Uremic Sarcopenia :
From Clinical Research to Patient Care

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2025/12/07

Outline

- Sarcopenia burden in CKD and ESRD
- Applying diagnostic criteria and screening tools derived from geriatric population into ESRD patients
- Etiologies of uremic sarcopenia, focusing on vascular burden and dysfunction
- Combating sarcopenia at Hualien Tzu-Chi Hospital

Sarcopenia

- First proposed by I. H. Rosenberg in 1989
  - ✓ The gradual decline in muscle mass with the aging process
  - ✓ "***Sarx*** (flesh)" + "***penia*** (loss)"
- Highly predicts falls, hospitalization and mortality rate in elderly patients

  (Arango-Lopera et al., 2013; Landi et al., 2013; J. H. Kim et al., 2014)
- Becomes a popular research issue due to the accelerating global aging and increasing disease burdens

European Working Group on Sarcopenia in Older People, EWGSOP

Table 1. Criteria for the diagnosis of sarcopenia

Diagnosis is based on documentation of criterion 1 plus (criterion 2 or criterion 3)

1. Low muscle mass
2. Low muscle strength
3. Low physical performance

Age Ageing **2010**, *39*, 412-423.

Several consensus definitions for sarcopenia have been developed…

2014 Asian Working Group for Sarcopenia

People aged 60 or 65 years and older according to the definition of elderly in each individual country

Handgrip strength (HS) and gait speed (GS)

No low HS and No low GS

No sarcopenia

Low HS and/or low GS

Muscle mass measurement

Normal

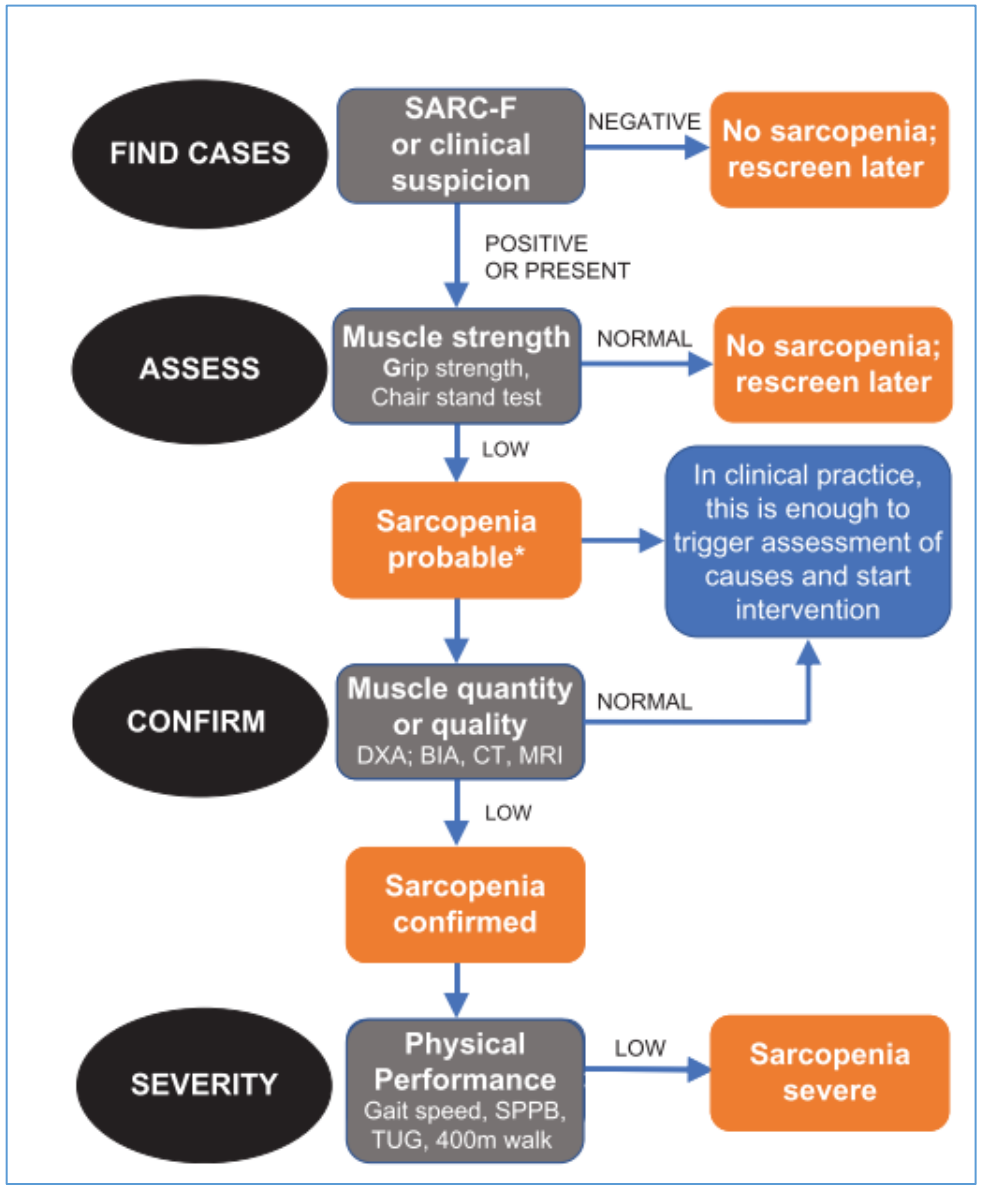
No sarcopenia

Low

Sarcopenia

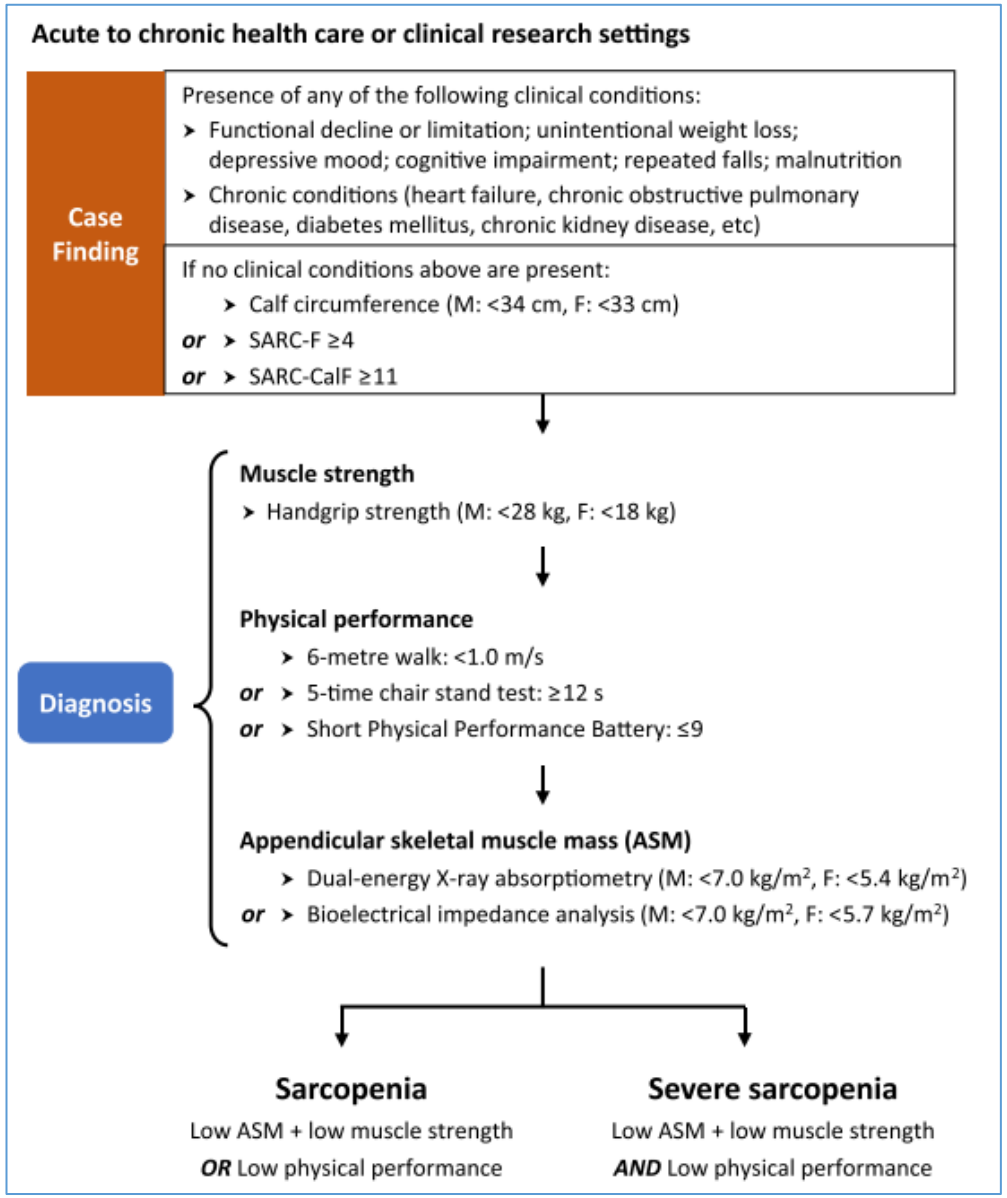
K. Chen et al. / JAMDA 15 (2014) 95e101

Revised EWGSOP 2018



Age and Ageing 2018; 0: 1–16

Revised AWGS 2020



J Am Med Dir Assoc. 2020 Mar;21(3):300-307.e2.

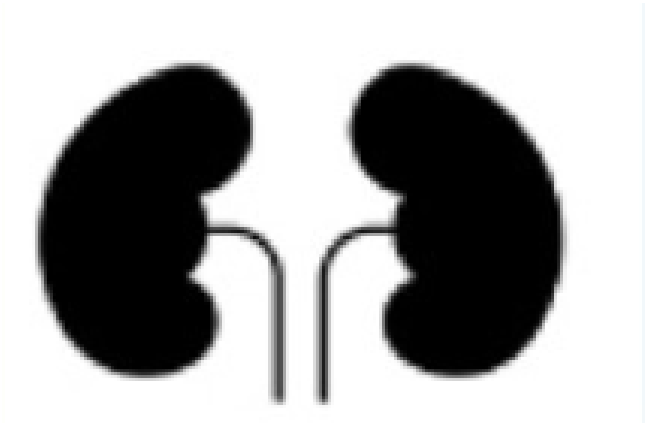
Table 2. Sarcopenia categories by cause

Primary sarcopenia	
Age-related sarcopenia	No other cause evident except ageing
Secondary sarcopenia	
Activity-related sarcopenia	Can result from bed rest, sedentary lifestyle, deconditioning or zero-gravity conditions
Disease-related sarcopenia	Associated with advanced organ failure (heart, lung, liver, kidney, brain), inflammatory disease, malignancy or endocrine disease
Nutrition-related sarcopenia	Results from inadequate dietary intake of energy and/or protein, as with malabsorption, gastrointestinal disorders or use of medications that cause anorexia

Age Ageing **2010**, *39*, 412-423.

The Prevalence of Sarcopenia

3.9-7.3 %



CKD patients

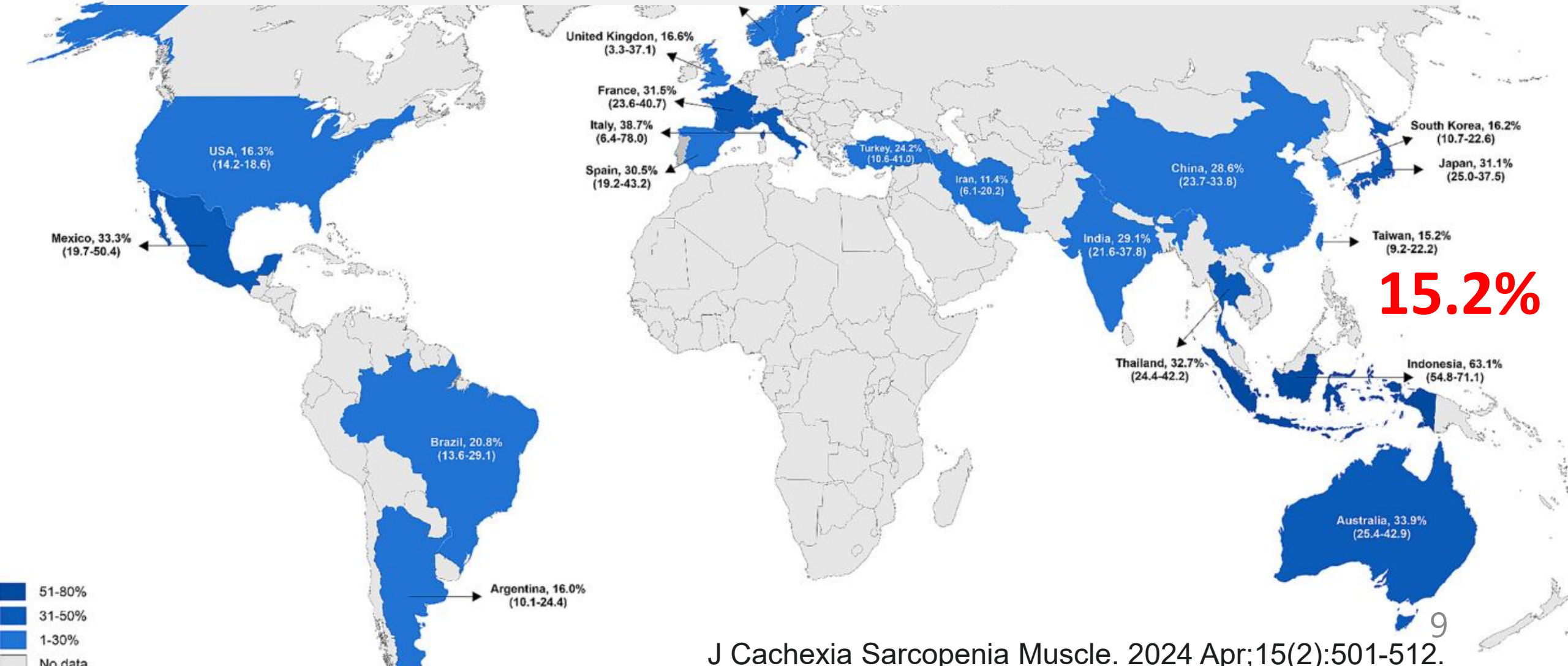
?

