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Nutrition policy: developing scientific recommendations for food-based dietary guidelines for older adults living independently in Ireland

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Older adults (≥65 years) are the fastest growing population group. Thus, ensuring nutritional well-being of the 'over-65s' to optimise health is critically important. Older adults represent a diverse population – some are fit and healthy, others are frail and many live with chronic conditions. Up to 78 % of older Irish adults living independently are overweight or obese. The present paper describes how these issues were accommodated into the development of food-based dietary guidelines for older adults living independently in Ireland. Food-based dietary guidelines previously established for the general adult population served as the basis for developing more specific recommendations appropriate for older adults. Published international reports were used to update nutrient intake goals for older adults, and available Irish data on dietary intakes and nutritional status biomarkers were explored from a population-based study (the National Adult Nutrition Survey; NANS) and two longitudinal cohorts: the Trinity-Ulster and Department of Agriculture (TUDA) and the Irish Longitudinal Study on Ageing (TILDA) studies. Nutrients of public health concern were identified for further examination. While most nutrient intake goals were similar to those for the general adult population, other aspects were identified where nutritional concerns of ageing require more specific food-based dietary guidelines. These include, a more protein-dense diet using high-quality protein foods to preserve muscle mass; weight maintenance in overweight or obese older adults with no health issues and, where weight-loss is required, that lean tissue is preserved; the promotion of fortified foods, particularly as a bioavailable source of B vitamins and the need for vitamin D supplementation.

Key words: Older adults: Food-based dietary guidelines: Nutrition policy

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Abbreviations: bw, body weight, DIAAS, digestible indispensable amino acid score, EFSA, European Food Safety Authority, IOM, Institute of Medicine, NANS, National Adult Nutrition Survey, PDCAAS, protein digestibility corrected amino acid score, TILDA, Irish Longitudinal Study of Ageing, TUDA, Trinity-Ulster and Department of Agriculture, T2DM, type 2 diabetes mellitus.

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Proceedings of the Nutrition Society

Ageing is not just a chronological process but also a lifelong biological process referred to as senescence. Chronological age is measured in years while biological age is measured by assessing physical and mental function. Biological age can vary greatly between individuals with some 80 year olds having a similar physical and mental capacity as individuals in their 20s, whereas others may be frail and reliant on long-term care[1].

Older adults, defined as those aged 65 years and older, are the fastest growing population group, both globally[2], and in Ireland where there has been a 19 % increase in 'over-65s' between 2011 and 2016 according to the most recent Irish census[3].

The ageing process is associated with an increase in illnesses. While most older adults remain relatively healthy in old age, many are affected by chronic conditions such as CVD, type 2 diabetes mellitus (T2DM), cognitive disease, cancer and osteoporosis[4–8]. A lifestyle incorporating healthy eating and physical activity can prevent or delay onset of these chronic conditions[1]. The high prevalence of these chronic conditions of ageing leads to polypharmacy. Drug–nutrient interactions are critical to consider as nutritional status may be negatively affected by use of certain medications, particularly when polypharmacy is the case[9].

In addition, it is well-established that changes in body composition occur with increasing age, whereby muscle mass and lean tissue decline as fat mass increases[10,11]. There are also changes in body fat distribution with increasing age as the amount of intra-abdominal fat around the vital organs increases while the layer of subcutaneous fat declines, leading to abdominal obesity[12,13]. Such changes in muscle mass and body fat distribution add to the increased risks associated with ageing of developing conditions such as sarcopaenia, CVD and T2DM[10–13]. While sarcopaenia and frailty are conditions associated with ageing, neither of these conditions is inevitable and can be prevented, delayed or reversed with timely and appropriate interventions[14–18]. Sarcopaenia, a progressive muscle disease characterised by a decline in muscle mass and strength, is common among older adults[19]. Sarcopaenia is associated with an increased risk of negative health outcomes including frailty, falls, functional decline and mortality[19]. Sarcopaenia accumulates over the lifetime. From the age of 40 years there is an 8 % decrease in muscle mass every decade which increases to 15 % per decade from the age of 70 years[20]. It is estimated that 10–40 % of community-dwelling older adults have sarcopaenia, depending on the definition used[21]. There is a high prevalence of obesity in older adults living in Ireland which can complicate the identification of sarcopaenia[22]. Obesity can stimulate sarcopaenia by altering lipid metabolism, insulin resistance and inflammatory pathways as well as negatively impacting sarcopaenia by promoting deposition of fat into skeletal muscle[23]. Therefore, individuals living with obesity and sarcopaenia, known as sarcopaenic obesity, will have poorer health status and functional capacity than that associated with either one of the conditions alone[24]. Frailty, a distinct condition characterised by diminished strength and endurance and an increased vulnerability to stress caused by a decline in many physiological functions during ageing, is also common in this age group and is associated with poor health outcomes[25]. European data suggest that up to 76 % of this age group living in long-term care are frail[26]. In Ireland, it is estimated that 15 % of community-dwelling older adults have frailty, with older age, female gender and lower socioeconomic status considered as predisposing factors[27].

