

# GROWTH MONITORING

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# OBJECTIVES

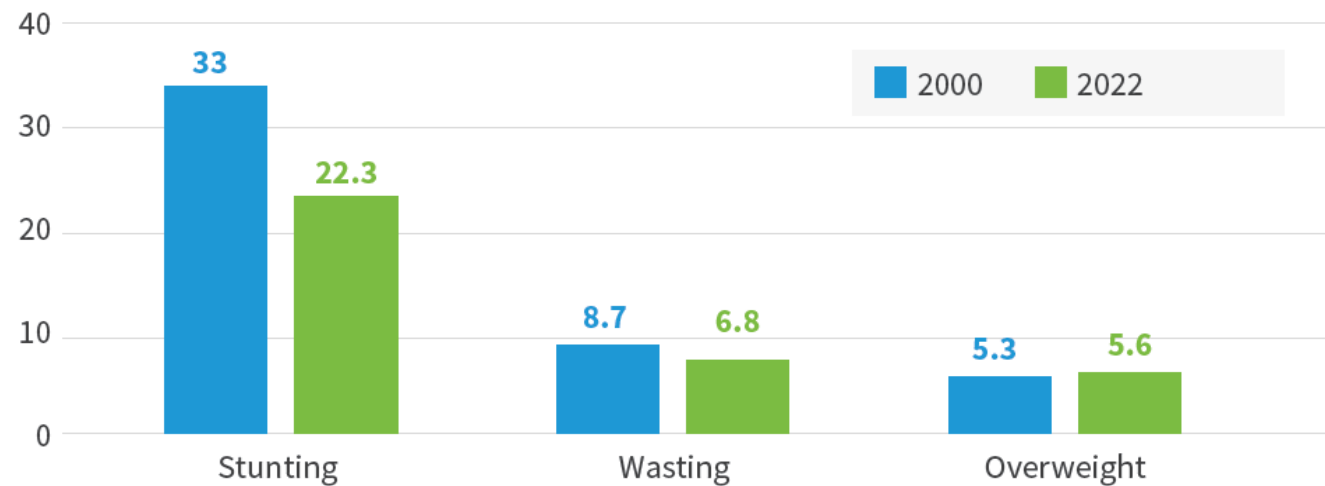
- Enumerate the fundamental principles of child growth monitoring as outlined in the World Health Organization (WHO) technical guide.
- Define the standardized methods for measurement.
- Describe interpretation of growth indicators.
- Identify importance of tracking trends over time.

# Understanding malnutrition

- **Malnutrition** is a broad term encompassing three primary categories of nutrient imbalances :
- **1. Undernutrition:** Includes stunting (low height-for-age/chronic), wasting (low weight-for-height/acute), and being underweight (low weight-for-age).
- **2. Micronutrient-related Malnutrition:** Deficiencies or excesses of vital vitamins and minerals.
- **3. Overweight and Obesity:** Often linked to diet-related noncommunicable diseases like diabetes and heart disease

# Prevalence of malnutrition

**Figure 1.** Percentage of children under 5 affected by stunting, wasting and overweight globally in 2000 and 2022



# The Role of Growth Monitoring

- **Growth monitoring** is a sequential process of measurement, plotting, and interpretation .
- It serves several critical functions:
  - 1. Early Detection: Identifies growth faltering before severe malnutrition occurs.
  - 2. Predictive Health: Offers insights into past growth and helps predict future health outcomes.
  - 3. Standardization: Uses the WHO Child Growth Standards (2006), which establish breastfed infants as the benchmark for growth regardless of ethnicity or socioeconomic status

# Practical Anthropometric Measurement

## I. Essential Measurements by Age

- Techniques change as a child develops:

• Measurement	<b>Age Range</b>	<b>Equipment</b>
• Weight	Birth onwards	Infant or digital floor scales
• Length	0–2 years old	Infantometer/Length board (measured lying down)
• Height	>2 years old	Stadiometer (measured standing up)
• Head Circumference	0–2 years old	Non-stretchable measuring tape
• MUAC tape	from 3 months	Mid-Upper Arm Circumference

## 2.1 Comprehensive Guide: How to Measure Child Growth

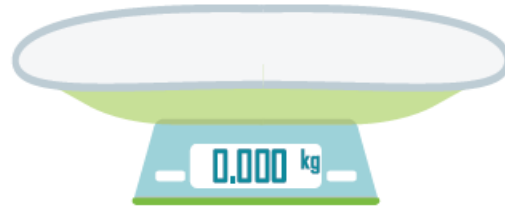
### 2.1.1 Weight measurement: <2 years of age

#### Equipment needed

Digital weight scales that allow tared weighing placed on a flat surface (Figure 5 and 6).



**Figure 5.** Digital floor scale



**Figure 6.** Infant scale





**If you have an adult digital scale:**

1. Ask the mother to stand in the middle of the scale, feet slightly apart, and remain still.
2. Tare the scale and gently hand the naked baby to the mother.
3. Record the child's weight to the nearest gram.

◀ **Figure 8.** Procedure for infant weight measurement using adult scale

### 2.1.2 Weight measurement: >2 years of age

#### Procedure

1.

Turn on the scale (if electronic) and ensure it reads <0.00>.

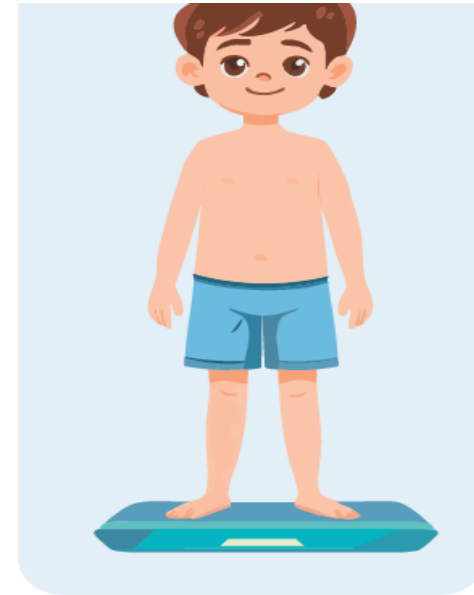
2.

Place the child in the middle of the scale, with feet slightly apart.

3.

Wait for the child to stop moving. If the child is restless, ask for the mother's assistance.

▶ Once the child is still, record their weight as shown on the scale. (Figure 9)



**Figure 9.** Procedure for infant weight measurement for children >2 years

### 2.1.3 Length measurement: <2 years of age

Length or “recumbent” length is obtained by the infant lying down and is generally done when they are less than 24 months.

#### Equipment needed

- Infantometer or length board on a table or flat surface (Figures 10 and 11).



**Figure 10.** Infantometer

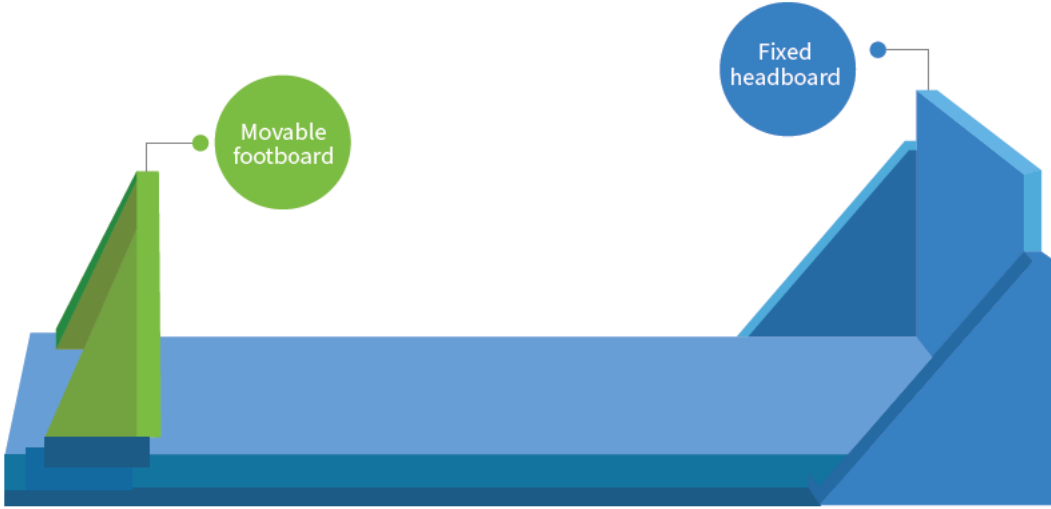
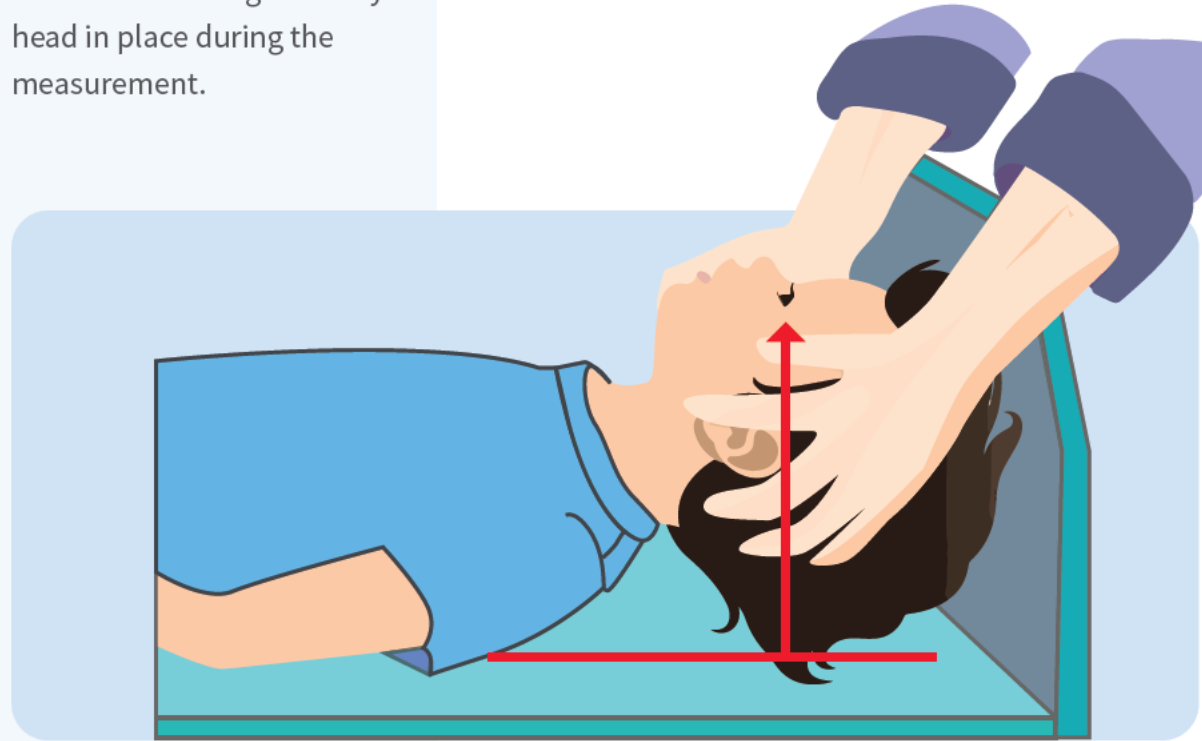


