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Prevalence of Sarcopenia According to the Method Used to Determine Physical Performance

Carlos Sáez and Sara García-Isidoro

Abstract

Sarcopenia is currently defined as a progressive and generalized skeletal muscle disorder that occurs with advancing age and is associated with an increased likelihood of adverse outcomes. Low levels of measures for muscle strength, muscle quantity, and physical performance define sarcopenia. In this chapter, we will see that the prevalence of a low value of physical performance will be different according to the method used to measure this parameter, and thus, it would be foreseeable to think that the prevalence of sarcopenia will also be different according to the method used. However, despite the differences found in physical performance, we will show that the prevalence of sarcopenia appears to be regardless of the method used for physical performance, and therefore, how is it possible that having a significant difference in the prevalence of physical performance depending on the method chosen, the prevalence of sarcopenia has an almost perfect agreement? To answer these questions, a new simplified model is studied, defining sarcopenia as low muscle strength and low muscle mass and without taking physical performance into account. Finally, we will see that, indeed, physical performance does not seem to be decisive or necessary for the diagnosis of sarcopenia.

Keywords: aging, prevalence, diagnosis, sarcopenia, EWGSOP

1. Introduction

1.1 Definition of sarcopenia

The term sarcopenia comes from the Greek words “*sarco*,” which means muscle, and “*penia*,” which means loss, and was used for the first time by Dr. Irwin Rosenberg, director of the “Research Center on Aging” at Boston University (USA) which in 1989 stated: “*the most dramatic and significant age-related physical decline was the loss of lean body mass*” (**Figure 1**) [1, 2].

Thus, sarcopenia was initially defined as “*normal and involuntary loss of muscle mass due to aging*” (Rosenberg, 1989).

This definition was based on the conceptual framework that states that the decline in muscle strength due to aging was due to a parallel decline in muscle mass. However, as the field of sarcopenia progressed, studies showed that the loss of age-related muscle strength outweighed the loss of muscle mass [3], so a definition of sarcopenia based only on muscle mass was not sufficient [4]. It was

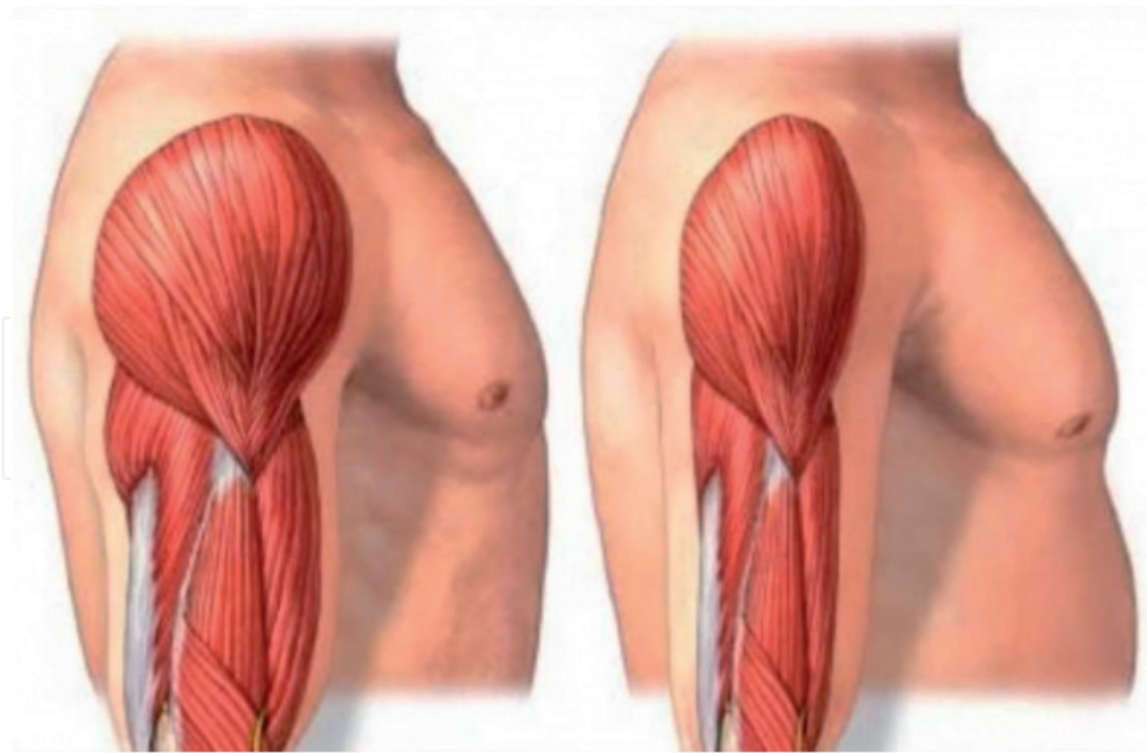


Figure 1.

