

## UNIT NO. 3

## PRESCRIBING DIETS: FROM FOOD TO ORAL NUTRITION SUPPLEMENTS

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**ABSTRACT**

**Diabetes and Sarcopenia are both growing public health concerns in the aged society. The effectiveness of medical nutrition therapy (MNT) in diabetes prevention and management has long been recognized. Sarcopenia, defined as the loss of muscle mass and muscle function, can likewise be combated by combining lifestyle and nutritional interventions. In clinical practice, early detection with validated screening tools is vital to identify older adults at high risk for sarcopenia, so that preventive interventions can be initiated. It is recognized that a healthful eating pattern and regular physical activity are keystones of sarcopenia and diabetes prevention and management. “Let food be thy medicine and medicine be thy food”. Hippocrates, the father of modern medicine, proclaimed that the power of nutrition simply begins with healthful food choices on our plates. This article summarises the current evidence in both the management of diabetes, sarcopenia and for clinicians to consider its implications for prevention and treatment strategies.**

**Key Words: Sarcopenia; Diabetes Mellitus; Nutrition; Protein; Exercise;**

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**INTRODUCTION**

Diabetes is a growing global burden for many countries across the world. In Singapore, diabetes is a serious health concern, with more than 400,000 Singaporeans living with this condition. One in three Singaporeans has a lifetime risk of having diabetes and the prevalence of type 2 Diabetes (T2DM) is forecasted to reach one million by 2050<sup>1</sup>. This high prevalence of diabetes is largely attributed to our ageing population as the risk of diabetes increases with age.

Along with ageing, Sarcopenia is a geriatric syndrome characterised by progressive and generalised loss of skeletal muscle mass and physical strength or function. Sarcopenia affects up to 30% of community-dwelling individuals in Asia<sup>2</sup>. In Singapore, the increasing prevalence of sarcopenia is mainly related to the country's rise in ageing population. The physiological changes with aging, sedentary lifestyle, poor dietary intake and nutritional status, especially inadequate

intake of high-quality protein increase the risk of sarcopenia. This article documents the role of nutrition as an intervention for both diabetes and sarcopenia.

**NUTRITIONAL MANAGEMENT IN DIABETES**

The effectiveness of medical nutrition therapy (MNT)<sup>3</sup> in diabetes prevention and management has long been recognized. Various international diabetes organizations<sup>3, 4</sup> recognize the integral role of nutrition therapy in diabetes management and offer evidence-based nutrition recommendations for health care professionals to use. Outcome studies of MNT have demonstrated improvements in HbA1c in both type 1 and 2 diabetes. It is suggested that individualized nutrition interventions delivered by a dietitian or a physician can potentially reduce the healthcare costs of managing patients with diabetes through the improvement of clinical outcomes.

**Energy Balance**

Obesity is a risk factor for diabetes. According to the position statement of the American Diabetes Association, effective nutrition therapy for overweight or obese adults with T2DM should emphasize reduced energy intake while maintaining a healthful eating pattern to promote weight loss<sup>3</sup>. Modest weight loss has been shown to improve glucose, blood pressure, increase HDL cholesterol, and decrease triglyceride levels<sup>5,6</sup>. To achieve modest weight loss, intensive lifestyle interventions through nutritional counselling, physical activity, and behaviour change with on-going support are recommended (Level of Evidence A)<sup>3</sup>.

**Carbohydrate**

In the past, high dietary intake of carbohydrate has been frequently highlighted as a major contributing factor to suboptimal diabetes control and leading to weight gain. Although evidence is inconclusive for an ideal amount of carbohydrate intake for people with diabetes, the Canadian Diabetes Association<sup>4</sup> and the Joslin Nutrition Guidelines<sup>7</sup> provided specific macronutrient recommendations, where total intake of carbohydrate falls between 40% to 60% of total caloric intake. The amount of carbohydrate and available insulin may be the most important factor influencing glycaemic response after a meal and should be considered when developing a meal plan<sup>3</sup>. Besides that, people with diabetes should limit or avoid sugar-sweetened beverages to reduce risk for weight gain and worsening of cardio-metabolic risk profile.

