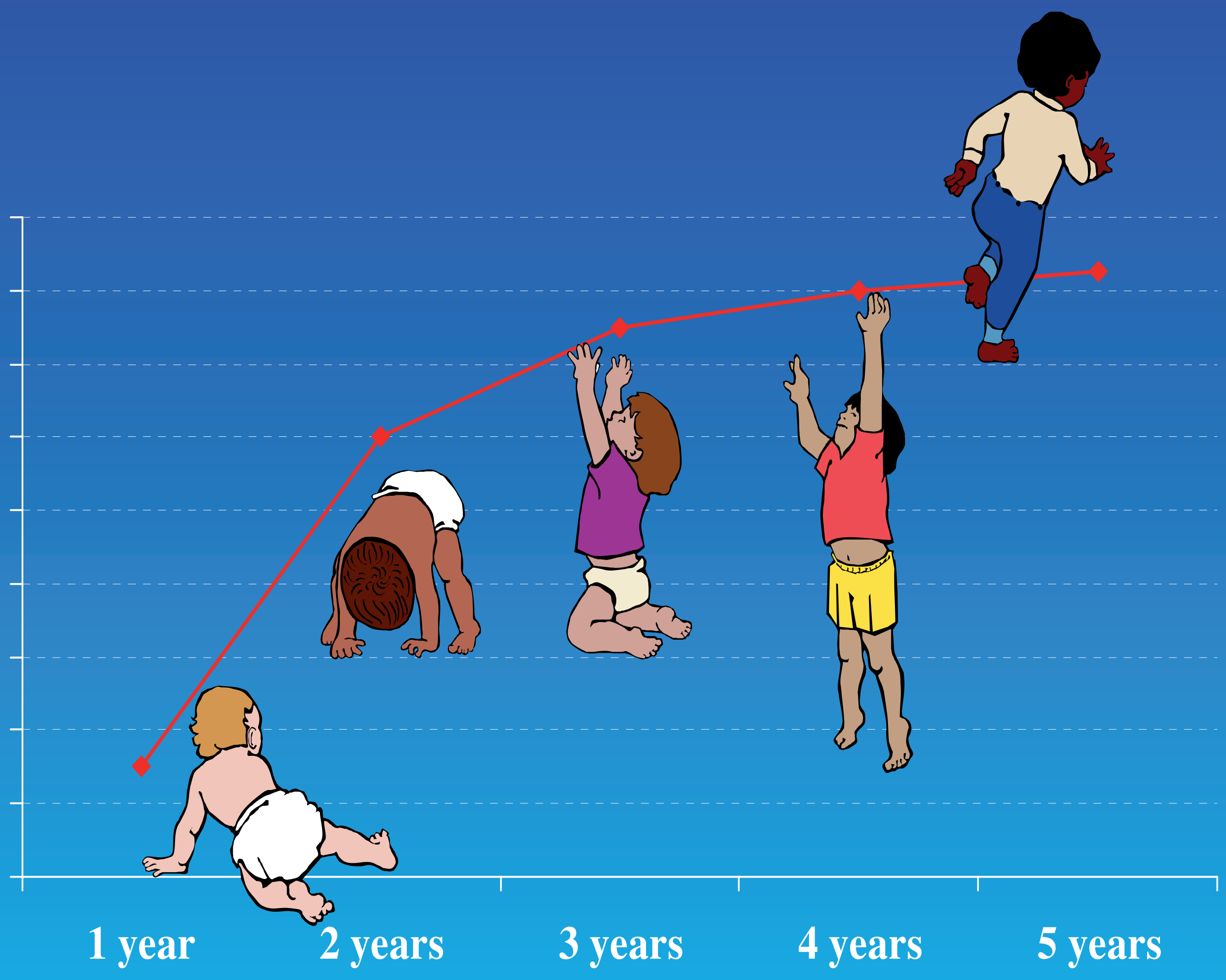
# WHO Child Growth Standards

## Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age

## Methods and development




World Health Organization

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Department of Nutrition for Health and Development

**WHO Library Cataloguing-in-Publication Data**

WHO child growth standards : length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age : methods and development.

Coordinating team: Mercedes de Onis ... [et al.].

1. Anthropometry. 2. Anthropometry - methods. 3. Body weights and measures - standards. 4. Child development. 5. Growth. 6. Reference standards. 7. Nutrition assessment. I. de Onis, Mercedes. II. World Health Organization. III. Title: World Health Organization child growth standards.

ISBN 92 4 154693 X (NLM classification: WS 103)



Printed in France

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## Acknowledgements

The WHO Child Growth Standards were constructed by the Coordinating Team in the Department of Nutrition for Health and Development of the World Health Organization.

The Study Group is indebted to the parents, children and more than 200 field staff that participated in the WHO Multicentre Growth Reference Study. The generous contribution of many individuals that provided expertise and advice was also crucial to the development of the growth standards.

The project has received funding from the Bill & Melinda Gates Foundation, the Netherlands Minister for Development Cooperation, the Norwegian Royal Ministry of Foreign Affairs, and the United States Department of Agriculture (USDA). Financial support was also provided by the Ministry of Health of Oman, the United States National Institutes of Health, the Brazilian Ministry of Health and Ministry of Science and Technology, the Canadian International Development Agency, the United Nations University, the Arab Gulf Fund for United Nations Development, the Office of the WHO Representative to India, and the Department of Child and Adolescent Health and Development.

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## Glossary

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| **BCPE** | The Box-Cox power exponential distribution. |
| **μ** | The median of the Box-Cox power exponential distribution. |
| **σ** | The approximate coefficient of variation of the Box-Cox power exponential distribution — related to the variance. |
| **ν** | The power of the Box-Cox transformation (to the normal distribution) of the Box-Cox power exponential distribution - related to the skewness. |
| **τ** | The power exponential parameter of the Box-Cox power exponential distribution — related to the kurtosis. |
| **λ** | The power of the age (or length/height) transformation. |
| **Body mass index (BMI)** | The ratio weight (in kg) / recumbent length or standing height (in $m^2$). |
| **Box-Cox transformation** | A power transformation to the normal distribution. |
| **Coefficient of variation** | The ratio of the standard deviation to the mean. |
| **Cubic spline** | A piecewise third-order polynomial function that passes through a set of *m* (or degrees of freedom) control points; it can have a very simple form locally, yet be globally flexible and smooth. |
| **Cut-off** | A designated limit beyond which a subject or observation is classified according to a pre-set condition. |
| **Degrees of freedom (df)** | The number of control points used to fit the cubic splines. |
| **Kurtosis** | An attribute of a distribution describing "peakedness". A high kurtosis portrays a distribution with fat tails in contrast to a low kurtosis, which portrays a distribution with skinny tails. |
| **P-value** | The probability of falsely rejecting the hypothesis being tested. In this report all p-values were compared to a level of significance set to 0.05. |
| **Q-test** | A statistical test which combines overall and local tests assessing departures from the normal distribution with respect to median, variance, skewness and kurtosis. |
| **Skewness** | A statistical term used to describe a distribution's asymmetry in relation to a normal distribution. |
| **Standard deviation score (SD)** | See z-score. |
| **Worm plots** | A set of detrended Q-Q plots — plots that compare the distribution of a given set of observations to the normal distribution. |
| **Z-score** | The deviation of an individual's value from the median value of a reference population, divided by the standard deviation of the reference population (or transformed to normal distribution). |

## Executive summary

In 1993 the World Health Organization (WHO) undertook a comprehensive review of the uses and interpretation of anthropometric references. The review concluded that the NCHS/WHO growth reference, which had been recommended for international use since the late 1970s, did not adequately represent early childhood growth and that new growth curves were necessary. The World Health Assembly endorsed this recommendation in 1994. In response WHO undertook the Multicentre Growth Reference Study (MGRS) between 1997 and 2003 to generate new curves for assessing the growth and development of children the world over.

The MGRS combined a longitudinal follow-up from birth to 24 months and a cross-sectional survey of children aged 18 to 71 months. Primary growth data and related information were gathered from 8440 healthy breastfed infants and young children from widely diverse ethnic backgrounds and cultural settings (Brazil, Ghana, India, Norway, Oman and USA). The MGRS is unique in that it was purposely designed to produce a standard by selecting healthy children living under conditions likely to favour the achievement of their full genetic growth potential. Furthermore, the mothers of the children selected for the construction of the standards engaged in fundamental health-promoting practices, namely breastfeeding and not smoking.

This report presents the first set of WHO Child Growth Standards (i.e. length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index (BMI)-for-age) and describes the methodical process followed in their development. The first step in this process was a consultative expert review of some 30 growth curve construction methods, including types of distributions and smoothing techniques to identify the best approach to constructing the standards. Next was the selection of a software package flexible enough to allow the comparative testing of the alternative methods used to generate the growth curves. Then the selected approach was applied systematically to search for the best models to fit the data for each indicator.

The Box-Cox-power-exponential (BCPE) method, with curve smoothing by cubic splines was selected for constructing the WHO child growth curves. The BCPE accommodates various kinds of distributions, from normal to skewed or kurtotic. The age-based indicators originating at birth required a power-transformation to stretch the age scale (x-axis) as a preliminary step to fitting the curves. For each set of curves, the search for the best model specification began by examining various combinations of degrees of freedom to fit the median and variance estimator curves. When data had a non-normal distribution, degrees of freedom for parameters to model skewness and kurtosis were added to the initial model and adequacy of fit evaluated. Apart from length/height-for-age, which followed a normal distribution, the other standards required the modelling of skewness, but not kurtosis. The diagnostic tools used iteratively to detect possible model misfits and biases in the fitted curves included various tests of local and global goodness of fit, worm plots and residual plots. Patterns of differences between empirical and fitted percentiles were also examined, as were proportions of observed versus expected percentages of children with measurements below selected percentiles.

The methodology described above was followed to generate ─ for boys and girls aged 0 to 60 months ─ percentile and z-score curves for length/height-for-age, weight-for-age, weight-for-length, weight-for-height and BMI-for-age. The last standard is an addition to the set of indicators previously available as part of the NCHS/WHO reference. In-depth descriptions are presented of how each sex-specific standard was constructed. Also presented are comparisons of the new WHO standards with the NCHS/WHO growth reference and the CDC 2000 growth charts.

To interpret differences between the WHO standards and the NCHS/WHO reference it is important to understand that they reflect differences not only in the populations used, but also in the methodologies applied to construct the two sets of growth curves. To address the significant skewness of the NCHS/WHO sample's weight-for-age and weight-for-height, separate standard deviations were calculated for distributions below and above the median for each of the two indicators. This approach is limited in fitting skewed data, especially at the extreme tails of the distribution, since it only partially adjusts for the skewness inherent in the weight-based indicators. The WHO standards, on the other hand, employed LMS-based methods that fit skewed data adequately and generate fitted curves that follow closely the empirical data. Like the WHO standards, construction of the CDC 2000 growth charts was also based on the LMS method and, therefore, differences between this reference and the WHO standards are largely a reflection of differences in the populations on which the two sets of curves were based.

*Length/height-for-age.* The standard for linear growth has a part based on length (length-for-age, 0 to 24 months) and another on height (height-for-age, 2 to 5 years). The two parts were constructed using the same model but the final curves reflect the average difference between recumbent length and standing height. By design, children between 18 and 30 months in the cross-sectional component of the MGRS had both length and height measurements taken. The average difference between the two measurements in this set of 1625 children was 0.73 cm. To fit a single model for the whole age range, 0.7 cm was therefore added to the cross-sectional height values before merging them with the longitudinal sample's length data. After the model was fitted, the median curve was shifted back downwards by 0.7 cm for ages above two years, and the coefficient of variation curve adjusted to the new median values to construct the height-for-age growth curves. The same power transformation of age was applied to stretch the age scale for each of the sexes before fitting cubic splines to generate their respective growth curves. The boys' curves required a model with higher degrees of freedom to fit both the median and coefficient of variation curves. The data for both sexes followed the normal distribution.

*Weight-for-age.* The weights of the longitudinal and cross-sectional samples were merged without any adjustments and a single model was fitted to generate one continuous set of curves constituting each sex-specific weight-for-age standard. The same power transformation was applied to both boys' and girls' age before fitting the curve construction model. The weight data for both sexes were skewed, so in specifying the model, the parameter related to skewness was fitted in addition to the median and the approximate coefficient of variation. In modelling skewness the girls' curves required more degrees of freedom to fit a curve for this parameter.

*Weight-for-length/height.* The construction of the weight-for-length (45 to 110 cm) and weight-for-height (65 to 120 cm) standards followed a procedure similar to that applied to construct the length/height-for-age standards. That is, to fit a single model, 0.7 cm was added to the cross-sectional height values, and after the model was fitted, the weight-for-length centile curves in the length interval 65.7 to 120.7 cm were shifted back by 0.7 cm to derive the weight-for-height standards corresponding to the height range 65 cm to 120 cm. The lower limit of the weight-for-length standards (45 cm) was chosen to cover up to approximately -2 SD girls' length at birth. The upper limit for the weight-for-height standards was influenced by the need to accommodate the tallest children at age 60 months, that is, 120 cm is approximately +2 SD boys' height-for-age at 60 months. The overlap between the upper end of the weight-for-length standards and the lower end of the weight-for-height standards is intended to facilitate their application in severely undernourished populations and emergency settings.

There was no evidence that a length/height transformation similar to that described for age was required for constructing the weight-for-length/height standards. The modelling of the median and variance curves followed the procedure described for the first two standards. Results from the final model for girls' weight-for-length/height suggested the need to investigate potential improvements in the curves by modelling kurtosis. Adjustment for kurtosis, however had a negligible impact on the final centiles. Therefore, considering that modelling the fourth parameter would increase complexity in application of the standards and create inconsistency between the sexes, the final curves were generated without adjusting for kurtosis. The degrees of freedom for the median and variance curves varied between the boys' and girls' standards. The fact that the weight-for-length/height indicator combines different velocities for the two measurements involved (weight and length/height) at overlapping ages likely explains the slight wiggle in the final WHO standards (for both boys and girls) as also observed in other references.

*Body mass index-for-age.* Body mass index is the ratio *weight (in kg)/recumbent length or standing height (in $m^2$)*. To address the difference between length and height, the approach used for constructing the BMI-for-age standards was different from that described for length/height-for-age. Because BMI is a ratio with squared length or height in the denominator, adding 0.7 cm to the height values and back-transforming them after fitting was not feasible. The solution adopted was to construct the standards for the younger and the older children separately based on two sets of data with an overlapping range of ages below and above 24 months. To construct the BMI-for-age standard based on length (0 to 2 years), the longitudinal sample's length data and the cross-sectional sample's height data (18 to 30 months) were combined after adding 0.7 cm to the height values. Analogously, to construct the standard from 2 to 5 years, the cross-sectional sample's height plus the longitudinal sample's length data (18 to 24 months) were combined after subtracting 0.7 cm from the length values. Thus, a common set of data from 18 to 30 months was used to generate the BMI standards for the younger and the older children. The resulting disjunction between the two standards thus in essence reflects the 0.7 cm difference between length and height. This does not mean, however, that a child at a specific age will have the same length- and height-based BMI-for-age z-score as this is mathematically impossible given the nature of the BMI ratio.

An age power transformation as described for the other age-based standards was required before constructing the length-based BMI-for-age curves. No such transformation was necessary for the height-based BMI-for-age. The WHO length- and height-based BMI-for-age standards do not overlap, i.e. the length-based interval ends at 730 days and the height-based interval starts at 731 days. Cubic spline fitting was achieved with variable degrees of freedom for the length- versus height-based standards, and also for the boys' versus girls' final curves.

*Technical aspects of the standards.* The method used to construct the WHO standards generally relied on the Box-Cox power exponential distribution and the final selected models simplified to the LMS model. As a result, the computation of percentiles and z-scores for these standards uses formulae based on the LMS method. However, a restriction was imposed on all indicators to enable the derivation of percentiles only within the interval corresponding to z-scores between -3 and 3. The underlying reasoning is that percentiles beyond ±3 SD are invariant to changes in equivalent z-scores. The loss accruing to this restriction is small since the inclusion range corresponds to the 0.135th to 99.865th percentiles.

The weight-based indicators presented right-skewed distributions. When modelled correctly, right skewness has the effect of making distances between positive z-scores increase progressively the farther away they are from the median, while distances between negative z-scores decrease progressively. The LMS method fits skewed data adequately by using a Box-Cox normal distribution, which follows the empirical data closely. The drawback, however, is that the outer tails of the distribution are highly affected by extreme data points even if only very few. A restricted application of the LMS method was thus used for the construction of the WHO weight-based indicators, limiting the Box-Cox normal distribution to the interval corresponding to z-scores where empirical data were available (i.e. between -3 SD and 3 SD). Beyond these limits, the standard deviation at each age (or length/height) was fixed to the distance between ±2 SD and ±3 SD, respectively. This approach avoids making assumptions about the distribution of data beyond the limits of the observed values.

*Epidemiological aspects of the standards.* As expected, there are notable differences with the NCHS/WHO reference that vary by age, sex, anthropometric measure and specific percentile or z-score curve. Differences are particularly important in infancy. Stunting will be greater throughout childhood when assessed using the new WHO standards compared to the NCHS/WHO reference. The growth pattern of breastfed infants will result in a substantial increase in rates of underweight during the first half of infancy and a decrease thereafter. For wasting, the main difference is during infancy when wasting rates will be substantially higher using the new WHO standards. With respect to overweight, use of the new WHO standards will result in a greater prevalence that will vary by age, sex and nutritional status of the index population.

The growth standards presented in this report provide a technically robust tool that represents the best description of physiological growth for children under five years of age. The standards depict normal early childhood growth under optimal environmental conditions and can be used to assess children everywhere, regardless of ethnicity, socioeconomic status and type of feeding.

# 1. INTRODUCTION

Growth charts are an essential component of the paediatric toolkit. Their value resides in helping to determine the degree to which physiological needs for growth and development are met during the important childhood period. Beyond their usefulness in assessing children's nutritional status, many governmental and United Nations agencies rely on growth charts to measure the general well-being of populations, formulate health and related policies, and plan interventions and monitor their effectiveness.

The origin of the WHO Child Growth Standards dates back to the early 1990s when a group of experts was appointed to conduct a meticulous evaluation of the National Center for Health Statistics/World Health Organization (NCHS/WHO) growth reference that had been recommended for international use since the late 1970s (WHO, 1995). The limitations of the NCHS/WHO reference have been documented (WHO Working Group on Infant Growth, 1994; de Onis and Yip, 1996; de Onis and Habicht, 1996). The data used to construct the reference covering birth to three years of age came from a longitudinal study of children of European ancestry from a single community in the USA. These children were measured every three months, which is inadequate to describe the rapid and changing rate of growth in early infancy. Also, the statistical methods available at the time the NCHS/WHO growth curves were constructed were too limited to correctly model the pattern and variability of growth. As a result, the NCHS/WHO curves do not adequately represent early childhood growth.

The initial phase of the expert group's work documented the deficiencies of the reference and led to a plan for developing new growth charts that would show how children *should* grow in all countries rather than merely describing *how* they grew at a particular time and place. The experts underscored the importance of ensuring that the new growth charts were consistent with "best" health practices (Garza and de Onis, 2004).

A logical outcome of this plan was the WHO Multicentre Growth Reference Study (MGRS), which was implemented between 1997 and 2003 (de Onis et al., 2004a). The MGRS is unique in that it was purposely designed to produce a standard rather than a reference. Although standards and references both serve as a basis for comparison, each enables a different interpretation. Since a standard defines how children should grow, deviations from the pattern it describes are evidence of abnormal growth. A reference, on the other hand, does not provide as sound a basis for such value judgments, although in practice references often are mistakenly used as standards.

The MGRS data provide a solid foundation for developing a standard because they are based on healthy children living under conditions likely to favour achievement of their full genetic growth potential. Furthermore, the mothers of the children selected for the construction of the standards engaged in fundamental health-promoting practices, namely breastfeeding and not smoking (de Onis et al., 2004b).

A second feature of the study that makes it attractive as a basis for an internationally applicable standard is that it included children from a diverse set of countries: Brazil, Ghana, India, Norway, Oman and the USA. By selecting privileged, healthy populations the study reduced the impact of environmental variation. Assessment of differences in linear growth among the child populations of the MGRS shows a striking similarity among the six sites, with only about 3% of variability in length being due to differences among sites compared to 70% due to differences among individuals (WHO Multicentre Growth Reference Study Group, 2006a). Thus, excluding any site has little effect on the 3rd, 50th, and 97th percentile values, and pooling data from all sites is entirely justified. The remarkable similarity in growth during early childhood across human populations is consistent with genomic comparisons among diverse continental groups reporting a high degree of inter-population homogeneity (Rosenberg, 2002; King and Motulsky, 2002; Jorde and Wooding, 2004). Nevertheless, the MGRS sample has considerable built-in ethnic or genetic variability in addition to cultural variation in how children are nurtured, which further strengthens the standards' universal applicability.

A key characteristic of the new standards is that they explicitly identify breastfeeding as the biological norm and establish the breastfed child as the normative model for growth and development (WHO Multicentre Growth Reference Study Group, 2006b). Another distinguishing feature of the new standards is that they include windows of achievement for six gross motor developmental milestones which are presented elsewhere (WHO Multicentre Growth Reference Study Group, 2006c). Although WHO in the past issued recommendations concerning attained physical growth, it had not previously made any recommendations for assessing motor development.

This report presents the first set of WHO Child Growth Standards and describes the methods used to construct the standards for length/height-for-age, weight-for-age, weight-for length, weight-for-height and BMI-for-age. It also compares the new standards with the NCHS/WHO growth reference (WHO, 1983) and the 2000 CDC growth charts (Kuczmarski, 2002). Electronic copies of the WHO growth charts and tables together with tools developed to facilitate their use are available on the Web: **www.who.int/childgrowth/en.**

# 2. METHODOLOGY

## 2.1 Design of the WHO Multicentre Growth Reference Study

The MGRS (July 1997–December 2003) was a population-based study that took place in the cities of Davis, California, USA; Muscat, Oman; Oslo, Norway; and Pelotas, Brazil; and in selected affluent neighbourhoods of Accra, Ghana and South Delhi, India. The MGRS protocol and its implementation in the six sites are described in detail elsewhere (de Onis et al., 2004a). Briefly, the MGRS combined a longitudinal component from birth to 24 months with a cross-sectional component of children aged 18–71 months. In the longitudinal component, mothers and newborns were screened and enrolled at birth and visited at home a total of 21 times on weeks 1, 2, 4 and 6; monthly from 2–12 months; and bimonthly in the second year. In the cross-sectional component, children aged 18–71 months were measured once, except in the two sites (Brazil and USA) that used a mixed-longitudinal design in which some children were measured two or three times at three-month intervals. Both recumbent length and standing height were measured for all children aged 18–30 months. Data were collected on anthropometry, motor development, feeding practices, child morbidity, perinatal factors, and socioeconomic, demographic and environmental characteristics (de Onis et al., 2004b).

The study populations lived in socioeconomic conditions favourable to growth and where mobility was low, ≥20% of mothers followed WHO feeding recommendations and breastfeeding support was available (de Onis et al., 2004b). Individual inclusion criteria were: no known health or environmental constraints to growth, mothers willing to follow MGRS feeding recommendations (i.e. exclusive or predominant breastfeeding for at least 4 months, introduction of complementary foods by the age of 6 months, and continued partial breastfeeding up to at least 12 months), no maternal smoking before and after delivery, single term birth, and absence of significant morbidity (de Onis et al., 2004b).

As part of the site-selection process in Ghana, India and Oman, surveys were conducted to identify socioeconomic characteristics that could be used to select groups whose growth was not environmentally constrained (Owusu et al., 2004; Bhandari et al., 2002; Mohamed et al., 2004). Local criteria for screening newborns, based on parental education and/or income levels, were developed from those surveys. Pre-existing survey data for this purpose were available from Brazil, Norway and the USA. Of the 13 741 mother-infant pairs screened for the longitudinal component, about 83% were ineligible (WHO Multicentre Growth Reference Study Group, 2006d). Families' low socioeconomic status was the most common reason for ineligibility in Brazil, Ghana, India and Oman, whereas parental refusal was the main reason for non-participation in Norway and USA (WHO Multicentre Growth Reference Study Group, 2006d). For the cross-sectional component, 69% of the 21 510 subjects screened were excluded for reasons similar to those observed in the longitudinal component.

Term low-birth-weight (<2500 g) infants (2.3%) were *not* excluded. Since it is likely that in well-off populations such infants represent small but normal children, their exclusion would have artificially distorted the standards' lower percentiles. Eligibility criteria for the cross-sectional component were the same as those for the longitudinal component with the exception of infant feeding practices. A minimum of three months of any breastfeeding was required for participants in the study's cross-sectional component.

## 2.2 Anthropometry methods

Data collection teams were trained at each site during the study's preparatory phase, at which time measurement techniques were standardized against one of two MGRS anthropometry experts. During the study, bimonthly standardization sessions were conducted at each site. Once a year the anthropometry expert visited each site to participate in these sessions (de Onis et al., 2004c). Results from the anthropometry standardization sessions have been reported elsewhere (WHO Multicentre Growth Reference Study Group, 2006e). For the longitudinal component of the study, screening teams measured newborns within 24 hours of delivery, and follow-up teams conducted home visits until 24 months of age. The follow-up teams were also responsible for taking measurements in the cross-sectional component involving children aged 18–71 months (de Onis et al., 2004b).

The MGRS data included weight and head circumference at all ages, recumbent length (longitudinal component), height (cross-sectional component), and arm circumference, triceps and subscapular skinfolds (all children aged ≥3 months). However, this report presents only the standards based on length or height and weight. Observers working in pairs collected anthropometric data. Each observer independently measured and recorded a complete set of measurements, after which the two compared their readings. If any pair of readings exceeded the maximum allowable difference for a given variable (e.g. weight, 100 g; length/height, 7 mm), both observers once again independently measured and recorded a second and, if necessary, a third set of readings for the variable(s) in question (de Onis et al., 2004c).

All study sites used identical measuring equipment. Instruments needed to be highly accurate and precise, yet sturdy and portable to enable them to be carried back and forth on home visits. Length was measured with the portable Harpenden Infantometer (range 30–110 cm, with digit counter readings precise to 1 mm). The Harpenden Portable Stadiometer (range 65–206 cm, digit counter reading) was used for measuring adult and child heights. Portable electronic scales with a taring capability, calibrated to 0.1 kg (i.e. UNICEF Electronic Scale 890 or UNISCALE), were used to measure weight. Length and height were recorded to the last completed unit rather than to the nearest unit. To correct for the systematic negative bias introduced by this practice, 0.05 cm (i.e. half of the smallest measurement unit) was added to each measurement before analysis. This correction did not apply to weight, which was rounded off to the nearest 100 g. Full details of the instruments used and how measurements were taken are provided elsewhere (de Onis et al., 2004c).

## 2.3 Sample description

The total sample size for the longitudinal and cross-sectional components from all six sites was 8440 children. A total of 1743 children were enrolled in the longitudinal sample, six of whom were excluded for morbidities affecting growth (4 cases of repeated episodes of diarrhoea, 1 case of repeated episodes of malaria, and 1 case of protein-energy malnutrition) leaving a sample of 1737 children (894 boys and 843 girls). Of these, the mothers of 882 children (428 boys and 454 girls) complied fully with the MGRS infant-feeding and no-smoking criteria and completed the follow-up period of 24 months (96% of compliant children completed the 24-month follow-up) (Table 1). The other 855 children contributed only birth measurements, as they either failed to comply with the study's infant-feeding and no-smoking criteria or dropped out before 24 months. The reason for using these measurements was to increase the sample size at birth to minimize the left-edge effect. The size at birth of these 855 children was similar to that of the compliant sample (Table 2). The total number of records for the longitudinal component was 19 900.

**Table 1 Total sample and number of compliant children in the longitudinal component**

| Site | N | Compliant[a] | | |
|---|---|---|---|---|
| | | Boys | Girls | Total |
| Brazil | 309 | 29 | 37 | 66 |
| Ghana | 328 | 103 | 124 | 227 |
| India | 301 | 84 | 89 | 173 |
| Norway | 300 | 75 | 73 | 148 |
| Oman | 291 | 73 | 76 | 149 |
| USA | 208 | 64 | 55 | 119 |
| All | 1737 | 428 | 454 | 882 |

[a] Compliant with infant-feeding and no-smoking criteria and completed the 24-month follow-up.

**Table 2 Comparison of mean size at birth for compliant newborns and those that contributed only birth measurements**

| Measurement | Compliant[a] N=882 | Non-compliant N=855 |
|---|---|---|
| Weight (g) | 3325 | 3306 |
| Length (cm) | 49.6 | 49.5 |
| Head circumference (cm) | 34.1 | 34.2 |

[a] Compliant with infant-feeding and no-smoking criteria and completed the 24-month follow-up.

The cross-sectional sample comprised 6697 children. Of these, 28 were excluded for medical conditions affecting growth (20 cases of protein-energy malnutrition, five cases of haemolytic anaemia G6PD deficiency, two cases of renal tubulo-interstitial disease, and one case of Crohn disease) leaving a final sample of 6669 children (3450 boys and 3219 girls) (Table 3). The total number of records in the cross-sectional component was 8306 as some children in Brazil and the USA were measured two or three times at three-month intervals (Table 4). A full description of the MGRS sample with regard to screening, recruitment, sample attrition and compliance, as well as the baseline characteristics of the study sample is provided elsewhere (WHO Multicentre Growth Reference Study Group, 2006d).

**Table 3 Total sample of children in the cross-sectional component**

| Site | Boys | Girls | Total |
|---|---|---|---|
| Brazil | 237 | 243 | 480 |
| Ghana | 684 | 719 | 1403 |
| India | 840 | 647 | 1487 |
| Norway | 725 | 660 | 1385 |
| Oman | 714 | 724 | 1438 |
| USA | 250 | 226 | 476 |
| All | 3450 | 3219 | 6669 |

**Table 4 Total sample of children in the cross-sectional component by number of visits and total number of records**

| Site | Brazil | Ghana | India | Norway | Oman | USA | All |
|---|---|---|---|---|---|---|---|
| One visit | 34 | 1403 | 1487 | 1385 | 1438 | 55 | 5802 |
| Two visits | 36 | 0 | 0 | 0 | 0 | 61 | 97 |
| Three visits | 410 | 0 | 0 | 0 | 0 | 360 | 770 |
| No. of children | 480 | 1403 | 1487 | 1385 | 1438 | 476 | 6669 |
| No. of records | 1336 | 1403 | 1487 | 1385 | 1438 | 1257 | 8306 |

## 2.4 Data cleaning procedures and exclusions

*Data cleaning*

The MGRS data management protocol (Onyango et al., 2004) was designed to create and manage a large databank of information collected from multiple sites over a period of several years. Data collection and processing instruments were prepared centrally and used in a standardized fashion across sites. The data management system contained internal validation features for timely detection of data errors and its standard operating procedures stipulated a method of master file updating and correction that maintained a clear trail for data-auditing purposes. Each site was responsible for collecting, entering, verifying and validating data, and for creating site-level master files. Data from the sites were sent to WHO/HQ every month for master file consolidation and more extensive quality control checking. All errors identified were communicated to the site for correction at source.

After data collection was completed at a given site, a period of about 6 months was dedicated to in-depth data quality checking and master file cleaning. Detailed validation reports, descriptive statistics and plots were produced from the site's master files. For the longitudinal component, each anthropometric measurement was plotted for every child from birth to the end of his/her participation. These plots were examined individually for any questionable patterns. Query lists from these analyses were sent to the site for investigation and correction, or confirmation, as required. As with the data collection process, the site data manager prepared correction batches to update the master files. The updated master files were then sent to WHO/HQ and this iterative quality assurance process continued until all identifiable problems had been detected and corrected. The rigorous implementation of what was a highly demanding protocol yielded very high-quality data.

*Data exclusions*

To avoid the influence of unhealthy weights for length/height, observations falling above +3 SD and below -3 SD of the sample median were excluded prior to constructing the standards. For the cross-sectional sample, the +2 SD cut-off (i.e. 97.7 percentile) was applied instead of +3 SD as the sample was exceedingly skewed to the right, indicating the need to identify and exclude high weights for height. This cut-off was considered to be conservative given that various definitions of overweight all apply lower cut-offs than the one used (Daniels et al., 2005; Koplan et al., 2005).

To derive the above-mentioned cut-offs based on the sex-specific weight-for-length/height indicator, the weight median and coefficient of variation curves were modelled continuously across length/height using an approach that accounted for the sample's asymmetry as described below. The data were split into two sets: one set with all points above the median and another with all points below the median. For each of the two sets, mirror values were generated to create symmetrically distributed values around the median for the upper and lower sets. The generation of mirror data was necessary to simulate a symmetric distribution based on the distinct variabilities of the upper and lower sets. For each of the mirror data sets, median and coefficient of variation curves were estimated continuously across the length/height range using the LMS method (Cole and Green, 1992) fixing L=1, i.e. fitting a normal distribution to the data for each specific length/height value, to derive the corresponding cut-offs. In total, only a small proportion of observations were excluded for unhealthy weight-for-length/height: 185 (1.4%) for boys and 155 (1.1%) for girls, most of which were in the upper end of the cross-sectional sample distribution (Table 5).

**Table 5 Number of observations by sex and study component included and excluded on the basis of weight-for-length/height**

| **Boys** | | **LS** | **%** | **CS** | **%** | **Total** | **%** |
|---|---|---|---|---|---|---|---|
| Included | | 9233 | 99.3 | 4135 | 97.2 | 13 368 | 98.6 |
| Excluded | Lower | 11 | 0.1 | 2 | 0.1 | 13 | 0.1 |
| | Upper | 56 | 0.6 | 116 | 2.7 | 172 | 1.3 |
| Total | | 9300 | 100.0 | 4253 | 100.0 | 13 553 | 100.0 |
| **Girls** | | **LS** | **%** | **CS** | **%** | **Total** | **%** |
| Included | | 9740 | 99.6 | 3886 | 97.2 | 13 626 | 98.9 |
| Excluded | Lower | 7 | 0.1 | 3 | 0.1 | 10 | 0.1 |
| | Upper | 35 | 0.3 | 110 | 2.7 | 145 | 1.0 |
| Total | | 9782 | 100.0 | 3999 | 100.0 | 13 781 | 100.0 |

LS, Longitudinal study; CS, Cross-sectional study.

In addition, a few influential observations for indicators other than weight-for-height were excluded when constructing the individual standards: for weight-for-age boys, 4 (0.03%) and girls, 1 (0.01%) observations and, for length/height-for-age boys, 3 (0.02%) and girls, 2 (0.01%) observations. These observations were set to missing in the final data set and therefore did not contribute to the construction of the weight-for-length/height and body mass index-for-age standards. The final number of observations used in the construction of the WHO child growth standards is shown in Table 6.

**Table 6 Number of observations used in the construction of the WHO child growth standards by sex and anthropometric indicator**

| Indicator | Girls | Boys | Total |
|---|---|---|---|
| Weight-for-length/height | 13 623 | 13 362 | 26 985 |
| Weight-for-age | 14 056 | 13 797 | 27 853 |
| Length/height-for-age | 13 783 | 13 551 | 27 334 |
| BMI-for-age | 13 623 | 13 362 | 26 985 |

## 2.5 Statistical methods for constructing the growth curves

The construction of the growth curves followed a careful, methodical process. This involved:

- detailed examination of existing methods, including types of distributions and smoothing techniques, in order to identify the best possible approach;
- selection of a software package flexible enough to allow comparative testing of alternative methods and the actual generation of the curves;
- systematic application of the selected approach to the data to generate the models that best fit the data.

A group of statisticians and growth experts met at WHO/HQ to review possible choices of methods and to define a strategy and criteria for selecting the most appropriate model for the MGRS data (Borghi et al., 2006). As many as 30 construction methods for attained growth curves were examined. The group recommended that methods based on selected distributions be compared and combined with two smoothing techniques for fitting parameter curves to further test and provide the best possible approach to constructing the WHO child growth standards.

*Choice of distribution*. Five distributions were identified for detailed testing: Box-Cox power exponential (Rigby and Stasinopoulos, 2004a), Box-Cox t (Rigby and Stasinopoulos, 2004b), Box-Cox normal (Cole and Green, 1992), Johnson's SU (Johnson, 1949), and modulus-exponential-normal (Royston and Wright, 1998). The first four distributions were fitted using GAMLSS (Generalized Additive Models for Location, Scale and Shape) software (Stasinopoulos et al., 2004) and the last using the "xriml" module in STATA software (Wright and Royston, 1996). The comparison was done by age group, without considering the smoothing component. The Box-Cox-power-exponential (BCPE) distribution with four parameters — $\mu$ (for the median), $\sigma$ (coefficient of variation), $\nu$ (Box-Cox transformation power) and $\tau$ (parameter related to kurtosis) — was selected for constructing the curves. The BCPE is a flexible distribution that offers the possibility to adjust for kurtosis, thus providing the framework necessary to test if fitting the distribution's fourth moment improves the estimation of extreme percentiles. It simplifies to the normal distribution when $\nu$=1 and $\tau$=2, and when $\nu \neq 1$ and $\tau$=2, the distribution is the same as the Box-Cox normal (LMS method's distribution). The BCPE is defined by a power transformation (or Box-Cox transformation) $Y^{\nu}$ having a shifted and scaled (truncated) power exponential (or Box-Tiao) distribution with parameter $\tau$ (Rigby and Stasinopoulos, 2004a).

Apart from other theoretical advantages, the BCPE presents as good or better goodness-of-fit than the modulus-exponential-normal or the SU distribution.

*Choice of smoothing technique*. The expert group recommended two smoothing techniques for comparison: cubic splines and fractional polynomials (Borghi et al., 2006). Using the GAMLSS software, the two techniques were compared for smoothing length/height-for-age, weight-for-age and weight-for-length/height curves. For the fractional polynomials, a function in GAMLSS was used that estimates the best set of powers among {-2, -1, -0.5, 0, 0.5, 1, 2, 3} within the choices of polynomials with the same number of terms. The best fractional polynomial for 1, 2 or 3 terms was fitted for each parameter curve. A number of combinations were tried among the different parameter curves, considering the Akaike Information Criterion (Akaike, 1974), *AIC*, defined as:

$$AIC = -2L - 2p,$$

where $L$ is the maximized likelihood and $p$ is the number of parameters (or the total number of degrees of freedom). According to this criterion, the best model is the one with the smallest AIC value.

The cubic spline smoothing technique offered more flexibility than fractional polynomials in all cases. For the length/height-for-age and weight-for-age standards, a power transformation applied to age prior to fitting was necessary to enhance the goodness of fit by the cubic spline technique.

*Choice of method for constructing the curves*. In summary, the BCPE method, with curve smoothing by cubic splines, was selected as the approach for constructing the growth curves. This method is included in a broader methodology, the GAMLSS (Rigby and Stasinopoulos, 2005), which offers a general framework that includes a wide range of known methods for constructing growth curves. The GAMLSS allows for modeling the mean (or median) of the growth variable under consideration as well as other parameters of its distribution that determine scale and shape. Various kinds of distributions can be assumed for each growth variable of interest, from normal to skewed and/or kurtotic distributions. Several smoothing terms can be used in generating the curves, including cubic splines, *lowess* (locally weighted least squares regression), polynomials, power polynomials and fractional polynomials. The simplified notation to describe a particular model within the class of the BCPE method is:

$$BCPE(x=x,\ df(\mu)=n_1,\ df(\sigma)=n_2,\ df(\nu)=n_3,\ df(\tau)=n_4),$$

where $df(\cdot)$ are the degrees of freedom for the cubic splines smoothing the respective parameter curve and $x$ is age (or transformed age) or length/height. Note that when $df(\cdot)=1$, the smoothing function reduces to a constant and when $df(\cdot)=2$, it reduces to a linear function. The GAMLSS software was used to construct the WHO child growth standards. The main selected diagnostic tests and tools are available in this software. To complement and test the software, Dr Huiqi Pan and Professor Tim Cole provided the software LMS Pro, which offers the fitting of growth curves using the LMS method in a user-friendly and interactive way, including some of the available diagnostics for choosing the best set of degrees of freedom for the cubic splines and goodness-of-fit statistics. Wright and Royston's package "xriml", developed in the STATA environment, was used to test the fitting of fractional polynomials (Wright and Royston, 1996).

*Diagnostic tests and tools for selecting the best model.* The process for selecting the best model to construct each growth standard involved choosing, first, the best model *within* a class of models and, second, the best model *across* different classes of models. The set of diagnostic tests and tools was selected based on recommendations from the statistical expert group (Borghi et al., 2006), with additional contributions by Rigby and Stasinopoulos (2004a) and Pan and Cole (2004).

In most cases, before fitting the cubic splines, an age transformation was needed to stretch the age scale for values close to zero. Despite their complexity in terms of shape, even the flexible cubic splines fail to adequately fit early infancy growth with reasonable degrees of freedom. When the degrees of freedom are increased excessively, the function can fit well in infancy but it under-smoothes at older ages. The solution is to expand the age scale when growth velocity is high and to compress it when it is low (Cole et al., 1998). A power transformation applied to age, i.e. $f(\lambda)=age^{\lambda}$, was a good solution for the considered cases. Therefore, prior to determining the best degrees of freedom for the parameter curves, a search was conducted for the best λ for the age power transformation. For this, an arbitrary starting model was used to search for the best age-transformation power (λ) based only on the global deviance values over a preset grid of λ values, since the degrees of freedom remained unchanged. The grid of λ values ranged from 0.05 to 1 in 0.05 intervals, with the exception of the BMI-for-age standards for children younger than 24 months, for which the value 0.01 also was considered. No length/height transformation was necessary for weight-for-length/height.

(a) Selecting the best model within a class of models

Models were grouped in classes according to the parameters to be modelled. The alternative to modelling parameters was to fix them, e.g. $\nu$=1 or $\tau$=2. The criteria used to choose among models within the same class were the *AIC* and the generalized version of it with penalty equal to 3 (*GAIC(3)*) as defined in Rigby and Stasinopoulos (2004a):

$$GAIC(3) = -2L + 3p,$$

where $L$ is the maximized likelihood and $p$ is the number of parameters (or the total number of degrees of freedom). While the use of the *AIC* enhances the fitting of local trends, smoother curves are obtained when the model's choice is based on the *GAIC(3)* criterion. Consistency in the use of these two criteria was attempted across all indicators. For selecting the best combination of df(μ) and df(σ), both criteria were used in parallel. In cases of disagreement, *AIC* was used to select df(μ) and *GAIC(3)* to select df(σ), overall favouring the options which offered a good compromise between keeping estimates close to the empirical values and producing smooth curves. Only *GAIC(3)* values were examined to select df(ν) and, whenever needed, df(τ). In rare cases, other age-specific diagnostic tools were considered for selecting the model with an adequate number of degrees of freedom for the cubic splines fitting the parameter curves. Worm plots (van Buuren and Fredriks, 2001) and Q-test (Royston and Wright, 2000) were used conjointly for this purpose.

Group-specific Q-test statistics resulting in absolute values of z1, z2, z3 or z4 that were larger than 2 were interpreted to indicate a misfit of, respectively, mean, variance, skewness or kurtosis. The overall Q-test statistics combining all groups were based on a Chi-square distribution, which assumes that observations from different groups are independent. In this case, however, given the repeated measurements in the longitudinal study component, the resulting test's p-values could be distorted slightly. To minimize this potential problem, age groups were designed to avoid repeated measurements of the same child within the same age group. The age groups were formed in time intervals (days) to achieve an approximately even sample size distribution across the entire age range of interest, especially in the cross-sectional component, where sample sizes are smaller than in the longitudinal data.

For the longitudinal component, i.e. the first 24 months, time intervals were selected to preserve the longitudinal follow-up structure and avoid having multiple measurements of a given child within one age group. Note that for the longitudinal sample, age ranges were defined to correspond to specific visits, although visits did not always take place at the exact targeted age. For this reason, the constructed age group sample sizes were sometimes slightly different from the designed follow-up visit sample sizes. Moreover, cross-sectional observations were added to the longitudinal sample between 18 and 24 months. In the cross-sectional data, it is possible that in a few cases more than one measurement from the same child occurs because of the multiple visits in Brazil and the USA, combined with the lower data density in this component. Similarly, it was impossible to break the sample into independent groups for the weight-for-length/height indicators. For this reason, the Q-test results required a conservative interpretation.

Overall, Q-test results were interpreted with caution and considered simultaneously with results of worm plots (van Buuren and Fredriks, 2001) which do not require any assumption and still offer very specific information about the goodness of fit for each group. The same age grouping was used as defined for the Q-test. Interpretation of results requires careful review of the shapes of the worms formed by a cubic polynomial (the red line in all worm plots) fitted to the points of the detrended Q-Q plots based on z-score values derived from the model being evaluated. A detrended Q-Q plot is presented for each age group. Confidence intervals (95%) are displayed for each of the worms (dotted curves in all worm plots). Table 7 summarizes the interpretation of various worm plot patterns. Flat worms indicate an adequate fit. The Q-test combined with the worm plot patterns provide a robust assessment of a model's goodness of fit, especially in terms of evaluating local fit.

**Table 7 Interpretation of various patterns in the worm plot[a]**

| Shape | Moment | If the worm | Then the |
|---|---|---|---|
| Intercept | Mean | passes above the origin, | fitted mean is too small. |
| | | passes below the origin, | fitted mean is too large. |
| Slope | Variance | has a positive slope, | fitted variance is too small. |
| | | has a negative slope, | fitted variance is too large. |
| Parabola | Skewness | has a U-shape, | fitted distribution is too skew to the left. |
| | | has an inverted U-shape, | fitted distribution is too skew to the right. |
| S-curve | Kurtosis | has an S-shape on the left bent down, | tails of the fitted distribution are too light. |
| | | has an S-shape on the left bent up, | tails of the fitted distribution are too heavy. |

[a] Reproduced from van Buuren and Fredriks (2001) with permission from © John Wiley & Sons Limited.

Pan and Cole (2004) proposed using a new tool to guide the choice of degrees of freedom for cubic splines fitting each of the parameter curves. They suggested plotting standardized Q-statistics against the number of age groups minus the corresponding degrees of freedom, for each of the L, M and S curves of the LMS method (Cole and Green, 1992). If fitting is adequate, the Q-statistics should be normally distributed with values within the range -2 to 2. This tool provides a global rather than a local test of significance and gives an accurate impression of the underlying goodness of fit because it does not depend on the precise choice of the number of groups. The proposed test is very useful for cross-sectional data where the choice of the number of groups can affect the Q-test results considerably. For example, points that are close in age but in opposite tails of the distribution generate opposing skewness when they fall into separate groups but cancel each other out when they are in the same group. This test was not implemented for the MGRS sample for two reasons. First, the largest number of observations was obtained in the study's longitudinal component, i.e. data were collected frequently at relatively well-defined ages from birth to 24 months. Second, splitting age intervals in a manner that failed to follow the study design, e.g. from birth to one month (which includes measurements taken at birth, and at 7, 14 and 28 days) would group together four measurements per child, thereby reducing the reliability of the Q-test results.

(b) Selecting the best model across different classes of models

The search for the best model was done in an add-up stepwise form, starting from the simplest class of models comprising the age transformation, if any, and the fitting of the $\mu$ and $\sigma$ curves, while keeping fixed $\nu=1$ and $\tau=2$ as described in section (a) above. The next step was to fit the $\nu$ curve, fixing only $\tau=2$ and using the df($\mu$) and df($\sigma$) selected in the previous step. Once the best model within this class of models was selected, Q-test and worm plot results were evaluated to inform the decision on whether or not to select the more complex model. In a few cases when Q-test and worm plots were not sufficient to assess the improvement offered by the more complex model, comparison of observed and fitted percentiles was used to determine if differences were of clinical significance.

The fit of $\tau$ was considered only when Q-test or worm plots indicated misfit with respect to kurtosis. In this case, a third class of models was considered and comparison of observed against fitted percentiles was done to assess the improvement in the final curves. Among the rare cases where this occurred, fitting the fourth parameter always led to change that was negligible in practical terms. Therefore, all the models fitted had at most 3 non-fixed parameters ($\mu$, $\sigma$ and $\nu$).

With df($\nu$) thus selected (i.e. when $\nu$ was not fixed to value 1), a new iteration was done to re-search for df($\mu$) and df($\sigma$). However, none of the additional iterations indicated any need to change either df($\mu$) or df($\sigma$). A further iteration was carried out to investigate if it was necessary to change the age-transformation power $\lambda$. This exercise did not lead to any changes in the selected models.

The methodology described above was used for all the indicators. Methodological aspects that are specific to the construction of each of the standards are described hereafter in relevant sections.

As part of the internal validation for each indicator, a detailed examination was made of the differences between empirical and the fitted centiles resulting from the selected model. Comparisons were also made between the observed and expected proportions of children with measurements below selected centiles across age (or length/height for weight-for-length/height) groups. For these two diagnostic tools, evidence of systematic patterns indicative of biases and the magnitude of deviations were examined.

Length/height-for-age, weight-for-age and BMI-for age curves were constructed using all available data (i.e. from birth to 71 months) but final age-based standards were truncated at 60 completed months to avoid the right-edge effect (Borghi et al., 2006). The weight-for-length standards go from 45 to 110 cm and weight-for-height from 65 to 120 cm.

# 3. CONSTRUCTION OF THE LENGTH/HEIGHT-FOR-AGE STANDARDS

## 3.1 Indicator-specific methodology

For the linear growth indicator, the objective was to construct a length-for-age (birth to 2 years) and height-for-age (2 to 5 years) standard using the same model and yet reflect the average difference between recumbent length and standing height. By design, children between 18 and 30 months in the cross-sectional component had both length and height measurements taken. The average difference between the two measurements in this set of 1625 children was 0.73 cm. The results by age group are shown in Table 8.

**Table 8 Summary of differences between recumbent length and standing height in a sample of children measured both ways**

| Age (months) | 18 to <21 | 21 to <24 | 24 to <27 | 27 to ≤30 | 18 to ≤30 |
|---|---|---|---|---|---|
| Sample size | 334 | 354 | 476 | 461 | 1625 |
| Mean (cm)[a] | 0.75 | 0.69 | 0.72 | 0.77 | 0.73 |
| St Deviation (cm)[a] | 0.61 | 0.67 | 0.61 | 0.61 | 0.62 |

[a] Recumbent length minus standing height.

To fit a single model for the whole age range, 0.7 cm was thus added to the cross-sectional height values. After the model was fitted, the median curve was shifted back downwards by 0.7 cm for ages above two years and the coefficient of variation curve adjusted to the new median values to construct the height-for-age growth curves. The adjusted coefficient of variation ($S^*$) was calculated as follows:

$$S^* = \frac{StDev}{M^*} = \frac{M \times S}{M^*},$$

where $M$ and $S$ are, respectively, the fitted median and coefficient of variation values, and $M^*$ are the shifted-down median values; *StDev* is the standard deviation calculated as the median times the coefficient of variation.

The curves were derived directly from a model that used cubic spline fitting functions for the median and coefficient of variation curves. The age transformation used to stretch the x-axis resulted in a large gap between the birth and day 14 measurements, and when the centiles were shrunk back to the original age scale, the cubic spline-fitted curves formed an artificial pattern in this interval. Therefore, keeping the cubic spline-fitted points at days 0 and 14, linear interpolation was applied to derive estimates of the median and the coefficient of variation curves from day 1 to 13 for the final standards.

Although all available data (birth to 71 months) were used when modelling the curves, to minimize the right-edge effect the length/height-for-age and all the other age-based standards extend up to 60 completed months only.

## 3.2 Length/height-for-age for boys

### 3.2.1 Sample size

There were 13 551 length/height observations for boys. The longitudinal and cross-sectional sample sizes by visit and age are shown in Tables 9 and 10.