Nutrition plays an important role in preventing or delaying the onset of both sarcopaenia and frailty, with nutritional interventions and physical activity considered to be the most effective interventions to delay or reverse these conditions[15,18,28]. Nutritional factors associated with sarcopaenia include low protein and energy intakes, micronutrient deficiencies and malabsorption[19]. Adequate energy intake and higher intakes of good quality protein (quality through amino acid profile and leucine content) are essential for maintaining muscle mass and preventing or delaying onset of these conditions[16,17,29–32]. Preservation of lean body mass cannot be optimised through dietary protein intake alone, with research showing that a combination of high protein intake and exercise have a greater effect on lean body mass preservation[33–37]. Specifically, resistance exercise is considered the most effective way of improving muscle mass in this age group[15].

In Ireland, older adults are the population group most affected by overweight and obesity. While there are known benefits to losing weight, such as the potential prevention or delaying of T2DM[38], it is critically important that weight-loss diets induce gradual weight loss and include consumption of good quality protein combined with daily physical activity in order to prevent loss of muscle mass which can increase risk of sarcopaenia[25].

Many other factors associated with ageing can impact nutritional requirements, such as poor food intake associated with loss of natural teeth, diminished sense of taste and dehydration[39].

For the last three decades in Ireland, healthy eating guidelines have been in place for the general population aged 5 years and older[40,41]. While these guidelines include older adults, they do not provide specific advice to cover nutritional issues associated with ageing. Therefore, the aims of the present paper were to (1) identify nutritional issues affecting older adults living independently in Ireland (i.e. not dependent on residential care) considering the evidence from dietary studies in Ireland and the scientific literature, (2) describe how national nutrient intake goals for older adults differ from the general population, requiring more specific guidelines on healthy eating and (3) summarise the key food-based dietary guidelines for independent living older adults in Ireland.

Methods

Two cohort studies and one population-based study have been completed or are currently on-going in Ireland, with

Proceedings of the Nutrition Society

a focus on older adults: the National Adult Nutrition Survey (NANS)[42], the Trinity-Ulster and Department of Agriculture (TUDA)[43] study and the Irish Longitudinal Study of Ageing (TILDA)[44]. Dietary intakes and biomarker status of older adults in Ireland were explored using these three cohort studies to identify macro- and micronutrients of public health concern in this age group. This analysis identified protein, carbohydrate, fibre, fat, B vitamins (folate, vitamin B_{12}, vitamin B_6 and riboflavin), vitamin C, vitamin D, calcium, iron and zinc. These macro- and micronutrients were examined to explore where nutrient goals or food-based dietary advice differs for older adults compared with the general adult population.

Scientific literature on ageing and the nutrients of public health concern identified from the three cohort studies were reviewed. Key reports from international bodies, such as the European Food Safety Authority (EFSA)[45], the Institute of Medicine (IOM)[46,47] and the Nordic Council of Ministers' Nordic Nutrition Recommendations[48], were examined to identify dietary intake reference values for these nutrients in older adults. Dietary intakes and biomarker status described in the three cohort studies of older adults in Ireland were examined in terms of these nutrient intake goals along with commonly-eaten food sources of key nutrients and patterns of consumption. Food sources of protein were examined in terms of protein quality using protein digestibility corrected amino acid score (PDCAAS), digestible indispensable amino acid score (DIAAS) and leucine content (an essential amino acid that appears to be of critical importance for the post-prandial stimulation of muscle protein syntheses)[49]. PDCAAS and DIAAS relate the essential amino acid content of a foodstuff to a reference amino acid profile, after applying a correction term for protein digestibility[50]. Specific food-based dietary guideline recommendations for older adults were developed based on this examination.

Results and discussion

The main characteristics of the three studies of older adults in Ireland are outlined in Table 1 which describes the study design, population sample and dietary intake assessment methods. In addition, the weight status of the sample is described.

Weight status

As shown in Table 1, up to 78 % of older adults in Ireland are living with overweight or obesity, with only approximately 2 % described as underweight[42,51,52]. These surveys, however, do not include those living in residential care; therefore, the true prevalence of underweight among the total older adult population in Ireland may be underestimated.

There are known benefits to losing weight, such as the potential prevention or delaying of the onset of T2DM[38]. However, as mentioned previously, for older adults living with overweight or obesity, rapid weight-loss diets are associated with loss of muscle mass which can lead to sarcopaenia[25].

Prevention of further weight gain by combining a balanced, nutrient-rich diet with physical activity will help maintain lean muscle mass in older adults who are overweight[25,39] and represents the best approach for overweight older adults unaffected by health conditions exacerbated by obesity. For those living with obesity and weight-related health problems where weight-loss interventions are required, weight loss should be slow, physical activity should be incorporated and rapid weight-loss diets avoided in order to preserve muscle mass[25,39].

Age-related nutritional issues. The nutritional issues affecting older adults in Ireland and the corresponding implications for diet-related advice are described next.

