Malnutrition, Cachexia, Sarcopenia, and Frailty in COPD

Jong Geol Jang, MD

Assistant Professor
Division of Pulmonary, Allergy, and Critical Care Medicine
Department of Internal Medicine
Yeungnam University Medical Center
Yeungnam University of Korea

Definition: malnutrition

A state resulting from lack of intake or uptake of nutrition

>> altered body composition (decreased fat free mass) and body cell mass

>> diminished physical and mental function and impaired clinical outcome from disease

British Journal of Nutrition (2004), 92, 799–808

Definition: malnutrition

A state resulting from lack of intake or uptake of nutrition

>> altered body composition (decreased fat free mass) and body cell mass

>> diminished physical and mental function and impaired clinical outcome from disease

British Journal of Nutrition (2004), 92, 799–808

Definition: malnutrition

A state resulting from lack of intake or uptake of nutrition

>> altered body composition (decreased fat free mass) and body cell mass

>> diminished physical and mental function and impaired clinical outcome from disease

British Journal of Nutrition (2004), 92, 799–808

Definition: malnutrition

A state resulting from lack of intake or uptake of nutrition

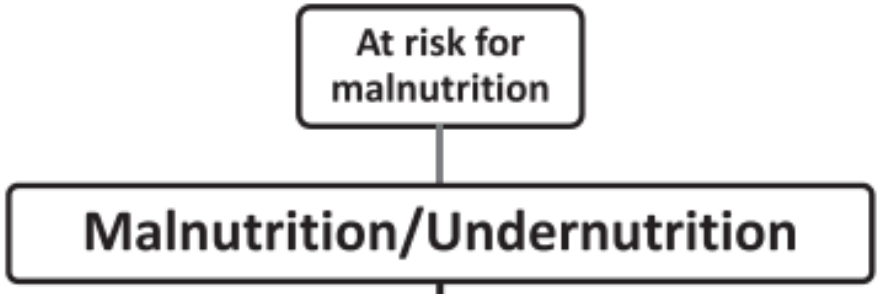
>> altered body composition (decreased fat free mass) and body cell mass

>> diminished physical and mental function and impaired clinical outcome

from disease

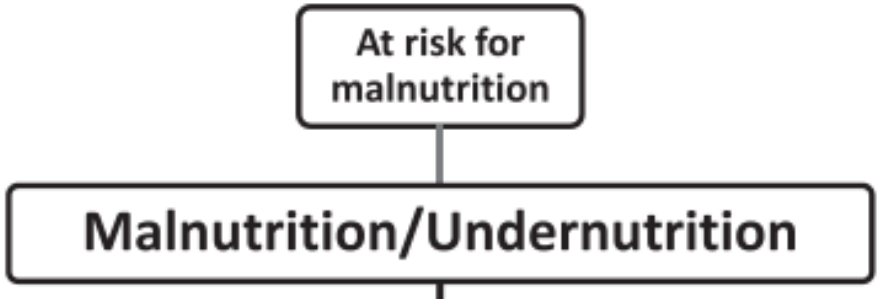
British Journal of Nutrition (2004), 92, 799–808

Diagnoses tree of malnutrition

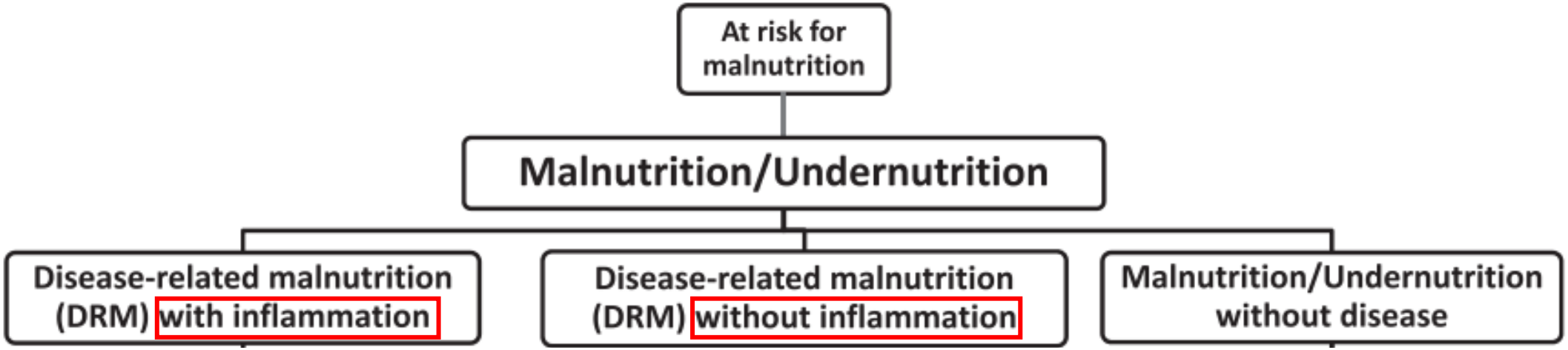


동반 질환 유무

Diagnoses tree of malnutrition



Diagnoses tree of malnutrition



Diagnoses tree of malnutrition

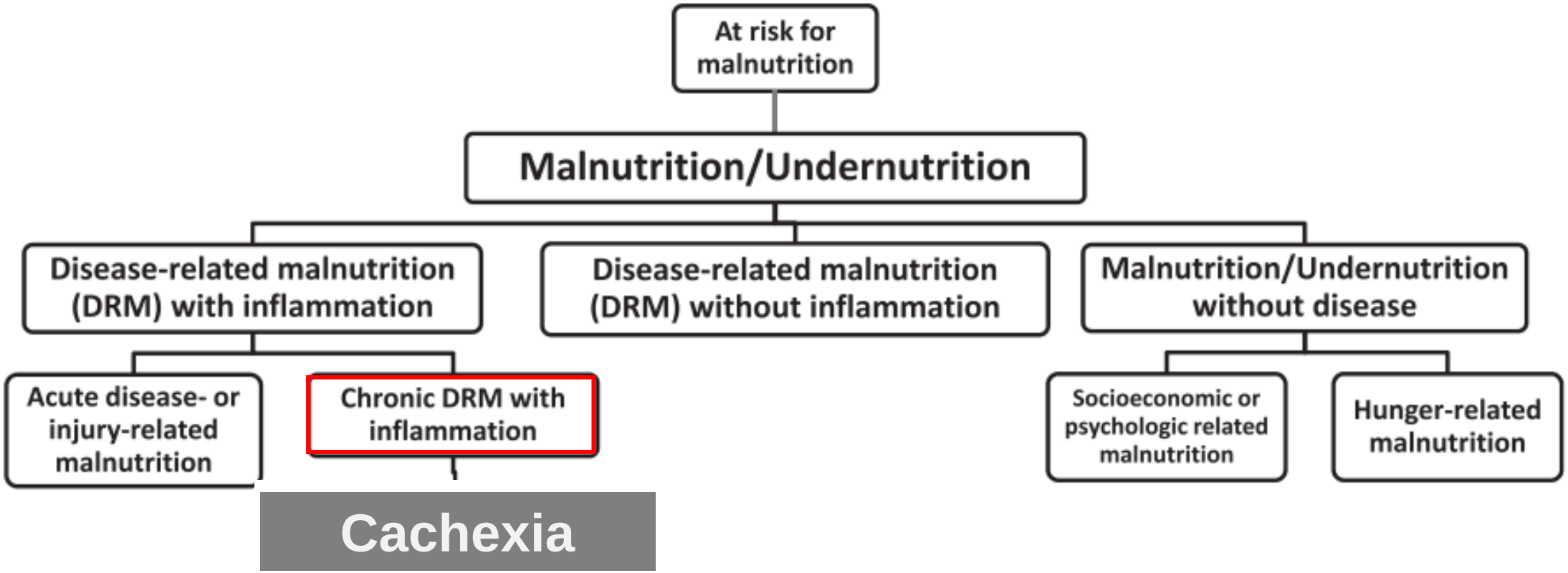


Fig. 2. Diagnoses tree of malnutrition; from at risk for malnutrition, basic definition of malnutrition to aetiology-based diagnoses

Condition	Prevalence of cachexia	Impact of cachexia
COPD	25–35%	Mortality 10–15%/year in cachectic patients; impaired mobility and worsened response to treatment
CHF	16–42%	50% mortality in 18 months as compared with 17% in non-cachectic individuals in an unselected population
Cancer	Approx. 30–60%	Up to 20% of deaths of cancer patients due to cachexia and its associated morbidity; impacts mobility, quality of life and treatment response
Advanced chronic kidney disease	30–60%	20–30% mortality/year; blunted response to treatment
Rheumatoid arthritis	67%	Lean body mass loss with fat mass gain
Chronic liver disease	Approx. 50%	Cachexia more common in males than in females with cirrhosis

Gerontology (2014) 60 (4): 294–305.

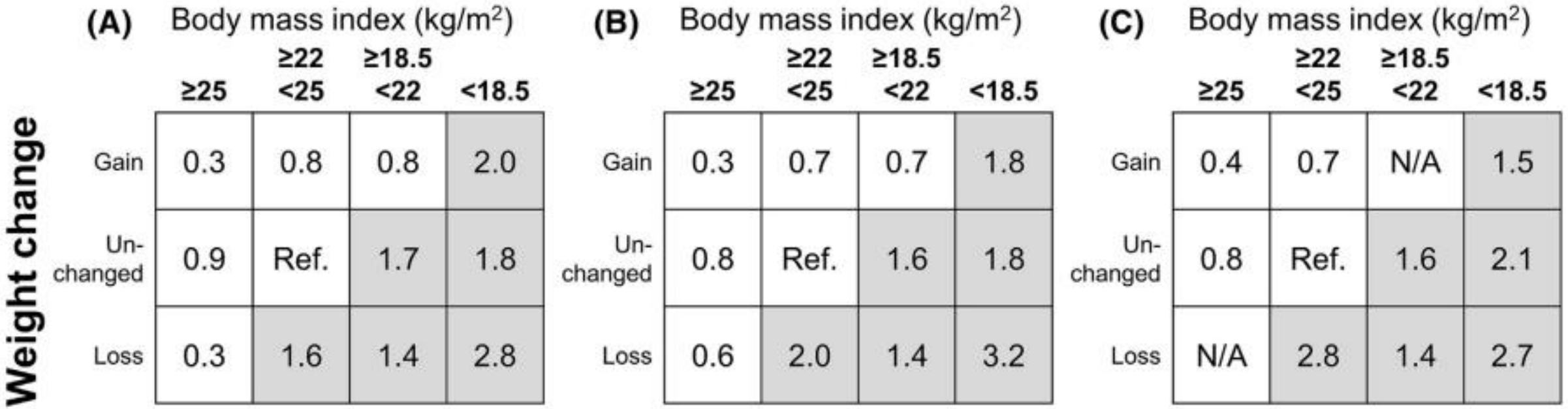
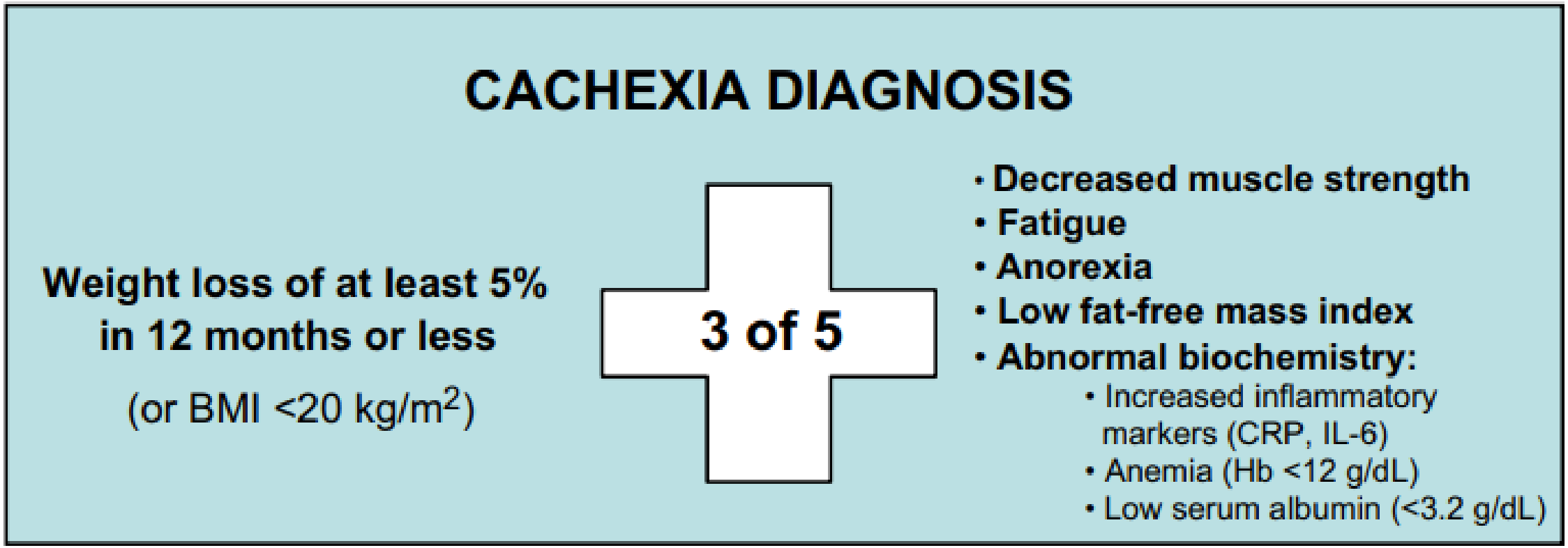
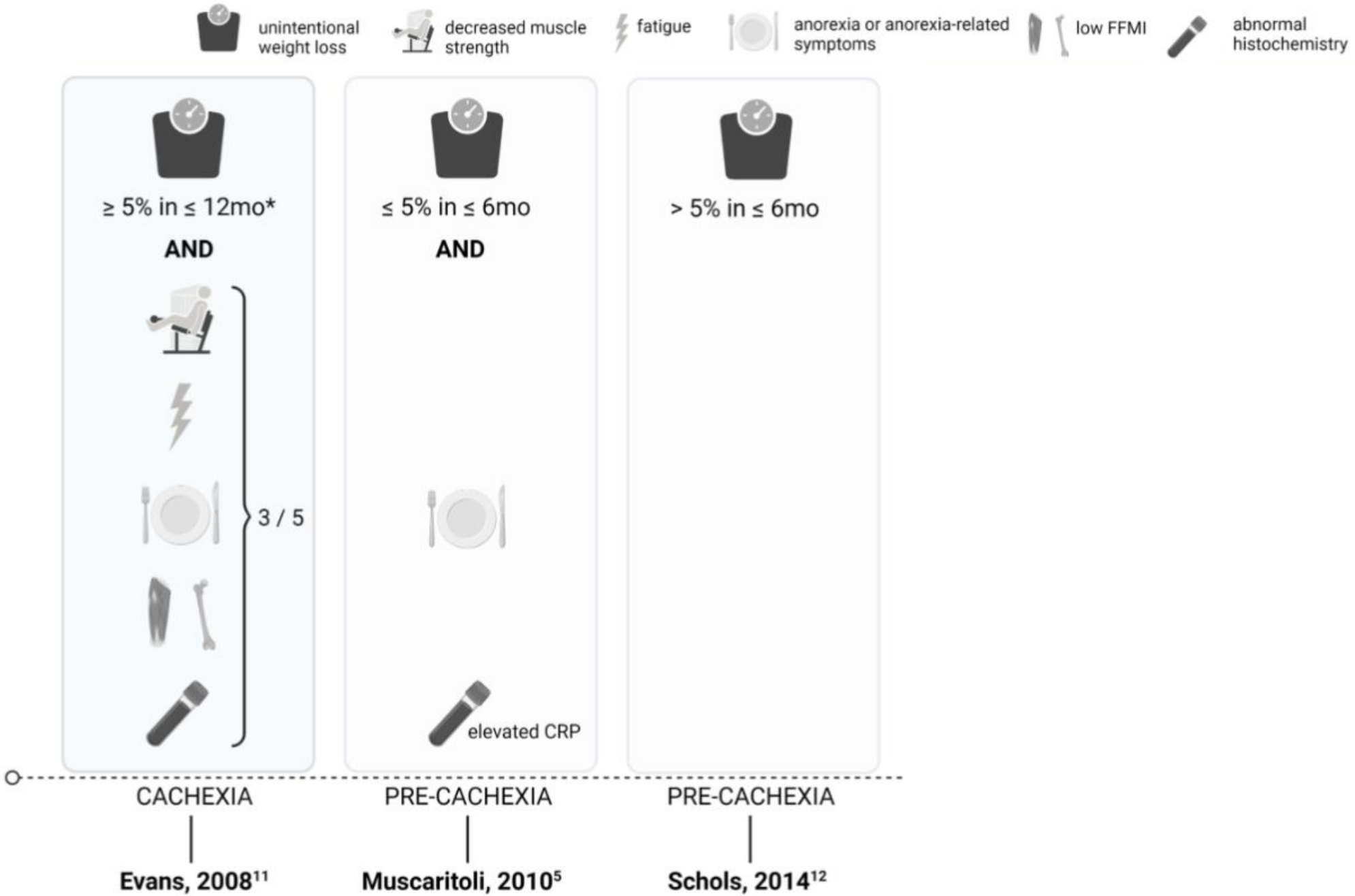


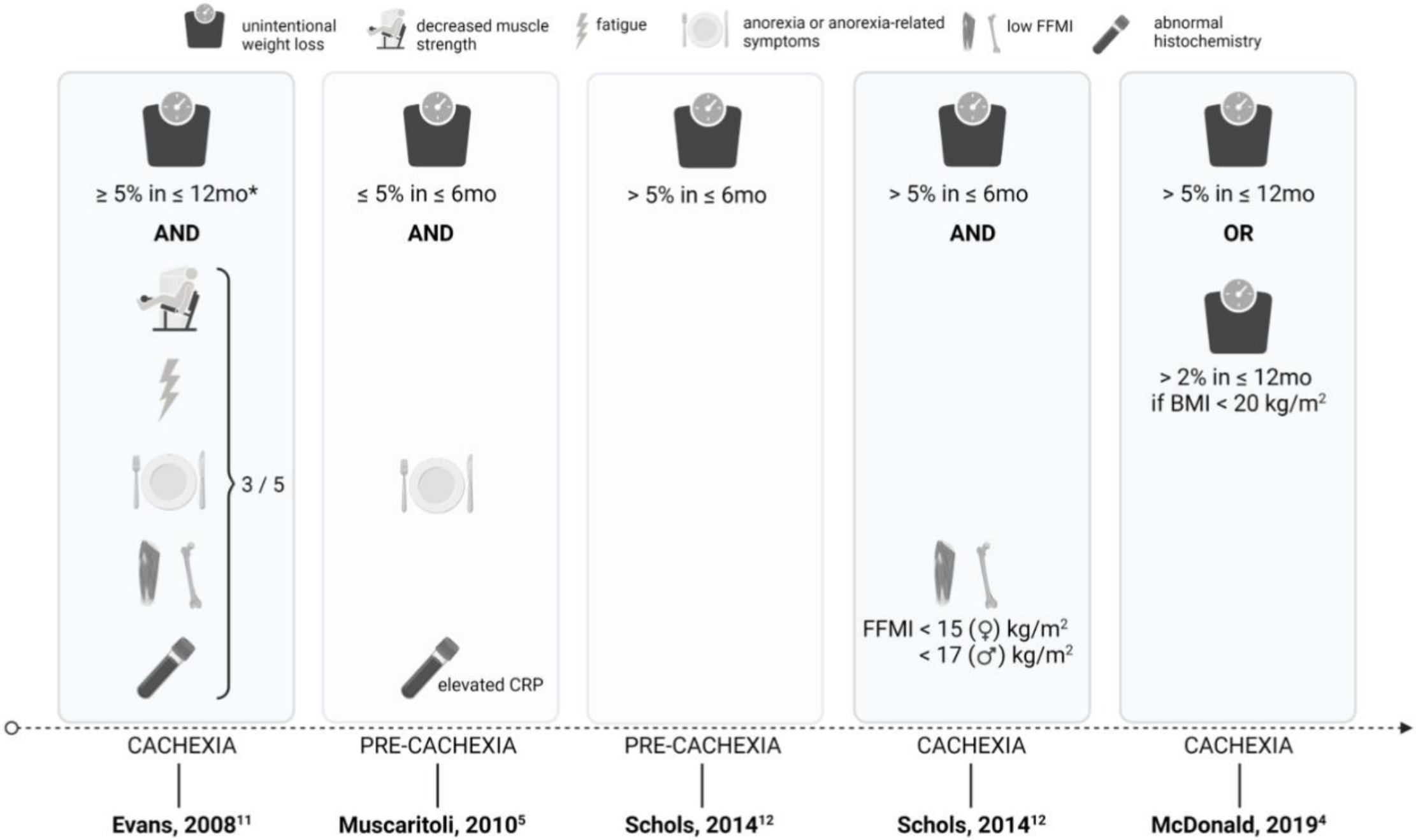
Figure 3 Weight change-body mass index (BMI) contingency tables. Hazard ratios (HRs) for mortality were obtained from the dataset of the Ishida et al. study. The unchanged weight is defined by ±1% change (A), ±2% change (B), and ±5% change (C). Greyed cells are considered at high risk of mortality. N/A: not applicable.

Diagnosis of Cachexia



Clinical Nutrition (2008) 27, 793-799


unintentional weight loss
decreased muscle strength
fatigue
anorexia or anorexia-related symptoms
low FFMI
abnormal histochemistry
≥ 5% in ≤ 12mo*
AND
3 / 5
≤ 5% in ≤ 6mo
AND
elevated CRP
> 5% in ≤ 6mo
CACHEXIA
PRE-CACHEXIA
PRE-CACHEXIA
Evans, 2008[11]
Muscaritoli, 2010[5]
Schols, 2014[12]


unintentional weight loss
decreased muscle strength
fatigue
anorexia or anorexia-related symptoms
low FFMI
abnormal histochemistry
≥ 5% in ≤ 12mo*
AND
3 / 5
CACHEXIA
Evans, 2008[11]
≤ 5% in ≤ 6mo
AND
elevated CRP
PRE-CACHEXIA
Muscaritoli, 2010[5]
> 5% in ≤ 6mo
PRE-CACHEXIA
Schols, 2014[12]
> 5% in ≤ 6mo
AND
FFMI < 15 (♀) kg/m²
< 17 (♂) kg/m²
CACHEXIA
Schols, 2014[12]
> 5% in ≤ 12mo
OR
> 2% in ≤ 12mo
if BMI < 20 kg/m²
CACHEXIA
McDonald, 2019[4]

REVIEW

Journal of Cachexia, Sarcopenia and Muscle 2023; **14**: 1949–1958
Published online 5 September 2023 in Wiley Online Library (wileyonlinelibrary.com) **DOI:** 10.1002/jcsm.13323

Diagnosis and outcomes of cachexia in Asia: Working Consensus Report from the Asian Working Group for Cachexia

Hidenori Arai[1*], Keisuke Maeda[2,3], Hidetaka Wakabayashi[4], Tateaki Naito[5], Masaaki Konishi[6], Prasert Assantachai[7], Wai Tung Auyeung[8], Chalobol Chalermsri[9,10], Wei Chen[11], Justin Chew[12,13], Ming-Yueh Chou[14], Chih-Cheng Hsu[15], Allyn Hum[16], In Gyu Hwang[17], Toshimi Kaido[18], Lin Kang[19], Shahrul Bahyah Kamaruzzaman[20], Miji Kim[21], Jenny Shun Wah Lee[22], Wei-Ju Lee[23], Chih-Kuang Liang[14,24], Wee Shiong Lim[25,26], Jae-Young Lim[27], Yen Peng Lim[28], Raymond See-Kit Lo[29], Terence Ong[30], Wen-Harn Pan[31], Li-Ning Peng[23], Pornpoj Pramyothin[32], Nurul Huda Razalli[33], Masakazu Saitoh[34], Suzana Shahar[35], Han Ping Shi[36], Heng-Hsin Tung[37], Yasuhito Uezono[38], Stephan von Haehling[39,40], Chang Won Won[41], Jean Woo[42] & Liang-Kung Chen[24,43*]

Table 2 Diagnostic criteria for cachexia in Asian patients

(1) Presence of underlying disease
(2) Weight loss >2%/3–6 months or low BMI (<21 kg/m^2)
One or more of the following:
(1) Subjective symptom: Anorexia
(2) Objective measurement: Decreased grip strength[a]
(3) Biomarker: Elevated CRP[b]

Check for updates

ORIGINAL RESEARCH

Mortality and Exacerbation Risk by Body Mass Index in Patients with COPD in TIOSPIR and UPLIFT

Nirupama Putcha[1], Antonio R. Anzueto[2], Peter M. A. Calverley[3], Bartolomé R. Celli[4], Donald P. Tashkin[5], Norbert Metzdorf[6], Achim Mueller[7], and Robert A. Wise[1]

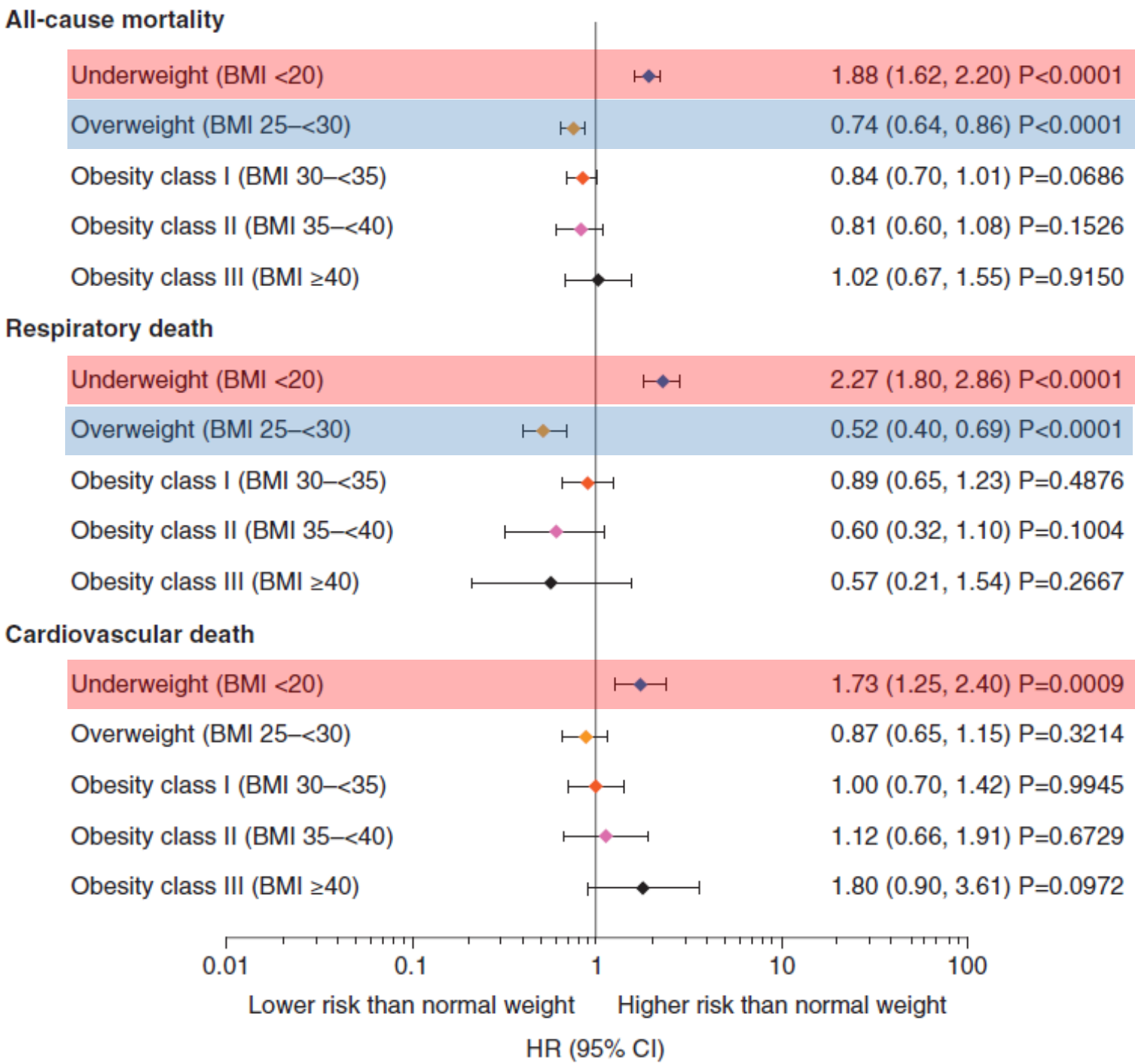
[1]Division of Pulmonary and Critical Care Medicine, Johns Hopkins University School of Medicine, Baltimore, Maryland; [2]Department of Pulmonary Medicine and Critical Care, University of Texas and South Texas Veterans Health Care System, San Antonio, Texas; [3]Clinical Science Centre, Institute of Ageing and Chronic Disease, University of Liverpool, Liverpool, United Kingdom; [4]Pulmonary Division, Brigham and Women's Hospital, Boston, Massachusetts; [5]Department of Medicine, David Geffen School of Medicine, University of California Los Angeles, Los Angeles, California; [6]Respiratory Medicine, Boehringer Ingelheim International GmbH, Ingelheim am Rhein, Germany; and [7]Biostatistics and Data Sciences Europe, Boehringer Ingelheim Pharma GmbH and Company KG, Biberach an der Riss, Germany