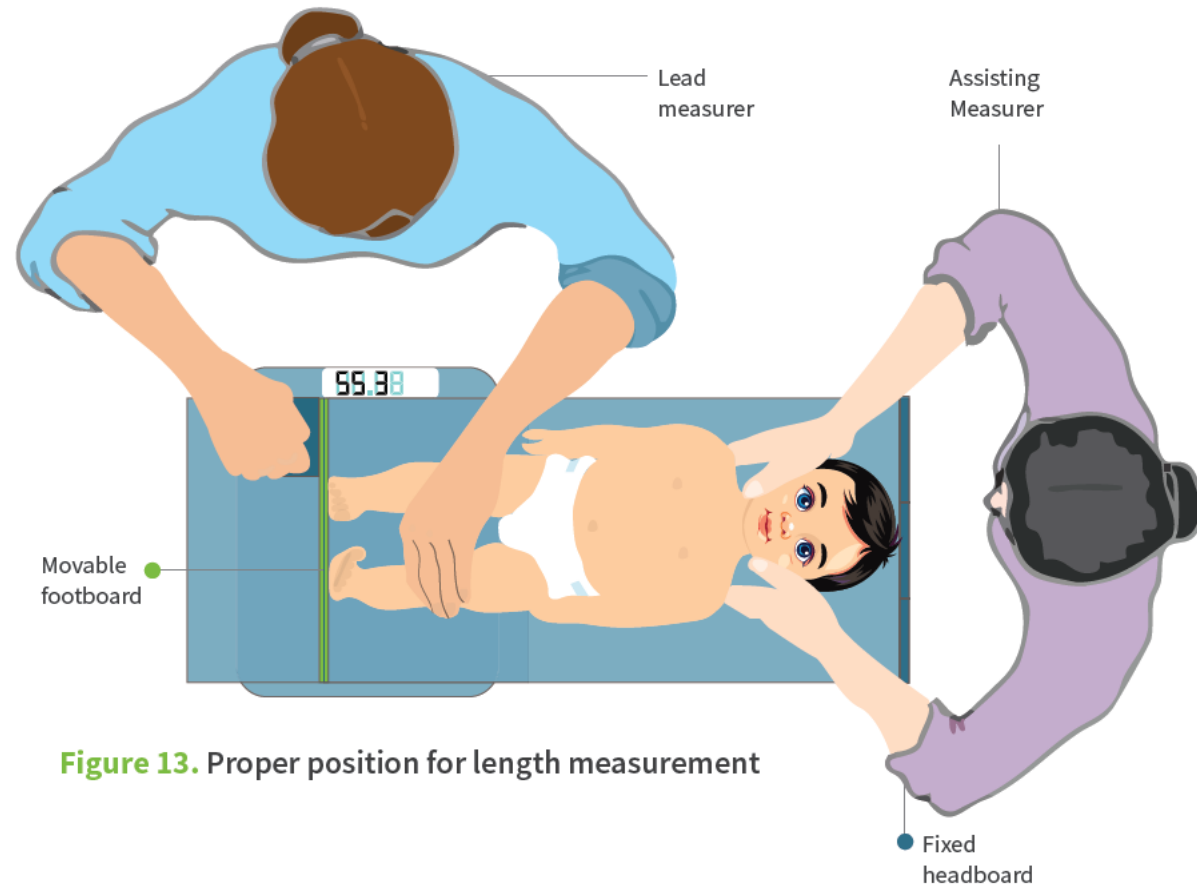
Figure 11. Length board



length board and request her to assist in holding the baby's head in place during the measurement.



**Figure 12.** Proper head positioning



**Figure 13.** Proper position for length measurement



**Figure 14.** Example for reading measuring tape



### 2.1.4 Height measurement: >2 years of age

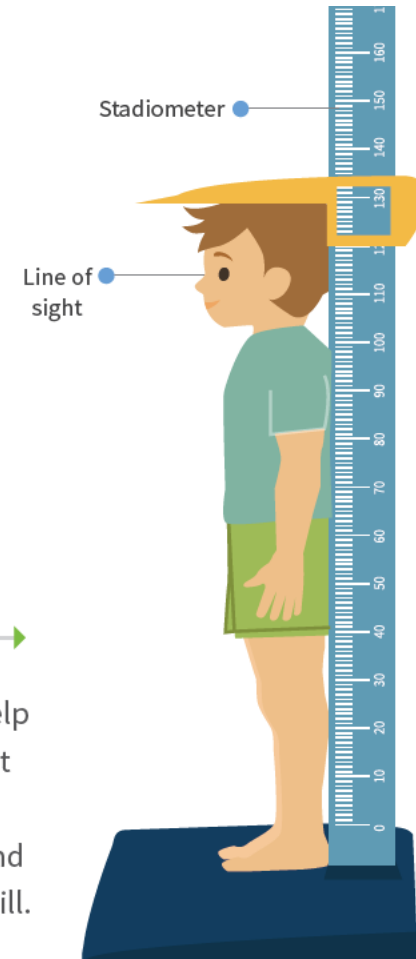
Standing height can be measured for children 2-3 years of age and older who are able to stand without assistance.

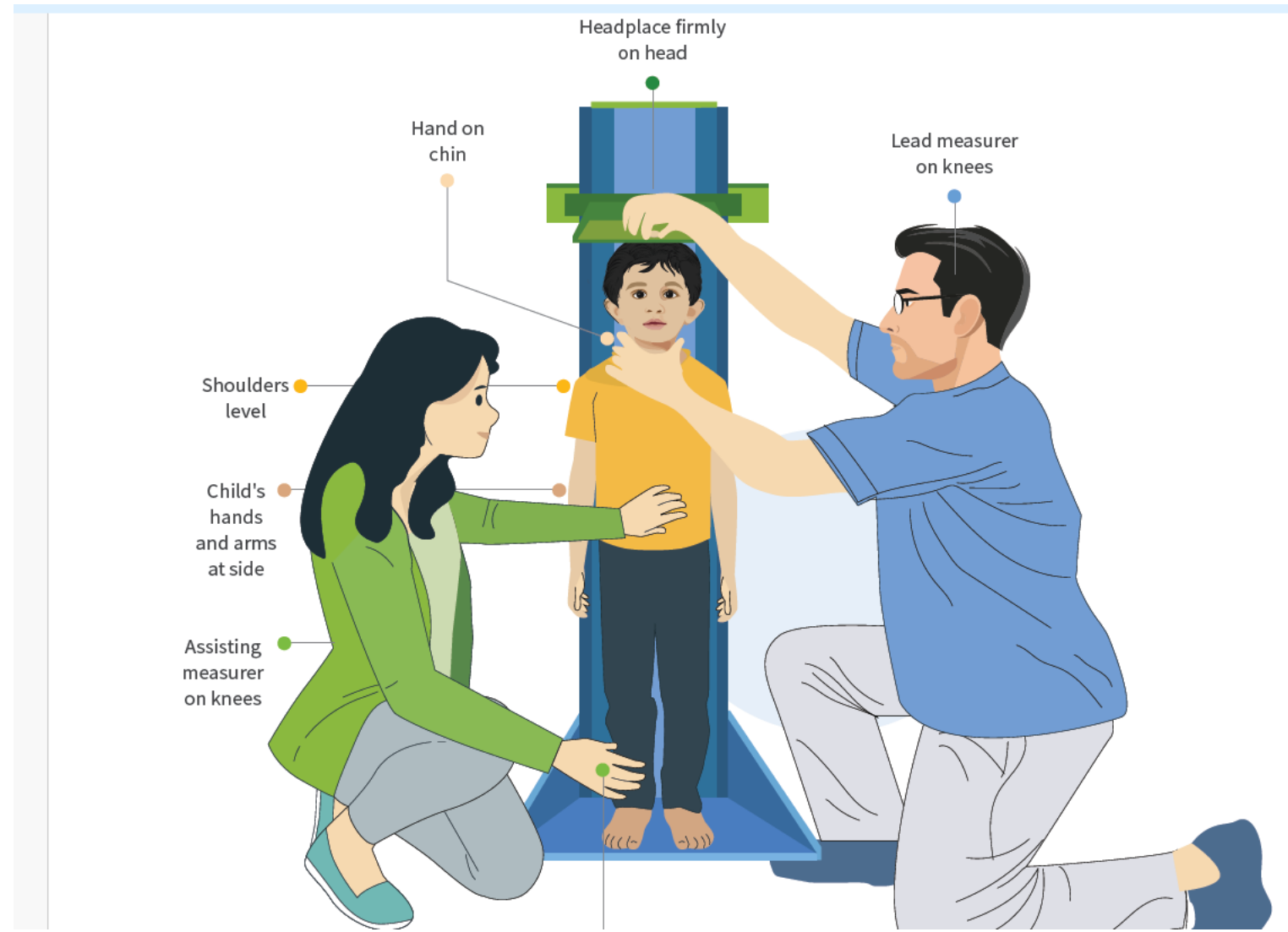
#### Equipment needed

- Stadiometer on a flat surface (Figure 15).

#### Procedure

1. Assist the child in standing on the baseboard with feet slightly apart, ensuring alignment against the vertical board. The back of the head, shoulder blades, buttocks, calves, and heels should all touch the vertical board (Figure 16).
2. Ask the mother to help keep the legs straight and feet flat while soothing the child and ensuring they stay still.





Headplace firmly  
on head

Hand on  
chin

Lead measurer  
on knees

Shoulders  
level

Child's  
hands  
and arms  
at side

Assisting  
measurer  
on knees

## 2.1.5 Head Circumference

### Equipment needed

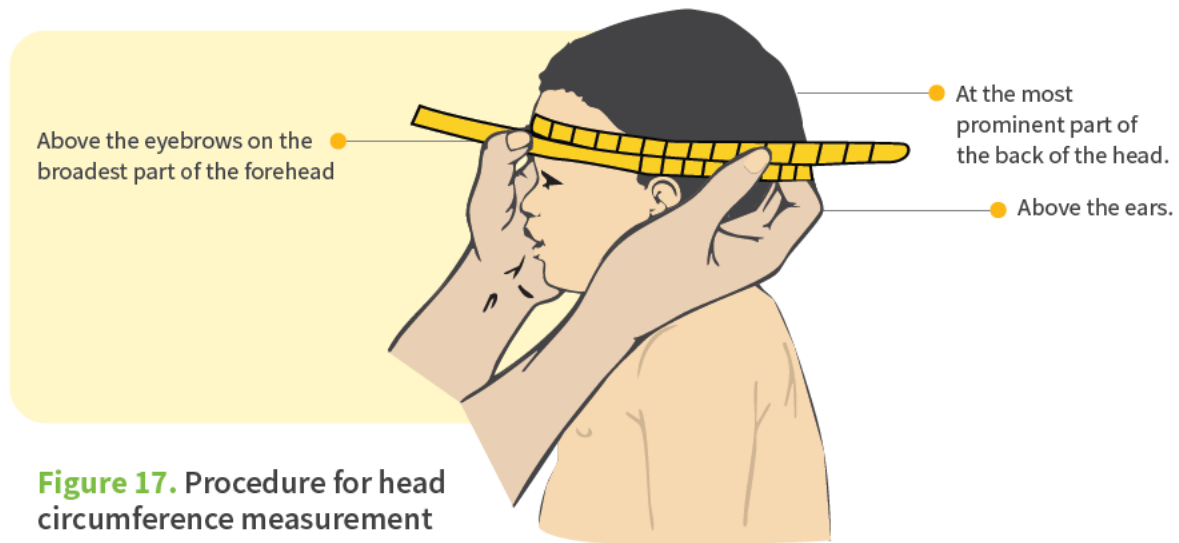
- Measuring tape (non-stretchable).

### Preparing for measurement

- Check that all hair ornaments have been removed.

### Procedure

- Securely wrap the tape around the head at its widest point (Figure 17):



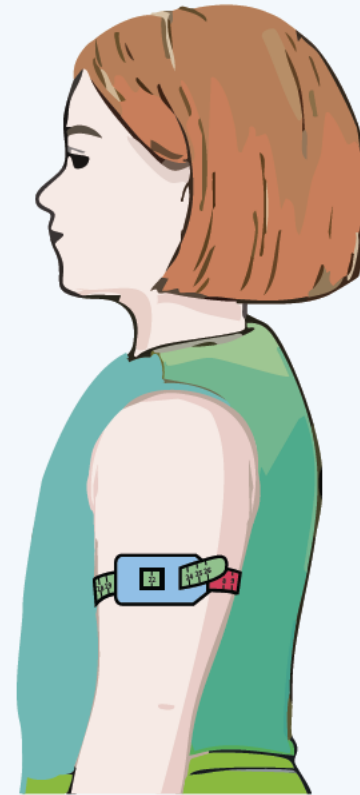
**Figure 17.** Procedure for head circumference measurement



# MUAC(left arm-mid point acromion and olecranon process)

## Procedure

1. Ensure the child's arm hangs relaxed. If the child is uncooperative, the assisting observer should hold the lower arm in the extended position. Ensure that the muscle of the arm is not flexed or tightened.
2. Place the tape around the arm at the marked midpoint level. The tape should encompass the upper arm's skin, fat, muscle, and bone without compressing the tissue. Alert the lead observer if there is any gap or compression. (Figure 19)
3. The measurement should be taken on the side of the arm.
4. Record the measurement to the last completed 1 mm.



