CUT-OFF POINTS FOR MUSCLE MASS — NOT GRIP STRENGTH OR GAIT SPEED —DETERMINE VARIATIONS IN SARCOPENIA PREVALENCE

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Abstract: *Objectives:* The European Working Group on Sarcopenia in Older People (EWGSOP) has proposed different methods and cut-off points for the three parameters that define sarcopenia: muscle mass, muscle strength and physical performance. Although this facilitates clinical practice, it limits comparability between studies and leads to wide differences in published prevalence rates. The aim of this study was to assess how changes in cut-off points for muscle mass, gait speed and grip strength affected sarcopenia prevalence according to EWGSOP criteria. *Methods:* Cross-sectional analysis of elderly individuals recruited from outpatient clinics (n=298) and nursing homes (n=276). We measured muscle mass, grip strength and gait speed and assessed how changes in cut-off points changed sarcopenia prevalence in both populations. *Results:* An increase from 5.45 kg/m^2 to 6.68 kg/m^2 in the muscle mass index for female outpatients and nursing-home residents increased sarcopenia prevalence from 4% to 23% and from 9% to 47%, respectively; for men, for an increase from 7.25 kg/m^2 to 8.87 kg/m^2, the corresponding increases were from 1% to 22% and from 6% to 41%, respectively. Changes in gait speed and grip strength had a limited impact on sarcopenia prevalence. *Conclusion:* The cut-off points used for muscle mass affect the reported prevalence rates for sarcopenia and, in turn, affect comparability between studies. The main factors influencing the magnitude of the change are muscle mass index distribution in the population and the absolute value of the cut-off points: the same difference between two references (e.g., 7.5 kg/m^2 to 7.75 kg/m^2 or 7.75 kg/m^2 to 8 kg/m^2) may produce different changes in prevalence. Changes in cut-off points for gait speed and grip strength had a limited impact on sarcopenia prevalence and on study comparability.

Key words: Sarcopenia, performance, epidemiology, screening, Comparability.

Introduction

The European Working Group on Sarcopenia in Older People (EWGSOP) has defined sarcopenia as low muscle mass and low muscle function (strength or performance) (1) and has proposed a stepped process to identify persons with sarcopenia in clinical settings based on only assessing muscle mass when muscle function (measured in terms of gait speed and grip strength) is found to be reduced. Thus, gait speed is first measured and, if normal (>0.8 m/s), grip strength is measured; muscle mass only is assessed when either of the former measures is abnormal. In such cases, a person is considered to have sarcopenia if their muscle mass value is below a critical threshold.

The EWGSOP consensus permits sarcopenia assessment in several ways. This means that results for the same person may differ depending on various factors: the technique used (e.g., dual energy X-ray absorptiometry vs bioimpedance analysis (BIA)); the parameters assessed (e.g., appendicular muscle mass vs total muscle mass); the devices used (e.g., strain vs hydraulic dynamometers when assessing grip strength); and, finally, threshold criteria (e.g., normative values for healthy young adults with cut-off points at 2 standard deviations below the mean reference value). Although detection and treatment in clinical settings is undoubtedly aided by this flexibility in assessment, comparability between studies is also potentially affected.

The above issues may explain the wide discrepancies found in sarcopenia prevalence according to the EWGSOP definition (2) when comparing different definitions (3,4) and when comparing different cut-off point combinations (5).

The few existing studies examining the role of cut-off points in sarcopenia prevalence (3–5) have been based on tabulating prevalence in the same population using a limited set of cut-off combinations for one or more parameters. Although extrapolations outside the studied ranges can be unreliable, this limitation can theoretically be overcome by plotting prevalence across the entire span of possible values for each parameter. However, we are not aware of any study to date that has used this approach.

The aim of this article is to show how different cut-off points for muscle mass, gait speed and grip strength affect sarcopenia prevalence and, in last term, comparability between studies. Note that our intention is not to appraise or recommend any particular method or cut-off point for sarcopenia assessment.

