



LITERATURE REVIEW

## Investing in adult nutrition to reduce mobility problems in ageing population

Ray Wagiu Basrowi<sup>1,2</sup>, Levina Chandra Khoe<sup>1</sup>, Tonny Sundjaya<sup>2</sup>

- <sup>1.</sup> Occupational Medicine Division, Department of Community Medicine, Faculty of Medicine, Universitas Indonesia
- <sup>2.</sup> Danone SN Indonesia

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### Abstract

As people age, most body organs deteriorate. Osteoporosis, arthritis, sarcopenia, muscle aches, low back pain and neuropathy are common mobility issues in the elderly. Body mass index (BMI), physical inactivity, and having comorbidities increase the likelihood to have mobility health problems. One in every ten adults over the age of 45 years in Indonesia develops these mobility problems, and one in every fifteen adults has difficulty in walking/stepping before entering the elderly age. Nutrition has been reported to have important role in controlling weight and physical locomotive organs. Generally, 46% adults in Indonesia have vitamin A deficiency, 70% vitamin C deficiency, 77% vitamin E deficiency, and inadequate calcium intake. Low nutrition intake can result in increasing mobility problems that lead to health issues in the aging population. Dietary strategies are necessary to achieve healthy ageing. Currently, no standardized guideline has been developed for preventing mobility health problems in Indonesia. This calls for urgent need to hinder poor quality of life in elderly population.

**Keywords** mobility health, nutrition, healthy ageing

### Introduction

Ageing is a lifelong accumulation of diverse deleterious changes of physiological functions that are responsible for the increased risk of age-related diseases. Despite genetic factor, having morbidities, poor nutrition, and unhealthy lifestyles contribute to the ageing process.<sup>1</sup> In addition, understanding health status and social service use can predict the levels of disability in the aging population.<sup>2</sup> Strategies to achieve healthy ageing should be performed far before the individuals enter the elderly age, and should take into account the nutrition, lifestyle, and health status in the adult stage.

Indonesia is one of the world's largest populations and projected to have more than 30% of population above the age of 50. In the current health system, only 25% of these senior adult population are included in the public health programs, and even less (12%) in private insurance policies.<sup>3</sup> Consequently, these increase the likelihood of impairment in the aging population.

Changes in aging body is inevitable. This include loss of muscle mass, reduced bone mineral density and water, reduced function of musculoskeletal and neuromotor. Previous research highlighted the importance of promoting physical activity that would improve the musculoskeletal and neuromotor function in the aging population, compared to those inactive.<sup>4</sup> Starting at the age of 35, joint and muscle pain appears slight, and increases with age. While sarcopenia and osteoporosis are more common in older age, above 50. Indonesian elderly frequently encounter arthritis, osteoporosis, sarcopenia, muscle

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#### Corresponding author:

Dr. dr. Ray Wagiu Basrowi, MKK  
Medical and Science Affairs  
Danone SN Indonesia  
Email: [ray.basrowi1@danone.com](mailto:ray.basrowi1@danone.com)

ache, and neuropathy.<sup>3</sup> Having muscle and bone problems are linked with mobility issues in the elderly population. Impairment can lead to fatigue, muscle weakness, lower motion, and balance. With poor mobility, people will have difficulty in doing daily activities, resulting in higher independence in elderly age and reduce quality of life.<sup>5</sup>

Most of the times, people with metabolic syndrome and poor diet would also develop mobility disorders. Studies have shown the association between protein, vitamin A, vitamin C, vitamin E, vitamin D, calcium, and omega-3 with mobility problems in later life.<sup>6</sup> Understanding factors contributing to these mobility-related diseases, prevention strategies that emphasizing the needs for dietary intervention would be vital to reduce the disease burden in ageing population.