Drug–nutrient interactions

Many medications commonly used by older adults interact with nutrients, negatively impacting nutritional status. Specifically, opioid painkillers, calcium channel blockers, antidepressants and diuretics can interfere with the effects of dietary fibre, thus leading to constipation which can decrease quality of life[53]. The use of H2 receptor antagonists and proton pump inhibitors, which result in gastric acid suppression, have been associated with an increased risk of vitamin B_{12} deficiency[54–56], while metformin (medication for the treatment of T2DM) has been linked to vitamin B_{12} and B_6 deficiencies[57].

In Ireland, studies from the TUDA cohort reported that metformin use was associated with a 45 % increased risk of vitamin B_{12} deficiency and a 48 % increased risk of vitamin B_6 deficiency[58], while those taking a proton pump inhibitor are more likely to have indicators of vitamin B_{12} deficiency[59].

The dietary recommendations in relation to drug–nutrient interactions are as follows:

(a) guidance to ensure adequate fibre intakes for the prevention of constipation and how this can vary among individuals due to drugs and/or immobility
(b) guidance on ensuring adequate intakes of iron, folate, vitamins B_{12} and B_6 to prevent deficiencies due to medication use (see Table 2 for food sources of each nutrient).

Dentition

Many older adults are edentate; thus, tend to choose softer and easier to chew foods, resulting in lower dietary intakes of nutrients such as *n*-3 fatty acids, non-starch polysaccharides, folate and vitamin C, compared with dentate older adults[60].

In Ireland, the NANS has reported that 87 % of older adults living independently either have all of their own teeth or are partially dentate with or without dentures[42]. However, this age group is highly susceptible to chronic dental diseases caused mainly by reduced manual cleaning as well as high-dietary intakes of sugars and refined carbohydrates[61].

Table 1. Characteristics of the three national studies of older adults in Ireland

	NANS	TUDA; TUDA 5+	TILDA
Year of study	2008–2010	2008–2012; 2016–2018	2009–2011
Sample size (*n*)	226*	5186; 1000 resampled	5356†
Age range (years)	18–90	>60	>50
BMI (kg/m²)	27·7 (4·1)	27·9 (5·4)	Not available
% Normal weight	39	24	21
% Underweight	0	2	<1
% Overweight	37	40	42
% Obese	24	34	36
Study design	Cross-sectional survey	Observational	Prospective cohort
Inclusion criteria	Not pregnant/lactating, no disability that impeded ability to fill in survey	Born on the island of Ireland, >60 years, without an existing diagnosis of dementia and not residing in nursing home	Aged ≥50 years, have an Irish residential address, without diagnosis of dementia or not residing in nursing home
Nationally representative (Y/N)	Y	N	Y
Dietary intake assessment type	4-d semi-weighed food record	Food frequency questionnaire/food record	Food frequency questionnaire

NANS, National Adult Nutrition Survey; TILDA, The Irish Longitudinal Study on Ageing; TUDA, Trinity-Ulster and Department of Agriculture study; TUDA 5+, resampling 5 years after initial investigation.
* NANS surveyed adults >18 and <90 years; 226 were aged >65 years.
† Blood samples only available for *n* 5356; total cohort *n* 8504.

Appropriate dietary advice, particularly in terms of free sugars and refined carbohydrate intakes, is important for this age group to prevent the onset of chronic dental diseases. This includes advice on dental hygiene, reduction in frequency of snacking and advice on reduction of cariogenic foods (sugars, refined carbohydrates and carbohydrate foods that are difficult to clear from mouth – sticky candies, crisps, biscuits, etc.). More specific dietary advice is required for edentate older adults to ensure adequate protein and nutrient intakes[62].

Sense of taste

Sense of taste diminishes with increasing age for a variety of reasons including physiological changes, disease and medication use[63,64]. This can lead to increased use of salt at the table among older adults to increase food palatability[63]. Such high-dietary salt intake is associated with an increased risk of hypertension[65].

Currently in Ireland, >50 % of older adults have hypertension[66]. While the maximum salt limit for older adults is the same as that for the general population at 6 g salt/d[65], this cut off is of particular importance for the older adult population due to an increased risk of hypertension caused by excess salt intake, which is a major modifiable risk factor in the development of CVD[67].

Limiting consumption of salty foods (e.g. processed meats, anchovies and olives) and using alternatives to salt, such as herbs and spices, to flavour foods, can help to keep salt intakes below the 6 g/d limit. For those at risk of renal impairment (those with diabetes, heart failure or hypertension), minimal use of salt substitutes due to their high potassium and sodium content is important[65].

Hydration

The ageing process is associated with two changes in the physiological responses to inadequate fluid intake, which increase the risk of dehydration; the feeling of thirst is dampened, and primary urine concentration by the kidneys is impaired[25]. Older adults are also at an increased risk of dehydration for various reasons including use of medications resulting in fluid losses, memory problems, dysphagia and fear of incontinence[25].

