VNIVERSITAT DE VALÈNCIA Facultat de Fisioteràpia

PROGRAMA DE DOCTORADO EN FISIOTERAPIA

TESIS DOCTORAL

Detección de casos de sarcopenia en población adulta mayor a partir del consenso del Grupo Europeo de Trabajo sobre Sarcopenia en Personas Mayores 2

PRESENTADA POR:

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DIRIGIDA POR:

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València, octubre de 2023

Dra. Maria dels Àngels Cebrià i Iranzo, Profesora Titular de la *Universitat de València*, adscrita al *Departament de Fisioteràpia*,

Hace costar:

Que el trabajo presentado como Tesis Doctoral por Dña. Natalia Cezón Serrano, titulado "Detección de casos de sarcopenia en población adulta mayor a partir del consenso del Grupo Europeo de Trabajo sobre Sarcopenia en Personas Mayores 2" ha sido realizado bajo mi dirección para optar al grado de Doctor por la *Universitat de València*. Habiéndose concluido, y reuniendo a mi juicio las condiciones de originalidad y rigor científico necesarias, se autoriza su presentación a fin de que pueda ser defendido ante el tribunal correspondiente.

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Hace constar:

Que la tesis doctoral realizada por Dña. Natalia Cezón Serrano, presentada a continuación, sigue el modelo de compendio de artículos científicos. Esta tesis forma parte de un proyecto de investigación desarrollado en el *Departament de Fisioteràpia de la Universitat de València* subvencionado por la Generalitat Valenciana (GV/2019/131) en el que Dña. Natalia Cezón Serrano es colaboradora. El proyecto SARCOFUNC versa sobre el estudio de la sarcopenia en población adulta mayor de la provincia de Valencia.

La autora de la presente tesis es la primera firmante en uno de los artículos y última firmante (autora senior) en los otros dos artículos que se presentan. En los dos artículos en los que la doctoranda es última autora, su contribución ha sido tan importante como la de las primeras autoras en las diferentes fases del proyecto, como son el diseño, las valoraciones de las personas participantes, la interpretación de los resultados y la redacción de los artículos científicos. Se anexa en esta tesis, además, documento firmado por todos/as los/as autores/as en el que se constata que ninguno de los artículos forma parte de otra tesis doctoral.

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AGRADECIMIENTOS

Quiero mostrar mi agradecimiento:

A Maria dels Àngels Cebrià i Iranzo, mi directora de tesis y gran amiga. La persona que me hizo embarcar en el duro, pero alucinante viaje de la investigación. Gracias por enseñarme tantas cosas, por tu generosidad, por guiarme con cariño y respeto. Infinitas gracias por elegirme, por confiar en mí.

También quería agradecer a todas las personas que participaron en este proyecto desinteresadamente, amigos presentes, amigos que se fueron, familiares, personas sin las cuales esta investigación no habría podido seguir adelante.

A mis compañeras del grupo de investigación, en especial a Anna Arnal y María Ángeles Tortosa, por su esfuerzo, por su inestimable ayuda, por enseñarme tantas cosas. Es un placer trabajar a vuestro lado.

A Constanza San Martín, por su desinteresada ayuda, por sus valiosos consejos, por su disponibilidad infinita.

A Giuseppe Borio, gracias por esas maravillosas ilustraciones que con inmensa paciencia me has regalado para enriquecer este trabajo. Gracias por tu apoyo en todo momento.

A mis padres e hijo, gracias por estar siempre ahí, por vuestro apoyo y cariño, por todo lo que me habéis dado.

Muchas gracias

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ALM	Masa magra apendicular (siglas en inglés)
ASM	Masa muscular apendicular (siglas en inglés)
ASMI	Índice de masa muscular apendicular (siglas en inglés)
AVD	Actividades de la vida diaria
AWGS	*Asian Working Group on Sarcopenia*
DE	Desviación estándar
EWGSOP	*European Working Group of Sarcopenia in Older People*
FNIH	*Foundation for the National Institutes of Health*
FP	Fuerza de prensión
GDS-SF	Versión corta Escala de Depresión Geriátrica de Yesavage
IB	Índice de Barthel
IC	Intervalo de confianza
ICC	Coeficiente de correlación intraclase
ICCA	Índice de comorbilidad de Charlson abreviado
IMC	Índice de masa corporal
IR	Índice resistivo
IWGS	*International Working Group on Sarcopenia*
MEC	Mini Examen Cognoscitivo de Lobo
MNA-SF	*Mini Nutritional Assessment-Short Form*
NS	No sarcopénicas
OR	Odds ratio
PS	Probable sarcopenia
SCWD	*Society of Sarcopenia, Cachexia and Wasting Disorders*
SF-8	*Short Form Health Survey* de ocho ítems
SMI	Índice de masa esquelética
SPPB	*Short Physical Performance Battery*
SS	Sarcopenia severa
TUG	*Timed-Up & Go Test*
VM	Velocidad de marcha
6MWT	Prueba de 6 minutos marcha

PRESENTACIÓN DE LOS ESTUDIOS

Se expone:

Que los artículos que componen esta tesis doctoral por compendio se enmarcan en el programa de Doctorado en Fisioterapia, código 3165, de la *Universitat de València*, R.D. 99/2011. Son el resultado de un proyecto de investigación desarrollado en la *Facultat de Fisioteràpia* de la *Universitat de València*, entre enero de 2019 y marzo de 2021, y subvencionado por la Generalitat Valenciana (GV/2019/131).

Para la realización de este estudio centrado en personas adultas mayores, se contactó con asociaciones y residencias de la provincia de València. A las personas participantes se les realizó una valoración que incluía pruebas de fuerza muscular, de análisis de la composición corporal mediante bioimpedanciometría y de rendimiento físico, así como varios cuestionarios que recogían datos sociodemográficos, calidad de vida, depresión, entre otros. La mayoría de las valoraciones se llevaron a cabo en una única sesión, sin embargo, a las personas residentes en "El Mas" de Torrent (València) se las evaluó un total de tres veces a modo de estudio longitudinal.

En este documento aparece información relevante sobre la materia tratada en esta tesis. Se han abordado aquellos detalles que faciliten entender cada uno de los apartados incluidos en los artículos que constituyen esta tesis doctoral. Por esta razón, se exponen con mayor extensión el apartado relacionado con el concepto de sarcopenia y su detección a través del algoritmo propuesto por el Grupo Europeo de Trabajo sobre Sarcopenia en Personas Mayores 2.

Cada uno de los artículos compilados en esta tesis ha sido publicado en revistas indexadas en el *Journal Citation Reports* (JCR) de la *Web of Science*^{TM} (WOS). A continuación, se presentan las revistas donde se publicaron, así como sus índices de calidad.

Artículo 1. ***Functional and Clinical Characteristics for Predicting Sarcopenia in Institutionalised Older Adults: Identifying Tools for Clinical Screening.***

Revista: *International Journal of Environmental Research and Public Health*. 2020; 17(12):4483.

N.º de citas en WOS: 11

PMID: 32580427 DOI: 10.3390/ijerph17124483

Categoría: *Public, Environmental & Occupational Health* (SCIE)		
Índice de impacto	*Ranking*	Cuartil
3,390	68/203	Q2

Categoría: *Public, Environmental & Occupational Health* (SSCI)		
Índice de impacto	*Ranking*	Cuartil
3,390	42/176	Q1
Categoría: *Environmental Sciences* (SCIE)		
Índice de impacto	*Ranking*	Cuartil
3,390	118/274	Q2

Artículo 2. ***Using the Updated EWGSOP2 Definition in Diagnosing Sarcopenia in Spanish Older Adults: Clinical Approach.***

Revista: *Journal of Clinical Medicine*. 2021; 10(5): 1018

N.º de citas en WOS: 9

PMID: 33801427 DOI: 10.3390/jcm10051018

Categoría: *Medicine, General & Internal*		
Índice de impacto	*Ranking*	Cuartil
4,964	55/172	Q2

Artículo 3. ***Functional and emotional impact of COVID-19 lockdown on older adults with sarcopenia living in a nursing home: A Fifteen-Month follow-up.***

Revista: *Nursing and Health Sciences.* 2023; *Online ahead of print*

PMID: 37705366 DOI: 10.1111/nhs.13050

Categoría: Nursing (SCIE)		
Índice de impacto	*Ranking*	Cuartil
2,7	23/125	Q1
Categoría: Nursing (SCII)		
Índice de impacto	*Ranking*	Cuartil
2,7	22/123	Q1

SECCIÓN PRIMERA: MARCO TEÓRICO

INTRODUCCIÓN

1. SARCOPENIA

1.1. Definición y evolución del término

El término sarcopenia viene de dos voces griegas, σάρξ y πενία, que transcritas son *sarx* (carne) y *penia* (pobreza), es decir, "pobreza de la carne" (Figura 1). En 1988, Irwin Rosenberg acuñó el término de sarcopenia como la pérdida normal e involuntaria de la masa muscular a causa del envejecimiento que afecta a la movilidad y a la independencia (1).

Así que, siguiendo esta idea, aparecieron distintas definiciones de sarcopenia que usaban exclusivamente la masa muscular como criterio diagnóstico (2–6). Durante décadas, el término sarcopenia se usó para describir el "desgaste" muscular o baja masa muscular sin tener en cuenta la función muscular: la fuerza muscular o el rendimiento físico (7). Con el tiempo, los estudios demostraron que una definición basada solo en la masa muscular no era correcta para referirse a la sarcopenia ya que por sí sola no era tan buena predictora de efectos adversos (8). Es más, definir la sarcopenia solo con la masa muscular puede tener un valor clínico limitado (9).

Claramente, una definición de sarcopenia basada únicamente en la masa muscular es insuficiente para identificar a las personas adultas mayores con cambios clínicamente significativos relacionados con la edad en el músculo esquelético, y esta constatación se ha convertido en un concepto clave entre los últimos esfuerzos por desarrollar criterios de consenso (10).

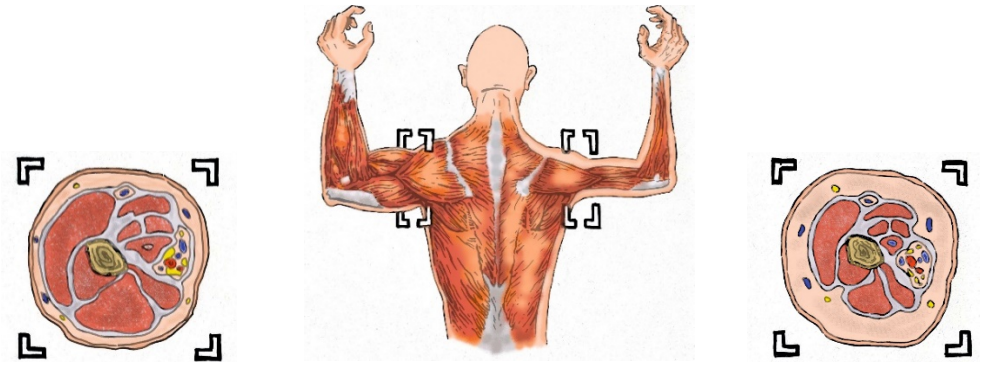

Figura 1. Esquema de sarcopenia. Fuente: imagen cedida por Borio, G.

En 2001, Morley *et al.* 2001 (11) fueron más allá de la masa muscular e introdujeron cambios en la definición de sarcopenia: "Disminución de la masa muscular y la fuerza debida al envejecimiento". Sin embargo, no fue hasta 2010 que apareció la primera definición operativa gracias al Grupo Europeo de Trabajo sobre Sarcopenia en Personas Mayores (EWGSOP1): "Síndrome caracterizado por una pérdida gradual y generalizada de masa muscular esquelética y fuerza muscular, con el riesgo de causar resultados adversos como discapacidad física, mala calidad de vida e incluso mortalidad".

Definición que también adoptó el Grupo Internacional de Trabajo sobre la Sarcopenia (IWGS) (12).

El hecho de que se empezara a considerar la sarcopenia como un síndrome geriátrico hizo que la investigación clínica aumentara (13), y que muchos grupos buscaran definir la sarcopenia y diferenciarla de otros síndromes asociados al desgaste muscular (14). Los avances en la investigación y el gran número de estudios publicados acerca de su diagnóstico hicieron que la situación de la sarcopenia cambiara en 2016 siendo formalmente reconocida por la Organización Mundial de la Salud como enfermedad muscular cuyo código de diagnóstico ICD-10-CM es M62.84 (15).

La definición del EWGSOP1 fue considerada el *gold standard* para el diagnóstico y detección de sarcopenia, y como ya se ha comentado anteriormente, otros grupos de investigación publicaron sus propias definiciones apareciendo numerosos consensos que, si bien han aceptado esta revisión del significado de sarcopenia, han aportado distintos puntos de corte para definirla. La mayoría de las definiciones están basadas en la combinación de tres marcadores primarios de capacidad física: masa muscular baja, fuerza de prensión baja y velocidad de marcha lenta.

En la Tabla 1 aparecen los distintos consensos que han existido desde 2010 hasta la actualidad y que han dado lugar a distintas definiciones de sarcopenia. Como se puede ver, cada definición propone diferentes puntos de corte y metodologías para evaluar la masa muscular, la fuerza y el rendimiento físico (12,14,16–20), incluso algunas de ellas no consideran siquiera la fuerza de prensión (12,16,17). Lo que sí está consensuado es que tanto la masa muscular como el rendimiento físico forman parte de la definición actual de sarcopenia.

Tabla 1. Definiciones de sarcopenia

Grupo, año	**Fuerza**		**Masa muscular**		**Rendimiento físico**
	Hombres	Mujeres	Hombres	Mujeres	Hombres y mujeres
ESPEN, 2010 (16)	----------	----------	% de masa > 2 DE por debajo media de personas sanas entre 18-39 años del mismo grupo étnico y sexo		VM <0,8 m/s bajo rendimiento en cualquier prueba utilizada en la evaluación geriátrica
EWGSOP1, 2010 (14)	<30 kg	<26 kg	SMI ≤8,87 kg/m^2	SMI ≤6,42 kg/m^2	VM <0,8 m/s
IWGS, 2011 (12)	----------	----------	ALM/h^2 ≤7,23 kg/m^2	ALM/h^2 ≤5,67 kg/m^2	VM <1 m/s
FNIH-SP, 2014 (19)	<26 kg	<16 kg	ALM <19,75 kg ALM_{IMC} <0,789	ALM <15,02 kg ALM_{IMC} <0,512	VM <0,8 m/s

AWGS, 2014 (20)	<26 kg	<18 kg	ASMI <7,0 kg/m^2	ASMI <5,7 kg/m^2	VM <0,8 m/s
SSCWD, 2019 (17)	----------	----------	ALM/h^2 > 2 DE por debajo media de personas sanas entre 20-30 años del mismo grupo étnico		VM <1 m/s 6MWT <400m
EWGSOP2, 2019 (18)	<27 kg Silla >15 s	<16 kg Silla >15 s	ASM <20 kg ASMI <7,0 kg/m^2	ASM <15 kg ASMI <5,5 kg/m^2	SPPB ≤8 puntos VM <0,8 m/s TUG ≥20 s
AWGS, 2019 (21)	<28 kg	<18 kg	ASMI <7,0 kg/m^2	ASMI <5,7 kg/m^2	VM <1 m/s Silla >12 s SPPB ≤9 puntos

Abreviaturas: ESPEN: ESPEN grupos especiales de "*cachexia-anorexia in chronic wasting diseases*" y "*nutrition in geriatrics*"; EWGSOP: *European Working Group on Sarcopenia in Older People*; IWGS: *International Working Group on Sarcopenia*; FNIH: *Foundation for the National Institutes of Health—Sarcopenia Project*; AWGS: *Asian Working Group on Sarcopenia*; SSCWD: *Society of Sarcopenia, Cachexia and Wasting Disorders*; DE: desviación estándar; Silla: *chair stand test* ; SMI: índice de masa muscular esquelética; ALM: masa magra apendicular; ALM/h^2: ALM ajustada por altura al cuadrado; ALM$_{IMC:}$ ALM ajustada por índice de masa corporal; ASM: masa muscular apendicular; ASMI: índice de masa muscular apendicular; IMC: índice de masa corporal; VM: Velocidad de marcha; SPPB: *Short Physical Performance Battery*; TUG: *Timed-Up and Go*; 6MWT: prueba de marcha de 6 minutos.
Nota: los valores expresados en la columna de "Fuerza" en kg se corresponden a fuerza de prensión manual.

Como se puede ver en la Tabla 1, por un lado, existen definiciones que no contemplan la fuerza muscular, manteniendo el papel dominante de la masa muscular. Por otro lado, los consensos más actuales han evolucionado a un modelo que no prioriza la masa muscular y que añade la funcionalidad muscular para realizar el diagnóstico de sarcopenia. Dada esta variabilidad en las definiciones, los expertos en la materia reconocen que el concepto de sarcopenia continúa siendo difícil de definir y continúan discutiendo activamente sobre este (13).

Actualmente, la definición realizada por el EWGSOP1 es la más citada en la literatura sobre sarcopenia (14,18,22) (Tabla 2). Recomendaron incluir para su diagnóstico la presencia de baja masa muscular y baja función muscular (fuerza o rendimiento) (14). Su objetivo era mejorar el proceso de identificación y del abordaje de la sarcopenia en personas mayores. Sin embargo, tras una década de nuevos avances en el campo de la investigación y la evidencia clínica recogida, el EWGSOP1 revisó y actualizó esa definición (EWGSOP2) (18) colocando a la fuerza muscular en un primer plano (la fuerza es mejor que la masa muscular para predecir resultados adversos) (23). Y el rendimiento físico pasó a ser el elemento usado para identificar la gravedad de la sarcopenia.

Tabla 2. Número de citas de las distintas definiciones de sarcopenia

Definición, año publicación	Número de citas
ESPEN, 2010 (16)	1136
EWGSOP1, 2010 (14)	7941
IWGS, 2011 (12)	1986
FNIH-SP, 2014 (19)	1330
AWGS, 2014 (20)	2491
SSCWD, 2019 (17)	717
EWGSOP2, 2019 (18)	5424
AWGS, 2019 (21)	1927

ESPEN: ESPEN grupos especiales de "*cachexia-anorexia in chronic wasting diseases*" y "*nutrition in geriatrics*"; EWGSOP: *European Working Group on Sarcopenia in Older People*; IWGS: *International Working Group on Sarcopenia*; FNIH: *Foundation for the National Institutes of Health—Sarcopenia Project*; AWGS: *Asian Working Group on Sarcopenia;* SSCWD: *Society of Sarcopenia, Cachexia and Wasting Disorders.*

Fuente: *Web of Science.* Citas actualizadas con fecha 16-09-2023

Antes de la publicación de las primeras directrices del EWGSOP1 en 2010, la sarcopenia era prácticamente una desconocida entre los clínicos e, incluso, entre profesionales especializados en personas adultas mayores (22). Y dentro del campo de la investigación, solo la Medicina geriátrica se interesaba, con poca implantación en otras ramas de la investigación a nivel clínico. Hoy en día, todavía un alto número de profesionales clínicos de la salud no identifican la pérdida significativa de la masa muscular y la fuerza con el término sarcopenia (24) por lo que todavía hace falta introducirla en la práctica clínica (25).

1.2. Categorías y estadios de evolución

En la práctica clínica se ha categorizado a la sarcopenia en primaria y secundaria. Cuando la sarcopenia está exclusivamente relacionada con la edad de la persona estaríamos hablando de *sarcopenia primaria* ya que no existe otra causa evidente a parte del envejecimiento en sí. Sin embargo, cuando existen otras causas estaríamos hablando de *sarcopenia secundaria* (14).

Los factores que están relacionados a la aparición de sarcopenia primaria son: la edad, la pérdida de unidades motoras que inervan el músculo, la inflamación sistémica, el estrés oxidativo, la disminución de las hormonas anabólicas, y la "anorexia del envejecimiento" unida a una disminución de la actividad física, entre otros. En la Figura 2 aparecen dichos factores.

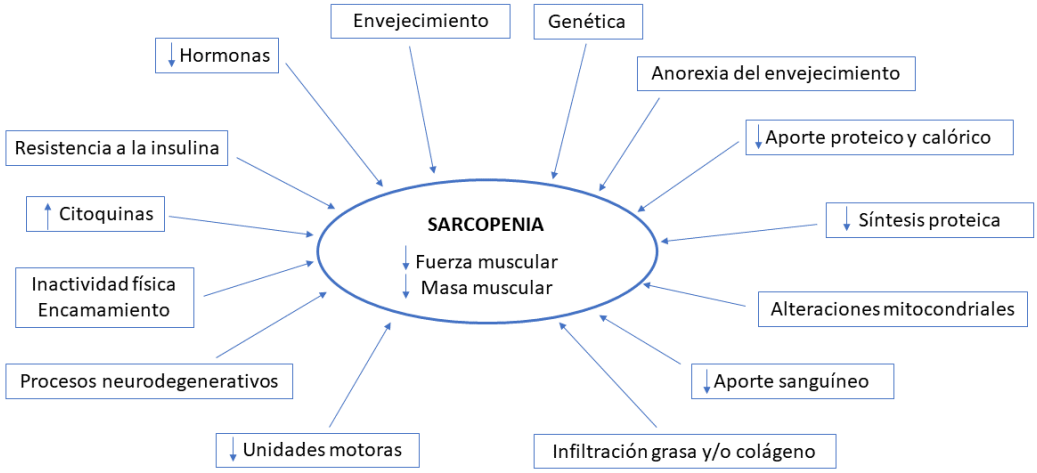

Figura 2. Factores que intervienen en la patogénesis de la sarcopenia primaria (relacionada con la edad).

Fuente: adaptada de Ali y García, 2014 (26); Bauer *et al.*, 2019 (27), Morley *et al.*, 2011 (17).

En cuanto a la sarcopenia secundaria, en la Tabla 3 pueden verse las causas subyacentes más frecuentes.

Tabla 3. Causas más frecuentes de sarcopenia secundaria

Causas de sarcopenia	
Nutricional	Bajo aporte proteico
	Bajo aporte energético
	Deficiencia de micronutrientes
	Malabsorción / trastornos gastrointestinales
	Anorexia
Asociados con inactividad	Reposo en cama, inmovilidad
	Baja actividad física, sedentarismo
	Situaciones de ingravidez
Enfermedades	Articulares / óseas
	Inflamatorias
	Cardiorrespiratorias (insuficiencia cardíaca, enfermedad pulmonar obstructiva crónica)
	Metabólicas (diabetes)
	Endocrinas (carencia androgénica)
	Neurológicas
	Cáncer
	Renales
	Hepáticas
Yatrogénicas	Hospitalizaciones
	Relacionadas con uso de fármacos

Fuente: adaptada de Cruz Jentoft *et al.*, 2010 (14), 2019 (7).

Por otra parte, la sarcopenia también puede ser clasificada según la estadificación o grado de gravedad. Esta clasificación depende de la definición que se haya utilizado. De esta forma, el EWSGOP en 2010 sugirió tres estadios a nivel conceptual: *presarcopenia* (baja masa muscular; no están afectados ni fuerza ni rendimiento físico), *sarcopenia* (baja masa muscular, junto con baja fuerza muscular o bajo rendimiento físico) y *sarcopenia severa* (están afectados masa y fuerza muscular, y el rendimiento físico) (14). Sin embargo, con la actualización de su definición en 2019, la sarcopenia pasó a clasificarse como probable, confirmada o severa. Cuando la fuerza muscular es baja, nos encontramos con una persona con *probable sarcopenia*; cuando, además, la masa muscular es baja, la persona tiene *sarcopenia confirmada*; y la severidad de la sarcopenia viene dada por el bajo rendimiento físico, *sarcopenia severa* (18).

1.3. Prevalencia en población adulta mayor

La prevalencia de la sarcopenia depende del entorno en el que se ha medido y de la definición utilizada, tanto la relativa exclusivamente a la masa muscular (28) como a las definiciones operativas utilizadas en los estudios (29,30). Ahora bien, la prevalencia de sarcopenia es mayor en pacientes institucionalizados y personas hospitalizadas que en personas que viven en comunidad (31,32).

A lo largo de los últimos años, se han realizado múltiples estudios en los que se analizaba la prevalencia de sarcopenia según la definición empleada para su detección y diagnóstico. A lo largo de este apartado, vamos a diferenciar aquellos estudios realizados antes y después de la aparición del actual consenso de sarcopenia del EWGSOP2 (2019).

Sin incluir el nuevo consenso, un metaanálisis encontró que la prevalencia de sarcopenia dependía de la definición utilizada, oscilando entre el 9,9% al 40,4% (29). A los autores les llamó la atención que las estimaciones de prevalencia agrupadas eran más bajas para las definiciones conceptuales (EWGSOP1/AWGS (12,9%; [95% IC: 9,9 – 15,9%]), IWGS (9,9%; [95% IC: 3,2 – 16,6%]) y FNIH (18,6%; [95% IC: 11,8 – 25,5%]) que para las que solo usaban la valoración de la masa muscular.

A partir de la publicación del nuevo consenso, han sido muy numerosos los estudios que han comparado la prevalencia de sarcopenia según si se aplican los criterios del EWGSOP1 o los del EWGSOP2. Aunque los expertos en la materia han aceptado el uso de esta nueva directriz del EWGSOP2, se ha expresado preocupación por su efecto sobre la prevalencia y los resultados de la sarcopenia (33,34). En comparación con EWGSOP1, la nueva clasificación produjo una estimación más baja de la prevalencia de sarcopenia, con menor número de personas adultas mayores diagnosticadas, y menos asociaciones de resultados adversos para la salud (33–41). Por lo que parece ser que la disminución de la prevalencia depende de los cambios en el algoritmo de detección y de los puntos de corte utilizados (33).

En una revisión sistemática, se halló que la prevalencia de sarcopenia osciló entre el 6,2 y el 35,3% para el EWGSOP1, y del 3,2 al 26,3% para el EWGSOP2. En ella, cinco estudios evaluaron la asociación entre la prevalencia de sarcopenia (EWGSOP1 frente a EWGSOP2) y los resultados sanitarios desfavorables, y tres de estos mostraron que EWGSOP1 se asociaba mejor con un mayor riesgo de hospitalización y/o mortalidad (36). Los resultados de un metaanálisis realizado por Petermann-Rocha *et al*. (42), de nuevo, muestran que la tasa de prevalencia de sarcopenia depende de la definición utilizada. En la Tabla 4 se pueden comparan los resultados de la prevalencia según la definición utilizada o usando solo la masa muscular, los datos se muestran en sentido creciente.

Tabla 4. Comparación de la prevalencia de sarcopenia según la definición utilizada

Definición de sarcopenia	Prevalencia (%)	95% IC
EWGSOP2	10,0	2,0 – 17,0
FNIH	11,0	9,0 – 14,0
IWGS	14,0	9,0 – 18,0
AWGS	15,0	13,0 – 17,0
EWGSOP1	22,0	20,0 – 25,0
Masa muscular	27,0	23,0 – 31,0

Fuente: datos extraídos de Petermann-Rocha *et al*., 2022 (42).

Aunque también se han publicados estudios que han comparado ambos algoritmos del EWGSOP1 cuyas diferencias en la prevalencia de sarcopenia eran pequeñas (43–46).

Las diferencias también se constatan en otros entornos como es la hospitalización donde la prevalencia de sarcopenia según el algoritmo EWGSOP1 fue del 43,7% (IC 95%; 38%-49,4%), y según EWGSOP2 del 28,5% (23,3%-33,7%) (47). Sin embargo, en el estudio de Rodríguez Rejón *et al.* (48) en población institucionalizada, no se encontraron diferencias de prevalencia al usar ambas definiciones.

