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1 **Why is the skeleton still in the hospital closet? A look at the complex aetiology of protein-**
2 **energy malnutrition and its implications for the nutrition care team**

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13

14 **Introduction**

15 The acknowledgement of protein-energy malnutrition (PEM) as one of “...*the most serious*
16 *nutritional problems of our time*” was actually made by Dr Butterworth Jr in 1974 in his seminal
17 article, “the skeleton in the hospital closet” (1). In most cases, major health problems prevalent
18 in the 1970s have been addressed and improved, such as vast improvements in vaccination rates,
19 pain management and contraception efficacy (4-6). But when it comes to PEM, the continuing
20 high prevalence **across all settings** (10 – 65% in our **home-dwelling**, hospitalised and
21 institutionalised elderly) (7-10) and hefty economic burden (>USD\$156 billion per annum) (11-
22 13) at first appears to suggest that medicine and medical nutrition therapy may have failed to
23 achieve any significant improvement in the past 40 years. However, PEM (**the unintentional loss**
24 **of lean tissues caused by inadequate energy, protein and nutrient intake**) is unique compared
25 with many other medical and nutritional problems, due to not only having a deeply complex
26 physiological cause, but also a multifactorial environmental, economic and psychosocial origin.
27 Furthermore, PEM is often underdiagnosed and/or overlooked in the presence of **similar**
28 **conditions** such as sarcopenia (**age-related loss of muscle mass and physical function**) and
29 cachexia (**loss of muscle mass due to disease-related increases in proinflammatory cytokines and**
30 **a prolonged acute phase protein response**) (9). Beyond the economic consequences of PEM, the
31 **high prevalence is significant for the individual, who may experience broad health problems**
32 **such as decreased cardiac, respiratory, hepatic, immune function; decreased quality of life; and**
33 **a significantly increased risk of hospitalisation, institutionalisation and mortality** (8, 14).

34 Therefore, a renewed examination of what we have learned about the complex aetiology of PEM
35 over the past 40 years **and its implications for practice** may be useful in helping to prevent and
36 manage this long-term geriatric syndrome across the continuum of care.

37 **The physiological causes of protein-energy malnutrition**

38 The physiological causes of PEM may be broadly categorised as a) impaired dietary intake, b)
39 altered metabolic requirements, c) impaired digestion and/or absorption, and d) excessive
40 nutrient losses. However, in most cases, a combination of factors **reflecting the individual and**
41 **the setting** may be responsible (2). A simple example may be an individual with ill-fitting
42 dentures (impairing dietary intake); where as a more complex example may be an individual
43 with oesophageal cancer (impairing dietary intake; altering metabolic requirements), having
44 undergone surgery (impairing dietary intake; altering metabolic **requirements**) and **experiencing**

45 **nausea and vomiting due to** chemotherapy (excessive nutrient losses; impairing dietary intake)
46 **and also taking** antibiotics (impairing digestion and absorption).

47 Impaired intake

48 Sometimes referred to as the ‘anorexia of ageing’, decreased appetite occurs as part of normal
49 ageing (15). Appetite is controlled by interactions between the cortex, limbic system and
50 midbrain as well as peripheral inputs from the gut, adipose tissue and endocrine system (15).
51 These processes may work less efficiently with increasing age leading to the consumption of a
52 less varied and lower quality diet (15). **PEM may occur in all age groups, but the physiological**
53 **and psychosocial changes that occur in ageing, such as a decreased appetite and increased**
54 **comorbidities, place older adults at significantly higher risk** (16). **Although** appetite loss is
55 common, PEM is not part of the normal ageing process and is preventable **and treatable** (17).
56 **Overall**, impaired dietary intake may be due to **both** poor appetite (figure 1) and/or an inability
57 to eat (figure 2), both of which have numerous and overlapping causes. Regarding dentition,
58 edentulousness, which is common in older adults, has been found to increase the risk of PEM
59 (18). When adjusting for confounders, the risk of PEM increased 1.15 times (95%CI 1.06-1.25)
60 for a decrease in masticatory percentage of 10 points (equivalent to the loss of two molars) (19).

