A GUIDE

TO

HONG KONG GROWTH CHARTS

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1. Hong Kong Growth Study 2020

1.1 Background

"Children's growth is a sensitive index of their health and nutrition. In Hong Kong, primary healthcare doctors and paediatricians are often consulted about potential disorders of growth – failure to thrive, short stature, thinness, obesity, big head, small head, etc. Identification of diseases such as growth hormone deficiency, brain tumour, precocious puberty are often made because of the child's abnormal growth compared to the reference population. A successful treatment could also be evidenced by regaining normal growth. That is why it has been a common practice to weigh and measure a child in the clinic. To interpret an individual child's growth, measurements have to be made accurately and plotted on an appropriate growth standard." A Simple Guide to Childhood Growth and Nutrition Assessment".(1)

Local growth charts developed in 1990s (HK1993) for Hong Kong children (2, 3) have been used for growth monitoring from 1996 to 2023. In the past few decades there has been rapid socio-economic advancement in Hong Kong which has impacted on the lifestyle and nutrition status of mothers and children. Growth pattern, growth potential and distribution of growth parameters of children born in the 1970s-1980s, and represented in the 1993 growth references, no longer reflect those of contemporary Hong Kong children.

The Hong Kong Growth Study (HKGS) was commissioned by the then Food and Health Bureau, Hong Kong SAR Government in 2018 to review the existing growth charts and study the growth of contemporary Hong Kong children so as to recommend and design a set of updated growth charts on weight, height, BMI and head circumference for children in Hong Kong. It included a growth survey (Hong Kong Growth Survey 2020-22) to collect growth data from Hong Kong children from 0 to 20 years to develop a set of new growth charts and assess the appropriateness of Child Growth Standards developed by the World Health Organization (WHO) in 2006 (WHO2006)(4) for use in children in Hong Kong.

This guide aims to provide healthcare professionals with:
1) Background information and methodology of the Hong Kong Growth Survey 2020-22
2) Recommendations for new growth charts for Hong Kong children
3) Growth charts for growth monitoring in Hong Kong
4) Frequently Asked Questions concerning HK2020 Growth Reference

1.2 The Hong Kong Growth Survey 2020-22

This was a population-based cross-sectional study using similar methodology used in previous growth surveys in 1993 and 2005/6.(2, 5)

Sample recruitment

We recruited and measured children aged 0-20 years in Hong Kong from various sources, including a public birthing hospital, a private birthing hospital, 6 Maternal and Child Health Centres (MCHCs), 5 Nurseries, 31 kindergartens, 19 primary schools, 14 secondary schools, one all-through school, 5 vocational schools, 3 universities and 5 community centres of a non-governmental organisation.

Anthropometry methods
We collected weight, length/height and head circumference for all ages. Standard measuring tools and standard measuring procedures (Appendix A) were used to guide the collection of anthropometric measurements. Training was provided to research staff taking the measurements. For length/height and head circumference, two measurers independently measured and measurements were repeated when the difference between the two readings exceeded 7mm for length/height and 5mm for head circumference. Secondary sexual characteristics was not collected.

Data for constructing HK2020 Growth References (HK2020)
Subjects who were preterm for those aged <2 years, born of parents who were both ethnically non-Chinese and those with extreme out-of-range measurements were excluded. A total of 21307 subjects (11711 males and 9596 females) at 0-20.5 years were included in the growth chart construction.

1.3 The Construction of HK2020 Growth References

HK2020 weight-for-age, length/height-for-age, BMI-for-age and head circumference-for-age references for birth to 18 years old were constructed using optimal modelling and smoothing techniques.

Data
Data collected from Hong Kong growth survey 2020-22 were used to construct the HK2020 Growth References, except for BMI-for-age and weight-for-age charts for 2-18 years:

For 2-18 years, to avoid normalizing childhood obesity, HK1993 BMI-for-age charts (3) were not updated. A novel methodology was adopted to construct weight-for-age charts using derived weight from historical BMI-for-age data and height data collected in the growth survey 2020-22. This effectively updated the weight-for-age chart for the current secular trend in height growth while keeping the BMI distribution in 1993 when obesity rate was lower.

For 0-2 years, BMI-for-age and weight-for-age charts were constructed from the data collected in the growth survey 2020-22. This is because the data indicated that the increase in weight among the contemporary infants were more attributed to an increase in length rather than to obesity.

The data used to construct the HK2020 Growth References are summarised as follow:

Charts	Data used for 0-2 years	Data used for 2-18 years
Height-for-age	HK Growth Survey 2020-22	HK Growth Survey 2020-22
BMI-for-age	HK Growth Survey 2020-22	HK1993 Growth Reference
Weight-for-age	HK Growth Survey 2020-22	Derived
Head circumference-for-age	HK Growth Survey 2020-22	HK Growth Survey 2020-22

Models, weighting and smoothing
Models with different combinations of distribution and age transformations were fitted for each of the growth parameters from 0 to 20 years with boys and girls together.

Since boys and newborns delivered in the private hospital were over-sampled in the growth survey, weighting was assigned to reflect the contemporary distribution of gestational age of newborns in 2014 reported by the territory-wide obstetrics and gynaecology audit report 2019 and sex ratio of 1:1. Average from repeated measurements for length/height and head circumference was used.

The smoothing of the model parameters across age from birth to 20 years was performed using penalized varying coefficient splines. The age-varying model parameters were extracted to construct the centile lines. The centiles were truncated at 18.0 years to avoid the right-edge effect. A logistic function was used to smooth centile lines at age 2 years for weight-for-age and BMI-for-age charts.

1.4 Features of HK2020 Growth References

1. Nine-centile line - The new growth charts were constructed with 9 centiles (99.6th, 98th, 91st, 75th, 50th, 25th, 9th, 2nd and 0.4th). The 9 centiles are spaced two-thirds (0.67) of a standard deviation (SD) apart. The two extreme centile lines (0.4th and 99.6th) may help screen out the more likely abnormal growth for further evaluation.

Centiles	SD
50th	0
25th, 75th	±0.67
9th, 98th	±1.33
2nd, 98th	±2.01
0.4th, 99.6th	±2.67

2. Comparisons with HK1993 Growth References - The 2nd, 50th, 98th centiles of the HK2020 growth references (length/height-for-age, weight-for-age*, BMI-for-age and head-circumference-for-age) were overlaid on those generated from the HK1993 Growth References. (Figure 1) The 2nd, 50th, 98th centiles of weight and height were higher in HK2020 than HK1993, particularly at pubertal ages. The HK2020 BMI-for-age charts from 2-18 years were the HK1993 charts. There was an increase of about 2cm in median height at 18 years in boys (170.9cm in 1993 to 172.5cm in 2020) and girls (158.2cm in 1993 to 160.2cm in 2020).
**HK2020 weight-for-age charts were constructed using actual weight in 0-2 years and derived weight in >2-18 years. Please refer to 1.3 for details.*

3. Birth weight - Since the measurements at birth contributing to the HK2020 Growth References was from contemporary healthy term newborns of Hong Kong, with the majority born just under 39 weeks, birth weight centiles of HK2020 at age 0 represents birth weight of babies born at 38-39 weeks. As such a transition from preterm gestation-specific birth weight charts to HK2020 at 38-39 weeks may provide a smoother transition than at 40 weeks.

4. Length/Height-for-age charts – There is a "structural" step of 7mm at 2 years when the measurement changes from supine length to standing height.

5. Mid-parental height comparator - An auxiliary growth assessment tool, mid-parental height comparator was created for healthcare professionals' use. Majority of children's height

centiles are within two centile spaces above or below the mid-parental centile. Comparison with parents' height should not be seen as a test for normal height and a child growing abnormally may still be within the parental height range.(6)

6. Weight-for-length/height charts - The HK2020 Growth References do not include weight-for-length/height charts because body shape related to height varied by age in young children, making the ratio of weight to length/height an unsatisfactory marker of obesity. Childhood obesity will be defined by BMI-for-age instead of weight-for-length/height.

7. Pubertal development charts – The HK2020 Growth References do not include pubertal development charts. With the exception of reported age of menarche and voice breaking, pubertal stages were not collected in the Hong Kong Growth Survey 2020-22.

8. Impact of COVID-19 pandemic - The data collection period (November 2019 to October 2022) coincided with the COVID-19 pandemic, resulting in concerns of the impact of home confinement and school closure on changes in diet, lifestyle and growth of children. However children taking part in the Hong Kong Growth Survey 2020-22 were not fatter (as indicated by BMI) compared to toddlers attending MCHC and students attending SHSCs in recent years. BMI and weight data above 2 years collected from HK growth survey were not used in the construction of new growth chart and thus the impact of the pandemic on BMI-for-age chart is likely minimal.

1.5 Performance of WHO 2006 Child Growth Standards for HK children

In 2006, the WHO launched the Child Growth Standards for children 0 to 5 years (WHO2006). It was developed based on the WHO Multicentre Growth Reference Study (MGRS) which collected growth data from healthy children from 6 countries (namely Brazil, Ghana, India, Norway, Oman and the USA) who were living in an environment that WHO considered optimal for growth.(7, 8) The study followed term infants from birth to 2 years of age with 21 measuring intervals. All of the infants were exclusively breastfed for 4 to 6 months and continued being breastfed after 6 months. Another group of children, age 18 to 71 months, were measured once. The data from the two samples were combined to create the WHO2006. WHO2006 is considered to establish breastfed infants as the normative model for growth and development.(9, 10)

When referencing the weight, length, BMI and head circumference at 0-5 years collected from Hong Kong Growth Survey 2020-22 to WHO2006, majority of the mean z-scores were classified as good (mean z-scores within ±0.33) to excellent (mean z-scores within ±0.17) fit, except that

1. Compared to WHO2006, Hong Kong children were lighter at birth (birth weight z-score: -0.4; BMI z-score -0.5). Close to 0% newborn were with birth weight above +2SD.
2. Shorter mean height at 3-4 years particularly for girls (mean z-score -0.43) as observed earlier. Slightly more girls at 4 years were classified as stunted (~4%).

The Hong Kong Growth Study did not assess the performance of WHO2006 among ethnic minorities living in Hong Kong.

WHO-HK2020 Growth References

Considering various factors including 1) there is a "structural" disjunction at 2 years when measurements change from supine length to standing height in WHO2006, and 2) the

discontinuities from WHO2006 to HK2020 are more pronounced at 5 years, transiting the WHO2006 for 0 – 2 years to HK2020 for 2 – 18 years (WHO-HK2020) is considered a more suitable option if one prefers to use WHO2006 growth standards for growth monitoring for Chinese children in Hong Kong. Additionally, no smoothing was used at 2-year-old for the WHO-HK2020 Growth References to avoid changing the WHO2006 centiles.

Compared to HK2020, WHO2006 screens out fewer infants with "growth faltering" for follow-up because infants in Hong Kong have lower birth weight than the median birthweight from WHO2006 and the variation of growth was greater (i.e. a wider SD) among the children recruited from six countries involved in constructing the WHO2006.

2. Recommendations from the Hong Kong Growth Study 2020

2.1 Appropriate growth charts for Hong Kong children

Based on the findings the Hong Kong Growth Study 2020, the project team made the following recommendations concerning appropriate growth charts for Hong Kong children:

1. The WHO2006 growth standards (WHO2006) are suitable for Hong Kong children 0-5 years and presumably for non-ethnic-Chinese children from 0-5 years. Healthcare professionals need to be aware of the lower weight of Hong Kong infants below 2 months and shorter children aged 3-5 years compared to WHO2006 growth standards to ensure correct interpretations when using these charts.
2. The HK2020 Growth References (HK2020) are suitable for Hong Kong children 0-18 years. Healthcare professionals need to be aware that Age 0 represents the birth parameters of infants born at 38-39 gestational weeks instead of 40 to ensure correct interpretations when using these charts.
3. Including both WHO2006 growth standards and HK2020 local references in electronic growth monitoring systems would allow the frontline clinicians to use the most suitable charts for each child.
4. Healthcare providers / organisations can decide whether or not to prioritize a particular set of growth charts (WHO-HK2020, HK2020 or WHO2006) for growth monitoring of Hong Kong Children.
5. Health professionals (and parents) must be educated on how to interpret children's growth using the various newly recommended growth charts.

2.2 Criteria for extra monitoring and further assessment

Growth monitoring plays an important role in protecting and promoting children's health. Growth charts are not intended to be used as a sole diagnostic instrument. Appropriate use and interpretation of growth data and charts are key to identify conditions that require treatment and intervention.

It is suggested to follow the standard operation procedures used in the Hong Kong Growth Survey 2020-22 (Appendix A) to measure children.

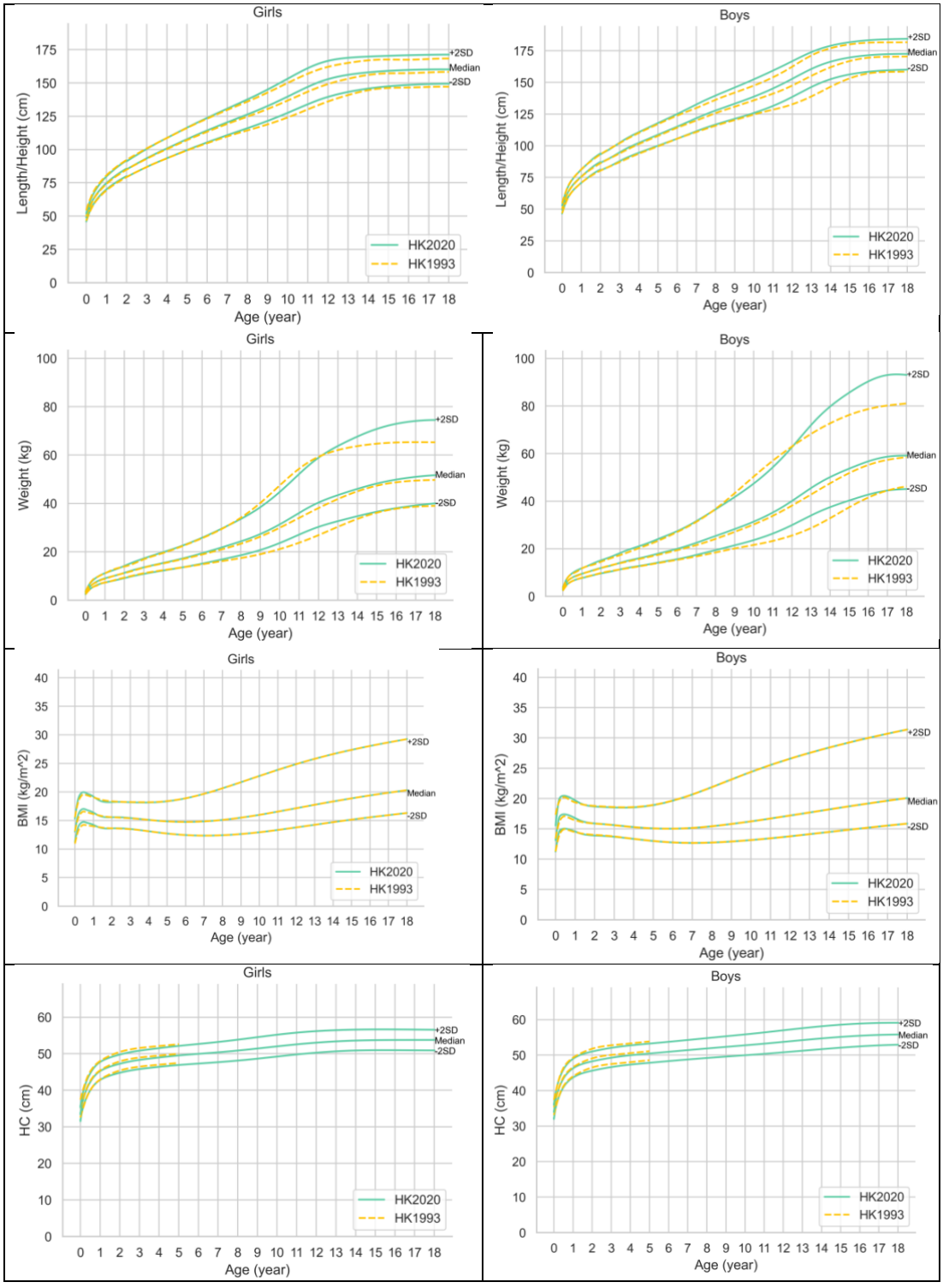
Recommended criteria for extra growth monitoring and further assessment are listed in Table 1. In addition to making reference to these recommended criteria, healthcare professionals should conduct an appropriate assessment of the child and manage accordingly.

Suggested further reading:
Module on Physical Growth. Preventive Care for children. Reference Framework. Primary Healthcare Office, Health Bureau.
https://www.healthbureau.gov.hk/pho/rfs/english/reference_framework/pre_care_for_child.html

Table 1. Recommended criteria for extra growth monitoring and further assessment

Parameter	**Doctor assessment & potential specialist referral**	**Doctor assessment & monitoring** (consider referral if other features on examination & history that raise concern of underlying growth issues)
Head	< 0.4th centile OR	0.4th – 2nd centiles OR
Stature	> 99.6th centile	98th – 99.6th centiles
BMI	< 0.4th centile OR Obesity	0.4th – 2nd centiles or Overweight
	> 99.6th centile (0 to 60 months)	99.6th centile ≥ BMI > 98th centile (0 to 60 months)
	> 98th centile (>5.0 to <18.0 years)	98th centile ≥ BMI > 91st centile (>5.0 to <18.0 years)
Weight	Growth faltering in infants - Weight-for-age declines across for 2 or more centiles	

Figure 1. Comparison of HK1993 and HK2020



3. Frequently Asked Questions

Q1 – The proposed WHO-HK2020 charts use WHO2006 for 0-2 years only. Why is WHO 2006 adopted for 0-2 years only but not for 0-5 years?
A1 – *Both HK2020 and WHO 2006 are considered suitable for local use for 0-5 years. Healthcare providers and organisations can decide whether or not to prioritise a particular set of charts for children 0-5 years. If WHO 2006 is used from 0-5 years then the step at 5 years (transition to HK2020) may be considered too big, and there will be 2 breaks (one from 0-2 year chart (supine length) to 2 to 5.0 years, and the second break at 5.0 years when transitioning to 5-18 year HK2020 chart) whereas the steps to HK2020 at 2 years are smaller and there will be only one break at 2 years. However some users may wish to use WHO2006 0-5 years for non- Chinese and some users may wish to use HK2020 0-5 years for routine use.*

Q2 – What are the characteristics of the HK2020 that I need to pay attention to when assessing birthweight centiles?
A2 – *The Hong Kong Growth Study 2020 revealed that the mean gestational age of infants born in Hong Kong is 38-39 weeks. As such, "Age 0" in HK2020 growth charts represents the birth parameters of infants born at 38-39 gestational weeks instead of 40 weeks. The centile width at age 0 were also narrower as they were derived from a more homogenous Chinese population (i.e. smaller standard deviation).*

Therefore healthcare professionals need to pay attention the following and should bear in mind when using the birth weight percentile from HK2020 as a reference point:
Birth weight centile - *Hong Kong infants born at full term (40 week gestation) likely have higher birth weight centile at birth (because the average gestational age has become 38-39 weeks).*
Extreme birth weight – *More extreme birth weight would be classified (4-5 % <2nd and 4-5%> 98th) than WHO2006 (2-3% <2nd and 0.3-0.4% >98th) based on routine MCHC data.*
Growth faltering – *More infants have downward crossing centile from birth compared to WHO2006 partly due to the narrower difference between centile lines.*
This has an impact on interpretation from the HK2020 Growth References on the birth weight centile, and growth trajectories for Hong Kong Chinese infants.

Q3 – What are the characteristics of the WHO2006 and HK2020 that I need to pay attention to when assessing growth of toddlers?
A3 – *Toddlers, particularly girls, are slightly shorter compared to WHO2006. A relatively large change in centile is expected when swapping WHO2006 to HK2020 at age 5 years.*

Q4 – I am a family physician, how should I choose between WHO2006, HK2020 and WHO-HK2020 for my patients under 5 years?
A4 – *Based on the assessment undertaken by the Hong Kong Growth Study, WHO2006 and HK2020 are both suitable for contemporary Chinese children living in Hong Kong under 5 years of age. No growth charts are perfect but an understanding of the population where the growth charts were derived would allow appropriate use of them. Family physicians are welcome to choose between them or use both for growth monitoring for patients under age of 5 years with special attention of the differences stated in this User Guide.*

Q5 – Should WHO2006 or HK2020 be used for non-ethnic Chinese?
A5 – *Given that HK2020 was developed from an ethnic Chinese Hong Kong population and that WHO was developed from a sample from 6 countries, it can be argued that WHO2006 could be a better choice for non-ethnic Chinese children aged 0-5 years. Some countries have adopted WHO2006*

totally or partially. US, Canada, Australia adopted the WHO2006 from birth to 24 months. UK adopted the part from 2 weeks to 48 months. Korea adopted the WHO2006 from 0 to 36 months. India and Pakistan adopted for 0-60m. Mainland China also adopted WHO2006 for 0 to 36 months until 2023 when they changed to use national growth reference.

Q6 – Will there be any change when monitoring growth of preterm babies with the launch of the new growth charts for Hong Kong?

A6 – *Hong Kong Growth Study 2020 did not update the gestational-age specific birthweight references for Hong Kong children. Healthcare professionals need to be aware that the mean gestation of births in Hong Kong are 38-39 weeks as the study population deriving the HK2020 growth charts. Our study group does not recommend a fixed gestation for transitioning all preterm babies as the gestation-specific growth curves have different characteristics from our HK2020 growth charts. Growth trajectories should be interpreted cautiously when crossing between growth charts at post conceptional age of 38-40 week gestation.*

Q7(a) – What is the rationale for the change in the definition of childhood obesity?

