Under-Nutrition in Older People: A Serious and Growing Global Problem!

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Abstract:
Everyone agrees that adequate nutrient intake is important to all living things. Without food or water, life on earth would cease to exist. In the field of medical health, some gains have been made in meeting maternal and child nutritional needs. There is great community awareness regarding the importance of meeting the nutritional needs of the developing foetus and child. Malnutrition secondary to decreased intake in older people and weight loss is also a serious problem with unfortunately, very little notice from the community at large. As one ages, several physiological processes may contribute towards the development of protein energy malnutrition. Under-nutrition in older people is sadly far too common, even in developed countries. It is very likely that the same concerted effort used to address child malnutrition is required to combat under-nutrition in our elders. Protein energy malnutrition in older people comes at a significant cost to the individual, families, communities and the healthcare system. Failure to address this syndrome is not only unethical and unhealthy, but also costly. Vigilance and community awareness is important in ensuring that this important syndrome is detected and managed appropriately. This review mainly attempts to describe the pathophysiology, prevalence and consequences of under-nutrition and aims to highlight the importance of this clinical syndrome and the recent growth in our understanding of the processes behind its development. Some management strategies are also briefly described. (J Postgrad Med 2003;49:352-60)

Key Words: Under-nutrition, Elderly, Outcome, Prevalence.

The population of the world is ageing and under-nutrition amongst older people is a global crisis that is set to increase. It has been reported that in some developed countries like Japan and the United States of America, people are living longer and healthily.1 Countries such as India can expect to face a 120-140% increase in populations aged 65 years and above, by the year 2020.2 Even smaller nations like Singapore can expect a large increase in this age group (> 65 years), with a 200% increase by 2020.2 People may also be starving amidst plenty and under-nutrition in older people remains a significant problem that frequently goes unnoticed even in developed countries. At present, (SENECA study- described later), almost 44% of healthy, community dwelling, older people in developed countries are at risk of malnutrition.3 While families remain the primary caregivers, their capacity to be the primary caregivers to older people has changed significantly with urbanisation, women entering the workforce and children migrating to towns or cities away from their elderly parents.1 Impoverishment in this age bracket is far too common and efforts need to be stepped up to develop a national system to prevent this, especially in developing nations. Lack of carer support and impoverishment contribute to under-nutrition. It is clear that with the ageing of the population, the prevalence of protein energy malnutrition (PEM), which is already too high, is set to increase further. Unless efforts are made now to develop prevention and management strategies, the healthcare costs as a result of this syndrome will increase.

Pathophysiology of Protein Energy Malnutrition
Physiological Causes of Weight Loss
1. Anorexia of Ageing

The anorexia of ageing describes the physiological decrease in appetite and food intake that accompanies normal ageing and which may result in undesirable weight loss. In the SENECA [Survey in Europe on Nutrition and the Elderly, a Concerted Action] study, over the first 4 years of follow-up, the average energy intake in men declined by 0.6 MJ/day and in women by 0.4 MJ/day.3 In these same studies, over a period of 10 years, 23% of men and 27% of women had lost 5 kg of their initial body weight.4 Over the 4-year follow-up period, a weight loss of more than 5 kg was predictive of reduced survival.4 There was also strong evidence that older people were at an increased risk of reduced energy and nutrient intake.4 The SENECA studies are part of a large longi-
tudinal study spanning Europe whereby older people were assessed in 1989 (n = 2586, born between 1913 and 1918, 1993 (n = 1273) and 1999 (n = 843). It is clear that although weight loss and decreased nutrient intake may accompany normal ageing, which is perhaps secondary to decreased physical activity and energy demands, this effect may be undesirable. The control of feeding involves complex interactions between the cortex, limbic system and the midbrain, in addition to peripheral inputs from the organs transducing taste and smell (Table 1): the gut, adipose tissue and the endocrine system. Brief examples from each system are given below.

1.1 Central Feeding Drive Mediators
Endogenous opioids are thought to act directly on structures such as the hypothalamus, amygdala, and nucleus accumbens to enhance appetite, food intake, and fluid intake. The stimulation of feeding by endogenous opioids in the elderly may be gender-specific and related to the oestrogen deficiency that occurs in post-menopausal years.

