Professional Certificate in Geriatric Nutrition (United Kingdom)

Metabolic Changes and Energy Balance

Basal metabolic rate (BMR) is the amount of energy expended by the body at complete rest, in a thermoneutral environment, after an overnight fast. In older adults, BMR declines by approximately 1–2 % per decade after the age of 40. This reduction is largely attributable to loss of lean body mass and changes in cellular metabolism. Understanding BMR is essential for calculating the total daily energy expenditure (TDEE) and for designing nutrition plans that meet the reduced energy needs while maintaining adequate nutrient intake.

Resting metabolic rate (RMR) is similar to BMR but is measured under less stringent conditions, typically after a short period of rest rather than an overnight fast. RMR values are usually 5–10 % higher than BMR because they include the energy cost of recent activities such as light walking or meal digestion. In clinical practice, RMR is often used because it is easier to obtain in a routine setting. When assessing an older patient, it is important to note that RMR may be influenced by factors such as recent illness, medication use, and the presence of chronic inflammation.

Thermic effect of food (TEF) represents the increase in metabolic rate after eating, due to the energy required for digestion, absorption, and nutrient assimilation. TEF accounts for roughly 10 % of the total calories consumed in younger adults, but the proportion can be lower in the elderly because of reduced gastric motility and altered enzyme activity. Protein has the highest TEF (20–30 % of its caloric content) compared with carbohydrates (5–10 %) and fats (0–3 %). Emphasising high-quality protein sources can therefore modestly increase overall energy expenditure, which may be beneficial for maintaining muscle mass.

Physical activity level (PAL) is a multiplier used to estimate the contribution of movement to TDEE. PAL values range from 1.2 (sedentary) to 2.5 (very active). Most older adults fall between 1.3 and 1.5, reflecting limited structured exercise and a reliance on routine activities such as walking to the mailbox or gardening. Accurate assessment of PAL requires a detailed activity log, or the use of accelerometers when available. In geriatric nutrition counseling, encouraging even modest increases in activity—such as short walks, chair-based resistance exercises, or household chores—can raise PAL and help counteract age-related metabolic decline.

Lean body mass (LBM) comprises muscle, bone, water, and organ tissue, and is the primary determinant of BMR because metabolically active tissues consume more energy at rest. Sarcopenia, the age-related loss of muscle mass and function, can reduce LBM by up to 30 % in people over 80 years old. This loss leads to lower BMR, decreased strength, and higher risk of falls. Nutritional strategies to preserve LBM include adequate protein intake (1.0–1.2 $g \cdot kg^{-1} \cdot day^{-1}$ for most older adults, higher for those with acute illness or

resistance training), vitamin D optimisation, and regular resistance exercise.

Fat mass tends to increase with age, especially visceral adipose tissue, even when overall body weight remains stable. Visceral fat is metabolically active and secretes pro-inflammatory cytokines such as interleukin-6 and tumour necrosis factor-α, which can raise resting energy expenditure slightly but also promote insulin resistance. In practice, distinguishing between subcutaneous and visceral fat is challenging without imaging, but waist circumference and waist-to-hip ratio provide useful proxies. Managing excess fat mass in older adults involves balancing energy intake with the need to protect lean tissue, often through modest calorie restriction combined with protein-rich diets and physical activity.

Metabolic adaptation refers to the body's ability to adjust its energy expenditure in response to changes in energy intake, body composition, or hormonal status. In the context of weight loss, older adults may experience a "metabolic slowdown" that exceeds what would be predicted by loss of LBM alone. This adaptive thermogenesis can be as much as 10–15 % of the expected reduction in energy expenditure, making further weight loss more difficult and increasing the risk of rebound weight gain. Recognising metabolic adaptation is important when setting realistic weight-management goals for older patients.

Energy balance is the relationship between energy intake (EI) and energy expenditure (EE). When EI exceeds EE, positive energy balance leads to weight gain; when EI is less than EE, negative energy balance results in weight loss. In geriatric nutrition, the focus often shifts from weight loss to weight maintenance or even modest weight gain, particularly for individuals who are underweight or frail. Achieving a stable energy balance may involve careful monitoring of food intake, adjusting portion sizes, and ensuring nutrient density is high while avoiding excessive calories from low-nutrient foods.