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Table 1
Sarcopenia prevalence applying different muscle mass index cut-off points from the literature with the default cut-off values of gait speed and grip strength

Study reference	Cut-off point (kg/m²)		Outpatient			Nursing-home resident		
	Men	Women	Men n=109	Women n=187	Total n=296	Men n= 84	Women n=188	Total n=272
(12)	6.19	4.73	0.0%	1.6%	1.0%	0.0%	0.5%	0.4%
(13)	7.26*	5.45	0.9%	4.3%	3.0%	6.0%	9.0%	8.1%
(14)	7.25	5.67	0.9%	5.9%	4.1%	6.0%	13.3%	11.0%
(15)	8.51*	5.76	14.7%	6.4%	9.5%	22.6%	16.0%	18.0%
(16)	8.60	6.20*	17.4%	12.3%	14.2%	25.0%	28.2%	27.2%
(17,18)	8.87	6.42	22.0%	17.1%	18.9%	40.5%	37.8%	38.6%
(11)	8.31	6.68	12.8%	23.0%	19.3%	15.5%	46.8%	37.1%
(15)	10.76	6.76	57.8%	27.3%	38.5%	77.4%	51.1%	59.2%

The studies are ranked from lower to higher outpatient prevalence rates; * Value 0.01 kg/m² lower than in the reference study.

Methods

The population in this cross-sectional analysis of the ELLI study — described elsewhere(6–8) — was composed of persons ≥70 years old, recruited from geriatric outpatient clinics and nursing homes from Spain, able to walk by themselves with or without the help of technical aids, who gave their consent to participate in the study. Exclusion criteria were as follows: advanced dementia (Global Deterioration Scale score of 7); terminal illness (life expectancy of less than 6 months); the presence of edema or hydration disorders that could affect BIA results; corticosteroid treatment for at least 30 days previously; hearing or vision impairments that could interfere with the study; degenerative muscle diseases; and the presence of any other condition that could suppose a risk to the participant. A total of 574 persons were recruited consecutively: 298 from 5 outpatient clinics and 276 from 7 nursing homes, those with incomplete data for muscle mass, gait speed or grip strength have been discarded..

Muscle grip strength was assessed as the best of 3 attempts with the dominant hand using a hydraulic dynamometer Jamar 5030J1 (Sammons Preston Rolyan, Chicago, USA). Gait speed was assessed using the 4 m walk from the Short Physical Performance Battery(9). Body composition in terms of fat, and fat-free mass was assessed by BIA using the AKERN BIA 101 New Edition 50 Khz monofrequency device (AKERN SRL, Florence, Italy). Skeletal muscle mass was estimated using the Janssen equation (10) and the muscle mass index (MMI) was calculated by dividing skeletal muscle mass by squared height (in meters).

For the purpose of our study, sarcopenia was defined according to EWGSOP criteria (1) as low muscle mass with weakness and/or low gait speed. Default cut-off points were set in accordance with EWGSOP recommendations: for the MMI, less than 2 standard deviations below the mean for a Spanish reference group, namely, 8.31 kg/m² and 6.68 kg/m² for young healthy men and women, respectively (11); for gait speed, 0.8 m/s or less; and for grip strength, less than 30 kg in men and less than 20 kg in women.

We plotted the data for each variable for men and for women (Figures 1 to 3) separated by outpatient clinics (A) and nursing homes (B). For all the graphs, the vertical axis shows prevalence, the horizontal axis shows the threshold at which a parameter is considered abnormal and the continuous lines represent persons with sarcopenia (low MMI with slowness and/or weakness according to the default cut-off points of the variables not present in the horizontal axis).

For the MMI plots (Figure 1), the broken lines represent the percentage of persons with their MMI below the threshold, independently of muscle function. The difference between continuous and broken lines at a given threshold represents persons with preserved gait speed and grip strength at that MMI. For instance, in men from outpatient clinics (chart A), for a threshold of 9.5 kg/m², 37% of all men have a MMI of 9.5 kg/m² or lower and 32% of all men have sarcopenia with the default cut-off values of gait speed and grip strength and 5% of all men have a MMI below the threshold with both gait speed and grip strength preserved).