2867 community-dwelling older adults

(Geriatrics & Gerontology International 2014; 14: 52-60)

A Recent Global Systematic Review and Meta-analysis in CKD

- Includes 140 studies (42,041 patients) across 25 countries



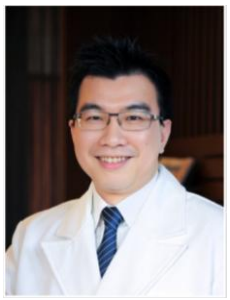
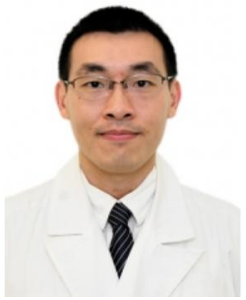
15.2%

J Cachexia Sarcopenia Muscle. 2024 Apr;15(2):501-512.

	Meta-analysis		Heterogeneity	
AWGS2	No. of studies	No. of patients	Prevalence (95% CI)	I^2
Non-dialysis	10	2680	**17.7%**	94.8%
Haemodialysis	26	6356	**31.6%**	96.3%
Peritoneal dialysis	1	186	**38.2%**	-
Kidney transplant	3	300	**19.1%**	-

J Cachexia Sarcopenia Muscle. 2024 Apr;15(2):501-512.



Tzu-Chi PD Cohort

Baseline 2020/2-2021/5, N=216

Enrollment during the pandemic of COVID-19






Definition of Sarcopenia

Table 1. Classifications and cut-off values to define sarcopenia in this study.

Classification	AWGS 2019	EWGSOP2	FNIH	IWGS
Low ASMI				
Male	ASM/height^2 < 7.0 kg/m^2	ASM/height^2 < 7.0 kg/m^2	ASM/BMI < 0.789	ASM/height^2 < 7.23 kg/m^2
Female	ASM/height^2 < 5.7 kg/m^2	ASM/height^2 < 6.0 kg/m^2	ASM/BMI < 0.512	ASM/height^2 < 5.67 kg/m^2
Low HGS				
Male	<28 kg	<27 kg	<26 kg	—
Female	<18 kg	<16 kg	<16 kg	—
Slow GS	<1.0 m/s	≤0.8 m/s	≤0.8 m/s	<1.0 m/s
Diagnosis	Low ASMI plus low HGS or slow GS	Low ASMI and low HGS	Low ASMI and low HGS	Low ASMI and slow GS

AWGS, Asian Working Group for Sarcopenia; EWGSOP, European Working Group on Sarcopenia in Older People; FNIH, Foundation for the National Institutes of Health; IWGS, International Working Group on Sarcopenia; ASMI, appendicular skeletal muscle index; BMI, body mass index; HGS, handgrip strength; GS, gait speed.

Lin et al., Nutrients 2022; 14: 923

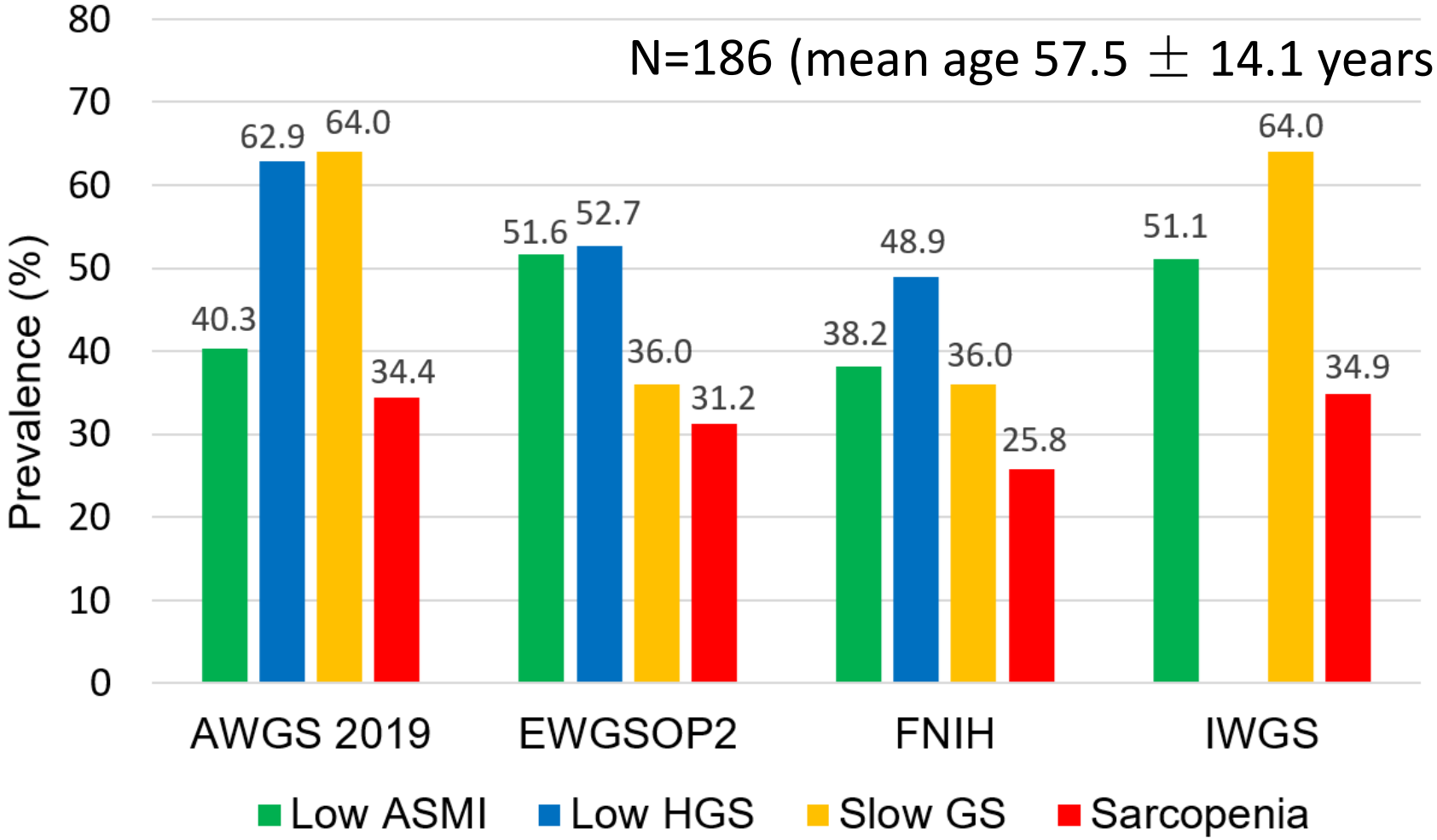


Figure 1. The prevalence of low ASMI, low HGS, slow GS, and sarcopenia across four sarcopenia criteria among PD patients. ASMI, appendicular skeletal muscle index; HGS, handgrip strength; GS, gait speed; AWGS, Asian Working Group for Sarcopenia; EWGSOP, European Working Group on Sarcopenia in Older People; FNIH, Foundation for the National Institutes of Health; IWGS, International Working Group on Sarcopenia.

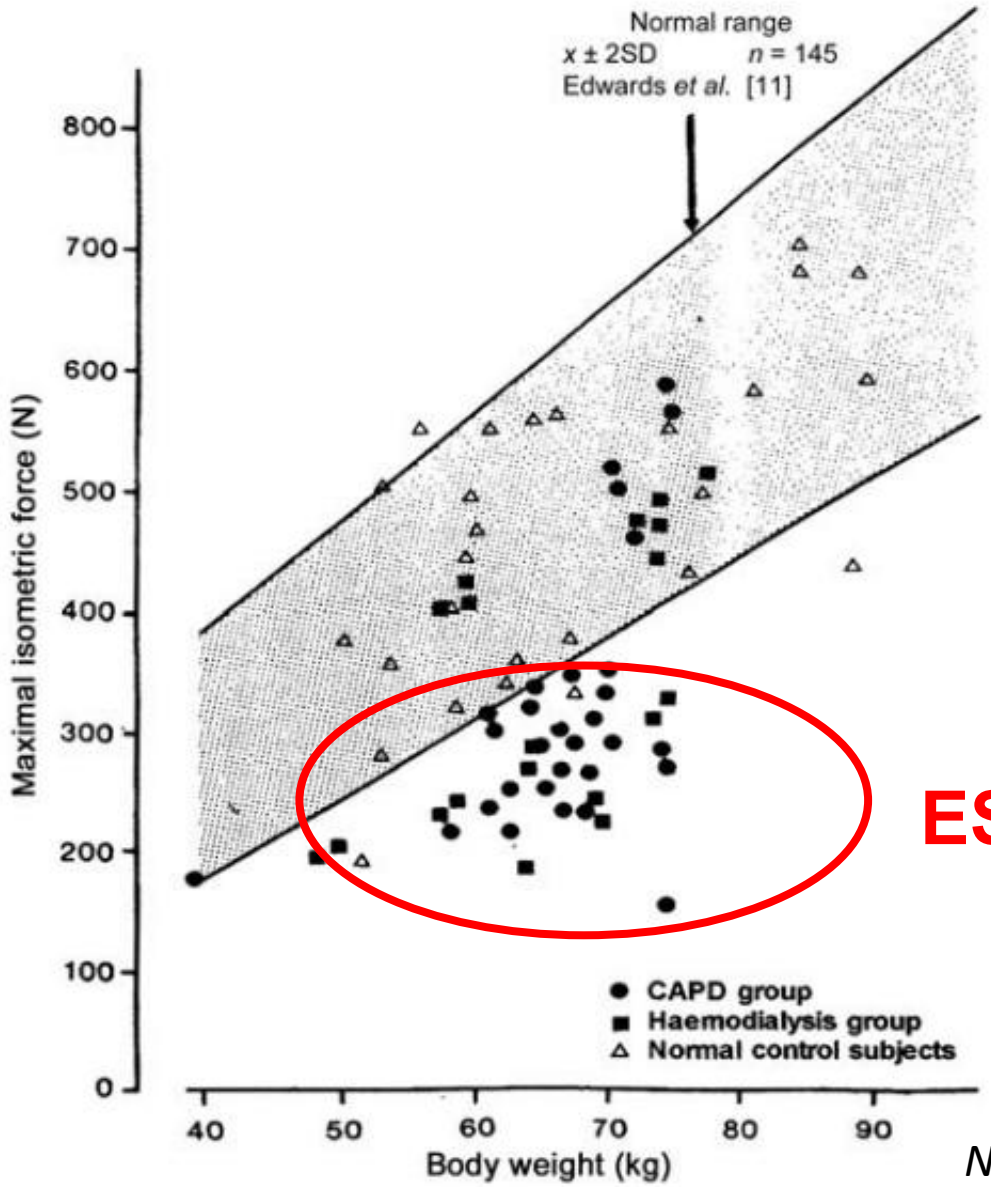
Lin et al., Nutrients 2022; 14: 923

Applying the diagnostic criteria for geriatric sarcopenia in ESRD patients

- Facilitate direct comparisons of prevalence among elderly, non-dialysis CKD, and ESRD population

1. How well do these criteria predict clinical outcomes in ESRD ?
2. Is there a difference in the clinical relevance of muscle mass, strength, and physical performance?

