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Association between Skeletal Muscle Mass and Clinical Outcomes of Chronic Kidney Disease

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Objectives : Sarcopenia is highly prevalent among patients with chronic kidney disease (CKD) and may contribute to the elevated risk of adverse clinical outcomes in this population. However, large-scale evidence examining the relationship between objectively quantified muscle mass and cardiorenal outcomes remains scarce. Therefore, we leveraged a large CKD cohort to quantify muscle mass and evaluate its associations with cardiorenal and mortality outcomes.
Methods : We conducted a retrospective cohort study of 10,125 adults with CKD who underwent abdominal computed tomography at Seoul National University Hospital between 2001 and 2023. Patients with end-stage malignancy at the time of CKD diagnosis were excluded. Skeletal muscle area (SMA) and muscle quality (NAMA, LAMA) were quantified at the L3 vertebral level using CT imaging. Outcomes included all-cause mortality, major adverse cardiovascular events (MACE), ≥50% decline in eGFR, and progression to end-stage renal disease (ESRD). Associations were evaluated using multivariable Cox proportional hazards models adjusted for demographic and clinical covariates.
Results : During a median follow-up of 8 years, Greater SMA/height² and NAMA/LAMA were independently associated with lower risks of all-cause mortality (adjusted HR 0.78 [95% CI 0.63–0.97] and 0.75 [0.60–0.93], respectively). Greater NAMA/LAMA was also associated with reduced risks of MACE (adjusted HR 0.62 [0.45–0.86]), ≥50% eGFR decline (adjusted HR 0.76 [0.59–0.98]), and progression to ESRD (adjusted HR 0.51 [0.27–0.99]).
Conclusions : Greater muscle mass and better muscle quality were associated with lower risks of All-cause mortality, eGFR decline, and MACE incidence in CKD patients. In patients with CKD, CT-derived skeletal muscle assessment is a stronger biomarker than body weight or body mass index alone. Notably, Our results suggest that muscle quality may serve as potential risk stratification tool for Cardiorenal outcomes in the future management of CKD.

table1.png

Table 1. The effects of muscle index (n=9468)

		Mortality				MACE			
		Unadjusted		Fully-adjusted		Unadjusted		Fully-adjusted	
		HR (95% CI)	P-value	HR (95% CI)	P-value	HR (95% CI)	P-value	HR (95% CI)	P-value
SMA/height²	Q1								
	Q2	0.22 (0.14, 0.34)	<0.01	0.76 (0.45, 1.30)	0.323	0.88 (0.50, 1.56)	0.664	0.79 (0.40, 1.56)	0.489
	Q3	0.07 (0.04, 0.12)	<0.01	0.64 (0.36, 1.14)	0.132	0.62 (0.34, 1.12)	0.113	1.01 (0.51, 2.00)	0.979
	Q4	0.03 (0.01, 0.05)	<0.01	0.42 (0.22, 0.81)	<0.01	0.55 (0.30, 1.00)	0.051	1.09 (0.52, 2.31)	0.82
	SD Linear	0.24 (0.20, 0.29)	<0.001	0.78 (0.63, 0.97)	0.023	0.72 (0.58, 0.90)	0.004	0.99 (0.76, 1.30)	0.965
NAMA/height²	Q1								
	Q2	0.24 (0.15, 0.37)	<0.01	0.97 (0.61, 1.56)	0.911	0.67 (0.40, 1.11)	0.118	1.28 (0.68, 2.40)	0.441
	Q3	0.07 (0.04, 0.12)	<0.01	0.66 (0.38, 1.13)	0.13	0.17 (0.09, 0.33)	<0.01	0.56 (0.28, 1.11)	0.095
	Q4	0.02 (0.01, 0.04)	<0.01	0.50 (0.28, 0.89)	0.018	0.25 (0.14, 0.48)	<0.01	0.67 (0.33, 1.36)	0.265
	SD Linear	0.21 (0.17, 0.26)	<0.001	0.71 (0.57, 0.88)	0.001	0.50 (0.40, 0.63)	<0.001	0.77 (0.60, 0.99)	0.045
LAMA/height²	Q1			0.96 (0.61, 1.53)					
	Q2	1.80 (0.94, 3.43)	0.075	1.06 (0.64, 1.76)	0.874	0.98 (0.44, 2.17)	0.954	1.54 (0.80, 2.96)	0.196
	Q3	3.68 (2.04, 6.63)	<0.01	1.18 (0.71, 1.95)	0.812	3.06 (1.52, 6.15)	<0.01	1.79 (0.91, 3.53)	0.092
	Q4	4.85 (2.73, 8.60)	<0.01	0.96 (0.61, 1.53)	0.522	3.91 (1.99, 7.69)	<0.01	2.11 (1.07, 4.14)	0.03
	SD Linear	1.53 (1.31, 1.78)	<0.001	1.17 (0.98, 1.39)	0.081	1.68 (1.40, 2.02)	<0.001	1.37 (1.10, 1.71)	0.005
NAMA/LAMA	Q1								
	Q2	0.24 (0.16, 0.38)	<0.01	0.65 (0.41, 1.03)	0.065	0.35 (0.21, 0.60)	<0.01	1.13 (0.63, 2.01)	0.682
	Q3	0.11 (0.06, 0.18)	<0.01	0.79 (0.49, 1.29)	0.353	0.23 (0.13, 0.43)	<0.01	1.01 (0.55, 1.87)	0.966
	Q4	0.04 (0.02, 0.08)	<0.01	0.49 (0.29, 0.84)	0.010	0.16 (0.08, 0.31)	<0.01	0.52 (0.26, 1.02)	0.056
	SD Linear	0.15 (0.11, 0.20)	<0.001	0.75 (0.60, 0.93)	0.009	0.36 (0.26, 0.51)	<0.001	0.62 (0.45, 0.86)	0.004