1.4. Resultados adversos

La presencia de sarcopenia tiene asociados una serie de resultados adversos en la salud de las personas que la padecen. La sarcopenia afecta a la capacidad de llevar a cabo las actividades de la vida diaria (49); provoca trastornos de movilidad (17); se asocia con el deterioro funcional (50), la pérdida de la independencia, la fragilidad (18) y la discapacidad (3). Además, incrementa el riesgo de padecer fracturas y caídas. En un metaanálisis, Yeung *et al*. encontraron que las personas mayores de 64 años con sarcopenia tenían un riesgo significativamente mayor de caídas y fracturas que las personas no sarcopénicas. Las personas con sarcopenia tenían un riesgo significativamente mayor de caídas (estudios transversales: OR 1,60; IC 95% 1,37-1,86, $p < 0,001$, $I^2 = 34\%$; estudios prospectivos: OR 1,89; IC 95% 1,33-2,68, $p < 0,001$, $I^2 = 37\%$)

y fracturas (estudios transversales: OR 1,84; IC 95% 1,30-2,62, p = 0,001, I^2 = 91%; estudios prospectivos: OR 1,71; IC 95% 1,44-2,03, p = 0,011, I^2 = 0%) en comparación con los individuos no sarcopénicos (51).

Por otra parte, la sarcopenia está vinculada al deterioro cognitivo (52), a la depresión (53) y a la pérdida de la calidad de vida (50); así como se asocia a toda causa de mortalidad entre personas adultas mayores (18,50,54). Además de estos resultados adversos, la sarcopenia tiene un gran impacto económico en el sistema sanitario (13,55,56).

2. DETECCIÓN Y DIAGNÓSTICO DE SARCOPENIA

2.1. Aplicación del algoritmo del EWGSOP2

En este trabajo se utilizó el algoritmo del EWGSOP2 para la detección y diagnóstico de los casos de sarcopenia en la muestra de personas reclutadas. La Figura 3 muestra los distintos pasos de aplicación del algoritmo. Se trata de cuatro pasos consecutivos que empiezan con el cribado, siguen con la valoración y la confirmación, y finalizan con la determinación del grado de severidad de la sarcopenia.

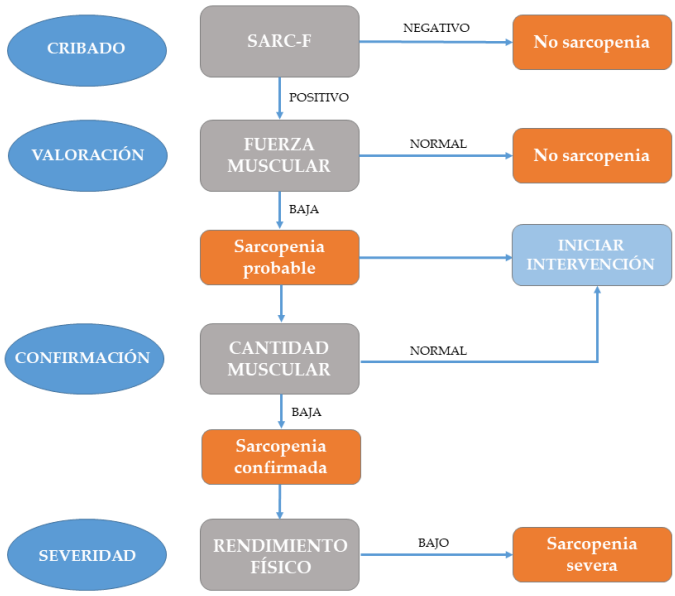

Figura 3. Algoritmo de detección y diagnóstico de sarcopenia en personas adultas mayores según el EWGSOP2. Fuente: adaptado de Cruz-Jentoft *et al.*, 2019 (18).

A continuación, se detallan las medidas resultado que han sido valoradas en el proyecto de investigación, así como el protocolo y equipamiento empleados.

2.1.1 Cribado o búsqueda de casos de sarcopenia

El cuestionario **SARC-F** está compuesto por 5 ítems cuyas respuestas están basadas en la propia percepción del/la paciente acerca de sus limitaciones en fuerza, capacidad de caminar, levantarse de una silla, subir escaleras y el número de caídas experimentadas (49,57) (Tabla 5). Cada ítem se puntúa entre 0 y 2 puntos, por lo que la puntuación oscila entre 0-10 puntos. Un valor igual o mayor a 4 puntos indica sospecha de sarcopenia.

Tabla 5. Cuestionario SARC-F

Ítems		**Puntuación**
S*trength* (Fuerza)	¿Cuánta dificultad tiene para levantar y desplazar 4,5 Kg?	Ninguna = 0 Alguna = 1 Mucha o incapaz = 2
A*ssistance in walking* (Asistencia para caminar)	¿Cuánta dificultad tiene para cruzar caminando una habitación?	Ninguna = 0 Alguna = 1 Mucha, usando ayudas auxiliares o incapaz = 2
R*ise from chair* (Levantarse de una silla)	¿Cuánta dificultad tiene para levantarse de una silla o cama?	Ninguna = 0 Alguna = 1 Mucha o incapaz sin ayuda = 2
C*limb stairs* (Subir escaleras)	¿Cuánta dificultad tiene para subir 10 escalones?	Ninguna = 0 Alguna = 1 Mucha o incapaz = 2
F*alls* (Caídas)	¿Cuántas veces se caído en el último año?	Ninguna = 0 1-3 caídas = 1 4 o más caídas = 2

Fuente: adaptada de Malmstron *et al*., 2013 (58).

A pesar de la buena fiabilidad del SARC-F y su especificidad de moderada a alta, su sensibilidad de baja a moderada hace que no sea óptimo utilizarlo para el cribado de la sarcopenia (59,60). Por esto, hay autores que recomiendan aplicar los criterios diagnósticos de sarcopenia sin cribado. Sin embargo, otros autores han sugerido que el SARC-CalF, que añade al SARC-F la medición de la circunferencia de la pantorrilla, puede ser una opción a la hora de incrementar la sensibilidad de este (61). El SARC-CalF se puntúa con 0 puntos cuando la persona tiene más de 31 cm de circunferencia y con 10 puntos si era inferior o igual a 31 cm (62). Un SARC-CalF de 11 puntos indica un cribado positivo de sarcopenia (63).

2.1.2 Valoración de la fuerza muscular:

La **prensión manual** o fuerza de agarre de la mano se valoró con un dinamómetro digital Jamar Plus+ (Patterson Medical, Sammons Preston, Bolingbrook, IL, USA) siguiendo el siguiente protocolo (64): paciente sentado/a con espalda apoyada en el respaldo de la silla, codo flexionado 90°, antebrazo apoyado en el reposabrazos en prono-supinación

neutra, y muñeca situada al borde del reposabrazos, en posición neutra y con el pulgar mirando hacia arriba. Tal y como se ve en la Figura 4, se coge el dinamómetro con la mano de forma cómoda para el/la paciente (se tiene que ajustar la empuñadura según el tamaño de su mano). Por su parte, la persona que realiza la valoración sujeta el dinamómetro por su borde inferior con el objetivo de mantener su peso y anima a la persona evaluada a que apriete todo lo que pueda y con la mayor fuerza posible hasta que el valor que aparece en pantalla deje de aumentar, pidiéndole entonces que deje de apretar. La medición se repite en la otra mano, y se vuelve a realizar hasta un total de tres intentos por mano. Se tuvo en cuenta el mayor valor de los seis intentos. Los puntos de corte para la fuerza de agarre fueron <27 kg para los hombres y <16 kg para las mujeres (65).

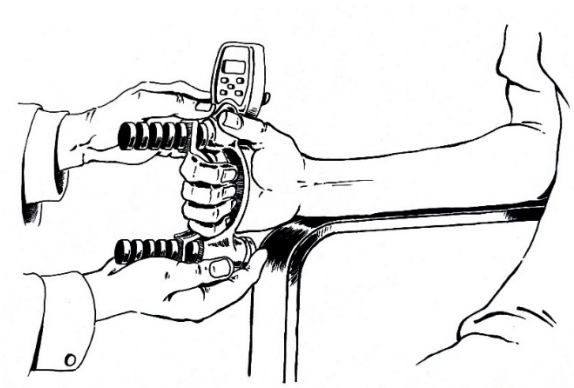

Figura 4. Medición de la fuerza de prensión manual. Fuente: imagen cedida por Borio, G.

En el ***Chair stand test*** (Figura 5), la persona está sentada en una silla, con pies apoyados en el suelo, caderas y rodillas a 90° de flexión, y ambos brazos cruzados por delante del pecho. Tiene que levantarse y sentarse de la silla con seguridad, a la mayor velocidad posible, y se registra el tiempo, en segundos, empleado en completar 5 repeticiones. El punto de corte fue de >15 segundos para ambos sexos (19).

Figura 5. *Chair stand test*. Fuente: imagen cedida por Borio, G.

2.1.3 Valoración de la masa muscular:

Para valorar la masa muscular apendicular (ASM) se utilizó un bioimpendanciómetro (BIA) Bodystat® 1500MDD (Bodystat Ltd., Douglas, UK) y electrodos adhesivos (Figura 6). Antes de realizar la medición, se pidió a los/as pacientes que no hicieran un ejercicio físico previo, que estuvieran en ayunas al menos 2-3 horas antes, que no hubieran consumido alcohol ni grandes cantidades de agua, que hubieran orinado media hora antes y que se quitaran cualquier joya, reloj o pieza metálica (66). Se comprobó que ninguna persona llevara marcapasos ni prótesis bilaterales (67).

Figura 6. Bioimpendanciómetro y electrodos

Para realizar la medición, la persona se tumba en decúbito supino sobre una camilla con miembros superiores e inferiores a lo largo del cuerpo sin tener contacto con él y permanece en esa posición durante 5 minutos para que se estabilicen los fluidos corporales. Mientras tanto, se limpia la piel (con alcohol de 70°) sobre la que se van a colocar los electrodos. La colocación sigue el método tetrapolar homolateral, los electrodos fueron colocados tal y como se describe en la Tabla 6.

Tabla 6. Colocación de los electrodos

	Distal (pinza roja)	**Proximal (pinza negra)**
Miembro superior	Nudillos de 2º a 5º dedo	Cara dorsal de la muñeca, entre apófisis estiloides del cúbito y del radio
Miembro inferior	Cara dorsal del pie, a la altura de cabeza de los metatarsianos	Cara dorsal del tobillo, entre maléolos del peroné y de la tibia

Fuente: elaboración propia

La BIA se realizó utilizando una corriente eléctrica alterna sinusoidal de 200 µA a una única frecuencia de funcionamiento de 50 kHz. Para la estandarización de la ASM, se recomienda el uso de parámetros en bruto (resistencia, reactancia) obtenidos en la BIA junto con la ecuación de Sergi (68) (basada en poblaciones de adultos mayores de Europa): **ASM** (kg) = -3,964 + (0,227 × IR) + (0,095 × peso) + (1,384 × sexo) + (0,064 × Xc), donde el índice resistivo (IR) era la resistencia (ohmios) normalizada para la altura (cm), el peso (kg), el sexo era 1 en los hombres y 0 en las mujeres, y la reactancia (Xc, ohmios). Los puntos de corte de ASM para la masa muscular baja fueron <20 kg y <15 kg para hombres y mujeres, respectivamente. El índice ASM (ASMI) se definió como ASM/altura^2. Los puntos de corte del **ASMI** para la masa baja corregida fueron <7,0 kg/m^2 y <5,5 kg/m^2 para hombres y mujeres, respectivamente (18). Por otra parte, la ASM también puede ser estandarizada por el IMC (ASM_{IMC}; m^2) (69), sin embargo, el actual algoritmo del EWGSOP2 no determina los puntos de corte para la baja masa muscular según la **ASM_{IMC}**.

2.1.4 Valoración del rendimiento físico

El rendimiento físico se define como la capacidad de realizar tareas físicas para desenvolverse en la vida cotidiana. Implica la función de todo el cuerpo y depende no sólo del músculo esquelético, sino también de un sistema musculoesquelético intacto integrado con los sistemas nervioso central y periférico, y la participación de otros sistemas corporales (7).

Para valorar el rendimiento físico se utilizaron tres pruebas: (1) *Short Physical Performance Battery* (SPPB); (2) velocidad de la marcha; y (3) *Timed-Up and Go test* (TUG).

(1) La **SPPB** es una prueba que consta de tres partes: equilibrio, marcha y prueba de levantarse 5 veces de una silla (70).

   a) El equilibrio es registrado en tres posiciones distintas: pies juntos, semi-tándem y tándem. Para obtener la puntuación máxima de cada subprueba, la persona ha de ser capaz de mantener la posición inicial de los pies durante 10 segundos. Para ello, se le asiste para lograr la posición inicial y se le explica que para mantener esa posición puede separar los brazos del cuerpo, flexionar rodillas o tambalearse, si lo necesita. Las tres posiciones y la puntuación obtenida en su realización se pueden ver en la Tabla 7.

Tabla 7. Pruebas de equilibrio de la *Short Physical Performance Battery* y su puntuación

Posición	Tiempo	Puntuación
 Pies juntos	< 10 s	0
	≥ 10 s	1
 Semi-tándem	< 10 s	0
	≥ 10 s	1
 Tándem	< 3 s	0
	3-9,99 s	1
	≥ 10 s	2

Fuente: elaboración propia

b) Durante la subprueba de marcha se registra el tiempo en segundos que emplea la persona en recorrer 4 metros a su velocidad habitual de paso (Figura 7). Se parte de una marca en el suelo y se camina hasta una segunda marca situada a 5 m, la medición del tiempo se registra cuando uno de sus pies atraviesa una tercera marca situada a cuatro metros de la posición inicial. Si es necesario, la persona puede utilizar muletas, bastón o andador. La prueba se repite dos veces, y se tiene en cuenta el intento más rápido.

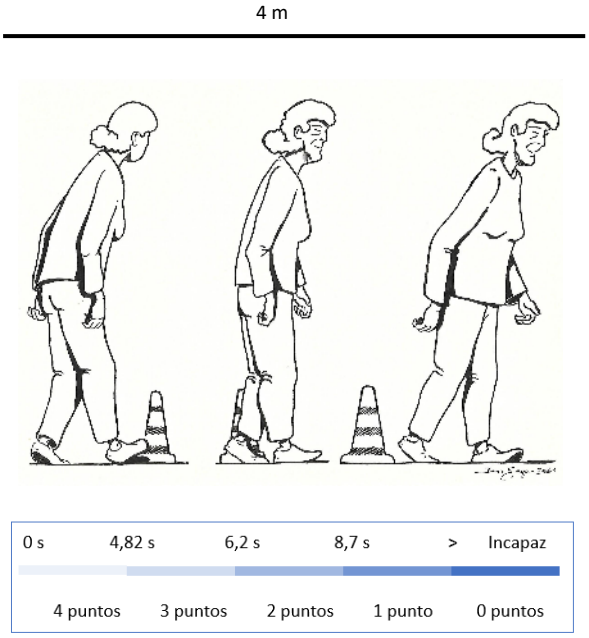

Figura 7. Prueba de la marcha de la *Short Physical Performance Battery* y puntuación.

Fuente: imagen cedida por Borio, G.

c) Tiempo empleado en levantarse y sentarse de la silla 5 veces, evaluación ya explicada en el apartado de medición de la fuerza muscular (Figura 8), con la diferencia que el cronómetro se detiene en la 5ª subida de la persona evaluada.

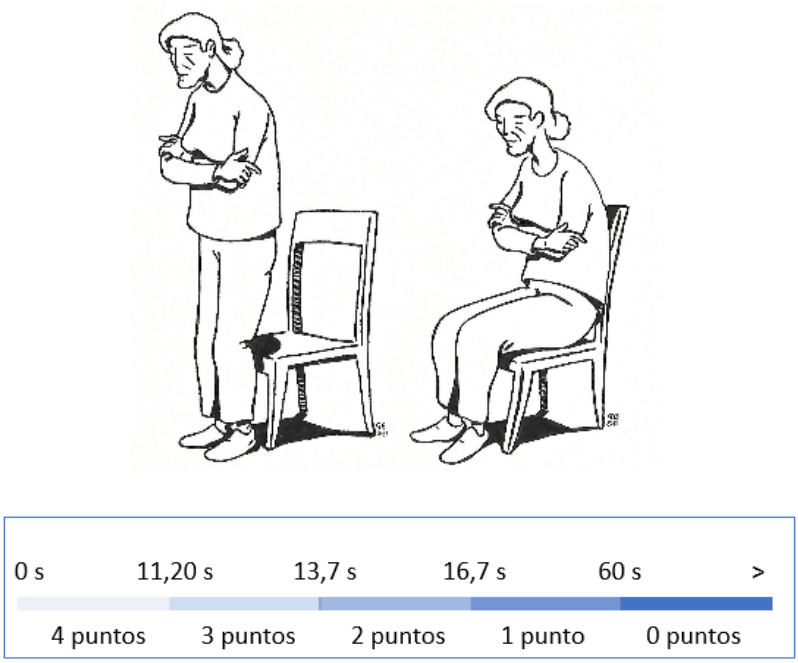

Figura 8. Prueba de levantarse y sentarse 5 veces de una silla de la *Short Physical Performance Battery* y su puntuación según tiempo registrado. Fuente: imagen cedida por Borio, G.

La puntuación total del SPPB va de 0 a 12 puntos, 4 puntos máximo por cada prueba. El punto de corte para ambos sexos es ≤8 puntos. El SPPB ha demostrado fiabilidad (coeficiente de correlación intraclase o ICC=0,92) y consistencia interna (α=0,76) (70).

(2) La **velocidad de la marcha** (71), se calculó utilizando el tiempo empleado en recorrer la distancia de 4 metros del SPPB cuya valoración ya ha sido explicada anteriormente [velocidad = 4 metros / tiempo (s)]. El punto de corte fue de <0,8 m/s para ambos sexos (14,72). Tiene una excelente fiabilidad (ICC=0,96) en adultos mayores (73).

(3) Por último, para la realización del **TUG**, la persona partía de sedestación, y tenía que levantarse de la silla (la ayuda de los miembros superiores estaba permitida), caminar hasta una marca en el suelo situada a 3 metros de distancia de la posición inicial, dar la vuelta y volver a sentarse en la silla, todo esto realizado a la velocidad habitual de marcha (Figura 9). El punto de corte para ambos sexos fue ≥20 segundos (74). El TUG tiene una fiabilidad adecuada (ICC=0,56) en adultos mayores (75).

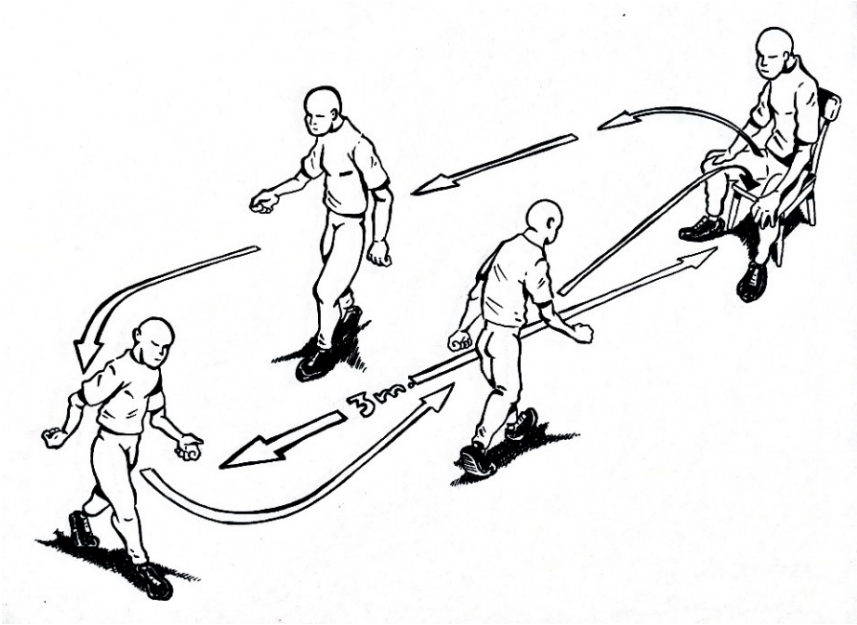

Figura 9. *Timed-Up and Go test*. Fuente: imagen cedida por Borio, G.

2.2. Valoración multidimensional en la persona adulta mayor

Actualmente, se recomienda una valoración multidimensional de la persona adulta mayor, que englobe diferentes perspectivas como son la funcional, la clínica y la psicológica, dirigida a identificar las necesidades médicas, psicosociales y funcionales de las personas mayores (76) y la existencia o no de algún síndrome geriátrico (caídas, depresión, deterioro cognitivo, malnutrición, etc.) (77,78).

En este apartado, se van a describir brevemente los instrumentos que se han utilizado en el presente trabajo y que forman parte de esa evaluación multidimensional, y otros que podrían completar la actual valoración de sarcopenia propuesta por el EWGSOP2.

El estudio de estos indicadores y su relación con la sarcopenia puede ser de gran ayuda a nivel clínico. Como se ha explicado en el apartado anterior, para la detección de sarcopenia se utilizan pruebas objetivas para evaluar la fuerza y masa muscular, y el rendimiento físico, en las que se invierte un tiempo considerable. Por lo que sería interesante y útil disponer de herramientas sencillas, rápidas y fáciles de usar (79) para poder realizar la detección en el ámbito clínico y no depender de aparataje costoso como es la BIA.

2.2.1. Variables funcionales

Índice de Barthel (IB)

Originariamente, el IB se desarrolló como una medida para evaluar la discapacidad en pacientes con enfermedades neuromusculares y musculoesqueléticas que recibían rehabilitación hospitalaria. Actualmente, se utiliza para evaluar la funcionalidad (80,81) y la independencia en las actividades de la vida diaria (AVD) de las personas mayores con distintas patologías (82,83).

El IB es un cuestionario muy sencillo de aplicar e interpretar que evalúa diez AVD: a) comer; b) lavarse; c) vestirse; d) arreglarse; e) deposiciones; f) micción; g) ir al retrete; h) trasladarse cama/sillón; i) deambular; y j) subir y bajar escaleras. Cada uno de los 10 ítems recibe un valor de 0 puntos si la persona no es capaz de realizar esa tarea o un valor variable (5, 10 o 15 puntos) dependiendo del grado de autonomía o independencia con la que realiza dicha tarea (84). Así pues, las personas evaluadas pueden obtener una puntuación que oscila entre 0 y 100 puntos. Podemos diferenciar 5 niveles de dependencia (85) según sea la puntuación obtenida (Tabla 8).

Tabla 8. Niveles de dependencia del Índice de Barthel

Clasificación	Puntuación
Independiente	100
Dependencia leve	91-99
Dependencia moderada	61-90
Dependencia severa	21-60
Dependencia total	<20

Fuente: adaptado de Shah *et al*., 1989 (85).

Por otra parte, el IB es un instrumento válido y fiable (82) que, además, ha demostrado tener una consistencia interna adecuada (α=0,70) (82).

Fenotipo de Fried

Para evaluar el estado de fragilidad de las personas adultas mayores se utilizó el fenotipo de Linda Fried (86) que define el modelo físico de la fragilidad. Algunos autores lo consideran el *gold standard*. Tiene buena fiabilidad y validez pronóstica (87). Este incluye 5 criterios clínicos: 1) pérdida involuntaria de peso; 2) fatiga; 3) bajo nivel de actividad física; 4) debilidad muscular (fuerza de prensión); y 5) lentitud en la marcha (Tabla 9). La presencia de cualquiera de estos criterios otorga 1 punto, pudiéndose obtener resultados de entre 0 y 5 puntos, en total. Según la puntuación obtenida, se clasifica a las personas como robustas (0 puntos), pre-frágiles (1-2 puntos) y frágiles (3 puntos)(86).

Tabla 9. Escala Fried de fragilidad

Criterio 1. Pérdida involuntaria de peso
¿Ha perdido más de 4,5 kg de peso de manera involuntaria en el último año?
Criterio 2. Fatiga
Sentí que todo lo que hacía era un esfuerzo durante la semana pasada. La semana pasada sentía que no podía seguir adelante. (Si alguna de estas respuestas es sí, la puntuación será igual a 1).
Criterio 3. Actividad física (88)
¿Realiza semanalmente actividad física? Hombres <2 horas y media / semana Mujeres <2horas / semana
Criterio 4. Lentitud (Tiempo que tarda el paciente en recorrer 4,5m a su velocidad de paso habitual)
≥7 segundos para altura ≤ 173 cm (hombres) / ≤ 159 cm (mujeres) ≥ 6 segundos para altura >173 cm (hombres) / >159 cm (mujeres)
Criterio 5. Debilidad de fuerza de prensión
Si fuerza < 20% del valor estratificado por sexo e índice de masa corporal.
Si la respuesta es afirmativa, el criterio puntúa con 1 punto.

Fuente: adaptada de Fried *et al*., 2001 (86).

Fuerza isométrica de bíceps braquial y cuádriceps

Para valorar la fuerza muscular isométrica del bíceps braquial y del cuádriceps (89,90) se utilizó un dinamómetro digital Lafayette (Modelo 01165, Lafayette, IN). Se llevaron a cabo tres repeticiones en el lado dominante con un minuto de descanso entre ellas y se tomó para el análisis el valor más alto. Para la valoración del bíceps braquial, la persona permanecía en decúbito supino, con el brazo a lo largo del tronco, antebrazo en supinación y mano abierta. Se colocaba el sensor en la cara palmar de la muñeca y se le pedía que realizara la flexión del codo. Para la valoración del cuádriceps, la persona se sentaba sobre una camilla con los miembros inferiores colgando y se colocaba una cincha alrededor del tobillo para evitar que la extensión de la rodilla dificultara al evaluador la correcta realización de la técnica de medición. A su vez, se colocaba el sensor en la cara anterior del extremo distal de la tibia y se pedía la extensión de la rodilla.

Número de caídas

Se registró el número de caídas sufridas en el último año. Estas se consideran un síndrome geriátrico y son un resultado adverso de la sarcopenia como ya se ha

mencionado en el apartado “Resultados adversos” de este documento. Las caídas se registraron como “número de caídas“ y de forma categórica según el cuestionario SARC-F: sin caídas, entre 1-3 caídas, y ≥ 4 caídas (49) .

Para las personas residentes en “El Mas”, además se obtuvo de la base de datos del centro el número de caídas que habían sufrido en el año previo al confinamiento por la pandemia de COVID-19.

2.2.2. Variables clínicas

Índice de comorbilidad de Charlson abreviado (ICCA)

El ICCA valora la presencia de ocho afecciones médicas (91): 1) enfermedad vascular cerebral; 2) diabetes; 3) enfermedad pulmonar obstructiva crónica; 4) insuficiencia cardiaca / cardiopatía isquémica; 5) demencia; 6) enfermedad arterial periférica; 7) insuficiencia renal crónica (diálisis); y 8) cáncer.

A la hora de valorar a las personas, la ausencia de estas condiciones médicas se puntúa con un valor de 0, mientras que su presencia se puntúa con un valor de 1, excepto para la insuficiencia renal crónica y el cáncer cuyo valor es 2. Por lo que la puntuación total oscila entre 0 y 10 puntos. A mayor puntuación, mayor comorbilidad tiene la persona evaluada. En general, se considera ausencia de comorbilidad una puntuación entre 0 y 1; baja comorbilidad cuando el índice es de 2, y alta comorbilidad cuando es ≥ 3 puntos.

El ICCA se utiliza como predictor de la mortalidad en personas adultas mayores (92,93) y su relación con la sarcopenia ha sido estudiada en población adulta mayor hospitalizada (94). Por otra parte, una reciente revisión crítica de sus propiedades clinimétricas concluyó que la fiabilidad entre evaluadores fue excelente y que es un índice fiable, altamente sensible y válido (95). El ICCA tiene una probabilidad pronóstica a corto plazo similar a la versión larga (78).

Número de medicamentos

Actualmente no existe un consenso en la definición de polifarmacia (96), sin embargo la definición más citada en la literatura habla de 5 o más medicamentos usados de forma simultánea (97). Para el propósito de este trabajo, esta variable se registró como el número de medicamentos prescritos y administrado de forma regular.

Número de ingresos hospitalarios

Otra variable registrada fue el número de ingresos hospitalarios que las personas participantes habían tenido durante el año previo a su evaluación.

Mini Nutritional Assessment-Short Form (MNA©-SF)

El MNA©-SF es una herramienta utilizada para detectar personas desnutridas o en riesgo de desnutrición, y está validada para población adulta mayor (98). Tiene una sensibilidad con respecto al MNA© del 81,4% y una especificidad del 92,7%, así como un fuerte valor predictivo positivo (99,100). Es una herramienta rápida (menos de 5 minutos) y sencilla de administrar. Además, es eficaz ya que logra identificar a las personas en riesgo antes de que exista una pérdida de peso.