A7(a) – *In Hong Kong, overweight (including obesity) for individuals under 18 years has been defined as body weight > 120% of the median weight-for-height for males with height between 55 and 175 cm and for females with height between 55 and 165 cm; and BMI ≥25 for males with height >175cm and for females with height >165cm. (1) The review in this study noted that the relation between ratio of weight-for-height and adiposity varies by age and thus it is not an ideal measure of childhood overweight.*

BMI-for-age instead of weight-for-height is recommended for use to assess overweight and obesity in children. The change is consistent with the practice in many countries. As obesity is less common among young children than those of older age. It has been shown that using the same BMI z-score cut off as older children overdiagnoses obesity under 6 years old,(11) it is therefore recommended to adopt the WHO approach to have higher BMI cut-offs to screen for overweight and obesity for children aged 0 to 5.0 years than for those >5.0 to <18.0 years.

Q7(b) – How will this affect the prevalence of childhood overweight and obesity in Hong Kong?

A7(b) *Using the routine data from Student Health Service Centres (SHSCs) from 2016 to 2018, and compared to the current definition of overweight (including obesity), the new definition i.e. BMI > 91% classified similar proportion of overweight (including obesity) among children > 5.0-13 years old but lower proportion at 14-17years old group. Using the routine data of Maternal and Child Health Centre (MCHC) from 2016 to 2021, there were very small differences in proportion of overweight and proportion of obesity by different BMI cut-offs when compared to the WHO definition for children under 60 months (98% vs 2SD; 99.6% vs 3SD)*

Q7(c) – How should I explain to children and their parents when their weight status change due to the change in its definition?

A7(c) – *Changes in definition of overweight and obesity will inevitably change the weight status for some children and the prevalence of childhood overweight and obesity. It is important for healthcare professionals to explain to children and the parents the limitation of using BMI to define adiposity and strengthen the importance of healthy diet and lifestyle for all children regardless of weight status.*

Q8 – What were the sampling frames and sample size of the HK2020 study?

A8 – *The methodology for Hong Kong growth study 2020 was similar to that used in the 1993 and 2005/6 local growth surveys and was based on advice from overseas experts. In brief, it was a*

population-based cross-sectional study of a minimum of 175-200 male participants and 175-200 female participants for each age category of 0, 1, 2, 4, 6, 12 months, 6-monthly from 1-18 year(s) and 19-20.5 years. They were recruited from a public birthing hospital, a private birthing hospital, 6 Maternal and Child Health Centres, 5 nurseries, 31 kindergartens, 19 primary schools, 14 secondary schools, one all-through school, 5 vocational schools, 3 universities and a non-governmental organisation. Recruitment sites were geographically distributed throughout Hong Kong.

We did not exert selection criteria at recruitment but we excluded data from the following children when constructing growth charts:

- *children of any age with both parents of non-Chinese ethnicity*
- *children aged <2.0 years who were born preterm (<37 week gestation) or multiple pregnancies*

Q9 – What are the effects of COVID-19 pandemic on the growth of children and how would these affect the new growth charts?

A9 – *The change in lifestyle and diet among school children during COVID-19 might result in transient increase in rates of obesity. However, mean weight, length/height and BMI from the HK growth survey were comparable with routine growth data from MCHCs and SHSCs, except that boys were taller at 10 years onwards; girls were taller at 10-11 & 17 years and 6-year-old children were slightly thinner.*

We did not update the HK1993 BMI-for-age charts (3) above age 2 years so as to avoid normalizing childhood obesity. Therefore the obesogenic effect of COVID-19 and the slightly thinner 6-year-old in HK growth survey, if any, would not have affected the BMI-for-age charts and their function in indicating obesity.

Q10 – Why do the new growth charts have 9 centiles? How should one interpret 99.6th centile and 0.4th centile?

A10 – *The new growth charts were constructed with 9 centiles (99.6th, 98th, 91st, 75th, 50th, 25th, 9th, 2nd and 0.4th). The centiles are equally spaced with a width correspondent to two thirds (0.67) of an SD for that age and included two extreme centiles (0.4th and 99.6th). In general, the closer the growth parameters are to the extremes, the more likely they are abnormal. The two extreme centile lines (0.4th and 99.6th) will help screen out the more likely abnormal growth for further evaluation.*

4. Research Team

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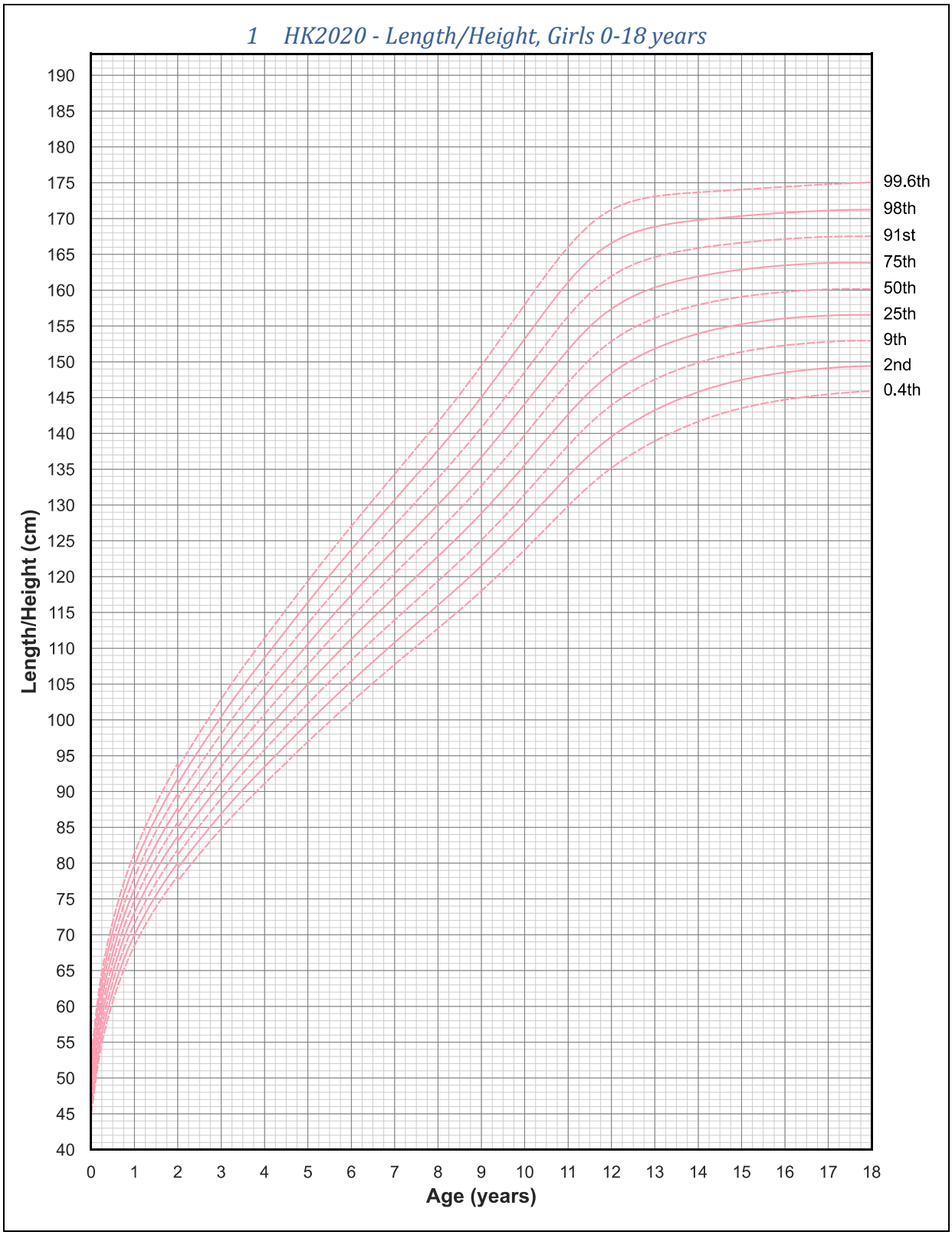
6. References

1. Leung SSF. A Simple Guide to Childhood Growth annd Nutrition Assessment. Hong Kong: MEDI-proficient; 1995.
2. Leung SS, Lau JT, Xu YY, Tse LY, Huen KF, Wong GW, et al. Secular changes in standing height, sitting height and sexual maturation of Chinese--the Hong Kong Growth Study, 1993. Ann Hum Biol. 1996;23(4):297-306.
3. Leung SS, Lau JT, Tse LY, Oppenheimer SJ. Weight-for-age and weight-for-height references for Hong Kong children from birth to 18 years. Journal of paediatrics and child health. 1996;32(2):103-9.
4. WHO MGRS. Assessment of differences in linear growth among populations in the WHO Multicentre Growth Reference Study. Acta paediatrica. 2006;450:56-65.
5. So HK, Nelson EA, Sung RY, Ng PC. Implications of using World Health Organization growth reference (2007) for identifying growth problems in Hong Kong children aged 6 to 18 years. Hong Kong Medical Journal 2011;17(3):174-9.
6. Moy RW, C.M.;. Using the new UK-WHO growth charts. Paediatrics and Child Health. 2014;24(3):97-102.
7. MGRS; W. WHO Child Growth Standards based on length/height, weight and age. Acta paediatrica. 2006;450:76-85.
8. Group WHOMGRS. Enrolment and baseline characteristics in the WHO Multicentre Growth Reference Study. Acta paediatrica. 2006;450:7-15.
9. WHO Child Growth Standards [Available from: https://www.who.int/news/item/27-04-2006-world-health-organization-releases-new-child-growth-standards.]
10. US CDC. [Available from: https://www.cdc.gov/growthcharts/who_charts.htm.]
11. Wright CM, Cole TJ, Fewtrell M, Williams JE, Eaton S, Wells JC. Body composition data show that high BMI centiles overdiagnose obesity in children aged under 6 years. The American journal of clinical nutrition. 2022;116(1):122-31.

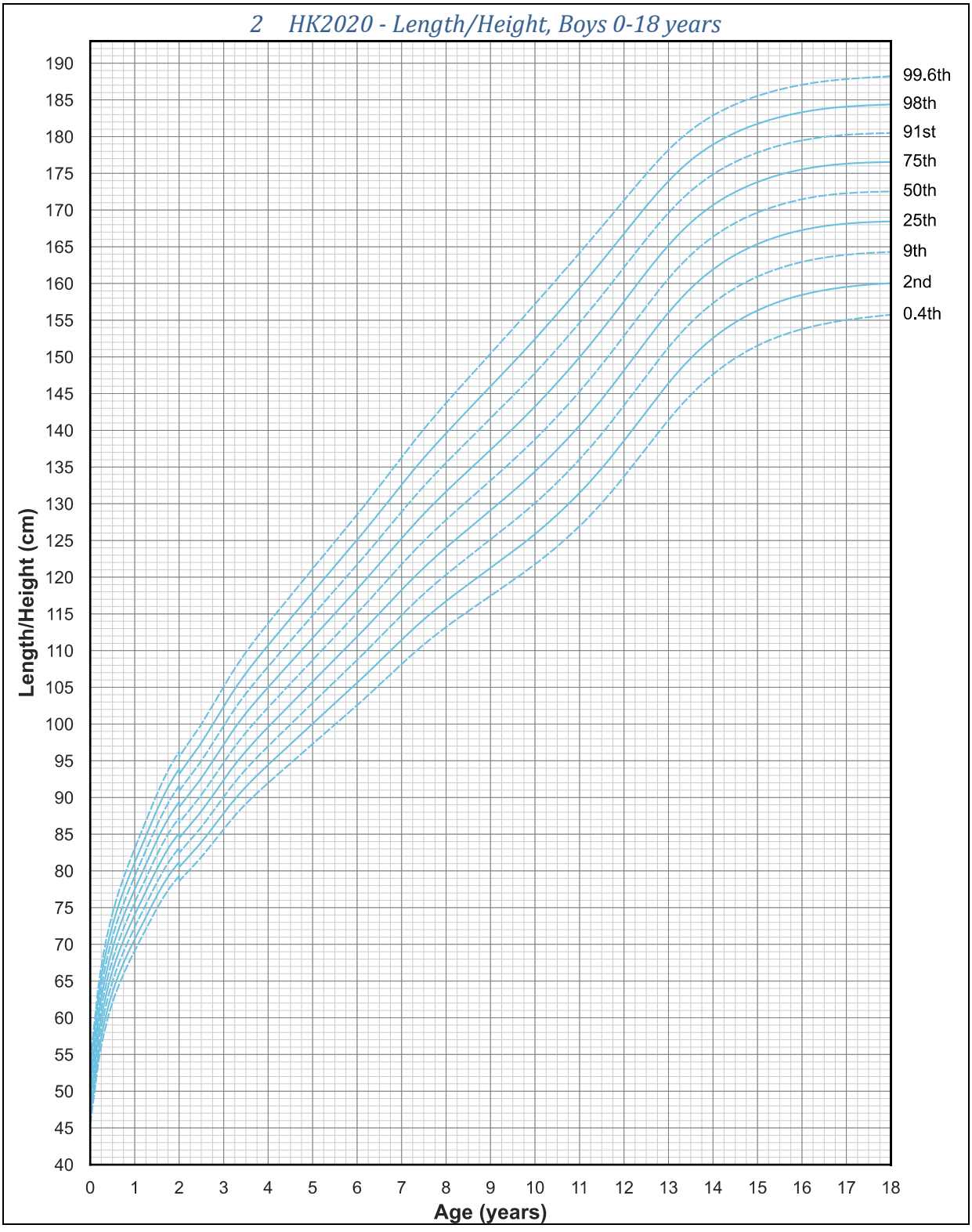
7. Percentile charts

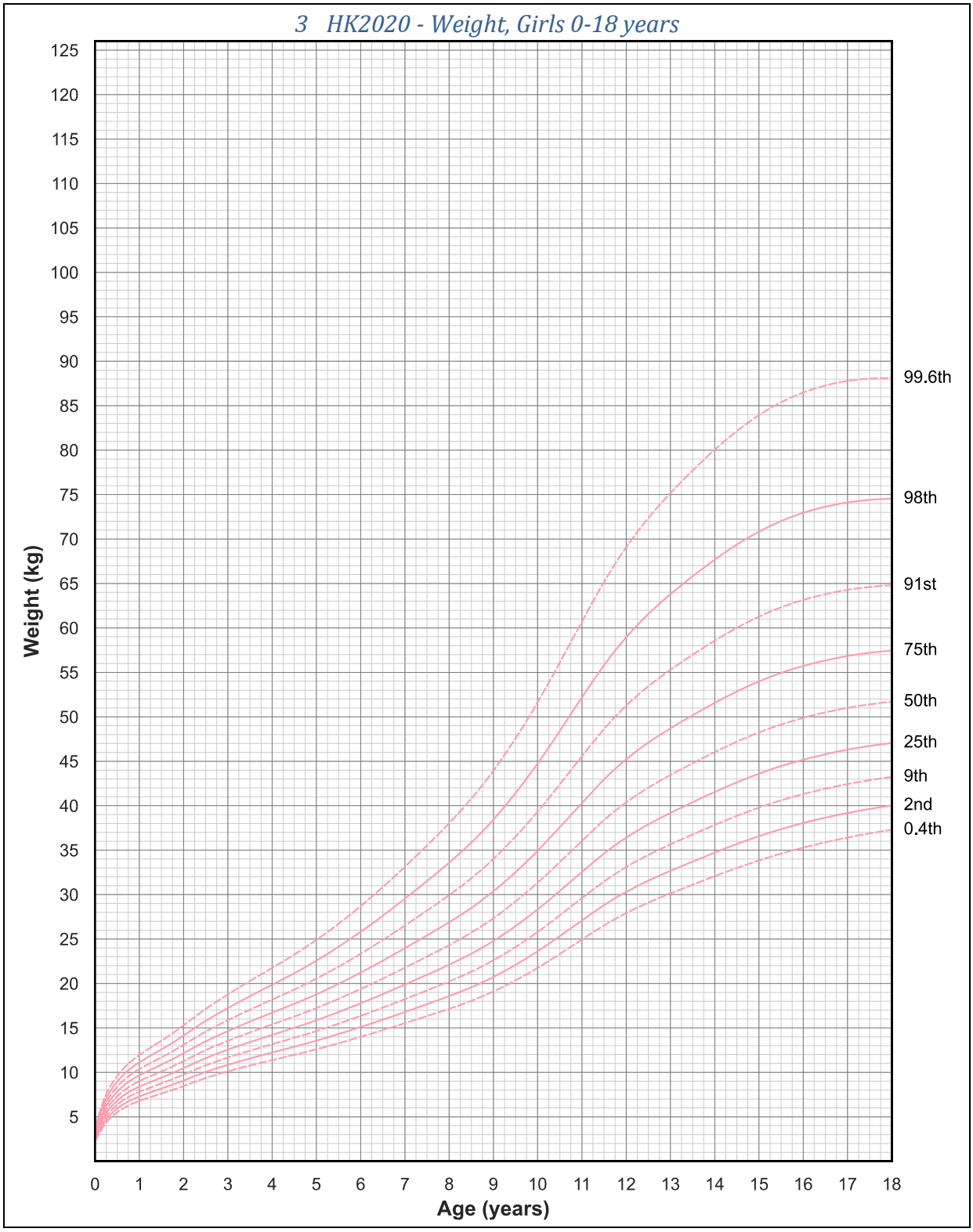
Charts	Sex	Segment
HK2020 Growth References		
1 HK2020 - Length/Height, Girls 0-18 years	F	0-18y
2 HK2020 - Length/Height, Boys 0-18 years	M	0-18y
3 HK2020 - Weight, Girls 0-18 years	F	0-18y
4 HK2020 - Weight, Boys 0-18 years	M	0-18y
5 HK2020 - BMI, Girls 0-18 years	F	0-18y
6 HK2020 - BMI, Boys 0-18 years	M	0-18y
7 HK2020 - Head circumference, Girls 0-18 years	F	0-18y
8 HK2020 - Head circumference, Boys 0-18 years	M	0-18y
9 HK2020 - Length/Height, Girls 0-5 years	F	0-5y
10 HK2020 - Length/Height, Boys 0-5 years	M	0-5y
11 HK2020 - Weight, Girls 0-5 years	F	0-5y
12 HK2020 - Weight, Boys 0-5 years	M	0-5y
13 HK2020 - BMI, Girls 0-5 years	F	0-5y
14 HK2020 - BMI, Boys 0-5 years	M	0-5y
15 HK2020 - Head circumference, Girls 0-5 years	F	0-5y
16 HK2020 - Head circumference, Boys 0-5 years	M	0-5y
17 HK2020 - Length/Height, Girls 0-2 years	F	0-2y
18 HK2020 - Length/Height, Boys 0-2 years	M	0-2y
19 HK2020 - Weight, Girls 0-2 years	F	0-2y
20 HK2020 - Weight, Boys 0-2 years	M	0-2y
21 HK2020 - BMI, Girls 0-2 years	F	0-2y
22 HK2020 - BMI, Boys 0-2 years	M	0-2y
23 HK2020 - Head circumference, Girls 0-2 years	F	0-2y
24 HK2020 - Head circumference, Boys 0-2 years	M	0-2y
WHO-HK2020 Growth References		
25 WHO-HK2020 - Length/Height, Girls 0-5 years	F	0-5y
26 WHO-HK2020 - Length/Height, Boys 0-5 years	M	0-5y
27 WHO-HK2020 - Weight, Girls 0-5 years	F	0-5y
28 WHO-HK2020 - Weight, Boys 0-5 years	M	0-5y
29 WHO-HK2020 - BMI, Girls 0-5 years	F	0-5y
30 WHO-HK2020 - BMI, Boys 0-5 years	M	0-5y
31 WHO-HK2020 - Head circumference, Girls 0-5 years	F	0-5y
32 WHO-HK2020 - Head circumference, Boys 0-5 years	M	0-5y
WHO Growth Standards		
33 WHO2006 - Length/Height, Girls 0-5 years	F	0-5y
34 WHO2006 - Length/Height, Boys 0-5 years	M	0-5y
35 WHO2006 - Weight, Girls 0-5 years	F	0-5y
36 WHO2006 - Weight, Boys 0-5 years	M	0-5y
37 WHO2006 - BMI, Girls 0-5 years	F	0-5y
38 WHO2006 - BMI, Boys 0-5 years	M	0-5y
39 WHO2006 - Head circumference, Girls 0-5 years	F	0-5y
40 WHO2006 - Head circumference, Boys 0-5 years	M	0-5y