Ann Am Thorac Soc. 2022 Feb;19(2):204-213

Table 1. Patient baseline characteristics by BMI class in TIOSPIR

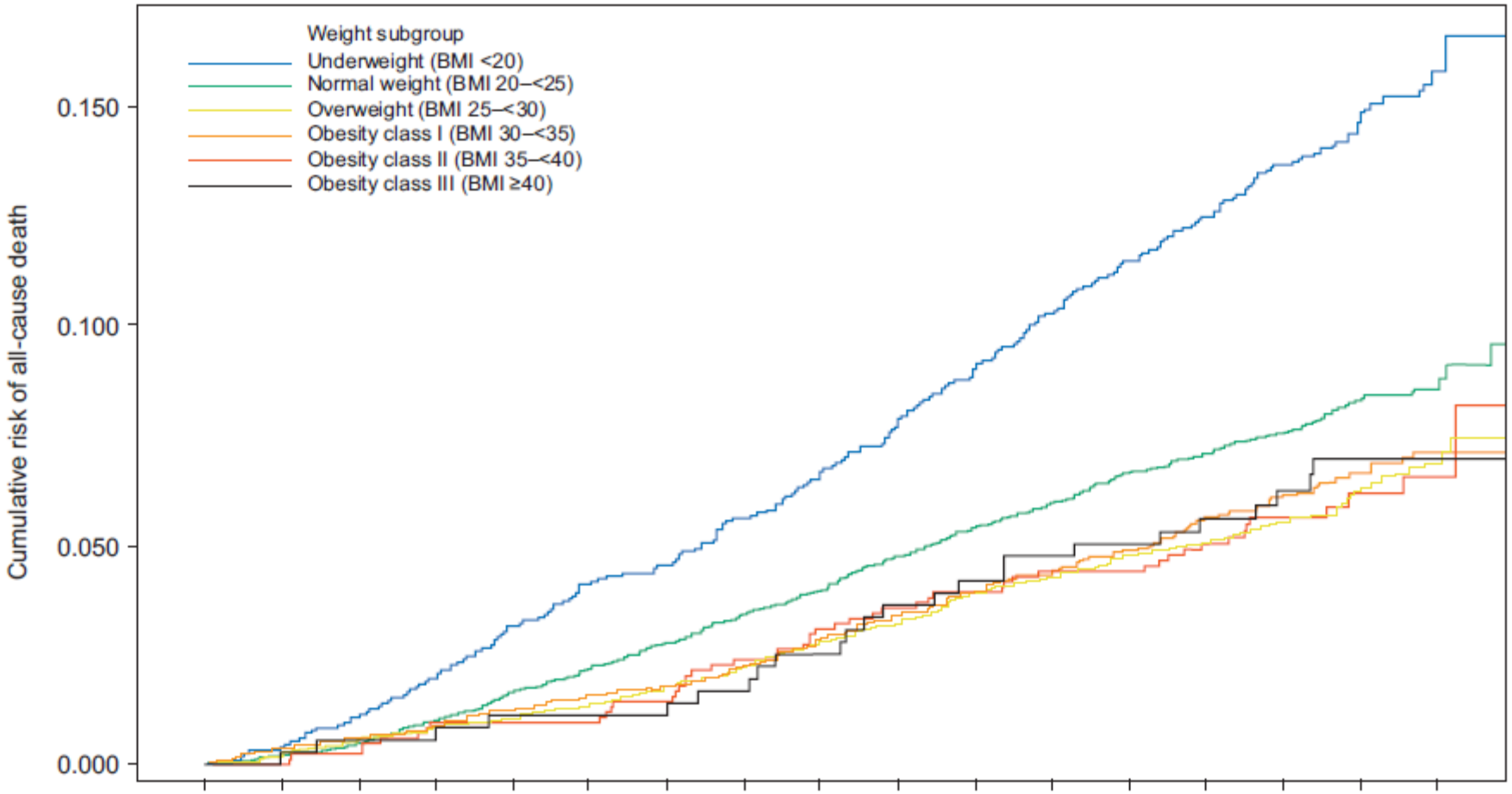
			Overweight and Obese			
	Underweight (BMI <20)* *n* = 2,063	Normal Weight† (BMI 20 to <25)* *n* = 5,721	Overweight (BMI 25 to <30)* *n* = 5,509	Obesity Class I (BMI 30 to <35)* *n* = 2,624	Obesity Class II (BMI 35 to <40)* *n* = 841	Obesity Class III (BMI ⩾ 40)* *n* = 358
Gender, male, *n* (%)	1,449 (70.2)	4,169 (72.9)	4,037 (73.3)	1,851 (70.5)	547 (65.0)	184 (51.4)
Age, years, mean (SD)	64.6 (9.3)	65.5 (9.2)	65.4 (9.0)	64.6 (8.7)	63.4 (8.6)	60.4 (8.1)
Race, *n* (%)						
White	1,206 (58.5)	4,324 (75.6)	4,868 (88.4)	2,432 (92.7)	795 (94.5)	338 (94.4)
Black	44 (2.1)	80 (1.4)	58 (1.1)	45 (1.7)	15 (1.8)	14 (3.9)
Asian	756 (36.6)	1,165 (20.4)	421 (7.6)	74 (2.8)	11 (1.3)	1 (0.3)
Region, *n* (%)						
Europe/Africa/Aus/NZ	821 (39.8)	3,118 (54.5)	3,452 (62.7)	1,632 (62.2)	472 (56.1)	144 (40.2)
Latin America	115 (5.6)	379 (6.6)	321 (5.8)	144 (5.5)	30 (3.6)	11 (3.1)
North America	385 (18.7)	1,087 (19.0)	1,336 (24.3)	781 (29.8)	329 (39.1)	203 (56.7)
Asia	742 (36.0)	1,137 (19.9)	400 (7.3)	67 (2.6)	10 (1.2)	0 (0.0)
Current smokers, *n* (%)	902 (43.7)	2,281 (39.9)	1,977 (35.9)	912 (34.8)	304 (36.1)	143 (39.9)
Smoking history, pack-years, mean (SD)	41.0 (21.9)	42.8 (23.7)	44.2 (25.0)	45.3 (26.2)	47.6 (28.0)	49.4 (31.0)
Postbronchodilator pulmonary function data						
FEV_1, L, mean (SD)	1.1 (0.4)	1.3 (0.5)	1.4 (0.5)	1.5 (0.5)	1.5 (0.5)	1.4 (0.5)
FEV_1/FVC ratio, mean (SD)	0.5 (0.1)	0.5 (0.1)	0.5 (0.1)	0.5 (0.1)	0.6 (0.1)	0.6 (0.1)
FVC, L, mean (SD)	2.5 (0.8)	2.7 (0.9)	2.8 (0.9)	2.7 (0.8)	2.6 (0.8)	2.5 (0.8)
FEV_1% predicted, mean (SD)	41.7 (14.8)	47.3 (14.5)	51.0 (13.9)	52.2 (13.5)	53.1 (13.8)	53.5 (13.9)
FVC% predicted, mean (SD)	74.6 (20.9)	79.5 (20.4)	80.1 (19.2)	78.1 (17.9)	77.5 (19.8)	75.6 (17.5)
Duration of COPD, years, mean (SD)	7.1 (6.2)	7.3 (6.2)	7.7 (6.3)	7.5 (6.2)	7.4 (5.8)	6.6 (5.5)

Ann Am Thorac Soc. 2022 Feb;19(2):204-213



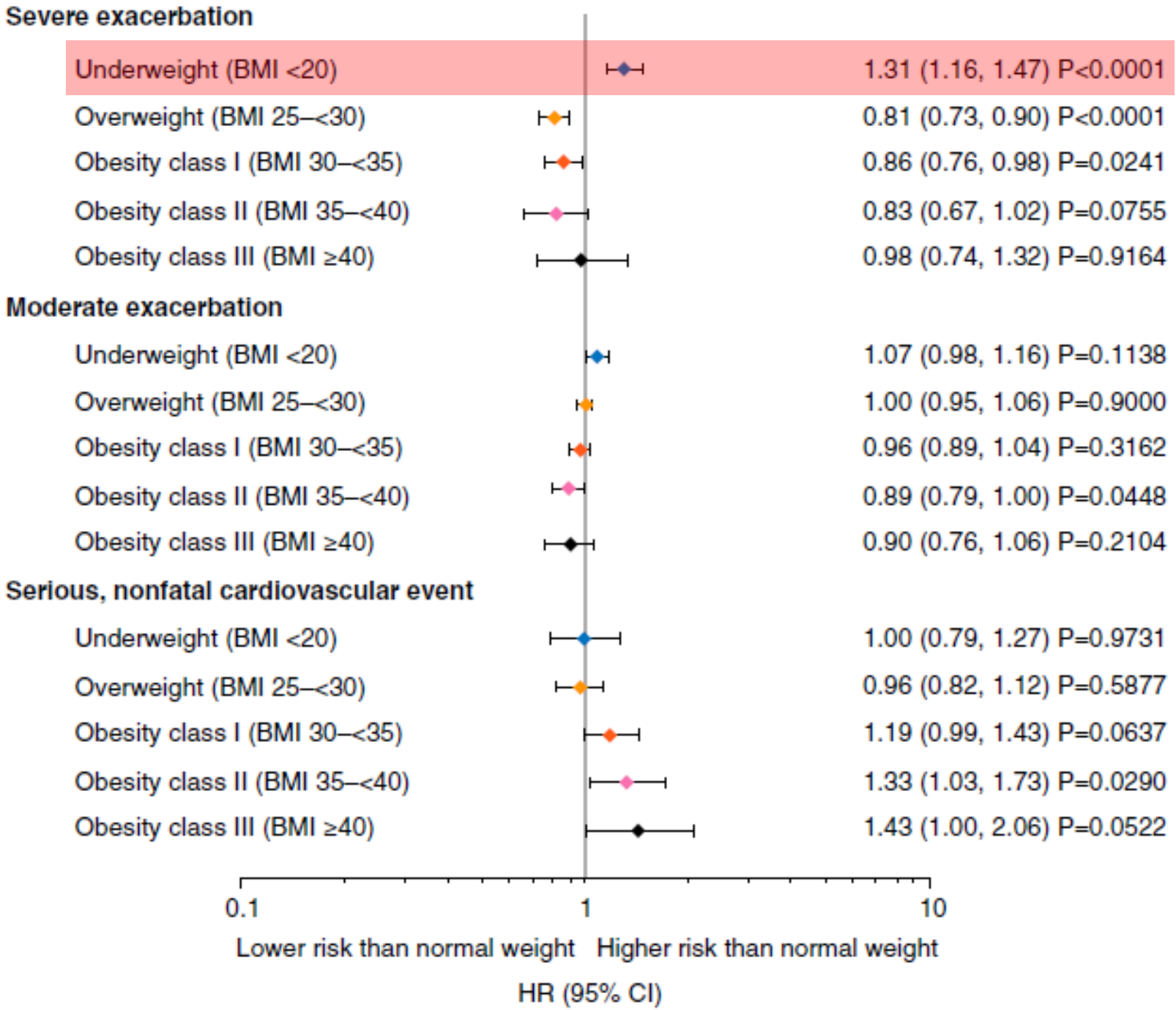
Ann Am Thorac Soc. 2022 Feb;19(2):204-213

A



Weight subgroup	Patients at risk																
Underweight (BMI <20)	2063	2055	2039	2021	1997	1977	1969	1946	1928	1900	1877	1849	1686	1532	1039	477	165
Normal weight (BMI 20–<25)	5721	5708	5689	5659	5621	5589	5555	5516	5483	5434	5397	5365	5098	4701	3341	1537	494
Overweight (BMI 25–<30)	5509	5498	5479	5458	5448	5430	5405	5379	5344	5321	5283	5261	5077	4803	3669	1570	496
Obesity class I (BMI 30–<35)	2624	2616	2609	2601	2592	2583	2575	2564	2547	2532	2518	2505	2435	2304	1789	837	290
Obesity class II (BMI 35–<40)	841	841	839	833	833	832	828	820	814	810	807	803	785	742	591	284	103
Obesity class III (BMI ≥40)	358	357	356	356	354	354	354	352	349	345	343	341	337	330	284	140	50

Ann Am Thorac Soc. 2022 Feb;19(2):204-213



Ann Am Thorac Soc. 2022 Feb;19(2):204-213

[COPD Original Research]

CHEST

Differential Impact of Low Fat-Free Mass in People With COPD Based on BMI Classifications

Results From the COPD and Systemic Consequences-Comorbidities Network

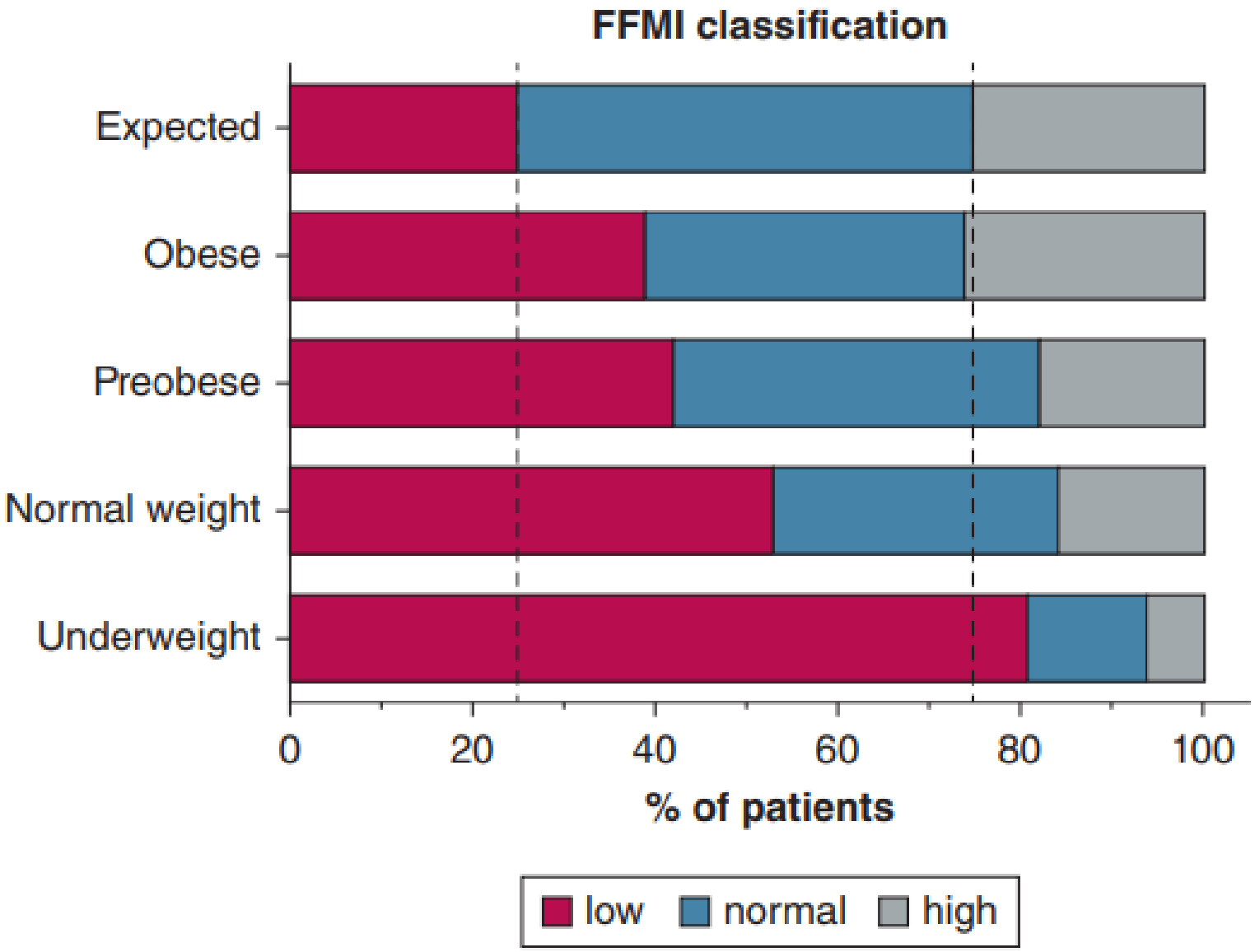
Felipe V. C. Machado, PhD; Claus F. Vogelmeier, MD; Rudolf A. Jörres, PhD; Henrik Watz, MD; Robert Bals, MD; Tobias Welte, MD; Martijn A. Spruit, PhD; Peter Alter, MD; and Frits M. E. Franssen, MD

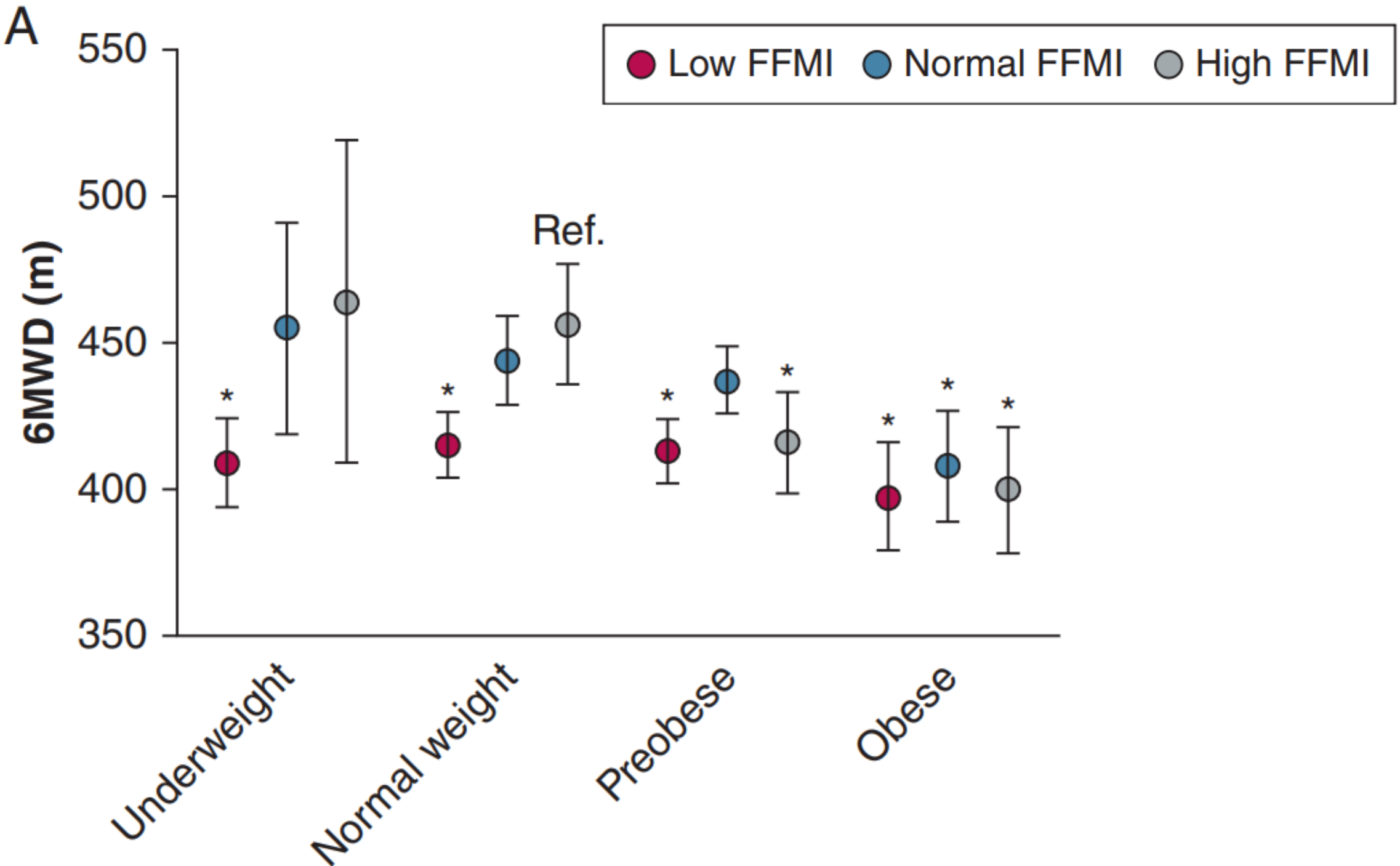
Check for updates

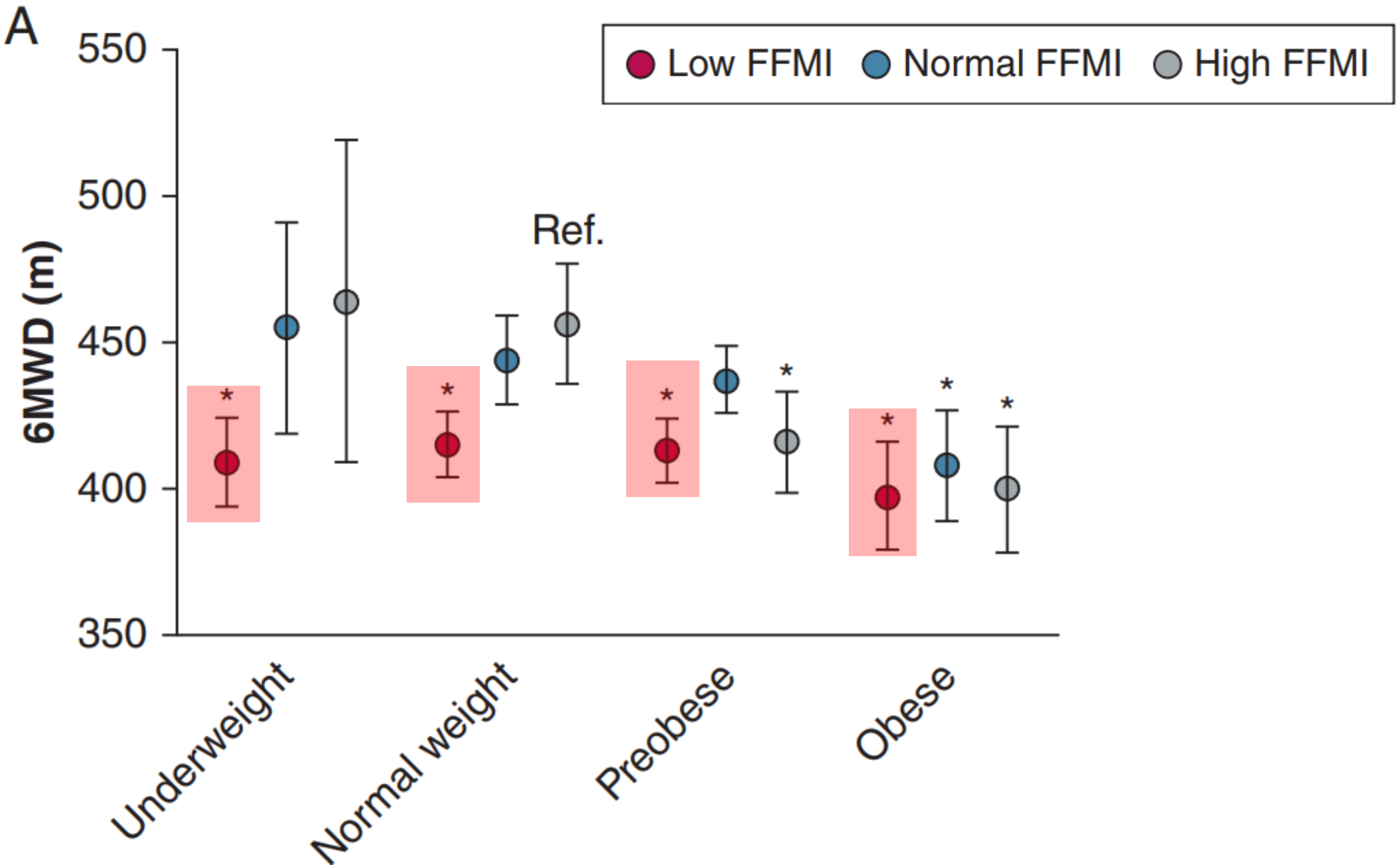
CHEST 2023; 163(5):1071-1083

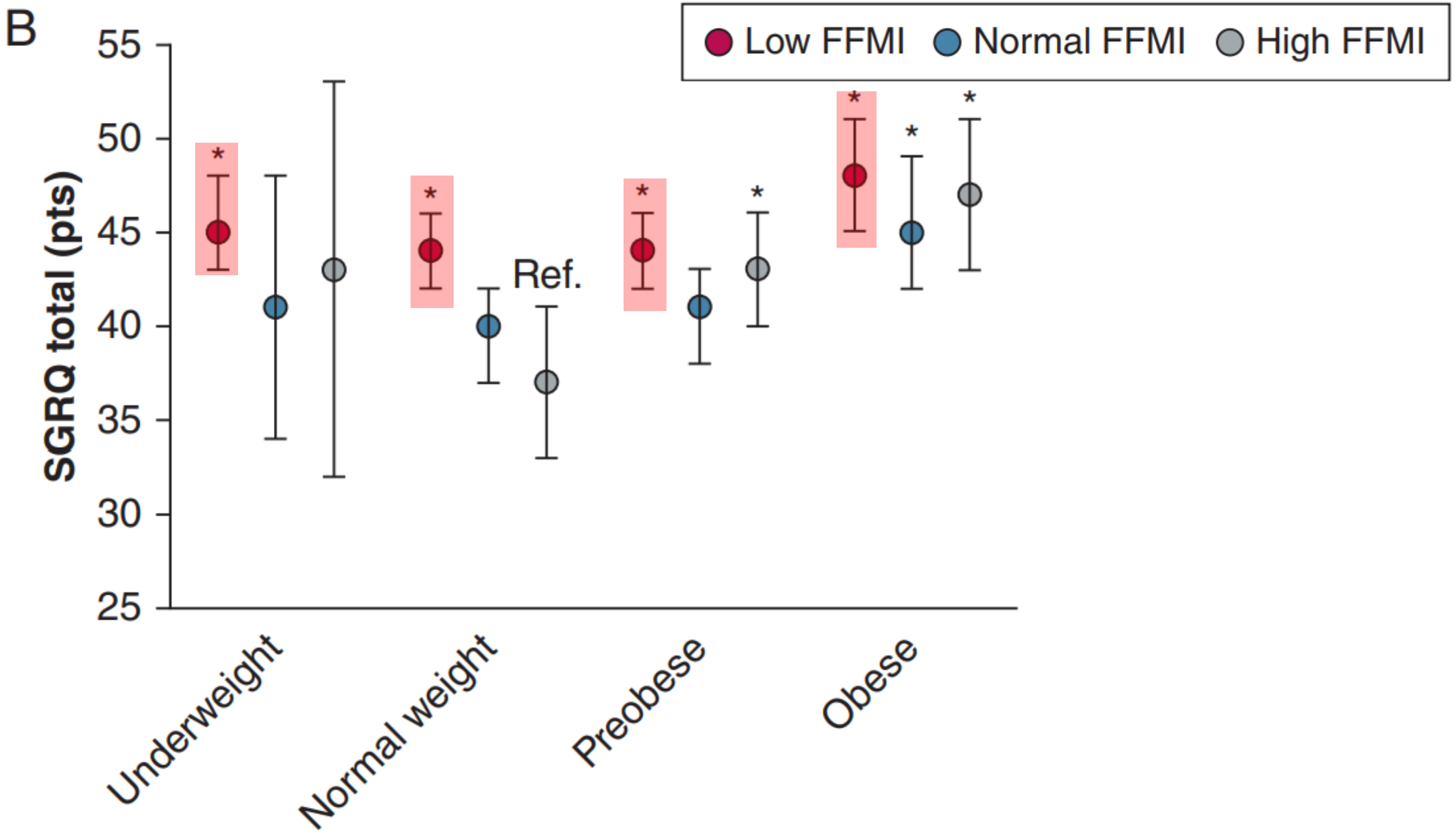
TABLE 1] Baseline Characteristics of Patients With COPD Stratified Into BMI Groups

Variable	Missing (%)	All Patients (N = 2,137)	Underweight (< 21 kg/m^2; n = 262)	Normal Weight (21-< 25 kg/m^2; n = 668)	Preobese (25-< 30 kg/m^2; n = 847)	Obese (30-< 35 kg/m^2; n = 360)
Male sex	0	1,306 (61)	98 (37)[a]	395 (59)	568 (67)[a]	245 (68)[a]
Age, y	0	65 ± 8	63 ± 9[a]	65 ± 8	66 ± 8	65 ± 8
BMI, kg/m^2	0	25.8 ± 4.1	18.9 ± 1.6[b]	23.2 ± 1.1	27.3 ± 1.4[b]	32.0 ± 1.4[b]
FFMI, kg/m^2	5.0	18.0 ± 2.8	14.5 ± 1.7[b]	16.8 ± 1.9	18.8 ± 2.0[b]	20.8 ± 2.5[b]
FMI, kg/m^2	5.0	7.8 ± 2.8	4.5 ± 1.6	6.4 ± 1.8[b]	8.5 ± 2.0[b]	11.2 ± 2.4[b]
FEV_1, % predicted	0	52.5 ± 18.8	45.7 ± 19.4[b]	51.4 ± 19.6	54.1 ± 18.0[b]	55.7 ± 17.5[b]
TLCO, % predicted	5.8	51.9 ± 20.3	39.8 ± 18.3[b]	49.3 ± 19.5	54.7 ± 20.0[b]	58.4 ± 19.8[b]
Current smokers	0.1	532 (25)	93 (36)	179 (27)	170 (20)[a]	90 (25)
Smoking history, pack-years	0.6	40 (19-62)	34 (14-55)	38 (17-60)	42 (19-64)	45 (22-70)[a]
Exacerbations ≥ 2	0	1,065 (50)	141 (54)	334 (50)	409 (48)	181 (50)
mMRC ≥ 2	0	986 (46)	129 (49)	281 (42)	392 (46)	184 (51)[a]
IPAQ, MET min/wk	3.7	2,718 (815-5,706)	2,623 (825-5,541)	2,772 (951-5,790)	2,778 (824-6,030)	2,079 (577-5,160)
6MWD						
Meters	3.1	420 ± 106	419 ± 101	429 ± 110	423 ± 105	400 ± 100[a]
% Predicted	3.1	65 ± 16	63 ± 16[b]	66 ± 17	66 ± 16	64 ± 16
6MWW, kg/m	3.1	31,898 ± 10,442	22,699 ± 6,734[b]	29,295 ± 8827	34,182 ± 9,888[b]	38,151 ± 4,620[b]
Fibrinogen, g/L	10.1	2.4 (1.8-3.2)	2.3 (1.8-3.2)	2.5 (1.8-3.2)	2.5 (1.8-3.3)	2.3 (1.7-3.1)
CRP, mg/dL	1.2	0.4 (0.2-0.7)	0.3 (0.1-0.6)	0.3 (0.1-0.6)	0.5 (0.2-0.8)[b]	0.5 (0.3-1.0)[b]
IL-6, pg/mL	7.2	2.9 (0.6-8.7)	2.0 (0.3-11.0)	2.8 (0.4-6.9)	3.0 (0.6-8.8)	3.8 (0.9-9.9)[a]
IL-8, pg/mL	7.2	8.3 (5.5-12.1)	9.1 (6.0-13.3)	8.1 (5.5-11.8)	8.3 (5.4-11.9)	7.8 (5.6-11.9)
TNFα, pg/mL	7.2	8.0 (4.9-12.4)	6.9 (4.1-11.7)	7.8 (4.9-11.6)	8.6 (5.3-13.3)[a]	7.8 (4.9-12.7)
WBC count, 10^9/mL	1.7	7.6 (6.4-9.1)	7.6 (6.3-9.4)	7.5 (6.3-9.0)	7.7 (6.4-9.1)	7.6 (6.5-9.0)
SGRQ, points						
Symptoms	0.6	56 ± 21	57 ± 20	55 ± 22	55 ± 22	57 ± 21
Activity	0.7	58 ± 26	60 ± 25	56 ± 27	56 ± 25	64 ± 23[b]
Impact	0.5	30 ± 21	32 ± 21	29 ± 21	30 ± 20	33 ± 22[b]
Total	0.9	43 ± 20	45 ± 20	42 ± 20	42 ± 20	47 ± 20[b]
BODE index	5.7	2 (1-4)	4 (2-5)[b]	2 (1-4)	2 (1-3)	2 (1-3)


FFMI classification
Expected
Obese
Preobese
Normal weight
Underweight
0
20
40
60
80
100
% of patients
low
normal
high


A
Low FFMI
Normal FFMI
High FFMI
6MWD (m)
550
500
450
400
350
Ref.
*
Underweight
Normal weight
Preobese
Obese


A
Low FFMI
Normal FFMI
High FFMI
6MWD (m)
550
500
450
400
350
Ref.
*
Underweight
Normal weight
Preobese
Obese


B
Low FFMI
Normal FFMI
High FFMI
SGRQ total (pts)
55
50
45
40
35
30
25
Ref.
*
Underweight
Normal weight
Preobese
Obese

Assessment Criteria of Cachexia

- **Phenotypic**
  - Non-volitional weight loss
  - Low body mass index
  - Reduced muscle mass
- **Etiologic**
  - Reduced food intake or assimilation
    Disease burden/inflammatory condition

Clinical Nutrition 38 (2019) 1-9

Nutrition disorders and Nutrition-related conditions

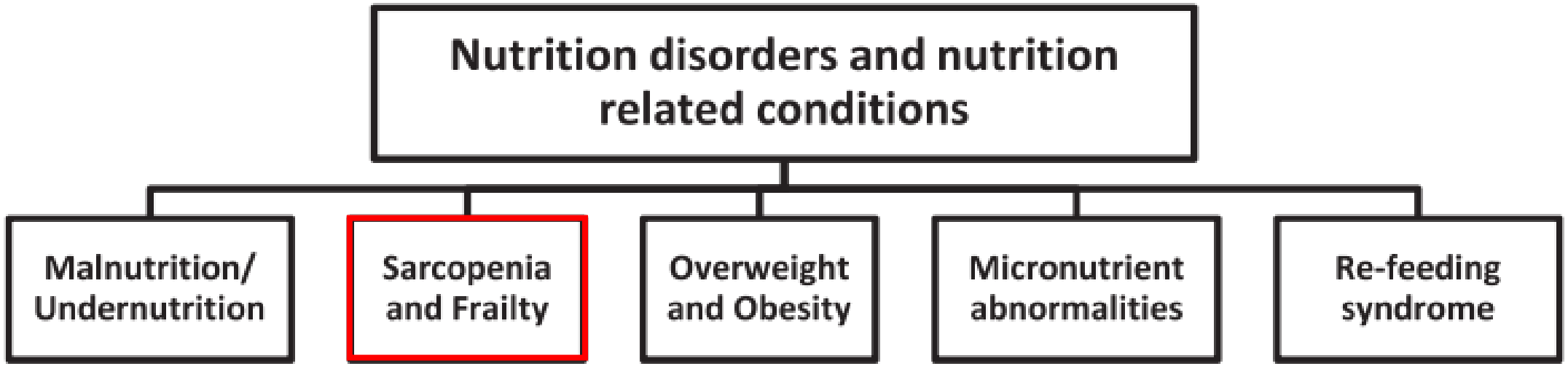


Fig. 1. Overview of nutrition disorders and nutrition-related conditions.

