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REVIEW

The short child: Importance of early detection and timely referral

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Abstract
Stunting is a common phenomenon in Malaysian children. Optimising outcomes for children with growth disorders rests on early recognition and prompt referral. In this context, a framework for the clinical approach can help to guide appropriate growth assessment and referral. This review article aims to provide family medicine specialists with such a framework whilst raising awareness about the shortcomings of the existing growth monitoring system in Malaysia. It also invites readers to consider additional measures that could further optimise this system.

Childhood stunting in Malaysia

One of the many child health goals from the World Health Organisation (WHO) 2025, which Malaysia is aiming to achieve, is a 40% reduction in childhood stunting.[1] In 2019, statistics from the National Health Morbidity Survey (NHMS) reported that 21.8% of Malaysian children under the age of 4 years are stunted and that stunting in 2017 (16.6%) and 2016 (20.7%) were not much different[1–3] Within Malaysia, there is a disparity in the rates of stunting, with higher rates in Kelantan (34%), Terengganu (26.1%) and Pahang (25.7%) and the lowest rates in Kuala Lumpur (10.5%)Click or tap here to enter text.[2] Stunting, defined as a height-for-age below -2 standard deviation (SD) in children under the age of 5 years, is associated with factors such as socioeconomic status, nutrition and household living conditions.[4] Notably, several adverse health and psychosocial consequences can impact future adult health and productivity.[5] Therefore, growth monitoring must serve as an integral component of healthcare delivery for all paediatric patients attending primary care. Family medicine specialists have the privilege of addressing the acute and preventative health care concerns of children and their families. This affords them the unique opportunity to incorporate regular childhood growth monitoring into their practice so that paediatric growth disorders may be identified early.

Understanding normal childhood growth

Growth is an important indicator of health in all children.[6] Healthcare professionals should be familiar with differentiating pathological from normal childhood growth. The process of childhood growth is dynamic and occurs in 'steps', with periods of growth punctuated by periods of quiescence rather than the smoothened lines on centile charts. Childhood growth begins in utero during the foetal phase, during which the growth rate is fastest at 60 cm/year. Maternal and utero-placental health are critical contributors to foetal growth, which ultimately determines the birth weight and length of the newborn. Notably, nutrition is a key regulator of growth in infancy. Psychosocial well-being and an intact thyroid axis facilitate a growth rate of 25 cm/year. During the first 18 months of life, a child's catch-up or catch-down growth towards their genetic potential is a common observation.[7,8] Height velocity then decelerates to 10 cm/year during the toddler phase, with nutrition remaining a critical regulator of growth. By 24 months, a child should have shifted towards its genetic potential.[9] Beyond 24 months of age, children grow at a steady rate of 5–6 cm/year and crossing centiles should be considered abnormal. The influences of growth hormone, thyroid hormone and nutrition are important during this phase. With the onset of puberty, the effects of sex steroids and growth hormone accelerate the growth rate to 8–12 cm/year in girls and 10–14 cm/year in boys. Sleep, nutrition and psychosocial health modulate growth hormone release and are crucial in all stages of growth.[10] The interaction of these variables should culminate in the attainment of a final height

within the mid-parental height centile. Working knowledge of these factors is important to identify the causes of short stature in children. **Figure 1** and **Table 1** illustrate and summarise the effects of these influencing factors on growth rate in the different phases of childhood growth, respectively.

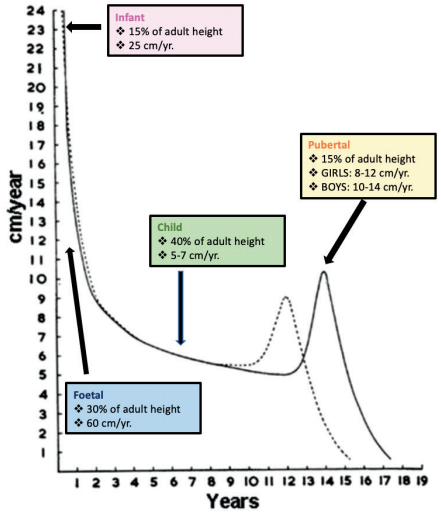

Figure 1. Graphical representation of growth rates during childhood and adolescence.[11]

Table 1. Phases of childhood growth and influencing factors.