**Figure 19.** Placing the tape around the arm

## II. Best Practices for Accuracy

- To ensure data integrity, healthcare providers must follow these "TIPS" :
- **Calibration:** Scales and height boards should be checked and calibrated weekly.
- **Positioning:** For height, ensure the "five points of contact" with the vertical board: back of head, shoulder blades, buttocks, calves, and heels.
- **Redundancy:** Take measurements more than once to achieve high precision

# Determining BMI

- BMI is a numerical measure associating an individual's weight with height or length.
- BMI is a valuable growth indicator when plotted against a child's age on a graph.
- The formula for BMI calculation is dividing weight in kilograms by the square of length or height in meters.
- Alternatively, it can be represented as kg/m<sup>2</sup>.

$$\text{BMI} = \frac{\text{weight}}{(\text{height} * \text{height})}$$

### 2.2.2 BMI determination using a BMI table:

L or H (cm)	Body Mass Index (BMI)																		L or H (cm)	
	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25		26
42	1.4	1.6	1.8	1.9	2.1	2.3	2.5	2.6	2.8	3.0	3.2	3.4	3.5	3.7	3.9	4.1	4.2	4.4	4.6	42
43	1.5	1.7	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.1	3.3	3.5	3.7	3.9	4.1	4.3	4.4	4.6	4.8	43
44	1.5	1.7	1.9	2.1	2.3	2.5	2.7	2.9	3.1	3.3	3.5	3.7	3.9	4.1	4.3	4.5	4.6	4.8	5.0	44
45	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.1	4.3	4.5	4.7	4.9	5.1	5.3	45
46	1.7	1.9	2.1	2.3	2.5	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.7	4.9	5.1	5.3	5.5	46
47	1.8	2.0	2.2	2.4	2.6	2.9	3.1	3.3	3.5	3.8	4.0	4.2	4.4	4.6	4.9	5.1	5.3	5.5	5.7	47
48	1.8	2.1	2.3	2.5	2.8	3.0	3.2	3.5	3.7	3.9	4.1	4.4	4.6	4.8	5.1	5.3	5.5	5.8	6.0	48
49	1.9	2.2	2.4	2.6	2.9	3.1	3.4	3.6	3.8	4.1	4.3	4.6	4.8	5.0	5.3	5.5	5.8	6.0	6.2	49
50	2.0	2.3	2.5	2.8	3.0	3.3	3.5	3.8	4.0	4.3	4.5	4.8	5.0	5.3	5.5	5.8	6.0	6.3	6.5	50
51	2.1	2.3	2.6	2.9	3.1	3.4	3.6	3.9	4.2	4.4	4.7	4.9	5.2	5.5	5.7	6.0	6.2	6.5	6.8	51
52	2.2	2.4	2.7	3.0	3.2	3.5	3.8	4.1	4.3	4.6	4.9	5.1	5.4	5.7	5.9	6.2	6.5	6.8	7.0	52

Omar is a one-month-old newborn. His length is 47.2 cm, and his weight is 2.3.

To determine his BMI, using the BMI table:

- Look for the closest value for his length in the far left column (47 cm).
- Omar's weight is 2.3 kg. his weight on the row for his length falls between 2.2 and 2.4 kg.
- Tracing a finger upward from Omar's weight, you find that his BMI (on the top row of the table) is 10.5.

L or H (cm)	Body Mass Index (BMI)																			L or H (cm)
	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	
42	1.4	1.6	1.8	1.9	2.1	2.3	2.5	2.6	2.8	3.0	3.2	3.4	3.5	3.7	3.9	4.1	4.2	4.4	4.6	42
43	1.5	1.7	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.1	3.3	3.5	3.7	3.9	4.1	4.3	4.4	4.6	4.8	43
44	1.5	1.7	1.9	2.1	2.3	2.5	2.7	2.9	3.1	3.3	3.5	3.7	3.9	4.1	4.3	4.5	4.6	4.8	5.0	44
45	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.1	4.3	4.5	4.7	4.9	5.1	5.3	45
46	1.7	1.9	2.1	2.3	2.5	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.7	4.9	5.1	5.3	5.5	46
47	1.8	2.0	2.2	2.4	2.6	2.9	3.1	3.3	3.5	3.8	4.0	4.2	4.4	4.6	4.9	5.1	5.3	5.5	5.7	47
48	1.8	2.1	2.3	2.5	2.8	3.0	3.2	3.5	3.7	3.9	4.1	4.4	4.6	4.8	5.1	5.3	5.5	5.8	6.0	48
49	1.9	2.2	2.4	2.6	2.9	3.1	3.4	3.6	3.8	4.1	4.3	4.6	4.8	5.0	5.3	5.5	5.8	6.0	6.2	49
50	2.0	2.3	2.5	2.8	3.0	3.3	3.5	3.8	4.0	4.3	4.5	4.8	5.0	5.3	5.5	5.8	6.0	6.3	6.5	50
51	2.1	2.3	2.6	2.9	3.1	3.4	3.6	3.9	4.2	4.4	4.7	4.9	5.2	5.5	5.7	6.0	6.2	6.5	6.8	51
52	2.2	2.4	2.7	3.0	3.2	3.5	3.8	4.1	4.3	4.6	4.9	5.1	5.4	5.7	5.9	6.2	6.5	6.8	7.0	52

Asma is a 3 years and 2 months old girl. Asma's height is 89.1 cm, and her weight is 12.6 kg.

To determine his BMI, using the BMI table:

- The closest height in the far left column of the table is 89 cm.
- Asma's weight is 12.6 kg. The closest weight on the row for her height is 12.7 kg.
- Tracing a finger upward from her weight, you find that her BMI (on the top row of the table) is 16.

L or H (cm)	Body Mass Index (BMI)												
	8	9	10	11	12	13	14	15	16	17	18	19	20
84	5.6	6.4	7.1	7.8	8.5	9.2	9.9	10.6	11.3	12.0	12.7	13.4	14.1
85	5.8	6.5	7.2	7.9	8.7	9.4	10.1	10.8	11.6	12.3	13.0	13.7	14.5
86	5.9	6.7	7.4	8.1	8.9	9.6	10.4	11.1	11.8	12.6	13.3	14.1	14.8
87	6.1	6.8	7.6	8.3	9.1	9.8	10.6	11.4	12.1	12.9	13.6	14.4	15.1
88	6.2	7.0	7.7	8.5	9.3	10.1	10.8	11.6	12.4	13.2	13.9	14.7	15.5
89	6.3	7.1	7.9	8.7	9.5	10.3	11.1	11.9	12.7	13.5	14.3	15.0	15.8
90	6.5	7.3	8.1	8.9	9.7	10.5	11.3	12.2	13.0	13.8	14.6	15.4	16.2
91	6.6	7.5	8.3	9.1	9.9	10.8	11.6	12.4	13.2	14.1	14.9	15.7	16.6
92	6.8	7.6	8.5	9.3	10.2	11.0	11.8	12.7	13.5	14.4	15.2	16.0	16.9

# Interpreting Growth Indicators\

## I. Using Z-Scores and Cut-off Points

- The WHO recommends using z-scores (standard deviations from the median) to identify growth problems:
- Normal: Between -1 and +1 z-scores .
- Preclinical Alert: Points between -1 to -2 or +1 to +2 .
- Clinical Level (Requires Treatment): Points falling below -2 or above +2 .
- Severe: Points falling below -3 or above +3

# The WHO Z-score growth charts

- developed by the World Health Organization (WHO) in 2006,
- establish international standards for assessing the optimal growth of children from birth to 5 years old based on gender.
- They measure growth using z-scores—indicating standard deviations from the median—for height/length, weight, and BMI.

- Provides charts for girls and boys.
- Birth to 6 months
- Birth to 2 years
- 2 to 5 years

## II. The Importance of Trends

- A single measurement is a "snapshot" and is often inadequate for diagnosis . Providers must look for:
- Parallel Growth: Healthy growth usually follows a track parallel to the median.
- Problematic Shifts: Watch for growth lines that cross a z-score line, show a significant upward/downward trend, or remain stagnant over time

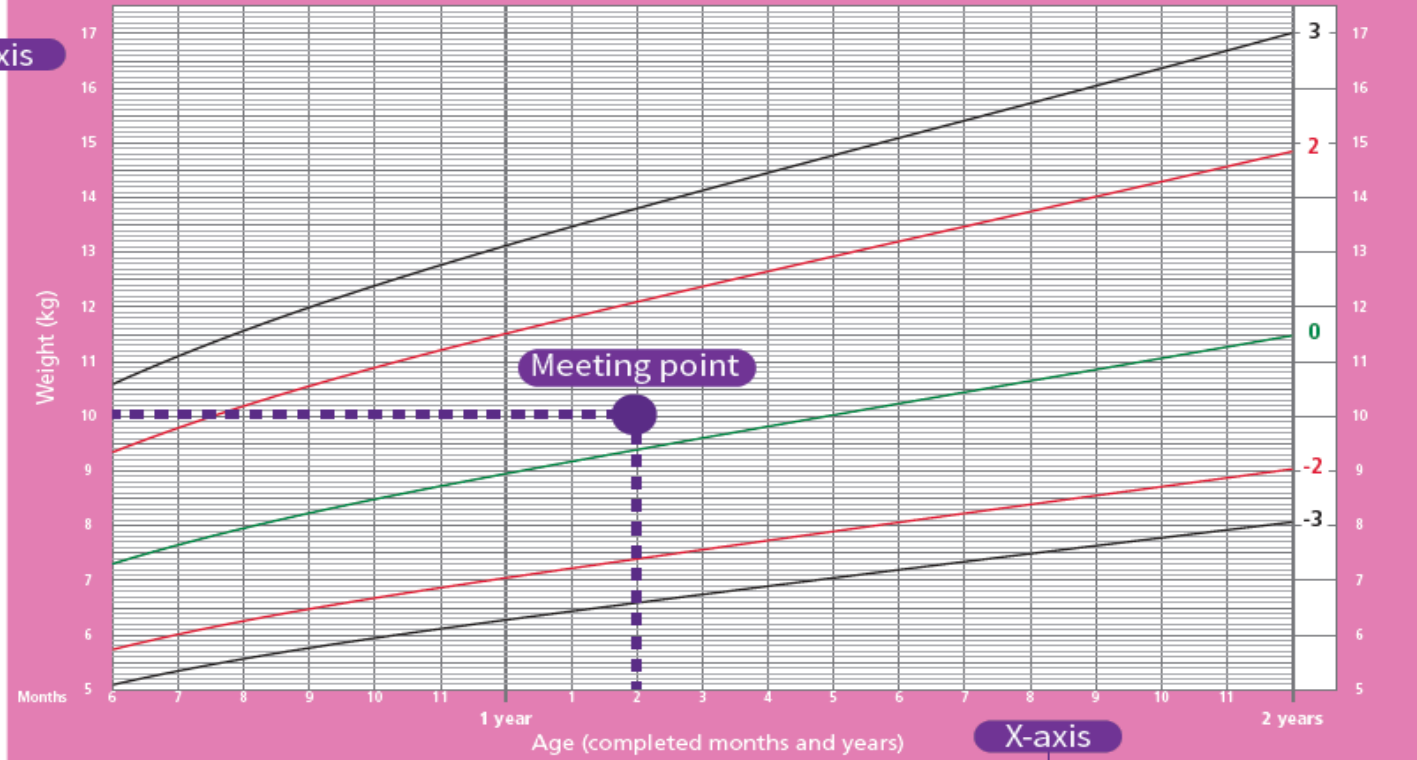
# Weight-for-age GIRLS

6 months to 2 years (z-scores)



The vertical line represents the y-axis, displaying length (in centimeters).