Poor muscle quality in ESRD patients



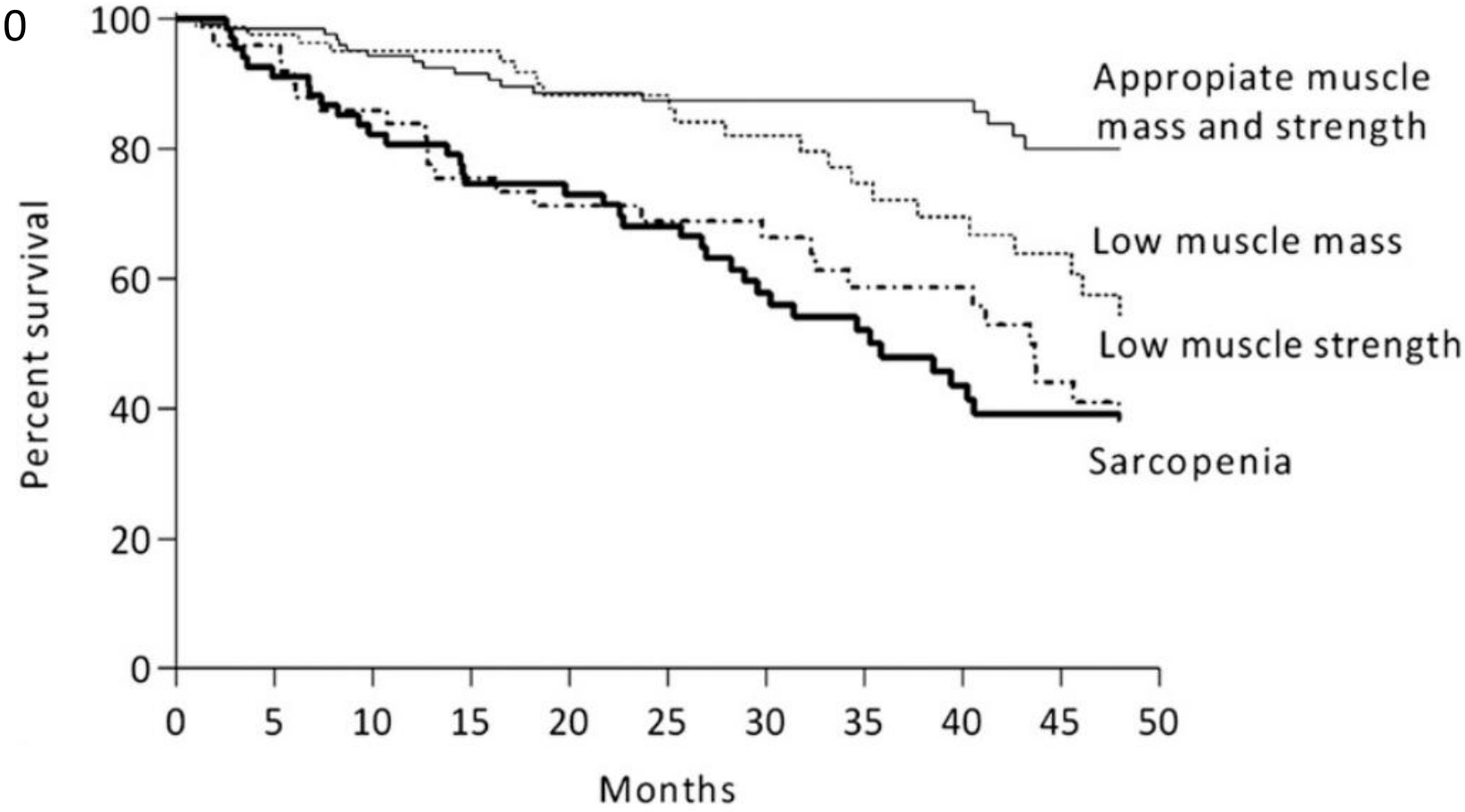
normal control subjects

ESRD patients

Nephrol Dial Transplant **2014**, *29*, 1655-1665

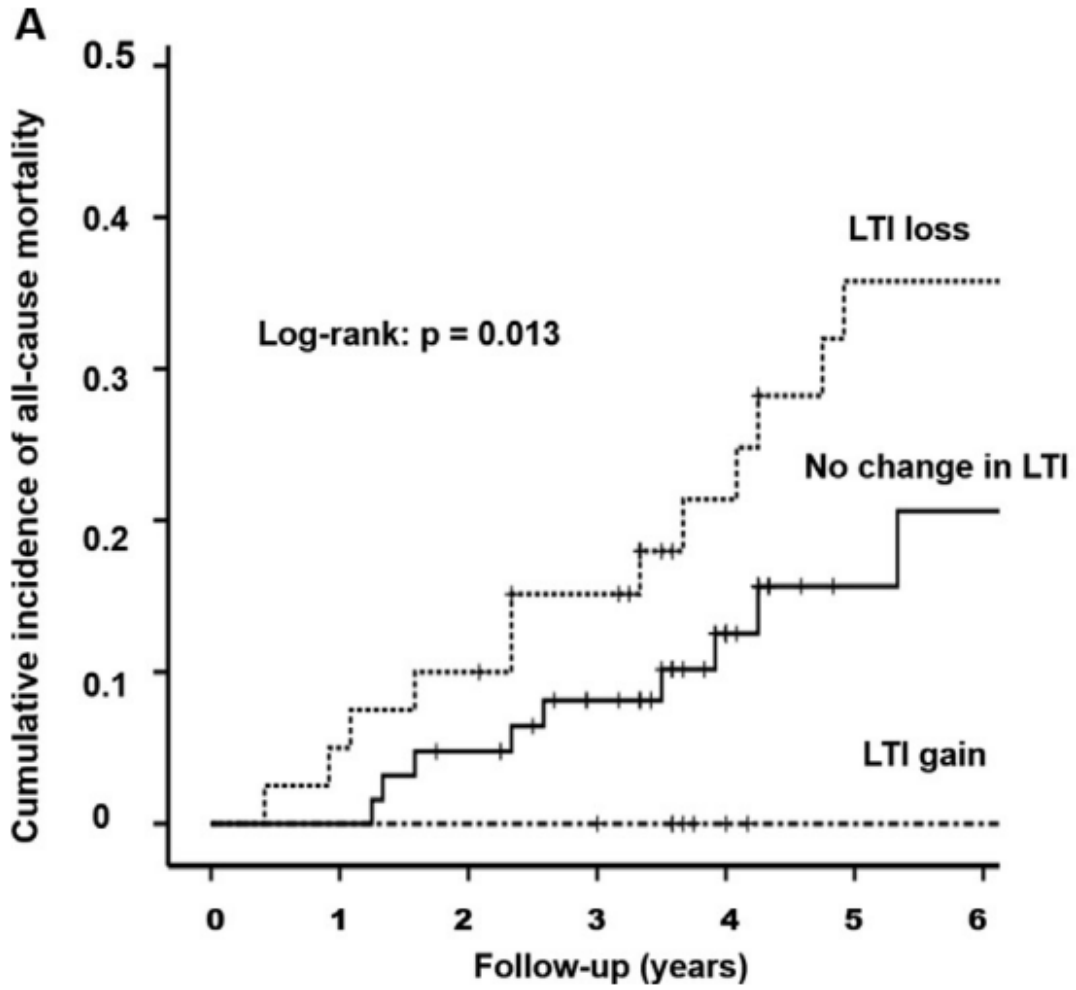
Comparative Associations of Muscle Mass and Strength with Mortality in Dialysis Patients

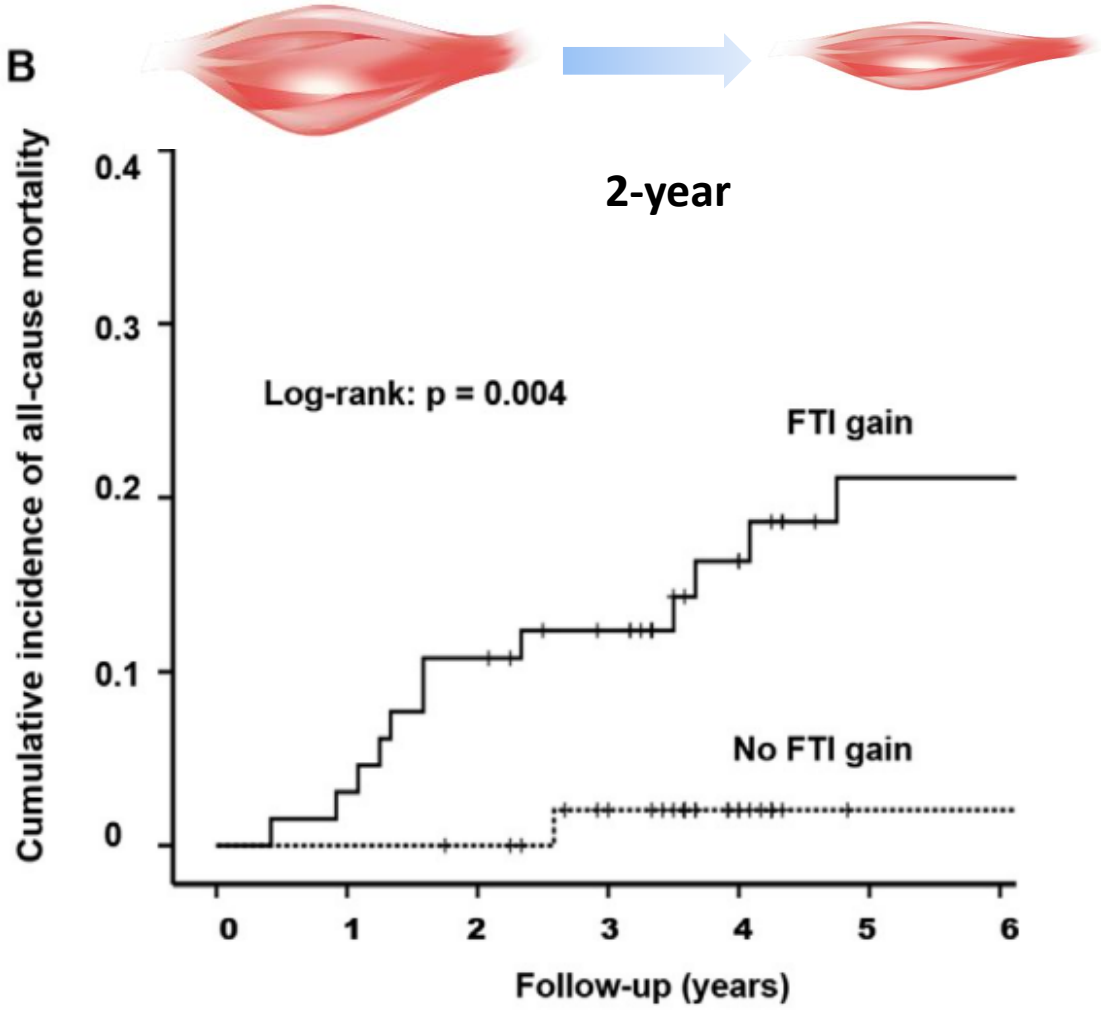
N=330



Isoyama N, et al. Clin J Am Soc Nephrol 9: 1720–1728, October, 2014

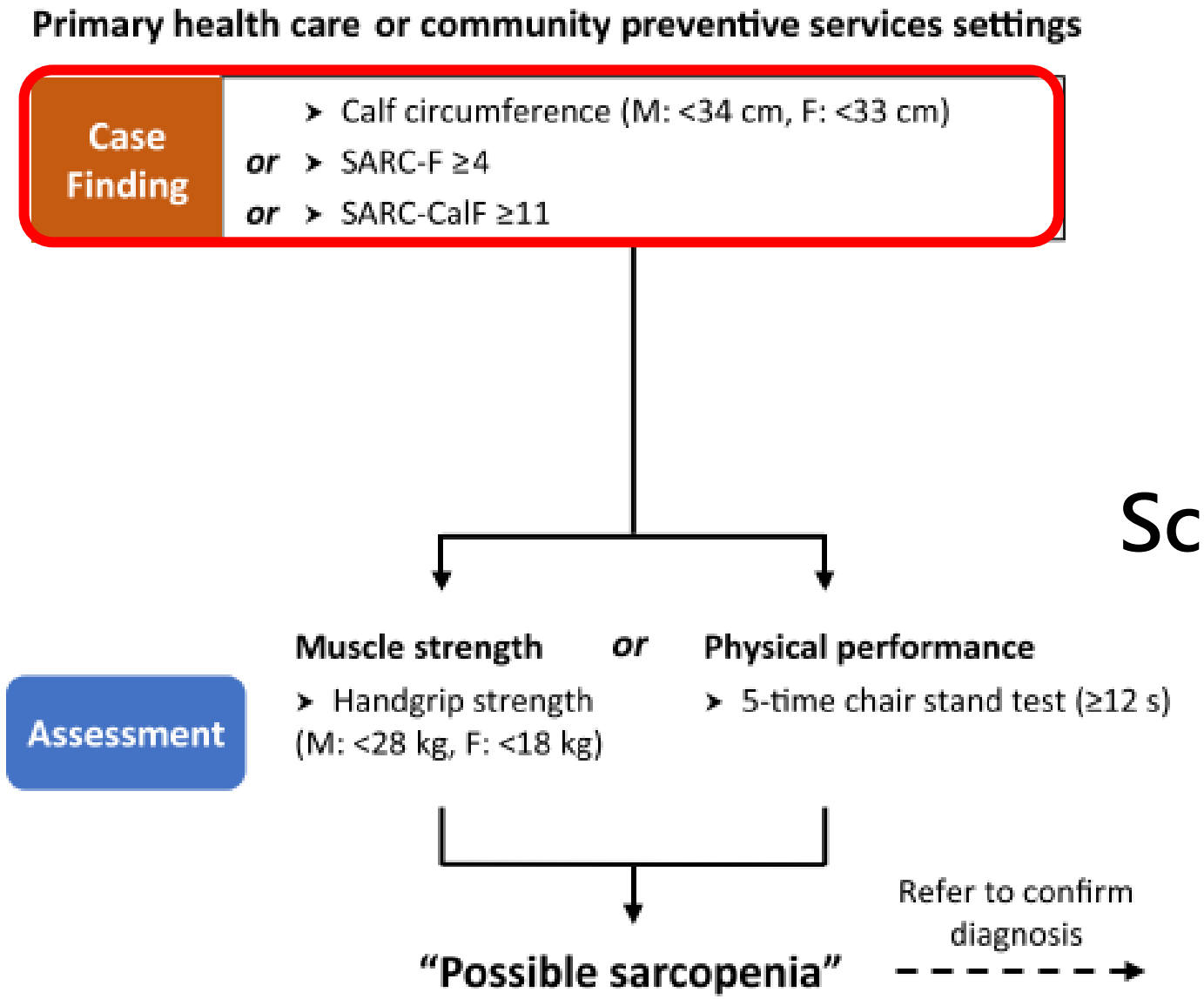
Association of 2-yr body composition changes and all-cause mortality in 160 PD patients





Kim et al., Clinical Nutrition 40 (2021) 120-126

Asian Working Group for Sarcopenia 2019



Applicability of Screening tools in ESRD patients ?

