI: 1.00–6.80, P=0.05) higher risk in the adjusted models (Table 3).

SPPB, Frailty, and Mortality

113 (15.7%) recipients were frail. 257 (35.7%) participants were SPPB impaired and not frail, 34 (4.7%) were frail and not SPPB impaired, 79 (11.0%) were both SPPB impaired and frail, and 349 (48.5%) were neither SPPB impaired nor frail (Figure 3). After additionally adjusting for frailty, SPPB impairment remained significantly associated with mortality (aHR=2.28; 95% CI: 1.08-4.84; P=0.03) in the full model while frailty became non-significant (P=0.91). The difference in

discrimination comparing the model including SPPB impairment (C-stat=0.76) to the one including frailty (C-stat=0.76) was not significant (P=0.92).

Sensitivity Analysis of SPPB and Mortality

SPPB impairment and composite score remained significantly associated with mortality in the saturated models such that impairment was associated with a 2.21-fold (95% CI: 1.04-4.70; P=0.04) increase in risk and a one-point decrease in score was associated with a 1.19-fold (95% CI: 1.08-1.31; P<0.001) increase in risk.

DISCUSSION

In this prospective, longitudinal cohort study of 719 KT recipients, pre-KT SPPB impairment was independently associated with 2.30-fold increased risk of post-KT mortality. In addition, each one-point decrease in SPPB composite score was independently associated with a 1.19-fold higher risk of post-KT mortality. Older-impaired KT recipients were at a 2.60-fold increased risk of post-KT mortality compared to younger-unimpaired recipients. However, even the younger-impaired KT recipients experienced a 2.34-fold increased risk of mortality compared to their unimpaired counterparts. Consistent with recent findings on SPPB performance and length of stay, performance on the balance portion had the single strongest association with mortality out of all the individual SPPB components (22). Finally, SPPB impairment performed similarly to frailty with regard to strength of association with (aHR 2.30 vs. 2.17) and prediction of (C-stat 0.76 vs. 0.76) mortality. However, we found that SPPB impairment remained significant when included in the same model as frailty whereas frailty became nonsignificant, potentially indicating that additional risk domains are captured by the SPPB. These findings point to the SPPB's great potential utility over frailty as an objective and potentially modifiable clinical risk stratification tool to determine KT recipients that may benefit from closer follow-up or even rehabilitation programs to improve strength and balance before or after KT. Furthermore, given

that KT among older adults has been increasing in recent years, utilizing easily-measured objective tests of functional status rather than chronologic age may be ideal in risk scores like the EPTS, especially given the strong discriminative performance of the SPPB in this analysis (23).

Our findings on the robust, independent association between SPPB-derived lower extremity function and mortality are consistent with previous reports of the association between the SPPB and dialysis risk in prevalent ESRD patients (24-31). Our study extends these findings from prevalent ESRD patients to KT recipients who are very highly selected from the dialysis population and who undergo an invasive procedure with subsequent immunosuppression. This is the first examination of the association between pre-KT SPPB performance and post-KT mortality, opening the door to the use of the SPPB as a potential risk stratification and prediction tool in KT.

This study has several important strengths, including a relatively large sample size from two different institutions, a prospective design (including pre-KT measurement), and the measurement of novel gerontology factors like frailty and the SPPB (rather than the use of proxies). While our study included enough patients to reach strong statistically significant conclusions about our questions of interest, this sample size somewhat limited the covariates that could be used in our models; to make up for this, we carefully selected these covariates based on clinical importance and strength of association with mortality. In addition, we conducted a sensitivity analysis adjusting for all transplant and donor factors that differed by SPPB impairment status. The strong associations between SPPB performance (score, impairment) and mortality remained in this saturated model. It is possible that insufficient power did not allow the detection of all interactions between SPPB and post-KT mortality. Finally, our analysis included patients from two different transplant centers with different case mixes and populations, strengthening the generalizability of our findings. However, this work has not been externally validated, providing a direction for future related work.

In conclusion, pre-KT SPPB impairment was independently associated with a 2.30-fold increased risk of post-KT mortality, supporting the use of the SPPB as high-utility objective physical assessments capable of successful post-KT mortality risk stratification. The SPPB's similar ease of measurement, predictive capability, and magnitude of association compared to frailty indicate that the SPPB is an ideal objective alternative to frailty. Given that the SPPB is a completely objective and easy-to-perform measure of a potentially modifiable factor, it provides a parsimonious and effective method for pre-KT mortality risk stratification with the potential to improve survival through interventions like closer follow-up or rehabilitation while avoiding biases inherent in subjective assessments.

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Disclosure

The authors of this manuscript have no conflicts of interest to disclose as described by the American Journal of Transplantation.