1.2 Central Satiety System
Ghrelin, an endogenous ligand for the growth hormone secretagogue receptor (GHS-R), has recently been purified from the human stomach and found to release more growth hormone, than growth hormone releasing hormone (GHRH), with which it acts synergistically. Ghrelin stimulates lactotroph and corticotroph secretion, has orexigenic activity, modulates energy balance via the influence on glucose metabolism and insulin secretion, and regulates gastric motility and acid secretion through vagal mediation. It is not clear as to what role Ghrelin plays in the causation of the anorexia of ageing. In one study, Ghrelin levels decreased with ageing, suggesting that this amino acid might play a significant part in the causation of weight loss seen with ageing. However, in another study, Ghrelin levels were raised in under-nourished older subjects, casting doubts as to whether Ghrelin is at all an important factor in the anorexia of ageing.

1.3 Hedonic Factors
The senses of smell and taste decline with increasing age. In addition, there is an age-related decline in sensory-specific satiety (normal decline in the pleasantness of the taste of food after it has been consumed) which results in the consumption of a less varied and more monotonous diet, leading to micronutrient deficiencies that compromise nutritional status and immune function.

1.4 Stomach
a) Gastric distension: Gastrointestinal sensory and motor functions are important in the regulation of satiety and these are mediated by the vagal mechanisms from mechanoreceptors situated in the stomach wall. Distension of the distal stomach (antrum) is related to increased sensations of fullness and is likely to be more important than the distension of the proximal stomach (fundus). There is also an impairment of the receptive relaxation of the gastric fundus with ageing and as a result, for any given gastric volume, there is more rapid antral filling and distension and also earlier satiety.

b) Gastric emptying: The slowing of gastric emptying may reduce appetite and food intake by increasing and prolonging antral distension and by prolonging the effect of small-intestinal satiety signals.

1.5 Small-intestinal Gastrointestinal Hormone
Cholecystokinin (CCK), a small intestinal hormone that is released in response to fat and protein in the gut, causes release of bile into the duodenum and also pancreatic enzyme secretion. The effects of CCK on food intake are mediated by an increase in the contractile activity of the pylorus, which slows gastric emptying and increases the sensitivity to gastric distension. The satiating effects of CCK increase with age and plasma CCK concentrations are higher in healthy older subjects than in young subjects.

Table 1: An overview of the central and peripheral mechanisms involved in the regulation of appetite

<table>
<thead>
<tr>
<th>Central Satiety System</th>
<th>Corticotrophin–releasing factor, serotonin, insulin, cholecystokinin (CCK), insulin</th>
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<tr>
<td>Central Feeding Drive Mediators</td>
<td>neuropeptide Y, noradrenaline, opioids, orexins (ghrelin)</td>
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<tr>
<td>Peripheral Satiety System</td>
<td>Stomach: gastric distension, gastric emptying</td>
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<td></td>
<td>Small intestine gastrointestinal hormones: insulin, CCK, amylin, peptide YY, glucagonlike peptide-1, ghrelin</td>
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<td>Small intestine motility</td>
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<td></td>
<td>Plasma nutrient levels: amino acids, monosaccharides, fatty acids</td>
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<td></td>
<td>Cytokines: Interleukin-6</td>
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The causes of under-nutrition are multifactorial and include physiological (anorexia of ageing, sarcopenia) and non-physiological causes.
1.6 Fat Stores
Leptin is thought to play a role in decreasing food intake and is produced predominantly in the adipose tissue and circulates in amounts directly related to the size of fat stores. Elevated leptin levels in post-menopausal women have been shown to be associated with reduced food intake. However, adjustment for fat mass in women abolishes the rise in serum leptin seen with ageing. The rise in leptin levels in ageing men, on the other hand, is not abolished by the adjustment for fat mass and may be mediated by the fall in circulating testosterone concentrations. Testosterone therapy has previously been shown to reduce circulating leptin levels.