### **Mobility problems in aging population**

Mobility refers to the ability of an individual to move the body and perform daily tasks. Good mobility is a characteristic of healthy ageing, as described by the World Health Organization (WHO). Lifestyle, climate, diet, and exposure to health hazards would reduce the functional capacity, and eventually affect the mobility.<sup>7</sup> Mobility system consists of bone, muscle, joint, cartilage, tendons and ligaments, supported by the central and peripheral nervous systems. These organs will deteriorate as humans get older. Bone mass decreases after reaching its peak bone mass at 30 years of age and loses approximately 0.3% and 0.5% in women each year. Muscle mass also decreases by approximately 3–8%.<sup>8</sup>

Common mobility problems found in elderly people include osteoporosis (reduced bone mineral density), arthritis (the inflammation of joints), sarcopenia (loss of muscle mass and strength), muscle aches, low back pain and neuropathy. Patients with sarcopenia have higher risk of osteoporosis and lower mineral density, than general population. Osteoarthritis patients would have less muscle strength than normal people.

Locomotive dysfunction can also lead to muscle pain, reduced movement, loss of muscle strength and impaired balance.<sup>9</sup>

Older people experience physiological changes related to age, such as lower bone mineral density

and loss of muscle mass. Lack of stamina, exhaustion, weakness, and lack of appetite are common complaints from older people that can lead to immobility and poor diet. Diet and micronutrient status have been extensively studied in the impact of physical and cognitive function. The relationship between micronutrient insufficiency and physical function has been a vicious cycle. It might have short-term and long-term impact on physical well-being, including immobility.<sup>10</sup>

Additionally, chronic diseases, such as hypertension, diabetes, heart disease, and chronic kidney disease are prevalent among elderly people. These conditions are considered as comorbidities that need to be addressed. Nutrition intervention is not only important for preventing mobility problems, but also for improving the overall physical well-being.

### **Role of nutrition in mobility**

Mobility health is not a common term for Indonesians. It is reflected by the mobility-related diseases, such as arthritis, osteoporosis and sarcopenia. The result from Basic Health Research (2018) identified that the incidence of osteoporosis and sarcopenia in people aged between 45 and 60 years old is associated with joint and muscular problems in adults (35 to 45 years). In addition, the number of chronic illness is prevalent among adults and must be treated in older ages (55-64). The disease burden will be higher as mobility issues increase.<sup>3</sup>

In Indonesia, physical activity among adults is relatively poor and trends in adequate physical activity are shown to be steadily declining by age. About 78% of the population between 35 and 39 years was considered physically active, but the percentage fell into 69% in the 60-64 age group. The most popular activity in the 31–59 age group is biking (46%). While walking and jogging opportunities are more favoured in the elderly (60+) population.<sup>3</sup> A study revealed that physical inactivity for two weeks would lower muscle strength by 30%.<sup>11</sup> This also supports the reason why mobility problems arise at 45+ population, and increases with age.<sup>3</sup> The risk of mobility issues in elderly people could also be attributed to insufficient calcium intake and vitamin D deficiency, which is

high prevalent in Indonesia.<sup>6</sup> **Table 1** listed the relationship between nutrients and its function in mobility.

Data in Indonesia revealed that about 34% of both male and female adults in their productive age, and 46 % of those above 55 have protein deficiencies that can affect muscle and bone health.<sup>3</sup> Higher protein intake than recommended daily intake (0.8 g protein/kg body weight per day) can increase the muscle mass, strength, and function in older people. Moreover, it can improve immune status, wound healing and blood pressure.<sup>12</sup> The European Society for Clinical Nutrition and Metabolism (ESPEN) generate recommendations for health care professionals to maintain muscle strength and function in elderly population. It recommends that the diet should contain at least 1.0-1.2 g protein/kg body weight/day for healthy older people, or 1.2-1.5 g protein/kg body weight/day for older people who are malnourished or at risk of malnutrition due to acute or chronic illness. This recommendation should even be higher for individuals with severe illness or injury. In addition, daily physical activity or exercise (resistance training, aerobic exercise) should be performed by all older people, for as long as possible.<sup>16</sup> Protein deficiency has been found to cause several clinical syndromes, but mainly affects skeletal muscles, physical exhaustion, calcium and bone mineral density, and weakness among elderly population. This nutritional problem can occur at any age in any group due to disease or poor diets and is often aggravated by a lack of energy intake. Protein deficiency can also exacerbate other nutrient deficiencies (including vitamin A and iron) and induce metabolic syndromes (diabetes, dyslipidemia, etc.).<sup>17</sup>