Clinical Nutrition 36 (2017) 49-64

	Sarcopenia	Cachexia
Definition	Muscle mass <2 SD of young healthy population, decreased muscle function	Weight loss >5% in 6 months
Mechanism	Aging	Pathologic
Comorbid condition	+/−	+++
Functional limitation	++	+++
Inflammation	−	++
Fat mass	Increased	Decreased
Protein degradation	−/+	+++
Resting energy expenditure	Decreased	Increased
Anorexia	+	++

Gerontology (2014) 60 (4): 294–305.

Sarcopenia

Table 1. 2018 operational definition of sarcopenia

Probable sarcopenia is identified by Criterion 1.
Diagnosis is confirmed by additional documentation of Criterion 2.
If Criteria 1, 2 and 3 are all met, sarcopenia is considered severe.

› **Sarcopenia**

EUROPEAN WORKING GROUP ON SARCOPENIA IN OLDER PEOPLE 2 (EWGSOP2)

Sarcopenia

Table 1. 2018 operational definition of sarcopenia

Probable sarcopenia is identified by Criterion 1.
Diagnosis is confirmed by additional documentation of Criterion 2.
If Criteria 1, 2 and 3 are all met, sarcopenia is considered severe.
(1) Low muscle strength
(2) Low muscle quantity or quality
(3) Low physical performance

Severe Sarcopenia

EUROPEAN WORKING GROUP ON SARCOPENIA IN OLDER PEOPLE 2 (EWGSOP2)

Prevalence of Sarcopenia in COPD

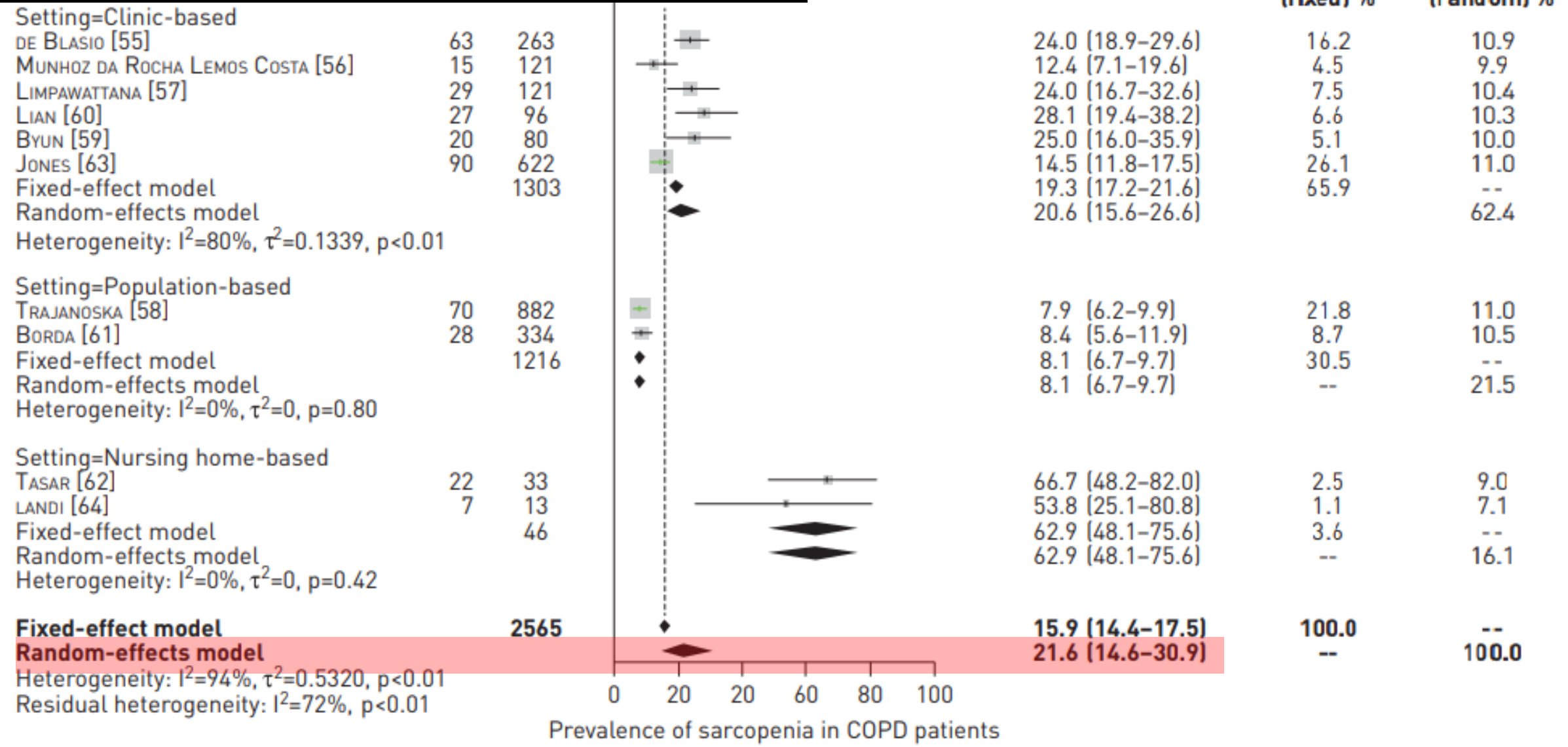
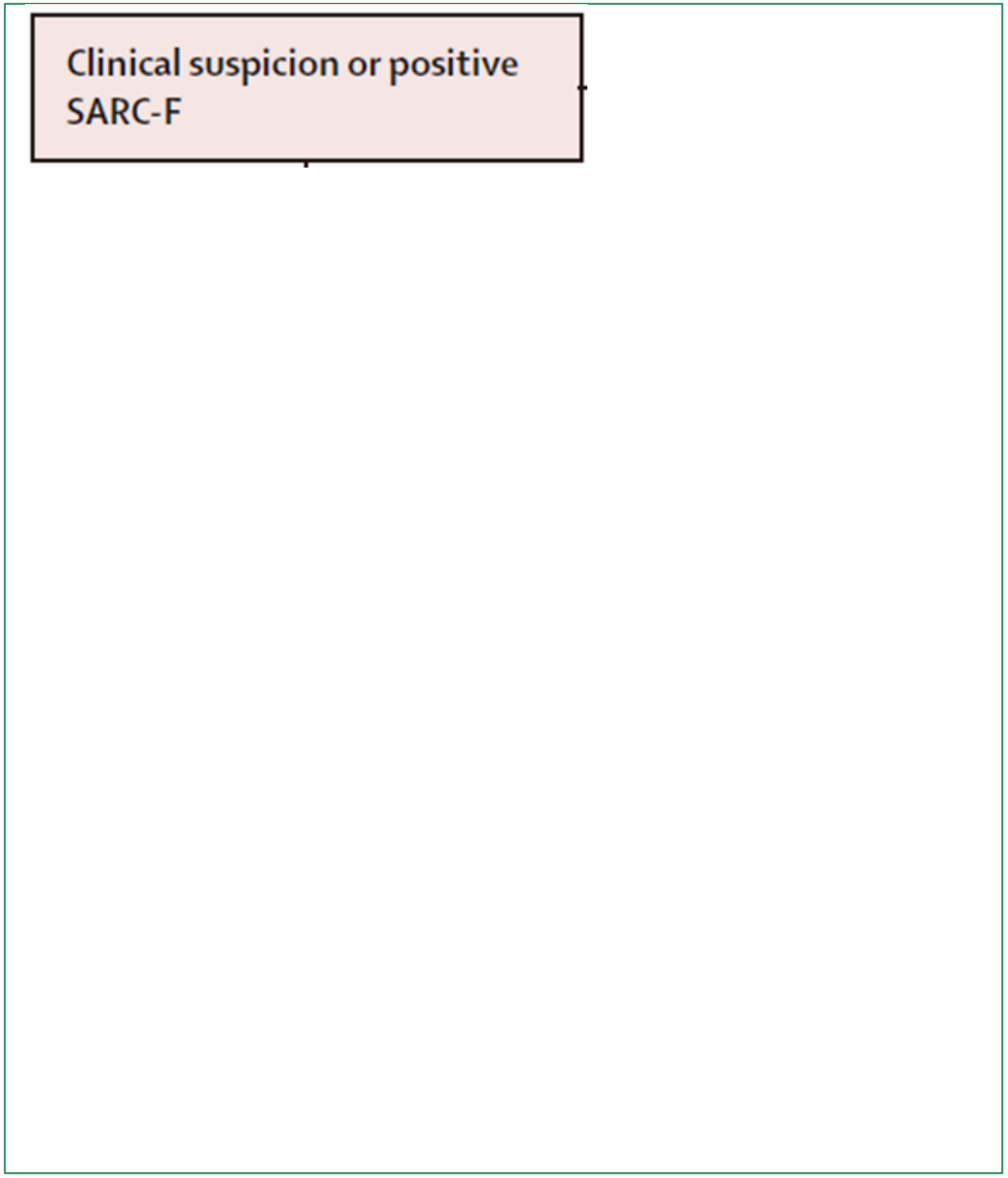


FIGURE 2 Fixed- and random-effects meta-analysis results for the prevalence of sarcopenia in patients with COPD, according to population setting. The authors directly provided the prevalence estimate for the study by Tasar *et al.* [62].

Eur Respir Rev 2019; 28: 190049



Lancet 2019; 393: 2636–46

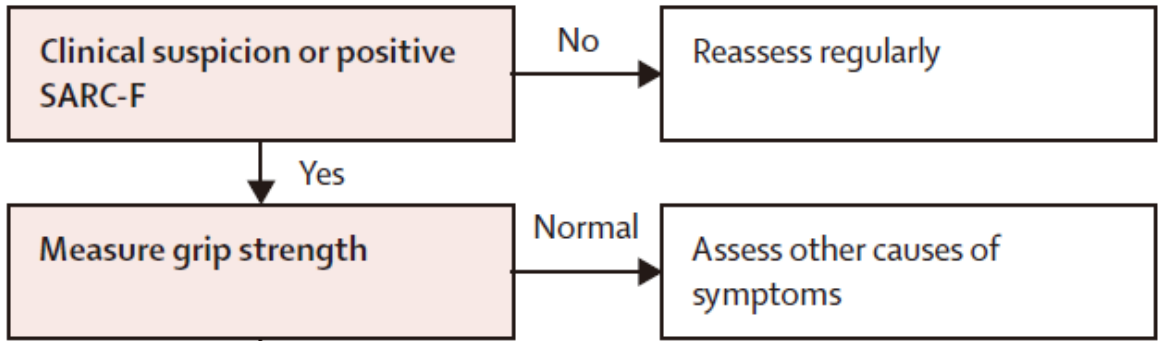
SARC-F

Component	Question	Scoring
Strength	How much difficulty do you have in lifting and carrying 10 lb?	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 falls = 2

JAMDA 15 (2014) 630-634

[한국형 근감소증 선별 질문지] * 4점 이상이면 근감소증 의심할 수 있음

항목	질문	점수
근력	무게 4.5kg (9개들이 배 한 박스)를 들어서 나르는 것이 얼마나 어려운가요?	전혀 어렵지 않다=0 조금 어렵다=1 매우 어렵다/할 수 없다=2
보행 보조	방안 한 쪽 끝에서 다른 쪽 끝까지 걷는 것이 얼마나 어려운가요?	전혀 어렵지 않다=0 좀 어렵다=1 매우 어렵다/보조기(지팡이 등)를 사용해야 가능/할 수 없다=2
의자에서 일어서기	의자(휠체어)에서 일어나 침대로, 혹은 침대에서 일어나 의자(휠체어)로 옮기는 것이 얼마나 어려운가요?	전혀 어렵지 않다=0 좀 어렵다=1 매우 어렵다/도움 없이는 할 수 없다=2
계단 오르기	10개의 계단을 쉬지 않고 오르는 것이 얼마나 어려운가요?	전혀 어렵지 않다=0 좀 어렵다=1 매우 어렵다/할 수 없다=2
낙상	지난 1년 동안 몇 번이나 넘어지셨나요?	전혀 없다=0 1~3회 =1 4회 이상 =2



Muscle Strength

Handgrip strength measurement

Quadriceps strength

Chair stand test

Lancet 2019; 393: 2636–46

Figure 1. JAMAR hydraulic hand dynamometer (A,B)

Figure 2. JAMAR hydraulic hand dynamometer measurement in a suitable position (A,B)

	Men	Women
Grip strength (kg)	<27	<16
Appendicular skeletal muscle mass divided by height^2 (kg/m^2)	<7	<5·5
Gait speed (m/sec)	≤0·8	≤0·8
Timed Up and Go test (sec)	≥20	≥20

Values shown are those recommended by the European Working Group on Sarcopenia in Older People (EWGSOP2).[35]

Table: **Reference values used to diagnose sarcopenia**

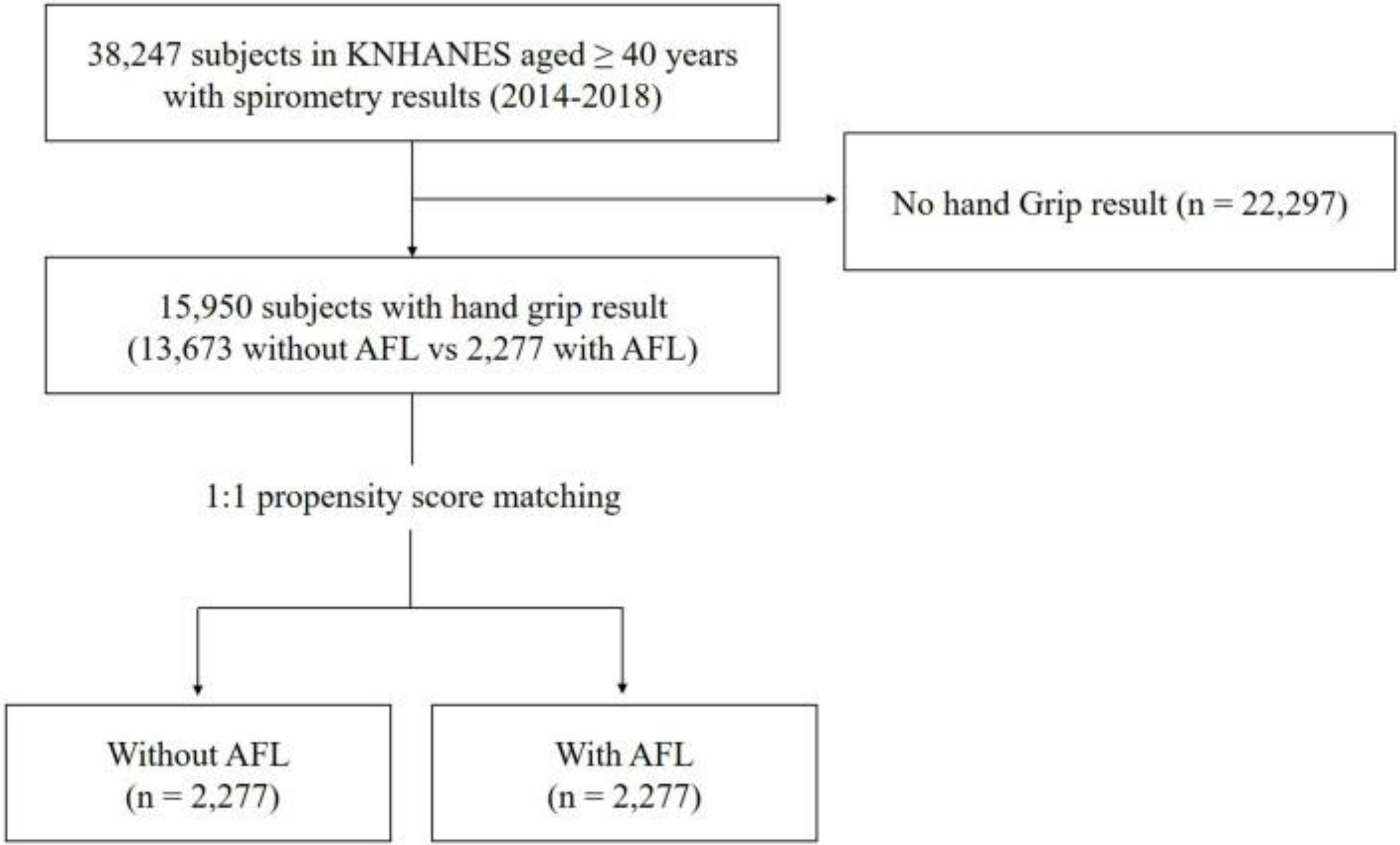
International Journal of Chronic Obstructive Pulmonary Disease Dovepress
open access to scientific and medical research

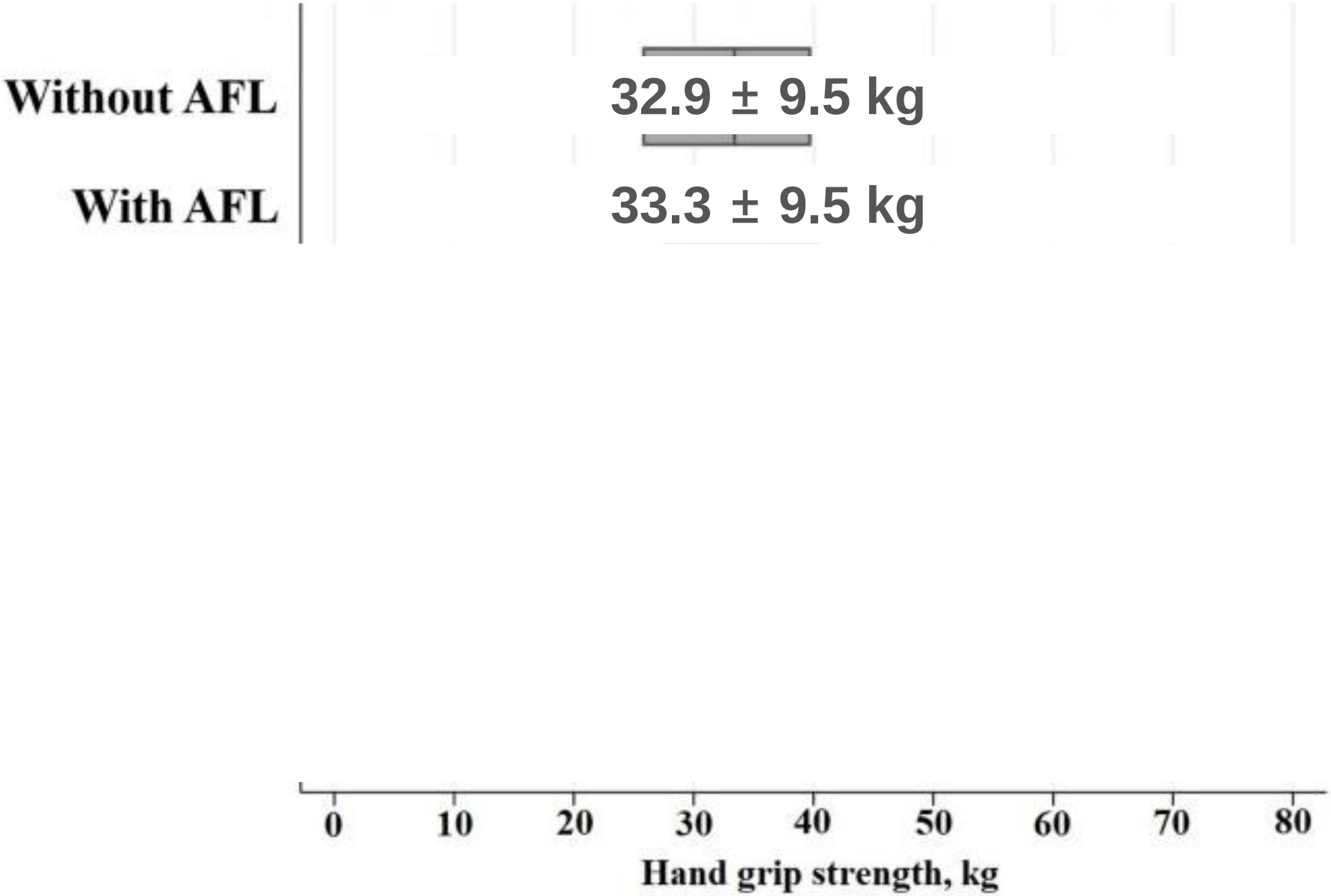
Open Access Full Text Article

ORIGINAL RESEARCH

Hand Grip Strength and Likelihood of Moderate-to-Severe Airflow Limitation in the General Population

Sunyoung Kim[1], Hyoung Kyu Yoon[2], Chin Kook Rhee[3], Hee-Won Jung[4], Hyun Lee[5], Yong Suk Jo[3]


38,247 subjects in KNHANES aged ≥ 40 years with spirometry results (2014-2018)
No hand Grip result (n = 22,297)
15,950 subjects with hand grip result (13,673 without AFL vs 2,277 with AFL)
1:1 propensity score matching
Without AFL (n = 2,277)
With AFL (n = 2,277)


Without AFL
32.9 ± 9.5 kg
With AFL
33.3 ± 9.5 kg
0
10
20
30
40
50
60
70
80
Hand grip strength, kg

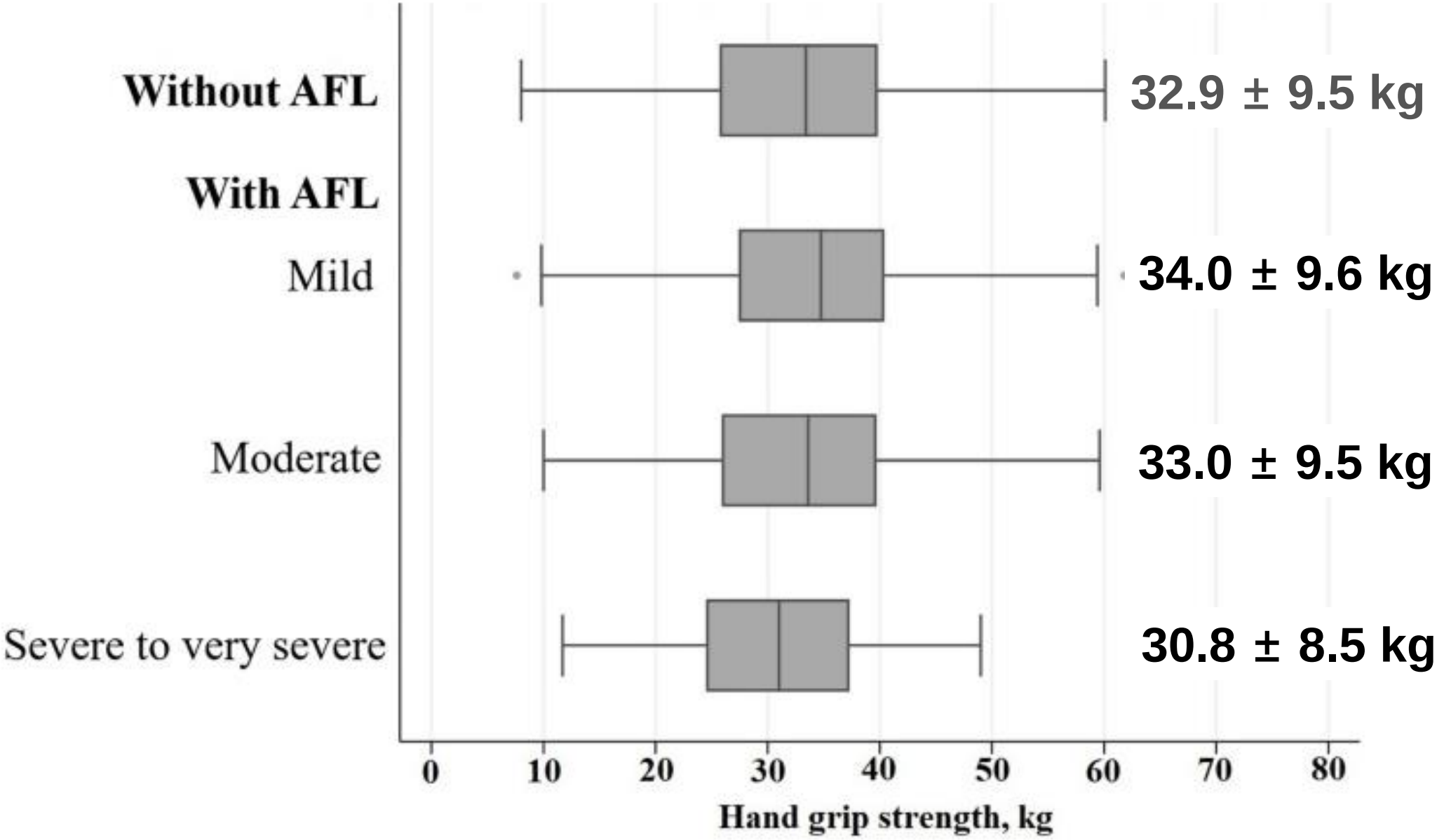
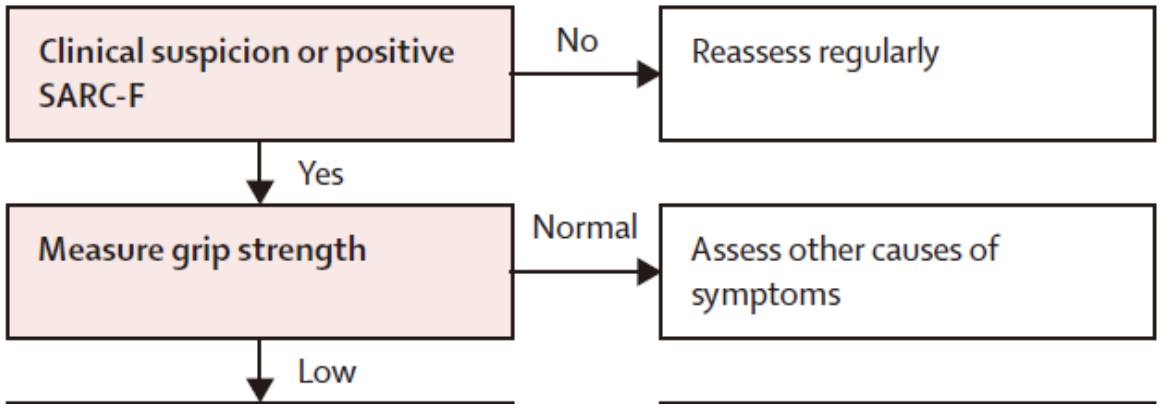

Without AFL
With AFL
Mild
Moderate
Severe to very severe
32.9 ± 9.5 kg
34.0 ± 9.6 kg
33.0 ± 9.5 kg
30.8 ± 8.5 kg
0
10
20
30
40
50
60
70
80
Hand grip strength, kg

Table 2 Impact of Hand Grip Strength on the Risk of Moderate-to-Severe or Very Severe Airflow Limitation

	OR (95% CI)		
	Crude	**Model 1**	**Model 2**
Hand grip[a]	0.99 (0.977–0.995)**	0.97 (0.951–0.987)**	0.97 (0.954–0.994)*
Hand grip[b]	0.99 (0.988–1.001)	0.98 (0.967–0.995)*	0.98 (0.968–0.999)*



	Men	Women
Grip strength (kg)	<27	<16
Appendicular skeletal muscle mass divided by height² (kg/m²)	<7	<5·5
Gait speed (m/sec)	≤0·8	≤0·8
Timed Up and Go test (sec)	≥20	≥20

Values shown are those recommended by the European Working Group on Sarcopenia in Older People (EWGSOP2).[35]

Table: **Reference values used to diagnose sarcopenia**

Lancet 2019; 393: 2636–46

Muscle Mass

Whole body Magnetic Resonance Imaging (MRI)

Computed Tomography (CT)

Dual-energy X-ray absorptiometry (DXA)

Bioelectrical Impedance Analysis (BIA)

Anthropometric measures (calf or mid-arm muscle circumference)

Muscle Mass

Whole body Magnetic Resonance Imaging (MRI)

Computed Tomography (CT)

Dual-energy X-ray absorptiometry (DXA)

Bioelectrical Impedance Analysis (BIA)

Anthropometric measures (calf or mid-arm muscle circumference)

TABLE 2 Appropriate measurements of body composition and surrogate markers in research and clinical practice

Variable	Research	Clinical practice
Fat-free mass/fat mass	Deuterium dilution	DEXA, single-frequency BIA Anthropometry (sum of four skin folds)
Intracellular mass	Deuterium dilution combined with bromide dilution	Multifrequency BIA
Muscle mass	CT MRI Biomarkers (*i.e.* D_3-creatine dilution)	DEXA Ultrasonography Biomarkers (*i.e.* creatine height index) Anthropometry (mid-arm muscle circumference)
Abdominal fat **Abdominal visceral fat**	CT MRI Biomarkers (*i.e.* PAI-1)	DEXA Anthropometry (*i.e.* sagittal diameter and/or waist/hip circumference) Ultrasonography
Bone mass and density	DEXA	DEXA HRCT
Muscle strength and related physical performance	Isokinetic quadriceps strength (Repetitive) magnetic stimulation Timed up-and-go test Stair-climb power test Cycle ergometry	One-repetition maximum Handgrip strength Timed up-and-go test Stair-climb power test

Eur Respir J 2014; 44: 1504–1520

Patient Information:

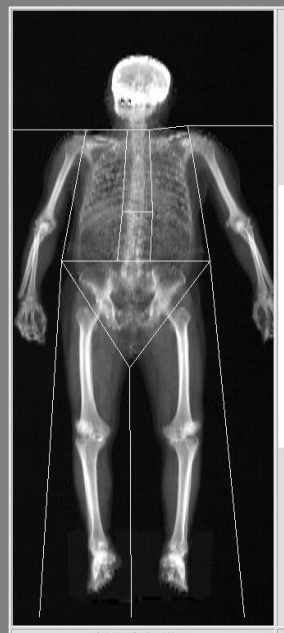
Name:	O, WEON IL
Patient ID:	14851996
Identifier 2:	
Postal Code:	
Sex:	Male
Ethnicity:	Asian
Height:	165.0 cm
Weight:	69.0 kg
DOB:	20.08.1948
Age:	75
Menopause Age:	
Referring Physician:	

Scan Information:

Scan Date:	07 May 2024 - A05072413
Scan Type:	a Whole Body
Analysis Date:	07.05.2024 11:32
Analysis Protocol:	Whole Body
Report Date:	07.05.2024 11:32
Institution:	YEUNGNAM UNIV.HOSP
Operator:	
Model:	Horizon W (S/N305266M)
Comment:	
Software version:	13.6.1.2

Comment:

HOLOGIC®



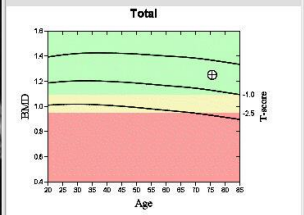


Image not for diagnostic use

318 x 150

k = 1.177, d0 = 48.8

T-score vs. White Male. Source:2012 BMDCS/NHANES.
Z-score vs. White Male. Source:2012 BMDCS/NHANES.

