

Supplemental Material

Appendix. Rationale for the inclusion of confounders in the multivariate model.

Supplemental Figure 1. The distribution of donor:recipient body surface area (BSA ratio).

Supplemental Figure 2. The impact of donor-recipient BSA ratio on death-censored graft failure according to donor and recipient age, complete case analysis (119,596 observations used out of 136,321).

Supplemental Table 1. The association between donor-recipient BSA ratio and death-censored graft failure, n=136,321.

Supplemental Table 2. Impact of recipient, donor and procedure characteristics on death-censored graft survival, n=136,321.

Supplemental Table 3. The impact of donor-recipient BSA ratio on death-censored graft failure, complete case analysis.

Supplemental Table 4. Estimated 5-year death-censored graft survival by donor-recipient BSA ratio (complete case analysis, n=119,596).

Supplemental Table 5. Estimated 10-year death-censored graft survival by donor-recipient BSA ratio (complete case analysis, n=119,596).

Appendix. Rationale for the inclusion of confounders in the multivariate model.

Donor and recipient age are not included as confounders as they are effect modifiers.

1. Association with exposure (donor-recipient BSA ratio) (Table 1)

Strong

Recipient sex

Recipient race African American

Recipient BSA

Most recent recipient cPRA

Donor sex

Donor hypertension

Donor diabetes

Donor stroke as cause of death

Donor terminal creatinine > 1.5 mg/dL

Moderate

Recipient time on dialysis pre-transplant

HLA mismatches

Public insurance

Donor after cardiocirculatory arrest

Donor African American race

Weak or none

Ischemic time

Transplant era

Cause of CKD

2. Association with outcome (death-censored graft survival) (Supplementary Table 2)

Recipient sex

Recipient race African American

Recipient BSA

Time on dialysis

HLA mismatch

Transplant era

Ischemic time

Insurance status

Donor sex

Donor African American race

Donor hypertension

Donor diabetes

Donor stroke as cause of death

Donor after cardiocirculatory arrest

Donor terminal creatinine > 1.5 mg/dL

3. Probable importance of confounding based on the association with both exposure and outcome

Strong

Recipient sex

Recipient race African American

Recipient BSA

Donor sex

Donor hypertension

Donor diabetes

Donor stroke as cause of death

Donor terminal creatinine > 1.5 mg/dL

Moderate

Time on dialysis

HLA mismatch

Donor African American race

Insurance status

Mild or none

Ischemic time

Transplant era

Cause of CKD

Most recent recipient cPRA

Supplemental Table 1. The association between donor-recipient BSA ratio and death-censored graft failure, n=136,321

Donor age category / donor-recipient body surface area (BSA) ratio	Multivariable Hazard Ratio* (95% confidence interval)				
	Recipients 18-30 y n=8,654	Recipients 31-40 y n=16,418	Recipients 41-50 y n=28,436	Recipients 51-60 y n=39,142	Recipients >60 y n=43,671
Donor age < 40 years	n=6,249	n= 10,390	n= 15,004	n=17,029	n=15,073
BSA ratio					
≥ 1.00 (reference)	1.00	1.00	1.00	1.00	1.00
0.90-0.99	0.93 (0.81-1.07)	1.02 (0.91-1.16)	1.09 (0.97-1.22)	1.05 (0.93-1.19)	0.98 (0.85-1.15)
0.80-0.89	0.87 (0.75-1.02)	1.11 (0.98-1.26)	1.08 (0.96-1.22)	1.00 (0.88-1.13)	1.08 (0.93-1.27)
<0.80	1.04 (0.91-1.20)	1.06 (0.93-1.20)	1.12 (1.00-1.26)	1.14 (1.00-1.29)	1.21 (1.03-1.41)
Donor age 40-49 years	n=1,535	n= 3,633	n=7,059	n=9,049	n=8,814
BSA ratio					
≥ 1.00 (reference)	1.00	1.00	1.00	1.00	1.00
0.90-0.99	1.29 (1.03-1.62)	1.13 (0.96-1.34)	0.98 (0.86-1.13)	1.06 (0.93-1.22)	0.94 (0.80-1.11)
0.80-0.89	0.91 (0.69-1.19)	1.25 (1.05-1.50)	1.03 (0.89-1.19)	1.12 (0.98-1.29)	1.13 (0.96-1.33)
<0.80	1.15 (0.84-1.57)	1.08 (0.88-1.33)	1.32 (1.11-1.56)	1.28 (1.09-1.50)	1.25 (1.02-1.53)
Donor age 50-59 years	n=779	n= 2,108	n=5,283	n=9,503	n=11,788
BSA ratio					
≥ 1.00 (reference)	1.00	1.00	1.00	1.00	1.00
0.90-0.99	1.20 (0.90 -1.61)	1.02 (0.83-1.25)	1.17 (1.02-1.35)	0.99 (0.87-1.11)	1.04 (0.92-1.17)
0.80-0.89	1.18 (0.86-1.62)	0.92 (0.74-1.14)	1.06 (0.91-1.23)	1.09 (0.96-1.24)	1.10 (0.96-1.25)
<0.80	1.80 (1.25-2.57)	1.20 (0.95-1.51)	1.09 (0.91-1.31)	1.07 (0.91-1.25)	1.31 (1.12-1.53)
Donor age ≥ 60 years	n=91	n=287	n=1,090	n=3,561	n=7,996
BSA ratio					
≥ 1.00 (reference)	1.00	1.00	1.00	1.00	1.00
0.90-0.99	1.15 (0.53-2.49)	1.20 (0.74-1.94)	1.00 (0.78-1.29)	1.21 (1.03-1.42)	1.05 (0.93-1.19)
0.80-0.89	1.35 (0.66-2.77)	1.12 (0.70-1.78)	0.76 (0.56-1.04)	1.18 (0.99-1.40)	1.13 (0.99-1.30)
<0.80	1.24 (0.48-3.18)	1.52 (0.85-2.72)	0.97 (0.70-1.36)	1.32 (1.08-1.61)	1.45 (1.22-1.72)