J Am Med Dir Assoc. 2020 Mar;21(3):300-307.e2.

SARC-F: A Simple Questionnaire to Rapidly Diagnose Sarcopenia

Theodore K. Malmstrom PhD [a,b], John E. Morley MB, BCh [b,*]

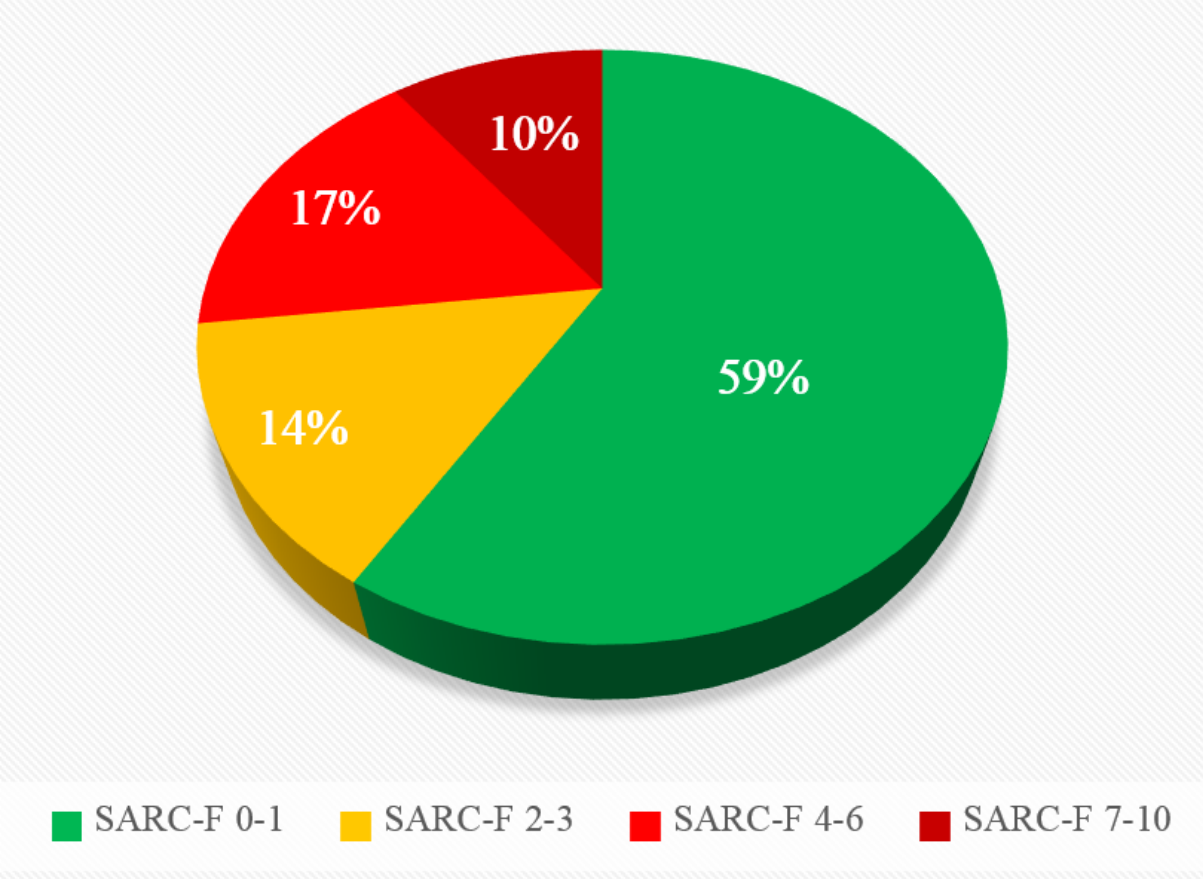
Table 1
SARC-F Screen for Sarcopenia

Component	Question	Scoring
Strength	How much difficulty do you have in lifting and carrying 10 pounds?	None = 0 Some = 1 A lot or unable = 2
Assistance in walking	How much difficulty do you have walking across a room?	None = 0 Some = 1 A lot, use aids, or unable = 2
Rise from a chair	How much difficulty do you have transferring from a chair or bed?	None = 0 Some = 1 A lot or unable without help = 2
Climb stairs	How much difficulty do you have climbing a flight of 10 stairs?	None = 0 Some = 1 A lot or unable = 2
Falls	How many times have you fallen in the past year?	None = 0 1–3 falls = 1 4 or more falls = 2

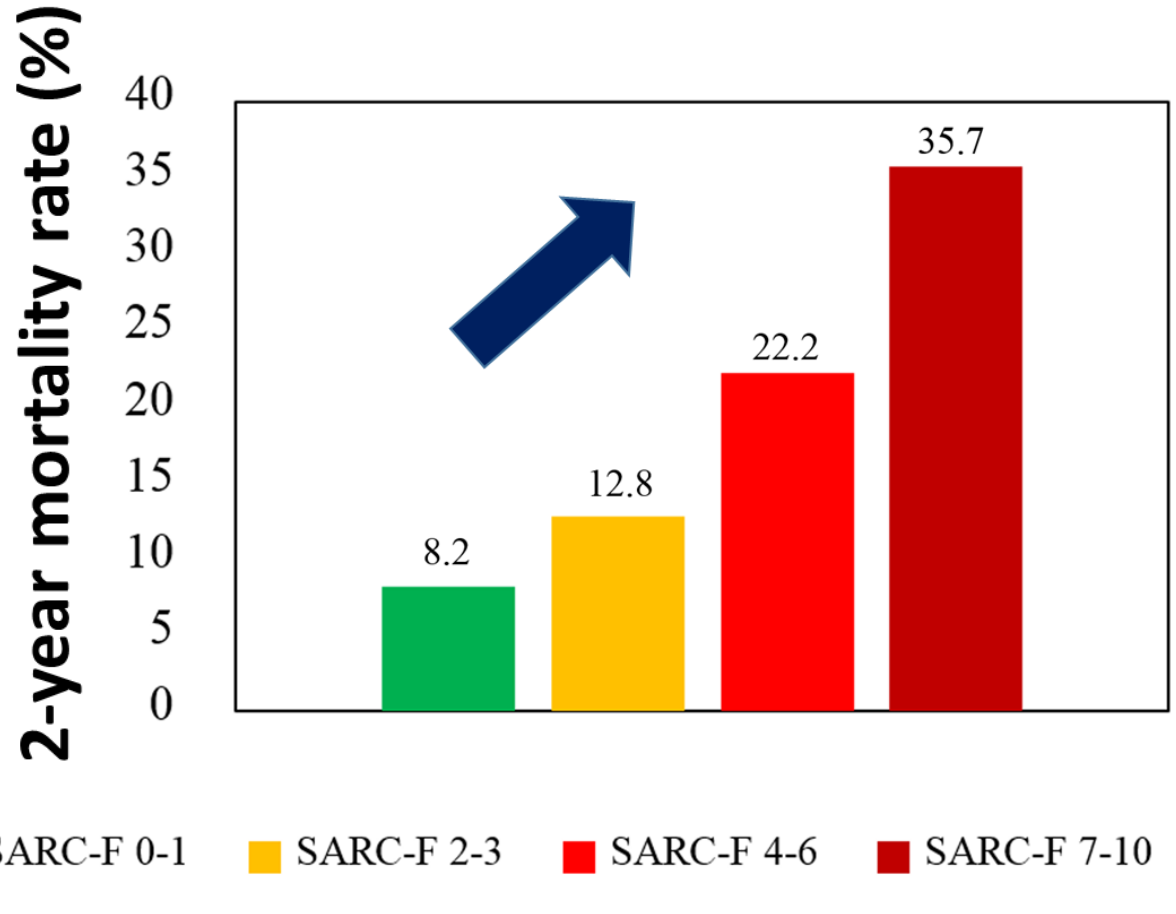
JAMDA 14 (2013) 531e532

Hualien Tzu-Chi HD patients

N= 271 (mean age 64.4 ± 14.3 years)



Higher SARC-F scores are associated with increased mortality in HD



Lin et al., Diagnostics (Basel). 2020 Oct 31;10(11):890.

Table 3. The best cut-offs of SARC-F score on low skeletal muscle index, handgrip strength weakness, poor physical performance, possible, and definite sarcopenia among 100 hemodialysis patients.

	AUC (95% CI)	Cut-Off	Sen (%)	Spe (%)	PPV (%)	NPV (%)
Low skeletal muscle index [a]	0.658 (0.556–0.750)	≥1	66.7	65.9	16.2	95.2
Handgrip strength weakness [b]	0.651 (0.549–0.744)	≥2	36.6	91.5	75.0	67.5
Slow gait speed [c]	0.685 (0.584–0.774)	≥1	56.1	76.3	62.2	71.4
Poor sit-to-stand test ≥12 s [d]	0.656 (0.554–0.748)	≥1	49.1	77.8	73.0	55.6
Possible sarcopenia [e]	0.671 (0.570–0.762)	≥1	47.7	82.9	83.8	46.0
Sarcopenia [f]	0.694 (0.593–0.782)	≥1	71.4	65.6	13.5	96.8

Clinical application:

- SARC-F ≥ 4:
  - **Low sensitivity** in the prediction of sarcopenia or mortality
  - Hinder its use in clinical practice to early detection of mild to moderate sarcopenia
- Lower the cut-off value to ≥ 1 could improve sensitivity and better identify each patients at sarcopenia risk.

Lin et al., Diagnostics (Basel). 2020 Oct 31;10(11):890.

SARC-CalF

Table 1
SARC-F Screen for Sarcopenia

Component	Question	Scoring
Strength	How much difficulty do you have in lifting and carrying 10 pounds?	None = 0 Some = 1 A lot or unable = 2
Assistance in walking	How much difficulty do you have walking across a room?	None = 0 Some = 1 A lot, use aids, or unable = 2
Rise from a chair	How much difficulty do you have transferring from a chair or bed?	None = 0 Some = 1 A lot or unable without help = 2
Climb stairs	How much difficulty do you have climbing a flight of 10 stairs?	None = 0 Some = 1 A lot or unable = 2
Falls	How many times have you fallen in the past year?	None = 0 1–3 falls = 1 4 or more falls = 2

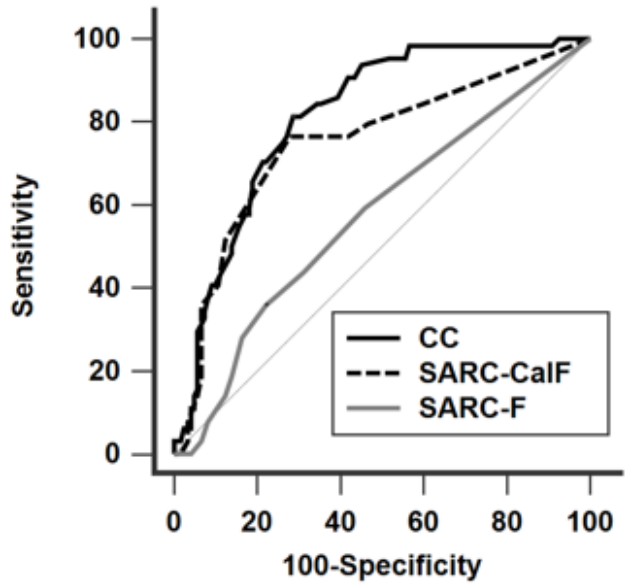
SARC-F score + 10

if calf circumference

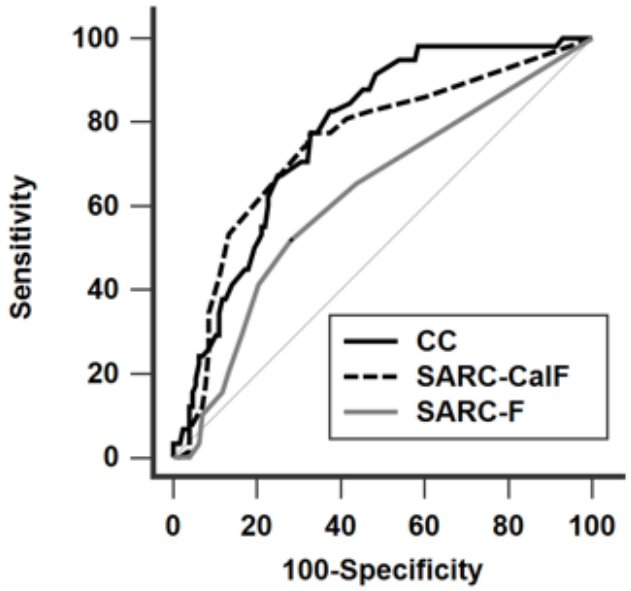
< 34 cm (male)

