

# Donor Health After Kidney Donation



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# Outline

- ▶ Immediate risk
- ▶ Long-term risk:
  - ▶ Mortality and cardiovascular disease
  - ▶ End-stage renal disease
  - ▶ Hypertension
  - ▶ Maternal and fetal outcomes
  - ▶ Gout
  - ▶ Metabolic diseases
  - ▶ Malignancy
  - ▶ Risk among older donors
  - ▶ Psychosocial outcomes
- ▶ FOLLOW-UP AFTER KIDNEY DONATION

**Long-term risk**

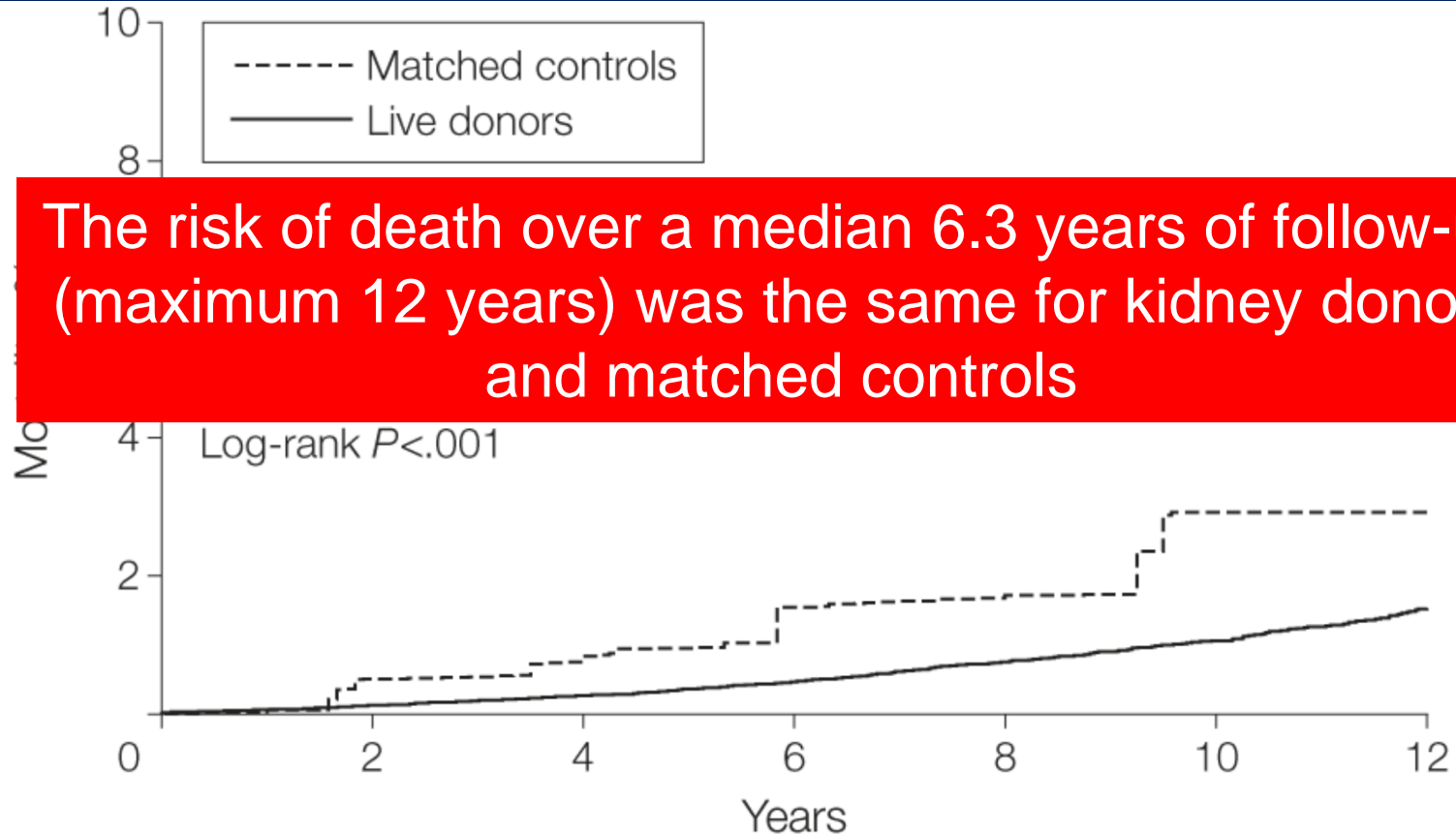




# Mortality and cardiovascular disease

## Perioperative Mortality and Long-term Survival Following Live Kidney Donation

More than 80,000 living kidney donors



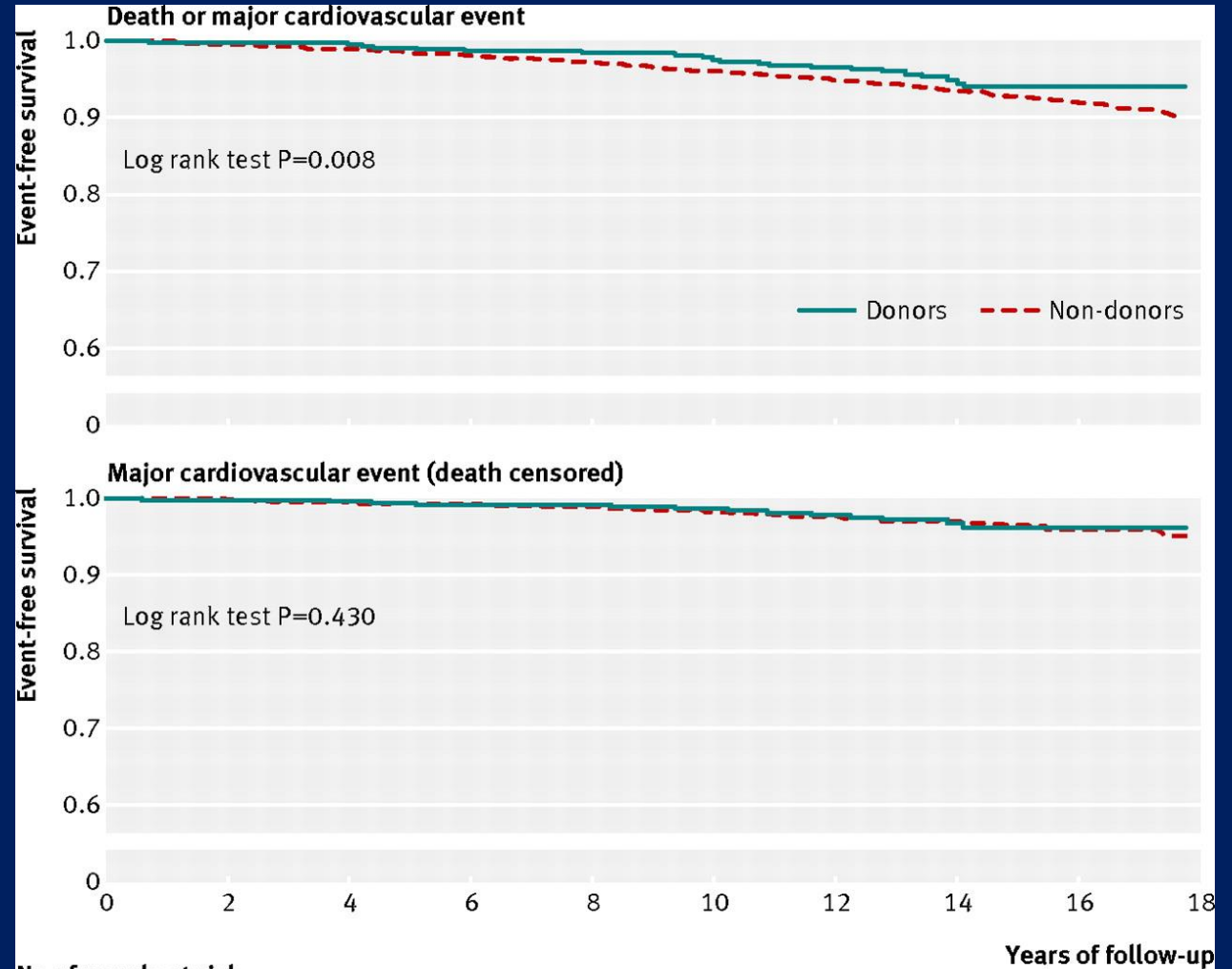
No. at risk							
Matched controls	80 347	67 966	54 998	41 679	19 259	5 896	127
Live donors	80 347	68 230	55 282	42 154	29 657	18 960	10 436

Fig 1 Kaplan-Meier estimates of survival probability without death or major cardiovascular event (top) and without major cardiovascular event (censored for death, bottom).