Y-axis



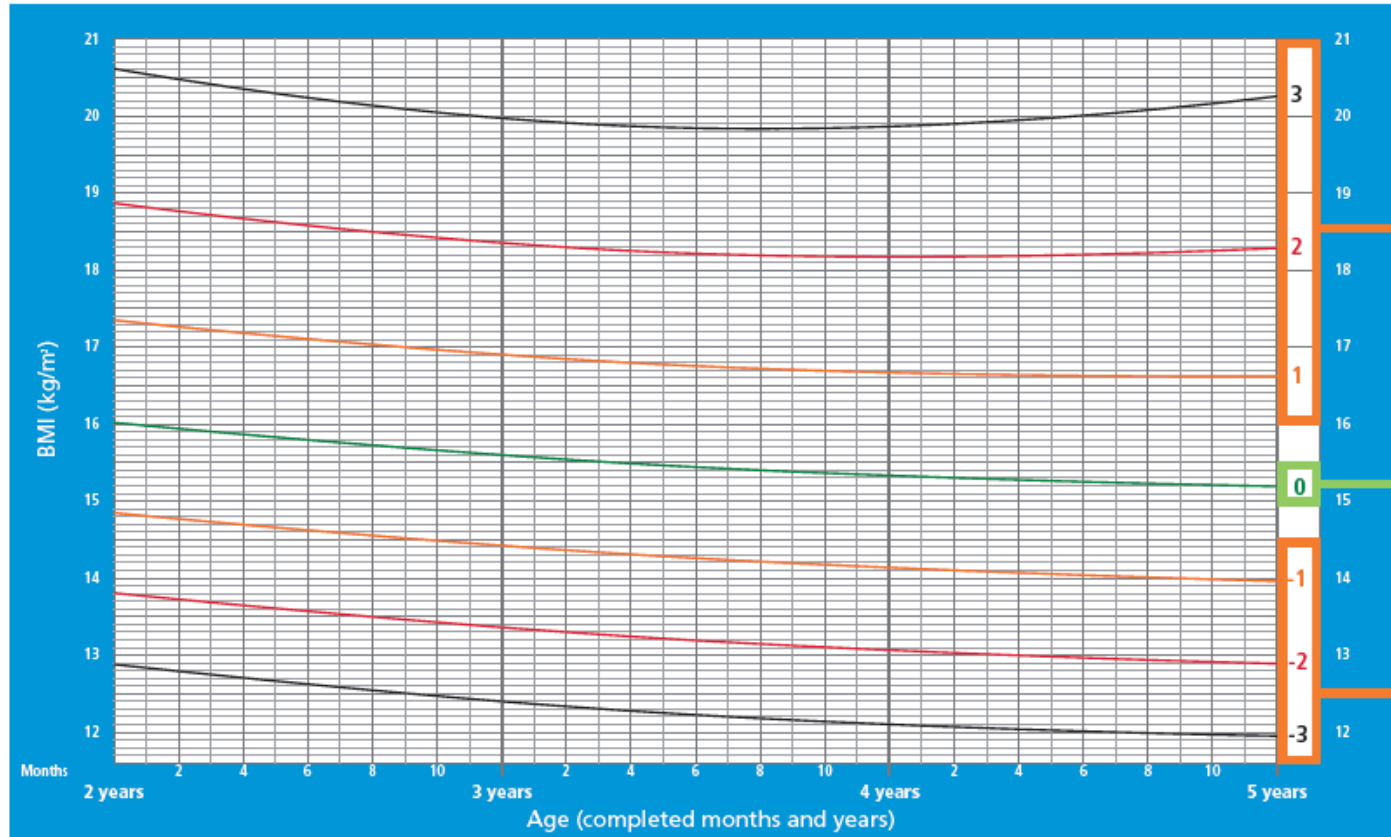
X-axis

WHO Child Growth Standards

The horizontal line at the bottom of the graph is known as the x-axis, depicting age (in completed months and years).

# BMI-for-age BOYS

2 to 5 years (z-scores)



Z-score lines on the growth charts are numbered **positively** (1, 2, 3) may represent a **growth problem**

The line labeled 0 on each chart represents the median (**average**)

Z-score lines on the growth charts are numbered **negatively** (-1, -2, -3) may represent a **growth problem**

WHO Child Growth Standards



A plotted point that is close to the median indicates normal growth



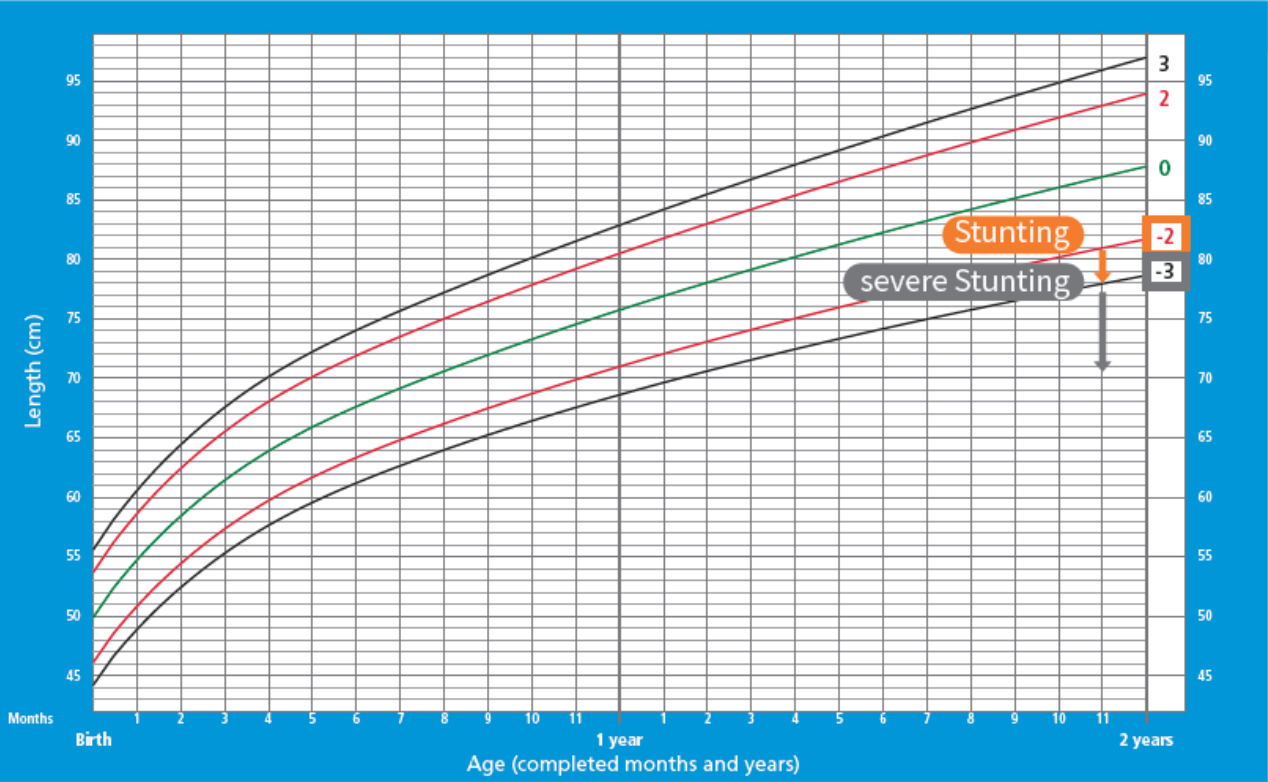
A plotted point that is close to the median indicates normal growth

**Table 3.** Cut-off points for growth assessment and growth problems.

Z-score	Height-for-age	Weight-for-age	Weight-for-length/height	BMI-for-age
Above 3	Tallness	Better to use BMI-for-age	Obese	Obese
Above 2	Normal	Better to use BMI-for-age	Overweight	Overweight
Above 1	Normal	Better to use BMI-for-age	Possible risk of overweight	Possible risk of overweight
0 (median)	Normal	Normal	Normal	Normal
Below -1	Normal	Normal	Normal	Normal
Below -2	Stunted	Underweight	Wasting	Wasting
Below -3	Severely stunted	Severely underweight	Severe wasting	Severe wasting

# Length-for-age BOYS

Birth to 2 years (z-scores)

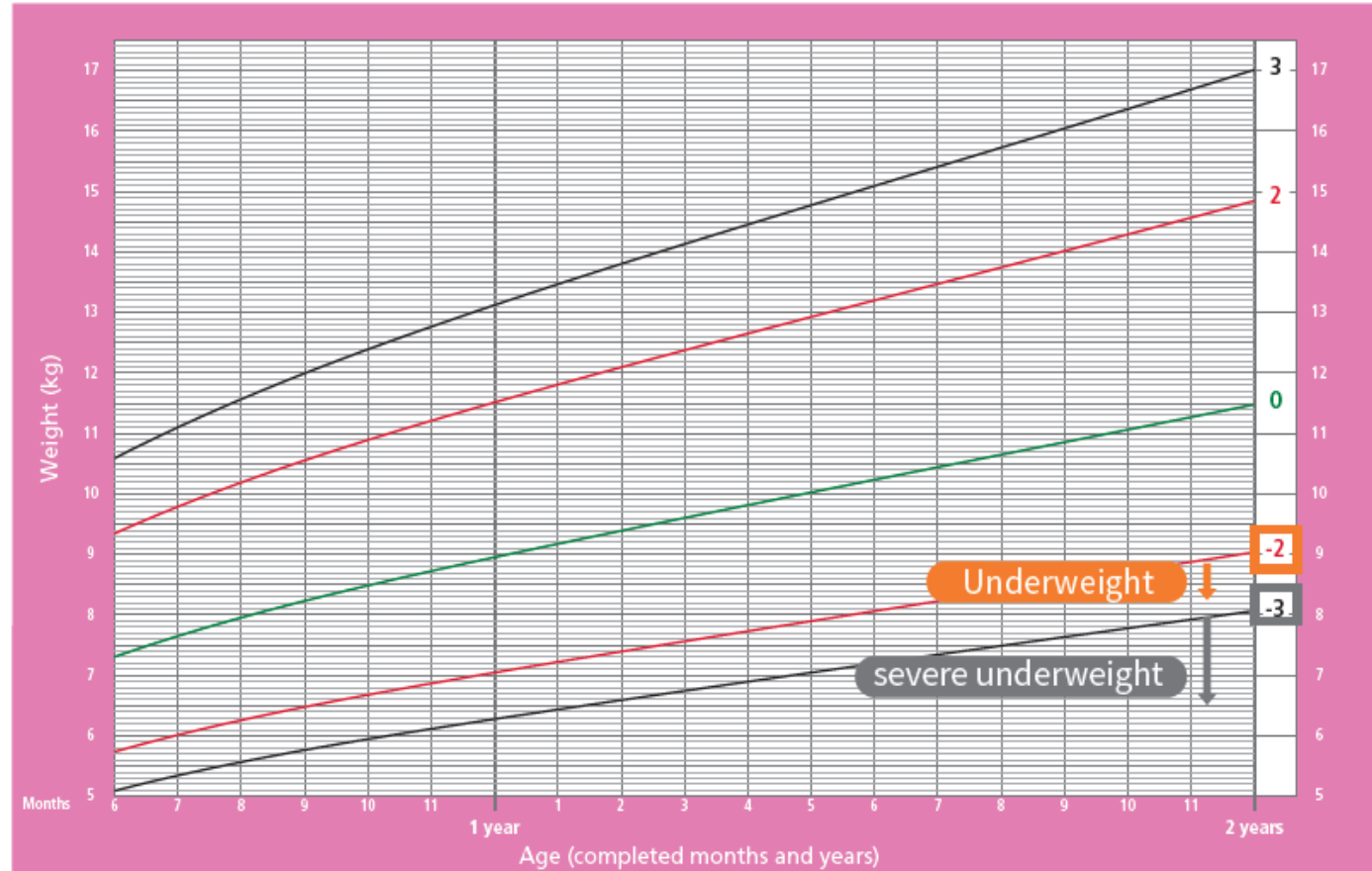


WHO Child Growth Standards

Figure 20. Cut-off points for length/height-for-age and growth problems

# Weight-for-age GIRLS

6 months to 2 years (z-scores)

