Aging and nutrition. Paving the way to better health.

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Running head: Aging and nutrition

Abstract

Sufficient caloric intake is important to maintain the balanced health status, especially during the period of aging, as aging and sickness share paths. Maintaining adequate nutritional balance is the best preventive measure to counteract the risk of malnutrition. There are several causes for malnutrition in elderly people, and some techniques like anthropometric measurements, laboratory and clinical parameters could help to diagnose malnutrition in these patients. The use of a simple validated questionnaire called the 'Mini Nutritional Assessment' measures the nutritional status of elderly patients. In this review, we discuss about the malnutrition in elderly people with and without a known cause and we present some of nutritional intervention. There are promising strategies that help overcoming malnutrition.

Key words: Aging, anthropometric assessment, elderly, malnutrition, nutrition.

INTRODUCTION

Appropriate dietary intake is essential during aging and can increase longevity, while aging *per se* can increase the risk of malnutrition in older adults. During life (such as growth, chronic disable conditions or diseases), an adequate nutritional intake can help the organs by protecting the tissue trophism or retaining the autonomy and defense against outside bacteria or infections. Maintaining a correct nutrition (especially if high in protein and balanced in calories) can eventually work against the degeneration processes which accompany aging and against the development of illnesses [1].

Here, we will discuss the concepts related to nutrition with aging in the absence of particular diseases. The topic is of extreme interest especially for internists and geriatricians, since about two-third of older adults fall in the category of nutritional risk or malnutrition [2], while malnutrition is associated to the increase of mortality risk [3].

GENERAL CONSIDERATIONS

In general, the term "malnutrition" encompasses two extreme conditions, namely undernutrition, as well as overweight and obesity [4].

Malnutrition intended as undernutrition is characterized by deficient nutritional status, inadequate dietary intake and use of nutrients which leads to change in quality of life, high rate of morbidity and mortality [5]. Undernutrition paves the way to various health concerns, which include a defective immune system, risk of infections, poor skeletal muscle mass, osteoporosis, and predisposition to bone fractures and other complications.

Malnutrition intended as being overweight or obese, on the other hand, predisposes to several cardiovascular complications such as coronary heart diseases, heart failure or sudden death, and metabolic disorders. Not only cardiovascular, but also respiratory (such as obstructive sleep apnea or hypoventilation) as well as osteo-articular diseases can be impaired by this pathological condition [6]. However, the impact of obesity in the elderly remains largely unexplored. This aspect is of particular relevance to address strategies able to decrease the impact of obesity on disability and health-related quality of life [7]. Disability is present ten years earlier in overweight/obese people than in people with normal weight, and most obese/overweight subjects will also suffer from disability at a later age [8]. However, one should also consider the so-called "obesity paradox" (i.e.

the potential protective effect of overweight against mortality and the negative effect of underweight) [9].

Thus, specific and adequate interventional models and guidelines in elderly people must be carefully balanced against specific risks of underweight and undernutrition versus overweight and obesity and comorbidity risks [10].

MALNUTRITION (UNDERNUTRITION) IN OLDER ADULTS

The physiological process of aging includes a general decrease of body functions and a less efficient immunological system. Both conditions are associated with systemic inflammation ('inflammaging'). This scenario points to fragility of elderly people, which then becomes more prone to several pathological hits. The general picture includes decreased gastrointestinal secretions and motility, and decreased nutrient absorption. Decreased saliva secretion (xerostomia) and gastric HCl secretion (due to progressive mucosal atrophy), are two examples of this progressive intestinal mucosa atrophy. In addition, decreased iron and vitamin B12 absorption may occur with age. Food intake might also decrease due to progressive decrease of caloric requirement and malabsorption. Hormonal pathways are also involved in this respect, including decreased secretion of gastrointestinal hormones such as ghrelin and cholecystokinin. Other actors are decreased taste and smell, as well as lifestyle changes, depending on aging. Additional factors include social environment, economic conditions, body composition changes, decreased lean mass (sarcopenia), and increased fat mass due to sedentary life. Furthermore, these additional factors might depend on ongoing specific diseases such as atrophic gastritis, , use of non-steroidal anti-inflammatory drugs (NSAIDs) or intestinal atrophic changes. NANHES studies suggest that elderly people are therefore prone to protein malnutrition, anemia, vitamin, mineral and calcium deficiencies, and changes of intestinal permeability. Clinical pictures might also include topographic, qualitative and quantitative changes of microbial distribution in the intestine (i.e. small intestinal bacterial overgrowth, decreased *Bifidobacteria* or *Faecalibacterium prausnitzii* and increased *Proteobacteria*). Changes might result in decreased ability to synthesize short-chain fatty acids.