7.1 HK2020 Growth References

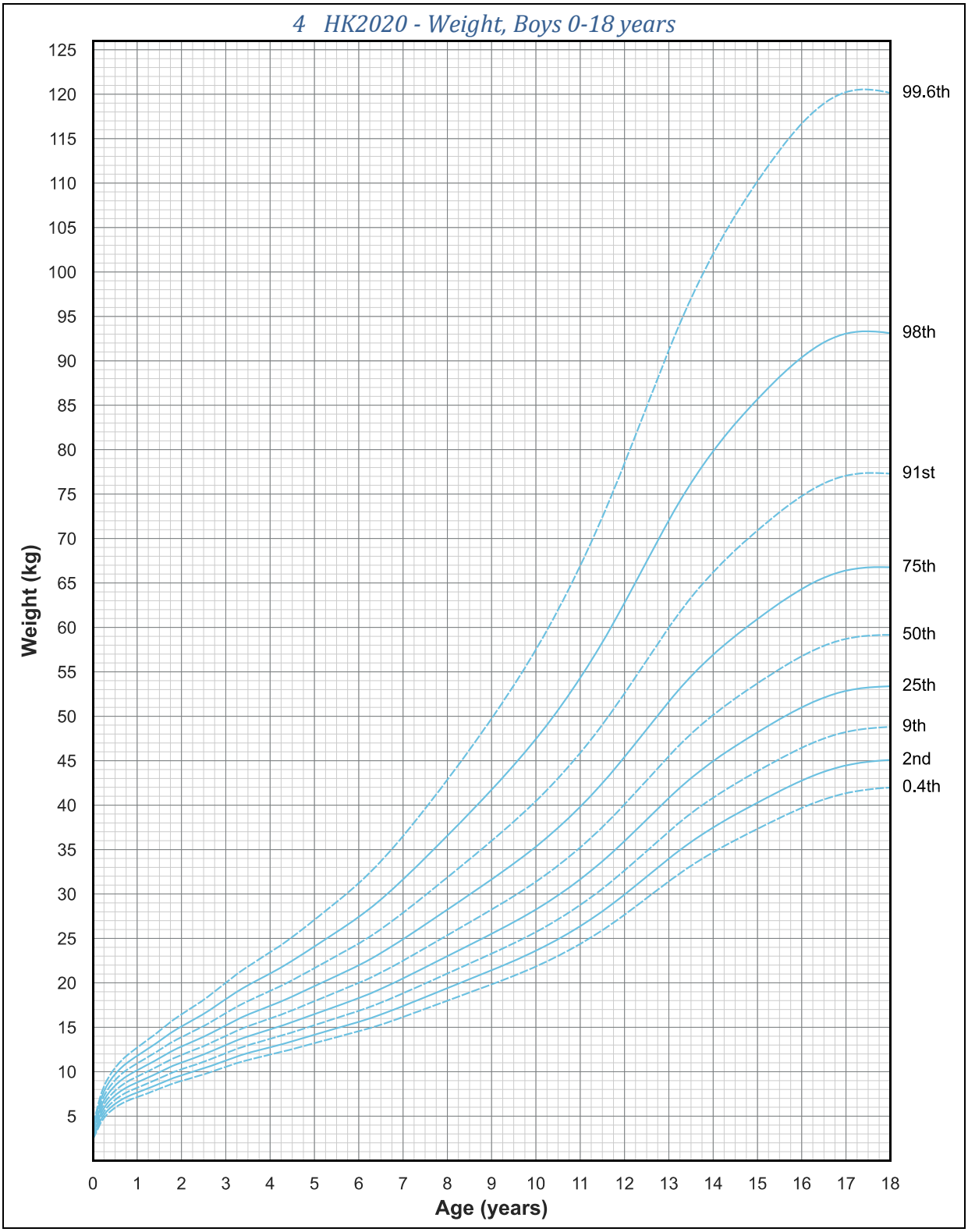


2 HK2020 - Length/Height, Boys 0-18 years

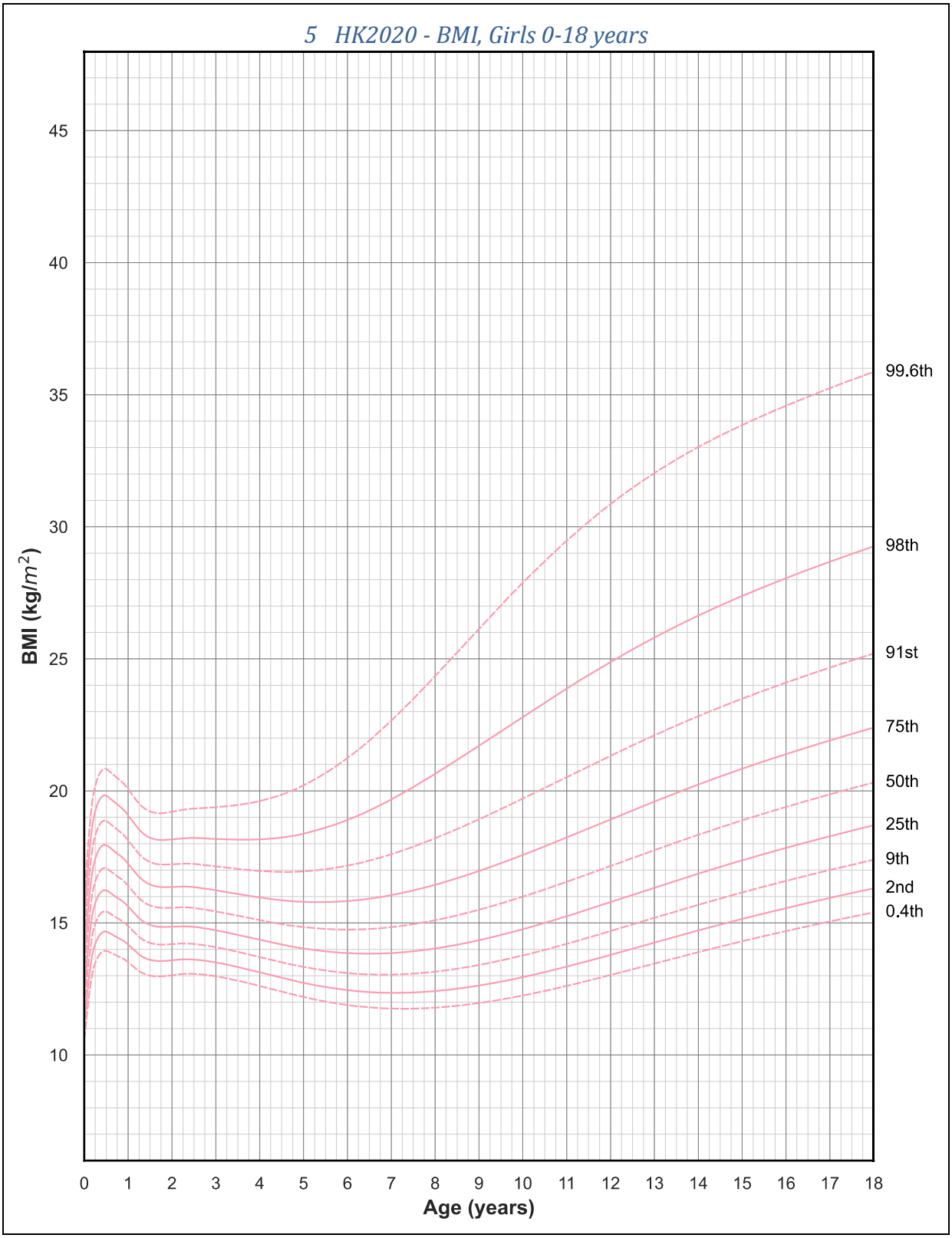



3 HK2020 - Weight, Girls 0-18 years
Weight (kg)
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Age (years)
99.6th
98th
91st
75th
50th
25th
9th
2nd
0.4th

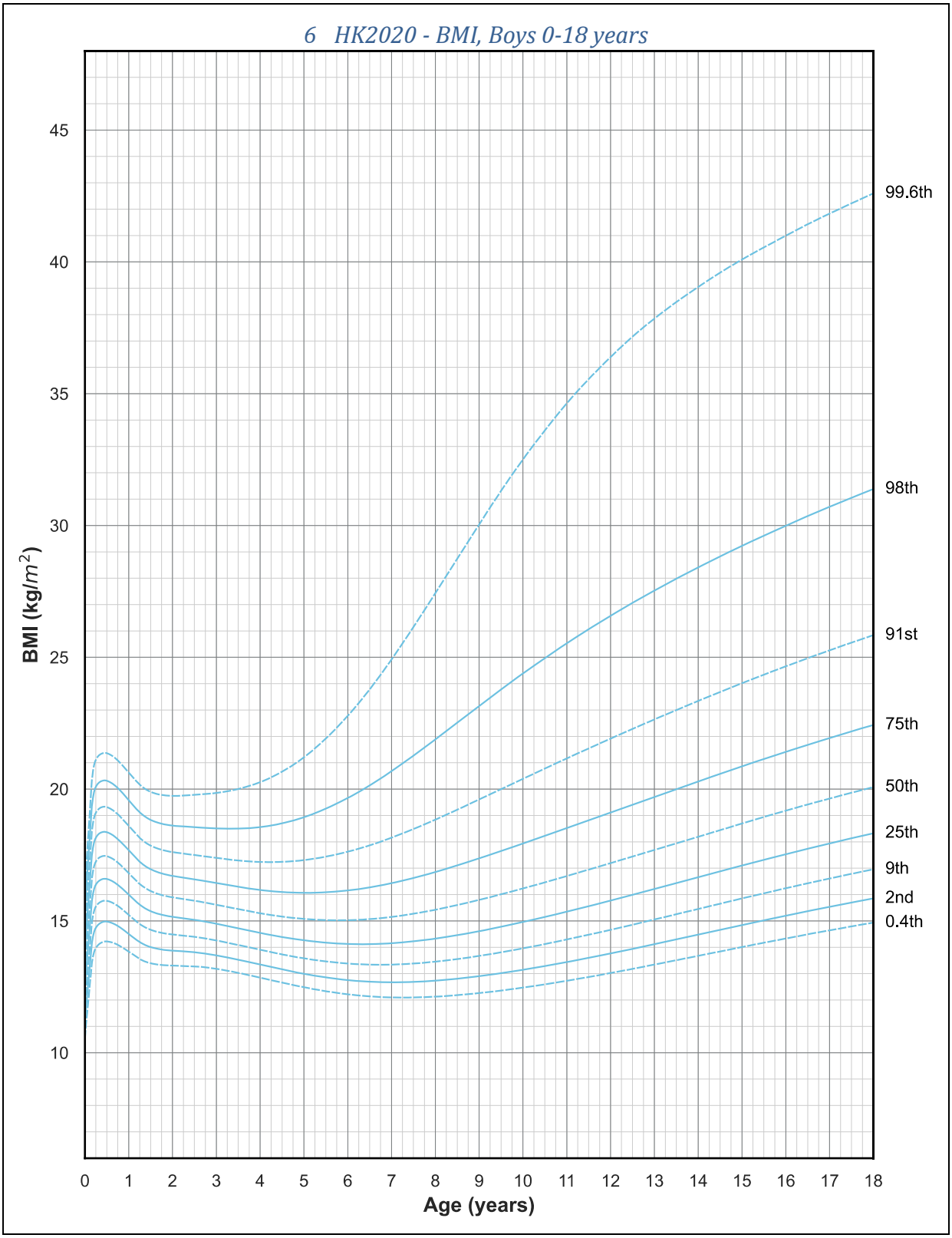
4 HK2020 - Weight, Boys 0-18 years



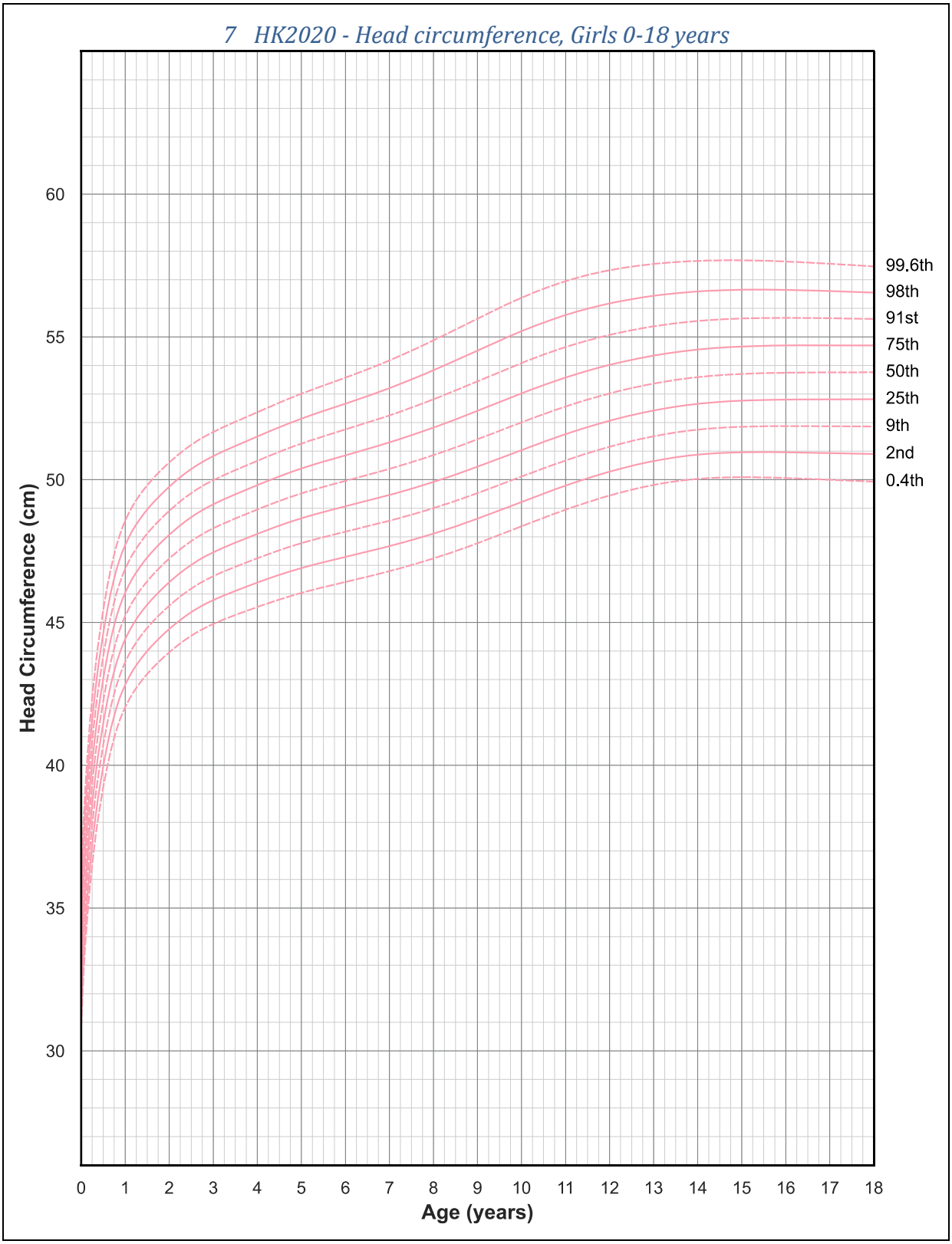
5 HK2020 - BMI, Girls 0-18 years



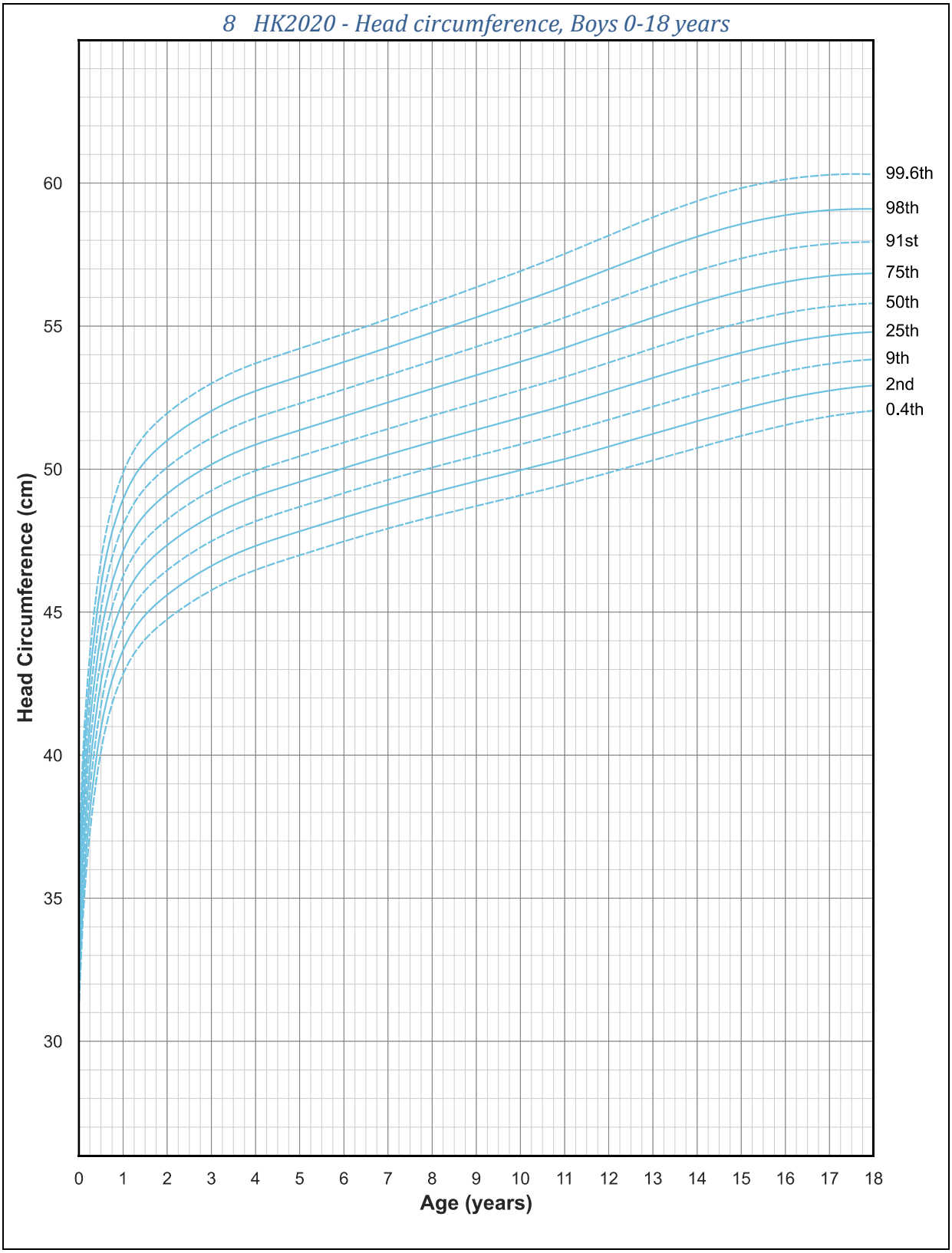
6 HK2020 - BMI, Boys 0-18 years



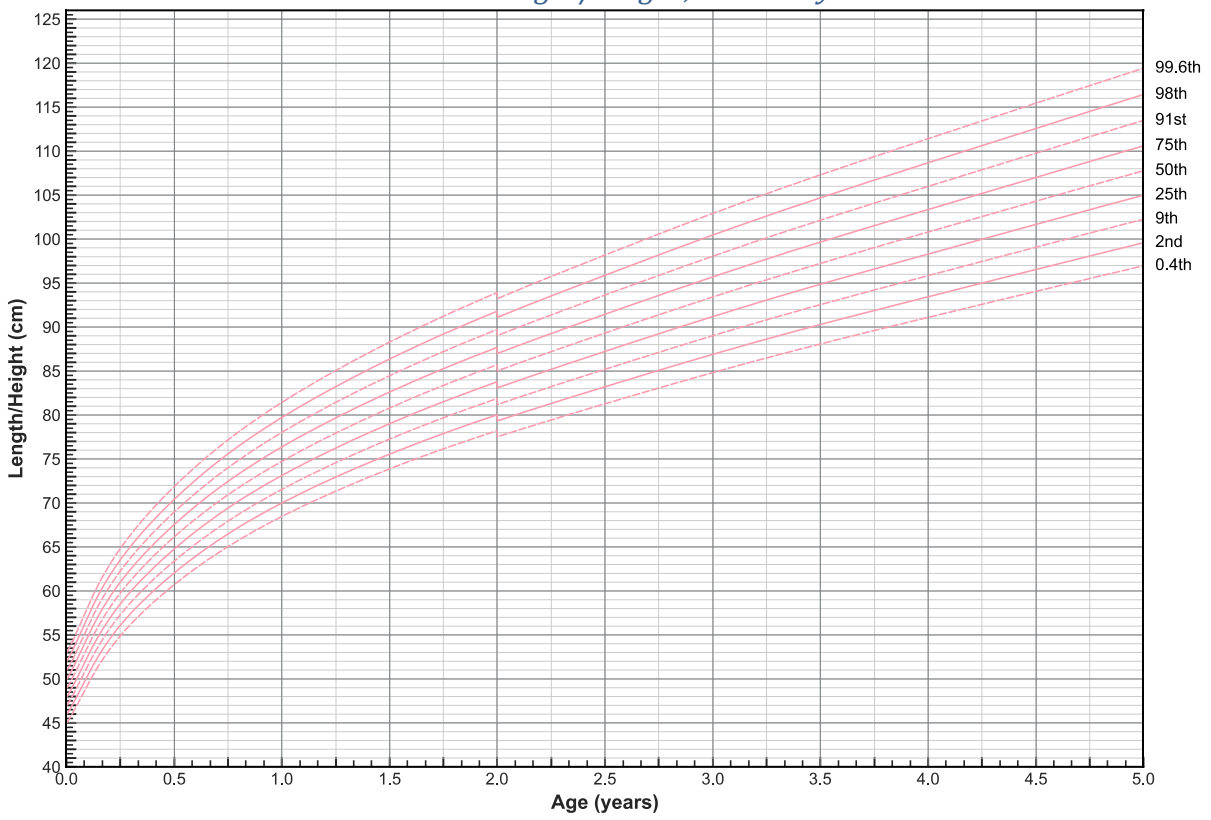
7 HK2020 - Head circumference, Girls 0-18 years



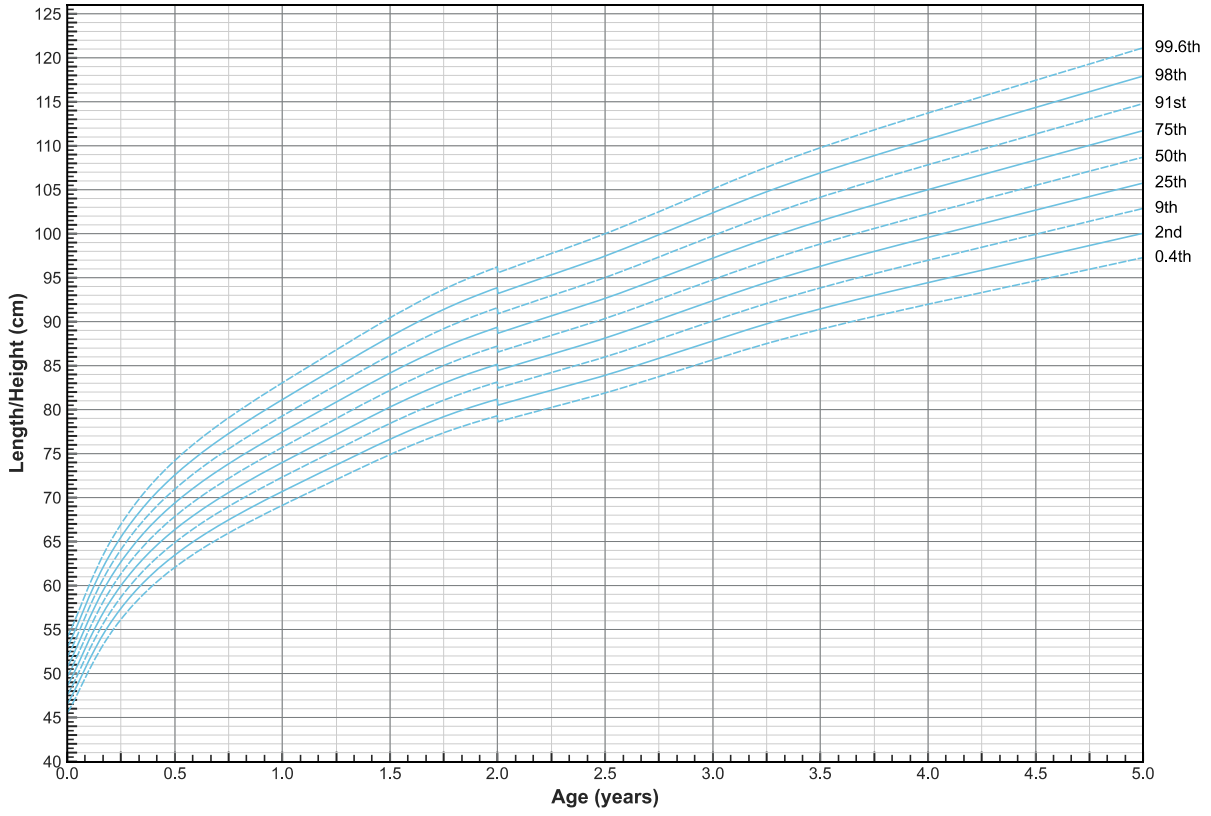
8 HK2020 - Head circumference, Boys 0-18 years



