

# Consensus on Medical Nutrition Therapy for Diabesity (CoMeND) in Adults: A South Asian Perspective

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**Abstract:** Diabetes and obesity are both increasing at a fast pace and giving rise to a new epidemic called diabesity. Lifestyle interventions including diet play a major role in the treatment of diabetes, obesity and diabesity. There are many guidelines on dietary management of diabetes or obesity globally and also from South Asia. However, there are no global or South Asian guidelines on the non-pharmacological management of diabesity. South Asia differs from the rest of the world as South Asians have different phenotype, cooking practices, food resources and exposure, medical nutrition therapy (MNT) practices, and availability of trained specialists. Therefore, South Asia needs its own guidelines for non-pharmacological management of diabesity in adults. The aim of the Consensus on Medical Nutrition Therapy for Diabesity (CoMeND) in Adults: A South Asian Perspective is to recommend therapeutic and preventive MNT in the South-Asians with diabesity.

**Keywords:** diabesity guidelines South Asia, medical nutrition therapy South Asia, nutrition therapy for obesity, nutrition therapy for diabetes, diabetes, obesity and diabesity

## Introduction

Diabetes and obesity are showing a rising trend and giving rise to a new epidemic called diabesity.<sup>1</sup> One in every ten individuals in the United States suffers from diabetes, and about 90–95% of them have type 2 diabetes (T2DM).<sup>2</sup> About 79% of individuals with diabetes live in low and middle income countries (LMIC).<sup>3</sup> Diabetes is reaching epidemic proportions in all South Asian countries, and more so in India, Pakistan and Bangladesh (Table 1).<sup>3</sup> If this trend continues, India is projected to have approximately 101 million and 134 million adults with diabetes by 2030 and 2045, respectively.<sup>1,3</sup>

The rising trend in obesity in LMICs of South Asia (Table 1) is linked to improved socioeconomic status, increase in sedentary lifestyle and adoption of a calorie-rich Westernized diet.<sup>4,5</sup>

## Background and Rationale

This guideline is prepared to address many gaps in the current day practice of non-pharmacological management of diabesity. There are many guidelines on dietary management of diabetes or obesity globally and also from South Asia. However, there are no guidelines or recommendations that address both diabetes and obesity and thus diabesity in the South Asian region. Additionally, the existing diabetes and

**Table 1** Diabetes and Obesity Burden in South Asia

Diabetes Estimates (20–79 Years)	India	Pakistan	Bangladesh	Myanmar	Sri Lanka	Afghanistan	Nepal	Bhutan
People with diabetes, in 1,000s	77,005.6	19,369.8	8,372.2	1,282.7	1,232.8	1,090.8	696.9	46.0
Deaths attributable to diabetes	1,010,262.1	158,973.7	109,857.3	31,288.3	15,459.1	18,630.3	11,678.9	326.7
Total diabetes-related health expenditure, USD million	7,057.4	1,612.8	535.0	235.2	244.4	182.7	56.0	7.6
Obesity burden in South Asia	Burden varies by state and socioeconomic factors. Percentage of men/women who are overweight/obese as per National Family Health Survey (NHFS)-3 (2005–2006): 30.3% men and 37.5% women in Punjab (North); 24.3% men and 34% women in Kerala NHFS-4 (2015–2016): >15% of adults were overweight/obese in 19 states; of these, in 6 states >25% of adults were overweight/obese <sup>8,83,84</sup>	BMI >30 was seen in 30.5% of population; Obesity in women (56.7%) and obesity in men (43.3%) <sup>85</sup>	Prevalence of overweight and obesity in urban women was 34% <sup>86</sup>	Overweight: 20.6% males and 29.96% females Obesity: 4.77% in males and 10.35% in females <sup>87</sup>	Global BMI vs Asian cut-offs: underweight (7.7% vs 7.7%), normal weight (39.6% vs 26.8%), overweight (37.0% vs 34.3%) and obesity (15.8% vs 31.2%). The community prevalence for abdominal obesity was 58.1% when using Asian cut-offs. <sup>88</sup>	2016: 36.9% of adults: male: 32.7% and female: 41.2% <sup>89</sup> 2020: Overweight: 19%, general obesity: 33.7% and abdominal obesity: 57.1% <sup>90</sup>	Nation-wide 2016 survey (overweight/obesity): women 32.87% and men 28.77% <sup>91</sup>	WHO 2016 data: Overweight: 24.8%, obese: 5.9% <sup>92</sup> According to a 2018 report, one-third of the Bhutan population is overweight (33%) <sup>93,94</sup>

Notes: Data from International Diabetes Federation.<sup>3</sup>

obesity guidelines have more data from the West and minimal data from South Asia.

The South Asian phenotype is very different from the rest of the world. Normal weight obesity (the lean-obese) is

a common phenotype in South Asia.<sup>6,7</sup> South Asian adults have higher body fat, lower skeletal mass, more visceral obesity, higher abdominal obesity, more ectopic fat deposition (in liver, muscle etc) and less subcutaneous fat space at the same or

lower body mass index (BMI) as compared to the Western world.<sup>5,6,8,9</sup> Many of these characteristics are genetically determined and unique to the South Asian phenotype.<sup>10</sup>

Even though the dishes from different countries of South Asia look different, they usually have similar macronutrient content across the region. Though the diet in South Asia is often on the higher calorie side (sometimes >3000 calories/day), it does not meet the protein requirements of adults. The South Asian diet is rich in carbohydrates, refined sugar, and processed food and low in fiber, fruits and vegetables. Deep frying, reusing oil for cooking and higher use of trans-fats is common in South Asia.<sup>11</sup> These dietary practices are very different from Western dietary practices.

South Asia is also witnessing increased exposure to the food industry. This along with an increasingly sedentary lifestyle in this region is complicating the diabetes problem further. There is an urgent need to curb this using technology. One way to utilize technology is to use smartphone applications (apps) that track nutrients, food labels, calorific value of food, footsteps, exercise level, etc and offer custom-made solutions. However, these apps have not been properly integrated in the management of diabetes.

Another unique feature in South Asia is paucity of specialists. The majority of individuals with diabetes, obesity and diabetes are managed by their primary care physicians. With few specialists in South Asia, it is difficult to give person-centric care. Hence, there is an urgent need to formulate practice guidelines for the physicians to follow. Smartphone apps can help patients maintain a healthy diet and lifestyle. They can be useful tools to provide patient-centric care to manage day to day nutrient intake and calorie intake and expenditure.

Medical nutrition therapy (MNT), or dietary advice given by a trained health care professional (HCP), plays a significant role in management of diabetes. However, MNT lacks proper understanding and a structured delivery approach in South Asia. Hence, there is a felt need to train more physicians in diabetes MNT care in South Asia.

Thus, South Asia needs its own guidelines for non-pharmacological management of diabetes in adults due to various reasons discussed in this section. The aim of the Consensus on Medical Nutrition Therapy for Diabetes (CoMeND) in Adults: A South Asian Perspective is to recommend therapeutic and preventive MNT in South Asians suffering from diabetes.

## Methodology

A group of general medicine, endocrine and obesity experts from South Asian countries, that is, Bangladesh, Bhutan, India, Nepal and Sri Lanka, met on January 17, 2020 to frame the Consensus on Medical Nutrition Therapy for Diabetes (CoMeND) in Adults: A South Asian Perspective.

Global and South Asian data on diabetes and obesity was reviewed in detail prior to the meeting. The following guidelines were studied in detail: the American Association of Clinical Endocrinologists (AACE) and American College of Endocrinology (ACE) clinical practice guidelines for obesity, the American Diabetes Association (ADA) Standards of Medical Care in Diabetes for “Obesity Management for the Treatment of Type 2 Diabetes” and “Lifestyle Management”,<sup>12,13</sup> a position statement from the Academy of Nutrition and Dietetics,<sup>14</sup> the Research Society for the Study of Diabetes in India (RSSDI) clinical practice recommendations for the management of type 2 diabetes mellitus,<sup>15</sup> other food-based dietary guidelines,<sup>16</sup> the European Association for the Study of Obesity (EASO) position paper,<sup>17</sup> and guidelines and recommendations for South Asia and India. Several review articles and landmark trials on non-pharmacological management of obesity/diabetes/diabetes were also reviewed for formulating the Consensus.<sup>1,5,18–23</sup> Patient-centered care and its benefits in diabetes were also explored.<sup>24–27</sup>

The first draft of the recommendations was prepared and circulated amongst the experts prior to the meeting for their detailed review. At the meeting, the experts provided suggestions, comments and opinions on the draft. The draft was then revised based on the discussions during the meeting and re-circulated among the experts for their final suggestions. Post this, the draft was finalized and approved by the experts and sent for publication.

## Overview of Recommendations

The recommendations on non-pharmacological management of diabetes in adults are considered under the following headings:

- (I) Screening and Diagnosis
- (II) Staging
- (III) Medical Nutrition Therapy
  - Definition
  - Indications
  - Goals
  - Types of Diets

- Integrated Approach
  - Components
  - General Recommendations
- (IV) Managing diet in a setting of abundance
- (V) Monitoring
- (VI) Counselling and Motivation
- (VII) Way Forward: Personalized Medicine and Person-centered Care