The risk of death or major cardiovascular events

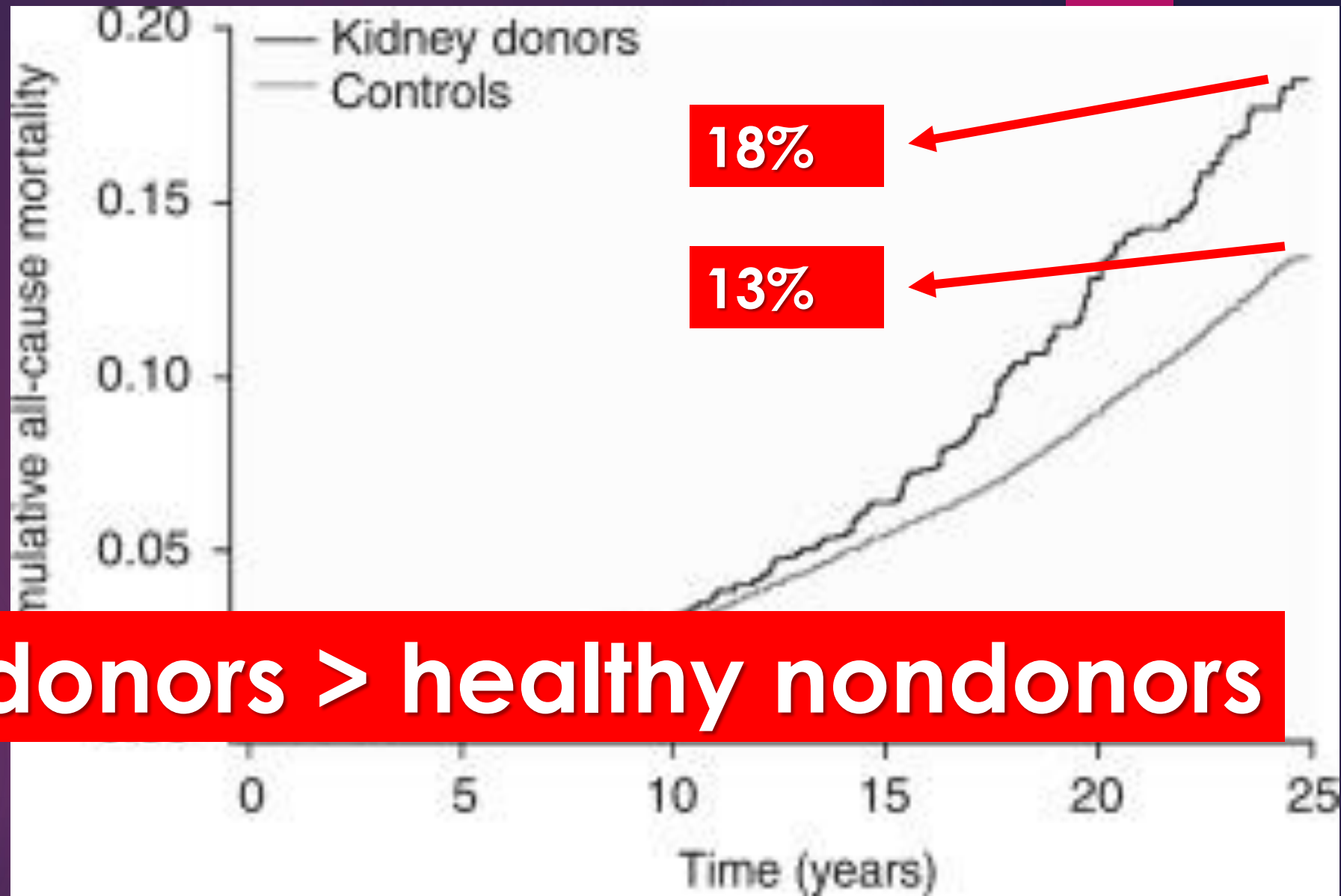


donors < healthy nondonors



	0	2	4	6	8	10	12	14	16	18
<b>No of people at risk</b>										
Non-donors	20 280	18 149	14 146	10 825	8181	5744	3636	1948	664	0
Donors	2028	1832	1455	1124	857	609	386	209	72	0