Loss of muscle mass and strength due to aging (modified from: ADAM©, atlas of human anatomy. Todd R. Olson, 1997).

more precisely defined as [5]: “Decrease in muscle mass and strength due to aging” (Morley et al., 2001).

Since then, the number of scientific publications has increased. In those, among other findings, its possible causes and consequences were identified, and the concept of sarcopenia has evolved as different definitions emerged among researchers [6, 7]. Still, there was still a lack of a definition of sarcopenia that would be suitable both for use in research settings and in clinical practice, until significant progress was made in 2010 thanks to a joint publication by the European Working Group on Sarcopenia in Older People [8] (EWGSOP) in which sarcopenia was defined as: “A syndrome characterized by a gradual and generalized loss of skeletal muscle mass and muscle strength with the risk of causing adverse outcomes such as physical disability, poor quality of life and even mortality” (Cruz-Jentoft et al., 2010).

This new definition incorporated sarcopenia not only the loss of muscle mass and strength but also its consequences on physical performance [5, 9] and for many years, it was the definition that was used in most studies as a reference or “gold standard” for the diagnosis of sarcopenia [10].

In October 2016, the World Health Organization gave a new advance to this condition, since through the International Classification of Diseases in its 10th revision (ICD-10-CM) recognized sarcopenia not as a geriatric syndrome but as a disease (muscular), with the code M62.84 [11, 12]. This forced it to revise and update its definition again.

In the 10 years passed since the initial work of the European group in 2010, researchers and clinicians have explored many aspects of sarcopenia, and expert groups around the world have published complementary definitions of sarcopenia [13–15]. However, the more recent definition and the current one are the one proposed by this same group [16–21] who, in a review carried out in 2019, defined sarcopenia as “A progressive and generalized skeletal muscle disorder that

occurs with aging and is associated with a greater probability of adverse outcomes such as falls, fractures, physical disability and even mortality” (Cruz-Jentoft et al., 2019).

Despite all these advances, international expert groups from around the world still do not reach a consensus on a definition of sarcopenia that is widely accepted, although they have agreed on the mechanisms and clinical implications of sarcopenia [22, 23] and especially in the fact that muscle mass, muscle strength, and physical performance are important components for the diagnosis of this disease and that therefore, all these parameters must be measured [4].

1.2 Clinical consequences of sarcopenia

The clinical consequences of sarcopenia are basically due to loss of strength and muscle mass, not only in terms of functional disabilities, fractures, hospitalizations, and increased mortality [24], but also in quality of life [25].

In terms of human health, sarcopenia increases the risk of falls and fractures [26, 27] and impairs the ability to carry out activities of daily living [28]; it is associated with heart disease [29], respiratory disease [15], and cognitive impairment [30]; and leads to mobility disorders [13]; it contributes to a decrease in the quality of life [31] and ultimately death [26].

1.3 Sarcopenia categories

Sarcopenia is a disease with many causes and variable outcomes. In some people, a clear and unique cause of sarcopenia can be identified, largely attributable to aging, but in other cases, other causes can be identified. In this way, defining the sarcopenia categories as primary and secondary can be useful in clinical practice [8, 16].

Sarcopenia can be considered “primary” (or age-related) when there is no obvious cause other than aging. Sarcopenia is considered “secondary” when there are one or more obvious causes other than aging [16].