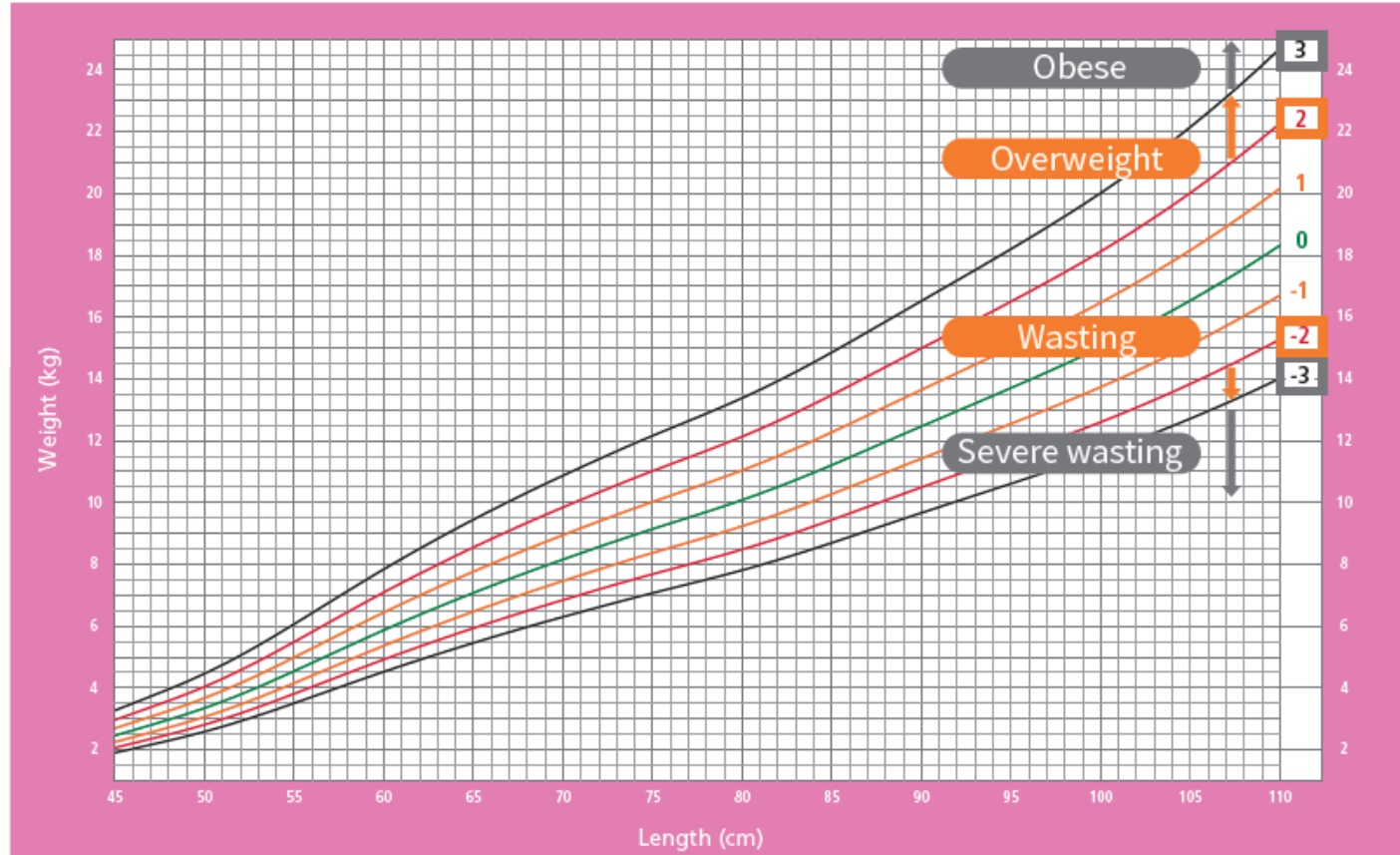


WHO Child Growth Standards

Figure 21. Cut-off points for weight-for-age and growth problems

# Weight-for-length GIRLS

Birth to 2 years (z-scores)



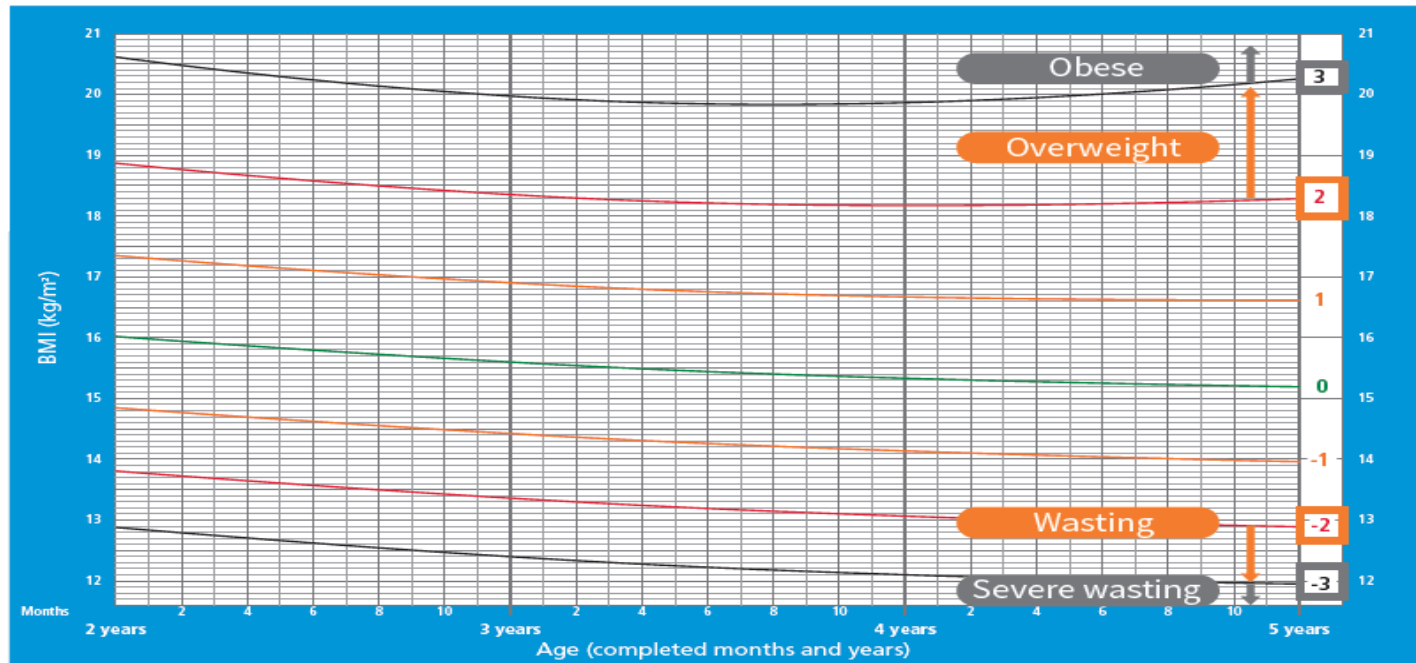
WHO Child Growth Standards

**Figure 22.** Cut-off points for weight-for-lengths and growth problems

**Figure 22.** Cut-off points for weight-for-lengths and growth problems

### BMI-for-age BOYS

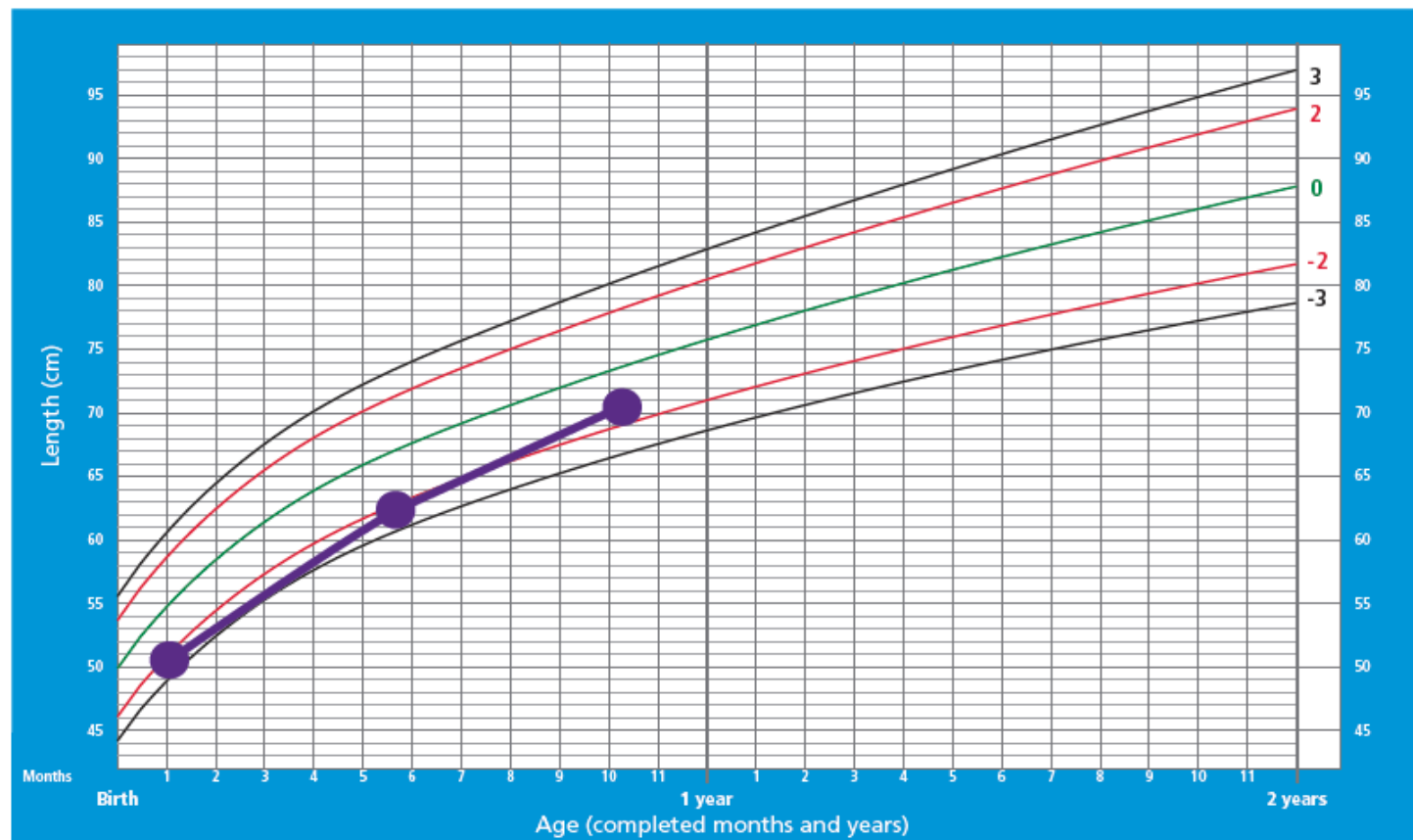
2 to 5 years (z-scores)



**Figure 23.** Cut-off points for BMI-for-age and growth problems

# Length-for-age BOYS

Birth to 2 years (z-scores)

