

CLINICAL PRACTICE GUIDELINES

# MANAGEMENT OF OBESITY

2<sup>ND</sup> EDITION (2023)



Ministry of Health  
Malaysia



Malaysia Endocrine  
& Metabolic Society



Malaysian Association  
for the Study of Obesity



Malaysian Dietitians'  
Association



Family Medicine Specialists  
Association of Malaysia

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***Availability***

The Clinical Practice Guidelines (CPG) for the Management of Obesity is available at the following websites:

<http://www.moh.gov.my>

<http://www.acadmed.org.my>

<http://www.mems.my>

<http://www.fms-malaysia.org>

Also available as an app for Android and IOS platform: MyMaHTAS.

## STATEMENT OF INTENT

This Clinical Practice Guidelines (CPG) is meant to provide guidance for the evidence-based clinical practice for managing obesity. It is based on the best available evidence at the time of the CPG development. Adherence to the guidelines may not necessarily guarantee the best outcome in every case. Every healthcare provider is responsible for the management of his/her unique patient based on the clinical picture presented by the patients and the management options available.

Every care has been taken to ensure that the information in this publication is correct at the time of publication. However, in the event of errors or omissions, corrections will be published in the web version of this document, which will serve as the definitive version at all times.

## NEXT UPDATE

The year of issue of this current CPG is 2023. It will be reviewed in 4 years (2027) or sooner if new evidence becomes available. The Chairman of the CPG or the National Advisor of the related specialty will be consulted to determine if there is a need for a revision, and if so, the extent of the revision needed. A multidisciplinary team will be formed and the latest systematic review methodology used by Malaysian Health Technology Assessment Section (MaHTAS) will be employed for the next update.

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# Terms of reference

## The guidelines development

The members of the Development Committee (committee) for this CPG were comprised of experts from different specialties managing obesity from the Ministry of Health (MoH) and the Ministry of Higher Education (MoHE) sectors. There was also an active involvement of a multidisciplinary Review Committee (RC) during the process of the CPG development.

A systematic literature search was carried out at the following electronic databases: PUBMED, Medline, Cochrane Databases of Systematic Reviews (CDSR), and OVID. Refer to Appendix 1 for an example of the Search Strategy used. The inclusion criteria were all children, adolescents and adults with overweight or obesity. The search was limited to literature published in the last 15 years, involving only human studies and in the English language. All searches were conducted from April 2019 to January 2022. In addition, the reference lists of relevant articles were searched to identify further studies. Reference was also made to the latest edition of other guidelines on the management of obesity including international guidelines. Future CPG updates will consider evidence published after this cut-off date. The details of the search strategy can be obtained upon request from the CPG Secretariat.

Some of the international guidelines that were used as reference were:

- The American Association of Clinical Endocrinologist and American College of Endocrinology Comprehensive Clinical Practice Guidelines for Medical Care of Patients with Obesity
- AHA/ACC/TOS Guideline for the Management of Overweight and Obesity in Adults: a Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines and The Obesity Society
- The American Diabetes Association's Position Statement on Physical Activity/Exercise and Diabetes
- The American College of Sports Medicine Position Stand on the Appropriate Physical Activity Intervention Strategies for Weight Loss and Prevention of Weight Regain for Adults
- The American Academy of Sleep Medicine's Recommendations for the Amount of Sleep for the Paediatric Population
- The National Health and Medical Research Council (Melbourne) Clinical Practice Guidelines for the Management of Overweight and Obesity in Adults, Adolescents and Children Australia

## Terms of reference

- The European Practical and Patient-Centred Guidelines for Adult Obesity Management in Primary Care
- The European Guidelines for Obesity Management in Adults
- The World Health Organization's Guidelines on Physical Activity and Sedentary Behaviour

A total of 11 clinical questions were developed for the different sections within this CPG. Members of the committee were assigned to a section of the CPG and tasked to develop the contents based on the relevant clinical questions (refer to Clinical Questions below). The committee met 12 times throughout the development of the guidelines – the first 4 meetings were held face-to-face while the subsequent 7 were held virtually due to the COVID-19 pandemic; the final (12<sup>th</sup>) meeting was held face-to-face, when movement restriction was lifted. All the retrieved articles were critically appraised by at least 2 committee members using the Critical Appraisal Skill Programme checklist, presented in evidence tables and discussed during the meetings. The statements and recommendations within these guidelines were formulated after they were commented on by both the committee and RC. Where the evidence was insufficient, the recommendations were derived by consensus of the committee and RC. Any differences in opinion were resolved consensually. The CPG was based largely on the findings of systematic reviews, meta-analyses and clinical trials, with local practices taken into consideration.

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This CPG uses the SIGN50 criteria for Grades of Recommendation and Levels of Evidence (see Grade of Recommendation and Level of Evidence section below).

On completion, the CPG draft was reviewed by external reviewers. It was also posted on the MoH, Malaysia official website for feedback from any interested parties. The feedback and comments were reviewed and the draft corrected based on the decision of the committee and RC. The final draft was presented to the Technical Advisory Committee for CPG and the Health Technology Assessment (HTA) and CPG Council MoH Malaysia for approval. Details of the CPG development by MaHTAS can be obtained from the Manual on Development and Implementation of Evidence-based Clinical Practice Guidelines published in 2015 at: [https://www.moh.gov.my/moh/resources/CPG\\_MANUAL\\_MAHTAS.pdf?mid=634](https://www.moh.gov.my/moh/resources/CPG_MANUAL_MAHTAS.pdf?mid=634).

## The guidelines objectives

The objectives of this CPG are to provide evidence-based recommendations on the management of obesity in Malaysia.

### Clinical questions

1. What are the effective screening strategies and assessments for diagnosing obesity?
2. Which classification of BMI cut-off level is used to diagnose overweight/obesity?
3. Are behavioural and psychological interventions effective and able to sustain lifestyle changes in people with overweight/obesity?
4. What are the effective dietary methods for the management of overweight and obesity?
5. What types of physical activity and exercise are effective in the management of overweight and obesity?
6. Are oral anti-obesity drugs effective and safe for short and long-term weight reduction in people with overweight and obesity?
7. Is long-term use of glucagon-like peptide-1 receptor agonists (GLP-1 RAs) safe for managing overweight and obesity?
8. Is bariatric surgery safe and effective in people with obesity and what are the types of procedures recommended for these patients?
9. Are the following interventions — lifestyle (dietary and physical activity), psychological, pharmacotherapy and bariatric surgery — cost effective in preventing overweight/obesity and how much weight reduction is required to reduce the risks associated with obesity?
10. What are the strategies to prevent overweight and obesity?
11. What are the indications for referral to tertiary centres?

### Target population

Children and adults who are at risk of or who are overweight and obese.

### Target user

This CPG intends to guide those involved in the management of obesity in primary, secondary and tertiary healthcare settings in the public and private sectors. It namely targets,

- i. Medical officers and specialists
- ii. Allied health professionals
- iii. Trainees and medical students
- iv. Patients and their advocates
- v. Professional societies

### Healthcare settings

The healthcare settings that this CPG is relevant to are at the outpatient, inpatient and community settings.

### Source of funding and declaration of conflict of interest

The development of this CPG was funded in its entirety by the Malaysian Endocrine and Metabolic Society. The authors have no conflicts of interest to declare.

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# Review committee

The draft CPG was reviewed by a panel of experts from the public and private healthcare sectors. They were asked to comment primarily on the comprehensiveness and accuracy of the interpretation of the evidence supporting the recommendations in this CPG.

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# Grades of recommendation and levels of evidence

## Level of evidence

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<b>1++</b>	High quality meta-analyses, systematic reviews of RCTs, or RCTs with a very low-risk of bias
<b>1+</b>	Well-conducted meta-analyses, systematic reviews, or RCTs with a low-risk of bias
<b>1-</b>	Meta-analyses, systematic, or RCTs with a high-risk of bias
<b>2++</b>	High quality systematic reviews of case-control or cohort studies
<b>2+</b>	Well-conducted case-control or cohort studies with a low-risk of confounding or bias and a moderate probability that the relationship is causal
<b>2-</b>	Case-control or cohort studies with a high-risk of confounding or bias and a significant risk that the relationship is not causal
<b>3</b>	Non-analytic studies, e.g. case reports, case series
<b>4</b>	Expert opinion

## Grades of recommendation

*Note: The grade of recommendation relates to the strength of the evidence on which the recommendation is based. It does not reflect the clinical importance of the recommendation.*

<b>A</b>	At least one meta-analysis, systematic review, or RCT rated as 1++, and directly applicable to the target population; <b>OR</b> A body of evidence consisting principally of studies rated as 1+, directly applicable to the target population, and demonstrating overall consistency of results
<b>B</b>	A body of evidence including studies rated as 2++, directly applicable to the target population, and demonstrating overall consistency of results <b>OR</b> Extrapolated evidence from studies rated as 1++ or 1+
<b>C</b>	A body of evidence including studies rated as 2+, directly applicable to the target population and demonstrating overall consistency of results <b>OR</b> Extrapolated evidence from studies rated as 2++
<b>D</b>	Evidence level 3 or 4 <b>OR</b> Extrapolated evidence from studies rated as 2+
<input checked="" type="checkbox"/>	Good practice points – Recommended best practice based on the clinical experience of the guidelines development group

# Recommendations

## Formulation of recommendations

In line with the new development in CPG methodology, the CPG Unit of MaHTAS is in the process of adapting the Scottish Intercollegiate Guidelines network (SIGN 50) in its work process. The quality of each retrieved evidence and its effect size are carefully assessed/reviewed by the CPG Development Group. In formulating the recommendations, overall balances of the following aspects are considered in determining the strength of the recommendations:-

- Overall quality of evidence
- Balance of benefits versus harm
- Values and preferences
- Resource implications
- Equity, feasibility and acceptability

## KEY RECOMMENDATIONS

The following recommendations were highlighted by the CPG Development Group as the key clinical recommendations that should be prioritised for implementation.

## ADULTS

### Screening and diagnosis

- Screening with body mass index (BMI) and waist circumference (WC) measurements should be done yearly
- Cut off BMI values that should be used are: pre-obesity (overweight) - $23\text{ kg/m}^2$  and obesity -  $>27.5\text{ kg/m}^2$
- Individuals diagnosed with pre-obesity and obesity should be assessed for associated conditions, co-occurring medical conditions and current treatments that could cause obesity

### Psychological and behavioural therapy

- Multicomponent psychological and behavioural therapy approaches should be integrated in managing people with obesity
  - › Enhancing communication and avoiding stigmatisation
  - › Psychoeducation
  - › Motivational interviewing and behavioural strategies
  - › Psychological interventions

## Medical Nutrition Therapy

- Dietary prescriptions should be individualised based on
  - › Individual's motivation level
  - › Age
  - › Sex
  - › Co-morbidities
  - › Physical activity level
  - › Weight loss goals
- Calorie restriction diet should be combined with either low carbohydrate or low fat intake

## Physical activity

- Physical activity should be encouraged in all individuals with obesity
  - › A minimum of 150 minutes/week (30 minutes/day) progressing to 300 minutes/week (60 minutes/day) of moderate intensity, or
  - › At least 75-150 minutes/week of vigorous intensity is required for weight loss.
- Combination of both moderate- and vigorous-intensity activity throughout the week should be encouraged to maintain weight loss
- Both resistance and aerobic exercise or activities should be emphasised to improve physical function and well-being

## Pharmacotherapy

- Pharmacotherapy for obesity should be used only as an adjunct to diet, exercise and behavioural modification and not alone
  - › Pharmacotherapy for obesity is indicated in patients with  $BMI \geq 30 \text{ kg/m}^2$  without comorbidities and  $BMI \geq 27 \text{ kg/m}^2$  with comorbidity
- Pharmacotherapy that may be prescribed are:
  - › Orlistat
  - › Combination of phentermine and topiramate
  - › Combination of naltrexone and bupropion
  - › High dose liraglutide
  - › High dose semaglutide
- Anti-obesity treatments should be used with medical supervision and careful monitoring

### Bariatric surgery

- Bariatric surgery should only be performed in individuals with morbid obesity who fail medical therapy
- Roux-En-Y gastric bypass surgery may be considered
- A comprehensive preoperative assessment and preparation should be done before bariatric surgery

### Prevention

- Fundamental preventive measures that should be implemented against the onset of obesity are promoting healthy eating, improving physical activity and implementing stress management practices
- Healthcare providers should offer weight management interventions for preventing weight gain in normal-weight or overweight adults

## CHILDREN AND ADOLESCENTS (<18 years old)

### Screening and diagnosis

- BMI cut-offs using the World Health Organization (WHO) BMI-for-age chart should be used for the classification of overweight and obesity in children
- Clinical evaluation (history and physical examination) should be performed to identify the aetiology and to rule out pathological causes
- Children and adolescents with obesity should be offered screening for related comorbidities
- Overweight children and adolescents should be offered screening if risk factors are present

### Management

- A step or staged approach for weight management in the paediatric population should be used
  - › For prepubertal children – allow a gradual decline in BMI with weight maintenance or a slower weight gain
  - › For pubertal children – gradual weight loss with a maximum loss of 0.5-1.0 kg/month
- Family-focused lifestyle intervention should be emphasised

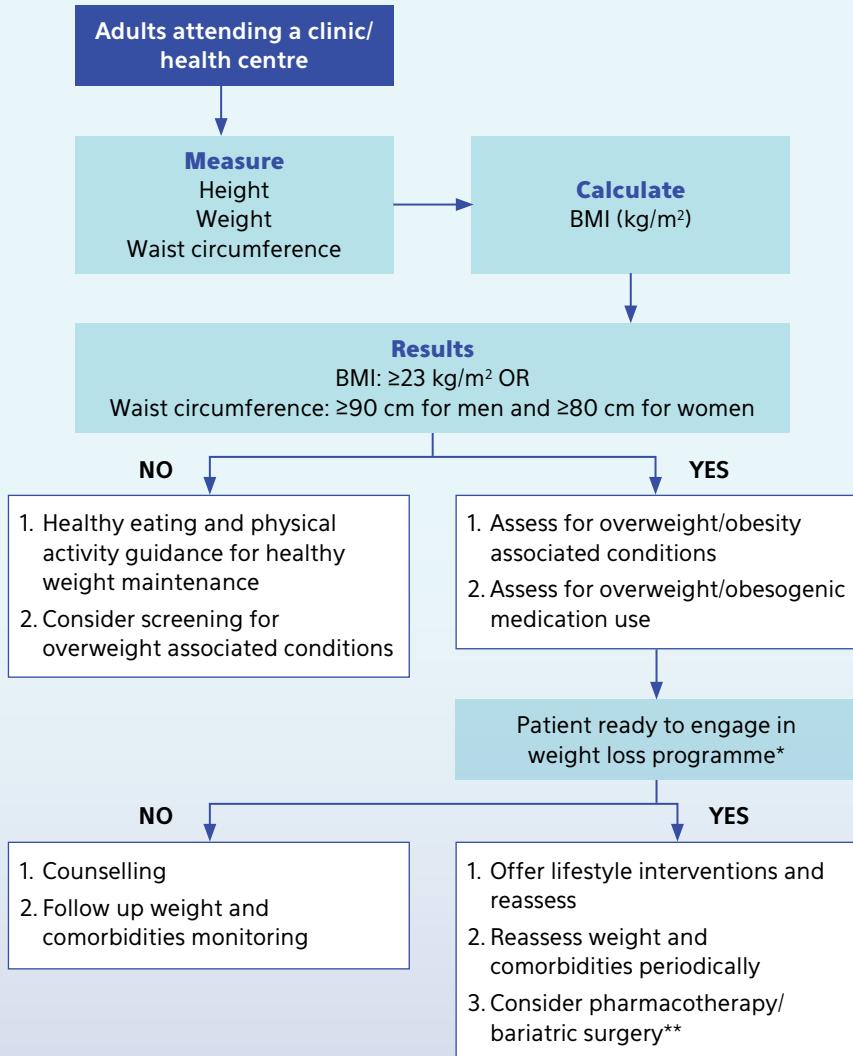
- Treatment programmes should target
  - › Decreasing overall dietary intake
  - › Increasing physical activity
  - › Decreasing time spent in sedentary behaviour
  - › Addressing sleep behaviour
- Pharmacotherapy may be considered in adolescents if formal intensive lifestyle modification programmes fail
  - › Liraglutide may be considered
- Metabolic and bariatric surgery may be considered for adolescents with extreme obesity and significant comorbidities

### Prevention

- Breast feeding should be encouraged and adherence to dietary guidelines during weaning should be advocated
- Multicomponent interventions should be used in preventing obesity
  - › Dietary
  - › Physical activity
  - › Behavioural aspects
- Family and parental involvement should be encouraged
- School-based programme with community engagement should be advocated
- Environmental changes should be made to support obesity prevention

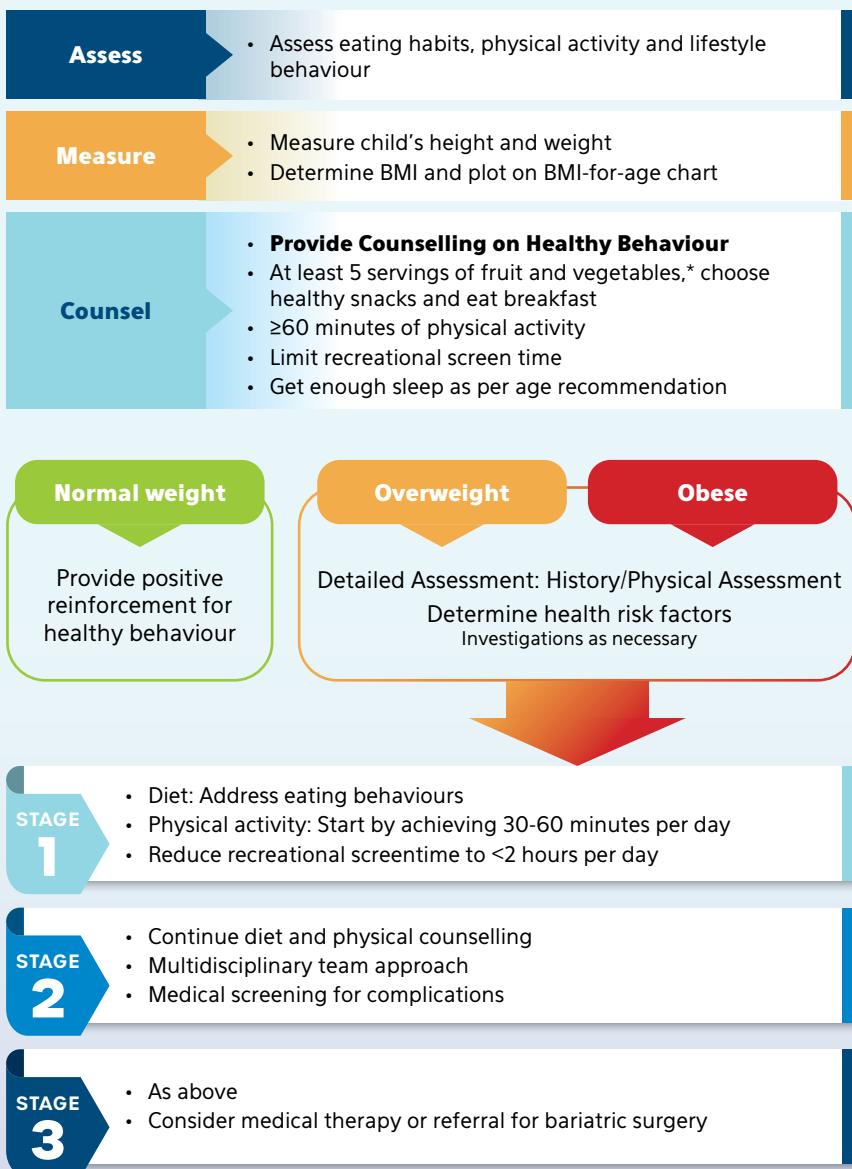
# Algorithms

## Algorithm for the assessment and management of adult obesity



## Algorithm for the assessment and management of childhood obesity

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\*5 servings = 400 grams. BMI, body mass index.

# **Foreword**

## **by Director General of Health, Malaysia**

The health scenario in Malaysia has undergone significant changes in recent years, resulting in a higher prevalence of Non-Communicable Diseases (NCDs), such as obesity. While socio-economic development has improved the overall quality of life, it has also led to lifestyle changes that are not always conducive to good health, including unhealthy diets and sedentary habits. Although the causes of obesity are complex and multifactorial, unhealthy lifestyle choices remain a significant risk factor.

To effectively manage obesity, it is crucial to involve various healthcare professionals, such as public health nutritionists and policymakers, to achieve optimal results. Patients also play a critical role, and a holistic approach that includes health education and lifestyle changes is essential for success. Recent evidence shows that multiple approaches can be effective in managing obesity, including various types of calorie restriction, exercise, pharmacotherapy, and bariatric surgery. The Clinical Practice Guidelines (CPG) for the Management of Obesity (2<sup>nd</sup> Edition) comprehensively reflect these approaches and have been eagerly awaited.

This CPG is a valuable resource for healthcare professionals at all levels, from primary to tertiary care, to deliver the best possible care for their patients. The guidelines also focus on preventing overweight and obesity in all age groups, especially in children and adolescents. I would like to extend my congratulations to the members of the development committee for their hard work, and I hope that this document will further elevate the standard of care for managing people with obesity.



**Datuk Dr Muhammad Radzi bin Abu Hassan**  
*Director General of Health, Malaysia*

# Preface

by the Chairperson of the Development Committee

The management of overweight and obesity is evolving. These guidelines are motivated by the recognition that the prevalence of overweight and obesity in Malaysia is increasing, and healthcare practitioners need to be alert to the associated health risks. Based on the National Health and Morbidity Survey 2019, one in two Malaysians is overweight or obese. The excess weight is often accompanied by hypertension, type 2 diabetes, coronary artery disease, metabolic-associated fatty liver disease, and other health issues.

The 1<sup>st</sup> edition of the Clinical Practice Guidelines for the Management of Obesity was developed almost two decades ago, and it is timely to have the guidelines revised. There have been many breakthroughs and advances in the management of obesity; through nutrition, different types of exercise, pharmacotherapy, and bariatric surgery.

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These guidelines used the principles of evidence-based medicine, and scientific evidence was examined thoroughly by the committee, by meticulously exploring various treatment strategies and their effects on weight loss. Cognitive behaviour, which helps people with obesity sustain lifestyle changes and improve their quality of life, is emphasised in these guidelines. In addition, recognising that overweight and obesity among children and adolescents in Malaysia is on the rise, a dedicated chapter has been developed to comprehensively address evaluating and managing this population.

We hope these clinical guidelines will help healthcare practitioners understand the importance of weight management and be able to assess and manage their patients effectively. It is equally important for people with obesity to obtain the optimum standard of care that they deserved.

I would like to thank all members of the committee for their tireless efforts in producing the 2<sup>nd</sup> edition of the Clinical Practice Guidelines for the Management of Obesity.