Growth phase	Influencing factors	Growth rate (cm/yr.)	Growth pattern
In utero	• Intrauterine environment • Maternal health/size • Placental health • Chromosomal abnormalities	60 cm/year	
Infant 0–12 months	• Nutrition • Environment • Parental genetics • Thyroid status	Birth weight (avg.): 3.5 kg Birth length (avg.): 52 cm Growth rate: 15–25 cm/year	Deceleration in growth rate in the first 6 months. After 6 months, the growth rate follows a genetic trajectory. Consider if preterm or small for gestational age (SGA).
Toddler 12–24 months	• Nutrition • Environment • Parental genetics • Thyroid status	6–12 cm/year	By 24 months, growth catches up to the genetic target. Unusual to cross centiles after 24 months.
Pre-school 2–5 years	• Nutrition • Environment • Parental genetics • Thyroid status	Normal growth rate: 7–8 cm/year Abnormal growth rate: <6 cm/year	
Childhood 5 years to prepubertal	• Growth hormone • Thyroid status • Nutrition • Parental genetics	Normal growth rate: 5–6 cm/year Abnormal growth rate: <4 cm/year	
Adolescent pubertal	• Sex steroids • Growth hormone	Growth rate: Girls: 8–12 cm/year Boys: 10–14 cm/year Height gained in puberty: Girls: 17–22 cm Boys: 22–27 cm	Height at the start of puberty has a major impact on the final height of the child.

Definition of short stature

Childhood short stature has several definitions. A static height measurement that is less than -2 standard deviation score SDS (<3rd centile) for that reference population on a sex- and age-appropriate centile chart is considered short stature. A child with a height less than 1.5 SDS (10 cm) compared to mid-parental height (MPH) or the genetic target is another definition.[14] A height velocity (HV) that is <25th centile for age and sex is also considered as poor growth and increases the risk of short stature.

Evaluation of childhood short stature

A comprehensive history, detailed physical exam, accurate anthropometric measurements and growth pattern evaluation are essential for short stature assessment. The history should include details on antenatal growth, perinatal and neonatal events, infant growth pattern, nutrition and the timing of growth faltering. The important elements of history taking for a case of short stature are summarised in **Table 2**.

Table 2: History taking for childhood short stature.

Maternal, perinatal and birth history	• *Maternal health: diabetes, hypertension, non-organic causes, medications, infections, psychosocial and emotional health, substance abuse* • *Gestational age, Intrauterine growth retardation, small for gestational age* • *Hypoglycaemia or jaundice during the neonatal period* • *Birth weight, length and head circumference*
Nutrition	• *24-hour food recall or 3-day food diary* • *Milk intake, breastfeeding, feeding history, snacks, food preference, eating behaviour*
Medications/ medical/surgical	• *Steroids*
Family history	• *Parental heights, pubertal onset, chromosomal abnormalities, severe short stature and investigation, therapy, height outcomes of these family member*
Review of systems	• *Headaches, visual field defects, constitutional symptoms, chronic diarrhoea, recurrent infections, underlying medical conditions, renal symptoms, previous chemo or radiation therapy*
Social history	• *Home and school situation, stressors* • *Socioeconomic background* • *Sleep patterns and exercise*

Anthropometric measurements can be single or serial measurements. Although single height measurements are convenient, repeated height measures over time are superior because they are more sensitive to detecting abnormal growth patterns and alert the clinician to potential growth disorders.[9] The accuracy of anthropometric measurements is paramount so that the detection of growth disorders is optimal.[11] This can be achieved by using the appropriate tools such as an infantometer or a stadiometer, where necessary. An infantometer measures recumbent length in children aged 0–2 years. It has three components: a ruler, a fixed headboard and a movable footplate. Notably, it requires two *skilled* personnel to conduct the measurement. Whilst measuring, the infant's head should be in line with the Frankfort plane and the legs in full extension.[11] Children over 2 years old should be measured using a wall-mounted calibrated Harpenden stadiometer with a horizontal bar that is fixed at 90 degrees. The child should be standing upright without footwear with the back of their head, buttocks and back touching the wall and with their head in the Frankfort plane. The horizontal bar is then lowered, three sequential measurements are taken and the mean height is recorded. The variation between each measurement should not be greater than 0.3 cm. For repeated measurements to monitor growth over time, it is important to focus on using the correct technique for height measurement by properly positioning the child to obtain accurate results using a reliable measurement tool (e.g., the Harpenden stadiometer, if available). Additional measurements to consider include arm span and sitting height. The correct techniques for using an infantometer and stadiometer are presented in **Figure 2.**

