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REVIEW

Should we screen for sarcopenia in Romanian patients with osteoporosis? An overview of the current knowledge on osteosarcopenia

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The combination of osteoporosis and sarcopenia is wider known as "osteosarcopenia", and it is considered to be a "hazardous duet" for the patient. The clinical consequences of this geriatric syndrome include a higher risk of fractures and mortality compared to osteoporosis or sarcopenia alone. Fractures are considered to be a burden for the patient but also for the health care system from an economic point of view, therefore it is important to prevent them. Emerging evidence shows that osteosarcopenia is an increasingly prevalent disease. The Fracture Risk Assessment Tool (FRAX) is of major importance for the management of a patient, however, muscle weakness is not part of this instrument. It has been suggested to go "beyond the FRAX" and to evaluate muscle mass/strength besides bone mineral density when it comes to the management of a patient with a sustained fragility fracture. In this review we try to answer whether this is feasible or not when it comes to Romanian patients.

Keywords: osteoporosis, sarcopenia, osteosarcopenia

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Introduction

Osteoporosis is an age-related skeletal disease characterized by low bone mineral density (BMD) and deterioration of bone microarchitecture which leads to an increased susceptibility for fractures [1]. Results from epidemiological studies show that osteoporotic fractures are common, with an estimated 4.28 million suffering fragility fractures each year in Europe, but this number is projected to increase to 5.05 million by 2034 [2]. Furthermore, nearly a quarter of a million deaths occur each year as a direct result of hip or spine fractures. Although Romania is classified as having a moderate risk of fracture, the estimated annual number of deaths associated with a fracture event in Romania was reported to be higher than the average reported in Europe (148/100,000 individuals aged 50+ and 116/100,000 individuals respectively) [2]. The burden of osteoporosis remains a great public health concern as the quality-adjusted life years (QALYs) loss has increased by 177 % in Romania, from 2010 to 2019. Furthermore, Romania has one of the highest treatment gaps as 78% of women at high risk of fracture do not receive therapy. Overall 469,000 women who were eligible for treatment, were untreated in 2019 [2, 3]. Barriers to successful screening and treatment include the lack of Fracture liaison services (FLS) or the fact that osteoporosis is delegated to medical specialists (endocrinologists, rheumatologists and rehabilitation medicine) rather than general practitioners who provide primary care services. Although this is beyond the scope of this overview, it is worth to mention that the limited screening effectiveness for osteoporosis is not particular since access to organized screening programs for breast cancer is limited or lacks for colorectal cancer in Romania [4]. Nonetheless, the opportunities for organizing such screening programs should be increased in the future.

Sarcopenia is another disease largely attributed to aging and is characterised by low muscle mass and strength. Similarly to osteoporosis, sarcopenia is associated with adverse outcomes such as falls, fractures, physical disability and mortality [5]. The combination of weak bones and sarcopenia is considered to be a "hazardous duet" [6]. Binkley and Buehring proposed more than a decade ago the term sarco-osteoporosis [7] to define this subset of frail individuals, but this syndrome is wider known as "osteosarcopenia"; however, in the latter definition the "osteo" component refers to low BMD which includes osteopenia besides osteoporosis [8]. Sarcopenia has received an International Classification of Diseases-10 code (M62.84) in 2016, which is a major step forward in recognizing it as a clinical entity [9].

Diagnosis

In the absence of a fracture, osteoporosis is diagnosed based on a T score, which compares an individual's bone mineral density (BMD) with the mean value of a young healthy reference population, with the difference expressed as a standard deviation (SD); a T score value less than or equal to -2.5 SD defines osteoporosis [1]. A fracture risk assessment tool (FRAX) has been developed in the UK [10] and validated in Romania as well [11]. Traditionally, osteoporosis has been diagnosed based on low BMD in the absence of a fracture but a diagnosis can be made if a patient has a T score between -1.0 and -2.5 SDs and a high FRAX score. Furthermore, in the presence of a fragility fracture of the spine or the hip, osteoporosis is diagnosed regardless of the BMD [12].

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The diagnosis of sarcopenia on the other hand, is not so straightforward because several definitions have been proposed by different working groups without a consensus [5, 13-16], although the newly launched Global Leadership Initiative on Sarcopenia aims to address this problem [17].