*The model is adjusted for recipient sex, race, body surface area, time on dialysis prior to transplantation, most recent panel reactive antibodies, insurance status, cause of chronic kidney disease and donor sex, race, hypertension, diabetes, terminal serum creatinine, cause of death (stroke versus other), donation after circulatory death, donor HCV serology status, cold ischemic time, donor-recipient HLA mismatch, and transplant era. Values in bold are statistically significant (p-value<0.05).

Supplemental Table 2. Impact of recipient, donor and procedure characteristics on death-censored graft survival, n=136,321

Recipient/ Donor/ Procedure characteristics	Univariable Hazard Ratio (95 % confidence interval)	Multivariable Hazard Ratio (95% confidence interval)
Donor-recipient body surface area ratio ≥ 1.00 (reference) 0.90-0.99 0.80-0.89 <0.80	1.00 1.08 (1.05-1.12) 1.15 (1.11-1.19) 1.23 (1.18-1.27)	cf Supplementary Table 1
Mean recipient age at transplant 18-30 (reference) 31-40 41-50 51-60 >60 years	1.00 0.76 (0.73-0.80) 0.62 (0.59-0.65) 0.56 (0.53-0.58) 0.54 (0.51-0.56)	cf Supplementary Table 1
Recipient male sex (versus female)	1.06 (1.04-1.09)	0.95 (0.93-0.98)
Recipient African American race (versus Caucasian)	1.74 (1.69-1.78)	1.46 (1.42-1.51)
Recipient body surface area (per 0.1 unit increase)	1.04 (1.04-1.04)	1.04 (1.03-1.05)
Cause of CKD Other or unknown (reference) Glomerular diseases Diabetes	1.00 1.00 (0.97-1.03) 1.01 (0.98-1.04)	1.00 0.99 (0.96-1.03) 1.10 (1.06-1.13)
Time on dialysis pre-transplant (per 1-month increase)	1.003 (1.002-1.003)	1.002 (1.002-1.002)
Pre-transplant PRA > 0% (versus 0%)	1.01 (0.98-1.04)	1.10 (1.07-1.14)
HLA mismatches (per 1 mismatch increase)	1.10 (1.09-1.11)	1.05 (1.04- 1.06)
Transplant date 2000-2005 (reference) 2006-2011 2012-2015	1.00 0.77 (0.75-0.79) 0.52 (0.50-0.54)	1.00 0.70 (0.68-0.72) 0.47 (0.45-0.49)
Cold ischemic time (per 1-hour increase)	1.01 (1.008-1.011)	1.01 (1.01-1.01)
Insurance Public (reference) Private Other	1.00 0.79 (0.76-0.81) 0.44 (0.27-0.71)	1.00 0.87 (0.85-0.90) 0.46 (0.28-0.75)
Donor age < 40 years (reference) 40-49 50-59 ≥ 60 years	1.00 1.34 (1.30-1.39) 1.61 (1.55-1.66) 2.01 (1.93-2.09)	cf Supplementary Table 1
Male donor sex (versus female)	0.86 (0.84-0.89)	0.95 (0.92-0.98)
Donor African American race (versus Caucasian)	1.36 (1.32-1.41)	1.21 (1.17-1.26)
Stroke as cause of donor death	1.47 (1.44-1.51)	1.13 (1.09-1.16)
Donor after cardiocirculatory arrest	0.91 (0.88-0.95)	1.14 (1.09-1.19)
Donor terminal serum creatinine > 1.5 mg/dL	1.06 (1.03-1.10)	1.14 (1.10- 1.18)
Donor hypertension	1.52 (1.47-1.56)	1.21 (1.17-1.25)
Donor diabetes	1.60 (1.53-1.67)	1.41 (1.34-1.47)
Donor positive HCV serology	1.71 (1.60-1.83)	1.69 (1.57-1.81)

