尿毒肌少症
的
臨床評估

花蓮慈濟醫院
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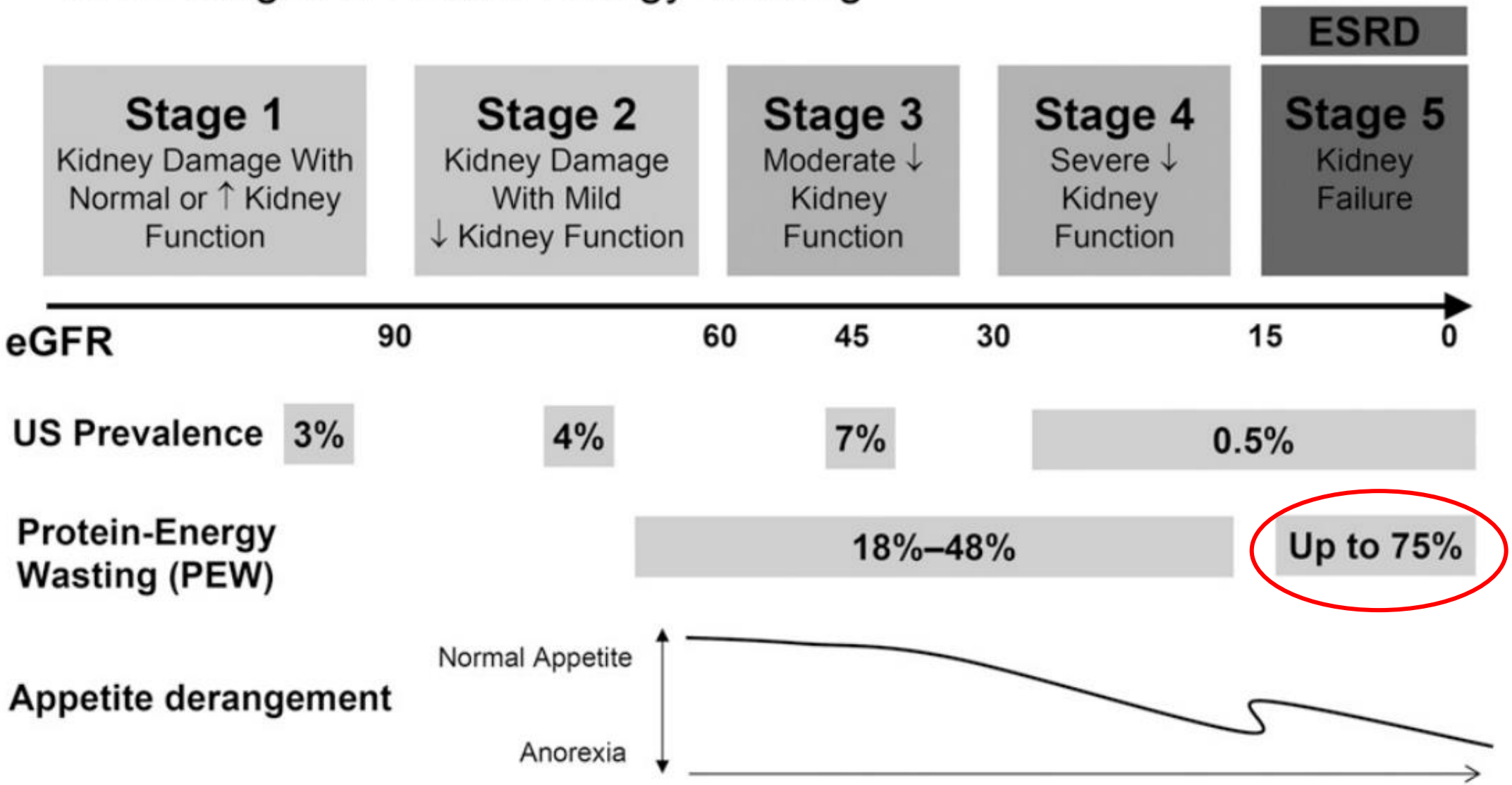
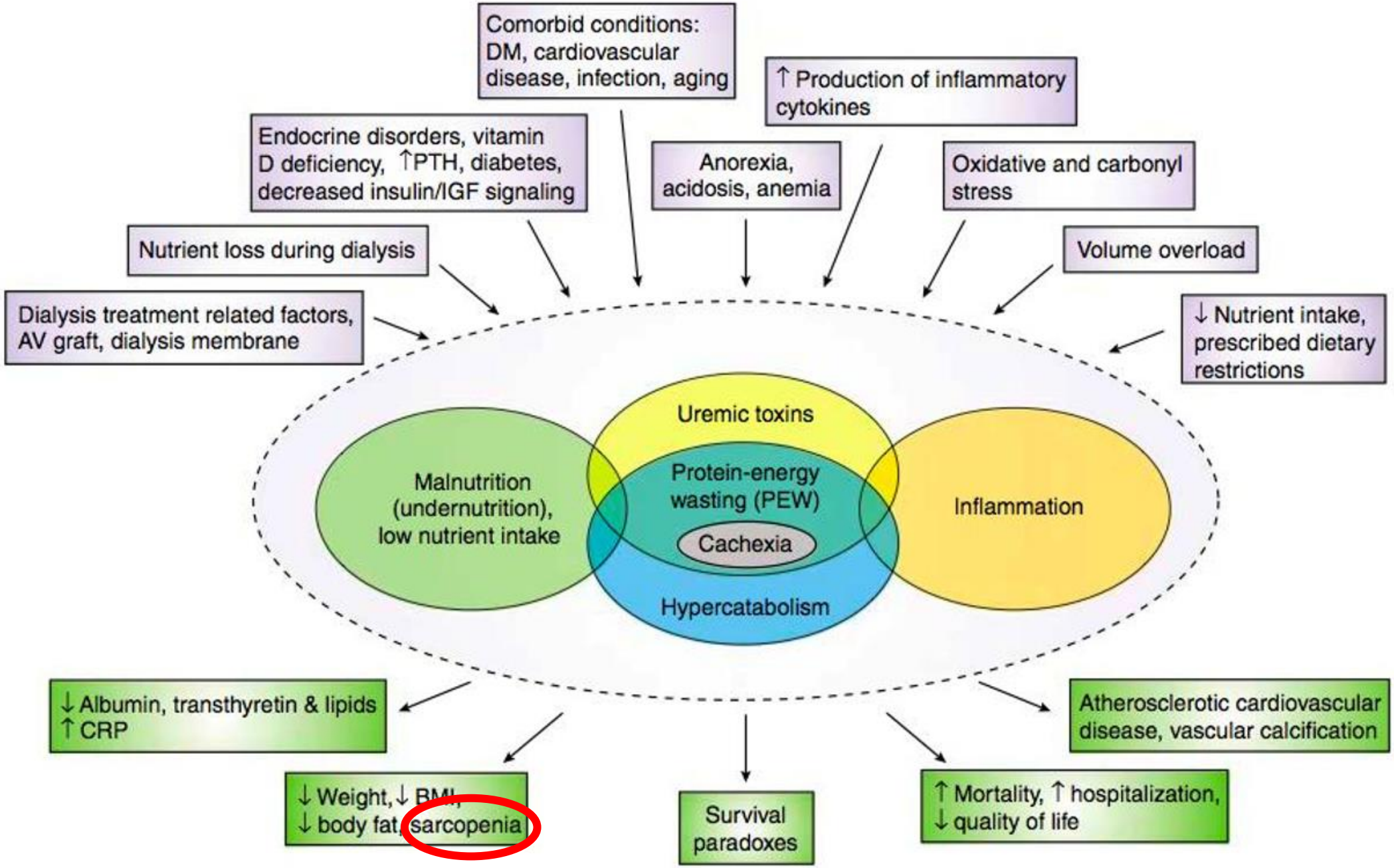
2022 年 08 月 21 日

CKD Stages & Protein-Energy Wasting

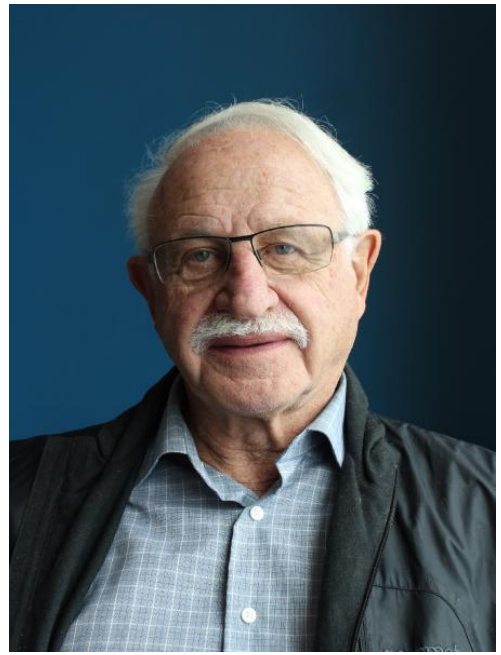


The American Journal of Clinical Nutrition **2013**, *97*, 1163-1177



Kidney International **2008**, *73*, 391-398

肌少症(Sarcopenia)



- I. H. Rosenberg所提出(Irwin H. Rosenberg, 1989)
  - ✓ “*Sarx*(肌肉)”與“*penia*(缺乏)”的組合
  - ✓ 隨著老化過程，肌肉質量逐漸下降的現象
- 預測老年人住院及死亡的風險

（Arango-Lopera et al., 2013; Landi et al., 2013; J. H. Kim et al., 2014)

- 隨著世界人口的加速老化，日益受到重視
- Internal Classiciation of Disease, ICD-10-CM: *M62.84* (Anker et al., 2016)

歐洲老年肌少症工作小組

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.

A number of consensus definitions for geriatric sarcopenia have been developed…

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.