In 2010, The European Working Group on Sarcopenia in Older People (EWGSOP) has proposed the following criteria for sarcopenia: evidence of (1) low muscle mass and (2) low muscle strength and/or (3) poor physical performance. Evidence of low muscle mass was considered to be mandatory for the diagnosis of sarcopenia [13]. However, in 2018 these criteria were revised (EWGSOP2) and the focus on low muscle mass was shifted towards low muscle strength as a key characteristic of sarcopenia, because muscle strength is recognized as a better predictor for adverse outcomes than muscle mass. In addition, physical performance is considered to be an indicator of severe sarcopenia rather than a diagnostic criteria [5]. This certainly simplifies things because measuring grip strength is more affordable and simple whereas measuring muscle mass quantity and muscle quality are technically and financially more complex [5]. The cut-off values for each parameter are summarised in Table 1.

Is it worth screening for sarcopenia in subjects with osteoporosis?

To answer this question we first need to explore several aspects such as the prevalence of this syndrome, clinical outcomes, potential therapeutic options and some financial aspects.

The prevalence of osteosarcopenia

Results from a systematic review (27 studies) and meta-analysis (17 studies) showed that the overall prevalence of osteosarcopenia in Caucasian subjects ≥65 years varied from 5%- 37% depending on the definition used for sarcopenia but in participants with osteoporotic fractures, sarcopenia was present in 7.8–58% and 1.3–96.3% of the cases, women and men, respectively. The authors of the above mentioned study, considered that the high prevalence found in men is attributable to small sample size studies. Despite the lack of consistency when it comes to the definition of sarcopenia, this meta-analysis showed that in subjects with osteoporotic fractures, sarcopenia was frequent as the pooled mean prevalence of sarcopenia in patient populations with fractures was 46% (95% CI 44, 48; p<0.001) [18].

Data driven from Romanian studies is scarce, however, in one study that included 122 osteoporotic postmenopausal women with low hand grip strength (mean age 67.02 ± 8.3 years), the prevalence of osteosarcopenia was reported to be 52.46% [19], whereas in the authors cohort (78 postmenopausal women with osteoporosis, mean age 64 ±6.74years) the prevalence of sarcopenia was much more lower, only 1.2% (unpublished data). One possible explanation for this discrepancy regarding the prevalence between the two cohorts is the fact that the first study included only subjects who already had muscle weakness [19] which can overestimate the prevalence of osteosarcopenia. Nevertheless, further epidemiological studies with large number of participants are needed to assess the prevalence of osteosarcopenia in Romanian subjects.

Clinical consequences of osteosarcopenia

Given the high occurrence of osteoporosis and sarcopenia, the next step would be to focus on the clinical consequences of this geriatric syndrome. Previous results from studies showed that half of subjects who sustain a hip fracture have osteosarcopenia [20] and that the 1-year mortality after a hip fracture is higher in osteosarcopenia (15.8%) than in sarcopenia (10.8%) or osteoporosis (7.8%) alone [21]. Recent results from meta-analysis of eight cohort studies (n=19836) showed that osteosarcopenia significantly increased the risk of fracture (OR 2.46, 95% CI 1.83–3.30). Furthermore, in three cohort studies (n=2601) the risk of mortality was increased significantly in osteosarcopenia (OR 1.66, 95% CI 1.23–2.26) [22].

Several other traits have been described for subjects with osteosarcopenia in a study that gathered 680 subjects (mean age 79 years and 65% women). In this study, osteosarcopenic subjects were found to be older, mostly women

Table I. Diagnostic criteria for osteoporosis and sarcopenia [1, 5, 12, 16]

Diagnosis of osteoporosis
• In the presence of a fragility fracture of the spine or hip (regardless of the BMD)
• Low BMD: T score ≤ -2.5 SDs measured at the spine, hip, 1/3 distal radius
• T score between -1.0 and -2.5 SDs + fragility fracture (proximal humerus, pelvis, or distal forearm)
• T score between -1.0 and -2.5 SDs + high FRAX score
EWGSOP2 cut off points for sarcopenia
• Low muscle mass on DXA/BIA:
• Men : ASM < 20 kg or ASM/Ht2 < 7.0 kg/m2
• Women: ASM < 15 kg or ASM/Ht2 < 5.5 kg/m2
• Low muscle strength:
• Men: < 27 kg
• Women < 16 kg
• Poor physical performance ≤0.8 m/s
Diagnosis of sarcopenia
• Low muscle strength defines probable sarcopenia (in clinical practice, low muscle strengths is enough to trigger intervention)
• Low muscle strength + low muscle mass to confirm the diagnosis;
• Low muscle strength + low muscle mass + poor physical performance, then sarcopenia is considered severe