1.7 Cytokines
Cytokines are thought to be an important mediator of increasing anorexia and muscle mass loss, as well as declining albumin levels when disease develops in older people. Ageing itself is a form of stress and is associated with increased cortisol and catecholamine production, and decreased sex hormones and growth hormones. All of these stimulate the release of cytokines such as interleukin-6 (IL-6).

2. Sarcopenia
Rosenberg coined the term sarcopenia in 1989 from a Greek word that means ‘poverty of flesh’ (Figure 1). Sarcopenia refers to the decline in muscle mass and strength that may occur with healthy ageing and is thought to be both a process and an outcome. Changes in muscle, decreasing anabolic hormones, decreasing physical activity, impaired oral intake and changes in the cytokine system contribute to sarcopenia and some examples are given below.

2.1 Changes in Muscle
Qualitative and quantitative changes in muscle are thought to be central to the development of sarcopenia. A decrease in muscle mass, muscle strength and muscle efficiency (i.e. muscle strength per unit of muscle mass) may be seen with increasing age. With increasing age, there may be disproportionate atrophy of Type IIa (fast-twitch) muscle fibres, decrease in total muscle fitness, decrease in muscle protein synthesis, unclear separation between the slow and fast fibres, decreased functional units, increased irregularity of muscle unit firing and loss of a- motor neurone input to muscle.

2.2 Anabolic Hormones
Testosterone has important anabolic effects on muscle. Circulating androgen concentrations decline in men with increasing age, and there is increasing evidence that this may contribute to the development of sarcopenia and decrease in functional status that may occur with ageing. Serum testosterone level is also related to the appendicular skeletal muscle mass in older women.

2.3 Physical Activity
Elderly people who are less physically active have less strength and lean mass than active elderly individuals and they do not live as long. Muscle disuse causes a large decline in muscle size and strength, even with adequate protein and energy intake.

2.4 Nutrition
Impaired nutritional intake may also lead to the development of sarcopenia. Castaneda and colleagues have shown that eating half the recommended dietary allowance (RDA) of protein 0.8 g/kg/d causes a significant decline in the strength and body cell mass in post-menopausal females.

2.5 Cytokines
Cytokines may be important in the development of sarcopenia. Older women with higher IL-6 levels were recently shown to be at increased risk of developing mobility disability, impairment of activities of daily living and steeper decline in walking ability than those with lower IL-6 levels, and this may be partially explained by a parallel decline in muscle strength.

Non-physiological (Pathological) Causes Of Weight Loss
A list of some of the many non-physiological causes of undernutrition in the elderly that should be actively sought and rectified where possible is given in Table 2.

Increasing age brings with it poverty as savings dwindle and earnings decrease, if not cease all together. Nelson and colleagues have shown that independent predictors of hunger and food insecurity in adults presenting to an urban hospital in the United States of America included an annual income of less than USD 10,000 per annum and increased medication use. The occurrence and chronicity of medical illnesses increase with age and may contribute to decreased nutrient intake.

Several validated screening methods have been developed for older people and should be used to detect older people at risk of adverse health outcomes (e.g. Mini Nutritional Assessment).
Non-Physiological Causes of Anorexia in Older Persons

**Social Factors**
- Poverty
- Inability to feed oneself
- Inability to shop
- Living alone, social isolation, or lack of social support network
- Inability to prepare and cook meals
- Failure to cater to ethnic food preferences

**Psychological factors**
- Alcoholism
- Bereavement
- Dementia or Alzheimer’s disease
- Depression
- Cholesterol phobia
- Cardiac failure
- Dysphagia
- Parkinson’s disease
- Rheumatoid Arthritis
- Parkinson’s disease

**Medical Factors**
- Cancer
- Chronic obstructive anorexia, early satiation, malabsorption, increased metabolism, cytokine-mediated and impaired functional status
- Hypermetabolism
- Malabsorption syndromes (e.g., hyperthyroidism)
- Gastrointestinal symptoms: dyspepsia, constipation, atrophic gastritis, vomiting, diarrhoea, Poor Dentition

