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Hong Kong Growth Study 2020

31 May 2024

Features of Growth Charts for Hong Kong Children

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3 sets of charts

- HK2020 Growth References
- WHO2006 Growth Standards
- WHO-HK2020 Growth References

HK2020 Growth References

1. HK2020 - Types of charts

A new set of growth charts from birth to 18 years consists of

- Height-for-age charts
- Weight-for-age charts
- BMI-for-age charts
- Head-circumference-for-age charts

No Weight-for-height charts

Reason – weight-for-height is not an ideal marker of obesity as body shape related to height varies by age in young children.

No puberty charts

Reason – not included in HK growth survey.

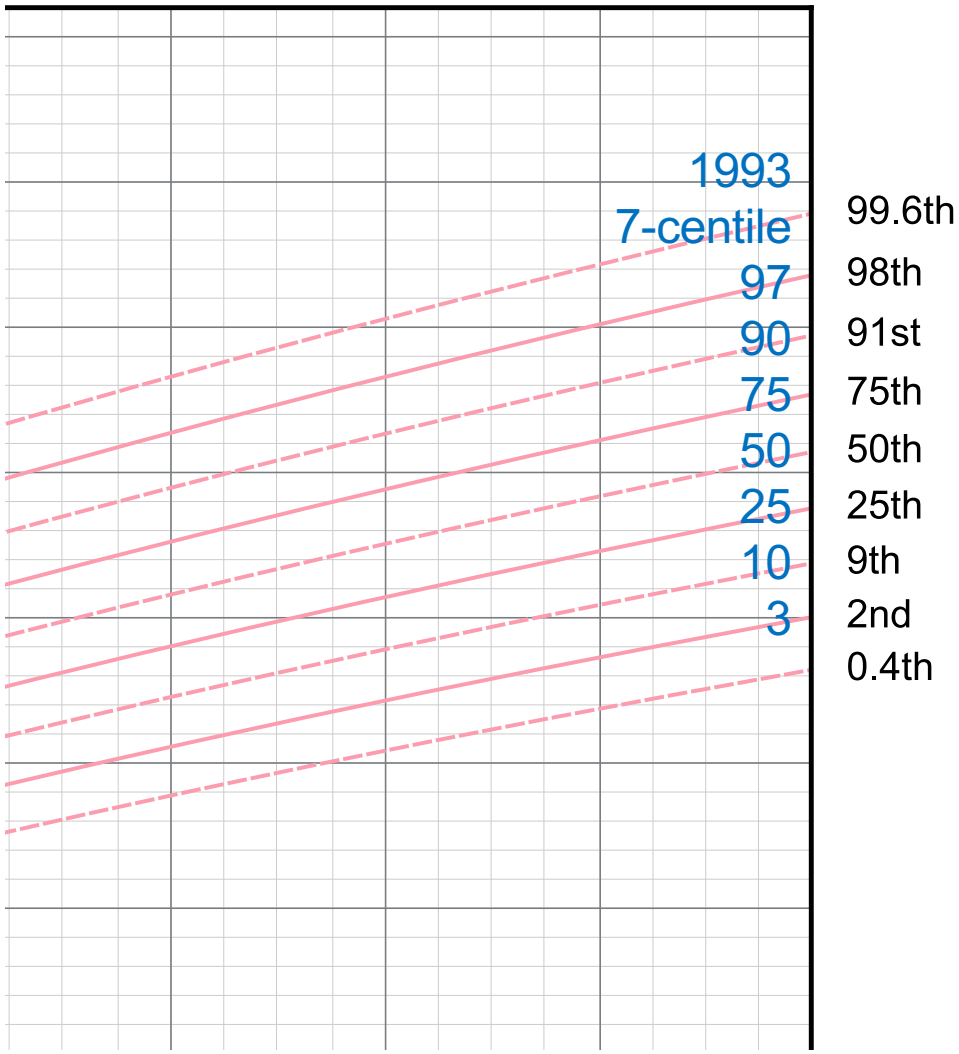
2. Nine Centile Lines (instead of seven centiles)

Extreme percentiles (99.6th and 0.4th)

Represent fewer than 1 in 250 having a measurement above/below

Help to indicate potential growth abnormality & referrals

Standard Deviation Score (SDS/z-score)	Equivalent growth chart percentile
-2.67	0.4th
-2.00	2nd
-1.33	9th
-0.67	25th
0	50th
0.67	75th
1.33	91st
2.00	98th
2.67	99.6th