Caloric density describes the number of calories per gram of food. Foods with high caloric density (e.g., oils, nuts, desserts) provide many calories in a small volume, whereas low-density foods (e.g., fruits, vegetables, broth-based soups) provide fewer calories per gram but are rich in vitamins and minerals. For older adults with reduced appetite, selecting nutrient-dense, moderately caloric foods can help meet both energy and micronutrient needs without requiring large portion sizes. Examples include fortified cereals, smooth nut butters, and creamy dairy products.

Micronutrient adequacy is a critical consideration because many older adults have reduced absorption of vitamins and minerals due to age-related physiological changes, medications, or co-morbidities. Deficiencies in vitamin B12, calcium, magnesium, and zinc are common and can affect energy metabolism, bone health, and immune function. Incorporating fortified foods, supplements when necessary, and a varied diet that includes leafy greens, legumes, and lean meats can help close these gaps.

Protein quality is determined by its amino acid composition and digestibility. High-quality proteins contain all essential amino acids in proportions that support tissue synthesis. Animal-source proteins (e.g., whey, eggs, meat) generally have higher biological value than most plant proteins, although combinations such as

beans with rice can provide a complete amino acid profile. In the elderly, the concept of “protein-pulse” – delivering 20–30 g of high-quality protein in each main meal – has been shown to stimulate muscle protein synthesis more effectively than spreading protein evenly throughout the day.

Vitamin D status influences calcium homeostasis, muscle function, and inflammatory regulation, all of which intersect with energy metabolism. Older adults in the United Kingdom often have limited sun exposure, leading to widespread insufficiency. Serum 25-hydroxyvitamin D concentrations below 25 $nmol·L^{-1}$ are linked to reduced muscle strength and higher fall risk, while levels above 50 $nmol·L^{-1}$ are associated with better functional outcomes. Supplementation of 800–1000 IU per day is commonly recommended, though individual dosing should be guided by blood tests.

Insulin sensitivity declines with age, partly due to increased visceral adiposity and reduced physical activity. Reduced insulin sensitivity impairs glucose uptake by muscle cells, leading to higher circulating glucose and a greater reliance on carbohydrate oxidation for energy. In practice, dietary strategies such as distributing carbohydrate intake evenly across meals, choosing low-glycaemic-index foods, and pairing carbs with protein or healthy fats can improve post-prandial glucose control and reduce the metabolic strain on older individuals.

Hormonal changes that affect metabolism include decreased production of sex hormones (estrogen, testosterone), growth hormone, and thyroid hormones. These declines contribute to reduced basal metabolic rate, loss of muscle mass, and altered lipid metabolism. For example, low testosterone in older men is associated with increased fat mass and decreased lean mass, while reduced estrogen in post-menopausal women can accelerate bone loss and affect lipid profiles. Hormone replacement therapy may be considered in selected patients, but nutritional approaches such as adequate protein, omega-3 fatty acids, and resistance exercise remain first-line interventions.

Omega-3 fatty acids (EPA and DHA) have anti-inflammatory properties and can modulate membrane fluidity, influencing cellular metabolism. In the elderly, supplementation with 1–2 g per day of EPA/DHA has been linked to modest improvements in muscle protein synthesis, reduced sarcopenic progression, and better cardiovascular health. Incorporating fatty fish (e.g., salmon, sardines) or algae-based supplements can provide these benefits while also contributing to overall energy intake.

Glycogen stores in the liver and skeletal muscle serve as short-term energy reservoirs. With advancing age, glycogen storage capacity diminishes, and the ability to replenish stores after exercise is slower. This reduced glycogen availability can limit exercise tolerance and increase fatigue during daily activities. Practical advice includes timing carbohydrate intake around periods of activity, such as a small snack of fruit or a slice of whole-grain toast before a morning walk, to ensure sufficient substrate for energy production.