**Medications**
- Nausea/Vomiting – Antibiotics, Opiates, Digoxin, Theophylline, Non-steroidal anti-inflammatory agents (NSAIDs)
- Anorexia – Antibiotics, Digoxin
- Hypogeusia – Metronidazole, Calcium channel blockers, Angiotensin – converting enzyme inhibitors (ACEI), Metformin
- Early satiety – Anticholinergic drugs, sympathomimetic agents
- Reduced feeding ability – sedatives, opiates, psychotropic agents
- Dysphagia – Potassium supplements, NSAIDs, Biphosphonates, Prednisolone
- Constipation – Opiates, Iron Supplements, Diuretics
- Diarrhoea – Laxatives, Antibiotics
- Hypermetabolism – Thyroxine, Ephedrine

**Table 2: The many well-known non-physiological causes of under-nutrition in the elderly**

- Nausea/Vomiting
- Anorexia
- Hypogeusia
- Early satiety
- Reduced feeding ability
- Dysphagia
- Constipation
- Diarrhoea
- Hypermetabolism

**Prevalence of Under-nutrition**

There is no gold standard for the determination of PEM and hence there is great variation in the reported prevalence of this syndrome in different settings. Several validated screening tools exist for the detection of under-nutrition in older people.

The DETERMINE Your Nutritional Health Checklist (Level 1 screen of the Nutrition Screening Initiative [NSI]) which is widely used in North America is the first step in a two-tiered approach to nutritional screening and assessment. The checklist was designed to enhance the older persons’ understanding of the determinants of nutritional well being and to promote the consideration of nutritional problems by health professionals. Those identified by the checklist then proceed to the second level screen of the NSI, which was designed to determine the causes of risk factors or indicators that might signify malnutrition and includes anthropometric, biochemical, dietary and functional measures which need to be performed by trained personnel.

The Mini Nutritional Assessment (MNA), on the other hand, was developed to assess geriatric patients in various clinical settings.
settings, and has a reported sensitivity of 96%, specificity of 98% and predictive value of 97% for malnutrition, when compared to the nutritional status determined by physicians using anthropometric, clinical biochemistry and dietary parameters. It consists of 18 items grouped into four main sections: a) anthropometric measurements (weight, height and weight loss); b) global assessment (six questions related to lifestyle, medication and mobility); c) dietary assessment (eight questions related to the number of meals, food and fluid intake, and autonomy of feeding); and d) subjective assessment (self perception of health and nutrition). Subjects are classified as well nourished (MNA≥24), at risk of malnutrition (MNA = 17-23.5) or malnourished (MNA<17) according to the MNA score (maximum=30). It is an easily administered clinical tool that can be performed in 15 minutes without the need for biochemical investigations or specialized training. The Mini Nutritional Assessment Short Form (MNA-SF) is a 6-item score derived from the MNA through a process of simplification and is said to be able to predict the absence of malnutrition as revealed by the full MNA with 100% sensitivity and 100% negative predictive value. Therefore, the MNA-SF and MNA can be administered as a 2-tiered process in a similar way to the NSI. Those identified as being under-nourished by the MNA-SF should ideally be further evaluated using the MNA.

In an attempt to provide meaningful comparisons, the prevalence figures for under-nutrition quoted in Table 3 are based on the MNA score.

**Consequences of Protein Energy Malnutrition**

Nutritional frailty refers to the disability that occurs in old age due to the rapid, physiological, unintentional loss of body weight (anorexia of ageing) and sarcopenia. It is said that a geriatric continuum exists and older adults comprise a heterogeneous group, ranging from the very robust to the very frail individuals. With increased age, there is a decreased margin of homeostatic reserve and an increased likelihood of experiencing numerous assaults to the homeostatic balance and these in turn result in an increased risk of frailty.

PEM in older people has many adverse consequences and this is an established fact. Many studies have clearly shown an increased risk of mortality with PEM as measured by various different nutritional parameters. Wedick and colleagues studied 1801 community dwelling people (mean age 71 at the beginning of mortality follow-up) and found that men and women losing 10 or more pounds between visits (10 years apart) had higher age-adjusted death rates during the follow-up.

