Nutrition and Healthy Aging

Subjects: Allergy

Contributor: Maria Cristina CRISTINA

Nutritinal well-being is a fundamental aspect for the health, autonomy and therefore the quality of life of all people, but expecially of the elderly. Old patients are particularly at risk of malnutrition, due to the multiple etiopathogenetic factors which can lead to a reduction in intake of nutrients, a progressive loss of functinal autonomy with dependence on food, psychological problems related to economic or social isolation, e.g. linked to poverty or loneliness. Gasteointestinal changes in aging involve motor function and therefore intestinal transit, mechanical breackdown of food and his chemical digestion. These alterations progressively lead to the reducede ability to supply the body with adequate quantities of nutrients, with the consequent development of malnutrition.

malnutrition nutrition elderly gastrointestial diseases

1. Introduction

Healthy Aging has been identified by the World Health Organization as a work priority and a policy framework has been designed to make older people well-being and able to live independently in society [1].

Old age is characterized by a reduced regenerative and adaptive capacity resulting in an easier development of morbidity; one prerequisite for wellbeing and have a good quality of life is to maintain an adequate nutritional status [2][3].

It is estimated that at least half of non-institutionalized elderly people need nutritional intervention to improve their health and that 85% have one or more chronic diseases that could get better with correct nutrition [4][5].

Although prevalence estimates are highly variable, in relation to the population considered and the tool administered for its assessment, malnutrition in the elderly is reported from 3% in the community setting up to 50% [6], in particular, its incidence varies from 12% to 50% in hospitalized old patients and from 23% to 60% in institutionalized older people [7][8][9][10].

Weight loss, due to lack of macronutrients or increased catabolism, represent the initial step of a catabolic process which may cause a high morbidity and mortality.

Old people patients are particularly at risk of malnutrition, due to multiple etiopathogenetic factors (changes in metabolism and organic function, a decline in physiological reserves associated with aging processes, chronic diseases and drug polypharmacy) which can lead to a reduction or utilization in intake of nutrients, a progressive

loss of functional autonomy with dependence on food, psychological problems related to economic or social isolation, e.g. linked to poverty or loneliness[11].

Although gastrointestinal function undergoes modest changes with aging [12], it is possible that there may still be alterations in the intake and assimilation of nutrients; it follows that a geriatric patient is defined on the basis of his fragility and the presence of chronic diseases, rather than by a specific age [13][14][15][16][17][18].

2. Definition and Causes of Malnutrition

Malnutrition is described by different organizations as the condition of being poorly nourished, caused by a lack of one or more nutrients (undernutrition) or an excess of these ones (overnutrition) [19][20][21].

A definition of malnutrition universally accepted has not yet defined [22]. According to The European Society for Clinical Nutrition and Metabolism (ESPEN-2015), malnutrition can be defined as “a state resulting from lack of intake or uptake of nutrition that leads to altered body composition (decreased fat free mass) and body cell mass leading to diminished physical and mental function and impaired clinical outcome from disease” [23].

In 2017 Enteral Nutrition in Geriatrics by the European Society of Clinical Nutrition and Metabolism (ESPEN) have defined the guidelines for geriatric patients, and established that malnutrition is characterized by the presence of weight loss (due to a catabolic state) and/or low BMI, representing depleted physiological stores[24].

In 2019, the result of a consensus of more than 70 national scientific societies represented by the 4 most important clinical nutrition societies (ESPEN, ASPEN, FELANPE and PENSA) published the Global Leadership Initiative on Malnutrition (GLIM) (25,26), with the aim of identifying criteria for malnutrition that can be used on a global scale in all clinical contexts. It considers three phenotypic criteria that are weight loss, low body mass index and reduced muscle mass - and two etiological criteria: reduced food intake or assimilation and inflammation due to disease / acute injury or related to chronic diseases. The presence of at least one phenotypic and one etiological criterion determine the diagnosis of malnutrition, with subsequent use of different thresholds of the criteria for the classification of its severity [25][26].

Furthermore, there are numerous ongoing evaluation studies on GLIM criteria

There are three types of weight loss, that are wasting, cachexia, and sarcopenia.

Wasting is due to insufficient dietary intake and leads to involuntary weight loss.

Cachexia is due to induced catabolic processes, with the production of proinflammatory cytokines such as interleukin-1 (IL-1), tumor necrosis factor alpha (TNF-alpha), IL-6 and others playing a predominant role; the main consequence is a reduction of lean mass and body cell mass [27].

Sarcopenia was defined by the European Working Group on Sarcopenia in Older Persons (EWGSOP) as a loss of muscle mass with concomitant loss of muscle strength or physical performance; these two features can often occur together, and have been defined with a new term "malnutrition sarcopenia syndrome " [28].

The etiology is poorly understood, but an important role is due to physical inactivity, induction of a proinflammatory response and dysregulation of anabolic hormones, such as testosterone or growth hormone[19][21][23].

The consequence of malnutrition is protein catabolism with rapid wasting of skeletal muscles, lower muscle mass, reduced muscle strength. At the same time, there could be a reduced dietary protein intake [29][30] with decreased bone mineral mass. The result is an impaired musculoskeletal function, increased disability and with reduced physical performance and an increased risk of falling, with possible consequent osteoporosis and osteoporotic fractures [28].

Malnutrition also leads to impaired immune function], with reduced cell-mediated immunity, and increased risk of infection and delayed healing [31].

The main cause is to be found in a reduced and / or unbalanced dietary intake, due to many causes that can be devided in three main categories: physiological, psychological and social. In developed countries the main factor of malnutrition is disease [32].

3. Pathophysiology of Undernutrition

Age is able to induce changes in the function of all organs and human physiological processes [23]

- Intestinal function with reduction of sensory perceptions, salivation, chewing, absorption of nutrients and lactose tolerance
- Brain function with cognitive impairment and Alzheimer's disease
- Body composition with loss of lean mass (especially in skeletal muscle tissue, defined as sarcopenia) and increase in fat mass with variation in its distribution
- Balance of fluids
- Bones and joints with osteoporosis and/or arthritis with consequent increased risk of falls and fractures
- Metabolism with type 2 diabetes mellitus and dyslipidemia
- The cardiovascular system with various diseases.
- Cell growth with cancer (cancer in the elderly grows more slowly because it has a slower rate of cell development than in the young) [33]

4. The Aging Gastrointestinal Tract

The gastrointestinal system represents the primarily and largest area of contact with environmental factors and ingested pathogens.

The regular functioning of the gastrointestinal tract is essential for maintaining good health of the body, as it guarantees absorption of nutrients and drugs, and protection against external pathogens.

Futhermore, the multi-organ system that composes the gastrointestinal tract has large reserve capacity, and thus there is little changes in gastrointestinal function because of aging in absence of specific disease [12]

Nevertheless, some older older people can show a reduction of gastrointestinal functions, including immune function [34][35], with a greater frequency of bacterial and viral gastrointestinal infections compared to young people. Aging is associated with structural and functional alterations of mucosal defense, increased oxidative stress, reduced ability to generate protective immunity, and increased incidence of inflammation and autoimmunity [36].