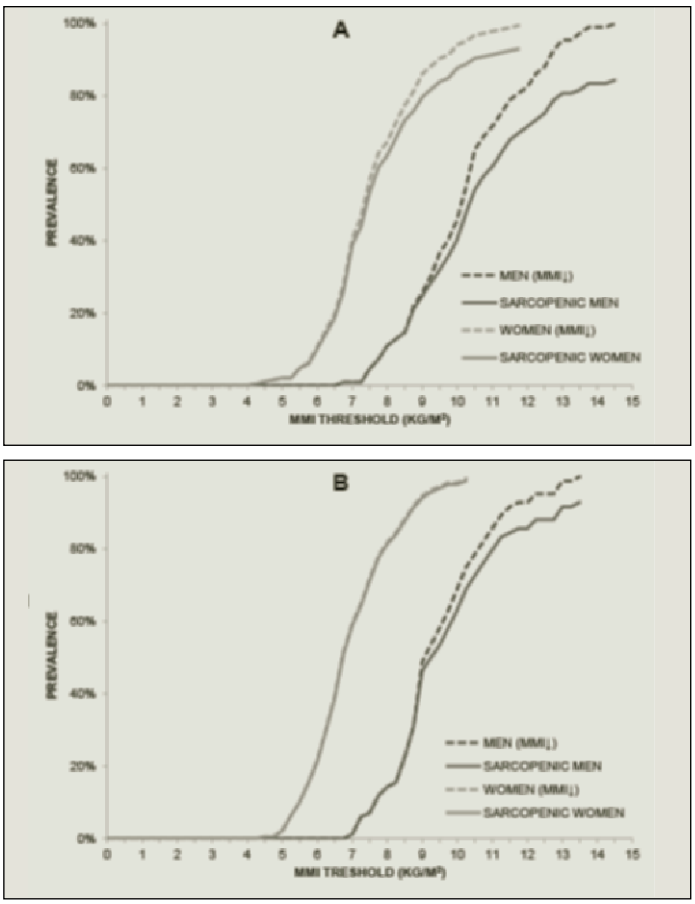
For the gait speed plots (Figure 2), broken lines represent persons with a low MMI (according to default values) and gait speed below the threshold. The difference between continuous and broken lines at a given threshold represents the percentage of persons with gait speed above the threshold but low MMI and weakness. For instance, in outpatient clinics (chart A), and referring to women, for an MMI under 6.68 kg/m² and grip strength under 20 kg: at a gait speed threshold of 0 m/s, 21% were considered to have sarcopenia, in all cases due to a low MMI and weakness (that is, none had low gait speed); and at a gait speed threshold of 0.6 m/s, 22% were considered to have sarcopenia, 13% due to low gait speed (independently of

strength) and 9% due to weakness when gait speed was over 0.6 m/s.

Grip strength plots (Figure 3) are interpreted in an analogous way to the gait speed plots: broken lines represent persons with a low MMI and grip strength below the threshold. The difference between continuous and broken lines at a given threshold represents the percentage of persons with grip strength above the threshold but with low MMI and slowness.

Figure 1

Muscle mass index (MMI): Prevalence of sarcopenia and distribution of MMI in outpatient clinics (A) and nursing homes (B)



Changes in prevalence are expressed as absolute percentage points. We used the McNemar test for paired proportions to compare sarcopenia prevalence with different cut-off points.

Results

Overall, elderly people attending outpatient clinics had higher MMI, gait speed and grip strength values than elderly people in nursing homes.