Está compuesta por 5 preguntas relativas a: 1) disminución de la ingesta de alimentos; 2) pérdida de peso involuntaria reciente; 3) movilidad actual; 4) estrés o enfermedad aguda; 5) presencia de demencia o depresión. A las que se añade, el cálculo del IMC o la medición del perímetro de la pantorrilla en el punto más ancho (98). En este estudio, se utilizó el IMC ya que todas las personas valoradas podían bipedestar (98). La puntuación total del MNA©-SF oscila entre 0 y 14 puntos. El MNA©-SF clasifica a las personas con un estado nutricional normal (12-14 puntos), riesgo de desnutrición (8-11 puntos) y desnutrición (0-7 puntos). Todas las versiones del MNA© pueden consultarse en http://www.mna-elderly.com.

2.2.3. Variables psicológicas

Short Form Health Survey de ocho ítems (SF-8)

La calidad de vida relacionada con la salud se valoró mediante la encuesta de salud abreviada de 8 ítems (SF-8) cuya puntuación oscila entre 0 y 40 puntos; una puntuación más alta indica mejor calidad de vida (101). El SF-8 es un instrumento factible, fiable, válido y sensible para evaluar la calidad de vida relacionada con la salud. Ha demostrado tener una alta consistencia interna (α=0,92) (102).

Mini Examen Cognoscitivo de Lobo (MEC)

Para valorar el estado cognitivo se utilizó el MEC. Este es un instrumento de cribado para la detección de deterioro cognitivo en personas adultas mayores (103) y su seguimiento (104). Se trata de una adaptación al español del instrumento original desarrollado por Folstein *et al*. en 1975 (105). Explora de forma rápida varias funciones cognitivas: 1) orientación témporo-espacial; 2) memoria inmediata y a largo plazo; 3) atención; 4) cálculo; 5) lenguaje; 6) razonamiento abstracto; y 7) praxias (104). La puntuación total está comprendida entre 0 y 35 puntos.

El punto de corte 23-24 discrimina la alteración cognitiva y una puntuación <18 se corresponde a deterioro cognitivo severo (106–108). En cuanto a su validez en población

institucionalizada, el MEC tiene una sensibilidad del 73,6% y una especificidad del 84,6% (103).

Versión corta de la Escala de Depresión Geriátrica de Yesavage

Para realizar el cribado de depresión se utilizó la versión corta de la Escala de Depresión Geriátrica de Yesavage (GDS-SF) (109). Está compuesto por 15 preguntas (respuesta sí/no) y su puntuación va de 0 a 15 puntos (Tabla 10).

Tabla 10. Interpretación de la Versión corta de la Escala de Depresión Geriátrica de Yesavage

Puntuación	Interpretación
0-4	Normal
5-8	Depresión leve
10-11	Depresión moderada
12-15	Depresión grave

Fuente: adaptado de Greenberg, 2007 (110).

Este instrumento ha demostrado una fiabilidad moderada, una consistencia interna moderada (α=0,749), una sensibilidad del 89,5% y una especificidad del 65,3% (111). La literatura recomienda utilizar como punto de corte para considerar la posible existencia de depresión puntuaciones ≥5 (111,112). Este instrumento está disponible en https://web.stanford.edu/~yesavage/GDS.html.

SECCIÓN SEGUNDA: RESULTADOS

A continuación, antes de pasar a resumir los tres estudios, se explica el nexo de las tres publicaciones que forman esta tesis doctoral por compendio. En el Proyecto SARCOFUNC se pretendía estudiar la detección de sarcopenia en personas adultas mayores mediante la aplicación del algoritmo del EWGSOP2, por lo que las tres publicaciones se basan en este objetivo. En la primera de ellas, la aplicación del algoritmo nos permitió clasificar a las personas como sarcopénicas y analizar qué variables clínico-funcionales estaban asociadas a la sarcopenia. Al tratarse de variables de sencilla aplicación y uso, se permitía a los clínicos la detección de personas sarcopénicas en menor tiempo y sin el uso de instrumental. Tras la observación de las distintas opciones que aparecen dentro de los 4 pasos del algoritmo, nos surgió la idea de comparar esas opciones y ver si detectaban por igual a las personas con sarcopenia. De esa forma, pretendíamos otorgar al clínico la capacidad de elección a la hora de decidir sobre qué opción del algoritmo emplear para detectar sarcopenia. Y, por último, la tercera publicación surge en un contexto de emergencia sanitaria como ha sido la pandemia por Covid-19. Tuvimos la oportunidad de realizar la detección de sarcopenia en una situación especial de confinamiento y obtener un estudio de tipo longitudinal para constatar qué sucedió durante ese periodo en una muestra de personas mayores institucionalizadas con sarcopenia.

Estudio 1: *Functional and Clinical Characteristics for Predicting Sarcopenia in Institutionalised Older Adults: Identifying Tools for Clinical Screening*.

Contexto

Detección de sarcopenia en personas mayores institucionalizadas mediante el algoritmo propuesto por el EWGSOP2.

Objetivo

Analizar la relación entre la sarcopenia y la capacidad funcional, el número de hospitalizaciones y caídas en el último año, el número de fármacos prescritos y la comorbilidad, con la finalidad de apoyar y facilitar la detección de sarcopenia en personas adultas mayores institucionalizadas.

Como objetivo secundario, identificar cuáles de las variables clínico-funcionales evaluadas eran las más relevantes como herramientas de apoyo para la detección de sarcopenia, así como estimar la prevalencia de sarcopenia en población adulta mayor institucionalizada siguiendo el actual consenso en sarcopenia del EWGSOP2.

Resultados

En este estudio trasversal multicéntrico, se incluyó una muestra formada por 132 personas que vivían institucionalizadas en residencias de personas mayores. La edad media era de 82 ± 8,3 años y 102 participantes (77,7%) eran mujeres.

La aplicación de todos los pasos del algoritmo clasificó a las personas como no sarcopénicas (NS) (n=86, 65%), con sarcopenia probable (SP) (n=18, 14%), con sarcopenia confirmada (SC) (n=0, =%) y con sarcopenia severa (SS) (n=28, 21%).

Al comparar los distintos grados de sarcopenia, los resultados mostraron diferencias significativas en el índice de Barthel (IB) ($F(2,129)=10,992$, $p<0,001$, $\eta^2=0,146$) y el índice de comorbilidad de Charlson abreviado (ICCA) ($F(2,129)=6,054$, $p=0,003$, $\eta^2=0,086$). Las comparaciones *post-hoc* mostraron diferencias significativas entre las personas NS y SP ($p=0,003$), y entre las NS y las SS ($p<0,001$) en el IB, mientras que para el ICCA solo encontró diferencias significativas entre NS y SS ($p<0,004$).

Al utilizar las mismas variables, pero categorizándolas, los resultados también mostraron diferencias significativas entre los distintos grados de sarcopenia y el IB ($\chi^2(8)=23,941$, $p=0,003$), el ICCA ($\chi^2(4)=12,86$, $p=0,014$) y el número de caídas (variable modificada según su registro en el SARC-F) ($\chi^2(4)=14,87$, $p=0,005$).

Aunque el tamaño del efecto fue pequeño, los resultados mostraron que las personas NS eran más independientes o tenían una dependencia ligeramente moderada, mientras que las personas con cierto grado de sarcopenia tenían principalmente dependencia moderada o severa. Por otra parte, las personas NS tenían menos comorbilidad y habían sufrido menor número de caídas.

Para poder realizar una ecuación de regresión, se decidió reunir a las personas con SP, SC y SS en un único grupo de personas sarcopénicas. Se consideró como predictores la edad, el IMC y el sexo como variables de control, junto con IB, ICCA, número de medicamentos, días de hospitalización y número de caídas (variable categórica). Por razones de tamaño de la muestra, se realizó una selección automatizada por pasos hacia delante de los predictores.

La edad, el IB y el ICCA tuvieron un efecto estadísticamente significativo sobre la variable dependiente (sarcopenia). Los Odds ratio (OR) asociados mostraron que a medida que aumenta la edad, las personas tienen más probabilidades de sufrir sarcopenia (OR: 1,16; IC: 1,04-1,17; $p=0,001$), y como las personas con sarcopenia tienden a tener una mayor dependencia (OR: 0,96; IC: 0,95-0,98; $p=0,001$) y comorbilidad (OR: 1,51; IC: 1,08-2,12; $p=0,015$). Siendo la comorbilidad el mejor predictor de la probabilidad de presentar sarcopenia. En general, el tamaño del efecto estimado para la regresión fue de 0,25 (R^2 de Cox y Snell) y 0,34 (R^2 de Nagelkerke).

Al analizar la prevalencia de sarcopenia entre sexos no se encontraron diferencias estadísticas ($\chi^2(2)=1,33$; $p=0,512$). Y con respecto a la edad, las personas de más de 85 años tenían mayor prevalencia de sarcopenia tanto para SP como para SS ($\chi^2(4)=15,06$; $p=0,005$).

Estudio 2: ***Using the Updated EWGSOP2 Definition in Diagnosing Sarcopenia in Spanish Older Adults: Clinical Approach*****.**

Contexto

Tras el estudio descrito anteriormente y tras observar cómo se comportaban algunas variables estudiadas, nos planteamos estudiar la capacidad de detección de casos de sarcopenia utilizando las distintas opciones que tiene cada paso del algoritmo del EWGSOP2.

Se partió de tres modelos para el cribado de los casos: modelo A que incluyó el SARC-F; modelo B sin el SARC-F; y modelo C que empleó el SARC-CalF. Por cada uno de estos modelos se plantearon 12 opciones distintas resultado de la combinación de las diferentes medidas de fuerza muscular (prensión manual y prueba de levantarse y sentarse 5 veces de la silla), masa muscular (ASM y ASMI) y rendimiento físico (SPPB, velocidad de marcha y TUG). Resultado de la combinación entre modelos y opciones se obtuvieron 36 opciones distintas.

Nuestra hipótesis de trabajo era que la no utilización del SARC-F aumentaría el número de casos de sarcopenia detectados. También se incluyó como hipótesis que no habría diferencias en el número de casos detectados a pesar de usar las diferentes opciones de cada paso del algoritmo del EWGSOP2, lo que permitiría a los profesionales de la salud utilizar el más factible en su práctica clínica diaria.

Objetivo

El objetivo de este estudio fue comparar el número de casos de sarcopenia en personas adultas mayores utilizando las diferentes opciones de medición de cada paso del algoritmo del EWGSOP2. Así como evaluar el impacto de utilizar el SARC-F, el SARC-CalF o no realizar el cribado en la detección de casos de sarcopenia en personas adultas mayores españolas residentes en la provincia de Valencia.

Resultados

En este estudio transversal multicéntrico, se incluyó una muestra formada por 272 personas adultas mayores que vivían tanto en comunidad como institucionalizadas.

Análisis de los modelos*:* para cada uno de los tres modelos y para cada una de las 12 opciones, se calcularon los intervalos de confianza del 95% y cada categoría de la clasificación (no sarcopenia, sarcopenia probable, sarcopenia confirmada y sarcopenia severa). En las Figuras 10, 11 y 12, aparecen esos intervalos de confianza.

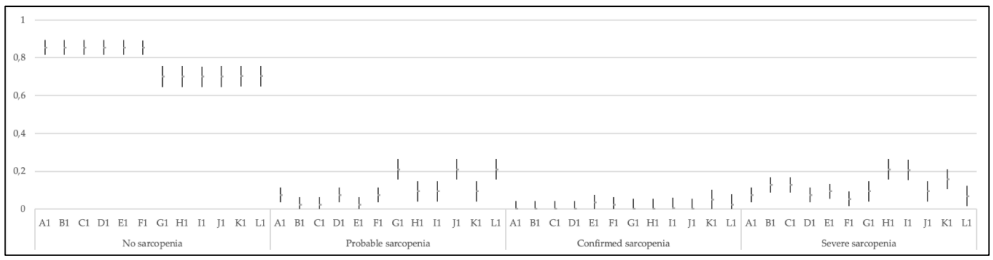

Figura 10. Intervalo de confianza del 95% para la proporción multinomial de cada categoría en las 12 opciones del Modelo que incluye el SARC-F

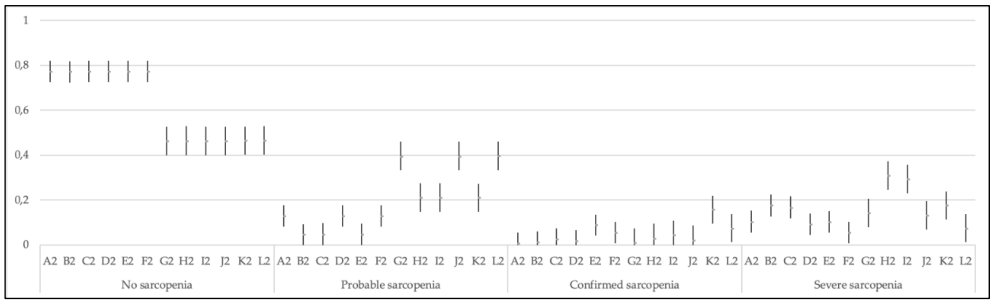

Figura 11. Intervalo de confianza del 95% para la proporción multinomial de cada categoría en las 12 opciones del Modelo que no incluye el SARC-F

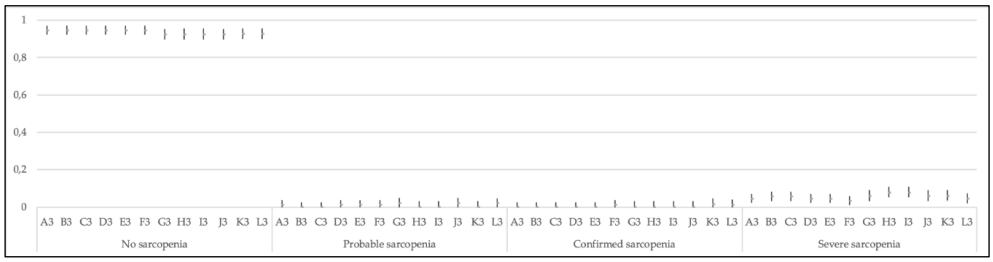

Figura 12. Intervalo de confianza del 95% para la proporción multinomial de cada categoría en las 12 opciones del Modelo que incluye el SARC-CalF

Una vez calculados estos IC, se promedió los intervalos de confianza para cada modelo, y en cada una de las doce opciones se realizó una prueba de bondad de ajuste chi-cuadrado entre las probabilidades esperadas y las probabilidades medias de cada modelo. Se hicieron 12 pruebas dentro de cada modelo para constatar si la clasificación de sarcopenia según la aplicación de los distintos pasos del algoritmo era estadísticamente igual o diferente. En cuanto al Modelo 1, todas las pruebas menos dos mostraron significación estadística, lo que indica que los distintos pasos del algoritmo afectan significativamente a la clasificación. Las pruebas del Modelo 2 mostraron resultados significativos en todos los casos, y por lo tanto esto apoya que los diferentes pasos del algoritmo conducen a diferentes clasificaciones. Sin embargo, en el Modelo 3, los resultados no mostraron significación estadística y, por tanto, para este algoritmo, los diferentes pasos no conducen a clasificaciones significativamente diferentes.

Además, se realizó una prueba de independencia chi-cuadrado para comparar las clasificaciones en los distintos grupos que hicieron los tres algoritmos. Esta fue

estadísticamente significativa ($\chi^2(6)=88,41$; $p<0,001$), y la asociación entre el algoritmo usado y la clasificación de sarcopenia fue moderada (V de Cramer= 0,226, IC 95% [0,177-0,276]).

Por otra parte, se analizó cómo se asociaba cada modelo en su conjunto con los niveles de gravedad de sarcopenia. La Figura 13 presenta gráficamente la asociación basada en los residuos de Pearson. Puede observarse que el Modelo 1 no se asocia significativamente con ninguna clasificación, tal como representa el color gris. Sin embargo, el Modelo 2 se asocia positivamente con la sarcopenia (color azul), siendo mayor la asociación con la sarcopenia probable, y tiene una asociación negativa (color rojo) con las personas sin sarcopenia. Por el contrario, el Modelo 3 está asociado positivamente (color azul) con las personas sin sarcopenia.

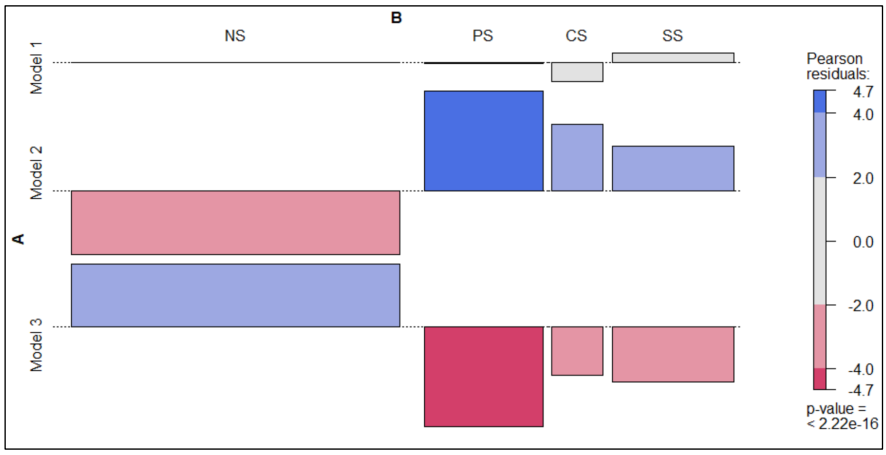

Figura 13. Asociación entre los tres modelos y los niveles de gravedad de la sarcopenia

Estudio 3: ***Functional and emotional impact of COVID-19 lockdown on older adults with sarcopenia living in a nursing home: A Fifteen-Month follow-up.***

Contexto

La población adulta mayor institucionalizada ha sufrido una elevada tasa de mortalidad durante la pandemia de COVID-19 debido a su vulnerabilidad y alto riesgo de contagio por su convivencia dentro de los centros. Para reducir el avance de la infección en las residencias, se adoptaron medidas de aislamiento social como la reclusión en las habitaciones, la ausencia de contacto físico con familiares, compañeros/as de residencia y profesionales/trabajadores, así como se prohibió toda actividad realizada de forma colectiva.

Para nosotras, el inicio de la pandemia supuso la imposibilidad de seguir realizando mediciones, sin embargo, habíamos evaluado a los/las residentes del Mas de Torrent durante el mes de enero de 2020 (T1), antes del estallido de la pandemia. La

fisioterapeuta del centro había realizado las mediciones en esa ocasión, por lo que planteamos seguir evaluando a las personas participantes y plantear un estudio longitudinal en un contexto difícilmente reproducible dada la extraordinaria situación que se estaba viviendo a nivel mundial. Así pues, realizamos una segunda valoración en enero de 2021 (T2), tras un periodo de confinamiento dentro de la residencia y una vez las personas participantes habían recibido la primera dosis de la vacuna, y una tercera valoración en marzo de 2021 (T3), tras un nuevo periodo de aislamiento por un brote dentro del centro.

Como todas las personas que participaron en el estudio fueron diagnosticadas de sarcopenia tras su primera valoración, planteamos el estudio para población institucionalizada con sarcopenia. Apoyándonos en nuestra anterior publicación, el diagnóstico de sarcopenia se realizó mediante la aplicación del algoritmo del EWGSOP2, en concreto el que incluye SARC-F, el *chair stand test*, la ASM y la velocidad de marcha.

Objetivo

El objetivo de este estudio fue detectar el impacto funcional y emocional en personas adultas mayores institucionalizadas con sarcopenia debido a las restricciones de movilidad y de socialización durante el confinamiento debido a la pandemia de COVID-19, y con un seguimiento de quince meses.

Un segundo objetivo fue analizar los cambios relativos a la clasificación de sarcopenia de las personas participantes en ese periodo de quince meses.

Resultados

Se realizó un estudio longitudinal prospectivo en una cohorte formada por 18 personas adultas mayores institucionalizadas y con sarcopenia. La mediana de edad fue de 86,5 años, y el 66,7% eran mujeres.

Cambios funcionales y físicos entre la valoración previa al confinamiento, el seguimiento a los doce meses y a los quince meses:

En las mediciones del seguimiento, el cribado de sarcopenia con el SARC-F no cambió significativamente, $X^2_F(2)=0,283$, $p=0,86$. La fuerza muscular del bíceps braquial disminuyó significativamente ($X^2_F(2)=16,55$, $p<0,001$) y la mediana de la fuerza de prensión mostró una tendencia a la disminución al igual que ocurrió con las medianas del *chair stand test*, y de la fuerza del cuádriceps femoral. Además, se produjo un aumento en el número de personas incapaces de realizar la prueba de levantarse y sentarse de la silla cinco veces, de tres personas en T1, a cinco en T2 y T3.

Tampoco en la masa muscular se observaron cambios significativos en el seguimiento, ni hubo cambios destacables en los valores de las medianas.

En relación con el rendimiento físico, aunque no hubo cambios significativos para la velocidad de la marcha, un análisis realizado sobre el tiempo empleado en realizar el TUG y la subprueba de marcha de la *Short Physical Performance Battery* mostró que el tiempo empleado aumentó. Esto fue más evidente en el caso de la subprueba de marcha, mientras que en el TUG el deterioro físico fue más evidente entre T1-T2 que entre T1-T3.

Además, el SPPB mostró diferencias significativas, con un aumento de las medianas entre T1-T2, debido al aumento de los tiempos de la subprueba de equilibrio. Sin embargo, hubo una disminución entre T2-T3 que también se observa en la prueba de equilibrio para la posición de tándem. En T3 el equilibrio en la posición de tándem se vio comprometido. Además, en T3 aumentó el número de personas incapaces de realizar las posiciones de semi-tándem y de tándem.

Un análisis adicional comparó el número de caídas de los participantes durante el año previo al confinamiento (marzo 2019-marzo 2020, recuperado de la base de datos de la institución) con las caídas durante el año del confinamiento (marzo 2020-marzo 2021), mostrando una disminución en la mediana del número de caídas 0,5 (0-16) vs 0 (0-8) (p=0,033), respectivamente.

Cambios emocionales y cognitivos entre la valoración previa al confinamiento, el seguimiento a los doce meses y a los quince meses:

Los participantes presentaban un deterioro cognitivo significativo ($X^2_F(2)$=8,581, p<0,014). Además, se observó un aumento significativo de la puntuación de la versión corta de la GDS-SF ($X^2_F(2)$=6,867, p<0,032), con diferencias entre T1-T2, además de una tendencia decreciente de las medianas del cuestionario SF-8 de calidad de vida.

SECCIÓN TERCERA: CONCLUSIONES

CONCLUSIONES GENERALES

La aplicación del algoritmo del EWGSOP2 ha permitido detectar y diagnosticar casos de sarcopenia en población adulta mayor que vive en comunidad o institucionalizada. Sin embargo, las distintas opciones de las que se compone el algoritmo plantean un dilema en cuanto a cuál es la opción más adecuada para detectar casos.

La aplicación del algoritmo requiere tiempo y algunas de las pruebas utilizadas, como son la bioimpedancia eléctrica y la dinamometría, emplean equipos de medición con un alto coste. Por ello, el uso de otros instrumentos y pruebas relacionadas con la sarcopenia, que permitan realizar una valoración más integral de las personas adultas mayores, podrían proporcionar más información y permitir a los clínicos su detección de forma más rápida y sencilla. De esta forma, el uso del algoritmo del EWGSOP2 junto con otros instrumentos y pruebas relacionadas con sarcopenia facilitarían las estrategias de prevención y tratamiento de la sarcopenia de personas adultas mayores.

CONCLUSIONES ESPECÍFICAS

Estudio 1

1. Existe una relación entre la sarcopenia detectada a través de la aplicación del algoritmo del EWSOP2 y variables clínico-funcionales como el índice de Barthel, la comorbilidad y el número de caídas.
2. Junto con la edad, el Índice de Barthel y el índice de comorbilidad de Charlson abreviado pueden ser considerados predictores de sarcopenia en personas adultas mayores institucionalizadas en la provincia de Valencia.
3. El uso de estos predictores puede contribuir a orientar a los/las profesionales sanitarios/as en la identificación precoz de la sarcopenia en este contexto, y de esa forma, prevenir una mayor severidad de esta al implementar medidas terapéuticas que la reviertan e impidan la aparición de sus efectos adversos.

Estudio 2

1. Al aplicar las diferentes opciones de medición para cada paso del algoritmo del EWGSOP2, existen diferencias en el número de casos detectados de sarcopenia y su nivel de gravedad en población adulta mayor.
2. En la evaluación de la fuerza muscular, la prueba de levantarse y sentarse cinco veces de la silla parece detectar más casos de sarcopenia probable. En lo relativo a la masa muscular, la ASM detecta más casos confirmados y graves. Y en cuanto

al rendimiento físico, el SPPB y la velocidad de la marcha parecen ser opciones fiables.

3. Por otra parte, la no utilización del SARC-F en el cribado permite identificar más casos de sarcopenia. Ante un/a paciente que muestre síntomas o signos de sarcopenia, se recomienda no utilizar el SARC-F y realizar una evaluación con pruebas funcionales.
4. Se debe tener en cuenta que los métodos utilizados para definir estos pasos pueden hacer que las intervenciones preventivas y terapéuticas sobre la sarcopenia varíen ampliamente.

Estudio 3

1. El confinamiento de personas adultas mayores institucionalizadas con sarcopenia detectada a través del algoritmo del EWGSOP2 se asocia con una pérdida de la capacidad funcional y deterioro emocional, esto es algo que los/as profesionales de la salud deben tener en cuenta a la hora de establecer medidas de aislamiento ya sea debido al COVID-19 como a otras enfermedades infecciosas.
2. En particular, la fuerza del bíceps braquial y el rendimiento físico medido con el SPPB son las medidas que muestran el mayor deterioro de la condición física, aunque nuestros resultados deben considerarse con cautela debido al pequeño tamaño muestral de este estudio.

FUTURAS LÍNEAS DE INVESTIGACIÓN

En el contexto de atención a personas adultas mayores, la detección y el diagnóstico de sarcopenia resulta de gran utilidad para realizar un abordaje precoz de esta enfermedad, en sus estadios más iniciales, y de esa forma minimizar los resultados adversos que se asocian a ella (caídas, morbi-mortalidad, fracturas, etc.).

Para asegurarnos que se identifica a todas las personas adultas mayores con sarcopenia, sería necesario detectar y validar los puntos de corte para cada una de las opciones de medición que componen los distintos pasos del algoritmo del EWGSOP2. En concreto, en población adulta mayor española ya que los que se disponen actualmente no han sido validados en esta.

Por otra parte, pensamos que sería interesante explorar la inclusión dentro del algoritmo del EWGSOP2 de otras opciones para valorar la fuerza como la del bíceps braquial y la del cuádriceps. Del mismo modo, nos hemos planteado estudiar el uso del ángulo de fase (variable relativa a la masa muscular) como posible detector de sarcopenia en población adulta mayor dada su relación con el envejecimiento celular y la integridad de la membrana celular.

Otra posible línea de investigación sería analizar los puntos de corte según el sexo en las variables de rendimiento físico incluidas en el algoritmo del EWGSOP2, ya que estos puntos de corte no han sido estudiados con perspectiva de género.

Actualmente, estamos desarrollado una línea de trabajo que sigue las indicaciones de la Organización Mundial de la Salud. Se trata del análisis del gradiente social de la sarcopenia para detectar aquellos determinantes sociales relacionados con la sarcopenia que ayuden a comprender las variaciones de su prevalencia y mejorar la adopción de medidas de salud.