Cumulative mortality risk in kidney donors and controls

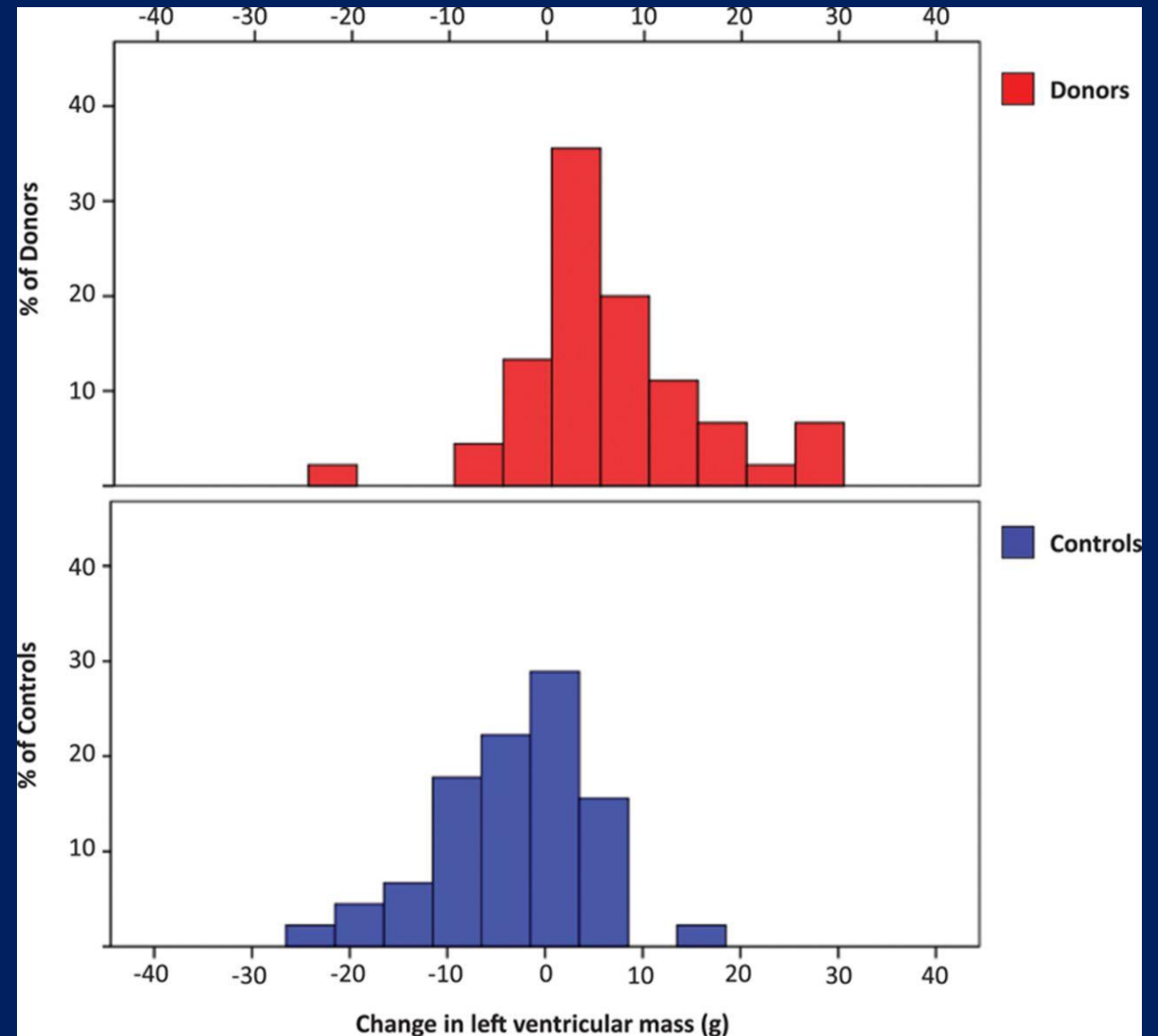


**Mortality: donors > healthy nondonors**

1901 kidney donors  
32,621 healthy, matched controls in Norway

# Cardiovascular Effects of Unilateral Nephrectomy in Living Kidney Donors.

**There was a significant increase in left ventricular mass in donors vs controls at 12 months.**

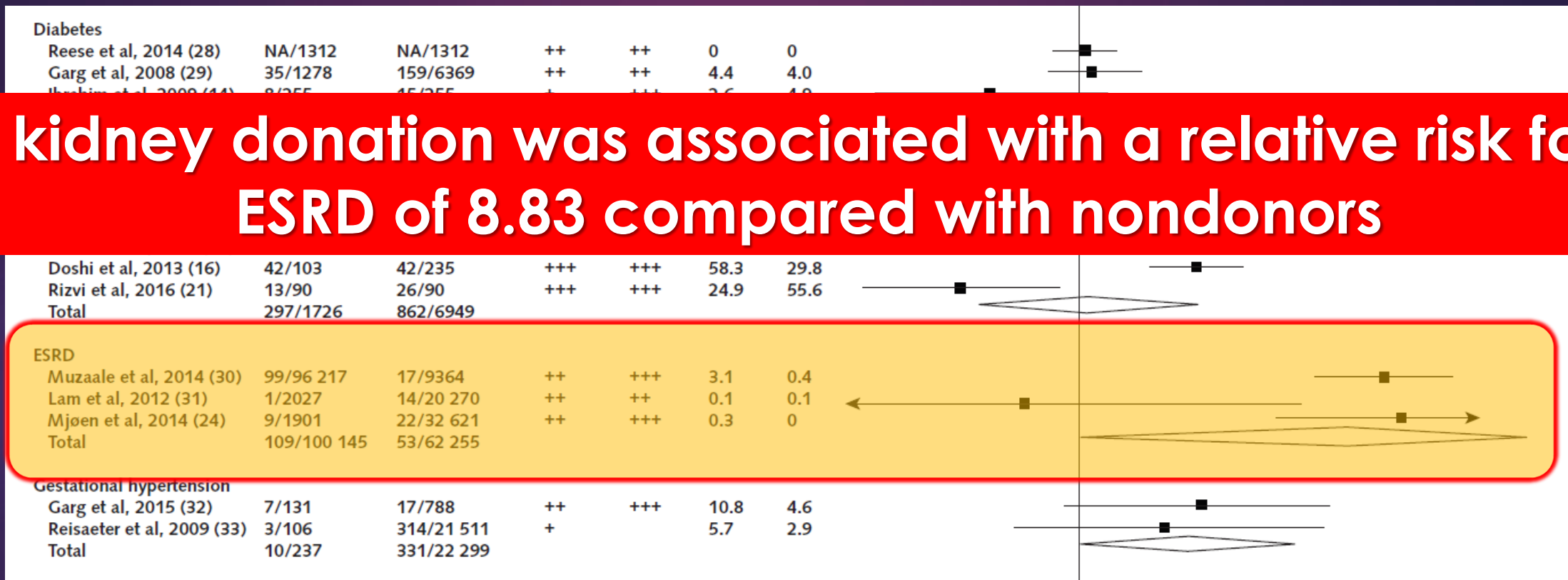




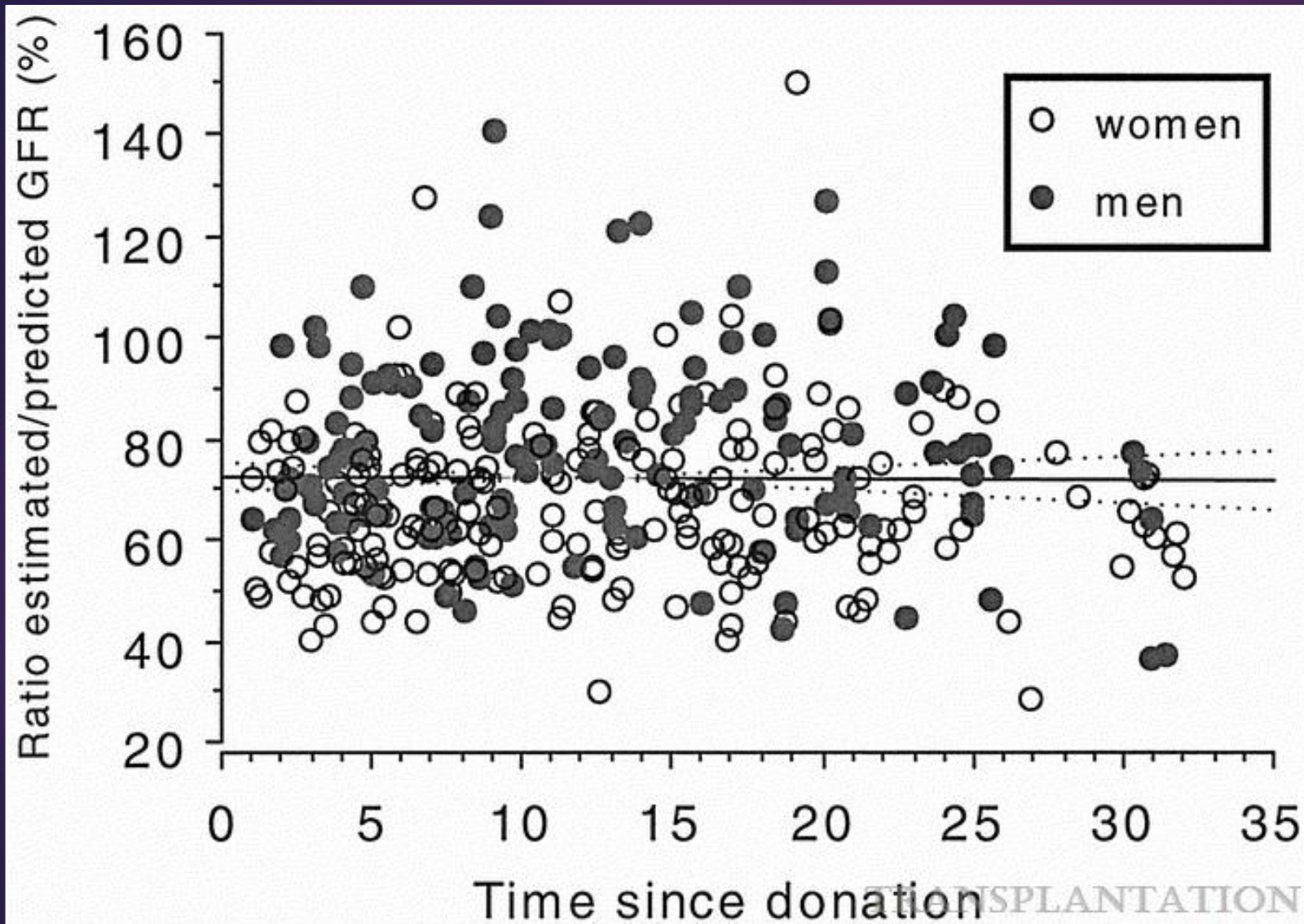
# End-stage renal disease



# Mid- and Long-Term Health Risks in Living Kidney Donors: A Systematic Review and Meta-analysis.



**kidney donation was associated with a relative risk for ESRD of 8.83 compared with nondonors**



Ratio (%) of estimated to predicted glomerular filtration rate (GFR), according to age and gender in relation to time elapsed since kidney donation.

$$\frac{eGFR}{\text{predicted GFR}} = 75-85\%$$

Transplantation 72(3):444-449, August 15th, 2001.



# Hypertension

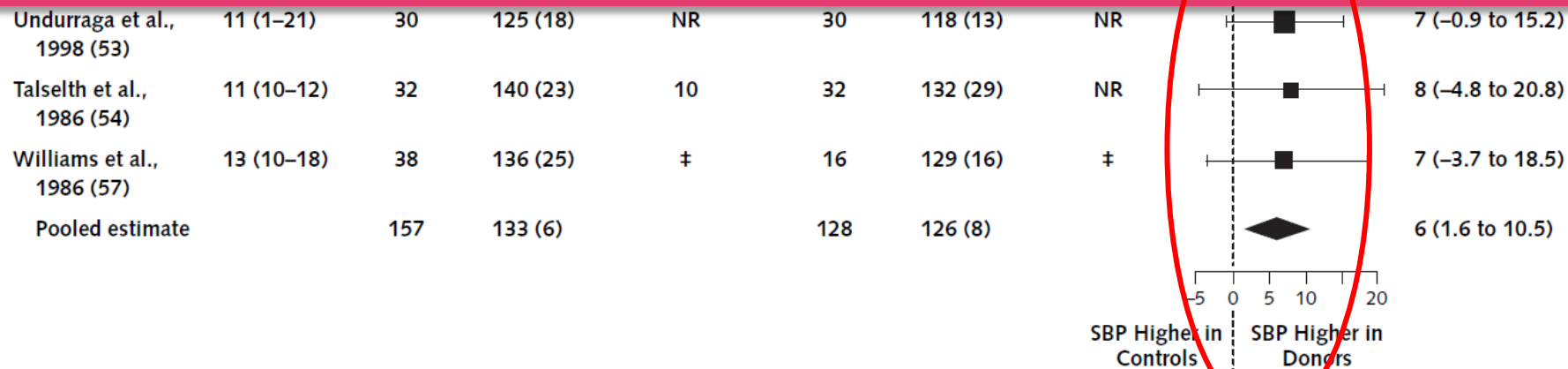


# Meta-analysis: risk for hypertension in living kidney donors

Figure 1. Meta-analysis of controlled studies of systolic blood pressure (SBP) and diastolic blood pressure (DBP) at least 5 years after kidney donation.

Study, Year (Reference)	Donors, after Donation		Control Participants		Mean Difference in SBP (95% CI), mm Hg
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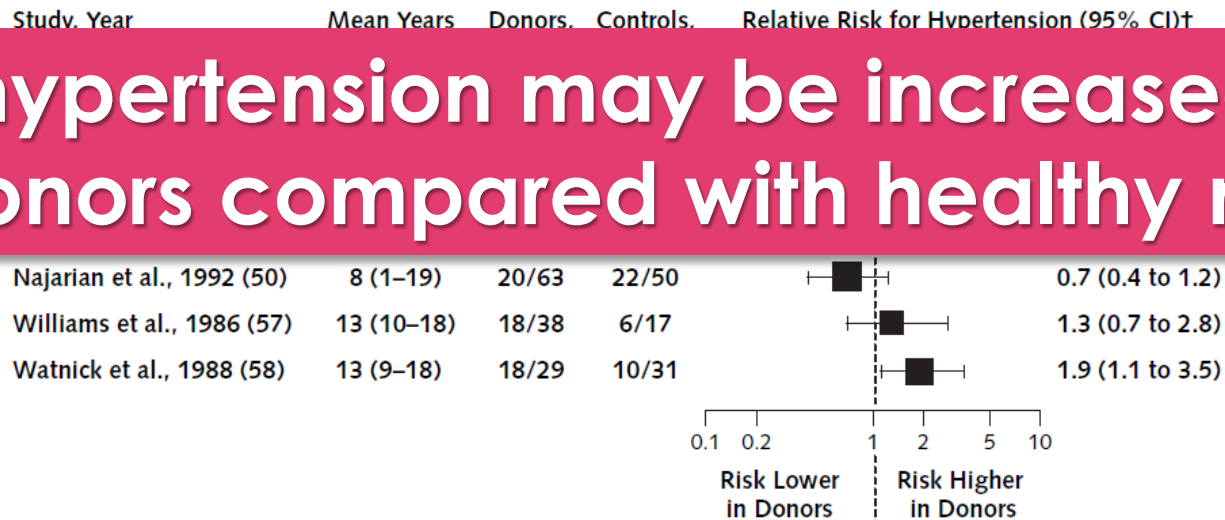
**SBP and DBP were 6 and 4 mmHg higher in kidney donors**



# Meta-analysis: risk for hypertension in living kidney donors.

Figure 2. Controlled studies of hypertension risk after kidney donation.