It is recommended that older women need at least 1·6 l of drinks daily, while older men need at least 2 l of drinks daily[25]. While water is mostly recommended, milk, tea, coffee and unsweetened fruit juice will all contribute to fluid intakes. Specific guidance is needed for those who are underweight or frail to have milky drinks which will also provide energy and protein as well as fluid. In addition, guidance to staff of the importance of offering drinks on a frequent basis to older adults in residential care to ensure adequate fluid intakes. Finally, consumption of strong tea at mealtimes is advised against to limit the effect of tannins interfering with iron absorption.

Nutrients of concern. The nutritional goals and recommendations developed for each nutrient of concern in older adults in Ireland are outlined in Table 2.

Protein

An adequate protein intake is one of the most important dietary factors for maintaining health during ageing due to its positive effects on body composition[25]. High-quality protein foods assessed using PDCAAS or DIAAS should be consumed in order to stimulate muscle protein synthesis[46]. It is well established that dietary protein is essential for stimulating muscle protein synthesis[49], and maintaining muscle mass (as mentioned previously) is critical for preventing or delaying the onset of

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Table 2. Nutrient goals from scientific literature and subsequent dietary recommendations for nutrients identified as of public health concern for this age group in Ireland[39]

Nutrient	Current intakes	Goal*	Dietary recommendations[39]
Protein	1·15 g/kg bw/d[107]	0·8 g/kg bw/d[45,72] 1–2 g/kg bw/d[73–76] 1·1–1·3 g/kg bw/d[48]	a) 0·4 g protein/kg bw/meal is needed to stimulate muscle protein synthesis[68–71] which can be achieved by consumption of the foods listed in (d); an extra portion of dairy foods at one of the main meals every day can help ensure this amount of protein is achieved b) A more protein-dense diet than the general population is required for older adults[25,39] c) For those at risk of frailty, sarcopaenia and undernutrition 1–1·2 g/kg bw/d is needed[25] d) High-quality protein foods (i.e. those with a PDCAAS or DIAAS of close to 100, e.g. meat, poultry, fish, dairy, eggs, beans, peas, lentils, nuts; see Table 3) are needed at two or more meals daily[30,31]
Carbohydrate free sugars	44% total energy[42] 8% total energy[42]	45–60% total energy[45] <10% total energy <5% if possible[78]	a) Moderate intakes of fibre-rich carbohydrate foods low in free sugars, eaten as mixed meals with food sources of protein and fat, to reduce the glycaemic effect of carbohydrates (see the firstly nutritional issue in Table 1) b) Include fibre-rich versions of carbohydrate foods such as wholemeal breads, cereals, pasta and rice along with plenty of vegetables, salads and fruit at every meal c) Limit foods such as confectionery, biscuits, cakes, preserves, honey and syrup
Fibre	Females: 18·4 g[42] Males: 19·6 g[42]	25 g[45]	a) Fibre goal for older adults in Ireland should be related to energy requirements and be set at ≥3 g/MJ/d b) Ensure all carbohydrate foods provide fibre through use of fibre-rich food sources such as wholegrain breads, pastas and cereals along with plenty of fruit and vegetables at every meal and as snacks
Total fat saturated fat	35% total energy[42] 14% total energy[42]	20–35% energy[45] 10% energy[45]	a) While this is the same goal as for the general adult population, intakes among older adults in Ireland are at the higher end of this range. Avoidance of very low fat intakes will help glycaemic control due to concomitant high carbohydrate intakes, is important for those at risk of developing T2DM b) Saturated fat intakes should be reduced through use of reduced-fat milk and yogurts, reduced-fat margarines rich in MUFAs and PUFAs, lean meats and inclusion of nuts and seeds in the diet c) Intakes of EPA and DHA to be increased through inclusion of oily fish and eggs enriched with *n*-3
B vitamins Riboflavin Vitamin B_6 Vitamin B_{12} Folate	**NANS** Males: 2·0 mg[42] Females: 3·7 mg[42] **TUDA** Males: 2·1 mg[43] Females: 1·8 mg[43] **NANS** Males: 3·1 mg[42] Females: 5·4 mg[42] **TUDA** Males: 1·9 mg[43] Females: 1·8 mg[43] **NANS** Males: 4·1 µg[42] Females: 4·8 µg[42]	1·6 mg[45] 1·6 mg[45] 4 µg[45] 330 µg DFE[45]	a) Include natural food sources such as meat (vitamins B_{12} and B_6), milk and dairy foods (riboflavin and vitamin B_6) and green leafy vegetables, legumes and liver (folate) in the diet b) Encourage use of fortified breakfast cereals as these are key contributors to B vitamin intakes in this age group[85,86,89,90] c) Consideration needs to be given to increasing the levels of fortification with vitamin B_{12} in order to optimise status of this nutrient[39]

(Continued)

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Table 2. (*Cont.*)