< 33 cm (female)

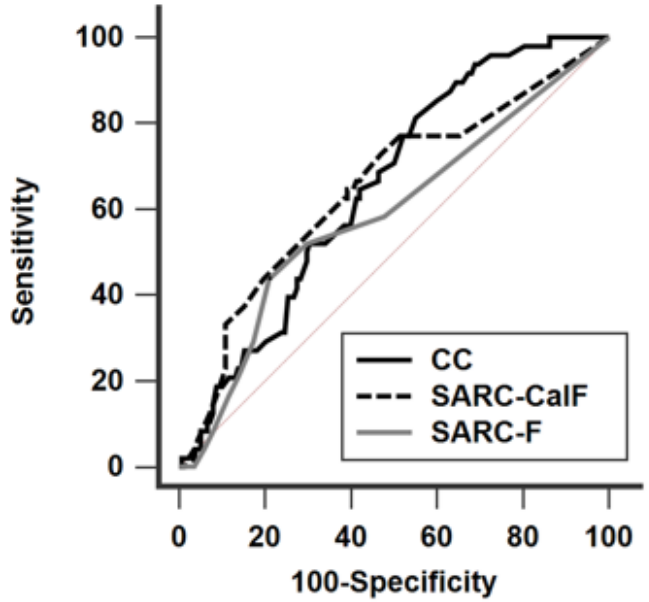
(A) AWGS 2019



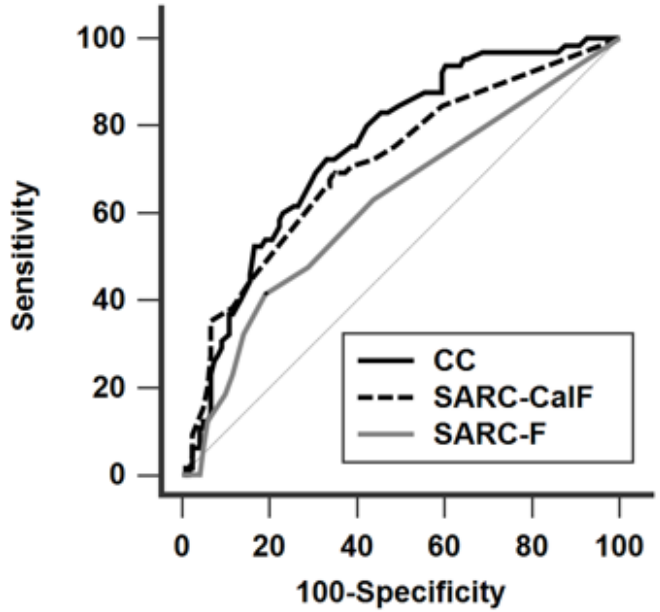
(B) EWGSOP2



(C) FNIH



(D) IWGS



N=186
PD patients

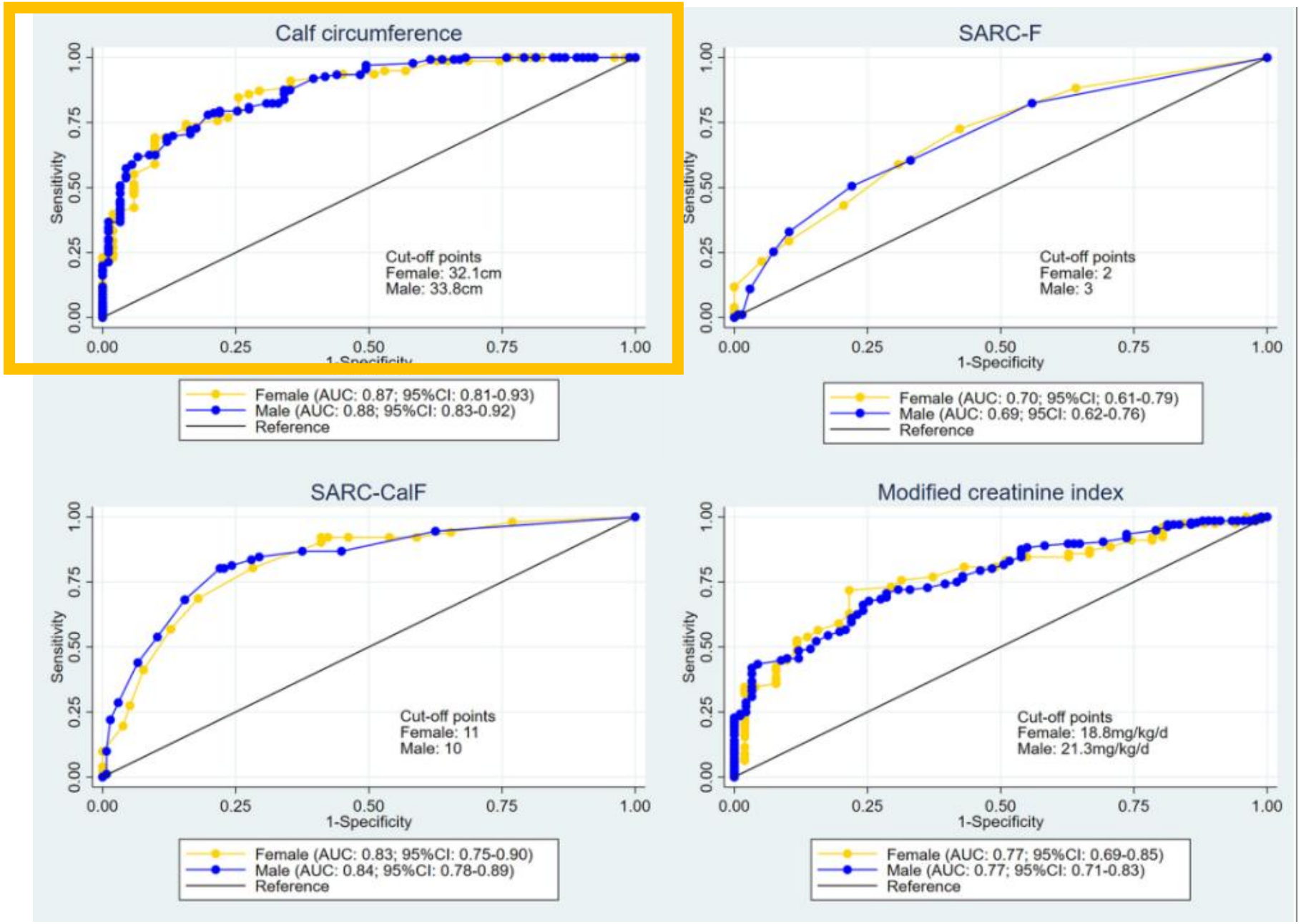
Calf circumference (CC) outperformed both SARC-F and SARC-CalF.

AWGS,
Asian Working Group for Sarcopenia;
EWGSOP,
European Working Group on Sarcopenia in Older People;
FNIH,
Foundation for the National Institutes of Health;
IWGS, International Working Group on Sarcopenia

Lin et al., Nutrients 2022; 14: 923

Chronic HD patients in Japan (n=356)

CC is a strong predictor of sarcopenia and outperforms other screening tools.



Journal of Cachexia, Sarcopenia and Muscle 2022; 13: 2898–2907

The thinner the calves, the higher the risk of sarcopenia.

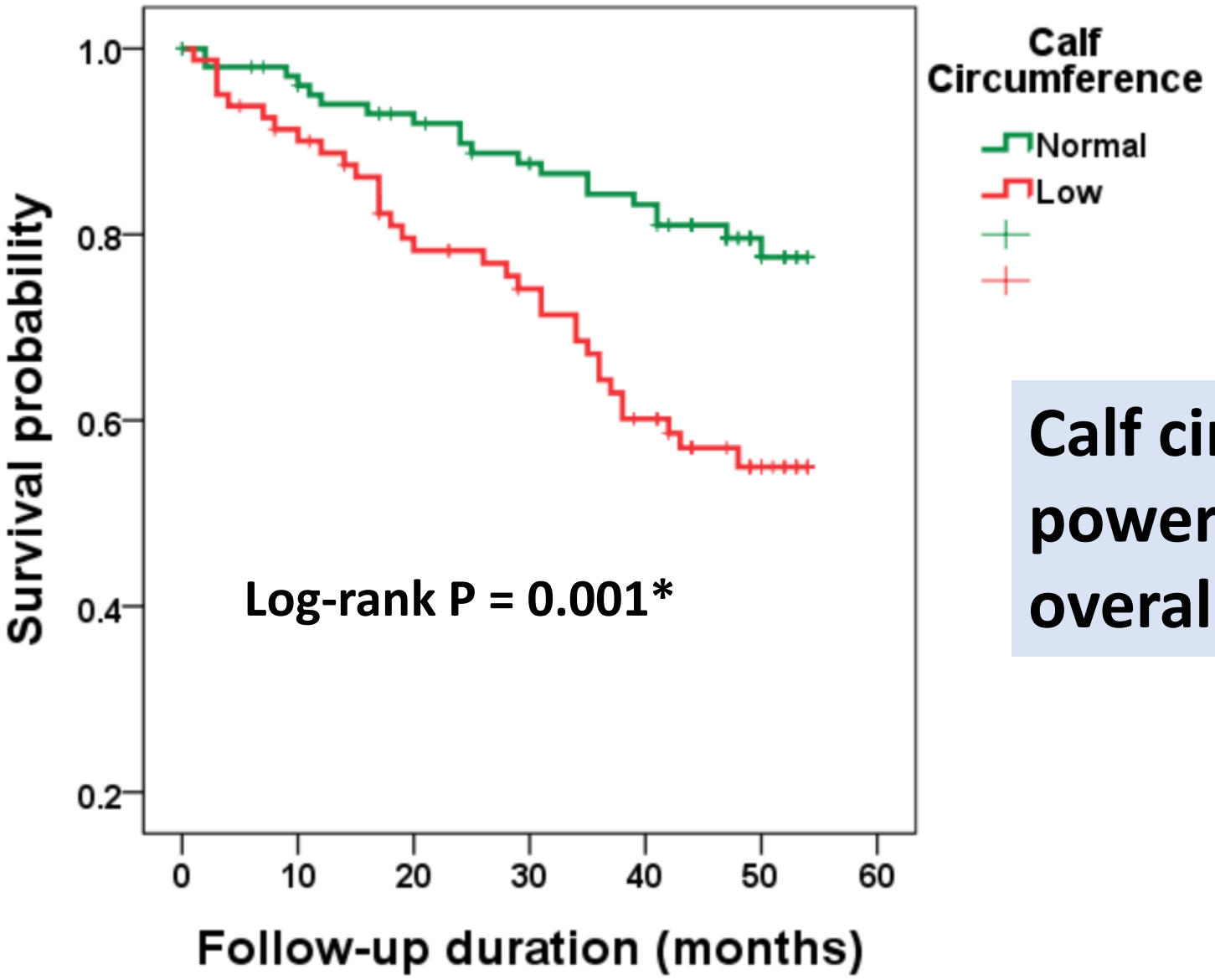
For ESRD population:

Male ≤ 34 cm (PPV 64%, NPV 93%)

Female ≤ 33 cm (PPV 59%, NPV 84%)

Lin et al., Nutrients 2022; 14: 923

4-year follow-up of Tzu-Chi PD cohort



Calf circumference is a powerful predictor for overall mortality.