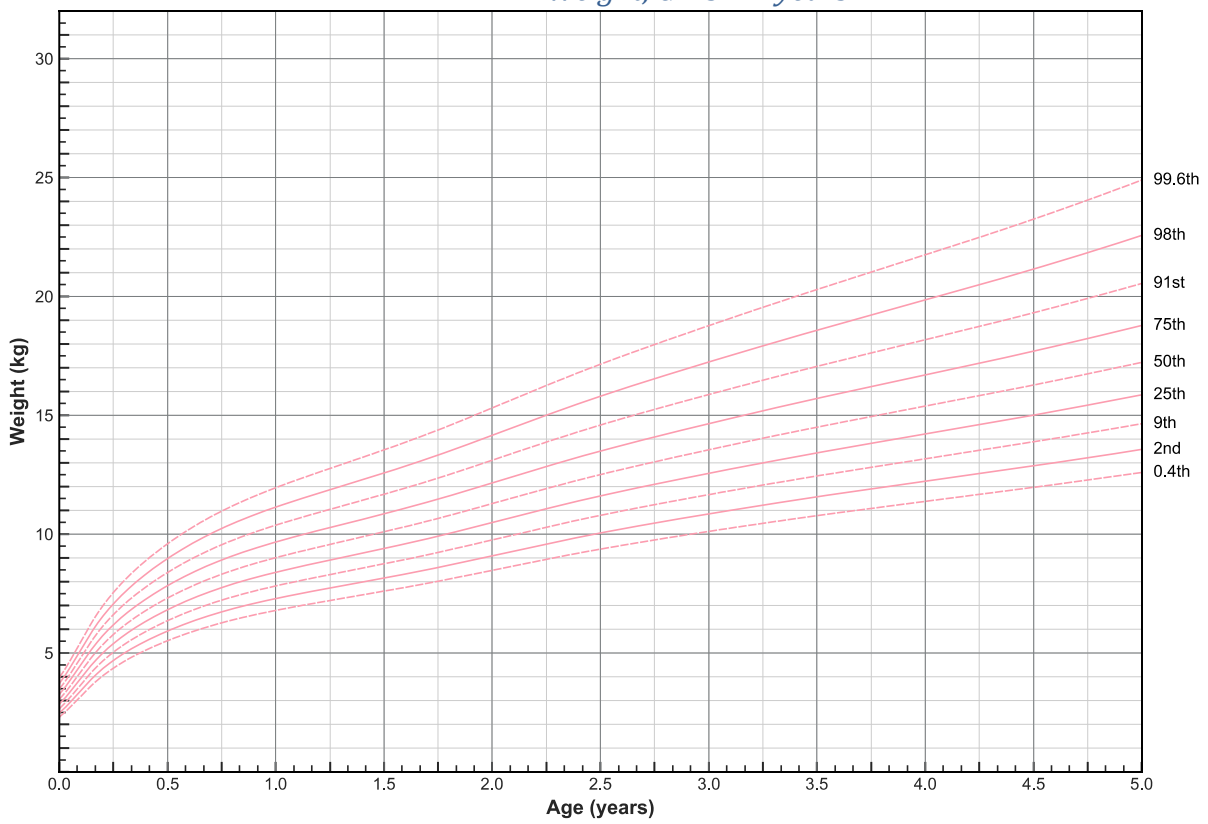
9 HK2020 - Length/Height, Girls 0-5 years



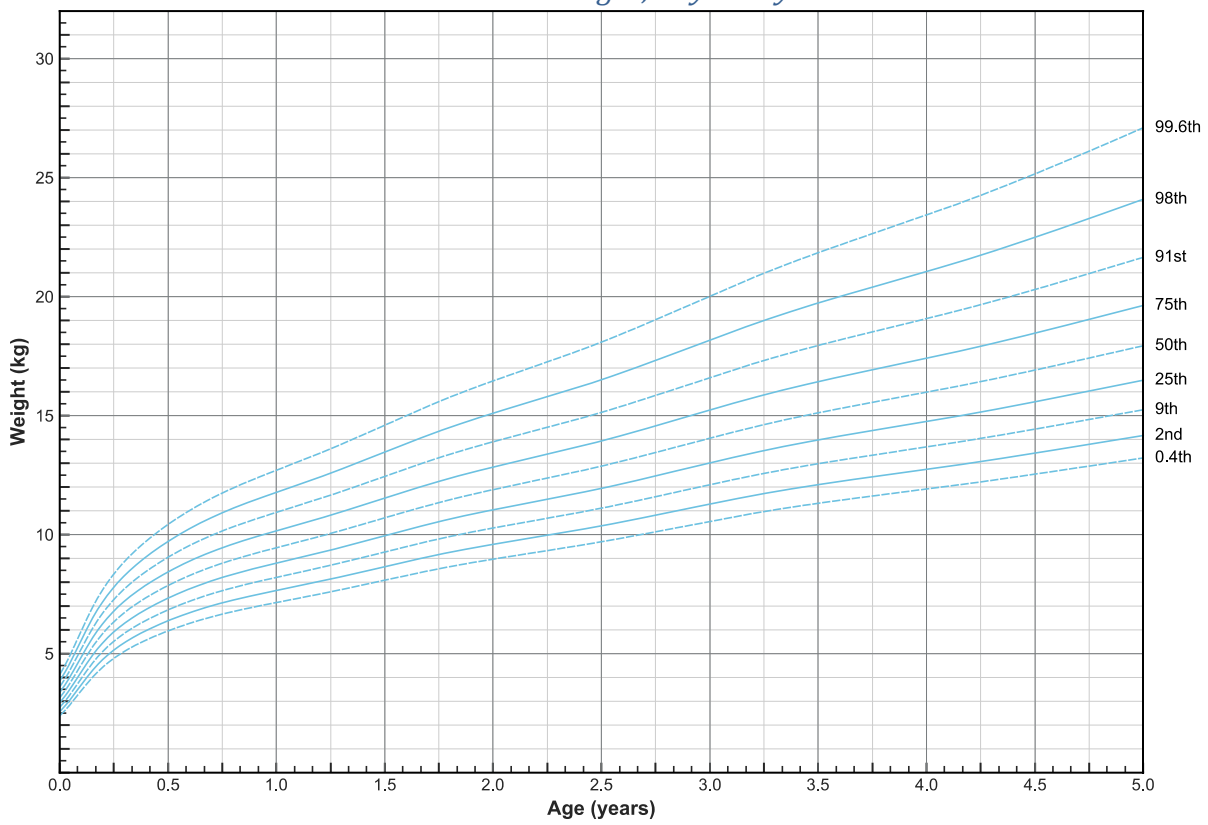
10 HK2020 - Length/Height, Boys 0-5 years



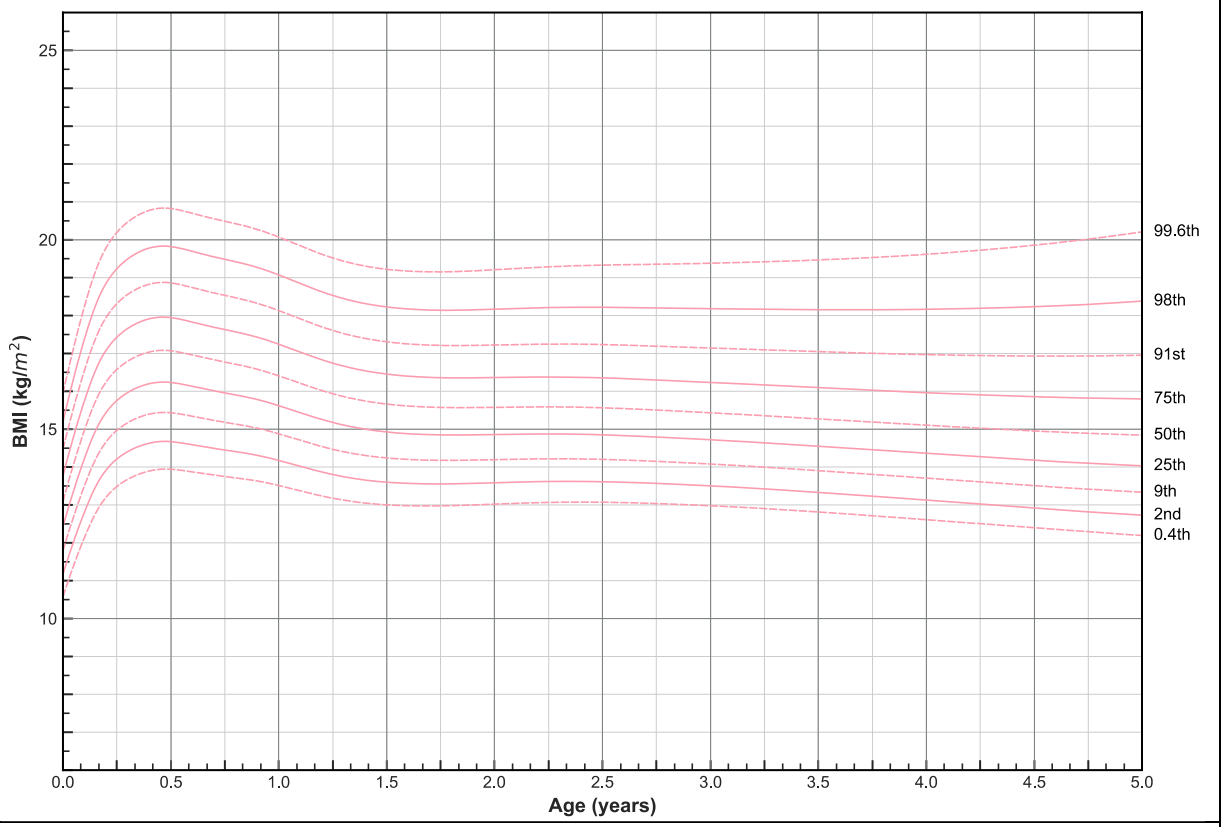
11 HK2020 - Weight, Girls 0-5 years



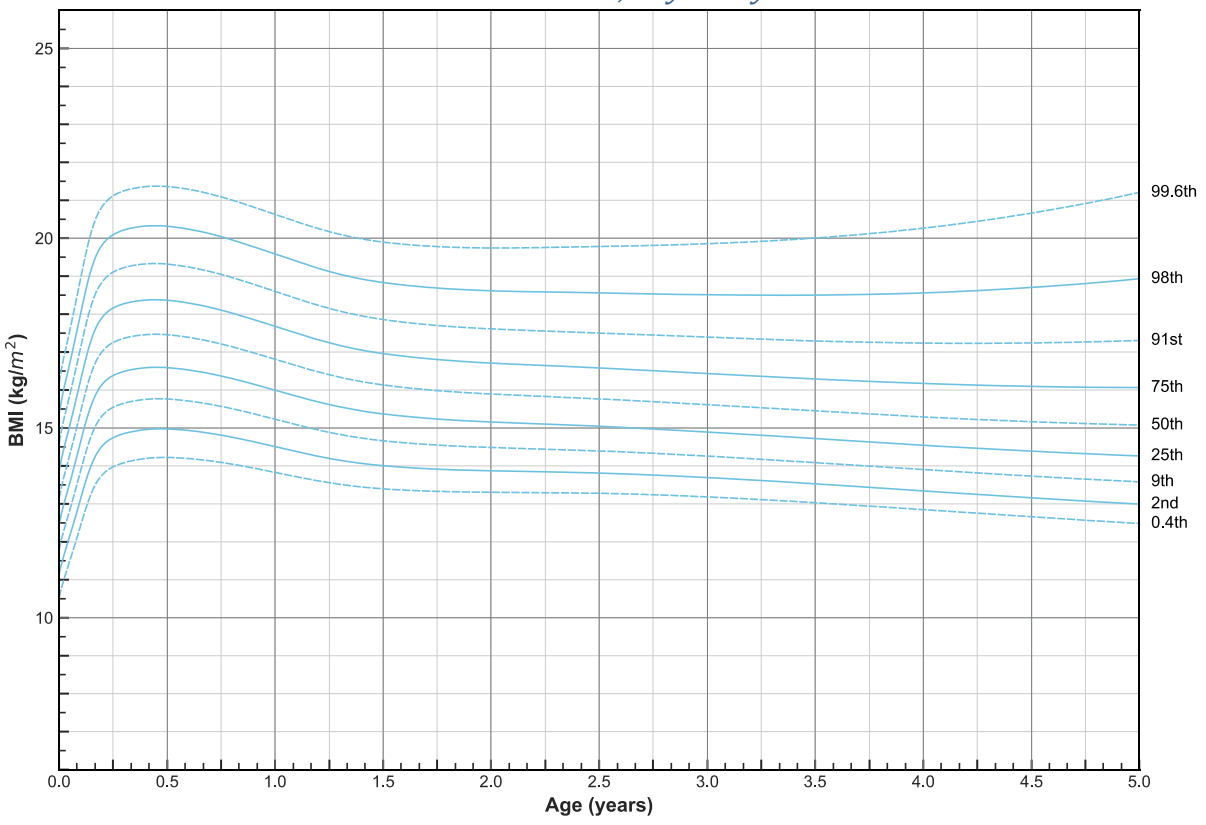
12 HK2020 - Weight, Boys 0-5 years



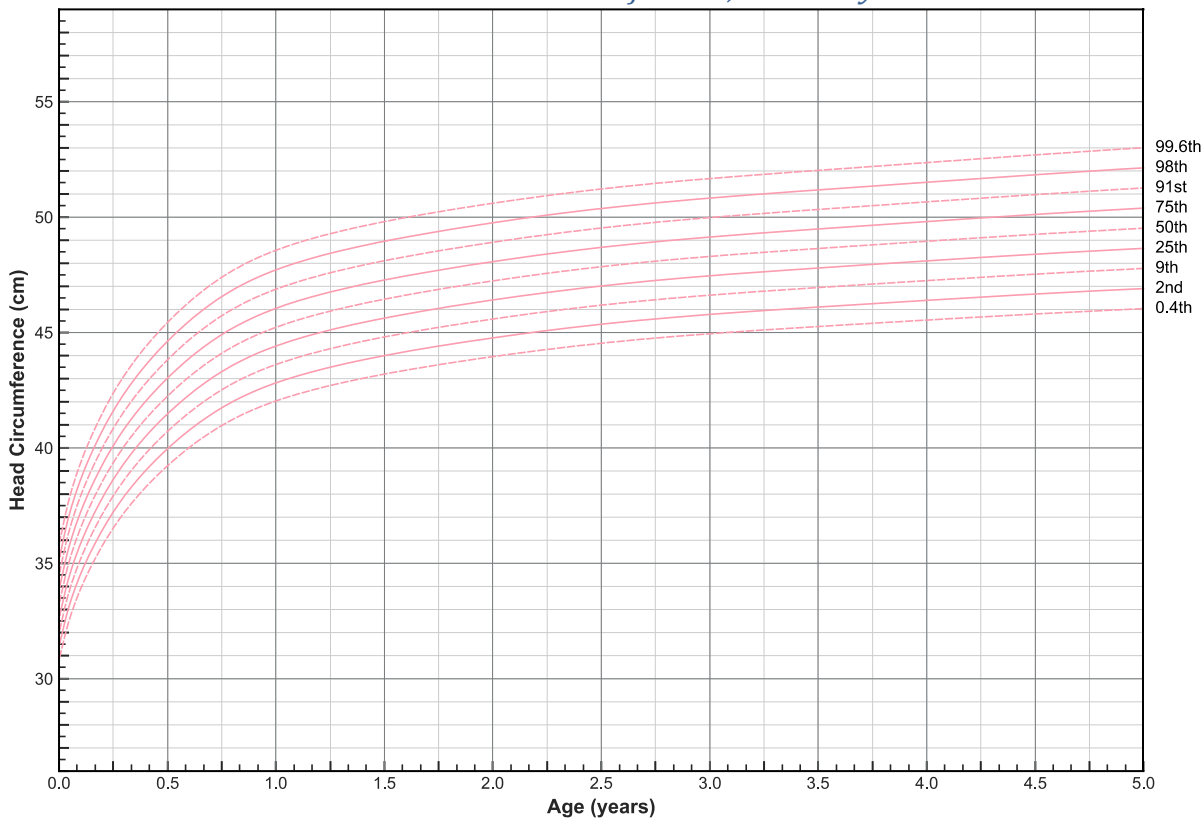
13 HK2020 - BMI, Girls 0-5 years



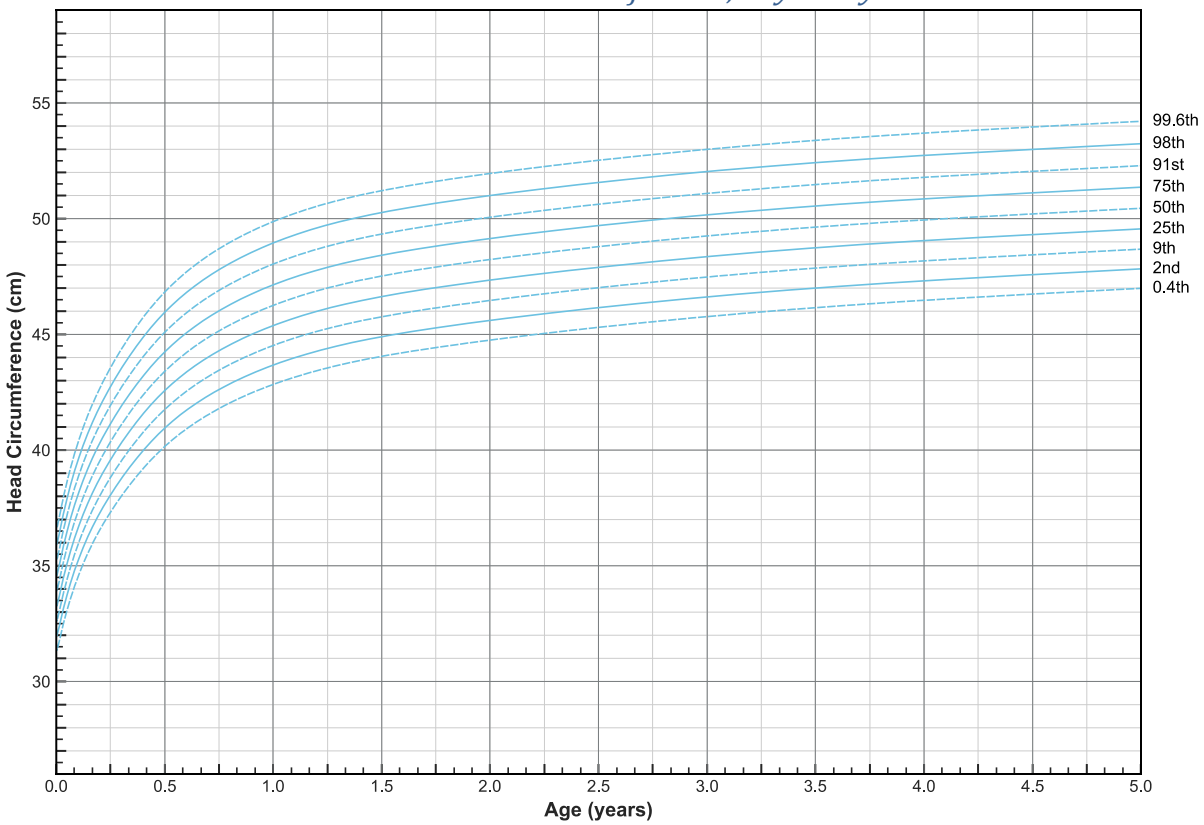
14 HK2020 - BMI, Boys 0-5 years



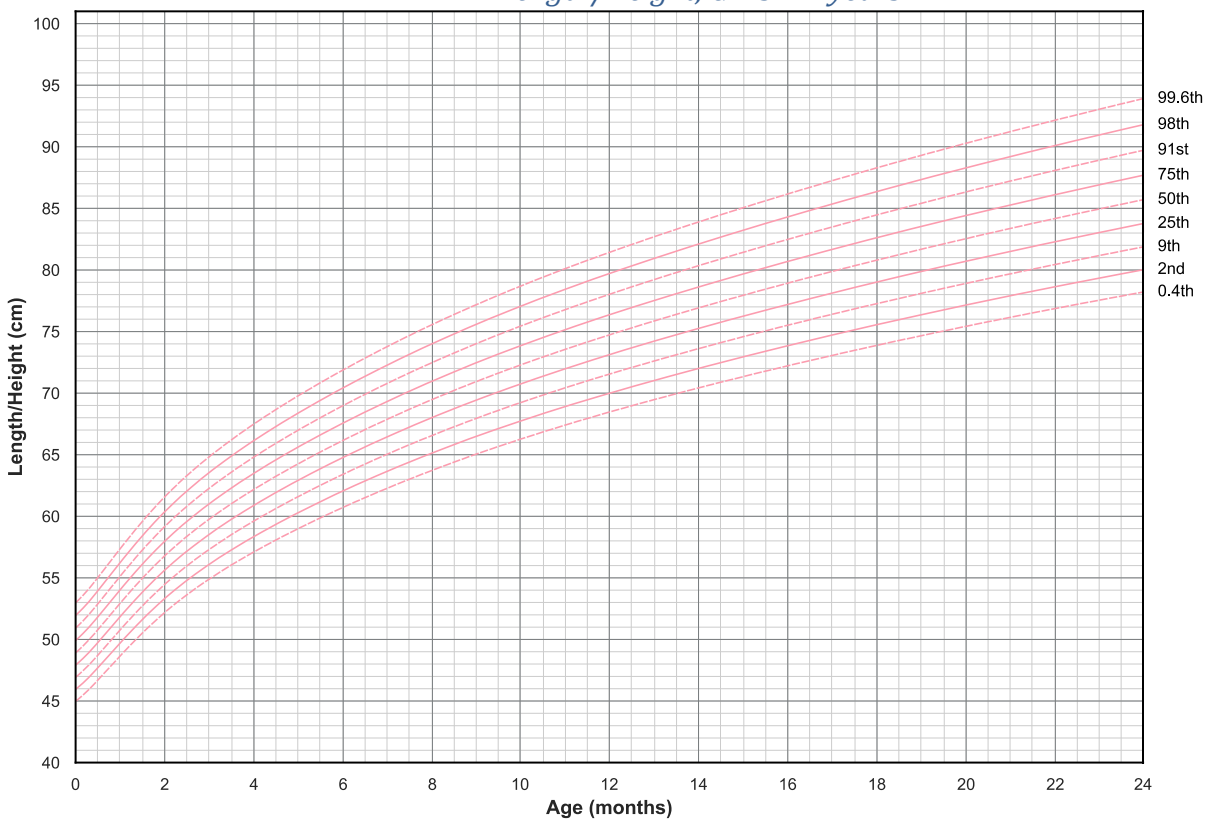
15 HK2020 - Head circumference, Girls 0-5 years