Several aspects of microbiota change during aging might be dictated by changes of gut-associated lymphoid issue, leading to decreased activation of natural killer immunological cells and lymphocytes T response, progressive timus atrophy, and increased secretion of pro-inflammatory systemic cytokines.

Malnutrition often occurs in elderly people and becomes a serious complication.

Clinicians are putting lot of attention on protein-caloric malnutrition, which is increasing drastically in Western societies and increasing with age and sex [1]. In older adults, the prevalence of malnutrition was 23% in one study across Europe, USA, and South Africa [11]. Prevalence differs since malnutrition occurs in about 5-12% of people leaving at home, in 26-65% of hospitalized patients, and up to 85% of those living in health residences [12–15]. The wide range of reported prevalence can also depend on different definition criteria of malnutrition, diagnosis, and settings.

CAUSES OF MALNUTRITION

Nutritional support in elderly is dependent on several causes, which include age-related organic conditions, disease-related conditions, and/or social, environmental and physiological conditions (**Figure 1**).

Even though protein-caloric malnutrition is a major issue for overall health status of elderly people, physicians and health workers often miss this condition [16-19]. In contrast, the early recognition of malnutrition reduces the negative consequences and is part of support strategies, including nutritional supplementation with personalized treatment plans [17-20]. Malnutrition as a marker of disease severity in elderly people appears in **Table 1.** Early diagnosis of malnutrition in elderly

people is important, since effects of malnutrition are associated with both morbidity and mortality [21], physical function [22], use of health care resources [23], and length of hospital stay [24, 25]. In previously undernourished patients, a weight increase of at least 5% of body weight is associated with a decreased incidence of death. Morbidity events appear also to decrease [26].

Frail elderly individuals show a progressive impairment of the ability to feed autonomously and adequately. Elderly people experience less frequent hunger than younger adults and defective adaptation to underfeeding, with poorer weight recovery [27].

Some causes of malnutrition are closely associated to aging itself, such as atrophy of the oral mucosa and tongue with altered/decreased taste/odor perception [28], edentulism with effects on chewing [29], delayed gastric emptying (leading to increased satiety) [30], reduced gastric and pancreatic secretion with impaired digestion, and absorption of nutrients. Age-dependent visual brilliance, joint problems and shiver in the hands, are additional event. Dysphagia has a prevalence of 7-10% in older patients but can increase dramatically, up to 50% in patients after a stroke episode or Parkinson disease [31-34]. The risk of dysphagia can increase due to reduced alertness. Some hormones, like glucagon-like peptide-1 (GLP-1), glucagon, cholecystokinin (CCK), leptin, and ghrelin act as peripheral satiety signals. During aging these hormones are less well-detected by the brain [35]. Impaired hormonal function might therefore affect the regulation of food intake in elderly people.

Further medical conditions (cardiovascular, gastrointestinal, infective, rheumatologic, and neurologic), may also affect the prevalence of dysphagia as a contributing factor to weight loss. The presence of malignancy [36], especially of the gastrointestinal tract [37] is an important cause of weight loss.

Among psychological factors, one should include depression, as well as dysphoria, especially in the subacute care, nursing home context, and community in older patients [36]

Use of drugs and/or polytherapy may affect body weight. Antacids and laxatives, diuretics, sedatives, digoxin, serotonin-reuptake inhibitors, opioids, topiramate, may interfere with gastric absorption, renal function, and alter taste perception.