Unpublished data

Outline

Sarcopenia burden in CKD and ESRD

Applying diagnostic criteria and screening tools derived from geriatric population into ESRD patients

Etiologies of uremic sarcopenia, focusing on vascular burden and dysfunction

Combating sarcopenia at Hualien Tzu-Chi Hospital

Table 1. Aetiology of muscle wasting in sarcopenia and CKD

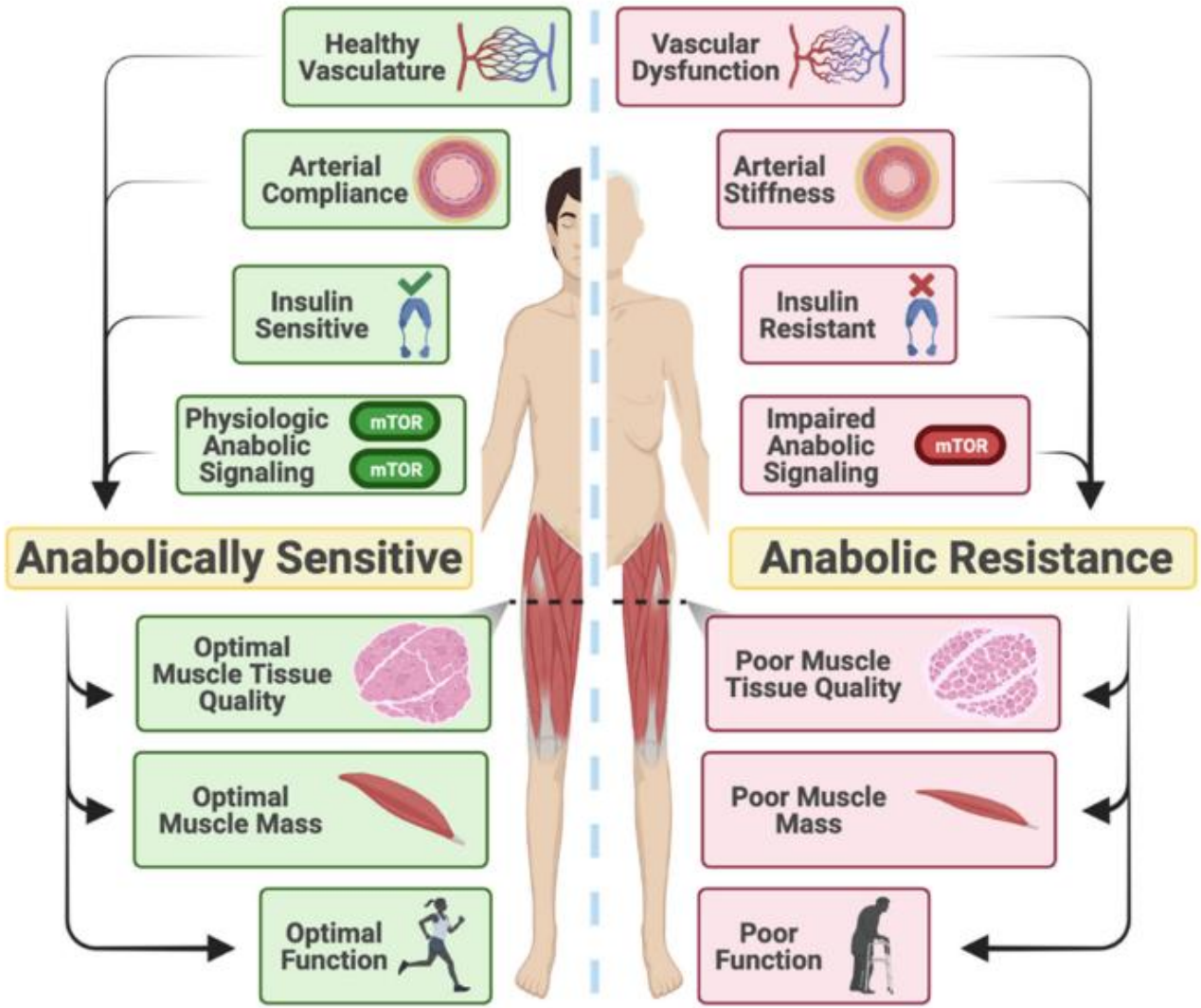
Sarcopenia	CKD
• Increase in proinflammatory cytokines	• Increase in proinflammatory cytokines
• Decreased protein intake	• Muscle protein imbalance
• Decline in exercise	• Inactivity
• Decrease sex hormones	• Decrease sex hormones
• Decreased Growth hormone	• Growth hormone resistance
• Decreased insulin	• Insulin resistance
• Decrease vitamin D	• Vitamin D abnormalities
• Decline in satellite cells	• Decline in satellite cells
	• Metabolic acidosis
	• Angiotensin II
	• PEW
	• Myostatin overexpression

Compared to sarcopenia resulting from aging alone, the mechanisms behind sarcopenia in dialysis patients are far more complex.

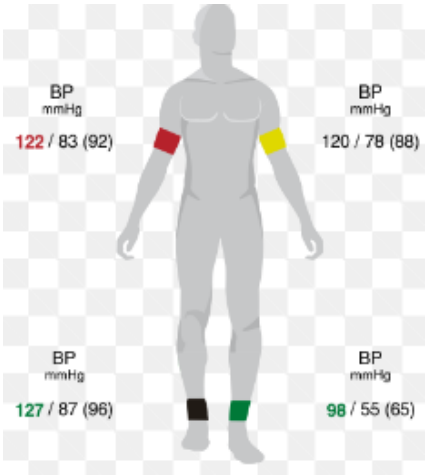
Nephrology Dialysis Transplantation 2014; 29:1655–65

Journal of Cachexia, Sarcopenia and Muscle 2022; **13**: 114–127

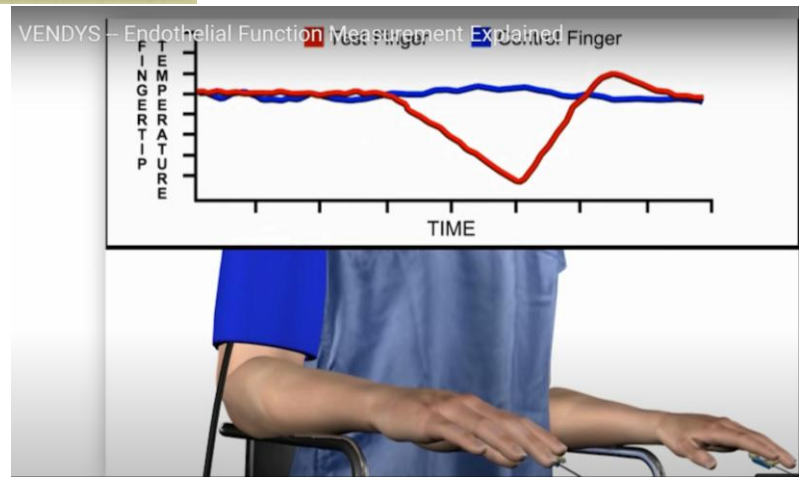
The contributory role of vascular health in age-related anabolic resistance



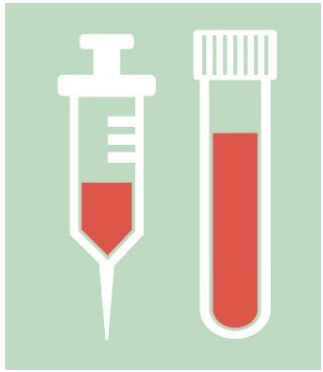
CKD Cohort, stage 3-5 (2018-2023, n=420)



Ankle-Brachial index (ABI)



Vascular reactivity Index (VRI)

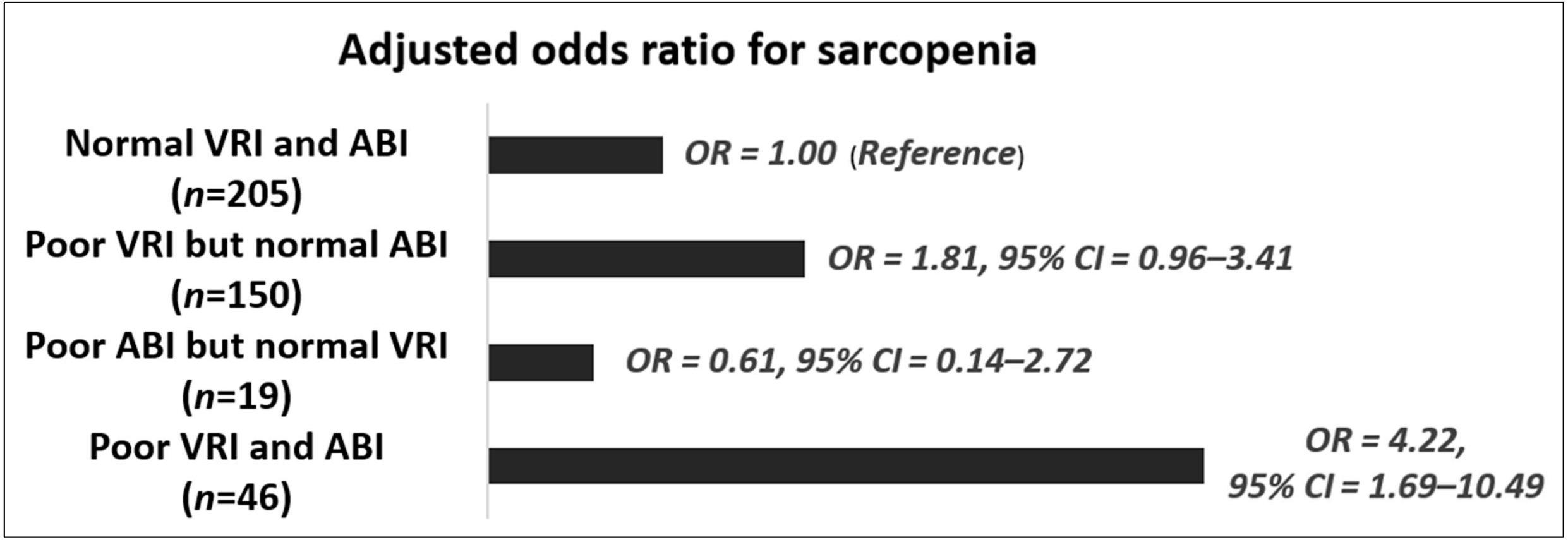


ICAM-1, VCAM-1, ADMA, endothelin-1, IL-6

Hsu et al., Journal of Cachexia, Sarcopenia and Muscle 2024; 15: 1199–1208

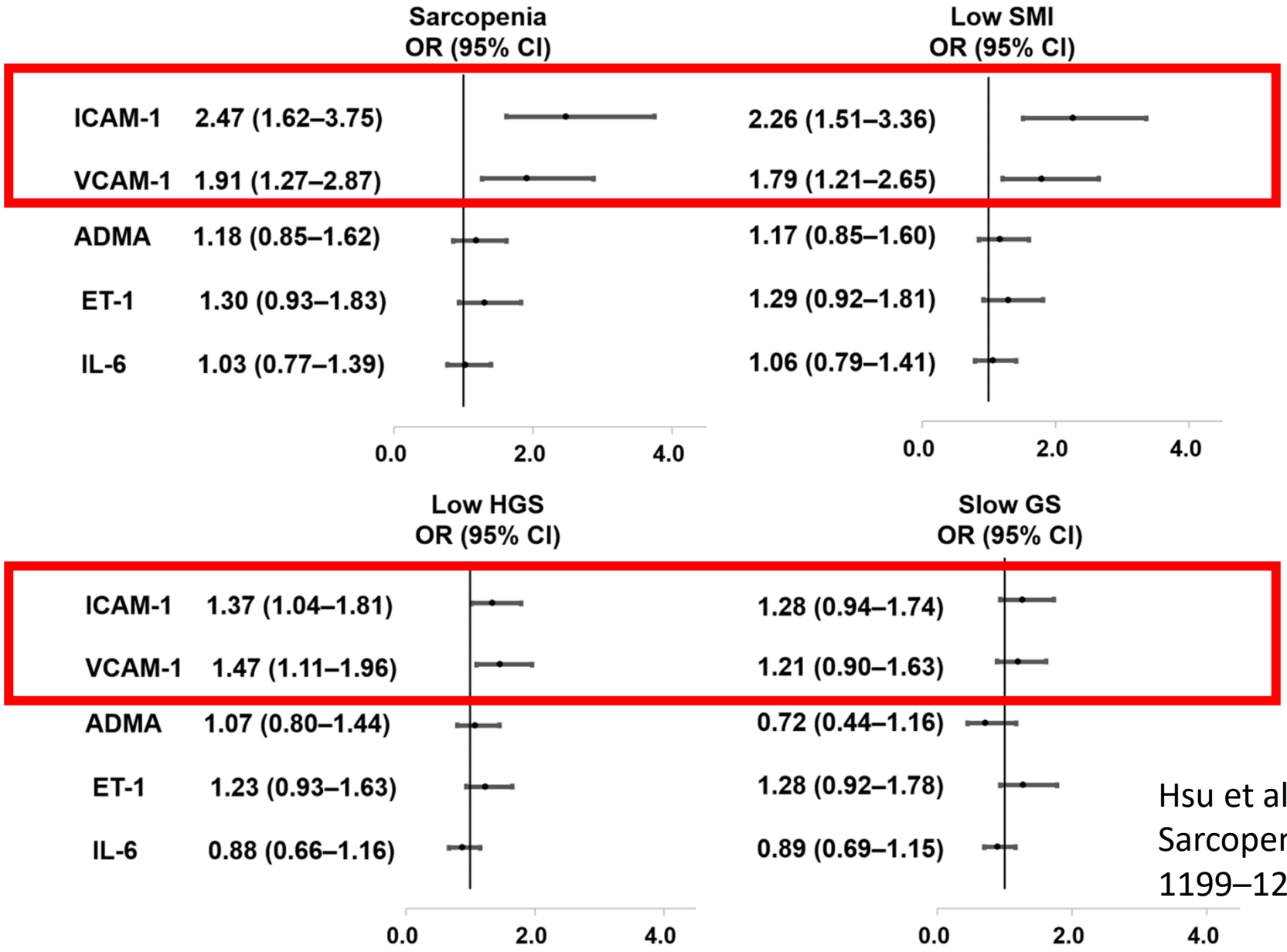
Hsu et al., Journal of Cachexia, Sarcopenia and Muscle 2024; 15: 1199–1208

Combined effects of poor VRI and ABI on the risk of sarcopenia.