Sarcopenia staging is a concept that can help to guide its clinical treatment, in this way it can be categorized according to its severity in the following states [16]:

- The “*probable sarcopenia*” stage is characterized by low muscle strength with no effects on muscle mass or physical performance [16].
- The “*possible sarcopenia*” stage is characterized by low muscle strength or poor physical performance (normal muscle mass) [32].
- The “*presarcopenia*” stage is characterized by low muscle mass with no effects on muscle strength or physical performance [8].
- The “*sarcopenia*” stage is characterized by low muscle mass with low muscle strength or poor physical performance [8, 32, 33]. However, according to other authors this condition can also occur with low muscle mass and low muscle strength (without taking into account physical performance) or with low muscle mass and poor physical performance (without taking into account muscle strength) [13, 34].
- “Severe sarcopenia” or “severe” is the stage that is identified when the three parameters that determine sarcopenia are low: muscle mass, muscle strength, and physical performance [8, 16, 32].

Identifying the stages of sarcopenia helps in selecting treatments and setting appropriate recovery goals. Staging can also support the design of research studies that focus on a specific stage or changes in stages over time [8].

1.4 Parameters that define sarcopenia and variables that measure these parameters

The parameters that define sarcopenia are the amount of muscle and its function. The measurable variables are muscle mass, muscle strength, and physical performance [8].

Muscle mass can be expressed as total body skeletal muscle mass or as appendicular skeletal muscle mass, which is the sum of skeletal muscle mass of arms and legs [16].

Muscle strength refers to the amount of force that a muscle can produce with a single maximal effort [35].

The concept of the physical performance was defined for the first time to evaluate objectively and from a clinical point of view, how an individual performed different activities of daily living or physical tasks, as opposed to scales based on asking questions about the ability to perform these task [35]. However, since then, the concept of physical performance has evolved, and today, it is mainly related to ambulation and transfers [35], forming part of the most current definitions of sarcopenia.

The most up-to-date definition of physical performance was provided by Beudart et al. [35] in 2019, who defined it as: “*A function of the whole body objectively related to locomotion*” (Beudart et al., 2019).

1.5 Measurement of sarcopenia parameters

Currently, there are a wide variety of tests and tools available to measure the parameters that define sarcopenia [22, 36, 37], cost, availability, and ease of use, determine whether they are better adapted for clinical practice or more useful for research [8].

The selection of tools may depend on the patient (disability, mobility), access to technical resources in the setting where the tests are performed (community, clinic, hospital, or research center), or the purpose of the tests (monitoring of progression or follow-up of rehabilitation and recovery) [16].

Accurate measurement of muscle mass is a fundamental step to detect cases of patients with sarcopenia, and various techniques can be used for its quantification, but choosing one of them is not easy since all existing methods have advantages and disadvantages [38].

Nuclear magnetic resonance, computerized axial tomography, dual-energy X-ray absorptiometry, bioelectrical impedance analysis, determination of urinary creatinine excretion, and anthropometry are available [19].

There are few well-validated techniques to measure muscle strength, some assess upper extremity strength, and others lower extremity, and although the latter are more important for gait and physical function, and the two have been shown to be highly correlated [35]. Again, cost, availability, and ease of use determine whether techniques are best suited for clinical practice or useful for research purposes [8].

For the assessment of physical performance, there are a wide variety of tests. Short-distance walking tests can be used, such as the 2.4, 4, 6 m, or up to 10 m, or long-distance walking tests such as the 400-meter walk test, or the 6-minute walk test.

Other tests of physical performance are also the time up and go test (TUG), and the short physical performance battery (SPPB) [23].

2. Prevalence of sarcopenia according to the method used to determine physical performance

2.1 Prevalence of low physical performance

In the same definition of sarcopenia suggested by the European working group of Cruz-Jentoft et al. in 2010 (EWGSOP) [8], the prevalence of sarcopenia is already expected to be highly dependent on the method used to measure the diagnostic parameters of this disease and although there are several studies that have used the model proposed by the EWGSOP to determine the prevalence of sarcopenia and at least one from Beaudart et al. from 2015 [39], in which, using two different methods for both muscle mass and strength determination, significant differences were found in the prevalence of sarcopenia, as far as it has been found only the study of Sáez et al. de 2020 [40] compared the prevalence of sarcopenia, using three different methods for assessing physical performance, the usual gain speed (UGS), the time up and go test (TUG), and the short physical performance battery (SPPB), with the cut-off points recommended by the EWGSOP (**Table 1**).