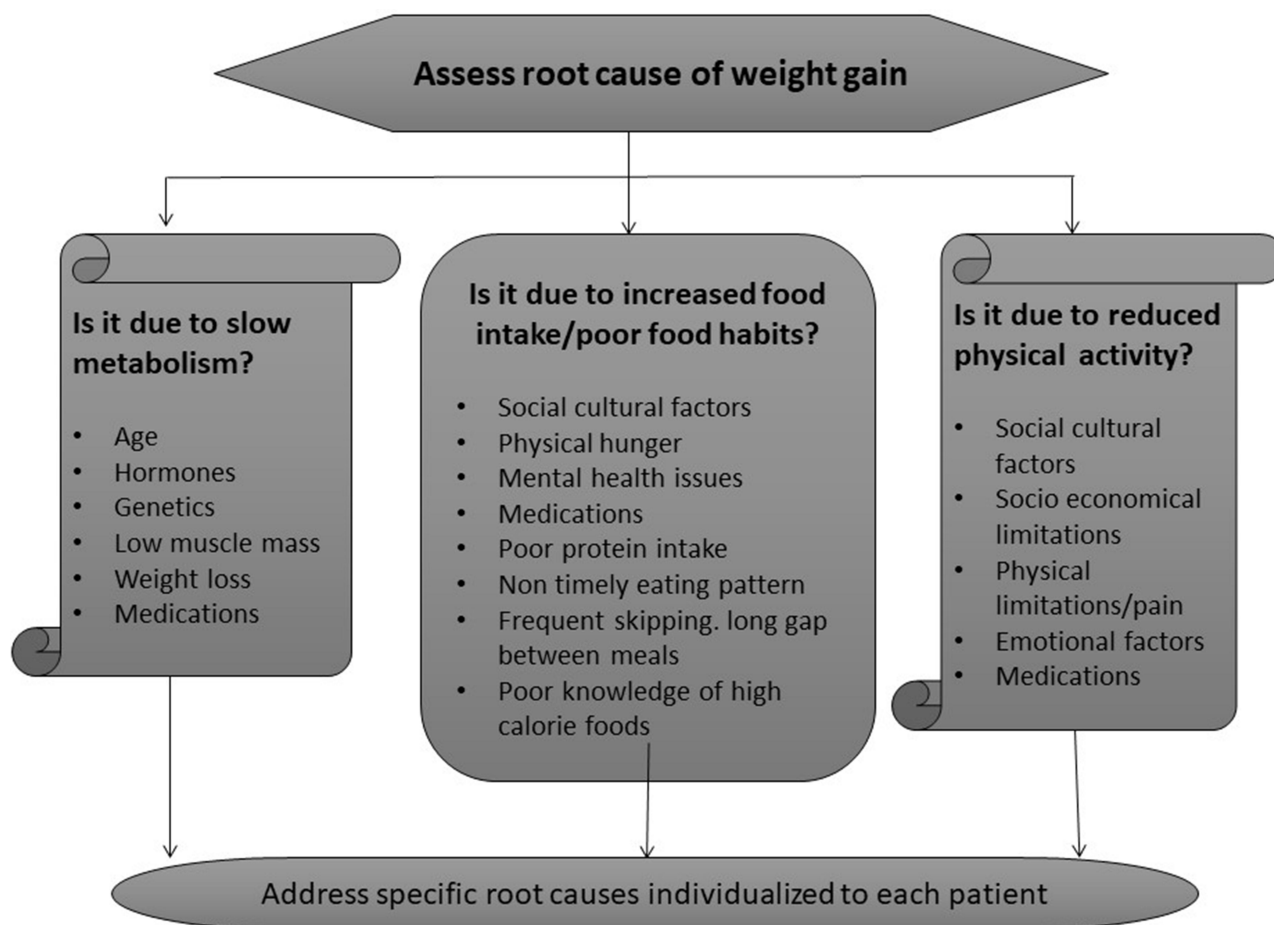
Also, approximate calorific values of some cooked food preparations are provided in [Appendix I](#).<sup>28</sup>

## Screening and Diagnosis

### Recommendation for Screening and Diagnosis

For screening and diagnosis of diabetes, the following should be done:<sup>5,29</sup>

1. History: Detailed history is taken to find the root cause of weight gain ([Figure 1](#)). This helps individualize patient treatment based on the identified causes.<sup>30</sup>
2. Physical exam: Double chin, dorsocervical pad of fat, ectopic fat as in sub-scapular, axillary and infra-axillary regions are seen in South Asians. Other things that should be looked for are acanthosis nigricans, xanthelasma, arcus, tendon xanthoma, abdominal striae, gynecomastia, thyroid nodules/swellings.
3. Anthropometry: Height, weight, waist circumference, waist:hip ratio, and body mass index (BMI) should be measured. Other optional investigation: percentage body fat. The South Asian ethnicity specific cut-offs should be used for these obesity indicators as proposed below:<sup>31</sup>
  - BMI of  $\geq 23$  kg/m<sup>2</sup> should be considered as overweight and  $\geq 25$  kg/m<sup>2</sup> as obese ([Table 2](#)). This is



**Figure 1** Root causes of diabetes.  
**Notes:** Data from Kapoor et al.<sup>30</sup>

**Table 2** Body Mass Index (BMI) Criteria for Obesity in Adults

Category	Asian <sup>37,38</sup>	WHO <sup>37</sup>
Underweight	<18.5	<18.5
Normal weight	18.5–22.9	18.5–24.9
Overweight	23–24.9	25.0–29.9
Obesity Grade I	25–29.9 kg/m <sup>2</sup>	30.0–34.9
Obesity Grade II	30–34.9 kg/m <sup>2</sup>	35.0–39.9
Obesity Grade III	>35 kg/m <sup>2</sup>	≥40

in agreement with ADA, WHO and Indian consensus group recommendations for BMI cut-off in Asians.<sup>21,32–34</sup>

- At BMI of  $\geq 23$  kg/m<sup>2</sup> screening for diabetes should be initiated.<sup>21,32</sup>
  - Waist circumference indicates visceral fat and is a useful predictor of cardiometabolic risk and can be combined with BMI. It can be measured at regular intervals to note decrease in visceral fat.<sup>35</sup>
  - Other anthropometric measures which can be combined with BMI include: the ratio of waist circumference to hip circumference (waist:hip ratio ([WHR]), and the ratio of waist circumference to height (waist:height ratio).<sup>36</sup>
  - Body fat percentage and visceral adipose tissue estimation, though currently used only in the research setting, has significant relevance in the South Asian population.<sup>6</sup> As per the American Society of Endocrinologists, the cut-off for total body fat percentage is 35% for women and 25% for men; however, for Asians, a cut-off of 20.6% in men and 33.4% in women has been suggested.<sup>7</sup>
4. Laboratory tests: Glycated hemoglobin (HbA1c), fasting and postprandial glucose, fasting lipid panel and albumin/creatinine ratio should be done. Based on clinical suspicion, other assessments may include uric acid, hepatic transaminases and serum cortisol.
5. The 4 Ms of assessment: The complete diabetes assessment framework should consider the 4 Ms: Metabolic, Mechanical, Mental and Monetary (Table 3). This helps in holistic management of the patients.<sup>30</sup>

## Limitations of Obesity Assessment Measures

Physicians often use only BMI for measuring obesity. Though BMI is a very popular method of assessing

**Table 3** The 4 Ms of Diabetes Assessment

Metabolic	Mechanical	Mental	Monetary
Type 2 diabetes mellitus	Sleep apnea	Cognition	Education
Dyslipidemia	Osteoarthritis	Depression	Employment
Hypertension	Chronic pain	Attention deficit	Income
Gout	Reflux disease	Addiction	Disability
Fatty liver	Incontinence	Psychosis	Insurance
Gall stones	Thrombosis	Eating disorder	Benefits
Polycystic ovarian syndrome	Intertrigo	Trauma	Bariatric supplies
Malignancy	Plantar fasciitis	Insomnia	Weight loss programs

Notes: Data from Kapoor et al.<sup>30</sup>

(screening and diagnosis) obesity, it has some limitations which the clinicians should be aware of.<sup>6,7</sup>

1. Asian-specific BMI and not the WHO Global BMI parameters should be used to assess obesity in South Asians.<sup>32,37,38</sup>
2. BMI should not be used as the only method to assess obesity. BMI should be combined with, at minimum, a waist circumference to capture adiposity correctly (Table 4).
  - BMI does not distinguish between muscle weight and fat weight. Though it has high specificity for obesity, it has very low sensitivity for adiposity. Therefore, approximately 50% of individuals with excess fat fail to be classified as overweight/obese.<sup>39</sup>
  - BMI is unable to catch body fat distribution, which is a marker of metabolic disturbance, cardiovascular risk and linked to T2DM.<sup>40–42</sup>

**Table 4** Parameters Used to Define Obesity in South Asians

Parameter Studied	Criteria for Overweight/Obesity
Body mass index	>23 kg/m <sup>2</sup>
Waist circumference	>90 cm in men and >80 cm in women
Waist:hip ratio	0.9 in men and 0.8 in women
Body fat percentage*	>25% in men and >30% in women

Notes: \*As measured by dual energy x-ray absorptiometry (DEXA) scan. Data from Thomas et al.<sup>38</sup>



Hence, for anthropometry, as discussed above, BMI should be combined with the waist:height ratio (WHR).

Other investigations which can be combined with BMI, if required, are (not usually done):

1. Dual-energy x-ray absorptiometry (DEXA) or air displacement plethysmography, which accurately assess lean body mass and body fat. DEXA is the gold standard to assess body composition. However, neither of these tests can be used routinely as they are very costly.
2. Measuring body water using bioelectric impedance is a relatively inexpensive method. It compares body fat mass with fat-free mass. However, large inter-individual variations limit its use.<sup>43</sup>

## Staging of Obesity

The diabetes therapy is guided by the level of obesity. Hence, physicians should be able to identify the stage of obesity and its biochemical parameters. This can be done using well-designed models. The SECURED (Severity of obesity, Expected prognosis, Comorbid conditions, Urgency of control, Risk of complications, Environmental factors, Dysfunction and disability) model (Table 5) lists the parameters that should be considered while developing patient/person-centered care.<sup>44</sup> The Edmonton Obesity Staging System (EOSS) (Table 6) or

**Table 5** SECURED Model

S	Severity of obesity	Body mass index, waist circumference
E	Expected prognosis	Expected life span
C	Comorbid conditions	Metabolic, mechanical and mood disturbances
U	Urgency of control	Biomedical or psychosocial issues that require early weight control
R	Risk of complications	Risk of malnutrition, gall stones, other complications due to rapid weight loss
E	Environmental factors	Socioeconomic factors influencing life with obesity
D	Dysfunction and disability	Biopsychosocial dysfunction and disability due to obesity

Notes: Data from Kalra et al.<sup>44</sup>

the Cardiometabolic Disease Staging (CMDS) system (Table 7) can help identify the stage of obesity and plan the intervention accordingly.

## Recommendations

Physicians can use any of the models in Tables 5, 6 and 7 to assess the stage of obesity and plan the diabetes intervention accordingly.

## Overview of Management of Diabetes

Diabetes can be managed by non-pharmacological, pharmacological and surgical interventions. Treating obesity is the primary focus. T2DM remission should aim to be a natural progression of weight control. Pharmacotherapy with anti-obesity medications and glucose-lowering agents should be started where required. Surgical interventions should be considered in patients who cannot be managed through anti-obesity medications and glucose-lowering agents. However, irrespective of pharmacological and surgical approach used, the focus should be on lifestyle management which primarily includes focus on diet and physical exercise. BMI may be used to guide the type of intervention in diabetes (Table 8). However, all treatment decisions should be made based on the patient's general condition, contraindications for pharmacotherapy/surgery and severity of comorbid conditions.