**Professor Dr Norlaila Mustafa**

*Senior Consultant Physician and Endocrinologist*

# 1. Obesity: the disease

## 1.1 Introduction

Obesity is a complex and chronic disease that has a heterogenous presentation. The excess and unwanted body fat accumulation or adiposity lead to many complications and increased risk of premature morbidity and mortality. Studies have shown that overweight and obesity increased the risk of chronic health conditions and reduced quality of life.<sup>1,2</sup> **[Level 1++]** Hence, like any other chronic disease, early recognition, appropriate and effective individualised intervention and long-term support are essential.

Not only are overweight and obesity associated with chronic diseases like type 2 diabetes mellitus (T2DM), hypertension, dyslipidaemia, metabolic syndrome, osteoarthritis and obstructive sleep apnoea (OSA), it also increases the risk of several types of cancers.<sup>3</sup> **[Level 1+]**

Apart from the impact that overweight and obesity have in reducing the quality of life and well-being, the physical, psychosocial functioning and perceptions of health of persons with obesity are greatly affected by the disease.<sup>4</sup> **[Level 1++]** Persons with obesity experience stigma and discrimination at the workplace and at healthcare facilities. In addition to the morbidity and mortality associated with obesity, there are significant healthcare expenditures resulting from obesity associated medical conditions.

The total cost of obesity related healthcare spending in Malaysia is the highest (19.36%), compared to other ASEAN countries (<10%). The estimated productive years lost for males and females associated with obesity in Malaysia is 6-11 years and 7-12 years respectively, and this has a negative impact to the overall economic status of the country.<sup>5</sup>

## 1.2 Epidemiology

The increasing global prevalence of obesity is alarming. Malaysia is no exception. The National Health Morbidity Survey (NHMS) 2019 with a significant number of respondents (n=16,688) determined the prevalence of overweight and obesity were 32.3% and 33.7%, respectively (body mass index; BMI based on Asian cut-off scales).

Generally, the prevalence of obesity increases with age.<sup>6</sup> **[Level 3]** Although the prevalence of physically inactive adults was only 25.1% (NHMS 2015), the choice of unhealthy foods seems to be the contributing factor for obesity. Apart from the NHMS data, smaller studies in targeted populations have also demonstrated

## 1. Obesity: the disease

a significant prevalence of obesity. The prevalence of overweight and obesity in 2,221 adolescents between the age of 12 to 18 years were 17.0% and 14.9%, respectively.<sup>7</sup> A prospective nationwide study, The Malaysian Cohort (TMC), involving more than 100,000 multi ethnic respondents from both urban and rural settings reported a baseline prevalence of obesity at approximately 17.7%.<sup>8</sup>

### 1.3 Obesity as a disease

Obesity is a disease because it meets the definition — it decreases the life expectancy and impairs the normal functioning of the body, has characteristic signs and symptoms, increases morbidity and can be caused by genetic factors. Obesity is a health threat that is associated with an increased risk of other chronic diseases including T2DM, fatty liver, cardiovascular disease, OSA, stroke, dementia and cancer.<sup>9</sup>

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The overproduction of leptin secondary to excess adipose tissue and increased food intake lead to abnormal energy expenditure. Additionally, obesity contributes to mechanical problems within the body, namely pain of the hip and knee joints. Obesity is also linked to reproductive problems in both men and women and is associated with infertility and the risk of miscarriage. Obesity has led to an increased risk of preventable early death, i.e., 29.5% for men and 14.6% for women compared to those with a normal BMI (19% for men and 11% for women).<sup>10</sup> **[Level 1++]**

### 1.4 Impact of weight loss on associated medical conditions

For persons who have weight related medical conditions, reducing weight benefits their health and reduces the risk of additional problems related to obesity-related complications.

A modest weight loss of 5% to 10% is associated with improvement in blood pressure and high-density lipoprotein (HDL) cholesterol.<sup>11</sup> **[Level 1++]** This is even more significant in those with a higher BMI where moderate weight loss is associated with improvement in glucose, triglycerides and low-density lipoprotein (LDL) cholesterol levels.<sup>12</sup> **[Level 1++]** Weight loss of between 10% to 15% is needed to improve other clinical conditions such as OSA, osteoarthritis and steatotic hepatitis. Real-world data on the benefits of weight loss revealed the greatest benefit for the reduction of cardiovascular risk factors that can be translated into reduction of morbidity and mortality.<sup>13</sup> **[Level 3]**

These clinical practice guidelines intend to provide healthcare providers comprehensive evidence-based guidance for screening and managing overweight and obesity, i.e., how to evaluate, treat, and manage a person with obesity while incorporating individual needs and preferences for improved clinical outcomes.

# 2. Assessment and diagnosis

## 2.1 Screening

All adults should be screened annually using body mass index (BMI) measurement; a cut-off point of  $\geq 23 \text{ kg/m}^2$  should be used to initiate further evaluation of overweight or obesity.<sup>14</sup> [Level 2+]

However, measurement of body fat can be used as an alternative to BMI for screening for obesity. Truncal obesity can be an indicator of obesity-associated conditions, especially in those with lower BMI.

## 2.2 Diagnosis

The BMI is an international standard for measurement of obesity as recommended by the World Health Organization (WHO), however, it was based on Europids and did not accurately reflect other ethnic groups,<sup>15</sup> e.g. in the Asian population, where morbidity and mortality occur at lower BMI and waist circumference.<sup>16,17</sup>

The BMI is still the most widely accepted measurement of obesity as it is easy to access, affordable to measure, and can conveniently be used to monitor weight changes.

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$$\text{Body mass index (BMI)} = \text{Weight (kg)} / \text{height}^2 (\text{m}^2)$$

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Asians generally have higher body fat percentages compared to Caucasians at similar BMI cut-off points.<sup>18</sup> [Level 1++]<sup>19</sup> [Level 2] Evidence from Asian countries reveal that the risk of comorbidities such as type 2 diabetes mellitus (T2DM), hypertension and other cardiovascular (CV) risks, begin to increase at lower BMI.<sup>20-23</sup> [Level 1+]<sup>24</sup> [Level 2+] Hence, the lower BMI cut-off points for overweight and obesity for the Asian population (Table 2-1).

### Classification of weight by BMI

The initial assessment of people with obesity should include height, weight and BMI ( $\text{kg}/\text{m}^2$ ). The classification of weight by BMI for the Asian population and its associated CV risk are shown in Table 2-1.

## 2. Assessment and diagnosis

**Table 2-1. BMI-based weight classification for adults (>18 years old).<sup>1,25</sup> [Level 1+]**

Classification	BMI (kg/m <sup>2</sup> )	Risk of comorbidities
<b>Underweight</b>	<18.5	Low, but with increased risk of other clinical problems
<b>Normal</b>	18.5-22.9	Optimal
<b>Pre-obese (Overweight)</b>	23.0-27.4	Increased
<b>Obese I</b>	27.5-32.4	High
<b>Obese II</b>	32.5-37.4	Very high
<b>Obese III</b>	≥37.5	Extremely high

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### *Limitations of BMI*

Though studies have demonstrated the utility of BMI in assessing population-based mortality and disease specific morbidity, it has some limitations;<sup>26</sup> [Level 3]<sup>27</sup> [Level 2+] BMI could not distinguish the weight between muscle and fat.

The elderly tends to have a higher body fat composition as a result of age-related loss of lean body mass (sarcopenia), which can be misclassified as a healthy BMI.<sup>28</sup> Therefore, in this subgroup, the use of BMI for health risk assessment may be less accurate.<sup>28</sup>

BMI also does not distinguish body fat distribution, a known determinant of metabolic risk. Hence, the assessment of visceral adiposity which is a predictor for the development of T2DM, hypertension, metabolic syndrome and CV mortality risk, is a better parameter than total body fat alone.<sup>29</sup> [Level 3]

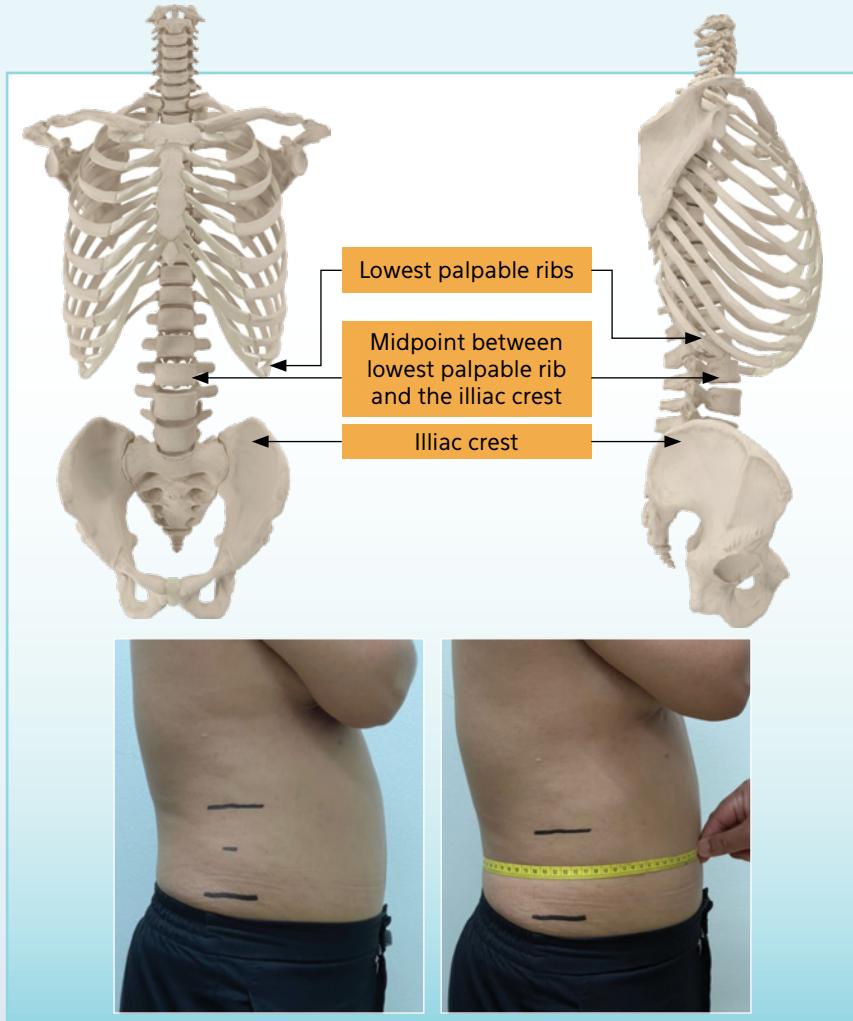
### **Classification by waist circumference**

Abdominal or visceral fat is an independent risk factor for cardiovascular disease (CVD).<sup>30</sup> Waist circumference (WC) is measured in the horizontal plane, midway between the lowest ribs and the iliac crest (see Figure 2-A). Its measurement correlates well with abdominal fat content irrespective of the BMI.<sup>31</sup> [Level 2+]

WC is a very practical measurement for assessing excess fat around the abdomen. There are other ways to measure body fat but most of these methods are not readily available or convenient in clinical settings. These include:

- skin-fold calliper measurement
- hydrodensitometry
- dual-energy X-ray absorptiometry
- magnetic resonance imaging
- bioelectrical impedance (BEI)

Figure 2-A. Measuring the waist circumference



WC measurement is most useful in individuals who are in the normal and overweight (pre-obesity) BMI-based categories. For those with a  $\text{BMI} > 35 \text{ kg/m}^2$  it is unnecessary to measure WC as it loses its predictive value.<sup>32</sup> **[Level 2+]**

## 2. Assessment and diagnosis

The WHO recommends WC of  $\geq 102$  cm in men and  $\geq 88$  cm in women. However, studies from Asian countries showed high prevalence of T2DM and CVD at lower cut-off points of 90 cm in men and 80 cm in women.<sup>25,33</sup> **[Level 2+]**

### 2.3 Assessment of obesity-related medical conditions

Patients who are pre-obese and above, should also be assessed for the following conditions:

- Hypertension
- T2DM and Prediabetes
- Metabolic syndrome
- Dyslipidaemia
- Obstructive Sleep Apnoea (OSA)
- Osteoarthritis/Degenerative joints/back pain
- Metabolic Associated Fatty Liver Disease (MAFLD)
- Gastroesophageal Reflux Disease
- Cancer

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Current medications history should also be elicited as some drugs can contribute to weight gain (Table 2-2).

**Table 2-2. Medications that may contribute to weight gain.**

Classes	Name of Medications
<b>Antidepressants</b>	<ul style="list-style-type: none"><li>• Mirtazapine</li><li>• Selective serotonin reuptake inhibitors (SSRI)</li><li>• Monoamine oxidase inhibitors (MAOIs)</li></ul>
<b>Antiepileptic drugs or mood stabilizers</b>	<ul style="list-style-type: none"><li>• Gabapentin</li><li>• Pregabalin</li><li>• Carbamazepine</li><li>• Divalproex</li><li>• Lithium</li><li>• Valproic acid</li><li>• Vigabatrin</li></ul>
<b>Antihistamines</b>	<ul style="list-style-type: none"><li>• Cetirizine</li><li>• Cyproheptadine</li></ul>

Classes	Name of Medications
<b>Antipsychotics</b>	<ul style="list-style-type: none"> <li>Quetiapine</li> <li>Clozapine</li> <li>Olanzapine</li> <li>Risperidone</li> <li>Thioridazine</li> </ul>
<b>Alpha-blockers</b>	<ul style="list-style-type: none"> <li>Terazosin</li> </ul>
<b>Beta-blockers</b>	<ul style="list-style-type: none"> <li>Metoprolol</li> <li>Atenolol</li> <li>Propranolol</li> </ul>
<b>Glucocorticoids</b>	<ul style="list-style-type: none"> <li>Prednisolone</li> <li>Methylprednisolone</li> <li>Hydrocortisone</li> </ul>
<b>Glucose lowering drugs</b>	<ul style="list-style-type: none"> <li>Insulin</li> <li>Sulfonylureas</li> <li>Meglitinides</li> <li>Thiazolidinediones</li> </ul>
<b>Hormonal Agents</b>	<ul style="list-style-type: none"> <li>Progestins</li> </ul>

## 2.4 Targets for control

The principal goals in obesity management are to:<sup>34</sup> **[Level 1]**

- Prevent complications by trying to keep the patient metabolically healthy (if possible)
- Prevent or to treat existing comorbidities
- Fight against stigmatisation of people with obesity
- Restore the individual's well-being, positive body image and self-esteem

The treatment goals should be tailored to the complications as listed in Table 2-3<sup>35</sup> **[Level 1]** that includes the predictive weight loss as an indicator of expected reduction of cardiometabolic risks. The expected weight loss depends on the pathology and ranges from 5%-15%.<sup>34</sup> **[Level 1]**

## 2. Assessment and diagnosis

Table 2-3. Treatment targets based on diagnosis in the medical management of patients with obesity

Diagnosis	Weight loss target (%)	Expected outcome
<b>Metabolic syndrome</b>	10	Prevention of T2DM
<b>T2DM</b>	5-15	↓ in HbA <sub>1c</sub> and glucose lowering drugs Diabetes remission if short duration
<b>Dyslipidaemia</b>	5-15	↓ TG and LDL ↑ HDL
<b>Hypertension</b>	5-15	↓ BP and medications
<b>PCOS</b>	5-15	Ovulation ↓ hirsutism and androgen levels ↑ insulin sensitivity
<b>Asthma</b>	7-8	Improvement of FEV1
<b>Sleep apnoea</b>	7-11	↓ of apnoea/hypopnoea index
<b>MAFLD</b>	10-40	↓ intrahepatocellular lipids and inflammation

Note: Weight loss is dependent on the nature of the comorbidity.

BP, blood pressure; FEV1, forced expiratory volume at 1 second; HDL, high density lipoprotein; LDL, low density lipoprotein; MAFLD, metabolic associated fatty liver disease; PCOS, polycystic ovarian syndrome; T2DM, type 2 diabetes mellitus; TG, triglyceride.

Adapted from Garvey WT, et al. Endocr Pract 2016.<sup>35</sup> [Level 1+]

### Recommendations 1

- Screening with BMI and WC measurements should be done yearly. **[Grade B]**
- Cut off BMI values that should be used are: pre-obesity (overweight) -23 kg/m<sup>2</sup> and obesity - >27.5 kg/m<sup>2</sup> **[Grade A]**
- Individuals diagnosed with pre-obesity and obesity should be assessed for associated conditions, co-occurring medical conditions and current treatments that could cause obesity. **[Grade A]**

# 3. Psychological and behavioural therapy

## 3.1 Psychological aspect of obesity

Persons with overweight and obesity struggle with various mental health issues such as weight bias, stigma and discrimination. These are generally negative attitudes, beliefs and behaviours towards individuals who are obese and include prejudice and stereotype labelling such as being lazy, unmotivated, lacking willpower and discipline.

Stigmatising being overweight and obese is not helpful as it is associated with reduced motivation to engage in healthy behaviours leading to avoidance of exercise and non-adherence to diet and medication. It also has mental health consequences such as body image dissatisfaction, reduced quality of life, low self-esteem and poor overall wellbeing.<sup>36,37</sup> **[Level 1+]**<sup>38</sup> **[Level 1-]** In addition to poor health outcomes, weight discrimination may shorten life expectancy.<sup>39</sup> **[Level 2+]**

A recent systematic review found that obesity is associated with depressive disorders, anxiety disorders (Odds ratio [OR] 1.27-1.40), personality disorders (OR 1.2-1.95), attention deficit hyperactivity disorder (OR 1.44) and eating disorders (OR 4.5). There is a bidirectional relationship between obesity and depression where people with obesity have a higher risk of developing depression (OR 1.21-5.8) while people with depression have a higher risk of becoming obese (OR 1.18-3.76), with a stronger association observed in women.<sup>40</sup> **[Level 1-]**

Healthcare providers should identify if patients with obesity or overweight have pre-existing mental health issues. These patients should be referred to a psychiatrist for diagnosis and to optimise their mental health status. They should also ensure that the psychological and behavioural interventions to treat obesity are done appropriately and effectively (refer to the relevant clinical practice guidelines for screening of specific mental disorders). Individuals with binge eating disorder can be identified by using the Binge Eating Scale tool (refer Appendix 2).

## 3.2 Psychological and behavioural interventions for obesity and weight management

Psychological and behavioural interventions for overweight and obesity aim to help people with obesity to sustain lifestyle changes that improve self-esteem, health, functioning and quality of life.<sup>41</sup> **[Level 1++]** The majority of these interventions are cognitive-based and are typically used in combination with lifestyle interventions.<sup>42</sup> **[Level 1++]** When behaviour therapy is combined with diet and exercise, it resulted in a greater weight reduction compared to diet or

### 3. Psychological and behavioural therapy

exercise alone. Increasing the intensity of the behavioural intervention further increased the weight reduction (weighted mean difference [WMD] -2.3 kg, 95% CI -1.4, -3.3).<sup>42</sup> **[Level 1++]**

Behavioural interventions aid adherence to lifestyle modifications and medications by enhancing self-efficacy (i.e. belief and confidence to overcome barriers to desired outcomes) and providing motivation (i.e. personal meaningful reasons to change).<sup>41</sup> **[Level 1++]** These types of multicomponent approaches incorporated by trained health providers are more effective in the long term compared to a single component approach.<sup>41</sup> **[Level 1++]** These strategies must be based on values that matter most to the patients at each phase, from working on motivation and goal setting, and to when the patients are facing setback.

Multicomponent approaches can include the following:

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- Enhancing communication and avoiding stigmatising
- Psychoeducation
- Motivational interviewing and behavioural strategies
- Psychological interventions

#### Enhancing communication and avoidance of stigmatisation

Communication is vital in obesity management and it is crucial to avoid stigmatising the individual as it produces negative consequences.

Approaches in communication may include,<sup>34</sup> **[Level 1++]**

- Communicating with empathy without negative judgements and bias
- Recognising that obesity has a complex multifactorial aetiology and that it is not fully under voluntary control
- Asking the individual first, if they are willing to speak about their weight before introducing the discussion around obesity, especially if their primary consult was for an unrelated cause
- Acknowledging that an individual with obesity has already been chronically exposed to negative experiences (such as stigmatisation and discrimination) when navigating the health system
- Avoiding the use of inappropriate or hurtful words in order to maintain a positive therapeutic relationship
- Referring to the individual as a person with obesity rather than “an obese person” will be less stigmatising

#### Psychoeducation

When educating patients, the emphasis is to work on achievable behavioural and psychological goals to achieve improved health, function and quality of life, and not just on the amount of weight loss.<sup>41</sup> **[Level 1++]**

#### Motivational interviewing

Motivational interviewing is a collaborative, goal-oriented and patient-centred guided-style counselling method depending on where they are on the Stages of Change\*.<sup>43,44</sup> **[Level 1++]**

These are the basic steps of practicing motivational interviewing:

- Engagement — listen and understand the patient's background, perspective, concerns, past experiences, strengths, and vulnerabilities
- Focus — focus on one behaviour at a time
- Evoke — evoke the patient's internal motivation by connecting the adoption of healthy behavioural change to their goals, values and concerns
- Plan — once the patient is ready to change, make a joint decision to address the specific situation(s) where behavioural change is needed

\*The stages of change include, precontemplation, contemplation, preparation, action, maintenance and relapse.

#### Behavioural strategies

Behavioural strategies improved adherence to lifestyle intervention programmes in adults with obesity.<sup>34,41,45</sup> **[Level 1++]** Healthcare providers can be trained to effectively implement the wide range of behavioural interventions available.<sup>41</sup> **[Level 1++]**

#### Behavioural and cognitive interventions

- Goal setting and action planning: Setting specific, measurable, achievable, relevant and time-bound (SMART) goals that can be adhered to:
  - › **Specific** — a behavioural goal is broken into small manageable specific steps which are documented
  - › **Measurable** — the goal and the steps taken to achieve it must be measurable to monitor progress and to know when the goal has been achieved
  - › **Achievable** — the set goal should not be too difficult to achieve and make the steps for accomplishing the goal achievable
  - › **Realistic and Relevant** — a goal must be realistic, relevant and be enjoyable to the individual
  - › **Time-based** — develop deadlines for achieving key milestones and goals to measure the progress

### 3. Psychological and behavioural therapy

- Self-monitoring: Monitoring of diet, exercise and mood to increase self-awareness, while getting feedback will enhance motivation (refer Appendix 2 for a sample format)
- Stimulus control: Uses techniques to modify the external environment to make it conducive for supporting behavioural changes
- Problem solving: An essential technique for when a patient faces barriers or setbacks to behavioural changes. It involves identifying and analysing issues and providing value-based solutions/options to move forward. The “IDEAL” approach will help a person to identify and understand the components in the problem-solving process:<sup>46</sup>
  - › Identify problems and consider them as opportunities to develop solutions. Complex problems may have to be divided into multiple simpler components so that they can be solved easily
  - › Define value-based goals in problematic situations
  - › Explore possible strategies to achieve goals. Utilise a systematic approach by listening and analysing each option
  - › Anticipate outcomes and Act on the strategies
  - › Look back at the effects of the strategies and Learn from experience

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- Cognitive reframing: This is a technique to see a situation in a different perspective, usually from an irrational point of view or challenging situation to a more rational view or outlook
  - › E.g. — “I only lost 1 kg this month. This is hopeless” to “I successfully lost 1 kg this month. Even though the amount is small, I also lost an inch off my waist, and I feel energised. This is still an achievement”
- Cognitive restructuring: Techniques in cognitive restructuring are used to make a person notice their irrational thought patterns and change it. This is done under a therapist’s guidance. Steps in cognitive restructuring are:
  - › Self-monitoring — noticing the cognitive error the patient is having
  - › Questioning assumptions and thoughts that impede adopting healthy behaviours or affecting their mood
  - › Gathering evidence — listing the evidence that support or negate these thoughts, assumptions or beliefs
  - › Analysing the evidence — listing the advantages or disadvantages of maintaining these cognitive distortions
  - › Generating alternatives — coming up with rational alternative explanations to replace the distortions which are inaccurate and unhelpful

### 3. Psychological and behavioural therapy

- Relapse prevention and management: As relapses are common in weight management, some strategies to prevent this are the early identification of high-risk situations and lapses and devising a plan to overcome high-risk situations and adapting to new coping mechanisms.