About half adult females in the age between 45 and 55; and more than one-third of females aged 60+ had vitamin D deficiency. Vitamin D is important element for calcium absorption and bone mineralization, that positively correlated with bone mineral density (BMD). Age-related reduced bone mineral density begins around the fourth decade, resulting in a steady decline in BMD. This trend is exacerbated even more among females during and up to 10 years after menopause due to estrogen deficiency. Vitamin D deficiency leads to lower absorption of calcium, that eventually would release

calcium from the bones. This would increase the risk of fracture, osteomalacia, osteoporosis, diabetes, cardiovascular disease, and rheumatoid arthritis.<sup>13,18</sup> Older people's dietary requirements for vitamin D are higher due to reduced skin development, reduced exposure to sunlight and thinning of the skin. Untreated vitamin D insufficiency increases reduced bone mineral density and thus increases the risk of fracture, but this is exacerbated by aging. Vitamin D and calcium are essential to the mechanical and structural integrity of the skeleton. Calcium metabolism homeostasis is closely regulated by many hormones, of which parathyroid and vitamin D play a key role. Calcium supplementation will not be useful without sufficient vitamin D.<sup>18</sup> More than half of the adults and female had calcium deficiency.<sup>6</sup> An analysis of 20 prospective studies concluded that in postmenopausal women, calcium supplementation decreased the probability of reduced bone mineral density on average by about 1% per year. The combination of vitamin D and calcium supplement would significantly reduce the risk of fractures. This showed that vitamin D and calcium are essential for bone health.<sup>18</sup>

Although Indonesian adults consume a variety of foods, it is not sufficient to meet the micronutrient requirements. This can be explained by lack of nutritional awareness, poor eating habits, low income or low capability to purchase foods.<sup>6</sup>

A research in Indonesia shows that overall nutrient adequacy of micronutrients was less than 100%, with the exception of iron and vitamin A, this might be due to low fruits and vegetable intakes.<sup>3</sup> Male adult nutrient intakes were higher than female, with the exception of vitamin C. Men aged 30-49 years had higher intakes of nutrient than men aged 19-29 years, excluding vitamin A. Women aged 19-29 years of age had higher nutrient intakes than women aged 30-49 years of age, excluding calcium and vitamin A. The nutrient density of calcium, zinc, vitamin C and vitamin A in Indonesian adults falls below guideline, classified as inadequate. The research also shows an adult calcium deficiency prevalence of 54.2%, iron deficiency of 36.4%, zinc deficiency of 74.3%, vitamin A deficiency of 44.8%, and vitamin C deficiency of 71.4%.<sup>6</sup> These deficits are significantly higher in older populations. Calcium and iron deficiency are higher in women than in men. Inversely, the prevalence of zinc,

vitamin A and C in women was lower than men. Zinc deficiency is evident in Indonesian adults. Indonesian study found that 7 in 10 adults have insufficient intake of zinc and vitamin C. This finding was also seen in other developing countries, such as Mali, Africa, which concludes that micronutrient deficiencies are more prevalent in developing countries than in developed countries.<sup>19</sup>

In Indonesia, 46% of adults have vitamin A deficiency, 70% have vitamin C deficiency and 77% have vitamin E deficiency.<sup>3</sup> Vitamin A, C, and E are excellent antioxidants that protect cells from oxidative damage and are primarily determined by dietary intake. Antioxidants can help with inflammatory reactions by inhibiting the development of reactive oxygen species (ROS), by scavenging free radicals, or by eliminating ROS derivatives. Free radicals, ROS and their derivatives may accumulate substantial structural damage, inflammation, and cell death in the synovial joint. Vitamin C (ascorbic acid), vitamin E, thiol (glutathione) or a variety of plant polyphenols may neutralize ROS in the joints and minimize oxidative stress associated with the progression of arthritis.<sup>20</sup> The effects of antioxidants in muscles and joints examined in a cohort study of Framingham Osteoarthritis (OA) with vitamins A, C and E decreased OA progression in the knee. Another Australian study shows that the beneficial impact of vitamin C intake on the reduction of bone size and bone marrow lesions, both of which are significant in the pathogenesis of the knee.<sup>21</sup> Antioxidant vitamins have essential functions to modulate oxidative stress, to participate in immune responses and to contribute to cell differentiation. The potential of antioxidants to neutralize reactive oxygen species (ROS) and oxidative stress is not limited to joints, but cellular in general.<sup>14</sup>