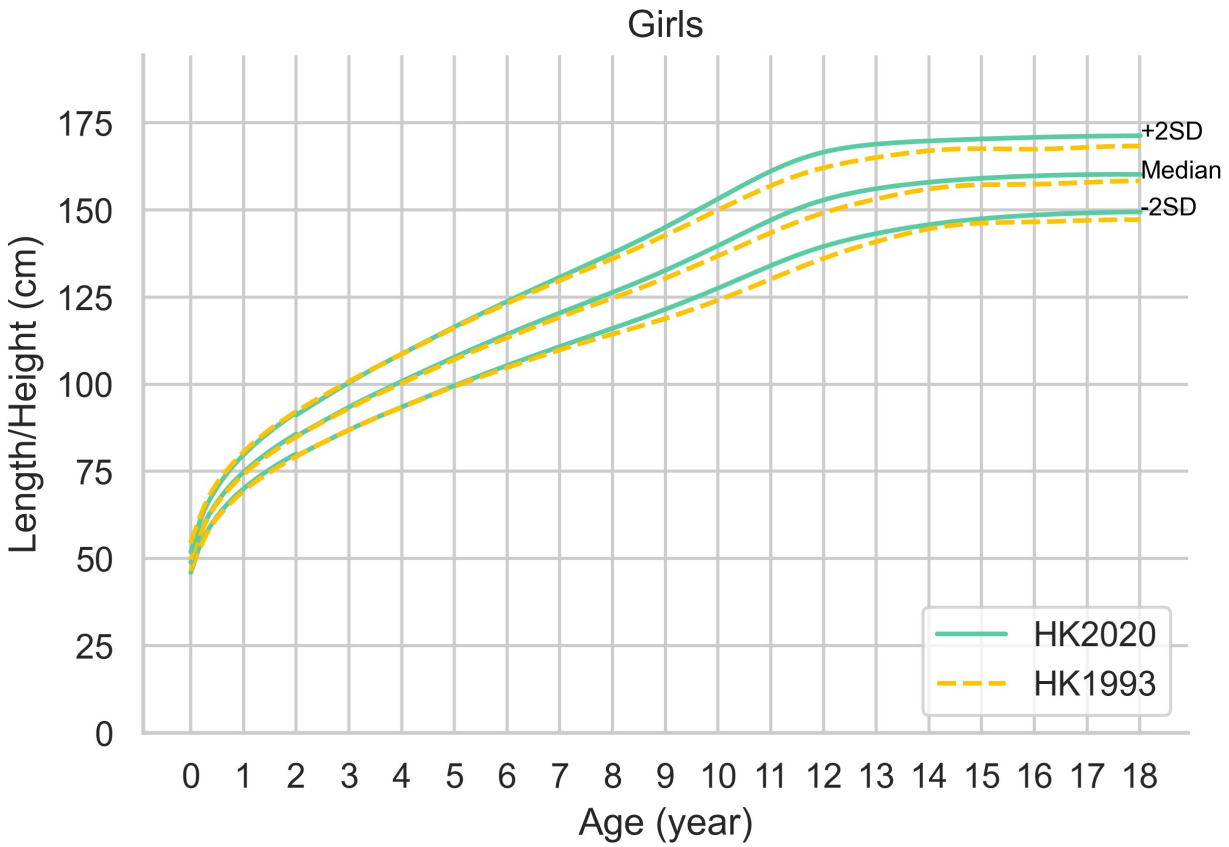


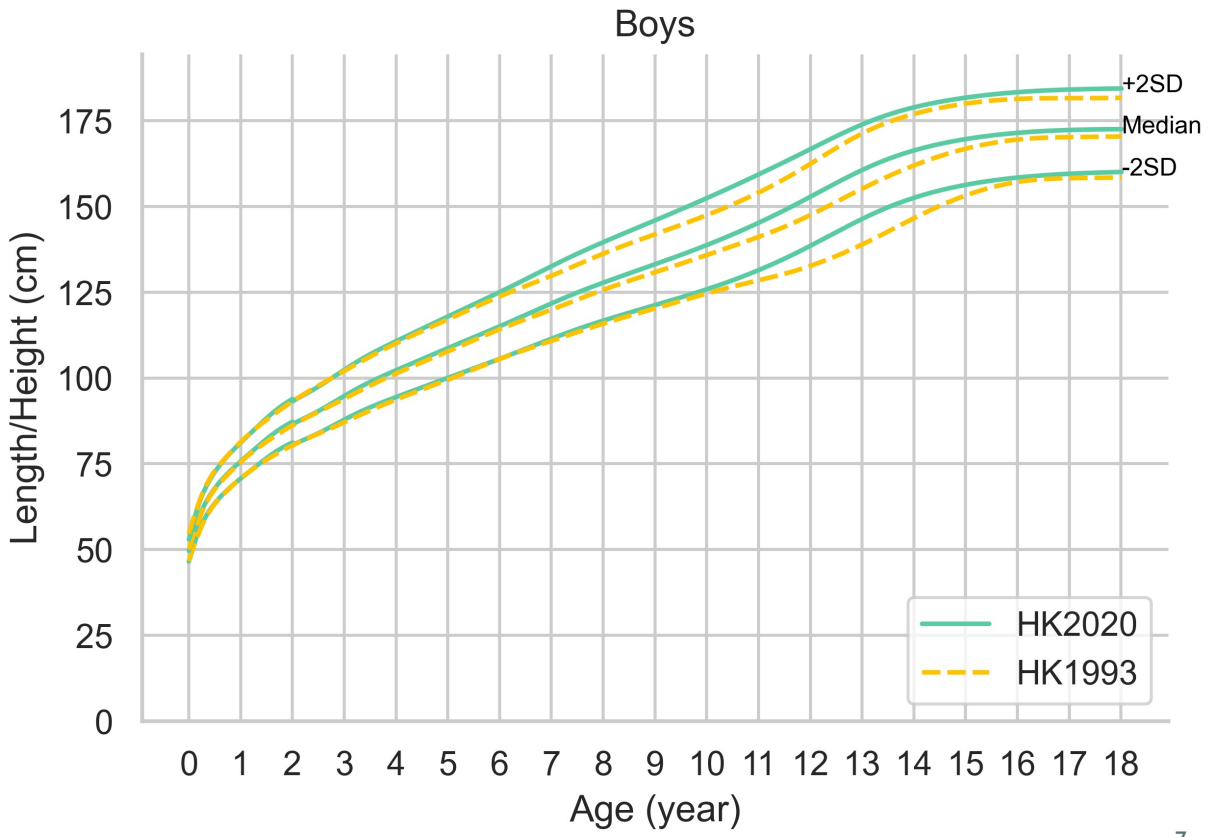
3. Secular trend in height, particularly at pubertal ages