## Dietary Concerns in Diabetes

Lifestyle habits need to be changed to prevent and therapeutically cure diabetes, which includes reduced daily calorie intake along with aerobic and strength-building exercises. Many food habits cause obesity/abdominal obesity in South Asians such as (but not limited to):<sup>5,11</sup>

1. Excess consumption of refined carbohydrates, sweets and sweetened beverages
2. Using saturated fats for cooking
3. Frequent consumption of fried snacks or snacks made with highly saturated fat
4. Low fruit and vegetable intake resulting in low fiber intake
5. Increased intake of calorie-dense food

People with obesity often fail to comply with a diet because they prefer highly processed simple sugar

**Table 6** Edmonton Obesity Staging System (EOSS)

EOSS Stage	Level of Obesity and Complications	Biochemical Parameters	Level of Prevention	Intervention
0	No apparent obesity-related risk factors, symptoms, psychopathology, limitations, and/or well-being impairments	No EOSS factors reported	Primordial/ No intervention	Healthy lifestyle to be encouraged
1	Subclinical obesity risk factors, physical symptoms, psychopathology, functional limitations, and/or well-being impairment is mild	Any of the following: i) Fasting glucose $\geq$ 100 mg/dL (ii) Cholesterol $\geq$ 200 mg/dL (iii) Triglycerides $\geq$ 150 mg/dL (iv) HDL $\leq$ 60 mg/dL (v) Fasting LDL $\geq$ 100 mg/dL (vi) SBP $\geq$ 130 mmHg (vii) DBP $\geq$ 85 mmHg	Primordial	Lifestyle modification
2	Established obesity, moderate limitations in activities of daily living, and/or well-being	Any of the following: (i) Fasting glucose $\geq$ 124 mg/dL (ii) Diagnosed with T2DM or on T2DM medication (iii) Total cholesterol $\geq$ 240 mg/dL (iv) Triglycerides $\geq$ 195 mg/dL (v) HDL $<$ 40 mg/dL (men) and $<$ 50 mg/dL in women (vi) LDL $\geq$ 160 mg/dL (vii) Diagnosed hypercholesterolaemia or hyperlipidaemia or hyperlipidaemia or on medication for it (viii) SBP $\geq$ 140 mmHg (ix) DBP $\geq$ 90 mmHg (x) Diagnosed hypertension or hypertension medication (xi) Any of the following comorbidities: Sleep apnea, gout, arthritis, anxiety, atherosclerosis, fatty liver, congestive heart failure medication, depression, on blood thinners	Primary	Behavioral therapy with supportive medication therapy for biochemical abnormalities and comorbidities
3	Established end-organ damage, significant psychopathology, significant functional limitations, and/or well-being impairment	Any of the following: (i) Angina (ii) Heart attack (iii) Heart failure (iv) Thrombosis (v) Coronary artery disease (vi) Coronary obstructive pulmonary disease (vii) Dyspnea (viii) Exercise dyspnea (ix) Coronary artery bypass surgery (x) Stroke	Secondary	Medical therapy/Surgery
4	Severe (potentially end-stage) disabilities from obesity-related chronic diseases, disabling psychopathology, functional limitations, and/or well-being impairment	No data available to evaluate this stage	Tertiary	Bariatric surgery

**Notes:** Data from these studies.<sup>44,95,96</sup>

**Abbreviations:** DBP, diastolic blood pressure; HDL, high-density lipoprotein; LDL, low-density lipoprotein; SBP, systolic blood pressure; T2DM, type 2 diabetes mellitus.

**Table 7** Cardiometabolic Disease Staging (CMDS)

Stage	Descriptor	Criteria	Level of Prevention	Intervention
0	Metabolically healthy	No risk factors	Primordial/ No intervention	Healthy lifestyle to be encouraged
1	One or two risk factors	Have one or two of the following risk factors: (a) High waist circumference ( $\geq 80$ cm in South Asian women and $\geq 90$ cm in South Asian men) (b) Elevated blood pressure (systolic $\geq 130$ mmHg and/or diastolic $\geq 85$ mmHg) or on antihypertensive medication (c) Reduced serum HDL cholesterol ( $< 40$ mg/dL in men; $< 50$ mg/dL in women) (d) Elevated fasting serum triglycerides ( $\geq 150$ mg/dL)	Primordial	Lifestyle modification
2	Metabolic syndrome or prediabetes	Have only one of the following three conditions in isolation: (a) Metabolic syndrome based on three or more of four risk factors: high waist circumference, elevated blood pressure, reduced HDL-C, and elevated triglycerides (b) Impaired fasting glucose (fasting glucose $\geq 100$ mg/dL) (c) Impaired glucose tolerance (2-h glucose $\geq 140$ mg/dL)	Primary	Behavioral therapy with supportive medication therapy for biochemical abnormalities and comorbidities
3	Metabolic syndrome and prediabetes	Have any two of the following three conditions: (a) Metabolic syndrome (b) IFG (c) IGT	Secondary	Medical therapy/Surgery
4	T2DM and/or CVD	Have T2DM and/or CVD: (a) T2DM (fasting glucose $\geq 126$ mg/dL or 2-h glucose $\geq 200$ mg/dL or on antidiabetic therapy) (b) Active CVD (angina pectoris, or status after a CVD event such as acute coronary artery syndrome, stent placement, coronary artery bypass, thrombotic stroke, nontraumatic amputation due to peripheral vascular disease)	Tertiary	Bariatric surgery if medically fit

**Notes:**Data from these studies.<sup>44,97</sup>

**Abbreviations:** CVD, cardiovascular disease; HDL-C, high-density lipoprotein cholesterol; IFG, impaired fasting glucose; IGT, impaired glucose tolerance; T2DM, type 2 diabetes mellitus.

**Table 8** BMI Cut-Offs for Management of Obesity in South Asians

BMI Asian in kg/m <sup>2</sup>	23–24.9 Overweight	25–26.9 Grade I	27–29.9 Grade I	30–34.9 Grade II	$\geq 37.5$ Grade III
Therapy					
Diet, exercise, behavioral therapy	□	□	□	□	□
Pharmacotherapy		□ if comorbidities	□	□	□
Bariatric surgery				□ if comorbidities	□

**Notes:**Data from these studies.<sup>5,21</sup>



containing foods instead of complex/raw carbohydrates. High glycemic index food stimulates serotonin secretion, which, apart from providing a feeling of well being, also increases a craving for carbohydrates.<sup>45</sup>

## Medical Nutrition Therapy

### Definition

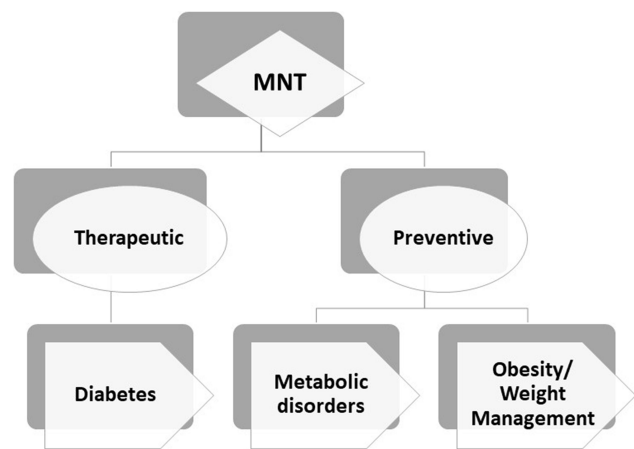
MNT is the provision of nutritional assessment, advice and follow-up, for prevention and/or management of disease, by a qualified or trained health care provider (HCP). MNT includes dietary, nutritional and culinary advice. It includes both home-made food and medical-grade formulations. As well as diet-related content, MNT also encompasses style of communication and counselling. In the context of diabetes, MNT aims to manage both dysglycemia and adiposity through nutritional intervention.

### Indications of Medical Nutrition Therapy

MNT should be integrated into care of all individuals who require glucose control and weight management: either to decrease or increase weight or maintain weight.