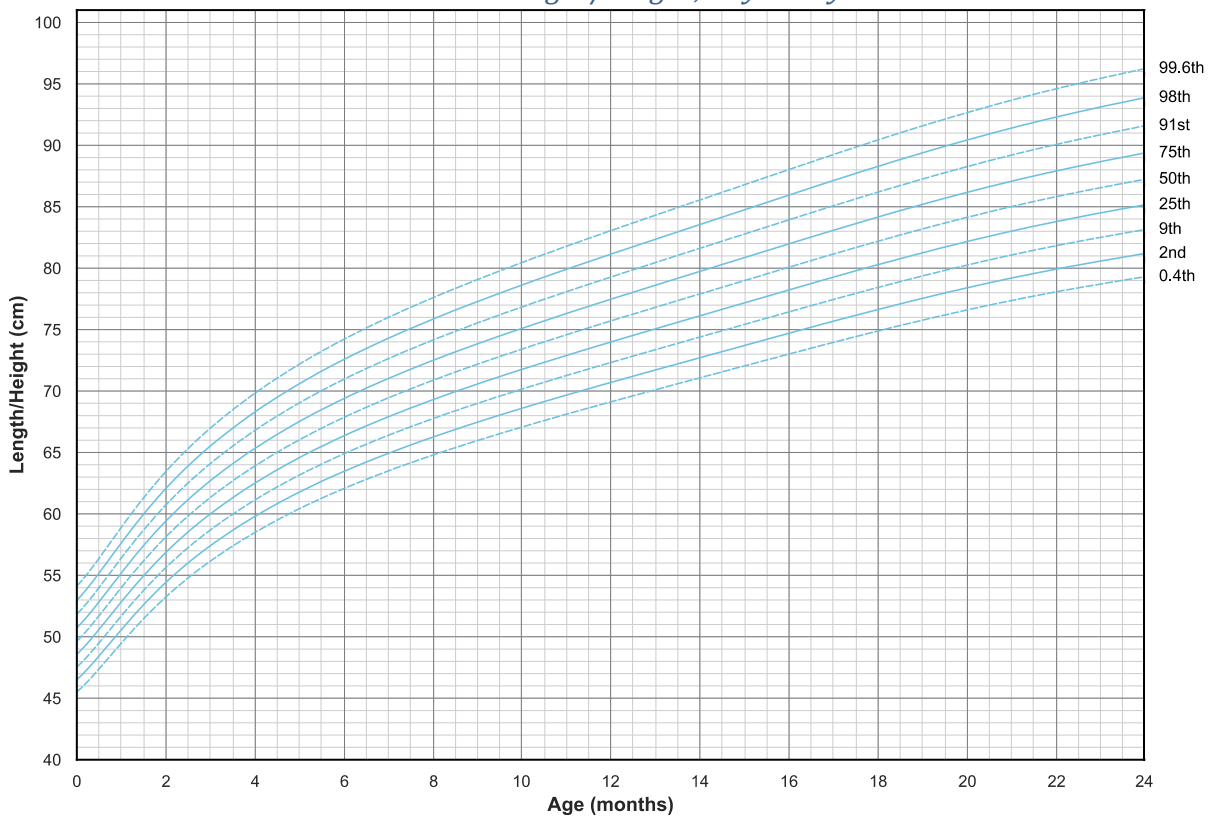
16 HK2020 - Head circumference, Boys 0-5 years



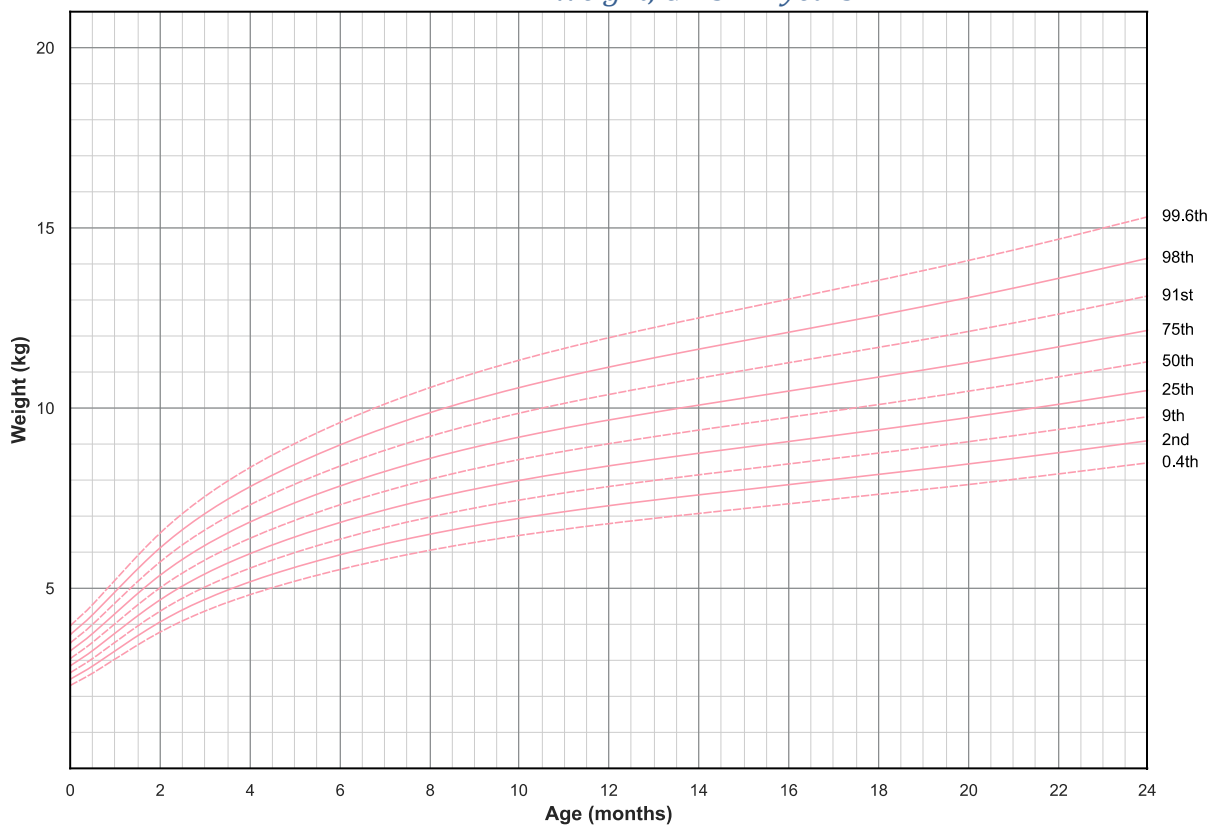
17 HK2020 - Length/Height, Girls 0-2 years



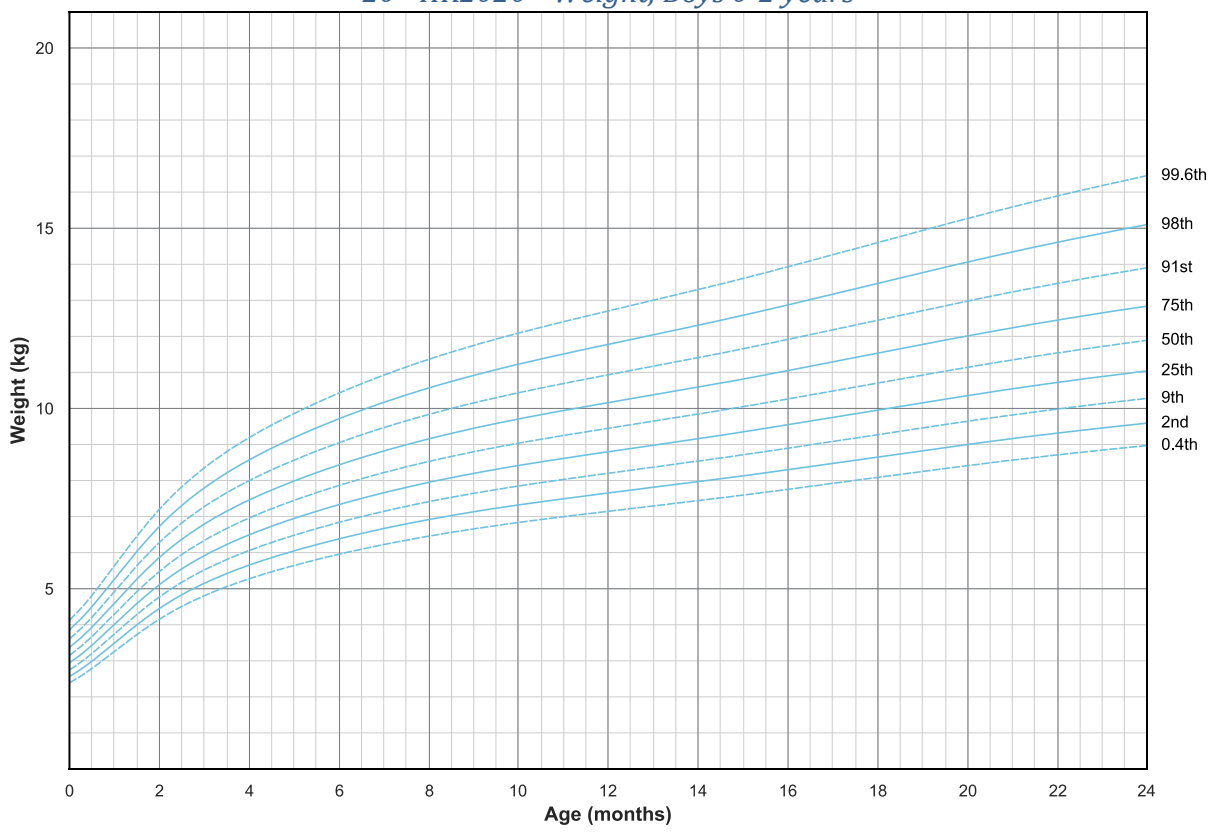
18 HK2020 - Length/Height, Boys 0-2 years