#### Psychological interventions

Psychological interventions such as Cognitive Behavioural Therapy (CBT) and, Acceptance and Commitment Therapy are effective. Acceptance and Commitment therapies focus on value-directed actions and commitment to multicomponent behavioural interventions.<sup>41</sup> **[Level 1]** CBT when combined with a diet or exercise intervention was found to increase weight loss compared to diet or exercise alone (WMD -4.9 kg; 95% CI -7.3, -2.4).<sup>42</sup> **[Level 1++]** As both these methods are intensive, patients may need a referral to a mental health professional.

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#### Recommendations 2

- Multicomponent psychological and behavioural therapy approaches should be integrated in managing people with obesity **[Grade A]**
  - › Enhancing communication and avoiding stigmatisation
  - › Psychoeducation
  - › Motivational interviewing and behavioural strategies
  - › Psychological interventions

# 4. Management of obesity in adults

## 4.1 Comprehensive lifestyle modification

Comprehensive lifestyle modification when managing persons with overweight and obesity includes modifying eating (dietary) and activity habits. Hence, the goal of lifestyle interventions for obesity treatment is to achieve weight loss through a decrease in calories consumed and an increase in energy expended.<sup>47</sup>

**[Level 4]**

A 6-month structured lifestyle intervention that included dietary counselling and a physical activity programme among overweight and obese women in a low socioeconomic community setting, produced a small percentage of weight loss and decreased visceral fat compared to the control group. There was, however, a significant increase in skeletal muscle mass (0.13 kg) in the intervention group compared to the control group (-0.37 kg),  $p=0.033$  throughout the study period. Unfortunately, this was not sustained during the maintenance period.<sup>48</sup> **[Level 2-]**

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In a workplace setting, a 4-month lifestyle intervention that incorporated diet changes, physical activity and behaviour modification education delivered through face-to-face, online (web-based) or printed education material (control group), the face-to-face group showed the greatest body weight reduction (-5.80 kg) compared to the online and the control groups (-1.12 kg and -1.82 kg, respectively). The face-to-face group also had the highest reductions in waist circumference (WC) and energy intake and improvement in lipid profile.<sup>49</sup> **[Level 2-]**

### 4.1.1 Medical nutrition therapy (MNT) for adults

Treating obesity requires achieving a state of negative energy balance. Hence, dietary intervention for obesity should primarily address the reduction in energy (calorie) intake. There are many dietary approaches that reduce calorie intake, some more than others, and the degree of weight loss generally reflects the size of this reduction.<sup>47</sup> **[Level 4]** The goals of MNT are to facilitate weight loss, prevent weight gain, improve cardiometabolic outcomes and optimise nutrient adequacy.

#### Weight management interventions by a dietitian

MNT for weight management reduced body mass index (BMI) (-1.5 kg/m<sup>2</sup>, 95% CI -1.74,-1.26 kg/m<sup>2</sup>), improved percentage weight loss (-4.01%, 95% CI -5.26, -2.75%), WC reduction (-3.45 cm, 95% CI -4.39, -2.51 cm), systolic blood pressure (BP) reduction (-3.04 mmHg, 95% CI -5.10, -0.98 mmHg), diastolic BP reduction (-1.99 mmHg, 95% CI -3.02, -0.96 mmHg) and fasting plasma glucose (FPG) reduction among individuals with type 2 diabetes mellitus (T2DM; -12.47 mg/dL, 95% CI -17.50, -7.44 mg/dL).<sup>50</sup> **[Level 1++]**

### Weight loss goals

MNT prescribed for <6 months reported a significant weight loss of approximately 0.5 to 1 kg per week. 6-12 months of MNT resulted in a significant mean weight loss of up to 10% of body weight. A sustained weight loss of 3-5% is likely to result in clinically meaningful improvement in cardiometabolic outcomes.<sup>47,51</sup> **[Level 4]** Therefore, realistic weight loss goals are,

- Up to 1 kg per week
- Up to 10% of baseline body weight
- A total of 3-5% of baseline body weight in the presence of cardiovascular (CV) risk factors (e.g., hypertension, hyperlipidaemia and hyperglycaemia)

### Energy restriction

A systematic review of randomised controlled trials (RCTs) showed that energy restrictive diets with 300-1000 kcal/day deficit from the daily energy requirement or usual intake, or the recommended 1200-1800 kcal/day energy intake in metabolically healthy obese adults resulted in reduction of BMI (-2.70 kg/m<sup>2</sup>, 95% CI -4.01, -1.39), BP (systolic BP: -4.73 mmHg; 95% CI -7.12, -2.23, and diastolic BP: -2.75 mmHg; 95% CI -4.30, -1.21) and triglycerides (-0.11 mmol/l; 95% CI -0.16, -0.06).<sup>52</sup> **[Level 1++]**

To determine short (6 months) and long-term (12 months) weight loss based on calorie reduction, obese women were randomly prescribed with 1,000 kcal/day or 1500 kcal/day balanced diet combined with increased walking (10,000 steps/day or 3,000 steps above baseline) for 6 months.<sup>53</sup> **[Level 1+]** In the short-term (first 6 months), weight loss was greater in the 1000 kcal/day group ( $p=0.045$ ). However, baseline caloric consumption moderated the effect of treatment on weight gain — participants with baseline intakes of  $\geq 2000$  kcal/day who were assigned 1000 kcal/day diets were significantly more susceptible to weight regain than those assigned 1500 kcal/day from months 7-12 ( $p=0.049$ ).

In another RCT, calorie restrictive diet alone ( $1,500 \pm 200$  kcal/day) was not as effective as combining it with physical activity (30-60 minutes/day of moderate intensity exercise) and behavioural modification in reducing BMI, WC, body fat and increased fat-free mass in obese women.<sup>54</sup> **[Level 1-]**

## 4. Management of obesity in adults

Calorie restriction diet should be individualised based on age, sex, readiness level, physical activity level, presence of comorbidities and patient preference. To achieve and maintain nutrient adequacy and reduce caloric intake, any one of the following strategies can be used to achieve an initial weight loss of 0.5-1 kg/ week:<sup>51</sup> **[Level 4]**

- 1,200-1,500 kcal/day for women
- 1,500-1,800 kcal/day for men
- Reduce daily energy by 500-750 kcal from the usual daily intake

Nutrient inadequacy with caloric restriction has been reported. The extent of inadequacy and the nutrients affected are dependent on the composition of the diet followed and the nutritional needs of the individual.<sup>55</sup> **[Level 4]** The use of very low calorie diet (VLCD), i.e. <800 kcal/day) as part of a comprehensive treatment plan should be prescribed under the supervision of a medical team that includes a dietitian.<sup>55</sup> **[Level 4]**

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### *Intermittent fasting*

There are various types of intermittent fasting. These include time restrictive diets (restricting the number of hours of eating per day) or alternate day fasting (restriction of calorie consumed during fasting and non-fasting days). The degree of weight loss depends on the cumulative caloric restriction and not the duration of the fast. However, a conclusion on its effectiveness cannot be reached as clinical studies, and systematic reviews and meta-analyses of clinical studies differ in their conclusions due to wide study variability.<sup>56-60</sup>

Alternate day fasting (consumption of 25% and 125% of usual energy intake on fast day and non-fast day, respectively with dietitian consultation) or daily energy restriction (consumption of 75% of usual energy intake with dietitian consultation) produced significant weight loss in a 12-month intervention among persons with obesity.<sup>61</sup> **[Level 1-]**

- The total weight loss was 6.0% (95% CI -8.5%, -3.6%) in the alternate day fasting group and 5.3% (95% CI -7.5%, -3.0%) in the daily energy restriction group compared to the control group (no energy restriction)
- Both diets showed no difference for weight loss, weight maintenance, diet adherence or improvement in CV risk

### Macronutrient modification

A sample menu plan and the food groups exchange lists can be found in Appendix 3.

#### *Low carbohydrate or balanced isocaloric diet*

Both short- and long-term studies comparing low carbohydrate diet (i.e., carbohydrate <45% of total energy combined with high fat or high protein diet) and balanced isocaloric diet (i.e., 40-65% carbohydrate from total energy) in overweight and obese adults with or without T2DM showed no difference in weight loss at 3-6 months (-0.74 kg; 95% CI -1.49, 0.01) and at 1-2 years (-0.48 kg; 95% CI -1.44, 0.49). There was also no significant difference in CV risk factors.<sup>62</sup>

**[Level 1++]**

#### *Low fat or low carbohydrate diet*

Reduction in weight, WC and body fat percentage were not significantly different when healthy adults with overweight and obesity without T2DM were randomly assigned to healthy low fat (24-29% of energy intake) or low carbohydrate (23-30% of energy intake) diets for 12 months. The mean between group difference was 0.7 kg (95% CI -0.2, 1.6).<sup>63</sup> **[Level 1+]**

- Both groups produced weight loss – mean weight change in the low-fat diet group was -5.3 kg (95% CI -5.9, -4.7) and in the low carbohydrate diet group was -6.0 kg (95% CI -6.6, -5.4)
- Both diets improved lipid profiles and lowered BP, insulin and glucose levels
- Low-density lipoprotein cholesterol (LDL-C) concentrations increased for participants in the low carbohydrate diet group
- LDL-C reduction significantly favoured the low-fat diet
- High density lipoprotein cholesterol (HDL-C) concentration significantly increased while triglyceride concentrations significantly reduced in the low carbohydrate diet group

Isocaloric diet containing either high (53% from total energy) or low (14% from total energy) carbohydrate, and limited in saturated fatty acids in adults with obesity and T2DM, showed a comparable reduction of body weight and BP.<sup>64</sup>

**[Level 1+]** The low carbohydrate diet resulted in greater reduction in lipid profile, FPG and requirements for glucose lowering drugs in the 2-year clinical trial.

## 4. Management of obesity in adults

### Glycaemic index (GI) and glycaemic load (GL)

In a meta-analysis of RCTs, low GI/GL was not superior to high GI/GL diets on body weight reduction in adults with  $BMI \geq 25 \text{ kg/m}^2$ . However, low GI/GL diets showed greater body weight reductions in adults with  $BMI \geq 30 \text{ kg/m}^2$  (-0.93 kg, 95% CI -1.73, -0.12). Compared to high GI/GL diets, low GI/GL diets reduced FPG (-1.97 mg/dL, 95% CI -3.76, 0.19) and fasting insulin (-0.55  $\mu\text{U/mL}$ , 95% CI -0.95, -0.15). No differences in fat mass, fat-free mass, WC and lipid profile were observed between low GI/GL and high GI/GL diets.<sup>65</sup>

### Meal replacement

In a meta-analysis of RCTs, meal replacement-based plans as part of a structured calorie restriction diet that replaced  $\geq 60\%$  of the total daily energy intake, replacing 3 meals/day or an intervention duration of 3-6 months resulted in greater weight loss than conventional food-based low energy diet.<sup>66</sup> **[Level 1++]**

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### Recommendations 3

- MNT provided by a dietitian is recommended for adults with overweight and obesity especially those with comorbidities. **[Grade A]**
- Dietary prescriptions should be individualised to the individual's motivation level, age, sex, comorbidities, physical activity level and weight loss goals. **[Grade C]**
- Calorie restriction diets should be combined with either low carbohydrate or low fat intake. **[Grade A]**
- Meal replacement or intermittent fasting may be used as alternative methods of calorie restrictions **[Grade A]**

### 4.1.2 Physical activity

Exercise is an integral part of any weight loss programme. Although physical activity and exercise are used interchangeably, their definitions are slightly different.<sup>67</sup>

**[Level 1++]**

- Physical activity means all movement that creates energy expenditure
- Exercise is a planned, structured, repetitive and purposeful physical activity

## 4. Management of obesity in adults

Physical activity and exercise integrated with other components of lifestyle modification such as energy restriction is significant in reducing weight and improving health.<sup>68</sup> **[Level 1++]** **[Grade A]** Physical activity or exercise alone without dietary intervention or calorie reduction produces a small impact on weight loss.<sup>69,70</sup> **[Level 1-]**

Physical activity and exercise can reduce obesity level by increasing total energy expenditure, hence promoting a negative energy balance.

- Moderate-intensity physical activity of at least 150 minutes/week has demonstrated weight maintenance.
- A longer duration of more than 300 minutes/week was associated with weight maintenance after weight loss.<sup>71</sup> **[Level 1++]** **[Grade A]**

Table 4-1 shows the duration of aerobic physical activity and the associated expected weight loss.

**Table 4-1. The duration of aerobic physical activity and expected weight loss**

<b>Aerobic Physical Activity</b>	<b>Amount Weight Loss Amount</b>
<b>&lt;150 min per week</b>	No weight loss or minimal weight loss
<b>150–225 min per week</b>	Weight loss of 2 to 3 kg
<b>225–420 min per week</b>	Weight loss of 5 to 7.5 kg
<b>200–300 min per week</b>	Weight maintenance after weight loss

Adapted from Donnelly JE, et al. *Med Sci Sports Exerc* 2009.<sup>71</sup>

Persons with obesity should get clearance on their health and physical conditions before embarking on an exercise programme. This is essential to ensure that they are able to perform any physical activity or exercise safely.

### Types of physical activity or exercise

The physical activity or exercise utilised for weight loss include aerobic training, resistance training and lifestyle physical activity (Table 4-2).

## 4. Management of obesity in adults

Table 4-2. Categories of physical activity/exercises with examples

Type of physical activity/exercise	Examples
<b>Aerobic training</b>	<ul style="list-style-type: none"><li>Low impact aerobic exercise – swimming, cycling, walking, rowing. These can be supervised programmes</li><li>Higher impact aerobic exercise – Running and jumping rope</li><li>High-intensity interval training (HIIT) – Alternating short bursts of high-intensity exercise and recovery periods</li></ul> <p>Moderate-intensity continuous training (MICT), which is frequently recommended for weight loss, compared to HIIT showed similar efficacy in body fat mass loss, WC reduction and body fat percentage. However, HIIT requires less time.<sup>72-74</sup> <b>[Level 1-]</b></p>
<b>Resistance training</b>	<ul style="list-style-type: none"><li>Free weights – using classic strength training tools such as dumbbells, barbells and kettlebells</li><li>Weight machines – devices that have adjustable seats with handles attached either to weights or hydraulics</li><li>Resistance bands – provides resistance when stretched</li><li>Suspension equipment – uses gravity and the body weight</li><li>Bodyweight exercise – uses only body weight without requiring any equipment, e.g., walking lunges, glute bridges, push-ups and side planks</li></ul>
<b>Lifestyle physical activity</b>	<ul style="list-style-type: none"><li>Getting more steps using a pedometer</li><li>Increasing activity during the day such as climbing stairs instead of using the elevator</li></ul>

There was no specific weight loss benefit associated with a specific kind of physical activity (aerobic, resistance, or lifestyle), but evidence indicates higher intensity activity or exercise has better effects on weight loss compared to lower intensity activity (Table 4-3).<sup>75,76</sup> **[Level 1+]**

**Table 4-3. Expected initial weight loss and possibility of clinically significant weight loss from different types of exercise training programmes**

Exercise Type	Range of Expected Weight Loss	Chance of Clinically Significant Weight Loss
<b>Aerobic exercise training only</b>	0 to 3%	Possible, but only with high exercise volumes
<b>Resistance training only</b>	0 to 1%	Very unlikely
<b>Aerobic and resistance training</b>	0 to 3%	Possible, but only with high volumes of aerobic exercise training
<b>Caloric restriction combined with aerobic exercise training</b>	5 to 15%	Possible

#### **Prescription of physical activity/exercise**

For adults who have never performed exercise or not physically active, prescribe undertaking small amounts of physical activity or exercise, and slowly increasing the frequency, intensity and duration over time.<sup>77</sup> **[Level 3] [Grade C]** For individuals with comorbid conditions clinical assessment by a healthcare provider to ensure the suitability and type of exercise should be performed.

For an appropriate exercise prescription, one should be considered using the FITT formula:

F = Frequency

I = Intensity

T = Time (duration)

T = Type of exercise

Physical activity or exercise (aerobic or resistance exercise) can be done in one session or accumulated over the day. Each level of intensity and duration should be maintained for at least 1 to 2 weeks before increasing it further. A regimen of physical activity or exercise should start with:

1. Increasing the number of steps (walking) or movement and daily chores
2. This is followed by a gradual progression of aerobic exercise training
3. Strength or resistance exercise is introduced
4. Flexibility exercises to attain the full range of joint motion can then be incorporated

## 4. Management of obesity in adults

Performing physical activity and exercise should not create any problems for persons with obesity, and caution should be exercised.

- Progressing too rapidly will result in muscle soreness, fatigue, increased cardiac risk, and decreased motivation
- Each exercise period should include warm-up and cool-down periods
- They should be encouraged to drink plenty of water before, during and after exercise to prevent dehydration
- They should be advised to stop when there are abnormal signs during physical activity or exercise, e.g., chest pain and excessive breathlessness

### Physical activity/exercise in person with obesity >65 years old

Physical activity or exercise is also encouraged among those above 65 years of age. This is to reduce the weight gain as well as to minimize the risk of developing sarcopenia in this group.<sup>78</sup> **[Level3] [Grade C]** Similar to individuals with comorbidities, older individuals should also be assessed by a healthcare provider for suitability to start an exercise programme and the type of exercise prescribed.

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For older adults,

- Start with small amounts of physical activity and gradually increase the frequency, intensity and duration over time
- Introduce muscle strengthening activities at moderate or greater intensity that involve all major muscle groups on 2 or more days a week. Resistance training should not be performed on consecutive days for the same muscle group
- Encourage them to limit the amount of time spent being sedentary
- Ensure that they perform varied multicomponent physical activity that emphasize functional balance and strength training at moderate or greater intensity, on 3 or more days a week, to enhance functional capacity and to prevent falls

### Recommendations 4

- Physical activity should be encouraged in all individuals with obesity **[Grade A]**
  - › A minimum of 150 minutes/week (30 minutes/day) progressing to 300 minutes/week (60 minutes/day) of moderate intensity
  - › or at least 75-150 minutes/week of vigorous intensity is required for weight loss.
- Combination of both moderate- and vigorous-intensity activity throughout the week should be encouraged to maintain weight loss. **[Grade B]**
- Both resistance and aerobic exercise or activities should be emphasised to improve physical function and well-being. **[Grade B]**

## 4.2 Pharmacotherapy

When used as an adjunct to lifestyle intervention (i.e., diet, exercise and behavioural modification), pharmacotherapy is effective in reducing weight by at least 5%.<sup>79</sup> **[Level 1++]**

Pharmacotherapy should be considered when weight loss goals or weight maintenance cannot be achieved with lifestyle interventions alone.<sup>79</sup> **[Level 1++]** Hence, anti-obesity treatments must only be used as an adjunct to lifestyle interventions.

A patient may require pharmacotherapy to:

1. Aid compliance with dietary restriction
2. Augment diet-related weight loss
3. Achieve weight maintenance after satisfactory weight loss

As arbitrarily determined by the US Food and Drug Administration (USFDA), pharmacotherapy is indicated in people with a BMI of  $\geq 30 \text{ kg/m}^2$  or  $\geq 27 \text{ kg/m}^2$  with weight-related medical comorbidities.<sup>35,79</sup> **[Level 1++]** The indications for initiation of anti-obesity treatments are listed in Table 4-4. When considering initiating anti-obesity drugs, the risks to a patient from continuing obesity need to be balanced against the risks from the drugs' side effects.

**Table 4-4. Indications for anti-obesity treatments<sup>35</sup> [Level 1++]**

Indications	Associated risk factors
<b>BMI 27.0-29.9 kg/m<sup>2</sup> with associated risk factors</b>	<ul style="list-style-type: none"> <li>• Type 2 diabetes mellitus (T2DM)</li> <li>• Hypertension</li> <li>• Dyslipidaemia</li> <li>• Obstructive sleep apnoea (OSA)</li> </ul>
<b>BMI <math>\geq 30 \text{ kg/m}^2</math> with or without risk factors</b>	

BMI, body mass index.

Pharmacotherapy reinforces behavioural and lifestyle strategies to create a negative energy balance.

- Several medications approved for weight loss such as combining phentermine and topiramate, combining bupropion and naltrexone, liraglutide and semaglutide reduce appetite and promote adherence to reduced dietary caloric intake<sup>80</sup>
- Orlistat reduces fat absorption and promotes avoidance of high-fat energy dense foods<sup>80</sup>

## 4. Management of obesity in adults

Additionally, pharmacotherapy clinically leads to improvement in weight-related quality of life and physical functioning.<sup>81</sup> **[Level 1++]**

As obesity is a chronic disease, pharmacotherapy should be considered long-term.<sup>35</sup> **[Level 1++]** Short courses of pharmacotherapy for ≤6 months do not result in sustained weight loss after medication discontinuation. Once treatment ceases, there will be rebound weight gain.<sup>82</sup> **[Level 1+]** <sup>80</sup> **[Level 4]**

- However, sympathomimetic amines such as phentermine alone should not be used long-term in patients with uncontrolled hypertension or a history of heart disease as long-term prospective studies on CV outcomes have not been conducted<sup>80</sup> **[Level 4]**

The USFDA has determined that a weight loss of ≤5% is considered a clinically important outcome with a positive impact on CV risk factors (i.e. BP, glucose and lipid levels).<sup>47</sup> **[Level 1++]** <sup>80</sup> **[Level 4]**

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- If a patient does not respond with a >5% weight loss after 3 months of initiating anti-obesity treatment or if there are significant safety or tolerability issues, the drug should be discontinued<sup>80</sup> **[Level 4]** and alternative medications or treatment approaches should be considered instead<sup>82</sup> **[Level 1+]**

Given that anti-obesity medications have significant side effects, including CV side-effects, they should be used with medical supervision and careful monitoring. Efficacy and safety should be reviewed frequently in all patients in face-to-face visits:<sup>80</sup> **[Level 4]**

- Monthly for the first 3 months
- At least every 3 months thereafter

### 4.2.1 Anti-obesity drugs

At present, there are 5 USFDA approved medications for obesity: orlistat, phentermine (for not more than 3 months), combining phentermine and topiramate, combining naltrexone and bupropion, high dose liraglutide (3 mg daily) and high dose semaglutide (2.4 mg weekly).