Results Summary:

Region	Area [cm²]	BMC [(g)]	BMD [g/cm²]	Fat[(g)]	Lean [(g)]	Lean + BMC[(g)]	Total [(g)]	% Fat [(%)]	T-score	PR (Peak Reference)	Z-score	AM (Age Matched)
L Arm	200.72	189.30	0.943	1712.0	1987.2	2176.5	3888.5	44.0				
R Arm	218.75	200.60	0.917	1388.1	2014.5	2215.1	3603.1	38.5				
L Ribs	101.70	65.79	0.647									
R Ribs	104.00	66.83	0.643									
T Spine	114.75	114.94	1.002									
L Spine	70.23	72.73	1.036									
Pelvis	188.82	202.43	1.072									
Trunk		522.72		13251.6	20372.0	20894.7	34146.3	38.8				
L Leg	336.19	478.52	1.423	3544.4	6041.3	6519.8	10064.2	35.2				
R Leg	354.61	483.07	1.362	3491.3	6404.3	6887.3	10378.7	33.6				
Subtotal	1689.77	1874.20	1.109	23387.4	36819.2	38693.4	62080.8	37.7				
Head	251.76	553.94	2.200	1461.4	3431.3	3985.3	5446.7	26.8				
Total	**1941.53**	**2428.14**	**1.251**	**24848.8**	**40250.6**	**42678.7**	**67527.5**	**36.8**	**0.5**	**105**	**1.1**	**111**

Total BMD CV 1.0%, ACF = 1.019, BCF = 1.002
TBAR1209 - NHANES BCA calibration

YEUNGNAM UNIV.HOSP

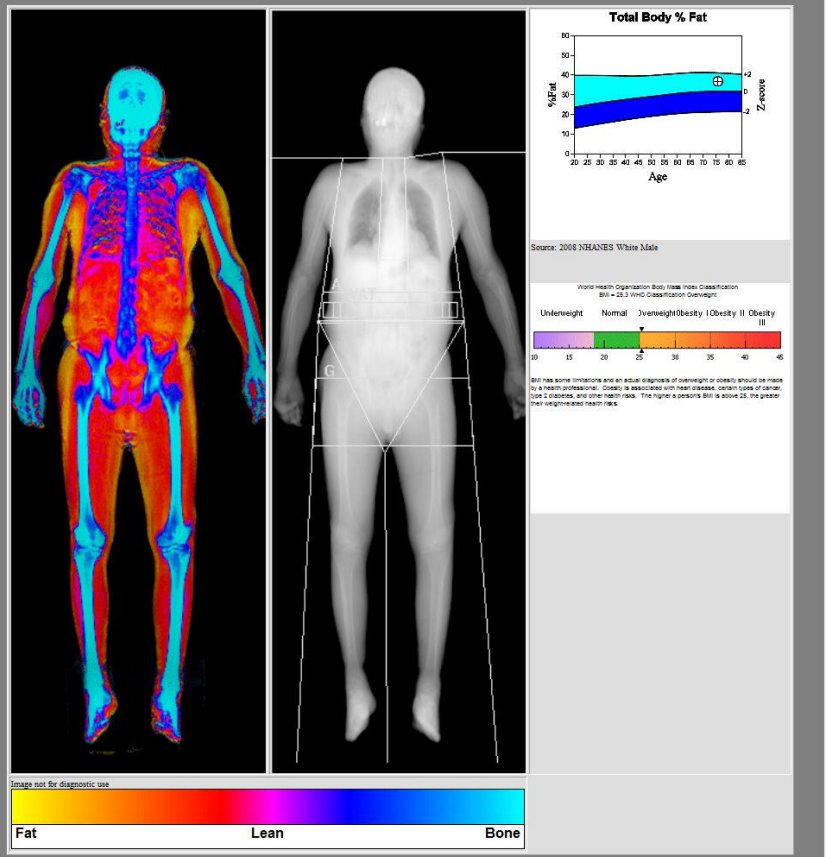
Patient Information:

Name:	O, WEON IL
Patient ID:	14851996
Identifier 2:	
Postal Code:	
Sex:	Male
Ethnicity:	Asian
Height:	165.0 cm
Weight:	69.0 kg
DOB:	20.08.1948
Age:	75
Menopause Age:	
Referring Physician:	

Scan Information:

Scan Date:	07 May 2024 - A05072413
Scan Type:	a Whole Body
Analysis Date:	07.05.2024 11:32
Analysis Protocol:	Whole Body
Report Date:	07.05.2024 11:32
Institution:	YEUNGNAM UNIV.HOSP
Operator:	
Model:	Horizon W (S/N305266M)
Comment:	
Software version:	13.6.1.2

HOLOGIC®



Results Summary:

Region	Fat[(g)]	Lean + BMC[(g)]	Total[(g)]	% Fat	% Fat YN %ile	% Fat AM %ile
L Arm	1712	2176	3888	44.0	99	98
R Arm	1388	2215	3603	38.5	97	89
Trunk	13252	20895	34146	38.8	95	83
L Leg	3544	6520	10064	35.2	90	83
R Leg	3491	6887	10379	33.6	85	73
Subtotal	23387	38693	62081	37.7	95	86
Head	1461	3985	5447	26.8		
Total	**24849**	**42679**	**67527**	**36.8**	**95**	**86**
Android (A)	2438	3344	5782	42.2		
Gynoid (G)	3531	6107	9637	36.6		

Total BMD CV 1.0%, ACF = 1.019, BCF = 1.002
TBAR1209 - NHANES BCA calibration

Adipose Indices:

Measure	Result	YN %ile	AM %ile
Total Body % Fat	**36.8**	**95**	**86**
Fat Mass/Height² (kg/m²)	9.13	80	57
Android/Gynoid Ratio	1.15		
% Fat Trunk/% Fat Legs	1.13	90	56
Trunk/Limb Fat Mass Ratio	1.31	94	46
Est. VAT Mass (g)	857		
Est. VAT Volume (cm³)	926		
Est. VAT Area (cm²)	178		

Lean Indices:

Measure	Result	YN %ile	AM %ile
Lean/Height² (kg/m²)	14.8	3	4
Appen. Lean/Height² (kg/m²)	6.04	1	3

YN = Young Normal
AM = Age Matched
Est. VAT = Estimated Visceral Adipose Tissue

Name:	O, WEON IL
Patient ID:	14851996
Identifier 2:	
Postal Code:	
Sex:	Male
Ethnicity:	Asian
Height:	165.0 cm
Weight:	69.0 kg
DOB:	20.08.1948
Age:	75
Menopause Age:	
Referring Physician:	

Region	Area [cm^2]	BMC [(g)]	BMD [g/cm^2]	Fat[(g)]	Lean [(g)]	Lean + BMC[(g)]	Total [(g)]	% Fat [(%)]	T-score	PR (Peak Reference)	Z-score	AM (Age Matched)
L Arm	200.72	189.30	0.943	1712.0	1987.2	2176.5	3888.5	44.0				
R Arm	218.75	200.60	0.917	1388.1	2014.5	2215.1	3603.1	38.5				
L Ribs	101.70	65.79	0.647									
R Ribs	104.00	66.83	0.643									
T Spine	114.75	114.94	1.002									
L Spine	70.23	72.73	1.036									
Pelvis	188.82	202.43	1.072									
Trunk		522.72		13251.6	20372.0	20894.7	34146.3	38.8				
L Leg	336.19	478.52	1.423	3544.4	6041.3	6519.8	10064.2	35.2				
R Leg	354.61	483.07	1.362	3491.3	6404.3	6887.3	10378.7	33.6				
Subtotal	1689.77	1874.20	1.109	23387.4	36819.2	38693.4	62080.8	37.7				
Head	251.76	553.94	2.200	1461.4	3431.3	3985.3	5446.7	26.8				
Total	**1941.53**	**2428.14**	**1.251**	**24848.8**	**40250.6**	**42678.7**	**67527.5**	**36.8**	**0.5**	**105**	**1.1**	**111**

Region	Fat[(g)]	Lean + BMC[(g)]	Total[(g)]	% Fat	% Fat YN %ile	% Fat AM %ile
L Arm	1712	2176	3888	44.0	99	98
R Arm	1388	2215	3603	38.5	97	89
Trunk	13252	20895	34146	38.8	95	83
L Leg	3544	6520	10064	35.2	90	83
R Leg	3491	6887	10379	33.6	85	73
Subtotal	23387	38693	62081	37.7	95	86
Head	1461	3985	5447	26.8		
Total	**24849**	**42679**	**67527**	**36.8**	**95**	**86**
Android (A)	2438	3344	5782	42.2		
Gynoid (G)	3531	6107	9637	36.6		

Lean Indices:

Measure	Result	YN %ile	AM %ile
Lean/Height² (kg/m²)	14.8	3	4
Appen. Lean/Height² (kg/m²)	6.04	1	3

InBody

[InBody970]

영남대학교병원
권역 호흡기 전문질환센터
YUMC Regional Center for Respiratory Diseases

회원번호	신장	나이	성별	검사일시
22029192 (서정우)	169cm	71	남성	2023.10.10. 12:10

체성분분석 Body Composition Analysis

	측정치	체수분	근육량	제지방량	체중
체수분 Total Body Water (L)	31.5 (35.4~43.2)	31.5	40.4 (45.4~55.4)	42.8 (48.1~58.7)	54.2 (53.4~72.2)
단백질 Protein (kg)	8.4 (9.4~11.6)				
무기질 Minerals (kg)	2.92 (3.27~3.99)				
체지방 Body Fat Mass (kg)	11.4 (7.6~15.1)				

골격근·지방분석 Muscle-Fat Analysis

	표준이하	표준	표준이상
체중 Weight (kg)	54.2		
골격근량 Skeletal Muscle Mass (kg)	23.2		
체지방량 Body Fat Mass (kg)	11.4		

비만분석 Obesity Analysis

	표준이하	표준	표준이상
BMI Body Mass Index (kg/m²)	19.0		
체지방률 Percent Body Fat (%)	21.0		

부위별근육분석 Segmental Lean Analysis

표준체중기준 ■■ 현재체중기준 ■■

	표준이하	표준	표준이상	세포외수분비
오른팔 Right Arm (kg)	2.10			0.377
(%)	81.5			
왼팔 Left Arm (kg)	2.22			0.376
(%)	86.0			
몸통 Trunk (kg)	19.4			0.387
(%)	94.3			
오른다리 Right Leg (kg)	6.79			0.388
(%)	94.7			
왼다리 Left Leg (kg)	6.81			0.391
(%)	94.9			

세포외수분비분석 ECW Ratio Analysis

	표준이하	표준	표준이상
세포외수분비 ECW Ratio	0.387		

신체변화 Body Composition History

	22.12.28 12:37	23.10.10 12:10
체중 Weight (kg)	53.5	54.2
골격근량 Skeletal Muscle Mass (kg)	22.8	23.2
체지방률 Percent Body Fat (%)	21.4	21.0
세포외수분비 ECW Ratio	0.385	0.387

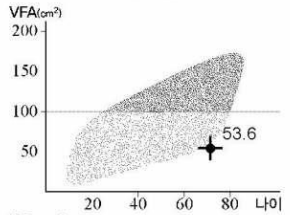
☑최근 □전체

인바디점수 InBody Score

67 /100 점

※체성분 종합점수입니다. 근육이 매우 많은 경우 100점을 넘을 수 있습니다.

내장지방단면적 Visceral Fat Area



체중조절 Weight Control

적정체중	62.9 kg
체중조절	+ 8.7 kg
지방조절	- 1.9 kg
근육조절	+ 10.6 kg

연구항목 Research Parameters

세포내수분	19.3 L	(21.9~26.7)
세포외수분	12.2 L	(13.4~16.4)
기초대사량	1295 kcal	(1266~1465)
복부지방률	0.87	(0.80~0.90)
체세포량	27.7 kg	(31.4~38.4)
SMI	6.3 kg/m²	

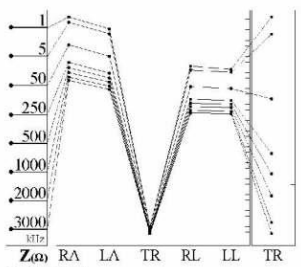
전신 위상각 Whole Body Phase Angle

ϕ(°) 50 kHz 4.9 °

부위별 위상각 Segmental Body Phase Angle

	RA	LA	TR	RL	LL
ϕ(°) 5 kHz	2.3	2.5	3.5	2.0	2.2
50 kHz	4.9	5.1	7.5	4.6	4.5
250 kHz	4.6	4.6	8.3	3.8	3.7

임피던스 Impedance



[000/000/000]

Copyright ⓒ 1996~ by InBody Co., Ltd. All rights reserved. BR-Korea-C7-B-140206

골격근·지방분석 Muscle-Fat Analysis

	표준이하	표준	표준이상
체중 Weight (kg)	55 70 85 100 115 130 145 160 175 190 205 %	54.2	
골격근량 Skeletal Muscle Mass (kg)	70 80 90 100 110 120 130 140 150 160 170 %	23.2	
체지방량 Body Fat Mass (kg)	40 60 80 100 160 220 280 340 400 460 520 %	11.4	

비만분석 Obesity Analysis

	표준이하	표준	표준이상
BMI Body Mass Index (kg/m²)	10.0 15.0 18.5 22.0 25.0 30.0 35.0 40.0 45.0 50.0 55.0	19.0	
체지방률 Percent Body Fat (%)	0.0 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0	21.0	

부위별근육분석 Segmental Lean Analysis

표준체중기준 ━━ 현재체중기준 ──

	표준이하	표준	표준이상	세포외수분비
오른팔 Right Arm (kg)	55 70 85 100 115 130 145 160 175 %	2.10		0.377
오른팔 Right Arm (%)		81.5		
왼팔 Left Arm (kg)	55 70 85 100 115 130 145 160 175 %	2.22		0.376
왼팔 Left Arm (%)		86.0		
몸통 Trunk (kg)	70 80 90 100 110 120 130 140 150 %	19.4		0.387
몸통 Trunk (%)		94.3		
오른다리 Right Leg (kg)	70 80 90 100 110 120 130 140 150 %	6.79		0.388
오른다리 Right Leg (%)		94.7		
왼다리 Left Leg (kg)	70 80 90 100 110 120 130 140 150 %	6.81		0.391
왼다리 Left Leg (%)		94.9		

체중조절 Weight Control

적정체중	62.9 kg	
체중조절	+ 8.7 kg	
지방조절	- 1.9 kg	
근육조절	+ 10.6 kg	

연구항목 Research Parameters

세포내수분	19.3 L	(21.9~26.7)
세포외수분	12.2 L	(13.4~16.4)
기초대사량	1295 kcal	(1266~1465)
복부지방률	0.87	(0.80~0.90)
체세포량	27.7 kg	(31.4~38.4)
SMI	6.3 kg/m²	

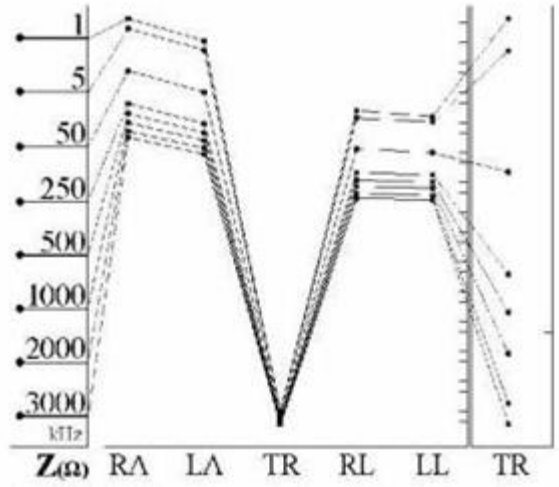
전신 위상각 Whole Body Phase Angle

ϕ(°) 50 kHz	4.9 °

부위별 위상각 Segmental Body Phase Angle

ϕ(°)	RA	LA	TR	RL	LL
5 kHz	2.3	2.5	3.5	2.0	2.2
50 kHz	4.9	5.1	7.5	4.6	4.5
250 kHz	4.6	4.6	8.3	3.8	3.7

임피던스 Impedance

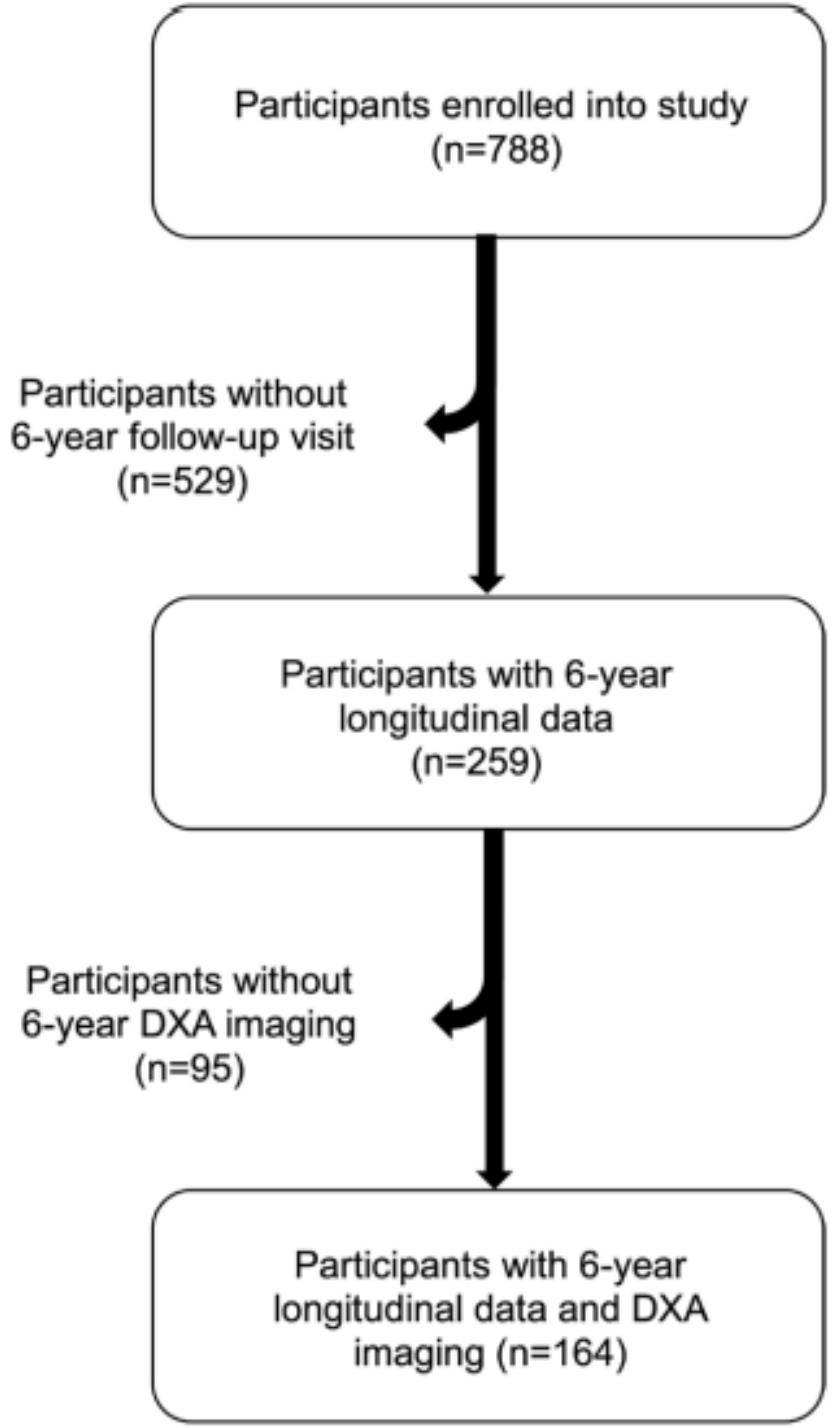


Original research

CT pectoralis muscle area is associated with DXA lean mass and correlates with emphysema progression in a tobacco-exposed cohort

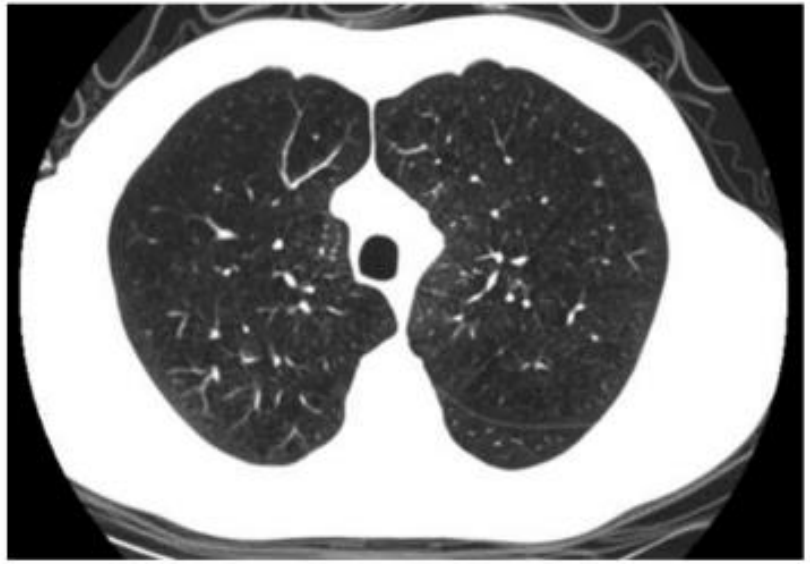
Michael Emmet O'Brien ,[1] Richard H Zou ,[1] Nathan Hyre,[2] Joseph K Leader,[3] Carl R Fuhrman,[3] Frank C Sciurba,[1] Mehdi Nouraie,[1] Jessica Bon[1]

Thorax 2023;78:394–401



Thorax 2023;78:394–401

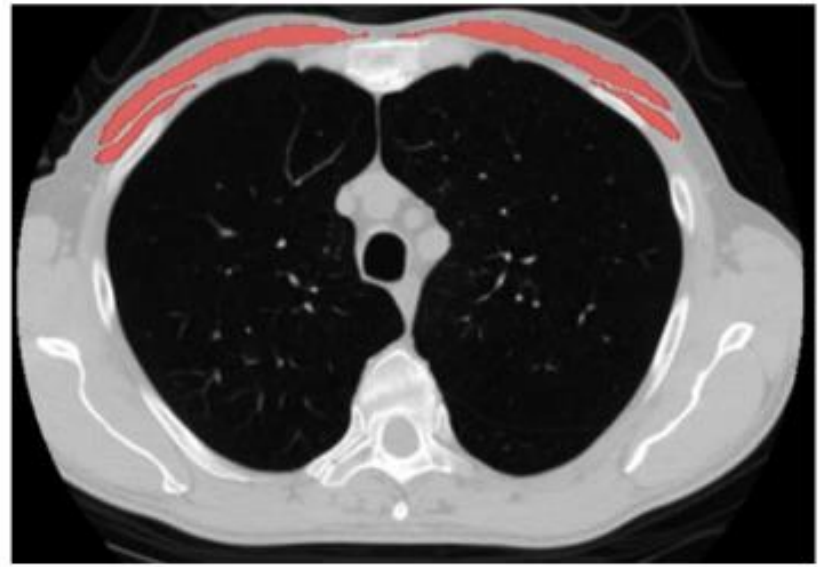
Lung window

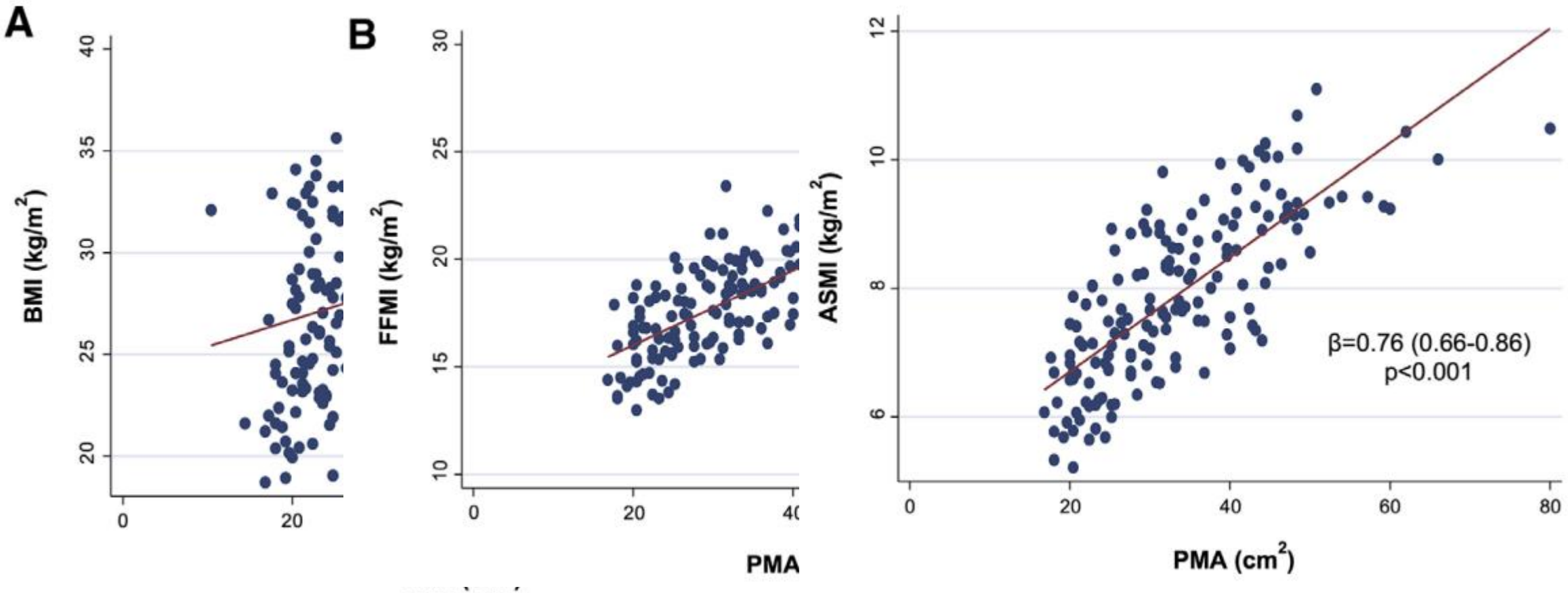


Pectoralis muscle (red)

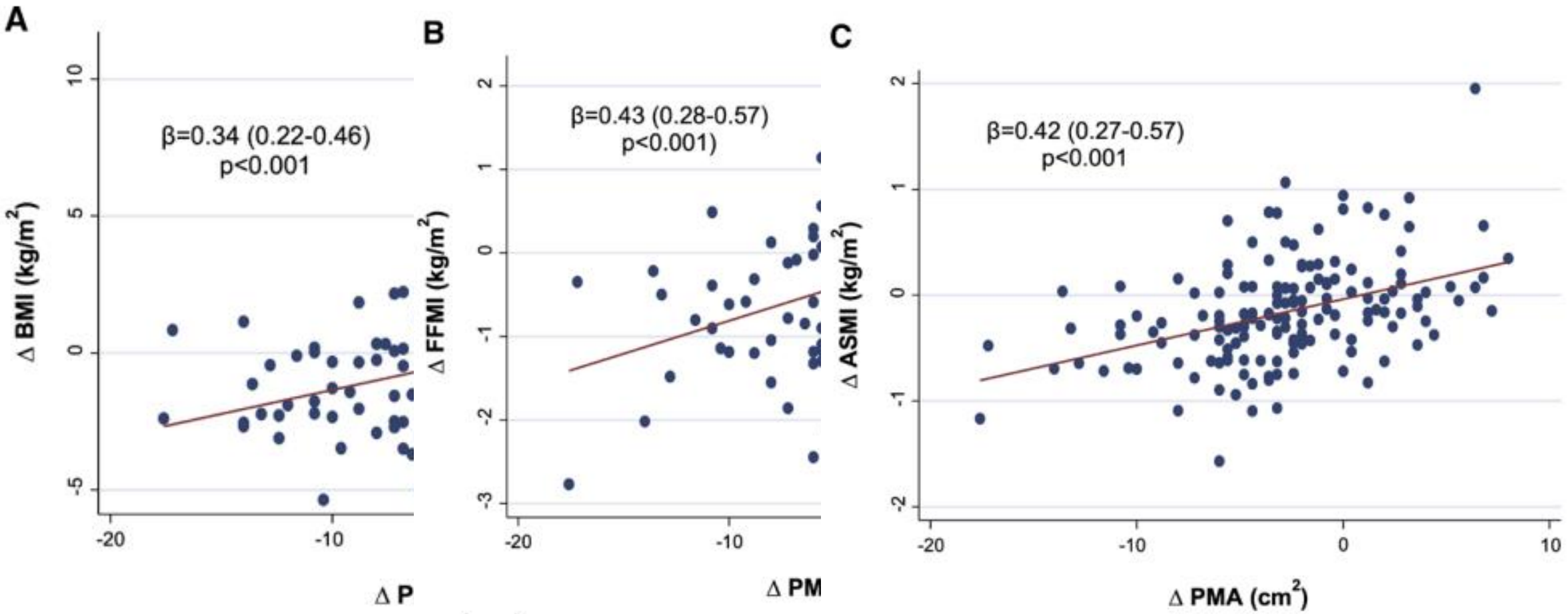
Lung window

Pectoralis muscle (red)