BMD, bone mineral density; FRAX, fracture risk assessment tool; EWGSOP2, The European Working Group on Sarcopenia in Older People; DXA, Dual-energy X-ray absorptiometry scan; BIA, bioimpedance; ASM, appendicular skeletal mass; Ht, height

and at a high risk for depression, malnutrition, lower body mass index (< 25 kg/m2) and showed a higher prevalence of peptic disease, inflammatory arthritis, maternal hip fracture, and a history of atraumatic fracture [23].

Treatment approaches in osteosarcopenia

The main goal of osteoporosis treatment is to prevent fractures. The FRAX instrument takes into account several risk factors such as: BMI, a prior history of fracture, a parental history of hip fracture, use of oral glucocorticoids, rheumatoid arthritis and other secondary causes of osteoporosis, current smoking, and alcohol intake (3 or more units daily). The major contribution of FRAX to patient care is indisputable, however, FRAX has some limitations because certain variables such as falls, physical activity, Vitamin D status, loss of BMD between sequential measurements are not taken into account [24]. Furthermore, Binkley and Buehring suggested more than a decade ago that muscle weakness should be recognized as an important element in the assessment of the fracture risk [7]. Bellelli reinforced recently the importance of osteosarcopenia construct as a single entity [25]. He even went further to suggest that when a bone fracture is diagnosed in elderly people, the management should not be limited to anti-osteoporotic treatment but rather should focus on optimizing both bone and muscle health. In the opposite circumstance, the author suggested that if sarcopenia is diagnosed, the clinician should assess the bone health especially before the occurrence of a fracture [25]. This becomes relevant especially in the light of the results published from a meta-analysis of four studies where an increased risk of osteoporotic fracture was observed in sarcopenic compared to non-sarcopenic subjects, with a relative risk of 1.37 (95% CI 1.18, 1.59; p<0.001); however, this result should be interpreted with a certain amount of caution as the heterogeneity among the studies was significant [18].

EWGSOP2 promotes early detection of sarcopenia and treatment to prevent or delay adverse health outcomes [5]. Treatment recommendations include rather general aspects such as provision of optimal protein intake, supplementation of vitamin D, and physical exercise [5] because currently there are no specific drugs [26]. Similarly, there are no pharmacologic therapies specifically targeting osteosarcopenia [27], however, emerging evidence has shown that compared to bisphosphonates, Denosumab, an established anti-osteoporotic drug, , improved appendicular lean mass and muscle strength [28] or gait speed [29]. More recent results showed that treatment with Denosumab and bisphosphonates increased grip strength compared to Vitamin D alone but only Denosmab showed a higher increase in physical performance [30]. Taken together, these results suggest that Denosumab might be a therapeutic candidate for subjects with osteosarcopenia which sounds promising, but further studies including double-blinded randomized controlled trials are needed to confirm these results.

Progressive resistance training is another option encouraged in osteosarcopenia [27]. Results from a recent systematic review and meta-analysis which included 14 studies showed that progressive resistance training improves concomitantly muscle strength and femur/hip BMD in men and/or women ≥ 65 years [31]. For some of the healthcare professionals and patients with osteoporosis, this strategy might cause some concerns from the perspective that physical activity could precipitate an osteoporotic fracture; however, a multidisciplinary expert group reviewed the available evidence to make recommendations on physical activity and exercise in osteoporosis, and the recently published UK consensus statement promotes resistance training progressing to high intensity as a strategy to strengthen the bone and concludes that there is little evidence in regards to the notion that physical activity is associated with significant harm [32].