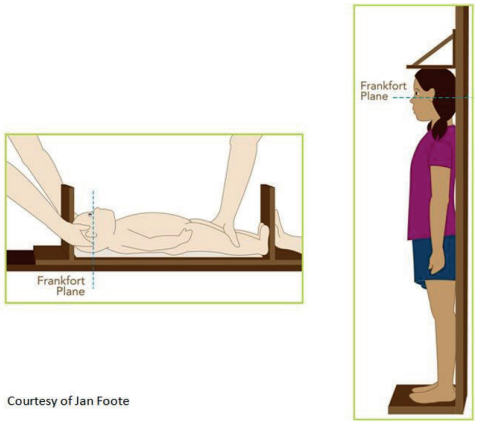

Figure 2. Infantometer and stadiometer for anthropometric measures in children.[15]

Anthropometric measurements should be taken opportunistically during unscheduled visits for minor illnesses and during scheduled appointments for routine vaccinations or well-child checks. In the Malaysian setting, the *Rekod Kesihatan Bayi* dan *Kanak-Kanak* booklet can serve as a good tool for growth monitoring in infants and children. However, any concerning features or red flags should be evaluated and followed up appropriately. Notably, clinicians should use a single centile chart to monitor serial growth measurements and visualise the growth trajectory.

Calculations involved in assessing short children

MPH, MPH target centile and HV are important calculations when assessing short children. Since genetics is a major contributor to the final height of a child, it is critical to calculate the MPH and MPH centile.[9] HV can be determined by calculating the difference between height measurements at two time points taken no less than 4 months apart. However, using a 6-month 'gap' minimises error. Notably, HV can be plotted on an age- and sex-specific HV centile chart, if available. The ratio between the upper segment and lower segment can help to identify cases of disproportionate short stature. **Table 3** presents the MPH and MPH centile calculations. **Table 4** summarises the auxology of short children

Table 3. Mid-parental height calculations.[7]

For boys, MPH (cm) = (Mother's height + 13 + Father's height) ÷ 2
For girls, MPH (cm) = (Father's height – 13 + Mother's height) ÷ 2
For boys and girls, MPH target height = MPH -/+ 10 cm, which represents the 3rd to 97th centiles

Table 4. Auxology of short children.[9,16]

Static height measurements required
Height more than 2 SDS (3rd percentile) ***below*** the mean is severe short stature
Height more than 1.5 SDS (10 cm) ***below*** the calculated MPH
Growth patterns to assess:
HV >1 SDS below the mean **AND** height more than 2 SDS over 12 months
OR
Height decrease by more than 0.5 SDS over a 12-month period in children aged 2 years and above
OR
HV more than 2 SDS (3rd centile) below the mean for a 12-month period **if NO** short stature present
OR
HV more than 1.5 SDS below the mean for a 24-month period

Growth charts

The use of growth charts is fundamental to the assessment of growth in children. Thus, selecting the appropriate growth chart is paramount. Growth charts can either be *standard* charts or *reference* charts—both of which are available in Malaysia. The WHO charts are *standard* charts, whereas the Centres for Disease Control and Prevention (CDC) charts are *reference* charts. The difference between these two types of charts is important to note. The WHO *standard* charts are derived from the longitudinal length and weight data from the WHO Multicentre Growth Reference Study, which recruited 8440 breastfed infants from six different countries. These charts are reflective of how infants *should* grow and provide a description of physiological growth under optimal feeding conditions.[16] The WHO charts can be used for all children, irrespective of ethnicity and type of feeding. The National Centre for Health Statistics (NCHS) and CDC centiles were derived from the National Health And Nutrition Examination Survey (NHANES), which intermittently collated data on the

growth of American children over a 30-year period that started in the 1960s.[17] Thus, the CDC charts describe the growth patterns of a specific *population*.[18,19] Within the Association of Southeast Asian Nations (ASEAN) region, national reference growth charts are being used in Singapore and Indonesia.[20] Thai reference growth charts are also in circulation; however, the WHO standard charts are used for growth monitoring.[21] Since there are currently no Malaysian reference growth charts, it is recommended that anthropometric measurements and the MPH of children aged 0–19 years be plotted on a sex-specific WHO *standard* chart. A syndrome-specific chart should be used where applicable. For infants <24 months, recumbent lengths should only be plotted on a length chart and prematurity should be corrected for all children until the age of 24 months.