Furthermore, in the elderly the response to infection is often exacerbated by malnutrition [37]; in fact, low-grade chronic inflammation can derive from the enteric environment but with consequences even at a distance from the intestine, leading to fragility, sarcopenia, degenerative disorders affecting various organic systems, including the central nervous system .

Table 1 shows the functional and/or organic changes that gastrointestinal tract may undergo with aging and the possible nutritional repercussions.

Table 1. Changes with aging in gastrointestinal organ function and resulting alterations of nutrient status.

Organ Function	Change with Aging	Nutrient Alteration
Gastric acid secretion	Decreased with atrophic gastritis	Decreased absorption of folate and protein-bound vitamin B 12
Gastric motility	Slow liquid and mixed solid–liquid emptying. Preserved solid emptying	Decreased bioavailability of mineral, vitamins and protein
Small intestine structure and motility	Minor changes in structure.	No clinical significance
Small intestine microflora	Bacterial overgrowth in small bowel owing to atrophic gastritis	Increased bacterial synthesis of folate. Possible decrease fat-soluble vitamin absorption
Pancreatic secretion	Reduced capacity for bicarbonate and enzyme production	No clinical significance

Modified by Saltzman, J.R. and Russel, R.M. The aging gut, *Gastroenterol. Clin. N. Am*. 1998, 27, 309–324 [21].

5. Adverse Consequences of Underutrition

Aging associated with malnutrition leads to a progressive deterioration of health in the elderly, with a consequent decrease in physical and functional abilities and greater vulnerability of the patient, dependence in the activities of

daily life, poor quality of life and greater morbidity and mortality [38].

Malnutrition also negatively affects the outcome of therapies because it reduces the immune response with a consequent increase in infections and delay in healing, reduces muscle mass, favoring inactivity and dependence, with psychological consequences leading to depression with relative possible loss of appetite [39].

Elderly subjects tested with BMI, weight loss and food intake have consistently showed an association between mortality and malnutrition or nutritional risk [40][41].

5.1. Nervous System

Neurodegenerative diseases and altered cognitive functions may be the cause but also the result of malnutrition.

In particular, an association between cognitive deficits and/or depressive symptoms and low levels of vitamin B6, folate, vitamin B12, and polyunsaturated fatty acids (PUFAs) was found in old people [42].

The brain has an high metabolic activity therefore it is often subject to oxidative stress with possible damage to neural tissue [43].

Futhermore, antioxidant nutrients may therefore play more relevant roles in the aging brain than in other organs because of the reduction in the number of antioxidant enzymes required for neuronal protection.

This is why a insufficient intake of antioxidant nutrients, typical of malnutrition or poor-quality diets, can therefore negatively affect cognitive function [44].

The only micronutrient with antioxidant properties promising to be protective on cognitive activities is vitamin E [44][45].

Vitamins B9 and B12 are also nutrient cofactors able to modulate neurocognitive development and neurodegeneration [46][47].

5.2. Muscoskeletal System

In healthy adults, muscle accounts for over half of total organic protein.

In the elderly, the muscles undergo a reduction in the number, size and contractility of muscle fibers as well as fat infiltration of the skeletal muscle

These deteriorations, associated to increased body fat, systemic low-level inflammation and oxidative stress, contribute to further changes in the musculoskeletal system that could lead to sarcopenia, osteoporosis, weight loss, malnutrition and frailty [48].

Frailty represents a geriatric syndrome characterized by less homeostatic capacity and a reduction in physiological functional reserves, which leads to a particular vulnerability and consequent adverse health outcomes including falls, fractures and increased mortality.

Sarcopenia was defined by the European Working Group on Sarcopenia in Older Persons (EWGSOP) as a loss of muscle mass in combination with a loss of muscle strength or physical performance [49].

Sarcopenia, osteoporosis, and frailty are worsened by malnutrition and specific nutrients deficiencies, in particular protein, antioxidant vitamins, minerals, and fatty acids [50].

Vitamin D, dietary protein and calcium intake represent an important key function in bone and mineral metabolism, and their deficiency leads to metabolic bone disease [51][52][53][54].

5.3. Cardiovascular Disease

In general, heart disease and atherosclerosis are correlated with overnutrition rather than undernutrition [55][56][57].

At the end, the possible nutritional deficiencies of micronutrients associated with cardiovascular disease can significantly increase morbidity and mortality.

5.4. Immune System

Immunosenescence is represented by a reduction in the ability of the aging organism to counteract the attacks of external pathogenic agents through an efficient immune response and is expressed through a dysfunction of T cells with aging, due to a reduced proliferation of T lymphocytes and an impaired T-helper activity, with consequent altered cell-mediated and humoral responses.

Hence, malnutrition with reduced nutrient intake has repercussions on the immune system, resulting in a reduction in total lymphocyte count, T cells proliferation and interleukins.

Furthermore, old age is also represented by an increase in low-grade systemic inflammation (“inflammaging”), with a greater development of chronic inflammatory diseases [58][59].

In old age, the immune system shows a decline in acquired immunity, as opposed to innate immunity which remains unchanged, if not enhanced [60].

Dietary lipids are precursors of eicosanoids, prostaglandins and leukotrienes, therefore they have a significant influence on the immune system[61].

In addition to lipids, the main nutrients that influence immune function and therefore the host response to infections are water-soluble vitamins (B6, folate, B12, C) and, among the fat-soluble ones, vitamins A, D and E [62].

Other trace elements present in the diet that are involved in immune function are selenium, zinc, copper and iron [63][64].

Nutritional status is therefore an important factor influencing the T cell response, in addition to the pathogenic load, and malnutrition contributes significantly to the immunological defects found with age.

5.5. Skin System

Malnutrition increases the risk of the onset of pressure sores and infections which also delay wound healing as it prolongs the inflammatory phase, alters the synthesis and proliferation of fibroblasts and collagen [65][66][67]. Pressure sores are an important and frequent cause of morbidity and mortality in old age.

6. Dietary Solutions for The Aging Gastrointestinal Tract

When a risk of malnutrition is diagnosed, it is essential to use measures to identify and correct risk factors and subsequently introduce a nutritional support [6][67][68].

- Dietary guidelines against malnutrition in the elderly

The European Food Safety Authority (EFSA) established Dietary Reference Values (DRV) for total carbohydrates and dietary fiber, fats, water, and protein for the European population [69][70][71].

In 2013, the EFSA reviewed nutritional recommendations, considering age categories of 60–69 years and 70–79 years [72].

A daily intake of 30–40 kcal/kg and 1.0–1.5 g protein/kg body weight was proposed, in order to reduce risk of protein-energy wasting and frailty in Europe, whereas the exact recommended values depend on the health status [73][74].