Financial aspects

Screening for sarcopenia is cheap as it simply relies on the use of the SARC-F questionnaire (acronym for Strength, Assistance walking, Rise from a chair, Climb stairs, and Falls) [5], which has been translated and validated in Romanian language as well [33]. Another questionnaire, the SarQoL (acronym for Sarcopenia-related quality of life questionnaire) which is also readily available in Romanian [34], could potential be applied for screening purposes as the sensitivity and specificity in identifying sarcopenic subjects was roughly equal between the SarQoL and SARC-F questionnaires [35]. After identifying individuals with a high suspicion of sarcopenia, the EWGSOP2 recommends the use of grip strength measures to identify subjects with probable sarcopenia (low muscle strength) which is also cheap and affordable. To confirm sarcopenia, a Dual-energy X-ray absorptiometry (DXA) scan would be optimal as it has the advantage to provide an accurate estimate for muscle mass and BMD [27]. If the whole body DXA scan is not possible for pecuniary reasons or other motives, and only a bone scan is available, this does not exclude the diagnosis of osteosarcopenia, because the EWGSOP2 acknowledges that in clinical practice, low muscle strength is enough to start intervention for sarcopenia. Screening for osteoporosis is also affordable in Romania as a reimbursement budget exists for DXA scans [3].

The costs, indications, availability and approval of anti-osteoporotic agents vary globally. Twelve out of 27 countries in Europe offered full reimbursement for osteoporosis medications according to recently published data [3]. Guidelines for the management of osteoporosis are available in Romania and treatment reimbursement of osteoporosis medication is offered between 50-100%, depending on the prescribed treatment [3].

Arguments against screening for sarcopenia in subjects with osteoporosis

The risk of overdiagnosis of (osteo)sarcopenia

Hasse and colleagues have recently argued that overdiagnosis of sarcopenia is inevitable since there is no specific treatment [36]. Broadly speaking, "overdiagnosis" encompasses overdetection and overdefinition. Potential definitions include the following: overdetection-"identification of abnormalities that were never going to cause harm, abnormalities that do not progress, that progress too slowly to cause symptoms or harm during a person's remaining lifetime, or that resolve spontaneously" and overdefintion which is the result of " lowering the threshold for a risk factor without evidence that doing so helps people feel better or live longer and by expanding disease definitions to include patients with ambiguous or very mild symptoms" [37]. Based on these definitions, potential harms derived from overdiagnosis include "overtreatment" and "overtesting" [37]. Perhaps the "overtreatment" aspect does not impose such a threat at the moment, as there is no specific treatment aiming to target the sarcopenic component. Overtesting might be something worth to consider since the diagnosis of sarcopenia involves some additional steps as opposed to the diagnosis of osteoporosis. Another important aspect suggested by Haase and colleagues is the fact that current studies do not assess the psychological burden on patients labelled with a diagnosis that carries an increased risk of morbidity and mortality but has no specific treatment [36].

Lack of specific pharmacological treatment

As previously said, treatment of sarcopenia overlaps with the management of osteoporosis, which brings uncertainties in terms of the necessity of screening for the sarcopenia. This aspect becomes even more relevant if we look at the principles of screening for a disease published by the WHO, where the authors emphasized that screening should be undertaken when the prospect of treatment is available. In addition, the prospect of a better prognosis by treating the condition strengthens the need for screening of a disease, thus if proven otherwise, there is no advantage for the patient [38]. Even if progressive resistance training improves concomitantly muscle strength and BMD [31], or that an optimal diet has some potential benefits on the muscle parameters [39], these results don't support that the diagnosis of sarcopenia improves the prognosis. Furthermore, the evidence to recommend screening for sarcopenia in adults over 65 years of age or older was graded to be of low certainty by the International Clinical Practice Guidelines for Sarcopenia (ICFSR) task force, which means that further research is warranted in this area [40].

Conclusions

Besides its research purposes, the motivation for screening of osteosarcopenia in clinical practice is hampered by the lack of a specific pharmacological treatment, not just in Romania but also worldwide. Even though the future envisioned by Binkley and Buehring, seems to be far away for now,with the growing interest towards osteosarcopenia, things might change sooner than we expected. Nonetheless, disease awareness among clinicians is warranted for osteosarcopenia .

Authors' contribution

GM (Conceptualization; Methodology; Resources; Writing – original draft)
IMP (Conceptualization; Supervision; Writing – review & editing)

Conflict of interest

None to declare.