**Table 9 Longitudinal sample sizes for length/height-for-age for boys**

| **Visit** | **Birth** | **1** | **2** | **3** | **4** | **5** | **6** |
|---|---|---|---|---|---|---|---|
| **Age** | **0** | **2 wk** | **4 wk** | **6 wk** | **2 mo** | **3 mo** | **4 mo** |
| N | 893 | 425 | 424 | 424 | 424 | 420 | 419 |
| **Visit** | **7** | **8** | **9** | **10** | **11** | **12** | **13** |
| **Age** | **5 mo** | **6 mo** | **7 mo** | **8 mo** | **9 mo** | **10 mo** | **11 mo** |
| N | 420 | 424 | 420 | 420 | 416 | 411 | 422 |
| **Visit** | **14** | **15** | **16** | **17** | **18** | **19** | **20** |
| **Age** | **12 mo** | **14 mo** | **16 mo** | **18 mo** | **20 mo** | **22 mo** | **24 mo** |
| N | 422 | 419 | 418 | 417 | 422 | 418 | 421 |

**Table 10 Cross-sectional sample sizes for length/height-for-age for boys**

| **Age (mo)** | **<18** | **18–20** | **21–23** | **24–26** | **27–29** | **30–32** | **33–35** |
|---|---|---|---|---|---|---|---|
| N | 3 | 177 | 185 | 238 | 263 | 232 | 259 |
| **Age (mo)** | **36–38** | **39–41** | **42–44** | **45–47** | **48–50** | **51–53** | **54–56** |
| N | 273 | 255 | 263 | 244 | 245 | 229 | 234 |
| **Age (mo)** | **57–59** | **60–62** | **63–65** | **66–68** | **69–71** | **>71** | |
| N | 245 | 236 | 221 | 225 | 221 | 4 | |

### 3.2.2 Model selection and results

The model BCPE(x=age$^{\lambda}$, df(μ)=10, df(σ)=6, ν=1, τ=2) served as a starting point to construct the length-for-age growth curves. Improvement of the model's fit was investigated by studying changes in global deviance at varying levels of the age-transformation power λ. Table 11 shows the global deviance for a grid of λ values. The smallest global deviance corresponds to age-transformation power λ=0.35.

**Table 11 Global deviance (GD) for models within the class BCPE(x=age$^{\lambda}$, df(μ)=10, df(σ)=6, ν=1, τ=2) for length/height-for-age for boys**

| **λ** | **0.05** | **0.10** | **0.15** | **0.20** | **0.25** | **0.30** | **0.35** | **0.40** | **0.45** | **0.50** |
|---|---|---|---|---|---|---|---|---|---|---|
| GD[a] | 339.9 | 333.7 | 329.1 | 325.6 | 323.0 | 321.3 | 320.8 | 322.2 | 326.2 | 332.6 |
| **λ** | **0.55** | **0.60** | **0.65** | **0.70** | **0.75** | **0.80** | **0.85** | **0.90** | **0.95** | **1.00** |
| GD[a] | 340.5 | 347.1 | 349.4 | 345.5 | 337.2 | 331.4 | 340.8 | 383.1 | 479.1 | 648.0 |

[a] In excess of 65 000

Having chosen the age-transformation power λ=0.35, the search for the best df(μ) and df(σ) followed, comparing models in which the parameters ν and τ had the fixed values 1 and 2, respectively. For this, all possible combinations of df(μ) ranging from 5 to 15 and df(σ) from 2 to 10 were considered. Partial results are presented in Table 12.

**Table 12 Goodness-of-fit summary for models using the BCPE distribution with fixed ν=1 and τ=2 for length/height-for-age for boys**

| df(μ) | df(σ) | GD[a] | AIC[a] | GAIC(3)[a] | Total df |
|---|---|---|---|---|---|
| | **4** | 338.5 | 364.5 | 377.5 | 13 |
| | **5** | 330.1 | 358.1 | 372.1 | 14 |
| **9** | **6** | 326.5 | 356.5 | 371.5 | 15 |
| | **7** | 324.5 | 356.6 | 372.6 | 16 |
| | **8** | 323.1 | 357.1 | 374.1 | 17 |
| | **4** | 332.9 | 360.9 | 374.9 | 14 |
| | **5** | 324.5 | 354.5 | 369.5 | 15 |
| **10** | **6** | 320.8 | 352.8 | 368.8 | 16 |
| | **7** | 318.9 | 352.9 | 369.9 | 17 |
| | **8** | 317.5 | 353.5 | 371.5 | 18 |
| | **4** | 329.8 | 359.8 | 374.8 | 15 |
| | **5** | 321.4 | 353.4 | 369.4 | 16 |
| **11** | **6** | 317.7 | 351.7 | 368.7 | 17 |
| | **7** | 315.8 | 351.8 | 369.8 | 18 |
| | **8** | 314.4 | 352.4 | 371.4 | 19 |
| | **4** | 327.8 | 359.8 | 375.8 | 16 |
| | **5** | 319.4 | 353.4 | 370.4 | 17 |
| **12** | **6** | 315.7 | 351.7 | 369.7 | 18 |
| | **7** | 313.8 | 351.8 | 370.8 | 19 |
| | **8** | 312.4 | 352.4 | 372.4 | 20 |
| | **4** | 326.4 | 360.4 | 377.4 | 17 |
| | **5** | 317.9 | 353.9 | 371.9 | 18 |
| **13** | **6** | 314.2 | 352.2 | 371.2 | 19 |
| | **7** | 312.3 | 352.3 | 372.3 | 20 |
| | **8** | 311.0 | 353.0 | 374.0 | 21 |

GD, Global Deviance; AIC, Akaike Information Criterion;
GAIC(3), Generalized AIC with penalty equal to 3;
[a] In excess of 65 000.

The best combination of *AIC* and *GAIC(3)* corresponds to df(μ)=11 or 12 and df(σ)=6. To select between df(μ)=11 and 12, their respective worm plots (Figures 1 and 5) were compared. Age group labels in the worm plots correspond to those shown in Table 14. The model df(μ)=11 presents evidence of misfit in the median curve for a few age groups (e.g. 14 d, 4 mo) for which corresponding plots have worms shifted down or up (Figure 1). The fit was improved by increasing the df(μ) to 12 (Figure 5), and thus the combination of df(μ)=12 and df(σ)=6 was chosen. Further evaluations of this model were carried out by examining the fit of the μ and σ curves and the patterns of the centile residuals (the empirical minus the fitted centiles) across age.

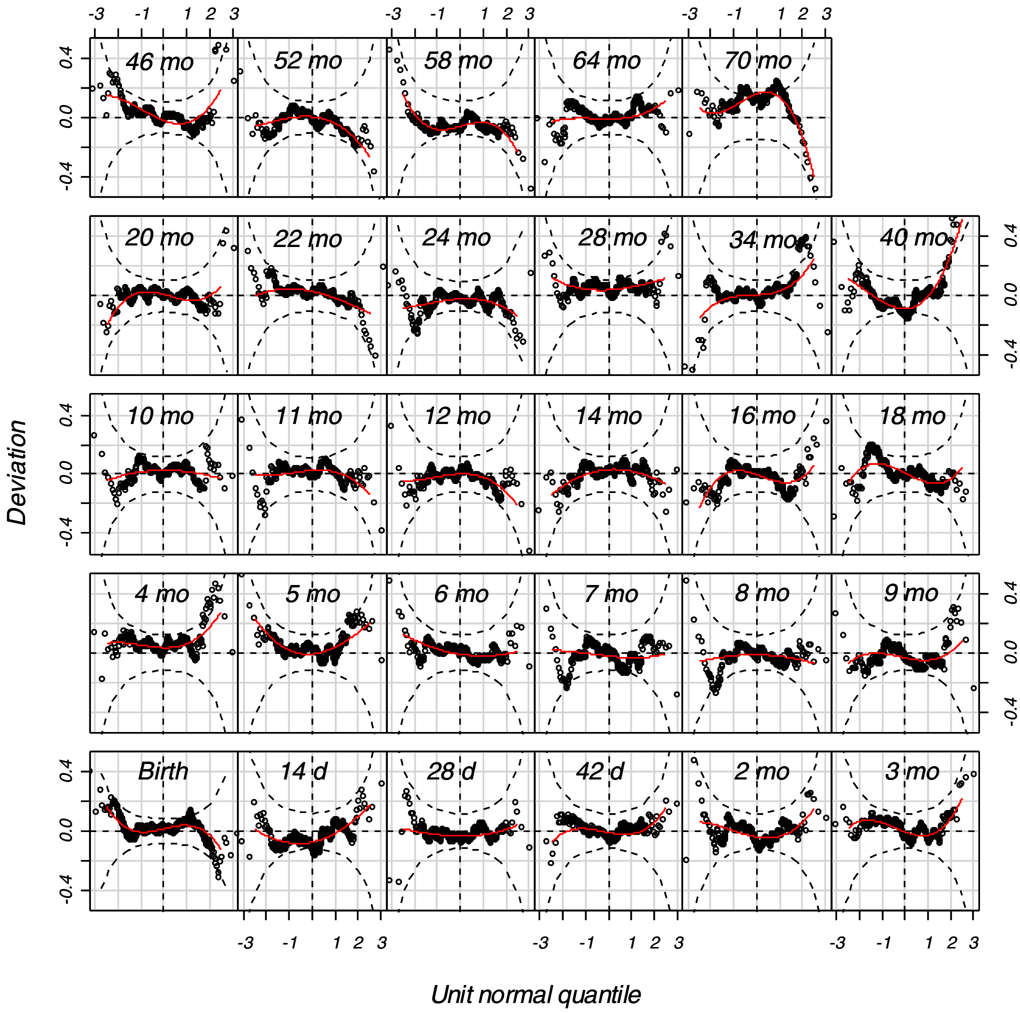


**Figure 1 Worm plots of z-scores for candidate model with df(μ)=11 and df(σ)=6 with age transformation age$^{0.35}$ for length/height-for-age for boys**

**Model 1: BCPE(x=age$^{0.35}$, df(μ)=12, df(σ)=6, ν=1, τ=2)**

The fitted parameter curves show adequate smoothing despite the erratic coefficient of variation in the cross-sectional sample's height (Figure 2). The residual plots of the fitted centiles for the period 0 to 24 months (Figure 3) showed no evidence of bias. For the age range 24 to 71 months, residuals of the fitted centiles showed a non-random pattern for the 50$^{th}$ centile, but were smaller than 0.6 cm up to 60 months where estimated SDs vary from 3.5 to 5 cm (Figure 4).

Table 13 shows the proportions of children with length (or height) below the fitted centiles. Age group labels correspond to the same age intervals provided in Table 14. Overall, there was no evidence of systematic departures from expected patterns suggestive of bias. Overestimates in the median (50$^{th}$ centile) for the age groups 14 d (55%), 2 mo (54%) and 40 mo (56%) were noted. The opposite was observed for the age group 70 mo (46%), i.e. the median was underestimated. The clinical significance of these few observed differences between fitted and observed proportions is likely to be small.

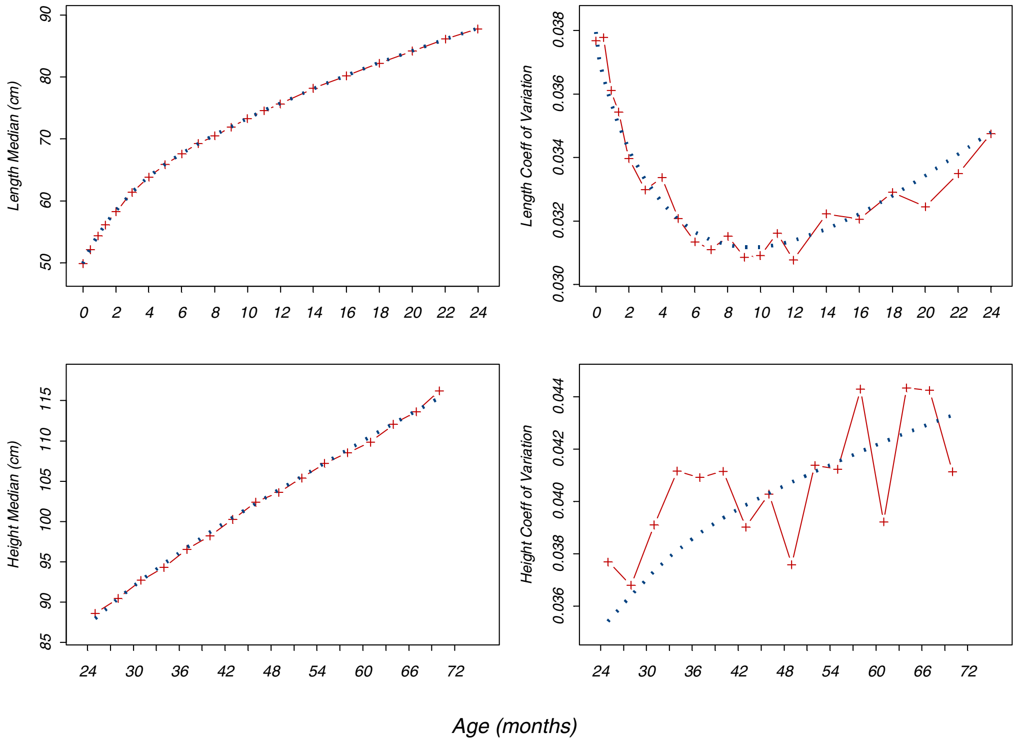


**Figure 2 Fitting of μ and σ curves of Model 1 for length/height-for-age for boys (dotted line) and their respective sample estimates (points with solid line)**

The worm plots for Model 1 are shown in Figure 5. The worms fitted to the points (solid red line) do not indicate any upward or downward shifts except in the last age group (70 mo). This implies that, overall, the fit of the median was adequate. In older age groups (40 mo and above), extreme values are noted outside the 95% confidence interval depicted by the dotted curve lines. This may be due to some extreme values that were not considered as data errors or outliers. The shapes of the worms deviate slightly from flat, but remain within bounds of the confidence intervals. For example, the age groups 40 mo, 46 mo and 70 mo present slightly U-shaped worms, indicating residual skewness to the left. There is no evidence of worms with a slope, which would indicate misfit in the variance curve. S-shaped worms indicate a misfit in the curve of the parameter related to kurtosis as is the case in the birth and 58 mo age groups, although here too, the worms are contained within the 95% confidence interval.

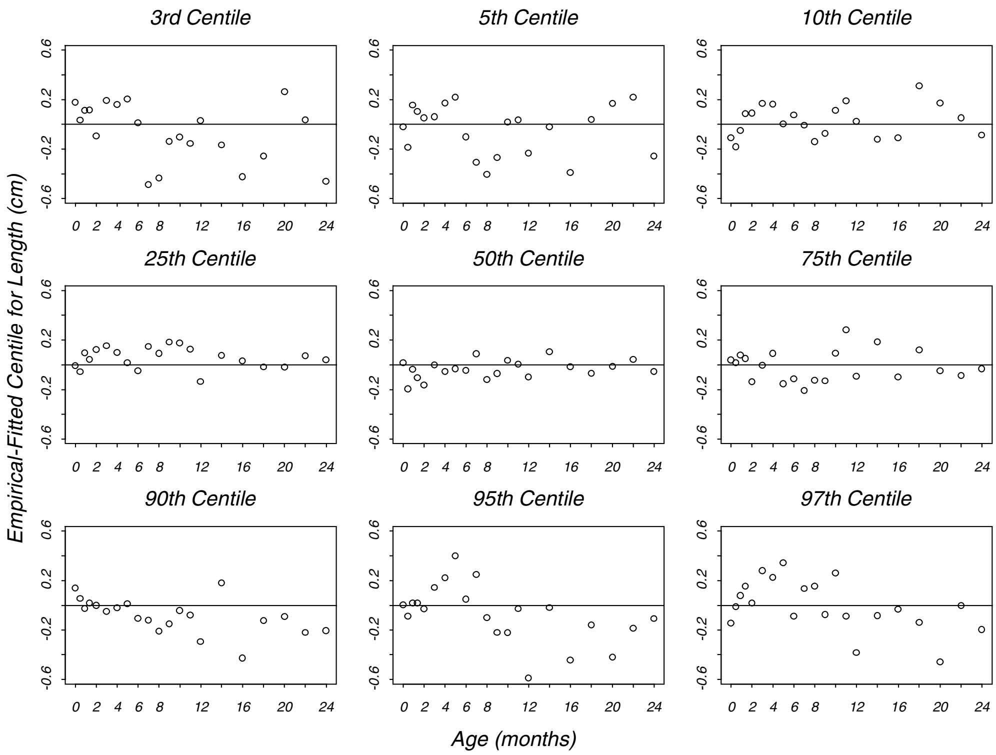


**Figure 3 Centile residuals from fitting Model 1 for length/height-for-age from 0 to 24 months for boys**

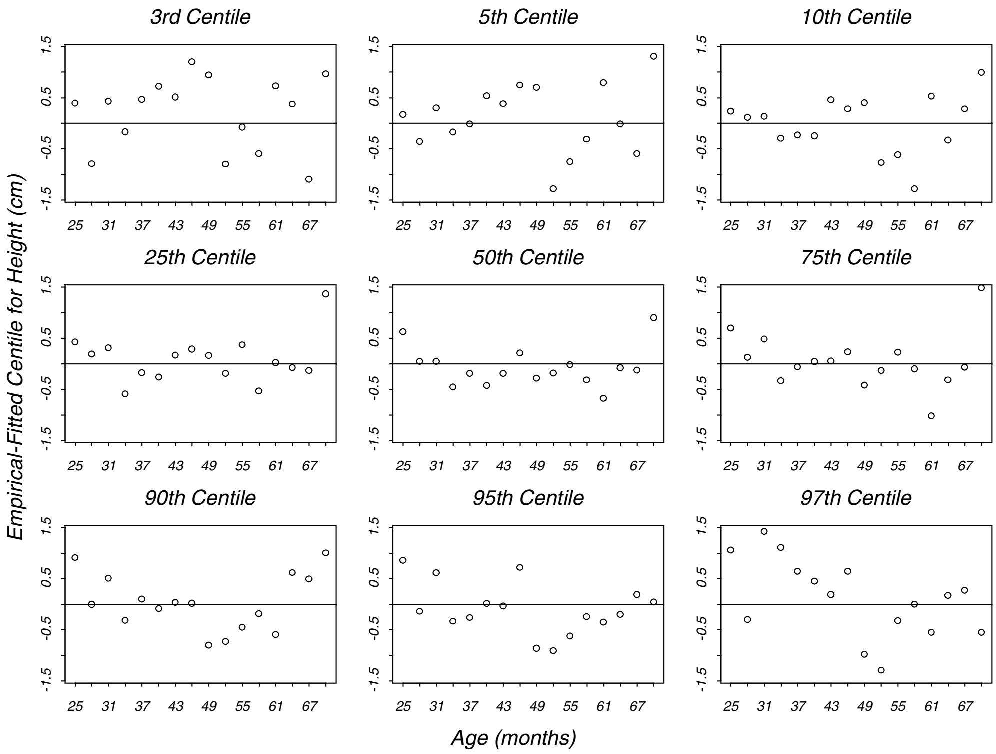


**Figure 4 Centile residuals from fitting Model 1 for length/height-for-age from 24 to 71 months for boys**

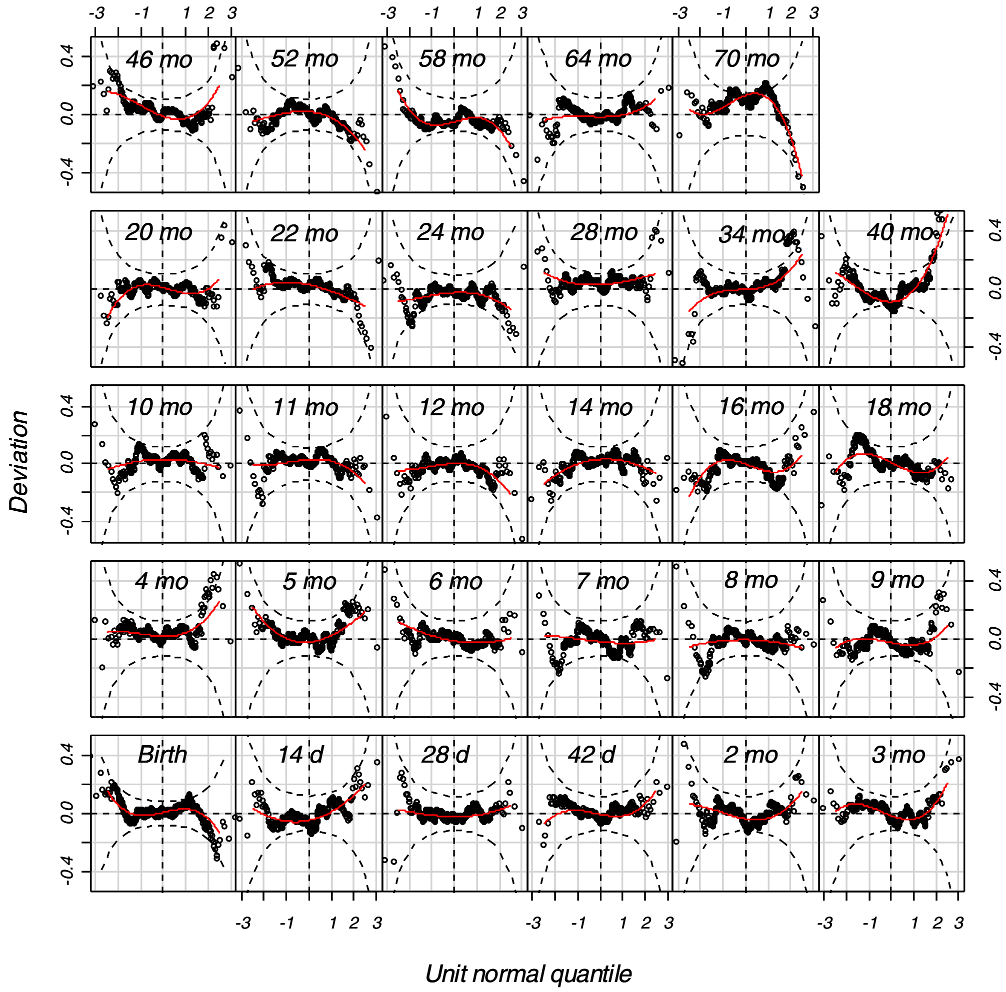


**Figure 5 Worm plots of z-scores for Model 1 for length/height-for-age for boys**

**Table 13 Observed proportions of children with measurements below the fitted centiles from Model 1, length/height-for-age for boys**

| Expected | Birth | 14 d | 28 d | 42 d | 2 mo | 3 mo | 4 mo | 5 mo | 6 mo | 7 mo |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 0.7 | 0.5 | 0.7 | 1.2 | 0.2 | 1.2 | 1.0 | 0.5 | 0.5 | 0.7 |
| **3** | 2.0 | 2.9 | 3.0 | 2.6 | 4.0 | 2.9 | 2.6 | 2.4 | 3.1 | 4.6 |
| **5** | 5.2 | 6.4 | 4.4 | 4.0 | 5.7 | 5.0 | 4.1 | 4.1 | 5.5 | 5.6 |
| **10** | 11.1 | 11.7 | 10.3 | 9.0 | 9.7 | 9.3 | 8.2 | 10.1 | 8.6 | 10.7 |
| **25** | 25.5 | 25.5 | 24.6 | 24.6 | 24.1 | 22.9 | 24.5 | 24.3 | 24.6 | 22.6 |
| **50** | 48.9 | 55.1 | 51.8 | 52.7 | 54.2 | 51.9 | 50.5 | 49.5 | 50.6 | 49.4 |
| **75** | 74.4 | 74.5 | 74.0 | 74.0 | 76.2 | 75.0 | 74.0 | 75.0 | 76.6 | 78.6 |
| **90** | 88.0 | 88.8 | 91.1 | 89.8 | 89.2 | 90.2 | 90.6 | 89.7 | 90.7 | 91.2 |
| **95** | 94.8 | 95.0 | 95.1 | 94.8 | 94.8 | 95.2 | 94.2 | 94.0 | 94.7 | 94.2 |
| **97** | 97.4 | 96.9 | 97.0 | 96.5 | 96.9 | 96.7 | 95.7 | 95.0 | 97.1 | 96.1 |
| **99** | 99.4 | 98.3 | 98.8 | 98.8 | 98.6 | 98.6 | 97.8 | 98.3 | 98.8 | 98.8 |
| **Expected** | **8 mo** | **9 mo** | **10 mo** | **11 mo** | **12 mo** | **14 mo** | **16 mo** | **18 mo** | **20 mo** | **22 mo** |
| **1** | 0.9 | 1.0 | 1.5 | 1.7 | 1.2 | 1.7 | 1.2 | 1.4 | 1.2 | 0.7 |
| **3** | 4.7 | 3.8 | 3.7 | 3.2 | 3.4 | 4.0 | 4.6 | 3.2 | 3.1 | 2.6 |
| **5** | 6.4 | 5.8 | 5.7 | 4.7 | 6.0 | 5.5 | 5.8 | 4.3 | 4.8 | 3.6 |
| **10** | 10.6 | 10.3 | 10.1 | 9.0 | 9.4 | 10.2 | 11.1 | 7.0 | 10.4 | 9.3 |
| **25** | 22.4 | 23.1 | 24.0 | 23.9 | 24.7 | 23.5 | 25.5 | 24.1 | 26.9 | 22.8 |
| **50** | 52.1 | 50.8 | 49.9 | 50.8 | 49.6 | 49.4 | 50.0 | 50.7 | 51.1 | 49.2 |
| **75** | 75.5 | 77.9 | 72.6 | 72.0 | 75.3 | 72.9 | 75.2 | 73.9 | 75.6 | 74.5 |
| **90** | 91.0 | 91.2 | 89.4 | 91.4 | 90.6 | 89.3 | 92.5 | 92.1 | 90.8 | 90.5 |
| **95** | 96.0 | 95.7 | 95.8 | 95.1 | 96.4 | 94.1 | 95.9 | 95.5 | 95.6 | 95.3 |
| **97** | 97.2 | 96.2 | 96.8 | 97.2 | 97.6 | 97.9 | 96.9 | 97.5 | 97.3 | 97.1 |
| **99** | 99.1 | 98.0 | 98.8 | 98.9 | 99.0 | 99.5 | 98.6 | 99.1 | 99.2 | 99.6 |

**Table 13 Observed proportions of children with measurements below the fitted centiles from Model 1, length/height-for-age for boys (continued)**

| Expected | 24 mo | 28 mo | 34 mo | 40 mo | 46 mo | 52 mo | 58 mo | 64 mo | 70 mo | Overall |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 1.2 | 0.4 | 1.3 | 1.0 | 0.8 | 1.2 | 0.4 | 1.5 | 0.7 | 1.0 |
| **3** | 4.0 | 3.1 | 2.3 | 2.1 | 1.7 | 3.9 | 3.2 | 3.4 | 2.4 | 3.1 |
| **5** | 5.2 | 4.8 | 5.3 | 4.4 | 3.6 | 5.5 | 5.7 | 4.2 | 5.1 | 5.0 |
| **10** | 11.5 | 10.2 | 10.4 | 10.7 | 9.0 | 10.1 | 11.5 | 9.1 | 8.8 | 10.0 |
| **25** | 25.3 | 23.1 | 24.3 | 26.7 | 22.8 | 22.3 | 26.3 | 25.9 | 22.1 | 24.3 |
| **50** | 50.9 | 48.8 | 50.7 | 56.0 | 50.7 | 49.3 | 52.4 | 52.2 | 45.9 | 50.9 |
| **75** | 75.5 | 71.5 | 75.1 | 75.6 | 74.8 | 75.1 | 75.3 | 75.8 | 70.7 | 74.8 |
| **90** | 91.2 | 89.4 | 89.5 | 89.7 | 91.4 | 91.7 | 91.1 | 88.2 | 87.1 | 90.2 |
| **95** | 94.9 | 95.0 | 94.2 | 94.5 | 95.2 | 96.1 | 96.0 | 94.9 | 95.6 | 95.1 |
| **97** | 97.6 | 96.5 | 95.9 | 96.2 | 97.1 | 97.8 | 97.4 | 96.6 | 98.0 | 96.9 |
| **99** | 99.5 | 98.8 | 97.6 | 97.7 | 98.7 | 99.4 | 99.4 | 99.2 | 100.0 | 98.9 |

Note: Group labels correspond to the age intervals in Table 14.

The Q-test was performed to assess the overall significance of the deviations noted for the birth and 40 mo, 46 mo, 58 mo age groups (Table 14). Absolute values of z3 larger than 2 were observed only in the age groups 40 mo and 46 mo, and for z4 at birth and in age group 58 mo. Nevertheless, the overall tests (p-values shown for each statistic in the last row of the table) do not suggest any significant departures of the fitted model z-scores from normality at the 5% level of significance.

**Table 14 Q-test for z-scores from Model 1 [BCPE(x=age$^{0.35}$, df(μ)=12, df(σ)=6, ν=1, τ=2)] for length/height-for-age for boys**

| Age (days) | Group | N | z1 | z2 | z3 | z4 |
|---|---|---|---|---|---|---|
| 0 | **Birth** | 893 | 0.21 | -0.30 | 0.07 | -2.24 |
| 1 to 16 | **14 d** | 419 | -0.46 | 1.02 | 1.29 | 0.08 |
| 17 to 34 | **28 d** | 427 | -0.21 | 0.08 | 0.39 | 0.24 |
| 35 to 49 | **42 d** | 423 | 0.01 | 0.23 | 0.29 | 1.25 |
| 50 to 69 | **2 mo** | 424 | -0.25 | -0.15 | 1.12 | 0.80 |
| 70 to 99 | **3 mo** | 420 | 0.11 | -0.28 | 1.09 | 1.38 |
| 100 to 129 | **4 mo** | 416 | 0.75 | 0.65 | 1.15 | 0.72 |
| 130 to 159 | **5 mo** | 416 | 0.27 | 0.23 | 1.73 | -0.07 |
| 160 to 189 | **6 mo** | 419 | -0.02 | -0.62 | 0.57 | 0.16 |
| 190 to 219 | **7 mo** | 411 | -0.36 | -0.01 | 0.16 | 0.30 |
| 220 to 249 | **8 mo** | 424 | -0.30 | -0.16 | -0.74 | 0.23 |
| 250 to 279 | **9 mo** | 398 | -0.38 | -0.14 | 0.69 | 0.91 |
| 280 to 309 | **10 mo** | 405 | 0.49 | 0.18 | -0.54 | 0.12 |
| 310 to 349 | **11 mo** | 465 | 0.29 | -0.18 | -0.83 | -0.42 |
| 350 to 379 | **12 mo** | 417 | -0.34 | -0.36 | -1.02 | -0.41 |
| 380 to 439 | **14 mo** | 421 | 0.21 | 0.37 | -1.04 | 0.13 |
| 440 to 499 | **16 mo** | 416 | -0.28 | -0.02 | -0.59 | 1.51 |
| 500 to 559 | **18 mo** | 444 | 0.00 | -0.96 | -0.15 | 1.69 |
| 560 to 619 | **20 mo** | 521 | -0.23 | 0.09 | -0.60 | 1.81 |
| 620 to 679 | **22 mo** | 549 | 0.51 | -0.92 | -1.05 | 0.83 |
| 680 to 749 | **24 mo** | 593 | -0.96 | 0.04 | -0.81 | -0.23 |
| 750 to 929 | **28 mo** | 480 | 1.02 | 0.15 | 0.63 | 0.11 |
| 930 to 1119 | **34 mo** | 531 | 0.27 | 1.52 | 0.29 | 1.37 |
| 1120 to 1309 | **40 mo** | 525 | -0.52 | 1.46 | 3.55 | 1.82 |
| 1310 to 1499 | **46 mo** | 523 | 0.37 | -0.62 | 2.01 | 1.47 |
| 1500 to 1689 | **52 mo** | 507 | -0.12 | -0.72 | -1.47 | -0.32 |
| 1690 to 1879 | **58 mo** | 494 | -1.04 | -0.38 | 0.09 | -2.07 |
| 1880 to 2069 | **64 mo** | 475 | -0.13 | 0.46 | 0.36 | 0.48 |
| 2070 to 2249 | **70 mo** | 295 | 1.39 | -0.25 | -1.86 | -1.23 |
| **Overall Q stats** | | **13 551** | **7.76** | **10.07** | **38.51** | **33.73** |
| **degrees of freedom** | | | **17.0** | **25.5** | **29.0** | **29.0** |
| **p-value** | | | **0.9714** | **0.9972** | **0.1113** | **0.2494** |

Note: Absolute values of z1, z2, z3 or z4 larger than 2 indicate misfit of, respectively, mean, variance, skewness or kurtosis.

To evaluate whether Model 1 could be improved by modelling the parameter that corrects for skewness, a model using the BCPE distribution fixing τ=2 and modelling the other three parameters was considered. The degrees of freedom of the cubic splines for μ and σ were kept as indicated earlier for Model 1, with the same age-transformation power. The best choice of degrees of freedom for the cubic splines to fit the parameter ν was then sought.

**Table 15 Goodness-of-fit summary for models BCPE(x=age$^{0.35}$, df(μ)=12, df(σ)=6, df(ν)=?, τ=2) for length/height-for-age for boys**

| df(ν) | GD[a] | GAIC(3)[a] | Total df |
|---|---|---|---|
| **3** | 312.1 | 375.1 | 21 |
| **4** | 307.4 | 373.4 | 22 |
| **5** | 301.4 | 370.4 | 23 |
| **6** | 297.0 | 369.0 | 24 |
| **7** | 294.4 | 369.4 | 25 |
| **8** | 292.7 | 370.7 | 26 |

GD, Global Deviance; GAIC(3), Generalized Akaike Information Criterion with penalty equal to 3;
[a] In excess of 65 000

To assess the goodness of fit of the models considered within this class, only the *GAIC(3)* values were compared, since this criterion penalizes more than does the *AIC* for increased degrees of freedom. Table 15 shows the *GAIC(3)* values for degrees of freedom varying from 3 to 8. In this case df(ν)=6 presented the best fit, so the corresponding model was selected for further evaluation.

**Model 2: BCPE(x=age$^{0.35}$, df(μ)=12, df(σ)=6, df(ν)=6, τ=2)**

Model 2 yielded a *GAIC(3)* of 65 369.0 compared with the 65 369.7 of Model 1. The results for Model 2 from the same diagnostic tools/tests presented for Model 1 were compared to assess the impact of modelling skewness for specific ages.

The worm plots for the z-scores derived from Model 2 (Figure 6) show very similar results to those that correspond to Model 1 (Figure 5). This indicates that deviations from normal that were observed in z-scores derived from Model 1 are unlikely to be corrected by modelling skewness. The Q-test for Model 2 (Table 16) provides slightly improved results where only one group (40 mo) has residual skewness compared to two groups in Model 1 (Table 14). Nonetheless both sets of results lead to the same conclusion, i.e. neither model's residuals (or z-scores) depart significantly from the normal distribution.

Although some indication of residual kurtosis was observed in two of the 29 age groups after fitting both Models 1 and 2, the overall test results were not significant: Q-test (z4) p-values were 0.25 and 0.26 for models 1 and 2, respectively (Tables 14 and 16).

Table 17 presents the observed proportions of children below specific fitted centiles by age group. Observed proportion values are slightly closer to the expected proportion of children below the centiles for age groups 40 mo, 46 mo and 70 mo, when Model 2 is fitted, i.e. modelling skewness.

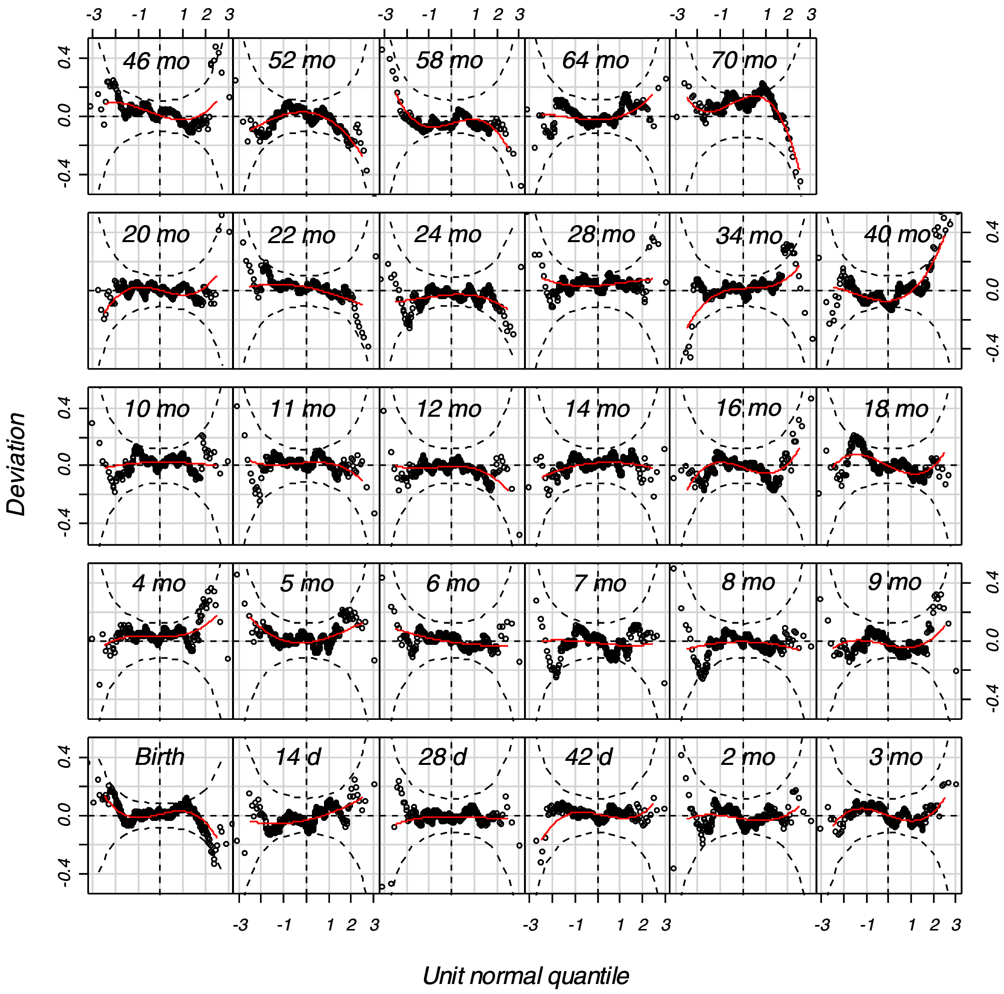


**Figure 6 Worm plots of z-scores for Model 2 for length/height-for-age for boys**

The diagnostic tools/tests used to evaluate distinct models supported the selection of the simplest model, i.e. the BCPE distribution with fixed ν=1 and τ=2, that corresponds to the normal distribution. Overall statistics like *GAIC(3)* supported this choice. Considering local goodness of fit, the Q-test indicated minor departures from normality as reflected by the residuals (z-scores) of very few age groups when Model 1 was fitted. The worm plot results similarly indicate misfits for very few age groups. Since those isolated discrepancies or misfits were only partially corrected by modelling the parameter ν of the distribution (Model 2), it is reasonable to assume that these deviations occurred by chance or for other than biological reasons, and that the simpler model (i.e. Model 1) is adequate.

Model 1 was selected and a new iteration was done using the values of df(μ) and df(σ) equal to 12 and 6, respectively, to re-search the best age-transformation power λ. The smallest global deviance in this case was for λ=0.4 (GD=65 315.6), but with only a very minor difference from the model using λ=0.35 (GD=65 315.7). There was thus no need for updating λ, and the selected model for constructing the length/height-for-age growth curves for boys remained BCPE(x= age$^{0.35}$, df(μ)=12, df(σ)=6, ν=1, τ=2).

**Table 16 Q-test for z-scores from Model 2 [BCPE(x=age$^{0.35}$, df(μ)=12, df(σ)=6, df(ν)=6, τ=2)] for length/height-for-age for boys**

| Age (days) | Group | N | z1 | z2 | z3 | z4 |
|---|---|---|---|---|---|---|
| 0 | **Birth** | 893 | 0.21 | -0.30 | -0.20 | -2.24 |
| 1 to 16 | **14 d** | 419 | -0.43 | 1.00 | 0.56 | -0.03 |
| 17 to 34 | **28 d** | 427 | -0.19 | 0.10 | -0.41 | 0.38 |
| 35 to 49 | **42 d** | 423 | 0.02 | 0.26 | -0.67 | 1.53 |
| 50 to 69 | **2 mo** | 424 | -0.25 | -0.15 | 0.24 | 0.76 |
| 70 to 99 | **3 mo** | 420 | 0.11 | -0.29 | 0.19 | 1.27 |
| 100 to 129 | **4 mo** | 416 | 0.75 | 0.61 | 0.40 | 0.65 |
| 130 to 159 | **5 mo** | 416 | 0.26 | 0.20 | 1.23 | -0.21 |
| 160 to 189 | **6 mo** | 419 | -0.02 | -0.60 | 0.23 | 0.10 |
| 190 to 219 | **7 mo** | 411 | -0.37 | 0.01 | -0.02 | 0.29 |
| 220 to 249 | **8 mo** | 424 | -0.30 | -0.14 | -0.76 | 0.24 |
| 250 to 279 | **9 mo** | 398 | -0.38 | -0.13 | 0.82 | 0.94 |
| 280 to 309 | **10 mo** | 405 | 0.49 | 0.19 | -0.30 | 0.12 |
| 310 to 349 | **11 mo** | 465 | 0.30 | -0.18 | -0.50 | -0.48 |
| 350 to 379 | **12 mo** | 417 | -0.35 | -0.39 | -0.64 | -0.46 |
| 380 to 439 | **14 mo** | 421 | 0.22 | 0.35 | -0.54 | 0.03 |
| 440 to 499 | **16 mo** | 416 | -0.28 | -0.04 | 0.01 | 1.56 |
| 500 to 559 | **18 mo** | 444 | -0.01 | -0.95 | 0.40 | 1.72 |
| 560 to 619 | **20 mo** | 521 | -0.22 | 0.09 | -0.08 | 1.78 |
| 620 to 679 | **22 mo** | 549 | 0.53 | -0.91 | -0.76 | 0.72 |
| 680 to 749 | **24 mo** | 593 | -0.93 | 0.05 | -0.70 | -0.25 |
| 750 to 929 | **28 mo** | 480 | 1.07 | 0.16 | 0.35 | 0.04 |
| 930 to 1119 | **34 mo** | 531 | 0.30 | 1.59 | -0.70 | 1.63 |
| 1120 to 1309 | **40 mo** | 525 | -0.54 | 1.34 | 2.41 | 1.30 |
| 1310 to 1499 | **46 mo** | 523 | 0.35 | -0.67 | 1.03 | 1.10 |
| 1500 to 1689 | **52 mo** | 507 | -0.13 | -0.63 | -1.90 | -0.18 |
| 1690 to 1879 | **58 mo** | 494 | -1.06 | -0.34 | 0.07 | -2.06 |
| 1880 to 2069 | **64 mo** | 475 | -0.12 | 0.46 | 0.84 | 0.43 |
| 2070 to 2249 | **70 mo** | 295 | 1.42 | -0.29 | -1.34 | -1.65 |
| **Overall Q stats** | | **13 551** | **7.94** | **9.80** | **19.92** | **33.53** |
| **degrees of freedom** | | | **17.0** | **25.5** | **23.0** | **29.0** |
| **p-value** | | | **0.9678** | **0.9978** | **0.6468** | **0.2568** |

Note: Absolute values of z1, z2, z3 or z4 larger than 2 indicate misfit of, respectively, mean, variance, skewness or kurtosis.

Figures 7 to 10 show the empirical and fitted centiles derived from the selected model for the length-for-age (0 to 24 months) and height-for-age (24 to 71 months) growth curves. The final standards were constructed as described in detail in section 3.1.

**Table 17 Observed proportions of children with measurements below the fitted centiles from Model 2, length/height-for-age for boys**

| Expected | Birth | 14 d | 28 d | 42 d | 2 mo | 3 mo | 4 mo | 5 mo | 6 mo | 7 mo |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 0.7 | 1.0 | 0.7 | 1.2 | 0.2 | 1.4 | 1.4 | 1.0 | 0.5 | 0.7 |
| **3** | 2.0 | 3.1 | 3.0 | 2.8 | 4.0 | 2.9 | 2.9 | 2.6 | 3.8 | 4.6 |
| **5** | 5.2 | 6.4 | 4.7 | 4.5 | 6.4 | 5.0 | 4.1 | 4.3 | 6.0 | 6.1 |
| **10** | 11.1 | 12.2 | 10.5 | 9.5 | 9.7 | 9.3 | 8.7 | 10.1 | 8.6 | 10.7 |
| **25** | 25.5 | 25.3 | 24.1 | 24.3 | 23.8 | 22.6 | 23.6 | 24.3 | 24.6 | 22.4 |
| **50** | 48.9 | 55.1 | 51.3 | 52.2 | 53.8 | 51.7 | 50.2 | 49.0 | 50.6 | 49.4 |
| **75** | 74.4 | 74.5 | 73.5 | 73.3 | 75.9 | 75.0 | 73.6 | 75.0 | 76.6 | 78.6 |
| **90** | 88.0 | 89.0 | 91.3 | 90.3 | 89.4 | 90.2 | 90.9 | 89.7 | 90.7 | 91.2 |
| **95** | 95.3 | 95.2 | 95.1 | 95.0 | 95.0 | 95.2 | 94.2 | 94.2 | 94.7 | 94.2 |
| **97** | 97.6 | 96.9 | 97.0 | 96.5 | 97.4 | 96.7 | 95.9 | 95.4 | 97.4 | 96.4 |
| **99** | 99.4 | 98.3 | 99.1 | 99.1 | 98.6 | 99.0 | 98.3 | 98.3 | 98.8 | 98.8 |
| **Expected** | **8 mo** | **9 mo** | **10 mo** | **11 mo** | **12 mo** | **14 mo** | **16 mo** | **18 mo** | **20 mo** | **22 mo** |
| **1** | 0.9 | 1.0 | 1.2 | 1.5 | 1.2 | 1.7 | 1.2 | 1.4 | 1.2 | 0.5 |
| **3** | 4.7 | 3.5 | 3.7 | 3.2 | 2.9 | 3.8 | 4.3 | 3.2 | 2.9 | 2.6 |
| **5** | 6.4 | 5.8 | 5.7 | 4.7 | 5.5 | 5.2 | 5.8 | 4.3 | 4.8 | 3.6 |
| **10** | 10.6 | 10.3 | 10.1 | 8.8 | 9.4 | 10.2 | 11.1 | 7.0 | 10.4 | 9.3 |
| **25** | 22.4 | 23.1 | 24.2 | 24.3 | 24.7 | 24.2 | 25.5 | 24.5 | 26.9 | 22.8 |
| **50** | 52.1 | 51.0 | 49.9 | 50.8 | 50.1 | 50.1 | 50.5 | 51.1 | 51.1 | 49.4 |
| **75** | 75.5 | 77.9 | 72.8 | 72.3 | 75.5 | 72.9 | 75.5 | 74.1 | 75.6 | 74.5 |
| **90** | 91.0 | 91.2 | 89.4 | 91.4 | 90.6 | 89.1 | 92.5 | 91.7 | 90.8 | 90.5 |
| **95** | 96.0 | 95.7 | 95.8 | 95.1 | 96.2 | 93.8 | 95.9 | 95.5 | 95.6 | 95.1 |
| **97** | 97.2 | 96.2 | 96.8 | 97.2 | 97.4 | 97.6 | 96.9 | 97.5 | 97.3 | 97.1 |
| **99** | 99.1 | 98.0 | 98.8 | 98.9 | 99.0 | 99.5 | 98.6 | 99.1 | 99.2 | 99.6 |

**Table 17 Observed proportions of children with measurements below the fitted centiles from Model 2, length/height-for-age for boys (continued)**

| Expected | 24 mo | 28 mo | 34 mo | 40 mo | 46 mo | 52 mo | 58 mo | 64 mo | 70 mo | Overall |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 1.2 | 0.4 | 1.3 | 1.3 | 0.8 | 1.2 | 0.4 | 1.3 | 0.7 | 1.0 |
| **3** | 4.0 | 3.1 | 2.6 | 2.1 | 1.9 | 3.9 | 3.2 | 3.4 | 2.4 | 3.2 |
| **5** | 5.2 | 4.8 | 5.5 | 4.6 | 4.6 | 5.5 | 5.7 | 4.2 | 5.1 | 5.1 |
| **10** | 11.5 | 10.2 | 10.4 | 10.9 | 9.2 | 10.3 | 11.5 | 9.1 | 8.5 | 10.0 |
| **25** | 25.3 | 22.7 | 24.1 | 25.9 | 22.8 | 22.3 | 26.7 | 26.1 | 22.4 | 24.3 |
| **50** | 50.9 | 47.7 | 49.9 | 55.2 | 50.5 | 48.9 | 52.4 | 52.2 | 46.9 | 50.8 |
| **75** | 75.5 | 71.5 | 74.8 | 75.2 | 74.2 | 75.1 | 75.3 | 76.0 | 71.1 | 74.7 |
| **90** | 91.2 | 89.4 | 89.5 | 89.9 | 91.4 | 91.7 | 91.1 | 88.2 | 87.1 | 90.3 |
| **95** | 94.8 | 95.0 | 94.4 | 94.7 | 95.8 | 96.3 | 96.0 | 94.5 | 95.2 | 95.2 |
| **97** | 97.6 | 96.7 | 96.2 | 96.2 | 97.3 | 98.0 | 97.2 | 96.4 | 98.0 | 97.0 |
| **99** | 99.5 | 98.8 | 97.7 | 97.9 | 98.7 | 99.4 | 99.2 | 99.2 | 100.0 | 98.9 |

Note: Group labels correspond to the age intervals in Table 16.