Apart from carbohydrate quantification, the type of carbohydrate is also vital in predicting an individual's glycaemic response post meal. Low Glycaemic Index (GI) carbohydrate foods are preferred as it slows the rate of digestion, absorption

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and metabolism in the body, and therefore lowers postprandial blood glucose levels. Systematic reviews and meta-analysis of randomized trials and intervention studies replacing high-GI foods with low-GI food have shown clinically significant improvements in glycaemic control from 2 weeks to 6 months in people with type 1 and type 2 diabetes<sup>8,9</sup>. Foods with low-GI property are often higher in dietary fibre, which may also assist in weight management through effects of satiety and fuel partitioning. In Singapore, the recommended fibre intake is 20g for women and 26g for men<sup>10</sup>. Although current recommendations do not differentiate between insoluble and soluble fibres, the addition of soluble fibre including pectins and beta-glucans (found in foods like oats and fruits) has been shown to demonstrate metabolic benefits through decreasing the rate absorption of glucose in small intestine and improve postprandial glycaemic control<sup>11</sup>.

## Fat

Likewise, the quality of fat has been shown to be more important than the quantity of fat, as part of the strategy to manage diabetes. The role of dietary fat in diabetes management is of particular interest because fatty acids influence glucose metabolism by altering cell membrane function, insulin sensitivity, and gene expression. Available data<sup>12</sup> from controlled intervention studies have shown beneficial effects on insulin sensitivity when saturated fatty acids and trans fatty acids are replaced with unsaturated fatty acids. Such dietary fat composition also lowers cardiovascular risk by reducing the serum LDL/HDL ratio and triglycerides<sup>13</sup>. Increased dietary consumption of fatty fish and polyunsaturated fatty acid omega 3 from vegetable oil (e.g. canola, corn) and walnut were found to be protective against cardiovascular disease mortality in patients with diabetes, through the inhibition of platelet aggregation, and improved lipid profiles<sup>14</sup>. Therefore, the recommendation to consume fish particularly fatty fish at least two times (two servings) per week is appropriate for people with diabetes because of their beneficial effects on prevention of heart disease and association with positive health outcomes in observational studies.

## Protein

Dietary proteins are important modulators of glucose metabolism. Epidemiological studies<sup>15</sup> have demonstrated that higher intake of animal protein was associated with increased risk of diabetes; while higher intake of vegetable protein was associated with modestly reduced risk. A meta-analysis<sup>16</sup> of a randomized clinical study found that low protein diet was not associated with significant improvements in markers of renal functions in patients with diabetic nephropathy and did not slow the progression of end-stage renal disease. Similarly, reducing the amount of dietary protein below usual intake does not alter glycaemic and cardiovascular risk measures<sup>3</sup>. Therefore, current practice guidelines do not recommend people with diabetic kidney disease to restrict protein intake below the dietary allowance of 0.8g/kg body weight/day, as the potential harm of malnutrition should not be ignored<sup>7,17</sup>.

## Micronutrients

Routine vitamin or mineral supplementations do not provide clear benefit for people with diabetes who do not have underlying deficiencies. There is insufficient evidence to support the routine use of micronutrients such as chromium, magnesium, vitamin D, Vitamin E and C to improve glycaemic control in people with diabetes<sup>3</sup>.

## The Role of Oral Nutritional Supplements (ONS)

Compared with standard formulas, diabetes-specific formulas are typically higher in fat (40-50% of energy), with a large contribution from monounsaturated fatty acids, with a lower carbohydrate content (35-40% of energy). This distribution could facilitate glycaemic control through delaying gastric emptying, delaying the intestinal absorption of carbohydrate and production of smaller glycaemic responses. A systematic review<sup>18</sup> involving 19 RCTs has shown that the use of diabetes-specific formulas given as ONS, compared with standard formulas, significantly lower postprandial rise in blood glucose and peak blood glucose concentrations in patients with diabetes. Another study<sup>19</sup> demonstrated that administration of diabetes-specific ONS compared with iso-caloric standard ONS for 12 weeks improves long-term glycaemic control in elderly patients with type 2 diabetes and involuntary weight loss, thereby reducing the risk of diabetes-associated complications. Therefore, the use of diabetes-specific formulas may be useful as an adjunct to glucose stabilization when compared with standard formulas.

## DIAGNOSIS OF SARCOPENIA

Sarcopenia can be considered 'primary' or age-related, or it can also be considered as 'secondary' when the loss of muscle mass is activity, disease, or nutritionally-related<sup>20</sup>. The European Working Group on Sarcopenia in Older People (EWGSOP)<sup>20</sup> recommends defining sarcopenia as the presence of both low muscle mass (dynapenia) and low muscle function (strength or performance). Among the various techniques that can be used to assess muscle mass, Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) are gold standards in research settings and clinical practice<sup>21</sup>. High cost, limited availability at certain settings and concerns about radiation exposure limit the use of these imaging methods for routine use. In practice, assessment of grip strength with handheld dynamometry is a valid and reliable technique to measure muscle strength and has been widely used as an indicator of frailty. Low handgrip strength is a clinical marker of poor mobility and a better predictor of clinical outcomes than low muscle mass<sup>20</sup>.