Nutrient	Current intakes	Goal*	Dietary recommendations[39]
	TUDA Males: 5·7 µg[43] Females: 5·3 µg[43] **NANS** Males: 356 µg DFE[42] Females: 269 µg DFE[42] **TUDA** Males: 309 µg DFE[86] Females: 301 µg DFE[86]		
Vitamin C	Males: 102 mg[42] Females: 132 mg[42]	95 mg[45]	a) Include five portions of fruit and vegetables in the diet b) One 150 ml portion of unsweetened orange juice daily would contribute significantly to vitamin C intakes c) A vitamin C supplement may be needed in some cases where diet is poor
Vitamin D	Males: 5·2 µg[42] Females: 8·5 µg[42]	10–20 µg[45,47,48,93]	a) Vitamin D supplementation is essential to meet requirements[100] b) All older adults need to take a daily 15 µg vitamin D supplement all year round[100,101]
Calcium	Males: 908 mg[42] Females: 985 mg[42]	950 mg[45]	a) Include four portions of calcium-rich dairy foods (e.g. milk, yogurt and cheese) in the diet b) Plant-based food sources such as cereals, pulses, nuts, seeds and dark-green leaves are generally much less bioavailable c) A daily calcium supplement (500 mg) may be needed for older adults who consume less than one portion daily
Iron	15·8 mg[42]	11 mg[45]	a) Include foods, such as meat, poultry, fish, eggs and beans in the diet b) Iron status should be regularly monitored in this age group in order to identify those with poor iron status and, thus, avoid the development of adverse health effects
Zinc	10·4 mg[42]	7·5–12·7 mg[45]	a) Include high-protein foods, such as 'dark meats' (tuna, red meat, dark poultry meat, i.e. leg meat), cheese, eggs and nuts in the diet b) Some older adults may require zinc supplementation (15 mg/d) if high-protein foods are not regularly consumed

bw, body weight; DFE, dietary folate equivalents; DIAAS, digestible indispensable amino acid scores; PDCAAS, protein digestibility-corrected amino acid scores; T2DM, type 2 diabetes mellitus.
* The nutrient goals outlined are for the general adult population, except for the additional protein goals (1–2 g/kg bw/d[73–76] and 1·1–1·3 g/kg bw/d[48]) which are specific to older adults.

sarcopaenia and frailty[32]. Research has shown that spreading protein intake across different meals during the day and ensuring that each meal provides approximately 0·4 g protein/kg body weight (bw), will maximise muscle protein synthesis [68–71].

Both the EFSA population reference intake and the IOM recommended daily allowance for protein is the same for adults of all ages (0·8 g/kg bw/d)[45,72]. However, some international working groups have more recently recommended higher protein requirements for older adults, ranging from 1 g/kg bw/d up to 2 g/kg bw/d[73–76], with the Nordic countries subsequently increasing the protein requirements for older adults to 1·1–1·3 g/kg bw/d[48].

In Ireland, data from the NANS show that 33 % of older adults had protein intakes below the EFSA estimated average requirement of 0·66 g/kg bw/d[77], which is insufficient to maintain adequate muscle mass and function.

Older adults need a more protein-dense diet than the general adult population, with those at risk of frailty, sarcopaenia and undernutrition having even higher requirements of 1–1·2 g/kg bw/d[25]. Protein quality is important and is determined by the digestibility and quantity of essential amino acids necessary for growth, maintenance and repair, assessed using PDCAAS or DIAAS [71]. As outlined in Table 3, the protein contents of commonly eaten foods in Ireland from animal sources, such as meat, poultry, fish and eggs, have higher PDCAAS and DIAAS quality scores and provide higher amounts of leucine. Consumption of high-quality protein foods (Table 3) providing approximately 0·4 g protein/kg bw in at least two meals daily will maximise muscle protein synthesis and thus reduce the likelihood or progression of sarcopaenia and frailty[30,31]. In addition, daily physical activity, resistance exercise, in particular, will greatly improve maintenance of muscle mass[15,18,28].

Carbohydrate

The EFSA reference intake range for carbohydrates is 45–60 % of total energy[45], while the IOM acceptable macronutrient distribution range is 45–65 % of total energy[72], with no recommendations specific for older adults. In terms of intake of free sugars, the WHO has established the most recent guidelines of <10 % total energy and <5 % if possible[78].

Average carbohydrate intakes among older adults in Ireland, while within the recommended range, are at the lower end and, according to NANS, almost one-third (31 %) exceed the 10 % limit for free sugars intake[42]. Due to the high incidence of overweight and obesity and tendency for abdominal body fat distribution, older adults in Ireland are at an increased risk of T2DM.

Moderate intakes of fibre-rich carbohydrates and low free sugars consumption, eaten as mixed meals (with protein and minimal fat), will reduce the effect of carbohydrates on blood glucose levels[79,80]. This is due to the protein and fat promoting insulin secretion and delaying the absorption of carbohydrates by slowing the rate of gastric emptying, thus reducing the rate of glucose absorption[79,80]. Carbohydrate foods higher in fibre and lower in free sugars are also more slowly digested, absorbed and metabolised, resulting in a lower and slower rise in blood glucose; thus, representing an approach for protecting against the onset of T2DM, obesity and CVD[39,81,82]. Such foods include wholemeal breads, cereals, pasta and rice, as well as vegetables, salads and fruit.