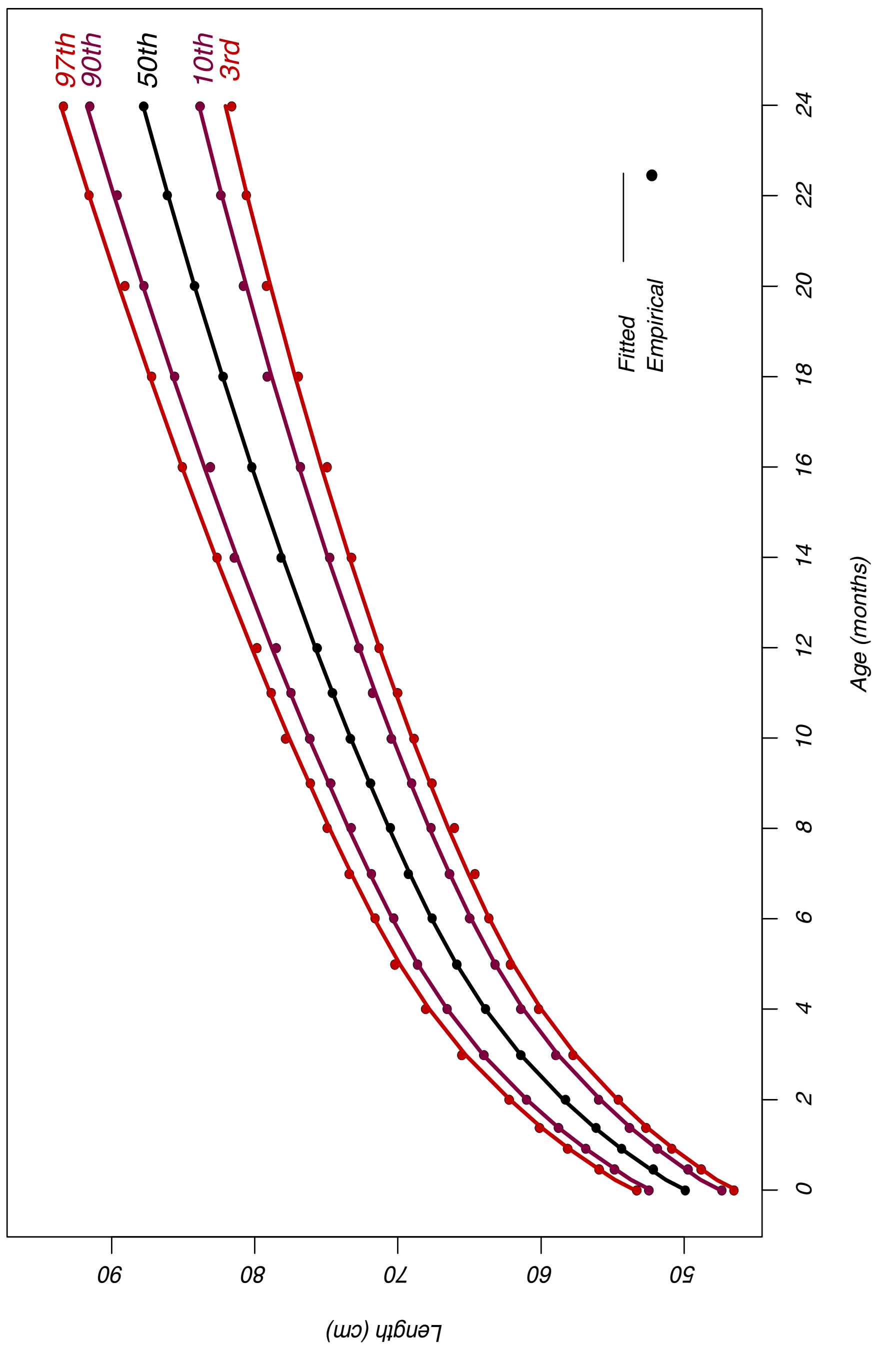


**Figure 7 3rd, 10th, 50th, 90th, 97th smoothed centile curves and empirical values: length-for-age for boys from birth to 24 months**

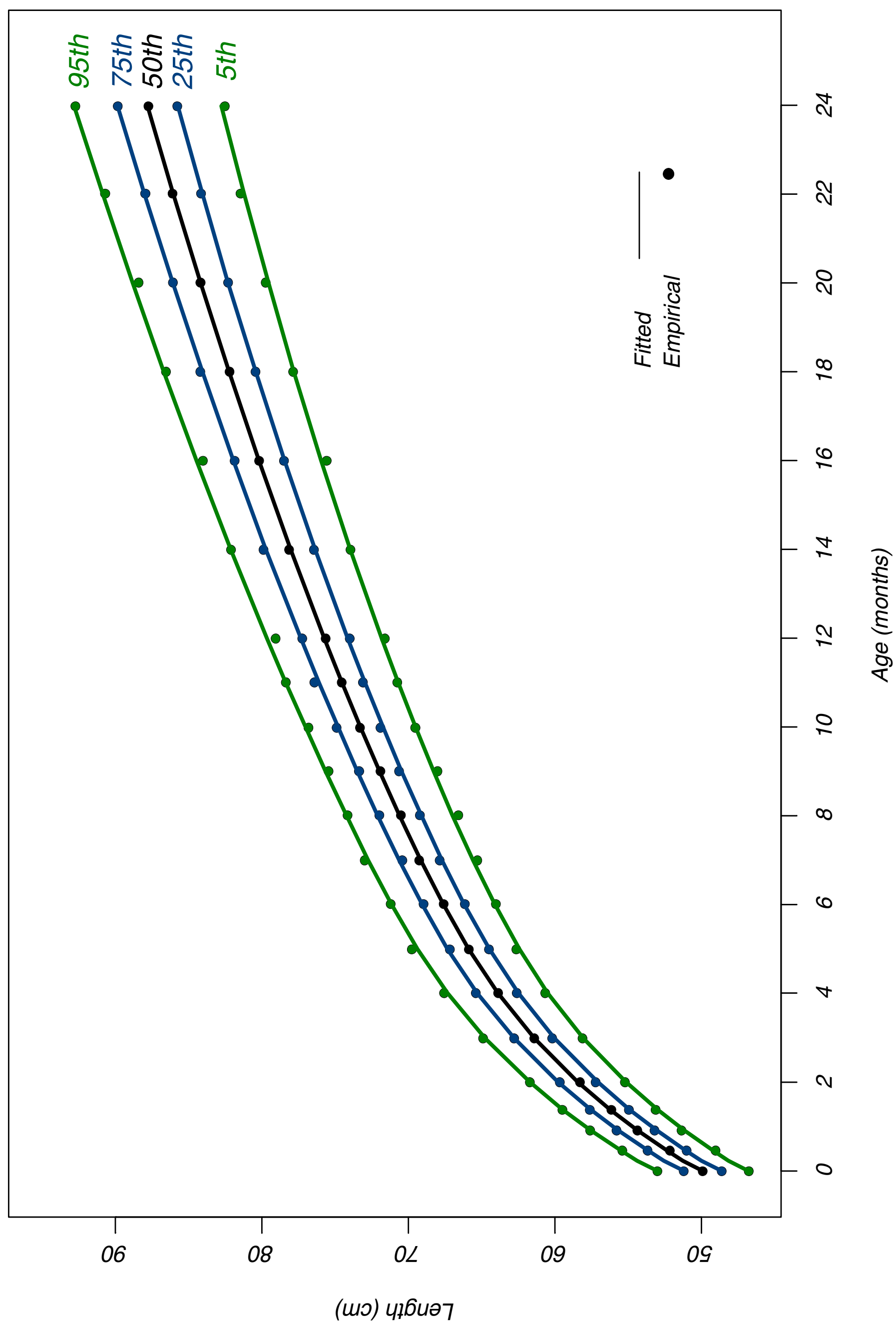


**Figure 8** **5th, 25th, 50th, 75th, 95th smoothed centile curves and empirical values: length-for-age for boys from birth to 24 months**

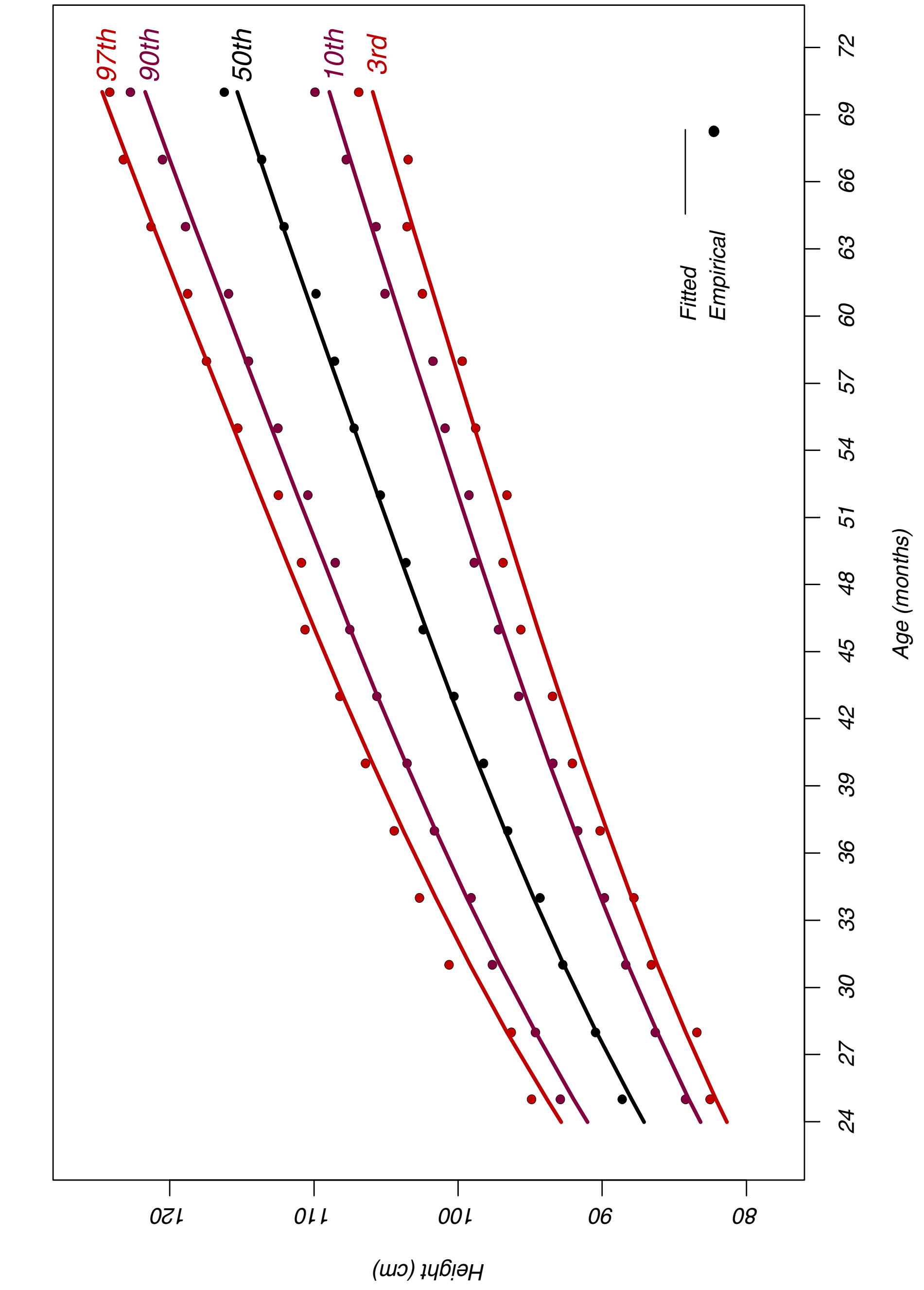


**Figure 9 3rd, 10th, 50th, 90th, 97th smoothed centile curves and empirical values: height-for-age for boys from 24 to 71 months**

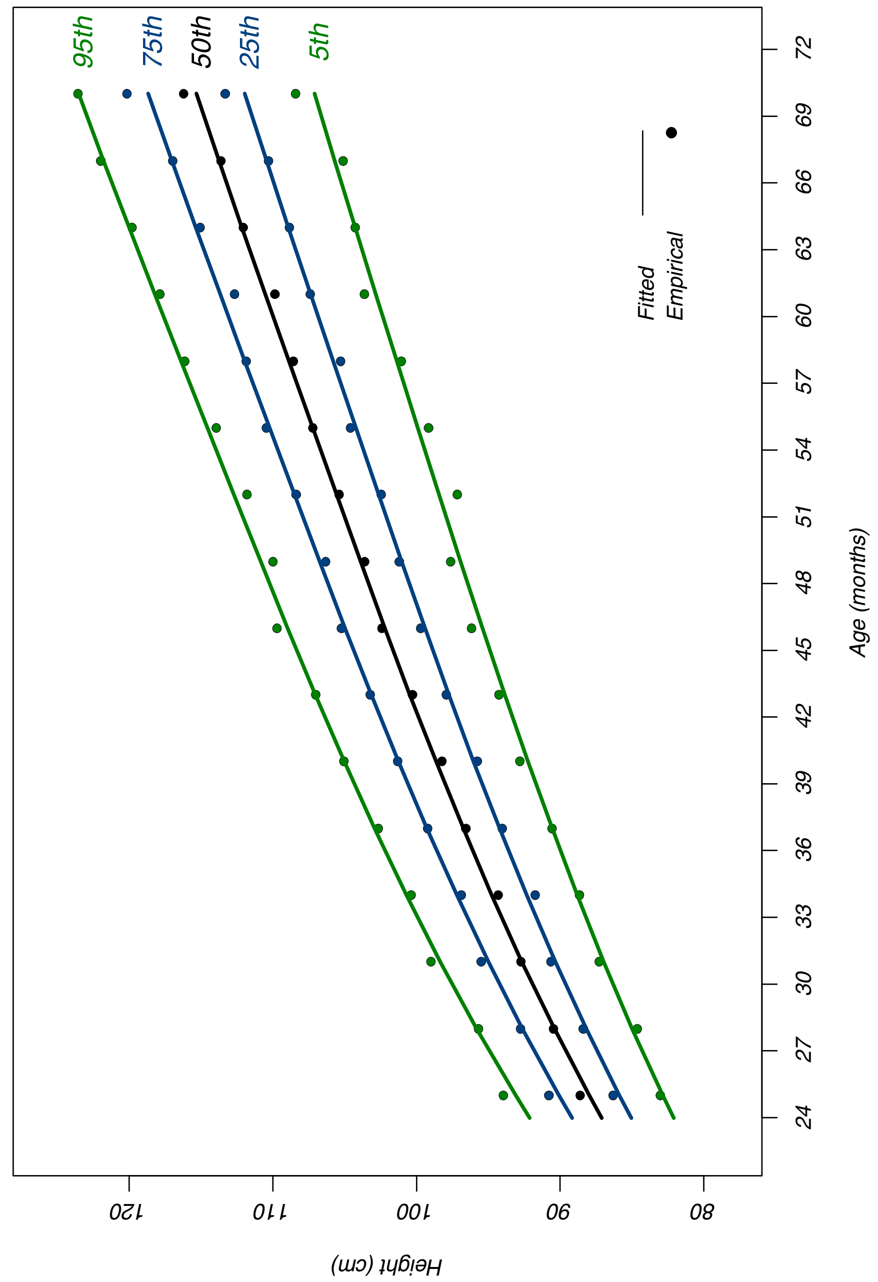


**Figure 10 5th, 25th, 50th, 75th, 95th smoothed centile curves and empirical values: height-for-age for boys from 24 to 71 months**

### 3.2.3 WHO standards and their comparison with NCHS and CDC 2000 references

This section presents the final WHO length/height-for-age z-score and percentile charts (Figures 11 to 14) and tables (Tables 18 to 20) for boys. It also provides the z-score comparisons of the WHO versus NCHS (Figure 15) and CDC 2000 (Figure 16) curves.

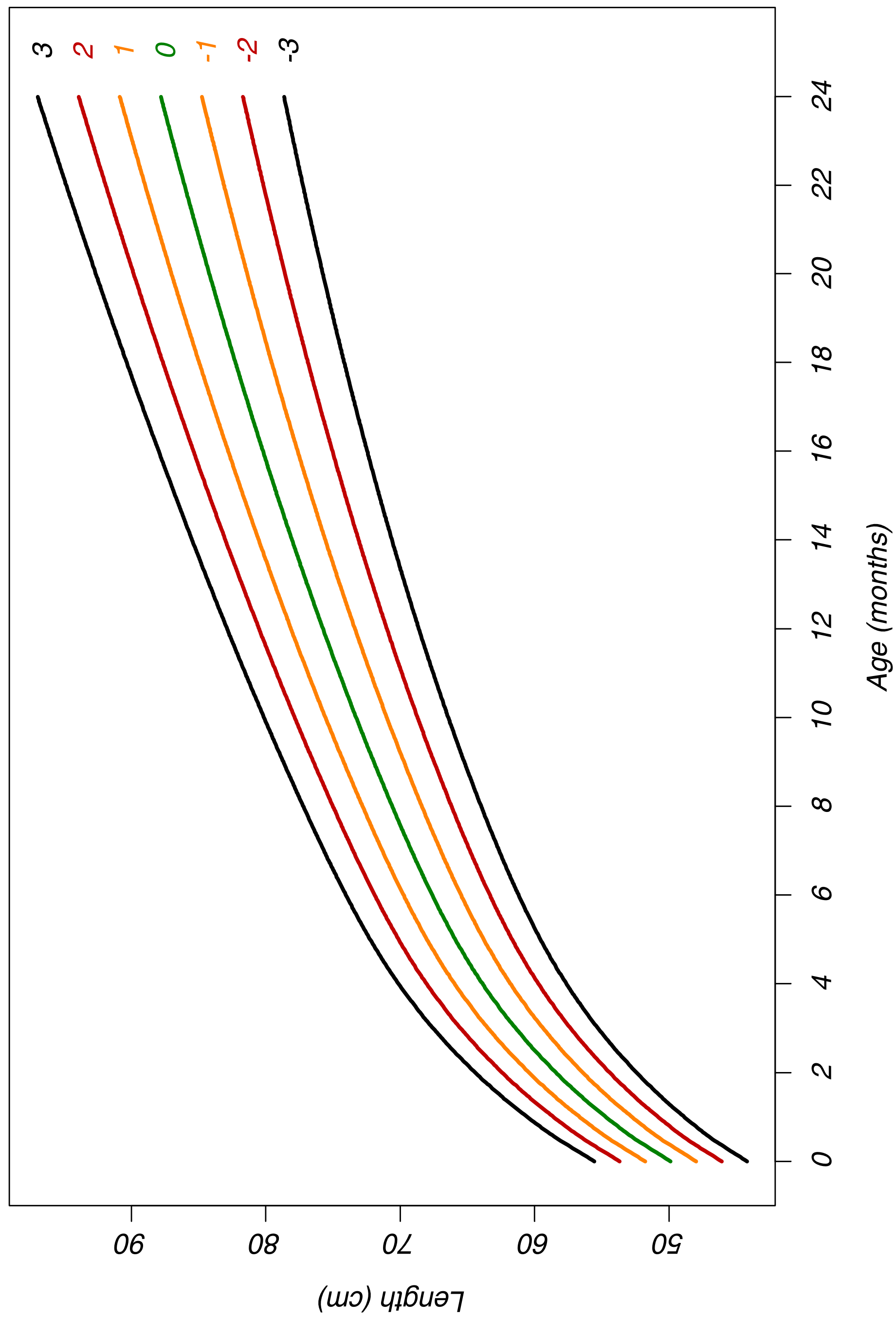


**Figure 11 WHO length-for-age z-scores for boys from birth to 24 months**

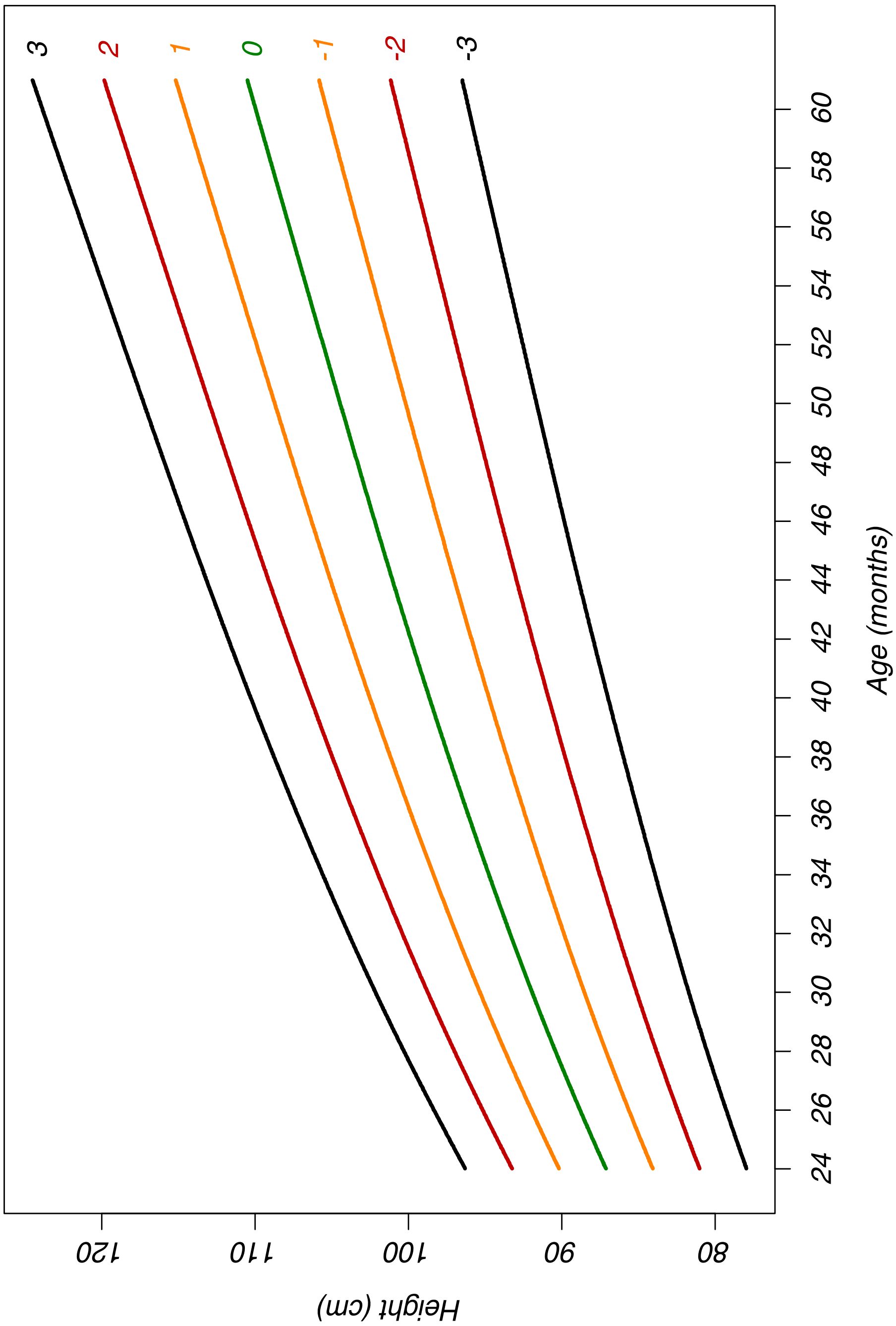


**Figure 12 WHO height-for-age z-scores for boys from 24 to 60 months**

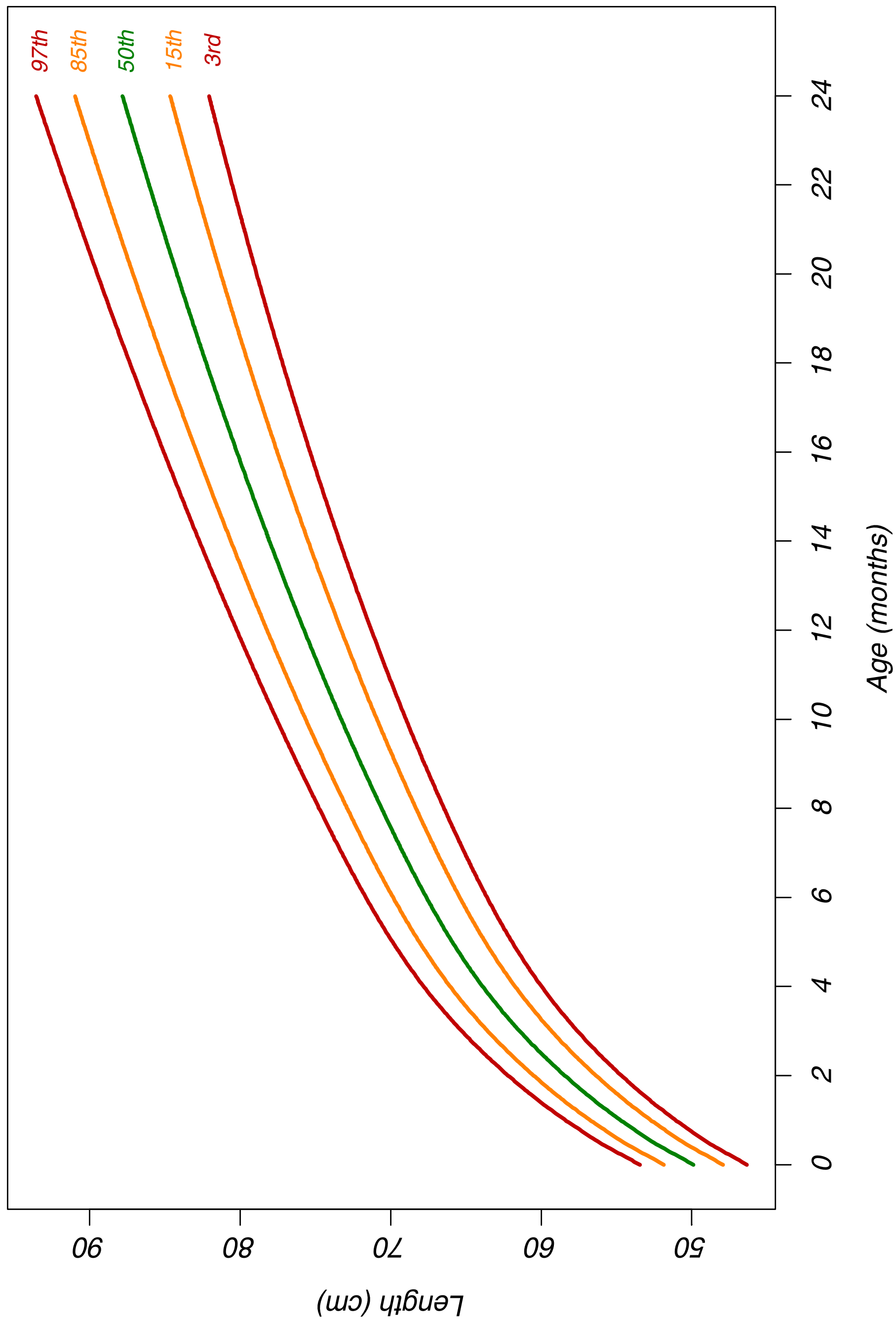


**Figure 13 WHO length-for-age percentiles for boys from birth to 24 months**

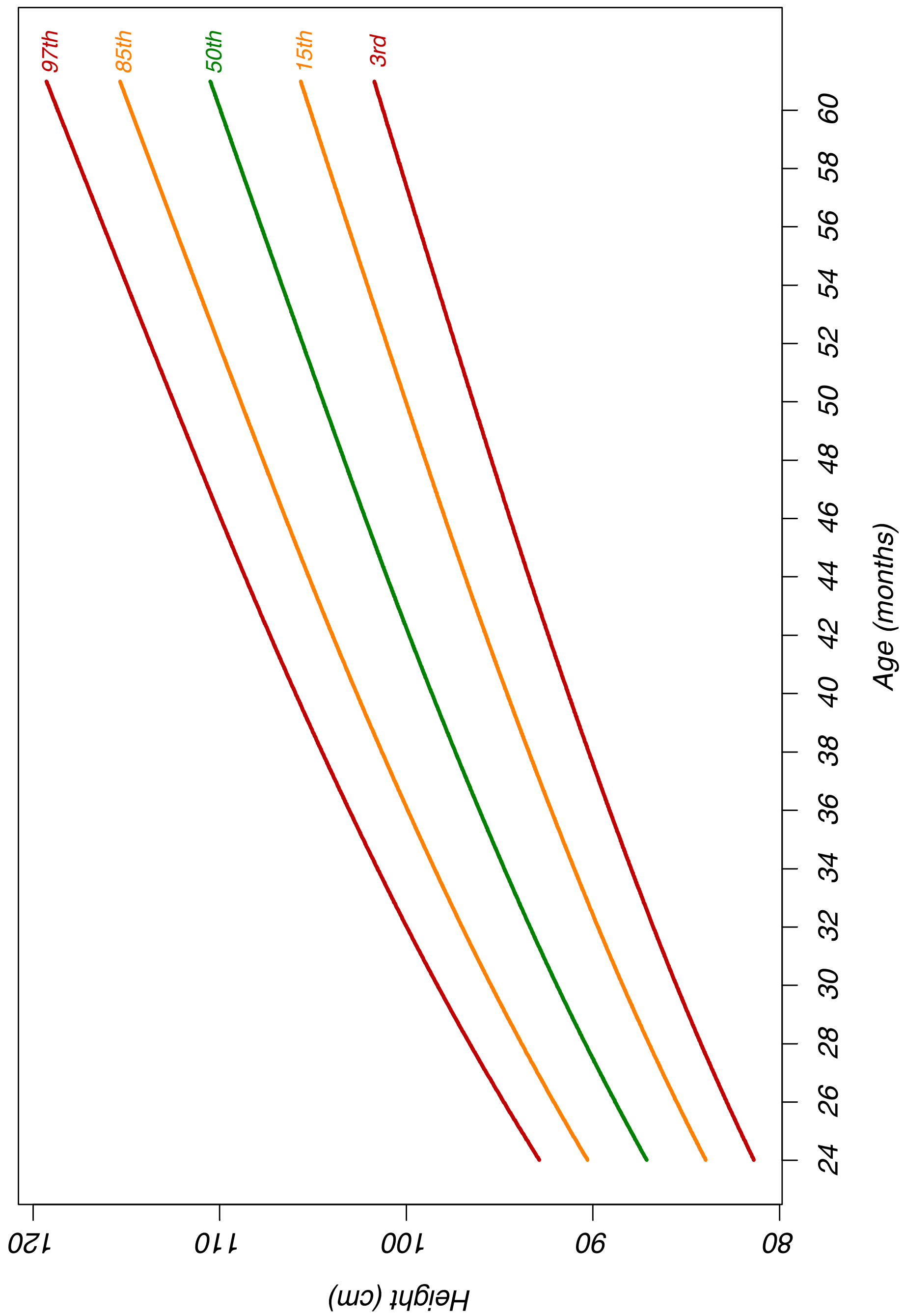


**Figure 14 WHO height-for-age percentiles for boys from 24 to 60 months**

*Tables*

**Table 18 Length-for-age for boys, age in weeks**

| | | | | | Percentiles (length in cm) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Week** | **L** | **M** | **S** | **SD** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **0** | 1 | 49.8842 | 0.03795 | 1.8931 | 45.5 | 46.3 | 46.8 | 47.9 | 48.6 | 49.9 | 51.2 | 51.8 | 53.0 | 53.4 | 54.3 |
| **1** | 1 | 51.1152 | 0.03723 | 1.9030 | 46.7 | 47.5 | 48.0 | 49.1 | 49.8 | 51.1 | 52.4 | 53.1 | 54.2 | 54.7 | 55.5 |
| **2** | 1 | 52.3461 | 0.03652 | 1.9117 | 47.9 | 48.8 | 49.2 | 50.4 | 51.1 | 52.3 | 53.6 | 54.3 | 55.5 | 55.9 | 56.8 |
| **3** | 1 | 53.3905 | 0.03609 | 1.9269 | 48.9 | 49.8 | 50.2 | 51.4 | 52.1 | 53.4 | 54.7 | 55.4 | 56.6 | 57.0 | 57.9 |
| **4** | 1 | 54.3881 | 0.03570 | 1.9417 | 49.9 | 50.7 | 51.2 | 52.4 | 53.1 | 54.4 | 55.7 | 56.4 | 57.6 | 58.0 | 58.9 |
| **5** | 1 | 55.3374 | 0.03534 | 1.9556 | 50.8 | 51.7 | 52.1 | 53.3 | 54.0 | 55.3 | 56.7 | 57.4 | 58.6 | 59.0 | 59.9 |
| **6** | 1 | 56.2357 | 0.03501 | 1.9688 | 51.7 | 52.5 | 53.0 | 54.2 | 54.9 | 56.2 | 57.6 | 58.3 | 59.5 | 59.9 | 60.8 |
| **7** | 1 | 57.0851 | 0.03470 | 1.9809 | 52.5 | 53.4 | 53.8 | 55.0 | 55.7 | 57.1 | 58.4 | 59.1 | 60.3 | 60.8 | 61.7 |
| **8** | 1 | 57.8889 | 0.03442 | 1.9925 | 53.3 | 54.1 | 54.6 | 55.8 | 56.5 | 57.9 | 59.2 | 60.0 | 61.2 | 61.6 | 62.5 |
| **9** | 1 | 58.6536 | 0.03416 | 2.0036 | 54.0 | 54.9 | 55.4 | 56.6 | 57.3 | 58.7 | 60.0 | 60.7 | 61.9 | 62.4 | 63.3 |
| **10** | 1 | 59.3872 | 0.03392 | 2.0144 | 54.7 | 55.6 | 56.1 | 57.3 | 58.0 | 59.4 | 60.7 | 61.5 | 62.7 | 63.2 | 64.1 |
| **11** | 1 | 60.0894 | 0.03369 | 2.0244 | 55.4 | 56.3 | 56.8 | 58.0 | 58.7 | 60.1 | 61.5 | 62.2 | 63.4 | 63.9 | 64.8 |
| **12** | 1 | 60.7605 | 0.03348 | 2.0343 | 56.0 | 56.9 | 57.4 | 58.7 | 59.4 | 60.8 | 62.1 | 62.9 | 64.1 | 64.6 | 65.5 |
| **13** | 1 | 61.4013 | 0.03329 | 2.0440 | 56.6 | 57.6 | 58.0 | 59.3 | 60.0 | 61.4 | 62.8 | 63.5 | 64.8 | 65.2 | 66.2 |

**Table 18 Length-for-age for boys, age in weeks (continued)**

| | | | | | Z-scores (length in cm) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Week** | **L** | **M** | **S** | **SD** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **0** | 1 | 49.8842 | 0.03795 | 1.8931 | 44.2 | 46.1 | 48.0 | 49.9 | 51.8 | 53.7 | 55.6 |
| **1** | 1 | 51.1152 | 0.03723 | 1.9030 | 45.4 | 47.3 | 49.2 | 51.1 | 53.0 | 54.9 | 56.8 |
| **2** | 1 | 52.3461 | 0.03652 | 1.9117 | 46.6 | 48.5 | 50.4 | 52.3 | 54.3 | 56.2 | 58.1 |
| **3** | 1 | 53.3905 | 0.03609 | 1.9269 | 47.6 | 49.5 | 51.5 | 53.4 | 55.3 | 57.2 | 59.2 |
| **4** | 1 | 54.3881 | 0.03570 | 1.9417 | 48.6 | 50.5 | 52.4 | 54.4 | 56.3 | 58.3 | 60.2 |
| **5** | 1 | 55.3374 | 0.03534 | 1.9556 | 49.5 | 51.4 | 53.4 | 55.3 | 57.3 | 59.2 | 61.2 |
| **6** | 1 | 56.2357 | 0.03501 | 1.9688 | 50.3 | 52.3 | 54.3 | 56.2 | 58.2 | 60.2 | 62.1 |
| **7** | 1 | 57.0851 | 0.03470 | 1.9809 | 51.1 | 53.1 | 55.1 | 57.1 | 59.1 | 61.0 | 63.0 |
| **8** | 1 | 57.8889 | 0.03442 | 1.9925 | 51.9 | 53.9 | 55.9 | 57.9 | 59.9 | 61.9 | 63.9 |
| **9** | 1 | 58.6536 | 0.03416 | 2.0036 | 52.6 | 54.6 | 56.6 | 58.7 | 60.7 | 62.7 | 64.7 |
| **10** | 1 | 59.3872 | 0.03392 | 2.0144 | 53.3 | 55.4 | 57.4 | 59.4 | 61.4 | 63.4 | 65.4 |
| **11** | 1 | 60.0894 | 0.03369 | 2.0244 | 54.0 | 56.0 | 58.1 | 60.1 | 62.1 | 64.1 | 66.2 |
| **12** | 1 | 60.7605 | 0.03348 | 2.0343 | 54.7 | 56.7 | 58.7 | 60.8 | 62.8 | 64.8 | 66.9 |
| **13** | 1 | 61.4013 | 0.03329 | 2.0440 | 55.3 | 57.3 | 59.4 | 61.4 | 63.4 | 65.5 | 67.5 |

**Table 19 Length-for-age for boys, age in years and months**

| Year: Month | Month | L | M | S | SD | Percentiles (length in cm) 1st | 3rd | 5th | 15th | 25th | 50th | 75th | 85th | 95th | 97th | 99th |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0: 0** | **0** | 1 | 49.8842 | 0.03795 | 1.8931 | 45.5 | 46.3 | 46.8 | 47.9 | 48.6 | 49.9 | 51.2 | 51.8 | 53.0 | 53.4 | 54.3 |
| **0: 1** | **1** | 1 | 54.7244 | 0.03557 | 1.9465 | 50.2 | 51.1 | 51.5 | 52.7 | 53.4 | 54.7 | 56.0 | 56.7 | 57.9 | 58.4 | 59.3 |
| **0: 2** | **2** | 1 | 58.4249 | 0.03424 | 2.0005 | 53.8 | 54.7 | 55.1 | 56.4 | 57.1 | 58.4 | 59.8 | 60.5 | 61.7 | 62.2 | 63.1 |
| **0: 3** | **3** | 1 | 61.4292 | 0.03328 | 2.0444 | 56.7 | 57.6 | 58.1 | 59.3 | 60.1 | 61.4 | 62.8 | 63.5 | 64.8 | 65.3 | 66.2 |
| **0: 4** | **4** | 1 | 63.8860 | 0.03257 | 2.0808 | 59.0 | 60.0 | 60.5 | 61.7 | 62.5 | 63.9 | 65.3 | 66.0 | 67.3 | 67.8 | 68.7 |
| **0: 5** | **5** | 1 | 65.9026 | 0.03204 | 2.1115 | 61.0 | 61.9 | 62.4 | 63.7 | 64.5 | 65.9 | 67.3 | 68.1 | 69.4 | 69.9 | 70.8 |
| **0: 6** | **6** | 1 | 67.6236 | 0.03165 | 2.1403 | 62.6 | 63.6 | 64.1 | 65.4 | 66.2 | 67.6 | 69.1 | 69.8 | 71.1 | 71.6 | 72.6 |
| **0: 7** | **7** | 1 | 69.1645 | 0.03139 | 2.1711 | 64.1 | 65.1 | 65.6 | 66.9 | 67.7 | 69.2 | 70.6 | 71.4 | 72.7 | 73.2 | 74.2 |
| **0: 8** | **8** | 1 | 70.5994 | 0.03124 | 2.2055 | 65.5 | 66.5 | 67.0 | 68.3 | 69.1 | 70.6 | 72.1 | 72.9 | 74.2 | 74.7 | 75.7 |
| **0: 9** | **9** | 1 | 71.9687 | 0.03117 | 2.2433 | 66.8 | 67.7 | 68.3 | 69.6 | 70.5 | 72.0 | 73.5 | 74.3 | 75.7 | 76.2 | 77.2 |
| **0:10** | **10** | 1 | 73.2812 | 0.03118 | 2.2849 | 68.0 | 69.0 | 69.5 | 70.9 | 71.7 | 73.3 | 74.8 | 75.6 | 77.0 | 77.6 | 78.6 |
| **0:11** | **11** | 1 | 74.5388 | 0.03125 | 2.3293 | 69.1 | 70.2 | 70.7 | 72.1 | 73.0 | 74.5 | 76.1 | 77.0 | 78.4 | 78.9 | 80.0 |
| **1: 0** | **12** | 1 | 75.7488 | 0.03137 | 2.3762 | 70.2 | 71.3 | 71.8 | 73.3 | 74.1 | 75.7 | 77.4 | 78.2 | 79.7 | 80.2 | 81.3 |
| **1: 1** | **13** | 1 | 76.9186 | 0.03154 | 2.4260 | 71.3 | 72.4 | 72.9 | 74.4 | 75.3 | 76.9 | 78.6 | 79.4 | 80.9 | 81.5 | 82.6 |
| **1: 2** | **14** | 1 | 78.0497 | 0.03174 | 2.4773 | 72.3 | 73.4 | 74.0 | 75.5 | 76.4 | 78.0 | 79.7 | 80.6 | 82.1 | 82.7 | 83.8 |
| **1: 3** | **15** | 1 | 79.1458 | 0.03197 | 2.5303 | 73.3 | 74.4 | 75.0 | 76.5 | 77.4 | 79.1 | 80.9 | 81.8 | 83.3 | 83.9 | 85.0 |
| **1: 4** | **16** | 1 | 80.2113 | 0.03222 | 2.5844 | 74.2 | 75.4 | 76.0 | 77.5 | 78.5 | 80.2 | 82.0 | 82.9 | 84.5 | 85.1 | 86.2 |
| **1: 5** | **17** | 1 | 81.2487 | 0.03250 | 2.6406 | 75.1 | 76.3 | 76.9 | 78.5 | 79.5 | 81.2 | 83.0 | 84.0 | 85.6 | 86.2 | 87.4 |
| **1: 6** | **18** | 1 | 82.2587 | 0.03279 | 2.6973 | 76.0 | 77.2 | 77.8 | 79.5 | 80.4 | 82.3 | 84.1 | 85.1 | 86.7 | 87.3 | 88.5 |
| **1: 7** | **19** | 1 | 83.2418 | 0.03310 | 2.7553 | 76.8 | 78.1 | 78.7 | 80.4 | 81.4 | 83.2 | 85.1 | 86.1 | 87.8 | 88.4 | 89.7 |
| **1: 8** | **20** | 1 | 84.1996 | 0.03342 | 2.8140 | 77.7 | 78.9 | 79.6 | 81.3 | 82.3 | 84.2 | 86.1 | 87.1 | 88.8 | 89.5 | 90.7 |
| **1: 9** | **21** | 1 | 85.1348 | 0.03376 | 2.8742 | 78.4 | 79.7 | 80.4 | 82.2 | 83.2 | 85.1 | 87.1 | 88.1 | 89.9 | 90.5 | 91.8 |
| **1:10** | **22** | 1 | 86.0477 | 0.03410 | 2.9342 | 79.2 | 80.5 | 81.2 | 83.0 | 84.1 | 86.0 | 88.0 | 89.1 | 90.9 | 91.6 | 92.9 |
| **1:11** | **23** | 1 | 86.9410 | 0.03445 | 2.9951 | 80.0 | 81.3 | 82.0 | 83.8 | 84.9 | 86.9 | 89.0 | 90.0 | 91.9 | 92.6 | 93.9 |
| **2: 0** | **24** | 1 | 87.8161 | 0.03479 | 3.0551 | 80.7 | 82.1 | 82.8 | 84.6 | 85.8 | 87.8 | 89.9 | 91.0 | 92.8 | 93.6 | 94.9 |

**Table 19 Length-for-age for boys, age in years and months (continued)**

| Year: Month | Month | L | M | S | SD | Z-scores (length in cm) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | -3 SD | -2 SD | -1 SD | Median | 1 SD | 2 SD | 3 SD |
| **0: 0** | **0** | 1 | 49.8842 | 0.03795 | 1.8931 | 44.2 | 46.1 | 48.0 | 49.9 | 51.8 | 53.7 | 55.6 |
| **0: 1** | **1** | 1 | 54.7244 | 0.03557 | 1.9465 | 48.9 | 50.8 | 52.8 | 54.7 | 56.7 | 58.6 | 60.6 |
| **0: 2** | **2** | 1 | 58.4249 | 0.03424 | 2.0005 | 52.4 | 54.4 | 56.4 | 58.4 | 60.4 | 62.4 | 64.4 |
| **0: 3** | **3** | 1 | 61.4292 | 0.03328 | 2.0444 | 55.3 | 57.3 | 59.4 | 61.4 | 63.5 | 65.5 | 67.6 |
| **0: 4** | **4** | 1 | 63.8860 | 0.03257 | 2.0808 | 57.6 | 59.7 | 61.8 | 63.9 | 66.0 | 68.0 | 70.1 |
| **0: 5** | **5** | 1 | 65.9026 | 0.03204 | 2.1115 | 59.6 | 61.7 | 63.8 | 65.9 | 68.0 | 70.1 | 72.2 |
| **0: 6** | **6** | 1 | 67.6236 | 0.03165 | 2.1403 | 61.2 | 63.3 | 65.5 | 67.6 | 69.8 | 71.9 | 74.0 |
| **0: 7** | **7** | 1 | 69.1645 | 0.03139 | 2.1711 | 62.7 | 64.8 | 67.0 | 69.2 | 71.3 | 73.5 | 75.7 |
| **0: 8** | **8** | 1 | 70.5994 | 0.03124 | 2.2055 | 64.0 | 66.2 | 68.4 | 70.6 | 72.8 | 75.0 | 77.2 |
| **0: 9** | **9** | 1 | 71.9687 | 0.03117 | 2.2433 | 65.2 | 67.5 | 69.7 | 72.0 | 74.2 | 76.5 | 78.7 |
| **0:10** | **10** | 1 | 73.2812 | 0.03118 | 2.2849 | 66.4 | 68.7 | 71.0 | 73.3 | 75.6 | 77.9 | 80.1 |
| **0:11** | **11** | 1 | 74.5388 | 0.03125 | 2.3293 | 67.6 | 69.9 | 72.2 | 74.5 | 76.9 | 79.2 | 81.5 |
| **1: 0** | **12** | 1 | 75.7488 | 0.03137 | 2.3762 | 68.6 | 71.0 | 73.4 | 75.7 | 78.1 | 80.5 | 82.9 |
| **1: 1** | **13** | 1 | 76.9186 | 0.03154 | 2.4260 | 69.6 | 72.1 | 74.5 | 76.9 | 79.3 | 81.8 | 84.2 |
| **1: 2** | **14** | 1 | 78.0497 | 0.03174 | 2.4773 | 70.6 | 73.1 | 75.6 | 78.0 | 80.5 | 83.0 | 85.5 |
| **1: 3** | **15** | 1 | 79.1458 | 0.03197 | 2.5303 | 71.6 | 74.1 | 76.6 | 79.1 | 81.7 | 84.2 | 86.7 |
| **1: 4** | **16** | 1 | 80.2113 | 0.03222 | 2.5844 | 72.5 | 75.0 | 77.6 | 80.2 | 82.8 | 85.4 | 88.0 |
| **1: 5** | **17** | 1 | 81.2487 | 0.03250 | 2.6406 | 73.3 | 76.0 | 78.6 | 81.2 | 83.9 | 86.5 | 89.2 |
| **1: 6** | **18** | 1 | 82.2587 | 0.03279 | 2.6973 | 74.2 | 76.9 | 79.6 | 82.3 | 85.0 | 87.7 | 90.4 |
| **1: 7** | **19** | 1 | 83.2418 | 0.03310 | 2.7553 | 75.0 | 77.7 | 80.5 | 83.2 | 86.0 | 88.8 | 91.5 |
| **1: 8** | **20** | 1 | 84.1996 | 0.03342 | 2.8140 | 75.8 | 78.6 | 81.4 | 84.2 | 87.0 | 89.8 | 92.6 |
| **1: 9** | **21** | 1 | 85.1348 | 0.03376 | 2.8742 | 76.5 | 79.4 | 82.3 | 85.1 | 88.0 | 90.9 | 93.8 |
| **1:10** | **22** | 1 | 86.0477 | 0.03410 | 2.9342 | 77.2 | 80.2 | 83.1 | 86.0 | 89.0 | 91.9 | 94.9 |
| **1:11** | **23** | 1 | 86.9410 | 0.03445 | 2.9951 | 78.0 | 81.0 | 83.9 | 86.9 | 89.9 | 92.9 | 95.9 |
| **2: 0** | **24** | 1 | 87.8161 | 0.03479 | 3.0551 | 78.7 | 81.7 | 84.8 | 87.8 | 90.9 | 93.9 | 97.0 |

**Table 20 Height-for age for boys, age in years and months**

| | | | | | | Percentiles (height in cm) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **SD** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **2: 0** | **24** | 1 | 87.1161 | 0.03507 | 3.0551 | 80.0 | 81.4 | 82.1 | 83.9 | 85.1 | 87.1 | 89.2 | 90.3 | 92.1 | 92.9 | 94.2 |
| **2: 1** | **25** | 1 | 87.9720 | 0.03542 | 3.1160 | 80.7 | 82.1 | 82.8 | 84.7 | 85.9 | 88.0 | 90.1 | 91.2 | 93.1 | 93.8 | 95.2 |
| **2: 2** | **26** | 1 | 88.8065 | 0.03576 | 3.1757 | 81.4 | 82.8 | 83.6 | 85.5 | 86.7 | 88.8 | 90.9 | 92.1 | 94.0 | 94.8 | 96.2 |
| **2: 3** | **27** | 1 | 89.6197 | 0.03610 | 3.2353 | 82.1 | 83.5 | 84.3 | 86.3 | 87.4 | 89.6 | 91.8 | 93.0 | 94.9 | 95.7 | 97.1 |
| **2: 4** | **28** | 1 | 90.4120 | 0.03642 | 3.2928 | 82.8 | 84.2 | 85.0 | 87.0 | 88.2 | 90.4 | 92.6 | 93.8 | 95.8 | 96.6 | 98.1 |
| **2: 5** | **29** | 1 | 91.1828 | 0.03674 | 3.3501 | 83.4 | 84.9 | 85.7 | 87.7 | 88.9 | 91.2 | 93.4 | 94.7 | 96.7 | 97.5 | 99.0 |
| **2: 6** | **30** | 1 | 91.9327 | 0.03704 | 3.4052 | 84.0 | 85.5 | 86.3 | 88.4 | 89.6 | 91.9 | 94.2 | 95.5 | 97.5 | 98.3 | 99.9 |
| **2: 7** | **31** | 1 | 92.6631 | 0.03733 | 3.4591 | 84.6 | 86.2 | 87.0 | 89.1 | 90.3 | 92.7 | 95.0 | 96.2 | 98.4 | 99.2 | 100.7 |
| **2: 8** | **32** | 1 | 93.3753 | 0.03761 | 3.5118 | 85.2 | 86.8 | 87.6 | 89.7 | 91.0 | 93.4 | 95.7 | 97.0 | 99.2 | 100.0 | 101.5 |
| **2: 9** | **33** | 1 | 94.0711 | 0.03787 | 3.5625 | 85.8 | 87.4 | 88.2 | 90.4 | 91.7 | 94.1 | 96.5 | 97.8 | 99.9 | 100.8 | 102.4 |
| **2:10** | **34** | 1 | 94.7532 | 0.03812 | 3.6120 | 86.4 | 88.0 | 88.8 | 91.0 | 92.3 | 94.8 | 97.2 | 98.5 | 100.7 | 101.5 | 103.2 |
| **2:11** | **35** | 1 | 95.4236 | 0.03836 | 3.6604 | 86.9 | 88.5 | 89.4 | 91.6 | 93.0 | 95.4 | 97.9 | 99.2 | 101.4 | 102.3 | 103.9 |
| **3: 0** | **36** | 1 | 96.0835 | 0.03858 | 3.7069 | 87.5 | 89.1 | 90.0 | 92.2 | 93.6 | 96.1 | 98.6 | 99.9 | 102.2 | 103.1 | 104.7 |
| **3: 1** | **37** | 1 | 96.7337 | 0.03879 | 3.7523 | 88.0 | 89.7 | 90.6 | 92.8 | 94.2 | 96.7 | 99.3 | 100.6 | 102.9 | 103.8 | 105.5 |
| **3: 2** | **38** | 1 | 97.3749 | 0.03900 | 3.7976 | 88.5 | 90.2 | 91.1 | 93.4 | 94.8 | 97.4 | 99.9 | 101.3 | 103.6 | 104.5 | 106.2 |
| **3: 3** | **39** | 1 | 98.0073 | 0.03919 | 3.8409 | 89.1 | 90.8 | 91.7 | 94.0 | 95.4 | 98.0 | 100.6 | 102.0 | 104.3 | 105.2 | 106.9 |
| **3: 4** | **40** | 1 | 98.6310 | 0.03937 | 3.8831 | 89.6 | 91.3 | 92.2 | 94.6 | 96.0 | 98.6 | 101.3 | 102.7 | 105.0 | 105.9 | 107.7 |
| **3: 5** | **41** | 1 | 99.2459 | 0.03954 | 3.9242 | 90.1 | 91.9 | 92.8 | 95.2 | 96.6 | 99.2 | 101.9 | 103.3 | 105.7 | 106.6 | 108.4 |
| **3: 6** | **42** | 1 | 99.8515 | 0.03971 | 3.9651 | 90.6 | 92.4 | 93.3 | 95.7 | 97.2 | 99.9 | 102.5 | 104.0 | 106.4 | 107.3 | 109.1 |
| **3: 7** | **43** | 1 | 100.4485 | 0.03986 | 4.0039 | 91.1 | 92.9 | 93.9 | 96.3 | 97.7 | 100.4 | 103.1 | 104.6 | 107.0 | 108.0 | 109.8 |
| **3: 8** | **44** | 1 | 101.0374 | 0.04002 | 4.0435 | 91.6 | 93.4 | 94.4 | 96.8 | 98.3 | 101.0 | 103.8 | 105.2 | 107.7 | 108.6 | 110.4 |
| **3: 9** | **45** | 1 | 101.6186 | 0.04016 | 4.0810 | 92.1 | 93.9 | 94.9 | 97.4 | 98.9 | 101.6 | 104.4 | 105.8 | 108.3 | 109.3 | 111.1 |
| **3:10** | **46** | 1 | 102.1933 | 0.04031 | 4.1194 | 92.6 | 94.4 | 95.4 | 97.9 | 99.4 | 102.2 | 105.0 | 106.5 | 109.0 | 109.9 | 111.8 |
| **3:11** | **47** | 1 | 102.7625 | 0.04045 | 4.1567 | 93.1 | 94.9 | 95.9 | 98.5 | 100.0 | 102.8 | 105.6 | 107.1 | 109.6 | 110.6 | 112.4 |
| **4: 0** | **48** | 1 | 103.3273 | 0.04059 | 4.1941 | 93.6 | 95.4 | 96.4 | 99.0 | 100.5 | 103.3 | 106.2 | 107.7 | 110.2 | 111.2 | 113.1 |