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ANEXOS

Anexo 1. Copia original del estudio 1

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Environmental Research and Public Health

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Article

Functional and Clinical Characteristics for Predicting Sarcopenia in Institutionalised Older Adults: Identifying Tools for Clinical Screening

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Received: 29 May 2020; Accepted: 19 June 2020; Published: 22 June 2020

Abstract: Background: Recently, the European Working Group on Sarcopenia in Older People (EWGSOP2) has updated the sarcopenia definition based on objective evaluation of muscle strength, mass and physical performance. The aim of this study was to analyse the relationship between sarcopenia and clinical aspects such as functionality, comorbidity, polypharmacy, hospitalisations and falls in order to support sarcopenia screening in institutionalised older adults, as well as to estimate the prevalence of sarcopenia in this population using the EWGSOP2 new algorithm. Methods: A multicentre cross-sectional study was conducted on institutionalised older adults (n = 132, 77.7% female, mean age 82 years). Application of the EWGSOP2 algorithm consisted of the SARC-F questionnaire, handgrip strength (HG), appendicular skeletal muscle mass index (ASMI) and Short Physical Performance Battery (SPPB). Clinical study variables were: Barthel Index (BI), Abbreviated Charlson's Comorbidity Index (ACCI), number of medications, hospital stays and falls. Results: Age, BI and ACCI were shown to be predictors of the EWGSOP2 sarcopenia definition (Nagelkerke's R-square = 0.34), highlighting the ACCI. Sarcopenia was more prevalent in older adults aged over 85 (p = 0.005), but no differences were found according to gender (p = 0.512). Conclusion: BI and the ACCI can be considered predictors that guide healthcare professionals in early sarcopenia identification and therapeutic approach.

Keywords: sarcopenia; older adults; institutionalised; functionality; clinical

1. Introduction

Population aging is a worldwide phenomenon which has been expressive and accelerated over the years [1]. Therefore, geriatric syndromes, such as sarcopenia with a higher prevalence among institutionalised older adults (14–33%) than those living in community (1–29%) [2,3], has a considerable clinical and research interest [4].

The most widely used definition of sarcopenia is the one of the European Working Group on Sarcopenia in Older People (EWGSOP) [5,6], which was updated in 2018 (EWGSOP2) and focuses on low muscle strength as a key characteristic of sarcopenia, uses detection of low muscle quantity and quality to confirm the diagnosis and identifies poor physical performance as indicative of severity [7]. Sarcopenia has also been associated with increased risk of falls, impaired ability to perform activities of daily living and, consequently, it can cause functional dependency and disability in older adults [5,8]. However, most of this previous research has mainly focused on older adults living in the community rather than on institutionalised people [3]. Taking into account that strong evidence predictors of institutionalisation in older adults are functional impairment, cognitive impairment, higher age, low self-related health status and a high number of prescriptions [9], it could be suggested that older adults with sarcopenia living in institutions could even have a higher prevalence of some of these adverse outcomes related to sarcopenia, such as functional capacity impairment, dependence, falls, physical disability, negative impact on quality of life, hospitalisation and even death [10–13].

Assessment of sarcopenia needs measurement instruments for objective evaluation of muscle strength, mass and function, which also requires substantial time. Hence, screening of sarcopenia with user friendly, simple tools is required [14]. Clinical aspects and measurements such as functionality, comorbidities, number of drugs, number of hospitalisations and number of falls are widely used tools in residential facilities for assessing health and do not require specific and expensive medical equipment. However, the few studies that have focused on institutionalised people have shown isolated results of one or other characteristic, and not on a comprehensive perspective which is what defines a person's health. Thus, functional capacity has been assessed mainly through the Barthel Index [15–17] and it has shown that participants diagnosed with sarcopenia tend to have worse functional status [15]. Others studies have identified the comorbidities of institutionalised people, quantifying the number of diseases [15–18] or using the Charlson's Comorbidity Index [19]. Generally, those that relate it to sarcopenia show no differences in prevalence of diseases between the sarcopenic or non-sarcopenic groups [15,19]. Some studies have used variables such as number of drugs or number of hospitalisations in order to describe the participants [15,18] but no relationship has been established with sarcopenia. A number of falls have been quantified in institutionalised older adults with sarcopenia with no significant relationship [15]. For the moment, the variables that have been mainly associated with sarcopenia in institutionalised older people are the anthropometric ones (age, gender and body mass index) [15].

Therefore, some bivariate relationships have been studied between variables widely used in the clinical context and with sarcopenic institutionalised older people, but research in this area is still sparse. Moreover, the different combinations of functional and clinical variables in relation to sarcopenia in a multivariate framework remain to be elucidated. Thus, to the best of our knowledge, there is no study evaluating sarcopenia according to EWGSOP2 criteria and relating it with functionality, comorbidities, number of drugs, number of hospitalisations and number of falls in institutionalised older people in order to help clinicians in the screening and detection of sarcopenia in this population.

It was hypothesised that institutionalised older people suffering from sarcopenia as defined by the EWGSOP2 criteria and cut-off points would have a lower functional capacity, higher number of hospitalisations, higher number of drugs used, higher number of falls and higher index of comorbidities when analysed individually. Moreover, the combination of these factors may correlate higher to sarcopenia and help in the screening process.

The main aim of this study was to analyse the relationship between sarcopenia and functional ability, hospitalisation, number of falls, polypharmacy and comorbidity in order to support and facilitate sarcopenia screening in institutionalised older adults. A secondary aim was to identify which of our clinical and functional variables are the most relevant as supporting tools for screening sarcopenia and to estimate the prevalence of sarcopenia in institutionalised older adults using the new algorithm of the EWGSOP2.

2. Materials and Methods

2.1. Study Design

A multicentre cross-sectional study was carried out between January and November 2019 in institutionalised older adults living in the province of Valencia (Spain).

This study was approved by the Ethics Committee for Human Research of University of Valencia (H1542733812827) and was conducted in accordance with the Declaration of Helsinki. This research was registered in the ClinicalTrials.gov (ID: NCT03832608). All participants were briefed beforehand and all signed a written consent form before participating in the study.

2.2. Participants

The sample included adults institutionalised in residential facilities, aged 65 or older. The exclusion criteria were: (1) patients with edema that could alter the bioimpedance analysis (BIA) results; (2) Mini-Mental State Examination (MMSE) < 18 points [20]; (3) acute disease, hospital admission or unstable chronic disease in the last month.

2.3. Sarcopenia Definition

The EWGSOP2 has proposed an algorithm for case-finding, diagnosis and severity determination [7] which includes the SARC-F questionnaire, the measurement of muscle strength, muscle quantity or quality, and the identification of physical performance.

Following this algorithm, in this study the measured parameters to identify sarcopenia cases and its level of severity were:

The *SARC-F* is a 5-item questionnaire (strength, assistance walking, rise from a chair, climb stairs, and falls) based on cardinal features or consequences of sarcopenia, that allows to identify cases when the score is ≥ 4 points out of 12 for the total score [21].

Muscle strength (kg), was measured by the handgrip strength technique using a Jamar Plus+ digital hand dynamometer (Patterson Medical, Sammons Preston, Bolingbrook, IL, USA) [22]. Grip strength cut-off points for low strength were <27 kg and <16 kg for men and women, respectively [23].

Muscle quantity or Appendicular Skeletal Muscle Mass (ASM) was measured with BIA using the Bodystat® 1500MDD (Bodystat Ltd., Douglas, UK). The device was calibrated daily using the standard control circuit supplied by the manufacturer. Before doing the test, participants were asked to follow these instructions [15]: (1) no previous physical exercise; (2) 2–3 h of fasting; (3) no alcohol or large amount of water intake; (4) urinating 30 min before; (5) every metal piece (such as a watch, jewellery) was taken off. Moreover, the test was not conducted in participants wearing a pacemaker and/or with edema [24]. The edema was assessed and diagnosed by the physician and recorded in clinical history. BIA test was done with the patient in supine position, on a non-conductive surface, ensuring that no parts of the body were touching. The patient stayed in this position for 5 min prior to measurement to ensure that fluid levels had stabilised in the body. Before placing the electrodes, the skin was cleaned with 70% alcohol. Using an ipsilateral tetrapolar method, the electrodes were placed behind the knuckle of the middle finger and on the wrist next to the ulna head (upper limb) and at the dorsal side of the second metatarsal head bone and on the ankle at the level of, and between, the medial and lateral malleoli (lower limb). The BIA was performed using an alternating sinusoidal electric current of 200 μA at a single operating frequency of 50 kHz. For estimating the ASM, the Sergi's BIA equation was used: ASM (kg) = −3.964 + (0.227 × RI) + (0.095 × weight) + (1.384 × sex) + (0.064 × Xc) [25], where resistive index (RI) was resistance (ohms) normalised for height (cm), weight (kg), sex was 1 in men and 0 in women, and reactance (Xc, ohms). ASM cut-off points for low mass were <20 kg and <15 kg for men and women, respectively. The ASM Index (ASMI) was defined as ASM/height squared. ASMI cut-off points for corrected low mass were <7.0 kg/m^2 and <5.5 kg/m^2 for men and women, respectively [7].

Physical performance was assessed through gait speed (m/s) using a 4-m walking test [26], where <0.8 m/s was the cut-off point [5,27]. Participants had to walk at their usual walking speed and using their usual walking aid. Moreover, the physical performance was measured by the Short Physical Performance Battery (SPPB) [28], where ≤8 points was used as a cut-off point both in men and women.

Finally, sarcopenia was classified in different severity levels according the EWGSOP2 [7]: (1) probable sarcopenia when SARC-F scored ≥4 points and there was low muscle strength (grip strength <27 kg and <16 kg in men and women, respectively); (2) confirmed sarcopenia when also low quantity muscle was detected (ASMI <7.0 kg/m^2 and <6 kg/m^2 in men and women, respectively); and (3) severe sarcopenia, when confirmed sarcopenia was summed up to low physical performance (SPPB ≤ 8 point score).

2.4. Measurements

Added to the algorithm parameters established by the EWGSOP2, each participant underwent all of the following assessments on the same day. Different health professionals took these measurements. In order to avoid to inter-individual errors, intraclass correlation coefficients (ICCs) were calculated to know the interrater reliabilities. According to Koo and Li (2016) [29], values of ICCs between 0.75 and 0.9 indicate good reliability and values greater than 0.90 indicate excellent reliability. All ICCS in this study ranged from 0.802 to 0.985 which may be considered a very good reliability.

The studied variables were:

Anthropometric variables: (1) Age and gender; (2) body weight (kg), assessed using a Tanita BC 601 model weighing device (TANITA Ltd., Tokyo, Japan); (3) barefoot standing height (cm), measured with a stadiometer SECA 213 (Seca Ltd., Hamburg, Germany); body mass index (BMI), calculated based on the parameters of weight (kg) divided by height squared (m^2).

Functional ability evaluation used the Barthel Index score [30]. This index was validated in older populations [31]. Values <20 points indicate total dependency for activities of daily living and scores between 21 and 60 indicate severe dependence [32].

Comorbidity severity was recorded using the Abbreviated Charlson's Comorbidity Index [33]. It encompasses eight medical conditions (cerebral vascular disease, diabetes, chronic obstructive pulmonary disease, heart failure/ischemic heart disease, dementia, peripheral arterial disease, chronic kidney failure (dialysis) and cancer) with total scores ranging from 0–10, where 0 is no comorbidity and 10 is high comorbidity. On the other hand, this variable allows us to classify participants in relation to their comorbidity level (as the modified Abbreviated Charlson's Comorbidity Index): absence of comorbidity is considered between 0 and 1 points, low comorbidity when the index is 2, and high comorbidity when it is ≥3 points.

Number of medications taken daily on a regular basis.

Number of hospital stays in the last year (recorded as the number of hospitalisations, either due to falls or any other clinical situation that required it).

Falls were analysed as number of falls in the last year (including both falls that did not require hospitalisation and those that required hospitalisation/surgery), and also registered according to the SARC-F questionnaire falls item (named as "modified falls"): no falls, 1–2 falls and ≥3 falls [21].

2.5. Sample Size Calculation

Given that the population size was larger than 100,000 and required accounting for the most variable situation (p = q = 0.5) with a confidence level of 95%, 375 subjects were needed. Of those, a stratification among institutionalised and community-dwelling adults were considered. For the purposes of this research, only institutionalised participants were considered.

2.6. Statistical Analyses

For descriptive purposes, the mean and standard deviation for quantitative variables were calculated, whereas percentages were estimated for categorical variables. At the bivariate level of the

relationship, several inferential tests were performed. Specifically, when means from a quantitative variable wanted to be compared across the levels of a factor, ANOVAs or t-tests were employed. Assumptions for the correct use of these parametric techniques were previously tested and opportune corrections were applied if necessary. Partial eta-squares were obtained as measures of effect size. When two categorical variables were related, independence chi-square tests were used with Cramer's V and Kendall's tau as measures of the effect size. Finally, a binary logistic regression was used to predict the likelihood of having sarcopenia at the multivariate level. Beta coefficients as well as the odds-ratio associated with each predictor were calculated. Additionally, two estimates of the overall predictive power of the logistic regression were calculated: Cox and Snell and Nagelkerke's R-square. Given the available sample size a stepwise procedure was used to select the predictors in the logistic regression. All statistical tests employed were considered statistically significant at $p < 0.05$ and in all cases, appropriate measures of effect size were estimated. All statistical analyses were performed in SPSS 24.

3. Results

3.1. Sample Characteristics

A total of 132 participants were included in this study. The age range for all the participants was 65–97 years, and according to gender the range was 65–96 years old and 65–97 years old for men and women, respectively. The mean age was 82 ± 8.3 years old and 102 participants (77.7 %) were women (Table 1).

Table 1. Characteristics of the participants according to gender: mean ± standard deviation and (95% confidence interval) or number of cases (percentages).

Variables	Total (n = 132)	Men (n = 30)	Women (n = 102)	*p*-Value [a]
Anthropometrics				
Age (years)	82.03 ± 8.25 (80.61–83.45)	78.70 ± 8.73 (75.44–81.96)	83.00 ± 7.88 (81.46–84.56)	0.11
Weight (kg)	66.66 ± 13.45 (64.34–68.97)	75.98 ± 12.60 (71.28–80.69)	63.92 ± 12.47 (61.47–66.37)	<0.001 †
Height (cm)	154.02 ± 9.08 (152.46–155.58)	165.05 ± 8.00 (162.07–168.04)	150.77 ± 6.46 (149.50–152.04)	<0.001 †
BMI (kg/m^2)	28.06 ± 4.89 (27.22–28.90)	27.92 ± 3.83 (26.49–29.35)	28.10 ± 5.17 (27.09–29.11)	0.831
EWSGOP2 algorithm				
SARC-F (0–10 score)	3.95 ± 2.59 (3.50–4.39)	3.63 ± 2.77 (2.60–4.67)	4.04 ± 2.54 (3.54–4.54)	0.453
Grip strength (kg)	18.77 ± 7.82 (17.42–20.11)	26.85 ± 9.89 (23.16–30.55)	16.39 ± 5.10 (15.39–17.39)	<0.001 †
ASM (kg)	15.10 ± 3.48 (14.50–15.71)	19.63 ± 3.14 (18.41–20.85)	13.84 ± 2.33 (13.38–14.30)	<0.001 †
ASMI (kg/m^2)	6.32 ± 0.98 (6.15–6.49)	7.20 ± 0.83 (6.87–7.52)	6.07 ± 0.87 (5.90–6.24)	<0.001 †
Gait speed (m/s)	0.56 ± 0.27 (0.51–0.61)	0.57 ± 0.29 (0.46–0.68)	0.56 ± 0.27 (0.50–0.61)	0.797
SPPB (0–12 score)	5.27 ± 2.99 (4.75–5.78)	6.17 ± 2.84 (5.11–7.23)	5.00 ± 2.99 (4.41–5.59)	0.06
Study's variables				
Barthel Index (0–100 score)	77.95 ± 19.07 (74.67–81.24)	79.00 ± 22.87 (70.46–87.54)	77.65 ± 17.92 (74.13–81.17)	0.767

Table 1. *Cont.*

Variables	Total (n = 132)	Men (n = 30)	Women (n = 102)	*p*-Value [a]
Barthel Index classification				
Independent (100)	23 (17.4%)	9 (30%)	14 (13.8%)	0.064
Mild dependence (91–99)	11 (8.3%)	3 (10%)	8 (7.8%)	
Moderate dependence (61–90)	76 (57.6%)	11 (36.7%)	65 (63.7%)	
Severe dependence (21–60)	20 (15.2%)	7 (23.3%)	13 (12.7%)	
Total dependency (0–20)	2 (1.5%)	0 (0%)	2 (2.0%)	
Abbreviated Charlson's Comorbidity Index (0–10)	1.70 ± 1.33 (1.47–1.93)	2.27 ± 1.34 (1.77–2.77)	1.53 ± 1.29 (1.28–1.78)	<0.01 *
Modified abbreviated Charlson's Comorbidity Index [b]				
No comorbidity	66 (50%)	10 (33.3%)	56 (55.5%)	0.027 *
Low comorbidity	35 (26.5%)	8 (26.7%)	27 (26.7%)	
High comorbidity	30 (22.7%)	12 (40.0%)	18 (17.8%)	
Medication (n)	8.67 ± 4.37 (7.92–9.43)	9.00 ± 4.59 (7.29–10.71)	8.58 ± 4.32 (7.73–9.43)	0.644
Hospitalisation stays (n)	0.24 ± 0.59 (0.14–0.34)	0.23 ± 0.50 (0.05–0.42)	0.25 ± 0.62 (0.12–0.37)	0.924
Falls (n)	1.13 ± 2.08 (0.77–1.49)	0.93 ± 1.48 (0.38–1.49)	1.19 ± 2.22 (0.75–1.62)	0.56
Modified falls (%) [c]				
No falls	65 (49.2%)	15 (50%)	50 (49%)	0.773
1–2 falls	59 (44.7%)	14 (46.7%)	45 (44%)	
≥3 falls	8 (6.1%)	1 (3.3%)	7 (7%)	

Abbreviatures: BMI = Body Mass Index; SPPB = Short Physical Performance Battery; ASM = Appendicular Skeletal Muscle Mass; ASMI = ASM Index. [a] *p*-value unpaired Student's t-test for quantitative variables and Chi-squared tests for qualitative variables; [b] Modified Charlson's Comorbidity Index as a codification of total score in three comorbidity levels (Berkman et al., 1992) [33]; [c] Modified falls according to its registration through the SARC-F questionnaire by Malmstrom and colleagues (2016) [21]. * $p < 0.05$; † $p < 0.01$.

Regarding the different cut-off points established by the EWGSOP2 algorithm, this study's sample showed that men had a SARC-F mean under four points, whereas women's mean was slightly over four. Grip strength values were just under cut-off points for men, and just over for women. Regarding ASM means in kg, both men and women scored below cut-off points, however, the ASM Index (kg/height^2) means were just over cut-off points for both genders. In addition, muscle strength and quantity variables showed significant differences between gender ($p < 0.001$). Physical performance variables scored under cut-off points both for men and women, thus gait speed was below 0.8 m/s and SPPB was below eight points. In fact, both variables had means well below the cut-off points (0.56 ± 0.27 m/s for gait speed and 5.27 ± 2.99 score for SPPB). Moreover, the results of the SPPB indicate that 61% of the sarcopenic participants presented with severe sarcopenia.

In relation to the study variables, significant differences were found between genders for the two comorbidity-related variables measured. Women had significant lower mean than men in the Abbreviated Charlson's Comorbidity Index ($p < 0.01$), and also the results of the modified Abbreviated Charlson's Comorbidity Index for women indicated a better health status than men ($p = 0.027$). Moreover, these findings highlighted that women have less comorbidity than men ("No comorbidity" 55.5% vs. 33.3%, respectively) in this sample.

When all the steps of the EWSGOP2 algorithm were applied (Figure 1), the 132 institutionalised older adults were classified as follows: with no sarcopenia (n = 86, 65%), with probable sarcopenia which was not confirmed (n = 18, 14%), with confirmed sarcopenia (n = 0, 0%), and with confirmed-severe sarcopenia (n = 28, 21%).

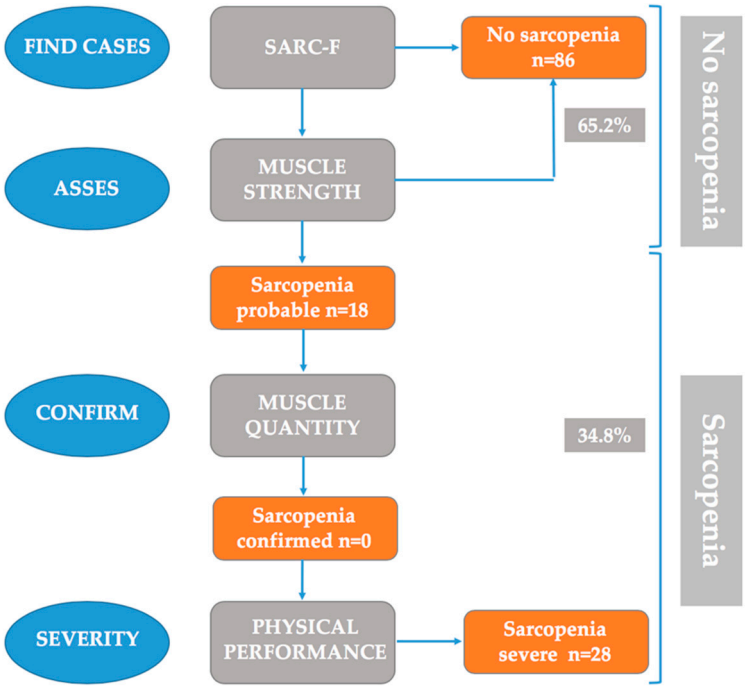

Figure 1. Sarcopenia: EWSGOP2 algorithm for case-finding, diagnosis and quantification of severity in practice.

3.2. Differences Based on EWSGOP2 Algorithm's Application Regarding Study's Variables

Regarding the severity levels of sarcopenia according to the EWGSOP2, results showed significant differences between the Barthel Index and the Abbreviated Charlson's Comorbidity Index. The statistical descriptions are provided in Table 2. Post-hoc comparisons in the Barthel Index found statistically significant differences between the "no sarcopenia" and "probable sarcopenia" participants ($p = 0.003$) and between the "no sarcopenia" and "severe sarcopenia" participants ($p < 0.001$). Moreover, post-hoc comparisons in the Abbreviated Charlson's Comorbidity Index found statistically significant differences between the "no sarcopenia" and "severe sarcopenia" participants ($p = 0.004$).

Table 2. Means, standard deviation and ANOVA results of the independent variables.

Variables	EWSOP2 Algorithm	Mean ± SD	*F*	*df*	*df (error)*	*p*-Value	η^2
Barthel Index (0–100 score)	NS	83.26 ± 16.90	10.992	2	129	<0.001 †	0.146
	PS	67.78 ± 18.96					
	SS	68.21 ± 19.54					
Abbreviated Charlson's Comorbidity Index (0–10)	NS	1.42 ± 1.30	6.054	2	129	0.003 †	0.086
	PS	2.06 ± 1.26					
	SS	2.32 ± 1.25					
Medication (n)	NS	8.43 ± 4.57	0.561	2	129	0.572	0.009
	PS	9.61 ± 4.07					
	SS	8.82 ± 3.94					
Hospitalisation stays (n)	NS	0.17 ± 0.47	1.876	2	129	0.157	0.028
	PS	0.44 ± 1.04					
	SS	0.32 ± 0.55					
Falls (n)	NS	1.07 ± 2.39	0.44	2	129	0.65	0.007
	PS	1.56 ± 1.72					
	SS	1.04 ± 1.0					

Abbreviatures: SD = standard deviation; *F* = result of the F test; *df* = degrees of freedom; η^2 Partial = partial eta-squared effect size; *p* = significance, † $p < 0.01$; NS = no sarcopenia; PS = probable sarcopenia; SS = severe sarcopenia.

Results of the relationship between the functional and clinical variables with the sarcopenia severity levels are shown in Table 3. Although the effect size is low for all variables, results point out that non-sarcopenia participants were found among the independent and slightly moderate-dependent older adults, while participants with some degree of sarcopenia mainly had moderate or severe dependence. On the other hand, the non-sarcopenic older adults had less comorbidity and number of falls.

Table 3. Number of cases (n) and Chi-squared results of the independent variables.

Variables	EWSOP2 Algorithm			χ^2	*df*	*p*-Value	Cramer's V	Kendall's τ
	NS	PS	SS					
Barthel Index classification								
Independent (100)	22	1	0	23.941	8	0.003 †	0.301	−0.353
Mild dependence (91–99)	9	0	2					
Moderate dependence (61–90)	48	11	17					
Severe dependence (21–60)	6	6	8					
Total dependency (0–20)	1	0	1					
Mod-Abb-Charlson-Index [a]								
No comorbidity	52	6	8	12.86	4	0.014 *	0.222	0.285
Low comorbidity	20	6	9					
High comorbidity	13	6	11					
Modified falls [b]								
No falls	52	5	8	14.87	4	0.005 †	0.237	0.244
1–2 falls	28	12	19					
≥3 falls	6	1	1					

Abbreviatures: NS = no sarcopenia; PS = probable sarcopenia; SS = severe sarcopenia; χ^2 = result of Chi-square test; *df* = degrees of freedom; *p* = significance, * $p < 0.05$; † $p < 0.01$; V = Cramer's V; T = Kendall's Tau; [a] Mod-Abb-Charlson-Index = Modified Charlson's Comorbidity Index as a codification of total score in three comorbidity levels (Berkman et al., 1992) [33]; [b] Modified falls according to its registration through the SARC-F questionnaire by Malmstrom and colleagues (2016) [21].

3.3. Derivation of the Regression Equation

A logistic binary regression was estimated to predict sarcopenia vs. non-sarcopenia. The two groups labeled with sarcopenia (probable or severe) were merged into a single sarcopenia group due to the sample size needed for stable estimates. The predictors considered were age, BMI and gender as control variables, together with Barthel's Index, Abbreviated Charlson's Comorbility Index, medications, hospitalisation stays and falls. Having taken into account previously presented bivariate results, the falls measure included in the regression was the indicator with three categories since it showed a better predictive power than the quantitative index. Due to sample size reasons an automated forward selection of predictors was used. Results of this logistic regression are shown in Table 4.

Table 4. Binary Logistic Regression to predict sarcopenia vs. non-sarcopenia.

Variables	B	SE	*p*	Odd-Ratio	95% CI
Age	0.101	0.03	0.001	1.16	1.04–1.17
Barthel's Index	−0.04	0.01	0.001	0.96	0.95–0.98
Abbreviated Charlson's Comorbility Index	0.418	0.17	0.015	1.51	1.08–2.12

Abbreviatures: B = β coefficient; SE = standard deviation; *p* = significance; CI = Confidence interval.

Three predictors had statistically significant effects on the dependent variable. The coefficients and associated odds-ratio for age showed that as age increases participants are more likely to have sarcopenia. The negative coefficient associated with the Barthel's Index shows that, as was more likely, dependent people also have sarcopenia. Finally, the Abbreviated Charlson's Comorbidity Index coefficient and odds-ratio showed that people with sarcopenia tend to present more comorbidities.

This last index is the best predictor of the likelihood of presenting sarcopenia. Overall, the estimated effect size for the regression was 0.25 (Cox and Snell's R-square) and 0.34 (Nagelkerke's R-square).

3.4. Prevalence of Sarcopenia by Gender and Age

The overall prevalence of sarcopenia according to gender, including probable sarcopenia and severe sarcopenia cases, is presented in Figure 2. The difference between genders did not reach the significance threshold ($\chi^2(2) = 1.33$, $p = 0.512$, Cramer's V = 0.101, Kendall's tau = −0.039).

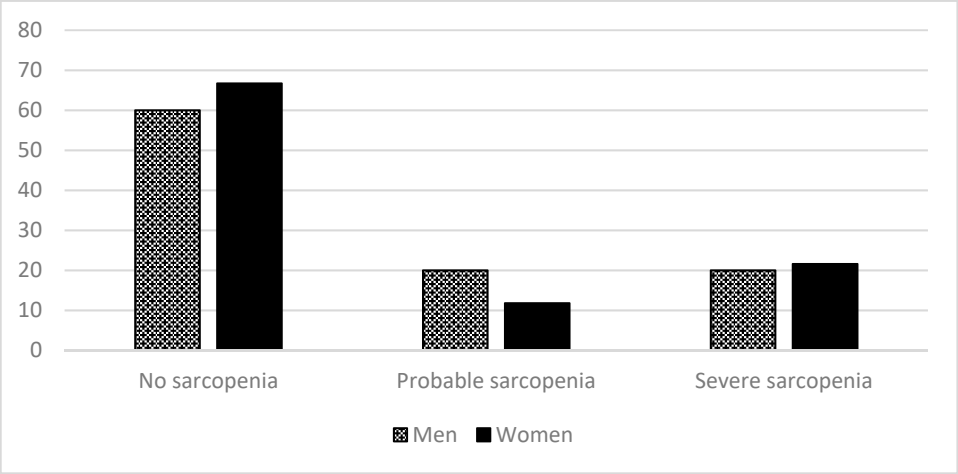

Figure 2. Percentages of no sarcopenia and severity sarcopenia levels (EWSGOP2, 2019) according to gender: no sarcopenia, probable sarcopenia, and severe sarcopenia.