**Risk of hypertension may be increased among kidney donors compared with healthy nondonors.**



Results were not mathematically pooled because of statistical heterogeneity between studies (chi-square, 10.1;  $P = 0.074$ ;  $I^2 = 50\%$ ). The size of each square is inversely proportional to the variability of the study estimate. \*Studies are arranged by the average number of years after donation. †Definitions of hypertension and a summary of various methods to assess blood pressure are presented in the Results section.

**Cardiovascular disease and hypertension risk in living kidney donors: an analysis of health administrative data**

**Higher incidence of hypertension diagnoses among living donors compared with healthy controls**

**TABLE 2.** Death or major cardiovascular events and hypertension among donors and controls

	Donors (n = 1,278)	Controls (n = 6,369)
Death or major cardiovascular events		
No. of events (%)	16 (1.3)	107 (1.7)
Mean (SD) years of follow-up (%)	6.2 (3.2)	6.2 (3.2)
Total follow-up (person years)	7920	39393
No. events per 1000	2.0	2.7
		1.0 (reference)
		56 (0.9)
		27 (0.4)
		9 (0.1)
		≤5 (≤0.1)
aneurysm repair or aortic bypass (%)		
Coronary artery angioplasty or bypass graft surgery (%)	≤5 (≤0.4)	30 (0.5)
Diagnosis of hypertension		
Number of events (%)	205 (16.3)	746 (11.9)
Number of events per 1000 person years	29.1	20.6
Model based risk ratios (95% CI)	1.4 (1.2–1.7)	1.0 (reference)

<sup>a</sup> Between 1 and 5 individuals developed some events, with exact numbers not reported for reasons of privacy.

*Cardiovascular disease and hypertension risk in living kidney donors: an analysis of health administrative data in Ontario, Canada.*  
*Transplantation* 86(3): 399-406.

# Maternal and fetal outcomes



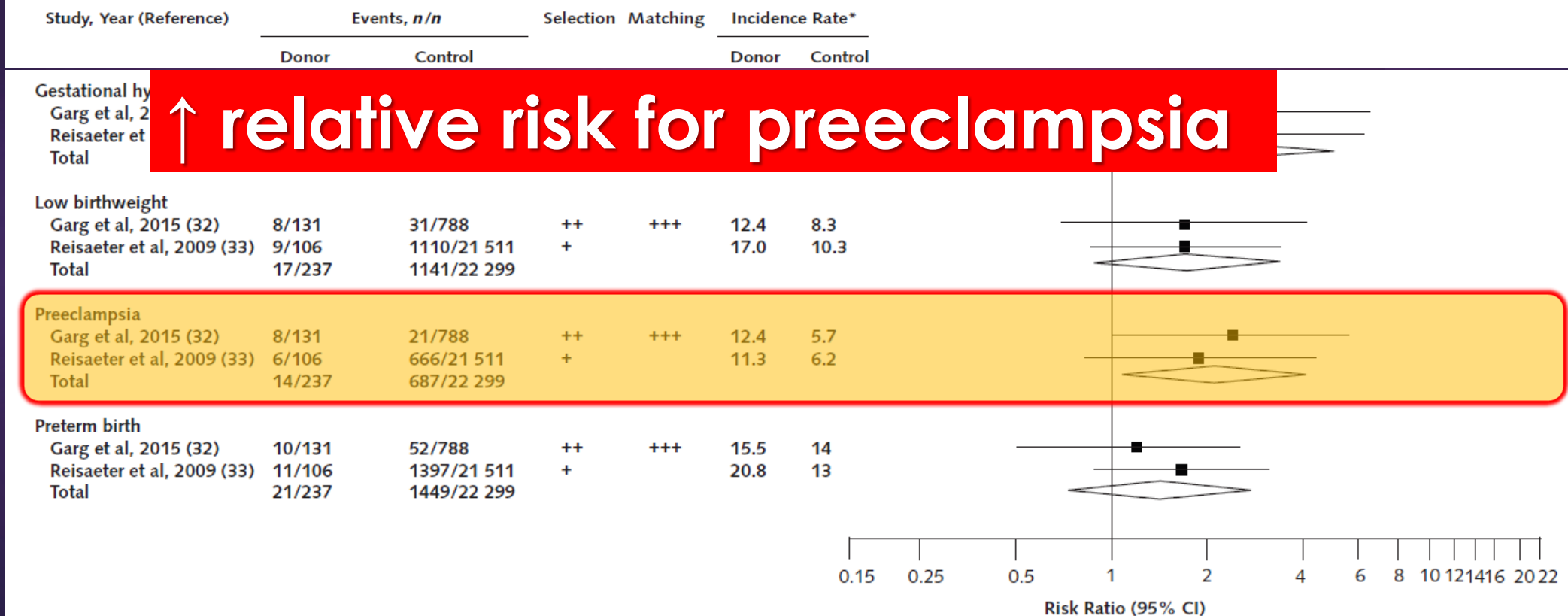


# Maternal and fetal outcomes

- ▶ Living kidney donation appears to increase the risk of gestational hypertension and preeclampsia compared with experience among otherwise similar healthy women.
- ▶ We generally advise women that it is ideal to have completed planned childbearing prior to kidney donation.
- ▶ Consistent with recommendations of a 2015 AST consensus statement and KDIGO clinical practice guidelines, OPTN policy requires informing female donor candidates that risks of preeclampsia or gestational hypertension are increased in pregnancies after donation.

# Mid- and Long-Term Health Risks in Living Kidney Donors: A Systematic Review and Meta-analysis.

**Figure 3.** Meta-analysis of relative risks for selected clinical end points in living kidney donors compared with nondonor control participants.