MMI distribution was sigmoid in shape in all cases (Figure 1). The lines for groups with a higher MMI (men vs women and outpatients vs nursing-home residents) were displaced to the right. Prevalence of sarcopenia followed a similar pattern (Figure 1), growing as the MMI threshold increased but never reaching 100% of the population, given that grip strength and gait speed were preserved in some cases: when the cut-off point was set at the highest MMI value measured in the group (each person with slow gait speed or low grip strength was thus considered to have sarcopenia), prevalence reached nearly 100% (187/188) in nursing homes and 93% (175/187) in outpatient clinics for women and 93% (78/84) in nursing homes and 84% (92/109) in outpatient clinics for men. All men with an MMI under 8.5 kg/m^2 and all women with an MMI under 5.5 kg/m^2 had slow gait speed and/or weak grip strength. No minimum MMI was found that guaranteed preservation of gait speed and/or grip strength. Furthermore, for the 20% of persons with the highest MMI in each group, in the best case over 8 out of 10 subjects had slowness and/or weakness. The slope between the change in MMI and the change in sarcopenia prevalence was not uniform but was influenced by the absolute MMI value, sex and setting. In outpatient men, for instance, a change in MMI from 7.5 kg/m^2 to 8.5 kg/m^2 to 9.5 kg/m^2 produced a rise in sarcopenia prevalence from 5% to 15% to 32%, respectively.

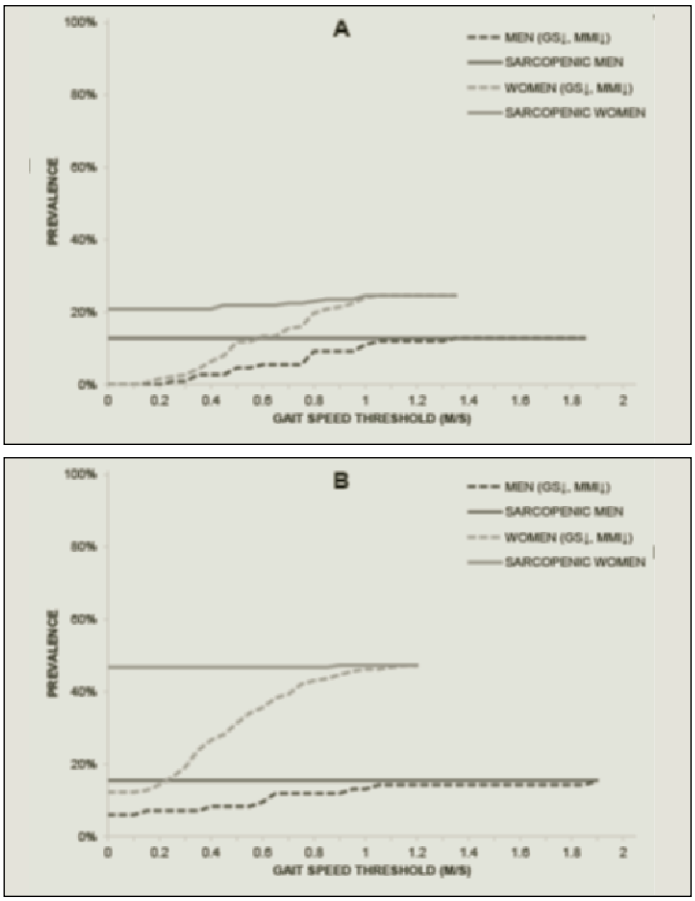
To demonstrate the impact of the MMI threshold, we tabulated sarcopenia prevalence in our sample using cut-off points as used in other studies (Table 1) (11–18). Discarding the lowest and highest cut-off values for men and women, in women, an MMI increase from 5.45 kg/m^2 to 6.68 kg/m^2 produced an absolute change of 19 and 38 percentage points in outpatients and nursing-home residents, respectively; for men, for an MMI increase from 7.25 kg/m^2 to 8.87 kg/m^2, the corresponding changes were 21 and 35 percentage points, respectively.

In relation to gait speed (Figure 2), noteworthy was the fact that 1 in 4 nursing-home residents was unable to walk safely. Rated slow at a 0.6 m/s threshold were 77%, 51%, 63% and 23% of female nursing-home residents, female outpatients, male nursing-home residents and male outpatients, respectively; the corresponding figures for a 1 m/s threshold were 97%, 94%, 92% and 84%, respectively. Nevertheless, in the range 0.6 m/s to 1 m/s, we only detected a change in sarcopenia prevalence in outpatient clinics women, from 22% to 25%.