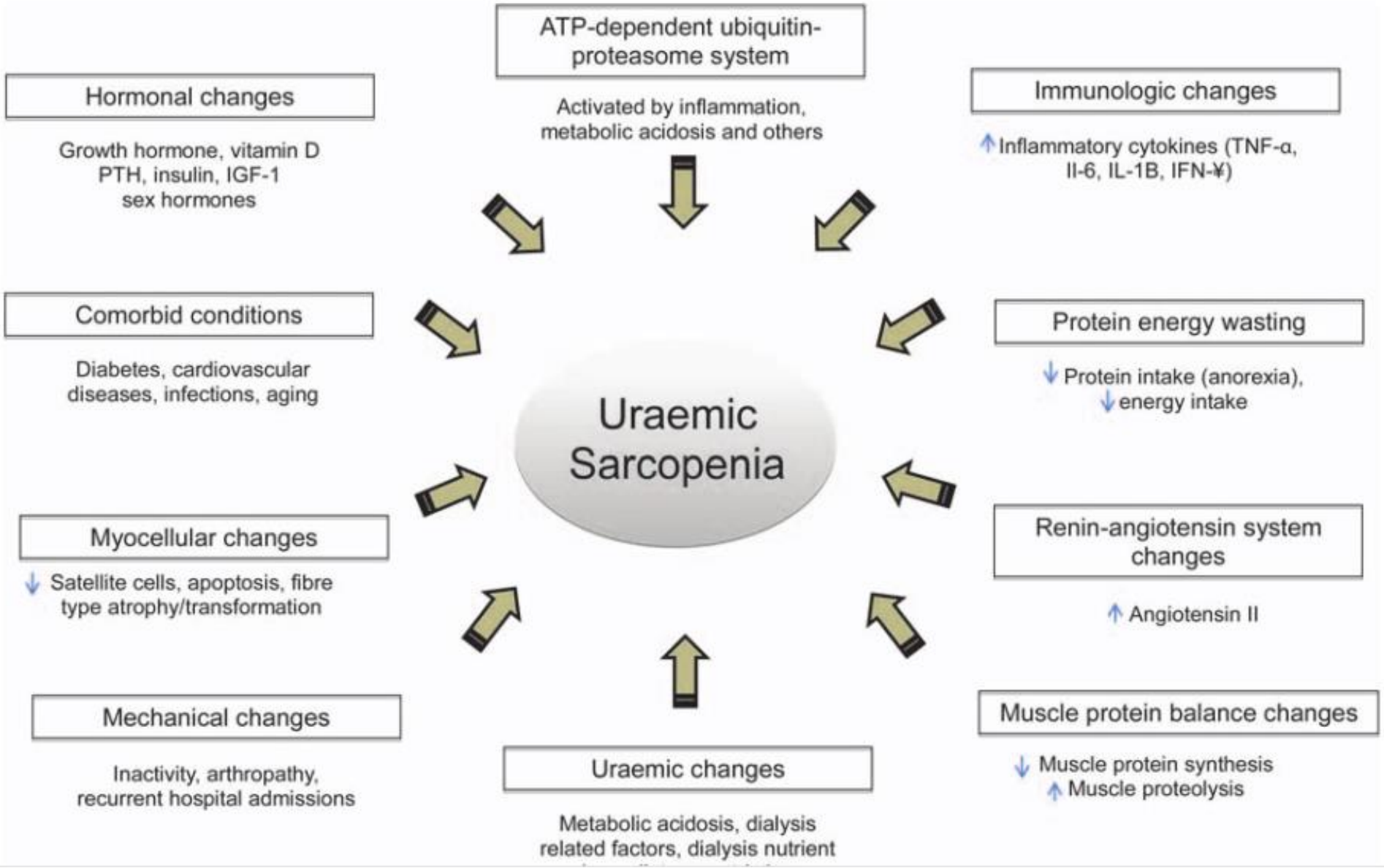
Nutrients 2022; 14: 923

末期腎臟疾病病患為肌少症的高危險群

Table 2. Sarcopenia categories by cause

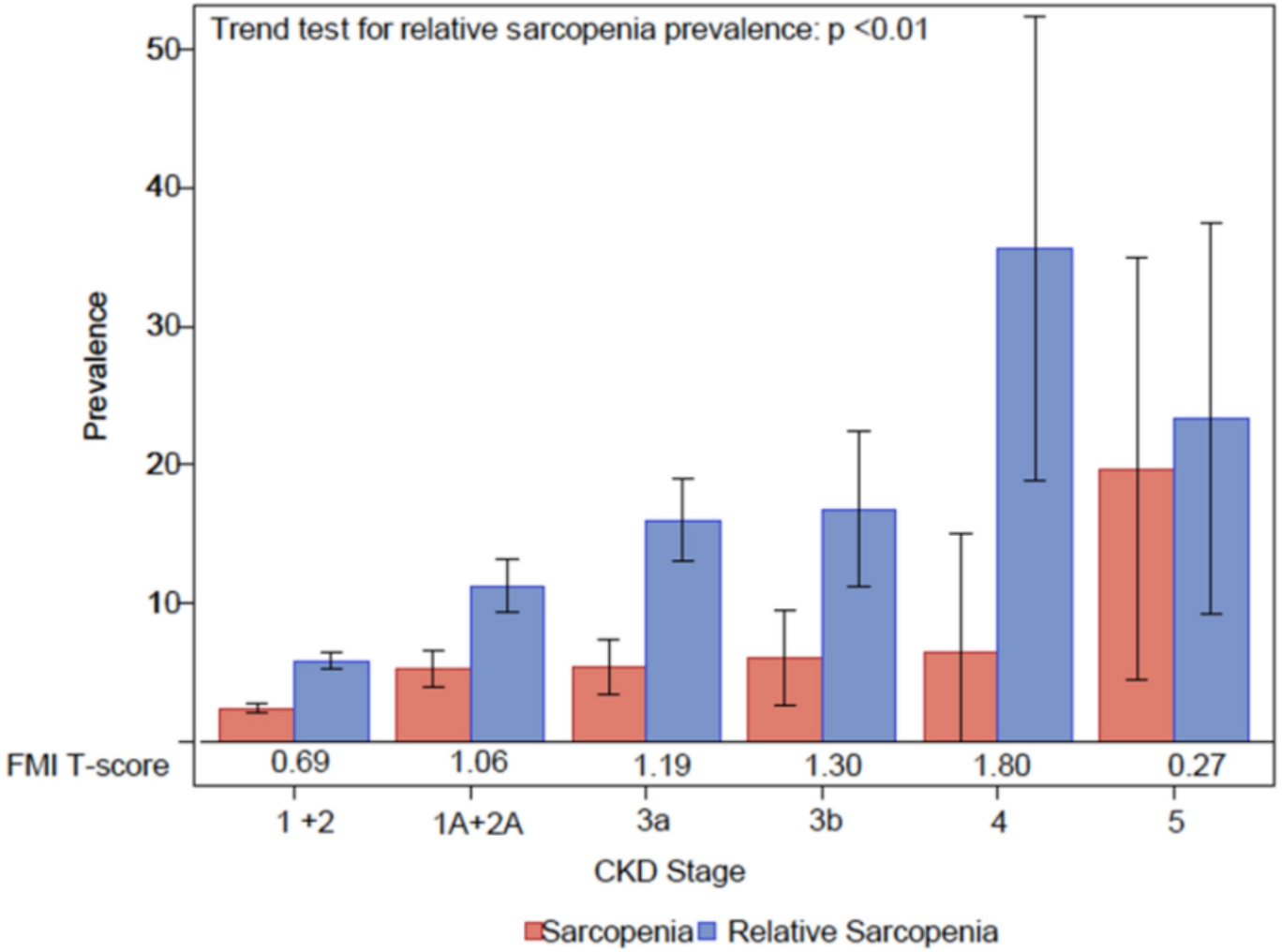
Primary sarcopenia	
Age-related sarcopenia	No other cause evident except ageing
Secondary sarcopenia	
Activity-related sarcopenia	Can result from bed rest, sedentary lifestyle, deconditioning or zero-gravity conditions
Disease-related sarcopenia	Associated with advanced organ failure (heart, lung, liver, 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.

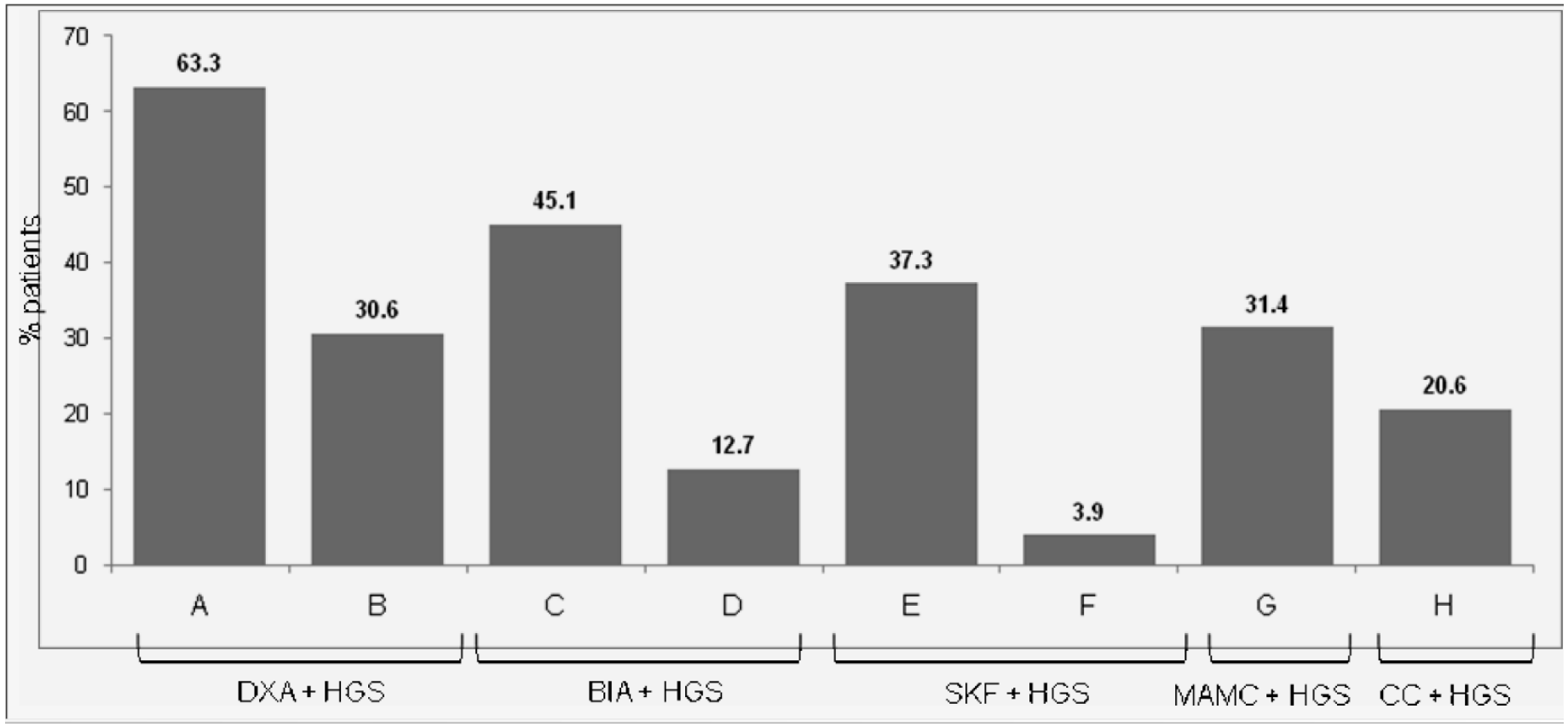


Nephrology Dialysis Transplantation 2014; 29:1655–65

Sarcopenia Prevalence in CKD



JCSM Clinical Reports 2018; 3: 1-11

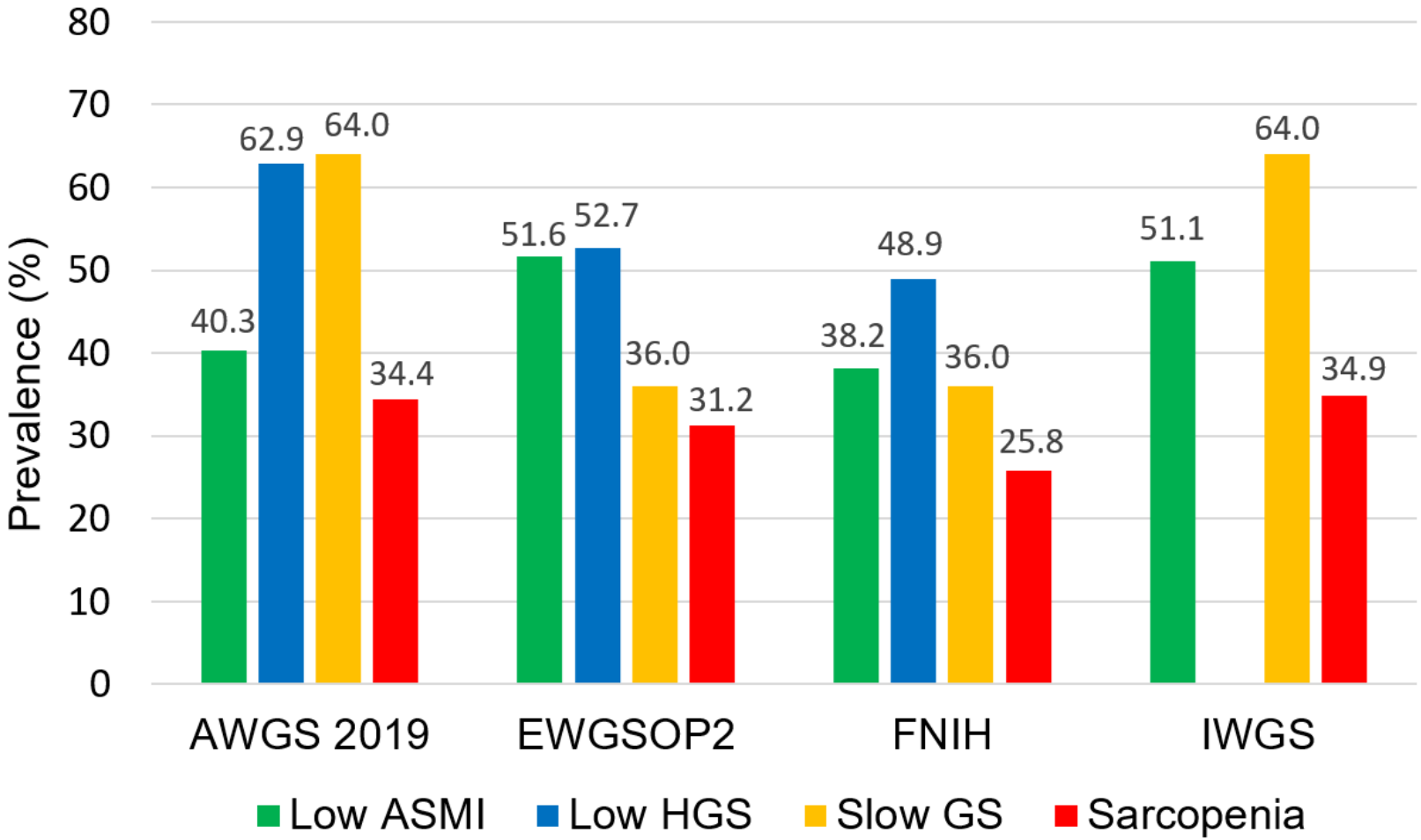


- 在末期腎臟疾病病患中，肌少症的盛行率:14%至63%

(J. K. Kim et al., 2014; Lamarca et al., 2014; Ren et al., 2016)

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.

N=186 (mean age 57.5 ± 14.1 years)



Nutrients 2022; 14: 923

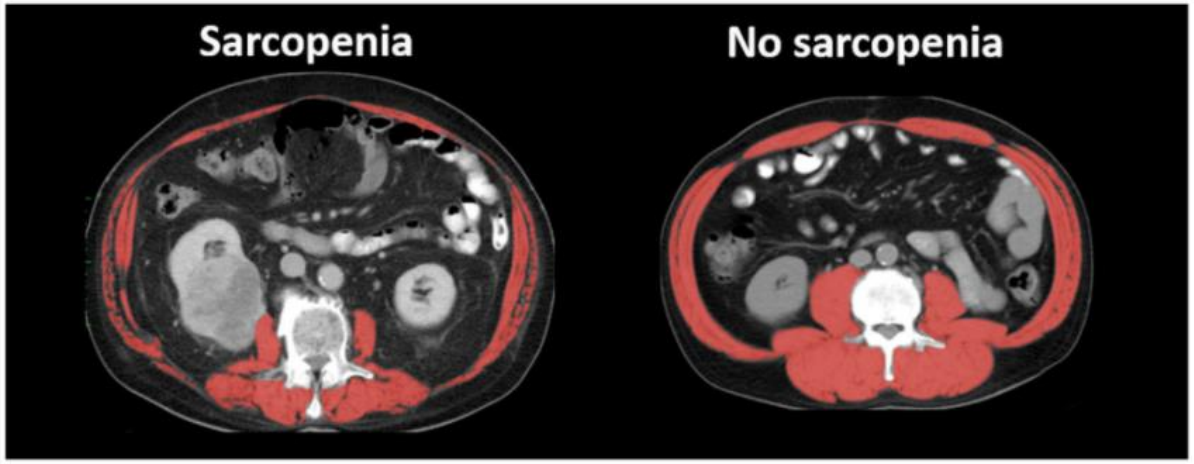
Available Clinical Tools for Skeletal Muscle Mass Measurement

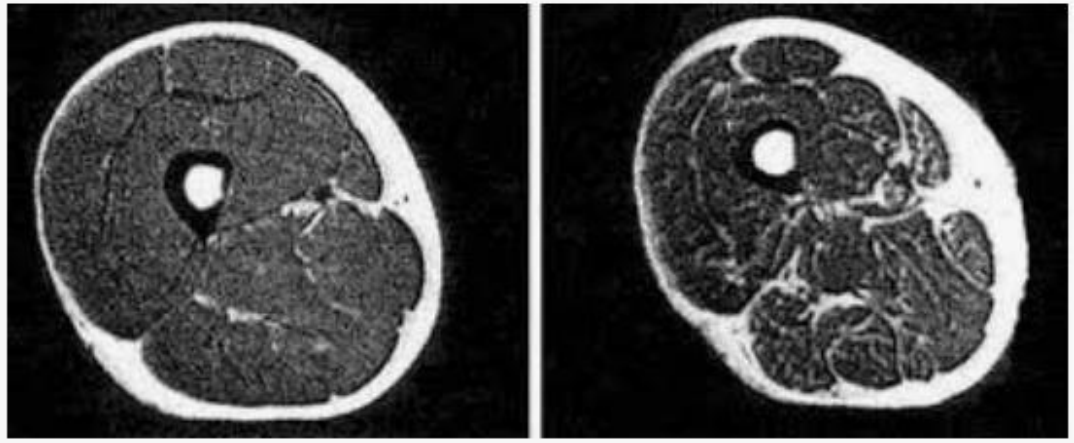
Tools	Accuracy	Cost	Radiation	Fat infiltration assessment	Operator-dependent	Clinical feasibility
MAMC	++	Low	No	No	Yes	High
BIA	+++	Low	No	No	No	High
DEXA	++++	Moderate	low	No	No	High
CT	++++	High	High	Yes	No	Low
MRI	++++	High	No	Yes	No	Low
Ultrasound	++	Low	No	Yes	Yes	High

MAMC: Mid-arm muscle circumference, BIA: Bioelectrical impedance analysis, DEXA: Dual-energy X-ray absorptiometry, CT: Computed tomography, MRI: Magnetic resonance imaging

YL Lin and BG Hsu. Tzu Chi Medical Journal 2021; 34:182-191

Figure 1. Computed tomography (CT) images of typical sarcopenic and non-sarcopenic cases. Skeletal muscle area is shown in red.