At 18 years 2cm increase

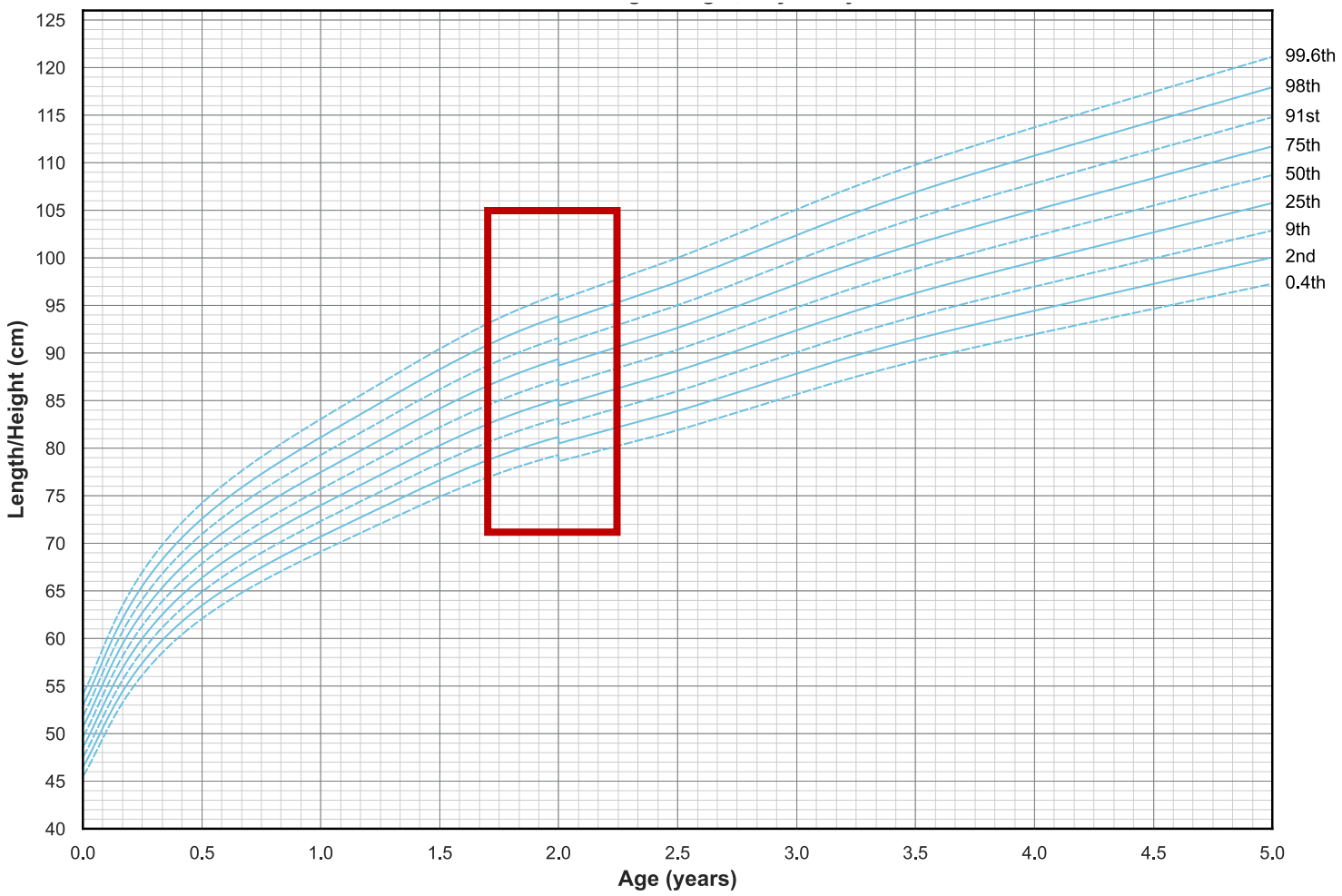
At puberty 3cm increase in girls

5cm increase in boys



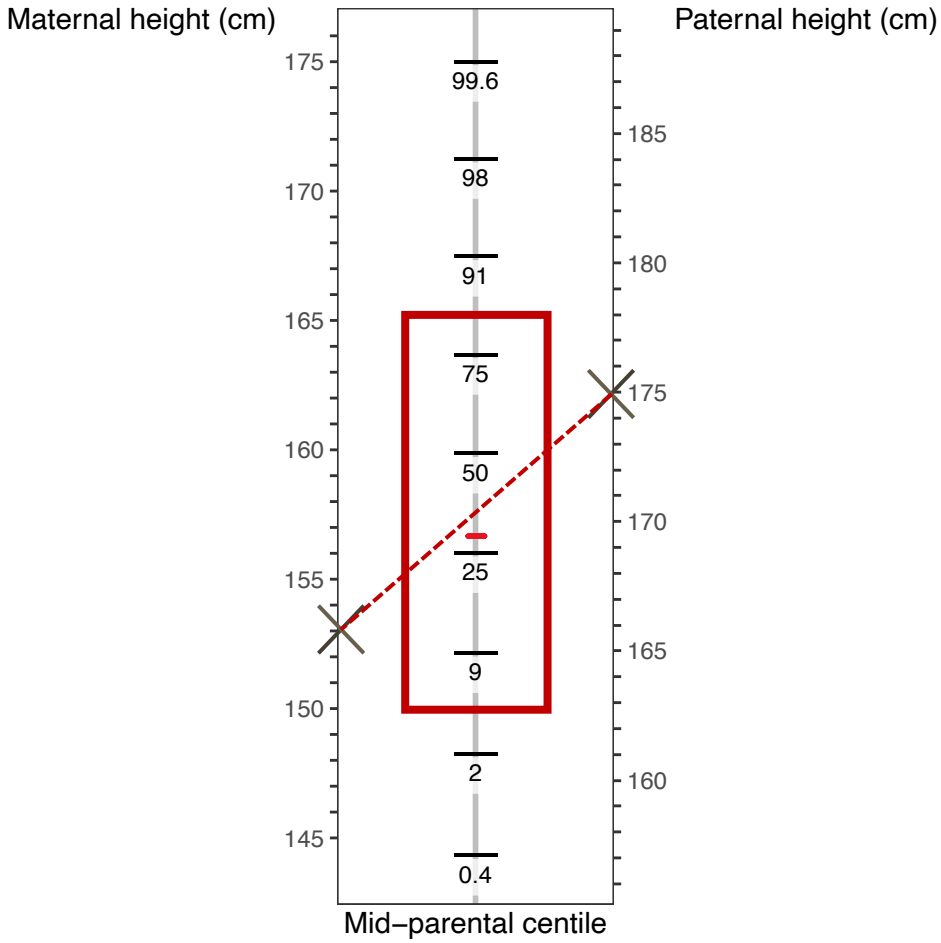


4. A step of 7mm at 2 years from supine length to standing height



5. Mid-parental centile reference

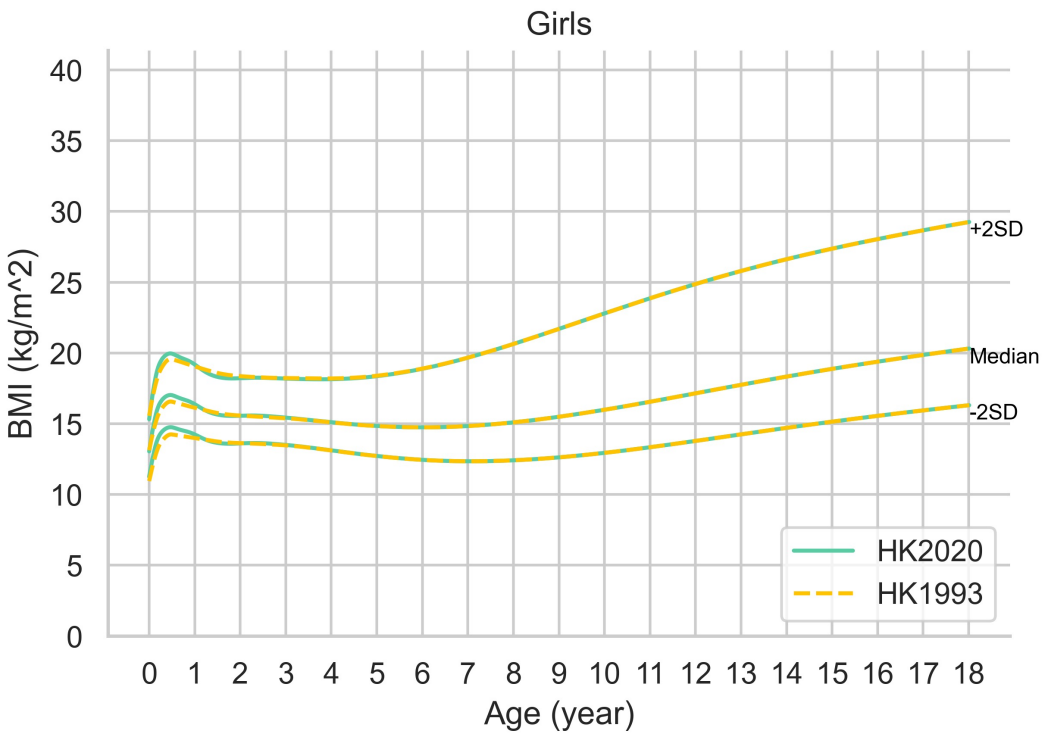
- Based on the HK2020 height-for-age chart
- Allow comparison to maternal, paternal and mid-parental centile
- A simple and quick reference
- 80% children fall inside ±2 centile space of mid-parental height

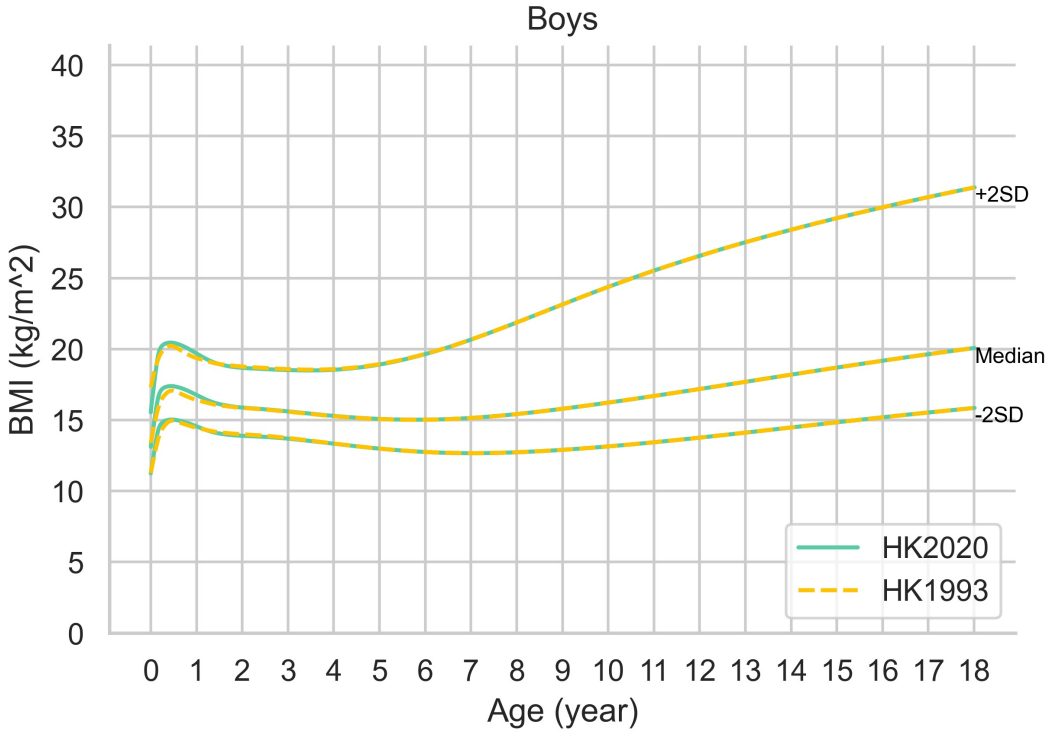


6.Frozen BMI-for-age charts at 2-18 years

To avoid normalizing childhood obesity

- 0 to <2.0 years - contemporary BMI data
- 2.0 to 18.0 years – HK1993 BMI charts (Frozen)