MNT is ideal for patients who have:<sup>46</sup>

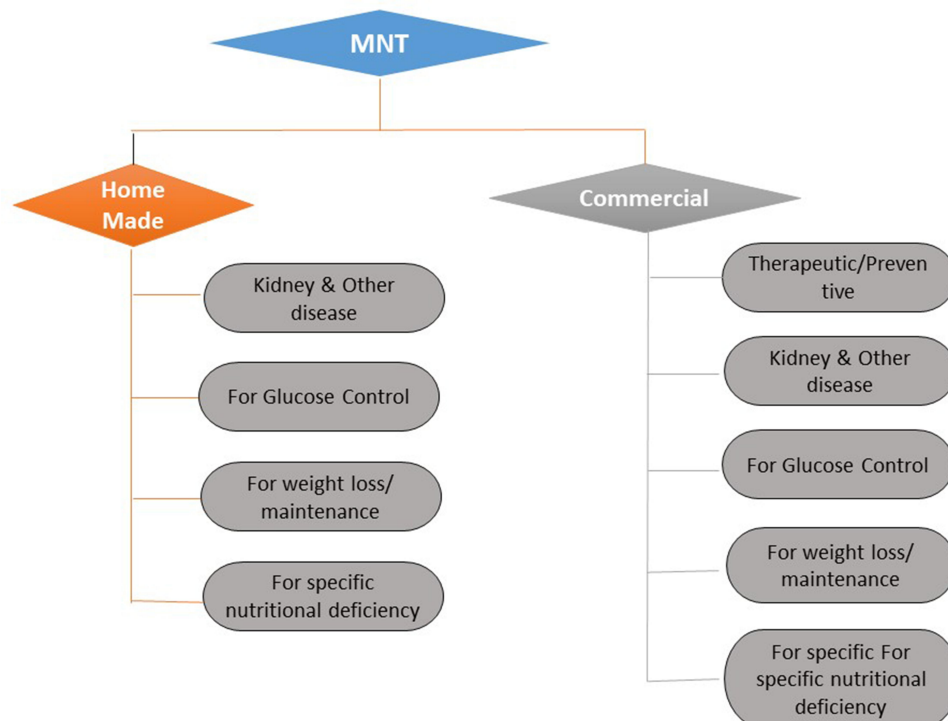
- Cardio-metabolic comorbidities



**Figure 2** Classification of MNT: therapeutic/preventive.

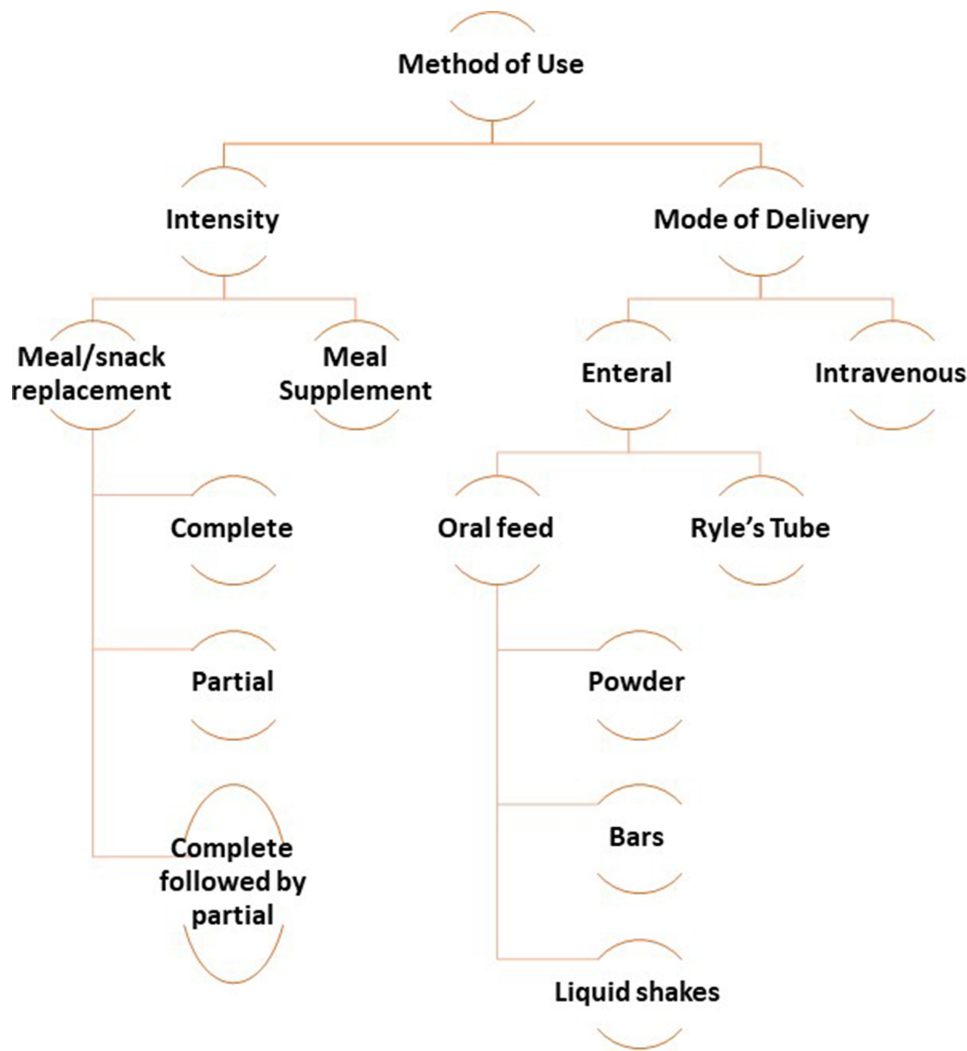
**Notes:** Data from these studies.<sup>46-48</sup>

- Dietary restrictions due to disease (such as kidney disease)
- A busy lifestyle and lack of resources for healthy cooking
- Chewing, swallowing or dextromotor limitations
- An unwillingness to adhere to a strict diet regime



**Figure 3** Classification of MNT: home-made/commercial.

**Notes:** Data from these studies.<sup>46-48</sup>



**Figure 4** Classification of MNT: method of use.

**Notes:** Data from these studies.<sup>46–48</sup>

## Classification of Medical Nutrition Therapy

MNT can be classified based on whether it is being given in a therapeutic or preventive setting (Figure 2), whether it is home-made or a commercial preparation (Figure 3) or depending on method of use (Figure 4).<sup>46–48</sup>

## Goals of Medical Nutrition Therapy

1. Attain and maintain individualized glycemic, blood pressure, lipid and weight goals.
2. Delay or prevent complications.

### Goals for Diabetes

The ADA recommends the following goals for diabetes:<sup>49</sup>

- A1C: 7%
- Blood pressure: 120/80 to 140/80 mmHg
- LDL cholesterol: 100 mg/dL
- HDL cholesterol: 40 mg/dL for men; HDL cholesterol 0.50 mg/dL for women
- Triglycerides: 150 mg/dL

### Goals for Obesity

According to the Position Statement of the Academy of Nutrition and Dietetics (2016), the weight management should be aimed at:<sup>50</sup>

- Preventing further weight gain
- Reducing body weight

- Short-term goal: 5 to 10% loss, or 0.5 to 1 kg per week
- Interim goal: Maintenance
- Long-term goal: Additional weight loss, if desired
- Maintaining the achieved lower body weight over the long term

Weight management in certain populations (such as eating disorders, pregnancy, receiving chemotherapy) will need to be individualized to their specific needs.<sup>50</sup> For example, the goals of MNT in gestational diabetes are to support maternal, placental and fetal metabolic requirements. It is the first step to introduction of a healthy eating pattern in mothers and therefore their children for the rest of their lives.<sup>51</sup>

## Challenges of Providing Medical Nutrition Therapy in South Asia

In the advanced countries, MNT forms an integral part of diabetes and obesity care, is person-centric, and necessary for proper management of the disease as the “only therapy” or as a therapy in addition to pharmacotherapy/surgery.<sup>52</sup> However, in South Asian countries like India, MNT is not covered by insurance. Physicians are not sensitized enough to place as much emphasis on MNT as on pharmacotherapy/surgery. Hence, mainstreaming MNT is a challenge in these regions.<sup>52</sup>

Additionally, most hospital and clinical settings in this region provide pre-printed standardized MNT charts/dietary options/dos and don'ts/list of healthy snacks/macronutrient alternatives etc. There is very little scope for a registered dietician (RD) to make individual specific changes based on medical requirement, psychosocial preference, culinary practices and taste.<sup>52</sup>

It is therefore important to integrate MNT given by an RD into the primary care of a patient with diabetes with an aim to restrict calories, improve metabolic parameters and achieve weight loss.<sup>53,54</sup>

## Different Types of Diets

Evidence shows that MNT is effective in reducing weight and resolving T2DM.<sup>18,19,55,56</sup> However, responses to a different diet varied in participants. Each diet type had its own benefits. In the Look AHEAD trial, the arm with intensive lifestyle intervention incorporated partial liquid meal replacement to achieve dietary goals. Participants in the intensive lifestyle intervention group lost significantly

more weight than DSE participants at year 1 and year 4 (net difference, -7.9% and -3.9%, respectively).<sup>19</sup>

Depending on the calorie intake, a hypocaloric diet ( $\leq 1200$  kcal/day) can be a low-calorie diet (LCD; 800 to 1200 kcal/day) and a very-low-calorie diet (VLCD; 200–800 kcal/day). If carbohydrate in VLCD is restricted to about 50 g/day, it is known as a very-low-calorie ketogenic diet (VLCKD).<sup>57</sup> The RSSDI recommends the low-carbohydrate ketogenic diet over the low-calorie diet.<sup>15</sup>

In the DIRECT trial, participants randomized to low fat, Mediterranean and low carbohydrate diets lost approximately 2.9 kg, 4.4 kg and 4.7 kg, respectively. The low carbohydrate arm showed a greater decrease in triglyceride levels than the low fat arm. Only the Mediterranean diet could decrease fasting glucose in patients with diabetes. All groups showed a decrease in insulin levels. Though HDL levels increased in all groups, the low carbohydrate group showed a higher increase in HDL than the low fat group.<sup>56</sup>

In the POUNDS Lost study, weight loss was similar in the low fat/average protein (highest carbohydrate), low fat/high protein, high fat/average protein and high fat/high protein (lowest carbohydrate) arms (2.9 kg vs 3.8 kg, vs 3.9 kg vs 3.5 kg).<sup>58</sup> HDL cholesterol increase was greater with the lowest versus highest carbohydrate diet. All diets except the highest carbohydrate increased fasting insulin.

MNT is also effective as a first-line therapy in gestational diabetes mellitus (GDM).<sup>51</sup> A sub-analysis of the St Carlos GDM Prevention Study showed that Mediterranean diet (MedDiet)-based MNT in GDM resulted in near-normoglycaemia and pregnancy outcomes were similar to women who did not have diabetes during pregnancy.<sup>55</sup>

Diet patterns, composition, quantity, advantages and disadvantages of various types of diets are included in Table 9. This is just for guidance, and many dietary patterns may overlap in a patient.

## Step-Wise Integrated Approach for Medical Nutrition Therapy

In their white paper on diabetes, Daly et al (2009) note that MNT provides

more intensive nutrition counselling and a therapy regimen that relies heavily on follow-up and feedback to assist patients with changing their behavior(s)....<sup>59</sup>

MNT cannot be generalized. It has to be individualized to patient need and involve proper diagnosis, nutritional assessment and counselling. MNT needs to be provided