Comprehensive physical examination

Physical examinations of short children should check for discordance between their height and weight measurements. Albeit rare, endocrine short stature is hallmarked by a 'short and fat' child whose height is outside the genetic target in association with height deceleration. Midline defects, visual field defects, shortened 4th metacarpals, goitre, striae, and precocious puberty can be indicative of endocrine aetiology. Clinical features of disproportionate short stature (e.g., skeletal dysplasias and inborn errors of metabolism) should be sought alongside facies of Down syndrome and Turner syndrome. All short girls must also be examined for other features of Turner syndrome. Moreover, clinical features of chronic disease (e.g., pallor, clubbing, cardiac murmur, hepatomegaly, chronic asthma, or rickets) are also important to examine. Finally, pubertal staging is critical when assessing short children since it may herald a sinister underlying disease process and because pubertal onset in short children requires a prompt referral. **Table 5** summarises the physical examination of short children.

Table 5. Physical examination of short children

Physical exam findings to elicit
• Fat vs thin
• Proportionate vs disproportionate (short limbs or short spine)
Sitting and standing heights
• Features of
Syndromes: Down syndrome, Turner syndrome, Russell-Silver syndrome
Nutritional deficiencies
Chronic diseases
Endocrine conditions
Inborn errors of metabolism
Skeletal dysplasias
Central Nervous System examination with fundoscopy
• Tanner staging of puberty
Short child in the early stages of puberty
Sub-optimal growth spurt in puberty

Causes of short stature in childhood

As per the European Society of Paediatric Endocrinology (ESPE), there are three categories of short stature: (i) primary growth disorder, in which the condition is intrinsic to the growth plate; (ii) secondary growth disorder, in which the milieu of the growth plate is impacted by a secondary condition; (iii) no identifiable cause, or idiopathic.[22] A more conceptual way of evaluating short stature is to determine whether the short stature is the result of intrinsic shortness, delayed growth, attenuated growth or failure to thrive. Notably, there are no published studies regarding the causes of short stature in Malaysian children. However, the Ministry of Health report on Maternal and Child Health (2016) has noted that stunting in Malaysian children is most common in the following groups: children from certain geographical areas (e.g., Kelantan); children from rural settings; males; those between the ages of 24 and 35 months; those of the 'Other Bumiputera' racial background.[3] **Table 6** outlines the ESPE classification for short stature.

Table 6. European Society of Paediatric Endocrinology (ESPE) classification for short stature.

Primary growth failure
- *Syndromes*
  - *Down, Turner, Prader-Willi, Silver-Russell, Noonan*
- *Small for gestational age (SGA)*
- *Bone dysplasia*
  - *Achondroplasia, hypochondroplasia*

Secondary growth failure
- *Endocrine disease*
  - *Growth hormone deficiency, hypothyroidism, Cushing syndrome, pituitary deficiency, precocious puberty, poorly controlled Type 1 diabetes, disorders of the GH-IGF-1 axis*
- *Inherited metabolic conditions*
- *Chronic disease*
  - *Chronic renal failure, cardiac failure, coeliac disease, inflammatory bowel disease, thalassemia*

Idiopathic

Approach to the assessment of childhood short stature in primary care and referral

In the primary care setting, the assessment of childhood short stature can be broken down into a few simple steps. It should commence with history taking and a physical examination that focuses on nutrition, chronic disease, endocrine disorders, syndromes and pubertal assessment. Accurate anthropometry with the appropriate tools (i.e., calculations for MPH and HV) should be performed for all children with growth concerns. The objective of first-line investigations is to rule out undiagnosed chronic conditions. If the appropriate resources are available, a karyotype must be conducted for all short girls. A bone age that assesses skeletal maturity—though invaluable in the assessment of short stature—can be performed as a second-tier test.[23] Finally, early referral should be considered if any one of the referral criteria is met. In some cases, it may be appropriate to observe growth or involve a nutritionist early on; however, this would depend on the level of concern, the suspected underlying cause and accessibility to allied health services. Rehabilitation services may be indicated in cases where children have difficulty feeding; however, prior assessment by a paediatrician would be required. **Figure 3** depicts the general approach to childhood short stature observed in the primary care setting.