Fibre

The current EFSA recommendation for fibre intake is 25 g/d[45]. Fibre intakes are highly dependent on total energy (kcal) intake and it is well known that as age increases, energy requirements decrease due to changes in body composition along with a decrease in physical activity[83]. The Nordic Nutrition Recommendations align fibre recommendations with energy intakes[48], allowing for the known variation in energy requirements.

Data from NANS indicate that up to 80 % of older adults do not meet the EFSA recommendation[42]. Consideration of the variation in energy requirements due to difference in body size and activity levels among Irish adults[42] demonstrates the need for dietary fibre recommendations to be related to energy requirements; ≥3 g/MJ/d, as established by the Nordic Nutrition Recommendations[48].

Guidance to choose high-fibre versions of all carbohydrate foods eaten, such as wholegrain breads, pastas and cereals, fruit, salad and vegetables, will do much to ensure older adults achieve adequate fibre intakes.

Fat

Older adults are at greater risk of CVD than younger adults, with high saturated fat intakes representing one of the main risk factors for CVD. Strong evidence also exists supporting a beneficial role for the *n*-3 PUFAs, EPA and DHA, on cardiac health in older adults[45].

According to NANS[42], total dietary fat intakes among older adults, at 35 % energy, are at the top end of the EFSA reference intake range[45], with saturated fat contributing to 14 % of energy, exceeding the upper recommendation of 10 % energy[45].

While the dietary fat recommendations for older adults are the same as those for the general population, additional considerations for maintaining fat intakes within the recommended range in older adults need to be considered. In order to facilitate healthy ageing and help reduce disease risk in this age group, saturated fat intakes should be reduced by substituting with MUFAs and PUFAs, and increasing intakes of EPA and DHA[45,84]. Guidance to use minimal amounts of oils and reduced-fat margarines rich in MUFA and PUFA and to include foods, such as reduced-fat oily fish, nuts and seeds will contribute to healthier intake of fats among older adults in Ireland. In addition, total fat intakes should be maintained at current intake levels in order to avoid the glycaemic effects of high-carbohydrate low-fat diets, with PUFAs also being linked to beneficial effects on glycaemic control[84].

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Table 3. Commonly eaten protein-rich food sources (protein g/100 g), ranked according to protein and leucine content per g of typical food portion sizes with corresponding DIAAS and PDCAAS

Food	Protein (g/100 g)	Adult portion size (household measure)	Protein (g/portion size)*	Leucine (g per portion size)*	DIAAS	PDCAAS
Tuna, canned in sunflower oil, drained	25·4	150 g (1 portion cooked fish)	38·1	3·2	NA	100[108]
Beef, sirloin steak, grilled well-done, lean	33·9	100 g (1 palm of hand size†)	33·9	2·9	91[109]	95[110]
Chicken, breast, grilled without skin, meat only	32·0	100 g (1 palm of hand size)	32·0	2·2	108[111]	100[110]
Sardines, canned in sunflower oil, drained	23·3	85 g (3 sardines)	19·8	1·7	NA	100[108]
Eggs, chicken, whole, boiled	14·1	100 g (2 eggs)	14·1	1·2	116[111]	100[110]
Lentils, red, split, boiled	7·6	144 g (¾ cup‡)	10·9	0·9	50[112]	54[112]
Beans, red kidney, dried, boiled in unsalted water	8·6	120 g (¼ standard tin)	10·3	0·7	59[113]	65[113]
Peanuts, dry roasted	25·7	40 g (30 kernels)	10·3	0·7	43[113]	51[113]
Milk, whole, pasteurised, average	3·4	200 ml (1 cup)	6·8	0·6	120[114]	100[114]
Milk, soya, non-dairy alternative to milk, unsweetened, fortified	2·4	200 ml (1 cup)	4·8	0·4	84[114]	100[113]
Rice, brown, wholegrain, boiled in unsalted water	3·6	146 g (1 cup cooked rice)	5·3	0·4	42[115]	NA
Beans, chickpeas, canned, reheated, drained	8·4	86 g (¾ cup)	7·2	0·4	NA	66[110]
Bread, wholemeal, average	9·4	60 g (2 slices)	5·6	0·4	20[115]	32[116]
Rice, white, basmati, boiled in unsalted water	2·8	116 g (1 cup cooked rice)	3·2	0·3	37[115]	62[113]
Porridge, made with water	1·4	30 (1 cup)	0·4	0·3	54[113]	67[113]
Peas, boiled in unsalted water	6·7	50 g (½ cup)	3·4	0·3	58[113]	60[113]
Ready-to-eat breakfast cereal	7·1	30 g (1 cup)	2·1	0·3	1[113]	8[113]
Potatoes, old, boiled in unsalted water, flesh only	1·8	180 g (1 medium potato)	3·2	0·2	NA	85[110]

DIAAS, digestible indispensable amino acid score; NA, not available; PDCAAS, protein digestibility-corrected amino acid score.
A PDCAAS or DIAAS below 100 indicates that at least one amino acid is limiting in the food or diet, whereas a score of 100 indicates that there is no limiting amino acid in the food or diet.
* Derived from McCance and Widdowson's The Composition of Foods Integrated Dataset 2019[117].
† The width and depth of palm without fingers and thumb.
‡ 1 cup = 200 ml.