Supplemental Table 3. The impact of donor-recipient BSA ratio on death-censored graft failure, complete case analysis

Donor age category / donor-recipient body surface area (BSA) ratio	Multivariable Hazard Ratio* (95% confidence interval)				
	Recipients 18-30 y n=7,585	Recipients 31-40 y n=14,424	Recipients 41-50 y n=24,892	Recipients 51-60 y n=34,339	Recipients >60 y n=38,356
Donor age < 40 years	n= 5,521	n=9,624	n=13,325	n=15,014	n= 13,357
BSA ratio					
≥ 1.00 (reference)	1.00	1.00	1.00	1.00	1.00
0.90-0.99	0.90 (0.77-1.04)	1.00 (0.88-1.14)	1.10 (0.98-1.24)	1.06 (0.93-1.21)	1.00 (0.85-1.18)
0.80-0.89	0.86 (0.72-1.01)	1.08 (0.94-1.24)	1.10 (0.97-1.25)	0.99 (0.86-1.13)	1.12 (0.95-1.33)
<0.80	1.00 (0.86-1.16)	1.03 (0.90-1.18)	1.15 (1.02-1.30)	1.13 (0.99-1.29)	1.26 (1.06-1.49)
Donor age 40-49 years	n=1,325	n=3,114	n=6,105	n=7,913	n=7,722
BSA ratio					
≥ 1.00 (reference)	1.00	1.00	1.00	1.00	1.00
0.90-0.99	1.13 (0.88-1.46)	1.15 (0.96-1.37)	0.95 (0.81-1.10)	1.10 (0.95-1.27)	0.96 (0.79-1.11)
0.80-0.89	0.85 (0.63-1.15)	1.20 (0.99-1.46)	1.02 (0.87-1.20)	1.11 (0.95-1.30)	1.20 (1.01-1.43)
<0.80	1.15 (0.84-1.53)	1.10 (0.88-1.36)	1.26 (1.05-1.50)	1.33 (1.12-1.58)	1.24 (0.99-1.53)
Donor age 50-59 years	n=665	n=1,807	n=4,535	n=8,339	n=10,339
BSA ratio					
≥ 1.00 (reference)	1.00	1.00	1.00	1.00	1.00
0.90-0.99	1.30 (0.95-1.78)	1.06 (0.85-1.33)	1.15 (0.99-1.35)	1.02 (0.89-1.16)	1.10 (0.96-1.25)
0.80-0.89	1.10 (0.78-1.54)	0.88 (0.69-1.11)	1.02 (0.86-1.21)	1.18 (1.03-1.36)	1.14 (0.99-1.32)
<0.80	1.68 (1.14-2.48)	1.08 (0.84-1.39)	1.10 (0.91-1.33)	1.12 (0.95-1.32)	1.30 (1.09-1.54)
Donor age ≥ 60 years	n=74	n=239	n=927	n=3,073	n=6,938
BSA ratio					
≥ 1.00 (reference)	1.00	1.00	1.00	1.00	1.00
0.90-0.99	1.05 (0.49-2.25)	1.20 (0.72-2.01)	0.85 (0.64-1.14)	1.15 (0.96-1.37)	1.03 (0.90-1.18)
0.80-0.89	1.01 (0.45-2.24)	1.12 (0.68-1.84)	0.77 (0.55-1.08)	1.17 (0.97-1.41)	1.14 (0.98-1.32)
<0.80	0.54 (0.19-1.55)	1.05 (0.56-1.96)	0.98 (0.69-1.39)	1.30 (1.05-1.61)	1.48 (1.24-1.78)