**Table 20 Height-for age for boys, age in years and months (continued)**

| | | | | | | Percentiles (height in cm) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **SD** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **4: 1** | **49** | 1 | 103.8886 | 0.04073 | 4.2314 | 94.0 | 95.9 | 96.9 | 99.5 | 101.0 | 103.9 | 106.7 | 108.3 | 110.8 | 111.8 | 113.7 |
| **4: 2** | **50** | 1 | 104.4473 | 0.04086 | 4.2677 | 94.5 | 96.4 | 97.4 | 100.0 | 101.6 | 104.4 | 107.3 | 108.9 | 111.5 | 112.5 | 114.4 |
| **4: 3** | **51** | 1 | 105.0041 | 0.04100 | 4.3052 | 95.0 | 96.9 | 97.9 | 100.5 | 102.1 | 105.0 | 107.9 | 109.5 | 112.1 | 113.1 | 115.0 |
| **4: 4** | **52** | 1 | 105.5596 | 0.04113 | 4.3417 | 95.5 | 97.4 | 98.4 | 101.1 | 102.6 | 105.6 | 108.5 | 110.1 | 112.7 | 113.7 | 115.7 |
| **4: 5** | **53** | 1 | 106.1138 | 0.04126 | 4.3783 | 95.9 | 97.9 | 98.9 | 101.6 | 103.2 | 106.1 | 109.1 | 110.7 | 113.3 | 114.3 | 116.3 |
| **4: 6** | **54** | 1 | 106.6668 | 0.04139 | 4.4149 | 96.4 | 98.4 | 99.4 | 102.1 | 103.7 | 106.7 | 109.6 | 111.2 | 113.9 | 115.0 | 116.9 |
| **4: 7** | **55** | 1 | 107.2188 | 0.04152 | 4.4517 | 96.9 | 98.8 | 99.9 | 102.6 | 104.2 | 107.2 | 110.2 | 111.8 | 114.5 | 115.6 | 117.6 |
| **4: 8** | **56** | 1 | 107.7697 | 0.04165 | 4.4886 | 97.3 | 99.3 | 100.4 | 103.1 | 104.7 | 107.8 | 110.8 | 112.4 | 115.2 | 116.2 | 118.2 |
| **4: 9** | **57** | 1 | 108.3198 | 0.04177 | 4.5245 | 97.8 | 99.8 | 100.9 | 103.6 | 105.3 | 108.3 | 111.4 | 113.0 | 115.8 | 116.8 | 118.8 |
| **4:10** | **58** | 1 | 108.8689 | 0.04190 | 4.5616 | 98.3 | 100.3 | 101.4 | 104.1 | 105.8 | 108.9 | 111.9 | 113.6 | 116.4 | 117.4 | 119.5 |
| **4:11** | **59** | 1 | 109.4170 | 0.04202 | 4.5977 | 98.7 | 100.8 | 101.9 | 104.7 | 106.3 | 109.4 | 112.5 | 114.2 | 117.0 | 118.1 | 120.1 |
| **5: 0** | **60** | 1 | 109.9638 | 0.04214 | 4.6339 | 99.2 | 101.2 | 102.3 | 105.2 | 106.8 | 110.0 | 113.1 | 114.8 | 117.6 | 118.7 | 120.7 |

**Table 20 Height-for-age for boys, age in years and months (continued)**

| | | | | | | Z-scores (height in cm) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **SD** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **2: 0** | **24** | 1 | 87.1161 | 0.03507 | 3.0551 | 78.0 | 81.0 | 84.1 | 87.1 | 90.2 | 93.2 | 96.3 |
| **2: 1** | **25** | 1 | 87.9720 | 0.03542 | 3.1160 | 78.6 | 81.7 | 84.9 | 88.0 | 91.1 | 94.2 | 97.3 |
| **2: 2** | **26** | 1 | 88.8065 | 0.03576 | 3.1757 | 79.3 | 82.5 | 85.6 | 88.8 | 92.0 | 95.2 | 98.3 |
| **2: 3** | **27** | 1 | 89.6197 | 0.03610 | 3.2353 | 79.9 | 83.1 | 86.4 | 89.6 | 92.9 | 96.1 | 99.3 |
| **2: 4** | **28** | 1 | 90.4120 | 0.03642 | 3.2928 | 80.5 | 83.8 | 87.1 | 90.4 | 93.7 | 97.0 | 100.3 |
| **2: 5** | **29** | 1 | 91.1828 | 0.03674 | 3.3501 | 81.1 | 84.5 | 87.8 | 91.2 | 94.5 | 97.9 | 101.2 |
| **2: 6** | **30** | 1 | 91.9327 | 0.03704 | 3.4052 | 81.7 | 85.1 | 88.5 | 91.9 | 95.3 | 98.7 | 102.1 |
| **2: 7** | **31** | 1 | 92.6631 | 0.03733 | 3.4591 | 82.3 | 85.7 | 89.2 | 92.7 | 96.1 | 99.6 | 103.0 |
| **2: 8** | **32** | 1 | 93.3753 | 0.03761 | 3.5118 | 82.8 | 86.4 | 89.9 | 93.4 | 96.9 | 100.4 | 103.9 |
| **2: 9** | **33** | 1 | 94.0711 | 0.03787 | 3.5625 | 83.4 | 86.9 | 90.5 | 94.1 | 97.6 | 101.2 | 104.8 |
| **2:10** | **34** | 1 | 94.7532 | 0.03812 | 3.6120 | 83.9 | 87.5 | 91.1 | 94.8 | 98.4 | 102.0 | 105.6 |
| **2:11** | **35** | 1 | 95.4236 | 0.03836 | 3.6604 | 84.4 | 88.1 | 91.8 | 95.4 | 99.1 | 102.7 | 106.4 |
| **3: 0** | **36** | 1 | 96.0835 | 0.03858 | 3.7069 | 85.0 | 88.7 | 92.4 | 96.1 | 99.8 | 103.5 | 107.2 |
| **3: 1** | **37** | 1 | 96.7337 | 0.03879 | 3.7523 | 85.5 | 89.2 | 93.0 | 96.7 | 100.5 | 104.2 | 108.0 |
| **3: 2** | **38** | 1 | 97.3749 | 0.03900 | 3.7976 | 86.0 | 89.8 | 93.6 | 97.4 | 101.2 | 105.0 | 108.8 |
| **3: 3** | **39** | 1 | 98.0073 | 0.03919 | 3.8409 | 86.5 | 90.3 | 94.2 | 98.0 | 101.8 | 105.7 | 109.5 |
| **3: 4** | **40** | 1 | 98.6310 | 0.03937 | 3.8831 | 87.0 | 90.9 | 94.7 | 98.6 | 102.5 | 106.4 | 110.3 |
| **3: 5** | **41** | 1 | 99.2459 | 0.03954 | 3.9242 | 87.5 | 91.4 | 95.3 | 99.2 | 103.2 | 107.1 | 111.0 |
| **3: 6** | **42** | 1 | 99.8515 | 0.03971 | 3.9651 | 88.0 | 91.9 | 95.9 | 99.9 | 103.8 | 107.8 | 111.7 |
| **3: 7** | **43** | 1 | 100.4485 | 0.03986 | 4.0039 | 88.4 | 92.4 | 96.4 | 100.4 | 104.5 | 108.5 | 112.5 |
| **3: 8** | **44** | 1 | 101.0374 | 0.04002 | 4.0435 | 88.9 | 93.0 | 97.0 | 101.0 | 105.1 | 109.1 | 113.2 |
| **3: 9** | **45** | 1 | 101.6186 | 0.04016 | 4.0810 | 89.4 | 93.5 | 97.5 | 101.6 | 105.7 | 109.8 | 113.9 |
| **3:10** | **46** | 1 | 102.1933 | 0.04031 | 4.1194 | 89.8 | 94.0 | 98.1 | 102.2 | 106.3 | 110.4 | 114.6 |
| **3:11** | **47** | 1 | 102.7625 | 0.04045 | 4.1567 | 90.3 | 94.4 | 98.6 | 102.8 | 106.9 | 111.1 | 115.2 |
| **4: 0** | **48** | 1 | 103.3273 | 0.04059 | 4.1941 | 90.7 | 94.9 | 99.1 | 103.3 | 107.5 | 111.7 | 115.9 |

**Table 20 Height-for-age for boys, age in years and months (continued)**

| Year: Month | Month | L | M | S | SD | Z-scores (height in cm) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | -3 SD | -2 SD | -1 SD | Median | 1 SD | 2 SD | 3 SD |
| **4: 1** | **49** | 1 | 103.8886 | 0.04073 | 4.2314 | 91.2 | 95.4 | 99.7 | 103.9 | 108.1 | 112.4 | 116.6 |
| **4: 2** | **50** | 1 | 104.4473 | 0.04086 | 4.2677 | 91.6 | 95.9 | 100.2 | 104.4 | 108.7 | 113.0 | 117.3 |
| **4: 3** | **51** | 1 | 105.0041 | 0.04100 | 4.3052 | 92.1 | 96.4 | 100.7 | 105.0 | 109.3 | 113.6 | 117.9 |
| **4: 4** | **52** | 1 | 105.5596 | 0.04113 | 4.3417 | 92.5 | 96.9 | 101.2 | 105.6 | 109.9 | 114.2 | 118.6 |
| **4: 5** | **53** | 1 | 106.1138 | 0.04126 | 4.3783 | 93.0 | 97.4 | 101.7 | 106.1 | 110.5 | 114.9 | 119.2 |
| **4: 6** | **54** | 1 | 106.6668 | 0.04139 | 4.4149 | 93.4 | 97.8 | 102.3 | 106.7 | 111.1 | 115.5 | 119.9 |
| **4: 7** | **55** | 1 | 107.2188 | 0.04152 | 4.4517 | 93.9 | 98.3 | 102.8 | 107.2 | 111.7 | 116.1 | 120.6 |
| **4: 8** | **56** | 1 | 107.7697 | 0.04165 | 4.4886 | 94.3 | 98.8 | 103.3 | 107.8 | 112.3 | 116.7 | 121.2 |
| **4: 9** | **57** | 1 | 108.3198 | 0.04177 | 4.5245 | 94.7 | 99.3 | 103.8 | 108.3 | 112.8 | 117.4 | 121.9 |
| **4:10** | **58** | 1 | 108.8689 | 0.04190 | 4.5616 | 95.2 | 99.7 | 104.3 | 108.9 | 113.4 | 118.0 | 122.6 |
| **4:11** | **59** | 1 | 109.4170 | 0.04202 | 4.5977 | 95.6 | 100.2 | 104.8 | 109.4 | 114.0 | 118.6 | 123.2 |
| **5: 0** | **60** | 1 | 109.9638 | 0.04214 | 4.6339 | 96.1 | 100.7 | 105.3 | 110.0 | 114.6 | 119.2 | 123.9 |

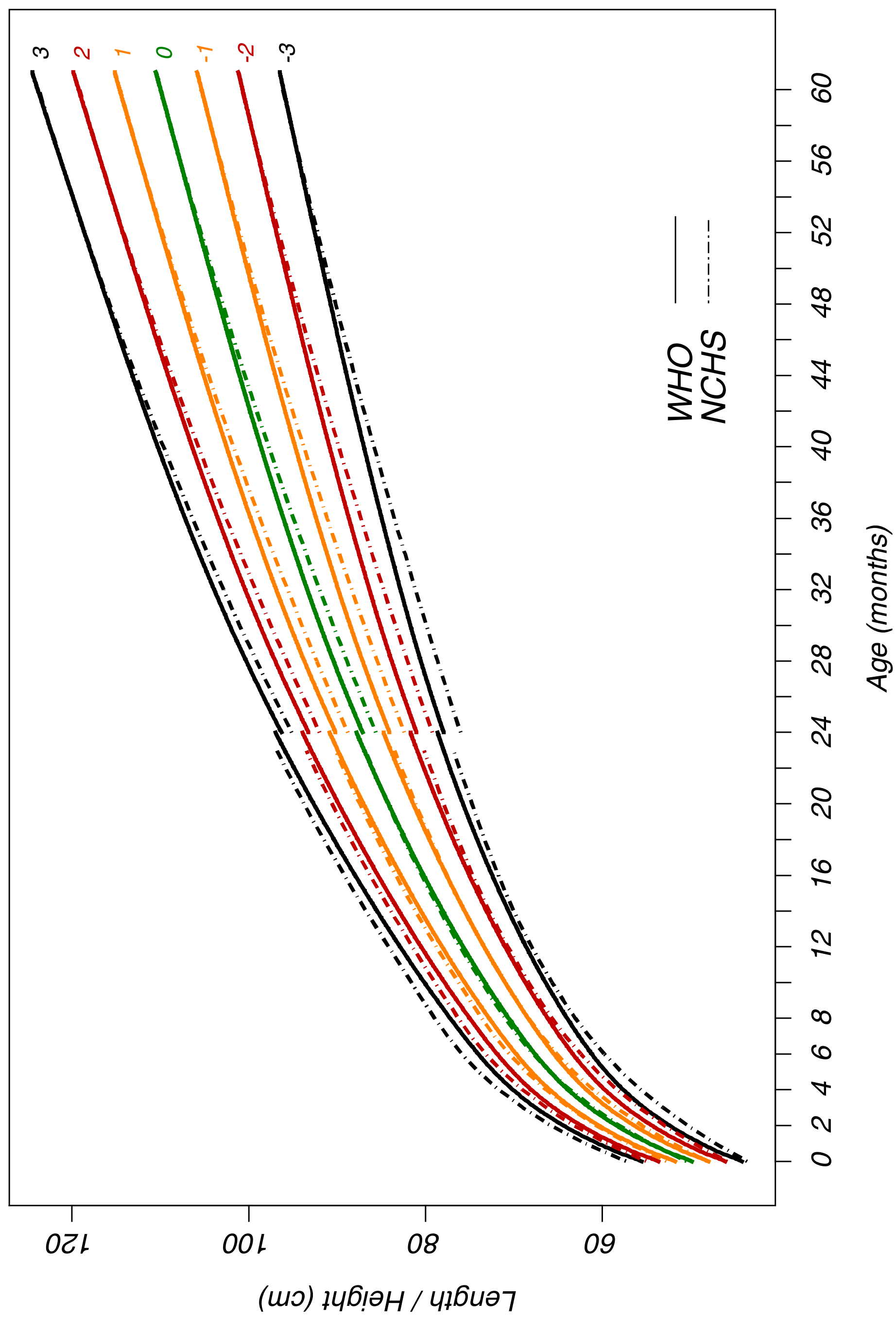


**Figure 15 Comparison of WHO with NCHS length/height-for-age z-scores for boys**

*Comparison with NCHS*

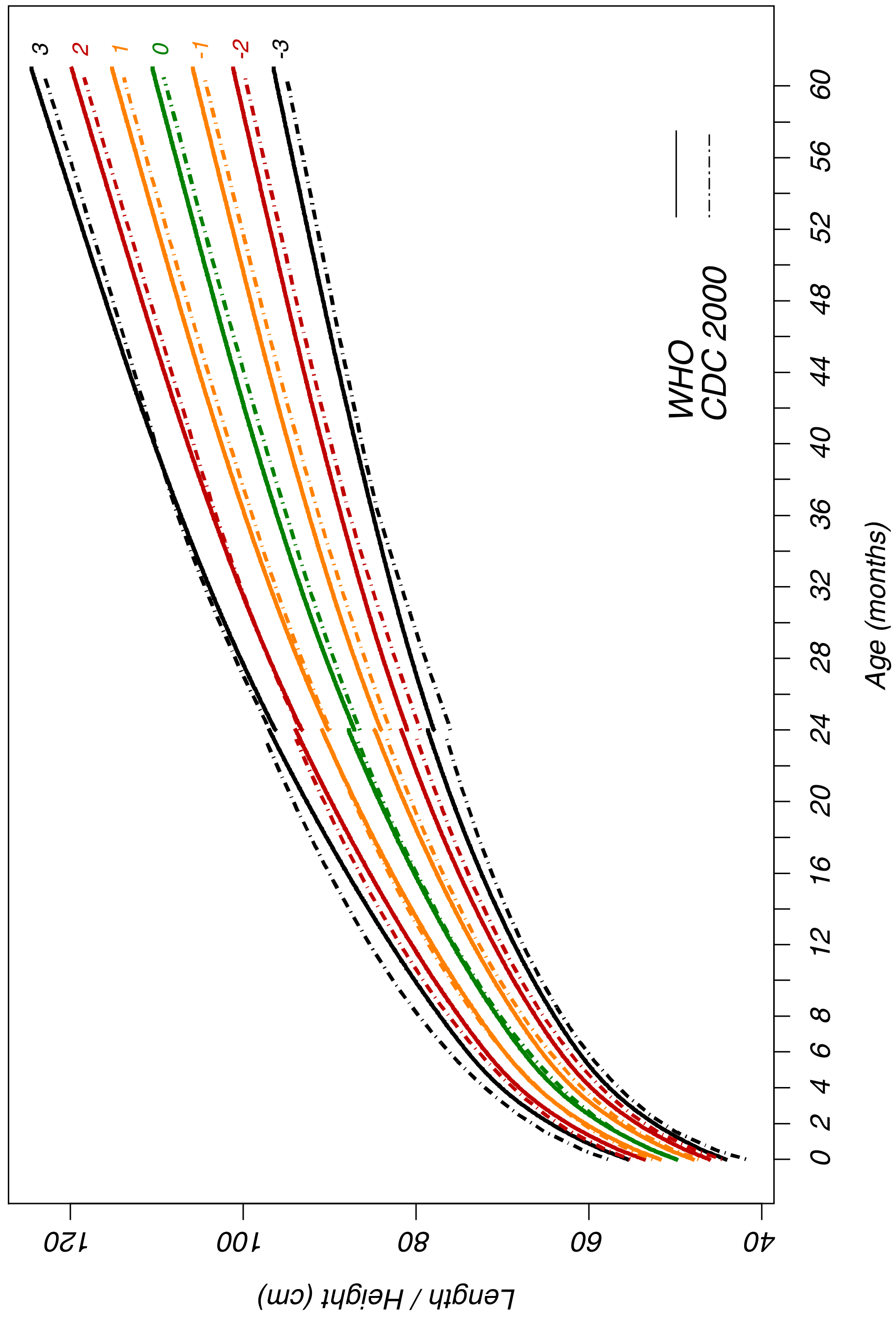


**Figure 16 Comparison of WHO with CDC 2000 length/height-for-age z-scores for boys**

## 3.3 Length/height-for-age for girls

The choice of the model to construct the length/height-for-age standards for girls followed the steps described for the corresponding standards for boys. In principle, unless a clear inadequacy is detected, models used for constructing the standards for both sexes should belong to the same class.

### 3.3.1 Sample size

There were 13 783 length/height observations for girls. The longitudinal and cross-sectional sample sizes by visit and age are presented in Tables 21 and 22.

**Table 21 Longitudinal sample sizes for length/height-for-age for girls**

| **Visit** | **Birth** | **1** | **2** | **3** | **4** | **5** | **6** |
|---|---|---|---|---|---|---|---|
| **Age** | **0** | **2 wk** | **4 wk** | **6 wk** | **2 mo** | **3 mo** | **4 mo** |
| N | 842 | 449 | 448 | 447 | 447 | 449 | 447 |
| **Visit** | **7** | **8** | **9** | **10** | **11** | **12** | **13** |
| **Age** | **5 mo** | **6 mo** | **7 mo** | **8 mo** | **9 mo** | **10 mo** | **11 mo** |
| N | 450 | 448 | 448 | 445 | 449 | 446 | 445 |
| **Visit** | **14** | **15** | **16** | **17** | **18** | **19** | **20** |
| **Age** | **12 mo** | **14 mo** | **16 mo** | **18 mo** | **20 mo** | **22 mo** | **24 mo** |
| N | 451 | 451 | 444 | 449 | 444 | 438 | 449 |

**Table 22 Cross-sectional sample sizes for length/height-for-age for girls**

| **Age (mo)** | **<18** | **18–20** | **21–23** | **24–26** | **27–29** | **30–32** | **33–35** |
|---|---|---|---|---|---|---|---|
| N | 2 | 160 | 171 | 244 | 219 | 238 | 231 |
| **Age (mo)** | **36–38** | **39–41** | **42–44** | **45–47** | **48–50** | **51–53** | **54–56** |
| N | 229 | 241 | 254 | 219 | 231 | 208 | 240 |
| **Age (mo)** | **57–59** | **60–62** | **63–65** | **66–68** | **69–71** | **>71** | |
| N | 242 | 223 | 205 | 230 | 210 | 0 | |

### 3.3.2 Model selection and results

Using the model BCPE(x=age$^{\lambda}$, df($\mu$)=10, df($\sigma$)=6, $\nu$=1, $\tau$=2) as the starting point, the best age-transformation power ($\lambda$) was sought. For girls, although the minimum global deviance corresponded to $\lambda$=0.30, its performance was similar to the model with $\lambda$=0.35 (Table 23) used for constructing the same standards for boys. Thus, $\lambda$=0.35 was selected as the age-transformation power and a search followed for the best combination of degrees of freedom for the cubic splines to fit the BCPE distribution parameter curves.

**Table 23 Global deviance (GD) for models within the class BCPE(x=age$^{\lambda}$, df(μ)=10, df(σ)=6, ν=1, τ=2) for length/height-for-age for girls**

| **λ** | **0.05** | **0.10** | **0.15** | **0.20** | **0.25** | **0.30** | **0.35** | **0.40** | **0.45** | **0.50** |
|---|---|---|---|---|---|---|---|---|---|---|
| GD[a] | 299.5 | 296.2 | 294.1 | 292.9 | 292.2 | 292.1 | 292.8 | 294.7 | 298.4 | 303.8 |
| **λ** | **0.55** | **0.60** | **0.65** | **0.70** | **0.75** | **0.80** | **0.85** | **0.90** | **0.95** | **1.00** |
| GD[a] | 310.0 | 314.8 | 316.2 | 312.6 | 305.7 | 300.9 | 308.3 | 341.4 | 416.1 | 547.2 |

[a] In excess of 67 000.

The search for the best combination of degrees of freedom for the cubic splines to fit the μ and σ parameter curves started from the simplest class of models using the BCPE distribution and fixing ν=1, τ=2, and λ=0.35. Table 24 shows various combinations that were considered. The best combination of *AIC* and *GAIC(3)* pointed to the model with df(μ)=10 and df(σ)=5. The properties of this model were evaluated using the same set of diagnostic tools used for length/height-for-age for boys.

**Table 24 Goodness-of-fit summary for models using the BCPE distribution with fixed ν=1 and τ=2 for length/height-for-age for girls**

| df(μ) | df(σ) | GD[a] | AIC[a] | GAIC(3)[a] | Total df |
|---|---|---|---|---|---|
| **8** | **3** | 319.6 | 341.6 | 352.6 | 11 |
| | **4** | 306.8 | 330.8 | 342.8 | 12 |
| | **5** | 303.7 | 329.7 | 342.7 | 13 |
| | **6** | 302.3 | 330.3 | 344.3 | 14 |
| | **7** | 301.6 | 331.6 | 346.6 | 15 |
| **9** | **3** | 313.0 | 337.0 | 349.0 | 12 |
| | **4** | 300.1 | 326.1 | 339.1 | 13 |
| | **5** | 297.0 | 325.0 | 339.0 | 14 |
| | **6** | 295.6 | 325.6 | 340.6 | 15 |
| | **7** | 294.9 | 326.9 | 342.9 | 16 |
| **10** | **3** | 310.2 | 336.3 | 349.3 | 13 |
| | **4** | 297.3 | 325.3 | 339.3 | 14 |
| | **5** | 294.1 | 324.1 | 339.1 | 15 |
| | **6** | 292.8 | 324.8 | 340.8 | 16 |
| | **7** | 292.0 | 326.0 | 343.0 | 17 |
| **11** | **3** | 308.7 | 336.8 | 350.8 | 14 |
| | **4** | 295.8 | 325.8 | 340.8 | 15 |
| | **5** | 292.6 | 324.6 | 340.6 | 16 |
| | **6** | 291.2 | 325.2 | 342.2 | 17 |
| | **7** | 290.5 | 326.5 | 344.5 | 18 |
| **12** | **3** | 307.7 | 337.7 | 352.7 | 15 |
| | **4** | 294.7 | 326.7 | 342.7 | 16 |
| | **5** | 291.5 | 325.5 | 342.5 | 17 |
| | **6** | 290.2 | 326.2 | 344.2 | 18 |
| | **7** | 289.5 | 327.5 | 346.4 | 19 |

GD, Global Deviance; AIC, Akaike Information Criterion;
GAIC(3), Generalized AIC with penalty equal to 3;
[a] In excess of 67 000.

**Model 1: BCPE(x=age$^{0.35}$, df(μ)=10, df(σ)=5, ν=1, τ=2)**

The two fitted parameter curves, i.e. the median and coefficient of variation appear to be adequately smoothed (Figure 17). Some evidence of a trend to underestimate extreme (3rd and 97th) centiles is shown in the distribution of the fitted centile residuals between birth and 24 months (Figure 18). Fitted centile residuals for the age interval 24 to 71 months showed mild systematic underestimations only for the 5th centile curve (Figure 19). The average bias for this centile curve was around 0.5 cm (SD estimates vary approximately from 3.2 to 5.5 cm across this age range). In this age interval, the proportions of children in the sample that are below the fitted 5th centile vary from 3.8% to 6%, but no clear pattern emerges to indicate bias. Overall, the distribution of the proportions below each of the fitted centiles does not indicate any bias (Table 25).

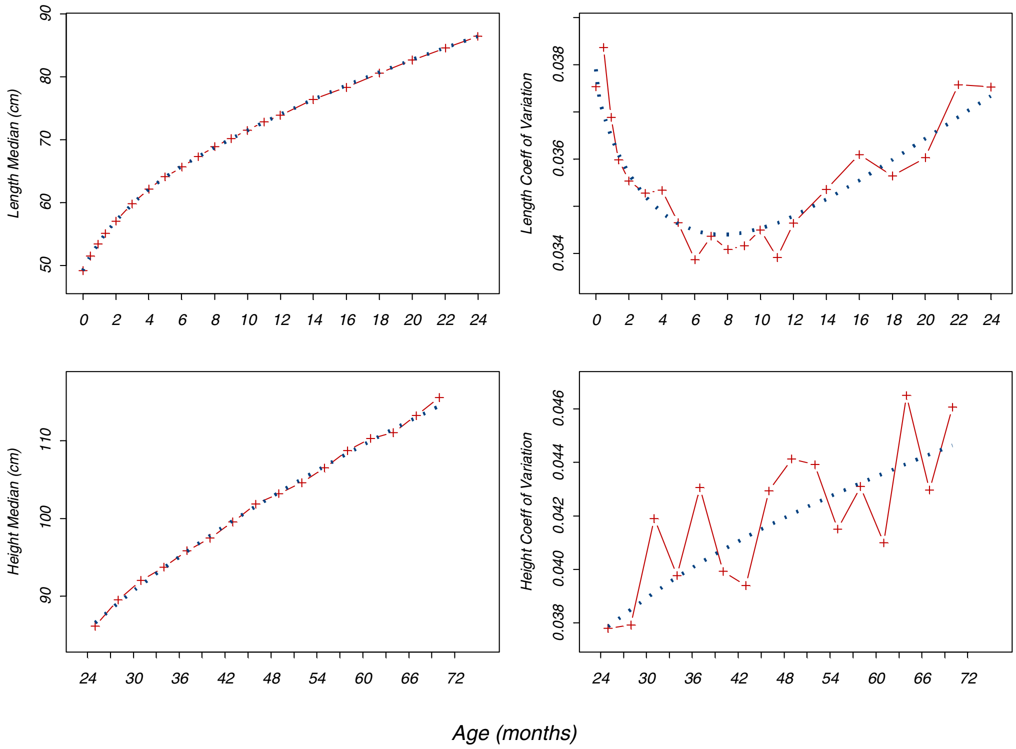


**Figure 17 Fitting of the μ and σ curves of Model 1 for length/height-for-age for girls (dotted line) and their respective sample estimates (points with solid line)**

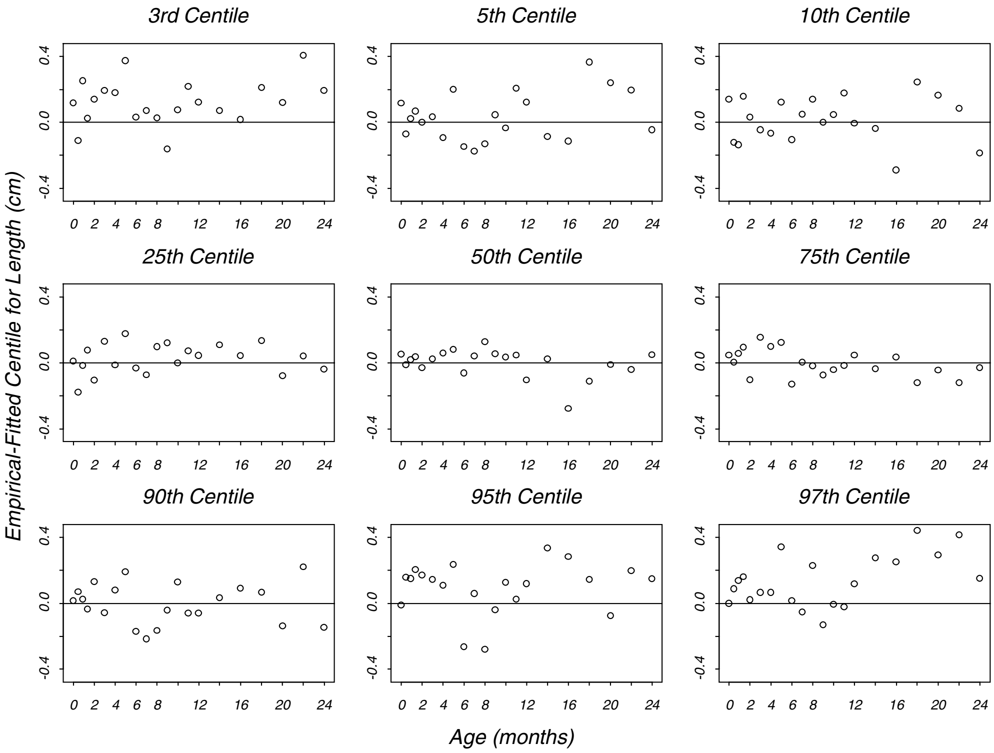


**Figure 18 Centile residuals from fitting Model 1 for length/height-for-age from 0 to 24 months for girls**

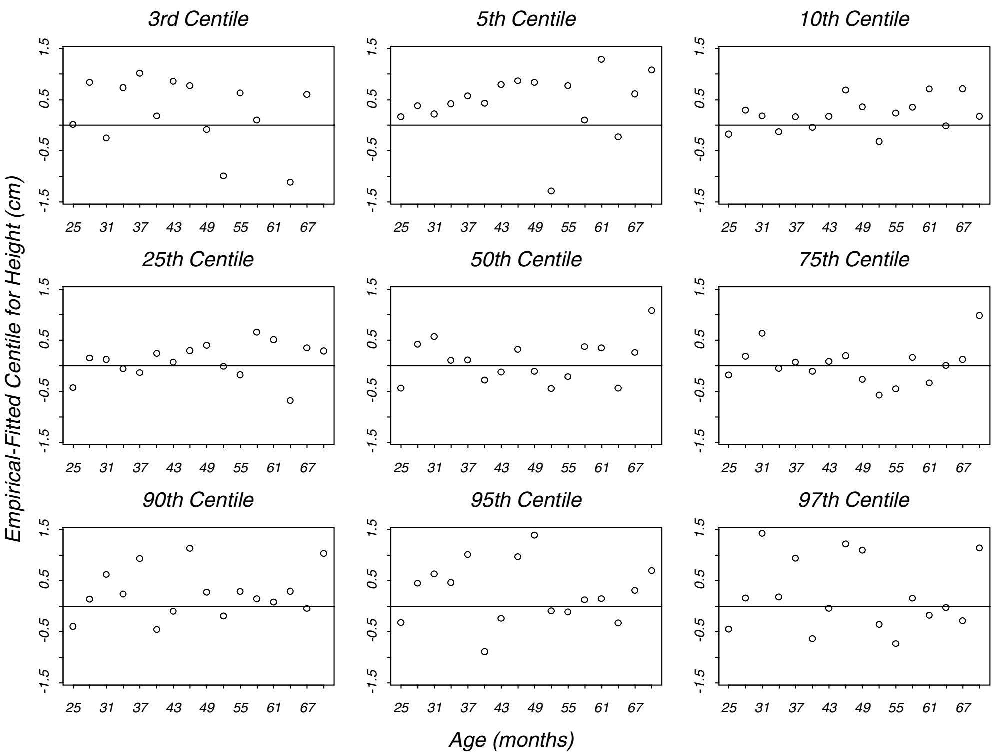


**Figure 19 Centile residuals from fitting Model 1 for length/height-for-age from 24 to 71 months for girls**

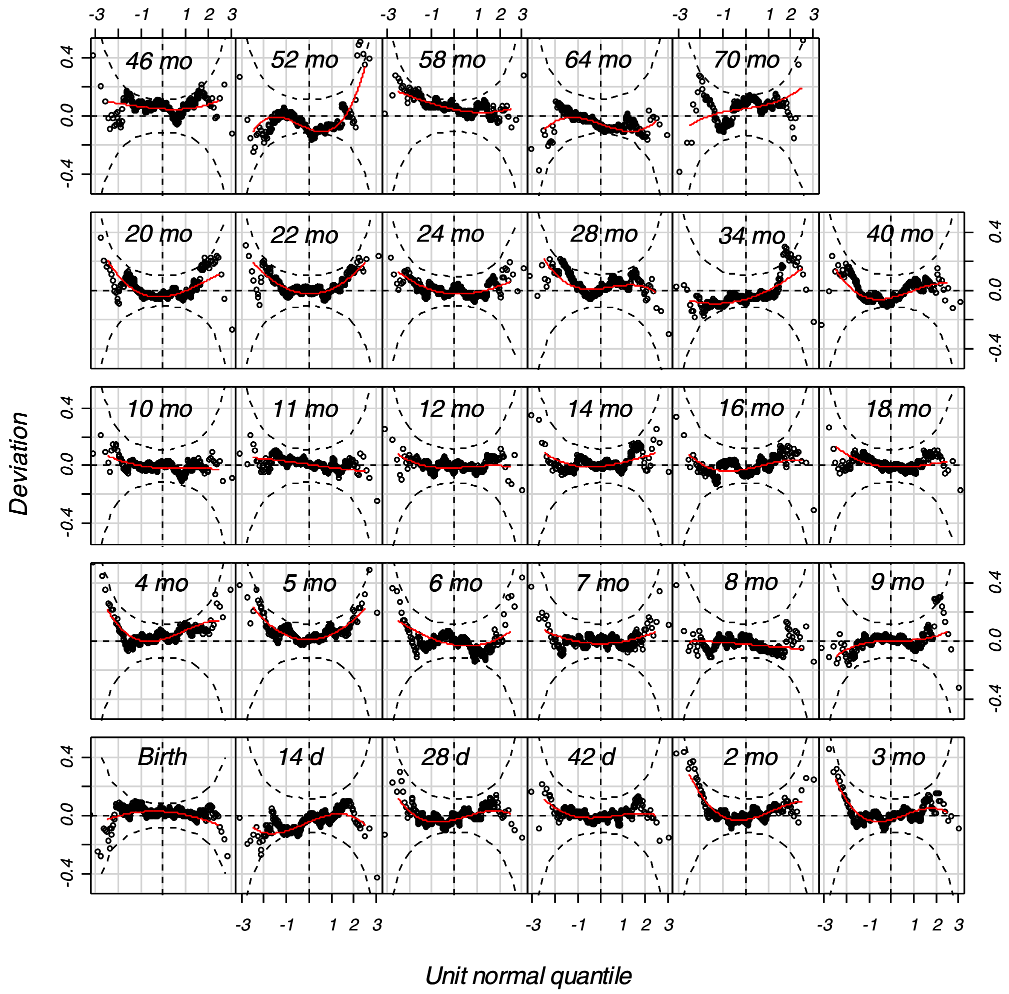


**Figure 20 Worm plots of z-scores for Model 1 for length/height-for-age for girls**

Figure 20 shows the worm plots for Model 1. For a few age groups, the shapes of the worms depart slightly from the flat shape but are still constrained within the 95% confidence intervals. For example, groups 52 mo and 64 mo indicate slight overestimation of the median (worms pass below origin). There was some indication of residual skewness in a few age groups, i.e. those with U-shaped worms (2, 5, 20 and 22 mo), but only one age group (52 mo) had an S-shaped worm, suggesting residual kurtosis. Results of the Q-test presented in Table 26 show that the misfits in terms of median and skewness were not significant, since the corresponding z1 and z3 absolute values were all below 2. The only evidence of residual kurtosis was in age group 52 mo (z4=2.36). However, the Q-test results for the z-scores derived from the selected model applied across all age groups bore evidence of the model's overall adequacy (p-values corresponding to overall statistics were all greater than 0.40). More complex modelling (e.g. fitting parameter ν) was therefore not pursued.

A new iteration was done to re-search for the best λ with df(μ)=10 and df(σ)=5. This exercise did not result in any notable changes to the previous findings. The model BCPE(x= age$^{0.35}$, df(μ)=10, df(σ)=5, ν=1, τ=2) was chosen to construct the length/height-for-age growth curves for girls. Figures 21 to 24 show the empirical and fitted centiles derived from the selected model for the length-for-age (0 to 24 months) and height-for-age (24 to 71 months) growth curves. The final standards were constructed as described in detail in section 3.1.

**Table 25 Observed proportions of children with measurements below the fitted centiles from Model 1, length/height-for-age for girls**

| Expected | Birth | 14 d | 28 d | 42 d | 2 mo | 3 mo | 4 mo | 5 mo | 6 mo | 7 mo |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 1.3 | 2.0 | 0.7 | 0.5 | 0.2 | 0.2 | 0.2 | 0.7 | 0.5 | 0.7 |
| **3** | 2.6 | 4.0 | 2.9 | 2.7 | 1.8 | 2.5 | 2.5 | 1.8 | 2.9 | 3.0 |
| **5** | 4.4 | 5.1 | 4.7 | 5.0 | 5.2 | 5.4 | 5.6 | 4.5 | 5.4 | 5.3 |
| **10** | 9.5 | 12.1 | 11.3 | 9.7 | 10.3 | 11.2 | 10.3 | 9.7 | 11.0 | 9.6 |
| **25** | 24.9 | 28.0 | 26.4 | 24.5 | 28.1 | 24.8 | 25.5 | 23.6 | 24.8 | 25.9 |
| **50** | 48.3 | 51.0 | 50.0 | 50.2 | 50.6 | 50.8 | 47.9 | 50.0 | 50.2 | 49.3 |
| **75** | 74.5 | 74.5 | 73.8 | 75.0 | 75.5 | 73.2 | 74.0 | 74.3 | 76.6 | 75.2 |
| **90** | 89.8 | 89.5 | 89.3 | 89.9 | 89.0 | 90.6 | 89.0 | 89.4 | 92.3 | 91.1 |
| **95** | 95.0 | 94.0 | 94.4 | 93.9 | 94.6 | 93.7 | 94.4 | 94.6 | 95.7 | 94.7 |
| **97** | 97.1 | 96.2 | 96.4 | 96.2 | 96.2 | 96.6 | 96.6 | 96.6 | 96.4 | 97.5 |
| **99** | 98.9 | 99.1 | 98.9 | 99.1 | 98.7 | 98.4 | 98.7 | 98.6 | 98.6 | 98.4 |
| **Expected** | **8 mo** | **9 mo** | **10 mo** | **11 mo** | **12 mo** | **14 mo** | **16 mo** | **18 mo** | **20 mo** | **22 mo** |
| **1** | 0.9 | 0.9 | 1.1 | 0.6 | 1.1 | 0.7 | 0.9 | 1.3 | 0.7 | 0.9 |
| **3** | 3.4 | 3.8 | 2.7 | 2.7 | 2.6 | 2.9 | 3.4 | 3.0 | 2.9 | 2.0 |
| **5** | 6.4 | 5.7 | 5.4 | 4.8 | 4.6 | 5.4 | 5.6 | 4.7 | 4.6 | 3.7 |
| **10** | 10.5 | 10.6 | 10.1 | 8.9 | 10.2 | 10.5 | 11.4 | 9.5 | 9.2 | 9.2 |
| **25** | 23.6 | 23.8 | 25.1 | 23.9 | 24.7 | 24.1 | 24.4 | 25.2 | 25.9 | 25.4 |
| **50** | 49.3 | 49.5 | 49.3 | 49.7 | 51.2 | 50.2 | 52.7 | 50.4 | 51.0 | 50.6 |
| **75** | 76.4 | 75.8 | 77.4 | 74.8 | 75.5 | 75.2 | 74.7 | 75.8 | 76.0 | 77.2 |
| **90** | 91.4 | 90.3 | 90.6 | 90.9 | 90.5 | 89.7 | 88.8 | 89.6 | 90.1 | 89.9 |
| **95** | 95.9 | 94.3 | 94.6 | 94.6 | 94.7 | 93.8 | 93.9 | 94.3 | 94.5 | 94.3 |
| **97** | 96.8 | 96.8 | 97.3 | 96.7 | 96.7 | 95.8 | 96.9 | 96.4 | 95.8 | 96.3 |
| **99** | 99.1 | 98.0 | 99.1 | 99.0 | 99.3 | 98.9 | 98.7 | 98.9 | 98.2 | 98.5 |

**Table 25 Observed proportions of children with measurements below the fitted centiles from Model 1, length/height-for-age for girls (continued)**

| Expected | 24 mo | 28 mo | 34 mo | 40 mo | 46 mo | 52 mo | 58 mo | 64 mo | 70 mo | Overall |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 0.8 | 0.9 | 1.4 | 0.6 | 1.1 | 1.5 | 0.4 | 1.7 | 1.0 | 0.9 |
| **3** | 2.5 | 2.3 | 3.7 | 2.2 | 3.4 | 3.8 | 2.2 | 2.4 | 2.0 | 2.8 |
| **5** | 5.2 | 3.8 | 6.0 | 4.1 | 4.0 | 5.3 | 4.2 | 4.2 | 3.9 | 4.9 |
| **10** | 10.9 | 7.9 | 11.7 | 10.6 | 8.3 | 10.0 | 8.7 | 9.4 | 11.4 | 10.1 |
| **25** | 25.8 | 26.4 | 26.1 | 26.9 | 23.7 | 24.9 | 21.8 | 25.0 | 26.7 | 25.2 |
| **50** | 49.8 | 51.1 | 52.8 | 53.1 | 47.5 | 56.5 | 46.0 | 53.3 | 46.9 | 50.3 |
| **75** | 75.9 | 72.3 | 75.4 | 75.3 | 76.3 | 78.7 | 74.6 | 77.8 | 71.7 | 75.3 |
| **90** | 90.3 | 90.0 | 90.8 | 89.0 | 88.3 | 91.5 | 88.7 | 91.0 | 89.3 | 90.0 |
| **95** | 94.5 | 93.8 | 94.3 | 94.7 | 93.4 | 94.2 | 95.2 | 96.2 | 94.1 | 94.5 |
| **97** | 96.5 | 96.6 | 95.5 | 96.9 | 95.8 | 96.8 | 97.2 | 97.9 | 96.1 | 96.6 |
| **99** | 98.5 | 98.9 | 98.4 | 98.8 | 99.2 | 98.5 | 98.8 | 99.1 | 99.0 | 98.8 |

Note: Group labels correspond to the age intervals in Table 26.

**Table 26 Q-test for z-scores from Model 1 [BCPE(x=age$^{0.35}$, df(μ)=10, df(σ)=5, ν=1, τ=2)] for length/height-for-age for girls**

| Age (days) | Group | N | z1 | z2 | z3 | z4 |
|---|---|---|---|---|---|---|
| 0 | **Birth** | 842 | 0.42 | -0.36 | -0.85 | 0.26 |
| 1 to 16 | **14 d** | 447 | -1.02 | 1.12 | -0.24 | -0.88 |
| 17 to 34 | **28 d** | 450 | -0.30 | 0.33 | 0.72 | -0.90 |
| 35 to 49 | **42 d** | 444 | -0.01 | -0.10 | 0.56 | -0.54 |
| 50 to 69 | **2 mo** | 445 | 0.08 | -0.12 | 1.74 | -0.63 |
| 70 to 99 | **3 mo** | 447 | -0.01 | 0.07 | 1.21 | -1.22 |
| 100 to 129 | **4 mo** | 447 | 0.67 | 0.50 | 1.24 | -0.62 |
| 130 to 159 | **5 mo** | 444 | 0.75 | 0.05 | 1.72 | 0.14 |
| 160 to 189 | **6 mo** | 444 | -0.27 | -0.54 | 1.14 | 0.75 |
| 190 to 219 | **7 mo** | 436 | -0.03 | -0.33 | 0.86 | 0.25 |
| 220 to 249 | **8 mo** | 440 | -0.56 | -0.45 | -0.22 | 0.06 |
| 250 to 279 | **9 mo** | 442 | 0.11 | 0.43 | 0.05 | 0.70 |
| 280 to 309 | **10 mo** | 446 | -0.24 | -0.41 | 0.08 | -0.23 |
| 310 to 349 | **11 mo** | 481 | 0.23 | -0.62 | -0.02 | 0.05 |
| 350 to 379 | **12 mo** | 453 | -0.12 | -0.15 | 0.40 | -0.34 |
| 380 to 439 | **14 mo** | 448 | 0.22 | 0.24 | 0.75 | -0.14 |
| 440 to 499 | **16 mo** | 446 | -0.24 | 0.38 | 0.62 | -0.50 |
| 500 to 559 | **18 mo** | 472 | 0.06 | -0.29 | 0.77 | -0.20 |
| 560 to 619 | **20 mo** | 545 | -0.09 | 0.08 | 1.76 | -0.27 |
| 620 to 679 | **22 mo** | 543 | 0.32 | 0.04 | 1.97 | 0.52 |
| 680 to 749 | **24 mo** | 598 | -0.09 | -0.36 | 1.18 | 0.13 |
| 750 to 929 | **28 mo** | 470 | 0.60 | -0.35 | 0.77 | -1.02 |
| 930 to 1119 | **34 mo** | 487 | -0.83 | 1.32 | 0.93 | 0.18 |
| 1120 to 1309 | **40 mo** | 490 | -0.58 | 0.22 | 1.19 | -0.75 |
| 1310 to 1499 | **46 mo** | 472 | 1.24 | -0.10 | 0.45 | 0.25 |
| 1500 to 1689 | **52 mo** | 469 | -1.30 | 0.47 | 1.98 | 2.36 |
| 1690 to 1879 | **58 mo** | 504 | 1.23 | -0.78 | 0.57 | 0.08 |
| 1880 to 2069 | **64 mo** | 424 | -1.16 | -0.67 | -0.16 | 0.99 |
| 2070 to 2191 | **70 mo** | 307 | 0.94 | 0.94 | 0.07 | 0.61 |
| **Overall Q stats** | | **13 783** | **11.45** | **7.65** | **30.09** | **14.81** |
| **degrees of freedom** | | | **19.0** | **26.0** | **29.0** | **29.0** |
| **p-value** | | | **0.9078** | **0.9998** | **0.4095** | **0.9865** |

Note: Absolute values of z1, z2, z3 or z4 larger than 2 indicate misfit of, respectively, mean, variance, skewness or kurtosis.