In relation to grip strength (Figures 3) — for which typical weakness thresholds are 26-32 kg in men and 16-21 kg in women — setting the threshold at 32 kg as opposed to 26 kg increased weakness prevalence from 59% to 92% for male outpatients and from 86% to 96% for male nursing-home residents; for women, setting the threshold at 21 kg as opposed to 16 kg increased weakness prevalence from 65% to 90% for outpatients and 81% to 97% for nursing-home residents. Nevertheless, for the above ranges, we only detected a change in sarcopenia prevalence in outpatient clinics women, from 20% to 23%.

Figure 2

Gait speed (GS): Prevalence of sarcopenia and prevalence of low muscle mass index (MMI) with low GS in outpatient clinics (A) and nursing homes (B)



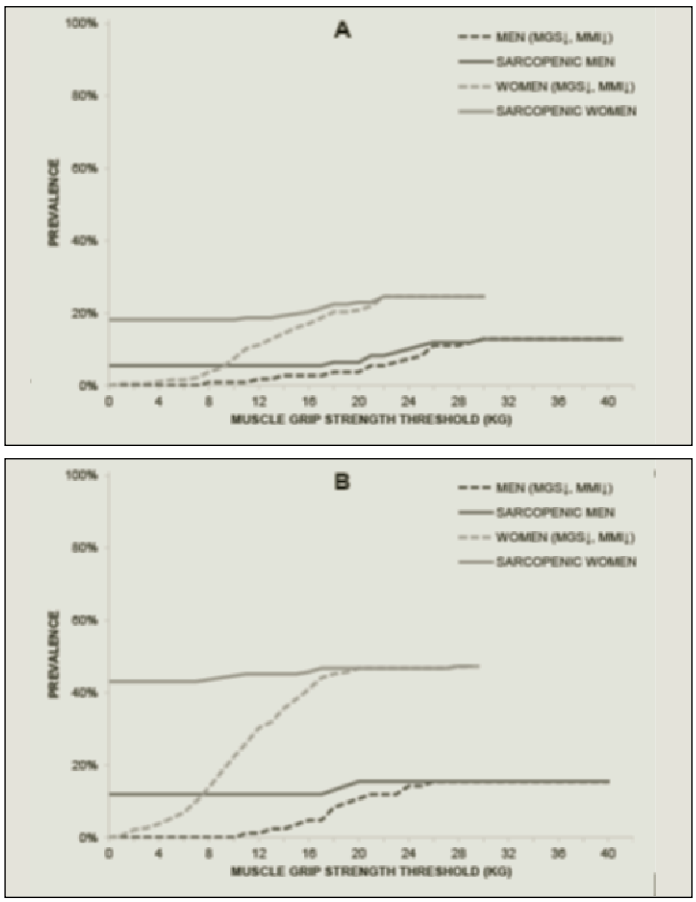
Discussion

Our findings are similar to those of the Foundation for the National Institutes of Health (FNIH) Sarcopenia Project, which reported sarcopenia prevalence based on muscle mass alone ranging from 7% to 50% (19, 20). However, since that study used appendicular lean mass measured by DXA rather than absolute muscle mass, the results are not directly comparable with our results. Another study (4) reported variations in sarcopenia prevalence — depending on the criteria used — ranging from 2% to 34% in elderly outpatients and from 0% to 15% in healthy elderly persons; however, this study did not explore the individual impact of muscle mass, grip strength and gait speed on prevalence.

Changes in cut-off points for gait speed and grip strength can affect prevalence rates for slowness or weakness. However, when sarcopenia is defined according to alterations in at least one of these parameters, use of Fried (19) or FNIH Sarcopenia Project (20, 21) values has little impact on prevalence and does not greatly affect comparability between studies, even when these are conducted in different settings. This fact can be explained by the lack of correlation between MMI and gait speed/grip strength scores(7, 8); thus, persons with a normal MMI may be weak and/or slow and persons with preserved gait speed and grip strength may have a low MMI. In our study, the correlation between gait speed and grip strength was weak, especially in nursing-home residents: of persons with a low MMI, most with normal gait speed were weak and most with normal grip strength were slow. Due to limitations of the study, we cannot state if this lack of correlation is due to presence of highly prevalent conditions (as arthritis or osteoporosis) that may affect muscle function (22, 23). Nevertheless, since our sample is not representative of the general population, data on gait speed and grip strength must be interpreted with care.