Social risk factors include loneliness and decreased calorie intake [38, 39], financial limitations/poverty, isolation, and institutionalization [12, 40].

Further components of malnutrition and unintentional weight loss also include:
- Anorexia is appetite loss. This condition can be physiological, due to simple age-dependent and adaptive decrease of food intake/calories [41], taste changes etc., or specific diseases [42]
- Cachexia (inflammatory effects of disease associated to muscle loss with or without fat mass loss) [43]. Can be associated also with anorexia, insulin resistance, and inflammation. Can be resistant to nutritional interventions, due to its multifactorial origin, especially cytokine-mediated response (i.e. interleukin (IL)-1, TNF-alpha (TNF-a), IL-6 [44, 45] [46]. Known predisposing factors to cachexia include neoplasms, chronic pulmonary disease, rheumatoid arthritis, end-stage renal disease, heart failure, and acquired immunodeficiency syndrome (AIDS). Mechanisms leading to myofibrillar breakdown include the ubiquitin proteasome pathway, as well as cortisol and adrenergic hormones activating fat oxidation, insulin resistance, fatigue [47].
- Sarcopenia (loss of muscle mass, strength and performance) [48-50]. Sarcopenia occurs independently of an underlying illness and is not necessarily associated with cachexia. Low

muscle mass in sarcopenic patients can be assessed by DEXA or bioelectrical impedance. Causes of sarcopenia include disuse, hormonal changes, chronic diseases, insulin resistance [51], inflammation, decreased physical activity [52, 53], as well as nutritional deficiencies [48] including decreased protein intake [54]

The prevalence of sarcopenia can be as high as 57-60% in both males and female over the age of 80 [55]. Sarcopenia with decreased muscle strength is also found in sarcopenic-obese [56], but also in normal and underweight individuals.

The elderly people may develop alcohol-related problems, and risk factors for alcohol abuse include a prior history of alcohol use, grief, anxiety, depression, pain, and disability. This issue is of key importance since alcohol dependence can be associated with inadequate dietary intake and malnutrition. Subjects at risk should be questioned about frequency and quantity of alcohol use, using CAGE questions. [57, 58] or a variety of available tools [59]. Epidemiological studies show that about 50% of adults aged more than 65 consume alcohol. A considerable group (about 15%) drink more than the dose allowed, i.e. more than seven drinks per week. In addition, more than 50% of older drinkers display hazardous consumption of alcohol [60], Elderly people having problematic alcohol consumption are at risk of impaired function, cognition, falls and general health.

DIAGNOSIS OF MALNUTRITION

A. Identification of at-risk individuals for malnutrition

The definition of malnutrition has followed since 2012 the Guidelines from the Academy of Nutrition and Dietetics (Academy) and the American Society for Parenteral and Enteral Nutrition (ASPEN) require at least two out of six conditions to be present for the diagnosis of malnutrition [61] (**Table 2**).

The emerging role of acute and chronic inflammation and its impact on malnutrition was subsequently appreciated by the Global Leadership Initiative on Malnutrition (GLIM) [62] which require both phenotype and etiologic criteria to be present (**Table 2**).

Anthropometric measurements are important diagnostic tools to determine the distribution of fat and proteins in the body. The assessment is safe, easy to perform, reproducible, quick and affordable [63]. Measurements include weight, height, hip circumferences, and thickness of subcutaneous skinfolds, legs and abdomen. In elderly people, however, anthropometric measurements are difficult in bedridden patients or with ongoing conditions such as edema or compartmentalized fluids (i.e. ascites, pleural and cardiac effusions).

Weight is the first measurement, and low body weigh occurs with less of 80% of the recommended body weight, according to specific tables for elderly people.