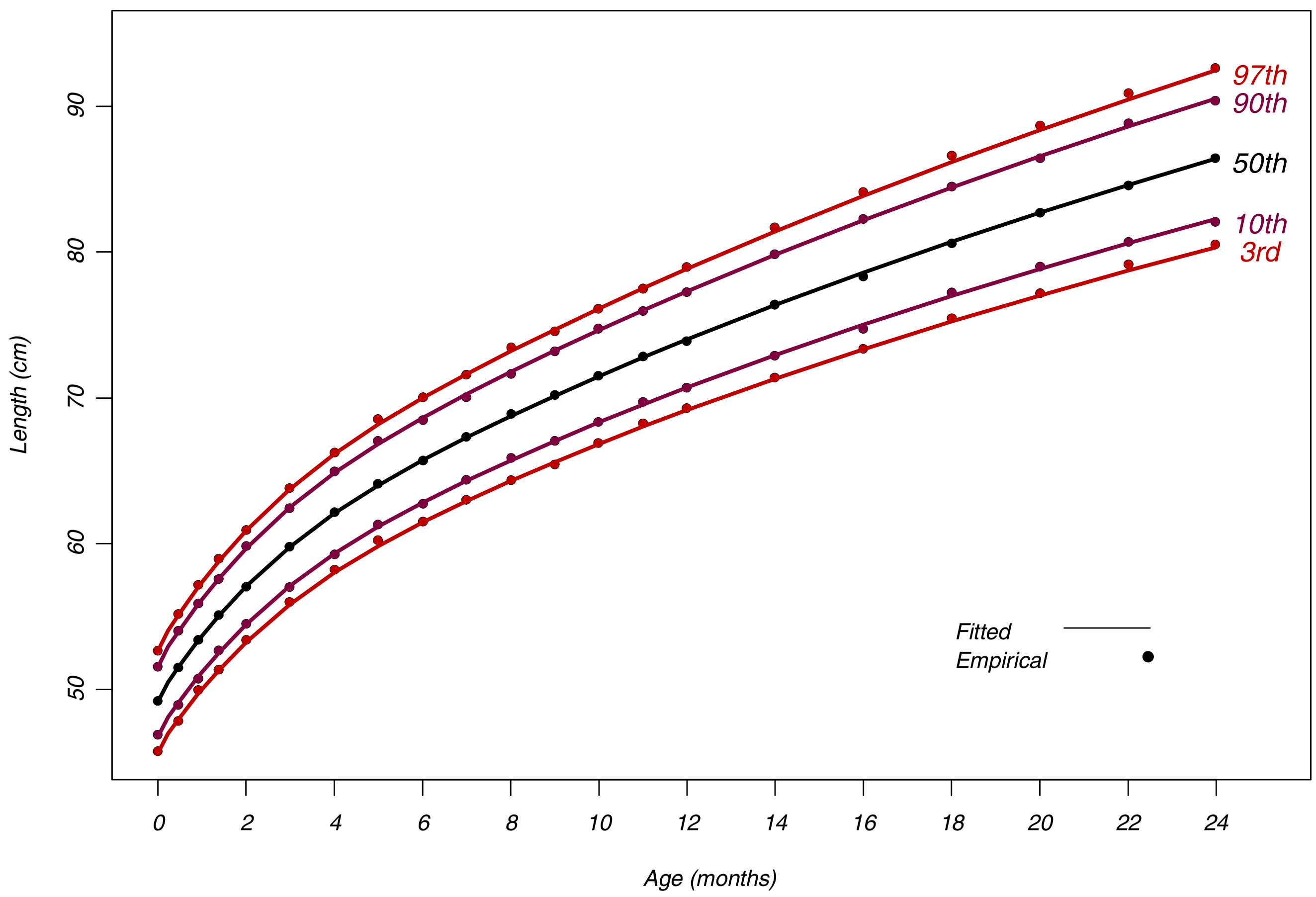


**Figure 21 3rd, 10th, 50th, 90th, 97th smoothed centile curves and empirical values: length-for-age for girls from birth to 24 months**

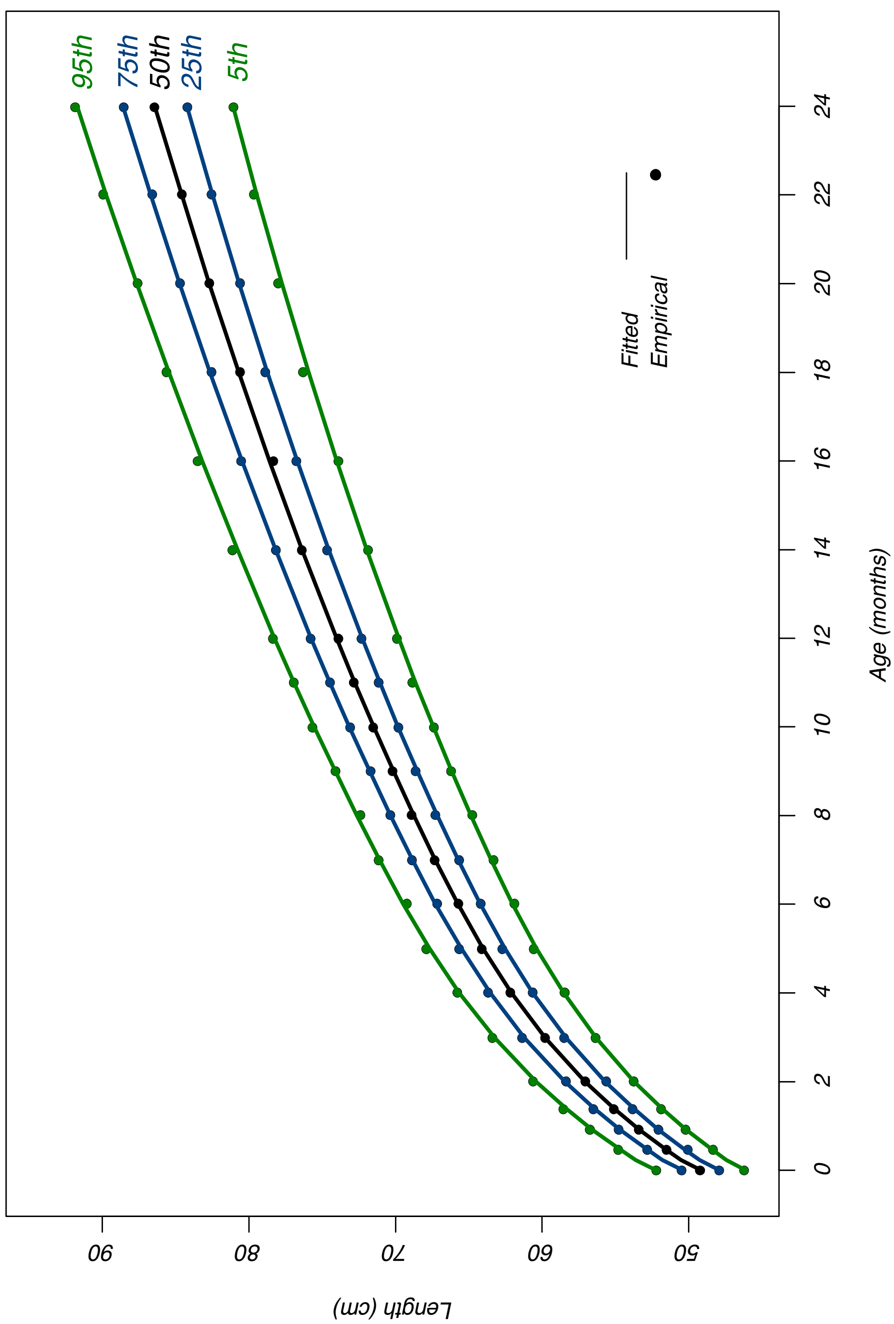


**Figure 22 5th, 25th, 50th, 75th, 95th smoothed centile curves and empirical values: length-for-age for girls from birth to 24 months**

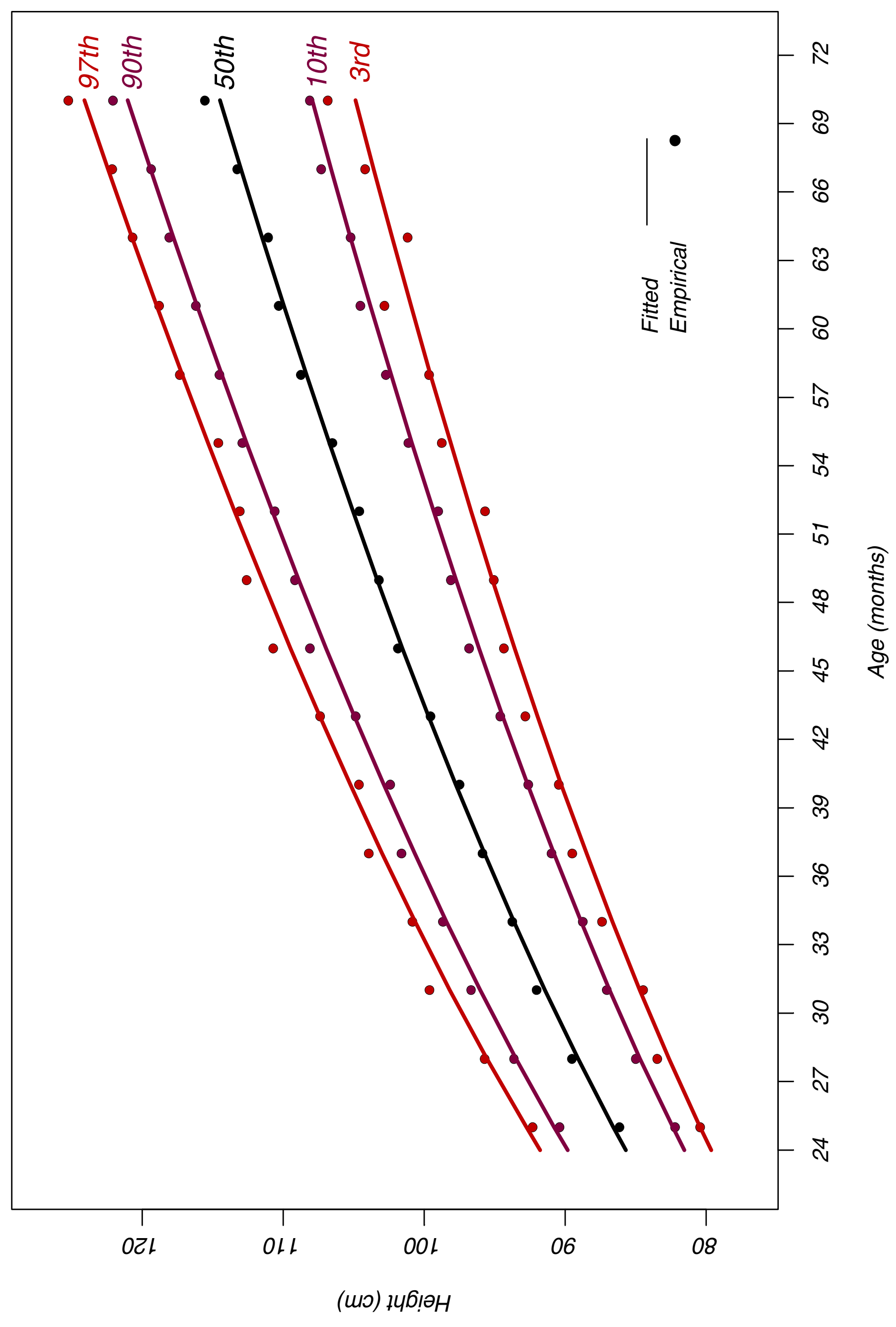


**Figure 23 3rd, 10th, 50th, 90th, 97th smoothed centile curves and empirical values: height-for-age for girls from 24 to 71 months**

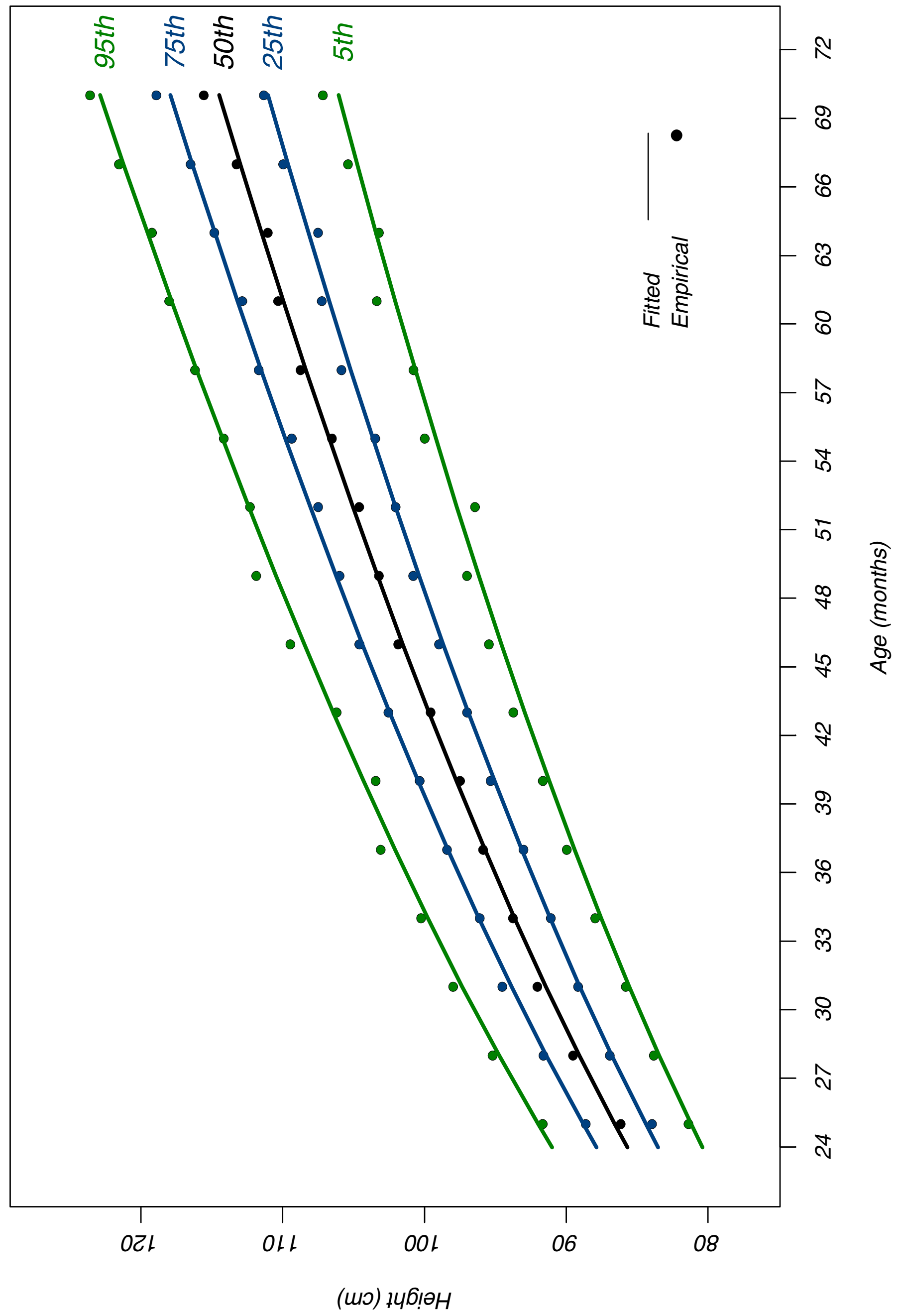


**Figure 24 5th, 25th, 50th, 75th, 95th smoothed centile curves and empirical values: height-for-age for girls from 24 to 71 months**

### 3.3.3 WHO standards and their comparison with NCHS and CDC 2000 references

This section presents the final WHO length/height-for-age z-score and percentile charts (Figures 25 to 28) and tables (Tables 27 to 29) for girls. It also provides the z-score comparisons of the WHO versus NCHS (Figure 29) and CDC 2000 (Figure 30) curves.

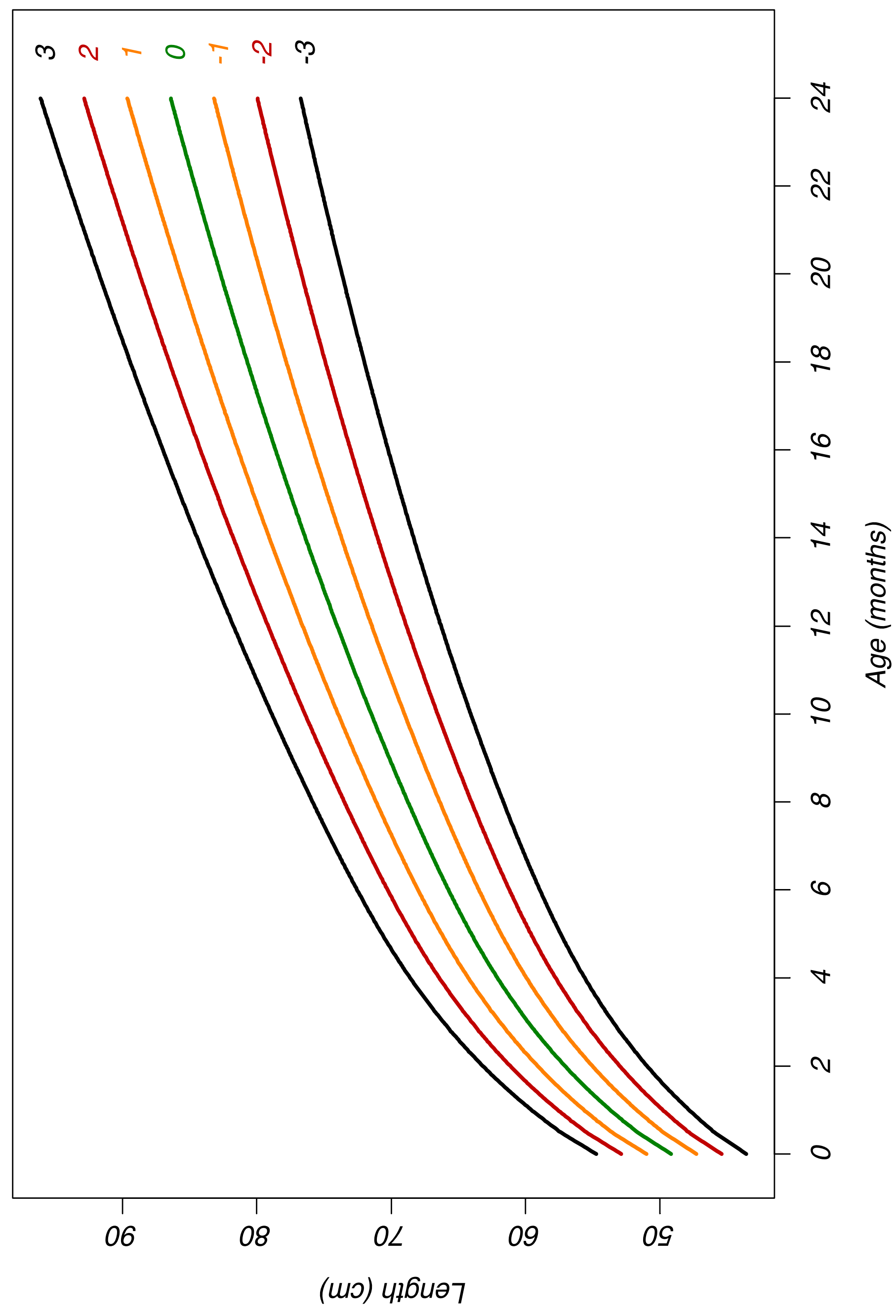


**Figure 25 WHO length-for-age z-scores for girls from birth to 24 months**

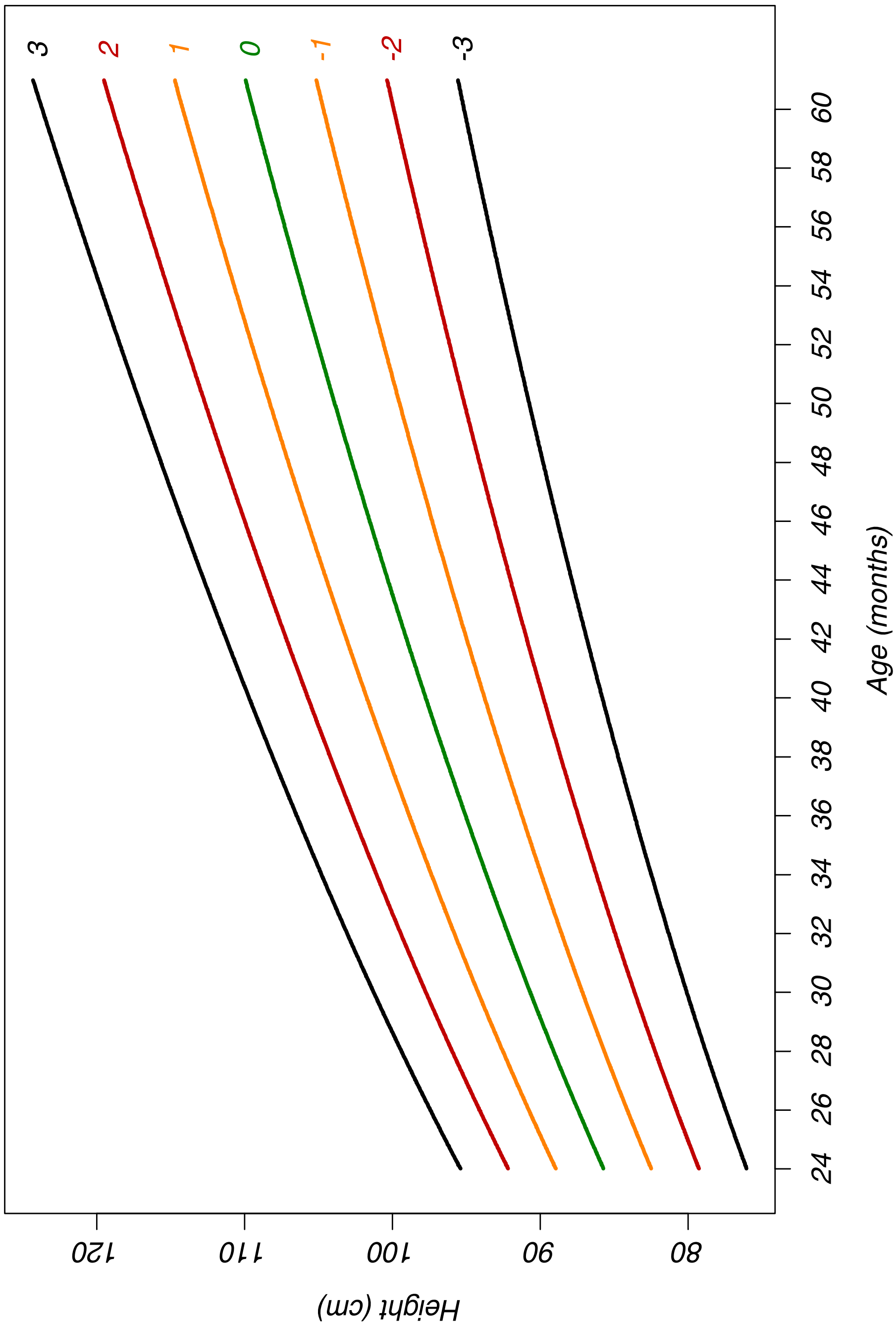


**Figure 26 WHO height-for-age z-scores for girls from 24 to 60 months**

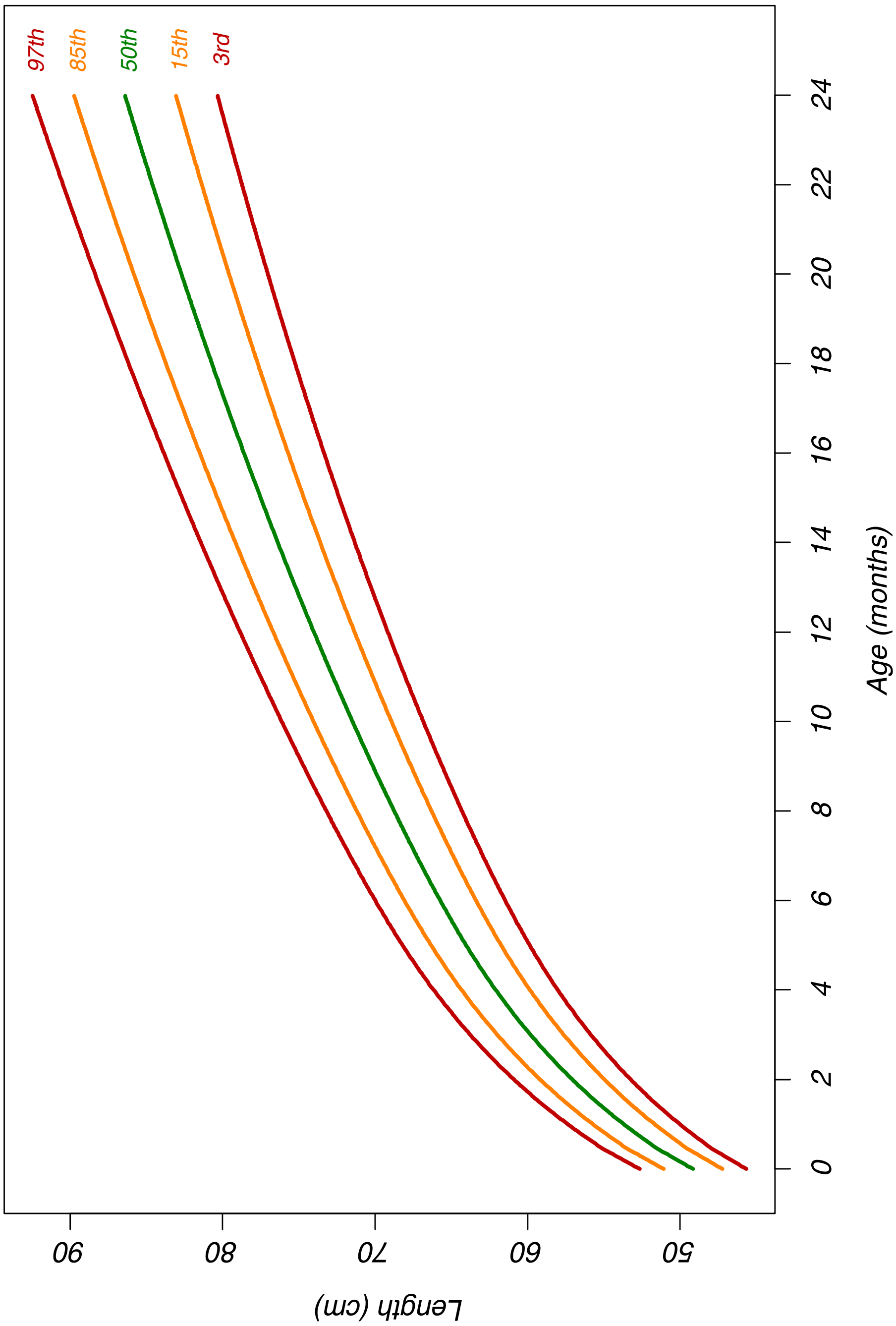


**Figure 27 WHO length-for-age percentiles for girls from birth to 24 months**

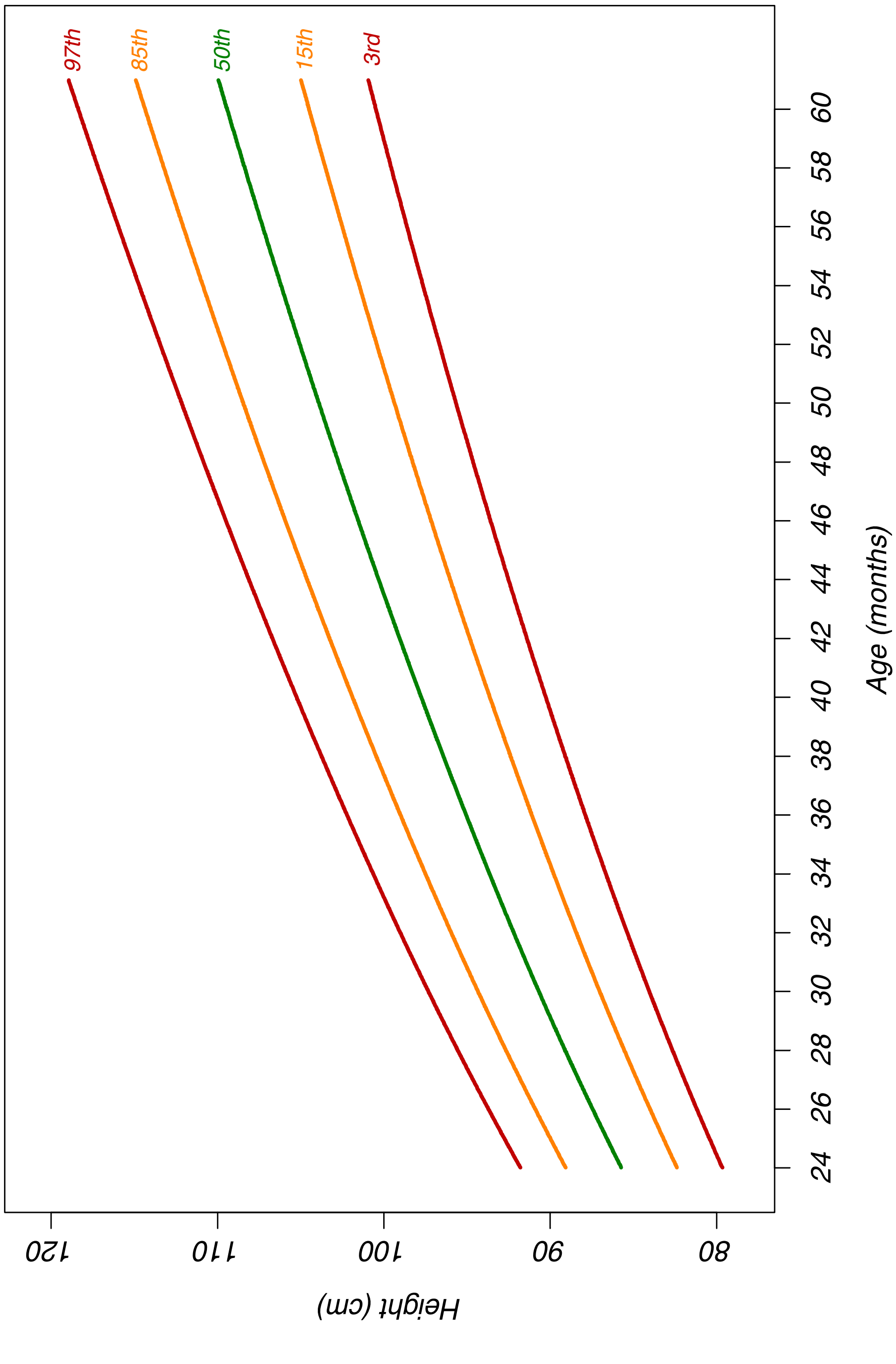


**Figure 28 WHO height-for-age percentiles for girls from 24 to 60 months**

**Table 27 Length-for-age for girls, age in weeks**

| Week | L | M | S | SD | Percentiles (length in cm) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1st | 3rd | 5th | 15th | 25th | 50th | 75th | 85th | 95th | 97th | 99th |
| **0** | 1 | 49.1477 | 0.03790 | 1.8627 | 44.8 | 45.6 | 46.1 | 47.2 | 47.9 | 49.1 | 50.4 | 51.1 | 52.2 | 52.7 | 53.5 |
| **1** | 1 | 50.3298 | 0.03742 | 1.8833 | 45.9 | 46.8 | 47.2 | 48.4 | 49.1 | 50.3 | 51.6 | 52.3 | 53.4 | 53.9 | 54.7 |
| **2** | 1 | 51.5120 | 0.03694 | 1.9029 | 47.1 | 47.9 | 48.4 | 49.5 | 50.2 | 51.5 | 52.8 | 53.5 | 54.6 | 55.1 | 55.9 |
| **3** | 1 | 52.4695 | 0.03669 | 1.9251 | 48.0 | 48.8 | 49.3 | 50.5 | 51.2 | 52.5 | 53.8 | 54.5 | 55.6 | 56.1 | 56.9 |
| **4** | 1 | 53.3809 | 0.03647 | 1.9468 | 48.9 | 49.7 | 50.2 | 51.4 | 52.1 | 53.4 | 54.7 | 55.4 | 56.6 | 57.0 | 57.9 |
| **5** | 1 | 54.2454 | 0.03627 | 1.9675 | 49.7 | 50.5 | 51.0 | 52.2 | 52.9 | 54.2 | 55.6 | 56.3 | 57.5 | 57.9 | 58.8 |
| **6** | 1 | 55.0642 | 0.03609 | 1.9873 | 50.4 | 51.3 | 51.8 | 53.0 | 53.7 | 55.1 | 56.4 | 57.1 | 58.3 | 58.8 | 59.7 |
| **7** | 1 | 55.8406 | 0.03593 | 2.0064 | 51.2 | 52.1 | 52.5 | 53.8 | 54.5 | 55.8 | 57.2 | 57.9 | 59.1 | 59.6 | 60.5 |
| **8** | 1 | 56.5767 | 0.03578 | 2.0243 | 51.9 | 52.8 | 53.2 | 54.5 | 55.2 | 56.6 | 57.9 | 58.7 | 59.9 | 60.4 | 61.3 |
| **9** | 1 | 57.2761 | 0.03564 | 2.0413 | 52.5 | 53.4 | 53.9 | 55.2 | 55.9 | 57.3 | 58.7 | 59.4 | 60.6 | 61.1 | 62.0 |
| **10** | 1 | 57.9436 | 0.03552 | 2.0582 | 53.2 | 54.1 | 54.6 | 55.8 | 56.6 | 57.9 | 59.3 | 60.1 | 61.3 | 61.8 | 62.7 |
| **11** | 1 | 58.5816 | 0.03540 | 2.0738 | 53.8 | 54.7 | 55.2 | 56.4 | 57.2 | 58.6 | 60.0 | 60.7 | 62.0 | 62.5 | 63.4 |
| **12** | 1 | 59.1922 | 0.03530 | 2.0895 | 54.3 | 55.3 | 55.8 | 57.0 | 57.8 | 59.2 | 60.6 | 61.4 | 62.6 | 63.1 | 64.1 |
| **13** | 1 | 59.7773 | 0.03520 | 2.1042 | 54.9 | 55.8 | 56.3 | 57.6 | 58.4 | 59.8 | 61.2 | 62.0 | 63.2 | 63.7 | 64.7 |

**Table 27 Length-for-age for girls, age in weeks (continued)**

| | | | | | Z-scores (length in cm) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Week** | **L** | **M** | **S** | **SD** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **0** | 1 | 49.1477 | 0.03790 | 1.8627 | 43.6 | 45.4 | 47.3 | 49.1 | 51.0 | 52.9 | 54.7 |
| **1** | 1 | 50.3298 | 0.03742 | 1.8833 | 44.7 | 46.6 | 48.4 | 50.3 | 52.2 | 54.1 | 56.0 |
| **2** | 1 | 51.5120 | 0.03694 | 1.9029 | 45.8 | 47.7 | 49.6 | 51.5 | 53.4 | 55.3 | 57.2 |
| **3** | 1 | 52.4695 | 0.03669 | 1.9251 | 46.7 | 48.6 | 50.5 | 52.5 | 54.4 | 56.3 | 58.2 |
| **4** | 1 | 53.3809 | 0.03647 | 1.9468 | 47.5 | 49.5 | 51.4 | 53.4 | 55.3 | 57.3 | 59.2 |
| **5** | 1 | 54.2454 | 0.03627 | 1.9675 | 48.3 | 50.3 | 52.3 | 54.2 | 56.2 | 58.2 | 60.1 |
| **6** | 1 | 55.0642 | 0.03609 | 1.9873 | 49.1 | 51.1 | 53.1 | 55.1 | 57.1 | 59.0 | 61.0 |
| **7** | 1 | 55.8406 | 0.03593 | 2.0064 | 49.8 | 51.8 | 53.8 | 55.8 | 57.8 | 59.9 | 61.9 |
| **8** | 1 | 56.5767 | 0.03578 | 2.0243 | 50.5 | 52.5 | 54.6 | 56.6 | 58.6 | 60.6 | 62.6 |
| **9** | 1 | 57.2761 | 0.03564 | 2.0413 | 51.2 | 53.2 | 55.2 | 57.3 | 59.3 | 61.4 | 63.4 |
| **10** | 1 | 57.9436 | 0.03552 | 2.0582 | 51.8 | 53.8 | 55.9 | 57.9 | 60.0 | 62.1 | 64.1 |
| **11** | 1 | 58.5816 | 0.03540 | 2.0738 | 52.4 | 54.4 | 56.5 | 58.6 | 60.7 | 62.7 | 64.8 |
| **12** | 1 | 59.1922 | 0.03530 | 2.0895 | 52.9 | 55.0 | 57.1 | 59.2 | 61.3 | 63.4 | 65.5 |
| **13** | 1 | 59.7773 | 0.03520 | 2.1042 | 53.5 | 55.6 | 57.7 | 59.8 | 61.9 | 64.0 | 66.1 |

**Table 28 Length-for-age for girls, age in years and months**

| | | | | | | Percentiles (length in cm) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **SD** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **0: 0** | **0** | 1 | 49.1477 | 0.03790 | 1.8627 | 44.8 | 45.6 | 46.1 | 47.2 | 47.9 | 49.1 | 50.4 | 51.1 | 52.2 | 52.7 | 53.5 |
| **0: 1** | **1** | 1 | 53.6872 | 0.03640 | 1.9542 | 49.1 | 50.0 | 50.5 | 51.7 | 52.4 | 53.7 | 55.0 | 55.7 | 56.9 | 57.4 | 58.2 |
| **0: 2** | **2** | 1 | 57.0673 | 0.03568 | 2.0362 | 52.3 | 53.2 | 53.7 | 55.0 | 55.7 | 57.1 | 58.4 | 59.2 | 60.4 | 60.9 | 61.8 |
| **0: 3** | **3** | 1 | 59.8029 | 0.03520 | 2.1051 | 54.9 | 55.8 | 56.3 | 57.6 | 58.4 | 59.8 | 61.2 | 62.0 | 63.3 | 63.8 | 64.7 |
| **0: 4** | **4** | 1 | 62.0899 | 0.03486 | 2.1645 | 57.1 | 58.0 | 58.5 | 59.8 | 60.6 | 62.1 | 63.5 | 64.3 | 65.7 | 66.2 | 67.1 |
| **0: 5** | **5** | 1 | 64.0301 | 0.03463 | 2.2174 | 58.9 | 59.9 | 60.4 | 61.7 | 62.5 | 64.0 | 65.5 | 66.3 | 67.7 | 68.2 | 69.2 |
| **0: 6** | **6** | 1 | 65.7311 | 0.03448 | 2.2664 | 60.5 | 61.5 | 62.0 | 63.4 | 64.2 | 65.7 | 67.3 | 68.1 | 69.5 | 70.0 | 71.0 |
| **0: 7** | **7** | 1 | 67.2873 | 0.03441 | 2.3154 | 61.9 | 62.9 | 63.5 | 64.9 | 65.7 | 67.3 | 68.8 | 69.7 | 71.1 | 71.6 | 72.7 |
| **0: 8** | **8** | 1 | 68.7498 | 0.03440 | 2.3650 | 63.2 | 64.3 | 64.9 | 66.3 | 67.2 | 68.7 | 70.3 | 71.2 | 72.6 | 73.2 | 74.3 |
| **0: 9** | **9** | 1 | 70.1435 | 0.03444 | 2.4157 | 64.5 | 65.6 | 66.2 | 67.6 | 68.5 | 70.1 | 71.8 | 72.6 | 74.1 | 74.7 | 75.8 |
| **0:10** | **10** | 1 | 71.4818 | 0.03452 | 2.4676 | 65.7 | 66.8 | 67.4 | 68.9 | 69.8 | 71.5 | 73.1 | 74.0 | 75.5 | 76.1 | 77.2 |
| **0:11** | **11** | 1 | 72.7710 | 0.03464 | 2.5208 | 66.9 | 68.0 | 68.6 | 70.2 | 71.1 | 72.8 | 74.5 | 75.4 | 76.9 | 77.5 | 78.6 |
| **1: 0** | **12** | 1 | 74.0150 | 0.03479 | 2.5750 | 68.0 | 69.2 | 69.8 | 71.3 | 72.3 | 74.0 | 75.8 | 76.7 | 78.3 | 78.9 | 80.0 |
| **1: 1** | **13** | 1 | 75.2176 | 0.03496 | 2.6296 | 69.1 | 70.3 | 70.9 | 72.5 | 73.4 | 75.2 | 77.0 | 77.9 | 79.5 | 80.2 | 81.3 |
| **1: 2** | **14** | 1 | 76.3817 | 0.03514 | 2.6841 | 70.1 | 71.3 | 72.0 | 73.6 | 74.6 | 76.4 | 78.2 | 79.2 | 80.8 | 81.4 | 82.6 |
| **1: 3** | **15** | 1 | 77.5099 | 0.03534 | 2.7392 | 71.1 | 72.4 | 73.0 | 74.7 | 75.7 | 77.5 | 79.4 | 80.3 | 82.0 | 82.7 | 83.9 |
| **1: 4** | **16** | 1 | 78.6055 | 0.03555 | 2.7944 | 72.1 | 73.3 | 74.0 | 75.7 | 76.7 | 78.6 | 80.5 | 81.5 | 83.2 | 83.9 | 85.1 |
| **1: 5** | **17** | 1 | 79.6710 | 0.03576 | 2.8490 | 73.0 | 74.3 | 75.0 | 76.7 | 77.7 | 79.7 | 81.6 | 82.6 | 84.4 | 85.0 | 86.3 |
| **1: 6** | **18** | 1 | 80.7079 | 0.03598 | 2.9039 | 74.0 | 75.2 | 75.9 | 77.7 | 78.7 | 80.7 | 82.7 | 83.7 | 85.5 | 86.2 | 87.5 |
| **1: 7** | **19** | 1 | 81.7182 | 0.03620 | 2.9582 | 74.8 | 76.2 | 76.9 | 78.7 | 79.7 | 81.7 | 83.7 | 84.8 | 86.6 | 87.3 | 88.6 |
| **1: 8** | **20** | 1 | 82.7036 | 0.03643 | 3.0129 | 75.7 | 77.0 | 77.7 | 79.6 | 80.7 | 82.7 | 84.7 | 85.8 | 87.7 | 88.4 | 89.7 |
| **1: 9** | **21** | 1 | 83.6654 | 0.03666 | 3.0672 | 76.5 | 77.9 | 78.6 | 80.5 | 81.6 | 83.7 | 85.7 | 86.8 | 88.7 | 89.4 | 90.8 |
| **1:10** | **22** | 1 | 84.6040 | 0.03688 | 3.1202 | 77.3 | 78.7 | 79.5 | 81.4 | 82.5 | 84.6 | 86.7 | 87.8 | 89.7 | 90.5 | 91.9 |
| **1:11** | **23** | 1 | 85.5202 | 0.03711 | 3.1737 | 78.1 | 79.6 | 80.3 | 82.2 | 83.4 | 85.5 | 87.7 | 88.8 | 90.7 | 91.5 | 92.9 |
| **2: 0** | **24** | 1 | 86.4153 | 0.03734 | 3.2267 | 78.9 | 80.3 | 81.1 | 83.1 | 84.2 | 86.4 | 88.6 | 89.8 | 91.7 | 92.5 | 93.9 |

**Table 28 Length-for-age for girls, age in years and months (continued)**

| | | | | | | Z-scores (length in cm) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **SD** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **0: 0** | **0** | 1 | 49.1477 | 0.03790 | 1.8627 | 43.6 | 45.4 | 47.3 | 49.1 | 51.0 | 52.9 | 54.7 |
| **0: 1** | **1** | 1 | 53.6872 | 0.03640 | 1.9542 | 47.8 | 49.8 | 51.7 | 53.7 | 55.6 | 57.6 | 59.5 |
| **0: 2** | **2** | 1 | 57.0673 | 0.03568 | 2.0362 | 51.0 | 53.0 | 55.0 | 57.1 | 59.1 | 61.1 | 63.2 |
| **0: 3** | **3** | 1 | 59.8029 | 0.03520 | 2.1051 | 53.5 | 55.6 | 57.7 | 59.8 | 61.9 | 64.0 | 66.1 |
| **0: 4** | **4** | 1 | 62.0899 | 0.03486 | 2.1645 | 55.6 | 57.8 | 59.9 | 62.1 | 64.3 | 66.4 | 68.6 |
| **0: 5** | **5** | 1 | 64.0301 | 0.03463 | 2.2174 | 57.4 | 59.6 | 61.8 | 64.0 | 66.2 | 68.5 | 70.7 |
| **0: 6** | **6** | 1 | 65.7311 | 0.03448 | 2.2664 | 58.9 | 61.2 | 63.5 | 65.7 | 68.0 | 70.3 | 72.5 |
| **0: 7** | **7** | 1 | 67.2873 | 0.03441 | 2.3154 | 60.3 | 62.7 | 65.0 | 67.3 | 69.6 | 71.9 | 74.2 |
| **0: 8** | **8** | 1 | 68.7498 | 0.03440 | 2.3650 | 61.7 | 64.0 | 66.4 | 68.7 | 71.1 | 73.5 | 75.8 |
| **0: 9** | **9** | 1 | 70.1435 | 0.03444 | 2.4157 | 62.9 | 65.3 | 67.7 | 70.1 | 72.6 | 75.0 | 77.4 |
| **0:10** | **10** | 1 | 71.4818 | 0.03452 | 2.4676 | 64.1 | 66.5 | 69.0 | 71.5 | 73.9 | 76.4 | 78.9 |
| **0:11** | **11** | 1 | 72.7710 | 0.03464 | 2.5208 | 65.2 | 67.7 | 70.3 | 72.8 | 75.3 | 77.8 | 80.3 |
| **1: 0** | **12** | 1 | 74.0150 | 0.03479 | 2.5750 | 66.3 | 68.9 | 71.4 | 74.0 | 76.6 | 79.2 | 81.7 |
| **1: 1** | **13** | 1 | 75.2176 | 0.03496 | 2.6296 | 67.3 | 70.0 | 72.6 | 75.2 | 77.8 | 80.5 | 83.1 |
| **1: 2** | **14** | 1 | 76.3817 | 0.03514 | 2.6841 | 68.3 | 71.0 | 73.7 | 76.4 | 79.1 | 81.7 | 84.4 |
| **1: 3** | **15** | 1 | 77.5099 | 0.03534 | 2.7392 | 69.3 | 72.0 | 74.8 | 77.5 | 80.2 | 83.0 | 85.7 |
| **1: 4** | **16** | 1 | 78.6055 | 0.03555 | 2.7944 | 70.2 | 73.0 | 75.8 | 78.6 | 81.4 | 84.2 | 87.0 |
| **1: 5** | **17** | 1 | 79.6710 | 0.03576 | 2.8490 | 71.1 | 74.0 | 76.8 | 79.7 | 82.5 | 85.4 | 88.2 |
| **1: 6** | **18** | 1 | 80.7079 | 0.03598 | 2.9039 | 72.0 | 74.9 | 77.8 | 80.7 | 83.6 | 86.5 | 89.4 |
| **1: 7** | **19** | 1 | 81.7182 | 0.03620 | 2.9582 | 72.8 | 75.8 | 78.8 | 81.7 | 84.7 | 87.6 | 90.6 |
| **1: 8** | **20** | 1 | 82.7036 | 0.03643 | 3.0129 | 73.7 | 76.7 | 79.7 | 82.7 | 85.7 | 88.7 | 91.7 |
| **1: 9** | **21** | 1 | 83.6654 | 0.03666 | 3.0672 | 74.5 | 77.5 | 80.6 | 83.7 | 86.7 | 89.8 | 92.9 |
| **1:10** | **22** | 1 | 84.6040 | 0.03688 | 3.1202 | 75.2 | 78.4 | 81.5 | 84.6 | 87.7 | 90.8 | 94.0 |
| **1:11** | **23** | 1 | 85.5202 | 0.03711 | 3.1737 | 76.0 | 79.2 | 82.3 | 85.5 | 88.7 | 91.9 | 95.0 |
| **2: 0** | **24** | 1 | 86.4153 | 0.03734 | 3.2267 | 76.7 | 80.0 | 83.2 | 86.4 | 89.6 | 92.9 | 96.1 |

**Table 29 Height-for-age for girls, age in years and months**

| | | | | | | Percentiles (height in cm) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **SD** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **2: 0** | **24** | 1 | 85.7153 | 0.03764 | 3.2267 | 78.2 | 79.6 | 80.4 | 82.4 | 83.5 | 85.7 | 87.9 | 89.1 | 91.0 | 91.8 | 93.2 |
| **2: 1** | **25** | 1 | 86.5904 | 0.03786 | 3.2783 | 79.0 | 80.4 | 81.2 | 83.2 | 84.4 | 86.6 | 88.8 | 90.0 | 92.0 | 92.8 | 94.2 |
| **2: 2** | **26** | 1 | 87.4462 | 0.03808 | 3.3300 | 79.7 | 81.2 | 82.0 | 84.0 | 85.2 | 87.4 | 89.7 | 90.9 | 92.9 | 93.7 | 95.2 |
| **2: 3** | **27** | 1 | 88.2830 | 0.03830 | 3.3812 | 80.4 | 81.9 | 82.7 | 84.8 | 86.0 | 88.3 | 90.6 | 91.8 | 93.8 | 94.6 | 96.1 |
| **2: 4** | **28** | 1 | 89.1004 | 0.03851 | 3.4313 | 81.1 | 82.6 | 83.5 | 85.5 | 86.8 | 89.1 | 91.4 | 92.7 | 94.7 | 95.6 | 97.1 |
| **2: 5** | **29** | 1 | 89.8991 | 0.03872 | 3.4809 | 81.8 | 83.4 | 84.2 | 86.3 | 87.6 | 89.9 | 92.2 | 93.5 | 95.6 | 96.4 | 98.0 |
| **2: 6** | **30** | 1 | 90.6797 | 0.03893 | 3.5302 | 82.5 | 84.0 | 84.9 | 87.0 | 88.3 | 90.7 | 93.1 | 94.3 | 96.5 | 97.3 | 98.9 |
| **2: 7** | **31** | 1 | 91.4430 | 0.03913 | 3.5782 | 83.1 | 84.7 | 85.6 | 87.7 | 89.0 | 91.4 | 93.9 | 95.2 | 97.3 | 98.2 | 99.8 |
| **2: 8** | **32** | 1 | 92.1906 | 0.03933 | 3.6259 | 83.8 | 85.4 | 86.2 | 88.4 | 89.7 | 92.2 | 94.6 | 95.9 | 98.2 | 99.0 | 100.6 |
| **2: 9** | **33** | 1 | 92.9239 | 0.03952 | 3.6724 | 84.4 | 86.0 | 86.9 | 89.1 | 90.4 | 92.9 | 95.4 | 96.7 | 99.0 | 99.8 | 101.5 |
| **2:10** | **34** | 1 | 93.6444 | 0.03971 | 3.7186 | 85.0 | 86.7 | 87.5 | 89.8 | 91.1 | 93.6 | 96.2 | 97.5 | 99.8 | 100.6 | 102.3 |
| **2:11** | **35** | 1 | 94.3533 | 0.03989 | 3.7638 | 85.6 | 87.3 | 88.2 | 90.5 | 91.8 | 94.4 | 96.9 | 98.3 | 100.5 | 101.4 | 103.1 |
| **3: 0** | **36** | 1 | 95.0515 | 0.04006 | 3.8078 | 86.2 | 87.9 | 88.8 | 91.1 | 92.5 | 95.1 | 97.6 | 99.0 | 101.3 | 102.2 | 103.9 |
| **3: 1** | **37** | 1 | 95.7399 | 0.04024 | 3.8526 | 86.8 | 88.5 | 89.4 | 91.7 | 93.1 | 95.7 | 98.3 | 99.7 | 102.1 | 103.0 | 104.7 |
| **3: 2** | **38** | 1 | 96.4187 | 0.04041 | 3.8963 | 87.4 | 89.1 | 90.0 | 92.4 | 93.8 | 96.4 | 99.0 | 100.5 | 102.8 | 103.7 | 105.5 |
| **3: 3** | **39** | 1 | 97.0885 | 0.04057 | 3.9389 | 87.9 | 89.7 | 90.6 | 93.0 | 94.4 | 97.1 | 99.7 | 101.2 | 103.6 | 104.5 | 106.3 |
| **3: 4** | **40** | 1 | 97.7493 | 0.04073 | 3.9813 | 88.5 | 90.3 | 91.2 | 93.6 | 95.1 | 97.7 | 100.4 | 101.9 | 104.3 | 105.2 | 107.0 |
| **3: 5** | **41** | 1 | 98.4015 | 0.04089 | 4.0236 | 89.0 | 90.8 | 91.8 | 94.2 | 95.7 | 98.4 | 101.1 | 102.6 | 105.0 | 106.0 | 107.8 |
| **3: 6** | **42** | 1 | 99.0448 | 0.04105 | 4.0658 | 89.6 | 91.4 | 92.4 | 94.8 | 96.3 | 99.0 | 101.8 | 103.3 | 105.7 | 106.7 | 108.5 |
| **3: 7** | **43** | 1 | 99.6795 | 0.04120 | 4.1068 | 90.1 | 92.0 | 92.9 | 95.4 | 96.9 | 99.7 | 102.4 | 103.9 | 106.4 | 107.4 | 109.2 |
| **3: 8** | **44** | 1 | 100.3058 | 0.04135 | 4.1476 | 90.7 | 92.5 | 93.5 | 96.0 | 97.5 | 100.3 | 103.1 | 104.6 | 107.1 | 108.1 | 110.0 |
| **3: 9** | **45** | 1 | 100.9238 | 0.04150 | 4.1883 | 91.2 | 93.0 | 94.0 | 96.6 | 98.1 | 100.9 | 103.7 | 105.3 | 107.8 | 108.8 | 110.7 |
| **3:10** | **46** | 1 | 101.5337 | 0.04164 | 4.2279 | 91.7 | 93.6 | 94.6 | 97.2 | 98.7 | 101.5 | 104.4 | 105.9 | 108.5 | 109.5 | 111.4 |
| **3:11** | **47** | 1 | 102.1360 | 0.04179 | 4.2683 | 92.2 | 94.1 | 95.1 | 97.7 | 99.3 | 102.1 | 105.0 | 106.6 | 109.2 | 110.2 | 112.1 |
| **4: 0** | **48** | 1 | 102.7312 | 0.04193 | 4.3075 | 92.7 | 94.6 | 95.6 | 98.3 | 99.8 | 102.7 | 105.6 | 107.2 | 109.8 | 110.8 | 112.8 |