61 Altered metabolic requirements

62 Trauma, sepsis, inflammation, fever and serious illnesses, such as cancer, respiratory disease and
63 acquired immunodeficiency syndrome, increase the body’s metabolic rate and can result in
64 catabolic stress. During catabolic stress there is increased protein breakdown and disrupted
65 protein synthesis. This means the body’s protein cycle is no longer in homeostasis and the net
66 loss of protein in the post-absorptive state is not compensated for by net postprandial gain (3).
67 Net protein losses may be up to 20%, which is usually from the breakdown of skeletal muscle
68 but also from organs including the liver, gastrointestinal tract, kidneys and heart (3). These
69 hypermetabolic states increase the requirement for protein, energy and nutrient intake.
70 Medications, polypharmacy and treatments such as haemodialysis can also alter the metabolic
71 requirements for nutrients (2).

72 Impaired digestion and/or absorption

73 The loss of gastrointestinal integrity as a result of protein catabolism can further exacerbate the
74 protein-energy deficit due to mucosal atrophy and resulting malabsorption (3). In addition, there
75 are multiple disease states which may prevent the digestion and/or absorption of nutrients in the

76 gastrointestinal tract (2). Acute conditions include bacterial or parasitic infections which may
77 cause gastritis or impair the breakdown of ingested food as well as contribute to diarrhoea.
78 Chronic conditions include those that affect the stomach, intestine, pancreas and liver such as
79 cystic fibrosis, inflammatory bowel disease, short bowel syndrome, pancreatitis, **hepatic**
80 **cirrhosis or bariatric surgery** (20-25).

81 Excessive nutrient losses

82 Nutrient losses may occur during gastrointestinal dysfunction such as diarrhoea, steatorrhoea,
83 vomiting **and protein losing enteropathy, which may cause a loss of up to 60% of the albumin**
84 **pool** (26). Losses also occur through internal or gastrointestinal bleeding, stomas, fistulae or
85 surgically placed drains **for the removal of intra-abdominal fluid, which may contain up to 12g**
86 **of protein per litre of fluid drained** (2, 27).

87 **Psychosocial and economic risk factors for protein-energy malnutrition**

88 For most individuals, the physiological causes of malnutrition may be confounded by
89 psychosocial and economic risk factors for **PEM (figure 1)**. For example, the individual with
90 poor fitting dentures may also be self-conscious of eating in front of others, which increases their
91 social isolation and may contribute to a decreased appetite. The individual with oesophageal
92 cancer may also be under financial stress due to the need to take extended leave from work, and
93 be unable to afford a suitable diet and/or prescribed oral nutrition supplements.

94 The influence of gender upon risk of PEM is unclear, due to the confounding effects of age,
95 medical status and ethnicity (28). However, the characterisation of PEM in older hospitalised
96 patients has been found to differ based on gender. Nutritional risk in men has been found to be
97 more often associated with higher depression scores, increased length of stay and poor appetite;
98 whereas nutritional risk in women was found to be associated with lower functional status and
99 higher number of disease states (29). **The association between depression and nutritional status**
100 **is multifactorial and it is unclear if it is a cause and consequence of malnutrition in older adults**
101 **(30). As shown in figure 1, depression is associated with loss of appetite. Research has found**
102 **depression to be further associated with weight loss, and malnourished community-dwelling**
103 **older adults are significantly more likely to have higher depression scores (OR=4.38; 95%CI:**
104 **2.23-8.64) (31-34). Self-perceived health has also been found to influence nutritional risk,**
105 perhaps due to its influence on behaviours and attitudes (28).

106 Living alone, social isolation, **financial strain** and socio-economic disadvantage have been found
107 to increase the risk of PEM in older adults (28). **Financial strain, represented by not having**
108 **enough money to make ends meet, was found to increase the risk of older women four-fold (OR:**
109 **4.08; 95% CI 1.95-8.52), accounting for income and education in a sample from Maryland, USA.**
110 **Using nationally representative data,** communities in the USA with higher levels of social
111 isolation, such as lack of access to telephones and cars, socioeconomic disadvantage and higher
112 levels of disability among the older adult population were found to have high rates of
113 malnutrition-related mortality (35). A one standard deviation increase in
114 socioeconomic/physical disadvantage was associated with a **substantial** 12% increase in the rate
115 of malnutrition-related mortality in older adults ($P<0.001$) (35).