Figure 3

Muscle grip strength (MGS): Prevalence of sarcopenia and prevalence of low muscle mass index (MMI) with low MGS in outpatient clinics (A) and nursing homes (B)



The wide range of criteria typically used to define low gait speed and weakness had little impact on the comparability of sarcopenia prevalence rates in our outpatient and nursing-home populations. In contrast, small changes in MMI thresholds significantly affect comparability. Given the shape of the distribution of the MMI, the magnitude of the change — the

increase of the prevalence per each additional MMI unit — responds to 2 factors: first, muscle mass distribution in the studied population, that is, whether the MMI curve is displaced to the left or the right, and second, the absolute cut-off values rather than the difference between thresholds; this is because the same difference between thresholds — e.g., 7.5 kg/m^2 to 8.5 kg/m^2 vs 8.5 kg/m^2 to 9.5 kg/m^2 — may result in different changes in prevalence. These results suggest that is relatively safe the comparison of studies with high cut-off points for gait speed(24) or grip strength as far as they have the same or very close MMI thresholds.

A simplistic classification of persons as "having sarcopenia" or "not having sarcopenia" implies a loss of meaningful information. Two reporting strategies would prevent this loss and improve comparability between studies. We thus recommend reporting (as well as prevalence data) median and interquartile range data for muscle mass, grip strength and gait speed, as these do not rely on definition criteria and are less affected than means and standard deviations by a non-normal distribution of the parameters. We also recommend providing a breakdown of the aforementioned data for men and women, given that each sex has different cut-off points for muscle mass and grip strength.

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Ethical standard: The authors declare that the study procedures comply with current ethical standards for research involving human participants in Spain and follows the principles outlined in the Declaration of Helsinki. The study was approved by the Healthcare Ethics Committee of the Hospital Clínic de Barcelona. Participants (or next of kin) gave informed written consent.