**Table 29 Height-for age for girls, age in years and months (continued)**

| | | | | | | Percentiles (height in cm) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **SD** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **4: 1** | **49** | 1 | 103.3197 | 0.04206 | 4.3456 | 93.2 | 95.1 | 96.2 | 98.8 | 100.4 | 103.3 | 106.3 | 107.8 | 110.5 | 111.5 | 113.4 |
| **4: 2** | **50** | 1 | 103.9021 | 0.04220 | 4.3847 | 93.7 | 95.7 | 96.7 | 99.4 | 100.9 | 103.9 | 106.9 | 108.4 | 111.1 | 112.1 | 114.1 |
| **4: 3** | **51** | 1 | 104.4786 | 0.04233 | 4.4226 | 94.2 | 96.2 | 97.2 | 99.9 | 101.5 | 104.5 | 107.5 | 109.1 | 111.8 | 112.8 | 114.8 |
| **4: 4** | **52** | 1 | 105.0494 | 0.04246 | 4.4604 | 94.7 | 96.7 | 97.7 | 100.4 | 102.0 | 105.0 | 108.1 | 109.7 | 112.4 | 113.4 | 115.4 |
| **4: 5** | **53** | 1 | 105.6148 | 0.04259 | 4.4981 | 95.2 | 97.2 | 98.2 | 101.0 | 102.6 | 105.6 | 108.6 | 110.3 | 113.0 | 114.1 | 116.1 |
| **4: 6** | **54** | 1 | 106.1748 | 0.04272 | 4.5358 | 95.6 | 97.6 | 98.7 | 101.5 | 103.1 | 106.2 | 109.2 | 110.9 | 113.6 | 114.7 | 116.7 |
| **4: 7** | **55** | 1 | 106.7295 | 0.04285 | 4.5734 | 96.1 | 98.1 | 99.2 | 102.0 | 103.6 | 106.7 | 109.8 | 111.5 | 114.3 | 115.3 | 117.4 |
| **4: 8** | **56** | 1 | 107.2788 | 0.04298 | 4.6108 | 96.6 | 98.6 | 99.7 | 102.5 | 104.2 | 107.3 | 110.4 | 112.1 | 114.9 | 116.0 | 118.0 |
| **4: 9** | **57** | 1 | 107.8227 | 0.04310 | 4.6472 | 97.0 | 99.1 | 100.2 | 103.0 | 104.7 | 107.8 | 111.0 | 112.6 | 115.5 | 116.6 | 118.6 |
| **4:10** | **58** | 1 | 108.3613 | 0.04322 | 4.6834 | 97.5 | 99.6 | 100.7 | 103.5 | 105.2 | 108.4 | 111.5 | 113.2 | 116.1 | 117.2 | 119.3 |
| **4:11** | **59** | 1 | 108.8948 | 0.04334 | 4.7195 | 97.9 | 100.0 | 101.1 | 104.0 | 105.7 | 108.9 | 112.1 | 113.8 | 116.7 | 117.8 | 119.9 |
| **5: 0** | **60** | 1 | 109.4233 | 0.04347 | 4.7566 | 98.4 | 100.5 | 101.6 | 104.5 | 106.2 | 109.4 | 112.6 | 114.4 | 117.2 | 118.4 | 120.5 |

**Table 29 Height-for-age for girls, age in years and months (continued)**

| | | | | | | Z-scores (height in cm) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **SD** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **2: 0** | **24** | 1 | 85.7153 | 0.03764 | 3.2267 | 76.0 | 79.3 | 82.5 | 85.7 | 88.9 | 92.2 | 95.4 |
| **2: 1** | **25** | 1 | 86.5904 | 0.03786 | 3.2783 | 76.8 | 80.0 | 83.3 | 86.6 | 89.9 | 93.1 | 96.4 |
| **2: 2** | **26** | 1 | 87.4462 | 0.03808 | 3.3300 | 77.5 | 80.8 | 84.1 | 87.4 | 90.8 | 94.1 | 97.4 |
| **2: 3** | **27** | 1 | 88.2830 | 0.03830 | 3.3812 | 78.1 | 81.5 | 84.9 | 88.3 | 91.7 | 95.0 | 98.4 |
| **2: 4** | **28** | 1 | 89.1004 | 0.03851 | 3.4313 | 78.8 | 82.2 | 85.7 | 89.1 | 92.5 | 96.0 | 99.4 |
| **2: 5** | **29** | 1 | 89.8991 | 0.03872 | 3.4809 | 79.5 | 82.9 | 86.4 | 89.9 | 93.4 | 96.9 | 100.3 |
| **2: 6** | **30** | 1 | 90.6797 | 0.03893 | 3.5302 | 80.1 | 83.6 | 87.1 | 90.7 | 94.2 | 97.7 | 101.3 |
| **2: 7** | **31** | 1 | 91.4430 | 0.03913 | 3.5782 | 80.7 | 84.3 | 87.9 | 91.4 | 95.0 | 98.6 | 102.2 |
| **2: 8** | **32** | 1 | 92.1906 | 0.03933 | 3.6259 | 81.3 | 84.9 | 88.6 | 92.2 | 95.8 | 99.4 | 103.1 |
| **2: 9** | **33** | 1 | 92.9239 | 0.03952 | 3.6724 | 81.9 | 85.6 | 89.3 | 92.9 | 96.6 | 100.3 | 103.9 |
| **2:10** | **34** | 1 | 93.6444 | 0.03971 | 3.7186 | 82.5 | 86.2 | 89.9 | 93.6 | 97.4 | 101.1 | 104.8 |
| **2:11** | **35** | 1 | 94.3533 | 0.03989 | 3.7638 | 83.1 | 86.8 | 90.6 | 94.4 | 98.1 | 101.9 | 105.6 |
| **3: 0** | **36** | 1 | 95.0515 | 0.04006 | 3.8078 | 83.6 | 87.4 | 91.2 | 95.1 | 98.9 | 102.7 | 106.5 |
| **3: 1** | **37** | 1 | 95.7399 | 0.04024 | 3.8526 | 84.2 | 88.0 | 91.9 | 95.7 | 99.6 | 103.4 | 107.3 |
| **3: 2** | **38** | 1 | 96.4187 | 0.04041 | 3.8963 | 84.7 | 88.6 | 92.5 | 96.4 | 100.3 | 104.2 | 108.1 |
| **3: 3** | **39** | 1 | 97.0885 | 0.04057 | 3.9389 | 85.3 | 89.2 | 93.1 | 97.1 | 101.0 | 105.0 | 108.9 |
| **3: 4** | **40** | 1 | 97.7493 | 0.04073 | 3.9813 | 85.8 | 89.8 | 93.8 | 97.7 | 101.7 | 105.7 | 109.7 |
| **3: 5** | **41** | 1 | 98.4015 | 0.04089 | 4.0236 | 86.3 | 90.4 | 94.4 | 98.4 | 102.4 | 106.4 | 110.5 |
| **3: 6** | **42** | 1 | 99.0448 | 0.04105 | 4.0658 | 86.8 | 90.9 | 95.0 | 99.0 | 103.1 | 107.2 | 111.2 |
| **3: 7** | **43** | 1 | 99.6795 | 0.04120 | 4.1068 | 87.4 | 91.5 | 95.6 | 99.7 | 103.8 | 107.9 | 112.0 |
| **3: 8** | **44** | 1 | 100.3058 | 0.04135 | 4.1476 | 87.9 | 92.0 | 96.2 | 100.3 | 104.5 | 108.6 | 112.7 |
| **3: 9** | **45** | 1 | 100.9238 | 0.04150 | 4.1883 | 88.4 | 92.5 | 96.7 | 100.9 | 105.1 | 109.3 | 113.5 |
| **3:10** | **46** | 1 | 101.5337 | 0.04164 | 4.2279 | 88.9 | 93.1 | 97.3 | 101.5 | 105.8 | 110.0 | 114.2 |
| **3:11** | **47** | 1 | 102.1360 | 0.04179 | 4.2683 | 89.3 | 93.6 | 97.9 | 102.1 | 106.4 | 110.7 | 114.9 |
| **4: 0** | **48** | 1 | 102.7312 | 0.04193 | 4.3075 | 89.8 | 94.1 | 98.4 | 102.7 | 107.0 | 111.3 | 115.7 |

**Table 29 Height-for-age for girls, age in years and months (continued)**

| | | | | | | Z-scores (height in cm) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **SD** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **4: 1** | **49** | 1 | 103.3197 | 0.04206 | 4.3456 | 90.3 | 94.6 | 99.0 | 103.3 | 107.7 | 112.0 | 116.4 |
| **4: 2** | **50** | 1 | 103.9021 | 0.04220 | 4.3847 | 90.7 | 95.1 | 99.5 | 103.9 | 108.3 | 112.7 | 117.1 |
| **4: 3** | **51** | 1 | 104.4786 | 0.04233 | 4.4226 | 91.2 | 95.6 | 100.1 | 104.5 | 108.9 | 113.3 | 117.7 |
| **4: 4** | **52** | 1 | 105.0494 | 0.04246 | 4.4604 | 91.7 | 96.1 | 100.6 | 105.0 | 109.5 | 114.0 | 118.4 |
| **4: 5** | **53** | 1 | 105.6148 | 0.04259 | 4.4981 | 92.1 | 96.6 | 101.1 | 105.6 | 110.1 | 114.6 | 119.1 |
| **4: 6** | **54** | 1 | 106.1748 | 0.04272 | 4.5358 | 92.6 | 97.1 | 101.6 | 106.2 | 110.7 | 115.2 | 119.8 |
| **4: 7** | **55** | 1 | 106.7295 | 0.04285 | 4.5734 | 93.0 | 97.6 | 102.2 | 106.7 | 111.3 | 115.9 | 120.4 |
| **4: 8** | **56** | 1 | 107.2788 | 0.04298 | 4.6108 | 93.4 | 98.1 | 102.7 | 107.3 | 111.9 | 116.5 | 121.1 |
| **4: 9** | **57** | 1 | 107.8227 | 0.04310 | 4.6472 | 93.9 | 98.5 | 103.2 | 107.8 | 112.5 | 117.1 | 121.8 |
| **4:10** | **58** | 1 | 108.3613 | 0.04322 | 4.6834 | 94.3 | 99.0 | 103.7 | 108.4 | 113.0 | 117.7 | 122.4 |
| **4:11** | **59** | 1 | 108.8948 | 0.04334 | 4.7195 | 94.7 | 99.5 | 104.2 | 108.9 | 113.6 | 118.3 | 123.1 |
| **5: 0** | **60** | 1 | 109.4233 | 0.04347 | 4.7566 | 95.2 | 99.9 | 104.7 | 109.4 | 114.2 | 118.9 | 123.7 |

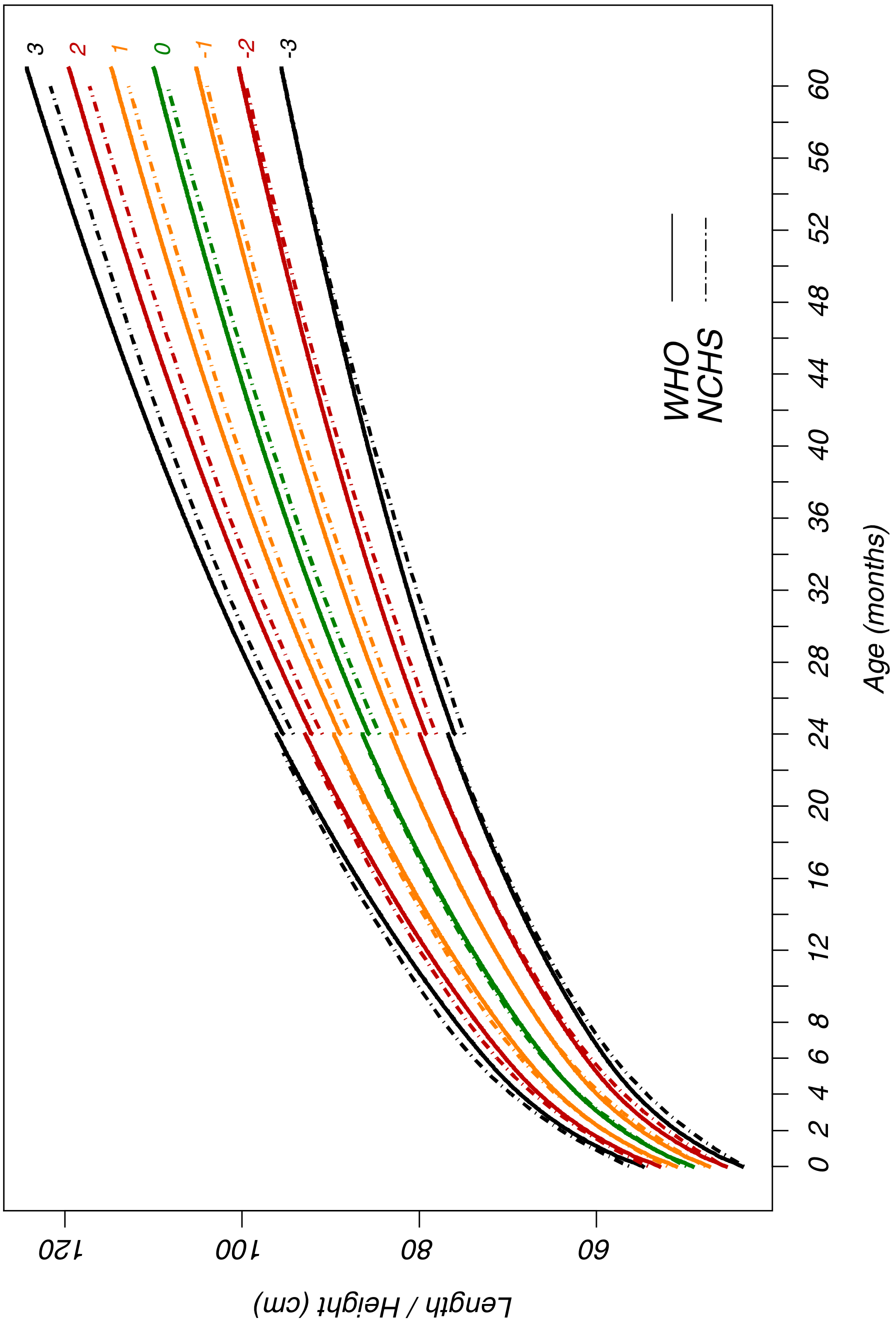


**Figure 29 Comparison of WHO with NCHS length/height-for-age z-scores for girls**

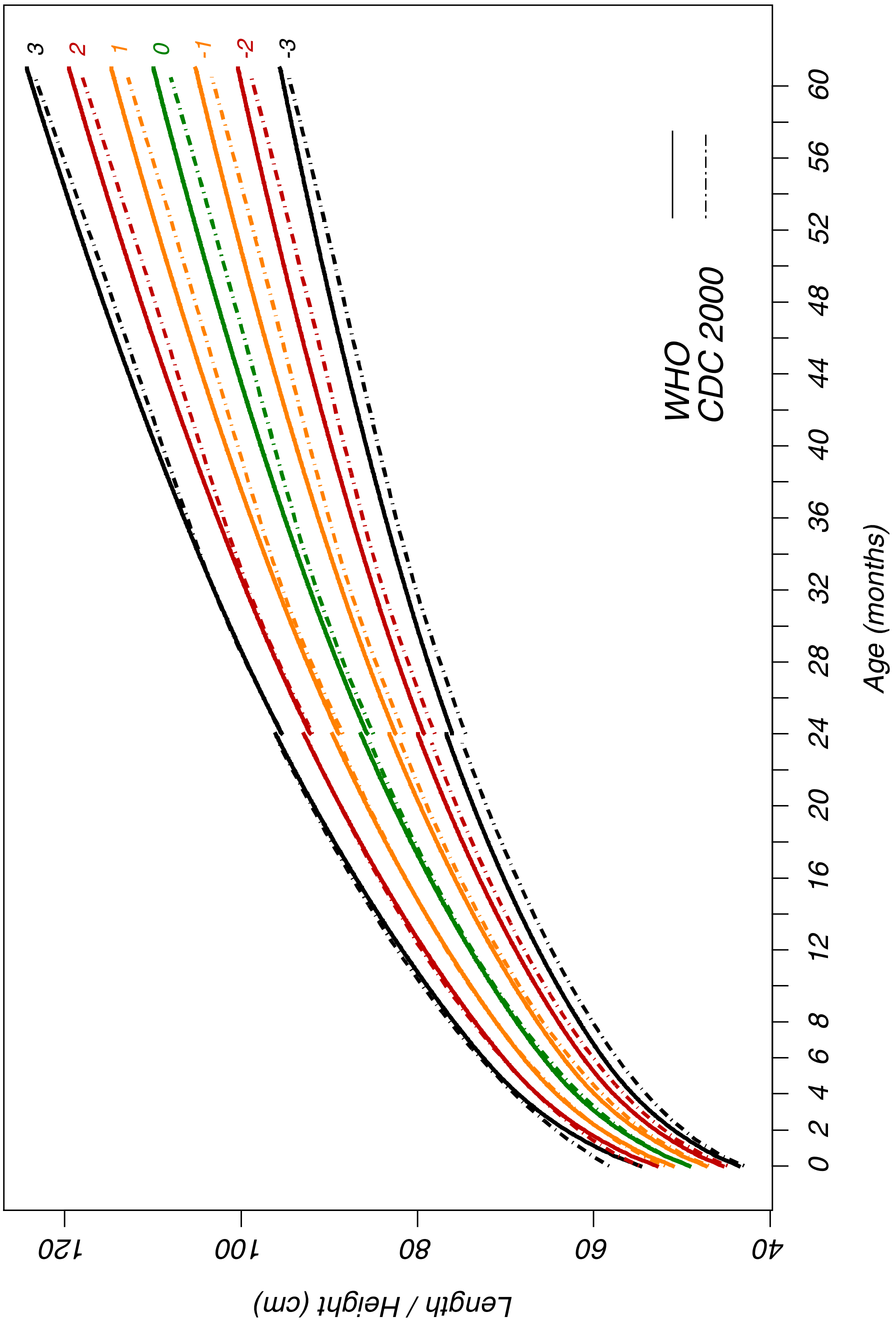


**Figure 30 Comparison of WHO with CDC 2000 length/height-for-age z-scores for girls**

## 3.4 Comparisons between boys and girls

This section presents the length/height-for-age z-score comparisons between boys and girls for WHO standards (Figure 31), and NCHS (Figure 32) and CDC 2000 (Figure 33) references.

### 3.4.1 WHO

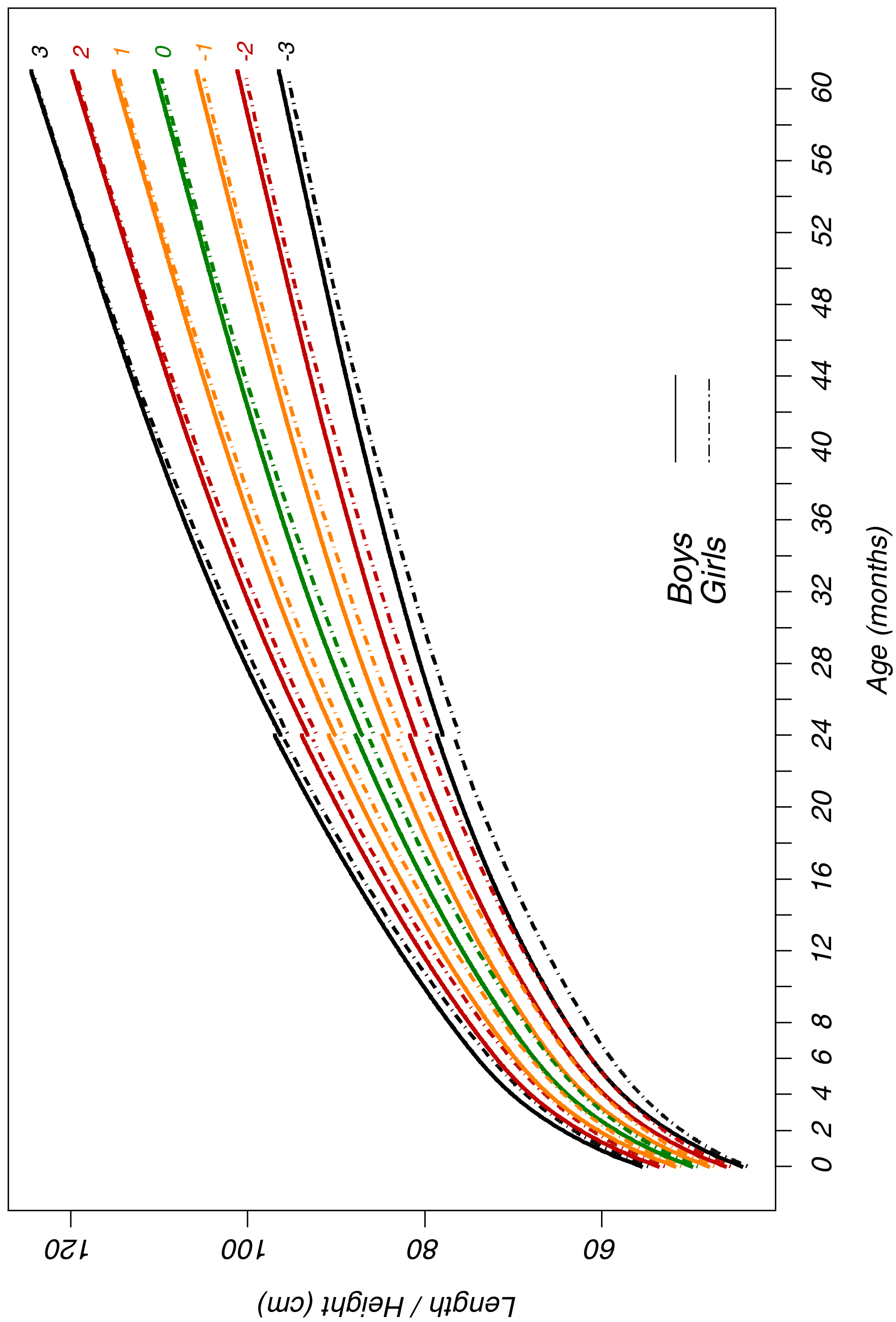


**Figure 31** Comparison of boys' and girls' WHO length/height-for-age z-scores

### 3.4.2 NCHS

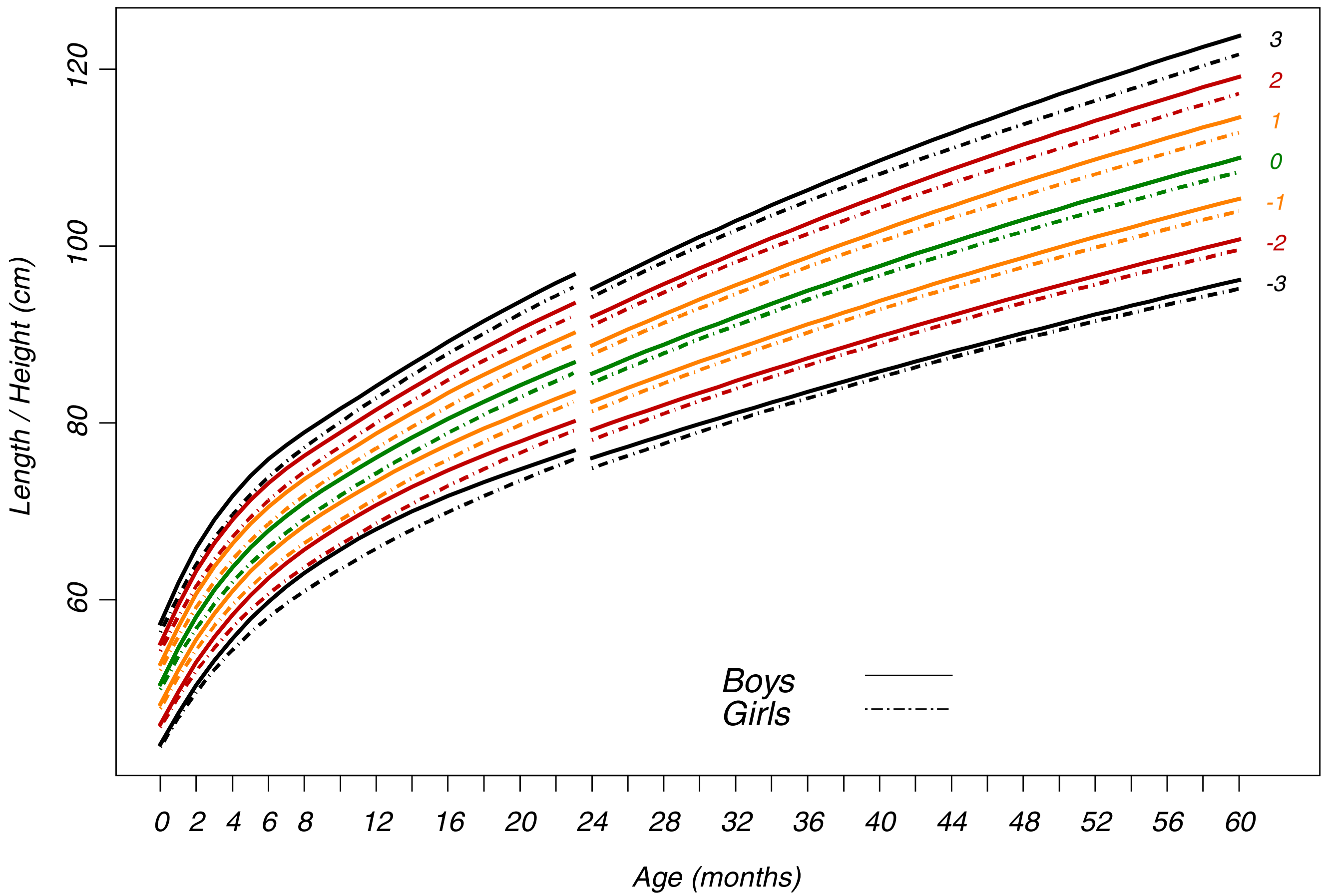


**Figure 32 Comparison of boys' and girls' NCHS length/height-for-age z-scores**

### 3.4.3 CDC 2000

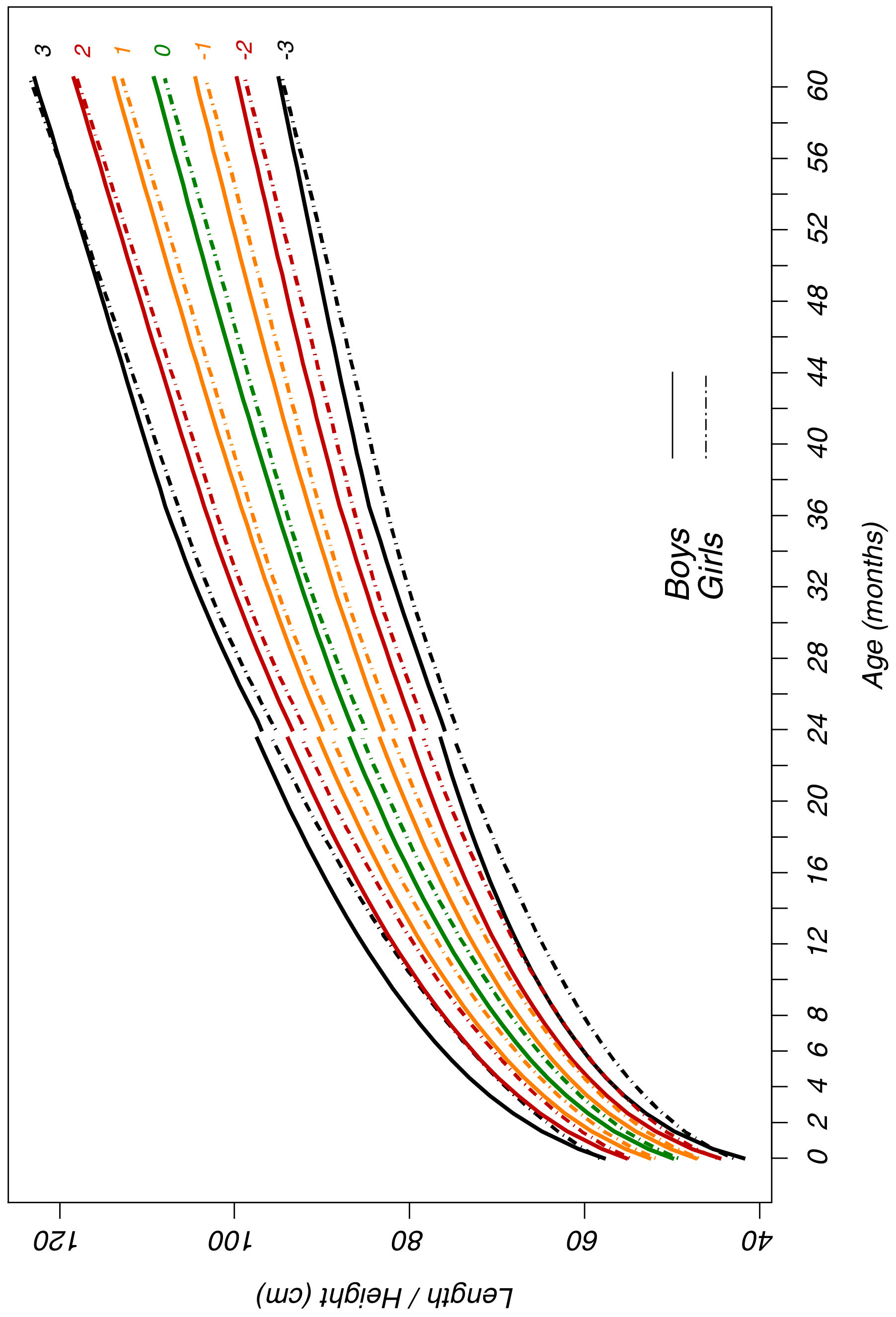


**Figure 33 Comparison of boys' and girls' CDC 2000 length/height-for-age z-scores**

## 4. CONSTRUCTION OF THE WEIGHT-FOR-AGE STANDARDS

### 4.1 Indicator-specific methodology

Similar steps to those described to select the best model for the length/height-for-age growth curves were followed to select the best model to construct the weight-for-age growth standards. The diagnostic tools applied to evaluate and compare candidate models were also similar. The weights of the longitudinal and cross-sectional samples were merged without any adjustments. To correct for right-edge effect, all data up to 71 months were used for modelling the weight-for-age growth curves but the standards were afterwards truncated at 60 completed months (Borghi et al., 2006).

### 4.2 Weight-for-age for boys

#### 4.2.1 Sample size

There were a total of 13 797 weight observations for boys. The longitudinal and cross-sectional sample sizes by visit and age are presented in Tables 30 and 31. In addition to the 20 home visits at which length was assessed in the longitudinal study, weight was also measured on day 7, except in Brazil (de Onis et al., 2004b).

**Table 30 Longitudinal sample sizes for weight-for-age for boys**

| **Visit** | **Birth** | **7 d** | **1** | **2** | **3** | **4** | **5** | **6** |
|---|---|---|---|---|---|---|---|---|
| **Age** | **0** | **1 wk** | **2 wk** | **4 wk** | **6 wk** | **2 mo** | **3 mo** | **4 mo** |
| N | 890 | 391 | 424 | 423 | 422 | 423 | 419 | 411 |
| **Visit** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** |
| **Age** | **5 mo** | **6 mo** | **7 mo** | **8 mo** | **9 mo** | **10 mo** | **11 mo** | **12 mo** |
| N | 413 | 417 | 415 | 415 | 410 | 407 | 418 | 417 |
| **Visit** | **15** | **16** | **17** | **18** | **19** | **20** | | |
| **Age** | **14 mo** | **16 mo** | **18 mo** | **20 mo** | **22 mo** | **24 mo** | | |
| N | 416 | 420 | 416 | 424 | 420 | 423 | | |

**Table 31 Cross-sectional sample sizes for weight-for-age for boys**

| **Age (mo)** | **<18** | **18–20** | **21–23** | **24–26** | **27–29** | **30–32** | **33–35** |
|---|---|---|---|---|---|---|---|
| N | 3 | 178 | 186 | 238 | 261 | 223 | 256 |
| **Age (mo)** | **36–38** | **39–41** | **42–44** | **45–47** | **48–50** | **51–53** | **54–56** |
| N | 268 | 249 | 255 | 238 | 237 | 221 | 229 |
| **Age (mo)** | **57–59** | **60–62** | **63–65** | **66–68** | **69–71** | **>71** | |
| N | 241 | 228 | 215 | 218 | 215 | 4 | |

#### 4.2.2 Model selection and results

To construct the weight-for-age growth curves, the model BCPE(x=age$^{\lambda}$, df($\mu$)=9, df($\sigma$)=4, df($\nu$)=4, $\tau$=2) was used as a starting point to search for the best value of the age-transformation power $\lambda$ by examining changes in global deviance. Table 32 shows the global deviance for values of $\lambda$ from 0 to 1. The smallest global deviance corresponded to the age-transformation power $\lambda$=0.35.

**Table 32 Global deviance (GD) for models within the class BCPE(x=age$^{\lambda}$, df(μ)=9, df(σ)=4, df(ν)=4, τ=2) for weight-for-age for boys**

| **λ** | **0.05** | **0.10** | **0.15** | **0.20** | **0.25** | **0.30** | **0.35** | **0.40** | **0.45** | **0.50** |
|---|---|---|---|---|---|---|---|---|---|---|
| GD[a] | 664.7 | 658.0 | 655.2 | 648.1 | 643.0 | 639.1 | 636.2 | 636.3 | 642.5 | 658.4 |
| **λ** | **0.55** | **0.60** | **0.65** | **0.70** | **0.75** | **0.80** | **0.85** | **0.90** | **0.95** | **1.00** |
| GD[a] | 685.3 | 720.1 | 755.1 | 782.0 | 795.3 | 795.3 | 789.3 | 790.6 | 816.5 | 887.4 |

[a] In excess of 41 000.

The search for the best df(μ) and df(σ) followed, fixing λ=0.35, ν=1 and τ=2. All possible combinations with df(μ) values ranging from 7 to 15 and df(σ) from 2 to 10 were considered and partial results are presented in Table 33. No fitted model minimized both *AIC* and *GAIC(3)* simultaneously. Models with df(μ)=11 or 12 and df(σ)=7 or 8 provided either the smallest *AIC* or the smallest *GAIC(3)*. The model resulting in the smoothest μ and σ curves, i.e. df(μ)=11 and df(σ)=7, was selected for further evaluation.

**Table 33 Goodness-of-fit summary for models using the BCPE distribution with fixed ν=1 and τ=2 for weight-for-age for boys**

| df(μ) | df(σ) | GD[a] | AIC[a] | GAIC(3)[a] | Total df |
|---|---|---|---|---|---|
| **9** | **5** | 891.8 | 919.8 | 933.8 | 14 |
| | **6** | 885.2 | 915.2 | 930.2 | 15 |
| | **7** | 880.6 | 912.6 | 928.6 | 16 |
| | **8** | 877.7 | 911.7 | 928.7 | 17 |
| | **9** | 875.9 | 911.9 | 929.9 | 18 |
| **10** | **5** | 885.6 | 915.6 | 930.6 | 15 |
| | **6** | 878.9 | 910.9 | 926.9 | 16 |
| | **7** | 874.4 | 908.4 | 925.4 | 17 |
| | **8** | 871.6 | 907.6 | 925.6 | 18 |
| | **9** | 869.9 | 907.9 | 926.9 | 19 |
| **11** | **5** | 881.4 | 913.4 | 929.4 | 16 |
| | **6** | 874.8 | 908.8 | 925.8 | 17 |
| | **7** | 870.3 | 906.3 | 924.3 | 18 |
| | **8** | 867.6 | 905.6 | 924.6 | 19 |
| | **9** | 866.0 | 906.0 | 926.0 | 20 |
| **12** | **5** | 878.4 | 912.4 | 929.4 | 17 |
| | **6** | 871.8 | 907.8 | 925.8 | 18 |
| | **7** | 867.4 | 905.4 | 924.4 | 19 |
| | **8** | 864.7 | 904.7 | 924.7 | 20 |
| | **9** | 863.1 | 905.1 | 926.1 | 21 |
| **13** | **5** | 876.2 | 912.2 | 930.2 | 18 |
| | **6** | 869.6 | 907.6 | 926.6 | 19 |
| | **7** | 865.2 | 905.2 | 925.2 | 20 |
| | **8** | 862.6 | 904.6 | 925.6 | 21 |
| | **9** | 861.0 | 905.0 | 927.0 | 22 |

GD, Global Deviance; AIC, Akaike Information Criterion;
GAIC(3), Generalized AIC with penalty equal to 3;
[a] In excess of 41 000.

**Model 1: BCPE(x=age$^{0.35}$, df(μ)=11, df(σ)=7, ν=1, τ=2)**

For this model, both the worm plots (Figure 34) and the Q-test results (Table 34) indicated good model fit of the μ and σ curves but pointed to the need to adjust for skewness. The worms presented a U-shape in most age groups, indicating residual skewness. This finding was confirmed by the Q-test results (Table 34), which show various groups with absolute values of z3 higher than 2. Only one age group presented an absolute value of z4 higher than 2, indicating residual kurtosis. The overall test also rejected the hypotheses of no skewness (p-value < 0.01).

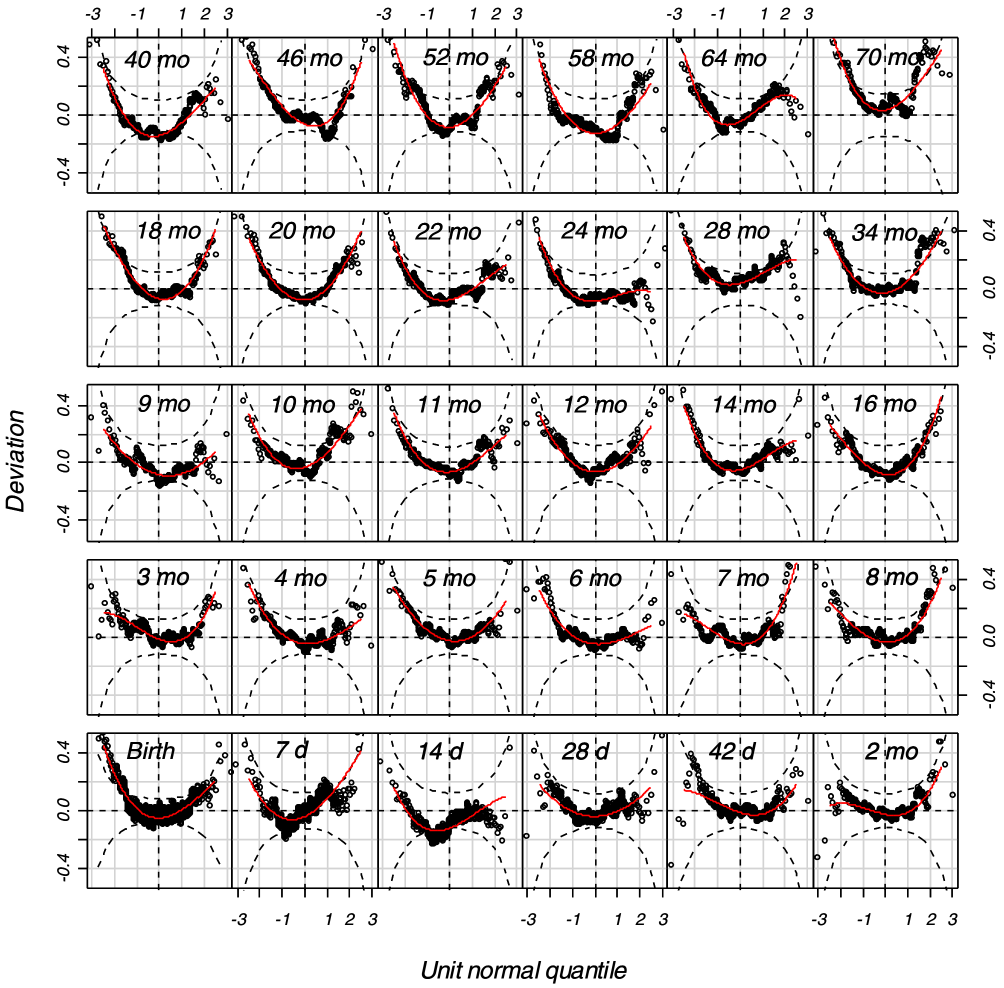


**Figure 34 Worm plots of z-scores for Model 1 for weight-for-age for boys**

**Table 34 Q-test for z-scores from Model 1 [BCPE(x=age$^{0.35}$, df(μ)=11, df(σ)=7, ν=1, τ=2)] for weight-for-age for boys**

| Age (days) | Group | N | z1 | z2 | z3 | z4 |
|---|---|---|---|---|---|---|
| 0 | **Birth** | 890 | 0.32 | -0.72 | 4.12 | -0.18 |
| 1 to 11 | **7 d** | 391 | 0.32 | 1.66 | 2.63 | 0.87 |
| 12 to 16 | **14 d** | 418 | -1.68 | 0.82 | 1.99 | -0.11 |
| 17 to 34 | **28 d** | 426 | -0.04 | -0.01 | 1.62 | 0.24 |
| 35 to 49 | **42 d** | 421 | 0.30 | -0.53 | 1.35 | 1.03 |
| 50 to 69 | **2 mo** | 423 | 0.14 | 0.35 | 1.54 | 1.28 |
| 70 to 99 | **3 mo** | 419 | 0.47 | -0.37 | 2.26 | 1.66 |
| 100 to 129 | **4 mo** | 408 | -0.09 | -0.73 | 2.31 | -0.15 |
| 130 to 159 | **5 mo** | 410 | 0.55 | -0.60 | 2.63 | 0.74 |
| 160 to 189 | **6 mo** | 411 | -0.31 | -1.03 | 1.82 | -0.26 |
| 190 to 219 | **7 mo** | 406 | 0.17 | 1.05 | 3.17 | 1.81 |
| 220 to 249 | **8 mo** | 420 | 0.43 | 0.45 | 2.97 | 1.27 |
| 250 to 279 | **9 mo** | 392 | -0.86 | -0.61 | 1.97 | 0.14 |
| 280 to 309 | **10 mo** | 400 | 0.76 | 1.09 | 2.66 | -0.16 |
| 310 to 349 | **11 mo** | 461 | -0.21 | -0.08 | 2.63 | -0.23 |
| 350 to 379 | **12 mo** | 412 | -0.10 | -0.16 | 2.72 | 0.28 |
| 380 to 439 | **14 mo** | 418 | 0.09 | -0.01 | 2.35 | -0.76 |
| 440 to 499 | **16 mo** | 418 | -0.17 | 0.33 | 3.50 | 1.68 |
| 500 to 559 | **18 mo** | 442 | 0.17 | -0.41 | 4.10 | 1.83 |
| 560 to 619 | **20 mo** | 526 | -0.18 | 0.48 | 3.94 | 1.13 |
| 620 to 679 | **22 mo** | 552 | -0.38 | 0.04 | 2.81 | -0.37 |
| 680 to 749 | **24 mo** | 594 | -1.17 | -0.97 | 2.28 | -0.90 |
| 750 to 929 | **28 mo** | 477 | 1.75 | 0.29 | 1.99 | -0.57 |
| 930 to 1119 | **34 mo** | 521 | 1.11 | 0.42 | 3.57 | 0.60 |
| 1120 to 1309 | **40 mo** | 512 | -1.76 | 0.34 | 3.21 | -0.35 |
| 1310 to 1499 | **46 mo** | 508 | 0.13 | -0.88 | 4.17 | 2.29 |
| 1500 to 1689 | **52 mo** | 489 | -0.08 | -0.03 | 3.97 | 0.19 |
| 1690 to 1879 | **58 mo** | 484 | -1.17 | -0.32 | 3.47 | 0.60 |
| 1880 to 2069 | **64 mo** | 461 | 0.20 | 0.53 | 2.30 | -1.94 |
| 2070 to 2249 | **70 mo** | 287 | 1.97 | 0.11 | 3.09 | 0.12 |
| **Overall Q stats** | | **13 797** | **19.63** | **12.32** | **249.88** | **31.24** |
| **degrees of freedom** | | | **19.0** | **26.0** | **30.0** | **30.0** |
| **p-value** | | | **0.4170** | **0.9892** | **< 0.01** | **0.4035** |

Note: Absolute values of z1, z2, z3 or z4 larger than 2 indicate misfit of, respectively, mean, variance, skewness or kurtosis.

The next step involved fitting the parameter ν for skewness using the BCPE distribution with fixed parameter τ=2 and keeping the degrees of freedom for the μ and σ curves selected for Model 1. Table 35 shows the *GAIC(3)* values for various degrees of freedom for the ν curve.

**Table 35 Goodness-of-fit summary for models BCPE(x=age$^{0.35}$, df(μ)=11, df(σ)=7, df(ν)=?, τ=2) for weight-for-age for boys**

| df(ν) | GD[a] | GAIC(3)[a] | Total df |
|---|---|---|---|
| **1** | 616.7 | 673.7 | 19 |
| **2** | 610.2 | 670.2 | 20 |
| **3** | 608.3 | 671.3 | 21 |
| **4** | 605.1 | 671.1 | 22 |
| **5** | 603.1 | 672.2 | 23 |
| **6** | 602.2 | 674.2 | 24 |
| **7** | 601.5 | 676.5 | 25 |

GD, Global Deviance; GAIC(3), Generalized Akaike Information Criterion with penalty equal to 3;
[a] In excess of 41 000.

The smallest *GAIC(3)* value corresponded to df(ν)=2 and the model BCPE(x=age$^{0.35}$, df(μ)=11, df(σ)=7, df(ν)=2, τ=2) was further evaluated.

**Model 2: BCPE(x= age$^{0.35}$, df(μ)=11, df(σ)=7, df(ν)=2, τ=2)**

Figure 35 shows the fitting of the parameters μ, σ and ν for Model 2 with their respective sample estimates, that is, the median for μ and Box-Cox transform power for ν. It should be noted that the sample estimate for the parameter σ is no longer the coefficient of variation when the distribution departs significantly from the normal distribution. In this case, the best estimator of σ is the sample standard deviation of the Box-Cox transformed data (Cole and Green, 1992).

Figures 36 and 37 show the distribution of the empirical minus fitted centile differences for the longitudinal and cross-sectional samples, respectively. For the longitudinal data, although there is some evidence of systematic overestimation in the 50th centile between 16 and 24 months, the average bias is less than 50 g (Figure 36) compared to SD values varying from 400 to 1800 g in this age range. For the cross-sectional component (Figure 37), underestimation in the 50th centile is noted between ages 25 and 35 months with an average bias of around 200 g relative to SD values varying from 1100 to 3700 g in this age range.

The worm plots for this model (Figure 38) were significantly improved compared to those of Model 1 (Figure 34). The U-shaped worms flattened out significantly (Figure 38), indicating that the residual skewness associated with Model 1 had been corrected. The median curve remained underestimated in only one age group (70 mo). Various groups' worms present slight S-shapes, e.g. ages 0 to 2 months and group 64 mo, but all are contained within the 95% confidence interval.

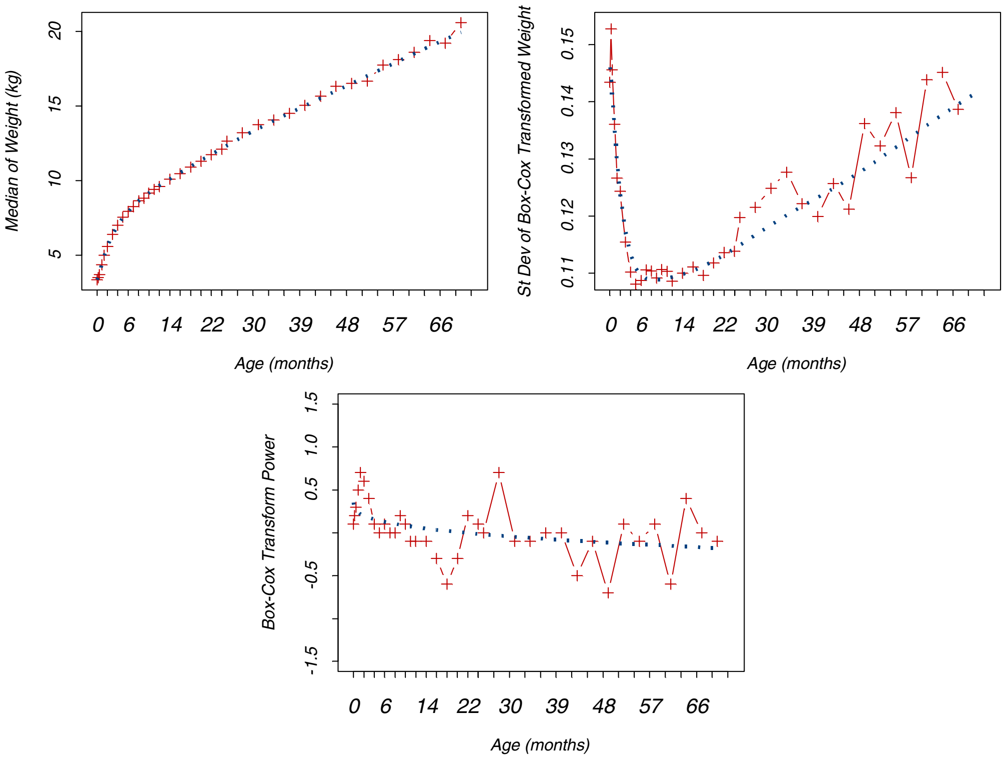


**Figure 35 Fitting of the μ, σ, and ν curves of Model 2 for weight-for-age for boys from 0 to 71 months (dotted line) and their respective sample estimates (points with solid line)**

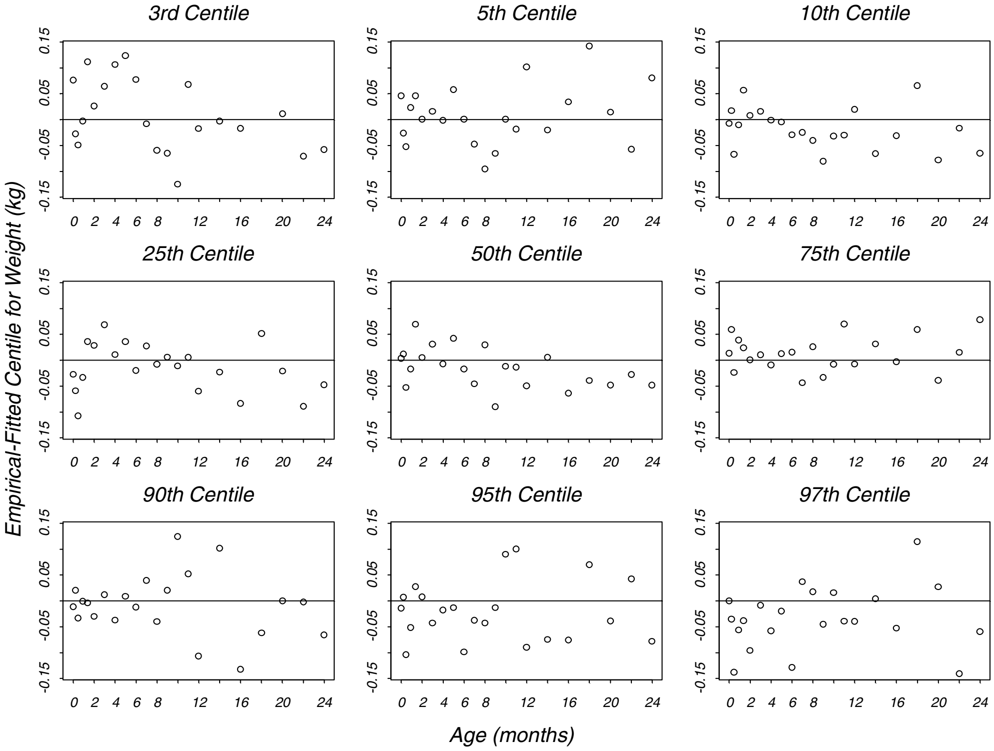


**Figure 36 Centile residuals from fitting Model 2 for weight-for-age from 0 to 24 months for boys**

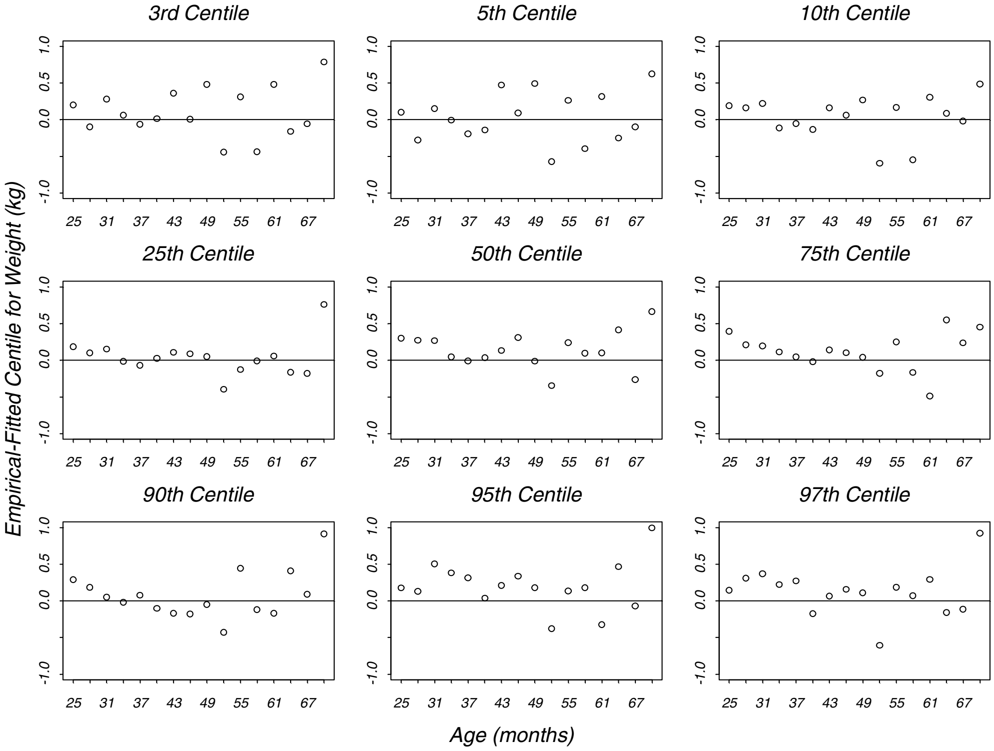


**Figure 37 Centile residuals from fitting Model 2 for weight-for-age from 24 to 71 months for boys**

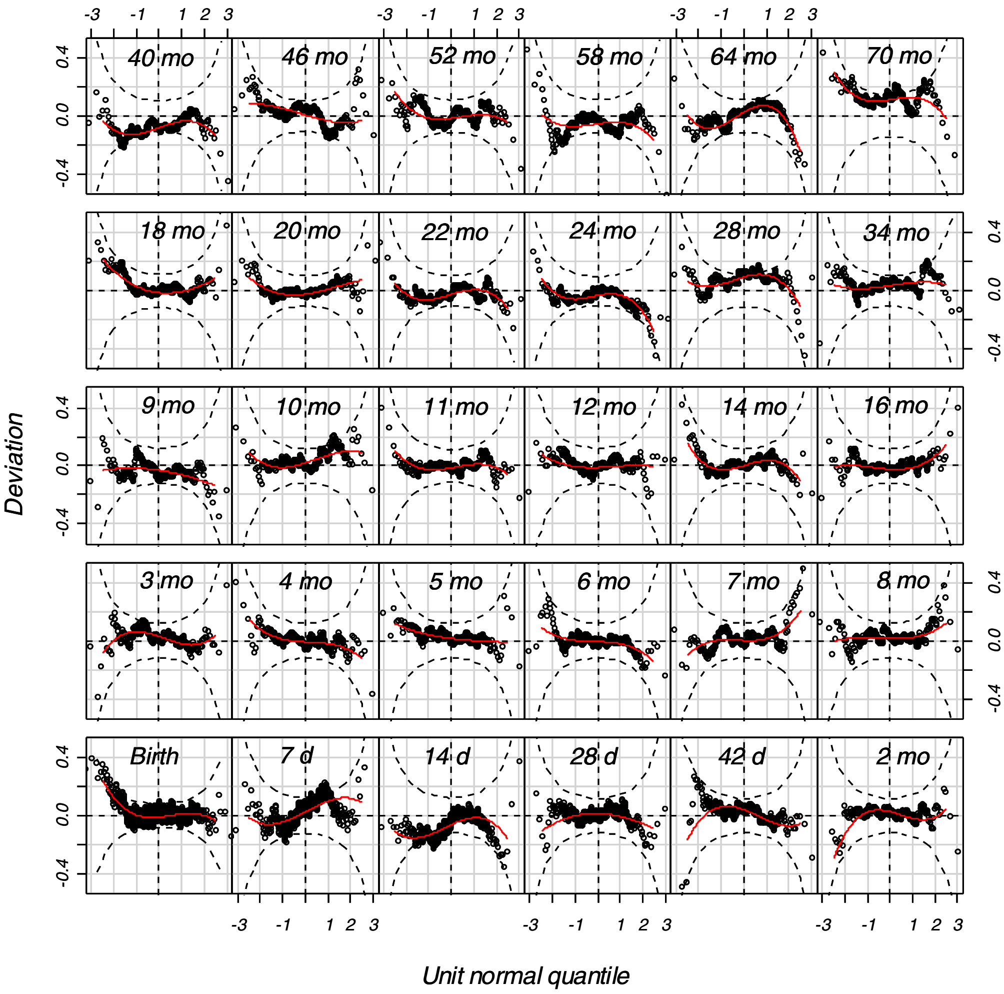


**Figure 38 Worm plots of z-scores for Model 2 for weight-for-age for boys**

The Q-test results from Model 2 are shown in Table 36. There were no absolute values larger than 2 for the statistics z1, z2 or z3. Only one value of z4 (group 64 mo) suggested residual kurtosis. Considering this, there was no justification in increasing the complexity of the model by adjusting for kurtosis (modelling $\tau$). The overall Q-test p-values were all non-significant, indicating an adequate fit of the boys' weight-for-age curves.