Fully adjusted for age, gender, DM, BMI, eGFR, albumin, UPCR, and pulse pressure

Associations of endothelial biomarkers (per 1-SD increase) with sarcopenia, low SMI, HGS, and slow GS in a subgroup of 262 patients with CKD



Adjust for age, gender, DM, BMI, eGFR, albumin, UPCR, pulse pressure, and IL-6

Hsu et al., Journal of Cachexia, Sarcopenia and Muscle 2024; 15: 1199–1208

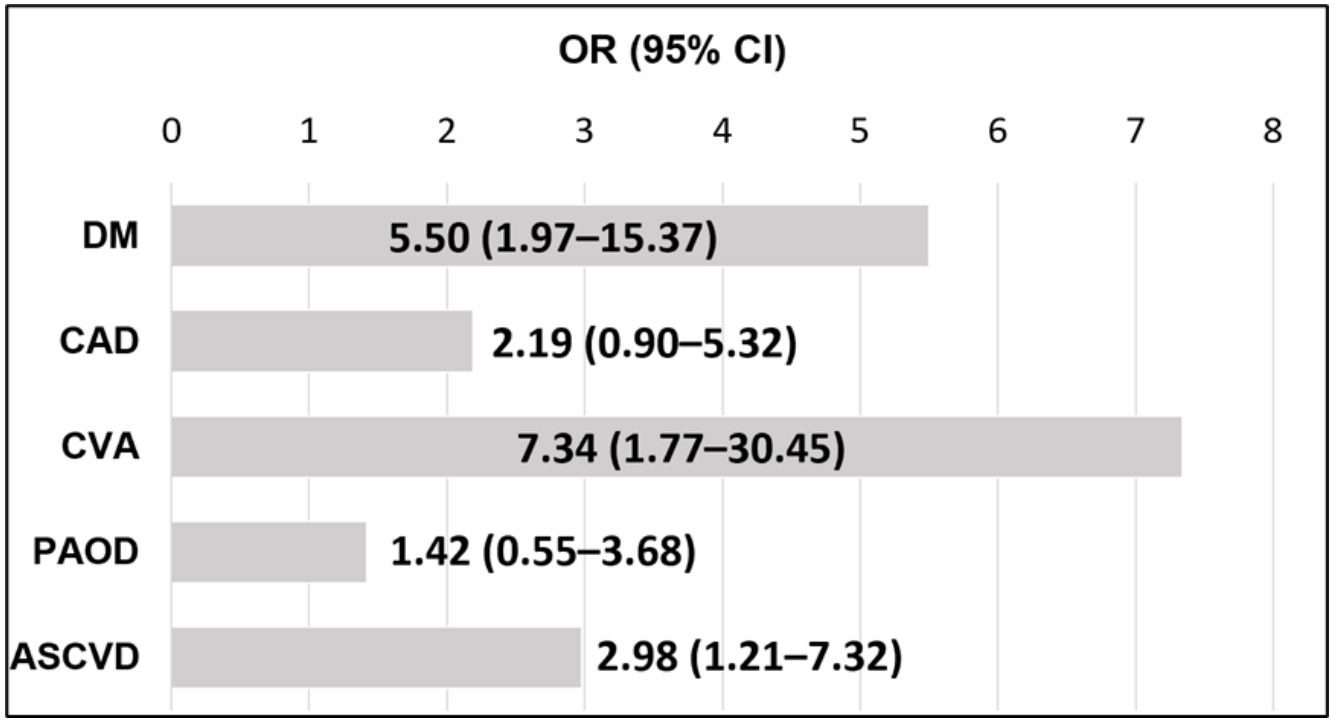
Tzu-Chi PD Cohort

TABLE 2 Univariate and multivariate factors associated with sarcopenia among PD patients.

Variables	Univariate		Multivariate	
	OR (95% CI)	*p*	OR (95% CI)	*p*
Age (years)	1.04 (1.01–1.06)	0.002*	1.04 (1.00–1.08)	0.035*
Gender (female)	1.18 (0.65–2.14)	0.580	—	—
PD duration (months)	1.00 (0.99–1.01)	0.467	—	—
DM	0.58 (0.31–1.08)	0.085	—	—
ASCVD	2.42 (1.16–5.08)	0.019*	4.12 (1.34–12.65)	0.014*
BMI (kg/m^2)	0.64 (0.55–0.73)	<0.001*	0.51 (0.41–0.64)	<0.001*
Relative OH (%)	1.03 (1.00–1.05)	0.042*	1.04 (1.00–1.07)	0.029*
SGA score	1.24 (1.09–1.43)	0.002*	1.21 (0.98–1.52)	0.080
Albumin (g/dL)	0.37 (0.16–0.89)	0.027*	1.07 (0.27–4.35)	0.921
Creatinine (mg/dL)	0.84 (0.75–0.93)	0.001*	0.89 (0.73–1.08)	0.236
Phosphorus (mg/dL)	0.78 (0.61–0.98)	0.036*	0.81 (0.53–1.25)	0.340
Intact PTH (pg/mL)[a]	1.85 (1.02–3.35)	0.041*	3.72 (1.51–9.14)	0.004*
FGF-23 (pg/mL)[a]	0.73 (0.48–1.11)	0.139	—	—
α-Klotho (pg/mL)[a]	1.14 (0.30–4.33)	0.850	—	—
Active vitamin D user	1.50 (0.75–3.00)	0.250		

Hsu et al. Front. Med. 2024; 11:1487449

Association of ASCVD, Vascular Dysfunction with Uremic Sarcopenia in Chronic HD Patients



N = 209 Unpublished data

highlights the impact of the CV burden and severity of vascular dysfunction on the risk of sarcopenia

Independent variable	Linear regression		
	Dependent variable	β (95% CI)	*p* value
Aortic PWV (m/s)	ASMI (kg/m^2)	-0.04 (-0.07–-0.00)	0.044*
	HGS (kg)	-0.59 (-0.95–-0.22)	0.002*
	GS (m/s)	-0.02 (-0.04–-0.00)	0.018*
	CC (cm)	-0.22 (-0.40–-0.04)	0.020*
	—	—	—
ABI, average	ASMI (kg/m^2)	-0.11 (-0.65–0.42)	0.677
	HGS (kg)	4.39 (-1.34–10.12)	0.135
	GS (m/s)	0.35 (0.09–0.60)	0.008*
	CC (cm)	1.22 (-1.74–4.18)	0.421
	—	—	—
CAVI, average	ASMI (kg/m^2)	0.01 (-0.02–0.04)	0.556
	HGS (kg)	0.20 (-0.12–0.52)	0.214
	GS (m/s)	0.01 (-0.01–0.02)	0.308
	CC (cm)	0.12 (-0.02–0.27)	0.093
	—	—	—
VRI[a]	ASMI (kg/m^2)	-0.07 (-0.26–0.12)	0.464
	HGS (kg)	-0.25 (-2.29–1.78)	0.808
	GS (m/s)	-0.02 (-0.12–0.07)	0.669
	CC (cm)	-0.41 (-1.43–0.62)	0.437
	—	—	—

Outline

Sarcopenia burden in CKD and ESRD

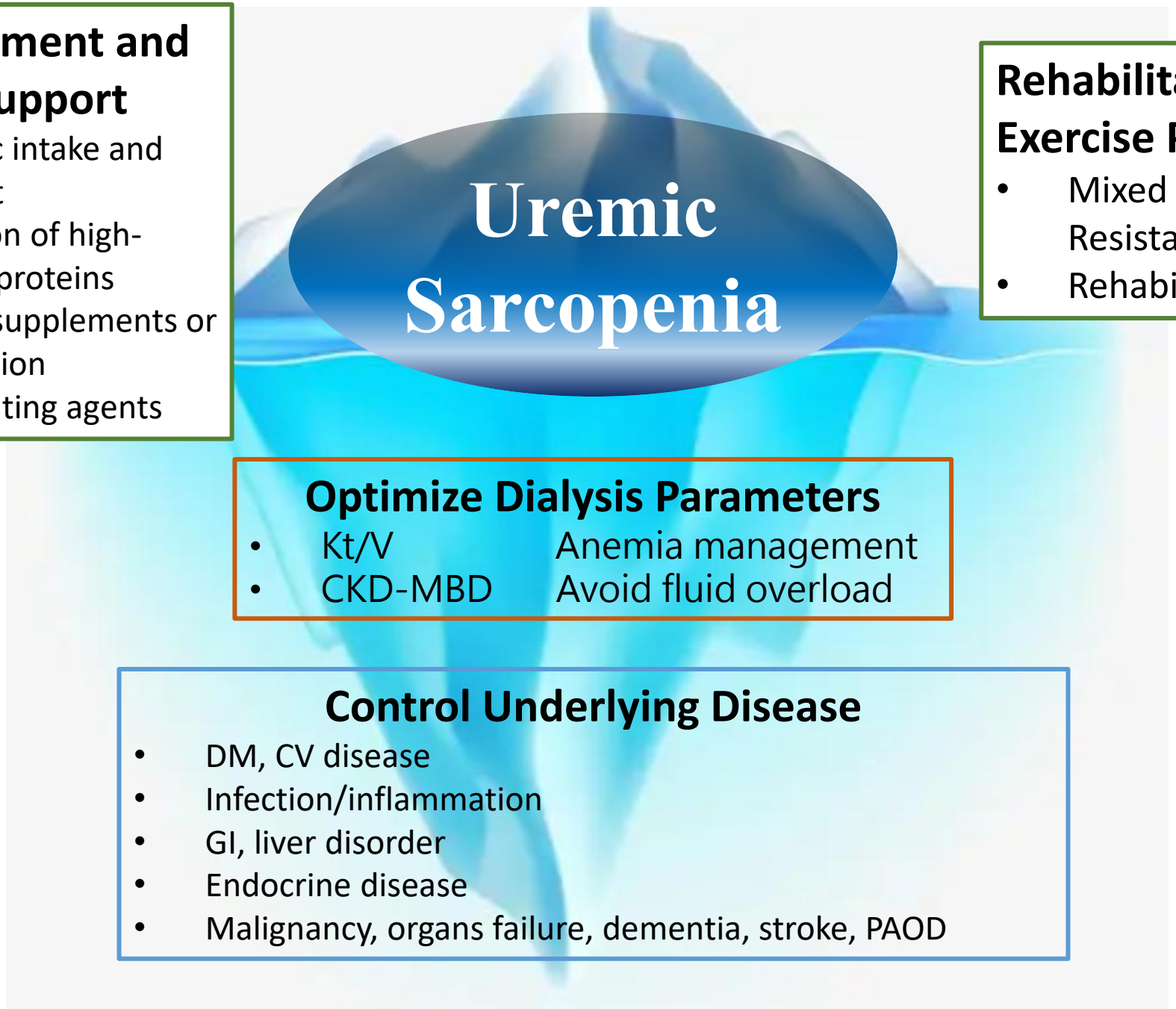
Applying diagnostic criteria and screening tools derived from geriatric population into ESRD patients

Etiologies of uremic sarcopenia, focusing on vascular burden and dysfunction

Combating sarcopenia at Hualien Tzu-Chi Hospital

Dietary Assessment and Nutrition Support

- Adequate caloric intake and high-protein diet
- Higher proportion of high-biological-value proteins
- Oral nutritional supplements or parenteral nutrition
- Appetite-stimulating agents



Rehabilitation and Exercise Prescription

- Mixed Anaerobic and Resistance Exercise
- Rehabilitation

Optimize Dialysis Parameters

- Kt/V
- CKD-MBD
- Anemia management
- Avoid fluid overload

Control Underlying Disease

- DM, CV disease
- Infection/inflammation
- GI, liver disorder
- Endocrine disease
- Malignancy, organs failure, dementia, stroke, PAOD

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透析病患營養不良暨肌少症的評估及處置原則

一、營養指標相關評估頻率

每個月	每 3 個月	每半年	視情況安排
乾體重、 Albumin、nPCR	TCH	BCM 身體組成 MIS、SARC-F	飲食紀錄 肌握力 步態速度

二、Protein energy wasting (PEW) 定義:

A. 血清營養指標
1. Albumin < 3.8 g/dL
2. TCH < 100 mg/dL

C. 肌肉質量
1. LTI 低於同年齡基準值
2. 肌肉流失:三個月>5%或六個月>10%

B. 身體質量 (body mass)
1. BMI<23
2. 體重減輕:三個月>5%或六個月>10%
3. 體脂率<10%

D. 飲食攝取量
nPCR < 0.8 g/kg/day
Energy < 25 kcal/kg/day

(Fouque et al. Kidney Int. 2008; 73:391-8)