Muscle protein synthesis can be promoted by protein pulse feeding and the consumption of fast proteins (such as whey protein), to prevent sarcopenia in older adults [75].

Data from literature recommend that old people should consume a balanced diet and that micronutrient supplements should only be given when food intake is too low, although several reviews point out that the elderly population is at increased risk for vitamin deficiencies. and minerals, especially vitamins A, B1, B2, B12, D, E, K, calcium and potassium although their energy intake is within recommendations [68][76].

The reasons for these deficiencies may be due not only to a reduced intake of food, but also to the poor choice and lack of variety of food, to an impaired intestinal absorbent function, to drugs that can interfere with the metabolism of micronutrients, to inflammatory state that can reduce their plasma reserves

Micronutrients have a multifactorial role in various metabolic processes (cell prolieration and growth, immune function, genomic stability) and their deficiency are involved in many age-related pathologies [77].

However, there are important oral nutritional support strategies needed to address established malnutrition or for individuals at risk of malnutrition [68][78].

The first step is therefore represented by increasing the intake of protein and energy from food in the diet.

Oral food supplements (ONS) (sip feeds) can be used as adjuncts to the nutritional management.

- Tools for nutrition assessment

It is very important and essential detecting nutritional screening for the assessment of malnutrition risks of aged people and so establishing a correct dietary program as soon as possible[79].

Among the several screening tools that been suggested for monitoring nutrition assessment in the elderly, the most widely used and studied is the Mini Nutritional Assessment (MNA) in its long or short form

With appropriate adjustment of the cut-off point for different populations, the MNA and MNA-SF have been used and validated worldwide.

In 2002, ESPEN developed the ESPEN Guidelines for Nutrition Screening 2002 to provide guidelines on nutritional risk screening through tools applicable to different situations and based on evaluated evidence; these guidelines are still used [80].

1. Malnutrition Universal Tool (MUST) for adult community residents
2. Nutritional Risk Screening (NRS) for elderly hospitalized
3. Mini Nutritional Assessment Short Form (MNA) in the elderly

The determination of the nutritional status in elderly is done through the mini nutritional assessment (MNA) , the most frequently instrument used for this purpose.

It includes questions associated to physical and mental features and a questionnaire on nutrition.

MNA has high predictive value characterized by its association with negative outcomes in terms of health and mortality [26].

- Impact of major food products on malnutrition

Dairy products

In old people dairy products represent an important source of energy, protein, vitamins (A, B2, B5, B9, B12), minerals (calcium, magnesium, phosphorus , zinc), and cholesterol; furthermore, some important nutrients, such as vitamin B9 and vitamin D, can be administered by fortifying milk [81][82][83].

The immune system is positively influenced by dairy products containing bacteria, such as milk fermented or yogurt added with probiotic strains and/or lactic acid bacteria [84][85][86][87][88].

Futhermore, probiotic yogurt showed a reduction of mutagenicity in the intestinal tract after consumption as well as an anti-inflammatory activity

Dairy products, in particular milk proteins, are also rich in branched-chain amino acids (BCAAs), in particular leucine, which are necessary for muscle protein synthesis, thus preventing the onset of sarcopenia in the elderly [82][89].

Other clinical indications are constipation, relieved by yogurt supplemented with dietary fiber, non-viral gastroenteritis, where probiotic fermented milk can alleviate symptoms [90][91][92] and dental health that can be improved by milk intake, supplemented with fluoride and probiotics [93].

- Meat products

Older people try to reduce meat consumption for various reasons such as difficulty in chewing, loss of smell and/or taste, loss of appetite.

Unfortunately, old people are characterized by an increased protein requirement despite a reduction in their physical activity [94].

Meat has remarkable nutritional properties, including indispensable and essential amino acids (IAA), high levels of B vitamins and minerals, and is also useful for preventing possible deficiencies of vitamins and minerals (vitamin B12, iron, zinc and selenium) when combined with other foods that are part of a healthy diet.

Meat has also significant biological and biochemical properties: meat iron presents a higher bioavailability than non-heme iron contained in plants or dairy products and its absorption is largely unaffected by other dietary components; it also improves the absorption of non-heme iron [95].

Two important aminoacids are Carnosine (β-alanine-L-histidine) and anxerine (β-alanine-L-1-methyl-histidine), found exclusively in mammalian skeletal muscle, are histidine-containing dipeptides (HDP). Their concentration in meat is generally little influenced by technological processes [96].

Diets rich in HDP can be beneficial for the elderly due to their antioxidant properties towards proteins and nucleic acids, due to their ability to bind divalent metal ions and trap free radicals; they also have an important buffer capacity. Furthermore, HDP would be able to reduce the aldehydes that are formed from unsaturated fatty acids during oxidative stress [97].

- Fish

Fish consumption has beneficial anti-inflammatory effects on health due to n-3 [99][100]long-chain polyunsaturated fatty acids (LC-PUFA), particularly eicosapentaenoic acid (EPA) and docosaenoic acid (DHA), which are present in

high quantities especially in oily fish [98].

In fact, from the literature it seems that the consumption of fish in the elderly is related to a better cognitive performance, to the improvement of memory in case of mild cognitive impairment, to a reduction of symptoms of depression, to a lower risk of hip fractures, and to a better renal function .

Futhermore, selenium and n-3 LC-PUFAs have shown a synergistic effect on health[101].

.

- Cereal-based foods

Carbohydrates have a special meaning in cereals, and usually contain around 50-80% carbohydrates on a dry weight basis.

Starch is the most abundant cereal polysaccharide in diets and is an important source of energy. There are available carbohydrates, such as starch and soluble sugars, which are digested and absorbed by humans, and unavailable carbohydrates, i.e. dietary fibers, such as resistant starch, cellulose and other complex polysaccharides (β-glucan , pectins, arabinoxylans .), which are not digested by the human intestine. These substances can be fermented by the intestinal microbiota, with production of methane, carbon dioxide, water and volatile fatty acids, or short-chain fatty acids (SCFA), essentially acetic, propionic and butyric acid, equipped with important functions: butyric acid supplies energy to the colocytes and integrates the mucosa, propionic acid is used for gluconeogenesis by hepatocytes, acetic acid is used by different tissues as a substrate for the cycle of Krebs or intermediate in lipid synthesis[102][103].

In 2010, the EFSA determined that, based on the role of dietary fiber in bowel function, the adequate intake of daily dietary fiber is 25-35g per day (of which 6 g of soluble fiber) for regular intestinal function in adults [69].

In addition, EFSA has approved some health claims regarding the consumption of dietary fiber:

1. arabinoxylan promotes the reduction of postprandial glycaemia [104][105].

2. barley grain, oat grain fiber and sugar beet fiber promote the increase in fecal mass.

3. wheat bran fiber promotes intestinal transit and increases fecal mass [106][107].

With the wording "High fiber", as listed in the annex to Regulation (EC) no. 1924/2006, it is understood that the product contains at least 6 g of fibers per 100 g or at least 3 g of fibers per 100 kcal.

