GUIDELINE

Growth birth – 18 years

Scope (Staff): Community health staff
Scope (Area): CACH,WACHS

This document should be read in conjunction with this DISCLAIMER

Aim
To provide information on the expected growth patterns and trajectories from birth to adolescence; and information on the early identification of growth concerns.

Risk
Where nurses do not have a sound knowledge of normal growth there may be delays in identifying deviations associated with growth. This can negatively impact on health and wellbeing and result in considerable cost to the health system, governments and the community when timely interventions are not implemented.

Background
Growth is a very important indicator of overall health, development and wellbeing. Poor growth in-utero and early childhood is associated with short and long term effects including increased rate of childhood infection and the development of lifestyle diseases including coronary heart disease, high blood pressure and diabetes. Over-nutrition and obesity are also linked to poorer health outcomes. Both body size during the early years of life and infant growth velocity are associated with a risk of later overweight and obesity in childhood and adulthood.

Monitoring growth and promoting optimal growth is important in:

- identifying and initiating effective strategies in response to deviations in growth patterns
- reviewing the impact of implemented strategies
- providing parents with information on how nutrition, physical activity, genetics and illness can affect growth.

Minor fluctuations in growth in an otherwise healthy and alert infant or child may be of no immediate concern. However, unexpected increases, decreases or stasis in growth trajectories from a previously established rate of growth, may be an early indicator of underlying health or developmental issues.

Nurses are well placed to undertake growth assessments, including weight, length or height, head circumference and body mass index, at relevant universal contacts and at additional contacts, as required. It is most meaningful when nurses undertake a holistic view of the child (and family) by gathering information from parents, identifying risk factors, completing age appropriate observations and assessments using suitable tools, reviewing
previous health professional assessments (if available) and acting on professional judgement.

Key Points

- Growth charts are not diagnostic tools and decisions about growth deviations should never be determined solely by these charts.\(^5\)

- Holistic assessments will include considering gestational age and birth weight, previously established rates of growth, feeding or nutritional assessments, physical assessment, elimination and health status, developmental milestones and enquiry about parental size.

- Growth assessment involves multiple measurements over time for weight, length or height, head circumference and body mass index (BMI); followed by precisely plotting on appropriate growth charts and correct interpretation of the percentiles to determine growth trajectories.

- When growth deviations are suspected, serial growth measurements will be undertaken and plotted on age and gender appropriate growth charts, as part of a holistic assessment and prior to determining relevant care planning.

- Growth is considered healthy when the child’s weight and length or height generally ‘track’ along percentile lines and when weight and length or height are mostly in proportion.\(^6\)

- Very few children grow along the same percentile line from birth.\(^7\)

- Growth deviations may be characterised by serial growth measurements indicating unexpected increases or decreases or stasis on the percentile lines, from a previously established rate of growth.

- Changes in weight and length or height trajectories should be investigated before the infant or child’s measurements cross two (2) percentile lines.\(^8\)

Factors influencing growth

A holistic view of the child (and family) requires an understanding of what influences growth. This includes considering genetics and epigenetics, birth weight, nutrition and environmental and health and wellbeing factors when undertaking growth assessments.\(^9\)

These factors may be modifiable (nutritional intake, feeding difficulties, acute illness) or non-modifiable (genetic disorders, chronic health conditions). It is the modifiable risk factors that can be managed to decrease the effects of these risks.

Genetics and epigenetics

Parental size has a direct influence on a child’s growth potential and predicted adult height.\(^10\) When concerns with a child’s growth have been identified, parental size should be considered as part of the assessment. For example, a short child with short parents may be a genetically small, healthy child (particularly in the absence of illness or poor nutritional intake). However, where there are sustained nurse or parental concerns further assessments and care planning may be required.

Genetic disorders and chromosomal abnormalities such as Prader-Willi syndrome, Turner Syndrome, and Trisomy 21 (Down syndrome) have the potential to alter a child’s growth. For example, children with Trisomy 21 typically have lower birth weights and have slower
growth patterns, than other children. Whilst specific growth charts have been developed for a number of the syndromes, these charts should not be used in isolation. The Royal Children’s Hospital (Melbourne) recommends that all children have their growth monitored on World Health Organization (WHO) birth to 2 years charts. In Western Australia (WA), WHO growth charts are used from birth to five (5) years.