**Table 9** Various Types of Diets in Diabesity and Their Advantages and Disadvantages

Type of Diet	Definition	Reported Benefits	Reported Limitations	Comments
Low carbohydrate diet	<26% carbohydrates or <130gm/day <sup>98</sup>	Beneficial effect on HbA1c level compared to normal carbohydrate diet; May be beneficial to cardiovascular risk factors, according to summaries of data of triglycerides and HDL-C; Some studies indicated short-term effects on weight loss <sup>99,100</sup>	No evidence to show effect on reducing TC and LDL-C; No significant association with weight loss throughout the duration of intervention. <sup>101</sup>	Watery and traditional Indian non-starchy vegetables low in carbohydrate (such as salad greens, cauliflower, cucumber, bottle gourd, cabbage, etc); fat from animal foods, oils, butter, and avocado; and protein in the form of meat, poultry, fish, shellfish, eggs, cheese, nuts, and seeds. Avoids starchy and sugary foods such as rice, potatoes, bread, and sweets. <sup>49</sup>
Very-low carbohydrate diet	<10% carbohydrates or <20–50 gm/day <sup>98</sup>	Decreased body weight, triglycerides and DBP and increased HDL-C. Achieved a greater weight loss than those assigned to a low fat diet <sup>102</sup>	Increased LDL. <sup>102</sup> Possible occurrence of diabetic ketoacidosis with SGLT2 inhibitors. <sup>103</sup>	Similar to low-carbohydrate pattern but further limits carbohydrate-containing foods, and meals typically derive more than half of calories from fat. Often has a goal of 20–50 g of non-fiber carbohydrate per day to induce nutritional ketosis. <sup>49</sup>
Ketogenic diet	No carbohydrates; Avoid excess protein; High fat (>70% of calories) <sup>15,104</sup>	Decreased HbA1c and insulin resistance; Improved lipid profile <sup>105</sup>	Likely reduction in endurance performance; Long-term impact on weight loss and physical activity remains unknown <sup>105</sup>	Lipid profile should be monitored while patient is on this diet and diet adjustments should be made based on the lipid profile. <sup>15</sup>
Paleo diet: the 80/20, the autoimmune, the lacto, the Paleolithic vegan and the Paleolithic ketogenic <sup>106</sup>	30% carbohydrate; lean protein of 30–35% daily caloric intake; 40% fat; fiber (up to 45–100 g daily) from non-cereal, plant-based sources <sup>106</sup>	Rapid weight loss; Liver fat reduction; Reduces inflammation; Improves body microbes; Improved lipid profiles and glucose sensitivities; Prevents T2DM and metabolic syndrome; Improves nutrition density, enhances satiety <sup>106,107</sup>	Expensive; Weight loss at 24 months is similar to that achieved by generalized caloric restriction; Side effects; Low calcium intake <sup>106–108</sup>	Diet includes natural environmental foods (lean meat, fish, fruits, vegetables, roots, eggs, and nuts) and eliminates grains, legumes and most processed foods so that it resembles the diet followed by human hunter-gatherer ancestors. <sup>106,108</sup>
Intermittent fasting (IF)	No food consumed, fasting	Reduction in weight, triglycerides, insulin, adiponectin, SBP, and TC; Lowers risk of CAD; Maintain lean body mass; May be sustainable for long periods of time <sup>107,108</sup>	Weight regain if there is non-adherence/non-compliance; Binge eating on non-fasting days; Weight loss at 24 months is similar to that achieved by generalized caloric restriction <sup>107,108</sup>	Time-restricted IF: Eating only during certain hours of the day, for example 16 hours fasting and eating during remaining 8 hours Complete IF: Not eating at all on fasting days, for example alternate day fasting, twice a week fasting Modified IF: Eating 20–25% of basal calorie needs on fasting days. <sup>108</sup>

(Continued)

Table 9 (Continued).

Type of Diet	Definition	Reported Benefits	Reported Limitations	Comments
Atkins diet	No calorie restriction; Low carbohydrate; Unrestricted protein and fat <sup>108</sup>	Reduction in weight, TG, LDL, TC, TC/LDL ratio, LDL/HDL ratio, leptin, and insulin DBP, SBP, CRP, Improved HDL, insulin sensitivity, and adiponectin <sup>108</sup>	Weight regain; Poor compliance; Fluctuating LDL <sup>108</sup>	Induction phase (2 weeks)= < 20 g/day carbohydrate Weight loss phase: gradually increase carbohydrate by 5 g/day Pre-maintenance phase: 40–100 g/day carbohydrates Maintenance phase: maintain ideal carbohydrate balance <sup>108</sup>
Mediterranean diet	50–55% low glycemic load (GL) carbohydrates; 30% fats; 15–20% protein <sup>108</sup>	Sustained weight loss; Reduction in waist circumference and BMI; HbA1C reduction; Reduced risk of diabetes and insulin resistance; Triglycerides, leptin, CRP lowered; Risk of major cardiovascular events reduced; Increase in HDL and adiponectin; Improves mental health <sup>109–112</sup>	No known limitations	Include more of: Plant-based food; Fish and other seafood; Olive oil as the main dietary fat source of monounsaturated and polyunsaturated fatty acids (MUFA and PUFA) Eat in low to moderation: Dairy products (mainly yogurt and cheese); Wine; <4 eggs/week Low frequency and amount: Red meat Rare: concentrated sugars or honey <sup>49</sup>
DASH diet	55% carbohydrates; 27% total fats; 6% saturated fats; 18% protein; fiber: 30 g; cholesterol: 150 mg; potassium: 4,700 mg; calcium: 1,250 mg; magnesium: 500 mg; sodium □ 1500 mg <sup>113</sup>	Weight loss; Reduction in waist and hip circumference, hip circumference and percent body fat; Improved muscle strength; Reduction in HbA1c and insulin resistance; Improvement in T2DM; Lowered blood pressure; Increased HDL-cholesterol; Lowered triglycerides (Evert et al 2019; Perry and Guilder 2019 <sup>115</sup> )	No known limitations	More intake of vegetables (five servings per day), fruits (five meals per day), whole intact grains (seven servings per day), low-fat dairy products (two servings per day), lean meat (fish and poultry) (≤two servings per day), and nuts (2 to 3 times per week) Reduced intake: saturated fat, red meat, sweets, sugar-containing beverages, and sodium. <sup>49,114,115</sup>
Low energy diet (LED)/Very low energy diet (VLED)/Very low calorie diet (VLCD)	EASO: 800 kcal/day VLEDs, <800 kcal/day; LEDs, 800–1200 kcal/day <sup>49,116,117</sup>	Rapid weight reduction (3–5 months), maintained up to 4 years; 10–15% of body weight can be reduced; T2DM remission possible in overweight and obese <sup>49,116,117</sup>	Not suitable for children, adolescents, pregnant or lactating women, hepatic/renal failure, heart disease, T1DM and elderly Possibility of non-adherence, safety issues, risk of eating disorders, high cost, questionable long-term efficacy <sup>49,116,117</sup>	Usually formula LED, VLED and VLCD are used as partial or total meal replacement; Combination of 3–4 products may be used per day. <sup>116</sup>

(Continued)

Table 9 (Continued).

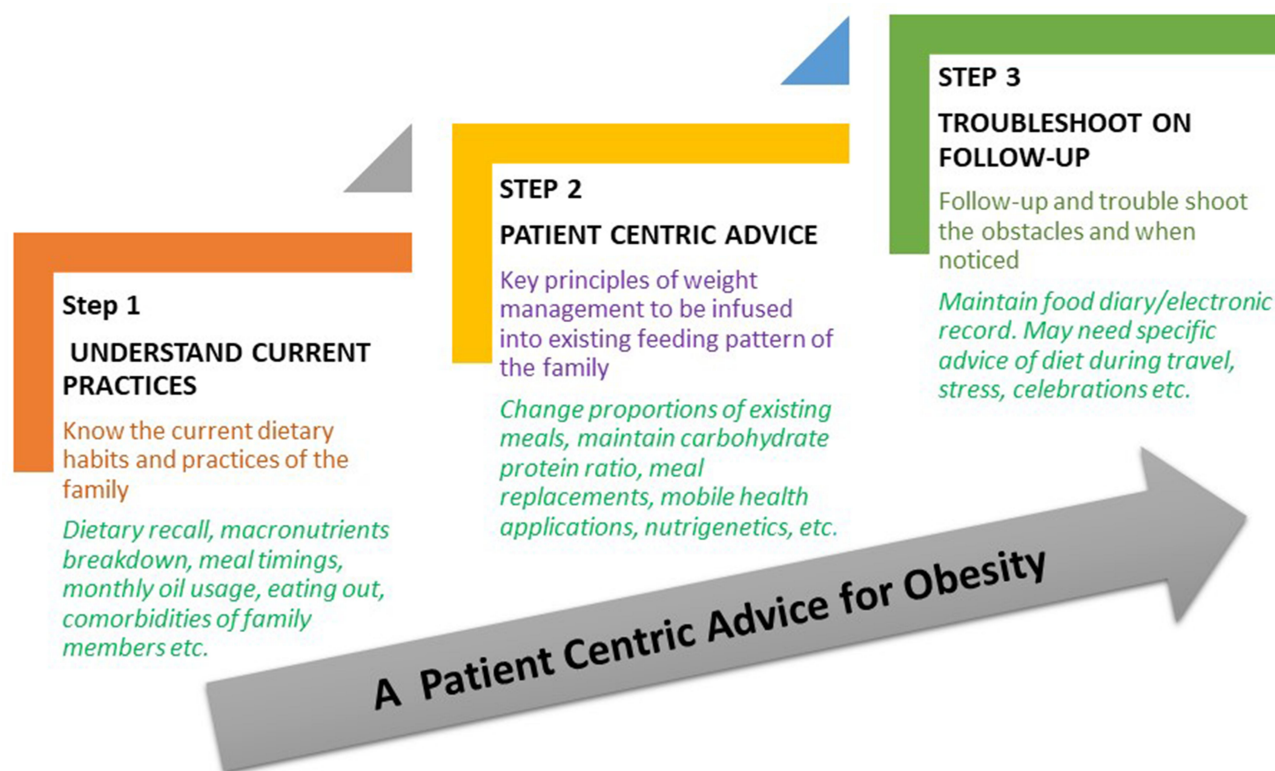
Type of Diet	Definition	Reported Benefits	Reported Limitations	Comments
Very low calorie ketogenic diet	Type of VLCD with daily energy intake <800 kcal but marked daily carbohydrate restriction to <30 g/day (□ 13% of total energy intake); fat □ 44% and protein □ 43% <sup>118</sup>	Rapid weight loss, positive psychology, increase compliance Personalized VLCKD: lean mass saved, abdominal fat mass reduced Preservation of fatty free mass which plays a key role in glucose metabolism Personalized VLCKD: Restoration of metabolic flexibility, resting energy expenditure maintained, and diabetes reversal <sup>17,27,49,118–120</sup>	Not suitable for children, adolescents, pregnant or lactating women, hepatic/renal failure, heart disease, T1DM and elderly Short-time therapy (maximum 12 weeks)	The ketogenic period (Phases 1–3): □ 600–800 kcal/day; Average length is 8–12 weeks but can be prolonged until 80–85% of the desired weight loss is reached Phase 1: Four to six protein preparations of high biological value derived from green peas, eggs, soy and whey are allowed along with low-carbohydrate vegetables. Phase 2/3: Lunch or/and dinner) are gradually replaced by natural protein meals (meat/fish/eggs/soy). Carbohydrate re-introduction (Phases 4–6): The daily calorie intake ranges between 800 and 1500 kcal/day Phase 4: Foods with the lowest glycemic index like fruit or dairy products Phase 5: Foods with moderate glycemic index such as legumes Phase 6: Foods with a high glycemic index (bread, pasta and cereals). <sup>118</sup>
Vegetarian or vegan	No or minimal animal-based food	Weight loss; HbA1c reduction; Reduced diabetes risk; Lowering of LDL and non-HDL-cholesterol <sup>49</sup>	Less acceptability and adherence in non-vegetarians, hence ideal only for vegetarians; Vitamin B12 supplementation may be required; Careful micronutrient planning (zinc, calcium and iron) required, especially in elderly <sup>121,122</sup>	Vegan diet can be purely vegan (no food from any animal source included), lactovegan (vegan diet that includes dairy products), eggo-vegan (vegan diet that includes eggs and the Jain diet (vegan diet that does not include onions, garlic, roots and tubers). <sup>121,122</sup>