Metabolic rate variability refers to the day-to-day fluctuations in BMR caused by factors such as sleep quality, stress, illness, and temperature. In older adults, sleep disturbances are common and can lower BMR

by up to 5 % due to altered hormone secretion (e.g., reduced growth hormone during deep sleep). Addressing sleep hygiene—maintaining a regular bedtime, limiting caffeine, and creating a comfortable sleeping environment—can stabilise metabolic rate and support overall energy balance.

Thermoregulation becomes less efficient with age, leading to a higher risk of hypothermia in cold environments and hyperthermia in hot climates. The body's ability to generate heat through shivering and non-shivering thermogenesis declines, which can slightly increase basal energy needs during cold exposure. Practical recommendations include dressing in layers, keeping indoor temperatures at a comfortable level (around 20–22 °C), and ensuring adequate intake of warm, nutrient-dense meals during winter months.

Hydration status influences metabolic processes because water is a medium for enzymatic reactions and nutrient transport. Dehydration, which is prevalent among older adults due to reduced thirst perception, can impair thermogenesis, reduce renal function, and increase the risk of constipation. An easy guideline is to encourage regular fluid intake—approximately 1.5–2 L per day—through water, herbal teas, and foods with high water content such as soups and fruits.

Appetite regulation involves complex signaling between the gastrointestinal tract, adipose tissue, and the central nervous system. Hormones such as ghrelin (hunger-stimulating) and leptin (satiety-inducing) can become dysregulated with age. Older adults often experience "anorexia of ageing," a gradual decline in appetite that contributes to inadequate energy intake. Strategies to stimulate appetite include offering smaller, more frequent meals; enhancing flavor with herbs and low-sodium seasonings; and providing nutrient-dense snacks between main meals.

Meal timing and distribution affect metabolic outcomes. Research suggests that consuming a larger proportion of daily calories earlier in the day (e.g., a substantial breakfast) aligns with circadian rhythms and may improve glucose tolerance. For older patients who have reduced morning appetite, a practical approach is to gradually shift the larger meal to the mid-morning, perhaps offering a fortified smoothie followed by a smaller breakfast, thereby capitalising on the natural metabolic peak.

Energy density of meals can be modified by adding healthy fats (e.g., olive oil, avocado) or protein powders to foods, thereby increasing caloric intake without substantially increasing volume. For individuals with dysphagia, pureed foods fortified with whey protein isolate can provide both energy and essential amino acids while maintaining safe texture consistency.

Dietary fibre is essential for gastrointestinal health but can also influence energy balance. Soluble fibre (e.g., oats, psyllium) slows gastric emptying, promoting satiety and stabilising post-prandial glucose levels. Insoluble fibre (e.g., whole-grain wheat, bran) adds bulk and aids bowel regularity. In older adults, an intake of 25–30 g per day is recommended, but excessive fibre without adequate fluid can exacerbate constipation, especially in those on constipating medications.

Nutrition risk screening tools such as the Mini Nutritional Assessment (MNA) or Malnutrition Universal

Screening Tool (MUST) incorporate energy intake and weight trends to identify patients at risk of malnutrition. These tools help clinicians decide when to intervene with dietetic support, oral nutritional supplements (ONS), or more intensive feeding strategies. A high-risk score often correlates with reduced BMR and heightened vulnerability to metabolic disturbances.

Oral nutritional supplements (ONS) are formulated to provide concentrated calories, protein, vitamins, and minerals. They are particularly useful when regular meals are insufficient to meet energy needs. Selecting an ONS with a caloric density of 1.5–2.0 $kcal \cdot mL^{-1}$ and at least 20 g of protein per serving can help address both energy deficit and sarcopenia. Timing the supplement between meals can prevent it from displacing regular food intake.

Enteral nutrition may be required for older adults who cannot meet their needs orally due to dysphagia, neurological disease, or severe frailty. Formulas are designed to match the energy and protein requirements of the individual, often providing 1.2–1.5 $kcal \cdot mL^{-1}$ and a protein concentration of 4–5 $g \cdot 100\,mL^{-1}$. Monitoring for over- or under-feeding is essential, as excessive caloric provision can lead to hyperglycaemia and fatty liver, while inadequate provision worsens muscle loss.