During the last decades, epidemiological and clinical studies demonstrated that consumption of dietary fiber and whole grain has a positive impact against obesity, type 2 diabetes, cancer, and cardiovascular diseases in middle aged people [108][109][110].

The mechanism of action of dietary fiber and bioactive components that lead to these beneficial effects may be partly due to short-chain fatty acids, coming from their degradation by intestinal microbiota, that are able to exercise protective, metabolic and anti-inflammatory actions [111][112].

In the United States, the Food and Drug Administration (FDA) has approved two health claims for dietary fiber. The first states that a diet that involves an increase in the consumption of dietary fiber, provided by fruits, vegetables and whole grains, associated with reduced fat consumption (<30% of calories), can reduce some types of cancer.

The "increase in consumption" is defined as ≥ 1 "equivalent ounce" (1 ounce = 28.3 g), with three ounces derived from whole grains [113].

The second FDA claim states that diets low in saturated fat (<10% of calories) and cholesterol, but high in fruits, vegetables, and whole grains, reduce the risk of coronary heart disease [114].

In summary, a healthy diet should consist of 25-35g of dietary fiber per day, of which 6g should be soluble fiber [115].

- Fruits and vegetables

The anti-inflammatory properties of phytochemicals, in particular polyphenols, play an important role in their beneficial effects on healthy aging [116].

Several polyphenols have shown positive effects on cognition including flavonoid-rich cocoa drinks or resveratrol [117][118].

- Water

Various factors contribute to the dehydration of the elderly; frequently old people do not drink their recommended daily intake of oral fluids especially in presence of diseases such as malnutrition and anorexia, or because of a decrease in appetite and less motivation to eat or drink, or a higher thirst threshold, typical of advanced age, or due to adverse effects of drugs, such as diuretics.

Older people are more vulnerable to water imbalance and, in the presence of dehydration, death occurs far more quickly than in the absence of any other nutrient, usually within a few days [119][120][121].

7. Summary

Malnutrition in the elderly has a complex and multifactorial origin; age is associated with physiological changes that make the old person more vulnerable and more easily subjected to malnutrition in conjunction with risk factors, such as diseases, lifestyle, drugs and so on.

Recognizing risk factors is a fundamental step in being able to treat malnutrition.

An adequate protein intake associated with a correct energy intake is essential to prevent malnutrition and sarcopenia in the elderly; furthermore, if the diet is not sufficient, it is necessary to supplement any micronutrient deficiencies.

It shows how the quality of the diet is very important with respect to the risk of frailty, and in particular the meta-analyzes have established that the Mediterranean dietary model has a high quality and greater beneficial effects, with high intake of micronutrients and antioxidants, as polyphenols and bioactive compounds present in the diet, characterized by high consumption of fruit, vegetables, and plant-based foods, use of olive oil and less consumption of meat and dairy products[122][123][124][125].

However, there are still significant gaps in the literature regarding the evidence for non-drug treatment of malnutrition, and it is necessary to plan high quality prospective studies and well-designed clinical trials.

References

1. Rudnicka, E.; Napierała, P.; Podfigurna, A.; Męczekalski, B.; Smolarczyk, R.; Grymowi, M.; The World Health Organization (WHO) approach to healthy ageing. Maturitas 2020, 139, 6–11.
2. Niccoli, T.; Partridge, L. Aging as a risk factor for disease. Curr. Biol. 2012, 22, R741–R752.
3. Norman, K.; Hab, U.; Pirlich, M. Malnutrition in Older Adults. Recent Adv. Remain. Chall. 2021, 13, 2764.
4. Posner, B.M.; Jette, A.M.; Smith, K.W.; Miller, D.R. Nutrition and Health Risks in the Elderly the Nutrition Screening Initiative. Am. J. Public Health 1993, 83, 972–978.
5. Hamirudin, A.H.; Charlton, K.; Walton, K. Outcomes related to nutrition screening in community living older adults: A systematic literature review. Arch. Gerontol. Geriatr. 2016, 62, 9–25.
6. Volkert, D.; Beck, A.M.; Cederholm, T.; Cereda, E.; Cruz-Jentoft, A.; Goisser, S.; de Groot, L.; Großhauser, F.; Kiesswetter, E.; Norman, K.; et al. Management of Malnutrition in Older Patients—Current Approaches, Evidence and Open Questions. J.Clin. Med. 2019, 8, 974
7. Ennis, B.W.; Saffel-Shrier, S.; Verson, H. Diagnosing Malnutrition in the Elderly. Nurse Pr. 2001, 26, 52–65.
8. Evans, C. Malnutrition in the Elderly: A Multifactorial Failure to Thrive. Perm. J. 2005, 9, 38–41.
9. Cereda, E.; Veronese, N.; Caccialanza, R. The final word on nutritional screening and assessment in older persons. Curr. Opin. Clin. Nutr. Metab. Care 2018, 21, 24–29.
10. Lochs, H.; Devens, C. Malnutrition—The ignored risk factor. Dig. Dis 2003, 21, 196–197.

11. Visvanathan, R.; McPhee Chapman, I. Undernutrition and Anorexia in the Older People. Gastroenterol. Clin. N. Am. 2009, 38, 393–409.
12. Soenen, S.; Rayner, C.K.; Jones, K.; Horowitz, M. The ageing gastrointestinal tract. Curr. Opin. Clin. Nutr. Metab. Care 2016, 19, 12–18.
13. Fried, L.P.; Tangen, C.M.; Walston, J.; Newman, A.B.; Hirsch, C.; Gottdiener, J.; Seeman, T.; Tracy, R.; Kop, W.J.; Burke, G.et al. Frailty in Older adults: Evidence for a phenotype. J. Gerontol. Ser. A 2001, 56, M146–M157.
14. Rizzi, M.; Mazzuoli, S.; Regano, N.; Inguaggiato, R.; Bianco, M.; Leandro, G.; Bugianesi, E.; Noè, D.; Orzes, N.; Pallini, P.; et al. Undernutrition, risk of malnutrition and obesity in gastroenterological patients: A multicenter study. World J. Gastrointest. Oncol. 2016, 8, 563–572.
15. Norman, K.; Kirchner, H.; Lochs, H.; Pirlich, M. Malnutrition affects quality of life in gastroenterology patients. World J.Gastroenterol. 2006, 12, 3380–3385.
16. Sturm, K.; MacIntosh, C.G.; Parker, B.; Wishart, J.; Horowitz, M.; Chapman, I.M. Appetite, Food Intake, and Plasma Concentrations of Cholecystokinin, Ghrelin, and Other Gastrointestinal Hormones in Undernourished Older Women and Well-Nourished Young and Older Women. J. Clin. Endocrinol. Metab. 2003, 88, 3747–3755.
17. Norman, K.; Pichard, C.; Lochs, H.; Pirlich, M. Prognostic impact of disease-related malnutrition. Clin. Nutr. 2008, 27, 5–15.
18. Saltzman, J.R.; Russel, R.M. The aging gut. Gastroenterol. Clin. N. Am. 1998, 27, 309–324.
19. Davis, J.N.; Oaks BM, Engle-Stone, R. The double burden of malnutrition: A systematic review of operational definitions. Curr. Dev. Nutr. 2020, 4, 1–14.
20. Hickson, M. Malnutrition and ageing. Postgrad. Med. J. 2006, 82, 2–8.
21. Mathur, P.; Pillai, R. Overnutrition: Current scenario and combact strategies. Indian J. Med. Res. 2019, 149, 695–705
22. Teigen, L.M.; Kuchnia, A.J.; Nagel, E.M.; Price, K.L.; Hurt, R.T.; Earthman, C.P. Diagnosing clinical malnutrition: Perspectives from the past and implications for the future. Clin. Nutr. ESPEN 2018, 26, 13–20.
23. Cederholm, T.; Barazzoni, R.; Austin P.; Ballmer, P.; Biolo, G.; Bischoff, S.C.; Compher, C.; Correia, I.; Higashiguchi, T.; Holst, M.; et al. An ESPEN Consensus Statement: ESPEN guidelines on definitions and terminology of clinical nutrition. Clin. Nutr. 2017, 36, 49–64.
24. Yeung, S.S.; Chan, R.S.; Kwok, T.; Lee, J.S.; Woo, J. Malnutrition According to GLIM Criteria and Adverse Outcomes in Community-Dwelling Chinese Older Adults: A Prospective Analysis. J. Am. Med Dir. Assoc. 2020, 22, 1953–1959.