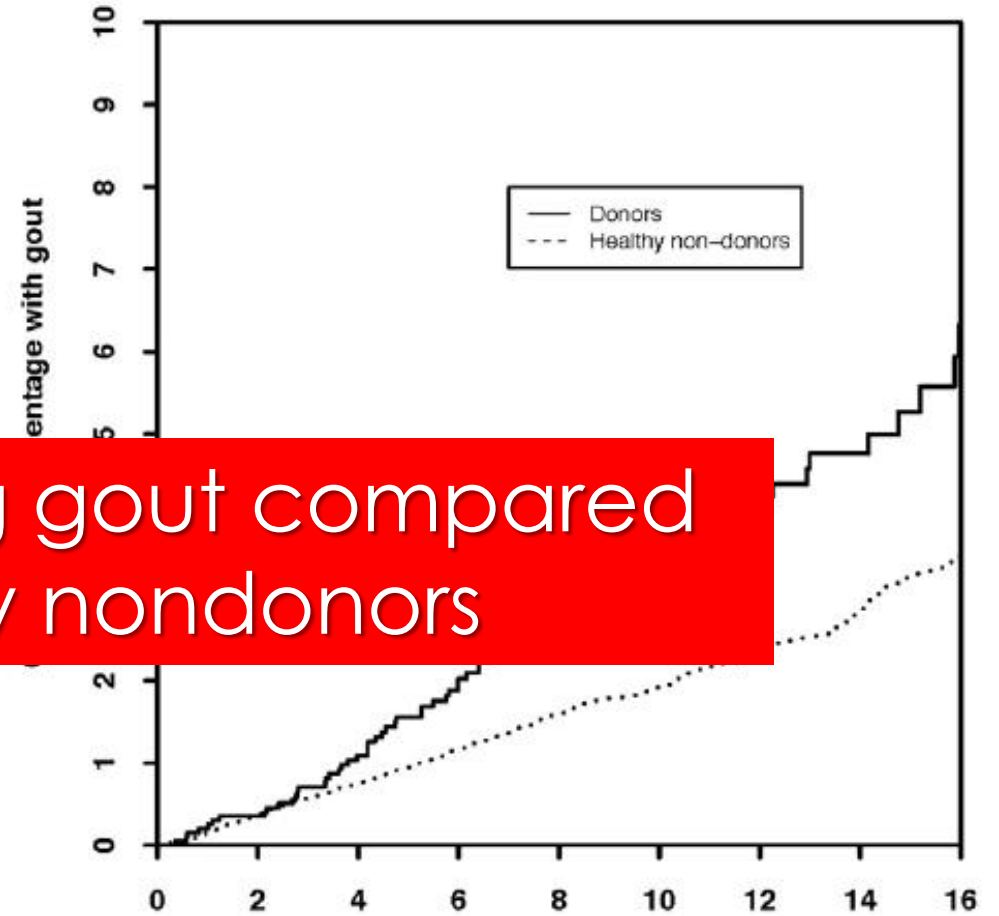


# Gout



# Gout after living kidney donation

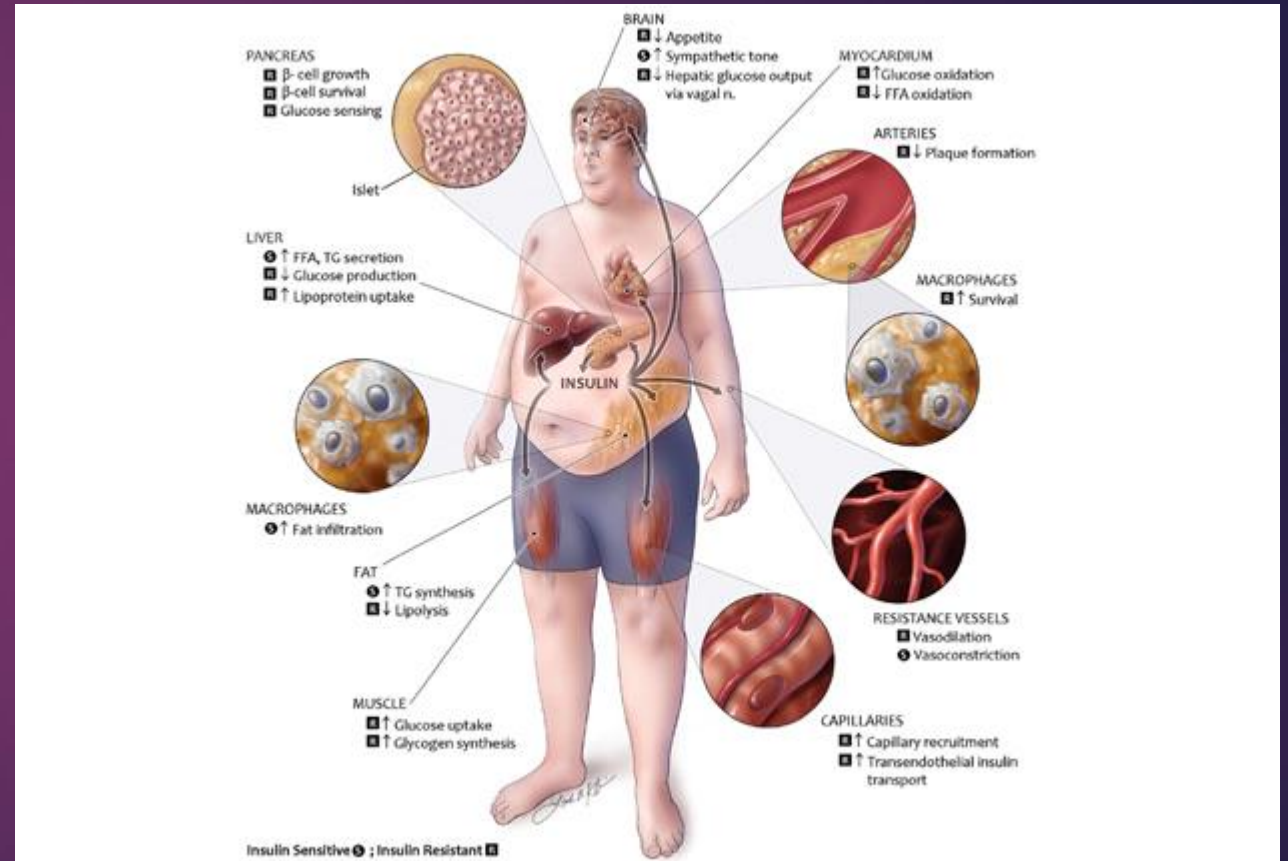
Higher risk for developing gout compared with equally healthy nondonors



		Years of follow-up								
No. of persons at risk		0	2	4	6	8	10	12	14	16
Donors	1988	1974	1759	1408	1091	844	631	422	248	
Healthy non-donors	19880	19619	17209	13670	10525	8145	6039	4118	2432	

Lam, N. N., et al. (2015). "Gout after living kidney donation: a matched cohort study." *Am J Kidney Dis* 65(6): 925-932.

# Metabolic diseases





# A prospective controlled study of kidney donors: baseline and 6-month follow-up.

Table 7. Laboratory Values

Variable	Baseline Visit		6-mo Visit		<i>p</i> <sup>a</sup>		
	Controls	Donors	Controls	Donors	Controls vs Donors <sup>b</sup>	Baseline vs 6 mo <sup>c</sup>	Interaction <sup>d</sup>
mGFR (mL/min)	106.5 ± 19.3 (n = 186)	106.7 ± 18.6 (n = 181)	104.9 ± 20.2 (n = 194)	74.3 ± 12.9 (n = 193)	0.8	<0.001	<0.001
mGFR (mL/min/1.73 m <sup>2</sup> )	96.9 ± 15.3 (n = 186)	96.9 ± 15.3 (n = 181)	94.6 ± 15.1 (n = 194)	67.6 ± 10.1 (n = 193)	0.5	<0.001	<0.001
SCr (mg/dL)	0.79 ± 0.15 (n = 200)	0.80 ± 0.15 (n = 199)	0.80 ± 0.17 (n = 198)	1.16 ± 0.22 (n = 199)	0.8	<0.001	<0.001
eGFR <sub>cr</sub> (mL/min/1.73 m <sup>2</sup> )	100.1 ± 16.0 (n = 200)	99.2 ± 14.4 (n = 199)	99.0 ± 16.0 (n = 198)	65.5 ± 13.1 (n = 199)	0.6	<0.001	<0.001
CysC (mg/dL)	0.81 ± 0.14 (n = 198)	0.80 ± 0.12 (n = 180)	0.81 ± 0.14 (n = 198)	1.11 ± 0.17 (n = 199)	0.6	<0.001	<0.001
eGFR <sub>cys</sub> (mL/min/1.73 m <sup>2</sup> )	102.8 ± 17.6 (n = 198)	103.2 ± 15.4 (n = 180)	102.1 ± 17.5 (n = 198)	71.6 ± 15.3 (n = 199)	0.7	<0.001	<0.001
eGFR <sub>cr-cys</sub> (mL/min/1.73 m <sup>2</sup> )	102.0 ± 16.3 (n = 198)	102.0 ± 13.9 (n = 180)	101.3 ± 16.8 (n = 198)	67.4 ± 11.6 (n = 198)	0.8	<0.001	<0.001
Urea nitrogen (mg/dL)	14.3 ± 3.8 (n = 199)	14.0 ± 3.3 (n = 181)	14.5 ± 4.0 (n = 198)	18.0 ± 4.4 (n = 200)	0.2	<0.001	<0.001
UPCR (g/g)	61 [50-114] (n = 196)	66 [50-128] (n = 175)	62 [50-128] (n = 195)	70 [50-116] (n = 201)	0.3 <sup>e</sup>	0.9 <sup>e</sup>	0.5 <sup>e</sup>
UACR (mg/g)	5.0 [4.0-6.9] (n = 186)	5.0 [3.8-5.8] (n = 167)	5.0 [4.0-6.6] (n = 193)	5.0 [3.3-5.4] (n = 198)	0.07 <sup>e</sup>	0.1 <sup>e</sup>	0.5 <sup>e</sup>
U <sub>creatinine</sub> (μg/min)	19.0 ± 4.0 (n = 186)	19.0 ± 4.0 (n = 167)	19.0 ± 4.4 (n = 193)	19.4 ± 4.0 (n = 198)	0.9	<0.001	<0.001

# A prospective controlled study of kidney donors: baseline and 6-month follow-up.

**Table 7. Laboratory Values**

Variable	Baseline Visit		6-mo Visit		<i>p</i> <sup>a</sup>		
	Controls	Donors	Controls	Donors	Controls vs Donors <sup>b</sup>	Baseline vs 6 mo <sup>c</sup>	Interaction <sup>d</sup>
Hemoglobin (g/dL)	13.6 ± 1.2 (n = 194)	13.6 ± 1.2 (n = 198)	13.6 ± 1.4 (n = 193)	13.1 ± 1.2 (n = 194)	0.9	<0.001	<0.001
Leukocyte count (/μL)	6.1 ± 1.6 (n = 195)	5.9 ± 2.0 (n = 198)	6.1 ± 1.7 (n = 193)	5.7 ± 1.5 (n = 194)	0.3	0.2	0.4
Serum albumin (mg/dL)	4.08 ± 0.28 (n = 199)	4.18 ± 0.29 (n = 199)	4.07 ± 0.33 (n = 198)	4.06 ± 0.31 (n = 200)	0.002	<0.001	<0.001
CRP (mg/dL)	1.1 [0.5-2.7] (n = 199)	0.9 [0.4-1.7] (n = 182)	1.4 [0.6-3.1] (n = 198)	1.2 [0.7-2.9] (n = 199)	0.1 <sup>e</sup>	<0.001 <sup>e</sup>	0.2 <sup>e</sup>
Fibrinogen (mg/dL)	295 ± 69 (n = 197)	292 ± 64 (n = 181)	305 ± 67 (n = 198)	300 ± 72 (n = 198)	0.8	0.004	0.7
Homocysteine (mg/L)	1.20 ± 0.35 (n = 193)	1.22 ± 0.39 (n = 176)	1.20 ± 0.34 (n = 196)	1.49 ± 0.43 (n = 198)	0.8	<0.001	<0.001
Uric acid (mg/dL)	4.8 ± 1.1 (n = 200)	4.6 ± 1.1 (n = 198)	4.9 ± 1.2 (n = 198)	5.3 ± 1.1 (n = 200)	0.08	<0.001	<0.001