*The model is adjusted for recipient sex, race, body surface area, insurance status, most recent recipient cPRA, time on dialysis, cold ischemic time, cause of chronic kidney disease, and donor sex, race, hypertension, diabetes, terminal serum creatinine, cause of death (stroke versus other), donation after circulatory death, donor HCV serology status, donor-recipient HLA mismatch, and transplant era. Values in bold are statistically significant (p-value <0.05). There were 119,596 observations used out of 136,321 for the complete case analysis.

Supplemental Table 4. Estimated 5-year death-censored graft survival by donor-recipient BSA ratio (complete case analysis, n=119,596)

	Estimated % probability for 5-year graft survival from multivariable model* (95% confidence interval)				
Donor age category / donor-recipient body surface area (BSA) ratio	Recipients 18-30 y n=7,585	Recipients 31-40 y n=14,424	Recipients 41-50 y n=24,892	Recipients 51-60 y n=34,339	Recipients >60 y n=38,356
Donor age < 40 years	n=5,521	n=9,264	n=13,325	n=15,014	n=13,357
BSA ratio					
≥ 1.00 (reference)	84% (83-85)	90% (89-91)	93% (92-93)	94% (93-94)	95% (94-95)
0.90-0.99	85% (84-87)	90% (89-91)	92% (91-93)	94% (93-94)	95% (94-96)
0.80-0.89	86% (84-88)	89% (88-90)	92% (91-93)	94% (93-95)	94% (94-95)
<0.80	84% (82-86)	90% (89-91)	91% (91-92)	93% (92-94)	94% (93-95)
Donor age 40-49 years	n= 1,325	n=3,114	n=6,105	n=7,913	n=7,722
BSA ratio					
≥ 1.00 (reference)	85% (83-87)	89% (87-90)	91% (90-92)	93% (92-93)	92% (92-93)
0.90-0.99	83% (80-87)	87% (85-89)	92% (91-93)	92% (91-93)	93% (92-94)
0.80-0.89	87% (84-91)	86% (84-89)	91% (90-92)	92% (91-93)	91% (90-92)
<0.80	83% (79-88)	88% (85-90)	89% (87-91)	90% (89-92)	91% (89-92)
Donor age 50-59 years	n=665	n=1,807	n=4,535	n=8,339	n=10,339
BSA ratio					
≥ 1.00 (reference)	82% (79-85)	86% (85-88)	90% (89-91)	90% (90-91)	91% (90-92)
0.90-0.99	78% (72-83)	86% (83-88)	88% (86-90)	90% (89-91)	90% (89-91)
0.80-0.89	81% (76-86)	88% (86-90)	89% (88-91)	89% (88-90)	90% (89-91)
<0.80	72% (64-81)	85% (82-89)	89% (87-90)	89% (88-91)	89% (87-90)
Donor age ≥ 60 years	n=74	n=239	n=927	n=3,073	n=6,938
BSA ratio					
≥ 1.00 (reference)	71% (62-81)	82% (78-87)	85% (83-88)	88% (87-89)	88% (87-89)
0.90-0.99	70% (55-88)	79% (71-88)	87% (84-90)	87% (85-88)	88% (87-89)
0.80-0.89	71% (56-90)	80% (73-88)	88% (85-92)	86% (84-88)	87% (85-89)
<0.80	83% (70-100)	82% (73-92)	85% (81-90)	85% (82-87)	83% (81-86)