116 **Conclusion and implications for practice**

117 Examining the aetiology of PEM in a purely physiological way is critical in order to understand
118 nutrient requirements and develop appropriate strategies. However, examining the physiological
119 aetiology alone will fail to recognise the significant psychological, social and economic factors
120 that influence the risk of PEM. This may lead to an inability for older adults to follow the
121 prescribed recommendations, or prevent their long term efficacy, because they fail to address
122 the complete picture for the individual. **In addition, PEM, which is usually identified during**
123 **admissions to acute, subacute or residential care, must be recognised as a long-term condition**
124 **requiring ongoing multidisciplinary treatment across the continuum of care (16, 36). Health**
125 **practitioners need to recognise and address all the causes of malnutrition in an individual, which**
126 **may only be achieved through individualised assessment and ongoing and flexible nutrition**
127 **intervention.** This may reveal why standardised nutritional interventions employed in many
128 health facilities, such as oral nutrition supplement protocol programs, fail to make any significant
129 impact in the prevalence of malnutrition.

130 **In order to provide suitable and proactive intervention, emerging research supports the**
131 **integration of multidisciplinary formal and informal care for malnourished patients (36-39).**
132 **Engaging the family and friends of malnourished persons as a critical part of the nutrition care**
133 **team may be a cost-effective way of ensuring patients receive highly individualised and cost-**
134 **effective care across settings and in the long term (37, 40). Research has revealed that family of**
135 **malnourished patients may already see themselves as having the primary responsibility for**
136 **providing nutrition support, even during inpatient admissions (37), and when family are provided**

137 with education regarding malnutrition, they can improve the nutrition status, quality of life and
138 physical function of their care-recipients (38).

139 To support this emerging research, further intervention and feasibility studies are needed which
140 address diverse the physiological, psychosocial and economic risk factors, and which examine
141 the efficacy of integrating multidisciplinary formal and informal care across all settings.