Metabolic syndrome is a cluster of conditions—including abdominal obesity, hypertension, dyslipidaemia, and insulin resistance—that increase cardiovascular risk. Its prevalence rises with age, and the syndrome can exacerbate energy imbalance by promoting fat accumulation and reducing metabolic flexibility. Dietary patterns such as the Mediterranean diet, rich in monounsaturated fats, whole grains, and antioxidants, have been shown to improve metabolic parameters and support healthier energy balance in older adults.

Glycaemic index (GI) and glycaemic load (GL) are tools for classifying carbohydrate foods based on their impact on blood glucose. Low-GI foods (≤55) cause slower, more gradual rises in glucose, which can reduce insulin spikes and improve energy utilisation. For an older adult with type 2 diabetes, choosing low-GI carbohydrates—such as steel-cut oats, legumes, and non-starchy vegetables—helps maintain steadier energy levels throughout the day.

Macronutrient distribution recommendations for older adults generally suggest 45–55 % of total energy from carbohydrates, 20–30 % from protein, and 25–35 % from fat. Adjustments may be needed based on individual health status: for example, a higher protein proportion is advisable for those with sarcopenia, while a modest reduction in saturated fat is recommended for cardiovascular risk reduction. Tailoring these percentages to the person's preferences and tolerances improves adherence.

Fatty acid profile influences membrane fluidity, inflammatory pathways, and energy metabolism. Replacing saturated fats with unsaturated fats—particularly polyunsaturated fatty acids (PUFA) like omega-3s—can lower LDL cholesterol and improve insulin sensitivity. Practical ways to modify the diet include using olive oil instead of butter, adding a handful of walnuts to oatmeal, and choosing fatty fish at least twice per week.

Micronutrient-energy interaction highlights that vitamins and minerals are co-factors in metabolic

pathways. For instance, B-vitamins (especially B_1, B_2, B_3, B_5, B_6, and B_{12}) are essential for carbohydrate, fat, and protein metabolism. Deficiencies can lead to reduced energy production and fatigue. Ensuring an adequate supply through a varied diet or supplementation is therefore integral to maintaining optimal energy balance.

Meal enrichment is a technique that adds caloric and nutrient density to regular foods without altering taste or texture dramatically. Examples include mixing powdered milk into soups, adding grated cheese to mashed potatoes, or incorporating pureed legumes into sauces. These modifications can increase daily energy intake by 200–300 kcal, which may be sufficient to reverse mild weight loss in frail elders.

Physical activity prescription for older adults should balance safety with effectiveness. The American College of Sports Medicine recommends at least 150 minutes per week of moderate-intensity aerobic activity, plus two days of resistance training targeting major muscle groups. Even low-impact activities such as tai chi, water aerobics, or chair-based resistance work can raise PAL and stimulate muscle protein synthesis when combined with adequate protein intake.

Metabolic flexibility is the ability of the body to switch between fuel sources (carbohydrates, fats) according to availability and demand. Age-related declines in metabolic flexibility can result in a reliance on carbohydrate oxidation, leading to rapid glycogen depletion and fatigue during prolonged activities. Interventions that improve flexibility include interval training, which alternates periods of higher intensity with rest, and ensuring a balanced intake of macronutrients throughout the day.

Therapeutic diets such as the DASH (Dietary Approaches to Stop Hypertension) or the MIND (Mediterranean-DASH Intervention for Neurodegenerative Delay) diet can be adapted for older adults to address specific health concerns while supporting energy balance. The DASH diet emphasises low sodium, high potassium, calcium, and magnesium foods, which can aid blood pressure control and support muscle function. The MIND diet combines elements of the Mediterranean diet with specific neuroprotective foods (e.g., berries, leafy greens) and may help preserve cognitive function, which indirectly influences appetite and feeding behaviour.

Nutrition–exercise synergy refers to the combined effect of diet and physical activity on metabolic outcomes. Protein ingestion within 30 minutes after resistance exercise maximises muscle protein synthesis, a phenomenon known as the “anabolic window.” For older patients, prescribing a post-exercise snack such as Greek yogurt with fruit can provide both high-quality protein and carbohydrate to replenish glycogen, thereby enhancing recovery and promoting a positive energy balance.