FIGURE LEGEND

Figure 1. **Distribution of Short Physical Performance Battery (SPPB) Scores at the Time of Kidney Transplantation (N = 719).** Lower extremity impairment was defined as a short physical performance battery score ≤10.

Figure 2. Cumulative Incidence of Mortality by Short Physical Performance Battery (SPPB) Impairment Status (N = 719). Lower extremity impairment was defined as a short physical performance battery score ≤10.

Figure 3. Distinction of Short Physical Performance Battery (SPPB) Impairment and Frailty Among Kidney Transplant Recipients (N = 719). Lower extremity impairment was defined as a short physical performance battery score ≤10. Frailty was defined as a Fried Frailty Phenotype score ≥3.

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Table 1. **Characteristics of Kidney Transplant Recipients (N = 719) by Short Physical Performance Battery (SPPB) Impairment Status.**

Characteristic	Unimpaired (SPPB Score > 10) N = 383	Impaired (SPPB Score ≤10) N = 336	P Value
Recipient factors			
Age, mean (SD)	47.5 (14.2)	56.3 (12.6)	< 0.001
Female	149 (38.9%)	122 (36.3%)	0.47
Race			0.003
White	228 (59.5%)	159 (47.3%)	
African American	124 (32.4%)	155 (46.1%)	
Asian	14 (3.7%)	13 (3.9%)	
Other/Multi-racial	17 (4.4%)	9 (2.7%)	
Education			0.11
None	1 (0.3%)	0 (0.0%)	
Grade school (0-8)	17 (4.4%)	22 (6.6%)	
High school (9-12) or GED	133 (34.7%)	133 (39.6%)	
College/technical school	146 (38.1%)	119 (35.4%)	
Post-college graduate degree	86 (22.5%)	62 (18.5%)	

Body mass index, mean (SD)	26.7 (5.4)	28.3 (6.2)	< 0.001
Hepatitis C virus positive	25 (6.5%)	23 (6.9%)	0.87
Preemptive transplant	80 (20.9%)	58 (17.3%)	0.22
Years on dialysis, median (IQR)	2.7 (0.1-4.0)	3.4 (0.5-5.0)	< 0.001
Previous KT	83 (21.7%)	54 (16.1%)	0.06
Cause of ESRD			< 0.001
Hypertension	106 (27.7%)	117 (34.8%)	
Diabetes	41 (10.7%)	68 (20.2%)	
Glomerulonephritis	12 (3.1%)	14 (4.2%)	
Other	224 (58.5%)	137 (40.8%)	
Diabetes	69 (18.0%)	121 (36.0%)	< 0.001
Cancer	1 (0.3%)	4 (1.2%)	0.19
Lung disease	25 (6.5%)	22 (6.6%)	0.99
Cardiovascular disease*	236 (61.6%)	200 (59.5%)	0.57
Transplant factors			
PRA, mean (SD)	16.6 (32.6)	17.4 (33.4)	0.70
ABO incompatible	63 (16.5%)	39 (11.6%)	0.06
0 HLA mismatches	33 (8.6%)	7 (2.1%)	< 0.001
CIT > 24h	116 (30.3%)	162 (48.2%)	< 0.001
Live donor KT	175 (45.7%)	96 (28.6%)	< 0.001
Donor factors			

Age, mean (SD)	37.4 (13.7)	39.2 (15.5)	0.07
Female sex	190 (49.6%)	164 (48.8%)	0.83
Race/Ethnicity			0.51
White	284 (74.2%)	235 (69.9%)	
African American	64 (16.7%)	74 (22.0%)	
Hispanic/Latino	18 (4.7%)	18 (5.4%)	
Other/Multi-racial	17 (4.4%)	9 (2.7%)	
Donation after cardiac death	38 (9.9%)	49 (14.6%)	0.06
Expanded criteria donor	9 (2.4%)	28 (8.3%)	< 0.001
History of hypertension	51 (13.3%)	66 (19.6%)	0.08
HCV positive	19 (5.0%)	18 (5.4%)	0.81
Creatinine > 1.5	78 (20.4%)	100 (29.8%)	0.004

Note: IQR, interquartile range

*Includes ischemic heart disease, cerebrovascular disease, congestive heart failure, peripheral vascular disease

Table 2: Risk of Mortality For KT Recipients by Short Physical Performance Battery (SPPB) Impairment.

	1-year (%)		3-year (%)		5-year (%)	
	Unimpaired	Impaired	Unimpaired	Impaired	Unimpaired	Impaired
Overall	1.5	4.1	4.5	14.8	4.5	20.6

Age						
18-44	0.7	0.0	0.7	14.4	0.7	14.4
45-64	2.8	4.5	6.9	9.0	6.9	16.7
>65	0.0	3.9	8.5	27.1	8.5	27.1
Race						
Non-black	0.9	2.1	3.2	11.1	3.2	13.6
Black	2.8	6.2	7.3	19.3	7.3	28.6
Sex						
Male	2.0	4.6	6.0	14.2	6.0	18.4
Female	0.8	3.1	2.3	15.8	2.3	24.3

Note: The risks (cumulative incidences) are expressed as % and estimated using a Kaplan-Meier approach. Lower extremity impairment was defined as a short physical performance battery (SPPB) score ≤10.