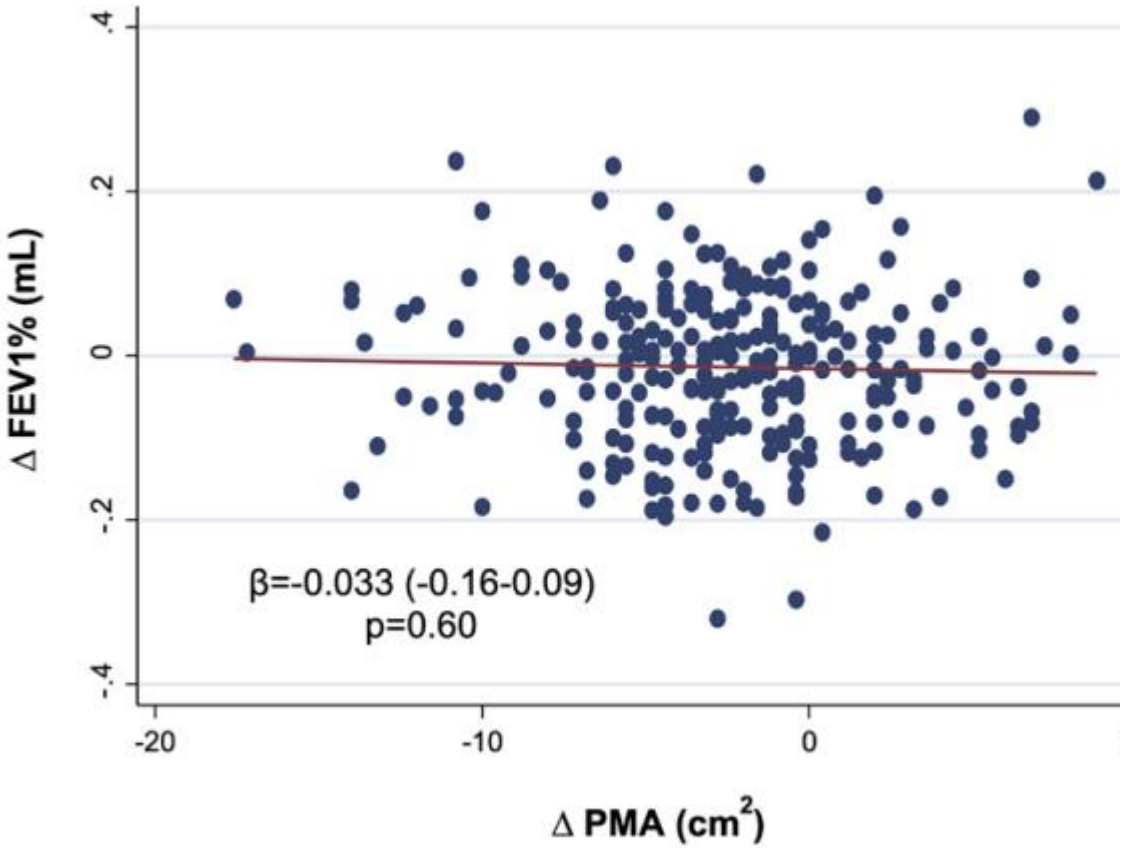


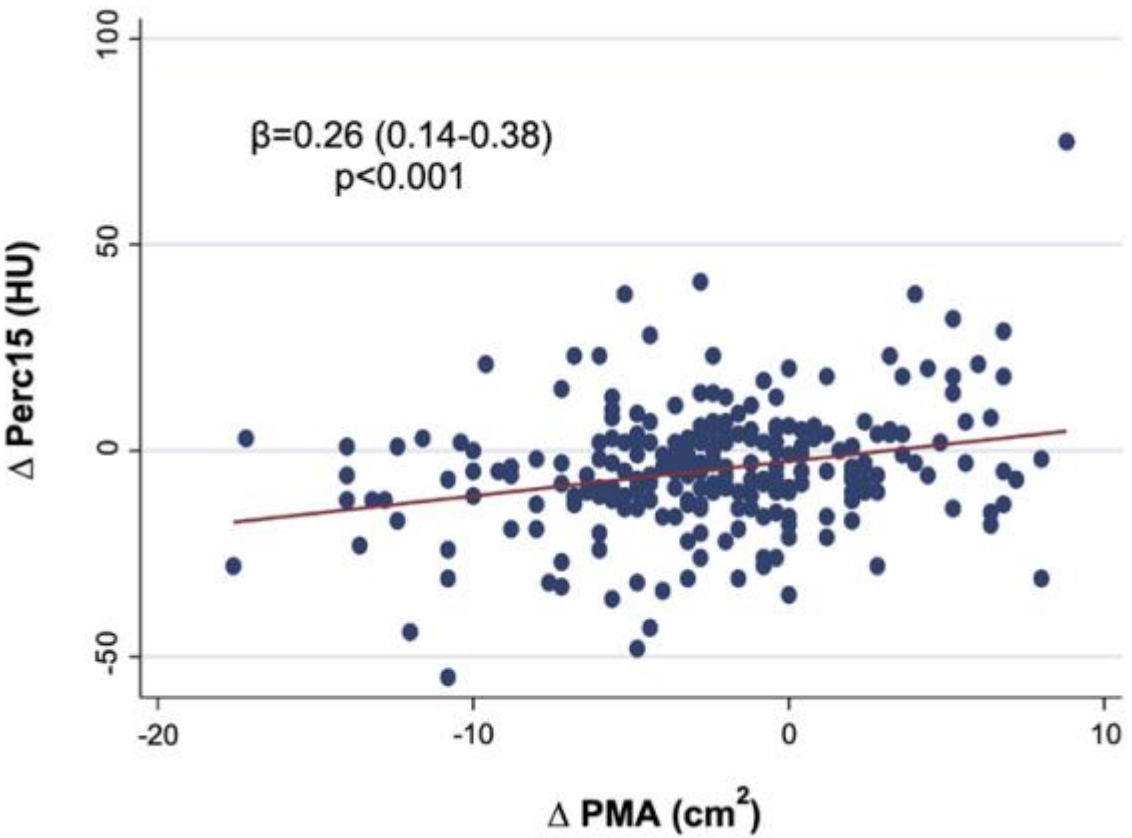


Thorax 2023;78:394–401



Thorax 2023;78:394–401





Thorax 2023;78:394–401

CHEST

Longitudinal Association Between Muscle Loss and Mortality in Ever Smokers

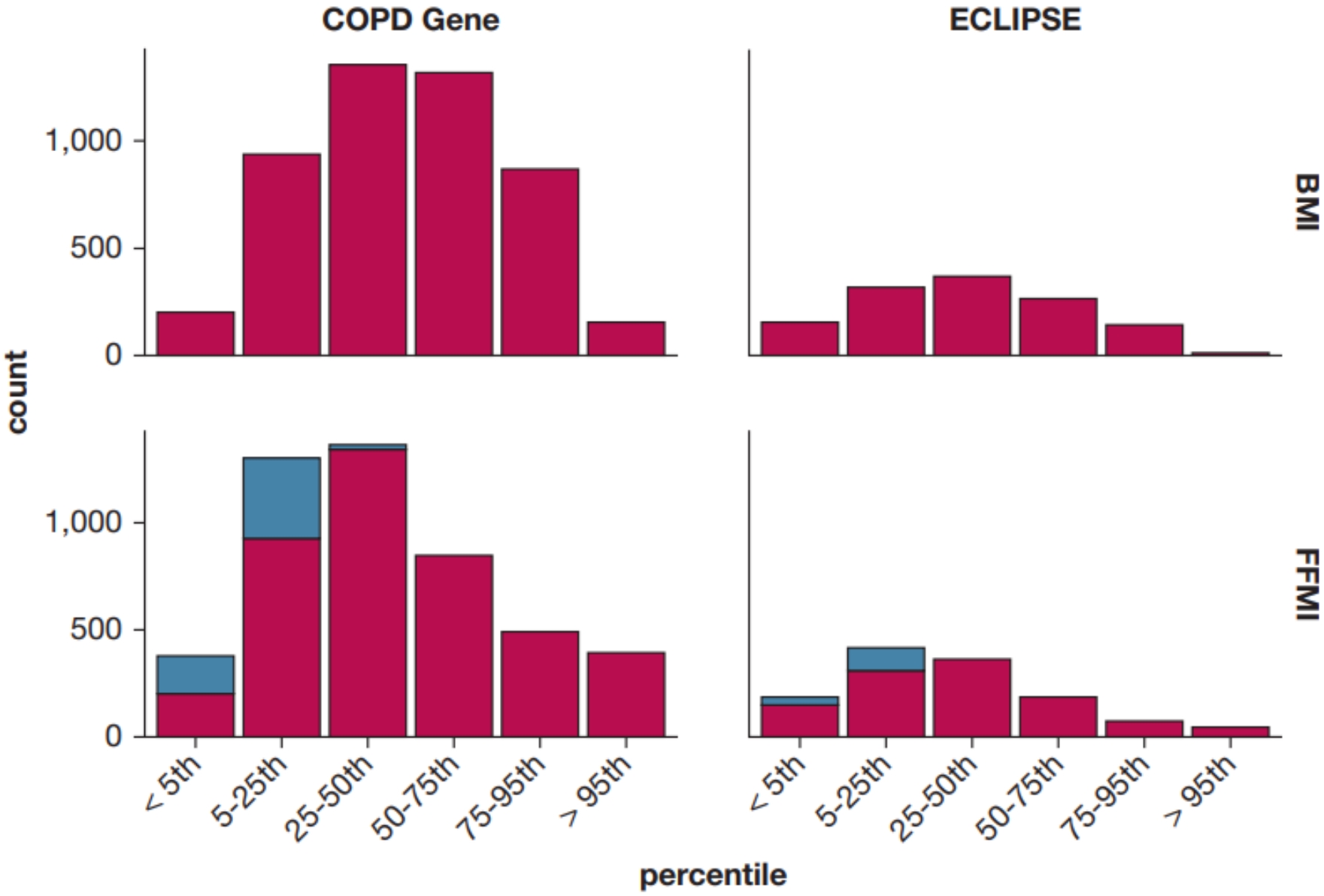
Check for updates

*Stefanie E. Mason, MD, MPH; Rafael Moreta-Martinez, MS; Wassim W. Labaki, MD; Matthew J. Strand, PhD; Elizabeth A. Regan, MD, PhD; Jessica Bon, MD; Ruben San Jose Estepar, MS; Richard Casaburi, PhD, MD; Merry-Lynn McDonald, PhD; Harry B. Rossiter, PhD; Barry Make, MD; Mark T. Dransfield, MD; MeiLan K. Han, MD; Kendra Young, PhD; Jeffrey L. Curtis, MD; Kathleen Stringer, PharmD; Greg Kinney, PhD; John E. Hokanson, PhD; Raul San Jose Estepar, PhD; and George R. Washko, MD; for the COPDGene Investigators**[*]

TABLE 1] Characteristics of Study Participants at Enrollment

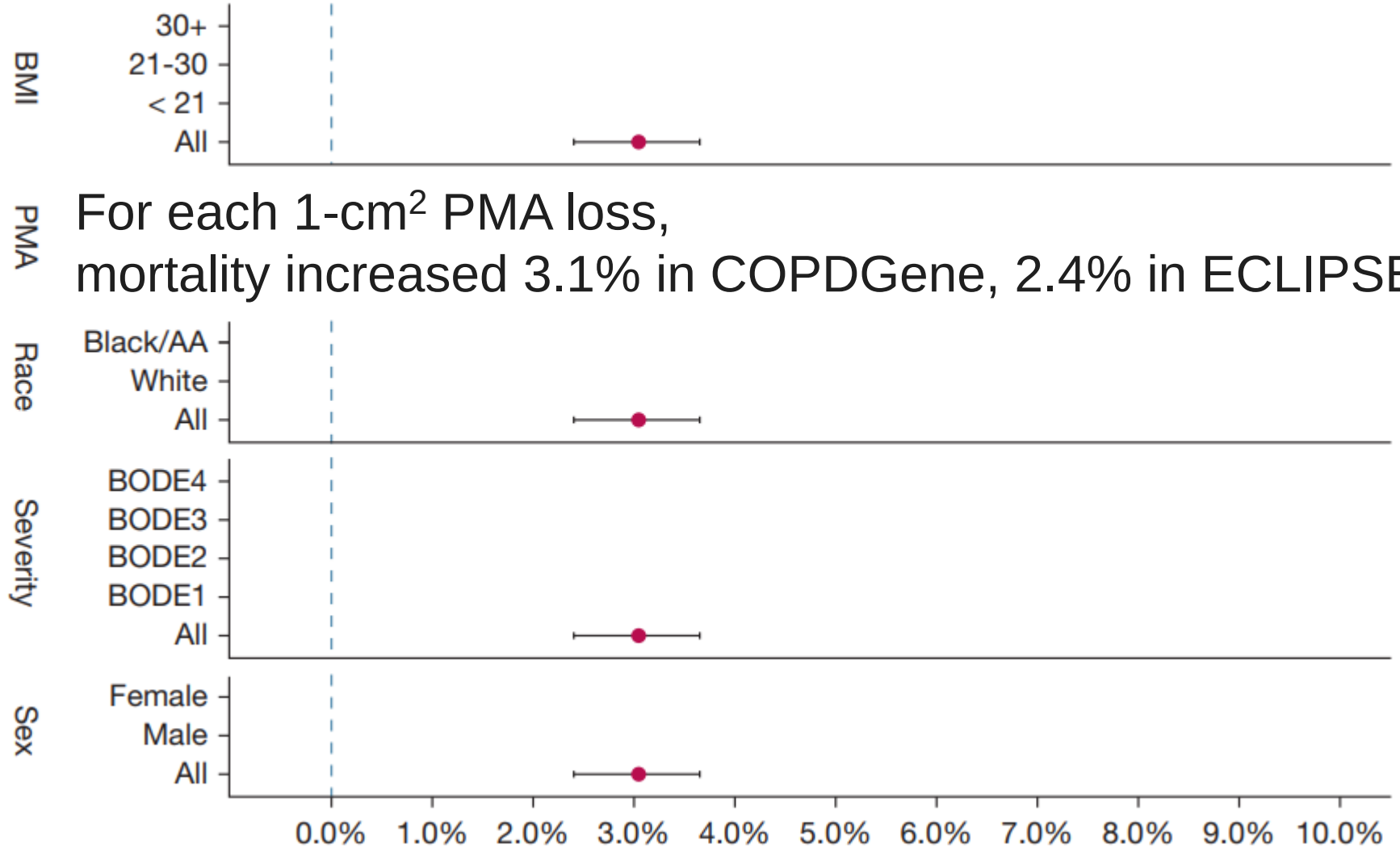
Characteristic	ECLIPSE	COPDGene
Sample size	1,760	9,268
Age, mean (SD), y	63.7 (7.1)	59.7 (9.0)
Male, No. (%)	1,136 (64.5)	4,991 (53.9)
Non-Hispanic White, No. (%)	1,719 (97.7)	6,188 (66.8)
Current smoker, No. (%)	630 (35.8)	4,859 (52.4)
Pack-years on study entry, median (IQR)	44.0 (30.0-60.0)	39.2 (27.1-54.4)
BMI, mean (SD)	26.5 (5.5)	28.8 (6.16)
Chronic oral steroid use, No. (%)	25 (1.4)	224 (2.4)
COTE index, median (IQR)	0 (0-1)	0 (0-1)
BODE index, mean (SD)	3.2 (2.2)	1.8 (2.3)
Pectoral muscle area, median (IQR), cm^2		
Men	38.37 (32.63-44.64)	48.55 (40.12-58.86)
Women	26.10 (22.55-29.74)	30.13 (25.36-36.01)
6-Min walk distance, mean (SD), m	367.2 (122.3)	412.2 (121.5)
FEV_1 percent predicted, mean (SD), %	48.0 (15.7)	76.8 (25.3)
Days monitored, median (IQR)	2,395 (1,095-2,921)	3,454 (1,767-3,899)
Deaths, No. (%)	510 (29.0)	1,922 (20.7)