References

1. Kanis JA, McCloskey EV, Johansson H, Cooper C, Rizzoli R, Reginster JY. European guidance for the diagnosis and management of osteoporosis in postmenopausal women. Osteoporos Int. 2013;24(1):23-57.
2. Kanis JA, Norton N, Harvey NC, Jacobson T, Johansson H, Lorentzon M, et al. SCOPE 2021: a new scorecard for osteoporosis in Europe. Arch Osteoporos. 2021;16(1):82.
3. Willers C, Norton N, Harvey NC, Jacobson T, Johansson H, Lorentzon M, et al. Osteoporosis in Europe: a compendium of country-specific reports. Arch Osteoporos. 2022;17(1):23.
4. Cancer Screening in the European Union (2017): Report on the Implementation of the Council Recommendation on Cancer Screening.
5. Cruz-Jentoft AJ, Bahat G, Bauer J, Boirie Y, Bruyère O, Cederholm T, et al. Sarcopenia: revised European consensus on definition and diagnosis. Age and ageing. 2019;48(1):16-31.
6. Crepaldi G, Maggi S. Sarcopenia and osteoporosis: A hazardous duet. J Endocrinol Invest. 2005;28(10 Suppl):66-8.
7. Binkley N, Buehring B. Beyond FRAX: it's time to consider „sarco-osteopenia". J Clin Densitom. 2009;12(4):413-6.
8. Hirschfeld HP, Kinsella R, Duque G. Osteosarcopenia: where bone, muscle, and fat collide. Osteoporosis International. 2017;28(10):2781-90.
9. Cao L, Morley JE. Sarcopenia Is Recognized as an Independent Condition by an International Classification of Disease, Tenth Revision, Clinical Modification (ICD-10-CM) Code. J Am Med Dir Assoc. 2016;17(8):675-7.
10. Kanis JA, Johnell O, Oden A, Johansson H, McCloskey E. FRAX and the assessment of fracture probability in men and women from the UK. Osteoporos Int. 2008;19(4):385-97.
11. Grigorie D, Sucaliuc A, Johansson H, Kanis JA, McCloskey E. FRAX-based intervention and assessment thresholds for osteoporosis in Romania. Arch Osteoporos. 2013;8:164.
12. Camacho PM, Petak SM, Binkley N, Diab DL, Eldeiry LS, Farooki A, et al. American Association Of Clinical Endocrinologists/American College Of Endocrinology Clinical Practice Guidelines For The Diagnosis And Treatment Of Postmenopausal Osteoporosis-2020 Update. Endocr Pract. 2020;26(Suppl 1):1-46.
13. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, Boirie Y, Cederholm T, Landi F, et al. Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. Age Ageing. 2010;39(4):412-23.
14. Chen LK, Liu LK, Woo J, Assantachai P, Auyeung TW, Bahyah KS, et al. Sarcopenia in Asia: consensus report of the Asian Working Group for Sarcopenia. J Am Med Dir Assoc. 2014;15(2):95-101.
15. Studenski SA, Peters KW, Alley DE, Cawthon PM, McLean RR, Harris TB, et al. The FNIH sarcopenia project: rationale, study description, conference recommendations, and final estimates. J Gerontol A Biol Sci Med Sci. 2014;69(5):547-58.
16. Cruz-Jentoft AJ, Bahat G, Bauer J, Boirie Y, Bruyère O, Cederholm T, et al. Sarcopenia: revised European consensus on definition and diagnosis. Age Ageing. 2019;48(4):601.
17. Cawthon PM, Visser M, Arai H, Ávila-Funes JA, Barazzoni R, Bhasin S, et al. Defining terms commonly used in sarcopenia research: a glossary proposed by the Global Leadership in Sarcopenia (GLIS) Steering