The WHO Multicentre Growth Reference Study found no effect of ethnicity on growth.

**Birth weight**

Birth weight is a reliable indicator of not only the infant’s health but also subsequent health risks in adulthood. Adverse health outcomes for children small for gestational age at birth include higher mortality rates, asthma, developmental issues and hypertension. Low birth weight infants (less than 2500 grams) born at or near term are expected to track along a lower percentile on the weight for age growth charts, compared to other infants. These infants may move to a higher percentile over time or may continue to follow their own line below the 3rd percentile.

It is important to consider the potential impact of pregnancy-related factors, such as gestational diabetes, on the size of an infant at birth. These infants may not grow along the same percentile from birth; rather their growth curve may move to a lower percentile. However, infants who are large for gestational age at birth have a higher risk of developing obesity and metabolic syndrome later in life.

Infants born prematurely (before 37 weeks gestation) or who are born small for gestational age may also be at increased risk of cardiovascular diseases, suggesting that foetal under-nutrition may increase susceptibility to diseases occurring later in life. For premature infants, corrected age should be used until two (2) years of age.

**Nutrition**

Nutrition directly impacts growth patterns and growth trajectories. Inadequate nutritional intake including energy, protein and micronutrients can slow growth potentially leading to growth faltering. Conversely, overfeeding associated with rapid weight gains may result in overweight or obesity. Refer to the *Growth faltering* guideline and the *Overweight and obesity* guideline for more information.

The *Infant Feeding Guidelines* developed by the National Health and Medical Research Council, state that infant formula with higher protein levels are associated with higher weight in the first two (2) years of life, but has no effect on length.

Protein content in:

- cow’s milk is 3.3 grams/100 ml
- infant formula (cow’s milk) is 1.3 to 2.0 grams/100 ml (with goat’s milk infant formula at the higher end of this range)
- human milk is 1.0 to 1.1 grams/100 ml.

Further research linking protein level in infant formula and cow’s milk with obesity and chronic disease in adulthood, has led to recommendations for infant formula composition to promote growth rates similar to that of breastfeeding infants.

There is convincing evidence for infants who breastfeed having reduced risk of becoming obese in childhood, adolescence and early adulthood, compared to infants who are infant formula fed. Data from seven (7) longitudinal studies of infant growth, determined that
infants who breastfeed for at least twelve (12) months grew more rapidly in the first two (2) months and less rapidly from three (3) to twelve (12) months of age.\textsuperscript{10} In a Western Australian study, infants who breastfed for more than twelve (12) months were leaner at one (1) year of age, than other children.\textsuperscript{15}

Children and adolescents should eat sufficient nutritious foods to grow and develop. The \textit{Australian Dietary Guidelines} recommend eating a wide variety of nutritious foods from the five food groups every day and limit intake of foods containing saturated fat, added salt and added sugars.\textsuperscript{16} In addition, the \textit{Australian Dietary Guidelines} provide information on the number of serves and serving sizes for specific age groups.

\textbf{Environment}

Maternal health, age, parity, socio-economic status and substance usage such as smoking can affect birth weight and growth.\textsuperscript{17}

\textbf{Health and wellbeing}

Frequent infections, developmental delays, feeding difficulties, long term medications and medical conditions such as renal or cardiac disease can all affect infant and young children's growth.\textsuperscript{10} Specific charts are available for some conditions and syndromes. However, as these charts have not been validated, the standard WHO charts should be used. The specific charts can be used in addition to the WHO charts, if required.

\textbf{Expected growth patterns}

Birth weight, length and head circumference measurements provide the first reference point for ongoing growth monitoring. The majority of healthy, full-term infants lose weight in the first days following birth, which is considered physiological.\textsuperscript{18} Whilst there is insufficient evidence to indicate what is a normal physiological weight loss,\textsuperscript{18} statements from authoritative organisations suggest a loss of between 7 to 10 percent within the first few days to first week of life.\textsuperscript{5, 18} The WHO indicates that whilst it is not possible to estimate precisely when infants should regain their birth weight, data suggests that 75 percent of infants may do so within seven (7) days.\textsuperscript{19} However, additional consideration is required for the percentage of weight lost, feeding efficiency and the infant's health status. Infants usually begin to gain weight from day three (3) to six (6) after birth, and return to their birth weight between ten (10) to twenty-one (21) days.\textsuperscript{5, 18, 20}