Table 5 shows the prevalence of sarcopenia according to age range. The participants aged over 85 years had a higher prevalence of sarcopenia, both for probable and severe sarcopenia ($\chi^2(4) = 15.06$, $p = 0.005$, Cramer's V = 0.239, Kendall's tau = 0.276).

Table 5. Age-stratified sarcopenia prevalence: percentages and (n).

Sarcopenia Subtypes	65–74 Years	75–84 Years	≥85 Years	Total
No-sarcopenia (n = 86)	24.4% (21)	44.2% (38)	31.4% (27)	65.2%
Probable sarcopenia (n = 18)	16.7% (3)	16.7% (3)	66.7% (12)	13.6%
Confirmed sarcopenia (n = 0)	0%	0%	0%	0%
Severe sarcopenia (n = 28)	3.6% (1)	35.7% (10)	60.7% (17)	21.2%
n = 132	18.9% (25)	38.6% (51)	42.4% (56)	100%

4. Discussion

The present study showed that the Barthel Index, the Abbreviated Comorbidity Index and falls as registered in the SARC-F were significantly related with sarcopenia in institutionalised older adults using the EWGSOP2 algorithm. In addition, the Barthel Index, the Abbreviated Comorbidity Index and age of participants was shown to be able to predict sarcopenia in this population. Moreover, with the new algorithm, sarcopenia has been shown to be more prevalent in aged people.

To the best of our knowledge, the EWGSOP2 algorithm in institutionalised older adults has not been broadly used since the most recent definition [34]. This algorithm detects probable sarcopenia when low muscle strength is detected, and in clinical practice this is enough to start intervention [7], therefore it is highly important to identify institutionalised older adults in this category. This initial screening is done by finding the cases through the SARC-F, and only those identified by this tool have muscle strength assessed. In this regard, since all the parameters of the algorithm were analysed for all the participants, the descriptive data showed contradictory differences in the first two steps of the

algorithm in relation to gender. The mean of SARC-F for men showed non-sarcopenic values, while women's mean showed sarcopenic ones; however, the grip strength results were opposite. If using only the SARC-F for screening, this could be at the expense of missing men who would have been at least in the category of probable sarcopenia since they show low muscle grip strength, but are classified as not sarcopenic according to the SARC-F. Although the SARC-F has shown excellent specificity and has been widely used in the field of sarcopenia research in community-dwelling population [21,35–38], it has shown to have a major problem in relation to its low sensitivity. Previous research applying the EWGSOP definition has reported sensitivity to be 4.2% and 9.9% [35], or 14.6% and 33.3% [36] in men and women, respectively. The low sensitivity of SARC-F means that there is a high risk of a missed diagnosis of individuals who have sarcopenia, so other tools like the clinical and functional variables shown in this study may complement the SARC-F information and may be used in future research.

Following the EWGSOP2 algorithm, once the cases of probable sarcopenia have been detected the confirmation must be done with muscle quantity analysis. It has been stated that low muscle mass potentially contributes to disability and frailty in older adults [39]. Therefore, the accurate measurement of muscle mass is a crucial step for classifying sarcopenic older adults, especially in residential facilities since residents have higher risks of adverse events. There is an ongoing debate about the preferred adjustment for muscle mass indices and whether the same method can be used for all populations [7]. This is in line with our results, where the mean ASM (kg) was below cut-off points for both men and women, and the mean ASM Index (kg/height^2) was over cut-off points for both genders. The EWGSOP2 consensus presented cut-off points for both ASM Index (kg/height^2) [40] and ASM (kg) [27] for use when calculating muscle mass. Among these parameters, in the present study the ASM Index (kg/height^2) was chosen since it consists of an anthropometric equation which adjusts through body size and has been reported to have associations with clinical outcomes such as physical disability, frailty or cardiovascular diseases [41–43]. However, it has to be taken into account that the most appropriate method defining low lean mass with the highest predictive value for identification remains uncertain [44]. Therefore, there is a need to elucidate in future research which method and operational definition is ideal for identifying sarcopenic people, especially older adults since they are at high risk.

In relation to the last step of the algorithm, 21% of the participants had severe sarcopenia which means that just over 60% of the sarcopenic people were in this category. Participants with severe sarcopenia not only have limited strength but also their performance is affected, which overall results in physical limitations [45] that can lead to adverse negative health outcomes such as care dependence, falls, fractures, hospitalisation and death.

Thus, in this study participants diagnosed with the EWGSOP2 algorithm had significantly lower functionality and higher comorbidity, especially those with severe sarcopenia. This supports previous studies which have also found a relationship between the Barthel Index and sarcopenia in institutionalised older adults [15,16] when applying the EWGSOP definition. Comorbidity has previously also been shown to be associated with sarcopenia, but it has been studied in community-dwelling people and measured by the presence of major chronic illnesses [46]. However, in the present study, severity of disease or comorbidity, which is an important issue in institutionalised older adults, has been carefully controlled by using the Abbreviated Charlson's Comorbidity Index [33].

Furthermore, falls measured through the SARC-F were shown to be significantly related with sarcopenia in our population. However, in previous studies which used the EWGSOP definition with institutionalised older adults with sarcopenia, no significant relationship was found [15]. Overall, this seems to indicate, as has been previously stated, that the EWGSOP2 algorithm appears to be more sensitive than the EWGSOP for predicting the incidence of falls, although this has been shown in community-dwelling people [47]. This is clinically important since falls in older adults are a major cause of injury that may result in fracture, disability, poor quality of life, and death [48].

The trend that can be observed among sarcopenic people of this study is that medication and hospitalisations have more presence with both probable and severe sarcopenic participants. Thus,

it was observed that both men and women present polypharmacy [49,50]. However, there was no significant relation with sarcopenic participants nor with hospitalisations, and although it has been previously stated that the risk of hospitalisation is higher in sarcopenic subjects [51], this has been studied in relation to community-dwelling people. This highlights the need to register these variables by a common and objectifiable tool to avoid differences in the registry protocols of each of the residential facilities.

In the regression analysis, the combination of age, Barthel Index and Abbreviated Charlson's Comorbidity Index showed to be significant for predicting sarcopenia. These functional and clinical variables can help health care professionals in residential facilities to pay special attention to older people who may be heading towards suffering sarcopenia. A baseline sarcopenia assessment systematically carried out in residential facilities for new residents could provide important prognostic information regarding the patient's future functional trajectory [52]. In this line, some authors have stated that the traditional medical model should move from a disease-centered perspective to a functioning-centered view [53]. Identifying loss of functionality and sarcopenia in early stages is important to prevent the progress of sarcopenia and its consequences, as well as to start treatment. Thus, treatment for sarcopenia is very important in residential facilities because the functional decline leads to a loss of independence in older adults and is associated with a higher demand for services in residential centers [54]. Therefore, the prevention of sarcopenia has become one of the major goals of public health professionals and clinicians [53], and easily applied tools for identifying it are of great importance.

As for the prevalence of sarcopenia, the application of the EWGSOP2 algorithm has shown that nearly 35% of the sample had some level of sarcopenia, which is within the wide range observed in previous studies of prevalence implemented in residential facilities up to the moment (17.7–73.3%) [54]. However, most of the studies carried out in this population have followed the EWGSOP algorithm [3,15]. Due to the novelty of the EWGSOP2 consensus, only one previous study has applied it in residential facilities [34] and showed a prevalence of 60%. Considering that their inclusion criteria was people aged 70 or more (higher age than our criteria) and that consequently their participants had a mean age of 85 years which is slightly higher than in the present study, and that sarcopenia is related to age [15], this can partially explain it. Future research with the EWGSOP2 algorithm in institutionalised older people could help ascertain the trends.

The EWGSOP2 definition classified the sarcopenic patients depending on the physical performance. The different categories showed that people with sarcopenia were mostly the older ones, and they were mainly diagnosed with severe sarcopenia. This is in line with other studies [15,55] which highlight the fact that in residential facilities people tend to have more dependency and disabilities [56].

Studies that have used the EWGSOP definition have found differences between gender but with contradictory conclusions. Some studies have shown women having a higher prevalence of sarcopenia than men (81.4% of sarcopenic patients), and in other studies—like the one conducted by Landi et al.—a higher ratio of sarcopenia corresponded to men [24]. When using the EWGSOP2 algorithm, no differences were found.

Taking into account that, currently, most health care professionals lack guidance or training to recognise and manage the decline in physical capacities in older age [45], our study offers promising results in relation to the assessment of sarcopenia with simple and available tools, such as the Barthel Index and Abbreviated Charlson's Comorbidity Index.

Limitations and Strengths

The main limitation of our study, common to other studies in residential facilities, is related to the inclusion criteria, which can exclude people with a greater probability of having sarcopenia and underestimate its prevalence. Another limitation is that the majority of the sample were women, and although this is characteristic related to aged population in Spain, greater equality between the sexes and their ages would be important in future research. This study offers the novelty of applying all of the steps of the updated definition of sarcopenia, plus the definition was applied on an

institutionalised population, which has not been so broadly studied. Moreover, our results offer health professionals a new use to well-known tools that can support the identification of sarcopenia.

5. Conclusions

A functional tool, such as the Barthel Index widely used in residential facilities, and a clinical and objective index, such as the Abbreviated Charlson's Comorbidity Index, can be considered predictors that guide healthcare professionals. This may support early sarcopenia identification and therapeutic approaches. Future research, with greater sample sizes and equality between gender and ages, may elucidate which of the different options of the EWGSOP2 algorithm may be more sensible to detect sarcopenic people, both in institutionalised and community-dwelling older adults.

Author Contributions: Conceptualization, M.A.C.iI., A.A.-G. and N.C.-S.; methodology, M.A.C.iI., A.A.-G., N.C.-S., M.A.T.-C., M.B.-B., S.F. and T.S.-M.; formal analysis, J.M.T., M.A.C.iI., A.A.-G. and N.C.-S.; investigation, M.A.C.iI., A.A.-G., N.C.-S., M.A.T.-C., M.B.-B., S.F. and T.S.-M.; resources, M.A.C.iI., A.A-.G. and N.C.-S.; data curation, M.A.C.iI., A.A.-G., N.C-.S. and M.B.-B.; writing—original draft preparation, M.A.C.iI., A.A.-G. and N.C.-S.; writing—review and editing, M.A.C.iI., A.A.-G., N.C.-S., M.A.T.-C., M.B.-B., S.F., T.S.-M. and J.M.T.; project administration, M.A.C.iI.; funding acquisition, M.A.C.iI. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Generalitat Valenciana (GV/2019/131).

Acknowledgments: We gratefully acknowledge the participation of residents and staff of the residential facilities of La Saleta Care, Parque Luz Xirivella, Parque Luz Catarroja, El Mas Torrent, and especially Mary Martínez Martínez, the Technical Manager of La Saleta Care.

Conflicts of Interest: The authors declare no conflict of interest.

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Anexo 2. Copia original del estudio 2

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Using the Updated EWGSOP2 Definition in Diagnosing Sarcopenia in Spanish Older Adults: Clinical Approach

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Abstract: Recently the European Working Group on Sarcopenia in Older People (EWGSOP2) has updated diagnostic criteria for sarcopenia, which consist of one or more measures of muscle strength, muscle mass, and physical performance, plus an initial screening test called SARC-F. The main objective was to compare the number of cases of sarcopenia, using the different measurements and screening options. A cross-sectional study was conducted on Spanish older adults (n = 272, 72% women). Combining the different measures proposed by the steps described in the EWGSOP2 algorithm, 12 options were obtained (A–L). These options were studied in each of the three models: (1) using SARC-F as initial screening; (2) not using SARC-F; and (3) using SARC-CalF instead of SARC-F. A χ^2 independence test was statistically significant ($\chi^2(6) = 88.41$, $p < 0.001$), and the association between the algorithm used and the classification of sarcopenia was moderate (Cramer's V = 0.226). We conclude that the different EWGSOP2 measurement options imply case-finding differences in the studied population. Moreover, when applying the SARC-F, the number of people classified as sarcopenic decreases. Finally, when SARC-CalF is used as screening, case finding of sarcopenic people decreases. Thus, clinical settings should consider these outcomes, since these steps can make preventive and therapeutic interventions on sarcopenia vary widely.

Keywords: sarcopenia; older adults; diagnostic criteria; clinical

Citation: Arnal-Gómez, A.; Cebrià i Iranzo, M.A.; Tomas, J.M.; Tortosa-Chuliá, M.A.; Balasch-Bernat, M.; Sentandreu-Mañó, T.; Forcano, S.; Cezón-Serrano, N. Using the Updated EWGSOP2 Definition in Diagnosing Sarcopenia in Spanish Older Adults: Clinical Approach. *J. Clin. Med.* **2021**, *10*, 1018. https://doi.org/10.3390/jcm10051018

Academic Editor: Gianluca Testa

Received: 30 December 2020
Accepted: 18 February 2021
Published: 2 March 2021

1. Introduction

The prevalence and impact of sarcopenia increase with age, and consequently, global aging of the population has turned sarcopenia into a public health concern of great priority both for clinicians and researchers [1]. Thus, the concept of sarcopenia has evolved in recent years at the same time that the number of scientific publications has increased in order to identify its possible causes and consequences [2–4].

Although there are different international teams which have published their guidelines or consensus for sarcopenia [5], the European Working Group on Sarcopenia in Older People of 2010 (EWGSOP) guideline has been one of the most widely used and has catalyzed research activity of sarcopenia worldwide [6–8]. In 2018, the Working Group updated the original definition (EWGSOP2), which since then considers low muscle strength as an essential characteristic of sarcopenia, uses detection of low muscle quantity or quality to

confirm its diagnosis, and regards poor physical performance as confirmation of severe sarcopenia [7].

Therefore, in this recent definition (EWGSOP2), muscle strength is brought to the forefront of the diagnostic algorithm [9]. To measure muscle strength, handgrip strength or chair stand are recommended; for measuring muscle mass, two different options are given in order to adjust Appendicular Skeletal Muscle Mass (ASM) either by height squared, weight, or body mass index (BMI); finally, for physical performance, four assessment options are given: gait speed, the Short Physical Performance Battery (SPPB), the Timed-Up and Go test (TUG), and the 400 m walk [7]. Therefore, one or more measures of muscle strength, muscle mass, and/or physical performance together with gender-specific cut-off points for some of these measurements are needed for diagnosing sarcopenia [10,11]. From the clinical perspective, it has to be taken into account that these different options imply that the correct implementation of sarcopenia diagnosis in daily clinical practices requires many factors such as acquisition and financial costs of diagnostic measurement equipment, evaluator training and knowledge, and time constraints of diagnostic measures, among other factors [12]. The assessment in sarcopenia has become a challenge for healthcare professionals in order to identify those who may benefit from intervention [13], leading to a small percentage using diagnostic measures in clinical practice [12]. Therefore, while all different options of the definition are convenient and reliable [12,14], the impact of the different measurements on case finding of sarcopenia is to be elucidated and could help transfer the diagnosis of sarcopenia from research to the clinical context [12,14].

In addition, to facilitate the detection of sarcopenia, a screening test called SARC-F has been proposed to be carried out, before performing the measurements of strength and muscle mass, as indicative of the risk of sarcopenia [15]. SARC-F consists of five questions answered by the patients themselves, so it is a simple, practical, and easily applied screening tool for older adults and for the applicant. However, the use of SARC-F is not mandatory for healthcare professionals, except with screening purposes in high-risk patients [16]. Thus, EWGSOP2 recommends the SARC-F questionnaire as a way to obtain self-reports from patients with signs of sarcopenia and as a formal approach [16].

Moreover, although in previous studies conducted in community-dwelling older adults, SARC-F has shown very good specificity to diagnose sarcopenia, its sensitivity is low, which may be not desirable for a questionnaire aimed at screening purposes [17–20]. With the intention to solve this, SARC-CalF, which adds calf circumference (CC) to SARC-F, has been suggested as an option that may significantly increase the sensitivity of SARC-F [21]. If not only community-dwelling people are studied, but also institutionalized older adults are included, a broader population is characterized and therefore clinicians have more information about the use of these tools. Therefore, they should be validated in different populations and living settings [21], plus the new EWGSOP2 definition has to be taken into account.

It was hypothesized that although there are different measurement options for each step of the algorithm of the EWGSOP2 definition, no difference in case finding will be found in older adults, allowing healthcare professionals to use the most feasible in their daily clinical practice. We also hypothesized that by not using the SARC-F, case finding of sarcopenia could be increased. Moreover, it may be increased when using the SARC-CalF instead of the SARC-F in these populations.

Therefore, the aim of this study was to compare the number of cases of sarcopenia in older adults using the different measurement options of each step of the algorithm of the European Working Group on Sarcopenia in Older People 2018 (EWGSOP2). We also aimed to evaluate the impact of using SARC-F, SARC-CalF, or no screening on the case finding of sarcopenia in Spanish older adults living in the province of Valencia.

2. Experimental Section

2.1. Study Design

A multicenter cross-sectional study was carried out between January 2019 and February 2020 in institutionalized and community-dwelling older adults, living in the province of Valencia (Spain). This study was approved by the Ethics Committee for Human Research of the University of Valencia (H1542733812827) and was conducted in accordance with the Declaration of Helsinki. This research was registered in the ClinicalTrials.gov database (ID: NCT03832608). Before entering in the study, participants signed a written consent, briefed beforehand.

2.2. Participants

The sample included 272 adults aged 65 or older, living in the community (n = 139) or institutionalized in residential facilities (n = 133). Candidates were not included if they: (1) had edema which could interfere with the bioimpedance analysis (BIA); (2) had a cognitive impairment measured with the Mini-Mental State Examination (MMSE) < 18 points [22]; (3) were suffering from any acute or unstable chronic disease, or had a hospital admission in the last month.

2.3. Sarcopenia Definition

The algorithm of the EWGSOP2 was followed for case finding and diagnosing sarcopenia and determining its severity [7]. It included the SARC-F and the measurements of muscle strength, muscle quantity, and physical performance.

The SARC-F questionnaire is composed of five items questioning strength, assistance in walking, rise from a chair, stair climbing, and falls. It is scored between 0 and 2, and it allows identifying cases with a score of $\geq$4 points from a total of 12 points [15].

Muscle strength was measured by:

- Handgrip strength technique, with a Jamar Plus+ digital hand dynamometer (Patterson Medical, Sammons Preston, Bolingbrook, IL, USA) [23]. Cut-off points were gender-specific for low grip strength: <27 kg for men and <16 kg for women [24].
- Chair stand, in which participants had to stand up five times as quickly as possible from a chair without stopping, with arms folded across the chest. Time (in seconds) was used for the present analyses. The cut-off point for strength was >15 s for five rises for both men and women [25].

Muscle quantity as Appendicular Skeletal Muscle Mass (ASM) was measured with BIA using the Bodystat® 1500MDD (Bodystat Ltd., Douglas, UK). This device was calibrated previous to the measurements. Prior to the assessment, the following criteria were checked [26,27]: participants could not have done previous physical exercise; 2–3 h of fasting was needed, including alcohol or a large amount of water, and emptying their bladder; every metal piece was taken off; and the test was not implemented if they were wearing a pacemaker and/or had edema (diagnosed by the physician). When applying the BIA test (alternating sinusoidal electric current of 200 μA at 50 kHz), the patient was asked to lie in supine position, on a nonconductive surface, with no contact between the limbs. Electrodes were applied with an ipsilateral tetrapolar method, on previously cleaned skin. The electrodes of the upper limb were placed at the knuckles and wrist, and those of the lower limb were placed at the metatarsal head bones line and the anterior side of the ankle. ASM was calculated following Sergi's BIA equation: ASM (kg) = $-3.964 + (0.227 \times RI) + (0.095 \times weight) + (1.384 \times sex) + (0.064 \times Xc)$ [28]. The proposed ASM cut-offs were:

- ASM: low muscle mass was <20 kg for men and <15 kg for women [29].
- ASM Index (ASMI, defined as ASM/height squared): low muscle mass was <7.0 kg/m^2 for men and <5.5 kg/m^2 for women [7,8].

Physical performance of participants was measured by:

- Gait speed (m/s): participants were asked to walk along a 4 m corridor at usual speed and, if needed, using an aid [30], with <0.8 m/s being the cut-off for men and women [31,32].
- Short Physical Performance Battery (SPPB): this test assessed balance, gait, strength, and endurance. Participants were asked to stand with the feet together, semi-tandem, and tandem positions, the time they needed to walk 4 m was measured, and also the time to rise five times from sitting position [33], with ≤8 points being the cut-off for men and women [34].
- Timed-Up and Go test (TUG): participants were asked to rise from sitting position, walk a 3 m distance, turn around, walk back, and sit down, with ≥20 s being the cut-off for men and women [35].

Following these assessments, participants were classified according to the EWGSOP2 algorithm [7,8]: (1) they had probable sarcopenia with a score of ≥4 points SARC-F and low muscle strength (grip strength < 27 kg for men and <16 kg for women; or chair stand > 15 s); (2) they had confirmed sarcopenia when low quantity muscle was also detected (ASM < 20 kg for men and <15 kg for women; or ASMI <7.0 kg/m^2 for men and <5.5 kg/m^2 for women); and (3) they had severe sarcopenia, when low physical performance was added (gait speed < 0.8 m/s; SPPB ≤ 8 points; or TUG ≥ 20 s).

2.4. Additional Measurements

Anthropometric variables: Age and gender were registered; body weight (kg) was measured using a Tanita BC 601 (TANITA Ltd., Amsterdam, The Netherlands); height (cm) was assessed with a stadiometer SECA 213 (Seca Ltd., Hamburg, Germany); and finally, BMI (kg/m^2) was calculated.

SARC-CALF consists of the same five items as SARC-F which are scored the same [36] and adds the CC that was measured as the widest circumference of calf. The CC item is scored as 0 points when the participant had more than 31 cm circumference and as 10 points if it was less than or equal to 31 cm. A SARC-CalF ≥ 11 indicates positive screening for sarcopenia [37–39].

All the assessments were done on the same day for each participant, and different physiotherapists took these measurements for all the samples. Intraclass Correlation Coefficients (ICCs) were calculated to know the interrater reliability, and they ranged from 0.802 to 0.985, which may be considered very good reliability (values between 0.75 and 0.90 indicate good reliability; values over 0.90 show excellent reliability) [40].

2.5. Applied Models

Three models were applied: Model 1: using SARC-F as initial screening; Model 2: not using any initial screening; and Model 3: using SARC-CalF as initial screening instead of SARC-F. By combining the different measures proposed by the steps described in the EWGSOP2 algorithm (Find–Assess–Confirm–Severity), 12 options were obtained (A to L), and to each one of the three models, each of their twelve options was tested (Table 1).

Table 1. Description of the three models and their 12 options.

Name of Combination	Model *	Option	Muscle Strength Measurement	Muscle Quantity Measurement	Physical Performance Measurement
A1	1				
A2	2	A	Handgrip strength	ASMI	SPPB
A3	3				
B1	1				
B2	2	B	Handgrip strength	ASM	SPPB
B3	3				
C1	1				
C2	2	C	Handgrip strength	ASM	Gait speed
C3	3				
D1	1				
D2	2	D	Handgrip strength	ASMI	Gait speed
D3	3				
E1	1				
E2	2	E	Handgrip strength	ASM	TUG
E3	3				
F1	1				
F2	2	F	Handgrip strength	ASMI	TUG
F3	3				
G1	1				
G2	2	G	Chair stand	ASMI	SPPB
G3	3				
H1	1				
H2	2	H	Chair stand	ASM	SPPB
H3	3				
I1	1				
I2	2	I	Chair stand	ASM	Gait speed
I3	3				
J1	1				
J2	2	J	Chair stand	ASMI	Gait speed
J3	3				
K1	1				
K2	2	K	Chair stand	ASM	TUG
K3	3				
L1	1				
L2	2	L	Chair stand	ASMI	TUG
L3	3				

* Model 1: using SARC-F as initial screening; Model 2: not using any initial screening; and Model 3: using SARC-CalF instead of SARC-F.

2.6. Statistical Analyses

With descriptive purposes, means, standard deviations, and 95% confidence intervals (CI) for all variables were calculated. All statistical analyses were performed with R [41], also employing the packages vcd [42] and DescTools [43]. Descriptive statistics (proportions) of multinomial variables were performed [44] including 95% CI for the proportions of each category by the method of Glaz and Sison [45,46]. Chi-square tests of goodness-of-fit and independence were also performed together with their association measures (Pearson residuals and Cramer's V). The CI for V coefficient was bias-corrected [47]. Whenever multiple statistical tests were made, the Sidak correction was employed.

3. Results

3.1. Sample Characteristics

A total of 272 participants were included in this study. The age range for all the participants was 65–97 years, the mean age was 77.0 (8.7) years old, and according to setting, the mean was 72.3 and 81.9 years old for community dwelling and institutionalized participants, respectively. Seventy-two percent of participants (n = 197) were women (Table 2).

Table 2. Characteristics of the participants (n = 272) according to setting and gender: mean (standard deviation) and [95% confidence interval].