* PEW 診斷標準: 4 項中符合 ≥ 3 項或 MIS ≥ 8
* At Risk of PEW: 4 項中符合 ≥ 2 項或 MIS ≥ 5

三、PEW 或 Risk of PEW 處置原則

PEW 或 At Risk of PEW

→ 排除末期疾病(腎臟病除外)

- 相關疾病的評估與控制(如糖尿病、體液堆積、手術後、住院、傷口、心血管疾病、感染、肝膽腸胃疾病、牙口不佳、內分泌、腫瘤、失智憂鬱、藥物...等)
- 飲食紀錄評估及飲食調整建議
- 透析配方牛奶補充:(約可補充 400-450 kcal、8-22g 蛋白質/份)
- IV 胺基酸補充:含 17.5 g 胺基酸/250cc
- ±食慾促進劑: Primperan、Megesterol 等
- Tube feeding or IDPN: 重度營養不良或治療反應不佳者

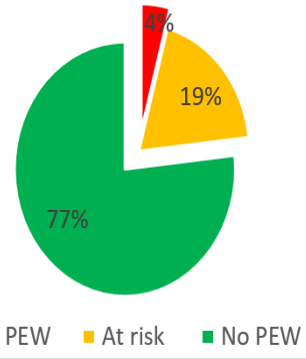
建議復健或運動處方 (SARC-F >1 且具復健潛能)

逐月評估食慾、體重、血清營養指標及 nPCR 變化; 6 個月重新評估 PEW 狀態

姓名	BMI	LTI	LTI_difference	Albumin	nPCR	PEW
胡 花	23.3	10.2	-0.6	2	0.89	At Risk
潘 源	29	12.9	0.3	2.8	0.66	At Risk
黃 溱	19.7	7.1	-3.7	3		PEW
許 傑	24.1	14	0.2	3.1	0.97	No PEW
余 英	24	6.1	-2.7	3.1	1.18	At Risk
陳 良	22.6	15.6	-0.4	3.2		PEW
孟 華	21.5	12.3	1.9	3.2	1.28	At Risk
潘 照	22.8	11.6	2	3.2	1.06	At Risk
簡 財	19.2	--	--	3.3	0.6	PEW
顏	19.9	11.2	2.2	3.3	1.39	At Risk
潘 興	23.8	8.2	-4.2	3.4	0.64	PEW
黃 子	16.7	12.3	2.7	3.4	1.13	At Risk
徐 豔	21.1	16.6	2.2	3.4	0.83	At Risk
陳 宇	25.8	23.1	7	3.4	0.62	At Risk
楊 卿	36.5	19.6	9.3	3.4	0.66	At Risk

2023年上半季血液透析病患PEW評估

欄1	PEW	At risk	No PEW	Total
N	12	55	221	288
%	4.2	19.1	76.7	



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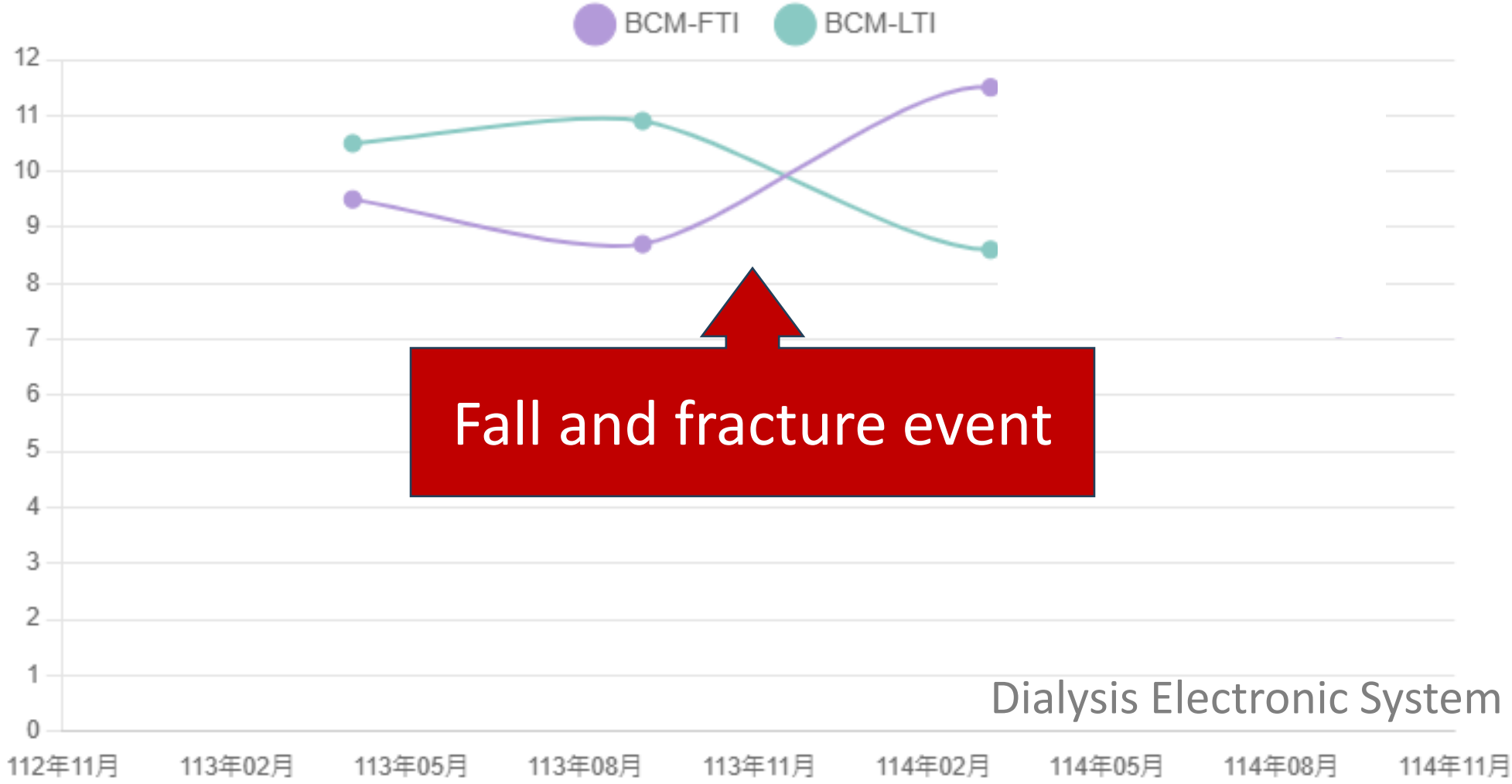
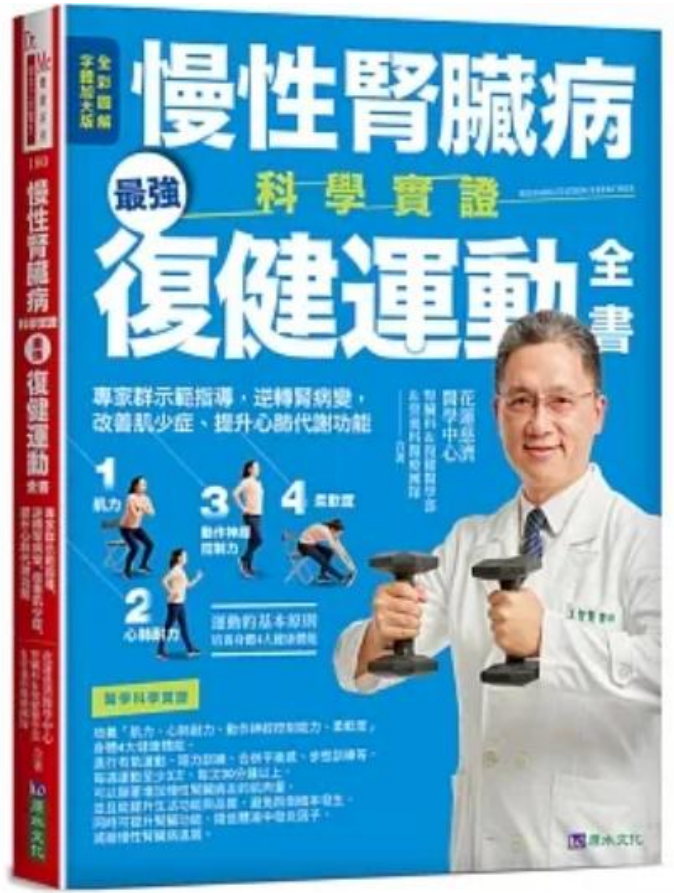
Body Composition Monitoring in a 59-year-old ESRD Woman Following a Fracture

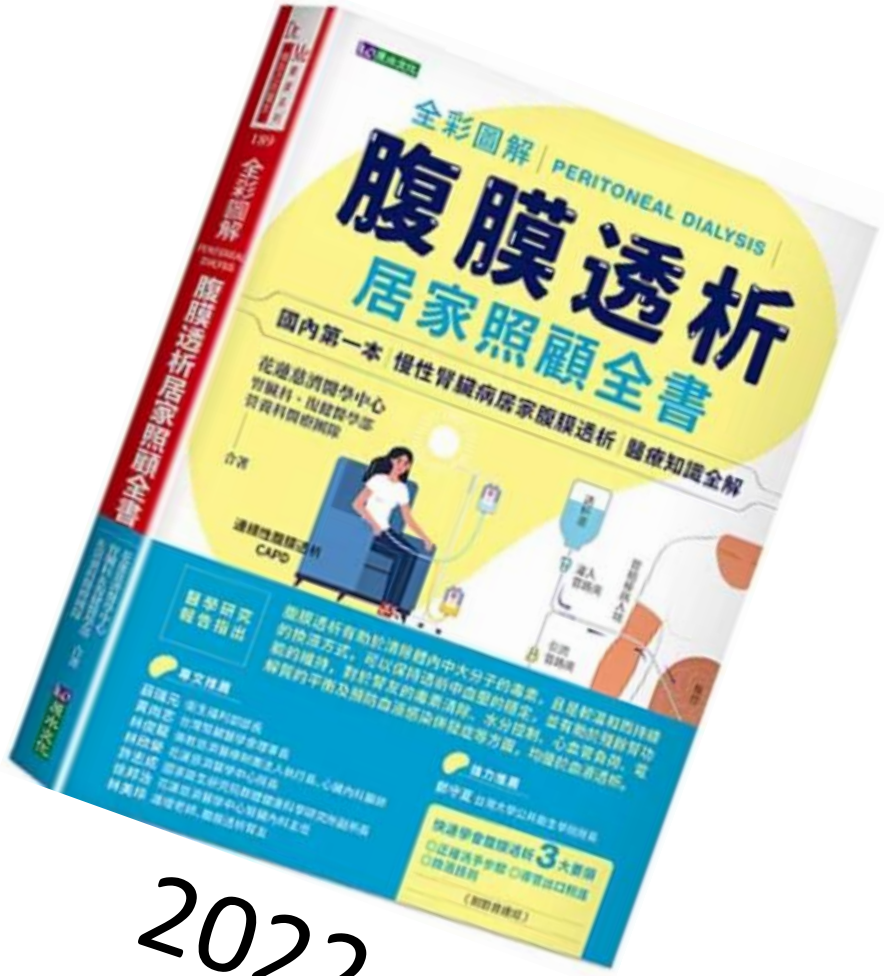


Patient education

2018



2020

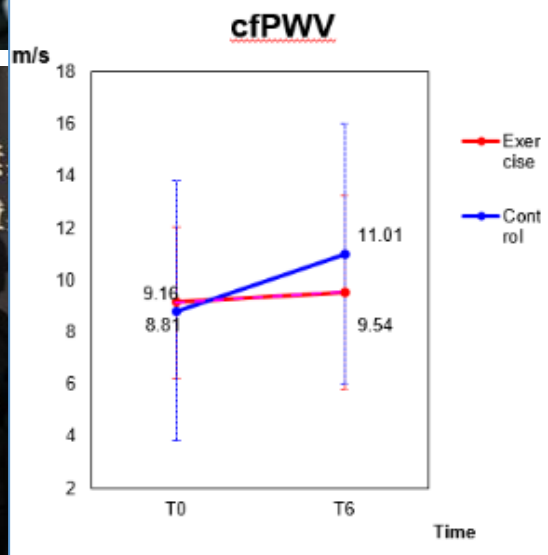


2022

Promote health awareness, encourage healthy Lifestyles, improve dialysis self-care

Intradialytic Cycling Exercise

血液透析中腳踏車運動介入改善動脈硬度之成效



運動介入六個月後與對照組比較有統計學上意義的改善 (p=0.007)
(N=114, Exercise: 75, Control: 39)

Changes in PWV from baseline to 6 months

	Group	N	Baseline	6 month	Between-group comparison by GEE P(T*G) 6 months
Vascular function					
PWV (m/s)	Exercise	75	9.16±2.90	9.54±3.71	0.007*
	Control	39	8.81±3.24	11.01±4.71	

* P value < 0.05, between-groups comparisons.

- Modest benefit on gait speed
- No significant benefits on muscle mass and strength
- Low intensity of the exercise and a lack of resistance training

Lai et al., Med Sci Monit. 2025;31:e947604.

Enhance intradialytic exercise by…

Electronic stimulation

Sandbags
砂袋

Resistance bands
彈力帶

Thank you for your attention