Importance of early detection and referral

The age at diagnosis of short stature has a marked impact on the future health and final adult height of a child. This has been observed in several conditions, such as growth hormone deficiency, Turner syndrome and inflammatory bowel disease. In growth hormone deficiency, it has long been demonstrated that early treatment with growth hormone therapy results in superior adult height outcomes.[25] Notably, the age at the start of therapy is negatively correlated with long-term height outcomes.[25] Moreover, adult psychosocial outcomes are also compromised in children with growth hormone deficiency who have delayed detection and treatment. Studies have shown that adults who had delayed growth hormone treatment (i.e., after 12 years of age) had suboptimal adult height, lower educational status, difficulties acquiring employment and social difficulties.[26,27] This has also been observed in children born small for gestational age.[25] Importantly, the early initiation of growth hormone treatment is reliant on early referrals of short stature. Short stature is the most common feature of Turner syndrome; however, despite this, it is frequently diagnosed late (mean age: 15.1 years).[28] Late diagnosis translates into an increased risk of undiagnosed cardiovascular, autoimmune and puberty-related complications in addition to poor height outcomes.[29] Non-endocrine conditions (e.g., coeliac disease and inflammatory bowel disease), though not necessarily amenable to growth hormone therapy, can adversely impact linear growth, bone health and puberty. The identification of abnormal growth in the early phases of childhood is important since these phases significantly contribute to final adult height.[11] Cumulatively, the data underscores the importance of early detection, referral and treatment of childhood short stature.