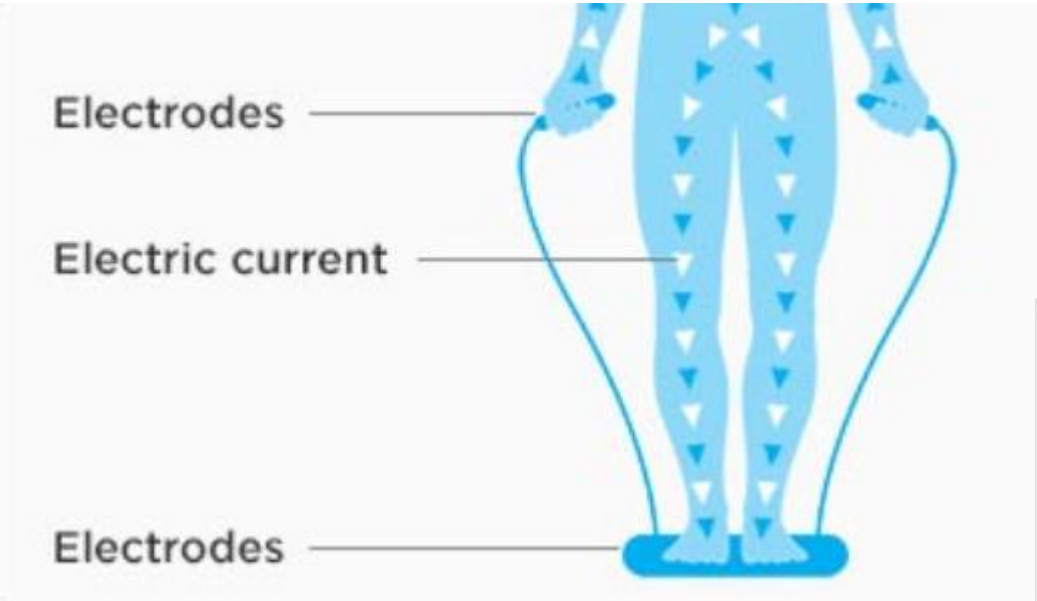


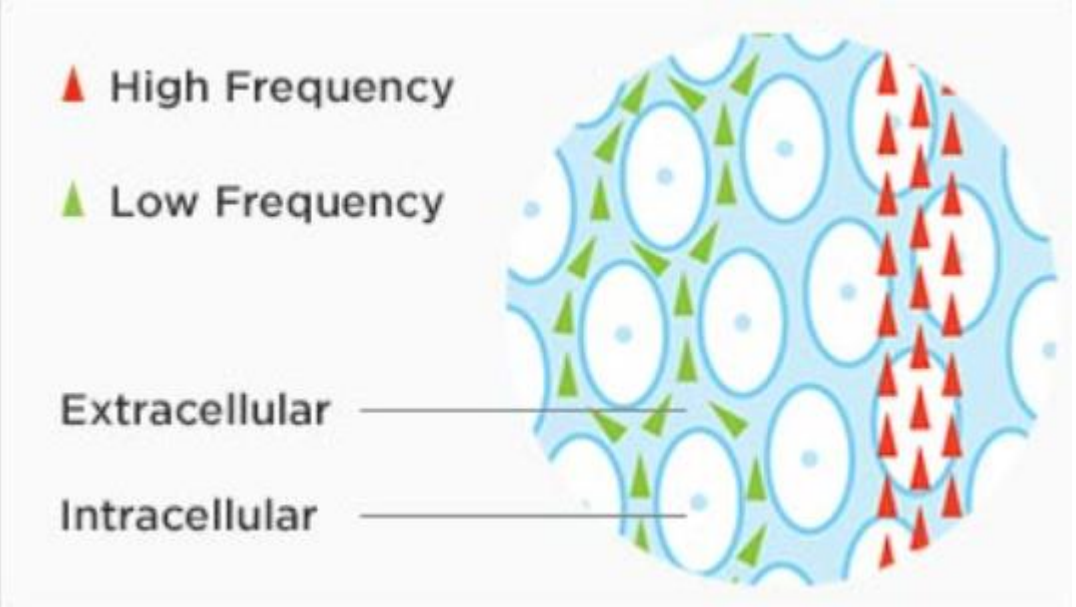


Int. J. Mol. Sci. **2018**, *19*(10), 2999

European journal of radiology 85.8 (2016): 1519-1524.

How Bio-impedance Device Works?

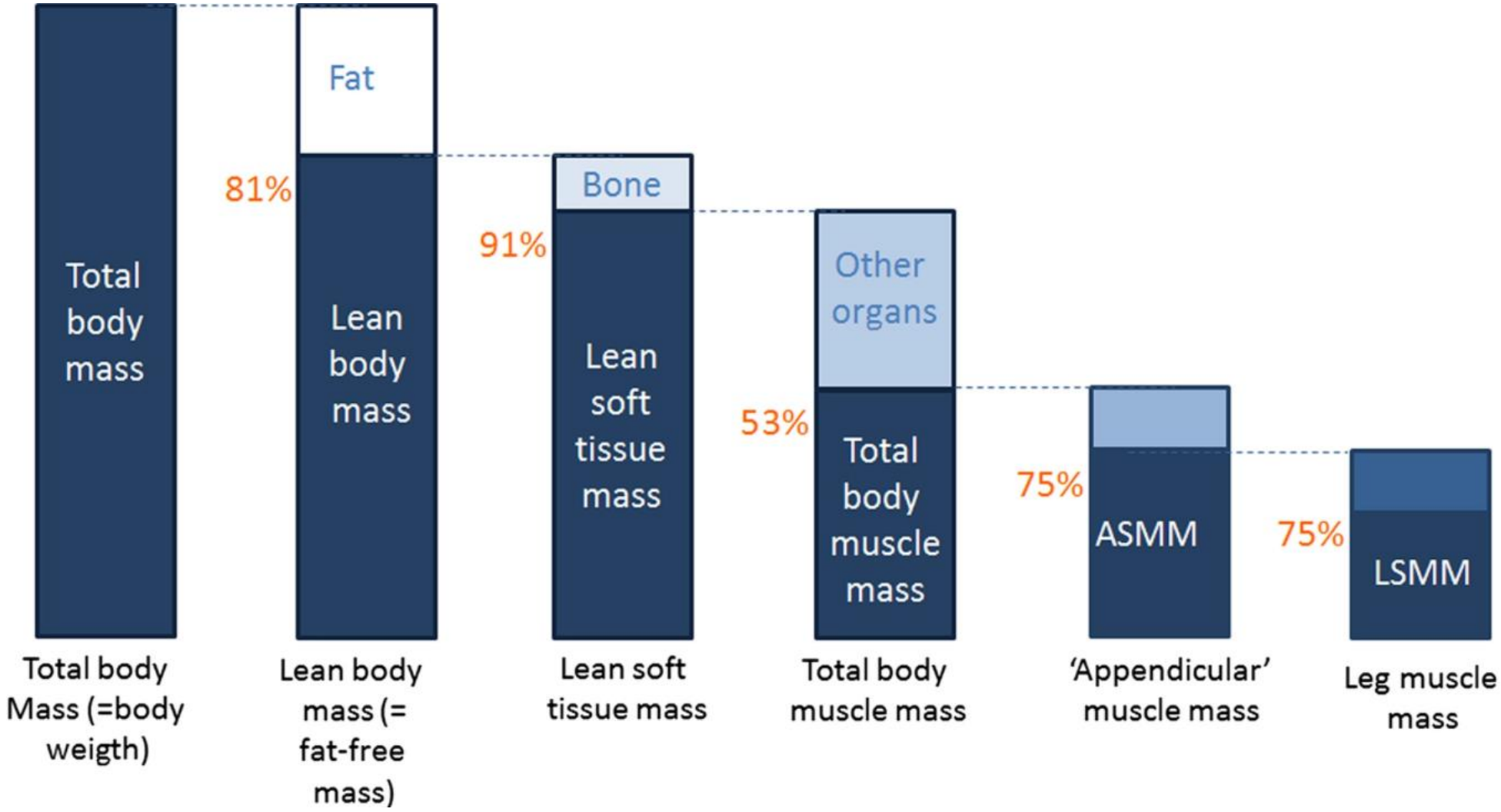




Not suitable for bio-impedance measurement:

- ✓ Amputation
- ✓ Pacemaker

https://www.tanita.com/



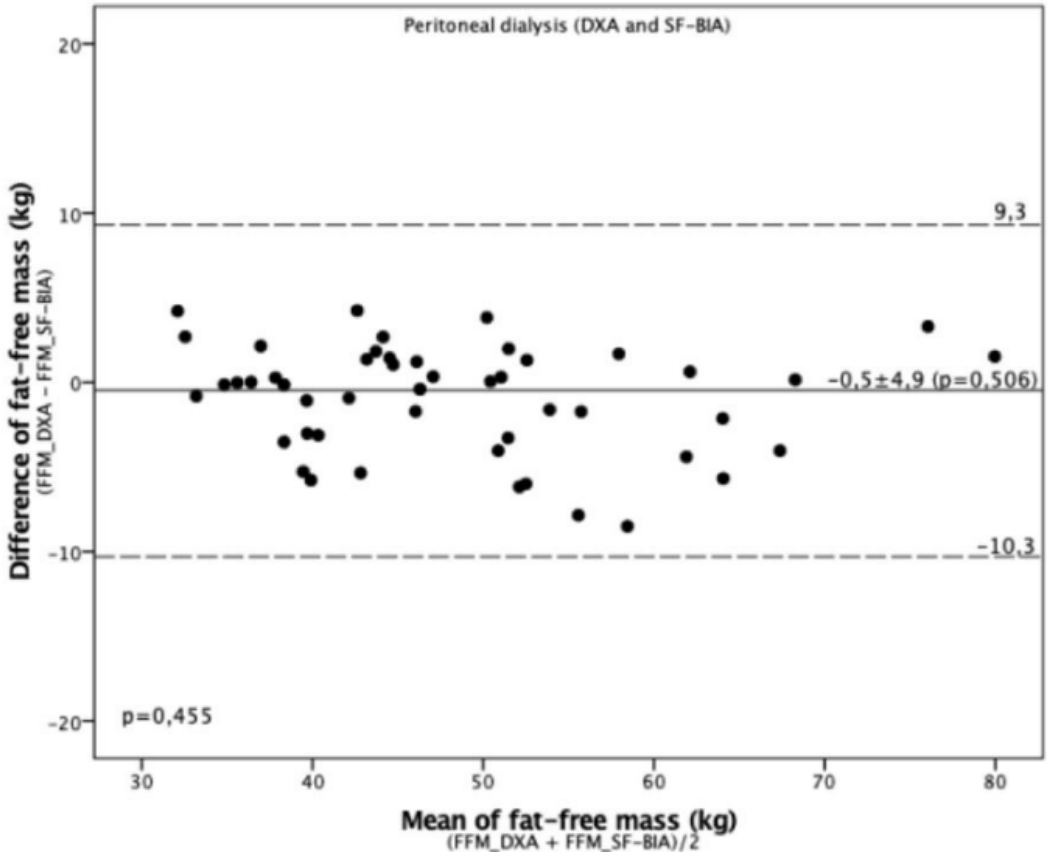
Journal of Cachexia, Sarcopenia and Muscle 2018, 9: 269– 278.