**Abbreviations:** BMI, body mass index; CAD, coronary artery disease; CRP, C-reactive proteins; DASH, Dietary Approaches to Stop Hypertension; DBP, diastolic blood pressure; EASO, The European Association for the Study of Obesity; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; SGLT2, sodium-glucose transport protein 2; T1DM, type 1 diabetes mellitus; T2DM, type 2 diabetes mellitus; TC, total cholesterol.

in a step-wise approach after careful assessment of the patient (Figure 5).<sup>53,60</sup> MNT advice should be aimed at promoting weight loss without major disruption in a family's eating practices.<sup>60</sup> MNT needs careful monitoring and adherence to achieve the desired outcomes. This can only be achieved through a collaborative effort between the patient, family members, RDs, diabetes educators, treating medical team and culinary scientists.<sup>53,54</sup>

MNT is recommended by the ADA, RSSD and Indian Council of Medical Research (ICMR) as part of routine care in diabetes.<sup>15,61</sup> The components of MNT recommended by the ADA, RSSD and ICMR are listed in Table 10.<sup>15,53,61</sup> Key recommendations for components of MNT were not available from other South Asian regions. Hence, the experts involved in CoMeND studied these recommendations to





**Figure 5** Step-wise approach for implementation of MNT.

**Notes:**Components of medical nutrition therapy. Data from Kapoor et al.<sup>60</sup>

formulate their own recommendations for South Asia. Key features are listed in Table 10.

## Recommendations for Medical Nutrition Therapy

These recommendations can be divided into three main groups.

### Group A: General Dietary Recommendations

1. Food portions should be reduced but not cut down drastically. The plate method can be used to control portion size of different major food groups (Figure 6).
2. The diet of a patient with diabetes in South Asia should be planned carefully, keeping in mind the country and region specific influence on culinary diversity, lifestyle and economic condition.<sup>11,62</sup>
3. Healthy dietary patterns should always be recommended. Diet education should be a part of patient counselling.<sup>17,63</sup>
4. A hypocaloric diet should be advised and individualized to patient's need.<sup>5,29</sup>

Appendix I gives the approximate calorific values of commonly cooked food items. This can serve as a guide for calorie planning.

5. Patients should be encouraged to maintain food diaries. These help understand food patterns, emotional eating patterns, and patients' perceptions of and behaviors towards food.<sup>17,63</sup>

### Group B: Nutrient and Care

1. Carbohydrate and saturated fats should be reduced (Table 10).
2. Correct oils (PUFA and MUFA) and cooking methods (steaming, baking, shallow-fat frying, low fat cooking etc) should be advised.<sup>11</sup>
3. Unless contraindicated (eg as in kidney disease), normal protein diets or supplements should be recommended as most patients in the South Asian region consume much less protein than their RDA.
4. The goals of MNT should be monitored regularly. The frequency of monitoring may need to be

**Table 10** Components of MNT: Comparative Analysis of Recommendations by the ADA, RSSDI, ICMR and CoMeND<sup>15,53,61</sup>

	ADA	RSSDI	ICMR	CoMeND
<b>Carbohydrates</b>				
Recommended intake	ADA does not provide any recommendations due to lack of clinical evidence	45–65% of total daily calories (minimum intake: 130 g/day)	55–60% of total daily calories	Try to reduce current carbohydrate intake by 10–15%
Fiber/glycemic index	High-fiber and low-glycemic index diet	High-fiber diet: increased intake of soluble and insoluble fibers	Intake of fiber-rich foods	Concordant with all current recommendations
Preferred sources	Fruits, vegetables, whole grains, legumes and dairy products (milk and yoghurt)	Pulses, legumes, coarse grains, sprouted grams, unprocessed vegetables and fruits Substitution of polished white rice with millets and brown rice	Cereals, mixed coarse grains, whole grains (eg, ragi, oats, barley, jowar), whole pulses, whole fruits, salads and soybeans, leafy vegetables, fenugreek seeds Restricted intake of all-purpose flour (maida)-based products	Concordant with all the current recommendations
<b>Proteins</b>				
Recommended intake	Typically 15–20% of total energy in individuals without diabetic kidney disease Recommended daily allowance in individuals with T2DM and compromised renal function: of 0.8 g/kg body weight/day	10–15% of total daily calories	10–15% of total daily calories	Try to increase the current protein intake by 10% to a maximum of 1 gram/kg body weight/day
Preferred source	Preferred sources: not mentioned	Preferred sources: not mentioned	Vegetable sources, low-fat milk and milk products, fish and lean meat	Concordant with ICMR guidelines
<b>Fats</b>				
Recommended intake	No specified ideal intake	No specified ideal intake	20–25% total daily calories	Try to minimize visible fat intake
Other restrictions	Restricted intake of saturated fats: <10% total daily calories Minimal intake of trans fats Restricted intake of dietary cholesterol: <300 mg/day	Restricted intake of saturated fats: <10% total daily calories Minimal intake of trans fats Restricted intake of dietary cholesterol: <300 mg/day	Restricted intake of saturated fats: <7% total daily calories Minimal intake of trans fats ((hydrogenated vegetable fats) Restricted intake of dietary cholesterol: <300 mg/day	Concordant with all current recommendations
Preferred source of MUFA/PUFA	Fatty fish, nuts and seeds	Moderate intake of fish/seafood, chicken without skin and red meat <sup>a</sup> as a source of PUFA Not recommended: sunflower oil	Groundnut, sesame, cotton seed, rice bran or safflower along with soybean, mustard, canola etc as preferred choices for edible oils containing MUFA and PUFA	Concordant with all current recommendations

(Continued)

Table 10 (Continued).

	ADA	RSSDI	ICMR	CoMeND
Sugars and sweeteners	Reduced intake of HFCS and sucrose Substitute nutritive sweeteners with non-nutritive sweetener Natural fructose/free fructose from fruits (3–4% of energy intake and not >12) is permissible	Reduced intake of refined sugars Moderate intake of non-nutritive artificial sweeteners Avoid consumption of HFCS	Avoidance of sugar, honey, jaggery Restricted use of artificial sweeteners and avoidance in pregnant/lactating women with diabetes Avoidance of very sweet fruits and fruit juices	Concordant with all current recommendations
<b>Micronutrients and other dietary recommendations</b>				
Micronutrients	No specific recommendations made	Inclusion of micronutrients (chromium, alpha-lipoic acid, magnesium and zinc) as adjunct to standard care <sup>b</sup>	No specific recommendations made	Ensure adequate micronutrient intake through diet and exogenous sources
Salt	Restricted sodium intake: <2300 mg/day <sup>c</sup>	Restricted intake of dietary salt: <5 g/day <sup>c</sup>	Restricted intake of dietary salt: ≤6 g/day	Concordant with all the current recommendations. Also restrict non-salt sources of sodium (eg ajinomoto)
Alcohol/tobacco	Alcohol allowed in moderation	Avoid alcohol; cessation of tobacco use	Moderate alcohol consumption; cessation of any form of tobacco use	Concordant with ICMR guidelines

**Notes:** <sup>a</sup>Particularly in patients with established cardiovascular disease; <sup>b</sup>insufficient evidence available; <sup>c</sup>further restriction in patients with diabetes and hypertension. Data from these studies.<sup>15,53,61</sup>

**Abbreviations:** ADA, American Diabetes Association; HFCS, high-fructose corn syrup; ICMR, Indian Council of Medical Research; MUFA, mono-unsaturated fatty acids; PUFA, poly-unsaturated fatty acids; RSSDI, Research Society for the Study of Diabetes in India; T2DM, type 2 diabetes mellitus.

individualized based on patient's acceptance and adherence to MNT.

- Any eating disorders identified should be treated as a priority through proper education, counselling and pharmacotherapy.<sup>17,63</sup>

### Group C: Medical Nutrition Therapy

- MNT should be individualized based on the Degustation Pentad (Figure 7) proposed by Dr. Kalra and colleagues. This pentad is based on a Vietnamese culinary philosophy. It suggests that an individual's meals should appeal to all five human senses (vision, smell, taste, touch, and hearing).<sup>54,64</sup>
- MNT should be designed such that it incorporates the:
  - Biomedical triplet of diet to provide the right macro-nutrient balance (protein energy) and

adequate micronutrients. MNT should be medically/metabolically appropriate and yet low in glycemic index.<sup>54</sup>

- Comorbidities like dyslipidaemia, renal disease, coeliac disease, hyperuricaemia etc.<sup>54</sup>
- MNT needs to follow the seven As of dietary choice in order to promote adherence in patients. Thus, it needs to be Appropriate and Accurate for the patient's needs, easily Absorbed, Affordable, easily Accessible, Acceptable (conform with taste preferences of the individual; have the right aroma) and Attractive (visually appealing) to that individual (Figure 8).<sup>53,54</sup>
    - MNT should be affordable; crafted with locally available food items; conform with local customs, beliefs and taboos; easy to prepare; provide enough alternatives; and consider religious and social practices of the community for which it is being designed.<sup>54</sup>