Infants and young children have a relatively higher proportion of fat as a normal component of growth, which may reflect the wide variation in what is considered expected or perceived normal weight gain.\textsuperscript{21} The WHO states it is not possible to recommend an expected minimum weight gain that would be appropriate for all infants or children with the same starting weight.\textsuperscript{19} The \textit{Infant Feeding Guidelines} indicate weight gain should be assessed on a four (4) week average, with growth trajectories being the most important factor.\textsuperscript{5} The WHO also emphasises the significance of interpreting growth trajectories on age and gender appropriate growth charts.\textsuperscript{19} Whilst the \textit{Infant Feeding Guidelines} provide an approximate guide for weight gain for infants in the first twelve (12) months of life, they do not consider infant gender and starting weights.

Nurses will consider the following indications developed by Australian Breastfeeding Association, for an infant requiring further assessment:

- A loss of more than 10 percent of birth weight in the first week of life
- Less than birth weight at two (2) weeks of age and not beginning to regain weight
• An average weight gain of less than 105 grams per week or unexplained weight loss in infants two (2) weeks to three (3) months of age

• Static or decreased weight gain compared to growth in length and head circumference

• Any deviation associated with elimination and hydration, frequent feeding and lack of contentment, infrequent feeding with a very placid infant and sleeping for long periods of time, and signs of ill health.²²

There is very little literature on childhood and adolescent growth patterns, and what is available, is heavily weighted to discussing physical growth in relation to sexual maturation. During middle childhood body mass index falls as children become relatively leaner, and then increases as puberty approaches and body composition approaches that of adulthood.²¹ It is important to note that age related increases in BMI are associated with increases in fat mass and fat-free mass (muscle and bone); which in turn are influenced by age, gender and puberty.⁸ In addition to BMI, family history, the presence of co-morbidities, nutritional intake, levels of physical activity and health history are required, to identify children who are at risk of growth deviations.

Males aged 12 to 17 may experience a ‘growth spurt’ (peaking between 13 and 15 years) characterised by a gain in height of up to ten (10) centimetres in the year of peak velocity.²³ Females may experience a ‘growth spurt’ between the ages of 9.5 and 14.5 years (peaking between 11 and 13.5 years) characterised by a gain in height of up to 9 cm in the year of peak velocity.²³

In instances where puberty is delayed, growth in height may slow until such time that a ‘growth spurt’ occurs until the child’s genetically determined height is reached.²³ At age 18 years growth for females is 99 percent complete, and for males there is 2.5 cm of growth in height remaining.²³

Females with an early onset of menarche will have a higher fat mass, especially at the end of puberty, which continues to exist into young adulthood.²⁴ In true precocious puberty (prior to the age of 8 years), early growth spurts occur with menarche and short stature may occur due to early closure of growth plates.²³

**Growth charts**

In WA community health services, the WHO growth charts are used as a standard of how children should grow, regardless of ethnicity, socioeconomic status and type of feeding.¹⁰ Growth charts show the growth of a reference population and are used to assess growth standards for individuals and groups. Often z-scores are used to identify population prevalence growth data, but as these are difficult to use in the clinical setting, percentiles are used instead. For more information on z-scores refer to Appendix A. Percentiles refer to the position of an individual on a given reference distribution and dictates the expected percentage of a population being above or below a percentile.²⁵ For example, the:

• 97th percentile indicates that 3 in approximately 100 children are above this line

• 3rd percentile indicates that 3 in approximately 100 children are below this line

• 50th percentile indicates that half the children at any age are above this line and half are below this line.

Patterns of growth are assessed by serial measurements of weight, length or height and head circumference, as one-off measurements only describe size, not growth. Growth
assessment involves plotting measurements on age and gender appropriate growth charts, and observing for the overall trajectories of growth. Growth charts are not diagnostic and therefore should be used in conjunction with a holistic assessment, to contribute to forming an overall clinical impression, prior to making any care planning decisions.