According to this study, the prevalence of a low level of physical performance evaluated by these three different measurement methods, ranged globally, between 20.9 and 45.9%, increasing to 68.8% in the case of women [40]. The highest prevalence of low physical performance was obtained when evaluated by the UGS test, and it was lower for the TUG test (**Figure 2**). The prevalence of low physical performance was always higher in women than in men for any of the methods used for its determination [41]. These results are consistent with the fact that the average results of all physical performance tests were also lower for women [40].

Regarding the association and the concordance between the three tests used to assess physical performance, a significant association was found for all of them, with a low concordance, the overall concordance being between 71.1 and 78.6% [41]. These results show that the three tests used to determine physical performance are not interchangeable with each other and that the choice of one or the other would give significantly different results in the prevalence of physical performance [40].

2.2 Prevalence sarcopenia

According to these results of the study by Sáez et al. [40] that show a discordance in the prevalence of physical performance, and while this parameter is used for the diagnosis of sarcopenia, in the same way, we could expect discordant results on the prevalence of sarcopenia depending on the method used to determine physical performance, even applying the same diagnostic algorithm for all of them and defining sarcopenia as low muscle mass and low muscle function (muscle strength or physical performance) (**Table 2**) [8].

However, the results found showed similar sarcopenia prevalence values regardless of the method used for physical performance (6.0 vs. 63.9 vs. 67.0%) (**Table 3**) and with a concordance almost perfect [40].

Physical performance test	Cut points
Usual gain speed test (UGS)	≤0.8 m/s
Short physical performance battery (SPPB)	≤8 points
Up-and-go test (TUG)	≥20 seconds

Table 1.
Physical performance tests and cut points recommended by the EWGSOP.