table1.png

Table 2. The effects of muscle index (n=6912)

		eGFR 50% reduction				ESRD			
		Unadjusted		Fully-adjusted		Unadjusted		Fully-adjusted	
		HR (95% CI)	P-value	HR (95% CI)	P-value	HR (95% CI)	P-value	HR (95% CI)	P-value
SMA/height²	Q1								
	Q2	0.54 (0.38, 0.79)	<0.01	1.23 (0.66, 2.31)	0.51	1.08 (0.70, 1.65)	0.729	1.15 (0.22, 5.98)	0.868
	Q3	0.54 (0.38, 0.79)	<0.01	1.00 (0.52, 1.92)	0.99	0.94 (0.61, 1.45)	0.771	0.52 (0.12, 2.18)	0.369
	Q4	0.39 (0.26, 0.58)	<0.01	0.68 (0.33, 1.39)	0.287	1.13 (0.74, 1.74)	0.563	0.64 (0.12, 3.31)	0.593
	SD Linear	0.71 (0.62, 0.83)	<0.01	0.84 (0.65, 1.08)	0.176	1.04 (0.90, 1.21)	0.580	1.08 (0.69, 1.71)	0.726
NAMA/height²	Q1								
	Q2	0.56 (0.39, 0.79)	<0.01	1.38 (0.73, 2.63)	0.321	1.18 (0.76, 1.84)	0.458	2.28 (0.49, 10.50)	0.29
	Q3	0.42 (0.29, 0.60)	<0.01	0.91 (0.47, 1.76)	0.785	1.34 (0.87, 2.07)	0.182	1.49 (0.34, 6.60)	0.596
	Q4	0.27 (0.18, 0.42)	<0.01	0.74 (0.36, 1.51)	0.401	1.29 (0.83, 1.99)	0.259	1.04 (0.20, 5.55)	0.959
	SD Linear	0.60 (0.52, 0.69)	<0.01	0.79 (0.61, 1.01)	0.058	1.09 (0.94, 1.27)	0.242	0.92 (0.57, 1.50)	0.747
LAMA/height²	Q1								
	Q2	0.94 (0.60, 1.48)	0.805	1.67 (0.95, 2.91)	0.073	0.85 (0.56, 1.29)	0.455	2.71 (0.55, 13.34)	0.219
	Q3	1.73 (1.15, 2.61)	<0.01	0.90 (0.48, 1.70)	0.74	0.82 (0.54, 1.24)	0.342	3.90 (0.63, 24.02)	0.143
	Q4	2.27 (1.53, 3.37)	<0.01	1.29 (0.70, 2.36)	0.418	0.78 (0.51, 1.19)	0.241	2.41 (0.43, 13.41)	0.316
	SD Linear	1.36 (1.20, 1.54)	<0.01	1.11 (0.91, 1.36)	0.311	0.91 (0.78, 1.07)	0.253	1.27 (0.79, 2.05)	0.319
NAMA/LAMA	Q1								
	Q2	0.54 (0.38, 0.78)	<0.01	1.03 (0.56, 1.89)	0.933	1.18 (0.76, 1.83)	0.472	2.13 (0.47, 9.57)	0.323
	Q3	0.43 (0.29, 0.62)	<0.01	1.41 (0.77, 2.56)	0.266	1.26 (0.81, 1.95)	0.304	1.37 (0.35, 5.31)	0.651
	Q4	0.32 (0.21, 0.48)	<0.01	0.69 (0.36, 1.30)	0.247	1.26 (0.81, 1.94)	0.304	0.13 (0.02, 0.95)	0.045
	SD Linear	0.59 (0.49, 0.71)	<0.01	0.76 (0.59, 0.98)	0.035	1.13 (0.99, 1.29)	0.059	0.51 (0.27, 0.99)	0.045