- In the absence of head-to head trials, the 3 most effective medications in terms of weight loss compared to placebo are high-dose semaglutide, combination of phentermine and topiramate and high dose liraglutide<sup>79,84</sup> **[Level 1++]**
- There is only one head-to-head RCT available, i.e., comparing orlistat and liraglutide 3 mg. The results demonstrated that liraglutide had greater efficacy for weight loss<sup>79,83</sup> **[Level 1++]**

In Malaysia, the anti-obesity drugs available for managing obesity are orlistat, phentermine, high dose liraglutide and semaglutide. Phentermine, while not USFDA-approved for the long-term management of obesity, is registered for use in Malaysia as an anti-obesity drug. However, it should be used only for a duration of 3 months and in a cyclical manner.

When selecting an anti-obesity drug, the decision should be made based on its efficacy, side-effects and cost.

### Types of anti-obesity drugs

Anti-obesity drugs can be classified into two groups, i.e., those acting on the gastrointestinal (GI) system to reduce fat absorption and those acting on the central nervous system (CNS) and have been summarised in Table 4-5.

#### *Drugs acting on the GI system*

##### **1. Oral orlistat**

Orlistat is the only non-systemically acting drug available for the long-term treatment of obesity. It is a selective pancreatic lipase inhibitor – inhibiting the breakdown of dietary triglycerides into absorbable free fatty acids. As a result, ~30% of ingested triglycerides are excreted, mainly in the stools, leading to a caloric deficit.<sup>85</sup>

Efficacy of orlistat compared to placebo in weight reduction:<sup>79</sup> **[Level 1++]**

- Odds Ratio (OR) 2.69 for 5% weight loss
- OR 2.41 for 10% weight loss
- Mean weight loss in excess of placebo was 2.6 kg

At 3-4 years of treatment, Orlistat together with lifestyle intervention or VLCD significantly reduced weight and maintained weight loss with minimal side effects.<sup>86,87</sup> **[Level 1+]**

Orlistat also causes reduction in BP and glucose levels<sup>88</sup> **[Level 1++]** and, improvement in the lipid profile (total cholesterol, LDL-C, triglycerides and HDL-C).<sup>89</sup> **[Level 1+]**

Side effects of orlistat include:<sup>90,91</sup>

- Abdominal discomfort such as borbygmi and cramps
- Liquid or oily stool
- Faecal incontinence and oily spotting
- Flatulence with discharge
- Reduced absorption of fat-soluble vitamins (vitamins A, D, E and K)

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- Mildly raised liver transaminase
- Increased urinary oxalate that might cause acute oxalate nephropathy
- Affecting absorption of certain drugs such as levothyroxine and/or iodine salts, cyclosporine, anticonvulsants and antiretroviral drugs

Orlistat is contraindicated in individuals with malabsorption syndromes and those with cholestasis.

### *Drugs acting on the CNS*

#### **2. Oral phentermine**

Oral phentermine is a noradrenergic sympathomimetic amine agent (dimethylphenethylamine hydrochloride) and was approved by the USFDA in 1959 for **short-term use** as an adjunct to lifestyle inventions for management of obesity. It appears to act within the hypothalamus and upregulates noradrenaline. This results in the stimulation of  $\beta$ 2-adrenergic receptors that induces appetite suppression.<sup>92</sup> It also inhibits monoamine oxidase, potentiating the effect of serotonin and increasing the basal metabolic rate.<sup>92</sup>

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The efficacy of phentermine compared to placebo for weight reduction:

- Mean weight loss – 4.43 kg (Standard mean difference [SMD] 1.37, 95% CI -1.55, -1.19)<sup>93</sup> **[Level 1++]**
- 86.5% of patients achieved 5% weight loss<sup>94</sup> **[Level 1+]**
- 48.6% of patients achieved 10% weight loss<sup>94</sup> **[Level 1+]**

Phentermine also reduced total cholesterol and LDL-C (-0.49 mmol/l and -0.33 mmol/l, respectively).<sup>94</sup> **[Level 1+]** However, there were no significant changes in triglyceride, HDL-C and FPG levels, and systolic and diastolic BP.

Side effects of phentermine are related to its sympathomimetic stimulation:<sup>94</sup>  
**[Level 1+]**

- Insomnia
- Palpitations
- Increased heart rate (SMD=0.64; 95% CI 0.35, 0.92)<sup>93</sup> **[Level 1++]**
- Dry mouth

#### **3. Oral phentermine/topiramate**

Phentermine stimulates the hypothalamic release of norepinephrine without any effect on serotonin<sup>89</sup> whilst topiramate is a gamma-aminobutyric acid (GABA) receptor modulator that was first developed as an anticonvulsant.<sup>80</sup> In combination, phentermine and topiramate increase energy expenditure, and reduce energy efficiency and caloric intake.<sup>89</sup>

The benefits of combining these drugs are:<sup>89</sup>

- It provides greater weight loss than either drug alone
- Using a lower dose of each drug hence, minimising their side effects
- Targeting multiple mechanisms to alter the energy balance

The efficacy of phentermine/topiramate compared to placebo for weight loss are:<sup>79</sup> **[Level 1++]**

- OR 9.1 for 5% weight loss
- OR 11.3 for 10% weight loss
- Mean weight loss in excess of placebo was 8.8 kg

Though phentermine alone has been associated with elevations in BP, the higher dose of phentermine/topiramate, i.e., 15 mg/92 mg has demonstrated reduction in BP. This combination also reduces glucose and lipid levels.<sup>89</sup> **[Level 1++]**

Side effects of the combination treatment are:<sup>89</sup> **[Level 1++]**

- Most common – paraesthesia, dry mouth, constipation, dysgeusia and insomnia
- Mood-related (depression, anxiety and irritability) and cognition-related (disturbance in attention) are seen at higher doses (15 mg/92 mg) – use with caution in patients with known depressive or anxiety disorders
- Non-significant increase in resting heart rate secondary to the sympathomimetic action of phentermine can occur at high doses (15 mg/92 mg)
- Teratogenic effects such as cleft lip/palate – due to topiramate if taken during pregnancy (Pregnancy category D)

### 4. Oral naltrexone/bupropion

Naltrexone is an opioid antagonist<sup>80</sup> used in alcohol and opioid dependence. It blocks opioid-mediated pro-opiomelanocortin (POMC) auto-inhibition by endogenous β-endorphins.<sup>95</sup>

The effects of bupropion are:<sup>96</sup>

- Inhibiting the reuptake of dopamine and norepinephrine
- Stimulating the hypothalamic POMC neurons in the arcuate nucleus that secrete α-melanocyte stimulating hormone (MSH) which mediates anorectic effects and regulates energy balance. However, POMC neurons also secrete β-endorphins that act in an auto-inhibitory manner via negative feedback by binding to opioid receptors situated on the POMC neurons.

Bupropion is also used as an anti-depressant and smoking cessation agent.<sup>96</sup>

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Therefore, combining naltrexone with bupropion potentiates the release of α-MSH and the anorexic effect of bupropion.<sup>96,97</sup> The synergistic effect of both agents suppresses appetite, controls eating behaviour and response to food craving<sup>95</sup> and produces greater weight loss than either agent alone.<sup>98</sup> **[Level 1++]**

The efficacy of combining naltrexone with bupropion compared to placebo on weight loss:<sup>79</sup> **[Level 1++]**

- OR 3.9 for 5% weight loss
- OR 4.11 for 10% weight loss
- Mean weight loss in excess of placebo was 4.95 kg

The combination also demonstrated significant difference in ability to control eating compared to placebo.<sup>95,97</sup> **[Level 1++]**

**48** Other beneficial effects of combining naltrexone and bupropion combination are:<sup>95-97</sup> **[Level 1++]**

- Reduction in glucose levels
- Reduction in requirement for glucose lowering drugs in T2DM
- Reduction of insulin resistance
- Reduction of lipid levels

The adverse sympathomimetic properties of bupropion on BP and heart rate, however, attenuate the benefits of weight loss on BP and pulse rate.<sup>96,97</sup> **[Level 1++]**

The most common side effect of combining naltrexone and bupropion is nausea.<sup>96</sup> **[Level 1++]**

Though there was no increase in depression or suicidal ideations,<sup>96,99</sup> **[Level 1++]** it is important to note that patients with serious psychiatric illnesses were excluded from the naltrexone/bupropion phase III trials. Hence, these drugs should be used with caution in patients with known depression.

## 5. Subcutaneous liraglutide 3 mg daily

Liraglutide is a glucagon-like peptide-1 receptor agonist (GLP1-RA) that improves glycaemic control in T2DM by stimulating insulin secretion, suppressing glucagon secretion<sup>100</sup> and reducing caloric intake by suppressing appetite.<sup>100,101</sup>

Doses up to 1.8 mg daily have been approved for T2DM<sup>100</sup> while doses up to 3 mg daily are used for managing obesity.

The efficacy of achieving weight loss with liraglutide 3 mg daily compared to placebo:

- OR 5.09 for 5% weight loss
- OR 4.36 for 10% weight loss
- Mean weight loss in excess of placebo was 5.24 kg<sup>79</sup> **[Level 1++]**

Only liraglutide 3 mg has been compared head-to-head with an anti-obesity agent, orlistat in a RCT. Liraglutide 3 mg demonstrated greater efficacy in terms of weight loss.

Liraglutide 3 mg daily confers other beneficial effects such as:<sup>100,101</sup> **[Level 1++]**

- Reduction in HbA<sub>1c</sub>
- Reducing use of oral glucose lowering drugs in individuals with T2DM
- BP reduction
- Reducing insulin resistance
- Reducing lipid levels

Liraglutide 1.8 mg daily has shown improvement in CV outcomes in patients with T2DM.<sup>102</sup> **[Level 1++]** It also has a beneficial impact on metabolic associated fatty liver disease (MAFLD).<sup>103</sup> **[Level 1-]**

The side effects of liraglutide 3 mg daily are:<sup>100,101</sup> **[Level 1++]**

- Most common – GI side effects such as nausea, vomiting, diarrhoea and constipation
- Increase in resting heart rate

### 6. Subcutaneous semaglutide 2.4 mg weekly

Semaglutide is a GLP1-RA that improves glycaemic control in T2DM by stimulating insulin secretion and suppressing glucagon secretion,<sup>104</sup> and reducing caloric intake by suppressing appetite.<sup>84</sup>

Doses of up to 1 mg weekly are indicated for the treatment of T2DM,<sup>104</sup> **[Level 1++]** whilst doses up to 2.4 mg weekly are used for managing obesity in patients without diabetes.<sup>84</sup> **[Level 1++]**

The efficacy of semaglutide 2.4 mg weekly compared to placebo:<sup>84</sup> **[Level 1++]**

- OR 11.2 for 5% weight loss
- OR 14.7 for 10% weight loss
- OR 19.3 for 15% weight loss
- OR 26.9 for 20% weight loss
- Mean weight loss in excess of placebo was 12.7 kg

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Other beneficial effects of semaglutide 2.4 mg are:<sup>84</sup> **[Level 1++]**

- Reduction of HbA<sub>1c</sub>
- Lowering BP
- Reducing lipid levels

In patients with T2DM, semaglutide 0.5 mg and 1.0 mg weekly improved CV and renal outcomes.<sup>104</sup> **[Level 1++]** Low dose semaglutide also has a beneficial impact on MAFLD.<sup>103</sup> **[Level 1-]**

The side effects of semaglutide 2.4 mg weekly:

- Most common – GI side effects such as nausea, vomiting, diarrhoea and constipation
- Very rare – acute pancreatitis and cholelithiasis

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The rapid improvement of glycaemia in T2DM patients with baseline retinopathy resulted in early transient worsening of retinopathy when treated with semaglutide 0.5-1.0 mg weekly.<sup>104</sup> **[Level 1++]** Patients with obesity and T2DM with retinopathy treated with semaglutide should be monitored closely and co-managed with an ophthalmologist.

### Key learning points:

- Pharmacotherapy for obesity is indicated and effective in those with BMI  $\geq 30\text{kg}/\text{m}^2$  or BMI  $\geq 27.5\text{kg}/\text{m}^2$  with comorbidities
- Pharmacotherapy for obesity should only be used as an adjunct to lifestyle/ behavioural modifications
- There are 5 USFDA approved drugs for chronic management of obesity, i.e., orlistat, phentermine/topiramate, naltrexone/bupropion, and high dose liraglutide and semaglutide
- Phentermine monotherapy can also be used. However, it is indicated only for the short-term management of obesity, i.e., for periods of no longer than 3 months and/or in a cyclical manner
- While there are no RCTs with head-to-head comparisons of the different anti-obesity agents – phentermine/topiramate and high-dose semaglutide 2.4 mg weekly resulted in the largest magnitude of weight loss of  $>10\%$
- Careful consideration of the side effects of these drugs is required before initiation
- GLP1-RAs such as liraglutide and semaglutide have the added benefit of improving glycaemic control, MAFLD and cardiorenal outcomes in patients with both T2DM and obesity

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### Recommendations 5

- Pharmacotherapy for obesity should be used only as an adjunct to diet, exercise and behavioural modification and not alone. [Grade A]
- Pharmacotherapy for obesity is indicated in patients with BMI  $\geq 30\text{ kg}/\text{m}^2$  without comorbidities and BMI  $\geq 27\text{ kg}/\text{m}^2$  with comorbidity. [Grade A]
- Pharmacotherapy that may be prescribed are:
  - › Orlistat
  - › Combination of phentermine and topiramate
  - › Combination of naltrexone and bupropion
  - › High dose liraglutide
  - › High dose semaglutide[Grade A]
- Anti-obesity treatments should be used with medical supervision and careful monitoring. [Grade B]

**Table 4-5. Pharmacotherapy for obesity**

<b>Drug</b>	<b>Dosage<sup>79</sup></b>	<b>Class/MoA</b>	<b>Weight loss vs lifestyle intervention<sup>79,80</sup></b>	<b>Common side effects<sup>80</sup></b>	<b>Warnings and precautions<sup>85</sup></b>	<b>Contraindications<sup>80</sup></b>
<b>Phentermine</b>	15 to 30 mg OD	Sympathomimetic amine/↑ appetite	3.6 kg	Headache, ↑ BP, palpitations, ischaemic events, insomnia, dry mouth, constipation, anxiety, psychosis	Only indicated for short-term use (3 months) Can be used cyclically Precautions in poorly controlled BP and CAD Rare cases of pulmonary hypertension, regurgitant valvular disease Risk of abuse and dependence	Pregnancy/breastfeeding, anxiety disorders, uncontrolled hypertension, seizures, hyperthyroidism, history of CVD (CAD, stroke, arrhythmias, heart failure)
<b>Orlistat</b>	120 mg TDS	Lipase inhibitor/ ↓ GI fat absorption	2.63 kg*	% Weight loss from baseline: 2.9-3.4%	Liquid or oily stool, oil leakage from rectum and flatulence	Pregnancy/breastfeeding, drug interactions (cyclosporine, thyroxine, warfarin, anticonvulsants), chronic malabsorption syndrome, cholestasis

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Drug	Dosage <sup>79</sup>	Class/MoA	Weight loss vs lifestyle intervention <sup>79,80</sup>	Common side effects <sup>80</sup>	Warnings and precautions <sup>80</sup>	Contraindications <sup>80</sup>
<b>Phentermine/ topiramate</b>	Starting dose: 3.75/23 mg OD  Recommended dose: 7.5/46 mg OD  High dose: 15/92 mg OD	Phentermine -NE releasing agent  Topiramate -GABA receptor modulation	8.8 kg*  % Weight loss from baseline: 8-1%	Insomnia, dry mouth, constipation, paraesthesia, dizziness, dysgeusia	Foetal toxicity – ensure negative UPT before starting treatment & monthly thereafter + utilisation of effective contraception	Pregnancy – Class D. teratogenic (cleft lip/ palate)  Breastfeeding
<b>Naltrexone/ bupropion</b>	High dose: 32/360 mg (2 tablets) QID	Bupropion – Inhibits reuptake of dopamine and NE  Naltrexone – Opioid antagonist	4.95 kg*  % Weight loss from baseline: 5-6%	Nausea, constipation, headache, vomiting, dizziness	Use with caution in patients with depression  Boxed Warning – Caution in patients with suicidal behaviour & ideation	Pregnancy  Uncontrolled HTN  Seizure disorders  Anorexia nervosa or bulimia  Drug/alcohol withdrawal  MAO inhibitors  Chronic opioid use  Glaucoma  1 BP/HR – Careful monitoring if used for patients with CVD  Hepatotoxicity

## 4. Management of obesity in adults

Drug	Dosage <sup>79</sup>	Weight loss vs lifestyle intervention <sup>79,80</sup>	Class/MoA	Common side effects <sup>80</sup>	Warnings and precautions <sup>80</sup>	Contraindications <sup>80</sup>
<b>Liraglutide (Subcutaneous)</b>	3 mg daily	5.24 kg*	GLP1-RA	Nausea, vomiting % Weight loss from baseline: 6-7%	Boxed Warning – Risk of thyroid C-cell tumours and contraindicated in MTC/MEN2 Warnings – Acute pancreatitis/gall-bladder disease Hypoglycaemia in combination with insulin/secretagogues	Caution in renal impairment – Post marketing reports of acute kidney injury or worsening of chronic kidney impairment Pregnancy Personal or family history of MTC or MEN2
<b>Semaglutide (Subcutaneous)<sup>80</sup></b>	2.4 mg weekly  Starting dose: 0.25 mg weekly  Increase every 4 weeks over 16 weeks till 2.4 mg	12.7 kg*  % Weight loss from baseline: 14.9 %	GLP1-RA	Nausea, vomiting	Boxed warning: thyroid C-cell tumours, contraindicated in MTC/MEN2 Warnings: acute pancreatitis/gall-bladder disease Hypoglycaemia in combination with insulin/secretagogues Transient worsening retinopathy in T2DM with baseline retinopathy and rapid improvement in glycaemic control	eGFR <15 ml/min Pregnancy Personal or family history of MTC or MEN2

\*mean weight loss in excess of placebo.

BP, blood pressure; CAD, coronary artery disease; CVD, cardiovascular disease; eGFR, estimated glomerular filtration rate; GABA, gamma aminobutyric acid; GI, gastrointestinal; GLP1-RA, glucagon-like peptide 1 receptor agonist; HR, heart rate; HTN, hypertension; MAO, mono-amine oxidase; MEN, multiple endocrine neoplasia; MTC, medullary thyroid carcinoma; NE, norepinephrine; OD, once daily; QID, 4 times daily; T2DM, type 2 diabetes mellitus; TDS, three times a day; UPT, urine pregnancy test.

### 4.3 Surgical procedures

Refer to the Malaysian Consensus for patient and procedure selection for bariatric and metabolic surgery for full details.<sup>105</sup>

The basis for bariatric surgery is to accomplish weight loss in severely obese individuals who have been unable to sustain weight loss by non-surgical means.

Weight loss induced by surgery:<sup>106</sup> **[Level 2++]** **[Grade B]**

- Reduces CV disease risk
- Resolves or improves pulmonary diseases such as OSA and asthma
- Reduces disabilities from joint disease
- Improves MAFLD
- Improves renal function and urinary incontinence

The ultimate benefit of surgery is weight loss and control, and the remission of obesity's metabolic component. Its effects are dependent on the type of procedures performed.

The procedures are:

- Roux-En-Y gastric bypass (RYGB)
- Sleeve gastrectomy (SG)
- Abdominal gastric banding (AGB)

#### 4.3.1 Efficacy of the different procedures

The percentage weight loss at 1-year:<sup>107</sup> **[Level 1+]** **[Grade A]**

- 31.2% (95% CI 31.1, 31.3) for RYGB
- 25.2 % (95% CI 25.1, 25.4) for SG
- 13.7 % (95% CI 13.3, 14.0) for AGB

The 5-year mean percentage weight loss:<sup>107</sup> **[Level 1+]** **[Grade A]**

- 25.5 % (95% CI 25.1, 25.9) for RYGB
- 18.8 % (95% CI 18.0, 19.6) for SG
- 11.7 % (95% CI 10.2, 13.1) for AGB

The excess weight loss percentage at 3- and 5 years for RYGB patients was greater (mean difference 11.93, p<0.000001 and 13.11, p=0.0004, respectively). Excess weight loss was significantly more important after one AGB than after RYGB after one year (mean difference -10.82, p=0.003).<sup>108</sup> **[Level 1+]** **[Grade A]**

## 4. Management of obesity in adults

A network meta-analysis to determine the control or remission of T2DM demonstrated:<sup>109</sup> **[Level 1++]** **[Grade A]**

- Mini-gastric bypass (MGB) was significantly more efficacious than laparoscopic SG (LSG) and AGB (Relative risk [RR] 1.85, 95% CI 1.15, 2.97 and RR 4.43, 95% CI 1.69, 11.15), respectively.
- MGB was marginally more efficacious than RYGB (RR 1.64, 95% CI 0.99, 2.71)
- RYGB was significantly more efficacious than AGB (RR 2.65, 95% CI 1.16, 6.07).
- RYGB was marginally more efficacious than LSG (RR 1.13, 95% CI 0.94, 1.36)
- LSG was significantly more efficacious than laparoscopic AGB (RR 2.35, 95% CI 1.02, 5.41).

In a Finnish multicentre randomised trial (SLEEVEPASS) of 240 patients with severe obesity, patients who had undergone RYGB had slightly greater percent excess weight loss than patients who had undergone SG at all time points, including at seven years (47 %; 95% CI 43%, 50% after SG vs 55%; 95% CI 52%, 59 % after RYGB).<sup>110</sup> **[Level 1++]** **[Grade A]** However, the overall morbidity rate after SG was 24% (29 of 121 patients) and 28.6% (34 of 199 patients) after RYGB.