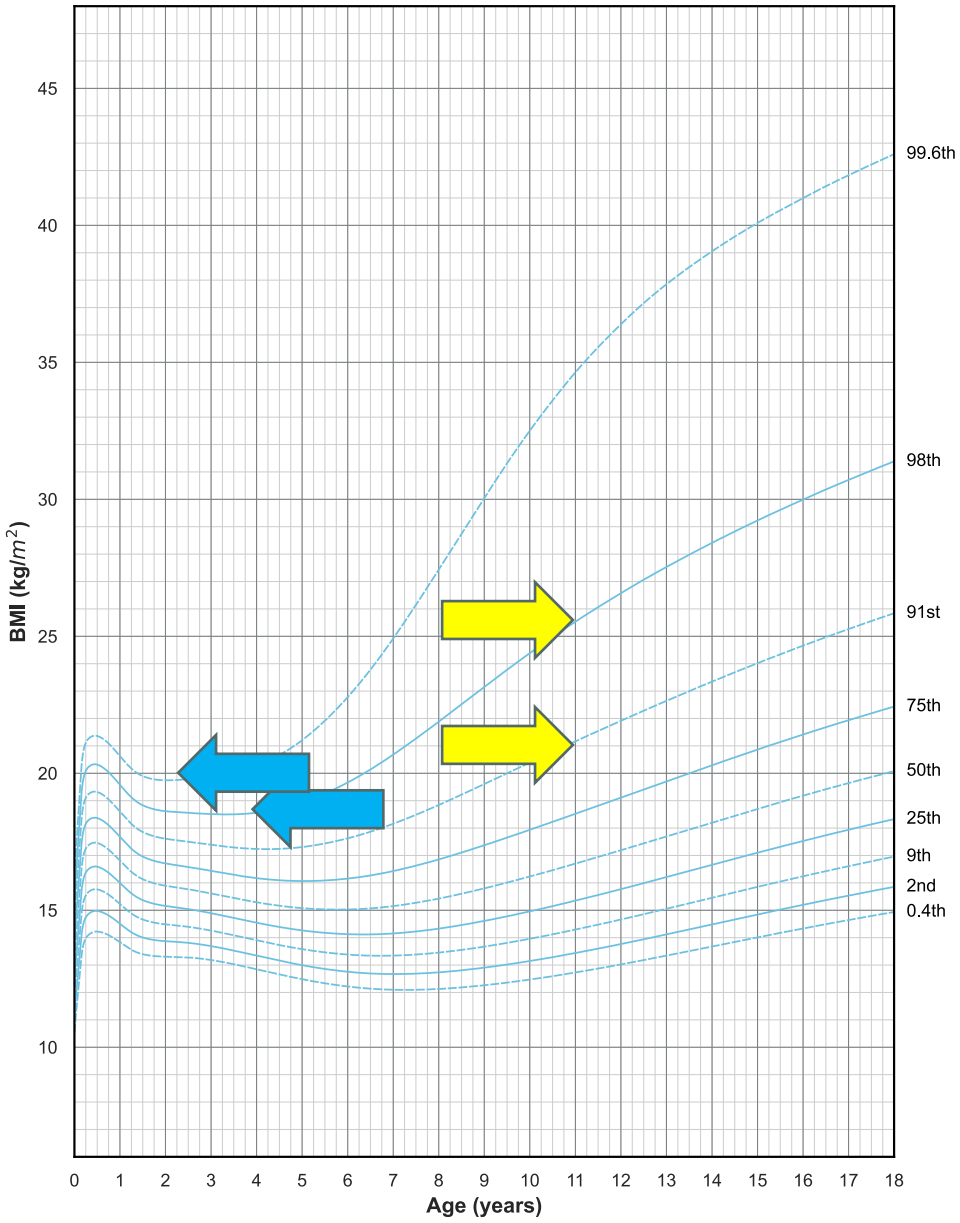
7. A higher BMI centile to classify childhood overweight & obesity in younger age group

Age	Overweight	Obesity
0 to 60 mo	BMI >98th centile and ≤99.6th centile	BMI >99.6th centile
>5.0 to <18.0y	BMI >91st centile and ≤98th centile	BMI >98th centile

Rationale:

- Obesity is less common among young children.
- To avoid over-diagnose childhood obesity in <5.0y.

Wright et al., Am J Clin Nutr 2022



7.1 Proportion of childhood overweight and obesity in 5- <18.0 years

Comparing % overweight (including obesity) defined by 120% median weight for height:

91st centile classified **similar % overweight (including obesity) in >5.0-13y but lower % in 14-17years.**

% overweight (including obesity) and % obesity

	number	>91st percentile (1.33SD) BMI	>98th percentile (2.00SD) BMI	>120% median weight-for-height
Girls				
5-13y	461143	15%	4.1%	16%
14-17y	116918	12%	2.8%	21%
Boys				
5-13y	495719	20%	4.4%	21%
14-17y	45090	16%	2.6%	24%

% overweight/obesity Reference to HK-1993 BMI-for-age charts
Data used: routine SHS data 2016-18

8. Weight-for-age charts for 2-18 years were derived from contemporary height (HK2020) and historical BMI (HK1993)

Purpose: Update height-for-age & weight-for-age charts without normalizing childhood obesity for 2-18 years old

How:

1. For each participant in HKGS, we simulated a hypothetical BMI using the age- and sex-specific LMS values of HK1993
2. Calculate the derived weight from the actual height, and the hypothetical BMI

9. Birth weight centiles of HK2020 (at age 0) represents birth weight of babies born at 38-39 weeks

The measurements at birth contributing to the HK2020 growth reference were from contemporary **healthy term newborns** in Hong Kong, weighted by the gestational age distribution in 2014, with mean **gestational age of 38.9 weeks**.

Distribution of gestational age of term births in Hong Kong in 2014 from the 2019 O&G territory-wide audit report

Gestations weeks	N	%
>42	10	0.02%
42	24	0.04%
41	3636	6.5%
40	11243	20.2%
39	15709	28.3%
38	18977	34.2%
37	5922	10.7%

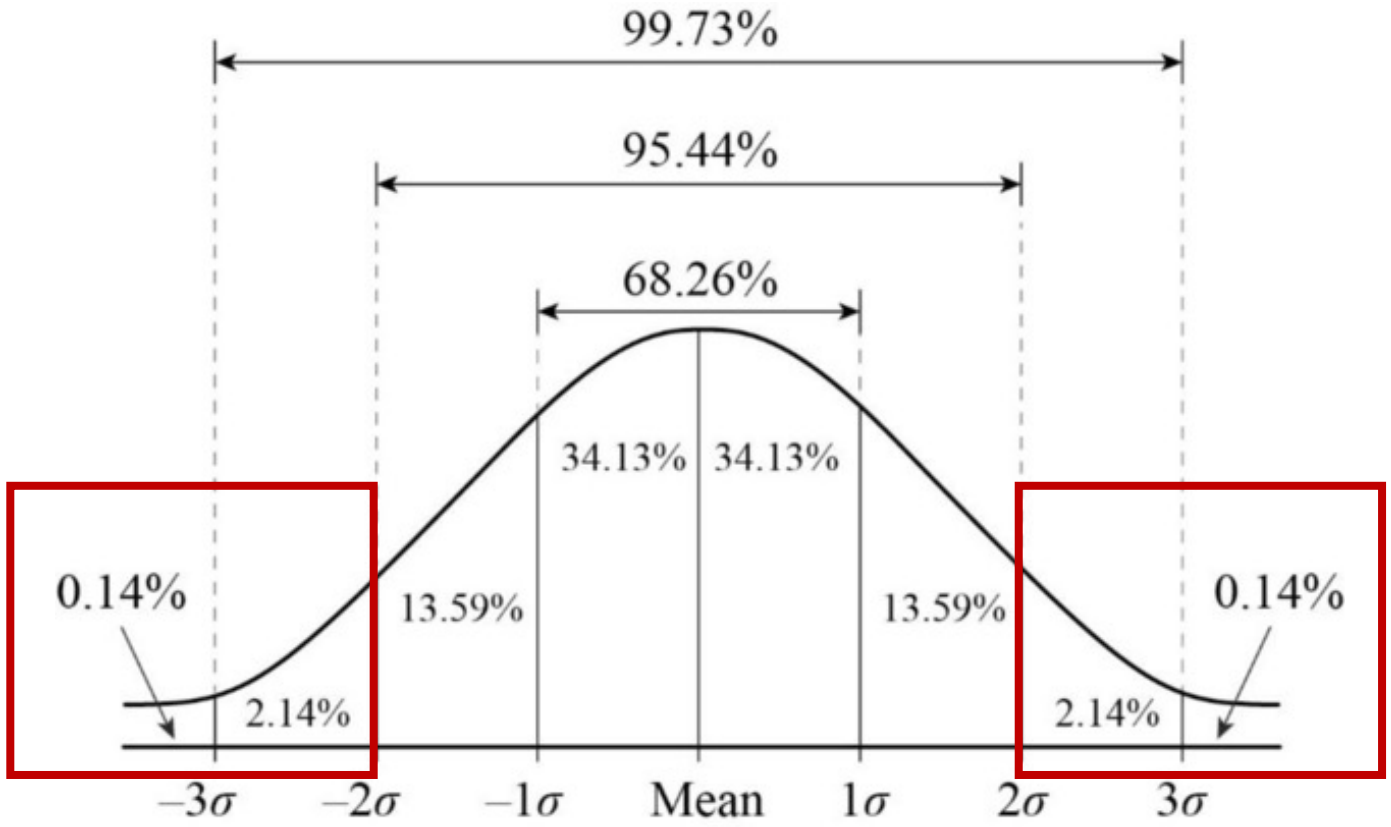
Implication for monitoring growth in preterm children