B vitamins

Deficient folate and related B vitamin intakes and status can be common in this age group[85–88] and are associated with higher risk of diseases of ageing, including CVD, cognitive dysfunction and osteoporosis. Of note, lower biomarker status of folate, vitamin B_6 and riboflavin are associated with an increased risk of depression in this age group, while deficient vitamin B_6 status is associated with increased anxiety[86]. The most common causes of folate and riboflavin deficiencies are low-dietary intakes, while deficient vitamin B_{12} status is mainly caused by food-bound malabsorption as a result of atrophic gastritis (affecting up to 20 % of older adults) and the widespread use of proton pump inhibitor drugs, and low vitamin B_6 status is attributed to increased requirements in ageing[87].

In Ireland, data from NANS reported that 13 % of women have inadequate folate intakes[42], biomarker data from TUDA reported 2 % of participants having folate deficiency[86], while data from TILDA reported 15 % of participants had low or deficient folate status[88]. Studies from both TUDA[87] and TILDA[88] reported that 12 % of participants had vitamin B_{12} deficiency. There was also a 12 % deficiency rate in vitamin B_6 status reported from TUDA[85]. Regarding riboflavin, NANS reported >50 % of older adults had suboptimal riboflavin status[42], while a similar level of 49 % was reported by TUDA[86].

Improving B vitamin status through improved diet requires separate consideration of each B vitamin, as the food sources differ for each. Natural food sources that should be included in the diet of this age group include lean meat (vitamins B_{12} and B_6), reduced-fat (to minimise saturated fat intake) milk and dairy foods (riboflavin and vitamin B_6) and green leafy vegetables, legumes and liver (folate). Fortified breakfast cereals are also key contributors to intakes of each of the B vitamins[85,86,89,90], providing a practical and highly effective means of improving B vitamin status in this age group. In addition, consideration needs to be given to increasing the levels of fortification with vitamin B_{12} in order to optimise status of this nutrient.

Vitamin C

Vitamin C plays an important role in immune function[91]. Older adults are particularly vulnerable to infections due to their reduced immune function. Thus, low vitamin C status in this group represents a potentially correctable contributing factor to morbidity and mortality[91]. Older adults, particularly those from lower socio-economic status groups and those dependent on long-term residential care, are at risk of low vitamin C status. This is caused mainly by low intakes of fresh fruit and vegetables, resulting in lower body stores, along with increased needs caused by smoking, infections and diseases, such as type 2 diabetes[91].

In Ireland, data from NANS reported that 17 % of male older adults had inadequate intakes, while 1 % of older adults had intakes less than the UK lower reference nutrient intake of 10 mg/d[42,92].

Including a small glass of unsweetened orange juice as one of the five daily servings of fruit and vegetables recommended for this age group will help in achieving adequate vitamin C intakes. A vitamin C supplement, as advised by a general practitioner, may be needed in some cases where diet is poor[39].

Vitamin D

The EFSA, IOM, Nordic Nutrition Recommendations and the Scientific Advisory Committee on Nutrition have all set dietary vitamin D requirements for older adults based on specified health outcomes and the associated serum 25-hydroxyvitamin D concentration, with requirements ranging from 10 to 20 μg/d[45,47,48,93]. Adequate vitamin D intake is essential for bone health[45,47,48,93] with low vitamin D status also strongly associated with frailty in this age group[94,95].

In Ireland, vitamin D deficiency is common among older adults, particularly in those in long-term residential care[96], and is more pronounced in winter months[97–99].

Vitamin D occurs naturally in few foods, such as oily fish and eggs. However, these foods do not provide adequate vitamin D for this age group. While vitamin D fortified foods (mostly breakfast cereals and milks) can significantly increase vitamin D intakes and improve status, due to the voluntary nature of food fortification practices in Ireland, these foods alone are insufficient for achieving adequate intakes. Thus, vitamin D supplementation is essential for this age group and it is recommended that all older adults take a daily 15 μg vitamin D supplement all year round[100,101].

Calcium

An adequate intake of calcium is needed for optimal bone health in older adults. While the IOM recommends a higher calcium intake than that of younger adults[47], EFSA does not recommend higher calcium intake for older adults because their modelling analysis excluded an effect of age or sex on calcium intake requirement[45].

Although calcium intakes among older adults in Ireland rank among the highest when comparing adults worldwide[102], very few older adults consume the recommended three portions of dairy foods daily. TUDA reported that 96 % of older adults do not consume three portions of dairy foods daily[103], while TILDA reported 70 %[104]. Additionally, NANS reported an average intake of 1·98 dairy portions daily[42].