	Community Dwelling (n = 139, 51.1%)				Institutionalized (n = 133, 48.9%)			
Variable	**Total**	**Men (n = 44, 31.7%)**	**Women (n = 95, 68.3%)**	**p-value**	**Total**	**Men (n = 31, 23.3%)**	**Women (n = 102, 76.7%)**	**p-Value**
Anthropometrics								
Age (years)	72.3 (6.1) [71.2–73.3]	72.8 (6.32) [70.9–74.7]	72.0 (6.1) [70.8–73.3]	0.498	81.9 (8.4) [80.5–83.3]	78.2 (9.0) [74.9–81.5]	83.0 (7.9) [81.5–84.6]	0.005 *
Weight (kg)	71.6 (12.4) [69.5–73.7]	79.5 (10.5) [76.3–82.7]	67.9 (11.5) [65.6–70.3]	<0.001 †	66.6 (13.4) [64.4–69.0]	75.6 (12.5) [71.0–80.2]	63.9 (12.5) [61.5–66.4]	<0.001 †
Height (cm)	158.9 (7.8) [157.6–160.2]	166.5 (6.8) [164.4–168.6]	155.4 (5.3) [154.3–156.5]	<0.001 †	154.1 (9.1) [152.5–155.6]	164.9 (7.9) [162.0–167.8]	150.8 (6.5) [149.5–152.0]	<0.001 †
BMI (kg/m^2)	28.3 (4.2) [27.6–29.0]	28.7 (3.7) [27.5–29.8]	28.1 (4.4) [27.2–29.0]	0.486	28.0 (4.9) [27.2–28.9]	27.8 (3.8) [26.4–29.2]	28.1 (5.2) [27.1–29.1]	0.075
Calf circumference	36.3 (3.2) [35.7–36.8]	37.5 (3.1) [36.6–38.5]	35.7 (3.0) [35.1–36.3]	0.001 *	33.4 (3.4) [32.8–34.0]	33.9 (3.0) [32.8–35.0]	33.3 (3.5) [32.6–34.0]	0.387
EWSGOP2 algorithm								
SARC-F (0–10 score)	0.7 (1.2) [0.5–0.9]	0.3 (0.6) [0.1–0.5]	0.9 (1.3) [0.7–1.2]	<0.001 †	3.9 (2.6) [3.5 – 4.4]	3.5 (2.8) [2.5–4.5]	4.0 (6.5) [3.5–4.5]	0.330
SARC-CalF (0–20 score)	0.9 (2.0) [0.6–1.3]	0.5 (1.6) [0.04–1.0]	1.1 (2.1) [0.7–1.6]	0.088	5.6 (5.1) [4.7–6.5]	4.8 (5.1) [2.9–6.7]	5.8 (5.2) [4.8–6.9]	0.338
Grip strength	28.4 (9.0) [26.9–29.9]	38.1 (8.4) [35.6–40.7]	23.8 (4.7) [22.9–24.8]	<0.001 †	18.8 (7.8) [17.4–20.1]	26.6 (9.8) [23.0–30.2]	16.4 (5.1) [15.4–17.4]	<0.001 †
Chair Stand	15.3 (13.0) [13.1–17.5]	11.4 (3.5) [10.4–12.5]	17.1 (15.2) [14.0–20.2]	0.001 *	31.2 (20.0) [27.8–34.7]	29.4 (19.2) [22.4–36.5]	31.8 (20.3) [27.8–35.8]	0.564
ASM (kg)	17.8 (4.0) [17.1–18.5]	22.3 (2.8) [21.4–23.2]	15.8 (2.5) [15.3–16.3]	<0.001 †	15.1 (3.5) [14.5–15.7]	19.5 (3.2) [18.3–20.7]	13.8 (2.3) [13.4–14.3]	<0.001 †
ASM/height^2 (kg/m^2)	7.0 (1.1) [6.8–7.2]	8.1 (0.9) [7.8–8.3]	6.5 (0.9) [6.3–6.7]	<0.001 †	6.3 (1.0) [6.2–6.5]	7.2 (0.8) [6.8–7.5]	6.1 (0.9) [5.9–6.2]	<0.001 †
Gait speed (m/s)	1.1 (0.3) [1.1–1.2]	1.2 (0.2) [1.1–1.3]	1.1 (0.3) [1.0–1.1]	0.012 *	0.6 (0.3) [0.5–0.6]	0.6 (0.3) [0.5–0.7]	0.6 (0.3) [0.5 –0.6]	0.576
SPPB (0–12 score)	10.4 (2.0) [10.1–10.8]	11.1 (1.1) [10.8–11.4]	10.4 (2.0) [9.6–10.6]	0.001 *	5.3 (3.0) [4.8 –5.8]	6.1 (2.8) [5.1–7.2]	5.0 (3.0) [4.4–5.6]	0.064
TUG (s)	9.8 (3.3) [9.2–10.3]	9.1 (2.0) [8.5–9.7]	10.1 (3.7) [9.3–10.8]	0.044 *	26.9 (18.7) [23.6–30.1]	28.8 (24.1) [20.0–37.6]	26.3 (16.7) [23.0–29.6]	0.588

Abbreviations: BMI = Body Mass Index; ASM = Appendicular Skeletal Muscle Mass; SPPB = Short Physical Performance Battery; TUG = Timed-Up and Go test. p-value unpaired Student's t-test. * $p < 0.05$; † $p < 0.001$.

3.2. Analysis of the Models

For each of the three models, and each of their 12 options (A to L), 95% CI and each category of classification (no sarcopenia, probable sarcopenia, confirmed sarcopenia, and severe sarcopenia) were calculated. These CIs are presented in Figures 1–3.

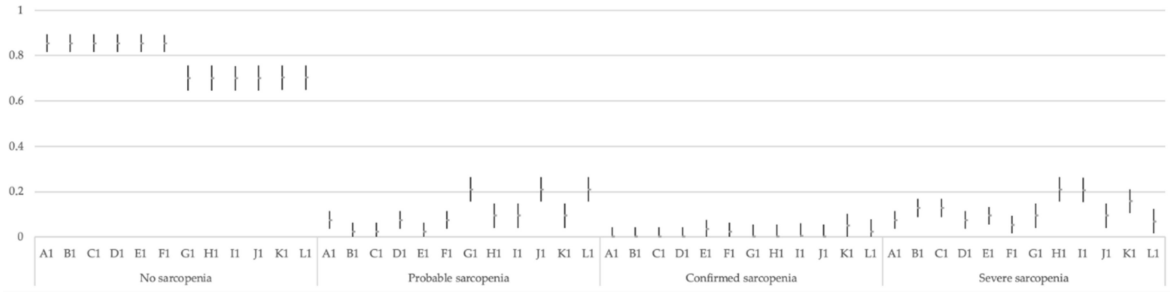

Figure 1. Multinomial 95% confidence intervals for the proportion of each category in the 12 options of Model 1.

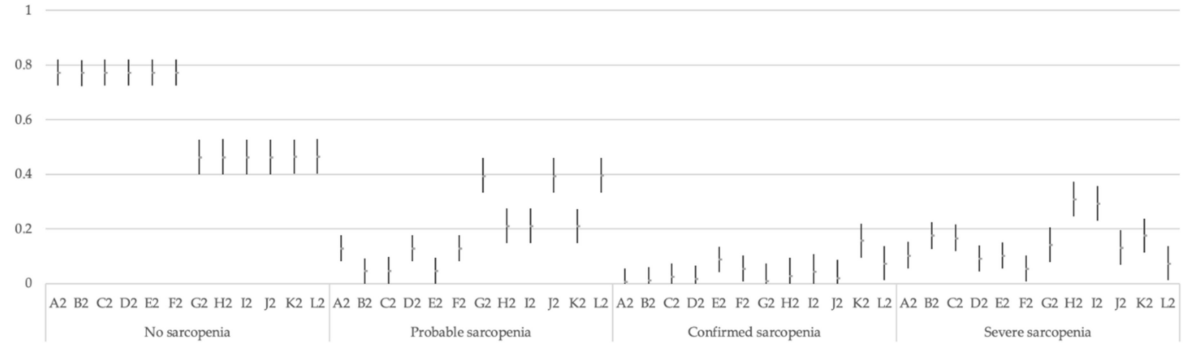

Figure 2. Multinomial 95% confidence intervals for the proportion of each category in the 12 options of Model 2.

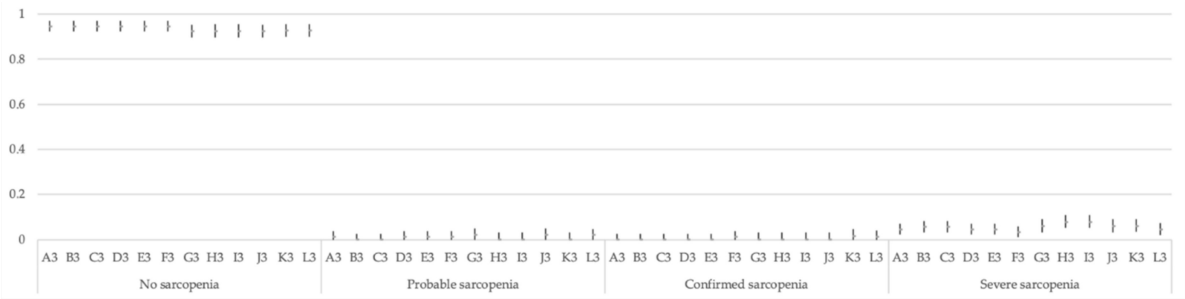

Figure 3. Multinomial 95% confidence intervals for the proportion of each category in the 12 options of Model 3.

Once these CIs were calculated, they were averaged for each model, and each of the 12 options (A to L) in each model was compared with a goodness-of-fit chi-square test with expected probabilities the average probabilities of each model. Therefore, the 12 tests within each model (algorithm) tested whether the classification of the different steps was statistically equal or different. Table 3 offers the results of all these chi-square tests. Regarding Model 1, all but two tests showed statistical significance, indicating that the different steps of the algorithm significantly affect the classification. Model 2 tests showed significant results in all cases, and therefore this supports that the different steps of the algorithm lead to different classifications. However, in Model 3, the results showed no statistical significance, and therefore for this algorithm, the different steps do not lead to significantly different classifications.

Table 3. Goodness-of-fit chi-square tests, probability level corrected with Sidak method.

Model 1	χ^2	df	*p*-Value	Model 2	χ^2	df	*p*-Value	Model 3	χ^2	df	*p*-Value
A1	10.45	3	>0.05	A2	30.43	3	<0.05	A3	1.64	3	>0.05
B1	21.47	3	<0.05	B2	48.49	3	<0.05	B3	3.12	3	>0.05
C1	21.47	3	<0.05	C2	44.05	3	<0.05	C3	3.12	3	>0.05
D1	10.45	3	>0.05	D2	27.92	3	<0.05	D3	1.64	3	>0.05
E1	31.86	3	<0.05	E2	57.01	3	<0.05	E3	8.39	3	>0.05
F1	10.45	3	<0.05	F2	34.16	3	<0.05	F3	8.12	3	>0.05
G1	37.98	3	<0.05	G2	72.80	3	<0.05	G3	4.35	3	>0.05
H1	26.07	3	<0.05	H2	56.71	3	<0.05	H3	5.78	3	>0.05
I1	22.79	3	<0.05	I2	46.70	3	<0.05	I3	5.78	3	>0.05
J1	37.98	3	<0.05	J2	69.28	3	<0.05	J3	4.35	3	>0.05
K1	41.36	3	<0.05	K2	90.20	3	<0.05	K3	14.45	3	<0.05
L1	42.65	3	<0.05	L2	81.24	3	<0.05	L3	9.56	3	>0.05

Notes: Model 1: using SARC-F; Model 2: not using any initial screening; Model 3: using SARC-CalF; *p*-values corrected with Sidak's correction.

A chi-square independence test was performed to compare the classifications into the different groups the three algorithms made. This chi-square was statistically signifi-

cant (χ^2 (6) = 88.41, $p < 0.001$), and the association between the algorithm used and the classification of sarcopenia was moderate (Cramer's V = 0.226, 95% CI [0.177, 0.276]).

In addition, we have analyzed how each model on the whole is associated with severity levels. Figure 4 graphically presents the association based on the Pearson's residuals. It can be seen that Model 1 is not significantly associated with any classification as represented by the grey color. However, Model 2 is associated with the classification into the different groups of sarcopenia with a positive association (blue color) with the levels of severity, being higher with probable sarcopenia, and with negative association (red color) with nonsarcopenic older adults. On the contrary, Model 3 is associated positively (blue color) with no sarcopenia.

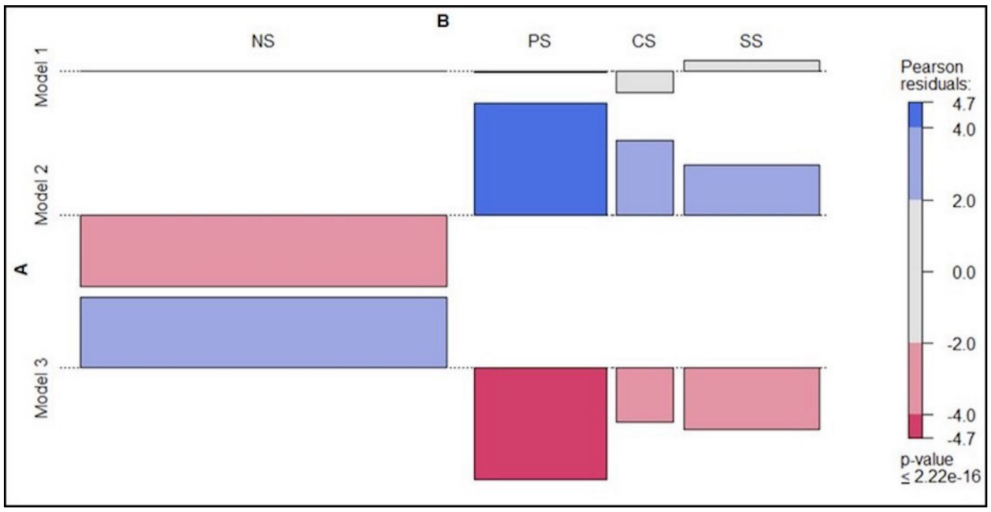

Figure 4. Association between the three models and the severity levels of sarcopenia (no sarcopenia (NS), probable sarcopenia (PS), confirmed sarcopenia (CS), and severe sarcopenia (SS)). Note: blue indicates positive association of row and column and red negative association.

4. Discussion

The present study showed that using the different measurement options for each step of the EWGSOP2 implied differences in case finding in the studied population. These differences have been analyzed in relation to each of the steps, describing which measurements detect more or less cases of sarcopenia. Moreover, our results indicate that when applying the SARC-F, case finding of sarcopenia decreases, thus by not applying it, more cases are found, especially among those with probable sarcopenia. Finally, when SARC-CalF is used as screening, the number of people classified as sarcopenic decreases.

To the best of our knowledge, this is the first study to analyze the different measurement options of the EWGSOP2 in Spanish older adults, and the fact that there are differences in case finding has important clinical consequences. Taking into account that sarcopenia is frequently not noticeable in earlier stages [48], detecting probable sarcopenia is of paramount importance in order to be able to start intervention. In Model 1, using SARC-F, and Model 2, using no screening, there are significant differences in case finding among most of the options. When analyzing these differences, it can globally be seen that those which use the chair stand for measuring muscle strength (G to L) are the ones that find more probable sarcopenic participants. This is interesting considering that previous research has highlighted that handgrip strength seems to be used widely for the measurement of muscle strength [13]. However, it requires the use of a calibrated handheld dynamometer under well-defined test conditions [23]. Therefore, commercial dynamometers are usually limited in clinical settings by the need to purchase specialized equipment, the relative expense, and the lack of trained staff [13]. In addition, sometimes measurement of grip is not possible due to hand disability, such as with patients who are suffering from advanced

arthritis or stroke [7]. On the whole, these facts could explain why only a small percentage of healthcare professionals use diagnostic measures in clinical practice as stated before [12]. On the other hand, in previous research, the chair stand has been shown to be able to provide a valid tool for assessing lower body strength [49]. This is in line with our results, which seem to show chair stand can be a reliable method for case finding of probable sarcopenia in the studied population. From the clinical approach, detection of cases as early as possible is important considering that it is better to prevent the skeletal muscle mass depletion and loss of strength and function rather than trying to restore them when they have progressed [50]. Therefore, for clinical settings where a handgrip dynamometer is not always available, the chair stand could be used as an alternative assessment of muscle strength [13]. This way, preventive strategies together with treatment interventions could be implemented before the muscle deterioration occurs [50].

After detecting probable sarcopenia cases, the second step of the EWGSOP2 algorithm evaluates muscle quantity. The EWGSOP2 consensus presents cut-off points for both ASMI (kg/height squared) [51] and ASM (kg) [29] for use when calculating muscle mass. In relation to Model 1, when analyzing the different options, there are more cases of severe sarcopenia in those options that previously have confirmed it by using the ASM (kg) cut-off for muscle quantity (B1, C1, E1, H1, I1, K1). Considering that low muscle mass is highly related to disability and frailty in older adults [52], measuring muscle mass in a precise way is crucial for confirming sarcopenia in this population. There is an ongoing debate about the preferred adjustment for muscle mass indices and whether the same method can be used for all populations [7]. For our population, the results show the ASMI is a more restrictive cut-off, whereas with the ASM, more sarcopenic participants are detected and, consequently, more are classified as suffering severe sarcopenia. This could also explain why G1, J1, and L1 show more cases of probable sarcopenia, since they are using the ASMI and therefore more participants are not being confirmed with sarcopenia and stay as probable. Therefore, some participants could present low strength, however, their amount of muscle mass would still be within the EWGSOP2 criteria, preventing categorization in more advanced stages of the pathology, as similarly stated in previous research [53]. Although the most accurate way to define muscle mass remains uncertain [54], our results show ASMI is more restrictive for our population, classifying them mostly as probable, whereas they could have been classified as severe if the ASM had been used. Thus, methods used to define low lean mass can make preventive and therapeutic interventions on sarcopenia vary widely.

In relation to Model 2, with no initial screening, there are significant differences in case finding among all of the options. When analyzing them individually, again the same trend can be found in relation to muscle strength and muscle mass, that is, chair stand detects more probable sarcopenia (options G to L) and ASMI is more restrictive (A, D, F, G, J, L). In relation to physical performance, the options which confirm sarcopenia with the ASM and then classify its severity with the SPPB or gait speed (B, C, and G to J) are the ones which detect more cases of severe sarcopenia. Detection of low physical performance predicts adverse outcomes [7], so it becomes of paramount importance for the clinical approach. However, in older populations, physical performance is frequently difficult to measure due to acute illness or because of dementia, gait disorder, or a balance disorder [55–57], thus finding a safe and valid assessment becomes necessary. Gait speed is considered a quick and reliable test for sarcopenia, which is why it is widely used in practice [58]. Although the SPPB also predicts outcomes [34], it is a more time-consuming test to apply and therefore, it is more used in research than in clinical practice. Therefore, and considering our results, clinicians can rely on SPPB and gait speed to detect the severe cases, although the latter can be considered as a more approachable measurement in the clinical context.

Regarding the use or not of SARC-F, it was not implemented in Model 2, and more cases were found as probable, confirmed, or severe sarcopenia. Therefore, when using SARC-F for screening in our population, it is at the expense of missing cases who would have been at least in the category of probable sarcopenia, since more cases were detected in Model 2. Although the SARC-F has shown excellent specificity [15,17,18,59–61], it has

shown some problems in relation to its low sensitivity [17,59], which means that there is a high risk of missed diagnosis of individuals who have sarcopenia. Moreover, as noted in the EWGSOP2 definition, in clinical settings, case finding should start when a patient has symptoms or signs of sarcopenia, and in these situations, further testing is recommended, the use of any screening tool not being mandatory [16]. This is in line with our results, which suggest SARC-F does not always detect possible cases of sarcopenia in our sample.

In relation to Model 3, which screens using the SARC-CalF, our results show case finding of sarcopenic people is not increased. Moreover, it is the model with which a lower amount of sarcopenic people are found. Although previous research has shown promising results regarding SARC-CalF, with a better sensitivity than SARC-F [21,39], this does not concur with our results. This may be explained by the cut-offs that have been used, since again different options are found in this regard [37], and should be addressed in future research. Moreover, the few participants that were detected as suffering from sarcopenia with any of the options of Model 3 were classified as severe sarcopenia, thus indicating they were highly impaired in their physical performance, which allows less options of recovery. From the clinical approach, if a sarcopenia screening test is used, it is expected to dismiss from further testing as many healthy individuals as possible but should also guarantee diagnosis of those who do have sarcopenia [39] in order to start the appropriate intervention, thus this may not be possible using the SARC-CalF in a population like ours.

Considering that from the three models, Model 2 has shown the highest positive associative probability in case finding of participants with sarcopenia, especially in probable and confirmed, this finding would allow clinicians to detect sarcopenia in earlier stages. This model has different options which have shown statistical differences and using one or other to detect the presence of sarcopenia can be time consuming and expensive and might require highly specialized equipment [50]. Moreover, selecting a way of diagnosing sarcopenia requires balancing the possible benefit of including functional and ASM measurements against the difficulties related to their inclusion [62]. Therefore, on the whole, those options of Model 2 which include the chair stand and use the ASM may be finding more cases of sarcopenia in its different classifications.

Limitations and Strengths

The main limitation of our study, common to other studies, is related to sample size. A larger sample size would be advisable, as well as studying case finding and implementing this model analysis in other populations besides the Spanish one to confirm our promising results. Another limitation is that the sample had a higher percentage of women, and although this is characteristic related to aged population in Spain, greater gender equality would be important in future research. Another interesting line to be implemented in the future could be analyzing how those older adults found to be sarcopenic in one model behave in the other models. However, this study offers the novelty of analyzing the different options of the EWGSOP2 to show the one that can find sarcopenia cases in an accurate way, which would promote an adequate and early intervention.

5. Conclusions

There are differences in case finding of sarcopenia in the studied Spanish older adults when the different measurement options for each step of the EWGSOP2 definition are applied. For muscle strength, the chair stand seems to be detecting more cases of probable sarcopenia, for muscle mass, ASM detects more confirmed and severe, and for physical performance, SPPB and gait speed seem to be reliable options. In addition, more sarcopenia cases are identified when no initial screening is used, therefore, in clinical practice, when a patient shows symptoms or signs of sarcopenia, a screening questionnaire may be surpassed and further testing is recommended to confirm sarcopenia. Thus, clinical settings should take into consideration that the methods used to define these steps can make preventive and therapeutic interventions on sarcopenia vary widely.

Author Contributions: Conceptualization, M.A.C.i.I., A.A.-G. and N.C.-S.; methodology, M.A.C.i.I., A.A.-G., N.C.-S., M.A.T.-C., M.B.-B., S.F. and T.S.-M.; formal analysis, J.M.T., M.A.C.i.I., A.A.-G. and N.C.-S.; investigation, M.A.C.i.I., A.A.-G., N.C.-S., M.A.T.-C., M.B.-B., S.F. and T.S.-M.; resources, M.A.C.i.I., A.A.-G. and N.C.-S.; data curation, M.A.C.i.I., A.A.-G., N.C.-S. and M.B.-B.; writing—original draft preparation, M.A.C.i.I., A.A.-G., N.C.-S. and J.M.T.; writing—review and editing, A.A.-G., M.A.C.i.I., N.C.-S., M.A.T.-C., M.B.-B., S.F., T.S.-M. and J.M.T.; project administration, M.A.C.i.I.; funding acquisition, M.A.C.i.I. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Generalitat Valenciana (GV/2019/131) and by FEDER/Ministerio de Ciencia e Innovación—Agencia (RTI2018-093321-B-100).

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethics Committee for Human Research of the University of Valencia (protocol code H1542733812827 approved 18 December 2018).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Acknowledgments: We gratefully acknowledge the participation of all community-dwelling participants as well as residents and staff of the residential facilities of La Saleta Care, Parque Luz Xirivella, Parque Luz Catarroja, El Mas Torrent, and especially Mary Martínez Martínez, the Technical Manager of La Saleta Care.

Conflicts of Interest: The authors declare no conflict of interest.

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Anexo 3. Copia original del estudio 3

Received: 27 January 2023 | Revised: 26 July 2023 | Accepted: 28 August 2023

DOI: 10.1111/nhs.13050

RESEARCH ARTICLE

Nursing & Health Sciences WILEY

Functional and emotional impact of COVID-19 lockdown on older adults with sarcopenia living in a nursing home: A 15-month follow-up

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Funding information
Generalitat Valenciana, Grant/Award Number: GV/2019/131

Abstract

This study aimed to detect the functional and emotional impact of COVID-19 lockdown on institutionalized older adults with sarcopenia during a 15-month follow-up. A prospective longitudinal cohort study was conducted in a nursing home. Participants were screened for sarcopenia, and those with a score of ≥4 points according to SARC-F questionnaire were included. Assessments were performed pre-lockdown (T1), 12 months (T2) after, and at a 15-month follow-up (T3). Functional measurements included chair stand test, handgrip, biceps brachii and quadriceps femoris strengths, appendicular skeletal mass, gait speed, Short Physical Performance Battery, and Timed Up-and-Go test. Emotional assessments included Short-Form Health Survey, Geriatric Depression Scale—Short Form, and the Mini-Mental State Examination. The analyzed sample showed a reduction in bicep strength, and other upper and lower limb strength variables showed a decreasing trend with no changes regarding muscle mass. Physical performance showed a change, specifically a deterioration in the subtest related to balance. Cognitive and emotional components were affected and quality of life was decreased. It is of paramount importance to focus on sarcopenic older adults since their characteristics can deteriorate when isolation measures are conducted.

KEYWORDS

COVID-19 lockdown, emotional aspects, functionality, institutionalized older adults, sarcopenia

Key points

- Institutionalized older adults with sarcopenia in the region of Valencia, Spain, had not been previously studied in either the physical or emotional sphere during the COVID-19 lockdown with a 15-month follow-up.
- In the 15-month follow-up, there was an evident decline in muscle strength, particularly biceps brachii strength and Short Physical Performance Battery performance, with no changes regarding muscle mass.

- There was an increase in cognitive impairment and depression symptoms in the 15-month follow-up.

1 | INTRODUCTION

Sarcopenia has been defined as a progressive and generalized skeletal muscle disorder, associated with an increased likelihood of adverse outcomes such as falls, fractures, physical disability, and mortality (Cruz-Jentoft et al., 2019). Sarcopenia has a high prevalence among older adults, ranging between 17.7% and 73.3% among institutionalized older adults (Rodríguez-Rejón et al., 2019). This may be related to the association of institutionalized older adults with sedentary behavior and a higher prevalence of chronic diseases, which therefore causes them to be the frailest of the population (Crocker et al., 2013).

In March 2020, the World Health Organization declared the outbreak of the coronavirus disease 2019 (COVID-19) as a pandemic. Physiological changes related to aging, comorbidities, and geriatric syndromes were associated with a higher risk of negative prognosis when infected with COVID-19, which was increased in nursing homes (McMichael et al., 2020). To slow the spread of the infection in nursing homes, social isolation measures were adopted, and physical activities carried out collectively were not allowed.

1.1 | Background

Previous studies have focused on community living older adults; they have reported that these measures, although necessary to stop the COVID-19 spread, have resulted in an increase in sedentary behavior and a reduction in physical activity (Ammar et al., 2020), which are known to be associated with muscle mass loss (Breen et al., 2013). Isolation and confinement have also had emotional consequences such as an increase in stress and anxiety levels (Lei et al., 2020), as well as depression among older adults (Meng et al., 2020).

Although some studies have analyzed the effects of lockdown on institutionalized older adults, the focus has mainly been on the emotional aspects (Ammar et al., 2020; Angevaare et al., 2022; Savci et al., 2021) and well-being (Levere et al., 2021). Among institutionalized older adults, recent research has also observed a significant functional, cognitive, and nutritional decline after the first wave of COVID-19 (Pérez-Rodríguez et al., 2021). Moreover, in institutionalized older adults, several alterations to frailty markers have been observed, such as the worsening of the nutritional status, the decrease in physical performance, and an increased risk of screening positive for sarcopenia (De Souza Oliveira et al., 2023). These studies showed that lockdown had substantial impacts on nursing home residents, adversely affecting the physical, functional, and emotional well-being of residents.

However, to the best of our knowledge, no previous study has focused on tracking nursing home residents longitudinally for over a year regarding all sarcopenia variables and how they could change due to lockdown. Therefore, it is necessary to evaluate the impact of confinement on older adults with sarcopenia who are more vulnerable to other comorbidities, as well as to quantify it in both the physical and emotional spheres in the long term. We hypothesized that lockdown would be associated with a decline in functional capacity and emotional impairment in institutionalized older adults with sarcopenia.

1.2 | Aim

The aim of this study was to detect the functional and emotional impact of the COVID-19 lockdown restrictions on institutionalized older adults with sarcopenia during a 15-month follow-up. The second objective of the study was to analyze the changes regarding the sarcopenia classification of the participants within a 15-month period.

2 | METHODS

2.1 | Study design

This is a prospective longitudinal cohort study. It was carried out in a nursing home in the province of Valencia, Spain, between January 2020 and March 2021. This study is related to a previous cross-sectional study registered in the ClinicalTrials.gov database (ID: NCT03832608).

2.2 | Ethics considerations

This study was approved by the Ethics Committee for Human Research of the University of Valencia (H1542733812827) and was conducted in accordance with the Declaration of Helsinki. To ensure protection of the rights of the potential participants, prior to the start of the study, the center's psychologist, together with the researcher, explained the study to the participants. All the participants were informed in person, both in writing and orally, to ensure that they understood each of the tests they would undergo and the purpose of the study. Finally, informed consent was obtained from the participants.

2.3 | Setting and participants

The nursing home was a skilled nursing care facility, with a total of 74 beds. The sample included institutionalized men and women over 65 years, who screened positive for sarcopenia using the SARC-F questionnaire (score ≥4 points) (Malmstrom et al., 2016). Exclusion

criteria included older adults with a diagnosis of Alzheimer's and/or dementia, with Mini-Mental State Examination score of <18 points (severe cognitive impairment) (Ghisla et al., 2007), being in an acute process of any disease, and having suffered any hospital admission in the previous month.

2.4 | Measures

All participants undertook face-to-face assessments. The Mini-Mental State Examination, number of medications taken daily, number of hospitalizations, number of falls, Barthel Index, the Geriatric Depression Scale—Short Form, and the Mini Nutritional Assessment-Short Form (MNA-SF) data were retrieved from the institution database.

Social and anthropometric characteristics: (1) age (years); (2) sex (men/women); (3) weight (kg) assessed with a Tanita BC 601 scale (TANITA Ltd., Netherlands); (4) height (cm); and (5) body mass index (BMI, kg/m^2).