A transition from preterm gestation-specific birth weight charts to HK2020 at 38-39 weeks may provide a smoother transition than at 40 weeks.

10. More % extreme birth weight when using HK2020

Newborns

- birthweight <-2SD: 4-5%
- birthweight >2SD : 4-5%

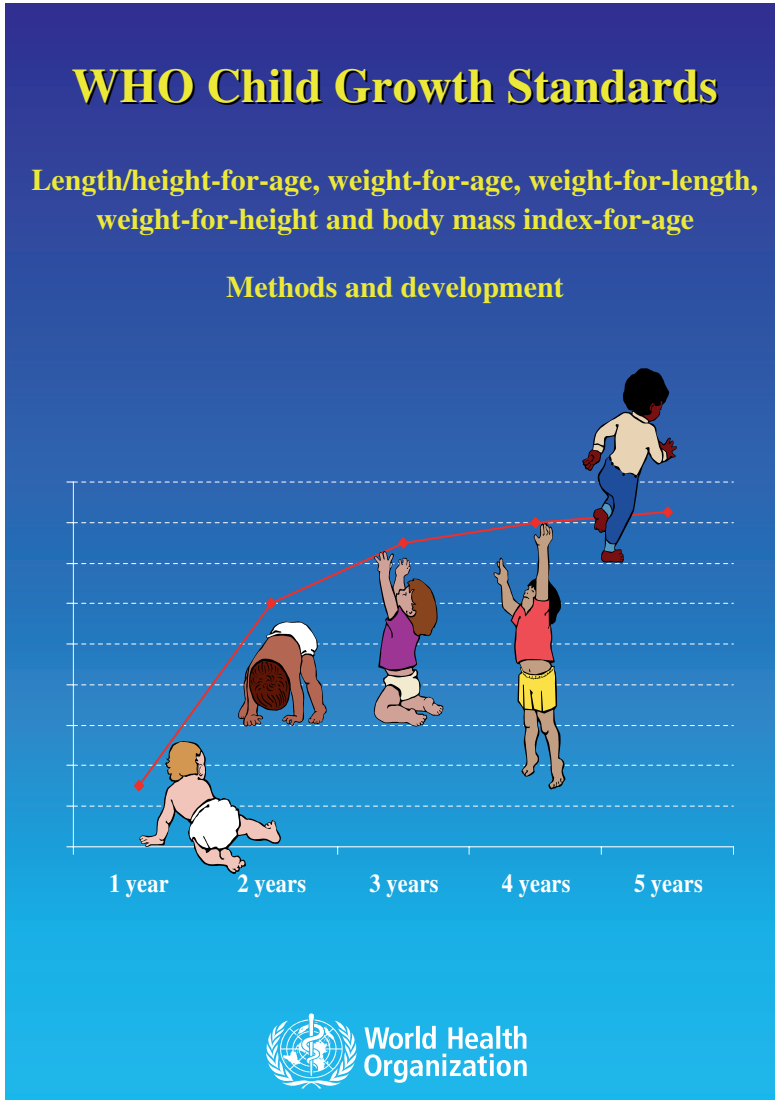


Due to the homogenous term and healthy newborn sample in the HK growth study.

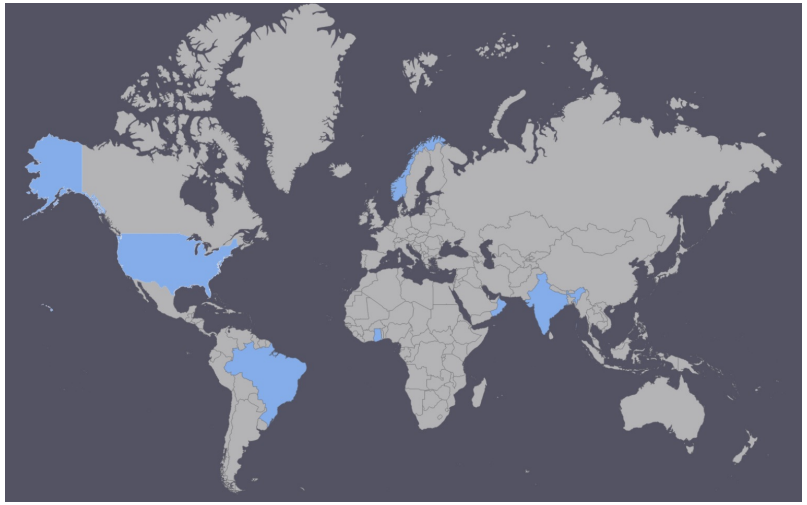
WHO2006 Growth Standards

WHO2006 as universal standards (not a reference)

- To reflect optimal growth of all healthy children worldwide
- To establish breastfed infants as the normative model for growth and development



MULTICENTER GROWTH REFERENCE STUDY (MGRS) (1997-2003)



Diverse geographical settings

- Brazil, Ghana, India, Norway, Oman, the United States

Selection criteria

- Term birth
- Absence of illness and socioeconomic constraints on growth
- Non-smoking mothers

Feeding criteria

- exclusive or predominant breastfed for at least 4m
- introduction of complementary foods at 4-6m
- partial breastfed to at least 12m

Sample size

- A longitudinal study (0-24m) (n=1737**)
- A cross-sectional study (18-71m) (n=6669)

1. Lower Birth weight centile referenced to WHO2006 compared to HK2020

LMS & weight at each centile

	Sex	L	M	S	Centiles (kg)								
					0.4th	2nd	9th	25th	50th	75th	91st	98th	99.6th
HK													
	F	0.263	3.04	0.101	2.30	2.47	2.65	2.84	3.04	3.25	3.47	3.70	3.95
	M	0.084	3.15	0.102	2.39	2.56	2.74	2.94	3.15	3.37	3.60	3.85	4.12
WHO													
	F	0.381	3.2	0.142	2.1	2.4	2.7	2.9	3.2	3.5	3.9	4.2	4.6
	M	0.349	3.3	0.146	2.2	2.5	2.7	3	3.3	3.7	4	4.4	4.8

2. Less % infants with growth faltering when using WHO2006 than HK2020

Reasons:

- the wider centile space of WHO2006
- lower birth weight centile of WHO2006

% infants with growth faltering using NICE definition

Age (months)	HK2020		WHO2006	
	Girls	**Boys**	**Girls**	**Boys**
1	4.0%	3.9%	2.0%	2.0%
2	6.6%	5.9%	2.6%	1.9%
4	10%	9.3%	3.3%	3.0%
6	12%	11%	3.6%	5.1%
12	14%	9.9%	4.0%	5.5%
18	11%	9.3%	3.7%	4.8%

NICE definition

- A fall across 1 or more weight centile spaces, if the birthweight was below the 9th centile
- A fall across 2 or more weight centile spaces, if the birthweight was between the 9th and 91st centiles
- A fall across 3 or more weight centile spaces, if the birthweight was above the 91st centile
- When current weight is below the 2nd centile for age, whatever the birthweight.