Weight loss is another important measurement in older adults, especially when is not volitional, and because weight loss predicts mortality [64, 65, 3]. Among community-dwelling older adults, even a loss of 5% of weight over a 3-year period is linked to increased mortality [66]. Weight loss becomes clinically relevant when ≥2%, 5%, 10% of baseline body weight in 1, 3, and 6 months respectively [67]. In patient living in the long-term care setting, weight-loss becomes clinically significant with a loss of 5% or 10% of usual body weight in 1 or 6 months, respectively [68]. The initial evaluation of weight loss should include the recording of changes, bioelectrical impedance, mid-upper- or mid-arm circumference, appetite and dietary intake, blood analyses (including glucose and electrolytes, thyroid-stimulating hormone (TSH), complete blood count (CBC), and C-reactive protein (CRP), serum albumin). Other investigations may include chest and abdominal radiographs [69], thoracic, abdominal, pelvic computed tomography (CT), magnetic resonance imaging (MRI), and endoscopic

procedures, depending on single cases. Multidimensional screening tools should be part of such evaluation (see below).

B. Assessment of nutritional status in at-risk individuals

In elderly people, the measurement of body mass index (BMI) might not be very informative when searching for malnutrition.

BMI is calculated as the Quetelet's index (i.e. kilograms divided by meter squared, kg/m^2). Subjects are therefore classified as underweight ($<18.5 \ kg/m^2$), normal weight ($\geq18.5 \ kg/m^2$ and $<25 \ kg/m^2$), overweight ($\geq25 \ kg/m^2$ and $<30 \ kg/m^2$) and obesity ($\geq30 \ kg/m^2$) [70].

Data discussed so far, need to be harmonized with further considerations. In older adults, weight loss is more dangerous for those with a BMI below 30 Kg/m^2 (greater mortality threat), than those with a BMI 25-30 Kg/m2 [71]. Obesity, however, is associated with increased morbidity and mortality in older adults. There is a link between extreme BMIs (i.e., very low or very high) and increased risk of death [72]. Intentional weight loss with exercise in these patients brings beneficial effects. This is particularly true in the presence of other conditions, such as diabetes mellitus, coronary heart disease osteoarthritis, and impaired activity tolerance [73-75].

Waist circumference, by contrast, provides a better basis for evaluation of obesity in aging populations [76].

To quantify and diagnose malnutrition, some clinical and laboratory tests could help, too [77]. The lean body mass of the patient can be determined by using the creatinine-height index [(measured urinary creatinine x 100)/ ideal urinary creatinine for a given height].

The severity of malnutrition and nutritional status is associated with the levels of some plasma proteins (**Table 3**). Serum albumin is used to assess changes in dietary protein intake, kidney function and other inflammatory conditions. Transferrin has a shorter half-life and is a measure of protein deposit, while prealbumin has an even shorter half-life and is a marker of reserve of proteins.

Together, these proteins help in the assessment of nutritional status in elderly patients.

Indirect methods also indicate malnutrition in patients, and include the complete number of circulating lymphocytes (abnormal when less of 1500 $cells/mm^3$). The delayed-type hypersensitivity skin testing is based on the reaction that occurs in response to the intradermal injection of an antigen (i.e. tuberculin, candida albicans, histoplasmin, etc.). Other serum biomarkers are much less informative and helpful to assess the nutritional status or to plan nutritional intervention [77].

Multidimensional screening tools can help in the evaluation of malnutrition, and include:

1. Prognostic Nutritional Index (PNI) is based on serum albumin, serum transferrin, triceps skinfold and the delayed-type hypersensitivity skin testing [78].
2. Geriatric Nutritional Risk Index (GNRI) helps in diagnosing weight, weight loss, and serum albumin [79].
3. Malnutrition Universal Screening Tool (MUST) can assess weight, height, weight loss (in 3 to 6 months) and acute diseases [80, 81].
4. Nutrition Risk Screening (NRS) measures weight, height, weight loss, acute diseases and reduced caloric intake [82]. Disease severity ranges from 0 score (patients with chronic illnesses or a hip fracture) to 3 (patients in the intensive care unit with an APACHE score of 10).
5. Malnutrition Screening Tool (MST) in acutely hospitalized patients and cancer patients. The tool relies on two simple questions, i.e., "Have you been eating poorly because of a decreased appetite?" and "Have you lost weight recently without trying?" Sensitivity is 74-100% in hospitalized patients and specificity is 76-93%, compared with Subjective Global Assessment [83].
6. Mini Nutritional Assessment (MNA) relies on subjective perception of health. MNA is the most widely used non-invasive, cost-effective tool to assess the nutritional status in elderly patients.