## NUTRITIONAL MANAGEMENT IN SARCOPENIA

Many consequences of sarcopenia are preventable or even reversible, through effective nutritional strategies. Till date, evidence suggests that nutrition intervention is an important component in the management and prevention of sarcopenia. The International Sarcopenia Initiative expert group<sup>20</sup> has

identified several studies showing that the combination of nutritional interventions and physical exercise (resistance and aerobic exercise) appears to be the most effective strategy presently available for the management of sarcopenia.

## **Protein**

Advancement in age is associated with anorexia and malnutrition, due to changes in eating habits, effects of polypharmacy, and age-related pathologic conditions. On average, many older people do not consume sufficient amounts of dietary intake and protein, which leads to a reduction in lean body mass and increased functional disability. Several studies<sup>22, 23</sup> illustrate the correlation between protein ingestion and muscle mass. Ingestion of protein-deficient meals fails to stimulate protein synthesis because of the lack of availability of blood amino acid. Inadequate or restriction of protein intake, coupled with lack of resistance exercise, speed lean muscle loss and may lead to profound sarcopenia. Therefore, it is encouraged to consume adequate calories intake (24-36 kcal/kg body weight/day), with protein intake of 1.0 - 1.5g/kg body weight/day from high-quality protein sources that are evenly distributed throughout the day (e.g. equivalent amounts at breakfast, lunch and dinner)<sup>24</sup>.

As for overweight or obese patients on hypocaloric weight reduction diet without any kidney diseases, ensuring adequate dietary protein intake is important to prevent the loss of muscle mass during the period of weight reduction. Joslin guidelines<sup>7</sup> recommend a daily protein intake of more than 1.2g/kg of adjusted body weight, which is approximately 20% to 30% of their total caloric intake. A study involving obese women greater than 65 years old showed that protein supplementation was able to preserve muscle mass compared to the control group during a weight reduction program<sup>25</sup>. In addition,  $\beta$ -hydroxy- $\beta$ -methyl butyrate (HMB), a metabolite of amino acid Leucine, is purported as a key nutritional supplement for the preservation of muscle mass. A systematic review<sup>26</sup> has investigated the beneficial effects of this single nutrient HMB on the prevention of muscle damage and stimulation of protein synthesis. Results from seven randomized controlled trials showed greater muscle gain in the intervention groups compared with the control group; however, more studies are needed to determine the effects of HMB on muscle strength and physical performances.

Contrarily, the effects of supplementation with omega-3 fatty acids on body composition have not been conclusive. One study<sup>27</sup> showed that healthy elderly individuals who took approximately 1.3g of omega-3 fatty acids supplements daily for 3 months did not positively improve muscle strength or physical performance, suggesting that a higher dose and a longer period of supplementation may be required to observe a positive impact.

## **Micronutrients**

In general, all nutritional needs should be optimized primarily through a balanced dietary pattern. Patients with no suspected

micronutrient deficiencies do not need specific vitamin and mineral supplementations. Low serum levels of vitamin D are known to be associated with reduced muscle strength and may lead to muscle atrophy and decreased protein synthesis<sup>28</sup>. As levels of 25-hydroxy vitamin D decline longitudinally with ageing<sup>29</sup>, this level should be monitored in all elderly patients, especially individuals who are homebound or in long-term care facilities. It is postulated that supplementation of vitamin D in individuals with low levels increases muscle strength - the recommended intake for calcium is 1000 mg/day for adults 51 years and above, and for vitamin D, 400 IU/day for adults 70 years and above<sup>30</sup>.

## **The Role of Oral Nutritional Supplements (ONS)**

ONS are widely used within the acute and community health settings for individuals who are unable to meet their nutritional requirements through oral diet alone. The elderly population who are affected by undernutrition and vitamin and mineral deficiencies are more vulnerable to infections and are at increased risk of poor health, including the development of sarcopenia and osteoporosis. According to the World Health's Organization<sup>3</sup>, current evidence suggests that the use of ONS can be a valuable adjunct to the nutritional management of patient who is at risk of malnutrition<sup>31</sup>. Studies have shown that the provision of ONS can improve weight, protein and energy intake, nutritional status, physical function and quality of life<sup>32</sup>. Although supplements have an important role, the first step to optimize a person's nutritional status is to explore strategies to improve adequately dietary intake from oral intake and preferred foods, through nutrition education, food fortifications and high protein or calorie snacks. Along with oral nutrition strategies, appropriate use of ONS forms an integral part of the management of malnutrition and sarcopenia.