3. Shorter Hong Kong Toddlers compared to WHO2006

Shorter at 3-4 years,
especially in girls in HK2020 growth survey

Weight z-score

	HKGS	
Age group	Male	Female
At birth	**-0.387**	**-0.379**
1m	-0.285	-0.304
2m	0.009	-0.116
4m	-0.026	0.009
6m	-0.023	0.047
12m	-0.113	0.072
18m	-0.110	-0.189
2y	-0.172	-0.108
2.5y	**-0.350**	-0.154
3y	-0.025	-0.254
3.5y	-0.019	-0.234
4y	-0.133	-0.222
4.5y	-0.145	-0.280
5y	-0.079	**-0.349**
5.5y	-0.069	-0.231

Length/Height z-score

	HKGS	
Age group	Male	Female
At birth	-0.144	-0.139
1m	-0.306	**-0.400**
2m	-0.112	-0.082
4m	0.043	0.071
6m	0.147	0.185
12m	-0.003	0.272
18m	0.023	0.030
2y	-0.253	-0.318
2.5y	**-0.531**	**-0.417**
3y	-0.207	**-0.434**
3.5y	-0.194	**-0.436**
4y	-0.296	**-0.419**
4.5y	-0.270	-0.316
5y	-0.214	-0.268
5.5y	-0.120	-0.190

Shorter at 3y
in term children born in 1997

Height z-score

1851 boys: -0.34

1656 girls: -0.38

Original article

Are universal standards for optimal infant growth appropriate? Evidence from a Hong Kong Chinese birth cohort

L L Hui,[1] C M Schooling,[1] B J Cowling,[1] S S L Leung,[2] T H Lam,[1] G M Leung[1]

HUI LL et al., Arch Dis Child 2008

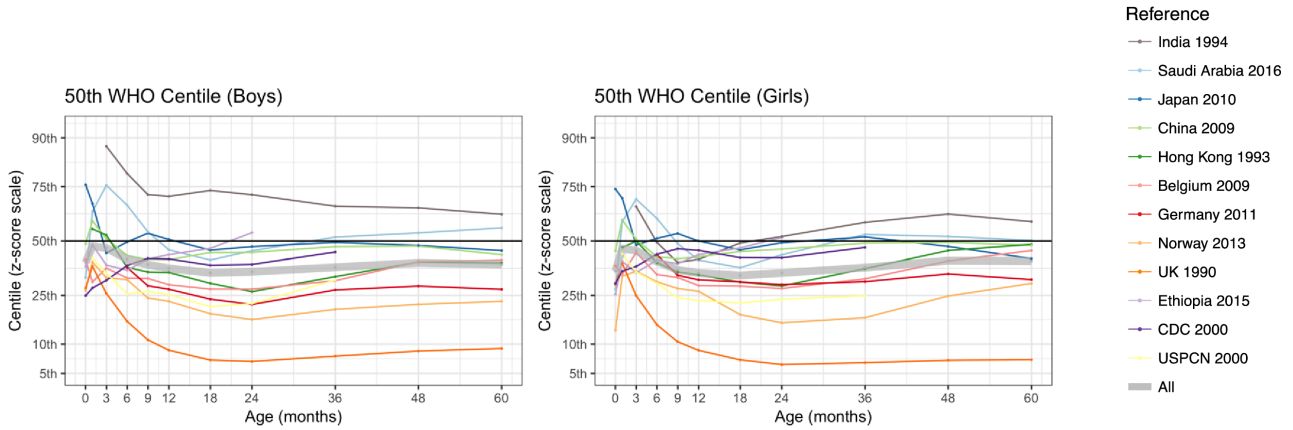
4. Smaller Head-circumference in general compared to WHO2006

- "Except for Indians and some Asian neonates, adopting the WHO head circumference standards would overdiagnose macrocephaly and underdiagnose microcephaly."

Original research

World variation in head circumference for children from birth to 5 years and a comparison with the WHO standards

Lai Ling Hui [1,2] Frederick K Ho [3] Charlotte Margaret Wright [4] Tim J Cole [5] Hugh Simon Lam [1] Han-Bing Deng [1] Hung-Kwan So [6] Patrick Ip [6,7] E Anthony S Nelson [1,8]