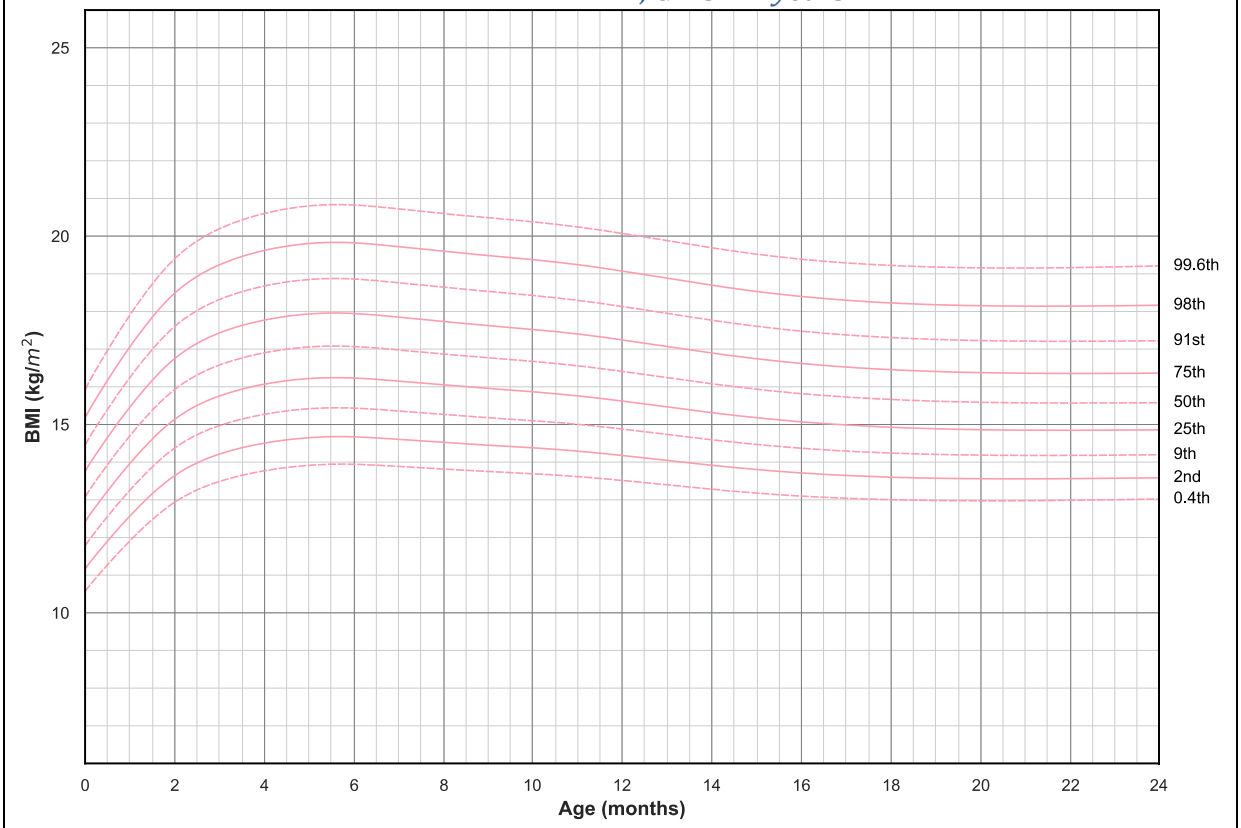
19 HK2020 - Weight, Girls 0-2 years



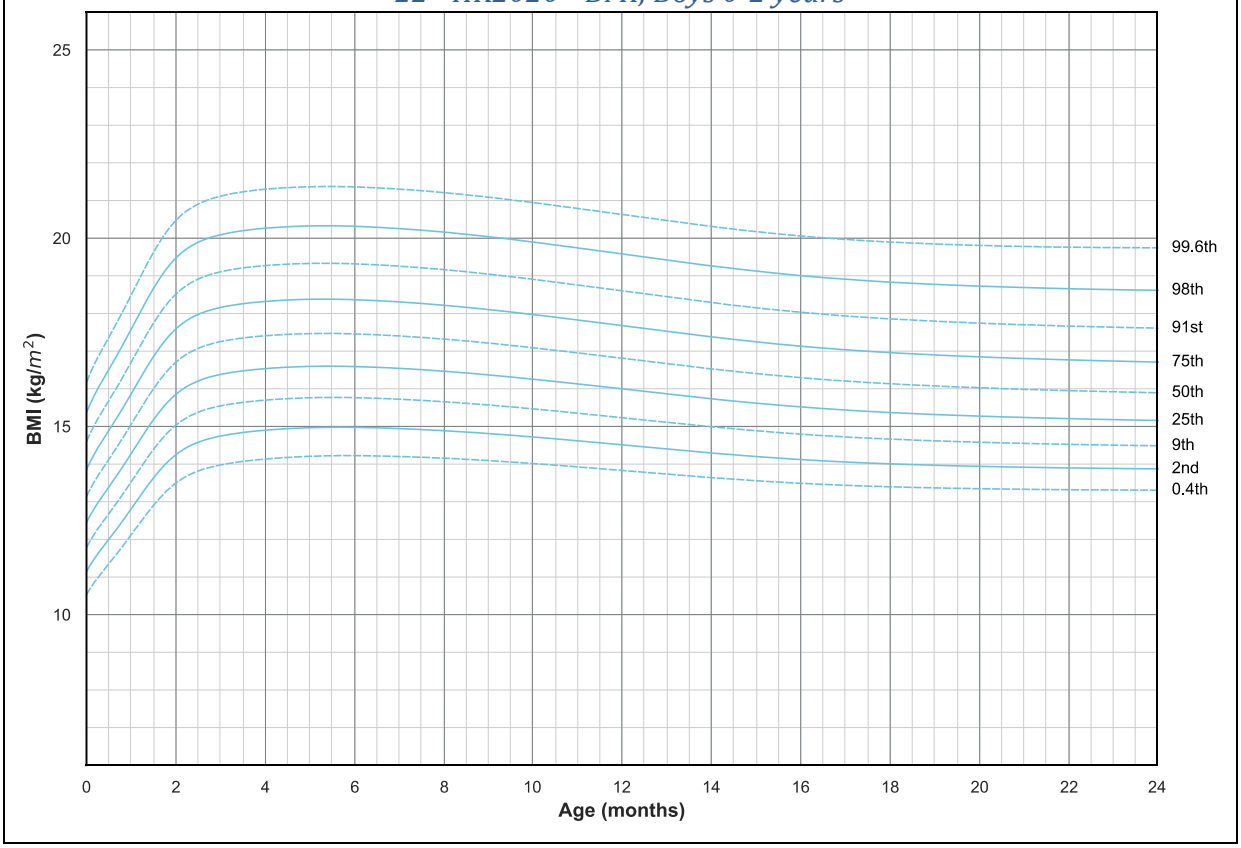
20 HK2020 - Weight, Boys 0-2 years



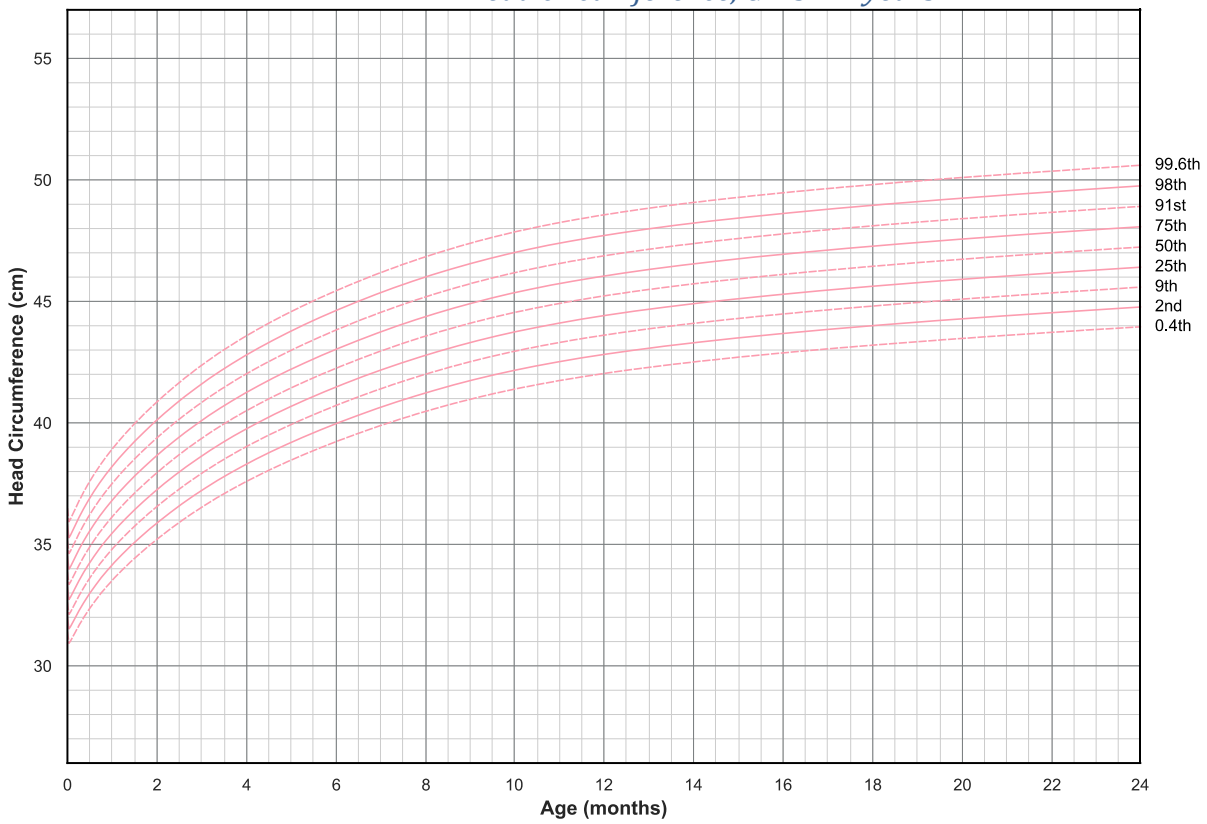
21 HK2020 - BMI, Girls 0-2 years



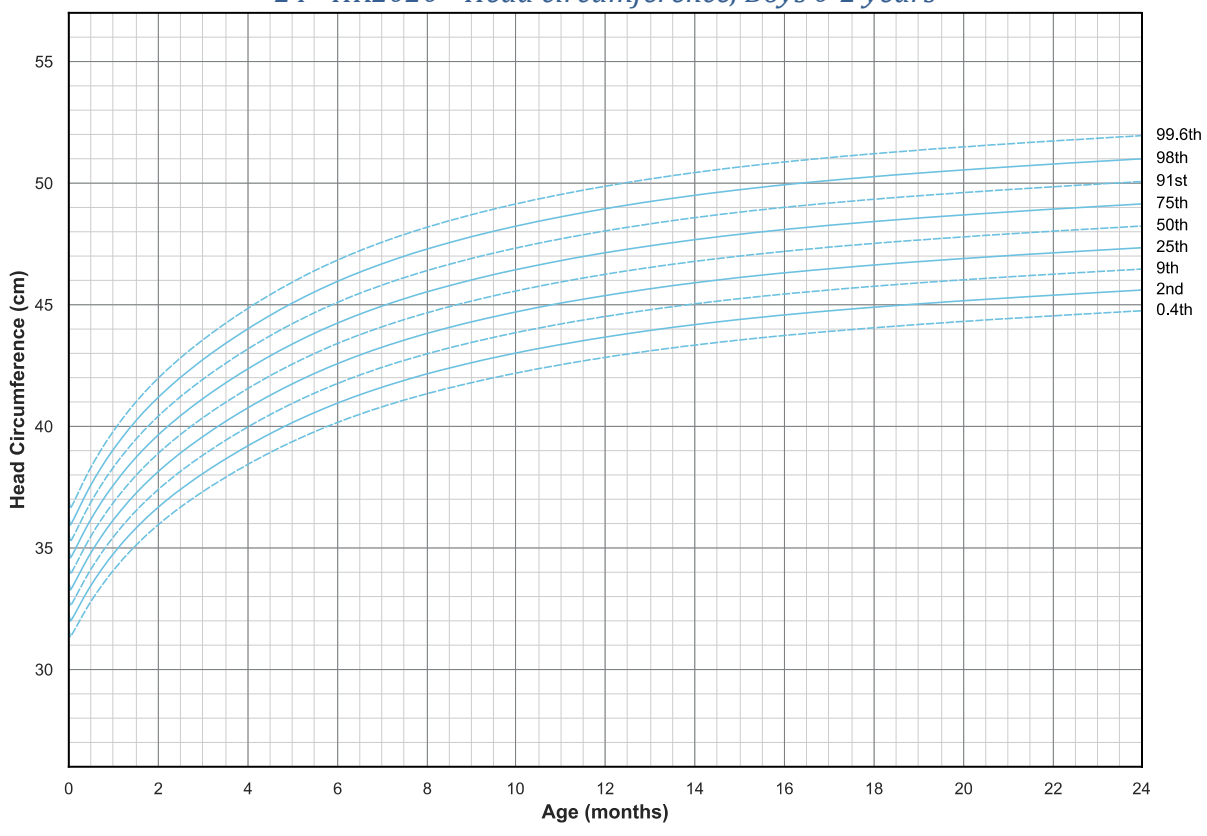
22 HK2020 - BMI, Boys 0-2 years



23 HK2020 - Head circumference, Girls 0-2 years

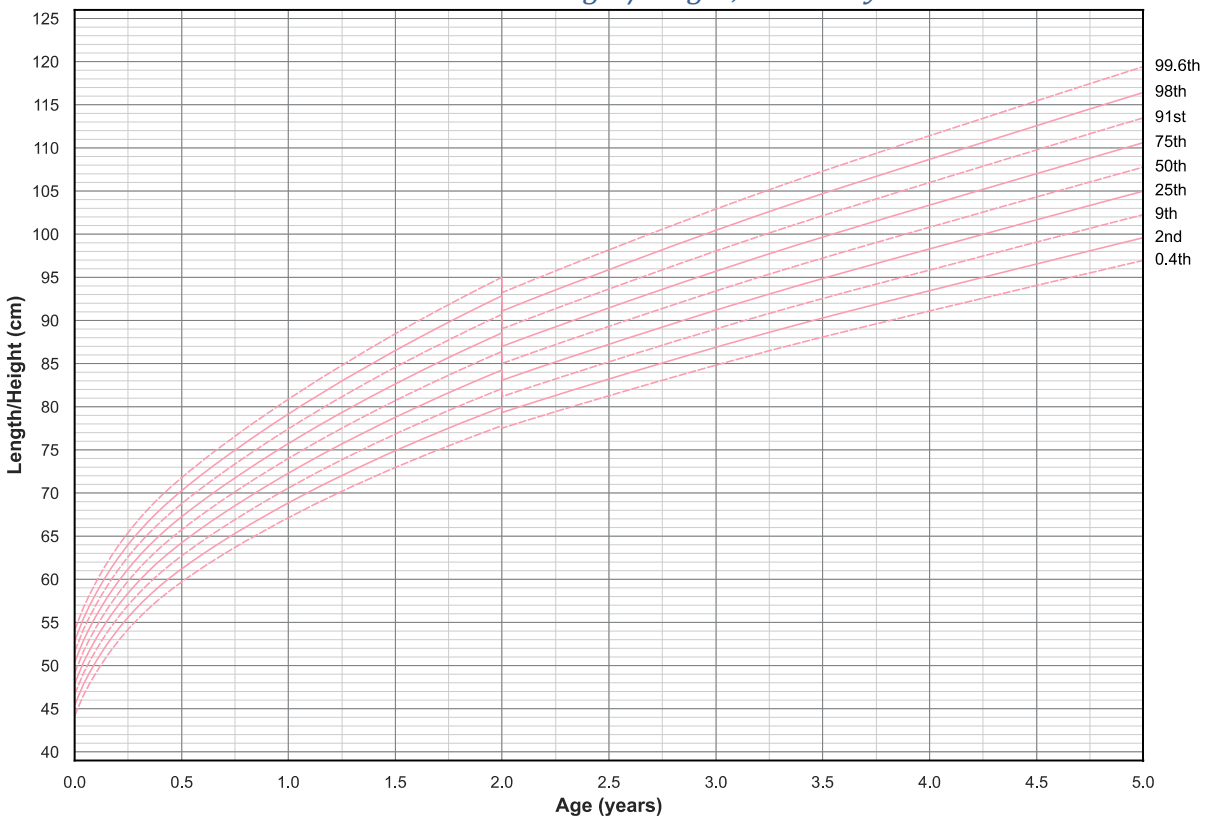


24 HK2020 - Head circumference, Boys 0-2 years

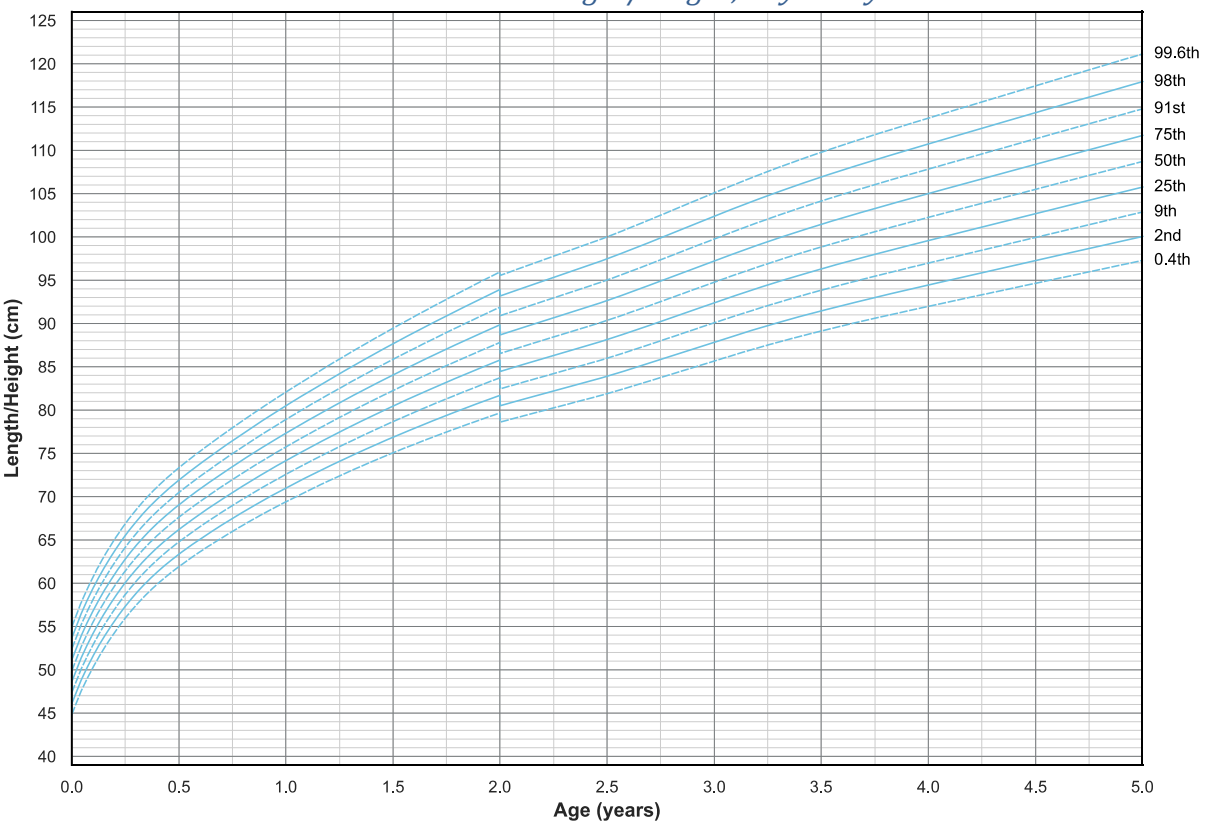


7.2 WHO-HK2020 Growth References

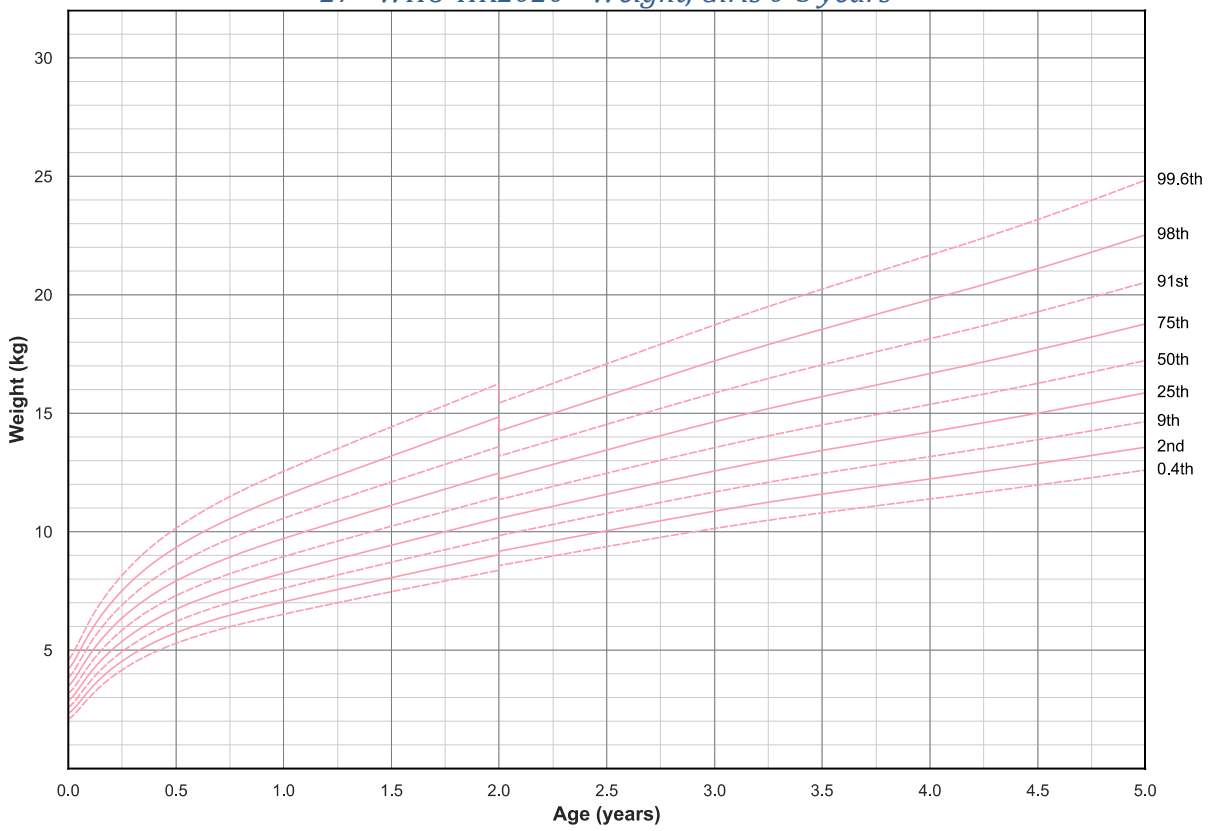
25 WHO-HK2020 - Length/Height, Girls 0-5 years



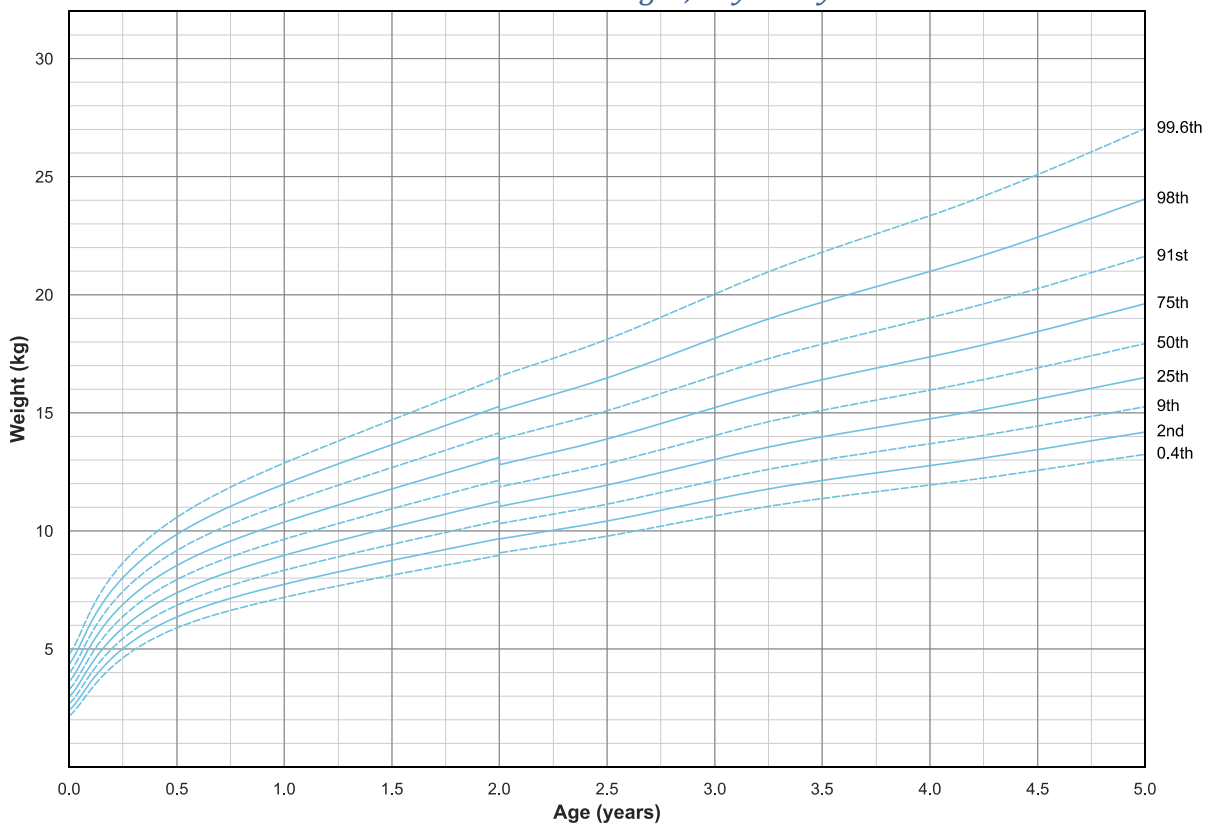
26 WHO-HK2020 - Length/Height, Boys 0-5 years