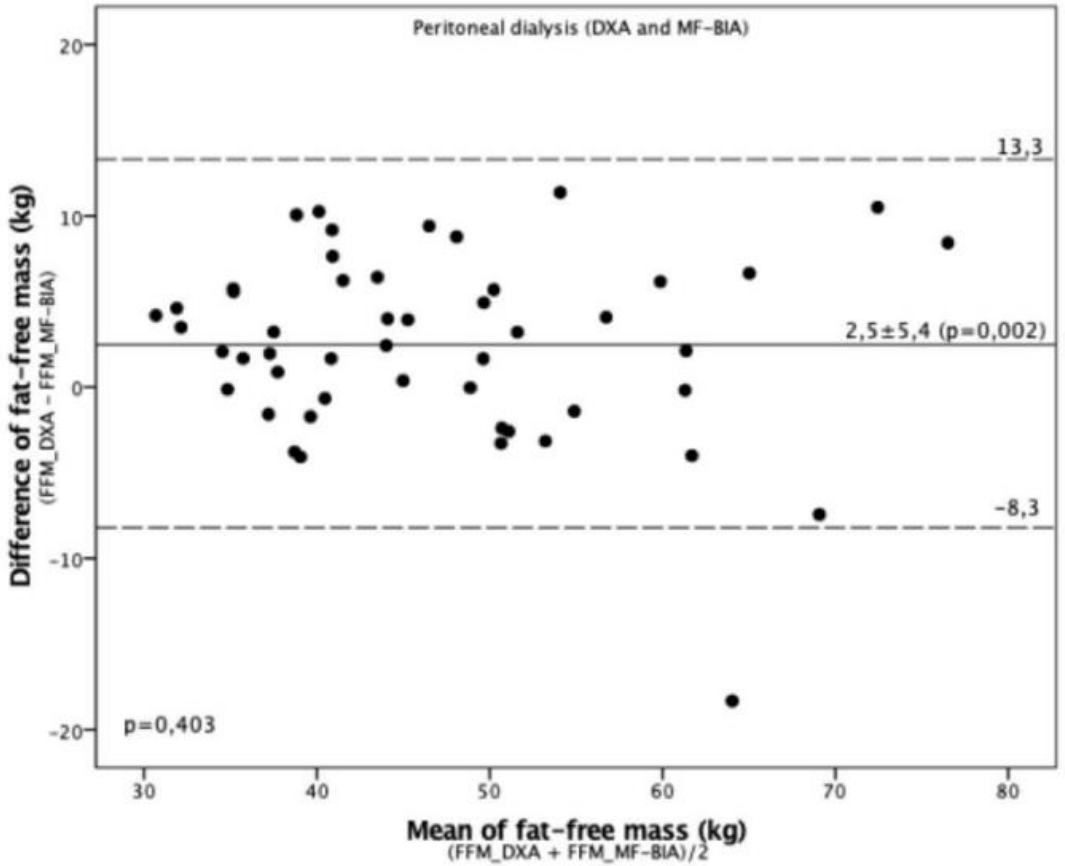
Single- vs Multi-frequency BIA ?

A Comparison among PD patients

Single-frequency

Multi-frequency





Front Nutr. 2021 May 31;8:686513.

Longitudinal changes in LTI and FTI were more strongly associated with all-cause mortality than single values

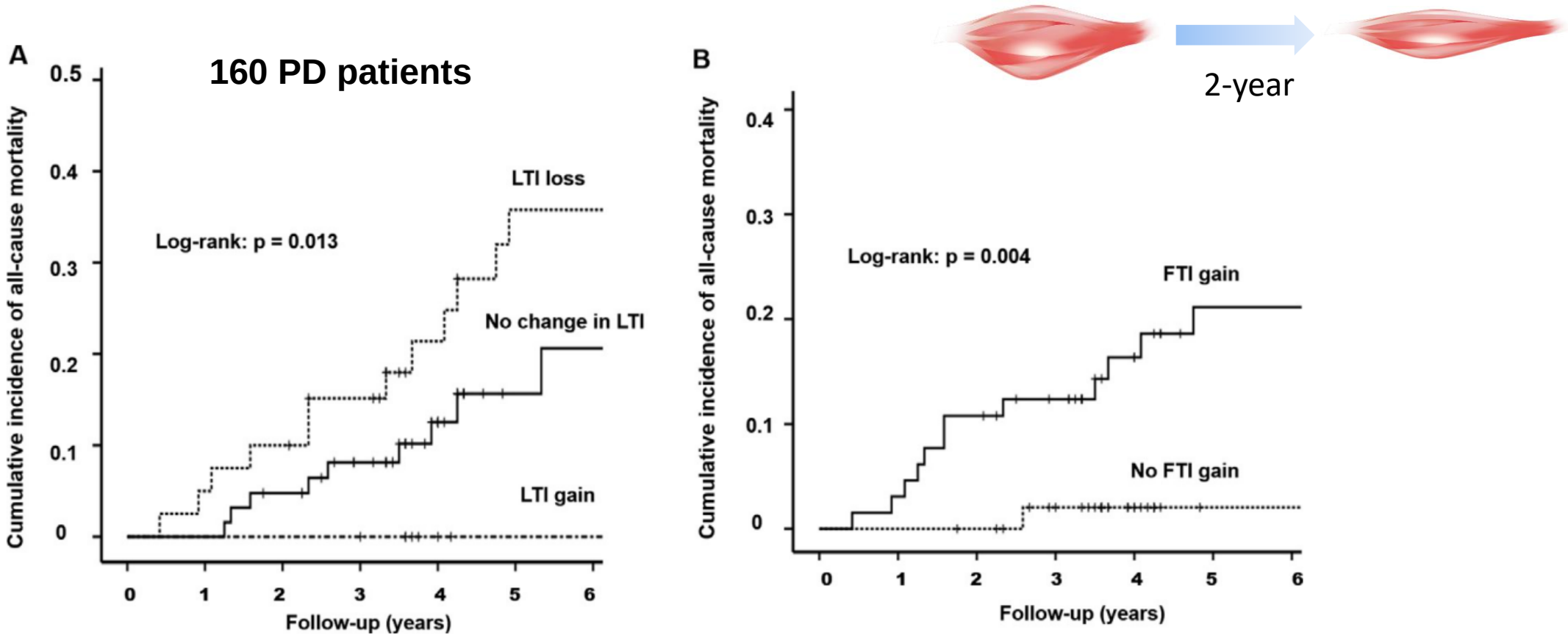
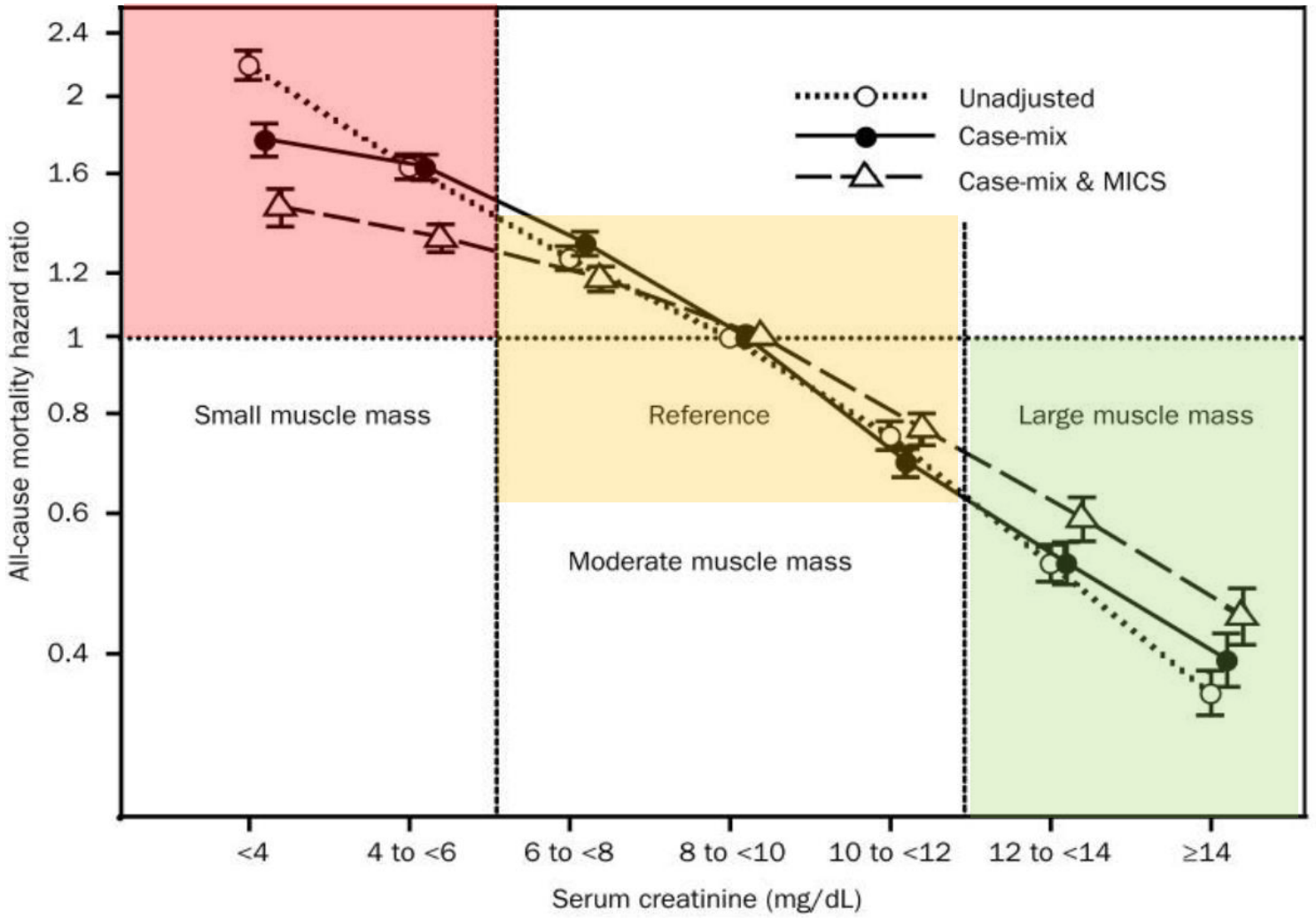


Fig. 3. Kaplan–Meier estimates of survival according to longitudinal changes in the LTI (A) or FTI (B).

Clinical Nutrition 40 (2021) 120-126

Clinical Biomarkers Useful for Skeletal Muscle Assessment ?

“Low” pre-HD Serum Creatinine Increases Mortality Risk in HD

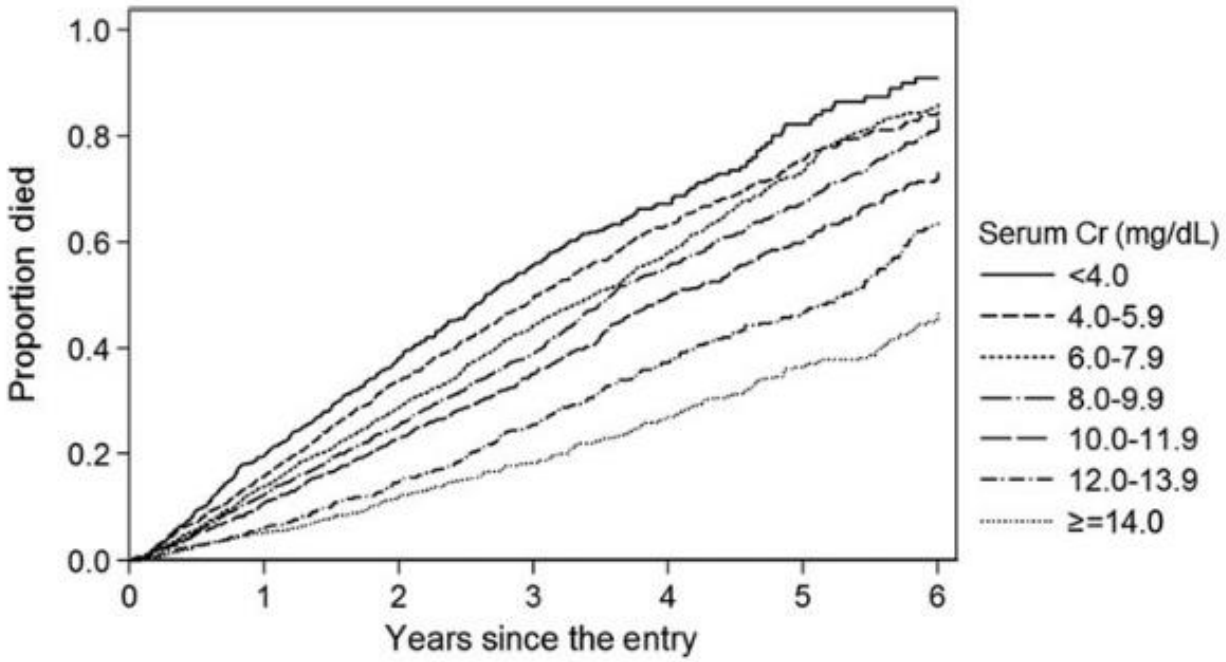


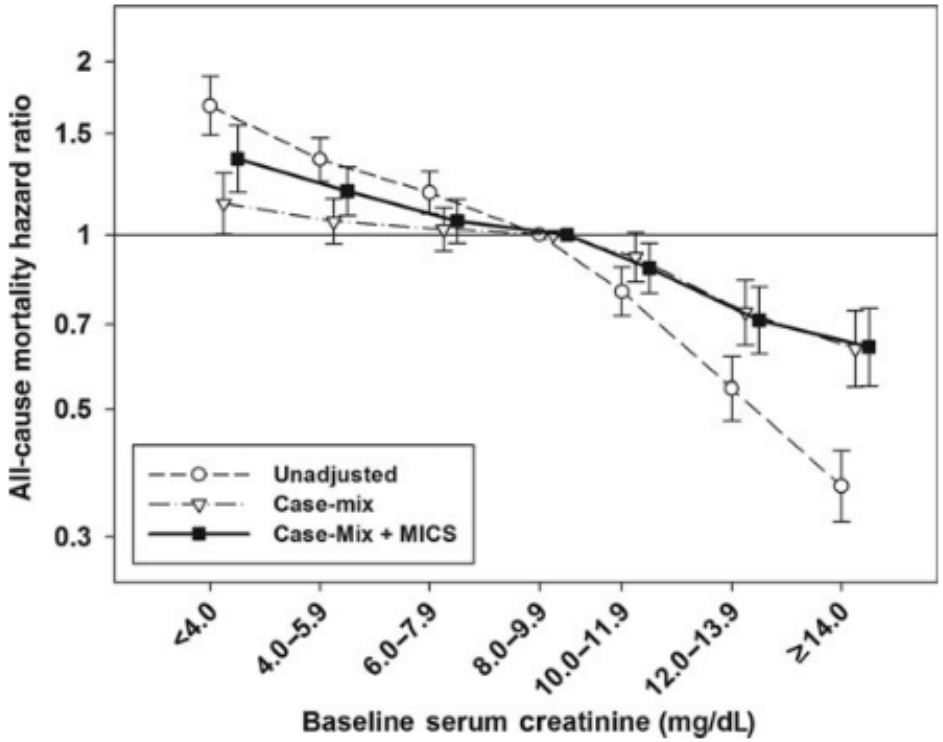
N=121,762

Mayo Clin Proc 2010;85(11):991-1001

“Low” serum creatinine increases mortality risk in PD

N=10,896





Nephrol Dial Transplant (2013) 28: 2146–2155

TABLE 1. Creatinine kinetics[a]

In the steady state, production (mg/day)	= excretion + metabolic degradation (urinary + dialysate)
Excretion (mg/day)	= $V_u \cdot C_u + V_d \cdot C_d$
Metabolic degradation (mg/day)	= 0.38 × S_{cr} (mg/dL) × body wt (kg) (14)
LBM (kg)	= (0.029 × production) (mg/day) + 7.38 (15)

[a] V_u, volume of urine (mL/24 h); V_d, volume of effluent dialysate (mL/24 h); C_u, creatinine concentration in urine (mg/mL); C_d, creatinine concentration in effluent dialysate (mg/mL); S_{cr}, serum creatinine (mg/dL).