Questions investigate diet, and some body measurements, and MNA is predictive of poor outcomes [84-86]. The Short Form version (MNA-SF) is based on 6 questions from MNA (A to F1/F2) [87], and which is used to extract information about the risk of malnutrition in a very fast and practical way. A score appears at the end [87]. The tool incorporates calf circumference instead of BMI, if not measurable [88] (**Table 4**) [87, 89-91]. The test is recommended by the European Society of Parenteral and Enteral Nutrition [82], the Programme National Nutrition Santé [92], and in Italy by the guidelines for the assessment of malnutrition in the elderly [21]. The specificity and sensitivity of this test is 98% and 96% respectively, in detection of malnutrition [87]. The complete test version is available online [Nestle Nutrition Institute, mna-elderly.com], and is validated against other anthropometric and biochemical markers [87], hence making the test reliability to 0.89 [93]. MNA is inversely related to both length of stay in hospital and hospital services [94, 95], and has been validated in different populations including Spanish [96], American [91], Australian [97], Korean [98], Italian [99], Estonian [100], Taiwan [101], Finnish [102], Japanese [103], Chilean [104] and Brazilian [105]. MNA also predicts the long- and short-term mortality and morbidity in hospitalized patients [106]. The MNA short form is reliable also in General Practice [13].

NUTRITIONAL INTERVENTION IN ELDERLY

During the process of aging, elderly people lack nutrients, which are required for their body metabolism; this could be fulfilled by nutritional interventions. The concept is to supply adequate necessary nutrients either by dietary, pharmacological or artificial strategies to prevent malnutrition combined with protein and non-protein calories [107, 108]. Appropriate healthy food pyramids for older adults exist [109], which emphasize the need of regular physical activity and social interaction, fluid intake, and balanced vegetable, fruit, cereals, animal proteins, fats, along with vitamins and calcium (**Figure 2**). The main aim of nutritional intervention is to reduce the mortality and morbidity, improve the quality of life and improve the physical performance by providing sufficient energy, macronutrients, and micronutrients [110]. Secondary causes of malnutrition must be adequately identified and treated, whenever possible, also following the acronym "MEALS ON WHEELS" (**Table 5**) by Morley JE [111]. Interventions in the malnourished patient should follow appropriate indications for calorie and protein requirements. In particular, Recommended Dietary Allowance (RDA) for protein is 0.80 g/kg body weight/day for adults ≥51 years old of both sexes [112]. Interfering and useless dietary restrictions should be corrected [113]. Feeding or shopping assistance should be available [114], while the choice of foods should follow each individual taste

The nutritional intervention is proposed for a higher period in elderly patients when compared to the younger patients, often to eradicate the malnutrition and to maintain a stable functioning of the body. Soon after establishing the diagnosis of the malnutrition, natural feeding is the next step, to balance the nutrients and to enhance the protein intake according to nutritional recommendation and use of supplements.