Food plays an important role in controlling weight and physical locomotive organs. Risk factors such as age, low physical activity, comorbidities, and low BMI are contributing to the increase of mobility problems.<sup>6</sup> Polyunsaturated fatty acid (PUFA) intake is very low for adults in Indonesia with only 3.5 percent energy with 6-11 % recommendation. This is due to insufficient consumption of fish and other seafood<sup>22</sup>. Omega-3 have anti-inflammatory effects that protects cell from oxidative stress that has shown benefits for

mobility organs. Moreover, The American Heart Association (AHA) recommends suggest replacing unsaturated fatty acids from vegetable oils, fish, nuts and legumes with saturated and trans fatty acids to prevent hypertension, heart disease and cardiovascular disease.<sup>23</sup> The use of PUFA may be beneficial for comorbidities prevention in mobility problems in elderly.<sup>6</sup> Some oligosaccharides, such as fructans, have a potential benefit to the lipid profile in the promotion of cardiovascular disease and other comorbidities. Fructans form of inulin has shown benefits in improving the lipid profile, glycemic levels, insulin resistance, and can be used as a substitute for fatty foods to improve satiety.<sup>15</sup>

Dietary strategies are urgently needed to improve the well-being of adults and older people. Increasing the knowledge, information and retention of healthy diets can improve future mobility outcomes. The study of mobility issues in Indonesia is not well established, and therefore, there are still rooms to explore supplements/medicine to support mobility.

### **Mobility assessment tools**

There are many assessment instruments that commonly used to evaluate mobility and balance among elderly population, such as the Timed Up and Go (TUG) test, Short Physical Performance Battery (SPPB), Dynamic Gait Index (DGI), and Berg Balance Scale (BBS). In fact, these tools differ from each other with regard to their functional level, content, and characteristics. Additionally, the interpretation of results could vary depending on the methodology of recording outcomes. For instance, some tests analyse quantitative measurements, while others focus on qualitative aspects. The Asian Working Group for Sarcopenia 2019 consensus recommends the use of gait test and 5-time chair stand test to evaluate the patient's mobility. Nevertheless, the TUG test is not recommended in the consensus since there are differences in interpreting the etiologies.<sup>24</sup> It is crucial to select an accurate assessment tool in order to properly evaluate the health condition, precisely determine the plan of care, and monitor progress. In order to choose the appropriate assessment test in the research field and in practice, several factors have to be taken into consideration. The tests must be valid,

suitable for the target population, and easy to be implemented.<sup>25</sup>

In general, the assessment or screening of mobility may be general or specific to an organ. Overall mobility assessment includes control, balance, durability and feature evaluation. General mobility assessment is good to increase public awareness of early symptoms. However, it might not be suitable for clinical setting, which need physical assessment, laboratory investigations, and regular monitoring. General mobility measures such as one-leg steady-state testing, five chairs, regular gait speed testing, locomotive testing, 6-minute walking and rock-port testing are ground-breaking examples of non-course mobility testing, and failure to provide any value or below average indicates practical mobility issues. Nevertheless, we cannot determine the exact etiology of the problem if we used the general assessment tools.<sup>25</sup>

Assessment of mobility problems are based on the diagnosis such as osteoarthritis, arthritis or low back pain with rigorous organ testing or a series of comprehensive physical/radiologic test based on current guidelines available. Risk factor assessment is also performed to understand the likelihood of mobility problems. The risk factors include personal information, history, lifestyle and diet. This should be carried out by healthcare professionals.<sup>30</sup> There is one study in Indonesia that assessed frailty in elderly using hand grip strength and usual gait speed to assess disability but no consensus has been made. The results by Setiati (2019) clearly reaffirm that slow gait speed is closely related to frailty. Walking requires the coordination of various organ systems and consumes energy, thus decreased organ function and increased energy consumption for walking may be reflected through slowing gait speed. Slowing gait speed (<0.8m/s based on 15-ft walking test) is a promising prognostic factor for mobility problems in Indonesia elderly.<sup>31</sup>