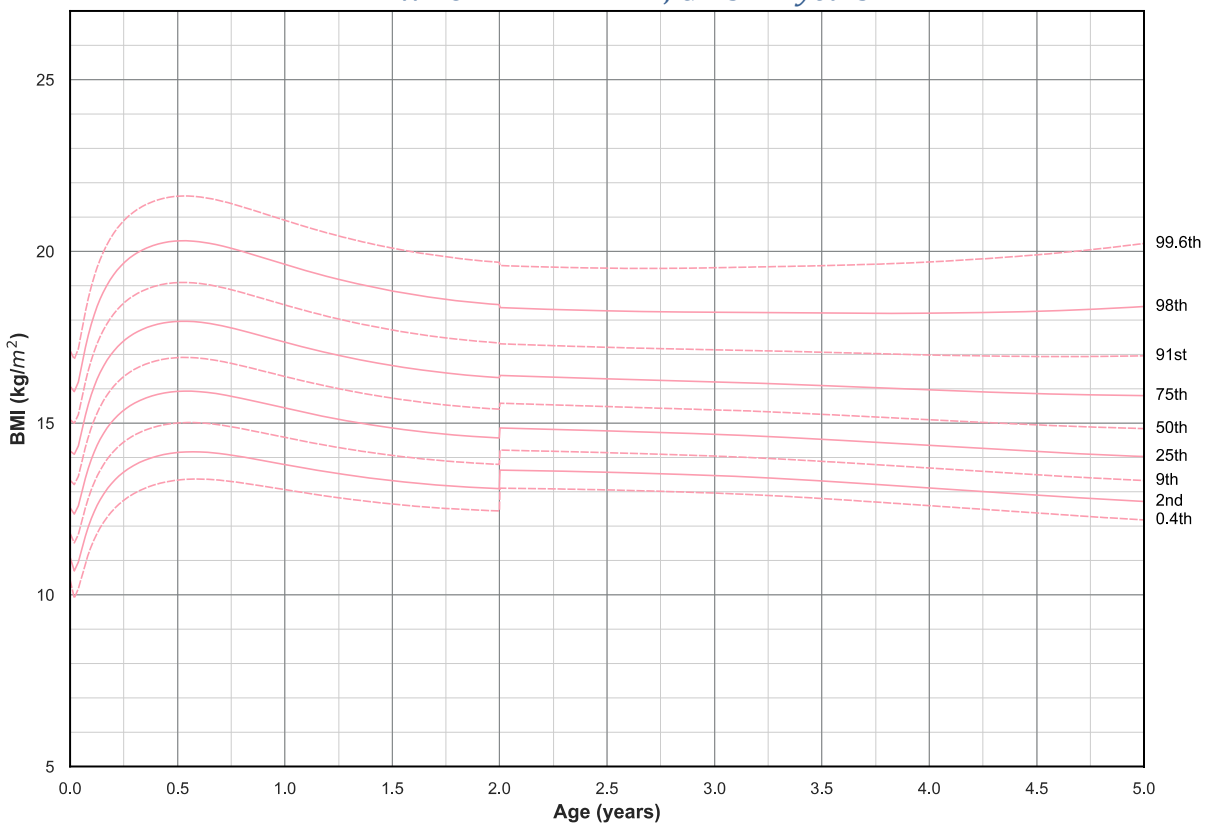
27 WHO-HK2020 - Weight, Girls 0-5 years



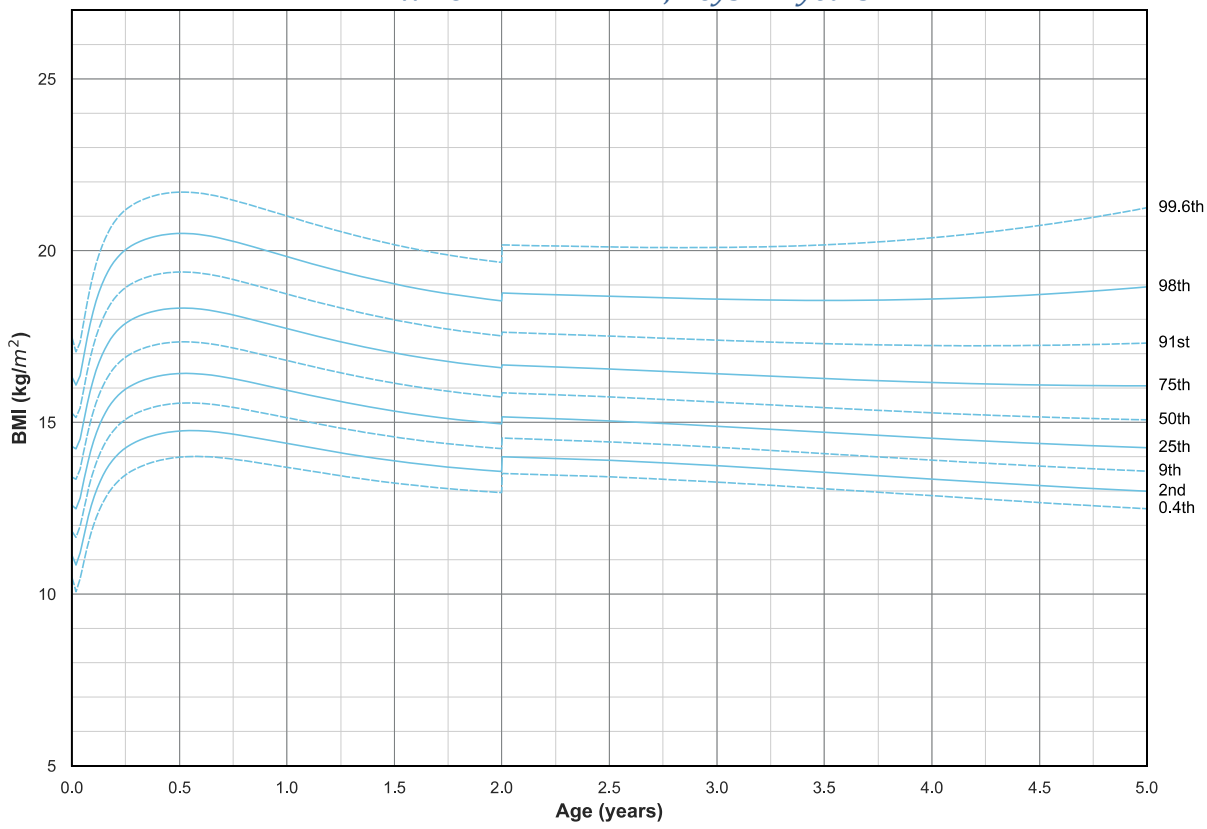
28 WHO-HK2020 - Weight, Boys 0-5 years



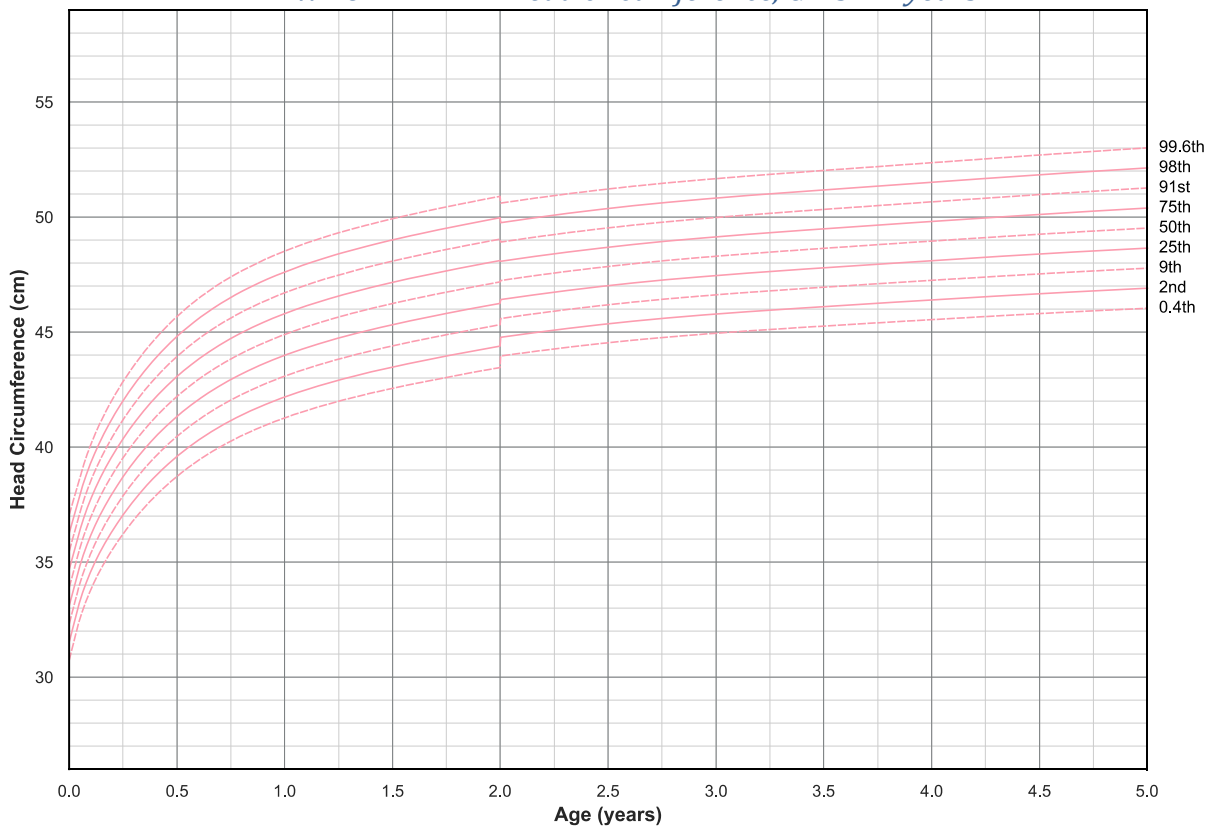
29 WHO-HK2020 - BMI, Girls 0-5 years



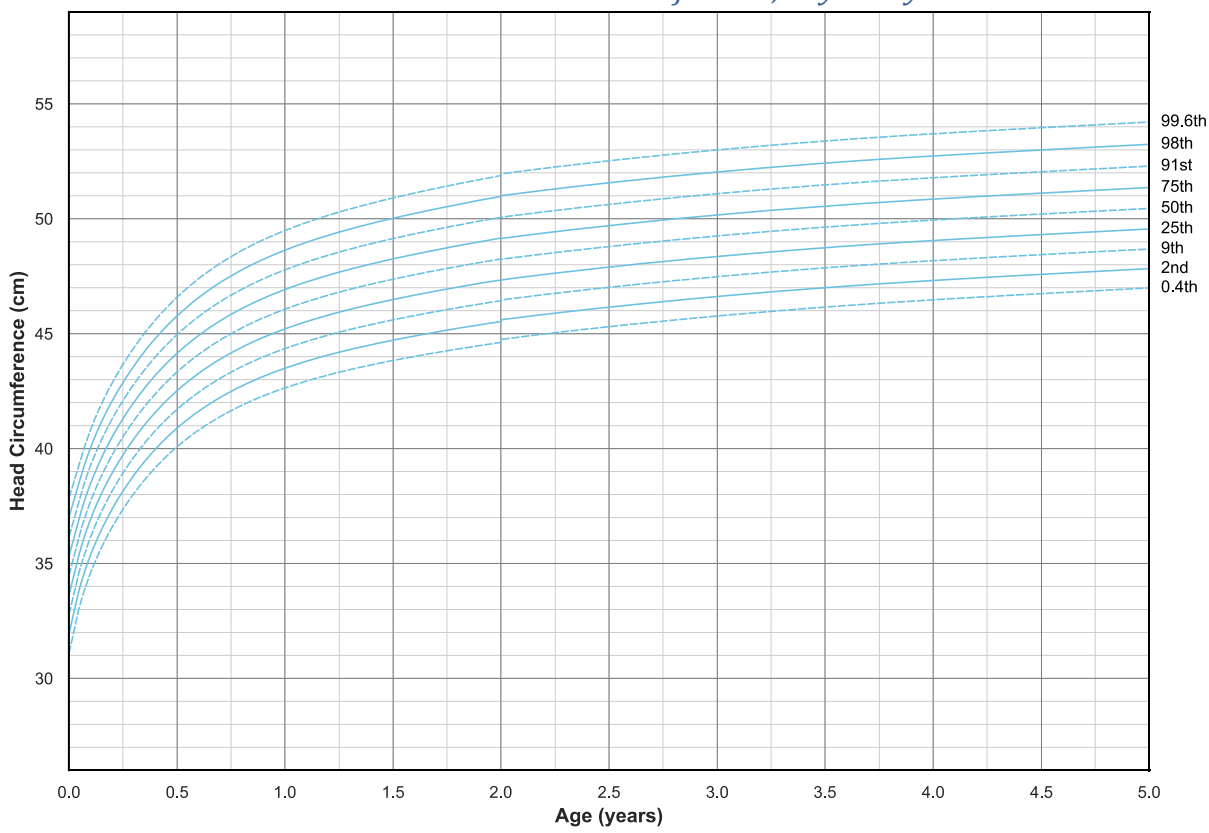
30 WHO-HK2020 - BMI, Boys 0-5 years



31 WHO-HK2020 - Head circumference, Girls 0-5 years

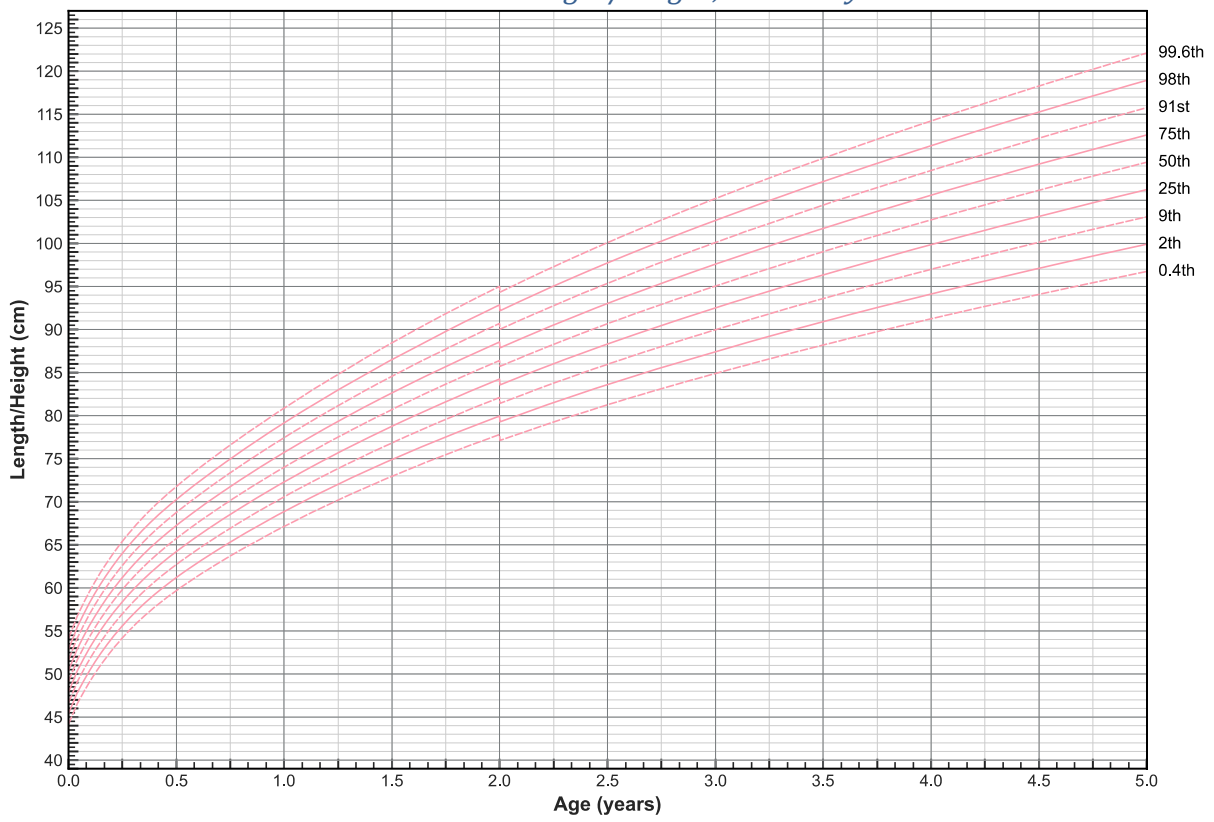


32 WHO-HK2020 - Head circumference, Boys 0-5 years

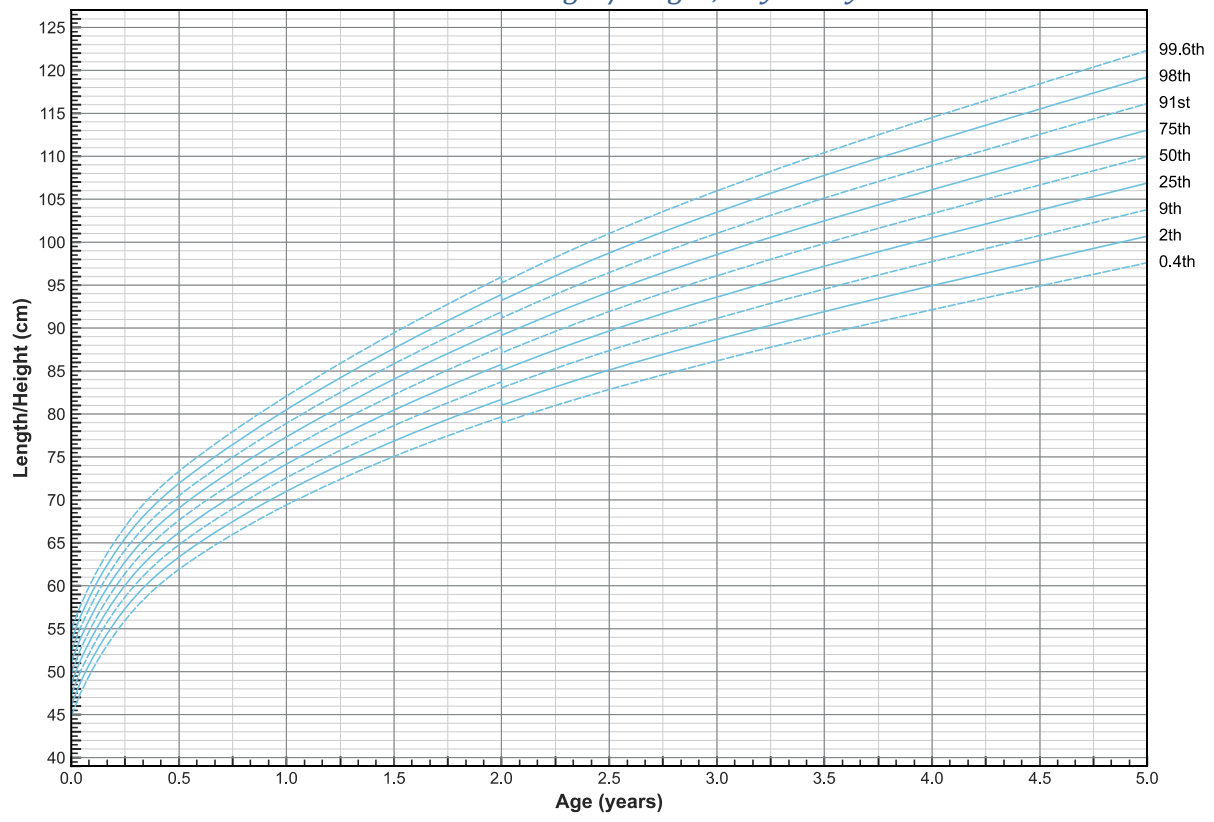


7.3 WHO2006 Growth Standards

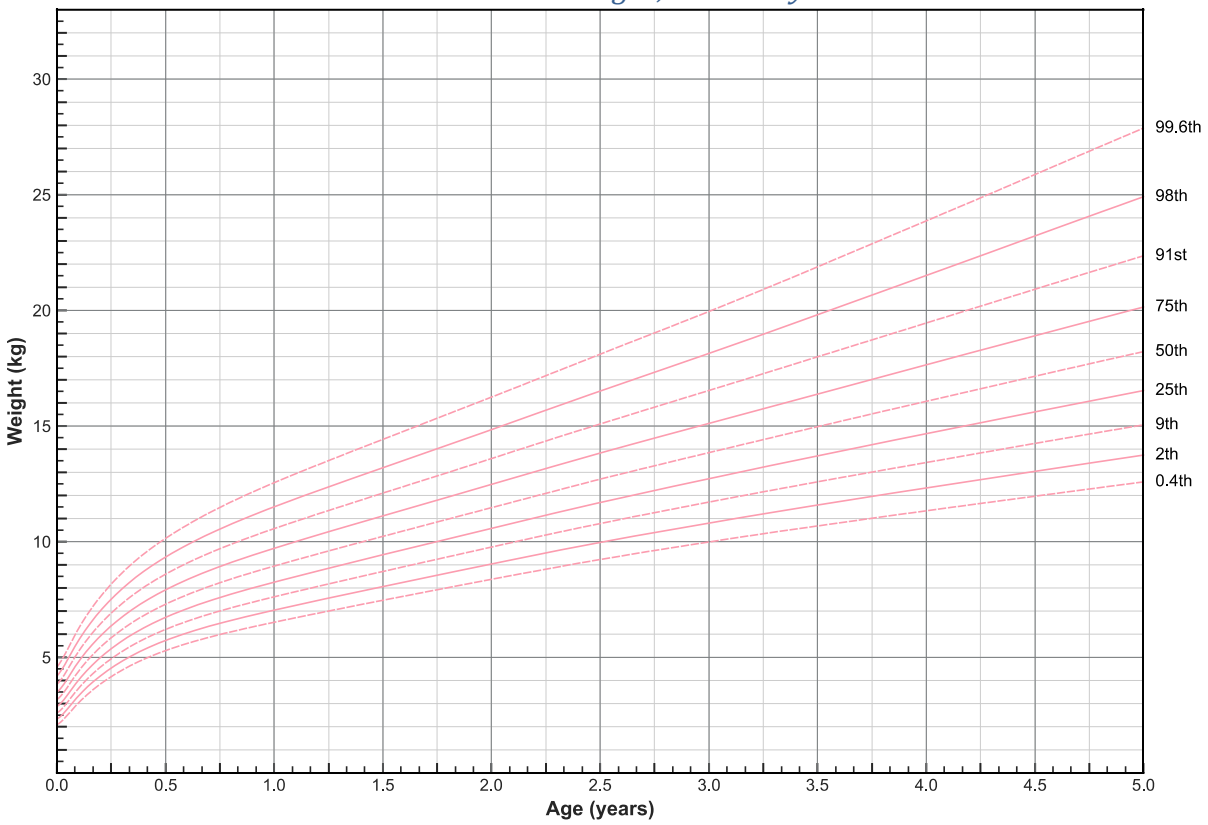
33 WHO2006 - Length/Height, Girls 0-5 years



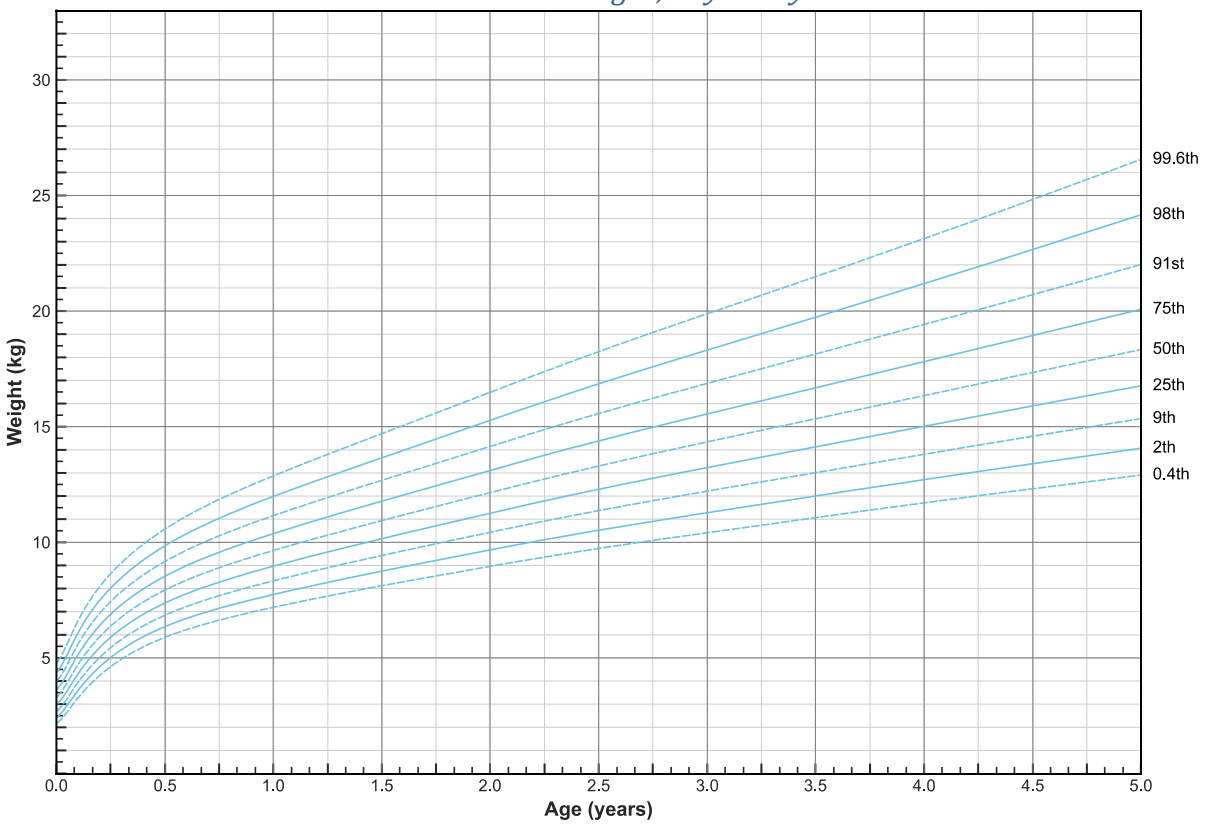
34 WHO2006 - Length/Height, Boys 0-5 years