Am Soc Nephrol **1994**, *4*, 1475-1485.

Noori formula

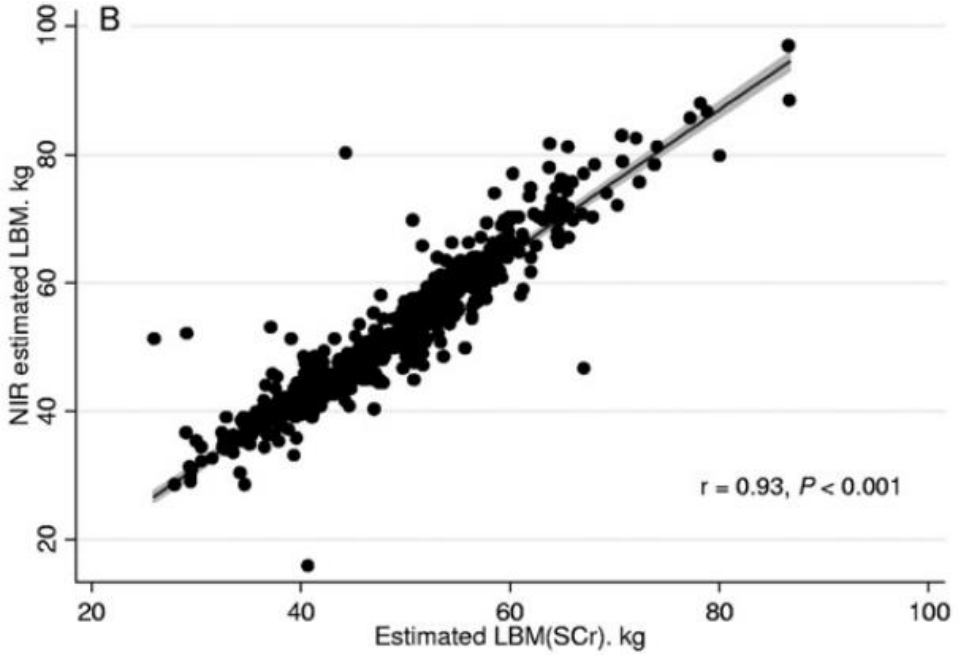
$$LBM_{SCr} = 0.34 \times SCr\ (mg/dL) + 5.58 \times \{1\ if\ female;\ 0\ if\ male\} + 0.30 \times weight\ (in\ kg) + 0.67 \times height\ (in\ inches) - 0.23 \times URR - 5.75$$

Noori et al. Am J Kidney Dis. 2011;57:130–9

Simplified creatinine index

$$SCI\ (mg/kg/day) = 16.21 + 1.12 * [1\ if\ male;\ 0\ if\ female] - 0.06 * age\ (years) - 0.08 * spKt/V\ urea + 0.009 * pre - dialysis\ SCr\ (\mu mol/L)$$

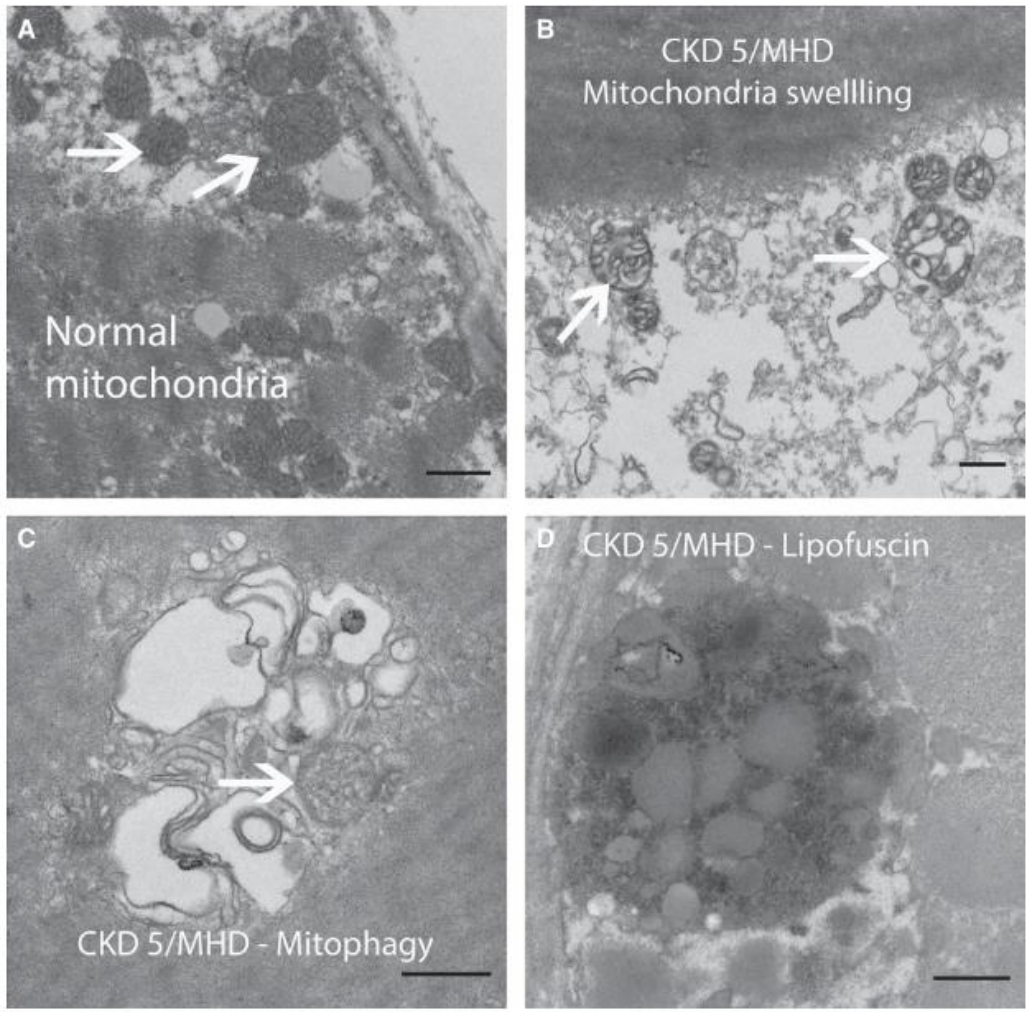
$$Estimated\ LTI\ (mg/m^2) = \left(SCI * Post - HD\ weight\ (kg) * 0.029 + 7.38\right) / \left(Body\ height\ (m)\right)^2$$