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References

1. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, et al. Sarcopenia: European con-sensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. 2010;Age Ageing doi:10.1093/ageing/afq034
2. Cruz-Jentoft AJ, Landi F, Schneider SM, et al. Prevalence of and interven-tions for sarcopenia in ageing adults: a systematic review. Report of the Interna-tional Sarcopenia Initiative (EWGSOP and IWGS). 2014; Age Ageing doi:10.1093/ageing/afu115
3. Bijlsma AY, Meskers CGM, Ling CHY, et al. Defining sarcopenia: the im-pact of different diagnostic criteria on the prevalence of sarcopenia in a large mid-dle aged cohort. 2013; AGE doi:10.1007/s11357-012-9384-z
4. Reijnierse EM, Trappenburg MC, Leter MJ, et al. The Impact of Different Diagnostic Criteria on the Prevalence of Sarcopenia in Healthy Elderly Partici-pants and Geriatric Outpatients. 2015;Gerontology doi:10.1159/000377699
5. Beaudart C, Reginster J-Y, Slomian J, Buckinx F, Locquet M, Bruyère O. Prevalence of sarcopenia: the impact of different diagnostic cut-off limits. J Musculoskelet Neuronal Interact. 14(4):425-431.
6. Osuna-Pozo CM, Serra-Rexach JA, Viña J, et al. Prevalencia de sarcopenia en consultas de geriatría y residencias. Estudio ELLI.Rev. Esp. 2014;Geriatría Gerontol. doi:10.1016/j.regg.2013.01.006
7. Cuesta F, Formiga F, Lopez-soto A, et al. Prevalence of Sarcopenia in Pa-tients Attending Outpatient Geriatric Clinics. The ELLI Study. 2015;Age Ageing doi:10.1093/ageing/afv088
8. Salvà A, Serra-Rexach JA, Artaza I, et al. La prevalencia de sarcopenia en residencias de España: comparación de los resultados del estudio multicéntrico ELLI con otras poblaciones.Rev. Esp. 2016;Geriatría Gerontol. doi:10.1016/j.regg.2016.02.004
9. Guralnik JM, Simonsick EM, Ferrucci L, et al. A short physical perfor-mance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol. 1994;49(2):M85-94.
10. Janssen I, Heymsfield SB, Baumgartner RN, Ross R. Estimation of skeletal muscle mass by bioelectrical impedance analysis. J Appl Physiol. 2000;89(2):465-471.
11. Masanes Toran F, Culla A, Navarro-González M, et al. Prevalence of sarco-penia in healthy community-dwelling elderly in an urban area of Barcelona (Spain). 2012;J. Nutr. Health Aging doi:10.1007/s12603-011-0108-3
12. Kelly TL, Wilson KE, Heymsfield SB. Dual Energy X-Ray Absorptiometry Body Composition Reference Values from NHANES.Vella A, ed.PLoS ONE, 2009; doi:10.1371/journal.pone.0007038
13. Baumgartner RN, Koehler KM, Gallagher D, et al. Epidemiology of Sarco-penia among the Elderly in New Mexico. Am J Epidemiol. 1998;147(8):755-763.
14. Delmonico MJ, Harris TB, Visser M, et al. Longitudinal study of muscle strength, quality, and adipose tissue infiltration.Am. 2009;. Clin. Nutr. doi:10.3945/ajcn.2009.28047
15. Janssen I. Skeletal Muscle Cutpoints Associated with Elevated Physical Disability Risk in Older Men and Women.Am. 2004;J. Epidemiol. doi:10.1093/aje/kwh058
16. Tichet J, Vol S, Goxe D, Salle A, Berrut G, Ritz P. Prevalence of sarcopenia in the French senior population. J Nutr Health Aging. 2008;12(3):202-206.
17. Chien M-Y, Huang T-Y, Wu Y-T. Prevalence of Sarcopenia Estimated Us-ing a Bioelectrical Impedance Analysis Prediction Equation in Community-Dwelling Elderly People in Taiwan.J. 2008;Am. Geriatr. Soc. doi:10.1111/j.1532-5415.2008.01854.x
18. Landi F, Liperoti R, Fusco D, et al. Prevalence and Risk Factors of Sarco-penia Among Nursing Home Older Residents. 2012;J. Gerontol. A. Biol. Sci. Med. Sci. doi:10.1093/gerona/glr035
19. Fried LP, Tangen CM, Walston J, et al. Frailty in Older Adults: Evidence for a Phenotype. J Gerontol Biol Sci Med Sci. 2001;56(3):M146-157.
20. McLean RR, Shardell MD, Alley DE, et al. Criteria for Clinically Relevant Weakness and Low Lean Mass and Their Longitudinal Association With Incident Mobility Impairment and Mortality: The Foundation for the National Institutes of Health (FNIH) Sarcopenia Project.J. Gerontol. A. Biol. Sci. Med, 2014;. Sci. doi:10.1093/gerona/glu012
21. Alley DE, Shardell MD, Peters KW, et al. Grip Strength Cutpoints for the Identification of Clinically Relevant Weakness.J. Gerontol. 2014;A. Biol. Sci. Med. Sci. doi:10.1093/gerona/glu011
22. Chen L, Nelson DR, Zhao Y, Cui Z, Johnston JA. Relationship between muscle mass and muscle strength, and the impact of comorbidities: a population-based, cross-sectional study of older adults in the United States. 2013;BMC Geriatr. doi:10.1186/1471-2318-13-74
23. de Souza Vasconcelos KS, Domingues Dias JM, de Carvalho Bastone A, et al. Handgrip strength cutoff points to identify mobility limitation in com-munity-dwelling older people and associated factors. 2016;J. Nutr. Health Aging doi:10.1007/s12603-015-0584-y
24. Htun NC, Ishikawa-Takata K, Kuroda A, et al. Screening for malnutrition in community dwelling older Japanese: Preliminary development and evaluation of the Japanese Nutritional Risk Screening Tool (NRST). 2016;J. Nutr. Health Aging doi:10.1007/s12603-015-0555-3