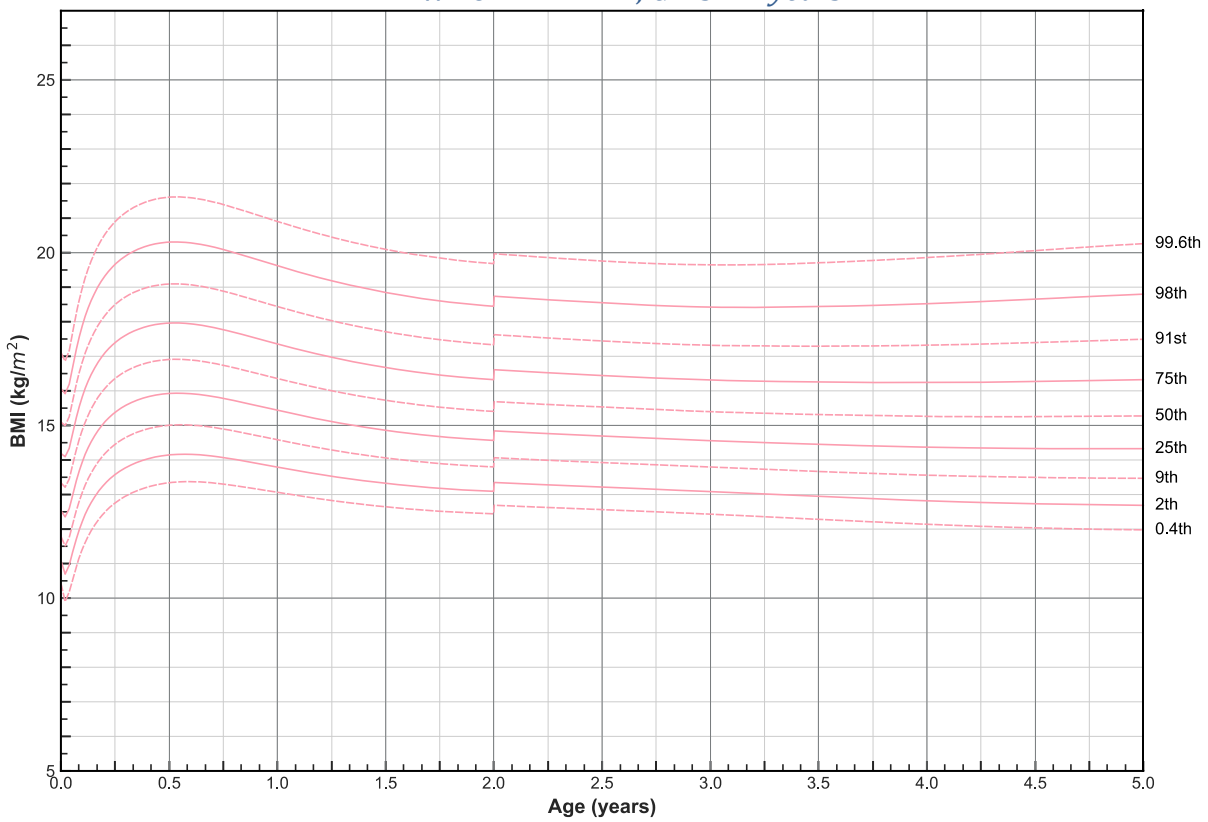
35 WHO2006 - Weight, Girls 0-5 years



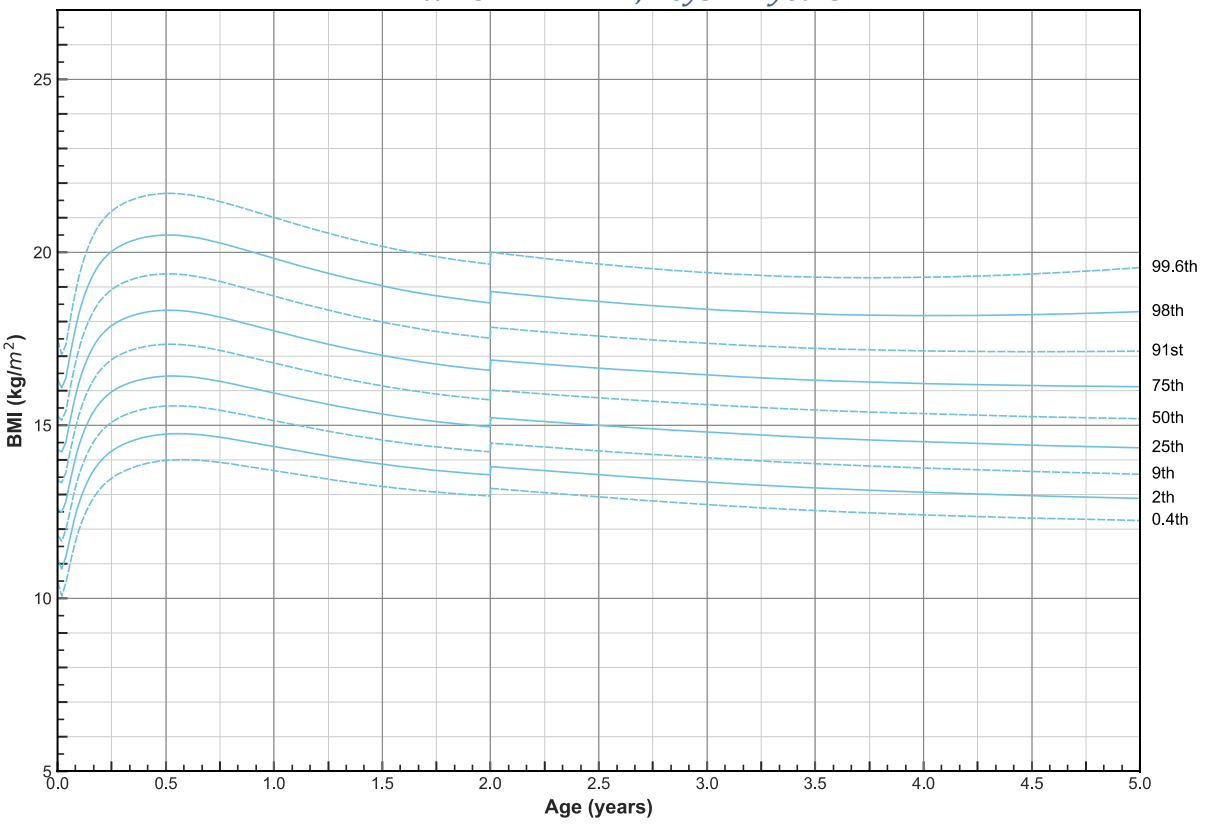
36 WHO2006 - Weight, Boys 0-5 years



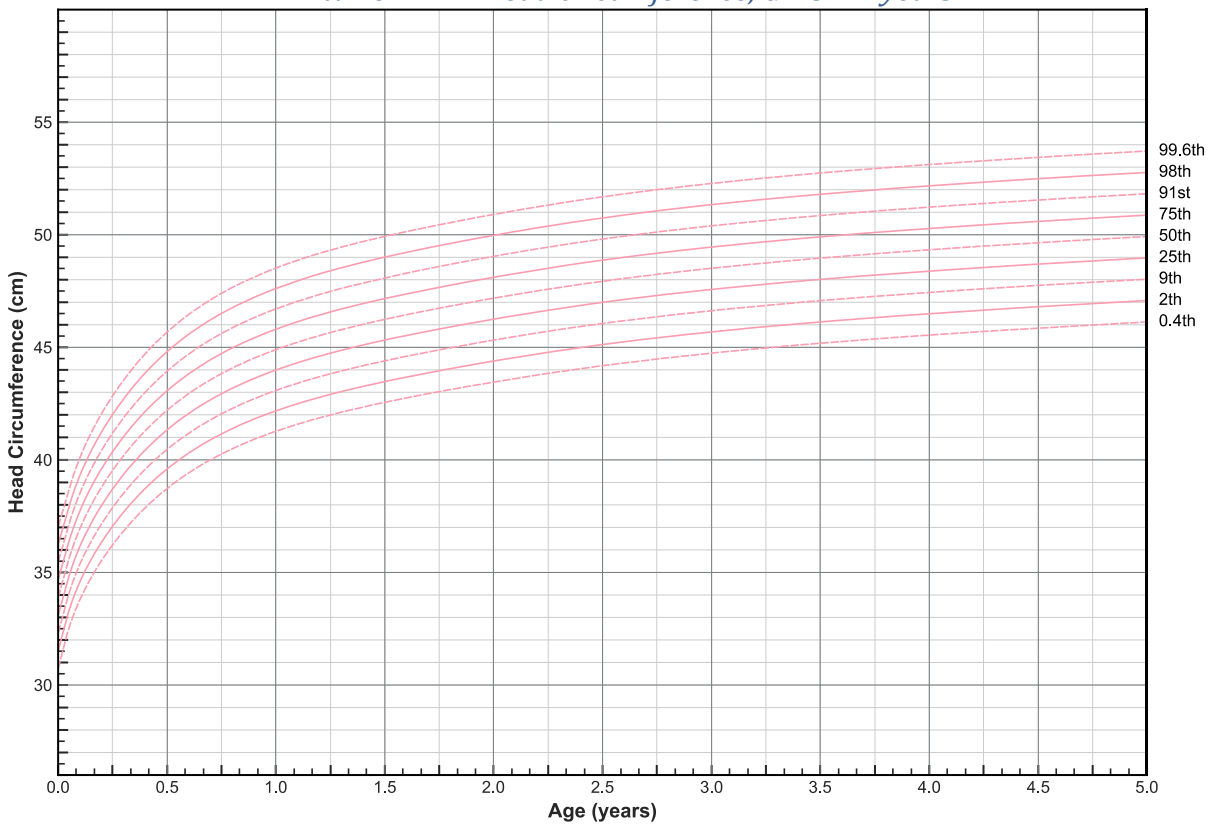
37 WHO2006 - BMI, Girls 0-5 years



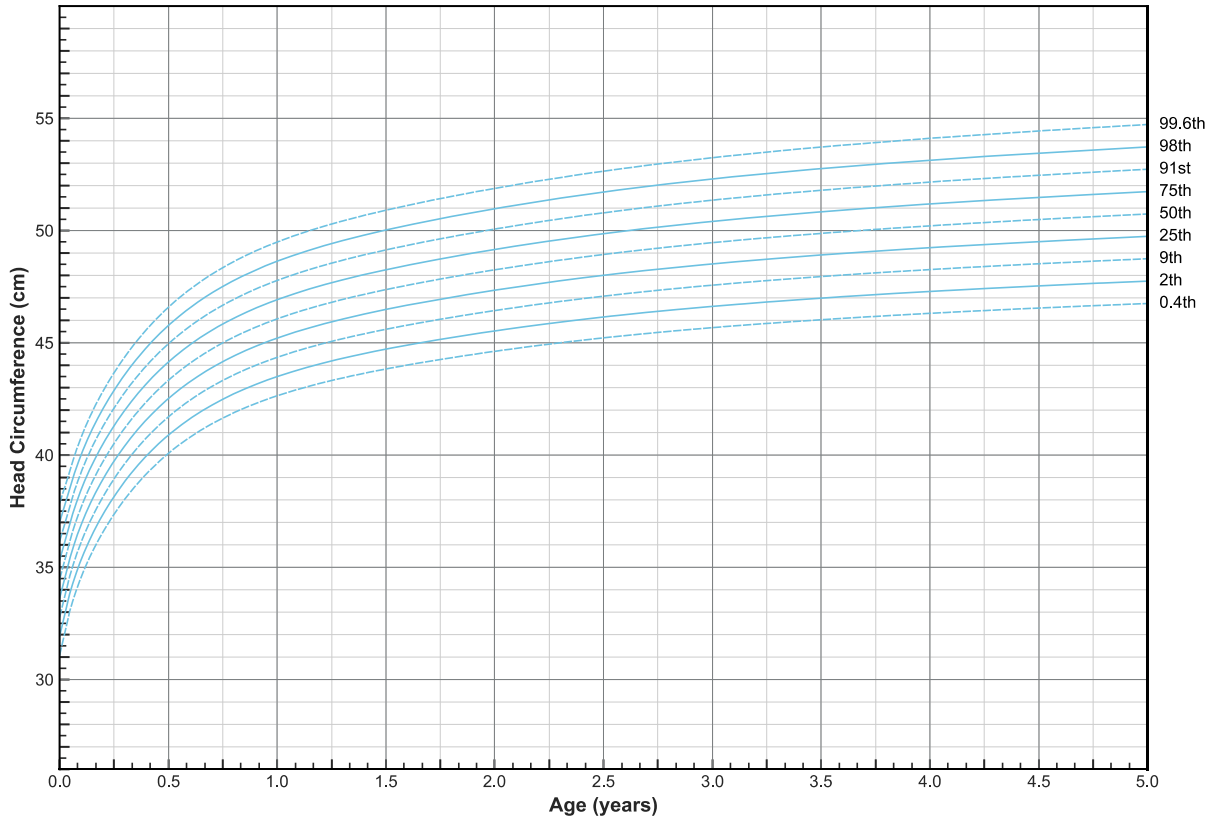
38 WHO2006 - BMI, Boys 0-5 years



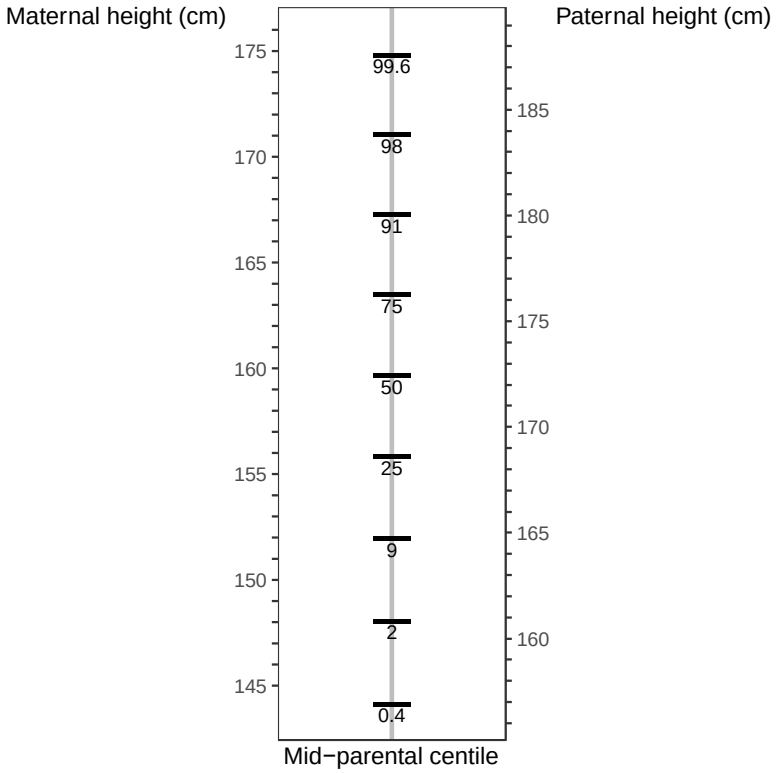
39 WHO2006 - Head circumference, Girls 0-5 years



40 WHO2006 - Head circumference, Boys 0-5 years



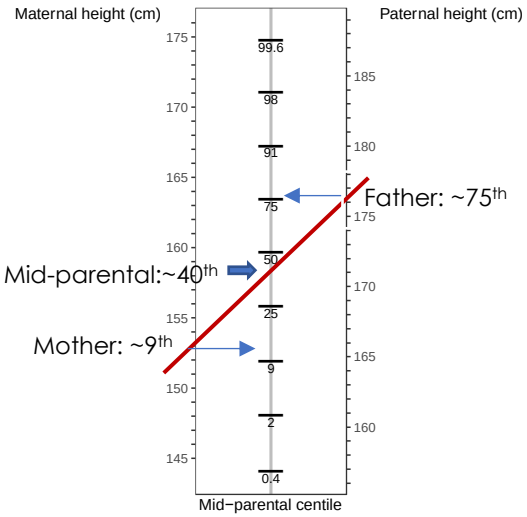
7.4 Mid-parental height comparator



Example: Mid-parental height comparator was developed from the HK2020 height-for-age reference at 18 years old. The mid-parental height centile of a mother 153cm tall (~ 9th centile referenced to HK2020) and a father 176.5cm tall (~ 75th centile referenced to HK2020) is roughly 40th centile (for both boys and girls). The approximate height centile for mother's, father's and mid-parental height can be **estimated** from the comparator.

Height(cm) at 18 years on HK2020 growth reference

Centile	Height (cm)	
	Female	Male
99.6th	175.0	188.2
98th	171.3	184.4
91st	167.5	180.5
75th	163.8	176.5
50th	160.2	172.5
25th	156.5	168.4
9th	153.0	164.3
2nd	149.4	160.0
0.4th	145.9	155.7



Appendix - A Measuring & Plotting Technique

A1. Length/Height

Using an infantometer

Equipment
SECA416 Infantometer (measuring range 33-100cm; graduation 1mm)
Preparation
• Cover the infantometer with soft paper towel for hygiene.
Procedures
1. Length should be measured by 2 persons. 2. Ask the carer to remove the infant's shoes, socks, hair ornaments and undo braids. 3. Ask the carer to lay the infant on the infantometer with the head against the fixed headboard, compressing the hair. 4. Measurer A (or the carer) move behind the headboard and hold the head of the infant so that an imaginary vertical line from the ear canal to the lower boarder of the eye socket is perpendicular to the board. 5. Measurer B stands by the side of the infantometer and check if the infant lies straight along the board, the shoulders are touching the board and the spine is not arched. 6. Measurer B hold down both legs of the infant and **apply gentle pressure** to extend the knees with one hand, while the other hand brings the footboard up to the infant's heels until it touches the heels. Hold one of the legs and measure with one heel on the board if holding two legs is not feasible. 7. The soles/sole should be FLAT against the footboard, toes pointing UPWARDS. 8. Measurer B takes the length and records the measurement to the nearest 0.1cm. Record to the last/lowest completed unit, not to the nearest unit, i.e. if the measurement value lies between 74.2cm and 74.3cm the value 74.2 is recorded.
Remarks
• Explain the procedure to the parent/carer with the use of pictures. • **Do not leave the infant unattended in any position that they may roll from.** • If the infant fails to lie down properly or his/her length exceeds 100cm, measure standing height and record the result as height. • If the infant is crying, the spine may not be straight. Comfort the infant. Ask the mother to talk to the infant. Distract the infant with toys. • Do not take measurement when the heels are not touching the footboard.

Using a stadiometer

Equipment
SECA217 Stable stadiometer (measuring range 20-205cm; graduation 1mm) SECA707 or SECA284 (measuring range 30-200cm; graduation 1mm)
Procedures
1. Instruct the child to remove shoes, hair ornaments and undo braids. 2. Ask the child to stand on the baseboard with feet slightly apart. 3. Check if the child's back of the head, shoulder, blades, buttocks, calves and heels are all touching the vertical board. 4. Instruct the child to align the head so that a horizontal line from the ear canal to the lower border of the eye socket runs parallel to the base board. 5. Instruct the child to stand as tall as possible, take a deep breath to straighten the spine, and hold this position. 6. Pull down the headboard so that it rests on the top of the head and compresses the hair. 7. Measurer measures and records the measurement to the nearest 0.1cm. Record to the last (i.e. lowest) completed unit, not to the nearest unit, i.e. if the measurement value lies between 84.2cm and 84.3cm the value 84.2 is recorded.
Remarks
• Read the readings at eye level. Stand on a small chair/stool for better observation if necessary. • If the child is too young and could not stand well, help to hold the child's knees and ankles, in order to keep legs straight. • Push gently on the tummy of the child to help the child stand straightly. • To keep the head in the right position, measurer may hold the bridge between thumb and forefinger over the child's chin.

A2. Weight

Using an infant scale

Equipment
TANITA BD-585 (max capacity: 20kg; graduation 10g) or TANITA BD-815U (max capacity: 15 kg; graduation 2g)
Preparation
• Cover the scale's basket with towel, disposable incontinence mat and soft paper towel for hygiene and infant's comfort. • In winter, a small blanket can be used to cover the infant when it is weighed.
Procedures
1. Weigh the infant naked. Ask the carer to remove the infant's clothings and diaper (except ornaments that are difficult to remove). 2. Make sure the scale (with whatever being weighed with the infant, such as towel, mat, blanket) reading starts at 0.00kg. 3. Instruct the carer to place the infant on the center of the scale's basket. 4. Ensure the body parts of the infant are not touching anything other than the basket of the weighing scale. Also ensure the carer is not touching the infant and the scale. 5. Record the measurement with all the decimal places when the weight stabilizes.
Remarks
• Make sure the room is warm. • Do not keep the infant naked longer than is necessary. • Do not leave the infant unattended in any position that he/she may roll from. • If unable to weigh the infant using baby scale and for those who can stand/walk, perform tared weighing or measure by column scales. • Discard the soft paper towel and replace clean paper towel for the next measurement. • If there is any excretion during measurement, clean the places and equipment using 1:49 diluted bleach (or 70% alcohol for metal surfaces) and discard and replace the disposable incontinence mat.

Measuring tared weight

Equipment
SECA707 & SECA769 (max capacity: 200 kg; graduation 100g)
Procedures
1. Turn on the scale and wait until "0" appears. 2. Ask the carer to remove shoes and undress the infant (i.e. remove all clothing and diaper). 3. A staff holds the undressed subject wrapped in a blanket. 4. Ask the carer to stand in the middle of the scale, feet slightly apart and to remain still. 5. After the weight of the carer appears, tare the scale such that "0" displays again. 6. Hand the undressed infant to the carer and ask the carer remains still. 7. Record the measurement with all the decimal places.

Using a standing scale

Equipment
SECA876 for 2-5 years (max capacity: 250kg; graduation 100 g < 150 kg > 200 g) TANITA MC-780MA for 6 years or above (max capacity: 270kg)
Procedures
1. Turn on the scale; wait until "0" appears (depends on different electronic scale). 2. Ask the child to take off shoes and jackets, empty the pockets. 3. Ask the child to stand in the middle of the scale with feet slightly apart; and to remain still until the weight appears on the display. 4. Ensure the body parts of the child are not touching anything other than the scale. 5. Record the measurement with all the decimal places. 6. Clean the measuring platform using alcohol swap, then dry it with a dry towel.
Remarks
• Clean the scale contacting the soles using alcohol swap and dry before being used next.

A3. Head circumference

Measuring the head circumference

Equipment
SECA212 head circumference measuring tape (for head circumference ≤ 59.0cm) HOLTAIN 1.5m flexible tape (for head circumference 59.1cm or larger)
Procedures
1. Remove any hair ornaments or braids of the child. 2. For infants, ask the carer to sit down and hold the child on her lap. 3. Measurer positions the tape on the forehead just above the supra-orbital ridge and the occipital prominence at the back of the head. 4. Use middle and ring finger to keep the tape in position. Move the tape up and down over the back of head to locate the occiput to ensure that the maximum circumference. If needed, another staff helps by position the tape. 5. Pull the tape until some resistance is felt. 6. Measure to the nearest 0.1cm. Record to the last (i.e. lowest) completed unit, not to the nearest unit, i.e. if the measurement value lies between 34.2cm and 34.3cm the value 34.2 is recorded.
Remarks
• SECA212 head circumference measuring tape should be sufficient for most head sizes, while some adolescents/adults may have head size exceeds 59cm.