The oral supplementation of nutrients covers most of the nutritional need from macronutrient intake (**Table 6**). There are many supplements available in the market with different flavor and texture to help elderly patients in different conditions. However, such supplements fail when severity of the disease increases and supplementation is required through nasogastric tube or gastrostomy. The role of such supplements is doubtful when considering survival in frail patients [115, 116]. In patients with depression, the caloric integration improves the overall health status [107]. Moreover enteral nutrition by means of oral nutritional supplements and tube feeding increases nutrient intake if oral food intake is insufficient. Due to the nutritional deficiency in elderly patients after major surgery or fractures, protein supplements is recommended. This approach decreases the risk of complications. Patients with risk of pressure from ulcers are treated together with preventive measures and additional nutritional therapy [117]. Protein support contribute to reduce the risk of pressure from

ulcers developed during the healing process [118]. To stimulate the tissue repair, a nutritional intervention enriched with glutamine, arginine, β-hydroxyl-β-methyl butyrate (HMB), and zinc is better than a standard nutritional treatment. Well-balanced mixture of oral amino acids exist which stimulate the muscle protein synthesis and mitochondrial ATP production in cases of scarcity, and these have been effectively tested in patients of different metabolic conditions [119-121].

HMB, an amino acid leucine metabolite [122] is a safe therapy and nutritional supplement in elderly patients with muscular atrophy and pressure ulcers [123, 124]. Leucine, on the other hand, is a regulator of protein metabolism and provides an anti-catabolic activity [125]. This effect, in turn, counteracts muscle atrophy due to inactivity [126]. Medications could represent an option in subgroup of patients (**Table 6**), and they may include orexigenic drugs (i.e., appetite stimulants), such as dronabinol, mirtazapine, growth hormone secretagugues, megestrol acetate.

CONCLUSIONS

Nutritional balance in elderly patients plays a crucial role, as it involves the maintenance of adequate health status. Adequate nutritional intake provides maintenance of a strong immune system response, protecting subjects from infectious diseases, organ dysfunctions, and contributing to health status, and better quality of life. During aging, an early assessment of the nutritional status is vital to prevent/delay the severity of diseases, especially during disabling conditions, and should be proposed periodically. Early diagnosis of malnutrition could be an indicator of morbidity and mortality in frail people. On the other hand, adequate nutritional support with amount of micro- and macronutrients helps improving the health status of elderly. This policy might be one of the best strategies to reduce mortality and morbidity, and to maintain the nutritional status and physical performance. However, the inaccurate assessments of the nutritional status may result in an underestimation of the impact of obesity on morbidity and mortality in elderly people leading to poor evaluation of the health status. Accurate knowledge of the changes in body composition and fat distribution will help to better understand the relationship between obesity, morbidity, and mortality in the elderly. On the other hand, inadequate interventions (i.e. rapid weight loss, unbalanced diet) aimed at treating obesity in aged people should be carefully proposed to avoid negative consequences.

Aportul caloric suficient este important pentru a menţine starea de sănătate mai ales în timpul bătrâneţii având în vedere că înaintarea în vârstă se asociază cu morbiditatea. Menţinerea unei balanţe adecvate este cea mai bună măsură preventivă pentru contracararea riscuirlor malnutriţiei. Suint mai multe cauze ale malnutriţiei la pacienţii vârstnici iar pentru diagnosticarea sa sunt disponiblile măsuraătorile antropometrice şi diverse teste de laborator. Folosirea unui chestionar simpul de administrat denumit Mini Nutritional Assessment' măsoară statusul nutritional la pacienţii vârstnici. În acest articol sunt discutate aspecte ale malnutriţiei la vârstnic şi sunt prezentate anumite intervenţii nutriţionale. În prezent există strategii promiţătoare care ajută la prevenirea malnutriţiei.

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Table 1. Malnutrition as an indicator of disease severity in elderly.

OUTCOME	IMPACT OF MALNUTRITION	References
Morbidity	• Independent risk factor together with hospital readmission • Increases prevalence of morbidity to 48% in malnourished patients undergoing elective surgery for non-neoplastic causes • Affects depression and cognitive performance	[127, 128]
Hospitalization	• Inversely related to nutritional status in elderly women with hip fracture • Direct association between malnutrition and post-surgical mobility recovery in women • Double time of recovery in non-neoplastic subjects when malnourished	[129, 130, 24, 25]
Mortality	• Related to anthropometric, biochemical, immunological, functional or underlying conditions (body weight change and albumin levels most predictive) • Mortality is five times greater in malnourished women hospitalized for hip fracture	[131, 132, 130]
Costs	• Increased costs across Europe (>120€ billion annually) • Almost double than obesity management	[133-135, 13]

Table 2. Diagnosis of malnutrition (undernutrition).