Clinical characteristics:

1. Number of medications taken daily, considering polypharmacy as the routine use of five or more medications.
2. Number of hospitalizations in the last year.
3. The Barthel Index, which includes 10 items related to activities of daily living: feeding, grooming, bathing, dressing, bowel and bladder care, toilet use, ambulation, transfers, and stair climbing. The score ranges from 0 to 100, where values below 20 indicate total dependence for activities of daily living, values between 21 and 60 indicate severe dependence, values between 61 and 90 indicate moderate dependence, values between 91 and 99 indicate mild dependence, and a score of 100 points indicates independence (Shah et al., 1989). The BI has shown adequate internal consistency ($\alpha = 0.70$) (González et al., 2018).
4. Abbreviated Charlson's comorbidity index, which includes eight medical conditions (cerebral vascular disease, diabetes, chronic obstructive pulmonary disease, heart failure/ischemic heart disease, dementia, peripheral arterial disease, chronic kidney failure [dialysis], and cancer) scored between 0 and 10. An absence of comorbidity is indicated by a score of 0–1 points, low comorbidity corresponds to a score of 2, and high comorbidity is defined as a score of ≥3 points (Berkman et al., 1992). This instrument has a similar short-term prognostic probability to the long version (Jiménez, 2007).
5. Nutritional status was assessed using the MNA-SF, a validated tool for detecting malnourished people or those at risk of malnutrition among older adults (Kaiser et al., 2009). It comprises five questions related to decreased food intake, recent unintentional weight loss, current mobility, stress or acute illness, and presence of dementia or depression, to which the BMI calculation or the measurement of the calf circumference at the widest point is added. In this study, the BMI was used since all the assessed participants were able to stand. The total score of the MNA-SF ranges from 0 to 14 points and classifies nutritional status as normal (12–14 score), risk of malnutrition (8–11 score), and malnutrition (0–7 score) (Vellas et al., 1999). In relation to MNA, it has a sensitivity of 81.4% and a specificity of 92.7%, as well as a strong positive predictive value (De La Montana & Miguez, 2011; Garcia-Meseguer & Serrano-Urrea, 2013).
6. Frailty is measured by Fried Phenotype (Fried et al., 2001), which includes five clinical criteria: (1) involuntary weight loss; (2) fatigue; (3) low level of physical activity; (4) muscle weakness (grip strength); and (5) slow gait. The presence of any of these criteria scored 1 point, with the total score ranging from 0 to 5 points. Participants were classified as robust (0 points), pre-fragile (1–2 points), and fragile (3 points). It has good reliability and prognostic validity (Acosta-Benito & Martín-Lesende, 2022).

Functional and physical characteristics:

Sarcopenia classification: The European Working Group in Sarcopenia in Older People 2 algorithm was conducted (Cruz-Jentoft et al., 2019). This algorithm is an international guideline widely used to define and diagnose sarcopenia (Cruz-Jentoft et al., 2019; Witham & Stott, 2019). It includes multiple measures, which begin with an initial screening, followed by an assessment of low muscle strength as a key characteristic of probable sarcopenia. Low muscle quantity is then used to confirm the diagnosis, and physical performance is evaluated to determine the severity of sarcopenia (Cruz-Jentoft et al., 2019). Participants were screened for sarcopenia with a score of ≥4 points in the SARC-F questionnaire (Malmstrom et al., 2016). They had probable sarcopenia with low muscle strength assessed by the chair stand test (cutoff point >15 s for five rises) (Studenski et al., 2014). They were diagnosed with sarcopenia when low muscle quantity was also detected. The appendicular skeletal muscle mass was measured with bioimpedance analysis using the Bodystat® 1500MDD (Bodystat Ltd., Douglas, UK) and Sergi's bioimpedance analysis equation (Sergi et al., 2015). The appendicular skeletal muscle mass cutoff points for low mass were <20 kg for men and <15 kg for women (Studenski et al., 2014). They had severe sarcopenia when low physical performance was added, measured by gait speed (cutoff point was <0.8 m/s) (Cruz-Jentoft et al., 2010). The chair stand test and the appendicular skeletal muscle mass have been shown to detect more cases of probable and confirmed sarcopenia, respectively (Arnal-Gómez et al., 2021), and gait speed is considered a highly reliable test for sarcopenia (Bruyère et al., 2016). In addition, the use of equipment-free tests such as the chair stand test and gait speed facilitate diagnosis in clinical settings. These tests require no equipment, are simple and quick to perform, and can be performed by different health professionals after a period of training.

Muscle strength: Handgrip strength (kg) measured by Jamar Plus +® device (Patterson Medical, Sammons Preston, Bolingbrook, IL, USA) was assessed bilaterally. Three measurements were assessed, with the highest value being taken for analysis (Roberts et al., 2011). Biceps brachii and quadriceps femoris strengths (kg) were evaluated in the dominant limb using a dynamometry Lafayette Manual Muscle Tester device (Lafayette, IN, USA). Three measurements were taken

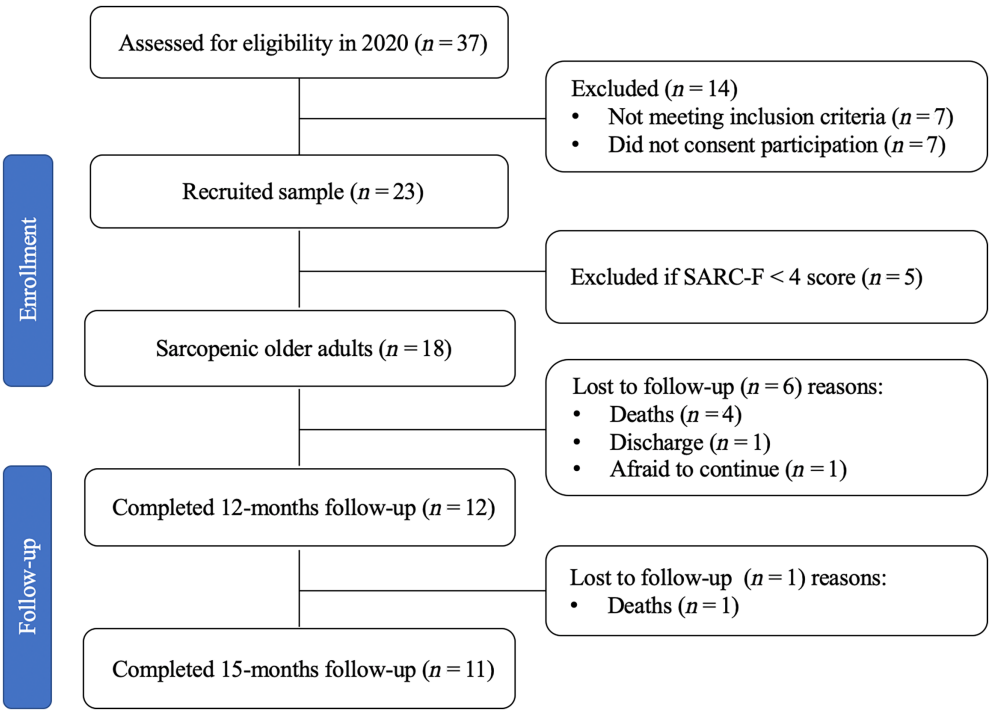

FIGURE 1 Flow diagram: Enrolment and follow-up periods.

for each strength variable, with the highest value being taken for analysis (Bohannon, 1986; Stark et al., 2011).

Muscle quantity: From the appendicular skeletal muscle mass value, two new variables were calculated following previous sarcopenia-related literature: (1) appendicular skeletal muscle mass/height squared (kg/m^2), with cutoff points for low mass <7.0 kg/m^2 and <5.5 kg/m^2, for men and women, respectively (Cruz-Jentoft et al., 2019); and (2) appendicular skeletal muscle mass/body mass index (kg/kg/m^2) (Kim et al., 2016).

Physical performance: (1) Short Physical Performance Battery (0–12 score), which has balance, walking, and rising subtests (Guralnik et al., 1994), with ≤8 points being the cutoff (Pavasini et al., 2016). Also, (2) the Timed Up-and-Go test (s), with ≥20 s being the cutoff (Podsiadlo & Richardson, 1991).

Emotional and cognitive characteristics: (1) health-related quality of life was assessed with the eight-item Short-Form Health Survey (SF-8). The score ranges from 0 to 40 points, with a higher score indicating better quality of life (Tomás et al., 2018). The SF-8 is a feasible, reliable, valid, and sensitive instrument to assess health-related quality of life. It has been shown to have high internal consistency ($\alpha = 0.92$) (Vallès et al., 2010). (2) The Geriatric Depression Scale—Short Form was implemented. It comprises 15 questions (yes/no answer) and its score ranges from 0 to 15 points. The literature recommends using scores of ≥5 as a cutoff point to consider the possible existence of depressive symptoms (Friedman et al., 2005; Martínez de la Iglesia et al., 2002). This instrument has shown moderate reliability, moderate internal consistency ($\alpha = 0.749$), 89.5% sensitivity, and 65.3% specificity (Friedman et al., 2005). (3) The Mini-Mental State Examination was used to assess cognitive characteristics (Lobo et al., 1999). It explores various cognitive functions: (1) temporal–spatial orientation; (2) immediate and long-term memory; (3) attention; (4) calculation; (5) language; (6) abstract reasoning; and (7) praxis (Calero-García & Navarro-González, 2006). The total score is between 0 and 35 points. A score of <18 corresponds to severe cognitive impairment (Black et al., 1999; Ghisla et al., 2007; Müller-Thomsen et al., 2005). Regarding its validity in the institutionalized population, the MMSE has a sensitivity of 73.6% and a specificity of 84.6% (Lobo et al., 1999).

2.5 | Time point measurements

The time points for data collection depended on the pandemic process and were conducted as follows: T1 or pre-lockdown (January 2020), T2 or 12-month follow-up (January 2021), and T3 or 15-month follow-up (March 2021). The assessor who conducted the assessments was the nursing home physical therapist. Thus, monitoring these vulnerable people who had a high risk of contagion was allowed under conditions of confinement.

2.6 | Lockdown description

In March 2020, under the state of alarm, nursing home lockdown employed the isolation of older adults in their rooms and stopped carrying out the weekly activity program: physical activities, cognitive stimulation, or activities of daily living (ADL) in the common areas (Orden SND/265/2020, de 19 de marzo, 2020). Between June and July 2020, movement was allowed under safe conditions. In this 'new normal', movement around the common areas was allowed, and

TABLE 1 Baseline characteristics for all the samples and by sex: median (minimum–maximum) and number of cases (percentages).

Variables	Total ($n = 18$)	Men ($n = 6$, 33.3%)	Women ($n = 12$, 66.7%)	p-value[a,b]
Anthropometric characteristics				
Age (years)	86.5 (66–93)	78.5 (76.0–89.0)	88.5 (66.0–93.0)	0.102
Weight (kg)	65.7 (51.0–94.3)	78.8 (57.8–81.3)	62.4 (51.0–94.3)	0.250
Height (cm)	150 (141–169)	159.0 (150.0–169.0)	148.3 (141.0–157.0)	**0.002**
BMI (kg/m^2)	28.1 (22.6–44.9)	28.0 (24.5–35.8)	28.1 (22.6–44.9)	0.682
Clinical characteristics				
Medication (*n*)	10 (6–18)	11 (7–18)	9.5 (6–12)	0.102
Hospitalizations (*n*)	0 (0–2)	0 (0–2)	0 (0–1)	0.385
Barthel Index (0–100 score)	67.5 (15–90)	85 (45–90)	65 (15–90)	0.385
Ab-Charlson (0–10 score)	1.5 (0–4)	3 (1–4)	1 (0–3)	0.083
MNA (0–14 score)	12.0 (8.0–14.0)	9 (8–13)	12 (9–14)	0.053
Risk of malnutrition (MNA)				
Normal (12–14)	11 (61.1)	2 (33.3)	9 (75)	0.087
In risk (8–11)	7 (38.9)	4 (66.7)	3 (25)	
Malnutrition (0–7)	0 (0)	0 (0)	0 (0)	
Fried phenotype score	3 (1–4)	3 (2–4)	3 (1–4)	0.553
Frailty-Fried phenotype				
Yes (≥3 score)	12 (66.7)	5 (83.3)	7 (58.4)	0.289
No (<3 score)	6 (33.3)	1 (16.7)	5 (41.6)	
Functional and physical characteristics				
Sarcopenia classification				
SARC-F (0–10 score)	5.5 (4.0–9.0)	5.5 (4–8)	5.5 (4–9)	1.000
Chair stand test (s)	20.6 (15.8–34.19	20.9 (15.8–34.1)	20.1 (15.8–26.5)	0.710
ASM (kg)	15.0 (11.3–19.8)	18.2 (15.1–19.8)	14.3 (11.3–16.92)	**0.014**
Gait speed (m/s)	0.4 (0.1–0.9)	0.4 (0.3–0.9)	0.4 (0.1–0.6)	0.892
Other variables				
Handgrip strength (kg)	19.5 (7.8–28.8)	23.3 (17.4–28.8)	18.2 (7.8–23.5)	**0.032**
Biceps brachii strength (kg)	10.6 (6.3–17.6)	13.5 (8.5–17.6)	9.1 (6.3–15.0)	0.053
Quadriceps strength (kg)	13.6 (6.8–27.7)	18.8 (11.0–27.7)	10.0 (6.8–14.6)	**0.013**
ASM/heigth^2 (kg/m^2)	6.4 (5.0–8.5)	6.9 (6.3–8.5)	6.1 (5.0–8.4)	0.160
ASM/BMI (kg/kg/m^2)	0.5 (0.4–0.7)	0.6 (0.5–0.7)	0.5 (0.4–0.6)	**0.001**
SPPB (0–12 score)	4 (1–7)	4.5 (2–7)	3.5 (1–7)	0.437
Timed Up-and-Go (s)	24.3 (13.8–94.5)	30.8 (13.8–45.5)	24.3 (18.0–94.5)	1.000
Emotional and cognitive characteristics				
SF-8 (0–40 score)	31 (14–39)	34 (14–39)	29.5 (20–39)	0.616
GDS—Short Form (0–15 score)	5 (3–12)	4.5 (4–8)	8 (3–12)	0.051
MMSE (0–35 score)	28.5 (19–34)	30.5 (20–33)	26.5 (19–34)	0.637

Note: The bold font value means significance of $p < 0.05$.

Abbreviations: Ab-Charlson, abbreviated Charlson comorbidity index; ASM, appendicular skeletal muscle mass; BMI, body mass index; GDS—Short Form, Geriatric Depression Scale—Short Form; MMSE, Mini-Mental State Examination; MNA, mini-malnutrition assessment screening; SF-8, eight-item Short-Form Health Survey; SPPB, Short Physical Performance Battery.

[a]*U* Mann–Whitney test.

[b]Chi-squared test.

physical–cognitive activities were reestablished (Resolución de 29 de mayo de, 2020).

In September 2020, the epidemiological evolution in the nursing home led to a second strict lockdown in this nursing home due to its incidence rate. Participants were confined to their rooms until December 2020, when mobility around the nursing home was restored. After this relaxation of the isolation measures, a follow-up assessment (T2) was carried out concurring with a 12-month time frame from the first assessment

TABLE 2 Analysis of functional and emotional variables assessments at pre-lockdown (T1), 12-month follow-up (T2), and 15-month follow-up (T3).

Variables	T1 Median (range) ($n = 18$)	T2 Median (range) ($n = 12$)	T3 Median (range) ($n = 11$)	χ^2_F	df	*p*-value[a]	*Z*	*p*-value[b]
Functional and physical characteristics								
Handgrip strength (kg)	19.5 (7.8–28.8)	18.1 (13.2–25.1)	16.1 (12–21.3)	1.636	2	0.441		NS
Chair stand test (s)	20.6 (15.8–34.1)	19.6 (13.5–25.8)	18.5 (15.5–42.8)	1.333	2	0.513		NS
Biceps brachii strength (kg)	10.6 (6.3–17.6)	6.9 (3.6–10.6)	4.7 (3.3–8.2)	16.55	2	<0.001	−2.982 −1.778 −2.934	0.001 T1–T2 0.025 T2–T3 0.001 T1–T3
Quadriceps strength (kg)	13.6 (6.8–27.7)	13.1 (3.5–20.9)	13 (6.2–17.0)	0.727	2	0.695		NS
ASM (kg)	15.0 (11.3–19.8)	15.3 (11.4–18.8)	14.9 (11.0–17.9)	5.636	2	0.060		NS
ASM Index (kg/m^2)	6.4 (5.0–8.5)	6.6 (5.2–8.4)	6.3 (5.0–8.0)	5.636	2	0.060		NS
Gait speed (m/s)	0.4 (0.1–0.9)	0.4 (0.1–0.7)	0.3 (0.1–0.6)	2.364	2	0.307		NS
SPPB (0–12 score)	4 (1–7)	4.5 (1–10)	3 (1–6)	4.5	1	0.034	−2.490 −2.484 −0.277	0.004 T1–T2 0.004 T2–T3 0.260 T1–T3
Balance (0–4 score)	2 (0–4)	2 (0–4)	1 (0–3)	12.563	2	0.002	−2.598 −2.588 −0.632	0.003 T1–T2 0.003 T2–T3 0.175 T1–T3
Side-by-side stand (s)	10 (0–10)	10 (4.5–10)	10 (7.6–10)	1.80	1	0.180		NS
Semi-tandem stand (s)	10 (0–10)	10 (0–10)	2 (0–10)	0.667	1	0.414		NS
Tandem stand (s)	0.5 (0–10)	2.1 (0–10)	0.0 (0–3.3)	0.000	1	1.000		NS
4-m walk (0–4 score)	1 (1–2)	1 (1–3)	1 (1–2)	1.80	1	0.180		NS
Walk (s)	10.1 (4.6–48.1)	10.5 (5.8–61.0)	12.9 (6.5–72.2)	2.634	2	0.307		NS
Chair stand test (0–4 score)	1 (0–2)	1 (0–3)	1 (0–2)	1.80	1	0.180		NS
Timed Up-and-Go (s)	24.3 (13.8–94.5)	33.2 (16.81–127.42)	28.2 (15.5–176.0)	3.455	2	0.178		NS
Emotional and cognitive characteristics								
MMSE (0–35 score)	28.5 (19–34)	27.5 (16–35)	25 (16–35)	8.581	2	0.014	−2.439 −1.633 −2.313	0.005 T1–T2 0.034 T2–T3 0.007 T1–T3
GDS—Short Form (0–15 score)	5 (3–12)	8.5 (5–13)	8 (5–12)	6.867	2	0.032	−2.418	0.005 T1–T2
SF-8 (0–40 score)	31 (14–39)	25 (13–35)	24.5 (18–39)	3.368	2	0.186		NS

Abbreviations: ASM, appendicular skeletal muscle mass; GDS—Short Form, Geriatric Depression Scale—Short Form; MMSE, Mini-Mental State Examination; NS, nonsignificant; SF-8, eight-item Short-Form Health Survey; SPPB, Short Physical Performance Battery.
[a]Friedman test.
[b]Post hoc Wilcoxon test.

of the participants. Although the vaccination schedule began in January 2021 and all study participants were vaccinated, an outbreak occurred within the nursing home that led to a new isolation lockdown until March 2021. It should be noted that none of the participants contracted the SARS-CoV-2 virus. Once this isolation period ended (March 2021), the second follow-up was conducted (T3).

2.7 | Statistical analyses

Statistical analyses were carried out in SPSS 26 (IBM Corporation, Armonk, NY, USA) and included, for descriptive purposes, the median and minimum–maximum values for quantitative variables, whereas the number of cases and percentages were estimated for categorical variables. The assumption of normality of the dependent variable was not met, and since the study had a small sample size, nonparametric inferential statistics were applied. To compare baseline characteristics according to sex, Mann–Whitney *U* tests were conducted for quantitative variables, and for qualitative variables, the nonparametric chi-squared test was carried out. For inferential analyses, to compare the variables at the three time points of functional and emotional variables, Friedman's ANOVA and post hoc Wilcoxon's test were used, adjusting the significance for the total number of comparisons.

TABLE 3 Sarcopenia classification following the four steps of the EWGSOP2 algorithm: individual scores for the 12 participants that were assessed at follow-up.

		SARC-F (0–10 score)			Chair stand test (s)			ASM			Gait speed (m/s)			Classification		
Participant	Sex	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
1	W	4	4	4	15.86	18.87	18.36	14.29	15.50	14.91	0.36	0.53	0.54	SS	PS	SS
2	M	6	6	7	34.14	[a]	[a]	19.03	18.84	17.91	0.26	0.09	0.07	SS	SS	SS
3	M	4	4	D	20.64	25.83	D	[b]	[b]	D	0.43	0.35	D	PS	PS	D
4	M	8	8	5	[a]	[a]	[a]	16.03	16.91	15.49	0.31	0.42	0.53	SS	SS	SS
5	W	9	9	7	[a]	[a]	[a]	16.92	15.13	15.58	0.21	0.33	0.28	PS	PS	PS
6	W	7	7	7	22.63	[a]	[a]	16.16	15.78	15.80	0.51	0.23	0.28	PS	PS	PS
7	W	6	6	5	26.45	19.63	18.72	15.24	12.86	12.34	0.27	0.35	0.28	PS	SS	SS
8	M	4	4	6	15.8	13.45	27.72	15.05	15.41	14.81	0.87	0.67	0.31	CS	PS	SS
9	W	4	4	7	18.3	23.19	42.83	12.02	11.44	11.01	0.49	0.52	0.40	SS	SS	SS
10	W	7	7	7	[a]	[a]	[a]	14.72	13.98	12.88	0.08	0.07	0.06	SS	SS	SS
11	W	4	4	5	15.76	19.03	16.60	16.67	15.32	14.60	0.42	0.44	0.36	PS	PS	SS
12	W	6	6	6	16.73	20.2	15.48	11.33	14.09	15.30	0.56	0.69	0.61	SS	SS	PS

Note: Participant number 3 had a pacemaker so bioimpedance analysis was contraindicated.
Abbreviations: ASM, appendicular skeletal muscle mass; CS, confirmed sarcopenia; D, death; M, man; PS, probable sarcopenia; SS, severe sarcopenia; T1, pre-lockdown; T2, 12-month follow-up; T3, 15-month follow-up; W, woman.
[a]Inability to perform the test.
[b]Inability to perform bioimpedance analysis, precludes classifying this participant beyond confirmed sarcopenia.

3 | RESULTS

A total of 18 institutionalized older adults with sarcopenia were analyzed, with a median age of 86.5 years, 66.7% being women. Enrollment and follow-up data are depicted in Figure 1.

The baseline characteristics of the sample (Table 1) showed a low number of hospitalizations, low comorbidity, absence of malnutrition, and an acceptable quality of life. However, participants were overweight (>25 kg/m^2), had moderate dependence for ADL, polypharmacy, and two thirds were frail. The baseline characteristics between sexes showed significant differences related to muscle strength and quantity, but not in physical performance variables. In relation to emotional and cognitive characteristics, women showed a higher level of depressive symptoms.

3.1 | Functional and physical changes between pre-lockdown, 12-month follow-up, and 15-month follow-up

Sarcopenia screening with the SARC-F did not significantly change at follow-up measurements, $\chi^2(2) = 0.283$, $p = 0.86$. The muscle strength variables showed a slightly different behavior between the upper and lower limbs. Regarding upper limbs, there was a significant decrease in biceps brachii strength ($\chi^2(2) = 16.55$, $p < 0.001$) (Table 2) and a decreasing trend of handgrip strength median through the follow-up measurements. In relation to lower limbs, neither the chair stand test nor the quadriceps femoris strength significantly changed, although there was a decreasing trend in the medians of both over time. Moreover, there was an increase in the number of people unable to perform the chair stand test (Table 3), from three people at T1 to five at T2 and T3.

Regarding muscle mass variables, no significant changes were observed for any of them at T2 or T3, nor was there a notable change in the values of the medians.

In relation to physical performance, although there was no significant change in gait speed, an analysis conducted on the time spent when performing the Timed Up-and-Go test, and the Short Physical Performance Battery walking subtest showed the walking time increased, as can be seen in the median and the minimum and maximum intervals. This was more evident for the Short Physical Performance Battery walking subtest, and for the Timed Up-and-Go test, the decline was more evident between T1 and T2 than T1 and T3. A more detailed analysis of the individual changes in these tests is depicted in Table 4.

Moreover, the Short Physical Performance Battery showed significant differences, with an increase in the medians between T1 and T2, based on the increase in the balance component. However, there was a decrease between T2 and T3, which is also observed in the balance test for the tandem position. In this regard, in T3, balance in the tandem position is compromised. Moreover, an increase in people unable to perform semi-tandem and tandem was observed at T3 (Table 4).

An additional analysis compared the number of participants' falls during the year prior to the lockdown (March 2019–March 2020, retrieved from the institution's database) with falls during the year of lockdown (March 2020–March 2021), which showed a decrease in the median number of falls: 0.5 (0–16) versus 0 (0–8) ($p = 0.033$), respectively.

TABLE 4 Time spent in balance and gait tests of the SPPB, and in the TUG: individual scores for the 12 participants that were assessed at follow-up.

		Side-by-side stand (s)			Semi-tandem (s)			Tandem (s)			4-m walk (s)			Timed Up-and-Go (s)		
Participant	Sex	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
1	W	10	10	10	10	10	10	1.73	10	3.29	11.14	7.48	7.37	25.11	22.44	16.73
2	M	0	4.05	7.58	0	0	0	0	0	0	15.67	46.40	55.47	41.61	124.00	132.00
3	M	10	10	D	10	10	D	4.10	4.20	D	9.35	11.29	D	21.48	30.29	D
4	M	10	10	10	10	10	10	0	2.63	1.38	13.10	9.45	7.60	45.48	36.14	25.58
5	W	0	10	10	0	10	1.30	0	1.40	0	18.66	12.14	14.45	45.59	48.45	63.00
6	W	4.51	10	10	0	10	7.99	0	0	0	7.88	17.18	14.06	23.49	80.87	39.15
7	W	10	10	10	1.55	10	2.01	0	4.05	0	14.96	11.58	14.51	27.42	42.49	41.57
8	M	10	10	10	10	10	0	10	10	0	4.61	5.94	12.86	13.79	18.04	22.01
9	W	10	10	10	6.00	10	10	0	1.59	0	8.19	7.64	9.95	18.73	19.82	23.73
10	W	0	10	10	0	10	0	0	0	0	48.11	60.19	72.24	94.51	127.42	176.00
11	W	10	10	9.06	6.15	10	0	0	0	0	9.48	9.14	11.04	18.04	25.02	28.22
12	W	10	10	10	10	10	10	1.04	7.86	0	7.18	5.76	6.52	20.50	16.81	15.53

Abbreviations: D, death; M, man; SPPB, Short Physical Performance Battery; T1, time 1 or pre-lockdown; T2, time 2 or post-lockdown 12 months; T3, time 3 or post-lockdown 15 months; TUG, Timed Up-and-Go; W, woman.

3.2 | Emotional and cognitive changes between pre-lockdown, 12-month follow-up, and 15-month follow-up

The participants had significant cognitive deterioration ($\chi^2(2) = 8.581$, $p < 0.014$). Moreover, a significant increase in the score of the Geriatric Depression Scale—Short Form was observed ($\chi^2(2) = 6.867$, $p < 0.032$), with differences between T1 and T2. Moreover, there was a decreasing trend in the medians of the SF-8 quality of life questionnaire.

4 | DISCUSSION

This study showed that bicep strength was significantly reduced during lockdown, and other upper and lower limb strength variables all showed a decreasing trend, although no changes were found regarding muscle mass. Regarding physical performance, the Short Physical Performance Battery showed significant changes through the follow-up measurements, more specifically in the balance subtest. Moreover, cognitive and emotional characteristics were significantly affected, and quality of life showed a decreasing trend.