Guidance to include four portions of calcium-rich dairy food sources (e.g. milk, yogurt and cheese) in the diet every day will not only help older adults achieve the calcium goal but will also contribute to their need for higher protein intake. While calcium is obtained from plant-based foods such as cereals, pulses, nuts, seeds and dark-green leaves, these sources are generally much less bioavailable. A daily calcium supplement (500 mg) may be needed for older adults who consume less than one portion of calcium-rich dairy food sources daily[39].

Box 1

Older adults should be advised to:
Consume a more protein-dense diet than the general population to preserve muscle mass, and thus prevent, or delay, the onset of sarcopaenia and frailty. High-quality protein foods should be consumed in adequate quantities (0.4 g/kg bw) at two or more meals every day.
Avoid rapid weight-loss diets to safeguard muscle mass and prevent onset of frailty:
Limit weight reduction to older adults with health conditions that warrant weight loss and advise on how to ensure that this has minimal impact on lean body mass.

Ensure appropriate supervision of weight reduction with the objective of gradual weight loss accompanied by increased physical activity to whatever capacity possible.
Take physical activity daily, and resistance exercise in particular, to whatever capacity is possible to help ensure the maintenance of muscle mass and blood glucose control.
Consume high-fibre, low-free sugar carbohydrate foods as mixed meals (with protein and fat) to reduce the effect of carbohydrates on blood glucose levels.
Consume healthier fats that are protective against CVD, by using minimal amounts of oils and reduced-fat margarines rich in MUFA and PUFA; include foods, such as oily fish, nuts and seeds.
Consume fortified foods (e.g. high-fibre breakfast cereals, low fat milk) which will help to achieve many of the nutrient goals, especially as regards optimising B vitamin intakes and status.
Take a daily vitamin D supplement of 15 μg, all year round.
Consume adequate amounts of fluids; women need at least 1.6 l and men need at least 2 l of drinks per day. This can be provided from a number of sources – water, milk, tea, coffee and unsweetened fruit juice will all contribute to fluid intakes. Tea is best consumed between, rather than with, meals in order to avoid interference with iron absorption.
bw, body weight.

Iron

Prevalence of iron deficiency increases with age, particularly among older adults who are dependent on long-term residential care[105]. Iron deficiency in this age group can result in increased ill health and mortality, and is caused mainly by occult blood loss, poor diet, renal insufficiency and malabsorption of iron in the gut[105]. Iron status can be readily assessed by measuring serum iron, iron-binding capacity and ferritin.

In Ireland, most older adults meet the EFSA average requirement for iron (6 mg/d)[45] with NANS reporting average iron intakes of 15·8 mg/d from all sources and 10·8 mg/d from food alone[42].

The inclusion of iron-containing foods, such as meat, poultry, fish, eggs and beans, in the diet of this age group along with vitamin C-containing foods (potatoes, vegetables, salads and fruit) will enhance iron absorption, particularly from plant-based foods. Iron status should be regularly monitored in this age group in order to identify those with poor iron status and, thus, avoid the development of adverse health effects[39].

Zinc

Zinc is required for many diverse functions in the body including biochemical and immunological function[45]. Zinc deficiency is common in older adults, particularly in those dependent on residential care[106]. Factors such

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as low socioeconomic status, poor diet, inadequate chewing of food and impaired absorption in the gut all contribute to lower zinc intakes.

In Ireland, according to NANS average zinc intake in older adults is 10·4 mg/d from all sources and 8·7 mg/d from food alone. Thus, intakes are within the EFSA average requirement ranges (6·2–10·2 mg/d for women; 7·5–12·7 mg/d for men)[45] but below the EFSA population reference intake of 12·7 mg/d for women and 16·3 mg/d for men[42,45].

High-protein foods, including 'dark meats', such as tuna, read meat and dark poultry meat (i.e. leg meat), cheese, eggs and nuts, also represent best sources of zinc and their consumption should be encouraged in this age group. Some older adults may also require zinc supplementation (15 mg/d) if high-protein foods are not regularly consumed[39].

Key conclusions and recommendations

This review identified many nutritional issues associated with ageing, such as increased vulnerability to chronic diseases (e.g. CVD, T2DM), polypharmacy, changes in body composition and loss of muscle mass. Many of these issues can be addressed through dietary interventions. The macro- and micronutrients of public health concern identified in this age group were protein, carbohydrate, fibre, fat, B vitamins (folate, vitamin B_{12}, vitamin B_6 and riboflavin), vitamin C, vitamin D, calcium, iron and zinc. While nutrient intake goals for the majority of these nutrients were the same as those for the general adult population, some important differences requiring specific dietary guidance were evident, e.g. protein quality and quantity and adequacy of B vitamin intake.

In conclusion, specific food-based dietary guidance is needed for this age group in order to address such issues. The key recommendations for this age group are outlined in Box 1.

This work has formed the scientific basis to underpin the development of healthy eating guidelines for older adults living in Ireland. Next steps are to raise awareness among this population and their carers and provide accessible food-based advice that aligns with cultural habits.

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Conflict of Interest

None.

Authorship

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