Table 37 presents observed percentages with weights below the fitted centiles. As expected, age groups above 24 months presented larger differences compared to the age range younger than 24 months, yet there was no detectable pattern of a systematic bias.

**Table 36 Q-test for z-scores from Model 2 [BCPE(x=age$^{0.35}$, df(μ)=11, df(σ)=7, df(ν)=2, τ=2)] for weight-for-age for boys**

| Age (days) | Group | N | z1 | z2 | z3 | z4 |
|---|---|---|---|---|---|---|
| 0 | **Birth** | 890 | 0.22 | -0.74 | 1.21 | -1.59 |
| 1 to 11 | **7 d** | 391 | 0.55 | 1.52 | 0.14 | -0.62 |
| 12 to 16 | **14 d** | 418 | -1.55 | 1.04 | -0.42 | -1.17 |
| 17 to 34 | **28 d** | 426 | -0.01 | 0.01 | -1.05 | 0.61 |
| 35 to 49 | **42 d** | 421 | 0.31 | -0.49 | -1.61 | 1.98 |
| 50 to 69 | **2 mo** | 423 | 0.08 | 0.42 | -1.49 | 1.91 |
| 70 to 99 | **3 mo** | 419 | 0.41 | -0.45 | -0.46 | 1.16 |
| 100 to 129 | **4 mo** | 408 | -0.16 | -0.76 | 0.22 | -0.69 |
| 130 to 159 | **5 mo** | 410 | 0.50 | -0.72 | 0.37 | 0.03 |
| 160 to 189 | **6 mo** | 411 | -0.29 | -0.90 | -0.30 | -0.57 |
| 190 to 219 | **7 mo** | 406 | 0.11 | 0.96 | 0.51 | 0.85 |
| 220 to 249 | **8 mo** | 420 | 0.44 | 0.36 | 0.42 | 0.44 |
| 250 to 279 | **9 mo** | 392 | -0.80 | -0.38 | -0.33 | -0.01 |
| 280 to 309 | **10 mo** | 400 | 0.73 | 0.98 | 0.41 | -0.76 |
| 310 to 349 | **11 mo** | 461 | -0.17 | -0.02 | 0.28 | -0.95 |
| 350 to 379 | **12 mo** | 412 | -0.06 | -0.14 | 0.38 | -0.33 |
| 380 to 439 | **14 mo** | 418 | 0.11 | 0.05 | 0.16 | -1.52 |
| 440 to 499 | **16 mo** | 418 | -0.18 | 0.27 | 0.73 | 0.62 |
| 500 to 559 | **18 mo** | 442 | 0.21 | -0.64 | 1.46 | 0.17 |
| 560 to 619 | **20 mo** | 526 | -0.23 | 0.36 | 1.01 | -0.32 |
| 620 to 679 | **22 mo** | 552 | -0.41 | 0.16 | -0.03 | -1.38 |
| 680 to 749 | **24 mo** | 594 | -1.13 | -0.63 | -0.59 | -1.90 |
| 750 to 929 | **28 mo** | 477 | 1.75 | 0.17 | -0.85 | -1.09 |
| 930 to 1119 | **34 mo** | 521 | 1.14 | 0.14 | 0.24 | -0.24 |
| 1120 to 1309 | **40 mo** | 512 | -1.83 | 0.67 | -0.01 | -1.27 |
| 1310 to 1499 | **46 mo** | 508 | 0.21 | -1.04 | 0.28 | 0.50 |
| 1500 to 1689 | **52 mo** | 489 | -0.08 | -0.20 | 0.64 | -1.09 |
| 1690 to 1879 | **58 mo** | 484 | -1.17 | -0.04 | -0.33 | -0.66 |
| 1880 to 2069 | **64 mo** | 461 | 0.13 | 0.82 | -1.07 | -2.13 |
| 2070 to 2249 | **70 mo** | 287 | 2.00 | -0.39 | 0.25 | -1.11 |
| **Overall Q stats** | | **13 797** | **19.51** | **12.10** | **15.69** | **35.75** |
| **degrees of freedom** | | | **19.0** | **26.0** | **28.0** | **30.0** |
| **p-value** | | | **0.4248** | **0.9906** | **0.9701** | **0.2164** |

Note: Absolute values of z1, z2, z3 or z4 larger than 2 indicate misfit of, respectively, mean, variance, skewness or kurtosis.

A new iteration was performed using df(ν)=2 to re-search for df(μ) and df(σ) but, as before, no combination of df(μ) and df(σ) was found for which both *AIC* and *GAIC(3)* were simultaneously minimized. For example, *AIC* values were smallest for df(μ) 11 to 15, and df(σ) 7 to 9, while *GAIC(3)* values were smallest for df(μ) 11 or 12, and df(σ) 7 or 8. Since the previously selected model still provided better *GAIC(3)* with fixed df(ν)=2, there was no need to change Model 2. A new search for the best value of λ was carried out using the selected model. The lowest global deviance values were associated with λ 0.30 or 0.35, precluding the necessity to update the selected model. In conclusion, the model selected for constructing the weight-for-age growth curves for boys was BCPE(x=age$^{0.35}$, df(μ)=11, df(σ)=7, df(ν)=2, τ=2) that adjusts only for skewness, and thus reduces in essence to the LMS method. The fitted centile curves and empirical centiles are shown in Figures 39 to 42.

**Table 37 Observed proportions of children with measurements below the fitted centiles from Model 2, weight-for-age for boys**

| Expected | Birth | 7 d | 14 d | 28 d | 42 d | 2 mo | 3 mo | 4 mo | 5 mo | 6 mo | 7 mo |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 0.4 | 0.8 | 1.4 | 1.4 | 1.2 | 1.7 | 1.2 | 1.2 | 0.5 | 0.7 | 1.0 |
| **3** | 2.6 | 3.8 | 3.3 | 2.6 | 1.7 | 2.8 | 2.4 | 2.2 | 2.4 | 1.5 | 3.4 |
| **5** | 4.7 | 5.9 | 7.7 | 4.5 | 4.5 | 5.0 | 5.0 | 4.4 | 4.1 | 4.9 | 6.2 |
| **10** | 11.0 | 9.5 | 12.7 | 10.3 | 9.5 | 9.5 | 10.3 | 9.8 | 10.2 | 10.5 | 11.1 |
| **25** | 25.7 | 27.4 | 29.9 | 25.8 | 24.5 | 23.9 | 23.2 | 24.3 | 23.4 | 26.0 | 22.7 |
| **50** | 48.1 | 47.3 | 51.9 | 50.5 | 48.5 | 49.6 | 48.9 | 52.5 | 50.7 | 51.6 | 51.2 |
| **75** | 72.8 | 71.6 | 75.4 | 73.9 | 73.9 | 74.9 | 74.2 | 75.2 | 74.1 | 75.4 | 74.9 |
| **90** | 90.6 | 87.7 | 90.7 | 89.0 | 91.4 | 89.8 | 90.7 | 90.7 | 89.5 | 90.3 | 88.9 |
| **95** | 95.1 | 94.4 | 96.4 | 95.5 | 95.2 | 94.8 | 95.7 | 95.1 | 95.1 | 96.1 | 95.1 |
| **97** | 96.7 | 97.4 | 98.6 | 97.7 | 97.9 | 97.4 | 97.4 | 97.5 | 97.3 | 98.3 | 96.8 |
| **99** | 99.1 | 99.0 | 99.5 | 99.3 | 99.0 | 98.8 | 98.8 | 99.0 | 99.0 | 99.3 | 98.3 |
| **Expected** | **8 mo** | **9 mo** | **10 mo** | **11 mo** | **12 mo** | **14 mo** | **16 mo** | **18 mo** | **20 mo** | **22 mo** | **24 mo** |
| **1** | 1.0 | 0.5 | 1.0 | 0.9 | 1.0 | 0.2 | 1.0 | 0.5 | 0.8 | 0.9 | 1.0 |
| **3** | 3.6 | 3.3 | 3.0 | 3.0 | 2.4 | 2.6 | 3.1 | 1.8 | 3.2 | 3.3 | 3.7 |
| **5** | 5.5 | 5.9 | 5.0 | 5.2 | 4.9 | 5.7 | 4.1 | 3.8 | 4.9 | 5.1 | 5.1 |
| **10** | 10.2 | 11.7 | 10.3 | 10.4 | 8.7 | 10.8 | 9.8 | 9.0 | 11.0 | 10.3 | 10.8 |
| **25** | 23.8 | 24.7 | 24.5 | 25.6 | 26.2 | 25.1 | 25.8 | 24.7 | 25.5 | 27.2 | 27.1 |
| **50** | 48.6 | 53.3 | 50.5 | 51.4 | 50.0 | 50.0 | 51.2 | 50.7 | 51.5 | 50.7 | 50.3 |
| **75** | 74.3 | 75.8 | 73.8 | 74.0 | 73.5 | 73.4 | 75.6 | 74.9 | 75.5 | 73.9 | 75.6 |
| **90** | 90.5 | 90.6 | 87.5 | 89.8 | 90.3 | 88.8 | 90.4 | 91.4 | 89.4 | 90.9 | 91.6 |
| **95** | 94.8 | 95.2 | 93.3 | 94.4 | 94.7 | 95.5 | 95.5 | 95.0 | 94.5 | 94.4 | 96.5 |
| **97** | 96.4 | 96.7 | 96.5 | 97.6 | 97.1 | 96.9 | 96.9 | 96.4 | 96.6 | 97.1 | 97.6 |
| **99** | 98.3 | 99.5 | 98.5 | 98.9 | 99.3 | 99.5 | 99.0 | 98.9 | 99.2 | 99.3 | 99.7 |

**Table 37 Observed proportions of children with measurements below the fitted centiles from Model 2, weight-for-age for boys (continued)**

| Expected | 28 mo | 34 mo | 40 mo | 46 mo | 52 mo | 58 mo | 64 mo | 70 mo | Overall |
|---|---|---|---|---|---|---|---|---|---|
| **1** | 0.6 | 0.6 | 0.8 | 0.6 | 0.6 | 0.4 | 1.5 | 0.3 | 0.8 |
| **3** | 3.4 | 1.7 | 3.9 | 2.6 | 3.1 | 4.1 | 3.7 | 1.7 | 2.9 |
| **5** | 5.2 | 4.0 | 7.2 | 4.3 | 4.7 | 7.2 | 5.2 | 3.1 | 5.1 |
| **10** | 8.4 | 10.2 | 11.5 | 9.4 | 8.4 | 11.2 | 10.2 | 8.4 | 10.2 |
| **25** | 24.3 | 23.6 | 28.9 | 25.0 | 26.6 | 25.0 | 26.5 | 23.0 | 25.4 |
| **50** | 45.3 | 47.6 | 53.5 | 48.8 | 51.1 | 51.2 | 49.0 | 44.9 | 50.0 |
| **75** | 71.7 | 74.1 | 77.0 | 75.2 | 74.4 | 77.9 | 73.3 | 70.0 | 74.4 |
| **90** | 88.1 | 90.2 | 90.2 | 91.7 | 90.0 | 90.5 | 88.9 | 88.2 | 90.0 |
| **95** | 93.9 | 92.9 | 94.7 | 95.5 | 94.3 | 95.5 | 94.4 | 92.7 | 94.9 |
| **97** | 96.6 | 95.4 | 97.9 | 97.2 | 97.3 | 96.9 | 97.2 | 95.8 | 97.1 |
| **99** | 99.8 | 98.8 | 99.4 | 98.6 | 99.0 | 99.2 | 99.6 | 99.0 | 99.1 |

Note: Group labels correspond to the age intervals in Table 36.

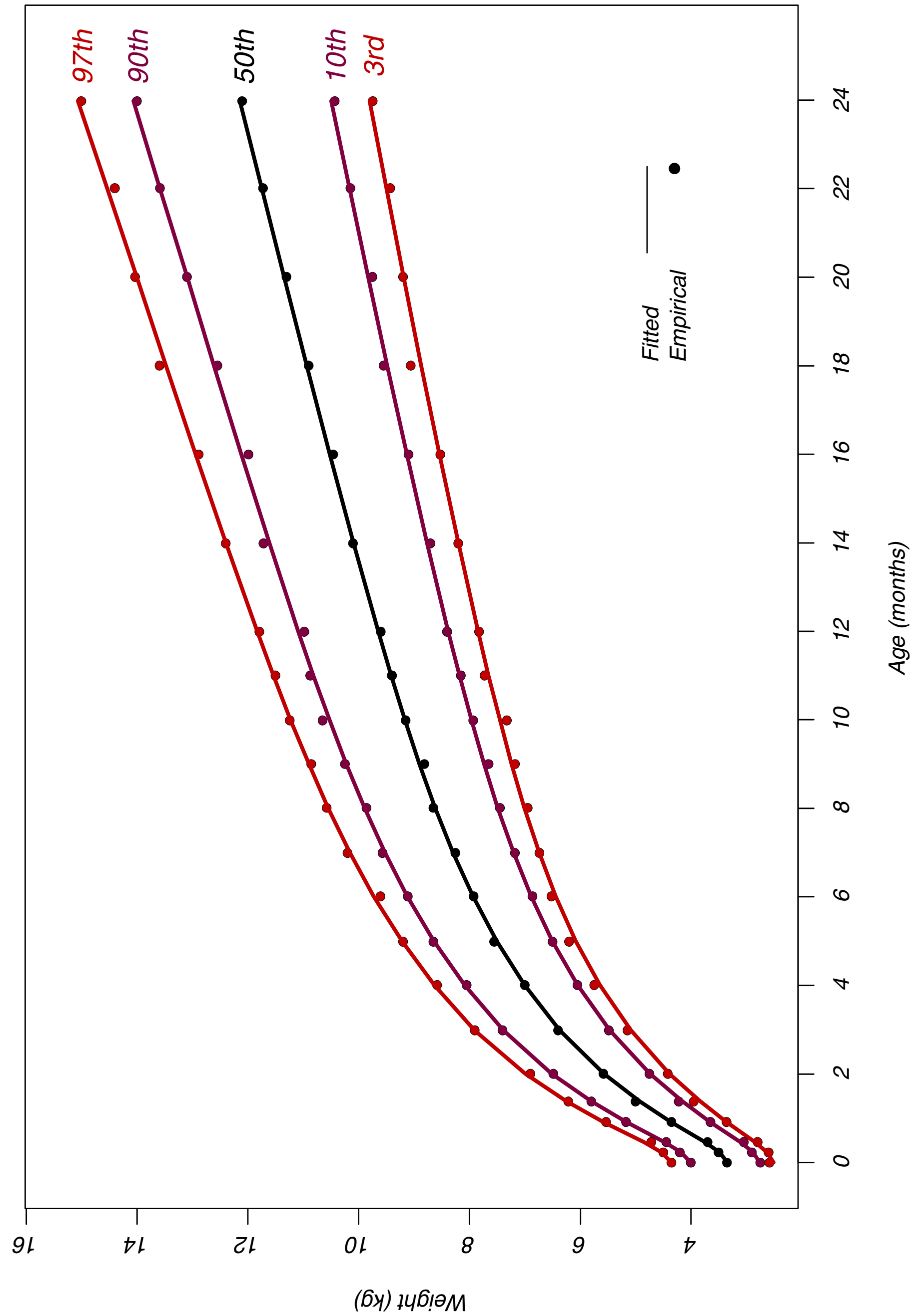


**Figure 39 3rd, 10th, 50th, 90th, 97th smoothed centile curves and empirical values: weight-for-age for boys from birth to 24 months**

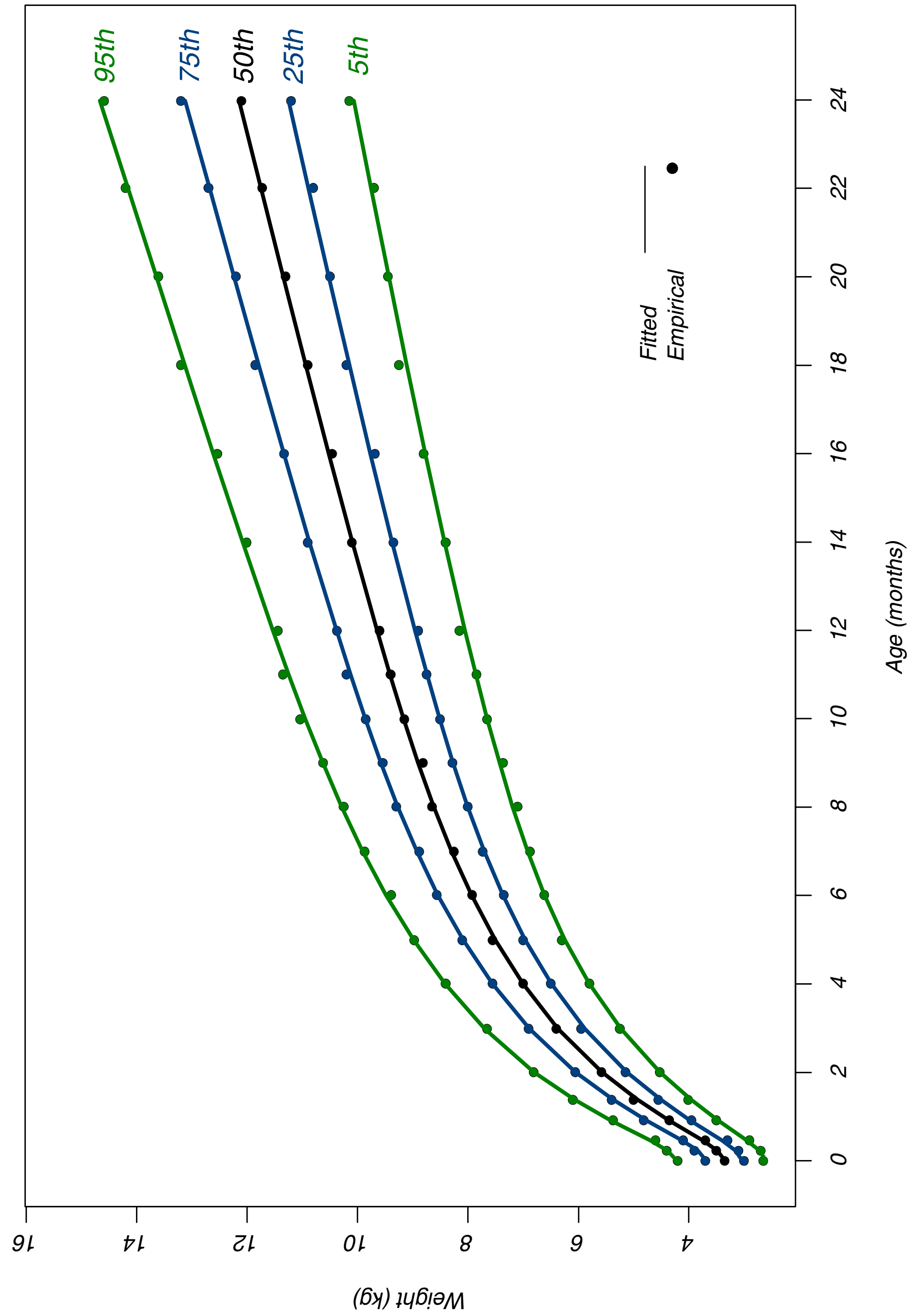


**Figure 40 5th, 25th, 50th, 75th, 95th smoothed centile curves and empirical values: weight-for-age for boys from birth to 24 months**

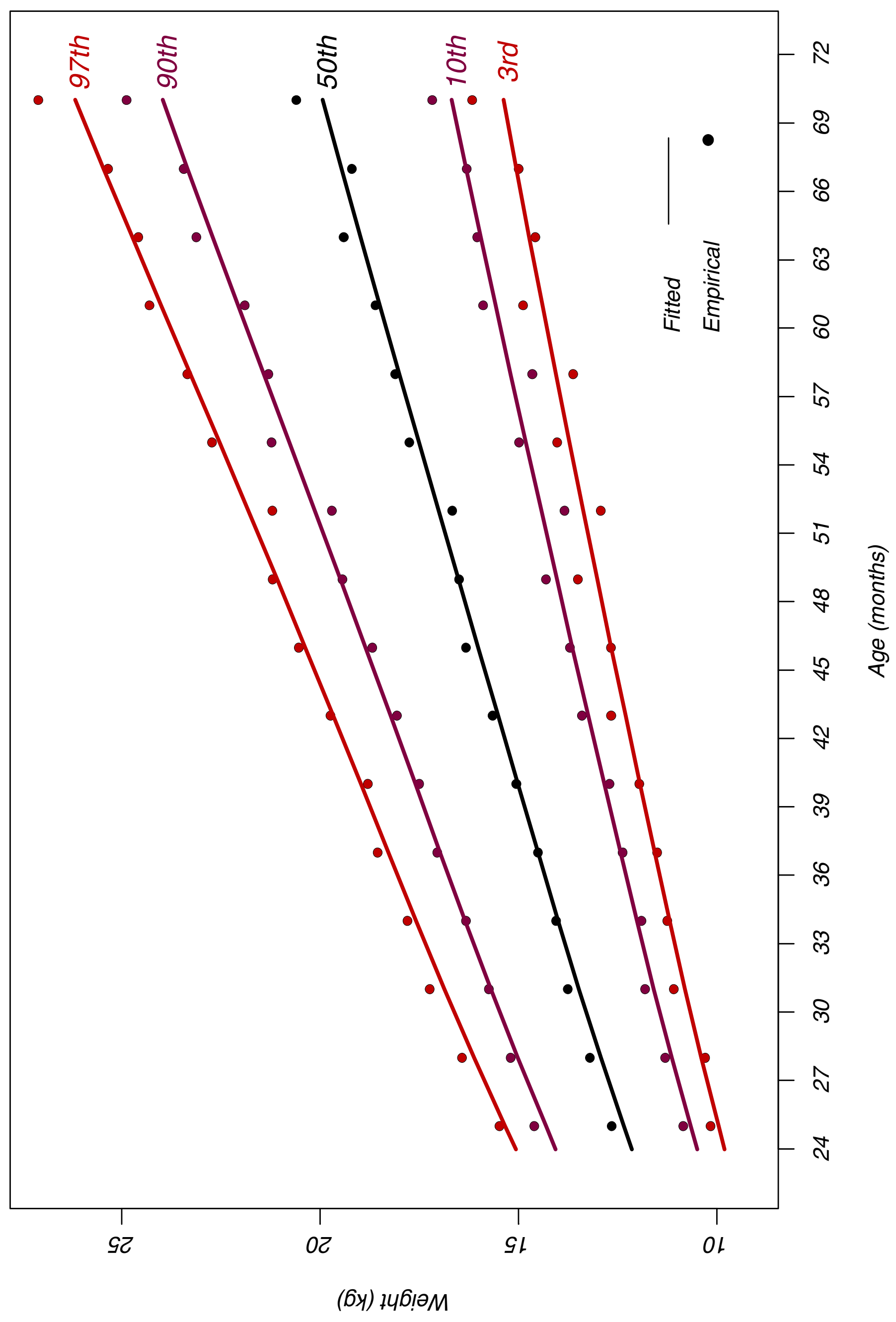


**Figure 41 3rd, 10th, 50th, 90th, 97th smoothed centile curves and empirical values: weight-for-age for boys from 24 to 71 months**

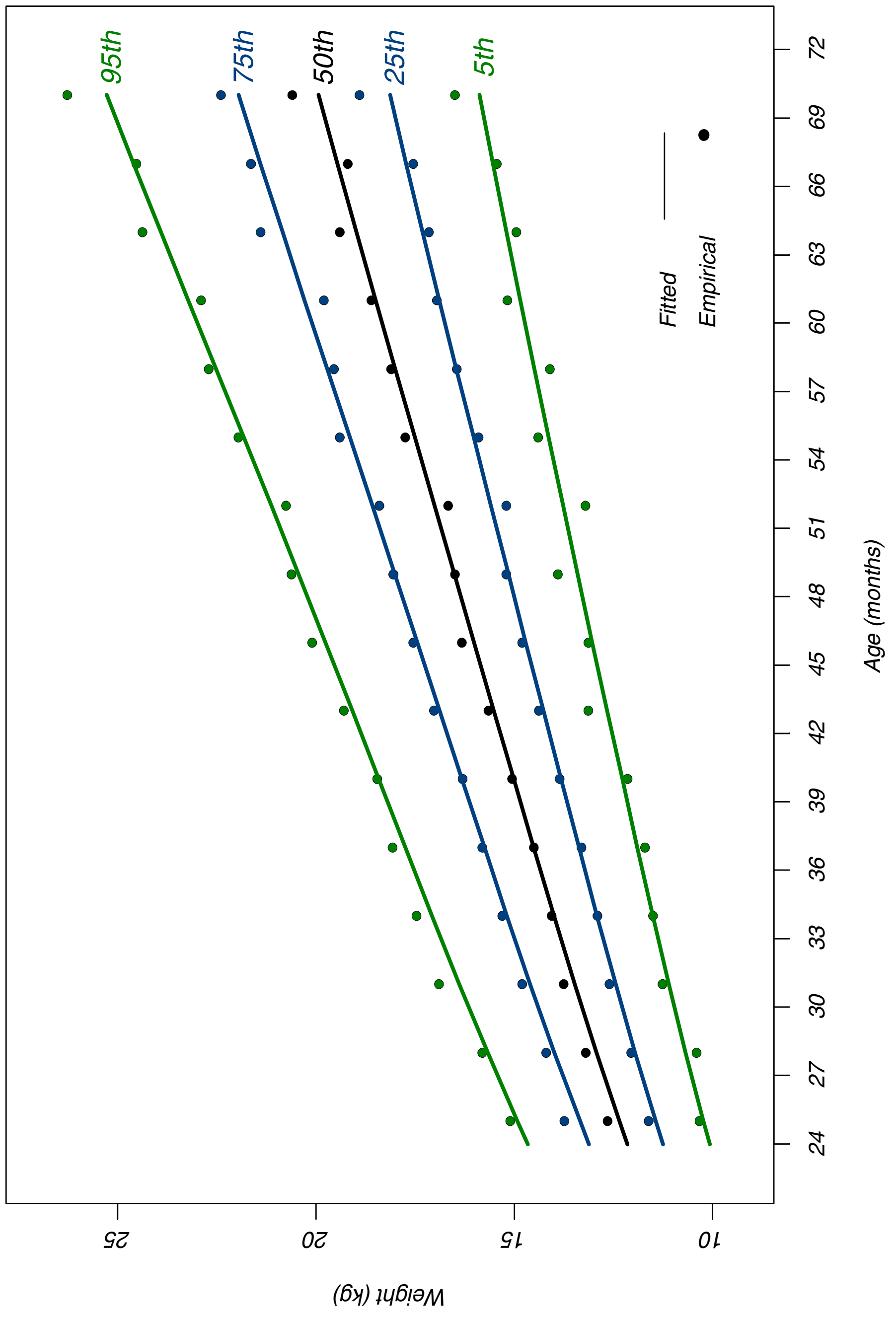


**Figure 42 5th, 25th, 50th, 75th, 95th smoothed centile curves and empirical values: weight-for-age for boys from 24 to 71 months**

### 4.2.3 WHO standards and their comparison with NCHS and CDC 2000 references

This section presents the final WHO weight-for-age z-score and percentile charts (Figures 43 and 44) and tables (Tables 38 and 39) for boys. It also provides the z-score comparisons of the WHO versus NCHS (Figure 45) and CDC 2000 (Figure 46) curves.

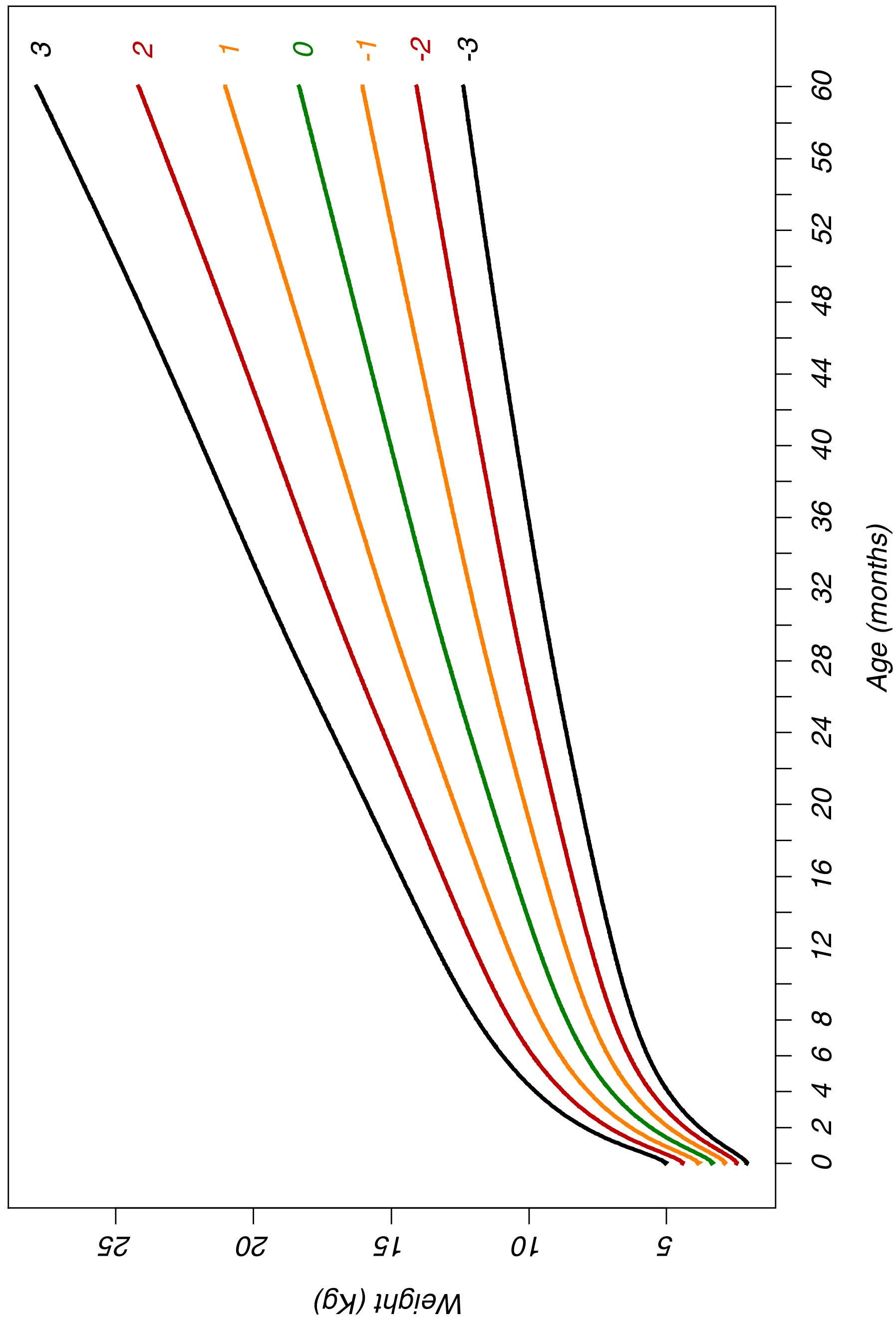


**Figure 43 WHO weight-for-age z-scores for boys from birth to 60 months**

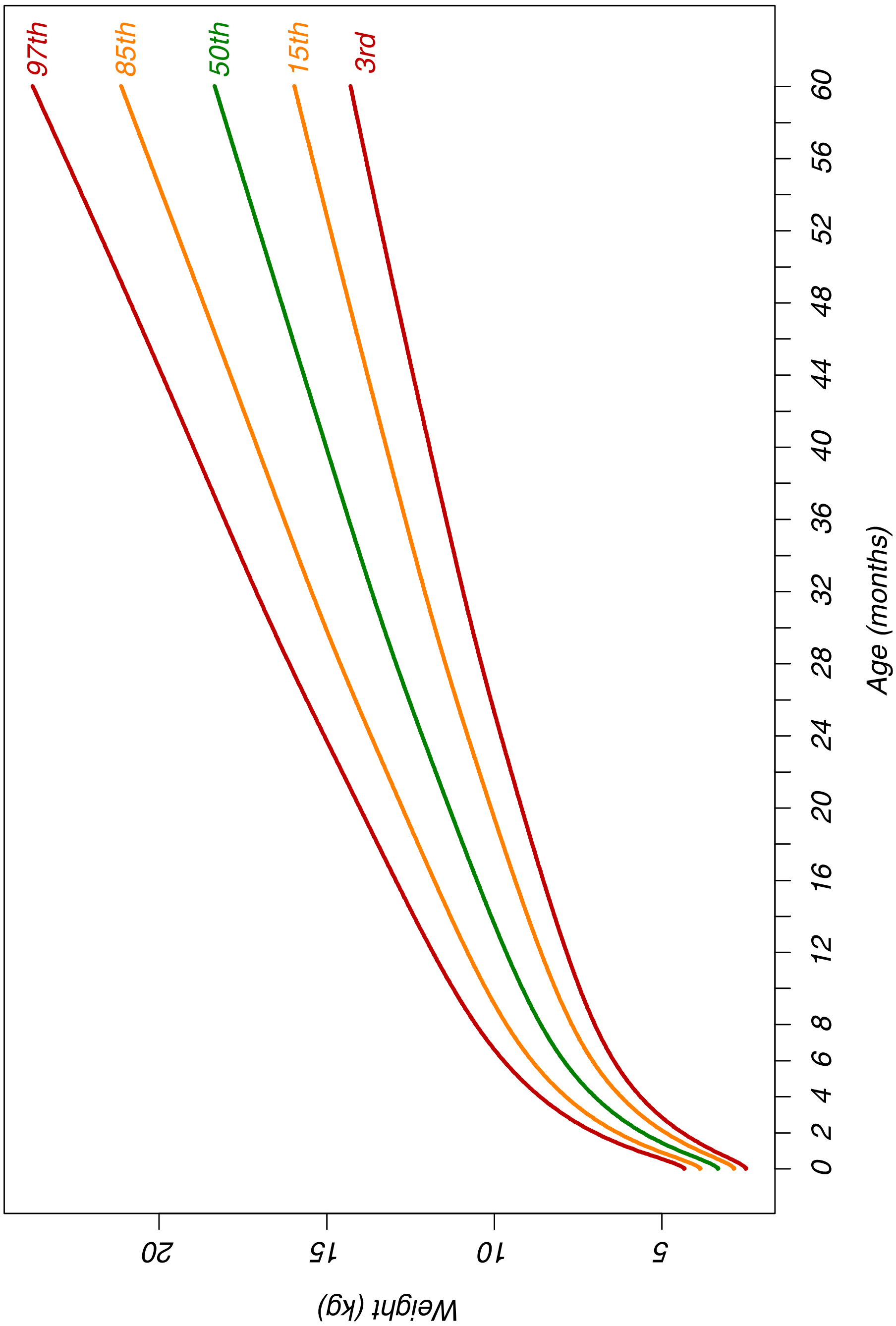


**Figure 44 WHO weight-for-age percentiles for boys from birth to 60 months**

*Tables*

**Table 38 Weight-for-age for boys, age in weeks**

| Week | L | M | S | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1st | 3rd | 5th | 15th | 25th | 50th | 75th | 85th | 95th | 97th | 99th |
| **0** | 0.3487 | 3.3464 | 0.14602 | 2.3 | 2.5 | 2.6 | 2.9 | 3.0 | 3.3 | 3.7 | 3.9 | 4.2 | 4.3 | 4.6 |
| **1** | 0.2776 | 3.4879 | 0.14483 | 2.4 | 2.6 | 2.7 | 3.0 | 3.2 | 3.5 | 3.8 | 4.0 | 4.4 | 4.5 | 4.8 |
| **2** | 0.2581 | 3.7529 | 0.14142 | 2.7 | 2.8 | 3.0 | 3.2 | 3.4 | 3.8 | 4.1 | 4.3 | 4.7 | 4.9 | 5.1 |
| **3** | 0.2442 | 4.0603 | 0.13807 | 2.9 | 3.1 | 3.2 | 3.5 | 3.7 | 4.1 | 4.5 | 4.7 | 5.1 | 5.2 | 5.5 |
| **4** | 0.2331 | 4.3671 | 0.13497 | 3.2 | 3.4 | 3.5 | 3.8 | 4.0 | 4.4 | 4.8 | 5.0 | 5.4 | 5.6 | 5.9 |
| **5** | 0.2237 | 4.6590 | 0.13215 | 3.4 | 3.6 | 3.7 | 4.1 | 4.3 | 4.7 | 5.1 | 5.3 | 5.8 | 5.9 | 6.3 |
| **6** | 0.2155 | 4.9303 | 0.12960 | 3.6 | 3.8 | 4.0 | 4.3 | 4.5 | 4.9 | 5.4 | 5.6 | 6.1 | 6.3 | 6.6 |
| **7** | 0.2081 | 5.1817 | 0.12729 | 3.8 | 4.1 | 4.2 | 4.5 | 4.8 | 5.2 | 5.6 | 5.9 | 6.4 | 6.5 | 6.9 |
| **8** | 0.2014 | 5.4149 | 0.12520 | 4.0 | 4.3 | 4.4 | 4.7 | 5.0 | 5.4 | 5.9 | 6.2 | 6.6 | 6.8 | 7.2 |
| **9** | 0.1952 | 5.6319 | 0.12330 | 4.2 | 4.4 | 4.6 | 4.9 | 5.2 | 5.6 | 6.1 | 6.4 | 6.9 | 7.1 | 7.4 |
| **10** | 0.1894 | 5.8346 | 0.12157 | 4.4 | 4.6 | 4.8 | 5.1 | 5.4 | 5.8 | 6.3 | 6.6 | 7.1 | 7.3 | 7.7 |
| **11** | 0.1840 | 6.0242 | 0.12001 | 4.5 | 4.8 | 4.9 | 5.3 | 5.6 | 6.0 | 6.5 | 6.8 | 7.3 | 7.5 | 7.9 |
| **12** | 0.1789 | 6.2019 | 0.11860 | 4.7 | 4.9 | 5.1 | 5.5 | 5.7 | 6.2 | 6.7 | 7.0 | 7.5 | 7.7 | 8.1 |
| **13** | 0.1740 | 6.3690 | 0.11732 | 4.8 | 5.1 | 5.2 | 5.6 | 5.9 | 6.4 | 6.9 | 7.2 | 7.7 | 7.9 | 8.3 |

**Table 38 Weight-for-age for boys, age in weeks (continued)**

| Week | L | M | S | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | -3 SD | -2 SD | -1 SD | Median | 1 SD | 2 SD | 3 SD |
| **0** | 0.3487 | 3.3464 | 0.14602 | 2.1 | 2.5 | 2.9 | 3.3 | 3.9 | 4.4 | 5.0 |
| **1** | 0.2776 | 3.4879 | 0.14483 | 2.2 | 2.6 | 3.0 | 3.5 | 4.0 | 4.6 | 5.3 |
| **2** | 0.2581 | 3.7529 | 0.14142 | 2.4 | 2.8 | 3.2 | 3.8 | 4.3 | 4.9 | 5.6 |
| **3** | 0.2442 | 4.0603 | 0.13807 | 2.6 | 3.1 | 3.5 | 4.1 | 4.7 | 5.3 | 6.0 |
| **4** | 0.2331 | 4.3671 | 0.13497 | 2.9 | 3.3 | 3.8 | 4.4 | 5.0 | 5.7 | 6.4 |
| **5** | 0.2237 | 4.6590 | 0.13215 | 3.1 | 3.5 | 4.1 | 4.7 | 5.3 | 6.0 | 6.8 |
| **6** | 0.2155 | 4.9303 | 0.12960 | 3.3 | 3.8 | 4.3 | 4.9 | 5.6 | 6.3 | 7.2 |
| **7** | 0.2081 | 5.1817 | 0.12729 | 3.5 | 4.0 | 4.6 | 5.2 | 5.9 | 6.6 | 7.5 |
| **8** | 0.2014 | 5.4149 | 0.12520 | 3.7 | 4.2 | 4.8 | 5.4 | 6.1 | 6.9 | 7.8 |
| **9** | 0.1952 | 5.6319 | 0.12330 | 3.8 | 4.4 | 5.0 | 5.6 | 6.4 | 7.2 | 8.0 |
| **10** | 0.1894 | 5.8346 | 0.12157 | 4.0 | 4.5 | 5.2 | 5.8 | 6.6 | 7.4 | 8.3 |
| **11** | 0.1840 | 6.0242 | 0.12001 | 4.2 | 4.7 | 5.3 | 6.0 | 6.8 | 7.6 | 8.5 |
| **12** | 0.1789 | 6.2019 | 0.11860 | 4.3 | 4.9 | 5.5 | 6.2 | 7.0 | 7.8 | 8.8 |
| **13** | 0.1740 | 6.3690 | 0.11732 | 4.4 | 5.0 | 5.7 | 6.4 | 7.2 | 8.0 | 9.0 |

**Table 39 Weight-for-age for boys, age in years and months**

| Year: Month | Month | L | M | S | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1st | 3rd | 5th | 15th | 25th | 50th | 75th | 85th | 95th | 97th | 99th |
| **0: 0** | **0** | 0.3487 | 3.3464 | 0.14602 | 2.3 | 2.5 | 2.6 | 2.9 | 3.0 | 3.3 | 3.7 | 3.9 | 4.2 | 4.3 | 4.6 |
| **0: 1** | **1** | 0.2297 | 4.4709 | 0.13395 | 3.2 | 3.4 | 3.6 | 3.9 | 4.1 | 4.5 | 4.9 | 5.1 | 5.5 | 5.7 | 6.0 |
| **0: 2** | **2** | 0.1970 | 5.5675 | 0.12385 | 4.1 | 4.4 | 4.5 | 4.9 | 5.1 | 5.6 | 6.0 | 6.3 | 6.8 | 7.0 | 7.4 |
| **0: 3** | **3** | 0.1738 | 6.3762 | 0.11727 | 4.8 | 5.1 | 5.2 | 5.6 | 5.9 | 6.4 | 6.9 | 7.2 | 7.7 | 7.9 | 8.3 |
| **0: 4** | **4** | 0.1553 | 7.0023 | 0.11316 | 5.4 | 5.6 | 5.8 | 6.2 | 6.5 | 7.0 | 7.6 | 7.9 | 8.4 | 8.6 | 9.1 |
| **0: 5** | **5** | 0.1395 | 7.5105 | 0.11080 | 5.8 | 6.1 | 6.2 | 6.7 | 7.0 | 7.5 | 8.1 | 8.4 | 9.0 | 9.2 | 9.7 |
| **0: 6** | **6** | 0.1257 | 7.9340 | 0.10958 | 6.1 | 6.4 | 6.6 | 7.1 | 7.4 | 7.9 | 8.5 | 8.9 | 9.5 | 9.7 | 10.2 |
| **0: 7** | **7** | 0.1134 | 8.2970 | 0.10902 | 6.4 | 6.7 | 6.9 | 7.4 | 7.7 | 8.3 | 8.9 | 9.3 | 9.9 | 10.2 | 10.7 |
| **0: 8** | **8** | 0.1021 | 8.6151 | 0.10882 | 6.7 | 7.0 | 7.2 | 7.7 | 8.0 | 8.6 | 9.3 | 9.6 | 10.3 | 10.5 | 11.1 |
| **0: 9** | **9** | 0.0917 | 8.9014 | 0.10881 | 6.9 | 7.2 | 7.4 | 7.9 | 8.3 | 8.9 | 9.6 | 10.0 | 10.6 | 10.9 | 11.4 |
| **0:10** | **10** | 0.0820 | 9.1649 | 0.10891 | 7.1 | 7.5 | 7.7 | 8.2 | 8.5 | 9.2 | 9.9 | 10.3 | 10.9 | 11.2 | 11.8 |
| **0:11** | **11** | 0.0730 | 9.4122 | 0.10906 | 7.3 | 7.7 | 7.9 | 8.4 | 8.7 | 9.4 | 10.1 | 10.5 | 11.2 | 11.5 | 12.1 |
| **1: 0** | **12** | 0.0644 | 9.6479 | 0.10925 | 7.5 | 7.8 | 8.1 | 8.6 | 9.0 | 9.6 | 10.4 | 10.8 | 11.5 | 11.8 | 12.4 |
| **1: 1** | **13** | 0.0563 | 9.8749 | 0.10949 | 7.6 | 8.0 | 8.2 | 8.8 | 9.2 | 9.9 | 10.6 | 11.1 | 11.8 | 12.1 | 12.7 |
| **1: 2** | **14** | 0.0487 | 10.0953 | 0.10976 | 7.8 | 8.2 | 8.4 | 9.0 | 9.4 | 10.1 | 10.9 | 11.3 | 12.1 | 12.4 | 13.0 |
| **1: 3** | **15** | 0.0413 | 10.3108 | 0.11007 | 8.0 | 8.4 | 8.6 | 9.2 | 9.6 | 10.3 | 11.1 | 11.6 | 12.3 | 12.7 | 13.3 |
| **1: 4** | **16** | 0.0343 | 10.5228 | 0.11041 | 8.1 | 8.5 | 8.8 | 9.4 | 9.8 | 10.5 | 11.3 | 11.8 | 12.6 | 12.9 | 13.6 |
| **1: 5** | **17** | 0.0275 | 10.7319 | 0.11079 | 8.3 | 8.7 | 8.9 | 9.6 | 10.0 | 10.7 | 11.6 | 12.0 | 12.9 | 13.2 | 13.9 |
| **1: 6** | **18** | 0.0211 | 10.9385 | 0.11119 | 8.4 | 8.9 | 9.1 | 9.7 | 10.1 | 10.9 | 11.8 | 12.3 | 13.1 | 13.5 | 14.2 |
| **1: 7** | **19** | 0.0148 | 11.1430 | 0.11164 | 8.6 | 9.0 | 9.3 | 9.9 | 10.3 | 11.1 | 12.0 | 12.5 | 13.4 | 13.7 | 14.4 |
| **1: 8** | **20** | 0.0087 | 11.3462 | 0.11211 | 8.7 | 9.2 | 9.4 | 10.1 | 10.5 | 11.3 | 12.2 | 12.7 | 13.6 | 14.0 | 14.7 |
| **1: 9** | **21** | 0.0029 | 11.5486 | 0.11261 | 8.9 | 9.3 | 9.6 | 10.3 | 10.7 | 11.5 | 12.5 | 13.0 | 13.9 | 14.3 | 15.0 |
| **1:10** | **22** | -0.0028 | 11.7504 | 0.11314 | 9.0 | 9.5 | 9.8 | 10.5 | 10.9 | 11.8 | 12.7 | 13.2 | 14.2 | 14.5 | 15.3 |
| **1:11** | **23** | -0.0083 | 11.9514 | 0.11369 | 9.2 | 9.7 | 9.9 | 10.6 | 11.1 | 12.0 | 12.9 | 13.4 | 14.4 | 14.8 | 15.6 |
| **2: 0** | **24** | -0.0137 | 12.1515 | 0.11426 | 9.3 | 9.8 | 10.1 | 10.8 | 11.3 | 12.2 | 13.1 | 13.7 | 14.7 | 15.1 | 15.9 |