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In a Swiss multicentre randomised trial (SM-BOSS) of 217 patients with BMI between 35 and 61 kg/m<sup>2</sup>, there was no significant difference in weight loss at 1-, 2- and 5-years after RYGB compared with SG. At five years, patients-maintained 61.1% excess BMI loss with SG versus 68.3% excess BMI loss with RYGB. Gastric reflux remission was observed more in RYGB (60.4%) compared to those who underwent laparoscopic SG (25%).<sup>111</sup> **[Level 1++]** **[Grade A]**

### 4.3.2 Preoperative assessment and preparation

Preoperative assessment and preparation are important for individuals undergoing bariatric surgery. This includes psychological, appropriate surgical risk and comorbidities assessments to ensure the success of the procedure and expected weight loss. Psychological assessment may identify individuals with psychopathology and predict the post-operative weight loss. Surgery is not contraindicated in patients with mood and anxiety, or binge eating disorders provided they receive appropriate medical treatment.<sup>112</sup> **[Level 1++]** **[Grade A]**

It is also imperative to ensure some percentage of weight loss prior to surgery.<sup>113</sup> **[Grade 3]** **[Level C]**

- Patients who achieved preoperative weight loss were less likely to be lost to follow-up ( $p=0.023$ )
- Postoperative weight loss was better in patients who could lose  $\geq 5\%$  total weight preoperatively ( $p=0.009$ ) in patient undergoing LSG and laparoscopic RYGB (LRYGB)

However, even though preoperative weight loss is important, it does not lead to reduction in perioperative mortality and comorbidities.<sup>114</sup> **[Level 1+] [Grade A]**

Patients who achieved  $\geq 8\%$  excess weight loss during 4 weeks of preoperative low-calorie diet (1200 kcal/day) experienced a significantly higher average percentage of excess weight loss at month 3 ( $42.3\% \pm 13.2\%$  vs  $36.1\% \pm 10.9\%$ ,  $p<0.001$ ), month 6 ( $56.0\% \pm 18.1\%$  vs  $47.5\% \pm 14.1\%$ ,  $p<0.001$ ) and month 12 ( $65.1\% \pm 23.3\%$  vs  $55.7\% \pm 22.2\%$ ,  $p=0.003$ ), postoperatively.<sup>115</sup> **[Level 3] [Grade C]**

Screening for OSA using the STOP-BANG criteria and utilisation of perioperative continuous positive airway pressure (CPAP) should be considered in patients with severe OSA who are undergoing bariatric surgery. Intensive care should also be given to patients at risk. Perioperative CPAP has been proven to be effective in controlling respiratory complications in bariatric surgery patients.<sup>116</sup> **[Level 2+] [Grade B]**

#### 4.3.3 Indications for bariatric surgery

The BMI and health outcomes of obesity of the Asian and European populations differ. Hence, the bariatric experts in the Asia-Pacific region recommend that the surgical approach may be considered as a non-primary alternative to treat inadequately controlled T2DM or metabolic syndrome for suitable Asian candidates with a BMI  $\geq 27.5\text{kg}/\text{m}^2$ .<sup>117</sup> **[Level 2++]** **[Grade B]**

In 2021, the Malaysian Bariatric and Metabolic Working Committee published a consensus statement on the indications for bariatric surgery (Table 4-6).<sup>105</sup> **[Level 4]** **[Grade D]**

**Table 4-6. Indications for bariatric surgery<sup>105</sup>**

<b>Morbid obesity without any comorbidities</b>	Bariatric surgery should be considered for the treatment of obesity in suitable patients with BMI $\geq 37.5\text{ kg}/\text{m}^2$ who fulfil the selection criteria
<b>Morbid obesity with metabolic syndrome</b>	The surgical approach may be considered as a non-primary alternative to treat obesity in suitable patients with BMI $\geq 32.5\text{ kg}/\text{m}^2$ with metabolic syndrome or CV risk following inadequate weight loss by virtue of medical therapy and lifestyle modifications
<b>Low BMI with or without comorbidities</b>	Any surgery for metabolic syndrome or obesity related comorbidity in patients with a BMI $<32.5\text{kg}/\text{m}^2$ <b>should not be a routine clinical practice</b> and should be strictly performed <b>only under clinical study protocol</b> with informed consent from the patient and prior approval from an ethics committee

## 4. Management of obesity in adults

<b>Age restriction</b>	Bariatric surgery is recommended for patients between the ages of 18 and 65 years
<b>Special circumstances</b>	Upon consultation with a physician, paediatrician, orthopaedic surgeon, clinical psychologist, or a surgeon, bariatric surgery may be performed in morbidly obese adolescent patients provided they have attained the physiological bone maturity consistent with Tanner stage 4

BMI, body mass index.

The indications, patient criteria and type of procedure for bariatric and metabolic surgery in Malaysia are based on the consensus reached by the Bariatric Metabolic Framework Committee, Ministry of Health, Malaysia (previously known as the Bariatric Metabolic Working Committee of Malaysia).<sup>105</sup> **[Level 4] [Grade D]**

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### 4.3.4 Patient selection criteria for bariatric surgery

Patients undergoing bariatric surgery should fulfil the following criteria:

- Weight loss history: Previous non-surgical attempts at weight reduction for at least six months
- Demonstrated patient commitment:
  - › Follow-up visits with healthcare teams, voluntary participation in support groups and other recommendations made by their healthcare team
  - › Compliance with instructions regarding any recommended medical management, procedures or tests including the use of dietary supplements and exercise routines
  - › Smoking cessation for a minimum of 4 weeks before surgery

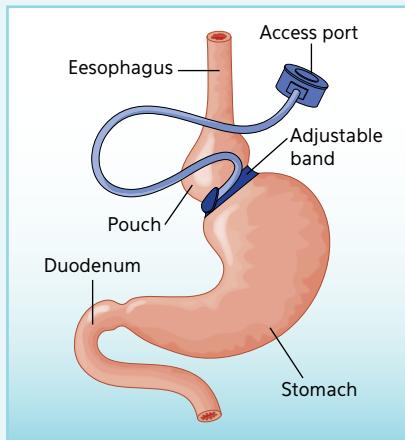
### 4.3.5 Types of bariatric procedures

The two types of bariatric surgery are restrictive and malabsorption.

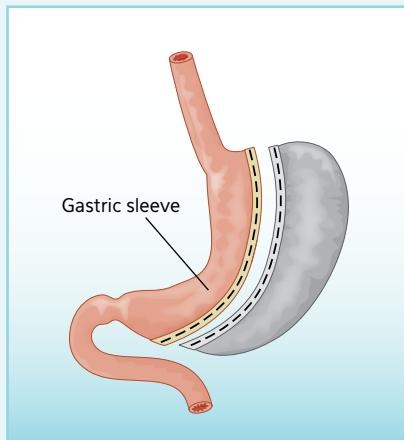
#### Restrictive procedures

1. Gastric banding
2. Sleeve gastrectomy

**Figure 4-A. Diagrammatic representation of gastric banding**



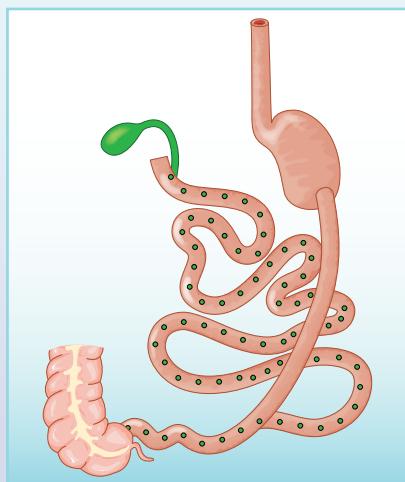
**Figure 4-B. Diagrammatic representation of SG**



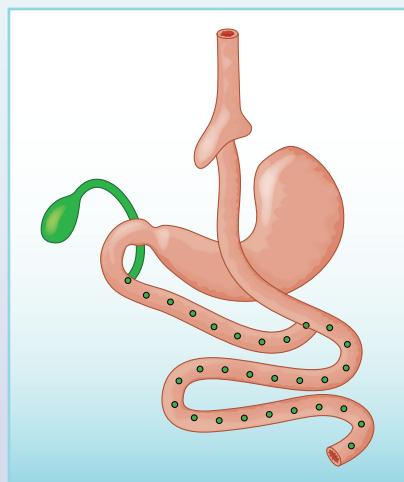
### Malabsorption procedures

1. Biliopancreatic diversion/duodenal switch (BPD/DS)
2. Roux-en-Y gastric bypass
3. Mini gastric bypass (MBG) or one anastomosis gastric bypass (AGB)

**Figure 4-C. Diagrammatic representation of a biliopancreatic diversion**

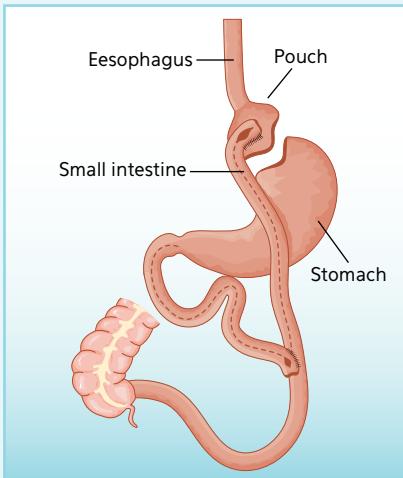


**Figure 4-D. Diagrammatic representation of a one anastomosis gastric bypass**



## 4. Management of obesity in adults

**Figure 4-E. Diagrammatic representation of a laparoscopic gastric bypass**



The complications of bariatric procedures are:<sup>118</sup> **[Level 2++]** **[Grade B]**

- RYGB: Complications of this procedure can be diverse and include gastric remnant distension, stomal stenosis, marginal ulcer formation, cholelithiasis, ventral hernias, internal hernias, small bowel obstructions, hypoglycaemia, dumping, metabolic and nutritional derangements, gastrogastric fistulas, and weight regain. Some complications are seen during the early post-operative period while others may present weeks to months following the surgery
- LSG: Complications of LGS include bleeding, narrowing or stenosis, leaks, and reflux

- One ABG/MBG: Complications include bleeding, anastomotic site stenosis, marginal ulcer formation, anastomosis leak and bile reflux<sup>119</sup> **[Level 2+]** **[Grade C]**
- AGB: Complications from AGB include band erosion, band slippage, port or tubing malfunction, stomal obstruction, port infection and insufficient weight loss<sup>120</sup> **[Level 2+]** **[Grade C]**

The following are contraindications for bariatric surgery:<sup>105</sup> **[Grade 2+]** **[Grade C]**

- Pregnancy
- Patients who are unable to comply to continuous medical follow-up as required
- Patients with non-stabilised psychotic disorders, severe depression or personality, and eating disorders, unless specifically advised by a psychiatrist/psychologist
- Patients with reversible endocrine disorders that cause obesity
- Alcohol abuse and/or drug dependencies
- Patients with short-term life-threatening diseases (ASA-4)
- Patients who are unable to care for themselves and have no long-term family or social support to provide such care

Post-operative care includes the use of proton-pump inhibitors (PPI) to prevent marginal ulcers, supplementation of micro and/or macronutrients, behavioural and nutritional advice and to delay pregnancy until weight stabilises.

### 4.3.6 Intragastric balloon (special non-operative procedure)

#### Efficacy

Intragastric balloon (IGB) is capable of producing 6-15% of total body weight loss (TBWL) compared with the 1-5% produced through lifestyle interventions alone.<sup>121</sup>

#### [Level 1++][Grade A]

A meta-analysis of 55 studies involving 6654 Orbera balloon implantations demonstrated pooled estimate of TBWL of:<sup>122</sup>

- 12.3% (95% CI 7.91, 16.73) at 3 months
- 13.16% (95% CI 12.37, 13.95) at 6 months
- 11.27% (95% CI 8.17, 14.36) at 12 months

#### Sustained weight loss

Although IGB is safe and effective in managing obesity for the short term, it is a temporary measure, and weight regain is expected after removal.

In a study involving 500 patients who underwent 6 months of treatment with IGB therapy:<sup>123</sup>

- Only 50% maintained a 20% excess weight loss at 1 year after balloon removal
- 25% maintained their weight loss (20% excess weight loss) at 5 years
- By 10 years, there was no difference between IGB therapy and lifestyle changes

#### Improvement in metabolic parameters

IGB therapy has shown improvement in metabolic parameters among patients who successfully lose weight.<sup>124</sup>

In a meta-analysis of 10 trials and 30 observational studies, there was moderate quality but mostly short-term evidence for improvement in most metabolic parameters after IGB therapy compared with lifestyle intervention.<sup>125</sup>

#### [Grade A]

#### Safety

The safety profile for IGB therapy depend on its type (fluid or gas filled) and how it was placed (endoscopically or swallowed).

- Gas-filled balloon systems are better tolerated than fluid-filled systems
- IGB that are swallowed cause fewer serious complications and death vs endoscopically-placed balloons

All patients undergoing IGB should be tested and treated for *Helicobacter pylori* before placement, and should receive PPI treatment while the balloon is in place to reduce the risk of gastric ulceration.

## 4. Management of obesity in adults

### *Fluid-filled endoscopically placed balloons*

- In a retrospective analysis of over 1000 procedures performed between 2016 and 2017, 7.2% of patients required treatment for dehydration, 2.0% required readmission, 1.1% required reoperation and 6.2% required intervention within 30 days<sup>126</sup> **[Level 3] [Grade D]**
- In another study of over 145,000 patients, IGB therapy was associated with a higher adverse event rate than laparoscopic bariatric surgery (OR 1.97, 95% CI 1.10, 3.52) due to a significantly higher non-operative reintervention rate (4.2% vs 1.0%)<sup>127</sup> **[Level 2+] [Grade C]**

### *Adverse events*

Common adverse events: At the beginning of IGB therapy, up to 91% of patients will develop some form of GI symptoms due to gastric accommodation to the balloon. Typical symptoms include nausea, vomiting, abdominal pain, acid reflux, burping, dyspepsia, and constipation.

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Early balloon removal may be necessary if symptoms persist. 4-7% percent continue to experience significant GI symptoms after the first week of therapy, and even fewer events (<3%) required endoscopic reintervention or early balloon removal.

Serious adverse events: In a meta-analysis, the incidence of balloon migration, gastric perforation, and mortality were 1.4%, 0.1%, 0.08%, respectively. Serious adverse events may be related to either the balloon or the procedure.<sup>122</sup> **[Level 1++]** **[Grade A]**

Balloon-related serious adverse events: These include balloon migration, gastric or esophageal perforation, and gastric ulceration. Serious adverse events that are largely unique to liquid-filled balloons include spontaneous hyperinflation and acute pancreatitis.

- Balloon migration – IGB left in the stomach longer than the intended duration of therapy are at risk of rupturing and migrating into the intestine. While most migrated balloons were excreted successfully, some caused intestinal obstructions
- Spontaneous hyperinflation – Hyperinflation involves the spontaneous filling of intragastric balloons with additional air or liquid while inside a patient's stomach resulting in the need for early removal
- Acute pancreatitis – Caused by direct injury from the balloon and distended stomach exerting pressure on the pancreatic parenchyma and/or indirect pancreatic injury through duodenal obstruction. Although acute pancreatitis can develop with any type of balloon, clinically it has been observed mostly with liquid-filled balloons

Procedure-related serious adverse events: Mostly occur during balloon removal, including esophageal tear, pneumonia, GI bleeding, and esophageal perforation.

Mortality: The FDA has issued multiple letters to alert health care providers of 18 reported deaths worldwide from 2016 to present in patients with liquid-filled IGB systems used to treat obesity. The incidence rate of death in those who received IGB therapy is not known. One systematic review published in 2016 showed a mortality rate of 0.05%, but that included many of the case series from the early 2000s. A meta-analysis of RCTs published in 2015 reported a 0% mortality rate in 20 studies and almost 1200 patients, but only with a 3-month follow-up.<sup>128</sup> **[Level 1++]** **[Grade A]**

Gas-filled or procedure-less balloons: Generally better tolerated than fluid-filled ones. In a prospective registry of 1343 patients, symptoms of nausea, vomiting, and abdominal pain occurred in 2.3-5.3%, and any GI symptom occurred in 13.4% of patients. While the rate of serious adverse events with the procedure-less balloon is similar to that of the gas-filled IGB, post-placement accommodative symptoms may be more similar to those of other fluid-filled balloons.

### Outcomes

- Overall percentage of patients successfully achieving weight loss and improvement in hepatic transaminases<sup>129</sup> **[Level 1++]** **[Grade A]**
  - › Weight loss achieved and improvement in hepatic amino transferases: Two studies reported outcomes based on the proportion of patients who successfully achieved >10% TBWL
  - › Overall, 86/141 (60.9%) patients were able to achieve this target. 112/182 (61.5%) patients achieved >20% excess weight loss
- TBWL – IGB favoured TBWL<sup>130</sup> **[Level 2++]** **[Grade B]**
  - › At 6 months (9.75 vs 7.48 kg, p=0.03)
  - › At 12 months (6.52 vs 4.42 kg, p=0.05)
  - › At 18 months (5.42 vs 3.57 kg, p=0.32)
  - › At 24 months (4.07 vs 2.93 kg, p=0.56)
  - › Total weight loss was maximal at 6 months post-intervention, and differences between groups (compared to Sibutramine) were significant at 6 months
- Bridging before bariatric surgery<sup>131</sup> **[Grade 2+]** **[Grade C]**
  - › During the time period of IGB treatment ( $168.1 \pm 43.1$  days), patients experienced a weight loss of  $17.3 \pm 14.1$  kg (BMI  $5.75 \pm 4.66$  kg/m<sup>2</sup>)
  - › Most of the patients with IGB showed a nadir of weight loss after 5 months with slight weight regain during the further course of treatment

## 4. Management of obesity in adults

**Table 4-7. Recommendation for IGB<sup>132</sup> [Level 1++][Grade A]**

Recommendation	Strength of recommendation	Quality of evidence
Use of IGB therapy with lifestyle modification over lifestyle modification alone in the individuals with obesity seeking a weight loss intervention who have failed a trial of conventional weight loss strategies	Conditional	Moderate
Moderate to high intensity concomitant lifestyle modification interventions to maintain and augment weight loss in individuals with obesity undergoing IGB therapy	Strong	Moderate
Prophylaxis with PPIs in individuals undergoing IGB therapy	Strong	Moderate
Intraoperative anesthetic regimens associated with the lowest incidence of nausea along with perioperative antiemetics in individuals undergoing IGB therapy	Conditional	Low
There needs a scheduled antiemetic regimen for 2 weeks after IGB placement	Conditional	Low
Perioperative laboratory screening for nutritional deficiencies in individuals undergoing IGB therapy	Conditional	Very Low
Daily supplementation with 1-2 adult dose multivitamins after IGB placement	Conditional	Very Low
After IGB removal, suggest subsequent weight-loss or maintenance interventions that include dietary interventions, pharmacotherapy, repeat IGB, or bariatric surgery. The choice of weight-loss or maintenance method after IGB is determined based on patient's context and comorbidities following a shared decision-making approach	Conditional	Very Low

### Recommendations 6

- Bariatric surgery should only be performed in individuals with morbid obesity who fail medical therapy. [Grade B]
- Roux-En-Y gastric bypass surgery may be considered [Grade A]
- A comprehensive preoperative assessment and preparation should be done before bariatric surgery. [Grade B]

# 5. Management of childhood and adolescent obesity

## 5.1 Prevalence of childhood and adolescent obesity

Temporal trends demonstrating a rise in the prevalence of overweight and obesity among children and adolescents have been documented worldwide.

Findings from the 2019 National Health and Morbidity Survey (NHMS) showed that,<sup>133</sup>

- 29.8% of children from ages 5-17 years (of which 15.0% were adolescents) were either overweight or obese
- Prevalence of obesity alone among children and adolescents has steadily risen (3.9% in 2011 to 14.8% in 2019)

Childhood overweight and obesity is a significant public health concern given the adverse effects on the health and quality of life in childhood, as well as the increased risk of obesity and associated health complications in adulthood.

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## 5.2 Diagnosis of childhood and adolescent obesity

Body mass index (BMI) is the accepted standard for determining overweight and obesity prevalence in children and adolescents.<sup>134</sup>

- In children, as the BMI changes with age, the BMI-for-age percentiles are more useful in the clinical setting
- BMI in children increases from birth until 1 year of age and subsequently decreases until ages 5-9 years old
- An early BMI rebound before 5 years of age carries a risk for adult obesity and could help identify which children are most likely to become overweight or obese in adulthood

The diagnosis of overweight or obesity in children and adolescents should be based on the BMI and the World Health Organization (WHO) 2007 reference system (Table 5-1).<sup>135</sup> In cases of extreme obesity, the United States Centres for Disease Control (US CDC) normative BMI percentiles can also be used – the definition of extreme obesity is BMI  $\geq 120\%$  of the 95<sup>th</sup> percentile of the US CDC growth charts or a BMI  $\geq 35 \text{ kg/m}^2$ .<sup>136</sup>

## 5. Management of childhood and adolescent obesity

**Table 5-1. Diagnosis of overweight and obesity in children and adolescents**

<b>Age (years)</b>	<b>Overweight</b>	<b>Obese</b>
<b>5-19</b>	BMI >1 SD above the WHO Growth Reference median	BMI >2 SD above the WHO Growth Reference median
<b>Under-5</b>	BMI >2 SD above the WHO Child Growth Standards median	BMI >3 SD above the WHO Child Growth Standards median

BMI, body mass index; SD, standard deviation; WHO, World Health Organization.

### 5.3 Clinical evaluation

The objectives of performing a clinical evaluation in children and adolescents who are overweight or obese are to:

- Determine any pathological causes of obesity
- Assess lifestyle and eating habits, and their contribution to the aetiology of obesity
- Ascertain the presence of obesity-related comorbidities

#### 5.3.1 Assessing causes of obesity in children and adolescents

##### Primary obesity

The vast majority (>95%) of children will have primary or exogenous obesity. In addition to the obvious environmental drivers, multiple common and rare genetic variants contribute to substantial heritability for BMI and waist circumference (WC).<sup>137</sup> Children with primary obesity usually have accelerated growth. These children are at risk for early development of secondary sexual characteristics and may have advanced bone age.<sup>136</sup>

##### Secondary obesity

Pathological causes or secondary obesity are uncommon but should be carefully considered, such as endocrinopathies (Cushing's syndrome, hypothyroidism and hypopituitarism), and syndromic/genetic conditions (e.g., pseudohypoparathyroidism and Prader Willi syndrome). Children with endocrinopathies may have decreased linear growth or short stature.<sup>138</sup> Clinicians should refer maturing children who are obese with short stature and decreased growth velocity despite continued weight gain for further evaluation.