In another study of 4714 community dwelling older people (>65 years), weight loss of 5% or more over a three-year period was associated with an increased risk of mortality that persisted even after a multivariate adjustment. Hospitalised older people (>65 years) with a low body mass index (BMI) (<18.5 kg/m²) are also at increased risk of death. After adjustment for multiple confounders, older Australians (>70 years) with a low corrected arm muscle area (CAMA) (<21.4 cm² for men and ≤21.6 cm² for women) had an increased risk of mortality at an 8-year follow-up.

Under-nourished older people are not only at risk of increased mortality. They are also at risk of multiple complications, which can significantly impact on their overall quality of life. Community dwelling older people with low MNA scores were recently shown to be at increased risk of frequent and prolonged hospitalisation and falls. In another study, weight loss (>5% within six months), BMI, mid-arm circumference and suprailiac skin fold thickness remained strong independent predictors of the development of life-threatening complications in hospitalised older people despite measures for controlling illness severity. A study in New York found that older people admitted for cardiac surgery with BMI less than 23 kg/m² were at increased risk of mortality and developing complications such as stroke, bleeding, respiratory failure and cardiovascular complications. Under-nutrition has also previously been shown to increase respiratory and cardiac complications, infections, pressure-ulcers, immune dysfunction and delayed ulcer healing.

**Management of Under-nutrition**

The management strategy employed should be multifaceted and targeted to those who most need it. It is likely that the management strategies employed would vary according to the setting and they could be tailored for each individual patient. Firstly, reversible non-physiological factors should be systematically sought out and rectified or improved where possible.

### Table 3: Increasing prevalence of older people scoring less than 17 on the Mini Nutritional Assessment

<table>
<thead>
<tr>
<th>Clinical Setting</th>
<th>Prevalence (%)</th>
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<tr>
<td>European community (healthy)</td>
<td>1.0</td>
</tr>
<tr>
<td>Australian domiciliary care recipients</td>
<td>4.8</td>
</tr>
<tr>
<td>Australian acute hospital</td>
<td>20.0</td>
</tr>
<tr>
<td>Swedish acute geriatric unit</td>
<td>26.0</td>
</tr>
<tr>
<td>Australian sub-acute care</td>
<td>27.7</td>
</tr>
<tr>
<td>Group Living - Demented - Sweden</td>
<td>38.0</td>
</tr>
<tr>
<td>Swedish Nursing Home</td>
<td>71.0</td>
</tr>
</tbody>
</table>
Secondly, once a management strategy is put in place, monitoring should be done to ensure improvement in nutritional parameters.

The success of nutritional supplementation varies according to the setting within which it is instituted. Nutritional supplementation with nourishing liquid meals, rich in various micro and macronutrients have been shown to reduce hospitalisation, complications and mortality in hospitalised and institutionalised elderly people. However, in community settings, studies to date have shown that nutritional supplementation results mainly in increased weight, increased nutrient intake, decreased falls and improved MNA scores but not in reduced mortality or hospitalisation.

Specific micro (i.e. vitamins and trace metals) or macronutrient (i.e. protein or cholesterol) replenishment or supplementation may be beneficial. In the New Mexico Ageing Process Study, older women with protein intake higher than the mid-range of 0.8-1.2g/kg of body weight appeared to have fewer health problems than those with protein intake < 0.8g/kg. Women with higher cholesterol intake (351-668 mg) also tended to have fewer health problems than those with low cholesterol intakes. There appears to be some evidence with regards to the benefits of vitamin supplementation on cognitive function and ulcer healing. In one study, modest oral micronutrient supplementation (vitamins, copper, selenium, iodine, zinc, etc.) was shown to improve cognitive function test scores whilst placebo supplementation had no effect on these scores in a group of healthy older volunteers (aged 66-86 years).