25. Cederholm, T.; Jensen, G.L.; Correia, M.; Gonzalez, M.C.; Fukushima, R.; Higashiguchi, T.; Baptista, G.; Barazzoni, R.; Blaauw, R.; Coats, A.; et al. GLIM criteria for the diagnosis of malnutrition–A consensus report from the global clinical nutrition community. Clin. Nutr. 2019, 38, 1–9.
26. De van der Schueren, M.A.E.; Keller, H.; Cederholm, T.; Barazzoni, R.; Compher, C.; Correia, M.; Gonzalez, M.C.; Jager Wittenaar, H.; Pirlich, M.; Steiber, A.; et al. Global Leadership Initiative on Malnutrition (GLIM): Guidance on validation of the operational criteria for the diagnosis of protein-energy malnutrition in adults. Clin. Nutr. 2020, 39, 2872–2880.
27. Roubenoff, R. Inflammatory and hormonal mediators of cachexia. J. Nutr. 1997, 127, 1014–1016
28. Lengelé, L.; Bruyère, O.; Beaudart, C.; Reginster, J.Y.; Locquet, M. Impact of Malnutrition Status on Muscle Parameter Changes over a 5-Year Follow-Up of Community-Dwelling Older Adults from the SarcoPhAge Cohort. Nutrients 2021, 13, 407.
29. Coin, A.; Sergi, G.; Benincà, P.; Lupoli, L.; Cinti, G.; Ferrara, L.; Benedetti, G.; Tomasi, G.; Pisent, C.; Enzi, G. Bone mineral density and body composition in underweight and normal elderly subjects. Osteoporos. Int. 2000, 11, 1043–1050.
30. Geinoz, G.; Rapin, C.H.; Rizzoli, R.; Kraemer, R.; Buchs, B.; Slosman, D.; Michel, J.P.; Bonjour, J.P. Relationship between bone mineral density and dietary intakes in the elderly. Osteoporos. Int. 1993, 3, 242–248.
31. Kawakami, K.; Kadota, J.; Iida, K.; Shirai, R.; Abe, K.; Kohno, S. Reduced immune function and malnutrition in the elderly. Tohoku J. Exp. Med. 1999, 187, 157–171..
32. Rémond, D.; Danit, R.; Shahar, D.R.; Gille, D.; Pinto, P.; Kachal, J.; Peyron, M.A. Nunes Dos Santos, C.; Walther, B.; Bordoni, A.; et al. Understanding the gastrointestinal tract of the elderly to develop dietary solutions that prevent malnutrition. Oncotarget. 2015, 6, 13858–13898.
33. Morley, J.E. Hormones and Sarcopenia. Curr. Pharm. Des. 2017, 23, 4484–4492.
34. Salazar, N.; Valdes-Varela, L.; Gonzalez, S.; Gueimonde, M.; de los Reyes-Gavilàn, C.G. Nutrition and the gut microbe in the elderly. Gut Microbes 2017, 8, 82–97.
35. Holt, P. Gastrointestinal diseases in the elderly. Curr. Opin. Clin. Nutr. Metab. Care 2003, 6, 41–48.
36. Hazeldine, J.; Lord, J.M. Innate immunesenescence: Underlying mechanisms and clinical relevance. Biogerontology 2015, 16, 187–201
37. Man, A.L.; Gicheva, N.; Nicoletti, C. The impact of ageing on the intestinal epithelial barrier and immune system. Cell. Immunol. 2014, 289, 112–118.
38. Soderstrom, L.; Rosenbland, A.; Adolfoss, E.T.; Saletti, A.; Bergkvist, L. Nutritional status predicts preterm deth in older people: A prospective cohort study. Clin. Nutr.2014, 333, 354–359.