# A prospective controlled study of kidney donors: baseline and 6-month follow-up.

**Table 7. Laboratory Values**

Variable	Baseline Visit		6-mo Visit		<i>p</i> <sup>a</sup>		
	Controls	Donors	Controls	Donors	Controls vs Donors <sup>b</sup>	Baseline vs 6 mo <sup>c</sup>	Interaction <sup>d</sup>
Serum calcium (mg/dL)	9.16 ± 0.38 (n = 200)	9.26 ± 0.38 (n = 199)	9.19 ± 0.38 (n = 198)	9.24 ± 0.42 (n = 200)	0.02	0.8	0.4
Serum phosphorus (mg/dL)	3.49 ± 0.52 (n = 198)	3.52 ± 0.50 (n = 199)	3.49 ± 0.48 (n = 198)	3.30 ± 0.48 (n = 200)	0.5	<0.001	<0.001
PTH (pg/mL)	42.8 ± 16.3 (n = 199)	42.3 ± 17.8 (n = 180)	42.8 ± 15.6 (n = 198)	52.7 ± 20.9 (n = 200)	0.6	<0.001	<0.001
Cholesterol (mg/dL)	186 ± 37 (n = 200)	185 ± 35 (n = 198)	186 ± 36 (n = 197)	186 ± 35 (n = 199)	0.7	0.7	0.6
LDL cholesterol (mg/dL)	112 ± 33 (n = 198)	110 ± 31 (n = 196)	111 ± 30 (n = 193)	110 ± 31 (n = 193)	0.6	0.7	0.6
HDL cholesterol (mg/dL)	55.2 ± 16.5 (n = 200)	56.2 ± 14.5 (n = 198)	54.9 ± 16.4 (n = 198)	54.1 ± 13.9 (n = 197)	0.5	0.002	0.03
Triglycerides (mg/dL)	77 [55-113] (n = 200)	76 [57-111] (n = 198)	80 [59-119] (n = 197)	84 [64-124] (n = 199)	0.8 <sup>e</sup>	<0.001 <sup>e</sup>	0.05 <sup>e</sup>

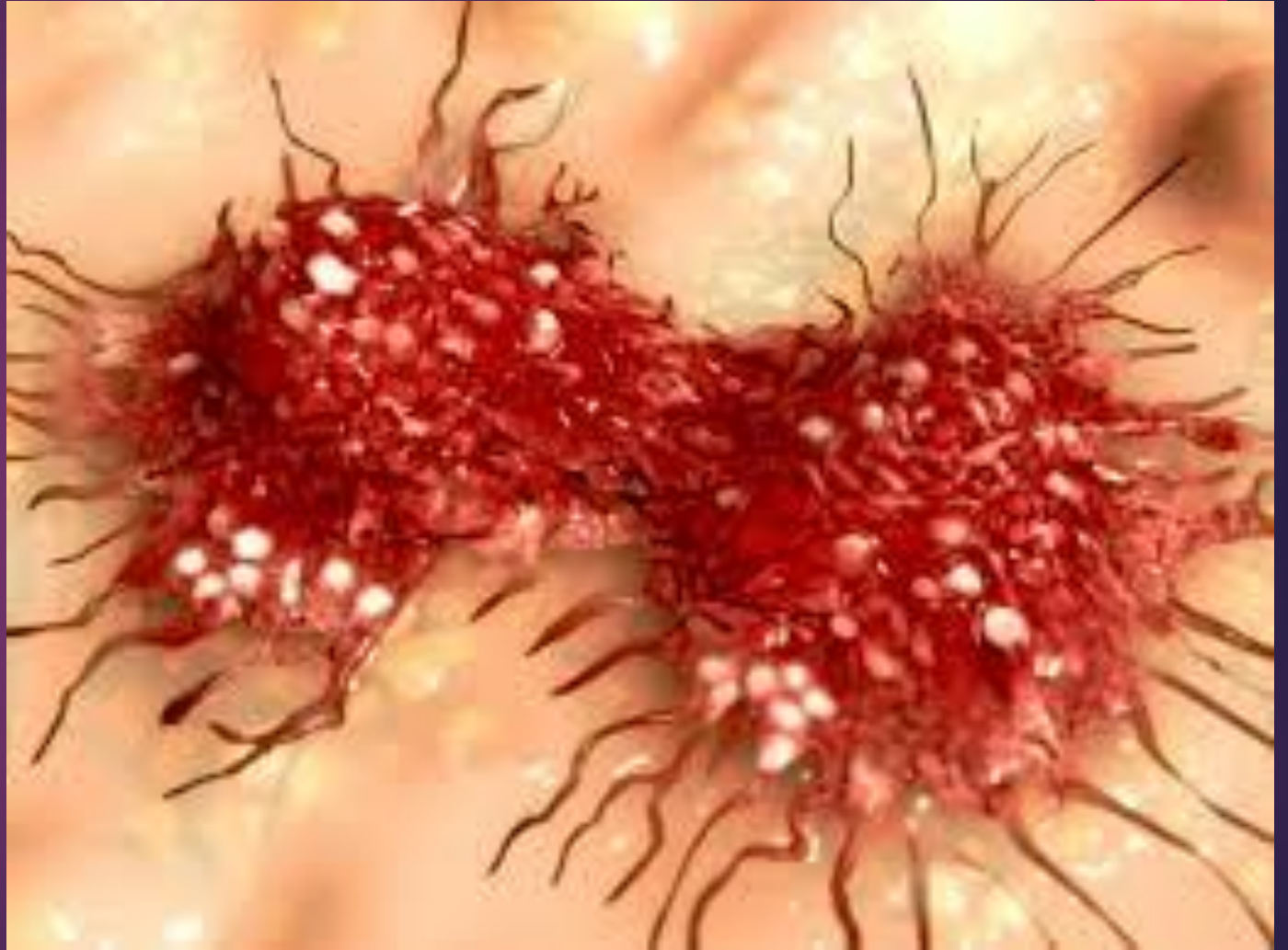


# A prospective controlled study of living kidney donors: three-year follow-up.

Table 6. Laboratory Measurements at 6, 12, 24, and 36 Months After Kidney Donation

Test	Group	Visit (time after donation)				P <sup>a</sup>		
		6 mo	12 mo	24 mo	36 mo	Donors vs Controls <sup>b</sup>	Visit <sup>c</sup>	Interaction <sup>d</sup>
Hemoglobin (g/dL)	Controls	13.6 ± 1.4 (195)	13.4 ± 1.4 (191)	13.6 ± 1.2 (175)	13.6 ± 1.2 (173)	0.003	<0.001	0.02
	Donors	13.2 ± 1.2 (200)	13.1 ± 1.3 (197)	13.4 ± 1.3 (183)	13.5 ± 1.4 (172)			
Leukocyte count (/μL)	Controls	6.0 ± 1.7 (195)	6.1 ± 1.8 (190)	6.0 ± 1.6 (174)	6.0 ± 1.8 (157)	0.1	0.6	0.8
	Donors	5.8 ± 1.5 (200)	5.9 ± 1.8 (196)	5.7 ± 1.5 (182)	5.8 ± 1.6 (169)			
Serum albumin (mg/dL)	Controls	4.07 ± 0.33 (198)	4.03 ± 0.30 (193)	4.06 ± 0.32 (182)	4.02 ± 0.27 (173)	0.9	0.008	0.9
	Donors	4.06 ± 0.31 (200)	4.03 ± 0.30 (198)	4.05 ± 0.30 (185)	4.00 ± 0.27 (182)			
CRP (mg/dL)	Controls	1.4 [0.6-3.1] (198)	1.2 [0.5-2.8] (193)	1.2 [0.5-2.6] (182)	1.0 [0.6-2.4] (173)	0.7 <sup>e</sup>	0.6 <sup>e</sup>	0.01 <sup>e</sup>
	Donors	1.2 [0.7-2.9] (200)	1.3 [0.6-2.5] (196)	1.1 [0.6-2.5] (185)	1.2 [0.6-3.0] (182)			
Fibrinogen (mg/dL)	Controls	305 ± 67 (198)	306 ± 74 (193)	311 ± 65 (182)	306 ± 67 (173)	0.8	0.2	0.3
	Donors	300 ± 72 (198)	310 ± 66 (196)	309 ± 81 (185)	309 ± 70 (181)			
Homocysteine (mg/L)	Controls	1.21 ± 0.34 (196)	1.21 ± 0.37 (193)	1.28 ± 0.43 (182)	1.23 ± 0.38 (173)	<0.001	0.6	0.05
	Donors	1.49 ± 0.43 (198)	1.46 ± 0.42 (196)	1.50 ± 0.42 (185)	1.41 ± 0.43 (182)			
Uric acid (mg/dL)	Controls	4.9 ± 1.2 (198)	4.9 ± 1.2 (193)	4.9 ± 1.2 (182)	5.0 ± 1.1 (173)	<0.001	<0.001	0.2
	Donors	5.3 ± 1.1 (200)	5.2 ± 1.2 (196)	5.4 ± 1.2 (185)	5.5 ± 1.3 (182)			
Serum potassium (mmol/L)	Controls	4.14 ± 0.32 (197)	4.10 ± 0.29 (187)	4.12 ± 0.31 (177)	4.11 ± 0.28 (172)	0.006	0.1	0.9
	Donors	4.20 ± 0.29 (199)	4.19 ± 0.35 (193)	4.20 ± 0.32 (181)	4.17 ± 0.27 (178)			
Serum calcium (mg/dL)	Controls	9.19 ± 0.38 (198)	9.18 ± 0.42 (193)	9.17 ± 0.41 (182)	9.21 ± 0.40 (173)	0.4	0.2	0.7
	Donors	9.24 ± 0.42 (200)	9.18 ± 0.41 (196)	9.24 ± 0.38 (185)	9.26 ± 0.40 (182)			
Serum phosphorus (mg/dL)	Controls	3.49 ± 0.48 (198)	3.55 ± 0.46 (190)	3.52 ± 0.46 (178)	3.51 ± 0.46 (172)	<0.001	0.007	0.003
	Donors	3.30 ± 0.48 (200)	3.37 ± 0.51 (195)	3.43 ± 0.51 (182)	3.42 ± 0.51 (178)			
PTH (pg/mL)	Controls	42.8 ± 15.6 (198)	42.4 ± 16.7 (193)	43.6 ± 16.3 (182)	43.2 ± 17.5 (173)	<0.001	0.7	0.3
	Donors	52.7 ± 20.9 (200)	52.9 ± 22.1 (196)	51.7 ± 20.6 (185)	52.5 ± 24.1 (182)			