Japanese has more awareness in mobility problems way before Indonesia. They conducted a loco campaign and challenge in 2015 and 2018. Locomo campaign, derived from locomotive syndrome is a campaign to measure locomotion syndrome with serial of test. This campaign obtained the reference value from almost 9000 people in nationwide study.<sup>8</sup> Locomotive Syndrome Test is a series of approaches to the assessment of locomotive

failure. It includes a sit-in test, a two-stage test and a self-reported questionnaire. The objective of the two-step test is to assess the weight, strength and balance of the lower limb. This test measures the probability of immobility separately at 70 years of age. In a stand-by test, people must stand on one or both of the four-height stools and stand for 3 seconds after standing up. Two-stage measures the total duration of the two-stage stage of the participant. Both approaches would require only a few seconds and minimal equipment, including an unarmed chair and a measuring device. These physical tests are combined with a self-reported Geriatric Locomotive Functional Scale (GLFS) questionnaire to assess mobility, body pain, daily activity and mental health status. With the national survey, Japan has recently acquired a benchmark of nearly 9,000 people at two risk levels; level 1 (decreased locomotive function) and level 2 (decreased locomotive function).

Sitting and Rest (SRT) is another early screening measure. In this test, stability, balance, motor control and the relationship between muscle power and body weight are measured in a short period of time. SRT is used to measure the number of supports needed to sit and rise from the floor (chest, knee, forearm, knee, thigh, and legs). The SRT score is considered to be correlated with all causes of mortality and relates to mobility of holistic strength, joint and balancing functions. This test may be able to screen Indonesia's population as soon as the movement in this test is surprisingly similar to everyday activities, including religious or religious meetings. The inability/difficulty of rising after sitting on the floor with a crossed leg is a symptom of a mobility problem.<sup>27</sup>

Learning from the Japanese locomotive campaign, the similarity of the movement in religious prayer or reunion can be a way to increase the sensitivity of mobility. Using general mobility tests such as the Sitting & Resting Test (SRT), early screening may involve a step closer to the flow of daily movements in religious prayer or gathering.<sup>32</sup> Early mobility problems may arise when lifting is not possible after sitting on the floor with a bent leg or prostrate position, and when some people prefer to pray with a chair. Hajj and Pilgrims are religious activities with active mobility; therefore, screening is important for health and mobility principles one year before departure, including multiple general

mobility assessments and regular weekly activity guidance. The role of health care practitioners in healthy aging also a critical point to be consider in promoting a favourable health environment and system in Indonesia.<sup>33</sup>

## Conclusions

The healthy adult population of Indonesia must be informed and aware of the health benefits of mobility and its relationship with nutrition. Some dietary deficiencies found in Indonesian adults include protein, vitamin A, vitamin C, vitamin E, vitamin D, zinc and omega-3. This dietary

deficiency will result in their well-being and impairment in the future. Mobility disorders are mostly the result of metabolic syndrome comorbidities in Indonesia, and food and lifestyle improvements are the only way to avoid them. Prevention and early screening are critical to improve the independence of older people in order to reduce the risk of harm and the potential inability to work. Disability can lead to a lower quality of life, and long-term care is needed to reduce the burden on families and the community by avoiding this impact.

**Table 1.** Nutrient's function in mobility

Nutrient	Function in Mobility	References
Protein	Promotes muscle protein synthesis and bone metabolism	3
Vitamin D	Enhanced calcium absorption in intestine and bone mineralization	12
Calcium	Important mineral for bone forming	13
Antioxidant (Vitamin A, C, E)	Reduce osteomalacia and osteoporosis	14
Polyunsaturated Fatty Acid (PUFA)	Reduce oxidative stress that helps inflammatory reaction such as in arthritis, osteoarthritis	6
	Omega-3 anti-inflammatory effect and reduce oxidative stress	15
	Reduce comorbidities that may increase mobility problem risk	