39. Feldblum, I.; German, L.; Bilenko, N.; Shahar, A.; Enten, R.; Greenberg, D.; Harman, I.; Castel, H.; Shahar, D. Nutritional risk and health care use before and after an acute hospitalization among the elderly. Nutrition 2009, 25, 415–420.
40. Schneider, S.M.; Veyres, P.; Pivot, X.; Soummer, A.-M.; Jambou, P.; Filippi, J.; van Obberghen, E.; Hebuterne, X. Malnutrition is an independent factor associated with nosocomial infections. Br. J. Nutr. 2004, 92, 105–111.
41. Landi, F.; Calvani, R.; Tosato, M.; Martone, A.M.; Ortolani, E.; Savera, G.; Sisto, A.; Marzetti, E. Anorexia of Aging: Risk Factors, Consequences, and Potential Treatments. Nutrition 2016, 8, 69.
42. Morris, M.C. Nutritional determinants of cognitive aging and dementia. Proc. Nutr Soc. 2012, 71, 1–13.
43. Christen, Y. Oxidative stress and Alzheimer disease. Am. J. Clin. Nutr. 2000, 71, 621S–629S.
44. Mangialasche, F.; Kivipelto, M.; Mecocci, P.; Rizzuto, D.; Palmer, K.; Winblad, B.; Fratiglioni, L. High plasma levels of vitamin E forms and reduced Alzheimer's disease risk in advanced age. J. Alzheimer Dis. 2010, 20, 1029–1037.
45. Engehhart, M.J.; Geerlings, M.I.; Riutenberg, A.; van Swieten, J.C.; Hofman, A.; Witteman, J.C.; Breteler, M.M. Dietary intake of antioxidants and risk of Alzheimer disease. J. Am. Med. Assoc. 2002, 287, 3223–3229.
46. Haan, M.N.; Miller, J.W.; E Aiello, A.; A Whitmer, R.; Jagust, W.J.; Mungas, D.M.; Allen, L.H.; Green, R. Homocysteina, B vitamins and the incidence of dementia and cognitive impairment: Results from the Sacramento Area Latino Study on Aging.Am. J. Clin. Nutr. 2007, 85, 511–517.
47. Seshadri, S. Elevated plasma homocysteine levels: Risk factor or risk marker for the development of dementia and Alzheimer's disease? J. Alzheimer Dis. 2006, 9, 393–398.
48. Delmonico, M.J.; Harris, T.B.; Visser, M.; Park, S.W.; Conroy, M.B.; Velasquez-Mieyer, P.; Boudreau, R.; Manini, T.M.; Nevitt, M.; Health AgingBody Composition Study; et al. Longitudinal study of muscle strength , quality, and adipose tissue infiltration. Am. J. Clin. Nutr.2009, 90, 1579–1585.
49. Cruz-Jontoft, A.J.; Landi, F.; Schneider, S.M.; Zaniga, C.; Arai, H.; Boirie, Y.; Chen, L.K.; Fielding, R.A.; Martin, F.C.; Michel, J.P.; et al. Prevalence of and interventions for sarcopenia in ageing adults: A systematic review. Report of the International Sarcopenia Initiative (EWGSOP and IWGS). Age Aging 2014, 43, 748–759.
50. Nieves, J.W. Skeletal effects of nutrients and nutraceuticals, beyond calcium and vitamin D. Osteoporos. Int. 2013, 79, 771–786.
51. Brincata, M.; Gambita, J.; Agiusa, J.C. The role of vitamin D in osteoporosis. Maturitas 2015, 80, 329–332.

52. Bauer, J.; Biolo, G.; Cederholm, T.; Cesari, M.; Cruz-Jentoft, A.J.; Morley, J.E.; Phillips, S.; Sieber, C.; Stehle, P.; Teta, D.; et al. Evidence-based recommendations for optimal dietary protein intake in older people: A position paper from the PROT-AGE Styudy Group. J. Am. Med. Dir. Assoc. 2013, 14, 542–559.
53. Paddon-Jones, D.; Leidy, H. Dietary protein and muscle in older persons. Curr. Opin. Clin. Nutr. Metab. Care 2014, 17, 5–11.
54. Schulman, R.C.; Weiss, A.J.; Mechanick, J.I. Nutrition bone and aging: An integrative physiology approach. Curr. Osteoporos. Rep. 2011, 9, 184–195.
55. McKeag, N.A.; McKinley, M.C.; Woodside, J.V.; Harbison, M.T.; McKeown, P.P. The role of micronutrients in heart failure. J. Acad. Nutr. Diet. 2012, 112, 870–886.
56. North, B.J.; Sinclar, D.A. The Intersection Between Aging and Cardiovascolar Disease. Circ. Res. 2012, 110, 1097–1108.
57. Lennie, T.A.; Moser, D.K.; Heo, S.; Chung, M.L, Zambroski CH. Factors influencing food intake in patients with heart failure: A comparison with healthy elders. J. Cardiovasc. Nurs. 2006, 21, 123–129.
58. Moreley, J.E. Pathophysiology of the anorexia of aging. Curr. Opin. Clin. Nutr. Metab. Care 2013, 16, 27–32.
59. Franceschi, C.; Campisi, J. Chronic inflammation (inflammaging) and its potential contribution to age-associated disease. J. Gerontol. A Biol. Sci. Med. Sci. 2014, 69, S4–S9.
60. Lesourd, B.; Mazari, L. Nutrition and immunity in the elderly. Proc. Nutr. Soc. 1999, 58, 685–695.
61. Sijben, J.W.; Calder, P.C. Differential immunomodulation with long-chain n-3 PUFA in health and chronic disease. Proc. Nutr Soc. 2007, 66, 237–259.
62. Wintergest, F.S.; Maggini, S.; Horning, D.H. Contribution of selected vitamins and trace elements to immune function. Ann. Nutr. Metab. 2007, 51, 301–323.
63. Liu, P.T.; Stenger, S.; Li, H.; Wenzel, L.; Tan, B.H.; Krutzik, S.R.; Ochoa, M.T.; Schauber, J.; Wu, K.; Meinken, C.; et al. Toll-like receptor triggering of a vitamin D-mediated human antimicrobial response. Science 2006, 311, 1770–1773.
64. Pae, M.; Meydani, S.N.; Wu, D. The role of nutrition in enhancing immunity in aging. Aging Dis.2012, 3, 91–129.
65. Arnold, M.; Barbul, A. Nutrition and wound healing. Plast. Reconstr. Surg. 2006, 117, 42S–58S.
66. Stechmiller, J.K. Understanding the role of nutrition and wound healing. Nutr. Clin. Pract. 2010, 25, 61–68.

67. Bernstein, M.; Muniz, N. Position of the Academy of Nutrition and Dietetics: Food and nutrition for older adults: Promoting health and wellness. J. Acad. Nutr. Diet. 2012, 112, 1255–1277.
68. Raynaud-Simon, A.; Revel-Delhom, C.; Hebuterne, X. Clinical practice guidelines from the French Health High Authority: Nutritional support strategy in protein-energy malnutrition in the elderly. Clin. Nutr. 2011, 30, 321–319.
69. EFSA. Panel on Dietetic Products, Nutrition and Allergies (NDA). Scientific Opinion on Dietary Reference Values for carbohydretes and dietary fibres. EFSA J. 2010, 8, 1462–1539.
70. EFSA. Panel on Dietetic Products, Nutrition and Allergies (NDA). Scientific Opinion on Dietary Reference Values for fats, including saturated fatty acids, polyunsatured fatty acids, trans fatty acids, and cholesterol. EFSA J. 2010, 8, 1461–1568.
71. EFSA. Panel on Dietetic Products, Nutrition and Allergies (NDA). Scientific Opinion on Dietary Reference Values for protein. EFSA J. 2012, 10, 2557.
72. EFSA. Panel on Dietetic Products, Nutrition and Allergies (NDA). Scientific Opinion on Dietary Reference Values for energy. EFSA J. 2013, 11, 3005.
73. Raynaud-Simon, A. Virtual clinical nutrition university: Malnutrition in the elderly, epidemiology and consequences. e-SPEN, Eur. e-Journal Clin. Nutr. Metab. 2009, 4, 422–450.
74. Deutz, N.E.; Bauer, J.M.; Barazzoni, R.; Biolo, G.; Boirie, Y.; Bosy-Westphal, A.; Cederholm, T.; Cruz-Jentoft, A.J.; Krznariç, Z.; Nair, K.S.; et al. Protein intake and exercise for optimal muscle function with aging.: Recommendations from the Espen Expert Group. Clin. Nutr. 2014, 33, 929–936.
75. Bouillanne, O.; Curis, E.; Hamon-Vilcot, B.; Nicolis, I.; Chrétien, P.; Schauer, N.; Vincent, J.-P.; Cynober, L.; Aussel, C. Impact of protein pulse feeding on lean mass in malnourished and at-risk hospitalized elderly patients: A randomized controlled trial. Clin. Nutr. 2013, 32, 186–192.
76. De Groot, C.P.; van Staveren, W.A. Nutritional concerns, health and survival in old age. Biogerontology 2010, 11, 99–103.
77. Mocchegiani, E.; Romeo, J.; Malavolta, M.; Costarelli, L.; Giacconi, R.; Diaz, L.-E.; Marcos, A. Zinc: Dietary intake and impact of supplementation on immune function in elderly. Age 2013, 35, 839–860.
78. Mak, T.N.; Caldeira, S. The role of nutrition in active and healthy ageing for ptrvrnyion and treatment of age-related diseases: Evidence so far. Sceince and Policy Report by the Joint Research Centre of the European Commission. Publ. Off. Eur. Union 2014.
79. Roberts, S.B.; Fuss, P.; Heyman, M.B.; Evans, J.W.; Tsay, R.; Rasmussen, H.; Fiatarone, M.; Cortiella. J.; Dallal, G.E.; Young, V.R. Control of food intake in older men. JAMA 1994, 272, 1601–1606.