**Malignancy**



# Cancer diagnoses after living kidney donation

	Living Donors Rate Per 1000 Person-Years	Matched Controls Rate Per 1000 Person-Years	Donor vs Control Rate Ratio (95% CI)
<b>All LKD</b>			
Total Non-skin	11.9	16.2	0.74 (0.55–0.99)*
Total Skin	6.1	6.8	0.91 (0.59–1.40)
			1.67 (0.61–4.59)
Colon	0.3	1.4	0.22 (0.05–1.03)
Lung	0.8	0.9	0.83 (0.25–2.73)
Kidney	0.3	0.9	0.33 (0.07–1.65)
Lymphoma	0.6	1.6	0.40 (0.13–1.28)
Hodgkin's	--	0.6	--
Leukemia	0.3	0.3	1.00 (0.14–7.10)
Myeloma	0.2	0.5	0.33 (0.03–3.20)
Central nervous system	0.6	0.2	4.00 (0.45–35.8)

The overall risk of developing cancer does not appear to be increased among donors.

# Risk among older donors

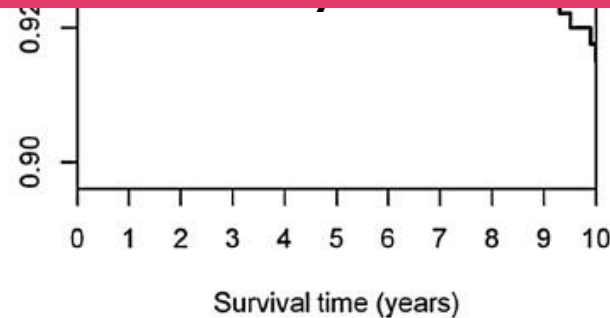
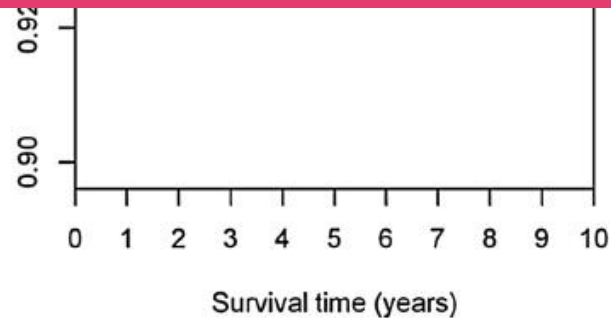
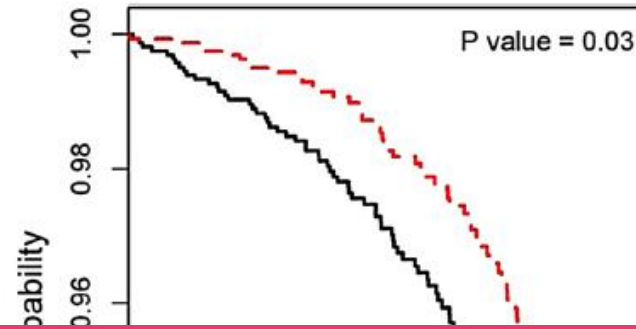
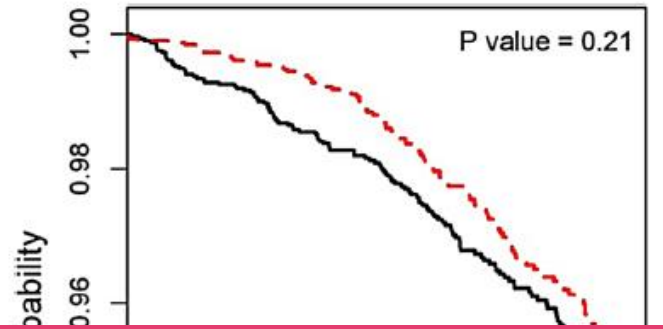




# Mortality among older live kidney donors

a study of 3368 older donors ( $\geq 55$  years) in the United States (1996 to 2006)

Outcomes are generally acceptable among carefully selected older living donors.

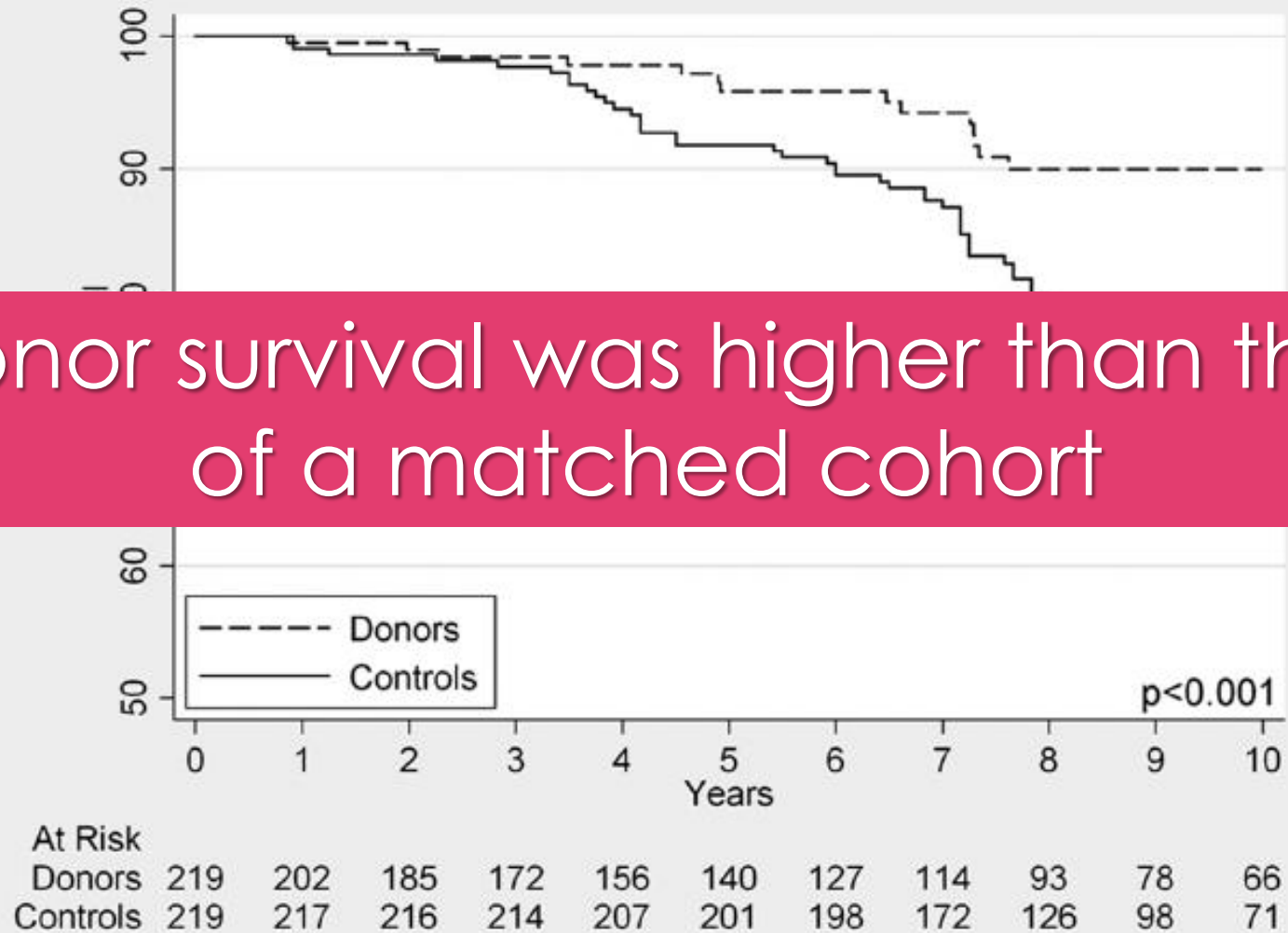


— Non-donor  
3368 3352 3338 3036 2797 2541 2249 1948 1623 1286 915  
- - - Donor  
3368 3365 3352 3059 2821 2555 2263 1962 1631 1287 921