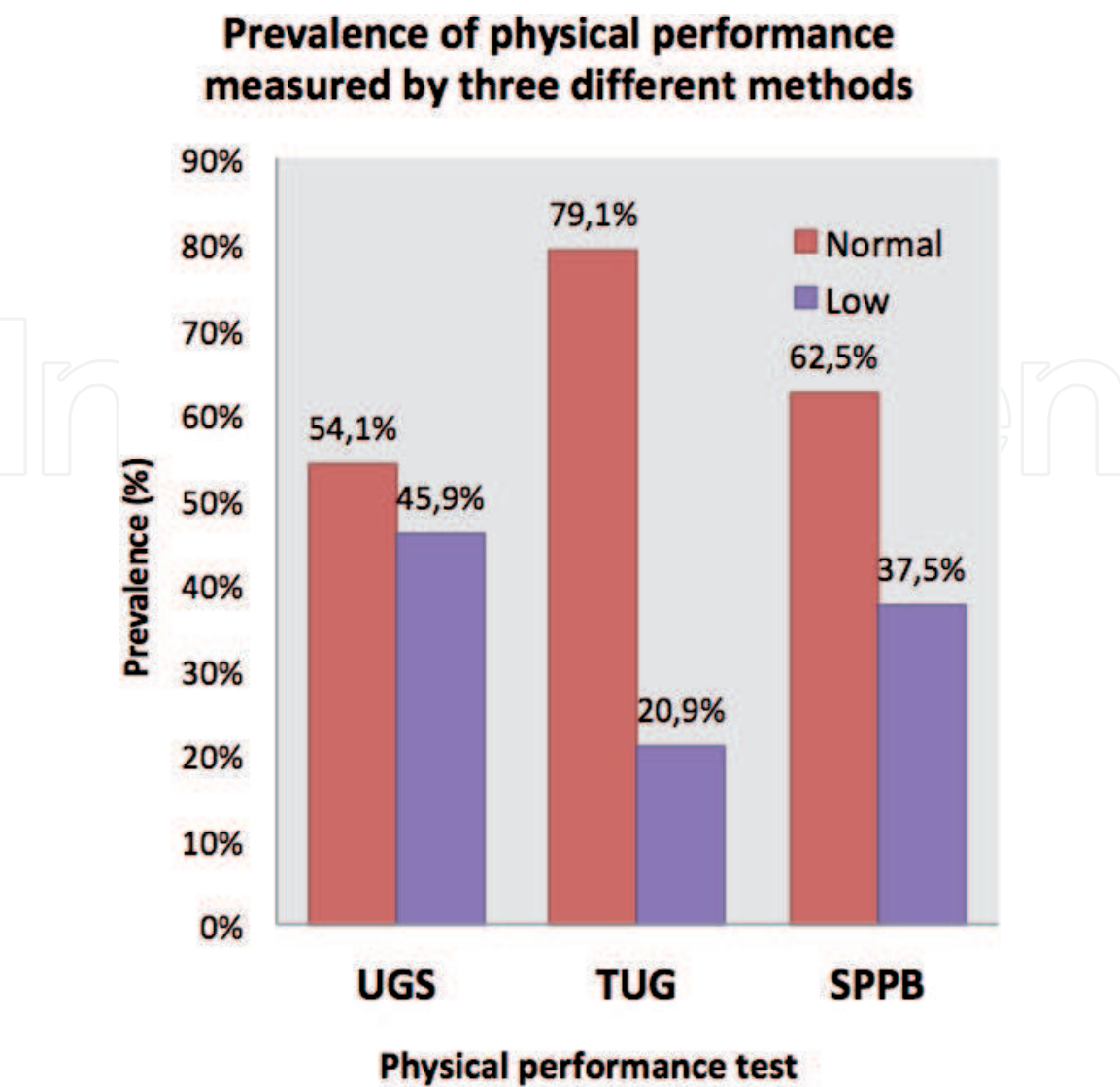


Figure 2.
Prevalence of physical performance using three different methods: Usual gait speed (UGS); get-up-go test (TUG); short physical performance battery (SPPB) (Sáez et al., 2020).

Muscle mass		Muscle function	
↓	AND	Muscle strength	↓
		OR	
		Physical performance	

Table 2.
Criteria for the diagnosis of sarcopenia according to the EWGSOP.

Physical performance test	Prevalence of sarcopenia		
	Total (%)	Men (%)	Women (%)
Usual gain speed test (UGS)	66.0	55.2	70.6
Short physical performance battery (SPPB)	63.9	55.2	67.6
Up-and-go test (TUG)	67.0	55.2	72.1

Table 3.
Sarcopenia prevalence comparing three different methods for the determination of physical performance (Sáez et al., 2020).

That is, an excellent concordance was found between the prevalence of sarcopenia regardless of the method used to assess physical performance, but at the same time with low concordance between the methods used to determine this parameter [40].

This finding allows us to hypothesize that possibly the diagnostic model used could not be dependent on the method used to determine physical performance and that therefore, the choice of one or another measurement technique for this parameter would not affect or influence the prevalence and the final diagnosis of sarcopenia [41].

These prevalence results are what would be expected and would be consistent with the definition of Cruz-Jentoft et al. of 2010 [8], suggesting that it is possible to choose any of the three methods of physical performance proposed by this group, which should be equally valid, and therefore give similar results for the prevalence of sarcopenia.

However, at this point, the following reflection could be made: *How is it possible that there is a significant difference in the prevalence of physical performance depending on the method chosen and a low concordance between the three methods used for its determination, and that the prevalence of sarcopenia has a near-perfect match? Could it be that physical performance was not a determining parameter for the diagnosis of sarcopenia?*

To answer these questions, it was proposed to apply a new model (**Table 4**), defining sarcopenia as low muscle strength plus low muscle mass and without taking physical performance into account, and comparing and assessing the concordance of the prevalence between this new algorithm and the one proposed by the EWGSOP in 2010 [40] for three different methods of assessing physical performance.

The prevalence of sarcopenia found according to this new algorithm was 63.9%, the association with the previous results, where physical performance was taken into account, was significant, and the agreement between them was excellent (**Figure 3**) [41].

These findings would indicate that indeed, being the agreement between the four cases almost perfect, physical performance does not seem to be determining or necessary for the diagnosis of sarcopenia [41].

The justification for these results is that for at least 95.4% of the cases in which the diagnosis is sarcopenia, muscle mass and strength have a low value, and according to the definition used for the diagnosis of sarcopenia (**Table 2**), this condition would be sufficient to confirm a positive case. In this way, the value, whether normal or low, of physical performance would no longer change the result of the diagnosis, and therefore for this 95.4% of cases, the method used to determine this parameter would no longer be relevant.

That is, most of the patients with low values of physical performance for any of the three tests (more than 82.4%) also had low values of muscle mass and strength [41], and thus when determining sarcopenia, the assessment of physical performance was indifferent.