80. Kondrup, J.; Allison, S.P.; Elia, A.; Vellas, B.; Plauth, M. ESPEN Guidelines for Nutrition Screening. Clin. Nutr. 2003, 22, 415–421.

81. Fukushuma, Y.; Miyaguchi, S.; Yamano, T.; Kuburagi, T.; Iino, H.; Ushida, K.; Sato, K. Improvement of nutritional status and incidence of infection in hospitalized, enterally fed elderly by feeding of fermented milk containing probiotic Lactobacillus johnsonii La1. Br. J. Nutr. 2007, 98, 969–977.

82. Iuliano, S.; Woods, J.; Robbins, J. Consuming two additional serves of dairy food a day significantly improves energy and nutrient intakes in ambulatory aged care residents: A feasibility study. J. Nutr. Health Aging 2013, 17, 509–513.

83. Russell, R.M.; Baik, H.; Kehayias, J.J. Older men and women efficiently absorb vitamin B 12 from milk and fortifield bread. J. Nutr. 2001, 131, 291–293.

84. Fujita, R.; Iimuro, S.; Shinizaki, T.; Sakamaki, K.; Uemura, Y.; Takeuchi, A.; Mtsuyama, Y.; Ohashi, Y. Decreased duration on acute upper respiratory tract infections with daily intake of fermented milk: A multicenter, double-blinded, randomized comparative study in users of day care facilities for elderly population. Am. J. Infect. Control. 2013, 41, 1231–1253.

85. Lahtinen, S.J.; Forssten, S.; Aakko, J.; Granlund, L.; Rautonen, N.; Salminen, S.; Viitanen, M.; Ouwehand, A.C. Probiotic cheese containing Lactobacillus rhamnosus HN001 and Lactobacillus acidophilus NCFM® modifies subpopulations of fecal lactobacilli and Clostridium difficile in the elderly. Age 2012, 34, 133-143.

86. 157. Boge, T.; Remigy, M.; Vaudaine, S.; Tanguy, J.; Bourdet-Sicard, R.; van der Werf, S. A probiotic fermented dairy drink improves antibody response to influenza vaccination in the elderly in two randomized controlled trials. Vaccine 2009, 27, 5677–5684.

87. Rizzoli, R.; Boonen, S.; Brandi, M.L.; Bruyere, O.; Cooper, C.; Kanis, J.A.; Kaufman, J.M.; Ringe, J.D.; Weryha, G.; Reginster, J.Y. Vitamin D supplementation in elderly or postmenopausal women: A 2013 update of the 2008 recommendations from the European Society for Clinical and Economic Aspects of Osteoporosis and Osteoarthritis (ESCEO). Curr. Med. Res. Opin. 2013, 29, 305–313.

88. Kau, A.L.; Ahern, P.P.; Griffin, N.W.; Goodman, A.L.; Gordon, J.I. Human nutrition, the gut microbiome and the immune system. Nature 2011, 474, 8, 97–103.

89. Engelen, M.; de Castro, C.; Rutten, E.; Wouters, E.; Schols, A.; Deutz, N. Enhanced anabolic response to milk protein sip feeding in elderly subjects with COPD is associated with a reduced splanchnic extraction of multiple amino acids. Clin. Nutr. 2012, 31, 616–624.

90. Sairanen, U.; Piirainen, L.; Nevala, R.; Korpela, R. . Yogurt containing galacto-oligosaccharides, prunes and linseed reduces the severity of mild constipation in elderly subjects. Eur. J. Clin. Nutr. 2007, 61, 1423–1328.

91. Rajala, S.A.; Salminen, S.J.; Seppanen, J.H.; Vapaatalo, H. Treatment of chronic constipation with lactitol sweetened yoghurt supplemented with guar gum and wheat bran in elderly hospital in-patients. Compr. Gerontol. A 1988, 2, 83–86.
92. Nagata, S.; Asahara, T.; Ohta, T.; Yamada, T.; Kondo, S.; Bian, L.; Wang, C.; Yamashiro, Y.; Nomoto, K. Effect of the continuous intake of probiotic-fermented milk containing Lactobacillus casei strain Shirota on fever in a mass outbreak of norovirus gastroenteritis and the faecal microflora in a health service facility for the aged. Br. J. Nutr. 2011, 106, 549–556.
93. Petersson, L.G.; Magnusson, K.; Hakestam, U.; Baigi, A.; Twetman, S. Reversal of primary root caries lesions after daily intake of milk supplemented with fluoride and probiotic lactobacilli in older adults. Acta Odontol. Scand. 2011, 69, 321–327.
94. Pederson, A.N.; Cederholm, T. Health effects of protein intake in healthy population: A systematic literature reviews. Food Nutr. Res. 2014, 58, 23364.
95. Hurrel, R.F.; Reddy, M.B.; Juillerat, M.; Cooks, J.D. Meat protein fractions enhance nonheme iron absorption in humans. J. Nutr. 2006, 136, 2808–2812.
96. Bauchart, C.; Savary-Auzeloux, I.; Mirand, P.P.; Thomas, E.; Morzel, M.; Rémond, D. Carnosine concentration of ingested meat affects carnosine net release into the portal vein of minipigs. J. Nutr. 2007, 137, 589–593.
97. Guiotto, A.; Calderan, A.; Ruzza, P.; Borin, G. Carnosine and carnosine-related antioxidants: A review. Curr. Med. Chem. 2005, 12, 2293–2315.
98. Calder, P.C. Fatty acids and inflammation: The cutting edge between food and pharma.Eur. J. Paharmacol. 2011, 668, 550–558.
99. Gozales, S.; Huerta, J.M.; Fernandez, S.; Patterson, A.M.; Lasheras, C. The relationship between dietary lipids and cognitive performance in an elderly population. Int. J. Food Sci. Nutr. 2010, 61, 217–225.
100. Baierle, M.; Vencato, P.H.; Oldenburg, L.; Bordignon, S.; Zibetti, M.R.; Trentini, C.M.; Duarte, M.M.M.F.; Veit, J.C.; Somacal, S.; Emanuelli, T.; et al. Fatty acid status and its relationship to cognitive decline and homocysteine levels in the elderly. Nutrition 2014, 6, 3624–3640.
101. Berr, C.; Akbaraly, T.; Arnaud, J.; Hininger, I.; Roussel, A.-M.; Gateau, P.B. Increased selenium intake in elderly high fish consumers may account for health benefits previously ascribed to omega-3 fatty acid. J. Nutr. Health Aging 2009, 13, 14–18 .
102. He, F.; Ouwehand, A.; Isolauri, E.; Hosoda, M.; Benno, Y.; Salminen, S. Differences in Composition and Mucosal Adhesion of Bifidobacteria Isolated from Healthy Adults and Healthy Seniors. Curr. Microbiol. 2001, 43, 351–354.