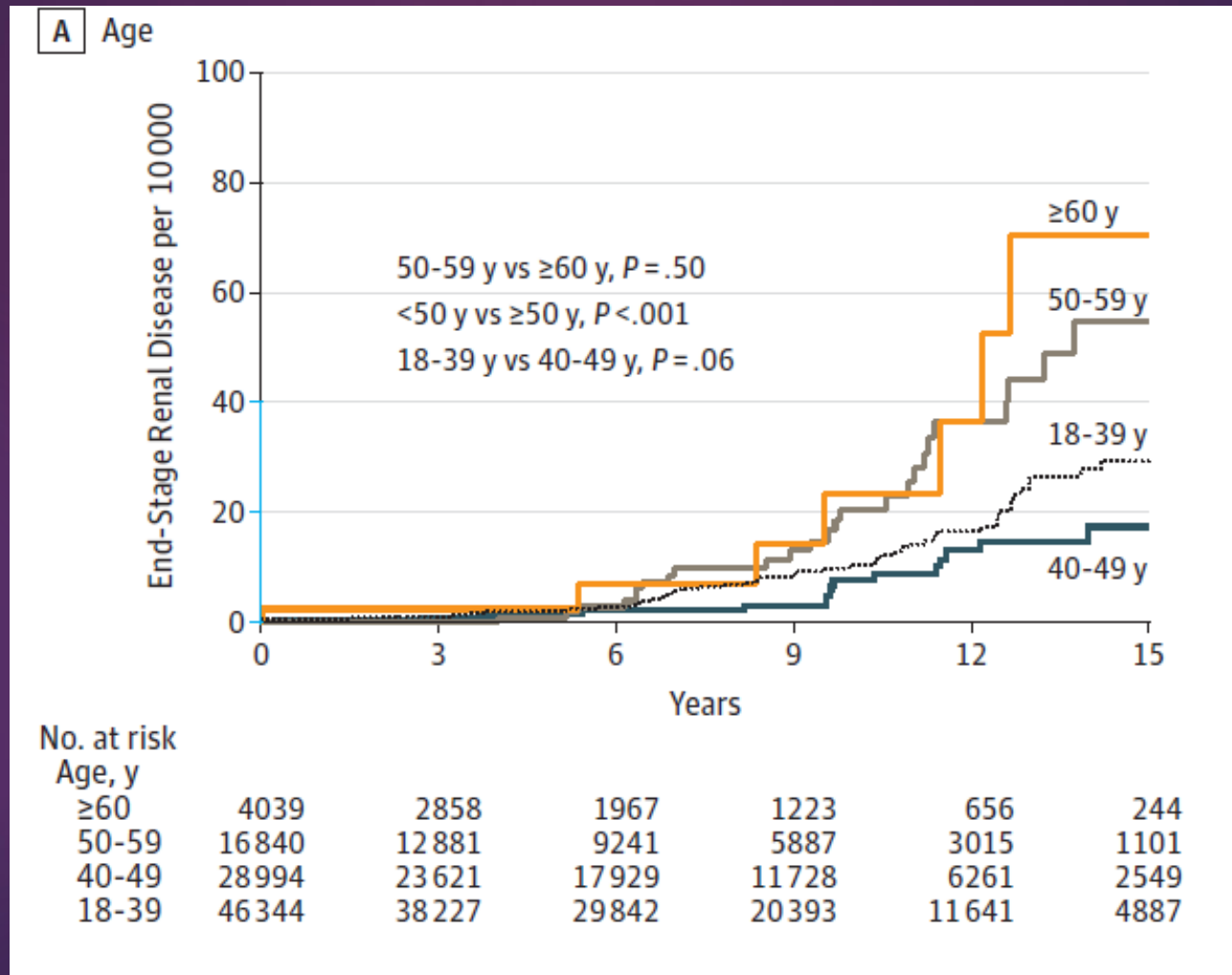
— Non-donor  
1648 1641 1632 1423 1242 1068 903 755 611 478 369  
- - - Donor  
1648 1647 1644 1436 1260 1085 921 769 620 489 377

# Survival of live kidney donors aged >70, compared with matched healthy controls

Donor survival was higher than that of a matched cohort



# Cumulative Incidence of End-Stage Renal Disease in Live Kidney Donors



Risk of end-stage renal disease following live kidney donation. *Jama*. 2014;311(6):579-86.

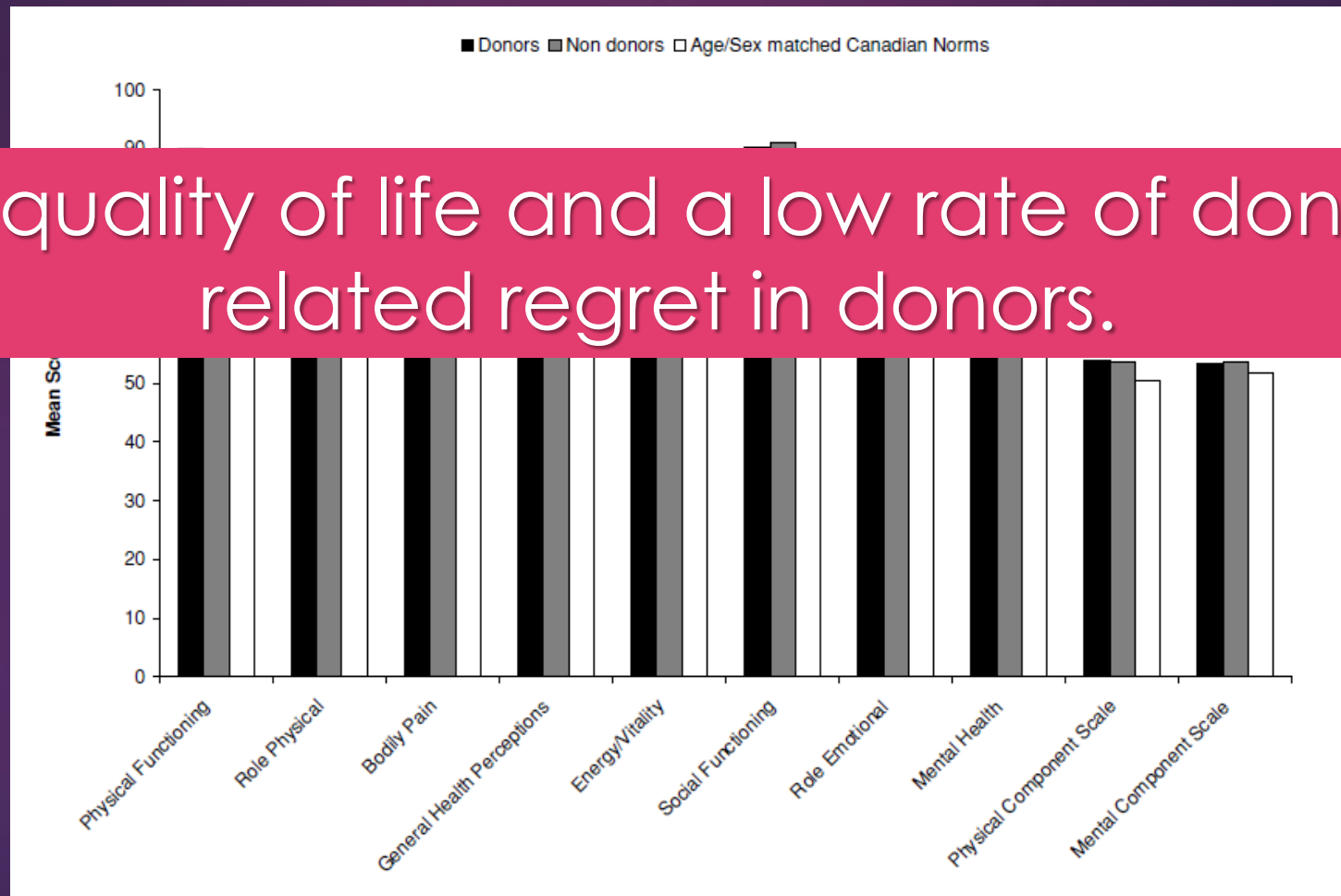


Psychosocial outcomes



# The long-term quality of life of living kidney donors

Good quality of life and a low rate of donation-related regret in donors.



The long-term quality of life of living kidney donors. American journal of transplantation : official journal of the American Society of Transplantation and the American Society of Transplant Surgeons. 2011;11(3):463-9.



**FOLLOW  
UP!**

# KDIGO Clinical Practice Guideline on the Evaluation and Care of Living Kidney Donors



Annually post-donation





# HEALTHY LIFESTYLE



Review and promotion of a healthy lifestyle including:

- Regular exercise
- Healthy diet
- Abstinence from tobacco

# CARE AFTER KIDNEY DONATION

- ▶ Avoidance of potentially nephrotoxic exposures (eg, tobacco use, NSAIDs, nephrotoxic medications)
- ▶ Prevention of diseases that may cause CKD (eg, hypertension, diabetes mellitus, CVD)



# Take home messages

- ▶ Kidney donors are at increased long-term risk for **ESRD**, **cardiovascular**, and **all-cause mortality**.
- ▶ Living kidney donation appears to increase the risk of **preeclampsia**.
- ▶ The overall risk of developing cancer does not appear to be increased among donors.
- ▶ Outcomes are generally acceptable among carefully selected **older living donors**.
- ▶ BP, BMI, creatinine, and albuminuria measurement should be performed at least **annually**.
- ▶ Review and promotion of a healthy lifestyle.