Patients with genetic obesity usually have an early onset of obesity (<5 years of age), clinical features of genetic obesity syndromes and/or a family history of extreme obesity.<sup>139</sup>

## 5. Management of childhood and adolescent obesity

These children may also have other features that should be identified during clinical assessment, such as:<sup>139</sup>

- Short stature
- Dysmorphic facies
- Retinitis pigmentosa
- Deafness
- Polydactyly
- Hyperphagia

Consanguinity may also be indicative of autosomal recessive obesity conditions. Genetic obesity syndromes can be classified into those:<sup>139</sup>

- With developmental delay (e.g., Prader Willi Syndrome, Albright hereditary osteodystrophy and Bardet-Biedl syndrome)
- Without developmental delay (e.g., Alstrom syndrome, Pro-opiomelanocortin [POMC] deficiency and Melanocortin 4 receptor [MC4R] deficiency)

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### 5.3.2 Patient history

A thorough medical and family history is crucial for assessing children with obesity to identify the underlying cause, rule out pathological causes of obesity and identify possible complications (refer to Table 5-2).<sup>136,140</sup>

Table 5-2. Assessing patient history

<b>Developmental</b>	<ul style="list-style-type: none"><li>• Type of delivery, birth weight and length, gestational age at birth, maternal gestational diabetes</li><li>• Infant feeding, including duration of breastfeeding</li><li>• Growth and development (e.g., age at which the child walked and talked)</li><li>• Schooling (e.g., academic performance)</li></ul>
<b>Physical and mental health</b>	<ul style="list-style-type: none"><li>• Weight history – onset of obesity, precipitating events, previous weight management interventions, behaviours, recent weight loss or gain</li><li>• Medications that may contribute to weight gain (e.g., glucocorticoids and psychoactive agents)</li><li>• Polyuria/polydipsia, blurring of vision, and vaginal discharge in girls</li><li>• Presence of frequent unexplained headaches, habitual snoring, restless sleep, morning headaches, generalized tiredness and/or excessive daytime sleepiness (sleeping routine and presence of snoring)</li></ul>

## 5. Management of childhood and adolescent obesity

<b>Physical and mental health</b>	<ul style="list-style-type: none"><li>Acne, hirsutism and pattern of menstruation to screen for the possibility of polycystic ovarian syndrome (PCOS)</li></ul>
<b>Health behaviours</b>	<ul style="list-style-type: none"><li>Dietary intake especially high intake of sugar-containing drinks and high-energy foods, and low intake of fruits and vegetables</li><li>Previous and current dietary behaviour, e.g., recurrent episodes of dieting, signs of pathological hyperphagia (such as eating large portions very quickly and difficulty to distract from food) and signs of disordered eating (such as binge eating)</li><li>Dietary pattern, e.g., eating breakfast and regular meals, snacking and eating prepared foods outside the home</li><li>Level of physical and sedentary (e.g., hours spent on screen-based activities per day) activities</li><li>Family capacity to make and sustain behavioural changes, and support behavioural change, including their financial capabilities</li></ul>
<b>Mental health</b>	<ul style="list-style-type: none"><li>Social isolation or risk of bullying</li></ul>

### 5.3.3 Physical examination

Clinicians should examine the following: **[Level 2+3]**

1. Weight, height and BMI
2. WC<sup>141</sup>
3. Blood pressure (BP) using height-age-sex percentile normalised BP tables to interpret the findings (refer to Appendix 4)
4. Acanthosis nigricans and skin tags
5. Dysmorphic features especially if there is concern of syndromic obesity (e.g., Prader-Willi, Albright Osteodystrophy and Alstrom Syndrome)
6. Fundoscopic examination
7. Thyroid examination for goitre
8. Tanner staging/extreme acne and hirsutism in pubertal girls
9. Abdominal examination for hepatomegaly
10. Musculoskeletal examination of the lower limbs – the clinician should be aware of the skeletal problems that occur in children with obesity. Young children with the bowed tibias of Blount's disease are usually ambulatory and may be "early walkers" and unaware of any problem<sup>142</sup>

## 5. Management of childhood and adolescent obesity

### 5.3.4 Investigations

#### For cause of obesity

Endocrine and genetic disorders as a cause for overweight/obesity are rare in children. If there are significant abnormalities in the history and physical examination indicative of a pathological cause of obesity, these patients should be referred to a tertiary centre for further evaluation and investigation.<sup>136</sup> **[Level 4]**

#### For comorbidities

Criteria for screening for comorbidities:<sup>136,142,143</sup> **[Level 4]**

1. Children and adolescents with obesity should be offered screening for related comorbidities
2. Overweight children and adolescents should be offered screening if ≥2 of the following risk factors is present:
  - Features suggestive of insulin resistance such as hypertension and acanthosis nigricans
  - Strong family history in first- or second-degree relatives of type 2 diabetes mellitus (T2DM), hypertension or premature coronary heart disease
  - History of maternal gestational diabetes mellitus
  - Birth history of small or large for gestational age
  - Signs and symptoms indicative of comorbidities, such as hyperglycaemia (polydipsia and polyuria), obstructive sleep apnoea ([OSA]; snoring, daytime somnolence and poor attention span), and hirsutism (PCOS)
3. Start screening for comorbidities at ages ≥10 years or at the onset of puberty, whichever comes first. However, if there are symptoms suggestive of comorbidities (polyuria, polydipsia, and others) or a rapid increase in BMI, it would be reasonable to screen earlier.

Children and adolescents with obesity should be offered screening for related comorbidities as detailed in Table 5-3.<sup>142</sup> **[Level 4]**

## 5. Management of childhood and adolescent obesity

Table 5-3. Screening for comorbidities of paediatric overweight/obesity

Comorbidities	Assessment
<b>Prehypertension/hypertension</b>	<ul style="list-style-type: none"><li>Diagnosis must be based on 3 separate measurements at least 1 week apart (refer to Appendix 4)</li></ul>
<b>Dyslipidaemia</b>	<ul style="list-style-type: none"><li>Fasting lipid profile</li><li>Typically, the dyslipidaemia of obesity is a high triglyceride and low high-density lipoprotein cholesterol (HDL-C) levels</li></ul>
<b>Prediabetes/diabetes mellitus</b>	<ul style="list-style-type: none"><li>Fasting plasma glucose or oral glucose tolerance test (OGTT) with glucose 1.75 g/kg (up to a maximum of 75 g)</li></ul>
<b>Microalbuminuria</b>	<ul style="list-style-type: none"><li>Urine microalbumin<sup>144,145</sup></li></ul>
<b>Metabolic associated fatty liver disease (MAFLD)</b>	<ul style="list-style-type: none"><li>Liver function test</li><li>Ultrasound of the hepatobiliary system if there is evidence of transaminitis</li></ul>
<b>Sleep disorders</b>	<ul style="list-style-type: none"><li>Varied presentations including apnoea associated with snoring or disrupted sleeping, daytime sleepiness, hyperactivity, depression, audible pauses in breathing, new onset nocturnal enuresis, irritability and learning difficulties</li><li>Referral for evaluation of OSA (e.g., polysomnography)</li></ul>
<b>PCOS/menstrual irregularities</b>	<ul style="list-style-type: none"><li>Testosterone and sex hormone binding globulin (SHBG)</li><li>Pelvic ultrasound, if indicated</li></ul>

### Recommendations 7

- BMI cut-offs using the WHO BMI-for-age chart should be used for the classification of overweight and obesity in children. [Grade C]
- Clinical evaluation (history and physical examination) should be performed to identify the aetiology of overweight and obesity and to rule out pathological causes. [Grade C]
- Children and adolescents with obesity should be offered screening for related comorbidities. [Grade C]
- Overweight children and adolescents should be offered screening if risk factors are present. [Grade C]

### 5.4 Management of obesity in children and adolescents

Obesity treatment in children and adolescents aims to reduce adiposity, improve complications and prevent the development of chronic diseases. In general, management principals in children and adolescents focus on changes in health behaviours that influence weight, i.e. dietary behaviours and physical activity, rather than on actual weight loss alone. The approach to weight management depends on the severity of obesity, the age and the developmental stage of the child and the preferences of the child and family.<sup>146</sup>

#### 5.4.1 Basic principles of management

Managing a child with obesity is age dependent (refer Table 5-4).<sup>142</sup> [Level 4]

**Table 5-4. Basic management principles for children and adolescents with obesity**

Age	Basic management
<b>Infants</b>	<ul style="list-style-type: none"><li>Exclusive breast feeding</li><li>Delay complementary food until 6 months of age</li><li>No sugar sweetened beverages</li><li>No screen time</li></ul>
<b>Toddlers (2-4 years old)</b>	<ul style="list-style-type: none"><li>Parents should model healthy behaviour habits</li><li>Three main meals with 1-2 snacks</li><li>Encourage routine sleep pattern</li></ul>
<b>Children (5-9 years old)</b>	<ul style="list-style-type: none"><li>Parents are important role models, involve family in the management</li><li>Recreational screen time should be kept to minimum</li><li>Activity should be done daily and as vigorously as possible</li></ul>
<b>Older children/ Adolescents</b>	<ul style="list-style-type: none"><li>Importance of peer group support</li><li>Regular sleep time</li><li>Use of technology to track exercise and meal intake</li></ul>

### 5.4.2 Family involvement

The involvement of family is crucial for managing obesity in children and adolescents.

- Findings from a recent meta-analysis suggest that family-based therapy is effective for treating obesity<sup>147</sup>
- In addition, studies involving weight loss among obese children and adolescents demonstrate the lack of parental inclusion resulted in non-significant weight loss<sup>148</sup>
- Family involvement should start from the first consultation through to the development of a care plan

A supportive and collaborative relationship between the healthcare professional, the young person and their parents/carers is important for the success of any intervention.

- When providing interventions for children and adolescents with overweight and obesity, it is also necessary to focus on family health behaviours<sup>148</sup> **[Level 1+]**
- Parents should be supported and encouraged as they make changes for the whole family and for themselves
- The level of family involvement among adolescents will depend on their age and maturity<sup>149</sup>

Possible approaches to implementing behavioural change in families include: ; **Level 4]**

- Making small, sustainable behavioural changes at a time
- Eating together
- Developing family-based goals for behaviour changes

### 5.4.3 Structured approach to management of obesity

A step or staged approach for weight management in the paediatric population consisting of 3 steps is recommended.<sup>142</sup> **[Level 4]**

1. Structured weight management
2. Multidisciplinary management
3. Tertiary care management

## 5. Management of childhood and adolescent obesity

Table 5-5. Staged approach to obesity management in children and adolescents

Stage	Components	Implementation	Frequency of visits
1	<ul style="list-style-type: none"><li>• Develop a structured plan with the patient and family</li><li>• Provide a log book for monitoring</li><li>• Should be done under parental supervision</li><li>• Diet:<ul style="list-style-type: none"><li>› Address eating behaviours</li><li>› Should include ≥5 servings of fruits and vegetables/day</li><li>› Eliminate sugar sweetened beverages</li></ul></li><li>• Physical activity:<ul style="list-style-type: none"><li>› Aim for a daily average of 60 minutes or more of physical activity</li><li>› Reduce recreational screen time to &lt;2 hours/day</li></ul></li></ul>	Primary care	3-6 monthly
2	<ul style="list-style-type: none"><li>• Continue diet and physical activity intervention</li><li>• Multidisciplinary approach that should include a dietitian, physical activity counsellor and psychological services</li><li>• Medical screening for complications of obesity</li></ul>	Obesity clinic/ Paediatrician	3 monthly
3	<ul style="list-style-type: none"><li>• Stages 1 and 2 components</li><li>• Increase intensity of interventions</li><li>• Consider medical therapy or referral for bariatric surgery</li></ul>	Tertiary weight management centres/Paediatric endocrinologist	More frequent visits for monitoring

Start at stage 1, 2 or 3 depending on the age, degree of obesity, health risks and motivation of the child/adolescent. If there is failure to achieve or maintain the goal BMI, advance to more-intensive levels of intervention. Advancement will depend on the age, presence of comorbidities, response to current interventions and the motivation of the patient and their family.

Refer for specialist care if:<sup>136,141-143</sup>

- The patient is <5 years old
- There is a clinical suspicion of an underlying medical/genetic syndrome or endocrine cause, or there are concerns about height and development
- There are comorbidities that require weight management, e.g. OSA and metabolic complications

### Lifestyle changes

There is sufficient evidence to demonstrate that intensive lifestyle modification programmes can be effective tools for paediatric weight control.<sup>150</sup> **[Level 1++]** Lifestyle intervention strategies include a combination of addressing dietary intake and exercise and behavioural modifications. Interventions have to involve the family as family-based interventions with parental involvement have improved outcomes.<sup>147,151</sup> **[Level 1++]**

Following the treatment phase, a formal maintenance programme should be continued to maintain the achieved weight loss.<sup>152</sup> **[Level 1++]**

### Diet

Healthy eating habits are at the core of any weight management plan. As children are still in the phase of growth, dietary modifications should be focused on healthy food choices rather than portion control only.

Clinicians are recommended to advocate for healthy eating habits as below:<sup>153-155</sup> **[Level 1++]**<sup>136</sup> **[Level 1+]**<sup>142</sup> **[Level 4]**

- Consumption of 5 servings of vegetables and fruits
- Start each day with a healthy breakfast
- Decrease consumption of fast foods and processed foods
- Water as the beverage of choice
- Reduce saturated dietary fat intake
- Portion control education
- Timely regular meals to avoid constant grazing during the day
- Reduce choice of snacks which are non-nutritive
- Ensure children have regular meals
- Whenever possible, eat meals as a family
- Separate eating from other activities such as watching televisions or using the computer
- Have healthy foods readily available

## 5. Management of childhood and adolescent obesity

- Avoid using foods as treats/rewards
- Comfort children with attention, listening and affection instead of food
- Encourage children to develop healthy methods of regulating emotions (i.e. those that do not involve food)

There has been research into the use of intensive dietary interventions in post-pubertal adolescents with obesity with ongoing larger trials. A meta-analysis of 20 studies found that Very Low-Calorie Diets (VLCD) are effective at inducing rapid short term weight loss in children and adolescents with obesity. However, it lacks long-term data.<sup>156</sup> **[Level 1++]**

### Physical activity

Regular physical activity has the potential to improve weight loss and maintenance. Physical fitness, even without weight loss, may also confer other benefits such as improving aerobic fitness and reducing cardiovascular (CV) risk factors in children and adolescents.<sup>157</sup> **[Level 1+]**

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Strategies to increase physical activity should include increasing structured and non-structured physical activity and reducing the amount of time spent on sedentary activities.<sup>158</sup> **[Level 1+]**

Clinicians should encourage the following:

- **Children/adolescents should spend on average 60 minutes/day on moderate or vigorous physical activity.**<sup>159</sup> **[Level 1+]** The increase of physical activity levels can be achieved starting from 2-3 years old by active play and gradually increasing the intensity and duration.<sup>160</sup> **[Level 1+]** As a guide, moderate intensity exercise allows talking but not singing, while vigorous exercise makes it difficult to talk and impossible to sing<sup>136</sup> **[Level 4]**
- **Children should be active and engage in a variety of light intensity physical activity throughout the day**<sup>161</sup> **[Level 1+]**
- **Children should engage in resistance training activities at least three times a week.**<sup>162</sup> **[Level 1+]** These activities should be supervised to improve physical literacy and reduce risk of injury. A meta-analysis of the types of exercise intervention revealed that combined aerobic and strength training ranked best in reducing BMI Z-scores<sup>163</sup> **[Level 1+]**
- **Participation in classical sports activities/programmes.** Classic sports activities have beneficial effects on overall physical activity level, body composition and metabolic profile in children and youth<sup>164</sup> **[Level 1+]**

## 5. Management of childhood and adolescent obesity

### Sleep

Adequate sleep has numerous health benefits for the growing child. Various studies have demonstrated a link between obesity and reduced sleep duration.<sup>165,166</sup>

#### **[Level 1++]**

- Electronic devices should be removed from the bedroom to allow for uninterrupted sleep

Children should be encouraged to practice healthy sleep habits which are in accordance with guidelines (refer Table 5-6).<sup>167,168</sup> **[Level 1++]**

**Table 5-6. Recommended hours of sleep based on age<sup>167,168</sup>**

<b>Age (years)</b>	<b>Hours of sleep</b>
<b>3-5</b>	10-13
<b>6-13</b>	9-11
<b>14-17</b>	8-10

### Screen time

The increasing prevalence of using technology and electronic devices for recreation and education requires a balanced approach. Screen times for ≥2 hours/day had demonstrated an increased risk of overweight/obesity among children.<sup>169</sup> **[Level 1+]** Recreational screen time should be limited to no more than 1 hour a day for 2– 5-year-olds, and no more than 2 hours a day for children 6 years and older.<sup>170</sup> **[Level 1++]**

### Psychosocial aspects

Maladaptive rearing habits around diet and exercise must be evaluated and identified. Interaction between parent and children and parenting styles contribute to obesity in children.<sup>171</sup> **[Level 2+]**

During adolescence, self-esteem becomes more closely tied to body image and rapidly plummets, with adolescent females who have higher BMIs and body image dissatisfaction having the lowest self-esteem.<sup>172</sup> **[Level 2+]** There is also a significant association between eating disorders and youth who are overweight/obese.<sup>173</sup> **[Level 1+]**

## 5. Management of childhood and adolescent obesity

The initial assessment of the child should include evaluation of psychosocial comorbidities.

- Clinicians should be aware of the stigma associated with obesity when managing these children
- Clinicians should employ a sensitive manner and appropriate language during consultations
- The patient's psychosocial comorbidities should be reviewed during each visit
- When indicated a referral to a mental health professional should be done

Clinicians should screen children for the presence of mental health issues by asking questions about:

- School absences or refusal to attend school
- Teasing by peers regarding their weight or appearance
- Persistent symptoms of anxiety, depression or self-harm
- Eating disorders like anorexia or binge eating
- Family dynamics and attitudes about weight

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### Medications

There are **limited number of well-controlled safety and efficacy studies involving obese children and adolescents**. The only two medications which are approved by the United States Food and Drug Authority (USFDA) are liraglutide and orlistat. The negative health impact of paediatric obesity may justify long-term medication.<sup>174,175</sup> **[Level 1+]**

Pharmacotherapy:<sup>146</sup> **[Level 1++]** <sup>136</sup> **[Level 4]**

- Can be considered in adolescents only after a formal programme of intensive lifestyle modification has proven suboptimal or unsuccessful in reducing BMI and improving obesity related complications
- Should be administered only with a concomitant lifestyle modification programme in a specialised centre
- Needs to be re-evaluated if there is failure of reduction of BMI after 12 weeks ( $<4\%$  BMI/BMI z-score reduction)

## 5. Management of childhood and adolescent obesity

**Liraglutide** is a new treatment option approved by most regulatory agencies (including the USFDA and the European Medicines Agency [EMEA]) for chronic obesity treatment in adolescents aged 12–18 years.<sup>176</sup> **[Level 1++]**

- Liraglutide belongs to the glucagon-like peptide-1 receptor agonist (GLP1-RA) class of drugs and is delivered subcutaneously
- It acts by reducing appetite, slowing gastric motility and enhancing satiety
- In the largest liraglutide randomised control trial (RCT), a 3 mg daily dose among adolescents (12 to 18 years of age) with obesity, resulted in a mean placebo-subtracted BMI reduction of approximately 5% at one year. Reduction in weight parameters also persisted even after treatment cessation

Though the most reported adverse event was gastrointestinal, there were no new safety concerns in relation to previous adult trials.

**Orlistat** is approved by the USFDA for obesity treatment for those above 12 years of age.

- Orlistat inhibits gastrointestinal lipases, reducing fat absorption by about 30%<sup>177</sup> **[Level 1++]**
- Though orlistat reduces the BMI significantly in adolescents, it is associated with significant gastrointestinal side effects making long-term treatment difficult<sup>178</sup> **[Level 1++]**

**Metformin** is not approved for use in obesity management. However, studies demonstrate that it has some weight loss effect and it may be useful in those with PCOS.<sup>177</sup> **[Level 1++]**

### Surgery

- Bariatric surgery should not be routinely offered and should only be undertaken by a highly specialised surgical team within the framework of a multidisciplinary team
- Metabolic and bariatric surgery can be considered in adolescents who have severe obesity and significant comorbidity<sup>179</sup> **[Level 1+]**
- Data from the Teen-LABS and AMOS studies have shown good outcomes in reduction of BMI and cardiometabolic effects (such as remission of diabetes and dyslipidaemia) in this group of adolescents<sup>180,181</sup> **[Level 1+]**
- Prior to surgical referral the patient should demonstrate the ability to adhere to the principles of healthy dietary and activity habits, and be compliant with a formal programme of lifestyle modification with or without pharmacotherapy<sup>179</sup> **[Level 1+]**

## 5. Management of childhood and adolescent obesity

Both Vertical Sleeve Gastrectomy (VSG) and Roux-En-Y Gastric Bypass (RYGB) are safe and effective procedures in adolescents, however there is still a lack of significant long-term data.<sup>179,182</sup> **[Level 1+]**

- There was a shift in procedure use over time, with a relative increase in patients undergoing VSG because of the lower risk of complications
- The most common complications with both RYGB and VSG are abdominal pain, diarrhoea, nausea or dehydration followed by stricture with RYGB and wound infection with VSG<sup>179,180</sup> **[Level 1+]**

### Recommendations 8

- A step or staged approach for weight management in the paediatric population should be used **[Grade D]**
  - › For prepubertal children – allow a gradual decline in BMI with weight maintenance or a slower weight gain.
  - › For pubertal children – gradual weight loss with a maximum loss of 0.5-1.0 kg per month.
- Family-focused lifestyle intervention should be emphasised **[Grade C]**
- Treatment programmes should target **[Grade B]**
  - › Decreasing overall dietary intake
  - › Increasing physical activity
  - › Decreasing time spent in sedentary behaviour
  - › Addressing sleep behaviour
- Pharmacotherapy may be considered in adolescents if formal intensive lifestyle modification programmes failed **[Grade B]**
  - › Liraglutide may be considered.
- Metabolic and bariatric surgery may be considered for adolescents with extreme obesity and significant comorbidities. **[Grade B]**

# 6. Prevention of overweight and obesity in adults, children and adolescents

## 6.1 Prevention of overweight and obesity in adults

Obesity is a chronic disorder that not only requires continuous care, support and follow-up, but should be off-set by preventive strategies. The United States Preventive Services Taskforce updated their recommendation in 2018 to include intensive behavioural counselling for individuals of normal weight with abnormal blood glucose levels or diabetes.<sup>183</sup>

Primary prevention measures are essential to halt the development of obesity as early as possible. It generally includes:<sup>34</sup>

- Promoting healthy eating
- Improving physical activity (reducing physical inactivity)
- Managing daily stress
- Improving the sense of well-being and self-esteem

These strategies can be challenging because it involves lifestyle and behavioural modifications that must be applied consistently. Individuals tend to have high levels of motivation initially that can decrease over time making these changes difficult to sustain. A systematic review of prevention of overweight and obesity using education and financial strategies for dietary, exercise and psychological approaches to weight management in the adult population provided moderate quality evidence for preventing weight gain in normal-weight individuals.<sup>184</sup>

### **[Level 2++]**

Primary prevention of further weight gain through dietary advice and increase in physical activity in overweight patients without other comorbidities is an appropriate target compared to weight loss.<sup>34</sup> **[Level 2++]**

#### **6.1.1 Low-calorie diet and orlistat for prevention of obesity in adults**

The cost effectiveness of pharmacologic treatment of obesity in combination with a low-calorie diet was linked with gains in length and quality of life (QoL) similar to prevention of chronic diseases such as diabetes, cardiovascular disease and osteoarthritis.

Incremental costs per quality-adjusted-life year (QALY) gained were €17,900 for the low-calorie diet-only intervention compared to no intervention and €58,800 for the low-calorie diet and orlistat compared to the low-calorie diet only. Assuming a direct relation between body mass index (BMI) and QoL, these ratios decreased to €6000 per QALY gained and €24,100 per QALY gained. Costs per QALY gained were sensitive to assumptions about long-term weight loss maintenance.

## 6. Prevention of overweight and obesity in adults, children and adolescents

Low-calorie diet is cost effective compared to low-calorie diet and orlistat combination. Hence, intervention using low-calorie diet should be recommended as the first option by policy makers in combating obesity for the population.<sup>185</sup>

**[Level 1++]**

### 6.1.2 Pharmacotherapy for prevention of obesity in adults

There is no pharmacotherapy that has shown significant benefits in preventing overweight and obesity in individuals with normal BMI at risk of obesity.