## **The Link between Diabetes and Sarcopenia**

Sarcopenia has been reported to be a complication of T2DM<sup>33-35</sup>. Metabolic dysregulation that leads to insulin resistance and chronic inflammation may negatively affect muscle mass<sup>36</sup>. In patients with diabetes, the defects in insulin signalling can lead to reduced muscle synthesis. In the Korean Sarcopenic Obesity Study (KSOS)<sup>35</sup> that included 810 subjects with and without diabetes, the prevalence of sarcopenia in patients with diabetes was shown to be 15.7%, compared with 6.9% in the non-diabetic counterparts. Accelerated sarcopenia is a typical finding in older people with diabetes. A large-scale study by Park and colleagues<sup>36</sup> involving community-dwelling elderly people with long-term diabetes have shown accelerated loss of muscle mass and strength when compared to healthy individuals. Patients with diabetes had three-fold higher risk of sarcopenia compared to a controlled group after adjusting for age, gender, body mass index (BMI), lifestyle factors and pre-existing co-morbidities. Furthermore, genetic influence, obesity, mitochondrial dysfunction, loss of neuromuscular integrity, muscle disuse related to physical inactivity and malnutrition have all been reported to be associated with sarcopenia<sup>37-39</sup>. As a consequence, excessive loss of muscle mass in older adults with diabetes may result in poor muscle strength,



functional limitations, physical disability and decreased quality of life. Despite the high prevalence of sarcopenia found in people with diabetes, this syndrome is often overlooked in clinical setting.

## Nutrition Screening

Early screening to identify individuals at risk for involuntary weight loss and malnutrition is essential. Clinicians should integrate nutrition assessment with sarcopenia screening for optimal evaluation of nutritional issues to assist in improving patients' clinical outcomes. A variety of malnutrition screening tools are available such as the Mini Nutrition Assessment (MNA) and Malnutrition Universal Screening Tool ( MUST) have been validated in both the community and healthcare settings especially for individuals over the age of 65<sup>40</sup>. Elements of nutritional history and physical examination are commonly shared among these tools, such as information on premorbid medical history, risk factors or signs of undernutrition, unintended weight loss, adequacy of fluid and food intake, eating ability, food preferences and tolerances, medications that may negatively affect intake and other factors that may impact nutritional status e.g. swallowing ability, gastrointestinal problems, depression. For better patient care and outcomes, clinicians are called upon to work together to implement a routine nutritional screening tool, with the aim of identifying patients at risk of malnutrition and provide the appropriately targeted interventions accordingly.

## CONCLUSION

Nutrition plays a vital role in both the prevention and management of diabetes and sarcopenia. The importance of overall dietary pattern, to ensure sufficient intakes of protein, vitamin D, antioxidant nutrients and unsaturated fatty acids, has been emphasized to be a more predictive overall health status than individual foods or nutrients. Effective prescription of diets for people with diabetes starts with a comprehensive nutritional assessment, so that carefully targeted nutritional interventions can be tailored according to one's needs. On the other hand, nutrition and exercise together have a synergistic effect that helps combat sarcopenia, increases strength, and promotes well-being. To prevent sarcopenia, early screening and detection in adults aged  $\geq 65$  with or without diabetes should be a routine clinical practice. Nutrition-focused physical examination such as the assessment of muscle mass and muscle strength must be included in the assessment of nutritional status. All in all, recommendations for dietary modifications and exercise are the appropriate steps to combat muscle deterioration and in the management of diabetes.

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## LEARNING POINTS

- **People with diabetes should receive individualized Medical Nutrition Therapy (MNT) to achieve treatment goals, which includes healthful eating patterns, emphasizing a variety of nutrient-dense foods in appropriate portion sizes.**
- **To prevent sarcopenia, early detection in older adults with diabetes should be routinely done in clinical practice, this includes the implementation of validated nutrition screening tools.**
- **Overall dietary pattern including sufficient intake of protein(1.2-1.5g/kg body weight/d), vitamin D, antioxidant nutrients and unsaturated fatty acids, coupled with exercise are keystones to sarcopenia prevention and management.**