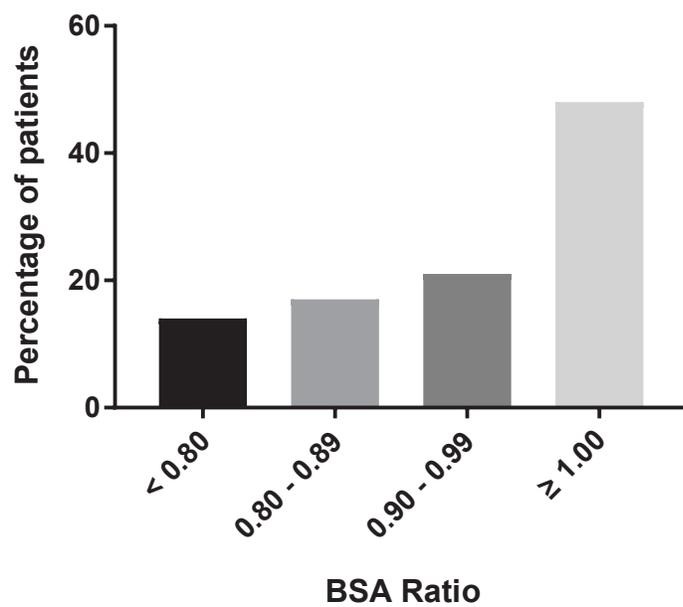
* The model calculates probability for a Caucasian male recipient of a Caucasian male donor, with a pre-transplant cPRA of 0%, median HLA mismatch, median cold ischemic time, median time on dialysis, median recipient body surface area, public insurance coverage in the 2012-2018 era.

Supplemental Table 5. Estimated 10-year death-censored graft survival by donor-recipient BSA ratio (complete case analysis, n=119,596)

	Estimated % probability for 10-year graft survival from multivariable model* (95% confidence interval)				
Donor age category / donor-recipient body surface area (BSA) ratio	Recipients 18-30 y n=7,585	Recipients 31-40 y n=14,424	Recipients 41-50 y n=24,892	Recipients 51-60 y n=34,339	Recipients >60 y n=38,356
Donor age < 40 years	n=5,521	n=9,264	n=13,325	n=15,014	n=13,357
BSA ratio					
≥ 1.00 (reference)	70% (68-72)	81% (79-82)	86% (85-87)	88% (87-89)	90% (89-91)
0.90-0.99	73% (70-76)	81% (79-83)	84% (83-86)	87% (86-89)	90% (89-91)
0.80-0.89	74% (70-77)	80% (77-82)	84% (83-86)	88% (87-90)	89% (87-90)
<0.80	70% (67-73)	80% (78-82)	84% (82-85)	87% (85-88)	88% (86-89)
Donor age 40-49 years	n=1,325	n=3,114	n=6,105	n=7,913	n=7,722
BSA ratio					
≥ 1.00 (reference)	72% (69-76)	78% (76-80)	83% (82-85)	86% (84-87)	85% (84-87)
0.90-0.99	69% (64-75)	76% (72-79)	84% (82-86)	84% (82-86)	86% (84-88)
0.80-0.89	76% (71-82)	74% (71-78)	83% (81-85)	84% (82-86)	82% (80-85)
<0.80	69% (62-77)	77% (73-81)	79% (76-82)	81% (79-84)	82% (79-85)
Donor age 50-59 years	n=665	n=1,807	n=4,535	n=8,339	n=10,339
BSA ratio					
≥ 1.00 (reference)	67% (63-72)	75% (72-77)	80% (78-82)	82% (80-83)	83% (82-84)
0.90-0.99	60% (52-69)	73% (69-78)	77% (75-80)	81% (80-83)	81% (80-83)
0.80-0.89	65% (57-74)	77% (73-82)	80% (77-82)	79% (77-81)	81% (79-83)
<0.80	51% (41-65)	73% (68-78)	78% (75-82)	80% (77-83)	78% (75-82)
Donor age ≥ 60 years	n=74	n=239	n=927	n=3,073	n=6,938
BSA ratio					
≥ 1.00 (reference)	51% (39-66)	67% (61-75)	72% (68-77)	78% (75-80)	78% (76-80)
0.90-0.99	49% (30-78)	62% (51-77)	76% (71-81)	75% (72-78)	77% (75-80)
0.80-0.89	50% (31-81)	64% (54-78)	78% (72-84)	74% (71-78)	75% (73-78)
<0.80	69% (48-99)	66% (52-84)	73% (66-80)	72% (68-76)	69% (65-74)

*The model calculates probability for a Caucasian male recipient of a Caucasian male donor, with median HLA mismatch, median cold ischemic time, median time on dialysis, median recipient body surface area, public insurance coverage in the 2012-2018 era.

Supplemental Figure 1. The distribution of donor:recipient body surface area (BSA ratio)



Supplemental Figure 2. The impact of donor-recipient BSA ratio on death-censored graft failure according to donor and recipient age, complete case analysis (119,596 observations used out of 136,321)