Committee. Eur Geriatr Med. 2022;13(6):1239-44.
18. Nielsen BR, Abdulla J, Andersen HE, Schwarz P, Suetta C. Sarcopenia and osteoporosis in older people: a systematic review and meta-analysis. Eur Geriatr Med. 2018;9(4):419-34.
19. Cevei M, Onofrei RR, Cioara F, Stoicanescu D. Correlations between the Quality of Life Domains and Clinical Variables in Sarcopenic Osteoporotic Postmenopausal Women. J Clin Med. 2020;9(2).
20. Di Monaco M, Vallero F, Di Monaco R, Tappero R. Prevalence of sarcopenia and its association with osteoporosis in 313 older women following a hip fracture. Arch Gerontol Geriatr. 2011;52(1):71-4.
21. Yoo JI, Kim H, Ha YC, Kwon HB, Koo KH. Osteosarcopenia in Patients with Hip Fracture Is Related with High Mortality. J Korean Med Sci. 2018;33(4):e27.
22. Teng Z, Zhu Y, Teng Y, Long Q, Hao Q, Yu X, et al. The analysis of osteosarcopenia as a risk factor for fractures, mortality, and falls. Osteoporos Int. 2021;32(11):2173-83.
23. Huo YR, Suriyaarachchi P, Gomez F, Curcio CL, Boersma D, Muir SW, et al. Phenotype of osteosarcopenia in older individuals with a history of falling. J Am Med Dir Assoc. 2015;16(4):290-5.
24. Silverman SL, Calderon AD. The utility and limitations of FRAX: A US perspective. Curr Osteoporos Rep. 2010;8(4):192-7.
25. Bellelli F. Letter to the Editor: Osteosarcopenia to Raise Awareness on the Complexity of the Older Person. J Frailty Aging. 2022;11(2):244.
26. Reginster J-Y, Beaudart C, Al-Daghri N, Avouac B, Bauer J, Bere N, et al. Update on the ESCEO recommendation for the conduct of clinical trials for drugs aiming at the treatment of sarcopenia in older adults. Aging Clinical and Experimental Research. 2021;33(1):3-17.
27. Kirk B, Zanker J, Duque G. Osteosarcopenia: epidemiology, diagnosis, and treatment-facts and numbers. J Cachexia Sarcopenia Muscle. 2020;11(3):609-18.
28. Bonnet N, Bourgoin L, Biver E, Douni E, Ferrari S. RANKL inhibition improves muscle strength and insulin sensitivity and restores bone mass. J Clin Invest. 2019;129(8):3214-23.
29. Phu S, Bani Hassan E, Vogrin S, Kirk B, Duque G. Effect of Denosumab on Falls, Muscle Strength, and Function in Community-Dwelling Older Adults. Journal of the American Geriatrics Society. 2019;67(12):2660-1.
30. Rupp T, von Vopelius E, Strahl A, Oheim R, Barvencik F, Amling M, et al. Beneficial effects of denosumab on muscle performance in patients with low BMD: a retrospective, propensity score-matched study. Osteoporos Int. 2022.
31. O'Bryan SJ, Giuliano C, Woessner MN, Vogrin S, Smith C, Duque G, et al. Progressive Resistance Training for Concomitant Increases in Muscle Strength and Bone Mineral Density in Older Adults: A Systematic Review and Meta-Analysis. Sports Med. 2022;52(8):1939-60.
32. Brooke-Wavell K, Skelton DA, Barker KL, Clark EM, De Biase S, Arnold S, et al. Strong, steady and straight: UK consensus statement on physical activity and exercise for osteoporosis. Br J Sports Med. 2022;56(15):837-46.
33. Gasparik A, Demián MB, Pascanu I. ROMANIAN TRANSLATION AND VALIDATION OF THE SARC-F QUESTIONNAIRE. Acta Endocrinol (Buchar). 2020;16(2):216-22.
34. Gasparik AI, Mihai G, Beaudart C, Bruyère O, Pop RM, Reginster JY, et al. Correction to: Psychometric performance of the Romanian version of the SarQoL®, a health-related quality of life questionnaire for sarcopenia. Arch Osteoporos. 2018;13(1):98.
35. Geerinck A, Dawson-Hughes B, Beaudart C, Locquet M, Reginster JY, Bruyère O. Assessment of the performance of the SarQoL(®) questionnaire in screening for sarcopenia in older people. Aging Clin Exp Res. 2021;33(8):2149-55.
36. Haase CB, Brodersen JB, Bülow J. Sarcopenia: early prevention or overdiagnosis? Bmj. 2022;376:e052592.
37. Brodersen J, Schwartz LM, Heneghan C, O'Sullivan JW, Aronson JK, Woloshin S. Overdiagnosis: what it is and what it isn't. BMJ Evid Based Med. 2018;23(1):1-3.
38. Wilson JM, Jungner YG. [Principles and practice of mass screening for disease]. Bol Oficina Sanit Panam. 1968;65(4):281-393.
39. Bloom I, Shand C, Cooper C, Robinson S, Baird J. Diet Quality and Sarcopenia in Older Adults: A Systematic Review. Nutrients. 2018;10(3).
40. Dent E, Morley JE, Cruz-Jentoft AJ, Arai H, Kritchevsky SB, Guralnik J, et al. International Clinical Practice Guidelines for Sarcopenia (ICFSR): Screening, Diagnosis and Management. J Nutr Health Aging. 2018;22(10):1148-61.