Very few infants grow along the same percentile line from birth, with up to half of these infants crossing at least one percentile (up or down), most often occurring in the first six (6) months and up to twelve (12) months of age. In addition, children do not always follow the same percentile for length or height and weight, but they generally ‘track’ along or between percentile lines.

WA community health services use the BMI charts from the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000) to assess BMI for children who are two (2) years and older. Weight for age is inadequate for monitoring growth beyond childhood, due to its inability to distinguish between relative height and body mass and therefore BMI is the recommended indicator for screening children who are two years and older.

The shape of the BMI-for-age curves is different to other growth charts. The BMI-for-age begins to drop after about one (1) year of age, continues to fall until it reaches a minimum at around four (4) to six (6) years of age, and then begins to increases throughout childhood and adolescence. This normal pattern of growth and increase in the BMI after it reaches its lowest point (adiposity rebound) occurs in all children. Adiposity rebound prior to four (4) to six (6) years of age, indicated by upward movement on the BMI chart, is associated with obesity in adulthood.

Fenton charts have been developed for infants born less than 37 weeks gestational age and can be used up to 50 weeks gestation age (10 weeks post-term age). These charts are a reference for growth, as ideal growth patterns of preterm infants remains undefined. Infants are transitioned onto the WHO growth charts between 40 and 50 weeks gestation. Measurements for these infants are plotted using the corrected (postnatal) age for prematurity. That is, postnatal age in weeks minus (40 weeks gestation minus the gestational age in weeks at birth). For example, an infant at 12 weeks postnatal age, who was born at 30 weeks gestation, has a corrected age of two (2) weeks. This can be represented as: $12 - 10 = 2$ weeks corrected age.

**Growth patterns requiring consideration**

The following growth patterns require additional consideration and holistic assessments to confirm healthy growth and development or to identify potential deviations:

- Unexpected increases, decreases or stasis on the percentile lines, from a previously established rate of growth
- A loss of more than 10 percent of birth weight in the first week of life
- An infant less than their birth weight at two (2) weeks of age and not beginning to regain weight
- Weight not regained following an acute illness
- Weight, length or height below the 3rd percentile
- Weight, length or height above the 97th centile
- BMI greater than the 85th percentile.
Possible causes of growth deviations

The following table outlines possible causes of growth deviations.\textsuperscript{10}  
Note: Causes listed in \textbf{bold text} are more common.\textsuperscript{20}

<table>
<thead>
<tr>
<th>Percentile trajectory</th>
<th>Possible causes</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increasing weight percentiles</td>
<td>Energy imbalance</td>
<td>Excessive food</td>
</tr>
<tr>
<td></td>
<td>Endocrine disorders</td>
<td>Hypothyroidism, Excess cortisol (Cushings), Pituitary disease</td>
</tr>
<tr>
<td></td>
<td>Genetic disorders</td>
<td>Trisomy 21, Prader-Willi</td>
</tr>
<tr>
<td>Decreasing weight percentiles</td>
<td>\textbf{Acute illness}</td>
<td>Short term illness, vomiting, diarrhoea</td>
</tr>
<tr>
<td></td>
<td>\textbf{Chronic illness}</td>
<td>Including but not limited to cardiac, respiratory gastrointestinal, renal disease</td>
</tr>
<tr>
<td></td>
<td>Physical and/or developmental concerns</td>
<td>Neurological conditions, cerebral palsy</td>
</tr>
<tr>
<td></td>
<td>\textbf{Nutritional}</td>
<td>Inadequate energy intake</td>
</tr>
<tr>
<td>Increasing height percentiles</td>
<td>Endocrine disorders</td>
<td>Excessive growth hormone, Hyperthyroidism</td>
</tr>
<tr>
<td>Decreasing height percentiles</td>
<td>Endocrine disorders</td>
<td>Growth hormone deficiency, Hypothyroidism</td>
</tr>
<tr>
<td></td>
<td>\textbf{Chronic illness}</td>
<td>Chronic anaemia, chronic illness, Systemic failure (renal and cardiac)</td>
</tr>
<tr>
<td></td>
<td>Genetics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>\textbf{Nutritional}</td>
<td></td>
</tr>
<tr>
<td>Increasing head circumference percentiles</td>
<td>Hydrocephalus, chromosomal abnormality, developmental delay</td>
<td></td>
</tr>
<tr>
<td>Decreasing head circumference percentiles</td>
<td>Prenatal insult</td>
<td>Maternal substance abuse, maternal infection</td>
</tr>
<tr>
<td></td>
<td>Birth complication</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chromosomal abnormality</td>
<td></td>
</tr>
</tbody>
</table>
### Related internal policies, procedures and guidelines