103. Newton, J.L.; Jordan, N.; Pearson, J.; Williams, G.V.; Allen, A.; James, O.F. The adherent gastric antral and duodenal mucus gel layner thins with advancing age in subjects infected with Helicobacter pylori. Gerontology 2000, 46, 153–157.
104. Kellow, N.J.; Walker, K.Z. Authorised EU health claim for arabinoxylan. In Foods, Nutrients and Food Ingredients with Authorised EU Health Claims; Elsevier: Amsterdam, The Netherlands, 2018; Volume 3, pp. 201–218.
105. Lu, Z.X.; Walker, K.Z.; Muir, J.G.; Mascara, T.; O'Dea, K. Arabinoxylan fiber, a byproduct of wheat flour processing, reduces the postprandial glucose response in normoglycemic subjects. Am. J. Clin. Nutr. 2000, 71, 1123–1128.
106. European Comiisssion. Commission Regulation (EU) No 432/2012. Off. J. Eur. Union 2012.
107. European Comiisssion. Commission Regulation (EU) No 40/2014. Off. J. Eur. Union 2014.
108. Food and Drug Administration FDA. Code of Federal Reguation: Heath Claims: Fiber-Contaning Grain Products, Fruits and Vegetables and Cancer; Food and Drug Administration: Silver Spring, MD, USA, 2008; Volume 2.
109. Food and Drug Administration FDA. Code of Federal Reguation: Heath Claims: Fruits, Vegetables and Grain Products that Contain Fiber, Particularly Soluble Fiber, and Risk of Coronary Heart Disease; Food and Drug Administration: Silver Spring, MD, USA, 2008; Volume 2.
110. Lattimer, J.M.; Haub, M.D. Effects of dietary fiber and its components on metabolic health. Nutrients 2010, 2, 1266–1289.
111. Tucker, K.A.; Thomas, K.S. Increasing total fiber intake reduces risk of weight and fat gains in women. J. Nutr. 2009, 139, 57–581.
112. Meyer, K.A.; Kushi, L.H.; Jacobs, D.R., Jr.; Slavin, J.; Sellers, T.A.; Folsom, A.R. Carbohydrates, dietary fiber and incident type 2 diabetes in older women. Am. J. Clin. Nutr 2000, 71, 921–930.
113. Streppel, M.T.; Ocke ,M.C.; Boshuizen, A.F.;Kok, F.J.; Kromhout, D. Dietary fiber intake in relation to coronary heart disease and all-cause mortality over 40 y:the Zutphen Study. Am. J. Clin. Nutr. 2008, 83, 119–125.
114. Story, J.A.; Furumoto, F.J.; Buhman, K.K. Dietary fiber and bile metabolism—An update. Adv. Exp. Med. Biol. 1997, 427, 259–266.
115. Ma, Y.; A Griffith, J.; Chasan-Taber, L.; Olendzki, B.; Jackson, E.; Stanek, E.J., 3rd; Li, W.; Pagoto, S.; Hafner, A.R.; Ockene, I.S. . Association between dietary fiber and serum C-reactive protein. Am. J. Clin. Nutr. 2006, 83, 760–766.
116. Salminen, A.; Kauppinen, A.; Kaarnirnta, K. Phytochemicals suppress nuclear factor-kappaB signaling impact on health span and aging process. Curr. Opin. Clin. Nutr. Metab. Care. 2012, 15, 23–28.

117. Krikorian, R.; Boespflug, E.L.; Fleck, D.E.; Stein, A.L.; Wightman, J.D.; Shidler, M.D.; Sadat-Hossieny, S. Concord grape juice supplementation and neurocognitive function in human aging. J. Agric. Food Chem. 2012, 60, 5736–5742.

118. Witte, A.V.; Kerti, L.; Margulies, D.; Flöel, A. Efffects of resveratrol on memory performance, hippocampal functional connectivity, and glucose metabolism in healthy older adults. J. Neurosci. 2014, 34, 7862–7870.

119. Godfrey, H.; Cloete, J.; Dymond, E.; Long, A. An exploration of the hydratation care of older people: A qualitative study. Int. J. Nurs. Stud. 2012, 49, 1200–1211.

120. Hooper, L.; Bunn, D.; Jimoh, F.O.; Fairweather-Tai, S.J. Water-loss dehydration and ging. Mech. Ageing Dev. 2014, 136–137, 50–58.

121. Ahmed, T.; Haboubi, N. Assessment and management of nutrition in older people and its importance to health. Clin. Interv. Aging 2010, 5, 207–216.

122. Rashidi Pour Fard, N.; Amirabdollahian, F.; Haghighatdoost, F. Dietary patterns and frailty: A systematic review and metaanalysis. Nutr. Rev. 2019, 77, 498–513.

123. Abdelhamid, A.; Jennings, A.; Hayhoe, R.P.G.; Awuzudike, V.E.; Welch, A.A. High variability of food and nutrient intake exists across the Mediterranean Dietary Pattern—A systematic review. Food Sci. Nutr. 2020, 8, 4907–4918.

124. Tsigalou, C.; Konstantinidis, T.; Paraschaki, A.; Stavropoulou, E.; Voidarou, C.; Bezirtzoglou, E. Mediterranean Diet as a Tool to Combat Inflammation and Chronic Diseases. An Overview. Biomedicines 2020, 8, 201.

125. Capurso, C.; Bellanti, F.; Buglio, A.L.; Vendemiale, G. The mediterranean diet slows down the progression of aging and helps to prevent the onset of frailty: A narrative review. Nutrients 2020, 12, 35.

Retrieved from https://encyclopedia.pub/entry/history/show/39840