Medication-induced metabolic changes are common in older populations. Drugs such as glucocorticoids increase appetite and promote gluconeogenesis, potentially leading to weight gain and hyperglycaemia. Conversely, beta-blockers can reduce resting metabolic rate and blunt the heart rate response to exercise, lowering overall energy expenditure. Recognising these effects enables dietitians to adjust energy

recommendations accordingly—either by reducing caloric intake when drug-induced appetite increase is present, or by encouraging additional physical activity when metabolism is suppressed.

Chronic disease impact on metabolism includes conditions like chronic obstructive pulmonary disease (COPD), heart failure, and chronic kidney disease (CKD). COPD often raises resting energy expenditure due to the work of breathing, whereas heart failure may reduce appetite and cause fluid overload, complicating energy balance assessment. CKD necessitates careful protein management to avoid excess nitrogen waste while still preserving muscle mass. Tailored nutrition plans must consider the specific metabolic demands of each disease state.

Stress and the hypothalamic-pituitary-adrenal (HPA) axis affect energy balance through cortisol release. Chronic stress can increase appetite for high-energy, palatable foods, leading to positive energy balance and weight gain. In older adults, stressors may include bereavement, social isolation, and financial concerns. Incorporating stress-reduction techniques—such as mindfulness, social support groups, and regular gentle exercise—can mitigate cortisol-driven metabolic disturbances.

Sleep-related hormones such as leptin and ghrelin are tightly linked to appetite regulation. Sleep deprivation lowers leptin (satiety hormone) and raises ghrelin (hunger hormone), prompting increased caloric intake. Older adults often experience fragmented sleep, which can exacerbate these hormonal shifts. Addressing sleep hygiene can therefore support better appetite control and more stable energy intake.

Energy needs estimation equations such as the Harris-Benedict, Mifflin-St Jeor, and the Schofield equations provide baseline BMR values based on age, sex, weight, and height. However, these equations may overestimate needs in frail older adults because they are derived from younger, healthier populations. Adjustments—typically a 10–20 % reduction—are recommended when applying these formulas to the elderly. For example, a 75-year-old woman weighing 60 kg and 160 cm tall may have a calculated BMR of 1300 $kcal \cdot day^{-1}$, but an adjusted value of around 1100 $kcal \cdot day^{-1}$ may be more realistic.

Indirect calorimetry offers a gold-standard measurement of energy expenditure by analysing oxygen consumption and carbon dioxide production. While not routinely available in primary care, it can be valuable in specialized geriatric units for patients with complex metabolic conditions, such as severe malnutrition or critical illness. Results guide precise tailoring of nutrition support, ensuring neither under- nor over-feeding.

Therapeutic fasting is generally not recommended for older adults due to the risk of muscle catabolism and nutrient deficiencies. However, short-term, medically supervised fasting may be employed in specific circumstances, such as pre-operative preparation, where careful monitoring of protein and electrolyte status is essential. In most cases, maintaining a consistent nutrient intake is safer and more effective for preserving lean mass and metabolic health.

Energy-dense snack ideas for older adults include peanut butter on whole-grain toast, cheese and

whole-grain crackers, smoothies with added whey protein, and oatmeal topped with dried fruit and a drizzle of honey. These options provide a balance of carbohydrates, protein, and healthy fats within a small volume, making them suitable for those with reduced appetite or chewing difficulties.

Nutrition during acute illness often requires increased energy provision because of the catabolic stress response. Fever, infection, and inflammation raise resting energy expenditure by 10–30 %. During hospitalization, older patients may experience reduced intake due to pain, nausea, or altered taste. Early introduction of high-calorie, high-protein oral supplements, alongside encouragement of small, frequent meals, can help mitigate the decline in lean body mass.

Rehabilitation nutrition focuses on supporting recovery after surgery, stroke, or prolonged immobilisation. Energy needs may be elevated for tissue repair, while protein requirements increase to 1.2–1.5 $g \cdot kg^{-1} \cdot day^{-1}$. Incorporating nutrient-dense foods such as fortified porridges, soft-cooked legumes, and enriched dairy products can meet these heightened demands without overwhelming a compromised digestive system.