In regard to sarcopenia variables, muscle strength is a determinant of sarcopenia (Cruz-Jentoft et al., 2019) and is associated with morbidity in older adults, thus our results for strength variables could be of interest when studying sarcopenia. Independent mobility is probably one of the last daily tasks to be lost with aging (Sousa et al., 2015), and although institutionalized older adults were confined to their bedrooms during lockdown, walking, though reduced, was still an activity they could do. Thus, lower limb muscles may have been more dynamic. However, previously practiced activities, such as strength and balance exercises, were not implemented during lockdown. This may explain why biceps brachii strength did show a significant decrease and why generally both upper and lower limb muscles showed a trend of impairment. This detraining, especially in upper limbs, may have led to muscle disuse during lockdown, which has shown to be accompanied by a decline in strength (Wall & van Loon, 2013) and may have substantially contributed to the decline in biceps brachii strength. Moreover, it has previously been stated that older adults with a moderate-to-low physical activity status can show a decline in muscle strength, and this decline can impact their ability to rise from a chair or use the toilet with or without assistance (Wall & van Loon, 2013). In this study, there was a decrease in the number of participants able to perform the chair stand test at follow-up, which again suggests that lower limb strength was somehow affected.

Higher levels of upper and lower limb muscle strength have been previously associated with a lower risk of mortality (García-Hermoso et al., 2018). Therefore, in nursing homes where the population is more vulnerable and which may still have isolation measures, it seems the assessment of muscle strength could be considered to be valuable. If sarcopenia and functional decline are detected early, they can be treated early and their consequences can be prevented (Cebrià i

Iranzo et al., 2020). In addition, in relation to the results of the study, clinicians could consider that physical exercise may always have to be balanced between upper and lower limbs. If isolation measures do not allow supervised treatment in person, telerehabilitation programs could offer a solution for institutionalized older adults with sarcopenia.

Another of the sarcopenia variables, muscle mass, had no significant changes. Other studies related to COVID-19 pandemic restrictions have also reported no change in muscle mass (Hasegawa et al., 2021). Previous studies that also focused on participants with sarcopenia but had implemented resistance training (Cebrià i Iranzo et al., 2018) did not show changes in muscle mass but did for strength. Further, the latest sarcopenia guidelines indicate that strength is better than mass in predicting adverse outcomes (Cruz-Jentoft et al., 2019).

Due to aging, there are decrements in muscle size, which occur at a 0.5%–0.8% annual rate for people over 50 years of age, or higher after 60, due to loss of fiber number (Deschenes, 2004). Considering our sample median age was 86.5 years, muscle mass medians suggest that the near-to-cutoff values may be more related to aging than to lockdown mobility restrictions. However, loss of muscle mass among the aged directly results in diminished muscle function (Morley et al., 2020), which may explain our results regarding muscle strength and performance. Thus, participants had an initial low muscle mass and lockdown conditions reduced their strength and physical capability.

Following the sarcopenia algorithm, the physical performance assessments showed a deterioration between T1 and T3 for gait speed, Timed Up-and-Go test, and Short Physical Performance Battery, and the latter had statistical changes throughout the follow-up. All of them were already experiencing deterioration at baseline, which reinforces the idea that aging involves functional loss (Garcia Meneguci et al., 2021). Moreover, the scores got worse at follow-up, probably due to mobility restrictions, thus not performing physical activity regularly relates to functional and physical decline (Kirwan et al., 2020). This is in line with a previous study that also detected a decrease in physical performance during the COVID-19 lockdown in nursing homes (De Souza Oliveira et al., 2023). Poor physical performance and institutionalization are associated with disability (Serrano-Urrea et al., 2017); thus, our participants may have increased their disability risk during lockdown. Moreover, when analyzing the Short Physical Performance Battery subtests, the balance subtest showed a significant decrease. Agility skills and balance have been shown to be significant in relation to disability, especially in instrumental ADL. Therefore, the physical function of our participants during the 15-month period declined and probably could have placed them at a higher risk of morbidity, which, in the pandemic, was not a minor problem.

Sarcopenia is associated with functional disability, a higher rate of falls, fractures, and incidence of hospitalizations (Beaudart et al., 2017). Moreover, in Spain, a significant proportion of COVID-19-associated deaths have been in nursing homes (Fallon et al., 2020). In spite of this, participants had low rates of hospitalizations, and the number of falls during the year of restrictions compared with the prior was reduced. The decrease in physical activity, walking, and movement due to isolation measures could explain this. In terms of sarcopenia screening, the decrease in the number of falls, although it led to a decrease in the SARC-F score (participants 4, 5, and 7), did not prevent them from becoming probable sarcopenic (score >4).

The results of the present study also showed there was a significant decrease in the cognitive and emotional sphere. Some risk factors previously described for cognitive impairment are physical activity reduction and an increase in sedentary behavior, both of which were aspects of lockdown and are also associated with sarcopenia (Ammar et al., 2020). Moreover, there was a higher suspicion of depression at follow-up, and this is related to a further decline in cognition (Santos et al., 2017). Depression and loneliness have also been related to falls, fear of falling, and disability (Martínez-Arnau et al., 2021). Previous studies have concluded that all older adult groups experienced depression and anxiety during the pandemic (Meng et al., 2020), and we have reported a significant cognitive change. Quality of life also showed a decrease, which can be explained by restrictive measures, loneliness, fear, and decrease in physical and mental stimulation, as has been shown by another study related to lockdown (Savci et al., 2021). Other studies have also shown a worsening in rates of depression (Meng et al., 2020) and cognitive functioning, and a decline in the well-being of nursing home residents as a result of lockdown (Levere et al., 2021).

4.1 | Limitations and strengths

The main limitation of the study was not having a control group, which did not allow us to assess whether those without sarcopenia might have deteriorated in the same manner and eventually become sarcopenic. Other limitations were the small sample size and the fact that the study was a single-center one. We did not have access to other nursing homes because external researchers were not allowed in institutions where populations such as older adults, who are especially vulnerable to COVID-19 with high mortality rate, lived. However, our objective was not statistical generalization but rather to provide transferability to similar contexts and guidance for health professionals regarding the physical and/or emotional consequences of isolation measures.

As strengths, our study shows a 15-month follow-up at a time when researchers were not allowed to access nursing homes and only workers could do so. In addition, participants were from the same center, thus making it possible to control nutritional habits and lifestyle conditions. Finally, our results, although interpreted with caution, suggest that nursing home clinicians could focus on assessing muscle strength, balancing upper and lower limb exercises, and focus on their emotional areas when isolation measures are applied, such as during the COVID-19 pandemic. Future research could further consider the importance of studying the impact of disuse in older adults with sarcopenia, and how muscle strength may contribute to maintaining independence and preventing further deterioration.

5 | CONCLUSIONS

Lockdown for institutionalized older adults with sarcopenia is associated with a loss of functional capacity and emotional deterioration, which clinicians should address in isolation measures due to COVID-19 or other infectious diseases. Particularly, biceps brachii strength and Short Physical Performance Battery performance are the measurements that

show the greatest deterioration in physical condition, although our results should be considered with caution due to our small sample size.

5.1 | Clinical implications

In nursing homes, there are high rates of sarcopenic older adults due to sedentary behavior and a higher prevalence of comorbidities. Our results seem to highlight that nursing home clinicians could focus on assessing muscle strength and balancing upper and lower limb exercises if isolation periods are required. Addressing the emotional areas of institutionalized older adults with sarcopenia is also of paramount importance. Therefore, both physical and emotional spheres should be taken into account in isolation situations that may occur in the healthcare of vulnerable populations.

AUTHOR CONTRIBUTIONS

Anna Arnal-Gómez: Conceptualization; methodology; formal analysis; writing – original draft; writing – review and editing; investigation. **Natalia Cezón-Serrano:** Conceptualization; methodology; investigation; formal analysis; data curation; writing – original draft; writing – review and editing. **Laura Arjona-Tinaut:** Conceptualization; methodology; investigation; writing – original draft; writing – review and editing. **María Àngels Cebria i Iranzo:** Conceptualization; methodology; investigation; formal analysis; data curation; writing – original draft; writing – review and editing.

ACKNOWLEDGMENTS

We gratefully acknowledge the participation of residents and staff of the nursing home "El Mas," located in Torrente, in the province of Valencia (Spain).

FUNDING INFORMATION

This research was funded by the Generalitat Valenciana (GV/2019/131).

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data is available under reasonable request.

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How to cite this article: Cezón-Serrano, N., Arnal-Gómez, A., Arjona-Tinaut, L., & Cebrià i Iranzo, M. À. (2023). Functional and emotional impact of COVID-19 lockdown on older adults with sarcopenia living in a nursing home: A 15-month follow-up. *Nursing & Health Sciences*, 1–12. https://doi.org/10.1111/nhs.13050

Anexo 4. Resolución concesión proyecto SARCOFUNC

RESOLUCIÓN de 9 de julio de 2019, de la Conselleria de Innovación, Universidades, Ciencia y Sociedad Digital, por la que se conceden subvenciones para la realización de proyectos de I+D+i desarrollados por grupos de investigación emergentes – GV/2019

Por Orden 86/2016, de 21 de diciembre, de la Conselleria de Educación, Investigación, Cultura y Deporte (DOGV núm. 7943 / 23.12.2016), modificada por Orden 37/2017, de 26 de septiembre, de la Conselleria de Educación, Investigación, Cultura y Deporte (DOGV núm. 8137 / 28.09.2017) se aprueban las bases reguladoras para la concesión de subvenciones del Programa para la promoción de la investigación científica, el desarrollo tecnológico y la innovación en la Comunitat Valenciana, entre ellas las subvenciones para la realización de proyectos de I+D+i desarrollados por grupos de investigación emergentes, Título II, Capítulo II, Sección primera, artículos 74 a 78.

Por Resolución de 1 de agosto de 2018, de la Conselleria de Educación, Investigación, Cultura y Deporte, se convocaron, para el ejercicio 2019, las subvenciones del Programa para la promoción de la investigación científica, el desarrollo tecnológico y la innovación en la Comunitat Valenciana (DOGV núm. 8355 / 06.08.2018), entre ellas las subvenciones para la realización de proyectos de I+D+i desarrollados por grupos de investigación emergentes – GV/2019 (Anexo IX).

Por Resolución de 11 de febrero de 2019, de la Conselleria de Educación, Investigación, Cultura y Deporte (DOCV núm. 8488 de 18 de febrero de 2019) se da publicidad al importe global máximo destinado a las subvenciones previstas en la Resolución de 1 de agosto de 2018, de la Conselleria de Educación, Investigación, Cultura y Deporte, del Programa para la promoción de la investigación científica el desarrollo tecnológico y la innovación en la Comunitat Valenciana, para el ejercicio 2019.

La disposición adicional segunda de la Orden 86/2016, de 21 de diciembre, de la Conselleria de Educación, Investigación, Cultura y Deporte, dispone que de acuerdo con lo establecido en el artículo 16 de la Ley 2/2009, de 14 de abril, de la Generalitat, de Coordinación del Sistema Valenciano de Investigación, Ciencia y Desarrollo Tecnológico, las subvenciones para la realización de proyectos de I+D+i desarrollados por grupos de investigación emergentes – GV/2019 tendrán alcance plurianual y el punto 3 del artículo 74 de la sección primera del capítulo II del título II donde se regulan estas ayudas, dispone que la ayuda tendrá una duración máxima de dos años.

Una vez finalizado el proceso de evaluación, la comisión evaluadora constituida al efecto ha elevado su propuesta de resolución, de conformidad con el artículo 19.1 del título I, disposiciones y bases generales de las subvenciones, de la Orden 86/2016, de 21 de diciembre.

Por ello, de acuerdo con lo dispuesto en el artículo 12 del Decreto 5/2019, de 16 de junio, del president de la Generalitat, por el que se determinan el número y la denominación de las consellerias, y sus atribuciones (DOGV núm. 8572/17.06.2019) y el Decreto 6/2019, de 17 de junio, del president de la Generalitat, por el que nombra a las personas titulares de las vicepresidencias y de las consellerias (DOGV núm. 8572/17.06.2019), dicto la siguiente:

RESOLUCIÓN

Primero

Conceder las subvenciones para la realización de proyectos de I+D+i desarrollados por grupos de investigación emergentes correspondientes a la convocatoria establecida en el anexo IX, de la Resolución de 1 de agosto de 2018, de la Conselleria de Educación, Investigación, Cultura y Deporte (DOCV núm. 8355, de 6 de agosto de 2018), a los beneficiarios que se indican en el anexo I de la presente resolución, y en las cuantías indicadas en el mismo, con cargo a la aplicación presupuestaria 09.02.03.542.50.7, línea de subvención S4015 de la Conselleria de Educación, Investigación, Cultura y Deporte, distribuidas en las siguientes anualidades:

Aplicación	2019	2020
09.02.03.542.50.7	638.225,64	458.385,14

Segundo

De conformidad con lo dispuesto en el artículo 44, apartado 2 f) de la Ley 28/2018, de 28 de diciembre de 2018, de presupuestos de la Generalitat para el ejercicio 2019, estas subvenciones podrán librarse anticipadamente al 100 por cien a las universidades públicas valencianas, al Consejo Superior de Investigaciones Científicas y a las entidades a que se refiere el artículo 2.3 de la Ley 1/2015, de 6 de febrero, de la Generalitat, de Hacienda Pública, del Sector Público Instrumental y de Subvenciones. A las restantes entidades se librará, previa justificación de la realización de la actividad para la que fueron concedidas.

Tercero
Denegar las subvenciones para la realización de proyectos de I+D+i desarrollados por grupos de investigación emergentes – GV/2019 correspondientes a la convocatoria establecida en el anexo IX de la resolución de 1 de agosto de 2018, de la Conselleria de Educación, Investigación, Cultura y Deporte (DOCV núm. 8355 de 06/08/2018), que se relacionan en el anexo II de la presente resolución.

Cuarto
Los beneficiarios deberán cumplir las obligaciones y normas de justificación previstas en el título I y en la sección primera del capítulo II del título II de la Orden 86/2016, de 21 de diciembre, de la Conselleria de Educación, Investigación, Cultura y Deporte (DOCV núm. 7943 de 23/12/2016) por la que se aprobaron las bases reguladoras para la concesión de subvenciones del Programa para la promoción de la investigación científica, el desarrollo tecnológico y la innovación en la Comunitat Valenciana y en el anexo IX de la resolución de 1 de agosto de 2018, de la Conselleria de Educación, Investigación, Cultura y Deporte, (DOGV núm. 8355 / 06.08.2018), por la que se convocaron, entre otras, las subvenciones para la realización de proyectos de I+D+i desarrollados por grupos de investigación emergentes – GV/2019.

El plazo máximo para la presentación de los documentos justificativos de estas subvenciones será el 14 de febrero de 2020 para las entidades con pago anticipado, y hasta el 20 de noviembre de 2019 para las restantes entidades.

Para el resto de anualidades el plazo de justificación se publicará en la página web de la Conselleria de Educación, Investigación, Cultura y Deporte (http://www.ceice.gva.es) mediante instrucción de la Dirección General de Universidad, Investigación y Ciencia.

Quinto
Publicar la presente resolución, mediante anuncio en el servidor de información de la Conselleria de Educación, Investigación, Cultura y Deporte (http://www.ceice.gva.es).

De conformidad con lo establecido en los artículos 112, 123 y 124 de la Ley 39/2015, de 1 de octubre, del procedimiento administrativo común de las administraciones públicas, y los artículos 10 y 46 de la Ley 29/1998, de 13 de julio, reguladora de la jurisdicción contencioso-administrativa, contra la presente resolución, que pone fin a la vía administrativa, se podrá interponer recurso potestativo de reposición o bien plantear directamente un recurso contencioso administrativo, en los plazos y ante los órganos que se indican a continuación:

a) El recurso de reposición deberá interponerse ante el órgano que dictó el acto en el plazo de un mes a contar desde el día siguiente al de la publicación de la presente resolución.

b) El recurso contencioso administrativo deberá plantearse ante el Tribunal Superior de Justicia de la Comunitat Valenciana en el plazo de dos meses a contar desde el día siguiente al de la publicación de la presente resolución.

Alicante, 9 de julio de 2019
La consellera de Innovación, Universidades, Ciencia y Sociedad Digital
Carolina Pascual Villalobos

ANEXO I

Concesión de las subvenciones para la realización de proyectos de I+D+i desarrollados por grupos de investigación emergentes GV/2019

ENTIDAD	CIF	IMPORTE 2018	IMPORTE 2019
CENTRO DE INVESTIGACIÓN BIOMÉDICA EN RED. (CIBER)	G85296226	15.496,60	15.997,00
ESCUELA SUPERIOR DE GESTIÓN COMERCIAL Y MARKKETING	R4600820G	8.000,00	8.000,00
FLORIDA CENTRO DE FORMACION COOP V	F46278669	7.700,00	7.900,00
FUNDACIÓN C.V.DE INVESTIGACIÓN PRÍNCIPE FELIPE	G46923421	7.805,00	7.805,00
FUNDACIÓN INVESTIGACIÓN HOSPITAL CLÍNICO UNIVERSITARIO DE VALENCIA	G96886080	16.000,00	16.000,00
FUNDACIÓN DE LA COMUNIDAD VALENCIANA HOSPITAL PROVINCIAL DE CASTELLÓN	G12633228	8.000,00	8.000,00
FUNDACIÓN INSTITUTO VALENCIANO DE ONCOLOGIA	G46129698	8.000,00	8.000,00
FUNDACIÓN PARA EL FOMENTO DE LA INVESTIGACIÓN SANITARIA Y BIOMÉDICA DE LA COMUNIDAD VALENCIANA	G98073760	39.915,25	40.000,00
FUNDACIÓN PARA LA INVESTIGACIÓN HOSPITAL UNIVERSITARIO LA FE	G97067557	23.751,40	16.266,00
UNIVESIDAD MIGUEL HERNÁNDEZ DE ELCHE	Q5350015C	47.242,00	31.260,00
UNIVERSIDAD CARDENAL HERRERA-CEU	G28423275	50.176,50	51.735,00
UNIVERSIDAD CATÓLICA DE VALENCIA SAN VICENTE MARTIR	G97025787	5.000,00	5.000,00
UNIVERSIDAD DE ALICANTE	Q0332001G	50.858,36	36.336,94
UNIVERSIDAD EUROPEA DE VALENCIA, SLU	B97934467	15.000,00	15.500,00
UNIVERSITAT JAUME I DE CASTELLÓN	Q6250003H	77.167,53	34.675,20
UNIVERSITAT DE VALÈNCIA	Q4618001D	194.275,00	148.060,00
UNIVERSITAT INTERNACIONAL VALENCIANA,S.L.	B98585797	7.888,00	7.850,00
UNIVERSITAT POLITÉCNICA DE VALÈNCIA	Q4618002B	55.950,00	0,00
	TOTAL	638.225,64	458.385,14

EXPEDIENTE	INVESTIGADOR PRINCIPAL	ENTIDAD	TOTAL	TOTAL 2019	TOTAL 2020
GV/2019/055	PUIG PÉREZ, SARA	UNIVERSITAT INTERNACIONAL VALENCIANA, S.L.	105	7.888,00	7.850,00
GV/2019/111	ANDREU MIRALLES,XAVIER	UNIVERSITAT DE VALÈNCIA	105	8.000,00	8.000,00
GV/2019/146	DIAGO NEBOT, PASCUAL DAVID	UNIVERSITAT DE VALÈNCIA	105	8.000,00	0,00
GV/2019/016	TRILLES OLIVER, SERGIO	UNIVERSITAT "JAUME I" DE CASTELLÓN	105	7.978,98	0,00
GV/2019/088	CASTILLO GOMEZ, ESTHER	UNIVERSITAT "JAUME I" DE CASTELLÓN	105	8.000,00	0,00
GV/2019/063	ROIG TIERNO, HONORAT	ESCUELA SUPERIOR DE GESTIÓN COMERCIAL Y MARKETING	105	8.000,00	8.000,00
GV/2019/130	GALLEGO ALBIACH, VICTOR	UNIVERSITAT POLITÈCNICA DE VALÈNCIA	103	8.000,00	0,00
GV/2019/025	UBEDA CASTELLANOS, ANDRES	UNIVERSIDAD DE ALICANTE	103	8.000,00	8.000,00
GV/2019/129	CARDELLS PERIS, JESÚS	UNIVERSIDAD CARDENAL HERRERA - CEU	103	7.900,00	7.900,00
GV/2019/033	PLAZAS AVILA, MARIA DE LA O	UNIVERSITAT POLITÈCNICA DE VALÈNCIA	101	8.000,00	0,00
GV/2019/114	BRÍGIDO CORACHÁN, ANA Mª	UNIVERSITAT DE VALÈNCIA	101	2.800,00	3.700,00
GV/2019/154	PULIDO ENDRINO, INES	UNIVERSITAT DE VALÈNCIA	101	8.000,00	0,00
GV/2019/095	SUSO RIBERA, CARLOS	UNIVERSITAT "JAUME I" DE CASTELLÓN	101	7.736,00	7.700,00

EXPEDIENTE	INVESTIGADOR PRINCIPAL	ENTIDAD	TOTAL	TOTAL 2019	TOTAL 2020
GV/2019/134	PERNI LLORENTE, REMEDIOS	UNIVERSIDAD DE ALICANTE	101	8.000,00	8.000,00
GV/2019/049	CABRERA PASTOR, ANDREA	FUND. INVESTIGACIÓN HOSPITAL CLÍNICO UNIVERSITARIO DE VALENCIA	101	8.000,00	8.000,00
GV/2019/028	LLORENS VILARROCHA, EUGENIO	UNIVERSITAT "JAUME I" DE CASTELLÓN	99	8.000,00	0,00
GV/2019/077	LLOP GARCIA, MARTA	FUNDACIÓN PARA LA INVESTIGACIÓN HOSPITAL UNIVERSITARIO LA FE	99	7.951,40	7.916,00
GV/2019/109	TORMO MARTIN, EDUARDO	CENTRO DE INVESTIGACIONES BIOMÉDICAS EN RED (CIBER)	99	7.500,00	8.000,00
GV/2019/149	IZQUIERDO SANCHIS, MARTA	UNIVERSITAT DE VALÈNCIA	97	8.000,00	8.000,00
GV/2019/159	SALAS VALLINA, ANDRES	UNIVERSITAT DE VALÈNCIA	97	7.900,00	7.500,00
GV/2019/164	TODOLI SIGNES, ADRIAN	UNIVERSITAT DE VALÈNCIA	97	8.000,00	8.000,00
GV/2019/075	GONZÁLVEZ MACIÁ, CAROLINA	UNIVERSIDAD DE ALICANTE	97	6.800,00	0,00
GV/2019/039	GRACIÁ MARTÍNEZ, EVA	UNIVERSIDAD "MIGUEL HERNANDEZ" DE ELCHE	97	8.000,00	0,00
GV/2019/037	FERNANDEZ CABALLERO FARIÑAS, M.ª DOLORES	UNIVERSITAT POLITÈCNICA DE VALÈNCIA	95	8.000,00	0,00
GV/2019/116	CANO CEBRIÁN, M.ª JOSE	UNIVERSITAT DE VALÈNCIA	93	8.000,00	4.700,00
GV/2019/148	GUILLÉN BOTELLA, VERONICA	UNIVERSITAT DE VALÈNCIA	93	7.950,00	7.950,00
GV/2019/166	LÓPEZ FRANCÉS, INMACULADA	UNIVERSITAT DE VALÈNCIA	93	7.100,00	6.200,00
GV/2019/173	RODRIGUEZ DEL PINO, JUAN ANTONIO	UNIVERSITAT DE VALÈNCIA	93	8.000,00	6.800,00
GV/2019/119	BALLESTER LURBE, BEGOÑA	UNIVERSIDAD CARDENAL HERRERA - CEU	93	8.000,00	8.000,00
GV/2019/110	CARPIO COBO, PABLO	UNIVERSITAT POLITÈCNICA DE VALÈNCIA	92	8.000,00	0,00
GV/2019/087	BELTRÁN SAN SEGUNDO, HECTOR	UNIVERSITAT "JAUME I" DE CASTELLÓN	92	8.000,00	8.000,00
GV/2019/141	GOMEZ-HURTADO CUBILLANA, ISABEL	FUNDACIÓN PARA EL FOMENTO DE LA INVESTIGACIÓN SANITARIA Y BIOMÉDICA DE LA COMUNIDAD VALENCIANA.	92	8.000,00	8.000,00
GV/2019/131	CEBRIÀ I IRANZO, M.ª DELS ANGELS	UNIVERSITAT DE VALÈNCIA	91	2.600,00	7.220,00
GV/2019/156	RANDAZZO, WALTER	UNIVERSITAT DE VALÈNCIA	91	8.000,00	0,00
GV/2019/161	SANCHEZ SANCHEZ, M.ª LUZ	UNIVERSITAT DE VALÈNCIA	91	1.200,00	6.600,00
GV/2019/105	GARCÍA SIMÓN, MÓNICA	FUND. INVESTIGACIÓN HOSPITAL CLÍNICO UNIVERSITARIO DE VALENCIA	91	8.000,00	8.000,00
GV/2019/167	MANGAS SANJUAN, VICTOR	UNIVERSITAT DE VALÈNCIA	90	6.475,00	2.700,00
GV/2019/122	ESCUDERO ORTIZ, VANESA	UNIVERSIDAD CARDENAL HERRERA - CEU	90	7.785,00	7.845,00
GV/2019/040	GUILABERT MORA, MERCEDES	UNIVERSIDAD "MIGUEL HERNANDEZ" DE ELCHE	90	7.942,00	7.860,00
GV/2019/104	GALIANA CABRERA, ANTONIO JOSÉ	FUNDACIÓN PARA EL FOMENTO DE LA INVESTIGACIÓN SANITARIA Y BIOMÉDICA DE LA COMUNIDAD VALENCIANA.	90	8.000,00	8.000,00
GV/2019/085	MACHADO PUERTO, ISIDRO	FUNDACIÓN INSTITUTO VALENCIANO DE ONCOLOGÍA	90	8.000,00	8.000,00
GV/2019/044	LUPO BARRETTA, VINCENZO	FUND. C.V. CENTRO DE INVESTIGACIÓN PRINCIPE FELIPE	90	7.805,00	7.805,00
GV/2019/099	CORRAL MARTINEZ, PATRICIA	UNIVERSITAT POLITÈCNICA DE VALÈNCIA	89	8.000,00	0,00
GV/2019/155	LLADOSA LÓPEZ, ESTELA	UNIVERSITAT DE VALÈNCIA	89	8.000,00	8.000,00
GV/2019/017	LOPEZ UBEDA, ISABEL	UNIVERSIDAD DE ALICANTE	89	5.258,36	6.786,94
GV/2019/021	MARTINEZ GUARDIOLA,FCO. JAVIER	UNIVERSIDAD DE ALICANTE	89	7.000,00	7.000,00
GV/2019/081	REYES CALZADA, SOLEDAD	FUNDACIÓN PARA LA INVESTIGACIÓN HOSPITAL UNIVERSITARIO LA FE	89	7.800,00	8.000,00

Anexo 5. Comité de ética

VNIVERSITAT DE VALÈNCIA Vicerectorat d'Investigació

D. José María Montiel Company, Profesor Contratado Doctor del departamento de Estomatología, y Secretario del Comité Ético de Investigación en Humanos de la Comisión de Ética en Investigación Experimental de la Universitat de València,

CERTIFICA:

Que el Comité Ético de Investigación en Humanos, en la reunión celebrada el día 13 de diciembre de 2018, una vez estudiado el proyecto de investigación titulado:
"Relación entre los puntos de corte diagnósticos de sarcopenia y la funcionalidad en adultos mayores (SARCOFUNC)",
número de procedimiento H1542733812827,
cuyo responsable es Dª María dels Àngels Cebrià i Iranzo, ha acordado informar favorablemente el mismo dado que se respetan los principios fundamentales establecidos en la Declaración de Helsinki, en el Convenio del Consejo de Europa relativo a los derechos humanos y cumple los requisitos establecidos en la legislación española en el ámbito de la investigación biomédica, la protección de datos de carácter personal y la bioética.

Y para que conste, se firma el presente certificado en Valencia, a diecinueve de diciembre de dos mil dieciocho.

Av. Blasco Ibáñez, 13 tel: 9638 64109 vicerec.investigacio@uv.es
València 46010 fax: 9639 83221 www.uv.es/serinves

ESPACIO DESTINADO PARA ANOTACIONES