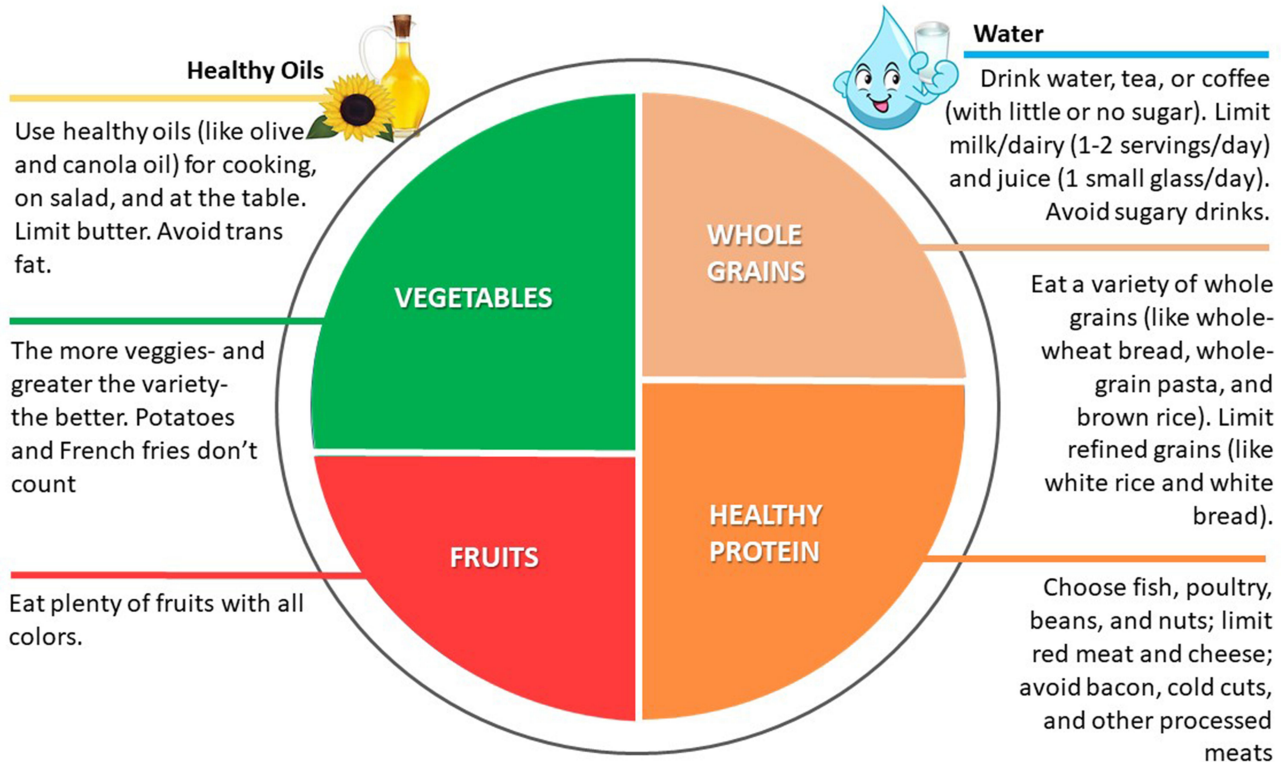


Figure 6 Plate method for meal planning.

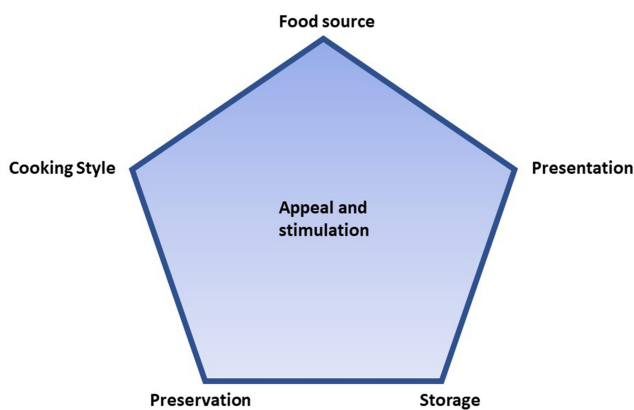


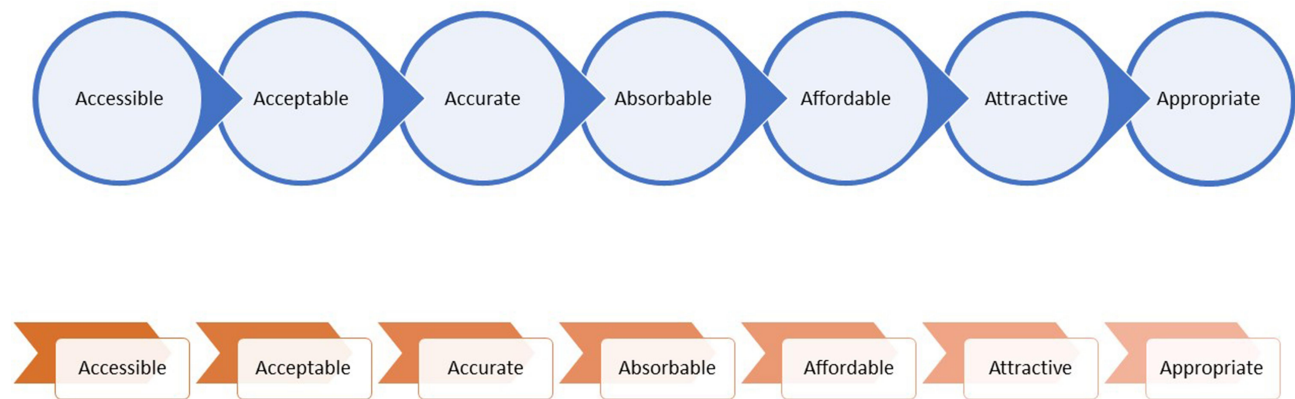
Figure 7 The culinary pentad/"Degustation Pentad".  
Notes: Data from these studies.<sup>54,64</sup>

4. Formula MNT can be a:
  - Meal replacement plan for patients who have a busy lifestyle or who are not willing to adhere to a strict diet regime.
  - Meal replacement for individuals who have limited access to healthy cooking or who have difficulty in calculating calories.

- Meal supplement for individuals involved in exertion activities or those having chewing, swallowing or dextromotor limitations.
5. MNT should be in concordance with pharmacotherapy, so<sup>13</sup>
    - A 3 + 3 meal pattern is recommended with
      - Intensive insulin therapy (basal bolus)
      - Sulfonylureas
    - Regular snacks should be suggested for individuals
      - On pre-mixed insulin
      - On human insulin
      - Having a lifestyle involving exertional physical activity.

### Physical Activity and Lifestyle Interventions

Lifestyle behavior therapies are successful in reducing weight and resolving T2DM. However, the level of benefit seen varies with BMI level. In the Look AHEAD trial, patients in the bottom and top 25% lost



**Figure 8** The seven A of MNT.  
**Notes:** Data from these studies.<sup>53,54</sup>

<3% of their body weight and 12 kg at eight years, respectively. Intensive lifestyle intervention produced better results than diabetes support and education.<sup>65</sup>

Physical activity can cause modest weight reduction. Its main importance during weight management is that it helps in preserving fat-free mass and maintaining weight. Physical activity promotes cardio-respiratory fitness and reduces cardiovascular risk.<sup>17</sup>

## Recommendations<sup>17,63</sup>

1. Physical activity counselling should be an integral part of obesity management. This should include advice on building physical activity in everyday life and a supervised structured exercise program under the guidance of an expert.
2. Exercise prescription must be individualized, keeping in mind the patient's health and fitness status and ability to exercise.
3. Structured exercise levels should be gradually stepped up to levels that are safe for the patient.
4. A higher volume of physical activity is required for weight maintenance than is recommended for the general population for health maintenance.
5. Adequate protein intake should be ensured to build muscle mass during strength training.

## Managing Right Food Intake in a Setting of Abundance

Urban areas in South Asia have an abundance of food. The urban population therefore needs to make the right choices in their diet when they are spoilt for choice. Many of the

strategies covered in this section, however, pose challenges in lower middle income South Asian countries.

## Recommendations

1. Patient education and self-restraint can help people make the right food choices. Health education and moderation in food intake should be started at school level to ensure development of healthy lifestyles and food practices for life.<sup>66</sup>
2. Restricting access to unhealthy food types may restrict their purchase and consumption and thus may help reduce weight.
3. Healthy food alternatives should be easily available at home and in the workplace.
4. It may be possible to curb obesity by providing more places for exercising and building exercise as a culture.
5. Encouraging use of smartphone apps which provide nutrition and/or exercise and fitness guidance. These apps have comprehensive nutrition databases that tell a user the nutritional content of an item after scanning the barcode, allow them to search for healthy options from restaurant menus and help them recognize food items on a plate. Smartphone sensors use machine learning and symbolic reasoning to recognize and quantify lifestyle activities of patients with diabetes and help them make more informed activity choices if necessary.
6. Proper pricing and promotion strategies need to be implemented to reduce intake of unhealthy food. These strategies include (but are not limited to)<sup>11,66-70</sup>
  - a. Establishing farmers' markets in all neighborhoods.

**Table 11** What to Assess and Monitor in Patients with Diabetes

Parameter	Assess	Monitor
Food- and nutrition-related history	<ol style="list-style-type: none"> <li>1. Beliefs and attitudes, including food preferences and motivation</li> <li>2. Food environment, including access to fruits and vegetables</li> <li>3. Dietary behaviors, including eating out and screen time</li> <li>4. Diet experience, including food allergies and dieting history</li> <li>5. Medications and supplements</li> <li>6. Physical activity</li> </ol>	<ol style="list-style-type: none"> <li>1. Beliefs and attitudes, including motivation</li> <li>2. Food environment, including access to fruits and vegetables</li> <li>3. Dietary behaviors, including eating out and screen time</li> <li>4. Medications and supplements</li> <li>5. Physical activity</li> </ol>
Anthropometric measurements	<ol style="list-style-type: none"> <li>1. Height, weight, body mass index</li> <li>2. Waist circumference</li> <li>3. Weight history</li> <li>4. Body composition</li> </ol>	<ol style="list-style-type: none"> <li>1. Weight, body mass index</li> <li>2. Waist circumference</li> <li>3. Weight history</li> <li>4. Body composition</li> </ol>
Biochemical data, medical tests, and procedures	<ol style="list-style-type: none"> <li>1. Glucose and endocrine profile</li> <li>2. Lipid profile</li> </ol>	<ol style="list-style-type: none"> <li>1. Glucose and endocrine profile</li> <li>2. Lipid profile</li> </ol>
Nutrition-focused physical findings	<ol style="list-style-type: none"> <li>1. Ability to communicate</li> <li>2. Affect</li> <li>3. Appetite</li> <li>4. Blood pressure</li> <li>5. Body language</li> <li>6. Heart rate</li> </ol>	<ol style="list-style-type: none"> <li>1. Affect</li> <li>2. Appetite</li> <li>3. Blood pressure</li> <li>4. Body language</li> <li>5. Heart rate</li> </ol>

**Table 12** ABCDE Approach to Counselling in Diabetes

Counselling Methodology
A: Ask permission to assess B: Be systematic C: Communicate with empathy D: De-stress the patient E: Engage all stakeholders
Counselling Content
A: Agree upon goals/targets B: Behavior change C: Cycling of weight (prevention) D: Diet and nutrition therapy E: Exercise

- b. Making subsidized fresh fruits and cooked vegetables available in schools.
- c. Increasing prices of high-fat and high-sugar foods, especially in school and office cafeterias and neighborhoods (one option is to increase taxes on these). Additionally, low fat/low sugar healthy foods can be made available at affordable prices.