CHEST 2022; 161(4):960-970



CHEST 2022; 161(4):960-970

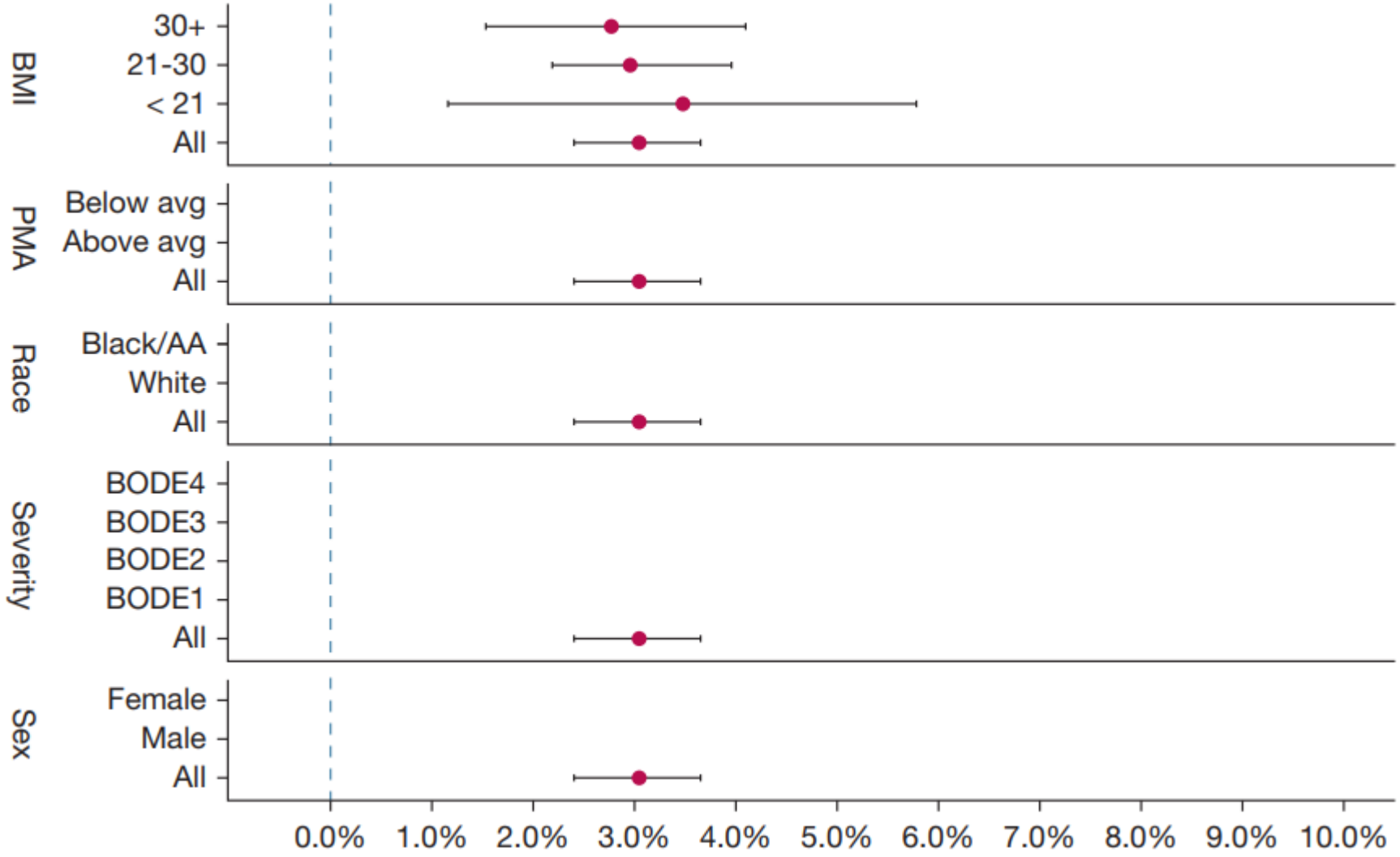
Mortality Risk



For each 1-cm^2 PMA loss,
mortality increased 3.1% in COPDGene, 2.4% in ECLIPSE

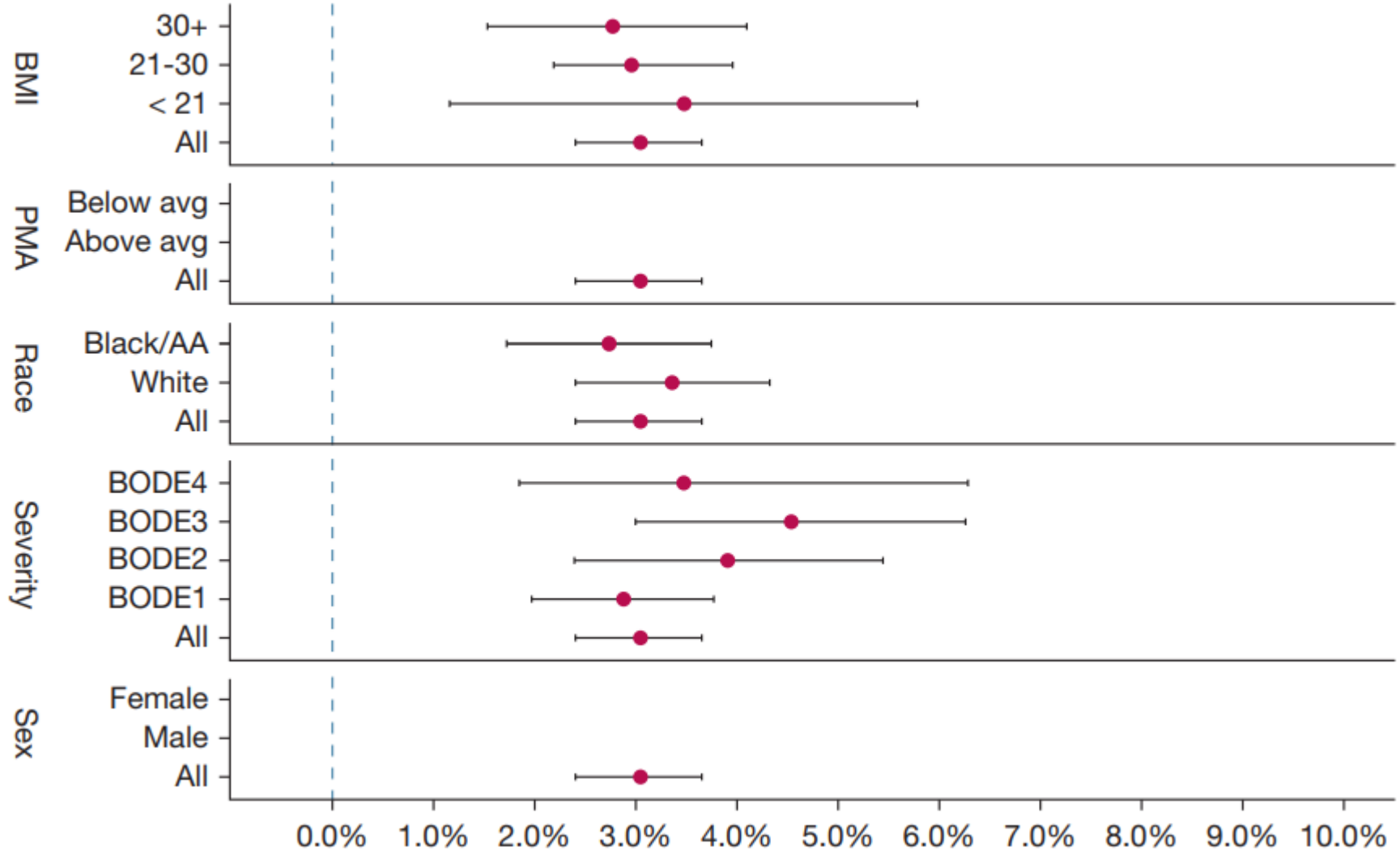
CHEST 2022; 161(4):960-970

Mortality Risk



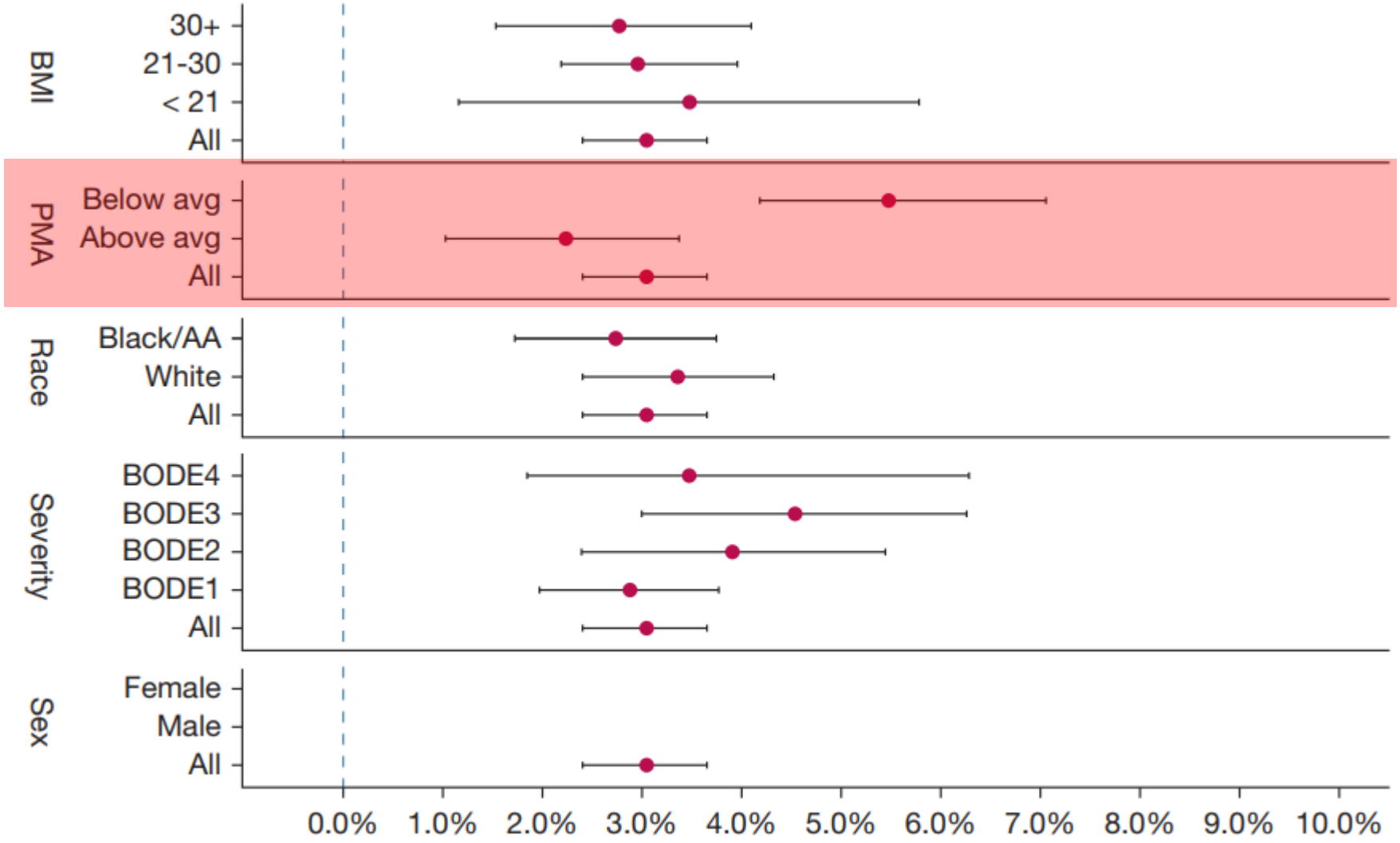
CHEST 2022; 161(4):960-970

Mortality Risk

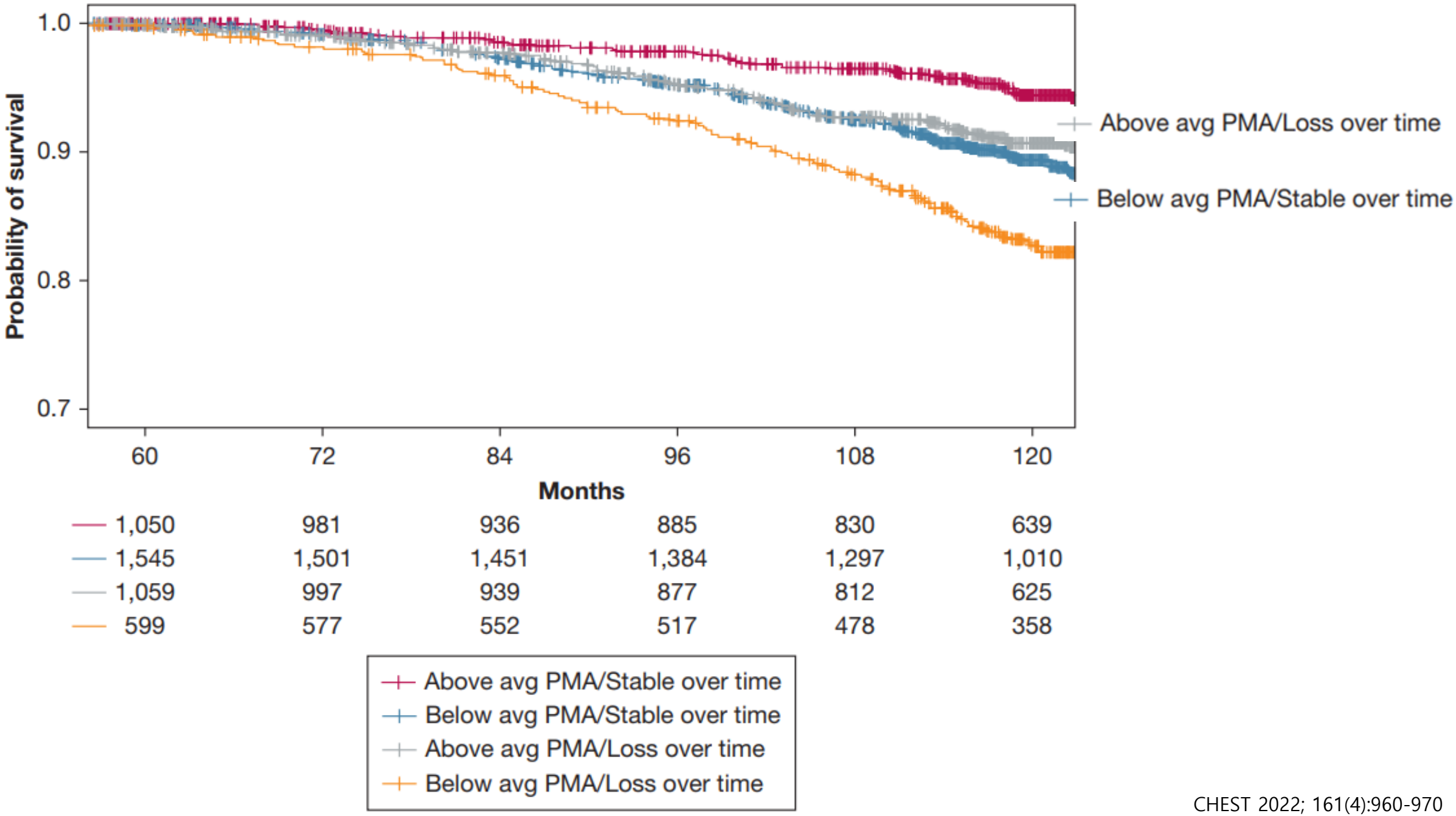


CHEST 2022; 161(4):960-970

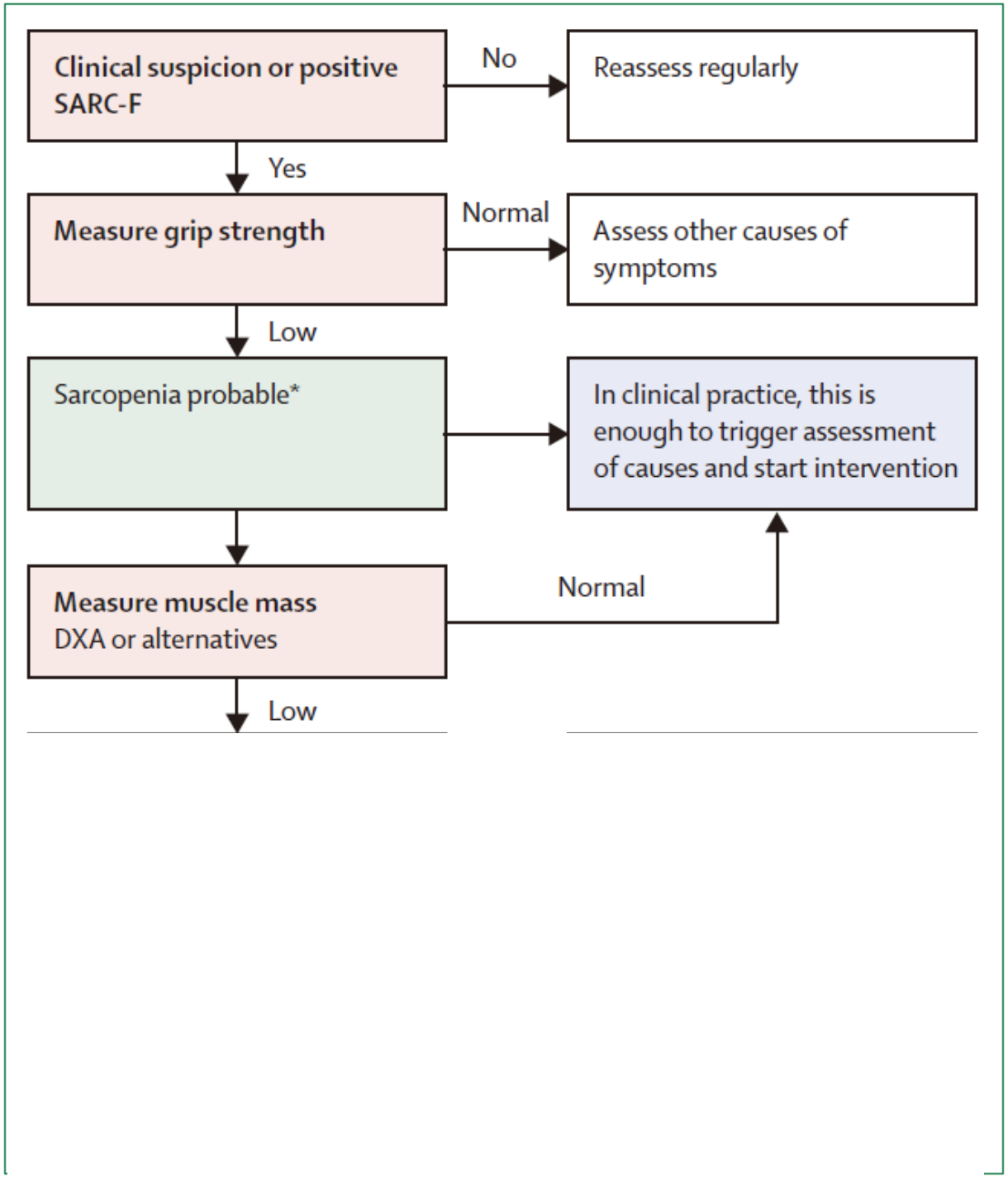
Mortality Risk



CHEST 2022; 161(4):960-970



CHEST 2022; 161(4):960-970



Lancet 2019; 393: 2636–46

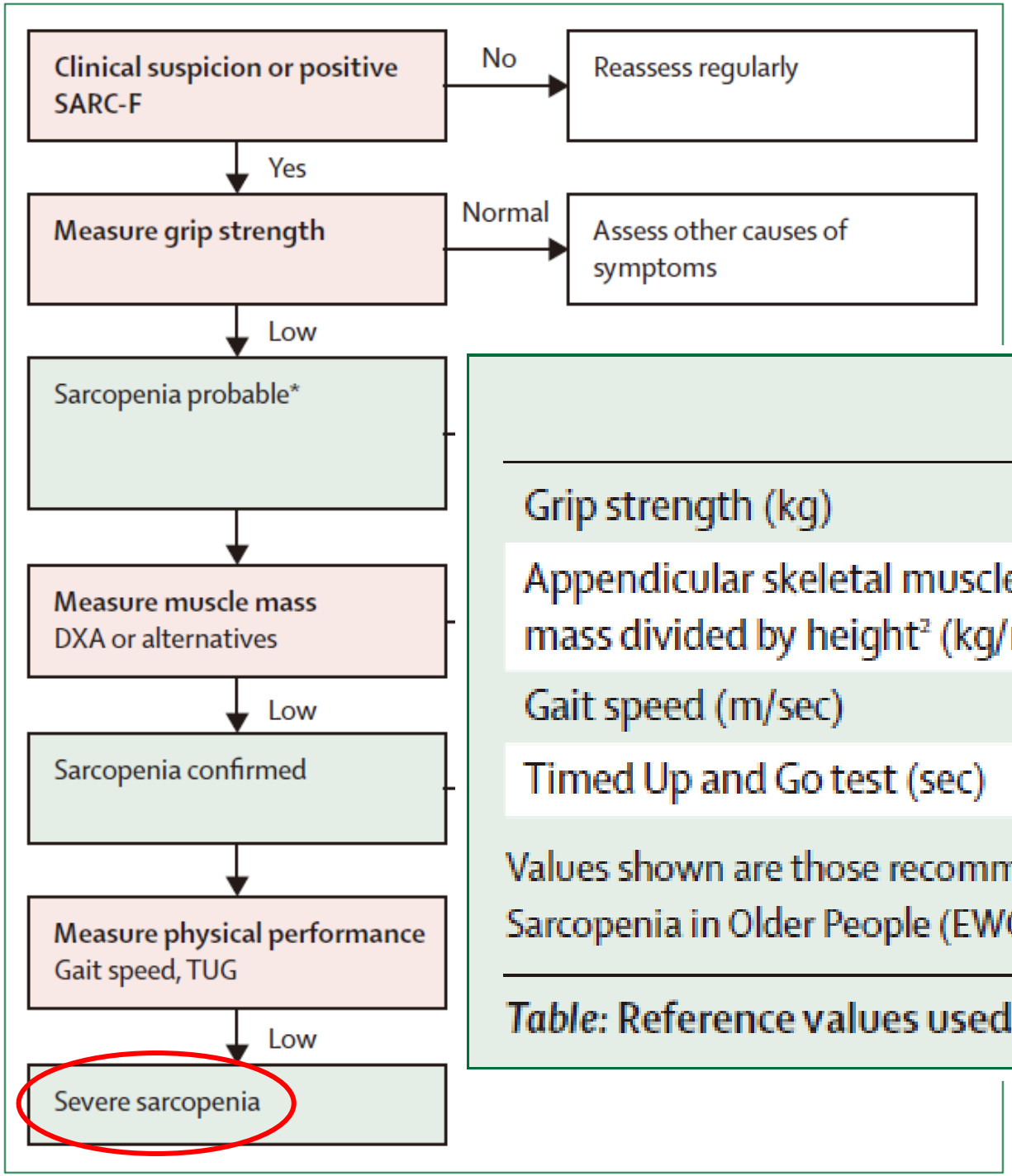
Physical Performance

Low gait speed

Short Physical Performance Battery (SPPB)

Timed Up and Go (TUG) test

6-minute walk test



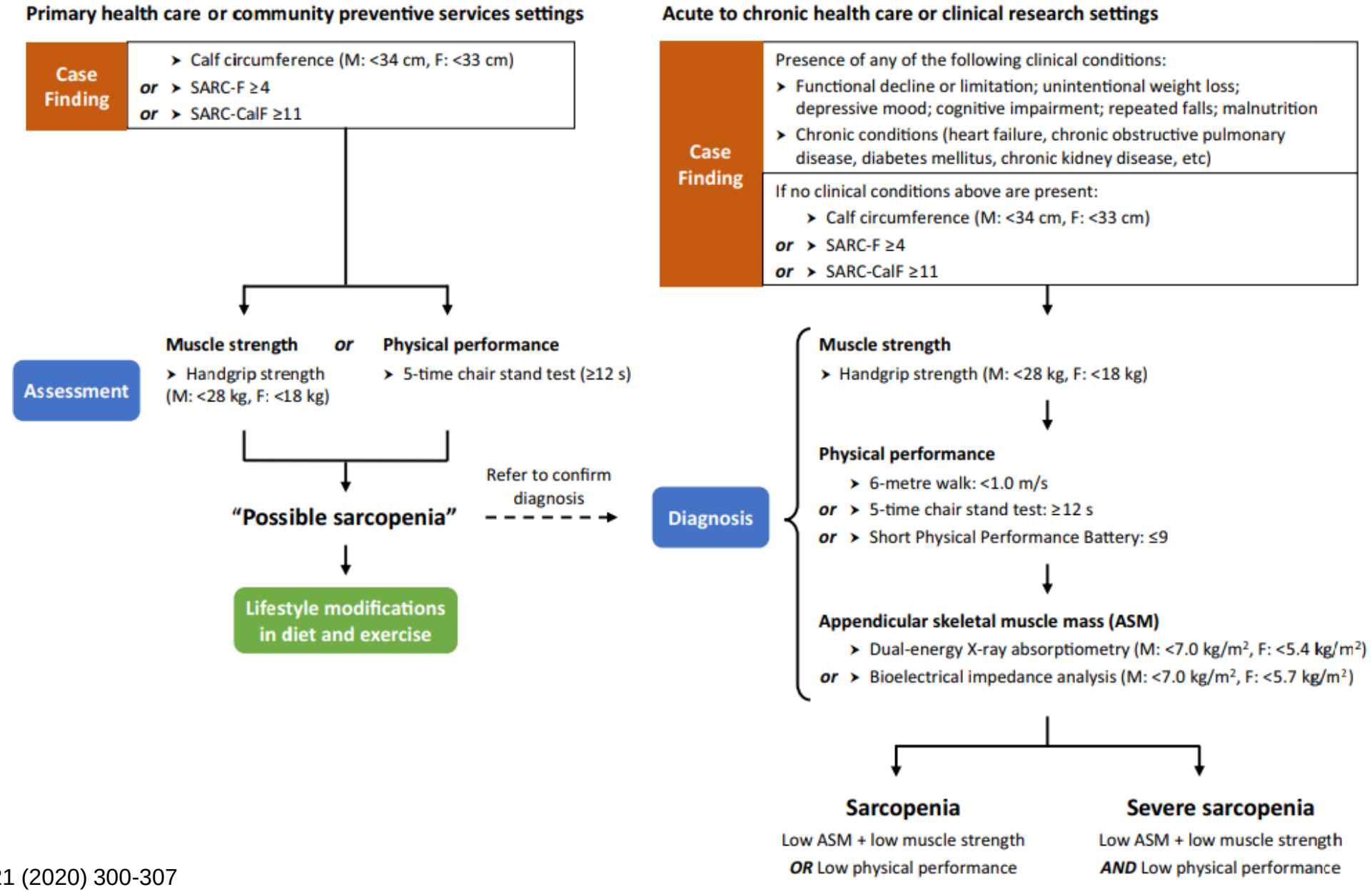
	Men	Women
Grip strength (kg)	<27	<16
Appendicular skeletal muscle mass divided by height² (kg/m²)	<7	<5·5
Gait speed (m/sec)	≤0·8	≤0·8
Timed Up and Go test (sec)	≥20	≥20

Values shown are those recommended by the European Working Group on Sarcopenia in Older People (EWGSOP2).[15]

Table: Reference values used to diagnose sarcopenia

Lancet 2019; 393: 2636–46

AWGS 2019 algorithm for sarcopenia



JAMDA 21 (2020) 300-307

Frailty

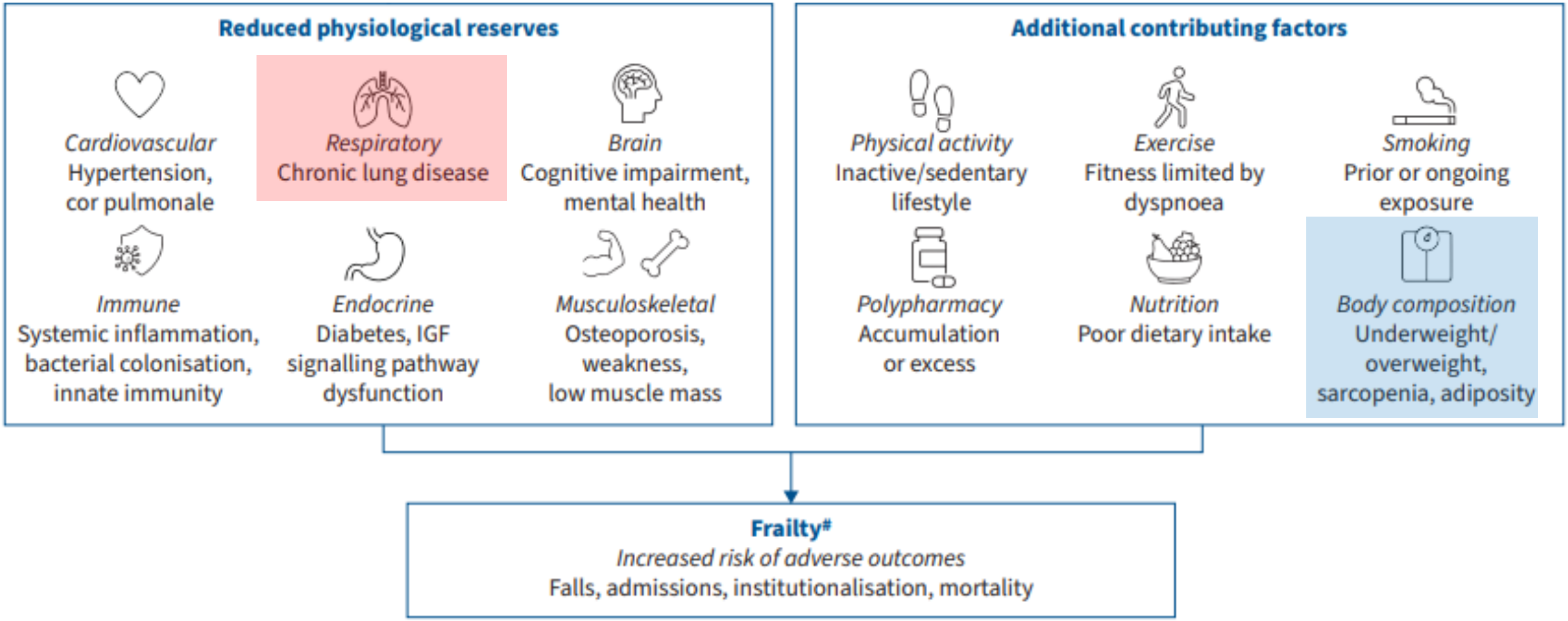
“a medical syndrome with multiple causes and contributors that is characterized by diminished strength, endurance, and reduced physiological function that increases an individual’s vulnerability for developing increased dependency and/or death”

Frailty

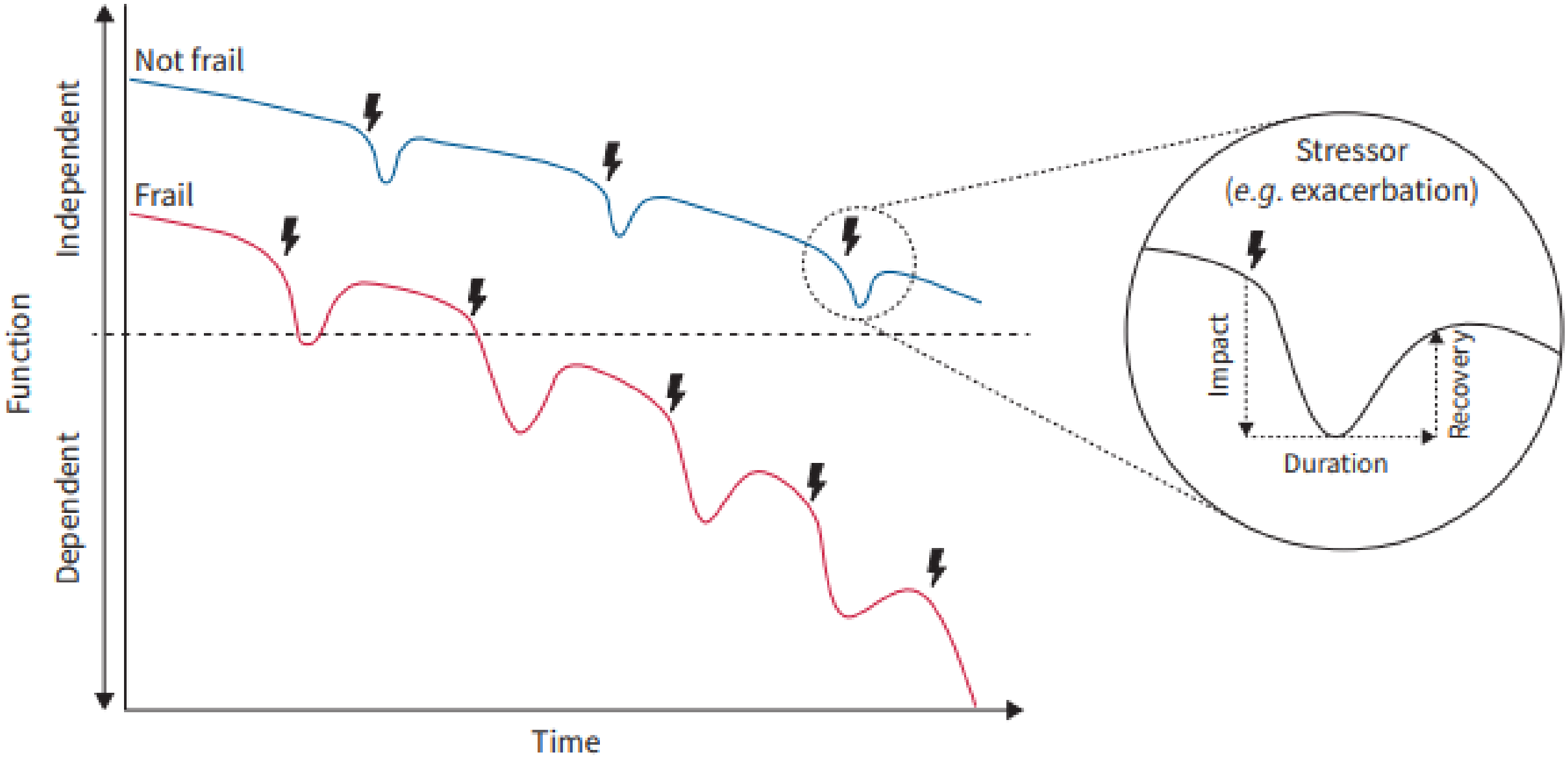
"a medical syndrome with multiple causes and contributors that is characterized by diminished strength, endurance, and reduced physiological function that increases an individual's vulnerability for developing increased dependency and/or death"

Frailty

"a medical syndrome with multiple causes and contributors that is characterized by diminished strength, endurance, and reduced physiological function that increases an individual's vulnerability for developing increased dependency and/or death"



Eur Respir J 2023; 62: 2300442



Eur Respir J 2023; 62: 2300442

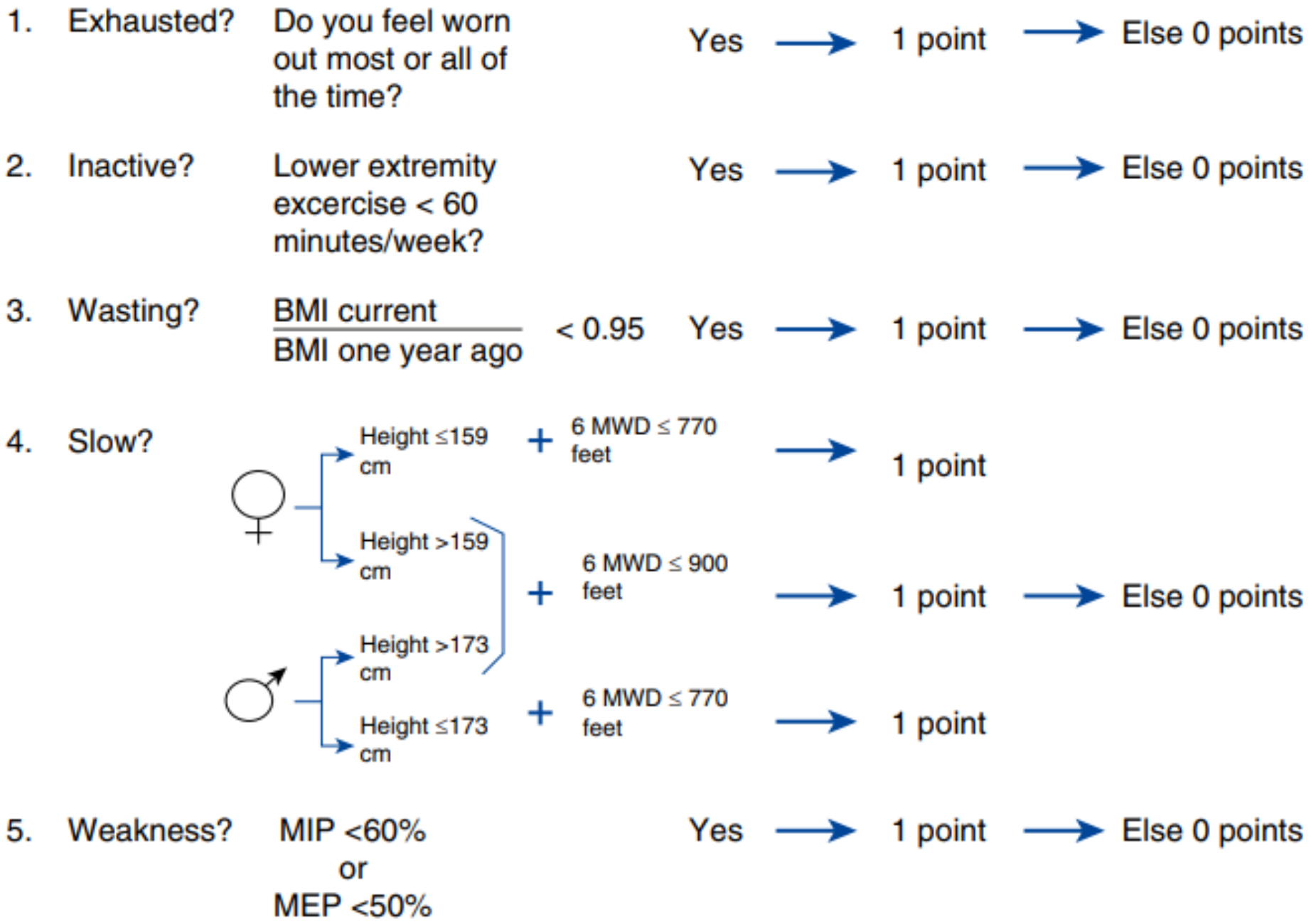
ORIGINAL RESEARCH

Frailty and Clinical Outcomes in Chronic Obstructive Pulmonary Disease

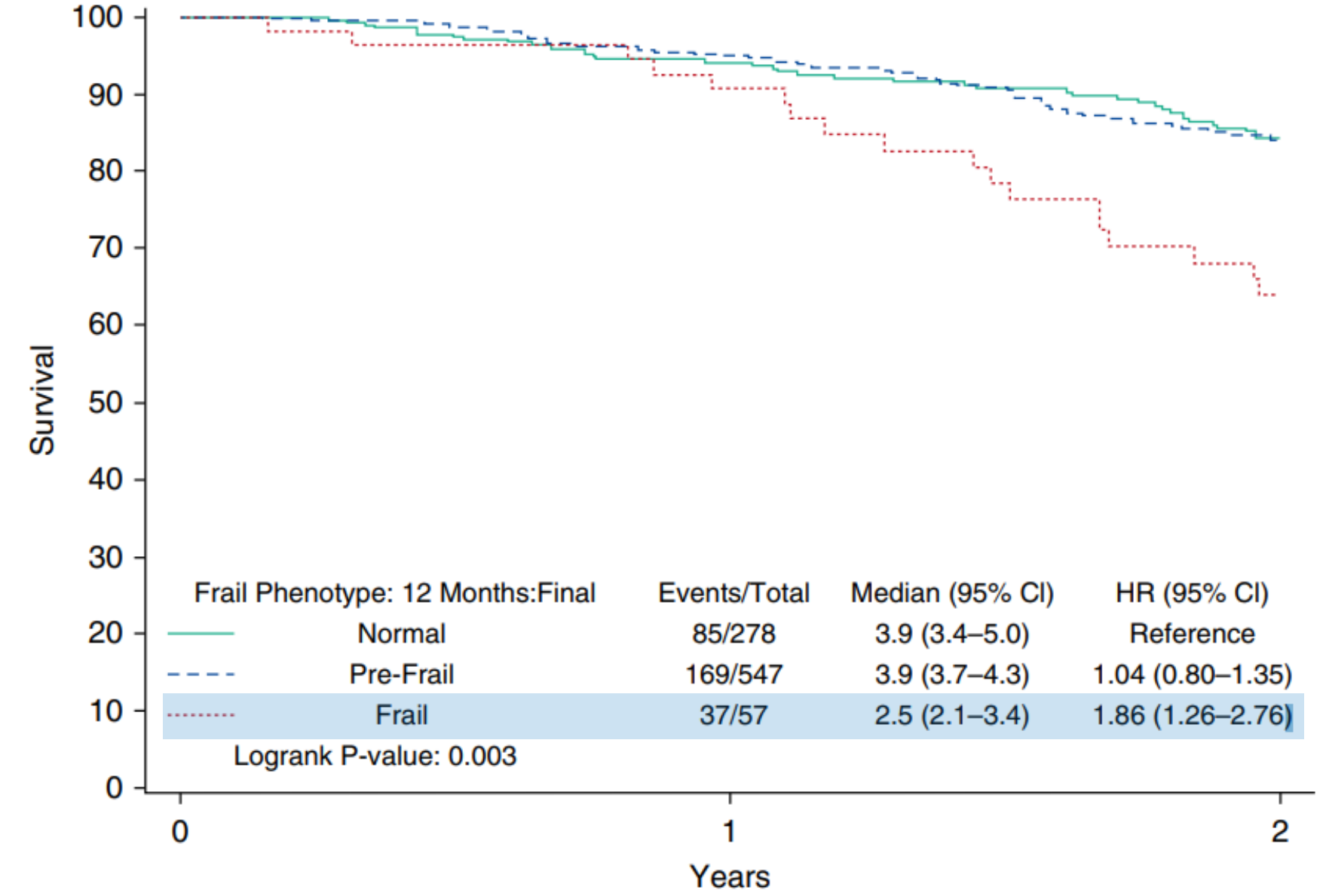
Cassie C. Kennedy[1,2], Paul J. Novotny[3], Nathan K. LeBrasseur[4], Robert A. Wise[5], Frank C. Sciurba[6], Roberto P. Benzo[1], and the NETT Research Group*

[1]Division of Pulmonary and Critical Care Medicine, [2]Robert D. and Patricia E. Kern Center for the Science of Health Care Delivery, [3]Health Sciences Research-Biomedical Statistics and Informatics, and [4]Department of Physical Medicine and Rehabilitation, Mayo Clinic, Rochester, Minnesota; [5]Division of Pulmonary and Critical Care Medicine, Johns Hopkins Bayview Medical Center, Baltimore, Maryland; and [6]Division of Pulmonary, Allergy, and Critical Care Medicine, University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania

Ann Am Thorac Soc. 2019; **16**: 217-224

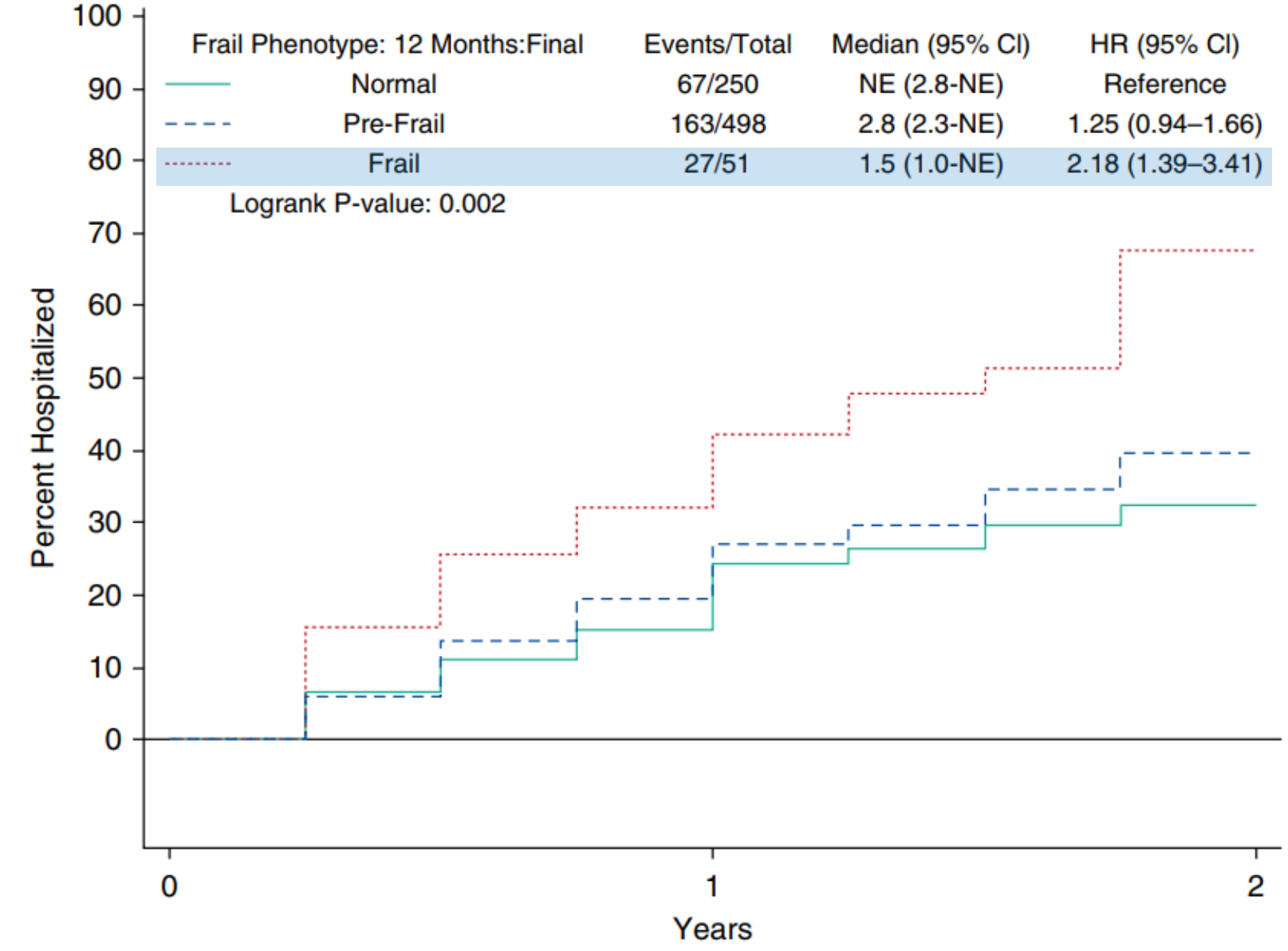


Ann Am Thorac Soc. 2019; **16**: 217-224



Patients-at-Risk			
Normal	278	235	167
Pre-Frail	547	487	320
Frail	57	47	30

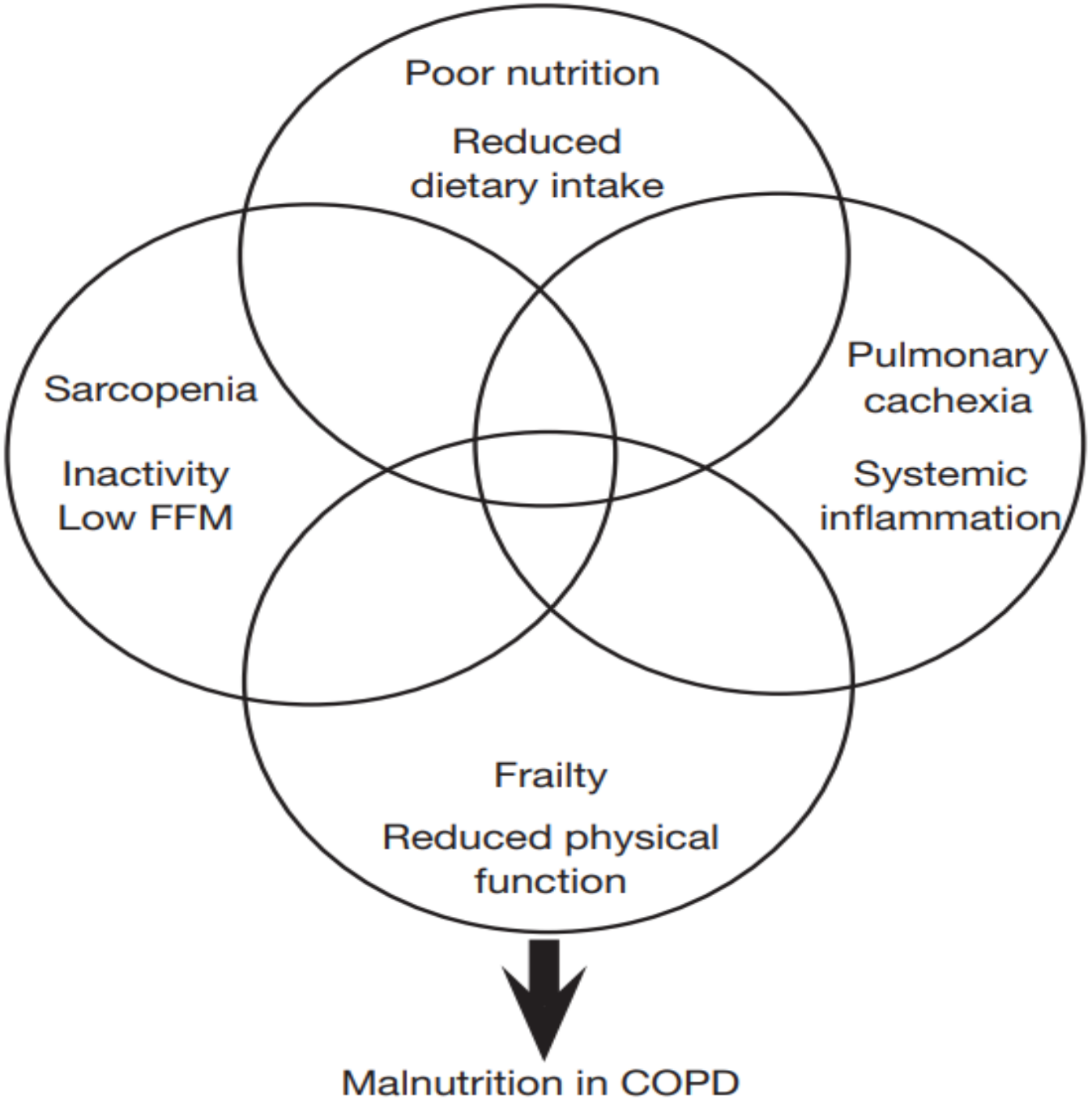
Ann Am Thorac Soc. 2019; **16**: 217-224



Patients-at-Risk

Normal	250	155	63
Pre-Frail	498	288	121
Frail	51	27	6

Ann Am Thorac Soc. 2019; **16**: 217-224



J Thorac Dis. 2019 Oct; 11(Suppl 17): S2230–S2237.