Weight loss in older adults should be approached with caution. Unintentional weight loss is a marker of frailty and is associated with higher mortality. When weight loss is medically indicated—such as in severe obesity—targets should be modest (0.5–1 % of body weight per week) and accompanied by resistance training to preserve muscle mass. Adequate protein ($\geq 1.2\ g \cdot kg^{-1} \cdot day^{-1}$) and vitamin D supplementation are essential components of a safe weight-reduction plan.

Nutrition labeling can assist older adults in making informed choices about energy and nutrient content. Front-of-pack statements that highlight “high protein” or “low sugar” help simplify decision-making, especially for those with visual impairments or limited health literacy. Teaching clients how to read these labels and compare products supports autonomous management of energy balance.

Social determinants of health influence dietary patterns and energy intake. Factors such as income, access to grocery stores, and social support affect the ability to procure and prepare nutrient-dense foods. Community programs—like Meals on Wheels, senior clubs offering cooking classes, and subsidised food schemes—can improve access to balanced meals and help maintain appropriate energy intake among vulnerable elders.

Food texture modification is crucial for individuals with dysphagia. Adjusting consistency to pureed, minced, or soft textures ensures safety while still delivering adequate calories. Adding thickening agents, pureed legumes, or mashed avocado can increase energy density without compromising swallow safety. Dietitians must collaborate with speech-language therapists to align texture modifications with the patient’s swallowing capacity.

Ethical considerations arise when managing nutrition in frail older adults who may have limited life expectancy. Decisions about aggressive nutritional support versus comfort-focused care require discussion with the patient, family, and multidisciplinary team. Respecting patient preferences while ensuring that any

chosen approach aligns with their goals of care is paramount.

Nutrition education strategies for older adults should incorporate clear, concise language, visual aids, and hands-on demonstrations. Teaching portion sizes using familiar objects (e.g., a fist for a cup of fruit) and encouraging the use of food diaries can improve self-monitoring of energy intake. Incorporating caregivers into education sessions enhances adherence, especially for those with cognitive impairment.

Monitoring and evaluation involve regular assessment of weight, body composition, dietary intake, and functional status. Tools such as bioelectrical impedance analysis (BIA) provide estimates of lean mass and fat mass, although hydration status must be considered. Tracking changes over time helps identify early signs of energy imbalance and allows timely intervention.

Case study illustration – Mrs. H, an 82-year-old woman with mild osteoarthritis, lives alone and reports reduced appetite. Her recent weight loss of 4 kg prompted a nutrition assessment. BMR measured by indirect calorimetry is 1150 kcal·day^{-1}; PAL is estimated at 1.3, giving a TDEE of about 1500 kcal·day^{-1}. Current intake is roughly 1200 kcal, with protein at 0.8 g·kg^{-1}. The plan includes adding a fortified smoothie (250 kcal, 20 g protein) mid-morning, enriching her evening soup with shredded cheese (additional 150 kcal), and encouraging a short daily walk to raise PAL to 1.4. Vitamin D supplementation (1000 IU) and a calcium-rich diet are also prescribed. Follow-up after four weeks shows weight stabilisation and improved energy levels, illustrating how targeted adjustments to energy intake and activity can restore balance.

Practical tip for caregivers – Prepare a weekly menu that incorporates three energy-dense meals, two fortified snacks, and a daily fluid schedule. Use a simple checklist to ensure each meal contains a source of protein, a healthy fat, and a carbohydrate, aiming for roughly 500 kcal per main meal. This structured approach simplifies planning, reduces the cognitive load on the older adult, and promotes consistent energy provision.

Future directions – Research is exploring the role of senolytic agents, which target ageing cells, in improving metabolic health. While still experimental, these agents may one day complement nutritional strategies to enhance energy balance in the elderly. In the meantime, adherence to evidence-based dietary patterns, adequate protein, and regular physical activity remains the cornerstone of metabolic health for older adults.