- Women with Polycystic Ovarian Syndrome (PCOS) who were not overweight or obese showed no reduction in BMI following metformin therapy of between 12 weeks to 6 months. There are no recent studies to demonstrate any other benefits<sup>186</sup> **[Level 1+]**<sup>187</sup> **[Level 2+]**
- Individuals with psychotic disorders who are prescribed antipsychotic medications may experience modest weight loss and metabolic improvements from 8-12 weeks of treatment with metformin<sup>35</sup> **[Level 1++]**
- A systematic review of the effect of glucagon-like peptide-1 receptor agonists (GLP1-RA) in individuals with normal BMI identified a small number of subjects who showed no significant difference in weight change.<sup>188</sup> **[Level 1+]**

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MANAGEMENT OF OBESITY 2<sup>ND</sup> EDITION (2023)

#### Recommendations 9

- Fundamental preventive measures that should be implemented against the onset of obesity are promoting healthy eating, improving physical activity and implementing stress management practices. **[Grade A]**
- Healthcare providers should offer weight management interventions for preventing weight gain in normal-weight or overweight adults. **[Grade B]**

## 6.2 Prevention of obesity in children and adolescents

The primary intervention in the management of paediatric obesity should be prevention. Preventive interventions should be designed to modify the environment surrounding the child. Primary prevention actions begin from the prenatal age into adolescence with actions at individual, family and community level.

## 6. Prevention of overweight and obesity in adults, children and adolescents

### 6.2.1 Early life interventions

Although beyond the scope of these guidelines, preconception and prenatal interventions are also of major importance in the prevention of childhood obesity.<sup>189</sup> **[Level 1+]**

- Breast feeding should be encouraged for its numerous health benefits and its role in obesity prevention<sup>189,190</sup> **[Level 1+]**
- Adherence to dietary guidelines during weaning is recommended. Solid foods and beverages other than breast milk or infant formulas should be introduced no earlier than 6 months as evidence suggests early introduction of weaning diet may be linked to childhood obesity<sup>191,192</sup> **[Level 2+]**

Systematic reviews demonstrate a beneficial effect using interventions focused on individual- or family-level behaviour changes through counselling provided through home or community visits.<sup>193</sup> **[Level 1+]**

We recommend early routine counselling on obesity prevention utilizing routine 'healthy baby' clinic visits. This would facilitate early referral for evaluation of at-risk children.

### 6.2.2 Lifestyle interventions

Lifestyle interventions remain the first-line approach for the prevention of childhood obesity. However, the combination of interventions is largely varied due to the complexity of childhood obesity itself. As a child's behaviour is very much dependant on their environment, preventive measures must target the family and school environment.

#### Family environment

There is evidence for an association between the development of paediatric obesity and family dysfunction, as well as, exposure to stress.<sup>194</sup> This requires programmes to foster healthy family functioning and to minimise paediatric stress.

In addition, research indicates the need for parental involvement and a whole family approach for successful prevention programmes.<sup>151</sup> Any preventive programme will, therefore, need to involve the whole family to advocate good parenting practices and lifestyle choices. There should be support for home activities that encourage children to be more active, eat nutritious foods and spend less time on screen-based activities.

## 6. Prevention of overweight and obesity in adults, children and adolescents

### School environment

The school environment is an important component in obesity prevention as, most children and adolescents spend the bulk of their waking hours in schools. A school-based programme can be standardised across multiple sites and reach large populations of children and adolescents during the early and teenage years. There is evidence that supports the use of school-based preventive programmes with family and community reinforcement.<sup>195</sup>

Some measures that can be used to promote obesity prevention within schools are: **[☒; Level 4]**

- School curriculum that includes healthy diet, importance of physical activity and positive body image
- Increasing physical activity sessions and the development of fundamental movement skills throughout the school week
- Improving the nutritional quality of foods in schools
- Supporting teachers and other staff to implement health promotion strategies and activities

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CLINICAL PRACTICE GUIDELINES  
MANAGEMENT OF OBESITY 2<sup>ND</sup> EDITION (2023)

### Diet and physical activity

Dietary interventions, ranging from brief advice or counselling to structured management by health professionals, have been studied the most. The use of multicomponent interventions focusing on dietary, physical activity and behavioural aspects may be useful depending on the age-group, settings and available resources. Also, the implementation of multidisciplinary childhood obesity intervention programmes in the clinical setting should involve a team of care providers including a psychologist, trained nurse, dietitian, physiotherapist and exercise specialist.<sup>196</sup> **[Level 1-1]**

Lifestyle intervention would have to be comprehensive involving the whole family and the environment the child lives in. Main findings from literature indicate using school-based preventive programmes with family and community reinforcement.<sup>195</sup> Research has indicated the need for parental involvement and a whole family approach in the success of prevention programmes.<sup>195,197</sup>

#### *In children ≤6 years old*

Data from a randomised controlled trial (RCT) involving 520 children focused solely on dietary intervention suggested little to no difference in BMI Z-score reductions in children ≤5 years old.<sup>198</sup> **[Level 1-1]**

## 6. Prevention of overweight and obesity in adults, children and adolescents

A Cochrane review of 153 RCTs by Brown *et al.* in 2019 reported that a range of interventions focusing on both diet and physical activity components contributed to a modest effect on obesity prevention in children aged 0 up to 12 years.<sup>199</sup>

**[Level 1++]** In children ≤5 years old,

- There was a pooled reduction of 0.07 units (95% CI -0.14, -0.01) in BMI Z-score from combined diet and physical activity interventions
- There was a BMI reduction of 0.11 kg/m<sup>2</sup> (95% CI -0.21, 0.00) from combined diet and physical activity interventions

While being modest, diet and physical activity behaviours adopted early in life suggests that these behaviours track to later ages in life when the health benefits might be seen.<sup>198</sup> **[Level 1-]**

In another Cochrane review of RCTs involving children aged 0-6 years old assigned to combination of interventions focusing on diet, physical activity and behavioural components vs usual care,<sup>200</sup> **[Level 1++]** there were greater BMI Z-score reductions on follow-up with mean difference of:

- -0.3 units (95% CI -0.4, -0.2) at 6 to 12 months
- -0.4 units (95% CI -0.6, -0.2) at 12-18 months
- -0.3 units (95% CI -0.4, -0.1) at 2 years

*In children 6-12 years old*

In children aged 6-12 years who received a combination of dietary and physical activity interventions compared to those assigned to the control group demonstrated,<sup>199</sup> **[Level 1++]**

- Reduction in their BMI Z-score (mean difference -0.05 units, 95% CI -0.10, -0.01)
- Reduction in their BMI (mean difference -0.05 kg/m<sup>2</sup>, 95% CI -0.11, -0.01), though it was not statistically significant.

Interventions that combined diet, physical activity and behavioural components for at least 6 months in children 6-11 years compared to no interventions or usual care were associated with reductions of,<sup>201</sup> **[Level 1++]**

- BMI (mean difference -0.53 kg/m<sup>2</sup>, 95% CI -0.82, -0.24)
- BMI Z-score (mean difference -0.06 units, 95% CI -0.10, -0.22)
- Body weight (mean difference -1.45 kg, 95% CI -1.88, -1.02)

## 6. Prevention of overweight and obesity in adults, children and adolescents

### *In adolescents 13-18 years old*

No significant reductions were demonstrated between interventions to change either diet or physical activity alone, or combining both interventions on BMI Z-score and BMI.<sup>199</sup> **[Level 1++]** However, these findings were from the pooled analysis of RCTs with low certainty (high heterogeneity and potential biased).

In another Cochrane review, children assigned to multi-component interventions containing diet, physical activity and behavioural components vs those with no interventions resulted in reductions of,<sup>202</sup> **[Level 1++]**

- BMI (mean difference -1.18 kg/m<sup>2</sup>, 95% CI -1.67, -0.69)
- BMI Z-score (mean difference -0.13 units, 95% CI -0.21, -0.05)
- Body weight (mean difference -3.67 kg, 95% CI -5.21, -2.31)

The favourable effect of the multi-component intervention was reported up to 24 months of follow up.<sup>202</sup> **[Level 1++]**

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### *All (children and adolescents 0-18 years old)*

Similarly, another review that included RCTs involving children 0-18 years found that combined interventions of diet and physical activity were linked with reductions in BMI and BMI Z-scores.<sup>199</sup> **[Level 1++]**

While most of the Cochrane reviews discussed indicate the favourable effects of combined diet, physical activity as well as behavioural interventions on weight reduction in children aged between 0 and 18 years, considerable inconsistencies in the weight management strategies used were evident. Other inconsistencies were also observed in the settings where the RCTs were conducted as well as the duration of the follow-up.

### **6.2.3 Environment**

Preventive measures for obesity will need to include changes in the environment. Availability and accessibility to greenspaces, parks, recreational facilities, and sidewalks were found to be associated with increased physical activity levels and reduced sedentary behaviour in children.<sup>203</sup>

## **6. Prevention of overweight and obesity in adults, children and adolescents**

### **Recommendations 10**

- Breast feeding should be encouraged and adherence to dietary guidelines during weaning should be advocated. [Grade B]
- Multicomponent interventions should be used in preventing obesity
  - › Dietary
  - › Physical activity
  - › Behavioural aspects
- Family and parental involvement should be encouraged. [Grade C]
- School-based programme with community engagement should be advocated. [Grade C]
- Environmental changes should be made to support obesity prevention. [Grade D]

# 7. Implementing the guidelines

Implementation of the clinical practice guidelines (CPG) is important as it helps in providing quality healthcare services based on best available evidence applied to the local scenario and expertise. Various factors and resource implications should be considered for the success of the uptake in the CPG recommendations.

## Facilitating and limiting factors

The existing facilitating factors in implementing the recommendations in the CPG are:

- Availability of CPG to healthcare providers (hardcopies and softcopies)
- Regular conferences and updates on management of obesity led by the Malaysian Endocrine and Metabolic Society
- Public awareness campaigns about obesity that can be conducted regularly
- Involvement of governmental/non-governmental organisations e.g., Bahagian Kawalan Penyakit (Cawangan Penyakit Tidak Berjankit) and Bahagian Pembangunan Kesihatan Keluarga of the Ministry of Health (MoH) and Malaysian Endocrine and Metabolic Society

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The existing limiting factors or barriers in implementing the recommendations in the CPG are:

- The lack of awareness about obesity as a chronic disease among healthcare providers and individuals living with obesity
- Lack of awareness among healthcare providers on the importance of treatment of obesity
- Lack of awareness among the general public on the importance of recognising obesity as a disease
- The misconception that obesity and overweight are solely attributed to lifestyle and is the responsibility of the individual
- The lack of resources at the school level to educate children/adolescents about obesity and access to healthy eating plans
- The lack of access to evidence-based effective and safe treatments for obesity

## Potential resource implications

To implement the CPG, there must be dedicated efforts to:

- Ensure widespread distribution of CPG to healthcare providers
- Provide regular training to healthcare providers via effective seminars and workshops

## 7. Implementing the guidelines

- Involve multidisciplinary teams at all levels of health care
- Explore opportunities to work with the school healthcare teams in addressing paediatric overweight and obesity

Implementation strategies will be developed following the approval of the CPG by MoH which include launching of the CPG, Quick Reference and Training Module.

# 8. Clinical indicators for quality management

To assist in the implementation of the clinical practice guidelines (CPG), the following are proposed as clinical audit indicators for quality management:

1.

$$\text{Percentage of people with obesity (at 6 months follow-up) who reduced weight by 5\%} = \frac{\text{Number of people with obesity with weight loss } \geq 5\%}{\text{Total number of people with obesity at 6 months follow-up attending the facility}} \times 100\%$$

\*(Proposed target: 50% for primary care and tertiary care)

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2.

$$\text{Percentage of people with obesity screened for complications} = \frac{\text{Number of people with obesity screened for complications}}{\text{Total number of people with obesity attending the facility}} \times 100\%$$

\*(Proposed target: 85% for primary care and tertiary care)

The targets are proposed based on existing evidence, taking into account the practicality of the recommendations and the reality of the current available resources and facilities.

# Appendices

## Appendix 1

### Example of a search strategy

Clinical question: What are the effective screening strategies and assessments for diagnosis of obesity?

#### OBESITY

1. OBESITY/
  2. Obesity\*
  3. Obesity/Adult/6-10
  4. Obesity/Children/6-10
  5. Obesity/Adolescent/6-10
  6. /Screening
  7. /Diagnosis
  8. /Assessment
  9. /Waist circumference
  10. /BMI
- Filter:
- Clinical trial
  - Meta-analysis
  - Randomised controlled trial
  - Review
  - Systematic review
  - Custom range: 1/1/2006-1/1/2021
  - Species: Humans
  - Language: English

#### OVERWEIGHT

1. OVERWEIGHT/
  2. Overweight\*
  3. Overweight/Adult/6-10
  4. Overweight/Children/6-10
  5. Overweight/Adolescent/6-10
  6. /Screening
  7. /Diagnosis
  8. /Assessment
  9. /Waist circumference
  10. /BMI
- Filter:
- Clinical trial
  - Meta-analysis
  - Randomised controlled trial
  - Review
  - Systematic review
  - Custom range: 1/1/2006-1/1/2021
  - Species: Humans
  - Language: English

### Appendix 2

#### Binge Eating Scale

The Binge Eating Scale is a 16-item questionnaire completed by the patient that assesses the presence of certain binge eating behaviours which may be indicative of an eating disorder. It is formatted as groups of statements about behaviour, thought and emotional states. The patient should indicate **which statement within each group best describes how they feel.**

1.
  - I don't feel self-conscious about my weight or body size when I'm with others.
  - I feel concerned about how I look to others, but it normally does not make me feel disappointed with myself.
  - I do get self-conscious about my appearance and weight which makes me feel disappointed in myself.
  - I feel very self-conscious about my weight and frequently, I feel intense shame and disgust for myself. I try to avoid social contacts because of my self-consciousness.
2.
  - I don't have any difficulty eating slowly in the proper manner.
  - Although I seem to be "gobble down" foods, I don't end up feeling stuffed because of eating too much.
  - At times, I tend to eat quickly and then, I feel uncomfortably full afterwards.
  - I have the habit of bolting down my food, without really chewing it. When this happens I usually feel uncomfortably stuffed because I've eaten too much.
3.
  - I feel capable to control my eating urges when I want to.
  - I feel like I have failed to control my eating more than the average person.
  - I feel utterly helpless when it comes to feeling in control of my eating urges.
  - Because I feel so helpless about controlling my eating I have become very desperate about trying to get in control.

4.
  - I don't have the habit of eating when I'm bored.
  - I sometimes eat when I'm bored, but often I'm able to "get busy" and get my mind off food.
  - I have regular habit of eating when I'm bored, but occasionally, I can use some other activity to get my mind off eating.
  - I have a strong habit of eating when I'm bored. Nothing seems to help me break the habit.
5.
  - I'm usually physically hungry when I eat something.
  - Occasionally, I eat something on impulse even though I really am not hungry.
  - I have the regular habit of eating foods, that I might not really enjoy, to satisfy a hungry feeling even though physically, I don't need the food.
  - Although I'm not physically hungry, I get a hungry feeling in my mouth that only seems to be satisfied my mouth hunger, I then spit the food out so I won't gain weight.
6.
  - I don't feel any guilt or self-hate after I overeat.
  - After I overeat, occasionally I feel guilt or self-hate.
  - Almost all the time I experience strong guilt or self-hate after I overeat.
7.
  - I don't lose total control of my eating when dieting even after periods when I overeat.
  - Sometimes when I eat a "forbidden food" on a diet , I feel like I "blew it" and eat even more.
  - Frequently, I have the habit of saying to myself, "I've blown it now, why not go all the way" when I overeat on a diet. When that happens I eat even more.
  - I have a regular habit of starting strict diets for myself, but I break the diets by going on an eating binge. My life seems to be either a "feast" or "famine".
8.
  - I rarely eat so much food that I feel uncomfortably stuffed afterwards.
  - Usually about once a month, I eat such a quantity of food, I end up feeling very stuffed.
  - I have regular periods during the month when I eat large amounts of food, either at mealtime or at snacks.
  - I eat so much food that I regularly feel quite uncomfortable after eating and sometimes a bit nauseous.

9.
  - My level of calorie intake does not go up very high or go down very low on a regular basis.
  - Sometimes after I overeat, I will try to reduce my calorie intake to almost nothing to compensate for the excess calories I've eaten.
  - I have a regular habit of overeating during the night. It seems that my routine is not to be hungry in the morning but overeat in the evening.
  - In my adult years, I have had week-long periods where I practically starve myself. This follows periods when I overeat. It seems I live a life of either "feast or famine".
10.
  - I usually am able to stop eating when I want to. I know when "enough is enough".
  - Every so often, I experience a compulsion to eat which I can't seem to control.
  - Frequently, I experience strong urges to eat which I seem unable to control, but at other times I can control my eating urges.
  - I feel incapable of controlling urges to eat. I have a fear of not being able to stop eating voluntarily.
11.
  - I don't have any problem stopping eating when I feel full.
  - I usually can stop eating when I feel full but occasionally overeat leaving me feeling uncomfortably stuffed.
  - I have a problem stopping eating once I start and usually I feel uncomfortably stuffed after I eat a meal.
  - Because I have a problem not being able to stop eating when I want, I sometimes have to induce vomiting to relieve my stuffed feeling.
12.
  - I seem to eat just as much when I'm with others (family, social gatherings) as when I'm by myself.
  - Sometimes, when I'm with other persons, I don't eat as much as I want to eat because I'm self-conscious about my eating.
  - Frequently, I eat only a small amount of food when others are present, because I'm very embarrassed about my eating.
  - I feel so ashamed about overeating that I pick times to overeat when I know no one will see me. I feel like a "closet eater".

13.  I eat 3 meals a day with only an occasional between meal snack.  
 I eat 3 meals a day, but I also normally snack between meals.  
 When I am snacking heavily, I get in the habit of skipping regular meals.  
 There are regular periods when I seem to be continually eating, with no planned meals.
  
14.  I don't think much about trying to control unwanted eating urges.  
 At least some of the time, I feel my thoughts are pre-occupied with trying to control my eating urges.  
 I feel that frequently I spend much time thinking about how much I ate or about trying not to eat urges.  
 I feel that frequently I spend much time thinking about how much I ate or about trying not to eat anymore.  
 It seems to me that most of my waking hours are pre-occupied by thoughts about eating or not eating. I feel like I'm constantly struggling not to eat.
  
15.  I don't think about food a great deal.  
 I have strong cravings for food but they last only for brief periods of time.  
 I have days when I can't seem to think about anything else but food.  
 Most of my days seem to be pre-occupied with thoughts about food. I feel like I live to eat.
  
16.  I usually know whether or not I'm physically hungry. I take the right portion of food to satisfy me.  
 Occasionally, I feel uncertain about knowing whether or not I'm physically hungry. At these times it's hard to know how much food I should take to satisfy me.  
 Even though I might know how many calories I should eat, I don't have any idea what is a "normal" amount of food for me.

Adapted from <https://psychology-tools.com/test/binge-eating-scale>.

### Self-monitoring worksheet

I am monitoring  exercise  dietary intake  sleep  mood

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Week 1							
Week 2							
Week 3							
Week 4							
Week 1							
Week 2							
Week 3							
Week 4							

### Appendix 3

#### Sample menu plan

(50% carbohydrate, 20% protein, 30% fat)

Food Exchanges	No. of Exchanges	1200 kcal		1500 kcal		
		Food Portion*	Sample Menu	No. of Exchanges	Food Portion*	Sample Menu
<b>BREAKFAST</b> Cereal/Grains	2	2 pcs whole meal bread	2 pcs egg sandwich/ 1 medium chappati/ 1 thosai/1 cup cooked mihun	2	1 cup mihun	1 bowl of mihun soto with shredded chicken
Lean Meat/ egg	1	1 egg		1	$\frac{1}{2}$ palm size	
Fat	1	1 tsp mayonnaise		1	1 tsp oil	
Vegetable	1	$\frac{1}{2}$ cup (cucumber + lettuce + tomatoes)		1	$\frac{1}{2}$ cup	Bean sprout
Low Fat Milk	$\frac{1}{2}$	$\frac{1}{2}$ cup	Coffee / tea with Low Fat milk	$\frac{1}{2}$	$\frac{1}{2}$ cup	Coffee / tea with Low Fat milk
<b>LUNCH</b> Cereal/Grains/ Starchy Vegetables	2	1 cup rice	1 cup rice	3	$1\frac{1}{2}$ of cup rice	$1\frac{1}{2}$ of cup rice
Fish	2	1 palm size	1 palm size fish asam pedas	3	$1\frac{1}{2}$ palm size	$1\frac{1}{2}$ palm size ikan kembong with asam gravy

		1200 kcal			1500 kcal		
Food Exchanges	No. of Exchanges	Food Portion*	Sample Menu	No. of Exchanges	Food Portion*	Sample Menu	
<b>LUNCH</b> <b>Fat</b>	1 ½	1 ½ tsp oil	½ cup stir fried ladies' fingers	2	2 tsp oil	½ cup stir-fried spinach	
	Vegetables	1 ½	¾ cup (cooked)	½ cup <i>ulam</i> with sambal	1 ½	¾ cup (cooked)	½ cup <i>ulam</i> with sambal
<b>Fruit</b>	1	½ guava	½ pc of guava Plain water	1	1 banana	1 banana Plain water	
	SNACK Cereal/Grains	1	6 pcs of small crackers	6 pcs of small crackers	1	3 pcs biscuit crackers	3 pcs of whole meal crackers
<b>Low Fat Milk</b>	½	½ cup	Coffee/tea with low fat milk	½	½ cup	Coffee/tea with fat milk	
	DINNER Cereal/Grains/ Starchy Vegetables	2	1 cup rice	1 cup rice	3	1 ½ of cup rice	1 ½ of cup rice
<b>Lean Meat</b>	2	1 palm size	1 palm size chicken tomyam	2	1 palm size	1 palm size chicken stew	
	Fat	1 ½	1 ½ tsp oil	2 tsp oil	3	3 tsp oil	
<b>Vegetables</b>	1 ½	¾ cup (cooked)	¾ cup stir-fried kangkung	1 ½	¾ cup (cooked)	¾ cup stir-fried sawi	
	Fruit	1	1 star fruit	1 whole star fruit Plain water	1	1 slice of papaya Plain water	1 slice of papaya Plain water

Summary of Total Food Exchanges	
Cereal/Grains/ Starchy Vegetables	
Fish	2
Lean Meat	3
Skim Milk	1
Fat	4
Vegetables	4
Fruit	2

**Samples of Food exchanges:**

- 1 cup size refers to 200 ml cup (teacup size)
- $\frac{1}{2}$  cup rice can be exchanged for 1 slice of bread or  $\frac{1}{2}$  cup noodles or 3 pieces of crackers
- 1 fruit refers to 1 hawker-size slice of papaya/watermelon/pineapple or 1 medium size orange/apple/pear
- $\frac{1}{2}$  palm size lean meat or fish can be exchanged for 1 matchbox size of lean meat or fish or 1 egg.
- Encourage mainly low-fat cooking (e.g.—steamed, grilled, baked, boiled)
- For more examples of food exchanges, refer Food Groups and Exchange List.

### Food groups and exchange lists

#### Cereals, Grain Products and Starchy Vegetables

Each item contains 15 g carbohydrate, 2 g protein, 0.5 g fat and 75 calories.