Management

Box 1 Ways to Minimize Modifiable Etiological Factors

- Encourage smoking cessation
- Consider oxygen therapy to treat hypoxemia
- Consider non-invasive ventilation to treat hypercapnia
- Increase physical activity
- Improve dietary intake
- Guide energy conservation
- Reduce alcohol consumption
- Treat comorbidities
- Optimize medical treatment

International Journal of Chronic Obstructive Pulmonary Disease 2022:17 2957–2976

Management

Box 2 Multimodal Interventions for Cachexia in COPD

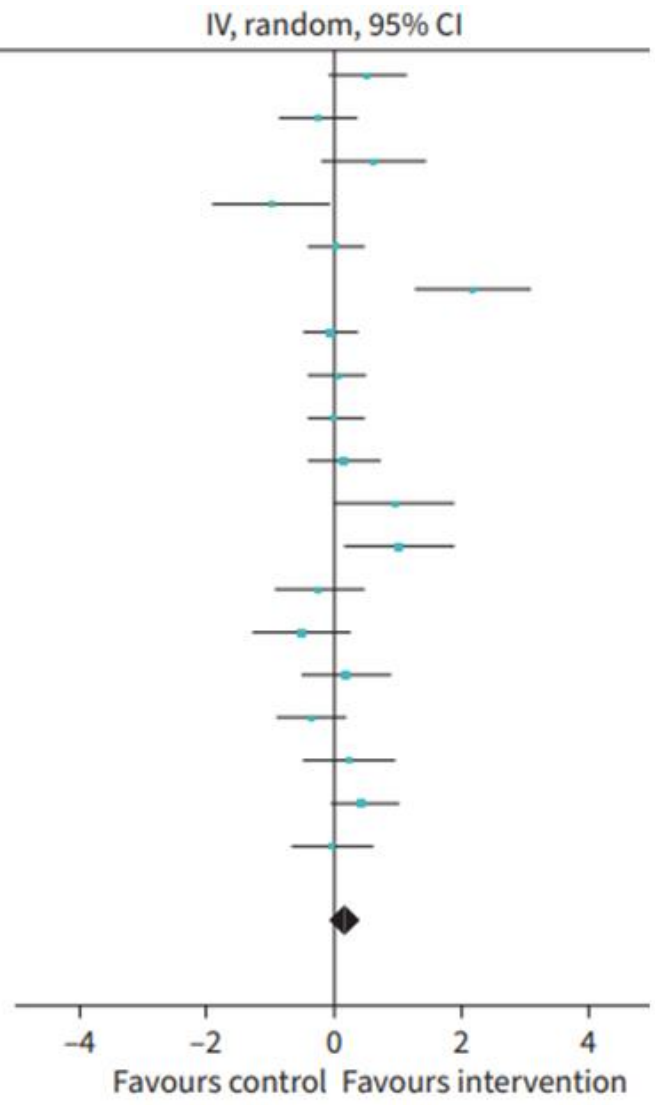
Nutritional Supplementation	Exercise Training
• A diet with at least 1.2 grams of protein per kg of body weight • High-quality proteins (casein, leucine, whey protein) • Smaller portions spread over the day • Poly unsaturated fatty acids might enhance the effects of exercise training	• **Resistance training**: 12 weeks, at least 2–3 sessions per week, at progressive loads of 30–90% of one-repetition maximum[a] • **Endurance training**: 8 weeks, at least 2–3 (1-hour) sessions per week, at >40% of maximal work rate (cycling) or >75% of walking speed achieved during 6MWT or peak speed achieved during incremental shuttle walk test (walking).

Nutritional supplementation versus no supplementation (FFM)

Study or subgroup	SMD±SE	Weight	IV, random, 95% CI
Ahmadi 2020	0.5321±0.3076	5.5%	0.53 (−0.07–1.13)
Aldhahir 2021	−0.2467±0.3028	5.5%	−0.25 (−0.84–0.35)
Baldi 2010	0.6313±0.4036	4.3%	0.63 (−0.16–1.42)
Beijers 2020	−0.9738±0.4677	3.6%	−0.97 (−1.89–−0.06)
Broekhuizen 2005	0.0461±0.2239	6.7%	0.05 (−0.39–0.48)
Dal Negro 2010	2.193±0.459	3.7%	2.19 (1.29–3.09)
Dal Negro 2012	−0.0521±0.2132	6.8%	−0.05 (−0.47–0.37)
Deacon 2008	0.0372±0.2239	6.7%	0.04 (−0.40–0.48)
De Benedetto 2018	0.0225±0.2108	6.9%	0.02 (−0.39–0.44)
De Bisschop 2021	0.1545±0.2842	5.8%	0.15 (−0.40–0.71)
Engelen 2022	0.9358±0.4767	3.6%	0.94 (0.00–1.87)
Fuld 2005	1.0278±0.4329	4.0%	1.03 (0.18–1.88)
Hamada 2018	−0.2399±0.351	4.9%	−0.24 (−0.93–0.45)
Ingadottir 2019	−0.5086±0.3751	4.6%	−0.51 (−1.24–0.23)
Pirabbasi 2016	0.1742±0.3503	4.9%	0.17 (−0.51–0.86)
Steiner 2003	−0.3525±0.264	6.1%	−0.35 (−0.87–0.16)
Sugawara 2012	0.2212±0.3622	4.8%	0.22 (−0.49–0.93)
van de Bool 2017	0.461±0.26	6.1%	0.46 (−0.05–0.97)
Vermeeren 2004	−0.037±0.3051	5.5%	−0.04 (−0.63–0.56)
Total (95% CI)		100%	0.16 (−0.06–0.39)

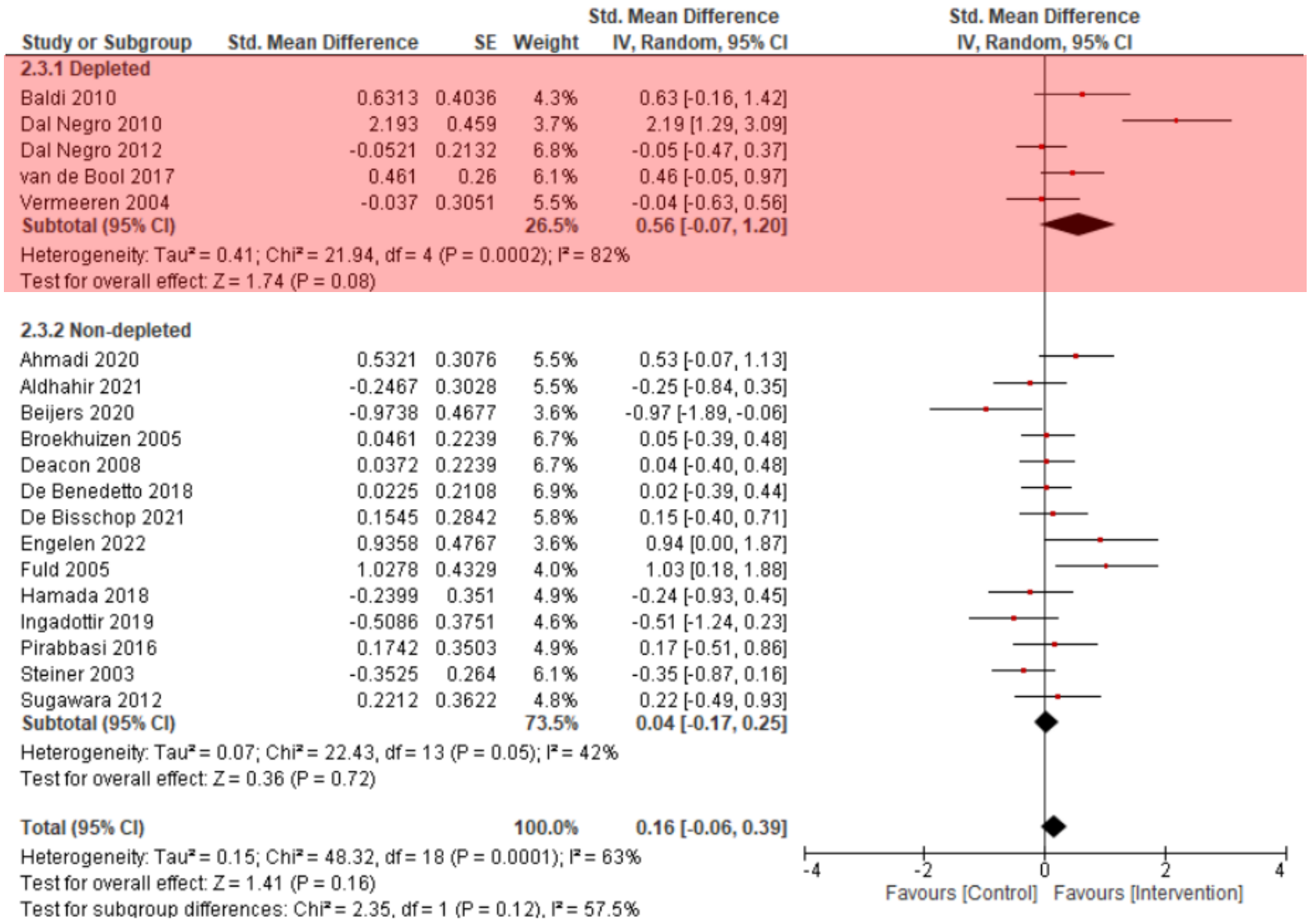
Heterogeneity: τ^2=0.15; Chi^2=48.32, df=18 (p=0.0001), I^2=63%

Test for overall effect: Z=1.41 (p=0.16)



ERJ Open Res 2023; 9: 00102-2023

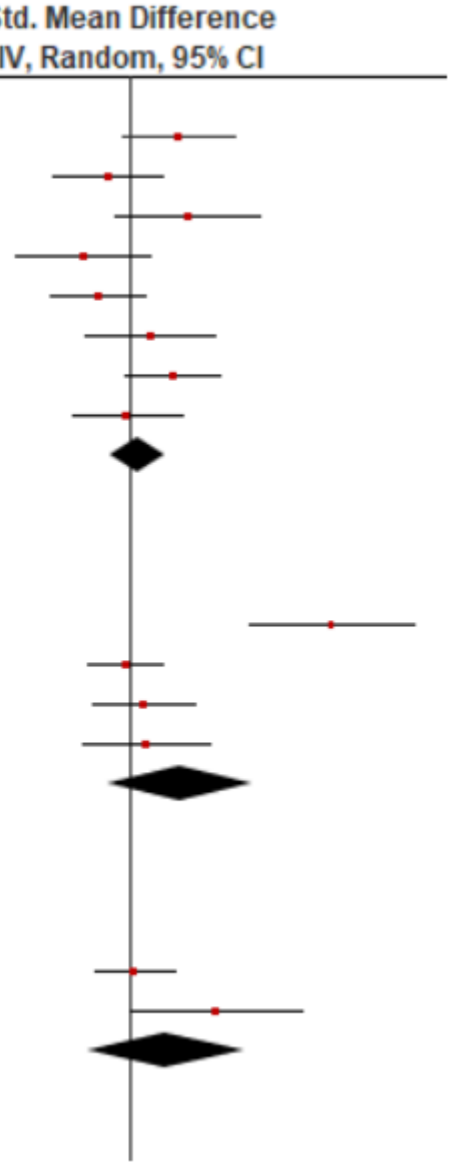
Nutritional supplementation versus no supplementation (FFM)

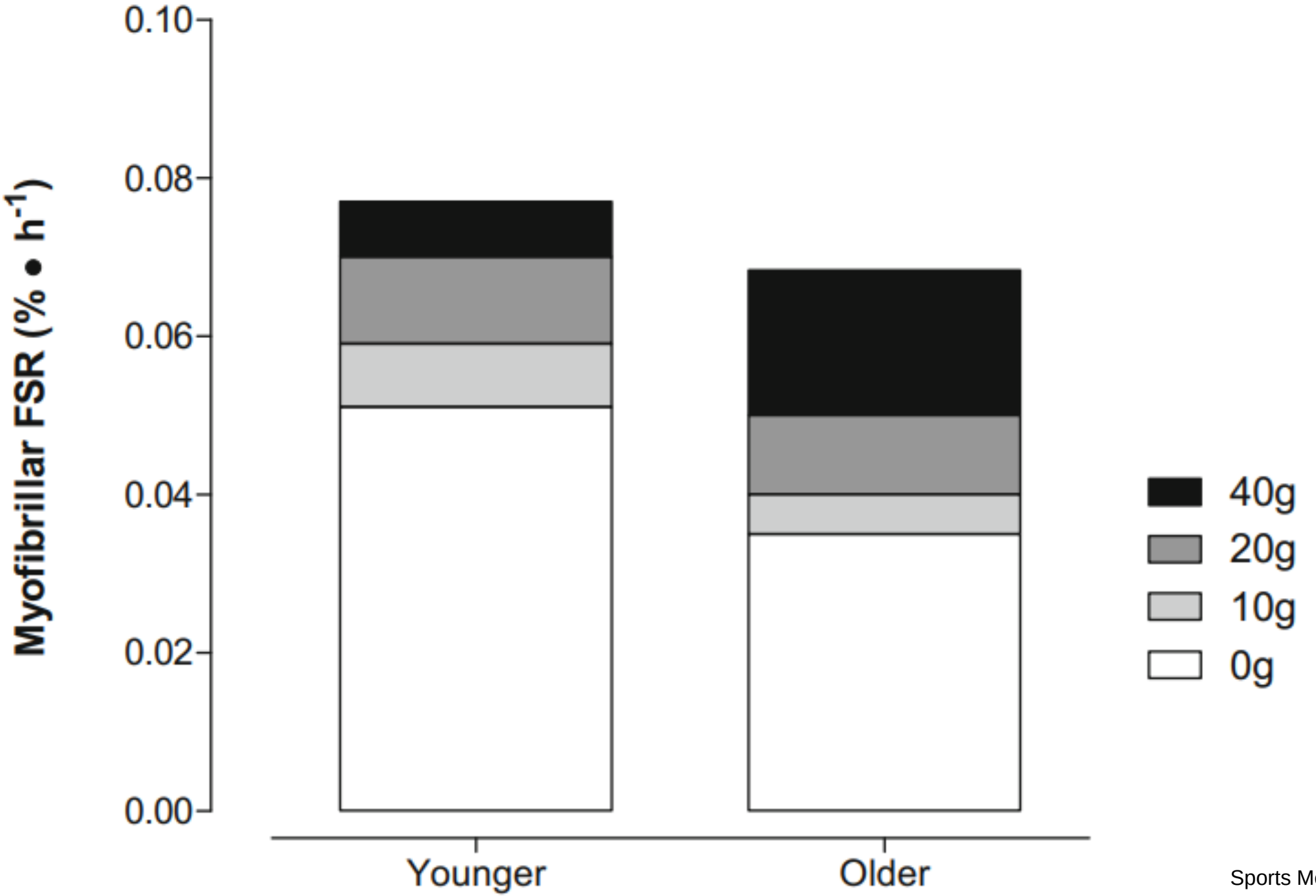


ERJ Open Res 2023; 9: 00102-2023

Nutritional supplementation versus no supplementation (FFM)

Study or Subgroup	Std. Mean Difference	SE	Weight	Std. Mean Difference IV, Random, 95% CI
2.5.1 Macronutrient targeted supplementation				
Ahmadi 2020	0.5321	0.3076	5.5%	0.53 [-0.07, 1.13]
Aldhahir 2021	-0.2467	0.3028	5.5%	-0.25 [-0.84, 0.35]
Baldi 2010	0.6313	0.4036	4.3%	0.63 [-0.16, 1.42]
Ingadottir 2019	-0.5086	0.3751	4.6%	-0.51 [-1.24, 0.23]
Steiner 2003	-0.3525	0.264	6.1%	-0.35 [-0.87, 0.16]
Sugawara 2012	0.2212	0.3622	4.8%	0.22 [-0.49, 0.93]
van de Bool 2017	0.461	0.26	6.1%	0.46 [-0.05, 0.97]
Vermeeren 2004	-0.037	0.3051	5.5%	-0.04 [-0.63, 0.56]
Subtotal (95% CI)			**42.4%**	**0.08 [-0.22, 0.38]**
Heterogeneity: $Tau^2 = 0.08$; $Chi^2 = 12.78$, df = 7 (P = 0.08); $I^2 = 45\%$				
Test for overall effect: Z = 0.53 (P = 0.60)				
2.5.2 Amino acids				
Dal Negro 2010	2.193	0.459	3.7%	2.19 [1.29, 3.09]
Dal Negro 2012	-0.0521	0.2132	6.8%	-0.05 [-0.47, 0.37]
De Bisschop 2021	0.1545	0.2842	5.8%	0.15 [-0.40, 0.71]
Pirabbasi 2016	0.1742	0.3503	4.9%	0.17 [-0.51, 0.86]
Subtotal (95% CI)			**21.3%**	**0.54 [-0.24, 1.33]**
Heterogeneity: $Tau^2 = 0.53$; $Chi^2 = 20.07$, df = 3 (P = 0.0002); $I^2 = 85\%$				
Test for overall effect: Z = 1.35 (P = 0.18)				
2.5.5 Polyunsaturated fatty acids				
Broekhuizen 2005	0.0461	0.2239	6.7%	0.05 [-0.39, 0.48]
Engelen 2022	0.9358	0.4767	3.6%	0.94 [0.00, 1.87]
Subtotal (95% CI)			**10.2%**	**0.39 [-0.46, 1.24]**
Heterogeneity: $Tau^2 = 0.26$; $Chi^2 = 2.85$, df = 1 (P = 0.09); $I^2 = 65\%$				
Test for overall effect: Z = 0.90 (P = 0.37)				





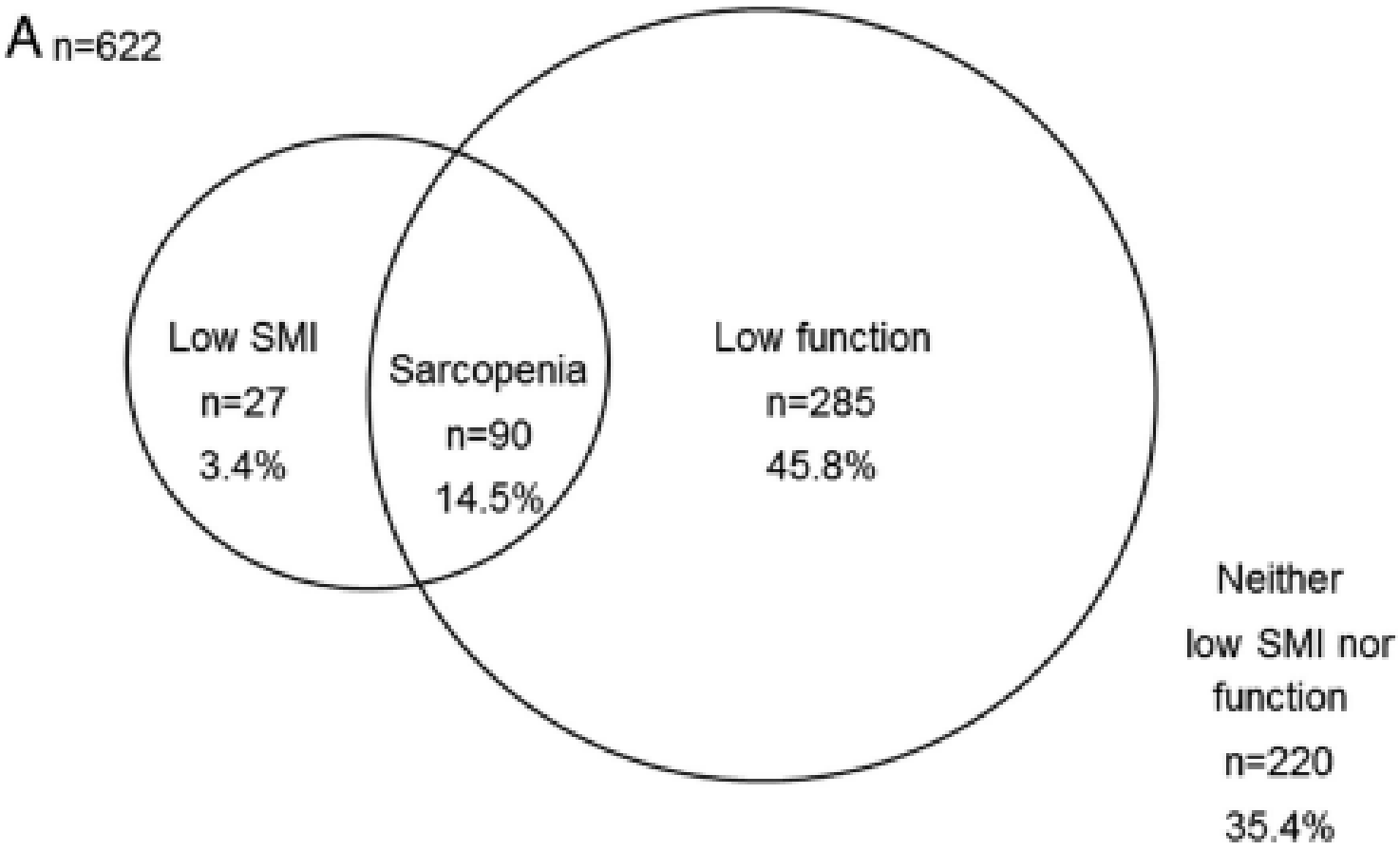
Sports Med (2016) 46:1205–1212

ORIGINAL ARTICLE

Sarcopenia in COPD: prevalence, clinical correlates and response to pulmonary rehabilitation

Sarah E Jones,[1] Matthew Maddocks,[2] Samantha S C Kon,[1] Jane L Canavan,[1] Claire M Nolan,[1,3] Amy L Clark,[3] Michael I Polkey,[1] William D-C Man[1,3]

Thorax 2015;70:213–218

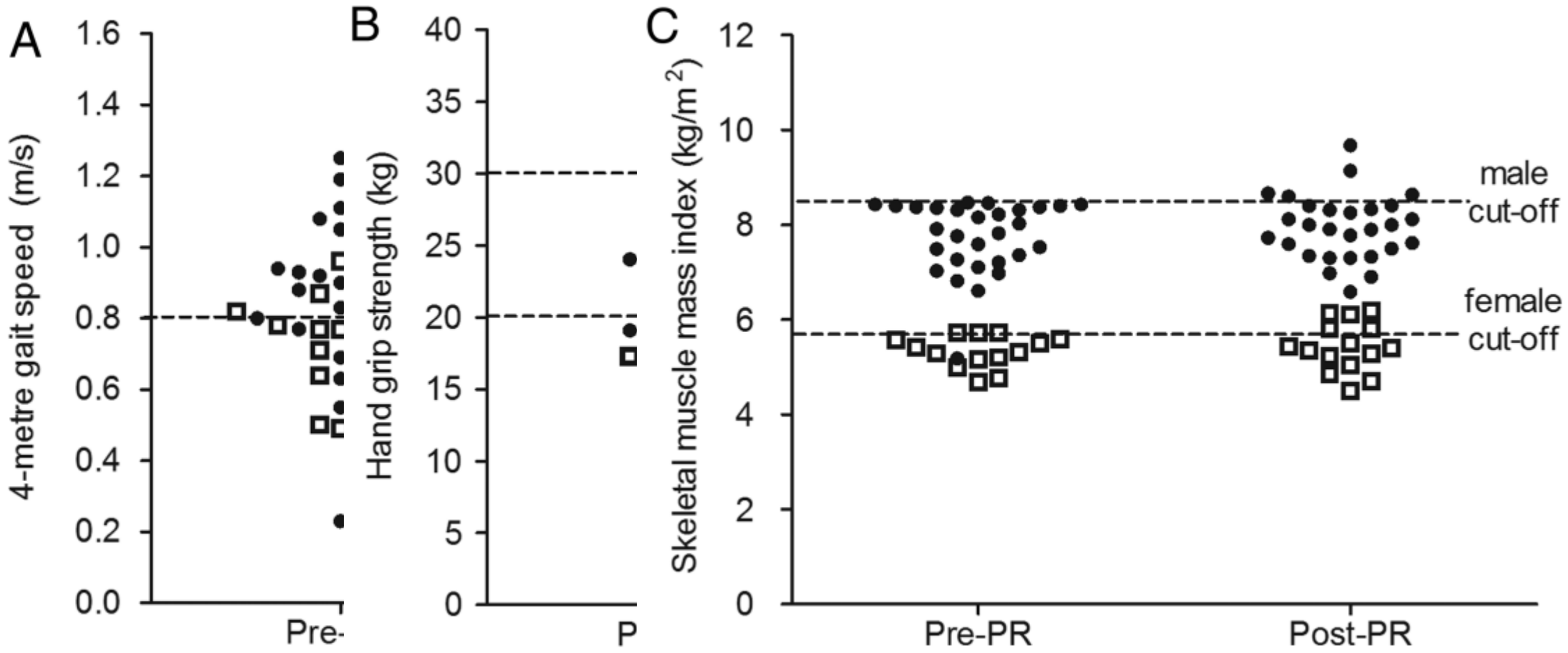


Thorax 2015;70:213–218

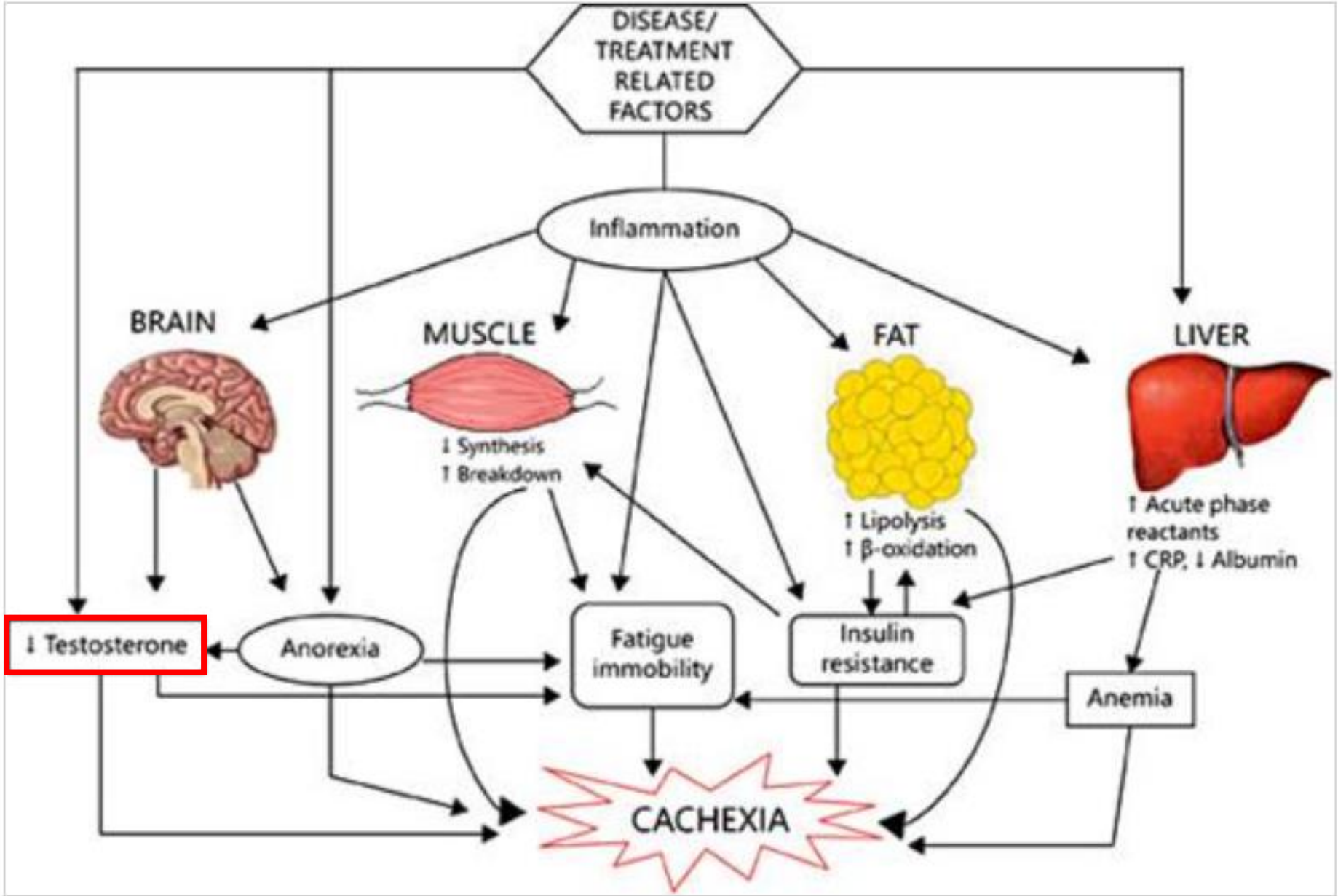
Table 2 Comparison of response to pulmonary rehabilitation between sarcopenic and propensity-matched patients with non-sarcopenic COPD expressed as mean (95% CI)