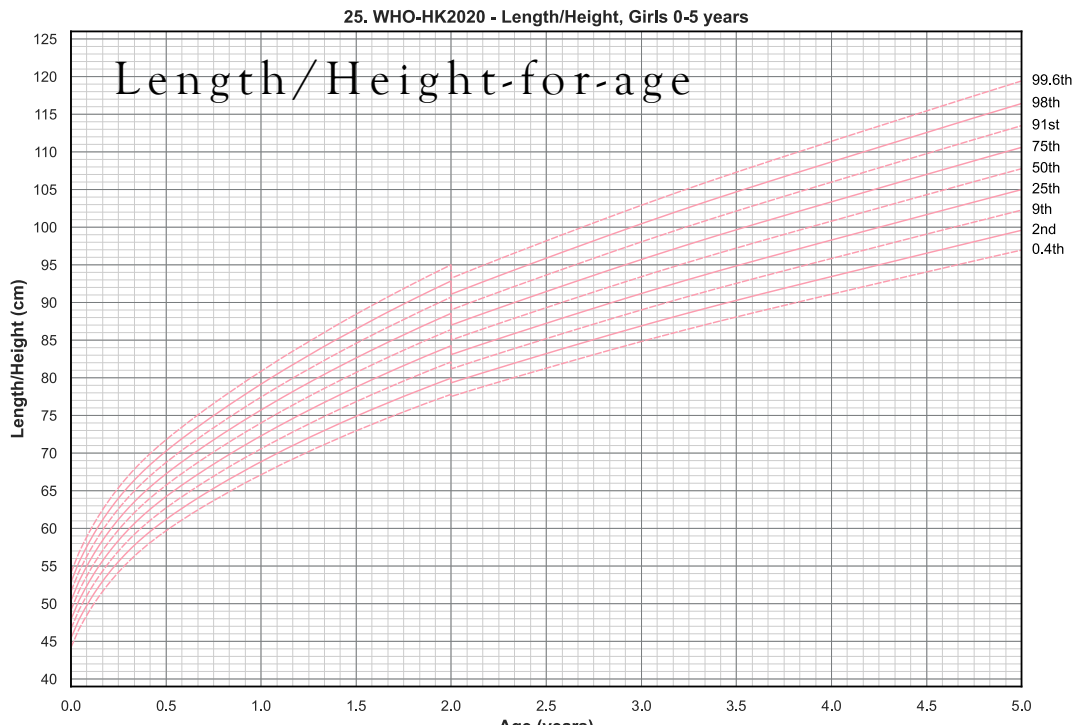
HUI LL et al., Arch Dis Child 2023

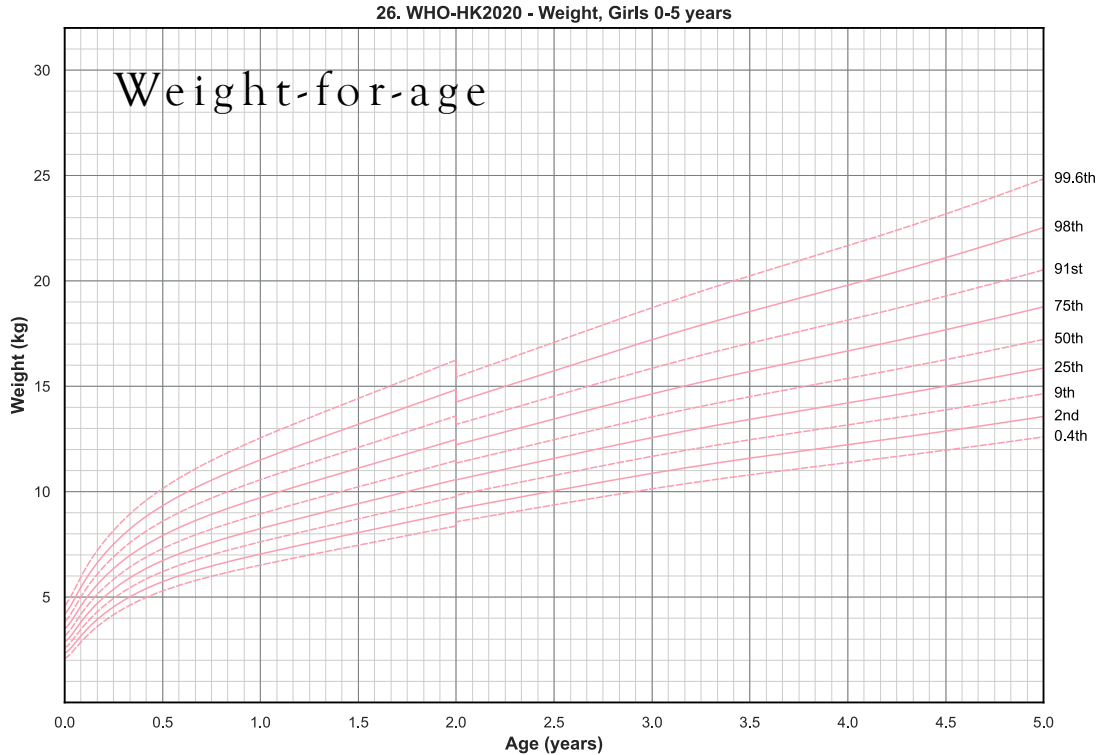
WHO-HK2020 Growth References

A transition at age 2 years from WHO2006 to HK2020

Rationale

- WHO2006 Growth Standards have a disjunction at 2 years in Length/Height for age chart.
- The difference between HK2020 and WHO2006 was larger at 5 years.





Resource –
Hong Kong Growth Study Website

https://www.cuhk.edu.hk/proj/hkgrowth/index.html

User Guide for Health Professionals

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HONG KONG GROWTH STUDY

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Home | About the Study | Researchers | Resources for Health Professionals | Downloads | Media and Events

- New Features of the new Growth References
- Suggested Criteria for extra Growth Monitoring and Assessment
- User Guide
- FAQ

User Guide

This guide is designed for healthcare

1. Background information and methodology of the Hong Kong Growth Survey 2020-22
2. Recommendations for new growth reference for Hong Kong children
3. Growth charts for growth monitoring in Hong Kong
4. Frequently Asked Questions concerning HK2020 Growth References

View **User Guide**

A GUIDE

TO

HONG KONG GROWTH CHARTS

20 April 2024 version

Downloads

- Nine-centile Charts
  - HK2020
  - WHO2006
  - WHO-HK2020
- Data Tables (LMS and centile values for HK2020)
  - Standard Tables (monthly / half-yearly)
  - Research Tables (age in days)
  - User Manual

Standard Data Tables (4 spreadsheets)