**Table 2.** Mobility screening tools

Test	Objective	Equipment	Time	References
Two-step test	Locomotive syndrome risk level of 1 indicates that the decline of your locomotive functions has already begun	Distance measurement tool	1 minutes	26
Sit to stand test		Unarmed chair and stopwatch	Few seconds	
Geriatric locomotive function scale		Self assessment	1-5 minutes	
Sitting rising test	Evaluation of Physical Performance, strength, balance	No need	Few seconds	27
One-leg standing test	Evaluation of muscle strength and balance	stopwatch	<1 minute	22
Pick up weight test	Assessment of reach down and pick up	5 kg object	Few seconds	25
5 times sit to stand 5TST	Evaluation of lower limb strength, muscle forces, balance	Unarmed chair and stopwatch	In a short time	
Timed up and go	Assessment of balance and walking ability	Armed chair and stopwatch	Few seconds	
8 Foot up and go	Measurement of power speed, ability and dynamic balance	Armed chair, stopwatch and cone	Few seconds	
Usual gait speed	Evaluation of gait speed	Hallway and stopwatch	Depends on	

Test	Objective	Equipment	Time	References
			walking distance	
Short physical performance battery	Examination of gait balance, strength and endurance	Walkaway, unarmed chair and stopwatch	10-15 minutes	
Tinetti performance assessment	Measurement of balance and gait	Walkway, armless chair and stopwatch	10 to 15 minutes	
Backward walking	Evaluation of mobility sensitively	No need	Depends on distance	
Turn 180	Evaluation of balance and mobility	No need	Few seconds	
Rockport test	Evaluation of physical performance, endurance and mobility	1.6 km track, stopwatch	Depends on the endurance	28
6 minute-walk test	Evaluation of physical performance, endurance and mobility	Hallway and stopwatch	6 minutes	29
Fingertip to floor test	Evaluation of flexibility	Ruler/distance measurement	Few seconds	
Hand grip strength	Evaluation of muscle strength and endurance	Hand grip dynamometer	<1 minute	

## Conflict of Interest

Authors declared no conflict of interest regarding this article.

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## References

1. Kirkwood TB. Why and how are we living longer? *Exp Physiol.* 2017;102(9):1067-1074.
2. Chen C-M, Su Y-Y, Mullan J, Huang M-S, Chiu H-C. Trajectories of disability and their relationship with health status and social service use. *Exp Aging Res.* 2015;41(3):240-258.
3. *Hasil Utama Riskeddas.* Kementerian Kesehatan Republik Indonesia;2018.
4. Tomás MT, Galán-Mercant A, Carnero EA, Fernandes B. Functional capacity and levels of physical activity in aging: a 3-year follow-up. *Front Med.* 2018;4:244.
5. Boulton C, Kane RL, Louis TA, Boulton L, McCaffrey D. Chronic conditions that lead to functional limitation in the elderly. *J Gerontol.* 1994;49(1):M28-M36.
6. Prasetyo TJ, Hardinsyah H, Baliwati YF, Sukandar D. The application of probability method to estimate micronutrient deficiencies prevalence of Indonesian adults. *Jurnal Gizi dan Pangan.* 2018;13(1):17-26.
7. Ignatavicius DD, Workman ML. *Medical-Surgical Nursing-E-Book: Patient-Centered Collaborative Care.* Elsevier Health Sciences; 2015.
8. Ponnappan S, Ponnappan U. Aging and immune function: molecular mechanisms to interventions. *Antioxidants & redox signaling.* 2011;14(8):1551-1585.
9. Council TLC. Locomotive Syndrome. In: Association JO, ed. Tokyo2015.
10. Ahmed T HN. Assessment and management of nutrition in older people and its importance to health. *Clinical interventions in aging.* 2010;5:207.

