Association of Sodium Intake with Adverse Cardiac Structure and Function Among Participants of the HyperGEN Study

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SUPPLEMENTAL MATERIAL

Supplementary Figure 1.

Title: Comparison of Tissue Doppler Imaging versus Speckle-Tracking Echocardiography: Scatterplot and Bland-Altman Plot

Caption: The equation for converting speckle-tracking echocardiography e' velocity values to tissue Doppler e' velocity values is shown next to the scatterplot. Speckle-tracking echocardiography underestimated tissue Doppler imaging for the measurement of e' velocity, as shown in the Bland-Altman plot. TDI = tissue Doppler imaging; STE = speckle-tracking echocardiography.

Supplementary Figure 2.

Title: Continuous relationship between estimated urinary sodium excretion and markers of cardiac mechanics

Caption: (A) longitudinal strain, (B) circumferential strain, (C) early diastolic (e') velocity, and (D) E/e' ratio. A reference line is drawn at an estimated sodium intake value of 3.7 g/day. The 95% confidence intervals are noted by dashed lines. Plots are shown for the unadjusted relationship using restricted cubic splines. Note: Tissue velocity values derived from speckle-tracking software are lower than values derived from tissue Doppler imaging. Thus, e' is lower and E/e' is higher in the present study compared to other studies that use conventional tissue Doppler imaging to measure tissue velocities.

Supplementary Table 1. Reproducibility of Speckle-Tracking Echocardiography Parameters (N=96)

		Interobserver Reliability			Intraobserver Reliability		
Parameter	**Mean±SD**	**ICC (95% CI)**	**Mean bias (95% CI)**	**CV**	**ICC (95% CI)**	**Mean bias (95% CI)**	**CV**
LS, %	15.3±2.7	0.77 (0.69, 0.85)	0.71 (0.34, 1.08)	9.9%	0.90 (0.87, 0.94)	-0.17 (-0.46, 0.11)	7.2%
CS, %	21.6±5.0	0.76 (0.67, 0.85)	1.22 (0.52, 1.93)	13.6%	0.88 (0.83, 0.93)	-0.52 (-0.06, 1.09)	9.6%
Septal STe', cm/s	3.4±1.0	0.77 (0.69, 0.86)	0.06 (-0.08, 0.21)	13.8%	0.78 (0.70, 0.85)	0.12 (-0.007, 0.25)	13.7%
Lateral STe',cm/s	2.7±1.1	0.76 (0.67, 0.84)	-0.11 (-0.28, 0.06)	26.9%	0.81 (0.75, 0.88)	-0.09 (-0.24, 0.06)	22.3%

CS = circumferential strain; LS = longitudinal strain; SD, standard deviation; ICC = intraclass correlation; CI, confidence interval; CV = coefficient of variation; STe' = speckle-tracking e' velocity.

Supplementary Table 2. Association of Urinary Sodium with Strain, E' Velocity, and E/e' Ratio on Multivariable-adjusted Analyses using Fractional Polynomial Regression

Dependent variable	Estimate sodium intake ≤3.7 g/day (N=1457)		Estimate sodium intake >3.7 g/day (N=1539)	
	β-Coefficient (95% CI)	P-value	β-Coefficient (95% CI)	P-value
Longitudinal strain, %	0.11 (-0.30, 0.53)	0.59	-0.41 (-0.73, -0.09)	0.012
Circumferential strain, %	0.01 (-0.70, 0.71)	0.98	-0.65 (-1.21, -0.10)	0.021
STe', cm/s	-0.05 (-0.20, 0.11)	0.56	-0.13 (-0.26, -0.01)	0.029
E/e' ratio	-1.02 (-2.95, 0.91)	0.30	-0.11 (-1.71, 1.48)	0.89

CI, confidence interval; STe', speckle-tracking derived early diastolic tissue velocity. All strain parameters are reported as absolute values. Beta-coefficients reflect the change in the dependent variable per 1 gram/day increase in estimated sodium intake.

Adjusted for age, sex, smoking status, alcohol use, blocks walked per day, diuretic use, estimated glomerular filtration rate, left ventricular mass, wall motion abnormalities, ejection fraction, center, speckle-tracking analyst, and image quality.

Supplementary Table 3. Association of Estimated Sodium Intake with Cardiac Mechanics Excluding Participants on Diuretics*

Dependent variable	Estimated sodium excretion >3.7 g/day (N=1114)	
	β-Coefficient (95% CI)	**P-value**
Longitudinal strain, %	-0.25 (-0.65, 0.14)	0.21
Circumferential strain, %	-0.94 (-1.57, -0.32)	0.003
STe', cm/s	-0.11 (-0.27, 0.05)	0.17

CI, confidence interval; STe', speckle-tracking derived early diastolic tissue velocity. All strain parameters are reported as absolute values.
Beta-coefficients reflect the change in the dependent variable per 1 gram/day increase in estimated sodium intake.