Therefore, if the objectives were to find sarcopenia cases in a chosen population, a new diagnostic model, where sarcopenia was defined only by a low value of muscle strength plus a low value of muscle mass without having to assess physical performance [40], would be sufficient, to obtain the same results as with the model proposed by Cruz-Jentoft et al. in 2010 [8] where physical performance was taken into account.

The results found are also consistent and could in this way reinforce the proposal made by other authors such as Studenski et al. in 2014 [14] or Cruz-Jentoft et al. in 2019 [16] who proposed new diagnostic models, where sarcopenia was defined and

Muscle mass		Muscle straight
↓	AND	↓

Table 4.
New criteria proposal for the diagnosis of sarcopenia (Sáez et al., 2020).

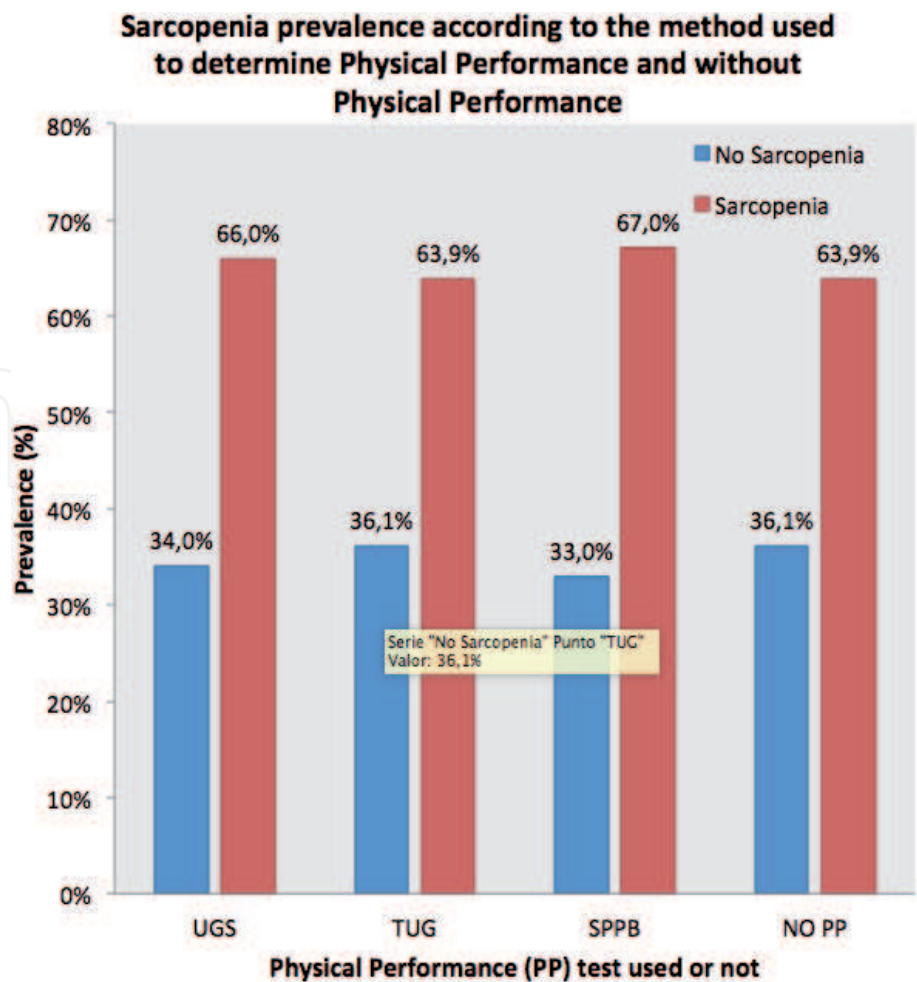


Figure 3.
Prevalence of sarcopenia using three different methods: Usual gait speed (UGS); get-up-go test (TUG); short physical performance battery (SPPB) and without physical performance (Sáez et al., 2020).

determined only taking into account these two properties of the muscle (strength and mass), without taking into account physical performance.

2.2.1 Older than 80 years

When the prevalence of sarcopenia was analyzed according to these four options, three taking into account physical performance and another without taking it into account, but for patients over 80 years of age, the results were even more conclusive, since the prevalence was the same in all cases (73.2%) and the agreement between them was perfect [41].