11. Exchange GHD. Global Burden of Disease Study 2017 (GBD 2017) Data Resources. 2017. Accessed October 5th 2020, 2020.
12. Wolfe RR, Miller SL, Miller KB. Optimal protein intake in the elderly. *Clin Nutr.* 2008;27(5):675-684.
13. Laird E, Ward M, McSorley E, Strain J, Wallace J. Vitamin D and bone health; Potential mechanisms. *Nutrients.* 2010;2(7):693-724.
14. Lynch SR, Stoltzfus RJ. Iron and ascorbic acid: proposed fortification levels and recommended iron compounds. *The Journal of nutrition.* 2003;133(9):2978S-2984S.
15. AlBishi LA. Does Inulin Ingestion Reduce Visceral Fat Adiposity? Mini Review. *Biomedical Journal.* 2018;2:4.
16. Deutz NE, Bauer JM, Barazzoni R, et al. Protein intake and exercise for optimal muscle function with aging: recommendations from the ESPEN Expert Group. *Clin Nutr.* 2014;33(6):929-936.
17. Wu G. Dietary protein intake and human health. *Food & function.* 2016;7(3):1251-1265.
18. Sahota O. Osteoporosis and the role of vitamin D and calcium-vitamin D deficiency, vitamin D insufficiency and vitamin D sufficiency. *Age and ageing.* 2000;29(4):301-304.
19. Kennedy G, Fanou-Fogny N, Seghieri C, et al. Food groups associated with a composite measure of probability of adequate intake of 11 micronutrients in the diets of women in urban Mali. *J Nutr.* 2010;140(11):2070S-2078S.
20. Mobasheri A, Biesalski H, Shakibaei M, Henrotin Y. Antioxidants and osteoarthritis. 2012.
21. Wang Y, Hodge AM, Wluka AE, et al. Effect of antioxidants on knee cartilage and bone in healthy, middle-aged subjects: a cross-sectional study. *Arthritis research & therapy.* 2007;9(4):R66.
22. Springer BA, Marin R, Cyhan T, Roberts H, Gill NW. Normative values for the unipedal stance test with eyes open and closed. *J Geriatr Phys Ther.* 2007;30(1):8-15.
23. Krauss RM, Eckel RH, Howard B, et al. AHA Dietary Guidelines: revision 2000: A statement for healthcare professionals from the Nutrition Committee of the American Heart Association. *Circulation.* 2000;102(18):2284-2299.
24. Chen LK, Woo J, Assantachai P, Auyeung TW, Chou MY, Iijima K, Jang HC, Kang L, Kim M, Kim S, Kojima T, Kuzuya M, Lee JSW, Lee SY, Lee WJ, Lee Y, Liang CK, Lim JY, Lim WS, Peng LN, Sugimoto K, Tanaka T, Won CW, Yamada M, Zhang T, Akishita M, Arai H. Asian Working Group for Sarcopenia: 2019 Consensus Update on Sarcopenia Diagnosis and Treatment. *J Am Med Dir Assoc.* 2020 Mar;21(3):300-307.
25. Soubra R, Chkeir A, Novella J-L. A systematic review of thirty-one assessment tests to evaluate mobility in older adults. *Biomed Res Int.* 2019;2019.
26. Yamada K, Ito YM, Akagi M, et al. Reference values for the locomotive syndrome risk test quantifying mobility of 8681 adults aged 20–89 years: A cross-sectional nationwide study in Japan. *J Orthop Sci.* 2020.
27. Araújo CGS, Laukkanen JA. Cardiac reinnervation influences exercise training outcomes in heart transplant patients. SAGE Publications Sage UK: London, England; 2020.
28. Seco J, Abecia LC, Echevarría E, et al. A long-term physical activity training program increases strength and flexibility, and improves balance in older adults. *Rehabil Nurs.* 2013;38(1):37-47.
29. Tveter AT, Dagfinrud H, Moseng T, Holm I. Health-related physical fitness measures: reference values and reference equations for use in clinical practice. *Arch Phys M.* 2014;95(7):1366-1373.
30. Association IR. Diagnosis dan penatalaksanaan osteoarthritis. *Indonesian Rheumatology Association.* 2014.
31. Setiati S, Laksmi PW, Aryana IS, et al. Frailty state among Indonesian elderly: prevalence, associated factors, and frailty state transition. *BMC Geriatr.* 2019;19(1):182.
32. Nakamura K, Ogata T. Locomotive syndrome: definition and management. *Clin Rev Bone Miner Metab.* 2016;14(2):56-67.
33. Basrowi RW, Sundjaya T, Krisnamurti D, Masita BM. General Practitioners' Perspective towards Healthy Ageing In Indonesia. *Amerta Nutr (2020).*supl.21-26