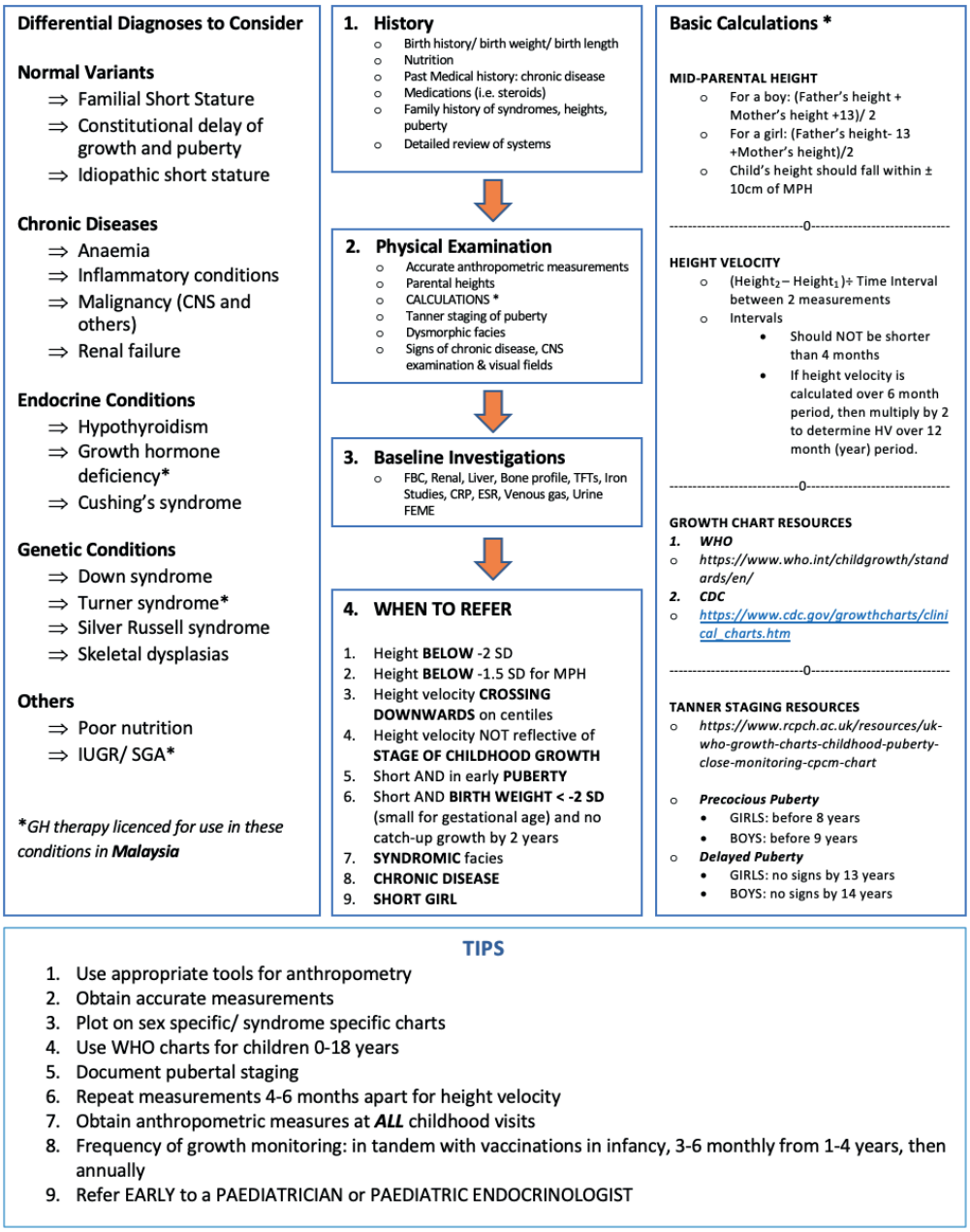

Figure 3. Assessment of short children (adapted from [7,13,24]).

Addressing the problem

The problem of short stature and stunting in Malaysian children requires serious attention in order to improve health outcomes. The early detection of short stature can be achieved through improved awareness, clinical training and re-certification. Moreover, raising parental awareness about short stature as well as how and when to seek help may potentially lead to earlier detection. There may also be a role for validated high-accuracy growth monitoring applications for parental use (e.g., Growth Journey™), which can serve as a screening tool and alert parents to faltering growth. Finally, a collaborative effort is required to identify and rectify gaps in how early childhood growth monitoring is conducted in Malaysia. At present, growth monitoring from birth until 18 months occurs in tandem with childhood vaccinations,[30] whereas it falls under the purview of the Standard Kecergasan Fizikal Kebangsaan untuk murid sekolah Malaysia (SEGAK) programme for school-aged children.[31] However, there is a gap between 18 months until 7 years of age during which time parents may not attend the recommended well-child visits and maternal child health clinics. This represents a gap during which an opportunity to detect growth disorders is lost. In the developed world, well-child visits are regular health checks that monitor growth, development and provide anticipatory

guidance.[32–34] Some countries have made school entry health checks mandatory, which are endorsed by their national paediatric association and enforced by the department of education.[34] In other countries, such health checks are voluntary and parents are invited to give informed consent for healthy child checks.[35] In Malaysia, the Ministry of Health Malaysia has endorsed healthy child checks for children aged 18 months to 7 years. Despite this, voluntary attendance by parents remains poor, with only 23.3% of pre-school children aged 5–6 years receiving school health services.[36,37] In 2017, 75.3% of children aged below 1 year and only 49.5% of toddlers aged 1–4 years received health services from the Ministry of Health Facilities.[37] This identifiable gap raises the question of whether professionals should advocate for a mandatory school entry health check so that paediatric growth disorders—amongst other health conditions—may be detected early.

Conclusion

Childhood growth is a dynamic process that is influenced by several factors. Regular growth monitoring with the appropriate tools is essential for the early detection of short stature and stunting and to mitigate its adverse consequences in childhood and adulthood. Future measures should be focused on improving growth monitoring in children prior to school entry. A dedicated dialogue between stakeholders is required to identify gaps and support legislation that may optimise the detection of growth disorders in Malaysian children.

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How does this paper make a difference to general practice?

Stunting is a common phenomenon in Malaysian children. Early detection and referral are critical to optimising outcomes for children with stunting or short stature. This review article aims to provide family medicine specialists with a framework on the recommended methods for conducting growth monitoring as well as when and how to make referrals. It also aims to raise awareness about the shortcomings of the existing growth monitoring system in Malaysia and invites readers to consider additional measures that must be considered to further optimise this system.

Key learning points

1. Growth in childhood is a dynamic process and provides important information on the general health of a child.
2. Regular growth assessments are critical for the early detection of growth disorders in childhood.
3. Comprehensive history and physical examinations with accurate auxological measurements taken in a standardised manner are the cornerstones of assessing short children.
4. Early referral to a paediatrician is important to ensure that the '*window of opportunity*' for medical intervention is not missed.

Key Points

- Normal growth is a sensitive indicator of child health
- Monitoring child growth is essential at all health visits
- History, anthropometric measures and targeted investigations are critical before considering endocrine conditions
- Early recognition of and intervention in faltering growth are essential to achieving an optimum adult height

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