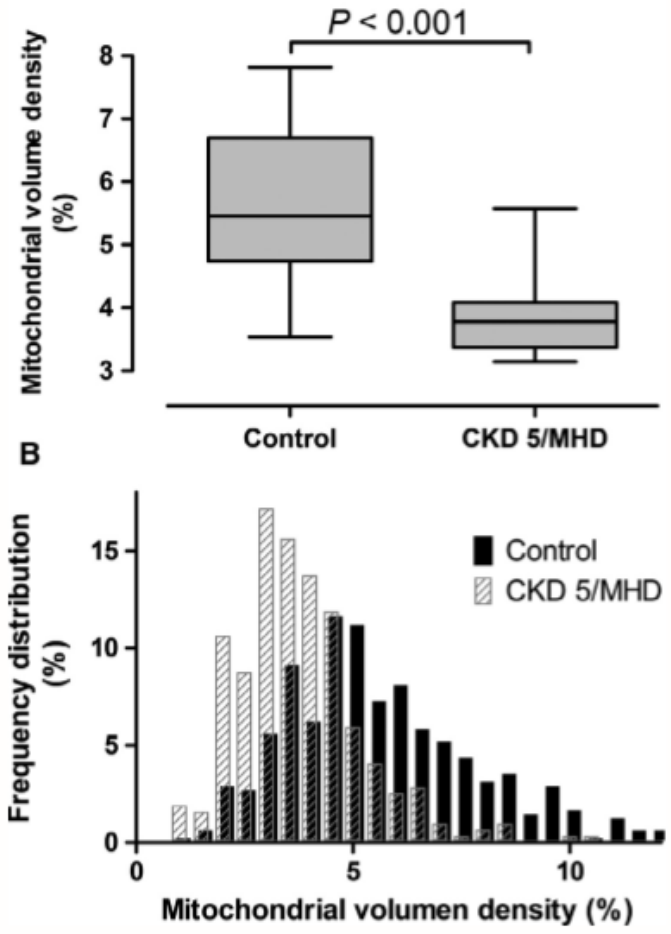


Canaud et al., Nephrol Dial Transplant (2020) 35: 2161–2171

Monitoring Skeletal Muscle Mass Alone may not be Adequate…

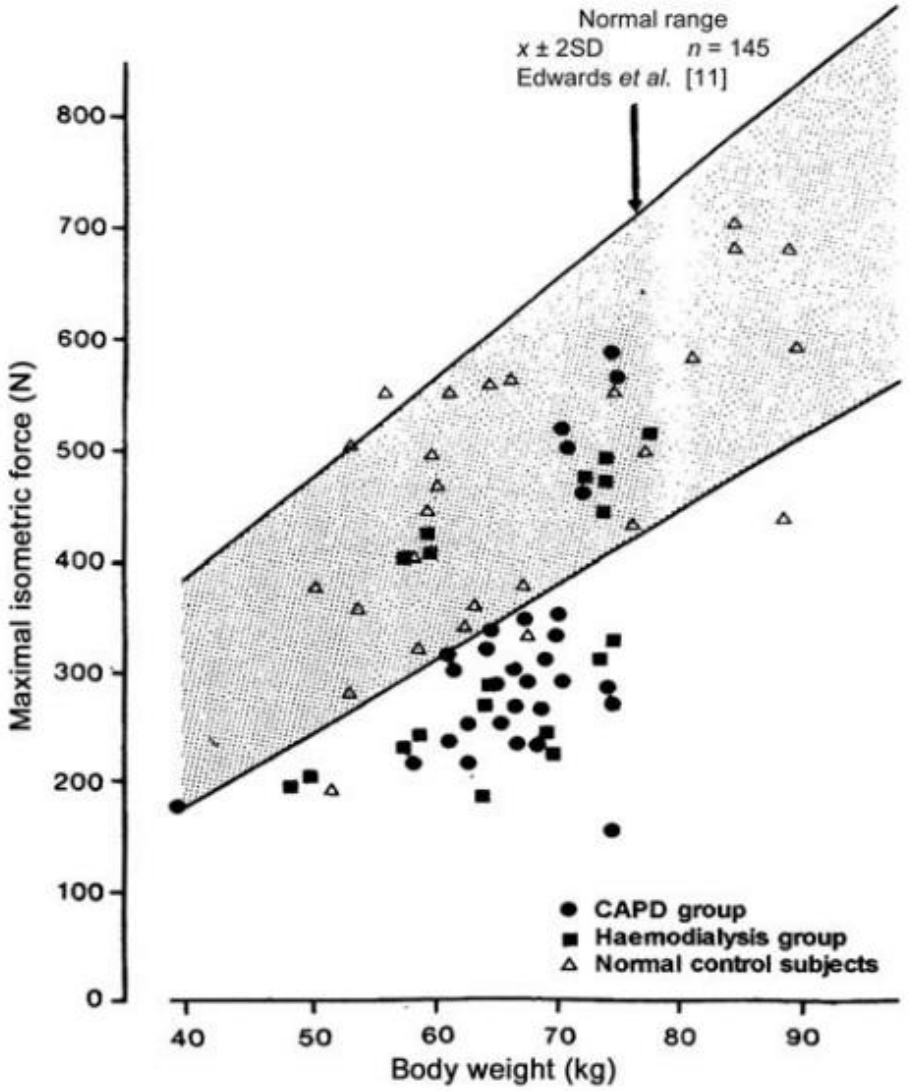
Mitochondrial Dysfunction in CKD





Physiol Rep **2016**, *4(9):e12780*

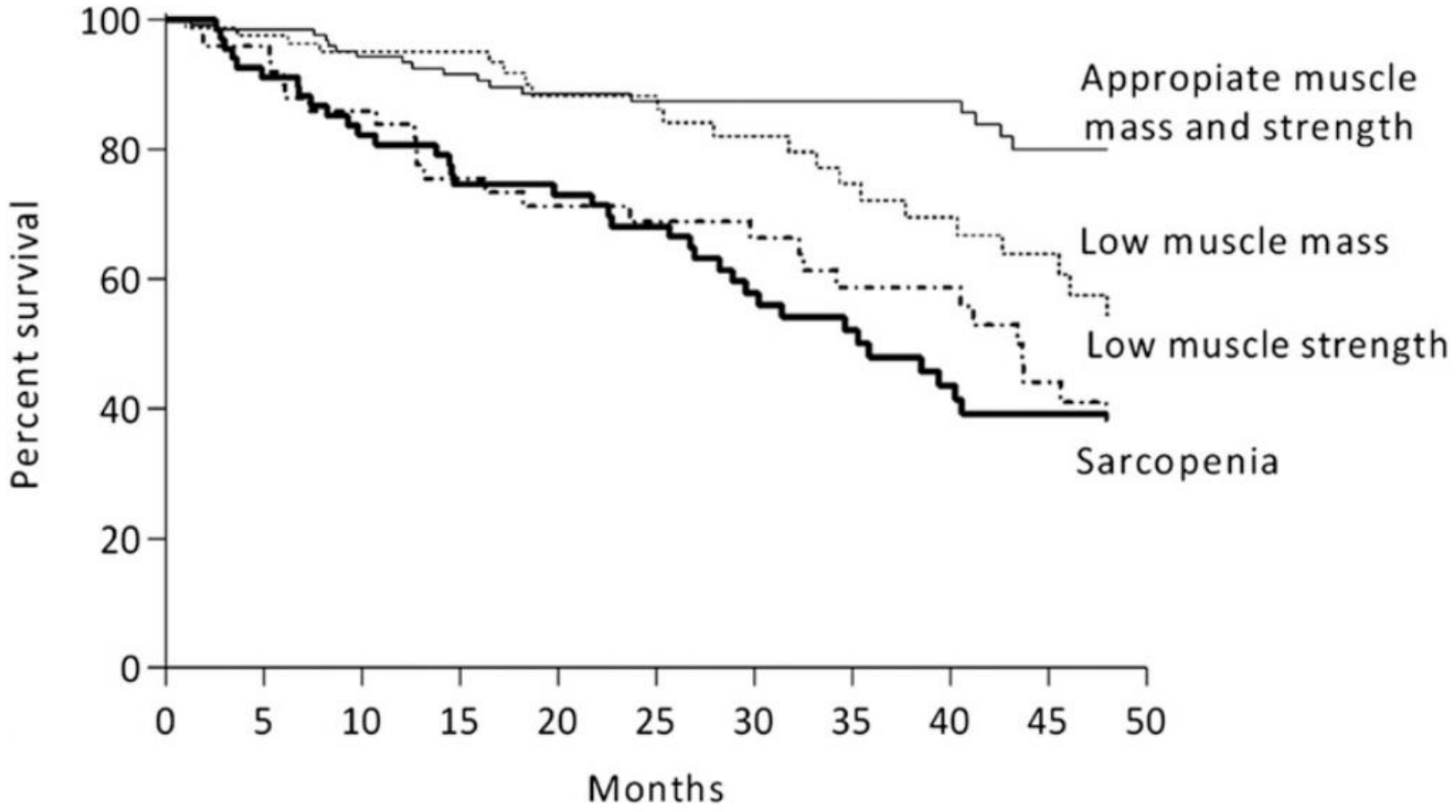
Poor muscle quality in ESRD patients



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

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

N=330



Clin J Am Soc Nephrol 9: 1720–1728, October, 2014

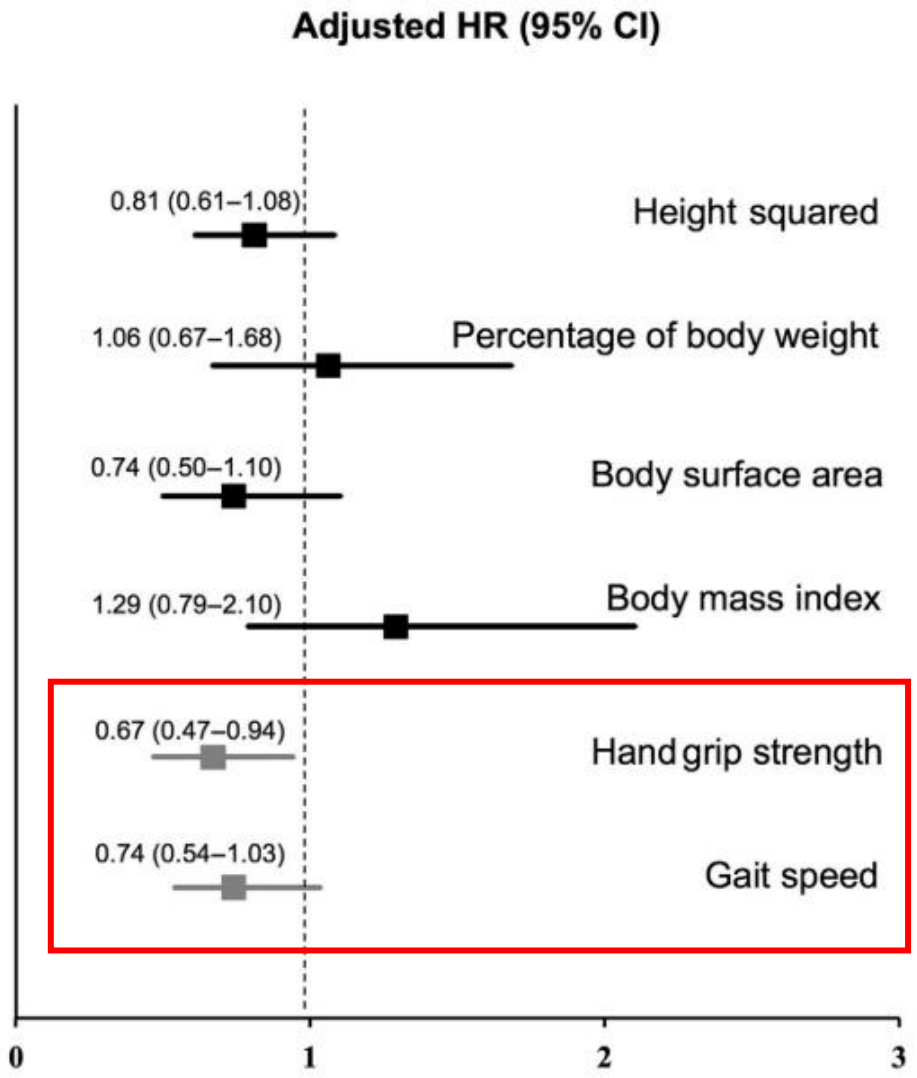
Table 5. HRs and 95% CIs associated with muscle strength and mass together as continuous variables and after categorization regarding the presence of low muscle mass alone, low muscle strength alone, or both in incident dialysis patients

Exposures	Model 1		Model 2	
	HR (95% CI)	*P* Value	HR (95% CI)	*P* Value
Together as continuous variables in the same model				
Muscle mass, per SD increase	0.58 (0.20 to 1.70)	0.32	0.43 (0.12 to 1.52)	0.19
Muscle strength, per SD increase	0.26 (0.16 to 0.43)	<0.001	0.34 (0.18 to 0.61)	<0.001
Crosscombined as categories according to young reference populations				
Group 1: Appropriate muscle mass and strength (*n*=134)	1.00		1.00	
Group 2: Low muscle strength alone (*n*=50)	2.82 (1.57 to 5.21)	0.001	1.98 (1.01 to 3.87)	0.04
Group 3: Low muscle mass alone (*n*=78)	1.35 (0.67 to 2.68)	0.39	1.23 (0.56 to 2.67)	0.59
Group 4: Low muscle mass and strength (sarcopenia) (*n*=68)	2.94 (1.64 to 5.27)	<0.001	1.93 (1.01 to 3.71)	0.04

Clin J Am Soc Nephrol 9: 1720–1728, October, 2014

Sarcopenia and mortality in hemodialysis

N=645



Muscle strength and gait speed may be more relevant predictors of survival than muscle size.

Kidney International (2017) 92, 238–247

Muscle strength loss > Muscle mass loss

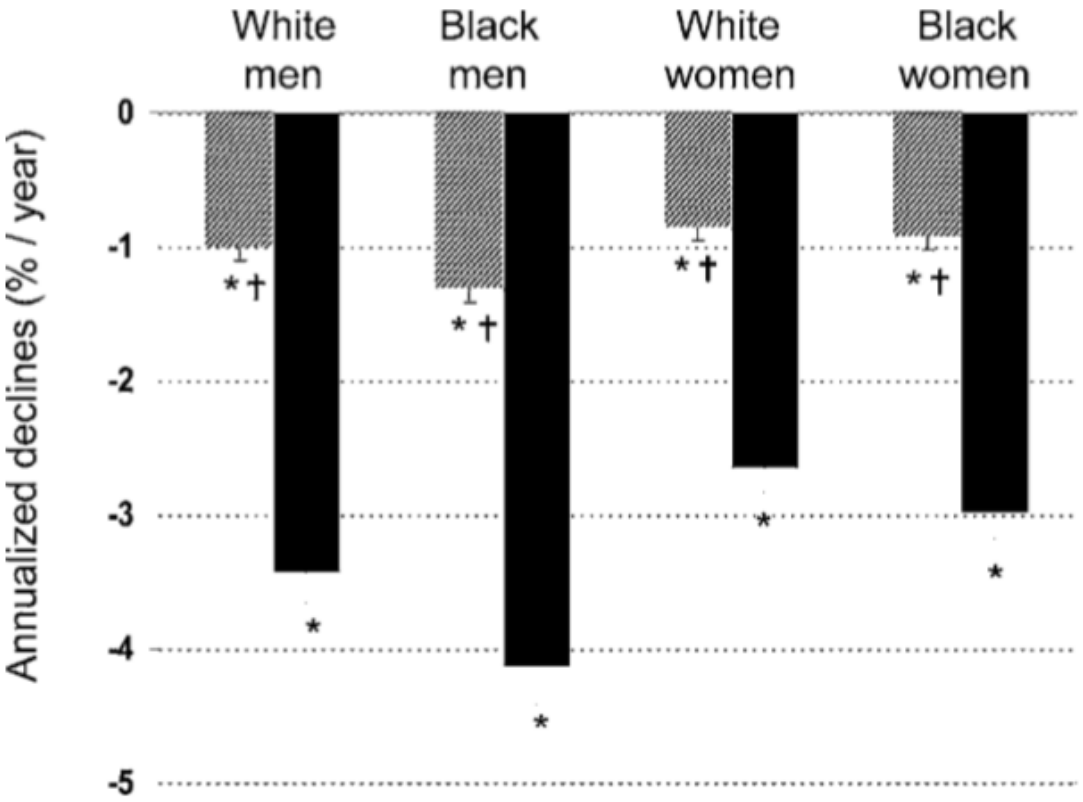


Figure 1. Annualized rates for declines in leg lean mass (*hatched bar*) and muscle strength (*black bar*) by gender and race. Gender difference within race, $p < .01$. Racial difference within gender, $p < .05$.

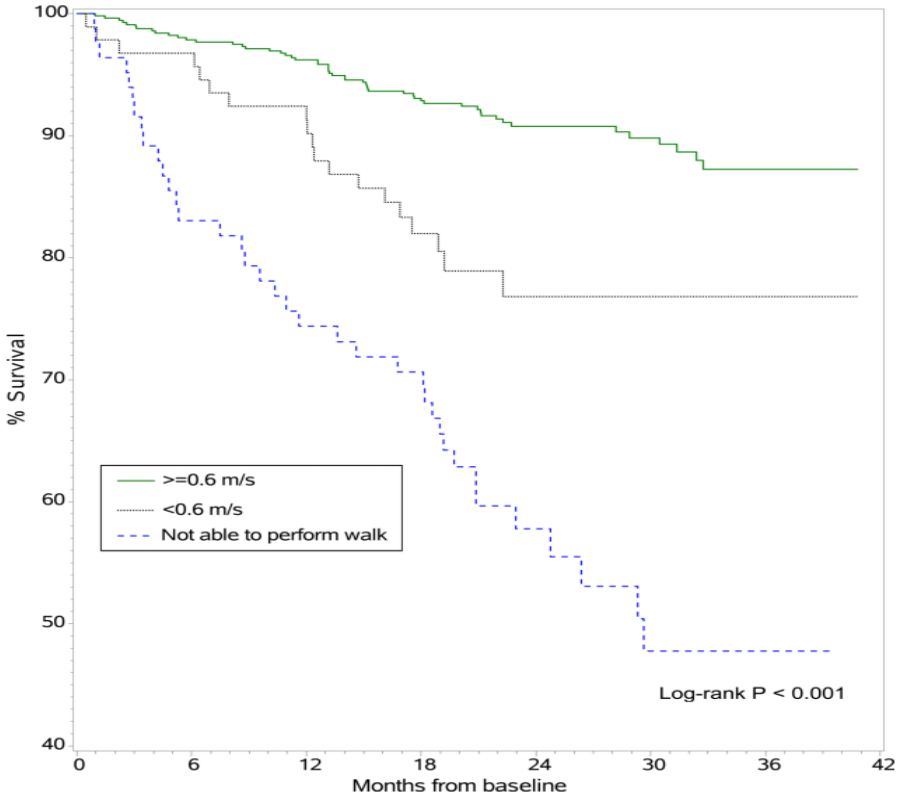
Sarcopenia may indicate the **late stage** of muscle wasting.

Journal of Gerontology: MEDICAL SCIENCES; 2006, Vol. 61A, No. 10, 1059–1064


JAMAR
PLUS+
67.5
JAMAR
PLUS+
98.6

Physical Performance Tests

- 4–6 m usual gait speed test
- The simplest method strongly predicts clinical outcomes



752 prevalent hemodialysis patients

Gait Speed Performance	Model 1[a]	Model 2[b]	Model 3[c]
≥ 0.6 m/s	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
< 0.6 m/s	2.46 (1.45–4.15)	2.39 (1.35–4.25)	2.17 (1.19–3.98)
Unable to perform walk	5.84 (3.84–8.89)	6.93 (4.25–11.29)	6.93 (4.01–11.96)

Am J Kidney Dis. 2015 August ; 66(2): 297–304.

Physical Performance Tests

EWGSOP2 sarcopenia cut-off points for low performance

Gait speed	≤0.8 m/s
SPPB	≤8 point score
TUG	≥20 s
400 m walk test	Non-completion or ≥6 min for completion

Age Ageing. 2019 Jan 1;48(1):16-31.