*Adjusted for age, sex, smoking status, alcohol use, blocks walked per day, estimated glomerular filtration rate, left ventricular mass, wall motion abnormalities, ejection fraction, center, speckle-tracking analyst, and image quality.

Supplementary Table 4. Interaction Analysis between Clinical and Laboratory Characteristics and Cardiac Mechanics

Cardiac mechanics parameter	Interaction term	P-value for the interaction term
Longitudinal strain, %	Urinary sodium × sex	0.55
	Urinary sodium × race*	0.66
	Urinary sodium × hypertension	0.53
	Urinary sodium x potassium excretion	0.46
Circumferential strain, %	Urinary sodium × sex	0.42
	Urinary sodium × race*	0.53
	Urinary sodium × hypertension	0.66
	Urinary sodium x potassium excretion	0.03
STe', cm/s	Urinary sodium × sex	0.95
	Urinary sodium × race*	0.69
	Urinary sodium × hypertension	0.20
	Urinary sodium x potassium excretion	0.98

STe', speckle-tracking derived early diastolic tissue velocity.
*The 7 participants who self-identified as "other race" were excluded from these analyses.
In addition to the specified interaction term, the models above were adjusted for age, sex, smoking status, alcohol use, blocks walked per day, diuretic use, estimated glomerular filtration rate, left ventricular mass, wall motion abnormalities, ejection fraction, center, speckle-tracking analyst, and image quality.

Supplementary Table 5. Stratified Multivariable Regression Analyses*

Cardiac mechanics parameter	Subgroup	Urinary Sodium	
		β-Coefficient (95% CI)	P-value
Circumferential strain, %	Low potassium (n=2633)	-0.79 (-1.36, -0.21)	0.007
	High potassium (n=365)	0.65 (-0.45, 1.75)	0.25

CI, confidence interval.
Beta-coefficients reflect the change in the index of circumferential strain per 1 gram/day increase in estimated sodium intake.
*Adjusted for age, sex, smoking status, alcohol use, blocks walked per day, diuretic use, estimated glomerular filtration rate, left ventricular mass, wall motion abnormalities, ejection fraction, center, speckle-tracking analyst, and image quality.

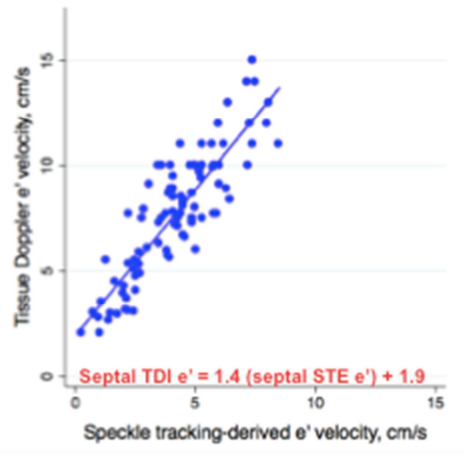
Supplementary Table 6. Association of Urinary Sodium with Strain and E' Velocity in Participants with Estimate Sodium Intake >3.7 g/day on Aldosterone Mediation Analysis by Race

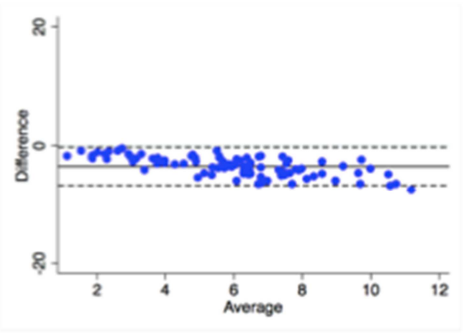
Dependent variable	White[†]			African-American[‡]		
	β-Coefficient (95% CI)	P-value	Proportion Explained by Serum Aldosterone	β-Coefficient (95% CI)	P-value	Proportion Explained by Serum Aldosterone
Longitudinal strain, %	-0.34 (-0.81, -0.14)	0.17	11%	-0.35 (-0.77, 0.07)	0.10	23%*
Circumferential strain, %	-0.39 (-1.22, 0.44)	0.35	3%	-0.64 (-1.29, 0.02)	0.056	-2%
STe', cm/s	-0.15 (-0.33, 0.02)	0.088	4%	-0.15 (-0.32, 0.02)	0.083	10%*