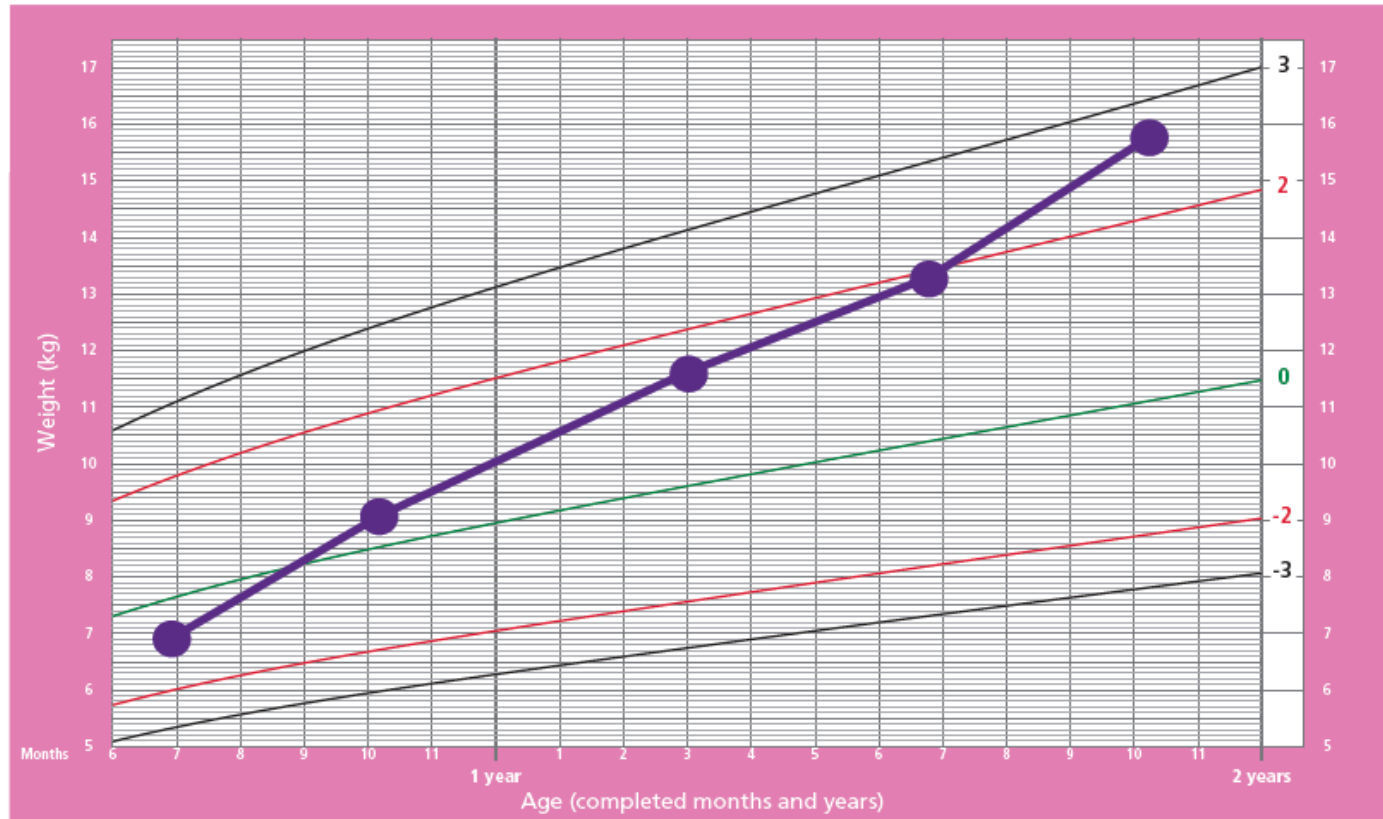


WHO Child Growth Standards

**Figure 24.** The child's growth line crosses a z-score line.

# Weight-for-age GIRLS

6 months to 2 years (z-scores)

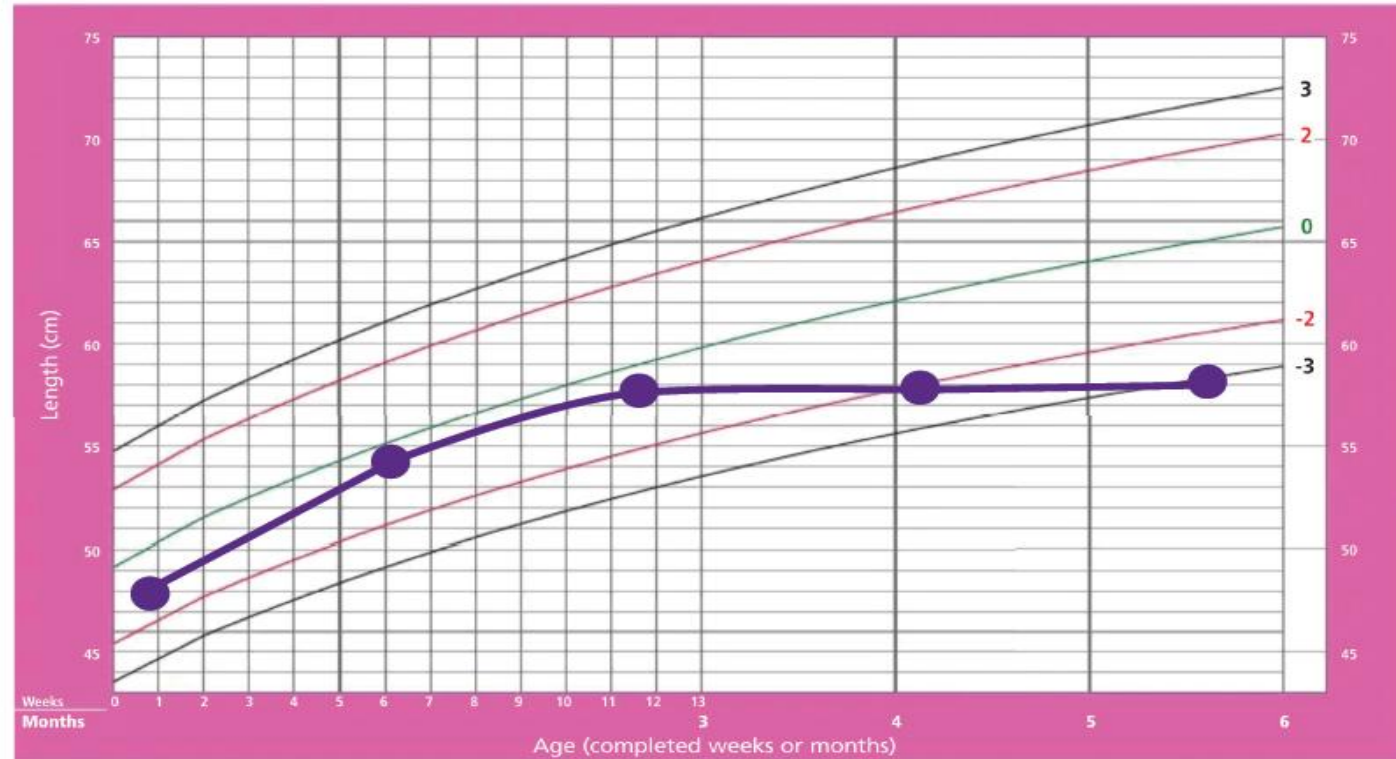


WHO Child Growth Standards

**Figure 25.** There is a significant upward or downward trend in the child's growth line.

## Length-for-age GIRLS

Birth to 6 months (z-scores)



WHO Child Growth Standards

**Figure 26.** The child's growth line remains stagnant, showing no increase in weight or length/height over time.

## 4.1 Case Study 1

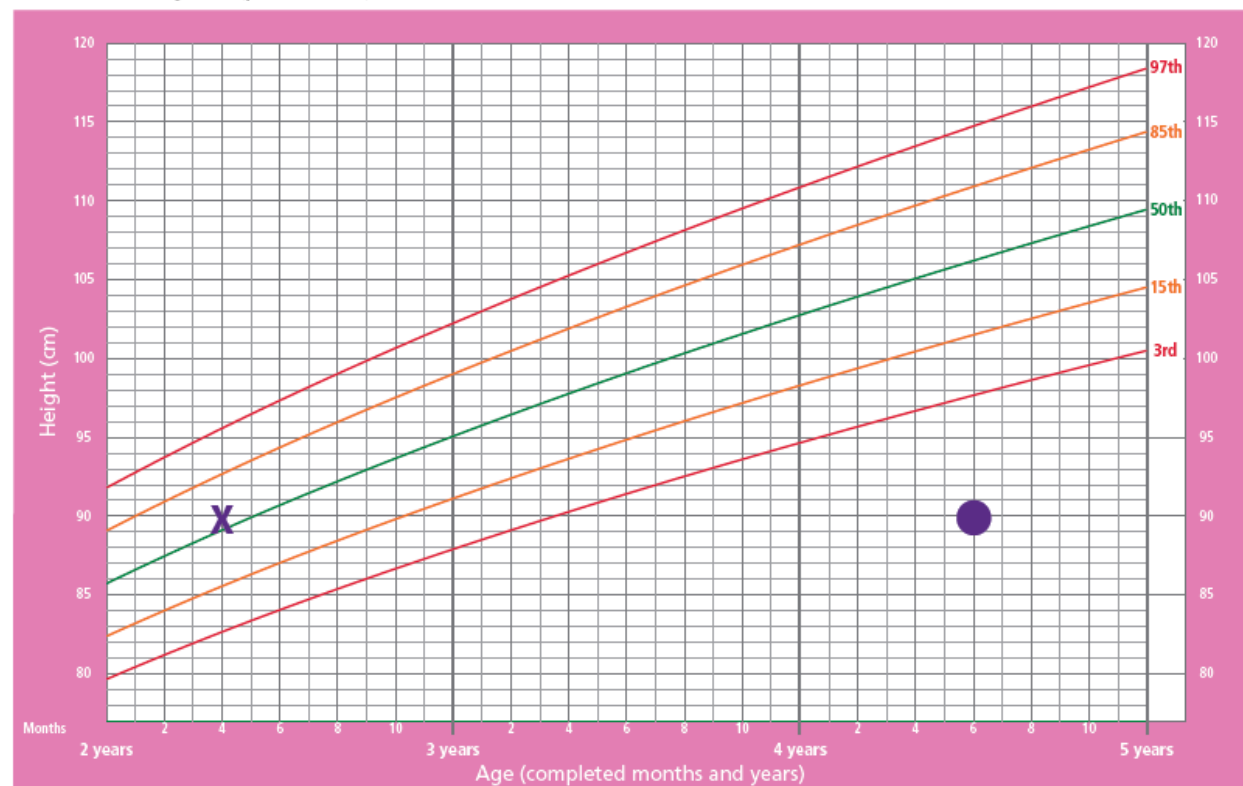
The following table presents the measurements for two girls (X) and (o).

Girl	Age	Weight (kg)	Length/height (cm)	BMI
X	2 years 4 months	12	90	14.8
•	4 years 6 months	12	90	14.8

The girls measurements are plotted on four different charts: weight-for-age, height-for-age, weight-for-height, and BMI-for-age.

## Height-for-age GIRLS

2 to 5 years (percentiles)