The following documents can be accessed in the Community Health Manual via the HealthPoint link or the Internet link

- Body Mass Index assessment – child health
- Body Mass Index assessment - primary school
- Breastfeeding deviations from normal
- Growth faltering
- Head circumference assessment
- Height assessment 2 - 5 years
- Length assessment 0 – 2 years
- Overweight and obesity
- Physical assessment 0 - 4 years
- Universal contact guidelines
- Weight assessment 0 - 2 years
- Weight assessment 2 - 5 years

### Related internal resources and forms

The following resources and forms can be accessed from the HealthPoint CACH Intranet link

- Baby’s First Foods
- Breastfeeding Assessment Guide
- Body Mass Index Boys (CHS430B)
- Body Mass Index Girls (CHS430A)
- Food For Kids
- How children develop
- Practice guide for Community Health Nurses
- Preterm Fenton Growth Charts (external link)
- Tips to support healthy choices (2 – 5 years)
### Useful external resources

- [Australian Dietary Guidelines](#) summary
- [Infant Feeding Guidelines](#)
- [Raising Children Network](#)
- [Royal Children’s Hospital - Child growth learning resource](#)
- [The Aboriginal and Torres Strait Islander Guide to Healthy Eating: educators resource](#)
- [Good food for new arrives (ASeTTS)](#)
Appendix A: Z-scores and percentiles

Often z-scores are used to identify population prevalence data on growth, as these scores describe the distance from the median (midpoint) in terms of standard deviations and are comparable between different age groups and allow comparisons across children at different growth lines.\textsuperscript{29}

The normal population range is from -2 to +2 standard deviation z-scores with the medial z-score being zero.\textsuperscript{29} Cut off points are used to classify population prevalence of malnutrition, stunting, wasting (thinness), at risk of overweight, overweight and obesity.\textsuperscript{25}

In statistical terms:

- 34.13\% of the population lies between 0 and -1 (or +1)
- 13.59\% between -1 and -2 (or between +1 and +2)
- 2.14\% between -2 and -3 (or between +2 and +3)
- the remaining 0.14\% of the data lies below -3 (or above +3)\textsuperscript{19}

These numerical statistics are represented in the diagram below. Note that the ‘Centile’ numbers closely correspond to the WHO growth chart percentiles used by Western Australia.

Annals of Pediatric Cardiology - Images
As z-scores are more difficult to explain to parents and to use in the clinical setting, percentiles are often used as they are more easily understood. The table below demonstrates percentile z-score conversion values which may be useful for when nurses are reading and interpreting literature. The figures in bold closely correspond to the WHO growth chart percentiles used by Western Australia.

<table>
<thead>
<tr>
<th>Percentiles</th>
<th>Z-scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2nd</td>
<td>−3</td>
</tr>
<tr>
<td>2.3rd</td>
<td>−2</td>
</tr>
<tr>
<td><strong>2.5th</strong></td>
<td><strong>−1.96</strong></td>
</tr>
<tr>
<td>5th</td>
<td>−1.64</td>
</tr>
<tr>
<td><strong>15th</strong></td>
<td><strong>−1.04</strong></td>
</tr>
<tr>
<td>16th</td>
<td>−1</td>
</tr>
<tr>
<td><strong>50th</strong></td>
<td><strong>0 (median)</strong></td>
</tr>
<tr>
<td>84th</td>
<td>+1</td>
</tr>
<tr>
<td><strong>85th</strong></td>
<td><strong>+1.04</strong></td>
</tr>
<tr>
<td>95th</td>
<td>+1.64</td>
</tr>
<tr>
<td>97.5th</td>
<td>+1.96</td>
</tr>
<tr>
<td><strong>97.7th</strong></td>
<td><strong>+2</strong></td>
</tr>
<tr>
<td>99.8th</td>
<td>+3</td>
</tr>
</tbody>
</table>
### References