	Baseline			Change with PR		
	Non-sarcopenic	Sarcopenic	p Value	Non-sarcopenic	Sarcopenic	p Value
Mean age (years (SD))*	72 (11)	73 (8)	0.733	–	–	–
Gender* (M:F)	25:18	28:15	0.508	–	–	–
FEV^1% predicted*	45.1 (39.2 to 51.0)	43.5 (37.4 to 50.2)	0.728	–	–	–
MRC*	3 (3.3 to 3.9)	3 (3.0 to 3.6)	0.275	−0.8 (−1.1 to −0.5)	−0.7 (−1.0 to −0.3)	0.495
Weight (kg)	77.3 (77.0 to 81.4)	57.9 (53.9 to 62.2)	<0.001	0.0 (−0.6 to 0.6)	−0.1 (−0.5 to 0.3)	0.616
BMI (kg/m)	28.7 (27.3 to 30.0)	21.3 (20.1 to 22.5)	<0.001	0.0 (−0.3 to 0.2)	0.0 (−0.3 to 0.1)	0.723
SMM (kg)	23.9 (22.1 to 25.6)	19.1 (17.6 to 20.7)	<0.001	0.1 (−0.3 to 0.5)	0.3 (0.0 to 0.7)	0.363
SMI (kg/m^2)	8.8 (8.3 to 9.3)	7.0 (6.6 to 7.3)	<0.001	0.0 (−0.1 to 0.2)	0.1 (0.0 to 0.2)	0.431
Handgrip (kg)	25.7 (22·8 to 28.4)	21.2 (19.2 to 23.3)	0.021	1.6 (0.5 to 2.6)	2.1 (1.3 to 2.9)	0.516
QMVC (kg)	25.7 (23.0 to 28.3)	19.9 (17.9 to 22.3)	0.003	0.9 (−1.1 to 3.5)	1.4 (0.3 to 3.7)	0.646
QMVC % predicted	60.0 (55.3 to 64.4)	55.1 (50.1 to 60.3)	0.164	1.1 (−3.7 to 6.5)	3.8 (0.4 to 9.8)	0.574
4MGS (m/s)	0.86 (0.80 to 0.91)	0.83 (0.77 to 0.89)	0.511	0.11 (0.07 to 0.14)	0.12 (0.08 to 0.16)	0.552
5STS (s)	15.5 (13.6 to 18.4)	18.1 (13.2 to 28.8)	0.186	−2.9 (−4.1 to −1.6)	−1.7 (−3.9 to 0.0)	0.517
SPPB	9 (8.4 to 9.8)	9 (8.0 to 9.4)	0.386	1.0 (10.51 to 1.5)	0.9 (0.4 to 1.4)	0.746
ISWT (m)*	168 (139 to 197)	194 (158 to 232)	0.284	40 (30 to 60)	50 (40 to 80)	0.214
CAT	20.0 (17.5 to 22.2)	23.8 (21.3 to 26.4)	0.031	−3.0 (−4.4 to −1.5)	−4.7 (−6.9 to −2.3)	0.236
SGRQ						
Symptoms	64.6 (58.3 to 70.9)	68.5 (63.5 to 74.1)	0.360	−9.7 (−17.3 to −2.4)	−7.85 (−12.0 to −3.6)	0.675
Activity	71.8 (64.6 to 79.1)	73.7 (68.4 to 78.9)	0.685	−5.7 (−10.4 to −1.5)	−5.66 (−10.7 to −0.4)	0.994
Impact	38.1 (32.0 to 44.5)	39.9 (34.3 to 45.7)	0.668	−7.9 (12.0 to −3.7)	−7.27 (−10.8 to −3.7)	0.821
Total	52.7 (47.3 to 58.4)	54.9 (50.1 to 60.1)	0.570	−6.3 (−9.5 to −3.0)	−6.81 (−10.1 to −3.4)	0.836

Thorax 2015;70:213–218



Thorax 2015;70:213–218



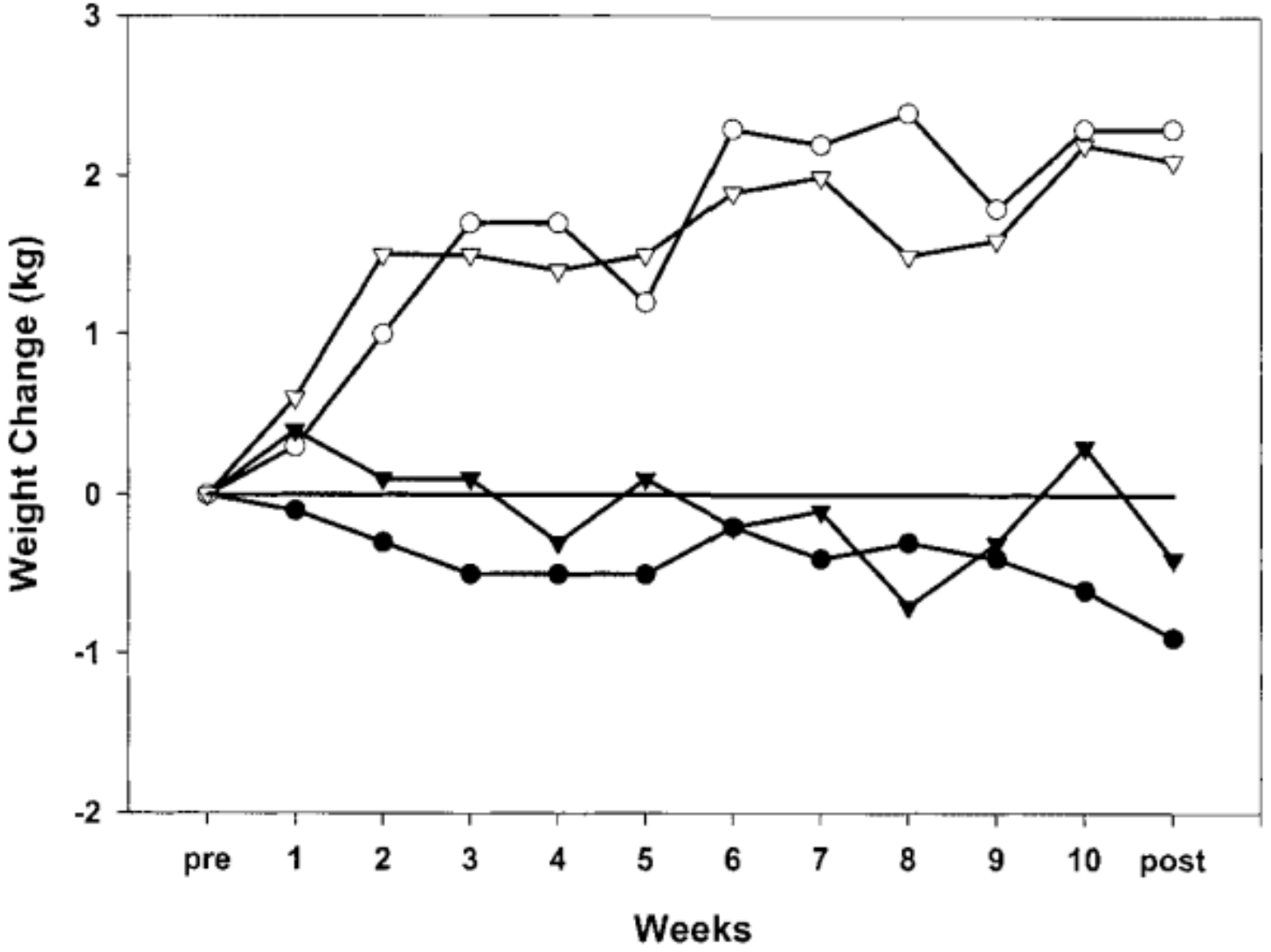
Gerontology (2014) 60 (4): 294–305.

Effects of Testosterone and Resistance Training in Men with Chronic Obstructive Pulmonary Disease

Richard Casaburi, Shalender Bhasin, Louis Cosentino, Janos Porszasz, Attila Somfay, Michael I. Lewis, Mario Fournier, and Thomas W. Storer

Division of Endocrinology and Molecular Medicine, Drew University of Medicine and Science; Division of Pulmonary and Critical Care Medicine, Cedars-Sinai Medical Center, Los Angeles; Rehabilitation Clinical Trials Center, Los Angeles Biomedical Research Institute at Harbor-UCLA Medical Center and Exercise Sciences Laboratory, El Camino College, Torrance, California

Am J Respir Crit Care Med. 2004 Oct 15;170(8):870-8



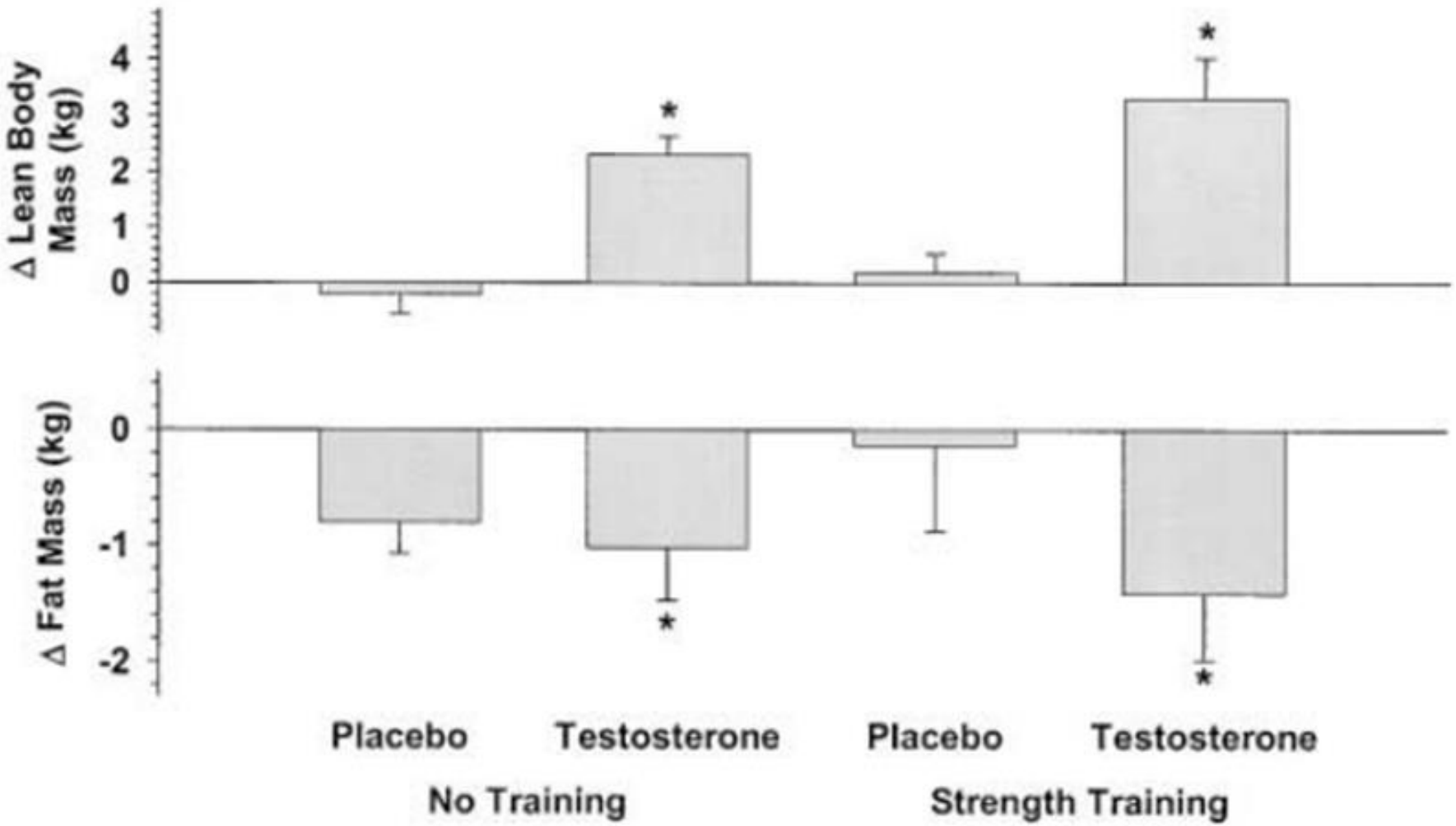
testosterone + no training

testosterone + resistance training

placebo + resistance training

placebo + no training

Am J Respir Crit Care Med. 2004 Oct 15;170(8):870-8



Am J Respir Crit Care Med. 2004 Oct 15;170(8):870-8

OPEN ACCESS

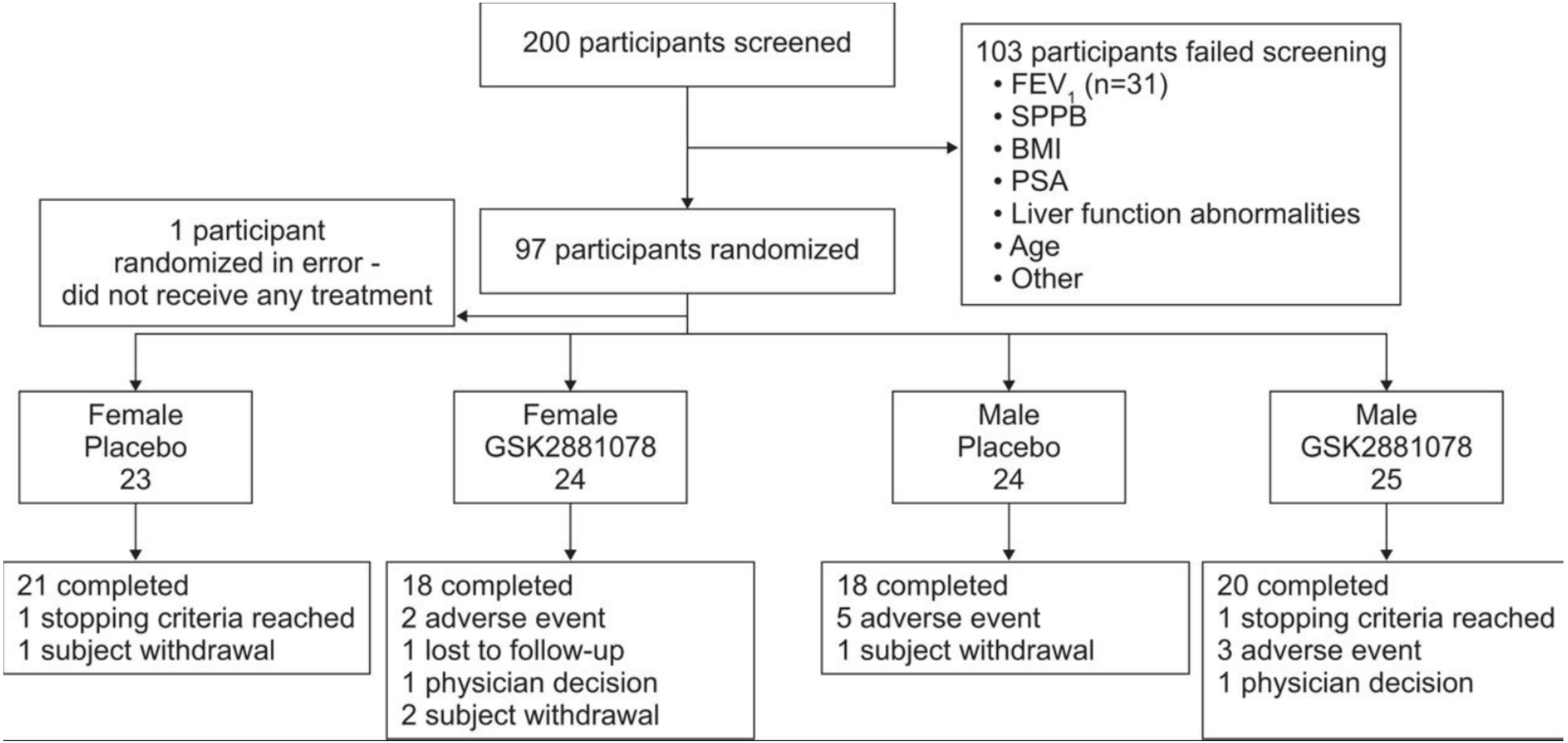
Original research

Selective androgen receptor modulation for muscle weakness in chronic obstructive pulmonary disease: a randomised control trial

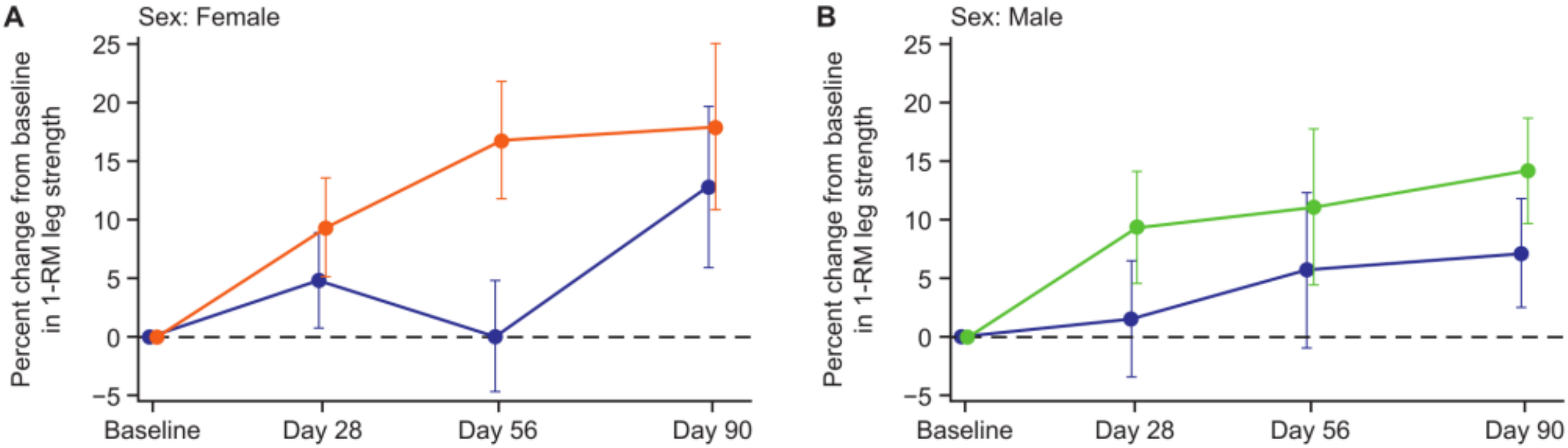
Divya Mohan,[1] Harry Rossiter ,[2] Henrik Watz,[3] Charles Fogarty,[4] Rachael A Evans ,[5] William Man ,[6] Maggie Tabberer,[7] Misba Beerahee,[8] Subramanya Kumar,[7] Helen Millns,[8] Sebin Thomas,[9] Ruth Tal-Singer,[10] Alan J Russell,[1] Marie Claire Holland,[1] Chika Akinseye,[8] David Neil,[1] Michael I Polkey [6,11]

Thorax 2023;78:258–266

Thorax 2023;78:258–266



Thorax 2023;78:258–266



	Female*					Male*				
	Placebo (N=21)		GSK2881078 (N=21)			Placebo (N=23)		GSK2881078 Baseline (N=23)		
Efficacy measure	Baseline mean (SD)†	Change at day 90 adjusted mean (90% CI)†	Baseline mean (SD)†	Change at day 90 adjusted mean (90% CI)†	Treatment difference (N=21) at day 90 (90% CI)	Baseline mean (SD)†	Change at day 90 adjusted mean (90% CI)†	Baseline mean (SD)†	Change at day 90 adjusted mean (90% CI)†	Treatment difference (N=21) at day 90 (90% CI)
1-RM (kg)	109.2 (40.12)	12.3 (5.1 to 19.6)	120.0 (45.81)	20.3 (12.8 to 27.8)	8.0 (−2.5 to 18.4)	168.8 (55.11)	14.2 (5.5 to 22.9)	202.3 (59.79)	26.0 (17.7 to 34.3)	11.8 (−0.5, 24.0)
1-RM (% change from baseline)	–	12.8 (5.9 to 19.6)	–	17.9 (10.9 to 25.0)	5.2 (−4.7, 15.0)	–	7.2 (2.5 to 11.8)	–	14.2 (9.7 to 18.6)	7.0 (0.5 to 13.6)

Thorax 2023;78:258–266

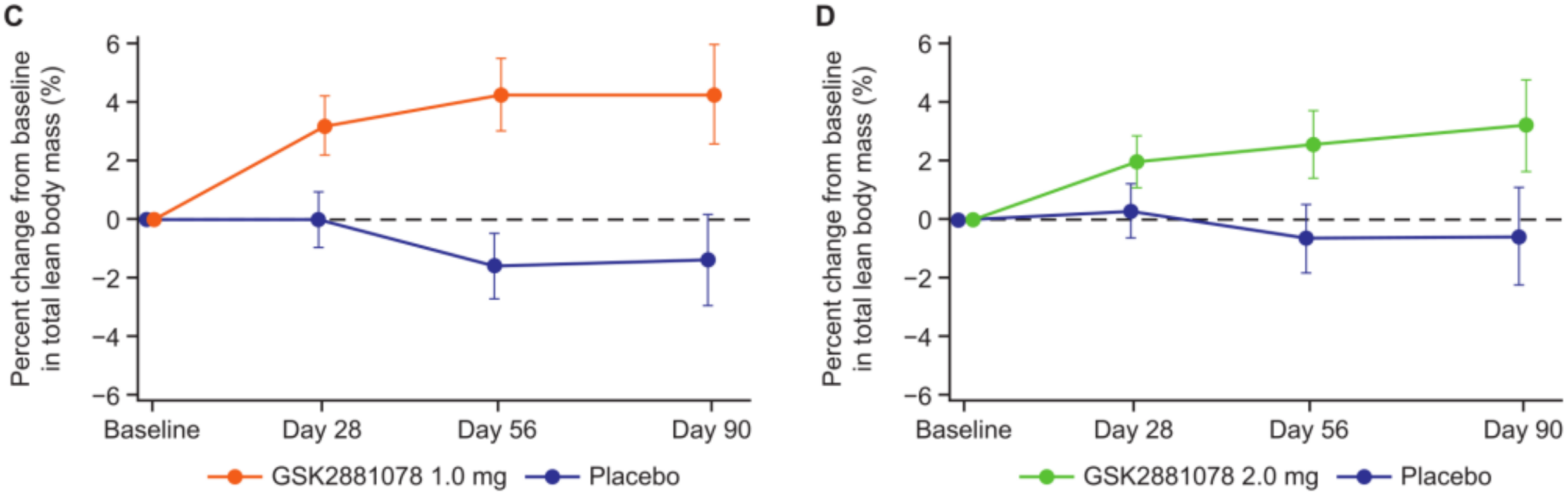


Table 3 Change in efficacy measures

	Female*					Male*				
	Placebo (N=21)		GSK2881078 (N=21)			Placebo (N=23)		GSK2881078 Baseline (N=23)		
Efficacy measure	Baseline mean (SD)†	Change at day 90 adjusted mean (90% CI)†	Baseline mean (SD)†	Change at day 90 adjusted mean (90% CI)†	Treatment difference (N=21) at day 90 (90% CI)	Baseline mean (SD)†	Change at day 90 adjusted mean (90% CI)†	Baseline mean (SD)†	Change at day 90 adjusted mean (90% CI)†	Treatment difference (N=21) at day 90 (90% CI)
tLBM (kg)	36.6 (5.04)	−0.5 (−1.1 to 0.0)	36.9 (4.99)	1.6 (1.0 to 2.2)	2.1 (1.3 to 3.0)	51.4 (8.41)	−0.4 (−1.3 to 0.4)	52.4 (7.09)	1.7 (0.9 to 2.5)	2.1 (1.0 to 3.3)

Thorax 2023;78:258–266

Table 3 Change in efficacy measures

Efficacy measure	Female*					Male*				
	Placebo (N=21)		GSK2881078 (N=21)			Placebo (N=23)		GSK2881078 Baseline (N=23)		
	Baseline mean (SD)†	Change at day 90 adjusted mean (90% CI)†	Baseline mean (SD)†	Change at day 90 adjusted mean (90% CI)†	Treatment difference (N=21) at day 90 (90% CI)	Baseline mean (SD)†	Change at day 90 adjusted mean (90% CI)†	Baseline mean (SD)†	Change at day 90 adjusted mean (90% CI)†	Treatment difference (N=21) at day 90 (90% CI)
SPPB score	9.5 (1.47)	0.3 (–0.2, 0.7)	9.6 (1.56)	0.5 (0.0, 1.0)	0.2 (–0.4, 0.9)	10.1 (1.20)	0.4 (0.0, 0.8)	9.9 (1.29)	0.5 (–0.5 to 0.8)	0.1 (–0.5 to 0.6)
5STS (s)	16.2 (6.51)	–1.1 (–2.2 to 0.1)	15.6 (5.14)	–2.3 (–3.3 to –0.8)	–1.0 (–2.7 to 0.8)	13.7 (2.24)	1.1 (–1.2 to 3.5)	13.9 (2.34)	–0.8 (–3.1 to 1.5)	–1.9 (–5.2 to 1.3)
4mGS (s)	4.60 (1.08)	–0.0 (–0.4 to 0.3)	4.5 (1.19)	–0.1 (–0.5 to 0.3)	–0.0 (–0.6, 0.5)	4.5 (1.06)	–0.1 (0.4, 0.1)	4.6 (1.11)	–0.4 (–0.6 to –0.2)	–0.2 (–0.5, 0.1)
ESWT (s)	224.6 (78.93)	–6.5 (–51.9 to 38.8)	316.1 (251.91)	4.6 (–45.0 to 54.1)	11.1 (–57.1 to 79.2)	253.4 (121.42)	105.1 (12.3 to 197.9)	297.0 (116.39)	–44.2 (–132.1 to 43.6)	–149.3 (–280.6 to 18.1)
ISWT (m)	318 (106.38)	–10.5 (–35.5 to 14.4)	363.8 (144.41)	–17.2 (–42.9 to 8.4)	–6.7 (–42.7 to 29.2)	341.3 (105.41)	–7.5 (–34.2 to 19.3)	399.1 (143.75)	–42.3 (-67.6 to –16.9)	–34.8 (–72.0 to 2.4)
CAT score	20.2 (6.08)	–1.3 (–2.6 to 0.1)	18.1 (6.86)	–2.2 (–3.6 to –0.7)	–0.9 (–2.9 to 1.1)	17.6 (6.18)	–1.4 (–3.0 to 0.1)	16.7 (6.98)	0.8 (–0.7 to 2.3)	2.2 (0.0 to 4.5)
SGRQ-C score	48.4 (15.88)	–3.9 (–6.8 to –1.0)	41.8 (13.69)	–0.9 (–4.1 to 2.3)	3.0 (–1.4 to 7.4)	43.5 (14.89)	–1.7 (–4.9 to 1.5)	39.5 (16.69)	0.4 (–0.2.6 to 3.4)	2.1 (–2.3 to 6.5)

Table 2 Safety summary (safety population)

Frequency of events (percentage of overall group)*	Female		Male	
	Placebo (N=23)	GSK2881078 (N=24)	Placebo (N=24)	GSK2881078 (N=25)
Any event	19 (83%)	20 (83%)	17 (71%)	19 (76%)
Any severe AEs	1 (4%)	3 (13%)	3 (13%)	2 (8%)
AEs leading to withdrawal	0	2 (8%)	5 (21%)	4 (16%)
Drug-related AEs leading to withdrawal	0	1 (4%)	0	3 (12%)
Drug-related AEs	1 (4%)	3 (13%)	1 (4%)	4 (16%)
Any SAEs	1 (4%)	2 (8%)	2 (8%)	0
Drug-related SAEs	0	0	0	0
Any AEs of special interest	3 (13%)	6 (25%)	5 (21%)	3 (12%)
Fatal SAEs	0	0	0	0
SAEs				
Diverticulitis	0	0	1 (4%)	0
Infective exacerbation of COPD	1 (4%)	0	0	0
Myocardial infarction	0	1 (4%)	0	0
Cholecystitis	0	1 (4%)	0	0
Adenocarcinoma of colon	0	0	1 (4%)	0

Thorax 2023;78:258–266

TABLE 1 Metabolic phenotypes

Metabolic phenotype	Definition	Clinical risk
Obesity	BMI 30–35 $kg \cdot m^{-2}$	Increased cardiovascular risk
Morbid obesity	BMI >35 $kg \cdot m^{-2}$	Increased cardiovascular risk Impaired physical performance
Sarcopenic obesity	BMI 30–35 $kg \cdot m^{-2}$ and SMI <2 SD below mean of young M and F reference groups [5]	Increased cardiovascular risk Impaired physical performance
Sarcopenia	SMI <2 SD below mean of young M and F reference groups	Increased mortality risk Impaired physical performance
Cachexia	Unintentional weight loss >5% in 6 months and FFMI <17 $kg \cdot m^{-2}$ (M) or <15 $kg \cdot m^{-2}$ (F)	Increased mortality risk Impaired physical performance
Precachexia	Unintentional weight loss >5% in 6 months	Increased mortality risk

경청해 주셔서 정말 감사합니다!!