Column name	Description
mu	M value from the LMS model
sigma	S value from the LMS model
nu	L value from the LMS model
cent	0.4th, 2nd, 9th, 25th, 75th, 91st, 98th, 99.6th centile values (rounded to closest 2 decimal places)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	Age		Girls												Boys											
2	months	years	mu	sigma	nu	cent0.4	cent2	cent9	cent25	cent50	cent75	cent91	cent98	cent99.6	mu	sigma	nu	cent0.4	cent2	cent9	cent25	cent50	cent75	cent91	cent98	cent99.6
3	0	0	[illegible]			44.98	45.95	46.93	47.92	48.92	49.92	50.93	51.95	52.98	49.65	0.03	0.09	45.51	46.51	47.54	48.58	49.65	50.73	51.84	52.97	54.13
4	1	0.1	52.87	0.03	0.58	48.60	49.65	50.72	51.79	52.87	53.96	55.06	56.17	57.29	53.95	0.03	0.07	49.43	50.53	51.65	52.79	53.95	55.14	56.35	57.59	58.85
5	2	0.2	56.80	0.03	0.54	52.19	53.33	54.47	55.63	56.80	57.98	59.17	60.37	61.58	58.15	0.03	0.04	53.26	54.44	55.65	56.89	58.15	59.44	60.75	62.10	63.47
6	3	0.2	59.73	0.03	0.51	54.87	56.07	57.28	58.50	59.73	60.98	62.24	63.51	64.80	61.31	0.03	0.01	56.14	57.39	58.67	59.98	61.31	62.68	64.07	65.50	66.95
7	4	0.3	62.19	0.03	0.47	57.11	58.36	59.62	60.90	62.19	63.49	64.81	66.15	67.50	63.92	0.03	-0.01	58.51	59.82	61.16	62.52	63.92	65.35	66.82	68.31	69.84
8	5	0.4	64.25	0.03	0.44	58.98	60.28	61.59	62.91	64.25	65.60	66.98	68.36	69.77	66.03	0.03	-0.04	60.42	61.77	63.16	64.57	66.03	67.51	69.03	70.59	72.18
9	6	0.5	66.17	0.03	0.41	60.73	62.06	63.42	64.78	66.17	67.57	68.99	70.43	71.89	67.88	0.03	-0.06	62.09	63.48	64.91	66.38	67.88	69.41	70.98	72.59	74.24
10	7	0.6	67.87	0.03	0.38	62.27	63.65	65.04	66.44	67.87	69.32	70.79	72.27	73.78	69.44	0.03	-0.09	63.50	64.93	66.40	67.90	69.44	71.02	72.64	74.29	75.99
11	8	0.7	69.49	0.03	0.34	63.74	65.15	66.58	68.02	69.49	70.98	72.49	74.02	75.57	70.90	0.03	-0.11	64.81	66.28	67.78	69.32	70.90	72.52	74.18	75.88	77.62
12	9	0.8	70.94	0.03	0.31	65.05	66.49	67.95	69.43	70.94	72.47	74.02	75.59	77.18	72.19	0.03	-0.13	65.97	67.47	69.00	70.58	72.19	73.85	75.55	77.29	79.08
13	10	0.8	72.28	0.03	0.29	66.25	67.73	69.22	70.74	72.28	73.84	75.43	77.04	78.68	73.40	0.03	-0.15	67.06	68.58	70.15	71.75	73.40	75.09	76.83	78.61	80.44
14	11	0.9	73.56	0.03	0.26	67.41	68.91	70.44	71.99	73.56	75.16	76.79	78.44	80.12	74.59	0.03	-0.17	68.12	69.68	71.27	72.91	74.59	76.32	78.09	79.92	81.79
15	12	1	74.73	0.03	0.23	68.46	69.99	71.54	73.12	74.73	76.36	78.02	79.71	81.43	75.70	0.03	-0.19	69.12	70.70	72.32	73.99	75.70	77.47	79.28	81.14	83.05
16	13	1.1	75.87	0.03	0.21	69.48	71.04	72.62	74.23	75.87	77.54	79.23	80.96	82.71	76.83	0.03	-0.21	70.12	71.73	73.38	75.08	76.83	78.62	80.47	82.37	84.33
17	14	1.2	76.92	0.03	0.18	70.43	72.01	73.61	75.25	76.92	78.62	80.35	82.11	83.90	77.90	0.03	-0.22	71.08	72.71	74.39	76.12	77.90	79.73	81.62	83.56	85.55
18	15	1.3	77.96	0.03	0.16	71.36	72.96	74.60	76.26	77.96	79.69	81.45	83.25	85.07	79.01	0.03	-0.24	72.06	73.73	75.44	77.20	79.01	80.88	82.80	84.78	86.81
19	16	1.3	78.93	0.03	0.14	72.22	73.85	75.51	77.21	78.93	80.69	82.48	84.31	86.17	80.08	0.04	-0.25	73.02	74.71	76.45	78.24	80.08	81.98	83.94	85.96	88.03
20	17	1.4	79.87	0.03	0.12	73.05	74.71	76.39	78.11	79.87	81.66	83.48	85.34	87.24	81.14	0.04	-0.27	73.95	75.67	77.44	79.26	81.14	83.07	85.07	87.12	89.24
21	18	1.5	80.80	0.03	0.10	73.88	75.56	77.27	79.02	80.80	82.62	84.48	86.37	88.30	82.20	0.04	-0.28	74.89	76.64	78.44	80.29	82.20	84.17	86.20	88.29	90.45
22	19	1.6	81.68	0.03	0.08	74.66	76.36	78.09	79.87	81.68	83.52	85.41	87.33	89.30	83.19	0.04	-0.29	75.76	77.54	79.36	81.24	83.19	85.19	87.25	89.38	91.57
23	20	1.7	82.55	0.03	0.06	75.43	77.15	78.91	80.71	82.55	84.42	86.34	88.30	90.29	84.15	0.04	-0.30	76.61	78.41	80.26	82.17	84.15	86.18	88.28	90.44	92.67
24	21	1.7	83.37	0.03	0.05	76.15	77.90	79.68	81.50	83.37	85.27	87.21	89.20	91.23	85.01	0.04	-0.30	77.37	79.19	81.07	83.01	85.01	87.07	89.20	91.40	93.67
25	22	1.8	84.19	0.03	0.03	76.87	78.64	80.45	82.30	84.19	86.12	88.09	90.11	92.17	85.83	0.04	-0.31	78.08	79.93	81.84	83.80	85.83	87.92	90.08	92.31	94.61
26	23	1.9	84.95	0.03	0.02	77.55	79.34	81.17	83.04	84.95	86.91	88.91	90.96	93.05	86.55	0.04	-0.31	78.71	80.58	82.51	84.50	86.55	88.67	90.86	93.11	95.45
27	24	2	85.70	0.03	0.01	78.21	80.02	81.87	83.77	85.70	87.69	89.71	91.79	93.91	87.22	0.04	-0.32	79.29	81.18	83.13	85.15	87.22	89.37	91.58	93.87	96.23
28	25	2.1	85.76	0.03	0.00	78.17	80.01	81.88	83.80	85.76	87.77	89.83	91.93	94.09	87.18	0.04	-0.32	79.16	81.07	83.04	85.08	87.18	89.35	91.59	93.91	96.30
29	26	2.2	86.48	0.03	-0.01	78.80	80.66	82.55	84.49	86.48	88.52	90.60	92.73	94.91	87.80	0.04	-0.32	79.69	81.62	83.62	85.67	87.80	89.99	92.26	94.60	97.02
30	27	2.3	87.21	0.04	-0.01	79.44	81.32	83.24	85.20	87.21	89.27	91.38	93.54	95.76	88.43	0.04	-0.32	80.23	82.19	84.20	86.28	88.43	90.64	92.94	95.30	97.75
31	28	2.3	87.91	0.04	-0.02	80.05	81.95	83.89	85.88	87.91	90.00	92.13	94.32	96.56	89.04	0.04	-0.31	80.76	82.73	84.77	86.87	89.04	91.28	93.60	96.00	98.47
32	29	2.4	88.63	0.04	-0.02	80.68	82.59	84.56	86.57	88.63	90.74	92.90	95.12	97.39	89.69	0.04	-0.31	81.32	83.32	85.37	87.50	89.69	91.96	94.31	96.73	99.23
33	30	2.5	89.32	0.04	-0.03	81.27	83.21	85.20	87.23	89.32	91.46	93.65	95.89	98.19	90.36	0.04	-0.31	81.89	83.91	85.99	88.14	90.36	92.65	95.02	97.47	100.00
34	31	2.6	90.03	0.04	-0.03	81.89	83.85	85.86	87.92	90.03	92.19	94.41	96.68	99.00	91.07	0.04	-0.30	82.51	84.55	86.65	88.83	91.07	93.39	95.79	98.27	100.83
35	32	2.7	90.71	0.04	-0.03	82.48	84.46	86.50	88.58	90.71	92.90	95.14	97.44	99.79	91.79	0.04	-0.29	83.12	85.18	87.31	89.51	91.79	94.13	96.56	99.06	101.65
36	33	2.7	91.39	0.04	-0.03	83.07	85.07	87.13	89.23	91.39	93.60	95.87	98.19	100.57	92.52	0.04	-0.28	83.75	85.84	87.99	90.22	92.52	94.89	97.34	99.88	102.50
37	34	2.8	92.08	0.04	-0.03	83.67	85.70	87.77	89.90	92.08	94.32	96.61	98.96	101.37	93.28	0.04	-0.27	84.40	86.52	88.70	90.95	93.28	95.68	98.16	100.73	103.38
38	[illegible]																									

Height | Weight | BMI | HC

Research Data Table (one spreadsheet)

Column name	Description	
var	Growth parameters:	
	hgt	length/height
	wgt	weight
	bmi	BMI
	hc	head circumference
sex	Sex:	
	F	Female
	M	Male

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	var	age.d	age.m	age	sex	mu	sigma	nu	cent0.4	cent2	cent9	cent25	cent50	cent75	cent91	cent98	cent99.6
2	hgt	0	0	0	F	48.91565	0.030669	0.613395	44.9788	45.95102	46.93126	47.91948	48.91565	49.91971	50.93165	51.95142	52.97899
3	hgt	1	0	0	F	49.00834	0.030674	0.612219	45.06355	46.0377	47.0199	48.01013	49.00834	50.01449	51.02856	52.0505	53.08029
4	hgt	2	0	0	F	49.11218	0.030679	0.611044	45.15854	46.13484	47.11923	48.11169	49.11218	50.12066	51.13709	52.16144	53.19368
5	hgt	3	0	0	F	49.22105	0.030685	0.609868	45.25816	46.2367	47.22339	48.21818	49.22105	50.23196	51.25086	52.27773	53.31253
6	hgt	4	0	0	F	49.33384	0.03069	0.608693	45.36136	46.34223	47.33129	48.32851	49.33384	50.34725	51.36871	52.39819	53.43563
7	hgt	5	0	0	F	49.44997	0.030696	0.607519	45.46763	46.4509	47.4424	48.4421	49.44997	50.46596	51.49005	52.5222	53.56236

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	var	age.d	age.m	age	sex	mu	sigma	nu	cent0.	cent2	cent9	cent2	cent5	cent7	cent9	cent9	cent99
13152	wgt	0	0	0	F	3.03861	0.101451	0.262705	2.295086	2.466725	2.647646	2.838167	3.03861	3.249302	3.470573	3.702761	3.946204
13153	wgt	1	0	0	F	3.07624	0.101463	0.261964	2.323497	2.497249	2.680408	2.873296	3.07624	3.289572	3.51363	3.748754	3.995293
13154	wgt	2	0	0	F	3.104763	0.101475	0.261222	2.345029	2.520381	2.705235	2.899918	3.104763	3.320105	3.546287	3.783654	4.032559
13155	wgt	3	0	0	F	3.132576	0.101487	0.260481	2.366025	2.542935	2.729443	2.925878	3.132576	3.34988	3.578134	3.817691	4.068907
13156	wgt	4	0	0	F	3.160371	0.101499	0.25974	2.387007	2.565475	2.753634	2.951819	3.160371	3.379635	3.609962	3.851709	4.105236
13157	wgt	5	0	0	F	3.188391	0.101511	0.258998	2.408159	2.588197	2.778022	2.977971	3.188391	3.409632	3.642049	3.886004	4.141861
13158	wgt	6	0	0	F	3.216753	0.101523	0.258257	2.429569	2.611196	2.802706	3.004442	3.216753	3.439995	3.674528	3.920717	4.178934

Take home message

- No growth chart is perfect.
- An understanding on the development of the growth charts is essential for appropriate use of them.