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146

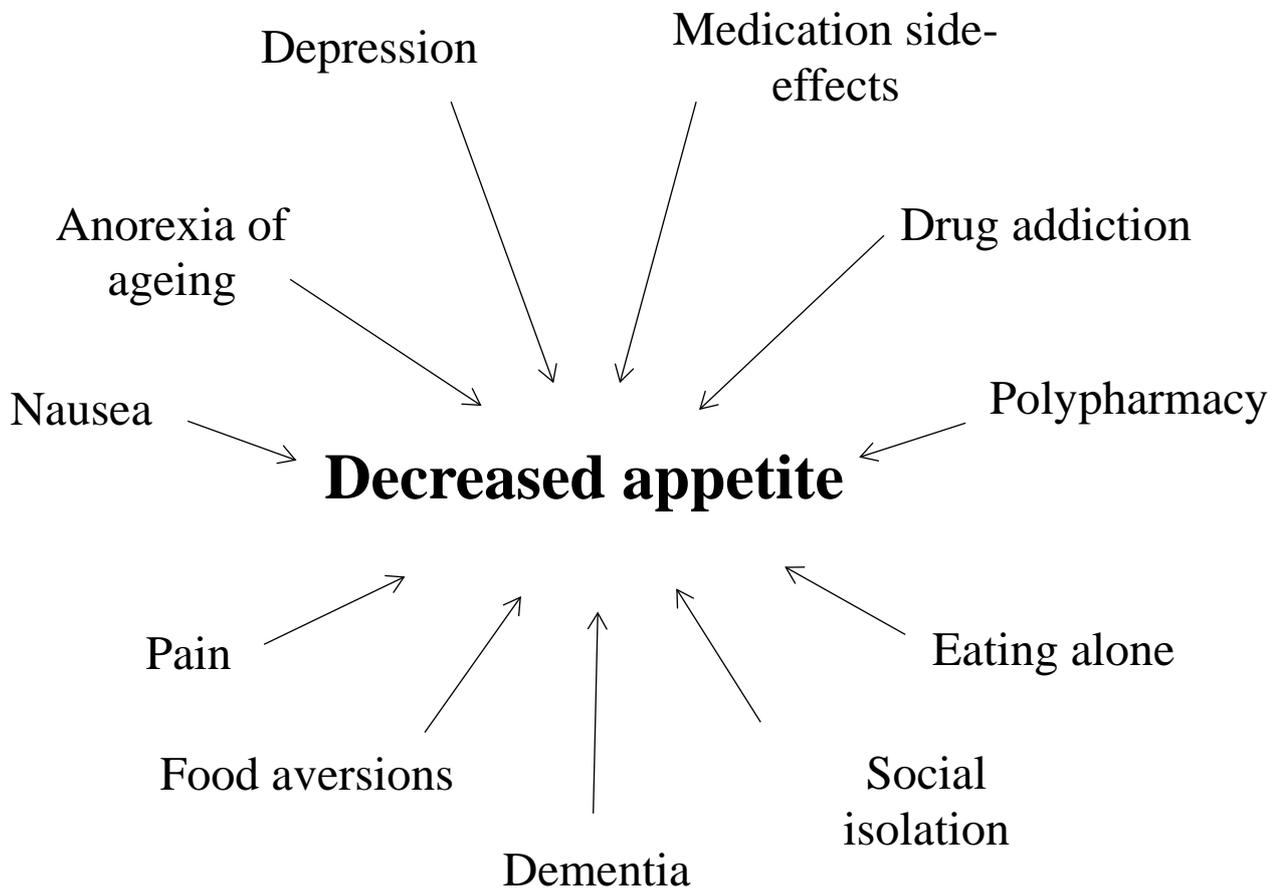


Figure 1. Diverse factors which may lead to a decreased appetite and subsequent impaired dietary intake in older adults (2, 3)

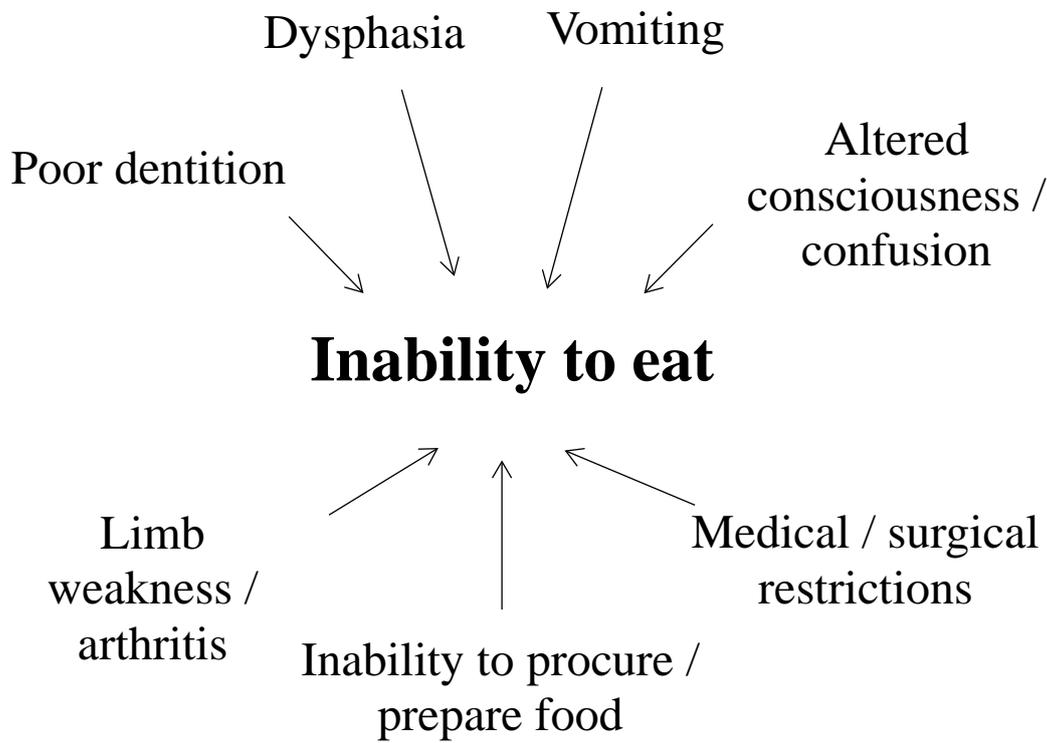


Figure 2. Diverse factors which may lead to an inability to eat and subsequent impaired dietary intake in older adults (2, 3).

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