- d. Revisiting marketing strategies involving healthy foods.

### Monitoring

Patient adherence to diet and motivation to stay on diet wanes over time if the dietary recommendations are not monitored over time.<sup>71</sup> According to the Academy of Nutrition and Dietetics, the parameters listed in Table 11 should be assessed and monitored for an effective weight management.

### Counselling and Motivation Need for Counselling and Motivation

Stress is associated with overeating, which increases weight. Obesity in turn adds further stress due to development of other comorbidities and because of stigmatization. A study from Southern India on morbidly obese individuals suggested that about 30% of individuals attending an obesity clinic had psychological problems.<sup>72</sup> This leads to a vicious cycle and diabetes management fails. Cognitive behavior therapy (CBT) can help an individual recognize and change behaviors associated with stress and overeating. It can teach an individual to manage stress well.<sup>17</sup>



## Recommendations for Counselling

MNT and lifestyle interventions are likely to fail if patients are not kept sufficiently motivated throughout life. Hence, it is very important for physicians to understand their patients well and keep them motivated.<sup>73</sup> The approaches mentioned in Table 12 can be used to guide counselling. However, help from a trained psychologist should be used if the physician feels that the patient needs more rigorous counselling and follow-up to follow recommended diet and lifestyle changes.

1. Diet, exercise and behavioral therapy is recommended with or without drug/surgical therapy (as applicable) and in both preventive and therapeutic settings.
2. HCPs should focus on patient's QOL and how diabetes is affecting their QOL.<sup>24</sup>
3. Addressing psychological aspects of diabetes care will help in better adherence to therapy.
4. The patient should be given the right to make decisions regarding treatment. The HCP should outline all treatment choices, their benefits and side-effects, to the best of his/her knowledge. However, the physician should guide the treatment decision in the right direction, especially in a low literacy level

patient, and where the patient's decision may cause dire consequences for health.<sup>25</sup>

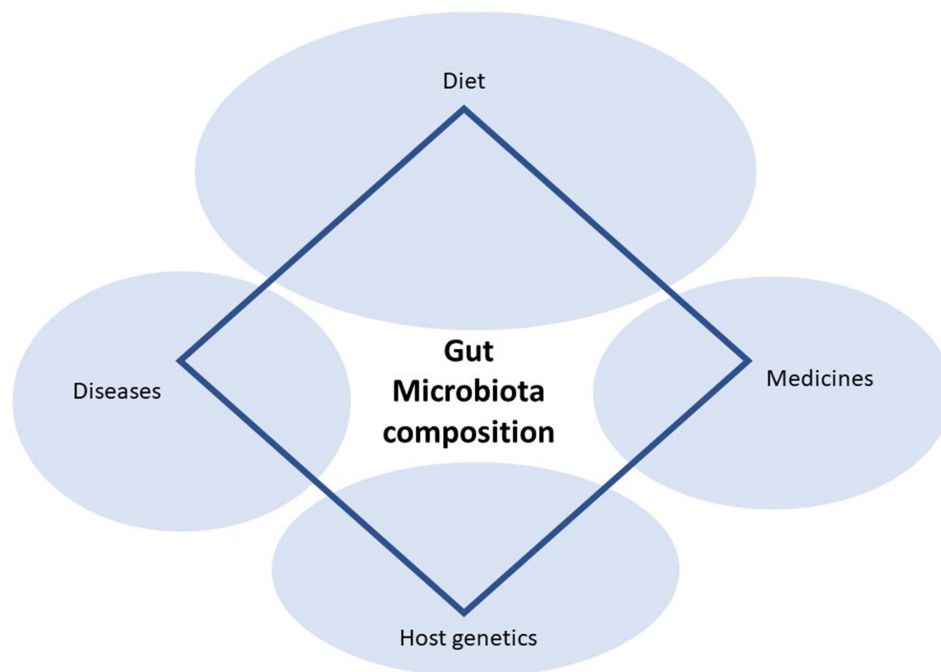
5. Patient education should be built into diabetes care. This should be reinforced at diagnosis, then annually, at the time of complications/change in treatment and when there is a change in care.<sup>13</sup>

## Way Forward in Diabetes Management in South Asia

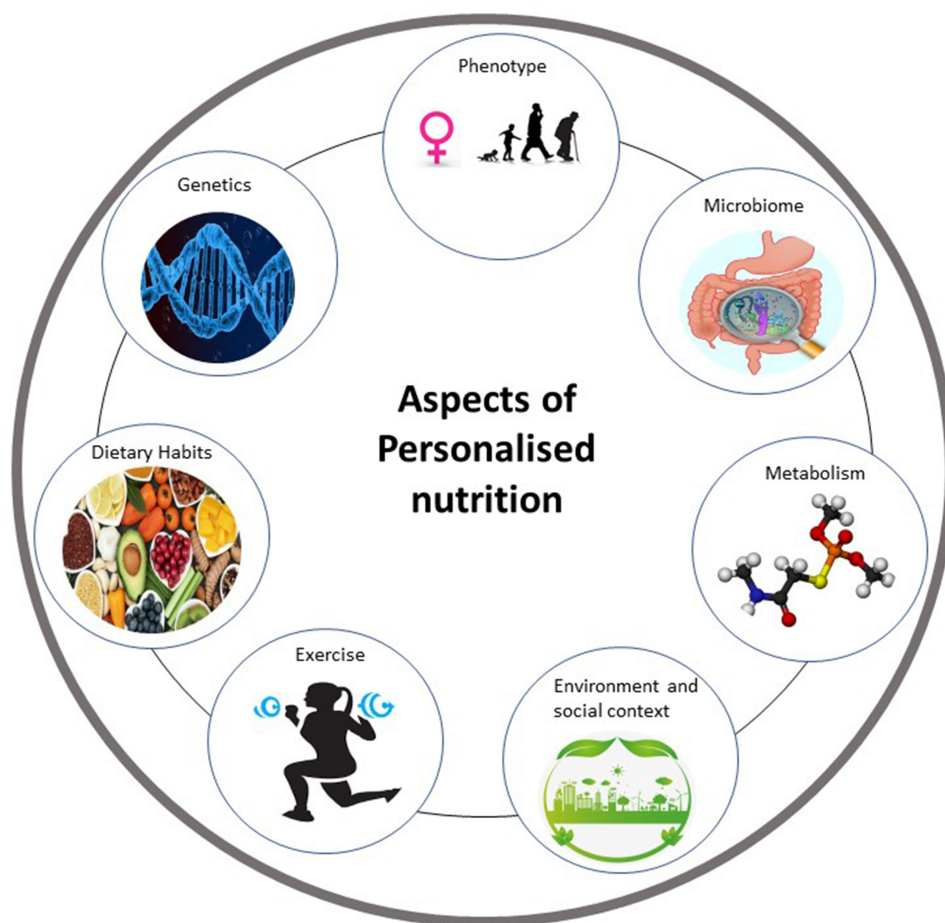
### Personalized Medicine in Diabetes: Role of Gut Microbes and Genes

Diabetes is a chronic disease influenced by the patient's nutrient intake, food and beverage consumption, genetic background, microbiome (microbes colonizing in human beings and their genes), and omic profiles including metabolome.<sup>74-76</sup>

The gut microbiota in a patient with diabetes causes many pathological changes in energy harvest and in the modulation of free fatty acids (mainly butyrate), bile acids, lipopolysaccharides and toll-like receptors. Many other changes have been implicated in diabetes. In a nutshell, these changes result in changes in inflammation, insulin signalling and incretin production and therefore contribute to the development of diabetes.<sup>74,75</sup>



**Figure 9** Diet is the main factor affecting composition of gut microbiota.



**Figure 10** Different aspects of personalized nutrition.

Gut microbiota, host (patient with diabetes) and diet form an important triad in diabetes.<sup>74</sup> Gut microbiota change with diet, disease, medication and other host factors. Therefore, gut microbiota in patients with diabetes differ from those in healthy individuals. Of these factors, the patient's diet plays the most important role (Figure 9).

Many genes modify the response to diet and their study can open the path to personalized medicine in diabetes.<sup>57,77,78</sup> The POUNDS Lost study was conducted to increase understanding of this area. The study randomized 811 individuals to one of four diets: (20% vs 40% fat and 15% vs 25% protein) to understand the genetic factors that modulate dietary response.<sup>79,80</sup>

Personalized medicine also combines many environmental factors to predict response to diet. A study showed that an algorithm integrating anthropometrics, blood parameters, dietary habits, gut microbiota and physical activity could accurately predict an individual's postprandial glycemic response to real-life meals (Figure 10).<sup>81,82</sup>

Current research in precision and/or personalized nutrition shows the benefits of individually tailoring dietary interventions (including therapeutic intervention to trigger gut microbiota with prebiotics, probiotics and synbiotics).<sup>74</sup> However, this is a new and upcoming field. Further research, especially in the form of large Phase 3 trials, are required to understand the exact benefits of personalized medicine in diabetes.

### Patient/Person-Centered Care

Since South Asia is a developing region, it is now time to introduce the Western concept of person-centered or patient-centered care. This means involving patients in their disease care, giving them the right to make treatment decisions, educating them about their disease and taking care of their psychological needs.<sup>13,24–26</sup> The Second Diabetes Attitudes, Wishes and Needs (DAWN2) study carried out in seventeen nations, including India, shows that 26.7% of HCPs in India fail to ask their patients how diabetes affects their lives. In contrast, about 55% of patients in India

reported that their HCPs do not ask them about their QOL with diabetes.<sup>24</sup> Hence, concentrated efforts should be made to integrate person/patient-centered care into the diabetes care algorithm.

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## Disclosure

The authors report no conflicts of interest in this work.

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