In the longitudinal Nurses Health Study, information about vitamin E and C usage was obtained in 1980 and there was also follow-up on cognitive functioning between 1995 and 2000. In this study (age 70 to 79 years), current users of vitamin E and C or vitamin E alone had better global cognitive scores than non-users or users of vitamin C alone. In this study also, there appeared to be significantly greater benefit with longer duration use (> 10 years) of these vitamin supplements than no use at all. Similarly, vitamin E from food was found to be possibly associated with a reduced risk of Alzheimer’s disease in a third study. There is also some evidence that vitamin C and zinc supplementation in older people with pressure ulcers may promote ulcer healing. However, the beneficial effects of vitamin supplementation on other illnesses associated with ageing have not been conclusively proven. In a randomised controlled trial involving 652 non-institutionalised older people, to evaluate the effects of multivitamin (physiological) or vitamin E (200 mg) supplementation on infection rates, no significant beneficial effect of these vitamins on the incidence or severity of acute respiratory tract infections was seen. Instead, there appeared to be a worsening of the acute illness with vitamin E supplementation with respect to symptoms, duration of illness and restriction of activity. In the Blue Mountain Eye Study conducted in Australia, there was no evidence of a protective effect associated with usual dietary antioxidant or zinc intakes (including the use of supplements) on the 5-year incidence of early age-related maculopathy. In a randomised clinical trial, the use of a high-dose formulation of vitamin C, vitamin E, and betacarotene in a relatively well-nourished older adult cohort had no apparent effect on the 7-year risk of the development or progression of age-related lens opacities or visual acuity loss. Interestingly, the same study found that similar supplementation was beneficial in reducing the progression of advanced macula degeneration. In the HOPE and micro-HOPE sub-study, no beneficial effect was seen with vitamin E supplementation on the rates of coronary and cerebrovascular disease or nephropathy in diabetics older than 55 years.

Therefore, in summary, there is some evidence from longitudinal studies that vitamin supplementation may have some benefits (especially on cognitive function) but there is lack of evidence from randomised controlled trials to support the routine use of these agents in all older patients. More trials are required before a firm recommendation can be made. Issues that need to be clarified include formulation and dosing regimen, treatment duration and population groups that should be targeted to obtain maximal benefit. Safety issues also need to be given due consideration.

Modification of food and environment may also be beneficial in improving nutritional intake. There is some evidence that consumption of some alcohol with meals may stimulate food intake. Food taste and smell intensification may also be beneficial. Eating in a group can encourage oral intake and providing a communal setting for at-risk older individuals to consume their meals may be beneficial.

Action may also be taken by governmental and non-profit organizations to improve knowledge as well as improve the overall community nutritional health status. In a small study conducted in Michigan, education about the nutritional benefits of fruits and vegetables, as well as safe storage after purchase of these products resulted in improved attitudes and increased consumption of these beneficial meal items. In this study, the provision of food coupons increased fruit and vegetable consumption but did not change the overall attitude and knowledge. For frailer older individuals, the provision of meals through programmes such as ‘Meals on Wheels’ or increasing the amount of food provided through such community services can result in improved nutrient intake and
The provision of supplements in the form of a soup or porridge at an outpatient service in Chile together with physical activity resulted in maintained functionality and improved muscle strength. 

Unfortunately, at present evidence is limited. There are many small studies with varied recommendations. However, firm clinical pathways consisting of stronger evidence are yet to be established with regards to the management of under-nutrition in different clinical settings (i.e. community or institutions). Further research addressing these deficiencies will lead to better overall health in our elders.

**Conclusion**

Under-nutrition in older people is a serious and growing global problem. It is clear that there are multiple physiological and non-physiological causes for the development of PEM in elderly people. Under-nutrition in older people is undesirable and brings with it many adverse health outcomes. There is strong evidence that nutritional supplementation when provided to under-nourished older people in hospitals and long-term care facilities, can decrease complications, decrease hospitalisation and even mortality. Further research is still required to determine cost-effective treatment strategies in the elderly. It is important to systematically screen for under-nutrition and actively look for the non-physiological causes as some of these may be easily reversed or improved. Simple measures such as BMI and ascertainment of recent weight loss estimation can be used as a quick screen in institutions with reduced resources. Validated screening tools such as the MNA can also be easily administered in clinics or the general practitioner’s office. However, despite the existence of such screening tools, the rate of screening is still well below optimum. This is further compounded by low community awareness. Untreated PEM is costly to the society and reduces the quality of an older person’s life. It is time for medical practitioners to be aware that PEM is important and vigilance is absolutely necessary. Research into better management strategies should strongly be encouraged and community awareness should be heightened.

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