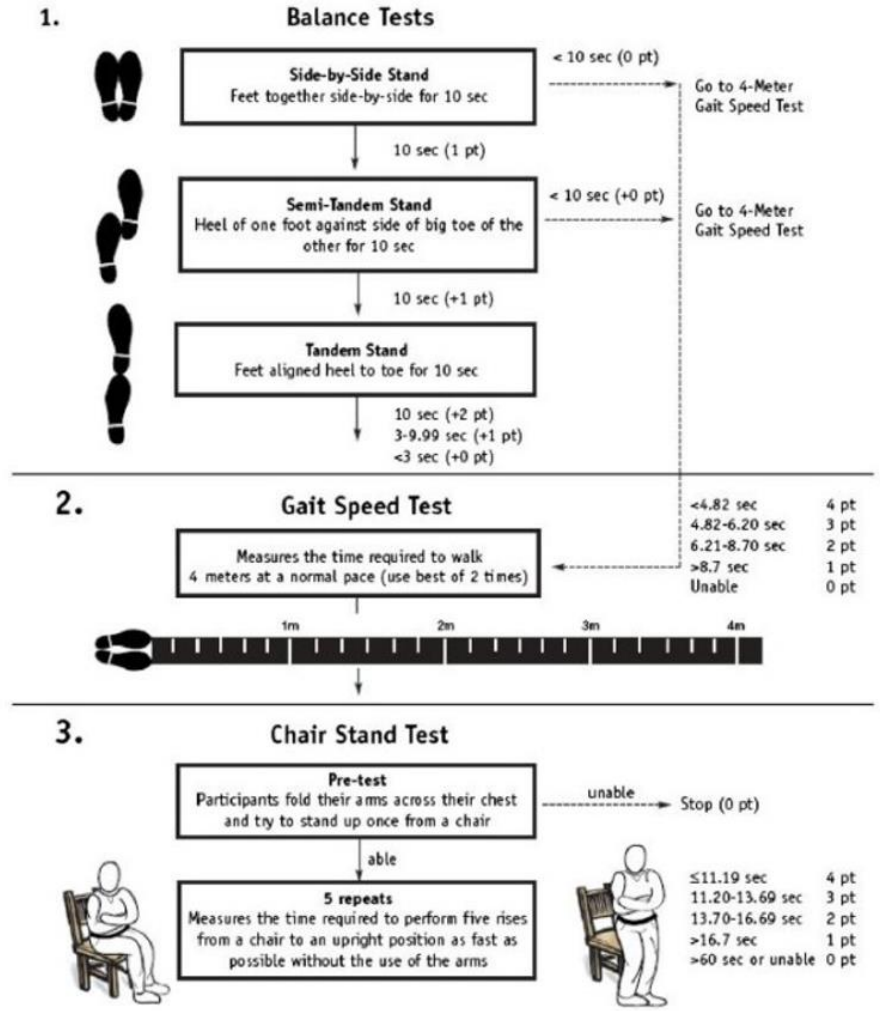
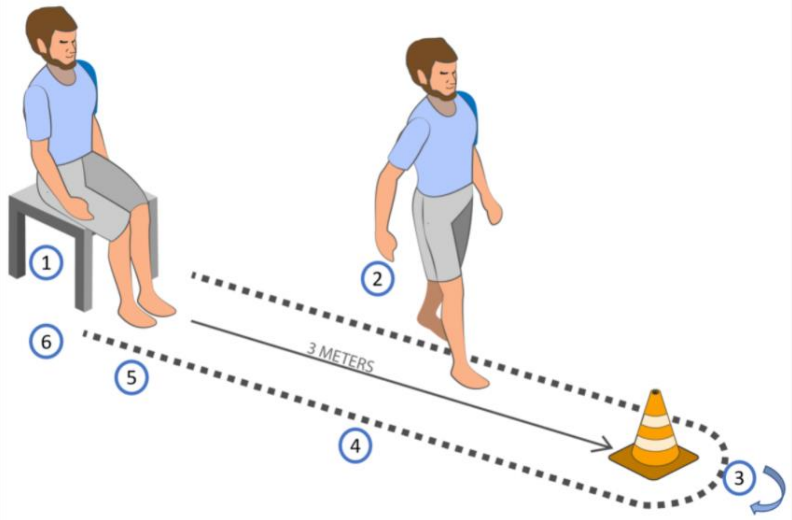
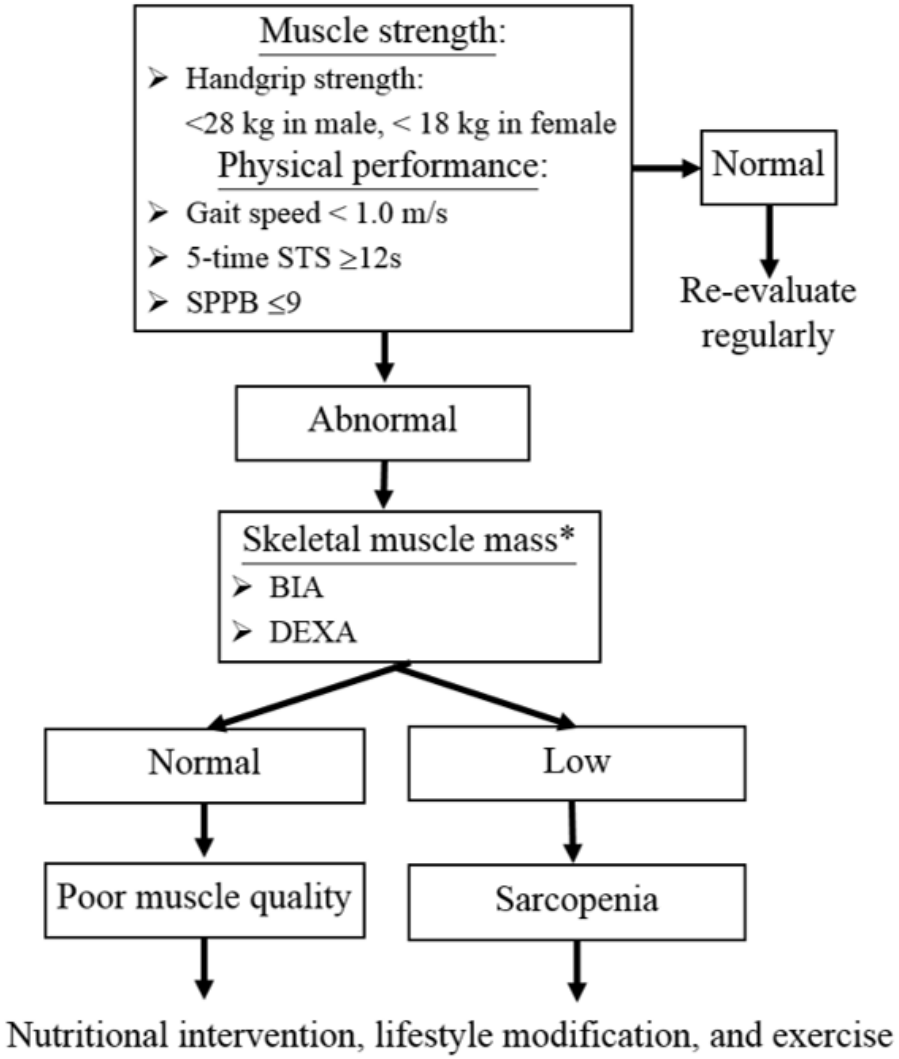


Figure 1. Activities performed in the 3-m TU & Go test. 1 = standing, 2 = first walk, 3 = 3-m turning, 4 = second walk, 5 = pre-sitting turning, and 6 = sitting.



Sensors **2019**, *19*(7), 1647

Proposed Algorithm for the Evaluation of Uremic Sarcopenia



YL Lin and BG Hsu. Tzu Chi Medical Journal 2021; 34:182-191

Screening Uremic Sarcopenia

SARC-F 問卷

力量 Strength	提10磅重物有多困難？	沒有困難 = 0 有點 = 1 非常或無法 = 2
行走 Assistance in walking	走過一個房間有多困難？	沒有困難 = 0 有點 = 1 非常、要協助或無法 = 2
起身 Rise from a chair	從椅子或床上起身有多困難？	沒有困難 = 0 有點 = 1 非常、要協助 = 2
登階 Clime stairs	爬10階樓梯有多困難？	沒有困難 = 0 有點 = 1 非常或無法 = 2
跌倒 Falls	過去一年你跌倒幾次？	沒有 = 0 1-3 次 = 1 4 次以上 = 2

4 分以上表示可能有肌少症

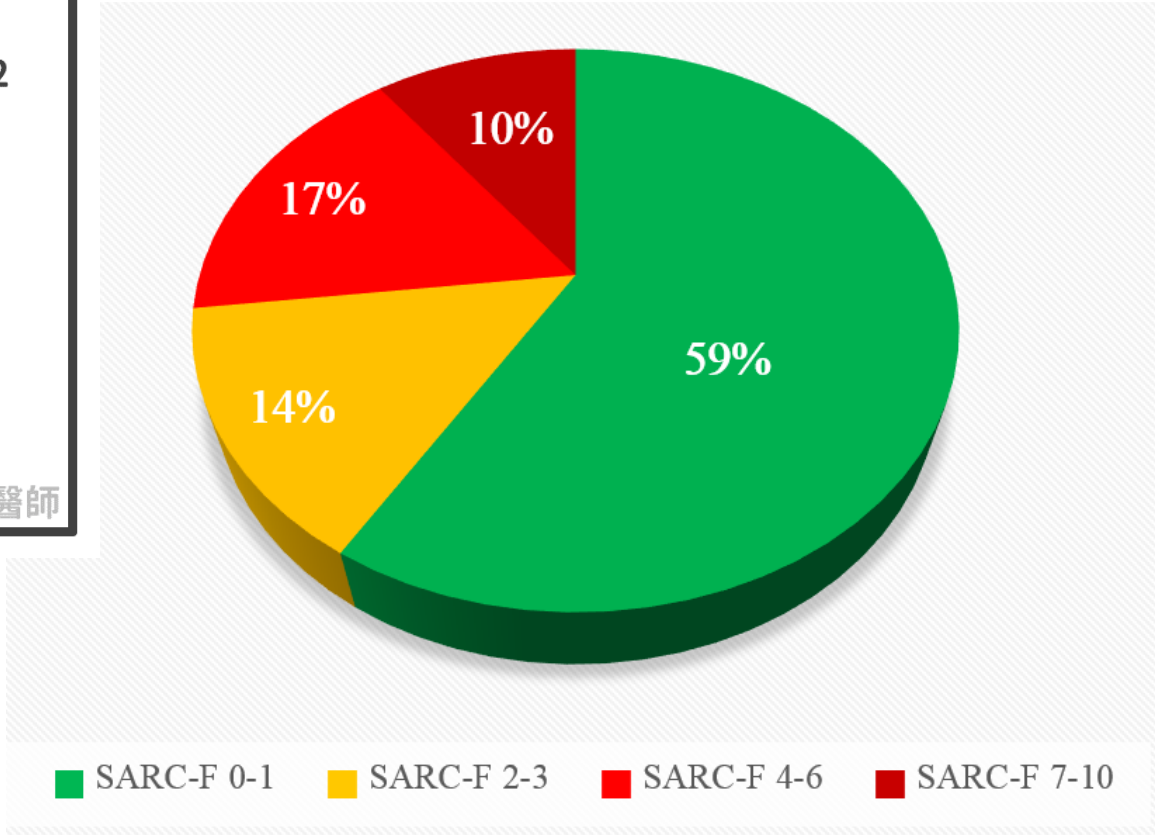
劉漢文醫師

SARC-CalF

+ 10 if calf circumference

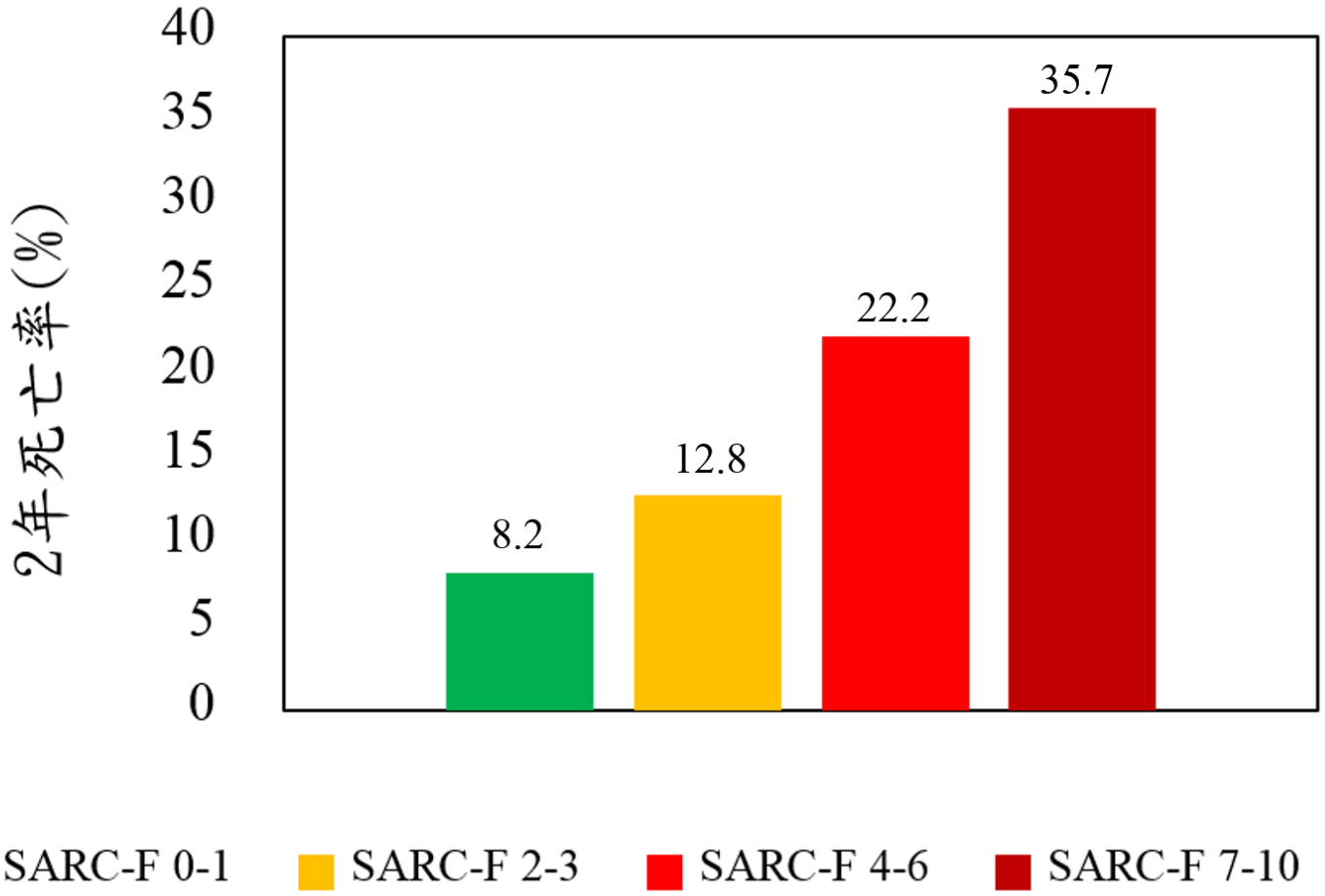
<34 cm (male)

<33 cm (female)



Diagnostics (Basel). 2020 Oct 31;10(11):890.