<b>Rice, white or unpolished (cooked)</b>	<b>½ cup or ¼ Chinese rice bowl</b>
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#### Can be exchanged for

i. Cereals, Grain & Bread	Quantity
Rice porridge	1 cup
Kuetiau Mihun Tang hoon Spaghetti Macaroni	½ cup or ¼ Chinese rice bowl
Mee, wet	⅓ cup
Putu mayam	1 piece (40 g)
Chapati, diameter 20 cm	⅓ piece
Bread (wholemeal, high fiber, white/brown)	1 slice (30 g)
Plain roll	1 small (30 g)
Burger bun	½ piece
Pita bread, diameter 6"	½ piece
Oatmeal, cooked	¼ cup
Oats, uncooked	3 rounded tablespoons
Muesli	¼ cup
Flour (wheat, rice, atta)	3 rounded tablespoons
Biscuits (plain, unsweetened) e.g., cream crackers, Ryvita	3 pieces
Small thin, salted biscuits (4.5 x 4.5 cm)	6 pieces

ii. Starchy vegetables	Quantity
*Baked beans, canned	1/3 cup
*Lentils	
Corn kernel (fresh/canned) Peas (fresh/canned)	1/2 cup
Sweet potato Tapioca Yam Breadfruit (sukun)	1/2 cup (45 g)
Pumpkin	1 cup (100 g)
Corn on the cob, 6 cm length	1 cob
Potato	1 small (75 g)
Potato, mashed	1 cup (94 g)
Water chestnut	4 pieces

\* Contains more protein than other foods in the list i.e., 5 g/serve

1 cup is equivalent to 200 ml in volume

1 cup = ¾ Chinese rice bowl (11.2 cm in diameter x 3.7 cm deep)

Tablespoon refers to dessert spoon level (equivalent to 2 teaspoons)

## Fruits

Each item contains 15 g carbohydrate and 60 calories

Fruits	Quantity
Banana	1 small (60 g)
Apple Custard apple (buah nona) Star fruit Pear Peach Persimmon Sapodilla (ciku) Kiwi	1 medium
Hog plum (kedondong)	6 whole
Mangosteen	2 small
Plum	2 small

## Appendices

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Fruits	Quantity
Duku langsat	
Grapes	
Langsat	8 pieces
Longan	
Water apple (jambu air), small	
Lychee	5 whole
Rambutan	5 whole
Pomelo	5 slices
Papaya	
Pineapple	
Watermelon	1 slice
Soursop (durian belanda)	
Guava	½ fruit
Cempedak	4 pieces
Jack fruit (Nangka)	4 pieces
Prunes	3 pieces
Dates (kurma), dried	2 medium seeds
Durian	2 medium seeds
Mango	½ small

### Lean Meat, Fish and Meat Substitute

Each serving of meat and substitutes contains 7 g protein. These foods contain varying amounts of fat and energy, but negligible carbohydrate.

	CHO (g)	Protein (g)	Fat (g)	Energy (kcal)
<b>Lean meat / Meat substitute</b>	0	7	4	65
<b>Fish / Shellfish</b>	0	7	1	35

**Chicken (raw, without skin)**

½ drumstick

**Can be exchanged for**

<b>i. Lean meat</b>	<b>Quantity</b>
<b>Lean meat (all varieties)</b>	1 small serve (40 g)
<b>Poultry (young)</b>	40 g raw/30 g cooked
<b>Egg (hen)</b>	1 medium
<b>Soya bean curd (tau kua)</b>	½ piece (60 g)
<b>Soya bean curd (soft, auhou)</b>	¾ piece (90 g)
<b>Fucuk</b>	1 ½ sheets (30 g)
<b>Tempeh</b>	1 piece (45 g)
<b>Cheese, cheddar</b>	2 thin slices (30 g)
<b>Cottage cheese</b>	1/4 small cup
<b>ii. Fish, shellfish</b>	<b>Quantity</b>
<b>Fish (e.g., ikan kembong, selar)</b>	½ piece (40 g)
<b>Fish cutlet</b>	¼ piece (40 g)
<b>Squid</b>	1 medium (40 g)
<b>Crab meat</b> <b>Lobster meat</b> <b>Prawn meat</b>	¼ cup
<b>Cockles</b>	20 small 6 medium

\* Beans & lentils are good sources of protein, but they also contain carbohydrates.

**Milk**

These foods contain varying amount of carbohydrate, fat and protein depending on which type of milk is chosen.

	<b>CHO (g)</b>	<b>Protein (g)</b>	<b>Fat (g)</b>	<b>Energy (kcal)</b>
<b>Skim (1% fat)</b>	15	8	trace	90
<b>Low fat (2% fat)</b>	12	8	5	125
<b>Full cream</b>	10	8	9	150

Milk	Quantity
Fresh cow's milk	1 cup (240 ml)
UHT fresh milk	1 cup (240 ml)
Powdered milk (skimmed, full cream)	4 rounded tablespoons or 1/3 cup
Yogurt (plain/low fat)	¾ cup
Evaporated (unsweetened)	½ cup

### Fat

Each item contains 5 g and 45 calories. Some of the foods in the list, e.g., nuts and seeds also contain small amount of carbohydrate and protein besides fat.

Oil (all types)	1 level teaspoon (5 g)
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### Can be exchanged for

Fat	Quantity
Butter, margarine	
Mayonnaise	1 level teaspoon
Shortening, lard	
Peanut butter	2 level teaspoons
Cream, unwhipped (heavy)	
Cream cheese	1 level teaspoon
Salad dressing	
Cream, unwhipped (light)	
Coconut, shredded	2 level teaspoons
Coconut milk (santan)	
Non-dairy creamer, powder	
Almond	6 whole
Cashew nut	6 whole
Walnut	1 whole
Peanut	20 small
Sesame seed	1 level teaspoon
Watermelon seed (kuaci) with shell	¼ cup

## Appendix 4

### Blood pressure levels for boys by age and height percentile

Age (Year)	BP Percentile ↓	Systolic BP (mmHg)									Diastolic BP (mmHg)								
		↔ Percentile of Height ↔									↔ Percentile of Height ↔								
		5 <sup>th</sup>	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	5 <sup>th</sup>	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	5 <sup>th</sup>	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>
1	50 <sup>th</sup>	80	81	83	85	87	88	89	34	35	36	37	38	39	39	39	39	39	39
	90 <sup>th</sup>	94	95	97	99	100	102	103	49	50	51	52	53	53	54	54	54	54	54
	95 <sup>th</sup>	98	99	101	103	104	106	106	54	54	55	56	57	58	58	58	58	58	58
	99 <sup>th</sup>	105	106	108	110	112	113	114	61	62	63	64	65	66	66	66	66	66	66
2	50 <sup>th</sup>	84	85	87	88	90	92	92	39	40	41	42	43	44	44	44	44	44	44
	90 <sup>th</sup>	97	99	100	102	104	105	106	54	55	56	57	58	58	58	59	59	59	59
	95 <sup>th</sup>	101	102	104	106	108	109	110	59	59	60	61	62	63	63	63	63	63	63
	99 <sup>th</sup>	109	110	111	113	115	117	117	66	67	68	69	70	71	71	71	71	71	71
3	50 <sup>th</sup>	86	87	89	91	93	94	95	44	44	45	46	47	48	48	48	48	48	48
	90 <sup>th</sup>	100	101	103	105	107	108	109	59	59	60	61	62	63	63	63	63	63	63
	95 <sup>th</sup>	104	105	107	109	110	112	113	63	63	64	65	66	67	67	67	67	67	67
	99 <sup>th</sup>	111	112	114	116	118	119	120	71	71	72	73	74	75	75	75	75	75	75
4	50 <sup>th</sup>	88	89	91	93	95	96	97	47	48	49	50	51	51	52	52	52	52	52
	90 <sup>th</sup>	102	103	105	107	109	110	111	62	63	64	65	66	66	66	66	66	66	67
	95 <sup>th</sup>	106	107	109	111	112	114	115	66	67	68	69	70	71	71	71	71	71	71
	99 <sup>th</sup>	113	114	116	118	120	121	122	74	75	76	77	78	78	78	78	78	79	79
5	50 <sup>th</sup>	90	91	93	95	96	98	98	50	51	52	53	54	55	55	55	55	55	55
	90 <sup>th</sup>	104	105	106	108	110	111	112	65	66	67	68	69	69	69	69	69	69	70
	95 <sup>th</sup>	108	109	110	112	114	115	116	69	70	71	72	73	74	74	74	74	74	74
	99 <sup>th</sup>	115	116	118	120	121	123	124	77	78	79	80	81	81	81	81	81	82	82
6	50 <sup>th</sup>	91	92	94	96	98	99	100	53	53	54	55	56	57	57	57	57	57	57
	90 <sup>th</sup>	105	106	108	110	111	113	113	68	68	69	70	71	72	72	72	72	72	72
	95 <sup>th</sup>	109	110	112	114	115	117	117	72	72	73	74	75	76	76	76	76	76	76
	99 <sup>th</sup>	116	117	119	121	123	124	125	80	80	81	82	83	84	84	84	84	84	84
7	50 <sup>th</sup>	92	94	95	97	99	100	101	55	55	56	57	58	59	59	59	59	59	59
	90 <sup>th</sup>	106	107	109	111	113	114	115	70	70	71	72	73	74	74	74	74	74	74
	95 <sup>th</sup>	110	111	113	115	117	118	119	74	74	75	76	77	78	78	78	78	78	78
	99 <sup>th</sup>	117	118	120	122	124	125	126	82	82	83	84	85	86	86	86	86	86	86

## Appendices

Age (Year)	BP Percentile ↓	Systolic BP (mmHg)									Diastolic BP (mmHg)								
		↔ Percentile of Height ↔									↔ Percentile of Height ↔								
		5 <sup>th</sup>	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	5 <sup>th</sup>	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>				
8	50 <sup>th</sup>	94	95	97	99	100	102	102	56	57	58	59	60	60	60	61			
	90 <sup>th</sup>	107	109	110	112	114	115	116	71	72	72	73	74	75	76				
	95 <sup>th</sup>	111	112	114	116	118	119	120	75	76	77	78	79	79	80				
	99 <sup>th</sup>	119	120	122	123	125	127	127	83	84	85	86	87	87	88	88	88	88	
9	50 <sup>th</sup>	95	96	98	100	102	103	104	57	58	59	60	61	61	62				
	90 <sup>th</sup>	109	110	112	114	115	117	118	72	73	74	75	76	76	77				
	95 <sup>th</sup>	113	114	116	118	119	121	121	76	77	78	79	80	81	81	81			
	99 <sup>th</sup>	120	121	123	125	127	128	129	84	85	86	87	88	88	89	89	89	89	
10	50 <sup>th</sup>	97	98	100	102	103	105	106	58	59	60	61	61	62	63				
	90 <sup>th</sup>	111	112	114	115	117	119	119	73	73	74	75	76	77	78				
	95 <sup>th</sup>	115	116	117	119	121	122	123	77	78	79	80	81	81	82	82			
	99 <sup>th</sup>	122	123	125	127	128	130	130	85	86	86	88	88	89	90	90	90	90	
11	50 <sup>th</sup>	99	100	102	104	105	107	107	59	59	60	61	62	63	63				
	90 <sup>th</sup>	113	114	115	117	119	120	121	74	74	75	76	77	78	78				
	95 <sup>th</sup>	117	118	119	121	123	124	125	78	78	79	80	81	82	82	82			
	99 <sup>th</sup>	124	125	127	129	130	132	132	86	86	87	88	89	90	90	90	90	90	
12	50 <sup>th</sup>	101	102	104	106	108	109	110	59	60	61	62	63	63	64				
	90 <sup>th</sup>	115	116	118	120	121	123	123	74	75	75	76	77	78	79				
	95 <sup>th</sup>	119	120	122	123	125	127	127	78	79	80	81	82	82	83	83			
	99 <sup>th</sup>	126	127	129	131	133	134	135	86	87	88	89	90	90	90	91	91	91	
13	50 <sup>th</sup>	104	105	106	108	110	111	112	60	60	61	62	63	64	64				
	90 <sup>th</sup>	117	118	120	122	124	125	126	75	75	76	77	78	79	79				
	95 <sup>th</sup>	121	122	124	126	128	129	130	79	79	80	81	82	83	83	83			
	99 <sup>th</sup>	128	130	131	133	135	136	137	87	87	88	89	90	91	91	91	91	91	
14	50 <sup>th</sup>	106	107	109	111	113	114	115	60	61	62	63	64	65	65				
	90 <sup>th</sup>	120	121	123	125	126	128	128	75	76	77	78	79	79	80				
	95 <sup>th</sup>	124	125	127	128	130	132	132	80	80	81	82	83	84	84	84			
	99 <sup>th</sup>	131	132	134	136	138	139	140	87	88	89	90	91	92	92	92	92	92	
15	50 <sup>th</sup>	109	110	112	113	115	117	117	61	62	63	64	65	66	66				
	90 <sup>th</sup>	122	124	125	127	129	130	131	76	77	78	79	80	80	81				
	95 <sup>th</sup>	126	127	129	131	133	134	135	81	81	82	83	84	85	85	85			
	99 <sup>th</sup>	134	135	136	138	140	142	142	88	89	90	91	92	93	93	93			

Age (Year)	BP Percentile ↓	Systolic BP (mmHg)							Diastolic BP (mmHg)						
		↔ Percentile of Height ↔							↔ Percentile of Height ↔						
		5 <sup>th</sup>	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	5 <sup>th</sup>	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>
16	50 <sup>th</sup>	111	112	114	116	118	119	120	63	63	64	65	66	67	67
	90 <sup>th</sup>	125	126	128	130	131	133	134	78	78	79	80	81	82	82
	95 <sup>th</sup>	129	130	132	134	135	137	137	82	83	83	84	85	86	87
	99 <sup>th</sup>	136	137	139	141	143	144	145	90	90	91	92	93	94	94
17	50 <sup>th</sup>	114	115	116	118	120	121	122	65	66	66	67	68	69	70
	90 <sup>th</sup>	127	128	130	132	134	135	136	80	80	81	82	83	84	84
	95 <sup>th</sup>	131	132	134	136	138	139	140	84	85	86	87	87	88	89
	99 <sup>th</sup>	139	140	141	143	145	146	147	92	93	93	94	95	96	97

BP, blood pressure

\* The 90<sup>th</sup> percentile is 1.28 SD, 95<sup>th</sup> percentile is 1.645 SD, and the 99<sup>th</sup> percentile is 2.326 SD over the mean.

### Blood pressure levels for girls by age and height percentile

Age (Year)	BP Percentile ↓	Systolic BP (mmHg)							Diastolic BP (mmHg)						
		↔ Percentile of Height ↔							↔ Percentile of Height ↔						
		5 <sup>th</sup>	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	5 <sup>th</sup>	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>
1	50 <sup>th</sup>	83	84	85	86	88	89	90	38	39	39	40	41	41	42
	90 <sup>th</sup>	97	97	98	100	101	102	103	52	53	53	54	55	55	56
	95 <sup>th</sup>	100	101	102	104	105	106	107	56	57	57	58	59	59	60
	99 <sup>th</sup>	108	108	109	111	112	113	114	64	64	65	65	66	67	67
2	50 <sup>th</sup>	85	85	87	88	89	91	91	43	44	44	45	46	46	47
	90 <sup>th</sup>	98	99	100	101	103	104	105	57	58	58	59	60	61	61
	95 <sup>th</sup>	102	103	104	105	107	108	109	61	62	62	63	64	65	65
	99 <sup>th</sup>	109	110	111	112	114	115	116	69	69	70	70	71	72	72
3	50 <sup>th</sup>	86	87	88	89	91	92	93	47	48	48	49	50	50	51
	90 <sup>th</sup>	100	100	102	103	104	106	106	61	62	62	63	64	64	65
	95 <sup>th</sup>	104	104	105	107	108	109	110	65	66	66	67	68	68	69
	99 <sup>th</sup>	111	111	113	114	115	116	117	73	73	74	74	75	76	76
4	50 <sup>th</sup>	88	88	90	91	92	94	94	50	50	51	52	52	53	54
	90 <sup>th</sup>	101	102	103	104	106	107	108	64	64	65	66	67	67	68
	95 <sup>th</sup>	105	106	107	108	110	111	112	68	68	69	70	71	71	72
	99 <sup>th</sup>	112	113	114	115	117	118	119	76	76	76	77	78	79	79

## Appendices

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Age (Year)	BP Percentile ↓	Systolic BP (mmHg)							Diastolic BP (mmHg)						
		↔ Percentile of Height →							↔ Percentile of Height →						
		5 <sup>th</sup>	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	5 <sup>th</sup>	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>
5	50 <sup>th</sup>	89	90	91	93	94	95	96	52	53	53	54	55	55	56
	90 <sup>th</sup>	103	103	105	106	107	109	109	66	67	67	68	69	69	70
	95 <sup>th</sup>	107	107	108	110	111	112	113	70	71	71	72	73	73	74
	99 <sup>th</sup>	114	114	116	117	118	120	120	78	78	79	79	80	81	81
6	50 <sup>th</sup>	91	92	93	94	96	97	98	54	54	55	56	56	57	58
	90 <sup>th</sup>	104	105	106	108	109	110	111	68	68	69	70	70	71	72
	95 <sup>th</sup>	108	109	110	111	113	114	115	72	72	73	74	74	75	76
	99 <sup>th</sup>	115	116	117	119	120	121	122	80	80	80	81	82	83	83
7	50 <sup>th</sup>	93	93	95	96	97	99	99	55	56	56	57	58	58	59
	90 <sup>th</sup>	106	107	108	109	111	112	113	69	70	70	71	72	72	73
	95 <sup>th</sup>	110	111	112	113	115	116	116	73	74	74	75	76	76	77
	99 <sup>th</sup>	117	118	119	120	122	123	124	81	81	82	82	83	84	84
8	50 <sup>th</sup>	95	95	96	98	99	100	101	57	57	57	58	59	60	60
	90 <sup>th</sup>	108	109	110	111	113	114	114	71	71	71	72	73	74	74
	95 <sup>th</sup>	112	112	114	115	116	118	118	75	75	75	76	77	78	78
	99 <sup>th</sup>	119	120	121	122	123	125	125	82	82	83	83	84	85	86
9	50 <sup>th</sup>	96	97	98	100	101	102	103	58	58	58	59	60	61	61
	90 <sup>th</sup>	110	110	112	113	114	116	116	72	72	72	73	74	75	75
	95 <sup>th</sup>	114	114	115	117	118	119	120	76	76	76	77	78	79	79
	99 <sup>th</sup>	121	121	123	124	125	127	127	83	83	84	84	85	86	87
10	50 <sup>th</sup>	98	99	100	102	103	104	105	59	59	59	60	61	62	62
	90 <sup>th</sup>	112	112	114	115	116	118	118	73	73	73	74	75	76	76
	95 <sup>th</sup>	116	116	117	119	120	121	122	77	77	77	78	79	80	80
	99 <sup>th</sup>	123	123	125	126	127	129	129	84	84	85	86	86	87	88
11	50 <sup>th</sup>	100	101	102	103	105	106	107	60	60	60	61	62	63	63
	90 <sup>th</sup>	114	114	116	117	118	119	120	74	74	74	75	76	77	77
	95 <sup>th</sup>	118	118	119	121	122	123	124	78	78	78	79	80	81	81
	99 <sup>th</sup>	125	125	126	128	129	130	131	85	85	86	87	87	88	88

Age (Year)	BP Percentile ↓	Systolic BP (mmHg)									Diastolic BP (mmHg)											
		↔ Percentile of Height ↔									↔ Percentile of Height ↔											
		5 <sup>th</sup>	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	5 <sup>th</sup>	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	5 <sup>th</sup>	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>
12	50 <sup>th</sup>	102	103	104	105	107	108	109	61	61	61	62	63	64	64	64	64	64	64	64	64	64
	90 <sup>th</sup>	116	116	117	119	120	121	122	75	75	75	75	76	77	78	78	78	78	78	78	78	78
	95 <sup>th</sup>	119	120	121	123	124	125	126	79	79	79	79	80	81	82	82	82	82	82	82	82	82
	99 <sup>th</sup>	127	127	128	130	131	132	133	86	86	86	87	88	88	89	89	89	89	89	89	89	90
13	50 <sup>th</sup>	104	105	106	107	109	110	110	62	62	62	62	63	64	65	65	65	65	65	65	65	65
	90 <sup>th</sup>	117	118	119	121	122	123	124	76	76	76	76	77	78	79	79	79	79	79	79	79	79
	95 <sup>th</sup>	119	120	121	123	124	125	126	79	79	79	79	80	81	82	82	82	82	82	82	82	82
	99 <sup>th</sup>	127	127	128	130	131	132	133	86	86	86	87	88	88	89	89	89	89	89	89	89	90
14	50 <sup>th</sup>	106	106	107	109	110	111	112	63	63	63	63	64	65	66	66	66	66	66	66	66	66
	90 <sup>th</sup>	119	120	121	122	124	125	125	77	77	77	77	78	79	80	80	80	80	80	80	80	80
	95 <sup>th</sup>	123	123	125	126	127	129	129	81	81	81	81	82	83	84	84	84	84	84	84	84	84
	99 <sup>th</sup>	130	131	132	133	135	136	136	88	88	88	89	90	90	91	91	91	91	91	91	92	92
15	50 <sup>th</sup>	107	108	109	110	111	113	113	64	64	64	64	65	66	67	67	67	67	67	67	67	67
	90 <sup>th</sup>	120	121	122	123	125	126	127	78	78	78	78	79	80	81	81	81	81	81	81	81	81
	95 <sup>th</sup>	124	125	126	127	129	130	131	82	82	82	82	83	84	85	85	85	85	85	85	85	85
	99 <sup>th</sup>	131	132	133	134	136	137	138	89	89	89	90	91	91	92	92	92	92	92	92	93	93
16	50 <sup>th</sup>	108	108	110	111	112	114	114	64	64	65	65	66	66	67	67	68	68	68	68	68	68
	90 <sup>th</sup>	121	122	123	124	126	127	128	78	78	78	79	80	81	81	82	82	82	82	82	82	82
	95 <sup>th</sup>	125	126	127	128	130	131	132	82	82	83	84	85	85	86	86	86	86	86	86	86	86
	99 <sup>th</sup>	132	133	134	135	137	138	139	90	90	90	90	91	92	93	93	93	93	93	93	93	93
17	50 <sup>th</sup>	108	109	110	111	113	114	115	64	65	65	66	66	67	67	68	68	68	68	68	68	68
	90 <sup>th</sup>	122	122	123	125	126	127	128	78	79	79	79	80	81	81	82	82	82	82	82	82	82
	95 <sup>th</sup>	125	126	127	129	130	131	132	82	83	83	84	85	85	86	86	86	86	86	86	86	86
	99 <sup>th</sup>	133	133	134	136	137	138	139	90	90	91	91	92	93	93	93	93	93	93	93	93	93

BP, blood pressure

\* The 90<sup>th</sup> percentile is 1.28 SD, 95<sup>th</sup> percentile is 1.645 SD, and the 99<sup>th</sup> percentile is 2.326 SD over the mean.

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