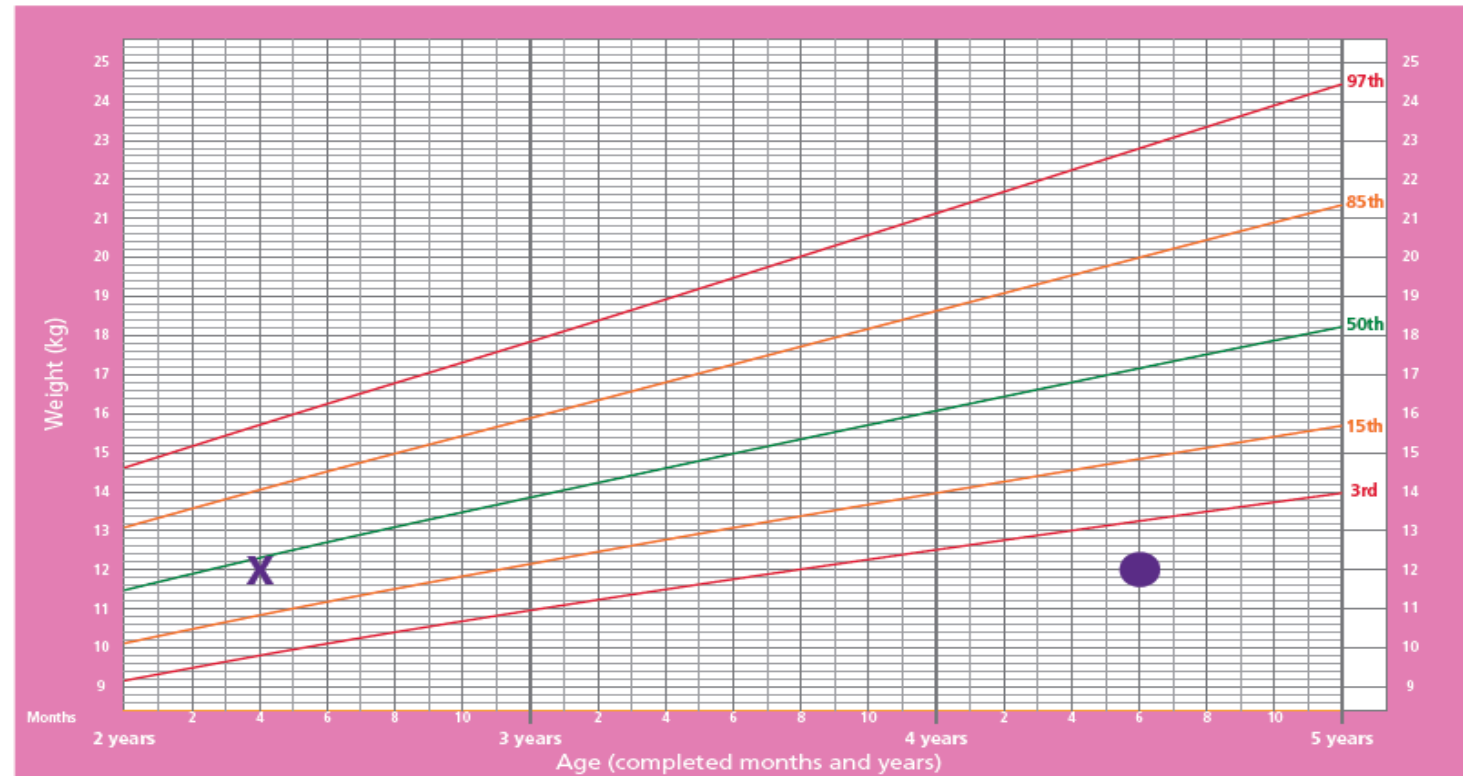


WHO Child Growth Standards

**Figure 27.** Height-for-age: Girl X's plotted point is just above the median for height-for-age indicating normal growth, while girl ● is below the -3 z-score line, indicating that she is severely stunted.

## Weight-for-age GIRLS

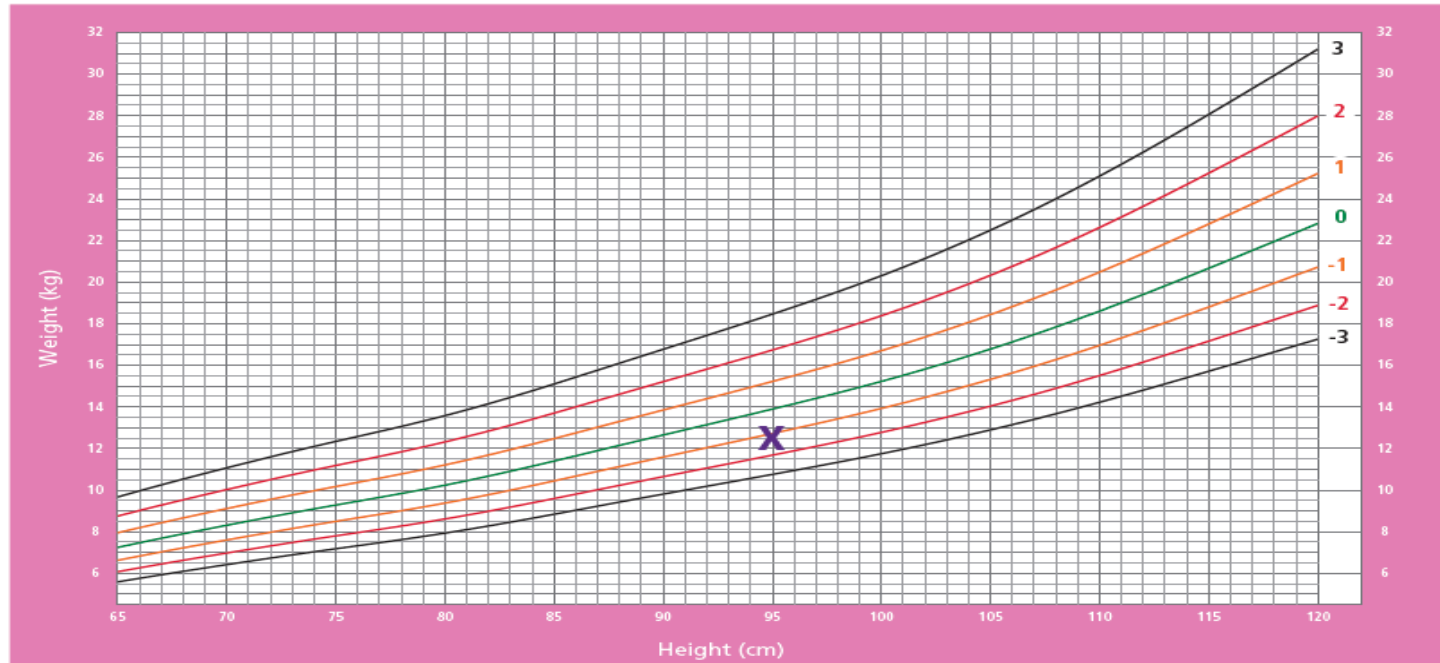
2 to 5 years (percentiles)



**Figure 28.** Weight-for-age: Girl X's plotted point is on the median indicating normal growth, while girl ● is below the -2 z-score line, indicating that she is underweight.

## Weight-for-Height GIRLS

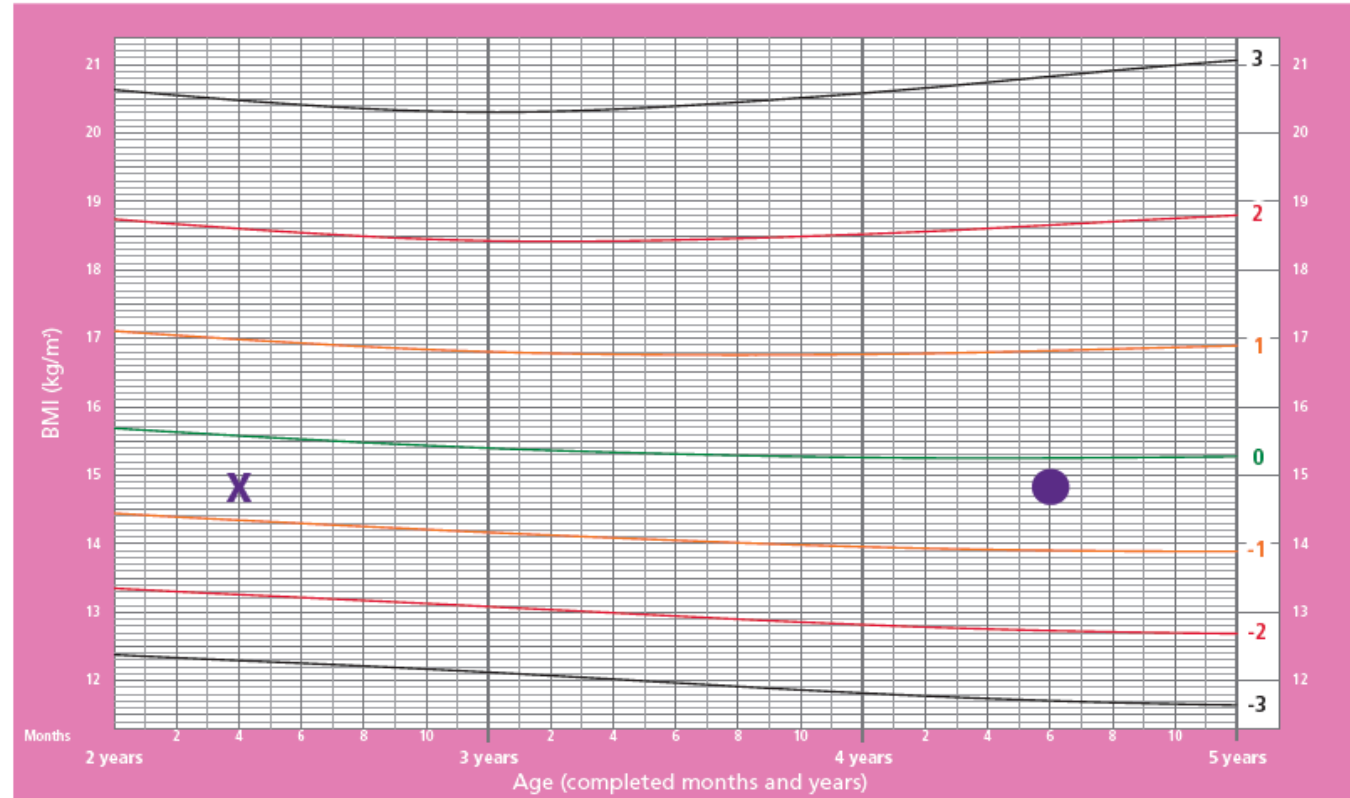
2 to 5 years (z-scores)



**Figure 29.** Weight-for-height: Both girls have the same weight and height falling just below the median.

# BMI-for-age GIRLS

2 to 5 years (z-scores)



**Figure 30.** BMI-for-age: Since the girls have the same weight and height, the BMI for-age for both girls is below the median.

# In conclusion

- interpreting growth patterns solely based **on one growth chart** may not provide a **comprehensive understanding** of a child's overall growth and development.
- For example, comparing Girl X and Girl ●, even though they have the same height and weight, the different positions of their plotted measurements on the height-for-age and weight-for-age charts show that Girl ● is shorter and lighter for her age. However, when we look at their BMI-for-age, it suggests they both have a healthy weight for their height.

## In conclusion(cont.)

- This highlights the importance of looking at different growth charts to fully understand a child's growth.
- Relying on just one chart might miss important signs of growth problems or nutritional issues.
- So, healthcare providers should combine information from various charts to get a complete picture of a child's growth and to spot any potential concerns.

## 4.2 Case Study 2

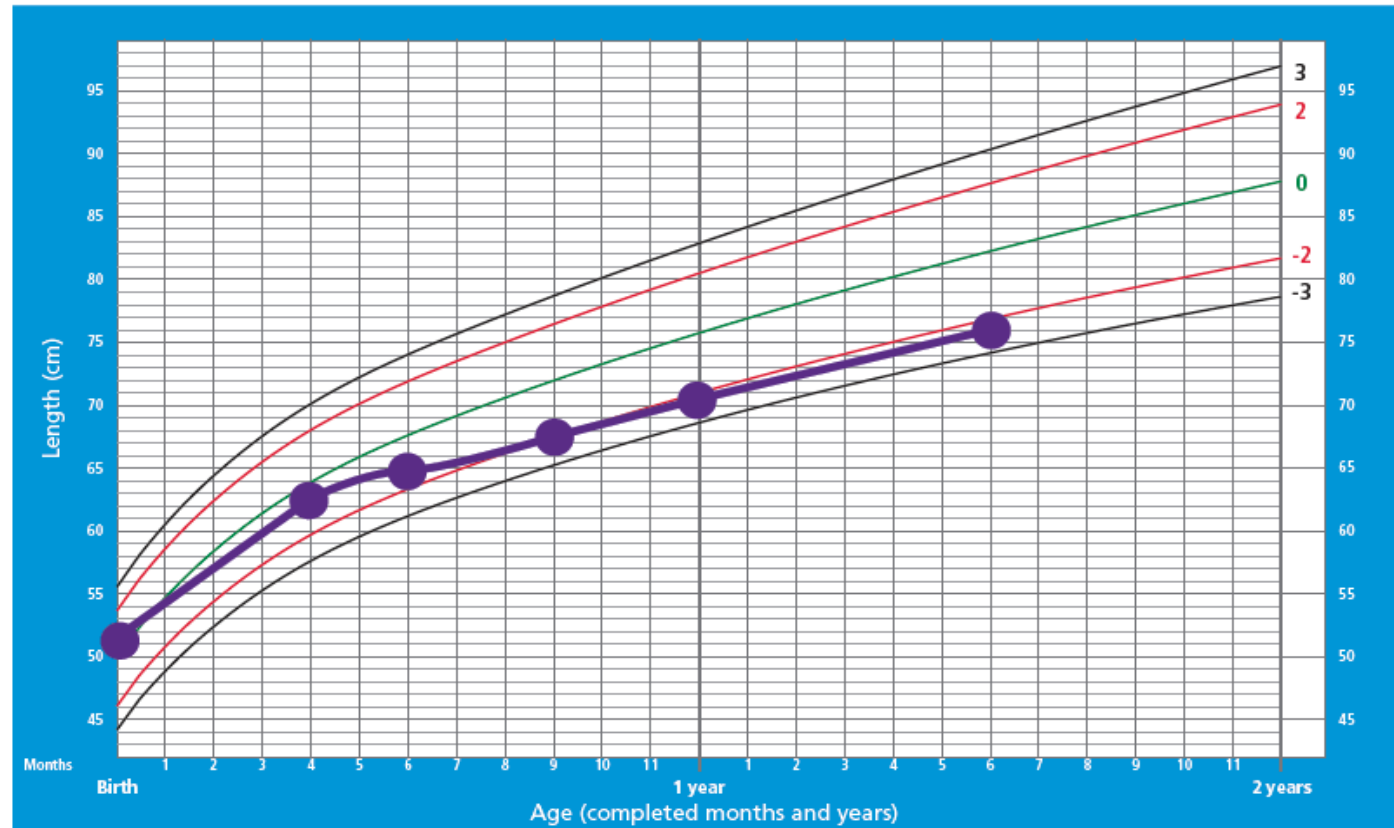
Fadi was born on 21 January 2023. He was a single, term birth (39 weeks of pregnancy). According to his birth record, his weight was 3.2 kg and length was 51.1 cm. Fadi is the only child born to his mother. He was breastfed exclusively till 6 months of age. There have been no unusual adverse events in his life so far.