Table 3. The Impact of Short Physical Performance Battery (SPPB) performance on Mortality.

	Unadjusted HR (95% CI)	P Value	Adjusted HR (95% CI)	P Value
SPPB Impairment	3.57 (1.83-6.98)	< 0.001	2.30 (1.12-4.74)	0.02
One-Point Decrease in				

SPPB Composite Score	1.22 (1.13-1.32)	< 0.001	1.19 (1.09-1.30)	< 0.001
Balance Score	1.53 (1.25-1.89)	< 0.001	1.50 (1.22-1.86)	<0.001
Walking Speed Score	1.28 (0.99-1.66)	0.06	1.21 (0.89-1.65)	0.22
Chair Stand Score	1.45 (1.20-1.76)	< 0.001	1.28 (1.02-1.60)	0.04
Younger-Unimpaired	Reference	-	Reference	-
Younger-Impaired	3.38 (1.59-7.17)	0.001	2.34 (1.06-5.17)	0.04
Older-Unimpaired	1.40 (0.31-6.41)	0.66	0.90 (0.16-5.00)	0.25
Older-Impaired	4.81 (1.99-11.59)	< 0.001	2.60 (1.00-6.80)	0.05

Note: The HRs are estimated using competing risks models treating graft failure as a potential competing risk. Adjusted models included age (not in age-impairment models), sex, race, BMI, years on dialysis, cause of ESRD, donor type, cardiovascular disease, lung disease, and diabetes. Older was defined as an age ≥65 years. Lower extremity impairment was defined as a short physical performance battery (SPPB) score ≤10. HRs for the decreases in scores represent the HR for a one-point decrease in that score. For example, a one-point decrease in SPPB composite score was associated with a 1.19-fold higher adjusted hazard of mortality.

Figure 3. **Distribution of Short Physical Performance Battery (SPPB) Scores at the Time of Kidney Transplantation (N = 719).** Lower extremity impairment was defined as a short physical performance battery score ≤10.