According to Guidelines from the Academy of Nutrition and Dietetics (Academy) and the American Society for Parenteral and Enteral Nutrition (ASPEN) [61]

At least two conditions:

- Weight loss

- Insufficient energy intake

- Loss of muscle mass

- Loss of subcutaneous fat

- Localized or generalized fluid accumulation that may mask weight loss

- Diminished functional status as measured by handgrip strength

According to the Global Leadership Initiative on Malnutrition (GLIM) [62]

At least one phenotype plus one etiologic criterion:

Phenotype criteria

- Non-volitional weight loss

- Low body mass index (BMI)

- Reduced muscle mass.

Etiologic criteria

- Reduced food intake or absorption

- Underlying inflammation due to acute disease/injury or chronic disease.

Table 3. Characteristics of plasma proteins.

Protein	Half-life	Information
Serum albumin	Long	• Changes in dietary protein intake • Predictor of chronic kidney disease • Other conditions: inflammation, acute or chronic stress, overhydration, urinary or peritoneal losses, and acidemia
Transferrin	Short (8 days)	• Depletion of protein deposit • Nutritional status • Correlation with clinical outcomes
Prealbumin	2-3 days	• Reserve of proteins • Nutritional status

Table 4. Mini Nutritional Assessment - short form.

Questions

A. Has food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties?
 0 = severe decrease in food intake
 1 = moderate decrease in food intake
 2 = no decrease in food intake

B. Weight loss during the last 3 months
 0 = weight loss greater than 3 kg [6.6 lbs.]
 1 = does not know
 2 = weight loss between 1 and 3 kg [2.2 and 6.6 lbs.]
 3 = no weight loss

C. Mobility
 0 = bed or chair bound
 1 = able to get out of bed / chair but does not go out
 2 = goes out

D. Has suffered psychological stress or acute disease in the past 3 months?
 0 = yes
 2 = no

E. Neuropsychological problems
 0 = severe dementia or depression
 1 = mild dementia
 2 = no psychological problems

F_1. Body Mass Index [BMI] [weight in kg]/ [height in m^2]
 0 = BMI less than 19
 1 = BMI 19 to less than 21
 2 = BMI 21 to less than 23
 3 = BMI 23 or greater

F_2. Calf circumference [CC] in cm
 0 = CC less than 31
 3 = CC 31 or greater

If BMI is not available, replace question F_1 with question F_2.

Screening score [max. 14 points]
12-14 points: normal nutritional status
8-11 points: at risk of malnutrition
0-7 points: malnourished

Table 5. Causes of weight loss in older adults (acronym "MEALS ON WHEELS").

Medications (i.e., theophylline, antibiotics, digoxin, selective serotonin reuptake inhibitors)

Emotional (i.e., depression, anxiety)

Alcoholism, older adult abuse

Late-life paranoia or bereavement

Swallowing problems

Oral factors (tooth loss, xerostomia)

Nosocomial infections (i.e., tuberculosis, pneumonia)

Wandering and other dementia-related factors

Psycho-neurological problems (Parkinson, depression,…)

Hyperthyroidism, hypercalcemia, hypoadrenalism

Enteral problems (i.e., esophageal stricture, gluten enteropathy)

Eating problems

Low salt, low cholesterol, and other therapeutic diets

**S**ocial isolation, stones (chronic cholecystitis)

Adapted from [111]. Copyright ©1997, American Society for Nutrition.

Table 6. Treatment of weight loss in older adults.