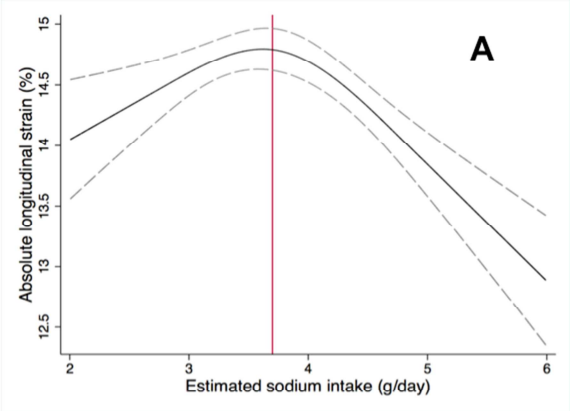
CI, confidence interval; STe', speckle-tracking derived early diastolic tissue velocity. All strain parameters are reported as absolute values. Beta-coefficients reflect the change in the index of dependent variable per 1 gram/day increase in estimated sodium intake.

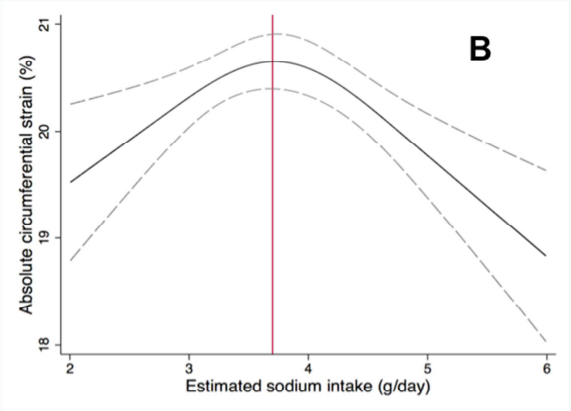
All models adjusted for age, sex, smoking status, alcohol use, blocks walked per day, diuretic use, estimated glomerular filtration rate, left ventricular mass, wall motion abnormalities, ejection fraction, center, speckle-tracking analyst, and image quality.

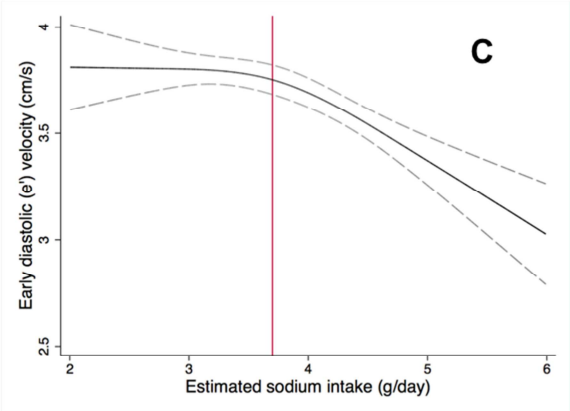
*Statistically significant change in model with addition of intermediary factor ($p<0.05$).

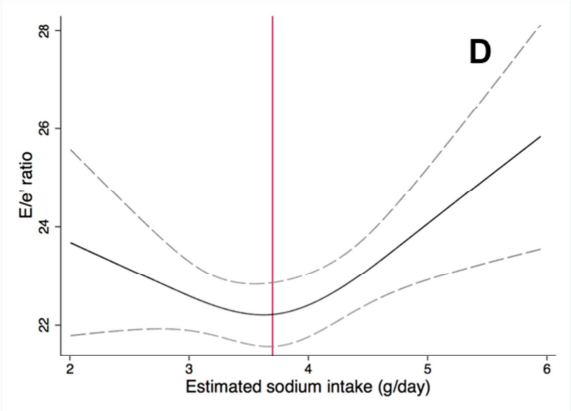

Tissue Doppler e' velocity, cm/s
0
5
10
15
Septal TDI e' = 1.4 (septal STE e') + 1.9
0
5
10
15
Speckle tracking-derived e' velocity, cm/s


Difference
20
0
-20
2
4
6
8
10
12
Average


A
Absolute longitudinal strain (%)
12.5
13
13.5
14
14.5
15
2
3
4
5
6
Estimated sodium intake (g/day)


B
Absolute circumferential strain (%)
18
19
20
21
2
3
4
5
6
Estimated sodium intake (g/day)


C
Early diastolic (e') velocity (cm/s)
2.5
3
3.5
4
2
3
4
5
6
Estimated sodium intake (g/day)


D
E/e' ratio
22
24
26
28
2
3
4
5
6
Estimated sodium intake (g/day)