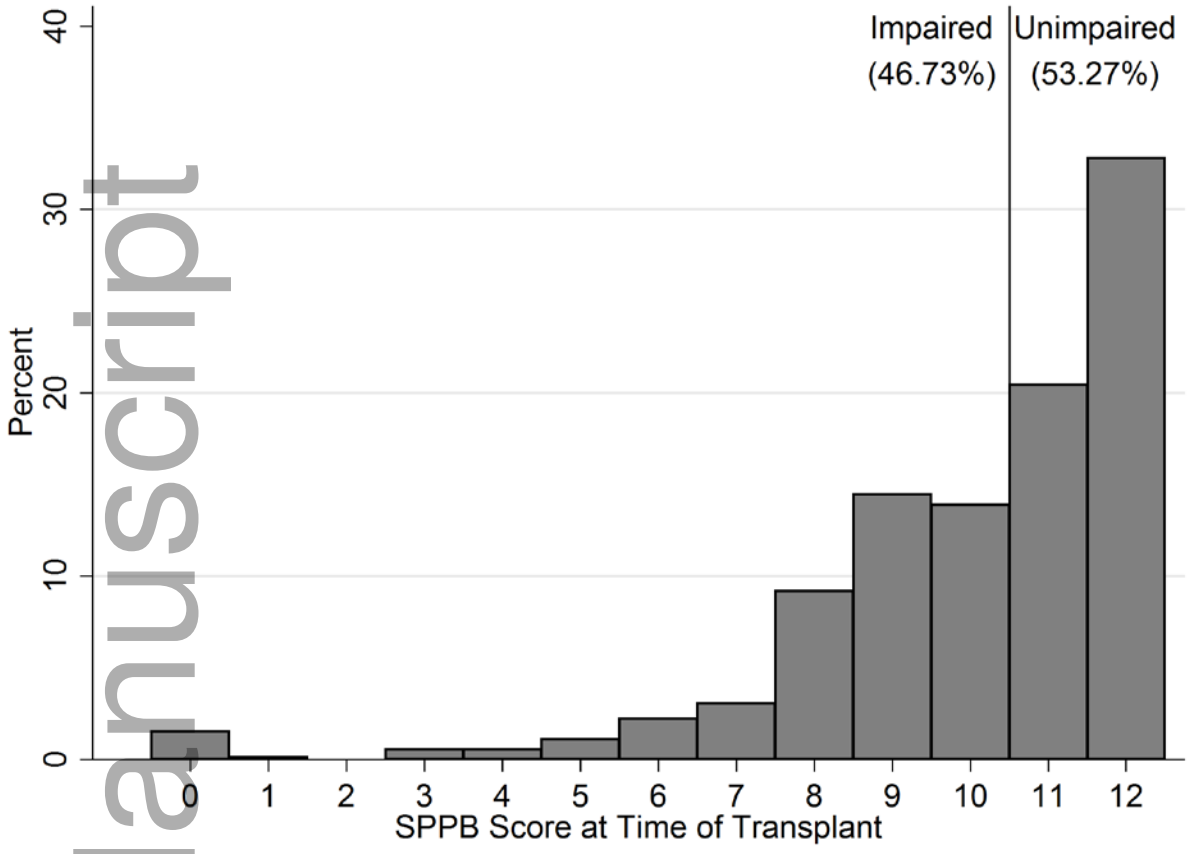

Figure 4. Cumulative Incidence of Mortality by Short Physical Performance Battery (SPPB) Impairment Status (N = 719). Lower extremity impairment was defined as a short physical performance battery score ≤10.

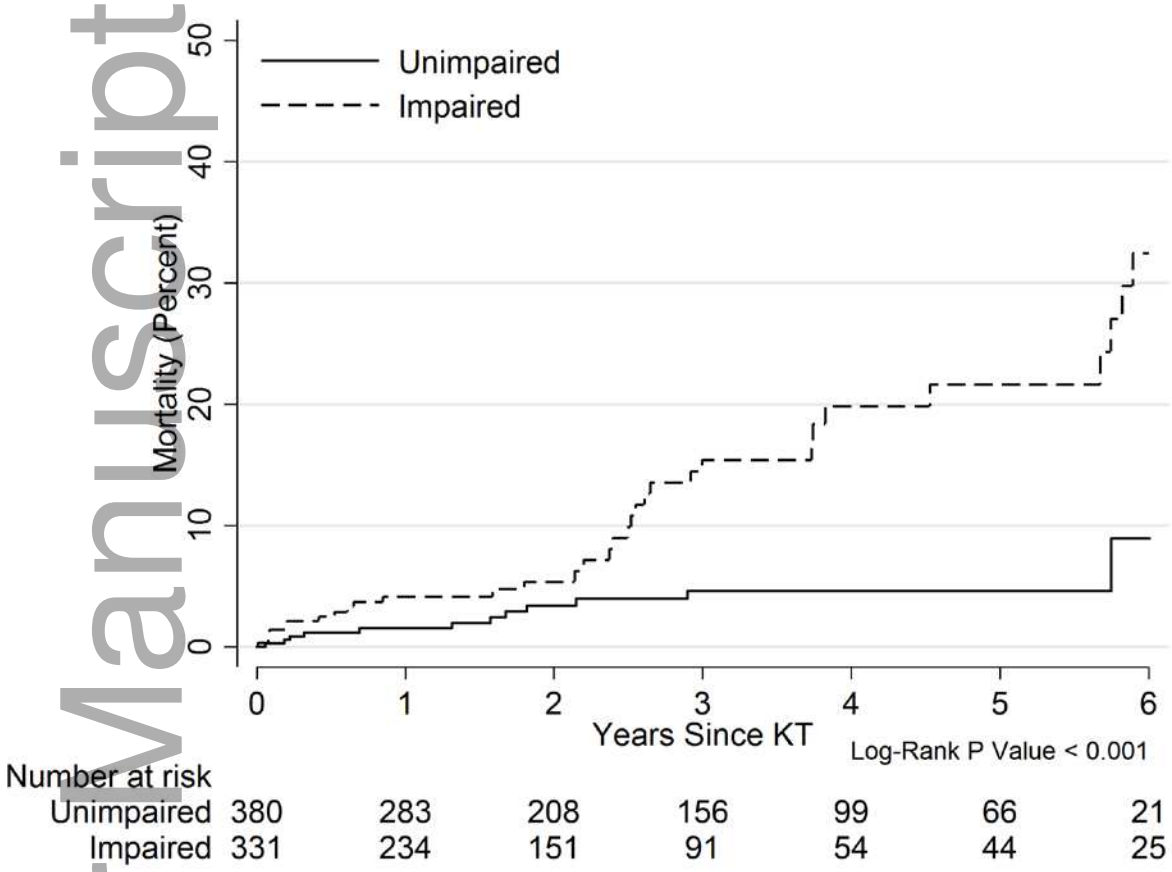

Figure 3. Distinction of Short Physical Performance Battery (SPPB) Impairment and Frailty Among Kidney Transplant Recipients (N = 719).

Lower extremity impairment was defined as a short physical performance battery score ≤10. Frailty was defined as a Fried Frailty Phenotype score ≥3.