Nutritional supplements	• Daily multivitamin and mineral supplement for a better physical performance and strength *[136]* • Protein and amino acids supplement to tackle undernourishment and sarcopenia *[137-139]* • Liquid dietary supplement
Appetite stimulants	• Megestrol acetate for weight gain in anorexia and cachexia patients [140-142] • Dronabinol to improve appetite in patients with AIDS [143] • Mirtazapine for management of weight loss in Alzheimer disease patients [144] • Ghrelin mimetics (growth hormone secretagogues) to increase fat-free mass [145]

Legends to Figures

Figure 1
Factors governing nutritional needs of older adults.
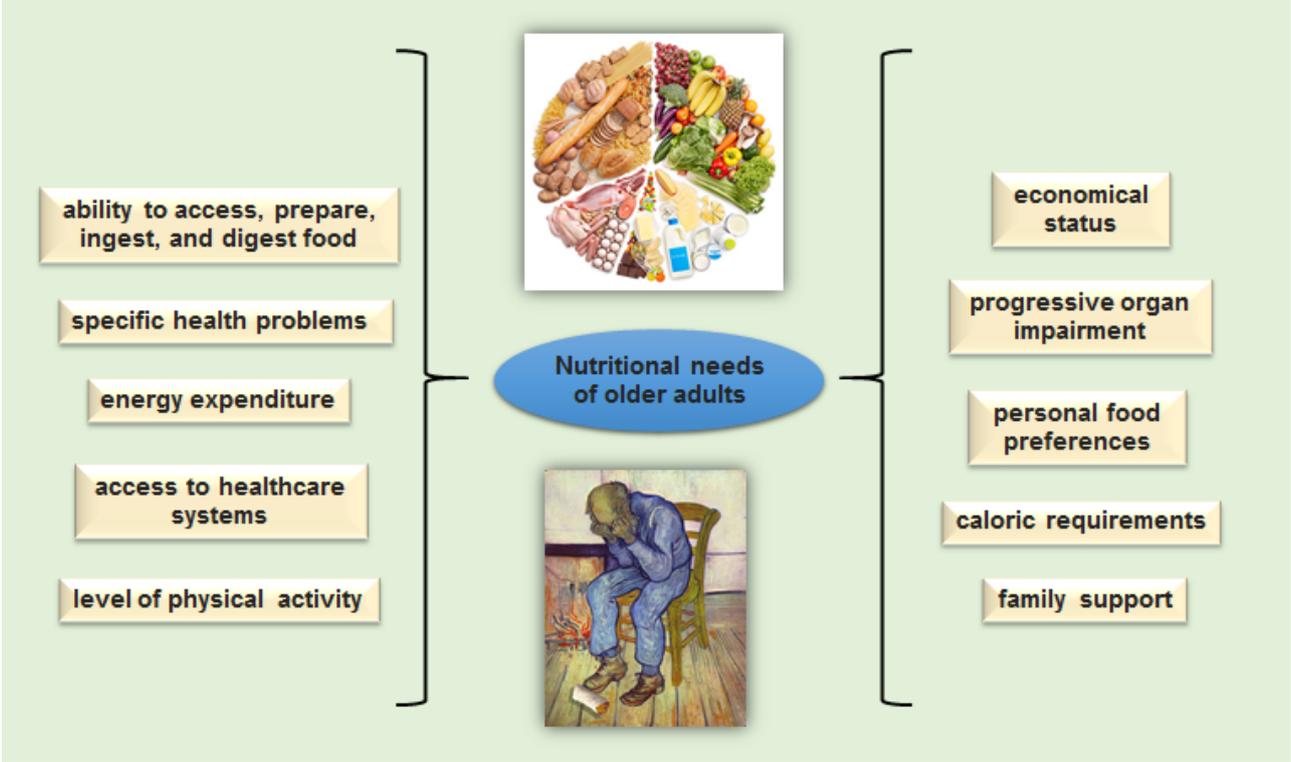
Figure 2
Food pyramid for older adults [109].
With permission from LICHTENSTEIN, A. H., RASMUSSEN, H., YU, W. W., EPSTEIN, S. R. & RUSSELL, R. M. 2008. Modified MyPyramid for Older Adults. The Journal of Nutrition, 138, 5-11.

Food pyramid for older adults