These results could mean two important things, first that sarcopenia is highly prevalent among the population over 65 years of age [42], but it could also mean that by increasing the age range from which sarcopenia is assessed, and the differences in the prevalence of this disease are reduced until identical results are found regardless of the method which is chosen to assess physical performance. This statement is consistent with that of other authors such as Petermann-Rocha et al. [43] who in a 2019 study in which they compared the prevalence between two diagnostic models, stated that the differences between the different results found in prevalence also decreased with increasing the age range considered. In other words, the greater the age range of the population studied, the less relevant it is to measure physical performance for the detection of cases of sarcopenia.

It has been found that concordance between these two diagnostic models remains perfect for patients 77 years of age or older and excellent for patients 75 years of age or older [41].

2.2.2 Sarcopenia staging

If the staging of sarcopenia in its different categories is taken into account (presarcopenia, sarcopenia, or severe sarcopenia), according to the model proposed by the EWGSOP in 2010, the results show that the prevalence of the state of presarcopenia and sarcopenia was higher for the physical performance measured with the TUG test, but for the severe sarcopenia state, the prevalence is higher with the UGS test [41].

Regarding the prevalence of absence of sarcopenia, it is observed that it is the same regardless of the method used for physical performance [41]. This is consistent since according to the EWGSOP definition, the absence of sarcopenia is determined only by a normal value of muscle mass, regardless of the value of the other two diagnostic parameters.

Regarding the association and concordance between the prevalence of sarcopenia states according to the method used for physical performance, a significant association was found and a global concordance percentage was greater than 76.0% in all cases, being the best 86.6% between the TUG and SPPB tests [41].

As mentioned above, a low concordance was found between the methods used to assess physical performance, and although on the other hand, it seems that the prevalence of sarcopenia would be independent of the method used to assess physical performance when assessing sarcopenia according to its states, it is observed that, although for the case of absence of sarcopenia, there are no variations in prevalence (17.5% for the three methods), for the state of presarcopenia, the greatest variation was 3.1% between the TUG test and the SPPB test, but these differences increased up to 16.5% points for the case of the severe sarcopenia state, between the UGS test and the TUG test [41]. The TUG test is the one that shows the greatest difference with respect to the other two in both sarcopenia and severe sarcopenia states.

These differences are due, on the one hand, to the fact that, as already mentioned, the three physical performance tests are not concordant with each other, and although it was found that this aspect did not influence the prevalence of sarcopenia, however, the severity of sarcopenia is influenced by physical performance, since according to the EWGSOP definition, the three diagnostic parameters must be low (**Table 2**).

When the prevalence of a low value of physical performance was assessed, precisely the TUG test was the one with the lowest prevalence (20.9%) with a difference of 25.0% points compared to the UGS test and 16.6% points regarding the SPPB, which is why the lowest value of severe sarcopenia was also obtained with this test [41].

On the other hand, it was the UGS test that had the highest prevalence of a low value for physical performance, which is why it was also the test that obtained the highest prevalence of severe sarcopenia. In fact, the higher the prevalence of the low value of physical performance, the higher the prevalence of severe sarcopenia [41].

This result was consistent with the definition of severe sarcopenia, for which this state only occurred with the low values of the three diagnostic parameters of this disease (**Table 2**), and therefore, physical performance is a necessary parameter if we want to determine the severity of sarcopenia.

3. Conclusions

The prevalence of sarcopenia obtained by applying the diagnostic algorithm proposed by the EWGSOP in 2010 [8] was very similar regardless of the method, which was used to determine physical performance. However, we also found that

the prevalence of poor physical performance was dependent on the method used to measure it. The apparent incongruity between these two conclusions could be explained by a third; that is, physical performance might not be a necessary parameter for the diagnosis of sarcopenia and therefore, it might be sufficient to use a simplified diagnostic algorithm that takes into account only strength and muscle mass but not the physical performance and obtain the same diagnostic results for sarcopenia. Finally, we conclude that the results found are consistent and reinforce the proposal made by the EWGSOP in 2018 [16] where physical performance is no longer a necessary parameter for determining sarcopenia, although it could be to determine the severity of this disease.

Conflict of interest

The authors declare no conflict of interest.

Nomenclature

EWGSOP	European Working Group on Sarcopenia in Older People
ICD	International Classification of Diseases
TUG	timed up-and-go
UGS	usual gain speed
SPPB	short physical performance battery

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