**The table below includes Fadi's measurements from different visits.**

Visit	Age	Weight (kg)	Length/height (cm)	BMI
1	4 months	6.5	62.3	16.7
2	6 months	7.3	64.3	17.7
3	9 months	8.6	66.9	19.2
4	12 months	10.1	70.0	20.7
5	18 months	12.0	75.1	21.3

## Length-for-age BOYS

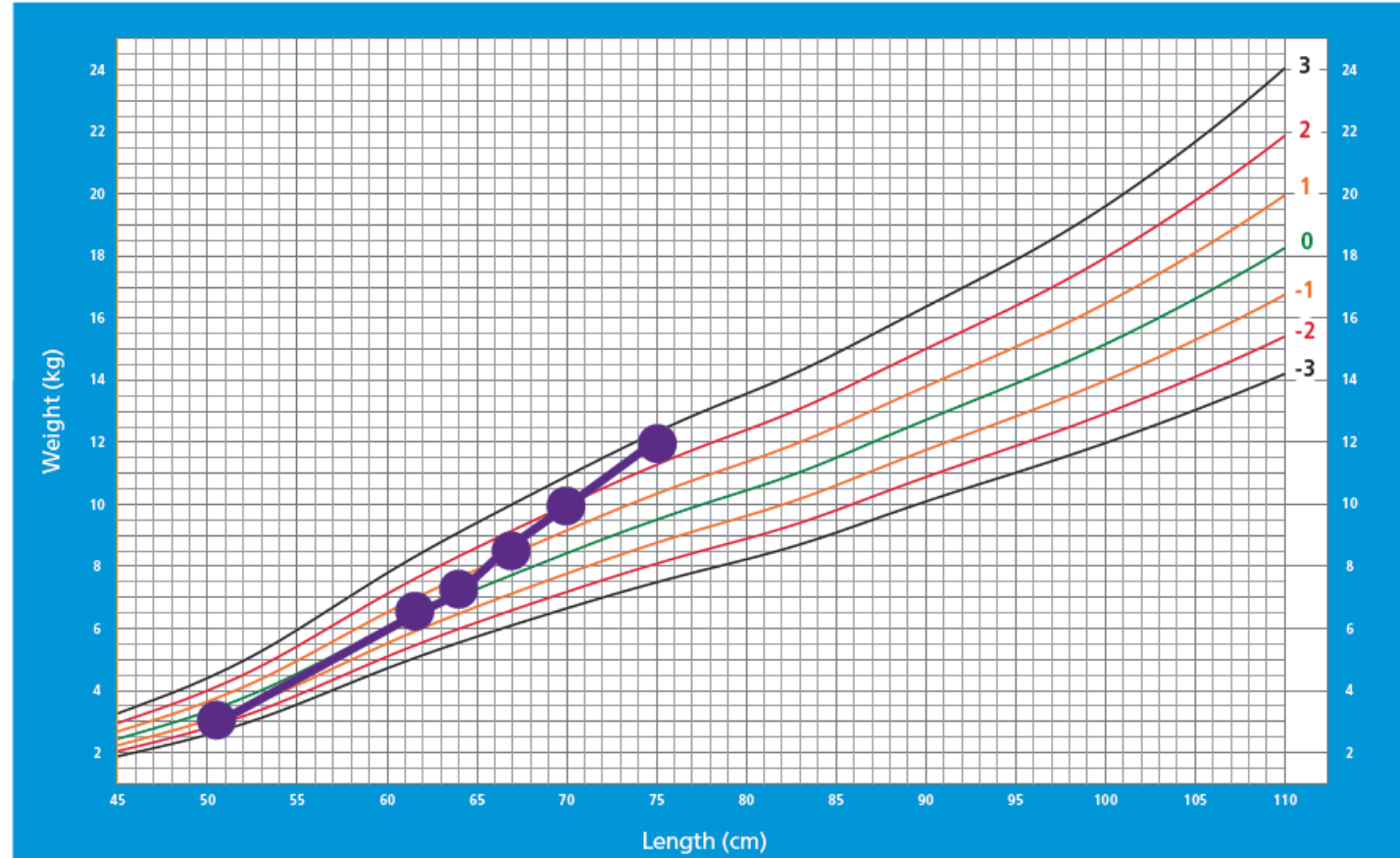
Birth to 2 years (z-scores)



**Figure 31.** Length-for-age: Fadi was of average length at birth, but his growth trend has shown periods of slow growth. Over a period of 18 months, his length-for-age has dropped from the median at birth to below -2 z-score. At 18 months, Fadi is identified as stunted based on his length-for-age chart.

# Weight-for-length BOYS

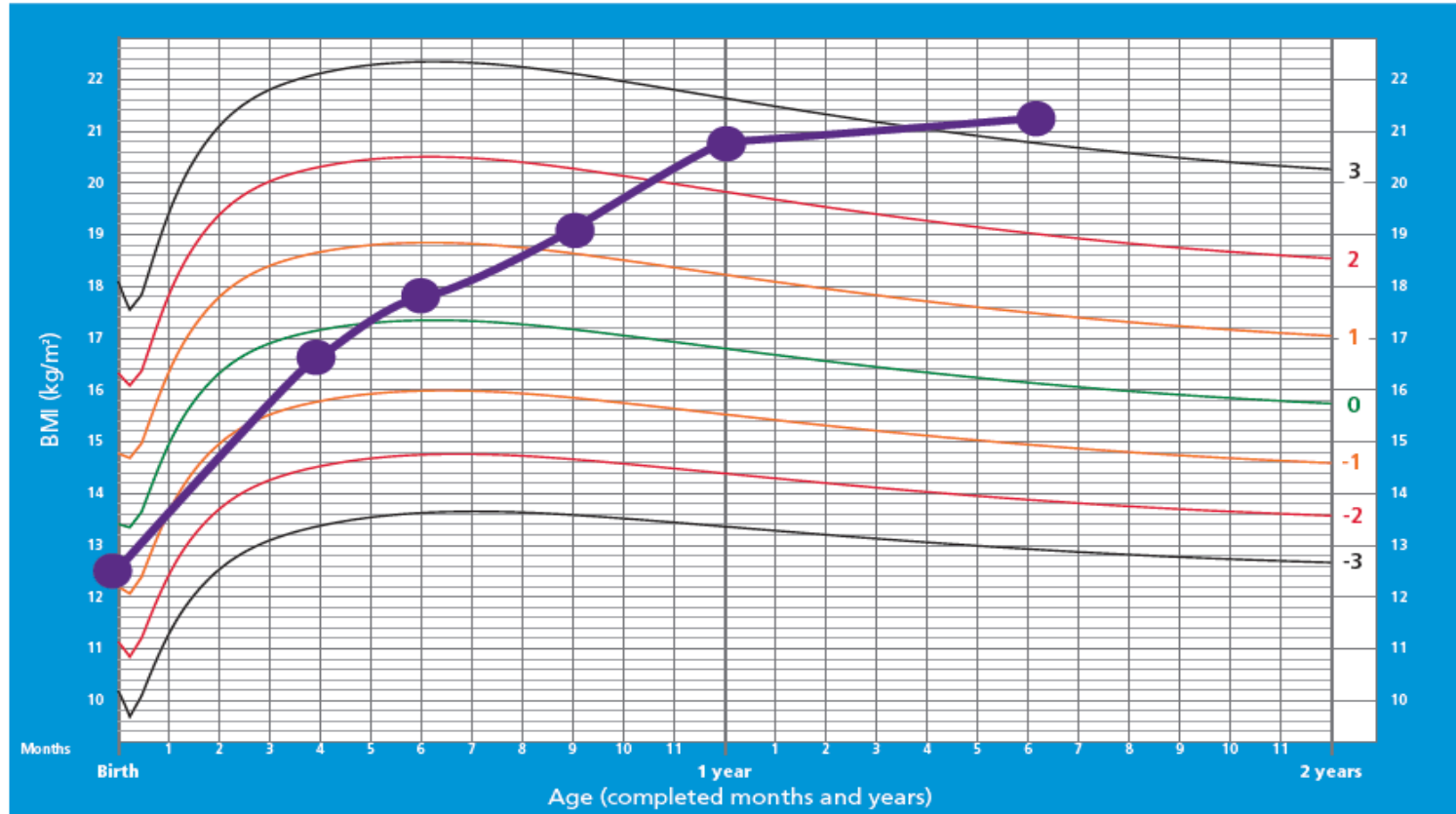
Birth to 2 years (z-scores)



**Figure 32.** Weight-for-length: Fadi's weight-for-length has moved from around -1 z-score at birth to above +2 z-score at 18 months as he was gaining weight while his length gains were slow. Fadi is identified as overweight at 18 months of age.

# BMI-for-age BOYS

Birth to 2 years (z-scores)



**Figure 33.** BMI-for-age: Fadi's BMI at birth was normal and around the median. In his subsequent visits, Fadi's BMI was significantly increased and crossed multiple z-score lines. At 9 months, Fadi's BMI was above the +1 z-score indicating overweight. This trend continued as he crossed the +2 z-score at 12 months reaching above the +3 z-score at 18 months. Fadi's BMI for age indicates that he is obese at 18 months of age as the point is above +3.

- While Fadi started with average length at birth, his growth trajectory has taken a concerning turn.

By 18 months, he has become stunted, with his length-for-age dropping below -2 z-score.

- This decline is compounded by his rapid weight gain, resulting in being identified as overweight
- based on the weight-for-length chart and ultimately obese based on the BMI-for-age chart.
- Despite his weight appearing appropriate for his age, as indicated by the weight-for-age chart, his stunted growth has resulted in him gaining weight disproportionately with his lengths leading to him becoming obese at 18 months.

This highlights the importance of plotting children's growth on different charts and examining different indicators to obtain a full picture and an accurate assessment of their nutritional status.

# Conclusion

- ❑ **Growth monitoring** plays a pivotal role in pediatric care, facilitating the **early detection** of growth problems that could potentially impact a child's health and development.
- ❑ It provides healthcare professionals with valuable insights into a child's growth **trajectory**, allowing for timely intervention when **deviations** from expected patterns are identified.
- ❑ **Accurate data collection** methods and the use of reliable tools are paramount in ensuring the effectiveness of growth monitoring practices.
- ❑ By integrating growth monitoring into comprehensive pediatric care, healthcare providers can **offer holistic support** to children and their families, addressing not only immediate concerns but also fostering optimal physical and cognitive development over the long term.
- ❑ This proactive approach **underscores the importance of regular monitoring** and intervention, ultimately contributing to the overall well-being of children.

**Reference :**

**WHO CHILD GROWTH MONITORING:  
A Technical Guide**