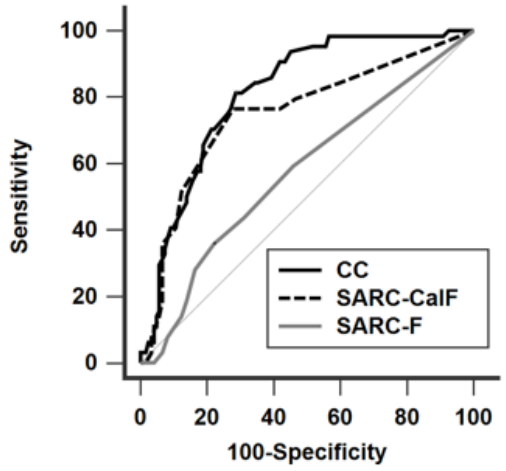
肌少症分數與死亡率



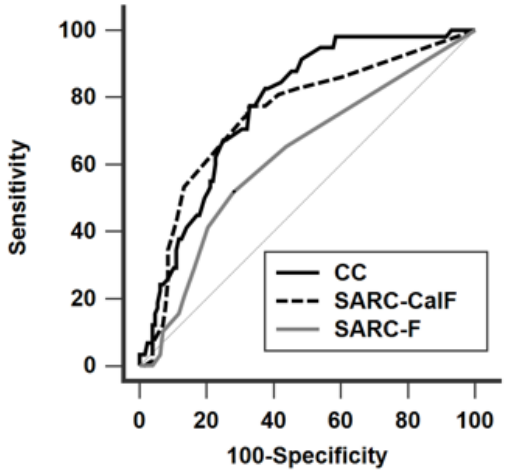
Diagnostics (Basel). 2020 Oct 31;10(11):890.

Comparison of SARC-F, SARC-CalF, and Calf Circumference

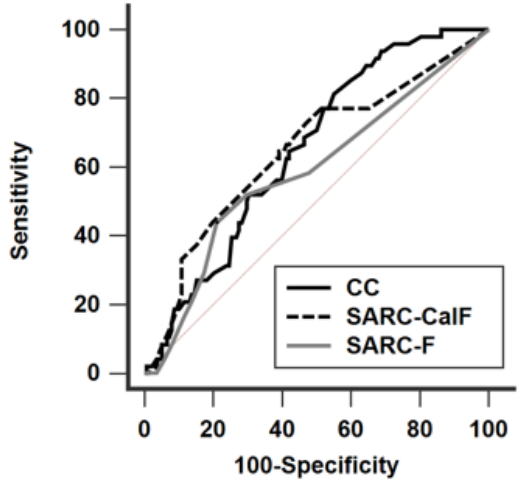
(A) AWGS 2019



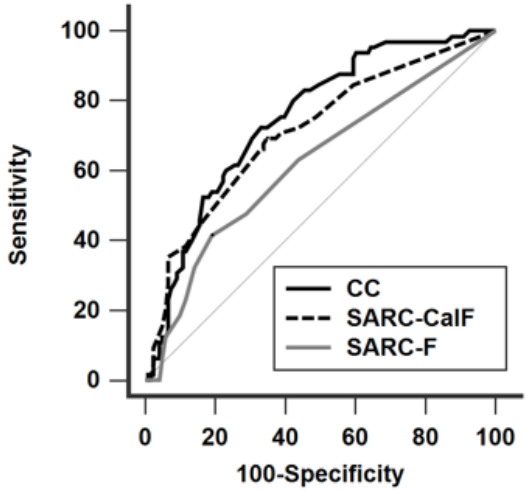
(B) EWGSOP2



(C) FNIH



(D) IWGS



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Comparison of SARC-F, SARC-CalF, and Calf Circumference

Table 3. The correlations of SARC-F, SARC-CalF, and CC with anthropometric and skeletal muscle measures.

Variables	SARC-F		SARC-CalF		CC	
	r	*p*	*r*	*p*	*r*	*p*
Anthropometric measures						
Weight (kg)	−0.029	0.692	−0.435	< 0.001*	0.721	< 0.001*
BMI (kg/m^2)	−0.009	0.900	−0.382	< 0.001*	0.625	< 0.001*
WC (cm)	0.120	0.104	−0.224	0.002*	0.436	< 0.001*
MAMC (cm)	−0.056	0.451	−0.395	< 0.001*	0.617	< 0.001*
Skeletal muscle measures						
ASMI (kg/m^2)	−0.125	0.090	−0.421	< 0.001*	0.683	< 0.001*
HGS (kg)	−0.363	< 0.001*	−0.445	< 0.001*	0.522	< 0.001*
GS (m/s)[a]	−0.452	< 0.001*	−0.293	< 0.001*	0.181	0.019*

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For ESRD population:

小腿愈**粗**愈好，愈細肌少症風險愈高。

男性 ≤ 34 cm (PPV 64%，NPV 93%)

女性 ≤ 33 cm (PPV 59%，NPV 84%)

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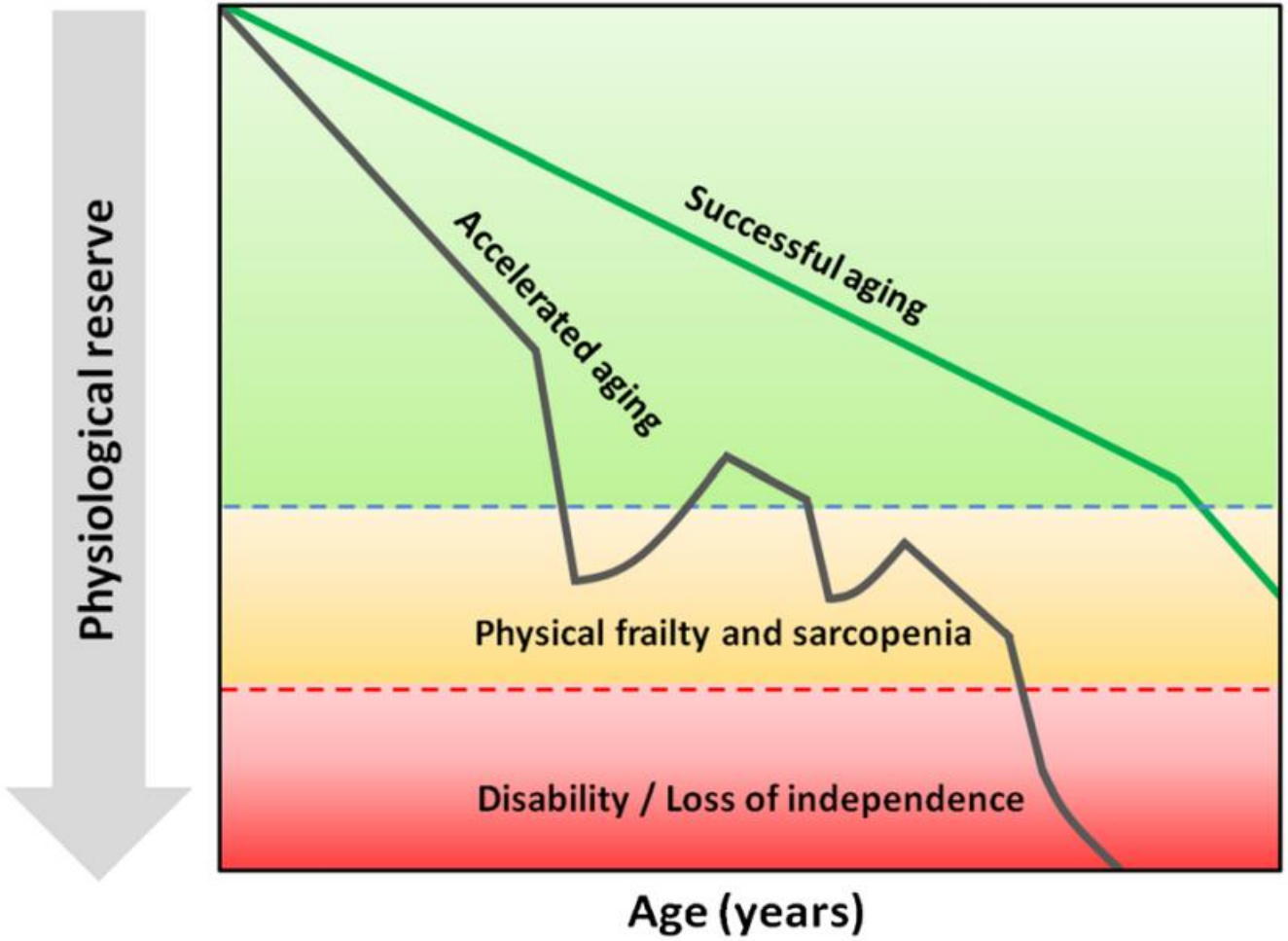
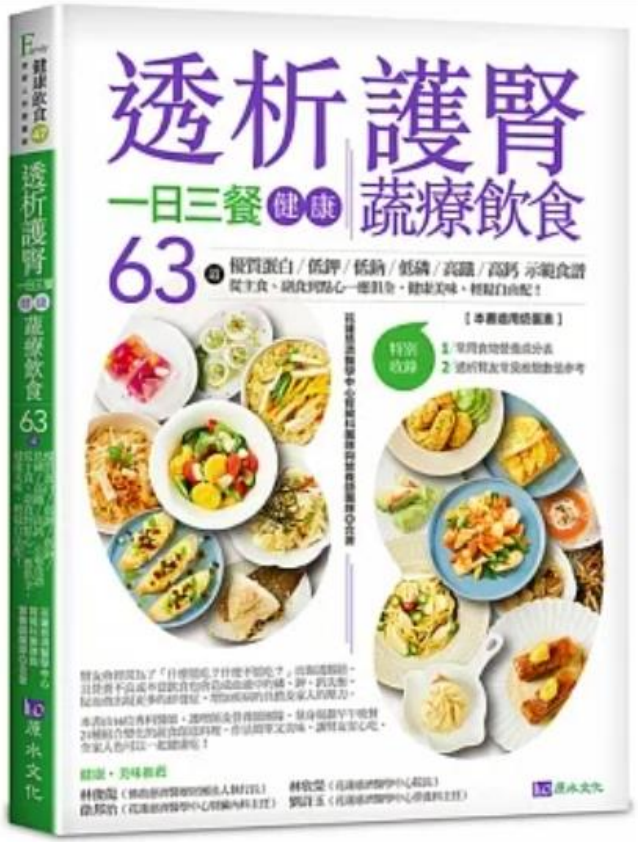
飲食評估及營養補給
• 充足的熱量及高蛋白攝取
• 高生物價蛋白的比例
• 口服營養配方或靜脈營養
• 促進食慾藥物的使用
肌少症
營養不良
復健及運動處方
• 規律運動
• 復健
適當的透析指標
• Kt/V
• CKD-MBD
Anemia management
Avoid fluid overload
原發疾病的控制
• DM, CV disease
• Infection/inflammation
• GI, liver disorder
• Endocrine disease
• Malignancy, organs failure, dementia, stroke, PAOD

Early Detection of Sarcopenia is Vital.

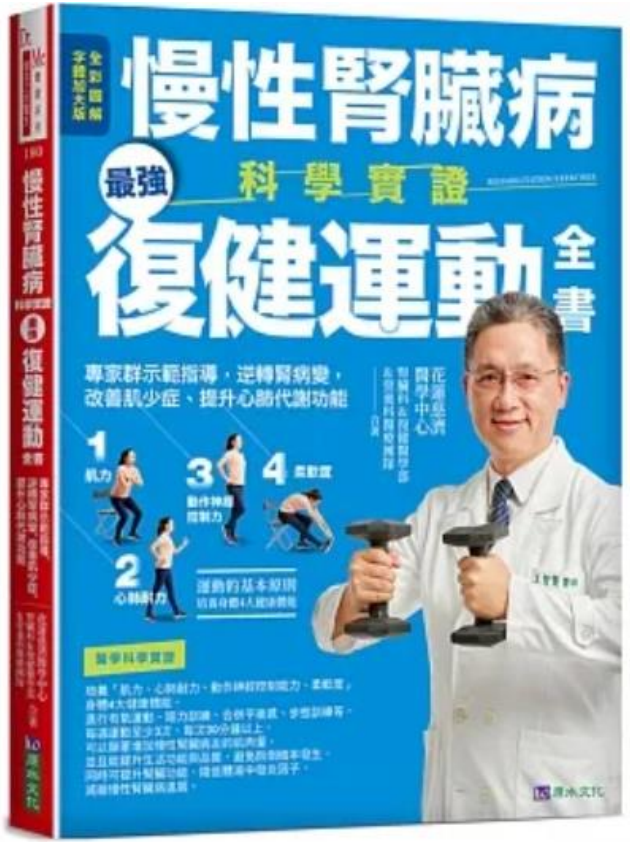


Journal of Cachexia, Sarcopenia and Muscle 2015; 6: 278–286

感謝聆聽


透析護腎
一日三餐健康
蔬療飲食
63
優質蛋白／低鉀／低鈉／低磷／高鐵／高鈣 示範食譜
原水文化


花蓮慈濟醫院
Hualien Tzu Chi Hospital,


慢性腎臟病
最強
科學實證
復健運動全書
專家群示範指導，逆轉腎病變，
改善肌少症、提升心肺代謝功能
原水文化