**Table 39 Weight-for-age for boys, age in years and months (continued)**

| | | | | | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **2: 1** | **25** | -0.0189 | 12.3502 | 0.11485 | 9.5 | 10.0 | 10.2 | 11.0 | 11.4 | 12.4 | 13.3 | 13.9 | 14.9 | 15.3 | 16.1 |
| **2: 2** | **26** | -0.0240 | 12.5466 | 0.11544 | 9.6 | 10.1 | 10.4 | 11.1 | 11.6 | 12.5 | 13.6 | 14.1 | 15.2 | 15.6 | 16.4 |
| **2: 3** | **27** | -0.0289 | 12.7401 | 0.11604 | 9.7 | 10.2 | 10.5 | 11.3 | 11.8 | 12.7 | 13.8 | 14.4 | 15.4 | 15.9 | 16.7 |
| **2: 4** | **28** | -0.0337 | 12.9303 | 0.11664 | 9.9 | 10.4 | 10.7 | 11.5 | 12.0 | 12.9 | 14.0 | 14.6 | 15.7 | 16.1 | 17.0 |
| **2: 5** | **29** | -0.0385 | 13.1169 | 0.11723 | 10.0 | 10.5 | 10.8 | 11.6 | 12.1 | 13.1 | 14.2 | 14.8 | 15.9 | 16.4 | 17.3 |
| **2: 6** | **30** | -0.0431 | 13.3000 | 0.11781 | 10.1 | 10.7 | 11.0 | 11.8 | 12.3 | 13.3 | 14.4 | 15.0 | 16.2 | 16.6 | 17.5 |
| **2: 7** | **31** | -0.0476 | 13.4798 | 0.11839 | 10.3 | 10.8 | 11.1 | 11.9 | 12.4 | 13.5 | 14.6 | 15.2 | 16.4 | 16.9 | 17.8 |
| **2: 8** | **32** | -0.0520 | 13.6567 | 0.11896 | 10.4 | 10.9 | 11.2 | 12.1 | 12.6 | 13.7 | 14.8 | 15.5 | 16.6 | 17.1 | 18.0 |
| **2: 9** | **33** | -0.0564 | 13.8309 | 0.11953 | 10.5 | 11.1 | 11.4 | 12.2 | 12.8 | 13.8 | 15.0 | 15.7 | 16.9 | 17.3 | 18.3 |
| **2:10** | **34** | -0.0606 | 14.0031 | 0.12008 | 10.6 | 11.2 | 11.5 | 12.4 | 12.9 | 14.0 | 15.2 | 15.9 | 17.1 | 17.6 | 18.6 |
| **2:11** | **35** | -0.0648 | 14.1736 | 0.12062 | 10.7 | 11.3 | 11.6 | 12.5 | 13.1 | 14.2 | 15.4 | 16.1 | 17.3 | 17.8 | 18.8 |
| **3: 0** | **36** | -0.0689 | 14.3429 | 0.12116 | 10.8 | 11.4 | 11.8 | 12.7 | 13.2 | 14.3 | 15.6 | 16.3 | 17.5 | 18.0 | 19.1 |
| **3: 1** | **37** | -0.0729 | 14.5113 | 0.12168 | 11.0 | 11.6 | 11.9 | 12.8 | 13.4 | 14.5 | 15.8 | 16.5 | 17.8 | 18.3 | 19.3 |
| **3: 2** | **38** | -0.0769 | 14.6791 | 0.12220 | 11.1 | 11.7 | 12.0 | 12.9 | 13.5 | 14.7 | 15.9 | 16.7 | 18.0 | 18.5 | 19.6 |
| **3: 3** | **39** | -0.0808 | 14.8466 | 0.12271 | 11.2 | 11.8 | 12.2 | 13.1 | 13.7 | 14.8 | 16.1 | 16.9 | 18.2 | 18.7 | 19.8 |
| **3: 4** | **40** | -0.0846 | 15.0140 | 0.12322 | 11.3 | 11.9 | 12.3 | 13.2 | 13.8 | 15.0 | 16.3 | 17.1 | 18.4 | 19.0 | 20.1 |
| **3: 5** | **41** | -0.0883 | 15.1813 | 0.12373 | 11.4 | 12.1 | 12.4 | 13.4 | 14.0 | 15.2 | 16.5 | 17.3 | 18.6 | 19.2 | 20.3 |
| **3: 6** | **42** | -0.0920 | 15.3486 | 0.12425 | 11.5 | 12.2 | 12.5 | 13.5 | 14.1 | 15.3 | 16.7 | 17.5 | 18.9 | 19.4 | 20.6 |
| **3: 7** | **43** | -0.0957 | 15.5158 | 0.12478 | 11.7 | 12.3 | 12.7 | 13.6 | 14.3 | 15.5 | 16.9 | 17.7 | 19.1 | 19.7 | 20.8 |
| **3: 8** | **44** | -0.0993 | 15.6828 | 0.12531 | 11.8 | 12.4 | 12.8 | 13.8 | 14.4 | 15.7 | 17.1 | 17.9 | 19.3 | 19.9 | 21.1 |
| **3: 9** | **45** | -0.1028 | 15.8497 | 0.12586 | 11.9 | 12.5 | 12.9 | 13.9 | 14.6 | 15.8 | 17.3 | 18.1 | 19.5 | 20.1 | 21.3 |
| **3:10** | **46** | -0.1063 | 16.0163 | 0.12643 | 12.0 | 12.7 | 13.0 | 14.1 | 14.7 | 16.0 | 17.4 | 18.3 | 19.8 | 20.4 | 21.6 |
| **3:11** | **47** | -0.1097 | 16.1827 | 0.12700 | 12.1 | 12.8 | 13.2 | 14.2 | 14.9 | 16.2 | 17.6 | 18.5 | 20.0 | 20.6 | 21.9 |
| **4: 0** | **48** | -0.1131 | 16.3489 | 0.12759 | 12.2 | 12.9 | 13.3 | 14.3 | 15.0 | 16.3 | 17.8 | 18.7 | 20.2 | 20.9 | 22.1 |

**Table 39 Weight-for-age for boys, age in years and months (continued)**

| | | | | | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **4: 1** | **49** | -0.1165 | 16.5150 | 0.12819 | 12.3 | 13.0 | 13.4 | 14.5 | 15.2 | 16.5 | 18.0 | 18.9 | 20.4 | 21.1 | 22.4 |
| **4: 2** | **50** | -0.1198 | 16.6811 | 0.12880 | 12.4 | 13.1 | 13.5 | 14.6 | 15.3 | 16.7 | 18.2 | 19.1 | 20.7 | 21.3 | 22.6 |
| **4: 3** | **51** | -0.1230 | 16.8471 | 0.12943 | 12.5 | 13.3 | 13.7 | 14.7 | 15.4 | 16.8 | 18.4 | 19.3 | 20.9 | 21.6 | 22.9 |
| **4: 4** | **52** | -0.1262 | 17.0132 | 0.13005 | 12.6 | 13.4 | 13.8 | 14.9 | 15.6 | 17.0 | 18.6 | 19.5 | 21.1 | 21.8 | 23.2 |
| **4: 5** | **53** | -0.1294 | 17.1792 | 0.13069 | 12.7 | 13.5 | 13.9 | 15.0 | 15.7 | 17.2 | 18.8 | 19.7 | 21.4 | 22.1 | 23.4 |
| **4: 6** | **54** | -0.1325 | 17.3452 | 0.13133 | 12.9 | 13.6 | 14.0 | 15.2 | 15.9 | 17.3 | 19.0 | 19.9 | 21.6 | 22.3 | 23.7 |
| **4: 7** | **55** | -0.1356 | 17.5111 | 0.13197 | 13.0 | 13.7 | 14.1 | 15.3 | 16.0 | 17.5 | 19.2 | 20.1 | 21.8 | 22.5 | 24.0 |
| **4: 8** | **56** | -0.1387 | 17.6768 | 0.13261 | 13.1 | 13.8 | 14.3 | 15.4 | 16.2 | 17.7 | 19.3 | 20.3 | 22.1 | 22.8 | 24.2 |
| **4: 9** | **57** | -0.1417 | 17.8422 | 0.13325 | 13.2 | 13.9 | 14.4 | 15.6 | 16.3 | 17.8 | 19.5 | 20.5 | 22.3 | 23.0 | 24.5 |
| **4:10** | **58** | -0.1447 | 18.0073 | 0.13389 | 13.3 | 14.1 | 14.5 | 15.7 | 16.5 | 18.0 | 19.7 | 20.7 | 22.5 | 23.3 | 24.8 |
| **4:11** | **59** | -0.1477 | 18.1722 | 0.13453 | 13.4 | 14.2 | 14.6 | 15.8 | 16.6 | 18.2 | 19.9 | 20.9 | 22.8 | 23.5 | 25.0 |
| **5: 0** | **60** | -0.1506 | 18.3366 | 0.13517 | 13.5 | 14.3 | 14.7 | 16.0 | 16.7 | 18.3 | 20.1 | 21.1 | 23.0 | 23.8 | 25.3 |

**Table 39 Weight-for-age for boys, age in years and months (continued)**

| | | | | | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **0: 0** | **0** | 0.3487 | 3.3464 | 0.14602 | 2.1 | 2.5 | 2.9 | 3.3 | 3.9 | 4.4 | 5.0 |
| **0: 1** | **1** | 0.2297 | 4.4709 | 0.13395 | 2.9 | 3.4 | 3.9 | 4.5 | 5.1 | 5.8 | 6.6 |
| **0: 2** | **2** | 0.1970 | 5.5675 | 0.12385 | 3.8 | 4.3 | 4.9 | 5.6 | 6.3 | 7.1 | 8.0 |
| **0: 3** | **3** | 0.1738 | 6.3762 | 0.11727 | 4.4 | 5.0 | 5.7 | 6.4 | 7.2 | 8.0 | 9.0 |
| **0: 4** | **4** | 0.1553 | 7.0023 | 0.11316 | 4.9 | 5.6 | 6.2 | 7.0 | 7.8 | 8.7 | 9.7 |
| **0: 5** | **5** | 0.1395 | 7.5105 | 0.11080 | 5.3 | 6.0 | 6.7 | 7.5 | 8.4 | 9.3 | 10.4 |
| **0: 6** | **6** | 0.1257 | 7.9340 | 0.10958 | 5.7 | 6.4 | 7.1 | 7.9 | 8.8 | 9.8 | 10.9 |
| **0: 7** | **7** | 0.1134 | 8.2970 | 0.10902 | 5.9 | 6.7 | 7.4 | 8.3 | 9.2 | 10.3 | 11.4 |
| **0: 8** | **8** | 0.1021 | 8.6151 | 0.10882 | 6.2 | 6.9 | 7.7 | 8.6 | 9.6 | 10.7 | 11.9 |
| **0: 9** | **9** | 0.0917 | 8.9014 | 0.10881 | 6.4 | 7.1 | 8.0 | 8.9 | 9.9 | 11.0 | 12.3 |
| **0:10** | **10** | 0.0820 | 9.1649 | 0.10891 | 6.6 | 7.4 | 8.2 | 9.2 | 10.2 | 11.4 | 12.7 |
| **0:11** | **11** | 0.0730 | 9.4122 | 0.10906 | 6.8 | 7.6 | 8.4 | 9.4 | 10.5 | 11.7 | 13.0 |
| **1: 0** | **12** | 0.0644 | 9.6479 | 0.10925 | 6.9 | 7.7 | 8.6 | 9.6 | 10.8 | 12.0 | 13.3 |
| **1: 1** | **13** | 0.0563 | 9.8749 | 0.10949 | 7.1 | 7.9 | 8.8 | 9.9 | 11.0 | 12.3 | 13.7 |
| **1: 2** | **14** | 0.0487 | 10.0953 | 0.10976 | 7.2 | 8.1 | 9.0 | 10.1 | 11.3 | 12.6 | 14.0 |
| **1: 3** | **15** | 0.0413 | 10.3108 | 0.11007 | 7.4 | 8.3 | 9.2 | 10.3 | 11.5 | 12.8 | 14.3 |
| **1: 4** | **16** | 0.0343 | 10.5228 | 0.11041 | 7.5 | 8.4 | 9.4 | 10.5 | 11.7 | 13.1 | 14.6 |
| **1: 5** | **17** | 0.0275 | 10.7319 | 0.11079 | 7.7 | 8.6 | 9.6 | 10.7 | 12.0 | 13.4 | 14.9 |
| **1: 6** | **18** | 0.0211 | 10.9385 | 0.11119 | 7.8 | 8.8 | 9.8 | 10.9 | 12.2 | 13.7 | 15.3 |
| **1: 7** | **19** | 0.0148 | 11.1430 | 0.11164 | 8.0 | 8.9 | 10.0 | 11.1 | 12.5 | 13.9 | 15.6 |
| **1: 8** | **20** | 0.0087 | 11.3462 | 0.11211 | 8.1 | 9.1 | 10.1 | 11.3 | 12.7 | 14.2 | 15.9 |
| **1: 9** | **21** | 0.0029 | 11.5486 | 0.11261 | 8.2 | 9.2 | 10.3 | 11.5 | 12.9 | 14.5 | 16.2 |
| **1:10** | **22** | -0.0028 | 11.7504 | 0.11314 | 8.4 | 9.4 | 10.5 | 11.8 | 13.2 | 14.7 | 16.5 |
| **1:11** | **23** | -0.0083 | 11.9514 | 0.11369 | 8.5 | 9.5 | 10.7 | 12.0 | 13.4 | 15.0 | 16.8 |
| **2: 0** | **24** | -0.0137 | 12.1515 | 0.11426 | 8.6 | 9.7 | 10.8 | 12.2 | 13.6 | 15.3 | 17.1 |

**Table 39 Weight-for-age for boys, age in years and months (continued)**

| | | | | | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **2: 1** | **25** | -0.0189 | 12.3502 | 0.11485 | 8.8 | 9.8 | 11.0 | 12.4 | 13.9 | 15.5 | 17.5 |
| **2: 2** | **26** | -0.0240 | 12.5466 | 0.11544 | 8.9 | 10.0 | 11.2 | 12.5 | 14.1 | 15.8 | 17.8 |
| **2: 3** | **27** | -0.0289 | 12.7401 | 0.11604 | 9.0 | 10.1 | 11.3 | 12.7 | 14.3 | 16.1 | 18.1 |
| **2: 4** | **28** | -0.0337 | 12.9303 | 0.11664 | 9.1 | 10.2 | 11.5 | 12.9 | 14.5 | 16.3 | 18.4 |
| **2: 5** | **29** | -0.0385 | 13.1169 | 0.11723 | 9.2 | 10.4 | 11.7 | 13.1 | 14.8 | 16.6 | 18.7 |
| **2: 6** | **30** | -0.0431 | 13.3000 | 0.11781 | 9.4 | 10.5 | 11.8 | 13.3 | 15.0 | 16.9 | 19.0 |
| **2: 7** | **31** | -0.0476 | 13.4798 | 0.11839 | 9.5 | 10.7 | 12.0 | 13.5 | 15.2 | 17.1 | 19.3 |
| **2: 8** | **32** | -0.0520 | 13.6567 | 0.11896 | 9.6 | 10.8 | 12.1 | 13.7 | 15.4 | 17.4 | 19.6 |
| **2: 9** | **33** | -0.0564 | 13.8309 | 0.11953 | 9.7 | 10.9 | 12.3 | 13.8 | 15.6 | 17.6 | 19.9 |
| **2:10** | **34** | -0.0606 | 14.0031 | 0.12008 | 9.8 | 11.0 | 12.4 | 14.0 | 15.8 | 17.8 | 20.2 |
| **2:11** | **35** | -0.0648 | 14.1736 | 0.12062 | 9.9 | 11.2 | 12.6 | 14.2 | 16.0 | 18.1 | 20.4 |
| **3: 0** | **36** | -0.0689 | 14.3429 | 0.12116 | 10.0 | 11.3 | 12.7 | 14.3 | 16.2 | 18.3 | 20.7 |
| **3: 1** | **37** | -0.0729 | 14.5113 | 0.12168 | 10.1 | 11.4 | 12.9 | 14.5 | 16.4 | 18.6 | 21.0 |
| **3: 2** | **38** | -0.0769 | 14.6791 | 0.12220 | 10.2 | 11.5 | 13.0 | 14.7 | 16.6 | 18.8 | 21.3 |
| **3: 3** | **39** | -0.0808 | 14.8466 | 0.12271 | 10.3 | 11.6 | 13.1 | 14.8 | 16.8 | 19.0 | 21.6 |
| **3: 4** | **40** | -0.0846 | 15.0140 | 0.12322 | 10.4 | 11.8 | 13.3 | 15.0 | 17.0 | 19.3 | 21.9 |
| **3: 5** | **41** | -0.0883 | 15.1813 | 0.12373 | 10.5 | 11.9 | 13.4 | 15.2 | 17.2 | 19.5 | 22.1 |
| **3: 6** | **42** | -0.0920 | 15.3486 | 0.12425 | 10.6 | 12.0 | 13.6 | 15.3 | 17.4 | 19.7 | 22.4 |
| **3: 7** | **43** | -0.0957 | 15.5158 | 0.12478 | 10.7 | 12.1 | 13.7 | 15.5 | 17.6 | 20.0 | 22.7 |
| **3: 8** | **44** | -0.0993 | 15.6828 | 0.12531 | 10.8 | 12.2 | 13.8 | 15.7 | 17.8 | 20.2 | 23.0 |
| **3: 9** | **45** | -0.1028 | 15.8497 | 0.12586 | 10.9 | 12.4 | 14.0 | 15.8 | 18.0 | 20.5 | 23.3 |
| **3:10** | **46** | -0.1063 | 16.0163 | 0.12643 | 11.0 | 12.5 | 14.1 | 16.0 | 18.2 | 20.7 | 23.6 |
| **3:11** | **47** | -0.1097 | 16.1827 | 0.12700 | 11.1 | 12.6 | 14.3 | 16.2 | 18.4 | 20.9 | 23.9 |
| **4: 0** | **48** | -0.1131 | 16.3489 | 0.12759 | 11.2 | 12.7 | 14.4 | 16.3 | 18.6 | 21.2 | 24.2 |

**Table 39 Weight-for-age for boys, age in years and months (continued)**

| Year: Month | Month | L | M | S | Z-scores (weight in kg) -3 SD | -2 SD | -1 SD | Median | 1 SD | 2 SD | 3 SD |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **4: 1** | **49** | -0.1165 | 16.5150 | 0.12819 | 11.3 | 12.8 | 14.5 | 16.5 | 18.8 | 21.4 | 24.5 |
| **4: 2** | **50** | -0.1198 | 16.6811 | 0.12880 | 11.4 | 12.9 | 14.7 | 16.7 | 19.0 | 21.7 | 24.8 |
| **4: 3** | **51** | -0.1230 | 16.8471 | 0.12943 | 11.5 | 13.1 | 14.8 | 16.8 | 19.2 | 21.9 | 25.1 |
| **4: 4** | **52** | -0.1262 | 17.0132 | 0.13005 | 11.6 | 13.2 | 15.0 | 17.0 | 19.4 | 22.2 | 25.4 |
| **4: 5** | **53** | -0.1294 | 17.1792 | 0.13069 | 11.7 | 13.3 | 15.1 | 17.2 | 19.6 | 22.4 | 25.7 |
| **4: 6** | **54** | -0.1325 | 17.3452 | 0.13133 | 11.8 | 13.4 | 15.2 | 17.3 | 19.8 | 22.7 | 26.0 |
| **4: 7** | **55** | -0.1356 | 17.5111 | 0.13197 | 11.9 | 13.5 | 15.4 | 17.5 | 20.0 | 22.9 | 26.3 |
| **4: 8** | **56** | -0.1387 | 17.6768 | 0.13261 | 12.0 | 13.6 | 15.5 | 17.7 | 20.2 | 23.2 | 26.6 |
| **4: 9** | **57** | -0.1417 | 17.8422 | 0.13325 | 12.1 | 13.7 | 15.6 | 17.8 | 20.4 | 23.4 | 26.9 |
| **4:10** | **58** | -0.1447 | 18.0073 | 0.13389 | 12.2 | 13.8 | 15.8 | 18.0 | 20.6 | 23.7 | 27.2 |
| **4:11** | **59** | -0.1477 | 18.1722 | 0.13453 | 12.3 | 14.0 | 15.9 | 18.2 | 20.8 | 23.9 | 27.6 |
| **5: 0** | **60** | -0.1506 | 18.3366 | 0.13517 | 12.4 | 14.1 | 16.0 | 18.3 | 21.0 | 24.2 | 27.9 |

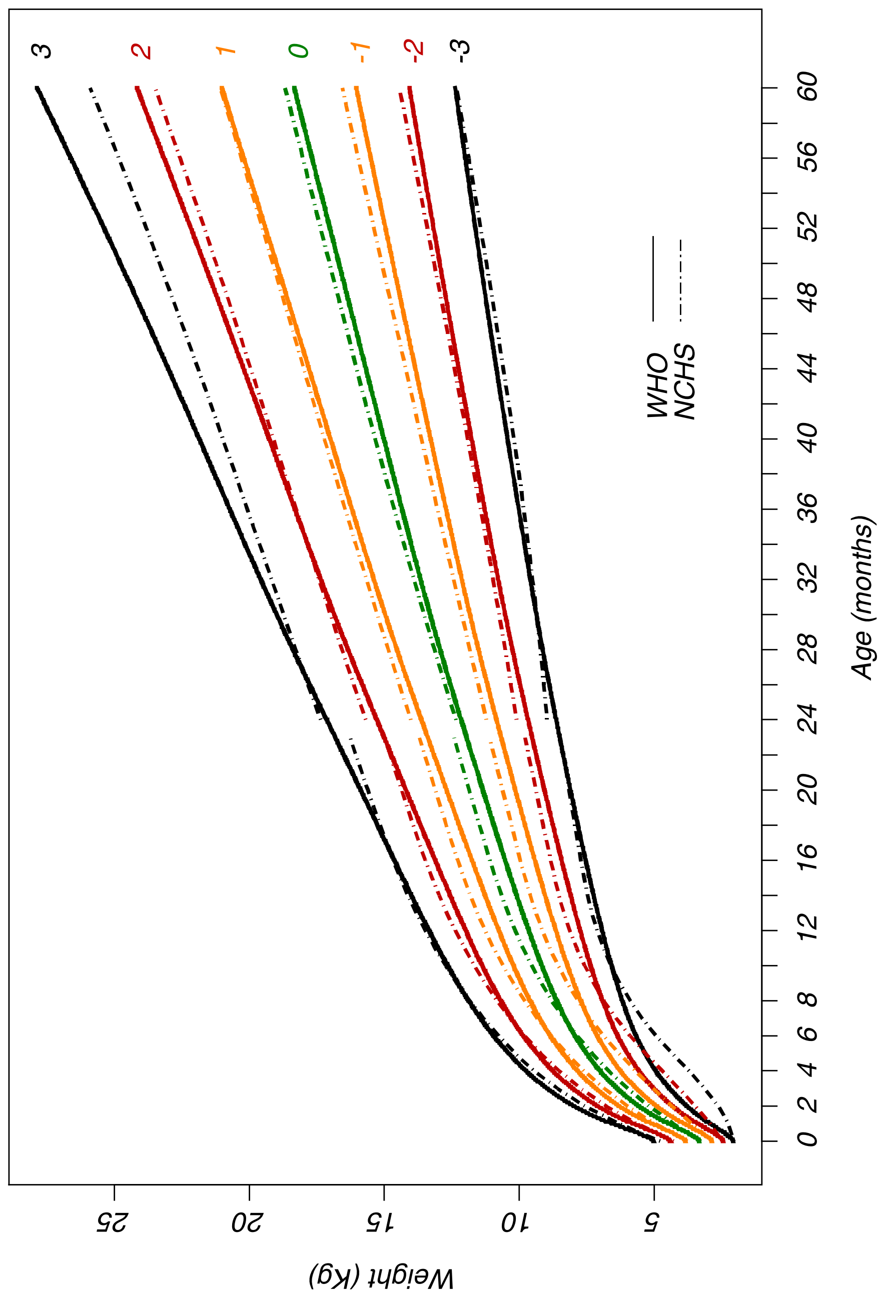


**Figure 45 Comparison of WHO with NCHS weight-for-age z-scores for boys**

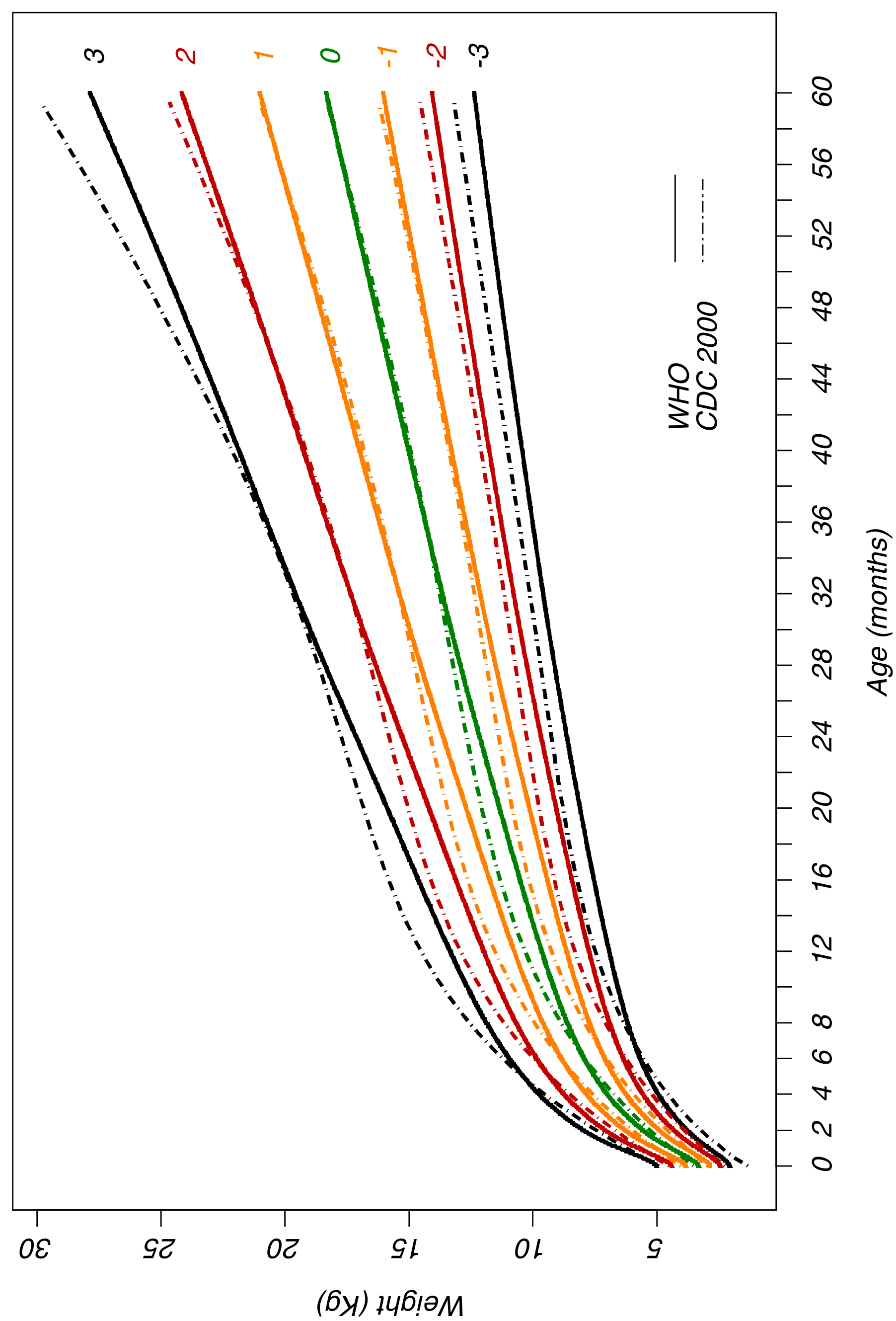


**Figure 46 Comparison of WHO with CDC 2000 weight-for-age z-scores for boys**

## 4.3 Weight-for-age for girls

Steps similar to those described in the preceding sections were followed to select the best model to fit the weight-for-age growth standard for girls.

### 4.3.1 Sample size

The data for constructing this standard combined weights from the longitudinal and cross-sectional samples without any adjustments. There were a total of 14 056 weight measurements for girls. The longitudinal and cross-sectional sample sizes by visit and age are presented in Tables 40 and 41.

**Table 40 Longitudinal sample sizes for weight-for-age for girls**

| **Visit** | **Birth** | **7 d** | **1** | **2** | **3** | **4** | **5** | **6** |
|---|---|---|---|---|---|---|---|---|
| **Age** | **0** | **1 wk** | **2 wk** | **4 wk** | **6 wk** | **2 mo** | **3 mo** | **4 mo** |
| N | 838 | 395 | 449 | 448 | 447 | 447 | 446 | 444 |
| **Visit** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** |
| **Age** | **5 mo** | **6 mo** | **7 mo** | **8 mo** | **9 mo** | **10 mo** | **11 mo** | **12 mo** |
| N | 447 | 445 | 444 | 440 | 446 | 444 | 444 | 449 |
| **Visit** | **15** | **16** | **17** | **18** | **19** | **20** | | |
| **Age** | **14 mo** | **16 mo** | **18 mo** | **20 mo** | **22 mo** | **24 mo** | | |
| N | 450 | 445 | 447 | 445 | 439 | 449 | | |

**Table 41 Cross-sectional sample sizes for weight-for-age for girls**

| **Age (mo)** | **<18** | **18–20** | **21–23** | **24–26** | **27–29** | **30–32** | **33–35** |
|---|---|---|---|---|---|---|---|
| N | 2 | 163 | 170 | 240 | 214 | 229 | 225 |
| **Age (mo)** | **36–38** | **39–41** | **42–44** | **45–47** | **48–50** | **51–53** | **54–56** |
| N | 224 | 236 | 250 | 209 | 225 | 201 | 231 |
| **Age (mo)** | **57–59** | **60–62** | **63–65** | **66–68** | **69–71** | **>71** | |
| N | 241 | 217 | 205 | 225 | 201 | 0 | |

### 4.3.2 Model selection and results

The initial step in the modelling process was to search for the best age power transformation using the same starting model as that used for boys. Table 42 shows the values of global deviance for a grid of possible powers from 0 to 1. The smallest global deviance value was associated with $\lambda=0.4$, but $\lambda=0.35$ — the power used in constructing the same standard for boys — yielded very similar global deviance. Therefore, in the interest of homogeneity between boys and girls, $\lambda=0.35$ was selected for the age transformation.

**Table 42 Global deviance (GD) for models within the class BCPE(x=age$^{\lambda}$, df(μ)=9, df(σ)=4, df(ν)=4, τ=2) for weight-for-age for girls**

| λ | 0.05 | 0.10 | 0.15 | 0.20 | 0.25 | 0.30 | 0.35 | 0.40 | 0.45 | 0.50 |
|---|---|---|---|---|---|---|---|---|---|---|
| GD[a] | 694.5 | 681.2 | 673.6 | 665.2 | 660.0 | 656.7 | 654.4 | 654.0 | 657.5 | 667.3 |
| **λ** | **0.55** | **0.60** | **0.65** | **0.70** | **0.75** | **0.80** | **0.85** | **0.90** | **0.95** | **1.00** |
| GD[a] | 684.8 | 708.2 | 732.5 | 751.1 | 759.6 | 757.0 | 747.7 | 740.4 | 747.3 | 783.1 |

[a] In excess of 42 000.

Using λ=0.35, optimal values for df(μ) and df(σ) were sought by fixing ν=1 and τ=2. All possible combinations of df(μ) values from 10 to 15 and df(σ) from 2 to 10 were considered. Partial results are presented in Table 43. There was no combination df(μ) and df(σ) that simultaneously minimized *AIC* and *GAIC(3)*. The smallest values of *AIC* corresponded to df(μ) 11 to 13 and df(σ) 8 to 10, while the smallest values of *GAIC(3)* corresponded to df(μ)=11 and df(σ) 7 or 8. Among these, the model that produced the smoothest curves, i.e. with df(μ)=11 and df(σ)=7, was selected, since it presented the smallest number of degrees of freedom. This model was further evaluated.

**Table 43 Goodness-of-fit summary for models using the BCPE distribution with fixed ν=1 and τ=2 for weight-for-age for girls**

| df(μ) | df(σ) | GD[a] | AIC[a] | GAIC(3)[a] | Total df |
|---|---|---|---|---|---|
| 9 | 6 | 1110.0 | 1140.0 | 1155.0 | 15 |
| | 7 | 1105.1 | 1137.1 | 1153.1 | 16 |
| | 8 | 1101.9 | 1135.9 | 1152.9 | 17 |
| | 9 | 1099.6 | 1135.6 | 1153.6 | 18 |
| | 10 | 1097.8 | 1135.8 | 1154.8 | 19 |
| 10 | 6 | 1105.9 | 1137.9 | 1153.9 | 16 |
| | 7 | 1101.0 | 1135.0 | 1152.0 | 17 |
| | 8 | 1097.8 | 1133.8 | 1151.8 | 18 |
| | 9 | 1095.5 | 1133.5 | 1152.5 | 19 |
| | 10 | 1093.7 | 1133.7 | 1153.7 | 20 |
| 11 | 6 | 1103.2 | 1137.2 | 1154.2 | 17 |
| | 7 | 1098.3 | 1134.3 | 1152.3 | 18 |
| | 8 | 1095.0 | 1133.1 | 1152.1 | 19 |
| | 9 | 1092.8 | 1132.8 | 1152.8 | 20 |
| | 10 | 1091.0 | 1133.0 | 1154.0 | 21 |
| 12 | 6 | 1101.1 | 1137.1 | 1155.1 | 18 |
| | 7 | 1096.2 | 1134.2 | 1153.2 | 19 |
| | 8 | 1092.9 | 1132.9 | 1152.9 | 20 |
| | 9 | 1090.6 | 1132.6 | 1153.6 | 21 |
| | 10 | 1088.9 | 1132.9 | 1154.9 | 22 |
| 13 | 6 | 1099.3 | 1137.3 | 1156.3 | 19 |
| | 7 | 1094.4 | 1134.4 | 1154.4 | 20 |
| | 8 | 1091.1 | 1133.1 | 1154.1 | 21 |
| | 9 | 1088.8 | 1132.8 | 1154.8 | 22 |
| | 10 | 1087.0 | 1133.1 | 1156.1 | 23 |

GD, Global Deviance; AIC, Akaike Information Criterion;
GAIC(3), Generalized AIC with penalty equal to 3;
[a] In excess of 42 000.

**Model 1: BCPE(x=age$^{0.35}$, df(μ)=11, df(σ)=7, ν=1, τ=2)**

Table 44 shows the Q-test results for this model. As noted in constructing the weight-for-age standards for boys, this class of models was inadequate, i.e. strong evidence was observed of residual skewness in almost all age groups (absolute values of z3 larger than 2). Only one group out of 30 had an absolute value of z2 larger than 2, indicating misfit of the variance, while residual kurtosis was indicated in five age groups (absolute values of z4 larger than 2). It was clear that the parameter ν should be modelled to adjust for skewness. Consequently, the optimal df(ν) was sought using df(μ)=11 and df(σ)=7 selected for the previous model, and fixing τ=2. Table 45 summarizes the resulting goodness-of-fit statistics from this step.

**Table 44 Q-test for z-scores from Model 1 [BCPE(x=age$^{0.35}$, df(μ)=11, df(σ)=7, ν=1, τ=2)] for weight-for-age for girls**

| Age (days) | Group | N | z1 | z2 | z3 | z4 |
|---|---|---|---|---|---|---|
| 0 | **Birth** | 838 | 0.29 | -0.74 | 4.68 | 1.86 |
| 1 to 11 | **7 d** | 396 | 0.06 | 2.50 | 2.02 | 1.20 |
| 12 to 16 | **14 d** | 446 | -1.40 | 0.29 | 1.84 | 0.83 |
| 17 to 34 | **28 d** | 450 | 0.24 | -0.58 | 2.10 | 0.92 |
| 35 to 49 | **42 d** | 444 | 0.45 | -0.53 | 2.73 | 1.62 |
| 50 to 69 | **2 mo** | 445 | 0.08 | -0.52 | 2.70 | 0.49 |
| 70 to 99 | **3 mo** | 444 | -0.07 | -0.08 | 3.17 | 0.58 |
| 100 to 129 | **4 mo** | 444 | -0.01 | 0.21 | 2.87 | 0.75 |
| 130 to 159 | **5 mo** | 441 | 0.31 | 0.29 | 3.24 | 1.34 |
| 160 to 189 | **6 mo** | 441 | 0.05 | -0.69 | 2.41 | -0.15 |
| 190 to 219 | **7 mo** | 432 | 0.32 | -0.32 | 2.83 | 0.91 |
| 220 to 249 | **8 mo** | 435 | -0.25 | -0.66 | 3.21 | 0.44 |
| 250 to 279 | **9 mo** | 439 | 0.63 | 0.63 | 3.65 | 1.28 |
| 280 to 309 | **10 mo** | 444 | -0.47 | -0.52 | 4.04 | 1.78 |
| 310 to 349 | **11 mo** | 480 | 0.29 | 0.65 | 4.82 | 1.80 |
| 350 to 379 | **12 mo** | 451 | -0.24 | 0.36 | 4.28 | 1.43 |
| 380 to 439 | **14 mo** | 447 | -0.09 | 0.83 | 4.98 | 2.27 |
| 440 to 499 | **16 mo** | 447 | -0.43 | -0.04 | 4.63 | 2.01 |
| 500 to 559 | **18 mo** | 469 | -0.01 | -0.52 | 4.27 | 1.83 |
| 560 to 619 | **20 mo** | 549 | 0.63 | 0.54 | 5.11 | 1.93 |
| 620 to 679 | **22 mo** | 545 | -0.52 | -0.39 | 5.15 | 2.50 |
| 680 to 749 | **24 mo** | 596 | -0.72 | 0.75 | 5.81 | 3.63 |
| 750 to 929 | **28 mo** | 459 | 1.55 | -0.51 | 3.69 | -0.94 |
| 930 to 1119 | **34 mo** | 475 | -0.84 | -0.57 | 1.92 | -2.49 |
| 1120 to 1309 | **40 mo** | 480 | 0.34 | -0.94 | 3.06 | 0.17 |
| 1310 to 1499 | **46 mo** | 456 | -0.20 | 0.56 | 3.24 | -0.42 |
| 1500 to 1689 | **52 mo** | 453 | -1.82 | -0.23 | 3.59 | 0.69 |
| 1690 to 1879 | **58 mo** | 496 | 1.12 | 0.62 | 5.33 | 1.69 |
| 1880 to 2069 | **64 mo** | 418 | 0.18 | -0.22 | 4.70 | 0.74 |
| 2070 to 2191 | **70 mo** | 296 | 0.86 | 0.28 | 4.31 | 2.00 |
| **Overall Q stats** | | **14 056** | **13.31** | **14.46** | **442.61** | **73.99** |
| **degrees of freedom** | | | **19.0** | **26.0** | **30.0** | **30.0** |
| **p-value** | | | **0.8220** | **0.9665** | **< 0.01** | **< 0.01** |

Note: Absolute values of z1, z2, z3 or z4 larger than 2 indicate misfit of, respectively, mean, variance, skewness or kurtosis.

**Table 45 Goodness-of-fit summary for models BCPE(x=age$^{0.35}$, df(μ)=11, df(σ)=7, df(ν)=?, τ=2) for weight-for-age for girls**

| df(ν) | GD[a] | GAIC(3)[a] | Total df |
|---|---|---|---|
| **2** | 640.5 | 700.5 | 20 |
| **3** | 634.6 | 697.6 | 21 |
| **4** | 628.5 | 694.5 | 22 |
| **5** | 623.6 | 692.6 | 23 |
| **6** | 620.8 | 692.8 | 24 |
| **7** | 619.2 | 694.2 | 25 |

GD, Global Deviance; GAIC(3), Generalized Akaike Information Criterion with penalty equal to 3;
[a] In excess of 42 000

The best df(ν) was 5, according to the criterion *GAIC(3)*, and this model was further evaluated.

**Model 2: BCPE(x=age$^{0.35}$, df(μ)=11, df(σ)=7, df(ν)=5, τ=2)**

With df(ν)=5 the ν curve seemed under-smoothed. If this number of degrees of freedom were used, it would probably result in the outer centile curves depicting a wiggly pattern not expected for this indicator, especially when compared to the boys' curve for the same parameter. When the degrees of freedom were reduced to df(ν)=3, the shape of the ν curve seemed more adequate (Figure 47). For reasons that remain unclear, weight data for girls are more irregular than for boys, especially in the age range corresponding to the cross-sectional component.

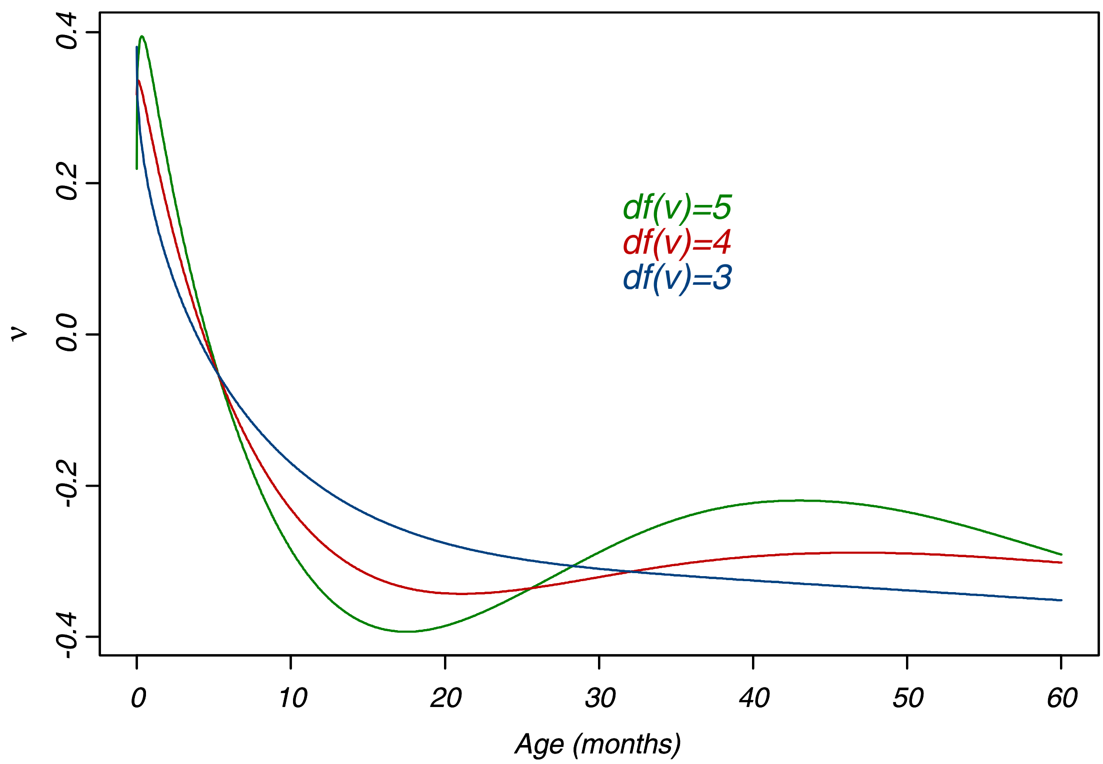


**Figure 47 Cubic splines fitted for the ν curve with varying numbers of degrees of freedom**

The Q-test results for Model 2 are presented in Table 46. The adjustment for skewness corrected the kurtosis in all groups with residual kurtosis noted in Model 1 (Table 44) except for two groups (28 mo and 34 mo). The overall Q-test p-values for kurtosis became non-significant. The indication of variance misfit observed at 7 days for the previous model remained when fitting Model 2 (absolute value of z2 larger than 2).

**Table 46 Q-test for z-scores from Model 2 [BCPE(x=age$^{0.35}$, df(μ)=11, df(σ)=7, df(ν)=5, τ=2)] for weight-for-age for girls**

| Age (days) | Group | N | z1 | z2 | z3 | z4 |
|---|---|---|---|---|---|---|
| 0 | **Birth** | 838 | 0.18 | -0.81 | 0.80 | 0.63 |
| 1 to 11 | **7 d** | 396 | 0.29 | 2.57 | -0.54 | 0.80 |
| 12 to 16 | **14 d** | 446 | -1.30 | 0.51 | -0.61 | 0.71 |
| 17 to 34 | **28 d** | 450 | 0.20 | -0.61 | -0.43 | 1.20 |
| 35 to 49 | **42 d** | 444 | 0.37 | -0.64 | 0.03 | 1.40 |
| 50 to 69 | **2 mo** | 445 | 0.01 | -0.57 | 0.20 | 0.28 |
| 70 to 99 | **3 mo** | 444 | -0.08 | -0.16 | 0.57 | -0.48 |
| 100 to 129 | **4 mo** | 444 | -0.03 | 0.24 | -0.13 | -0.05 |
| 130 to 159 | **5 mo** | 441 | 0.27 | 0.23 | 0.00 | -0.11 |
| 160 to 189 | **6 mo** | 441 | 0.04 | -0.53 | -0.58 | -1.08 |
| 190 to 219 | **7 mo** | 432 | 0.28 | -0.23 | -0.56 | -0.52 |
| 220 to 249 | **8 mo** | 435 | -0.23 | -0.53 | -0.09 | -0.94 |
| 250 to 279 | **9 mo** | 439 | 0.58 | 0.56 | -0.15 | -0.27 |
| 280 to 309 | **10 mo** | 444 | -0.39 | -0.40 | 0.00 | 0.51 |
| 310 to 349 | **11 mo** | 480 | 0.31 | 0.44 | 0.63 | 0.24 |
| 350 to 379 | **12 mo** | 451 | -0.20 | 0.43 | 0.20 | -0.25 |
| 380 to 439 | **14 mo** | 447 | -0.09 | 0.69 | 0.69 | -0.01 |
| 440 to 499 | **16 mo** | 447 | -0.38 | 0.01 | 0.52 | -0.68 |
| 500 to 559 | **18 mo** | 469 | 0.07 | -0.41 | -0.08 | -0.28 |
| 560 to 619 | **20 mo** | 549 | 0.60 | 0.29 | 0.66 | -0.95 |
| 620 to 679 | **22 mo** | 545 | -0.48 | -0.37 | 0.43 | 0.11 |
| 680 to 749 | **24 mo** | 596 | -0.84 | 0.73 | 0.34 | 0.72 |
| 750 to 929 | **28 mo** | 459 | 1.59 | -0.94 | 0.55 | -2.59 |
| 930 to 1119 | **34 mo** | 475 | -0.92 | -0.08 | -1.30 | -2.53 |
| 1120 to 1309 | **40 mo** | 480 | 0.39 | -0.99 | -0.72 | -0.87 |
| 1310 to 1499 | **46 mo** | 456 | -0.24 | 0.64 | -0.42 | -1.88 |
| 1500 to 1689 | **52 mo** | 453 | -1.80 | 0.38 | -0.72 | -0.28 |
| 1690 to 1879 | **58 mo** | 496 | 1.16 | 0.13 | 0.74 | -0.27 |
| 1880 to 2069 | **64 mo** | 418 | 0.21 | -0.24 | 0.38 | -0.03 |
| 2070 to 2191 | **70 mo** | 296 | 0.79 | 0.17 | -0.11 | 0.39 |
| **Overall Q stats** | | **14 056** | **13.12** | **14.16** | **8.39** | **27.74** |
| **degrees of freedom** | | | **19.0** | **26.0** | **25.0** | **30.0** |
| **p-value** | | | **0.8321** | **0.9709** | **0.9992** | **0.5840** |

Note: Absolute values of z1, z2, z3 or z4 larger than 2 indicate misfit of, respectively, mean, variance, skewness or kurtosis.

**Model 3: BCPE((x=age$^{0.35}$, df(μ)=11, df(σ)=7, df(ν)=3, τ=2)**

The Q-test results for Model 3 are shown in Table 47. Compared to Model 2 (Table 46), there was no significant loss in goodness of fit when using the smoother fitting function for the parameter ν.

**Table 47 Q-test for z-scores from Model 3 [BCPE(x=age$^{0.35}$, df(μ)=11, df(σ)=7, df(ν)=3, τ=2)] for weight-for-age for girls**

| Age (days) | Group | N | z1 | z2 | z3 | z4 |
|---|---|---|---|---|---|---|
| 0 | **Birth** | 838 | 0.21 | -0.82 | 1.63 | 0.74 |
| 1 to 11 | **7 d** | 396 | 0.34 | 2.57 | -1.07 | 0.86 |
| 12 to 16 | **14 d** | 446 | -1.27 | 0.57 | -1.27 | 0.83 |
| 17 to 34 | **28 d** | 450 | 0.19 | -0.60 | -1.12 | 1.45 |
| 35 to 49 | **42 d** | 444 | 0.35 | -0.65 | -0.60 | 1.51 |
| 50 to 69 | **2 mo** | 445 | 0.00 | -0.58 | -0.26 | 0.37 |
| 70 to 99 | **3 mo** | 444 | -0.09 | -0.17 | 0.30 | -0.52 |
| 100 to 129 | **4 mo** | 444 | -0.03 | 0.24 | -0.28 | -0.05 |
| 130 to 159 | **5 mo** | 441 | 0.27 | 0.23 | -0.04 | -0.11 |
| 160 to 189 | **6 mo** | 441 | 0.04 | -0.54 | -0.52 | -1.08 |
| 190 to 219 | **7 mo** | 432 | 0.28 | -0.23 | -0.41 | -0.51 |
| 220 to 249 | **8 mo** | 435 | -0.23 | -0.54 | 0.12 | -0.91 |
| 250 to 279 | **9 mo** | 439 | 0.58 | 0.57 | 0.14 | -0.24 |
| 280 to 309 | **10 mo** | 444 | -0.40 | -0.41 | 0.37 | 0.50 |
| 310 to 349 | **11 mo** | 480 | 0.31 | 0.46 | 1.06 | 0.27 |
| 350 to 379 | **12 mo** | 451 | -0.20 | 0.42 | 0.63 | -0.19 |
| 380 to 439 | **14 mo** | 447 | -0.09 | 0.71 | 1.16 | 0.12 |
| 440 to 499 | **16 mo** | 447 | -0.38 | 0.01 | 0.94 | -0.51 |
| 500 to 559 | **18 mo** | 469 | 0.07 | -0.41 | 0.33 | -0.19 |
| 560 to 619 | **20 mo** | 549 | 0.61 | 0.31 | 1.03 | -0.81 |
| 620 to 679 | **22 mo** | 545 | -0.48 | -0.38 | 0.74 | 0.17 |
| 680 to 749 | **24 mo** | 596 | -0.83 | 0.71 | 0.59 | 0.78 |
| 750 to 929 | **28 mo** | 459 | 1.59 | -0.96 | 0.58 | -2.61 |
| 930 to 1119 | **34 mo** | 475 | -0.93 | -0.07 | -1.45 | -2.47 |
| 1120 to 1309 | **40 mo** | 480 | 0.38 | -1.00 | -1.03 | -0.83 |
| 1310 to 1499 | **46 mo** | 456 | -0.27 | 0.64 | -0.75 | -1.87 |
| 1500 to 1689 | **52 mo** | 453 | -1.82 | 0.43 | -1.06 | -0.19 |
| 1690 to 1879 | **58 mo** | 496 | 1.15 | 0.09 | 0.48 | -0.28 |
| 1880 to 2069 | **64 mo** | 418 | 0.23 | -0.24 | 0.24 | 0.01 |
| 2070 to 2191 | **70 mo** | 296 | 0.82 | 0.18 | -0.14 | 0.39 |
| **Overall Q stats** | | **14 056** | **13.21** | **14.42** | **19.22** | **28.40** |
| **degrees of freedom** | | | **19.0** | **26.0** | **27.0** | **30.0** |
| **p-value** | | | **0.8276** | **0.9670** | **0.8619** | **0.5491** |

Note: Absolute values of z1, z2, z3 or z4 larger than 2 indicate misfit of, respectively, mean, variance, skewness or kurtosis.

As was the case for Models 1 and 2, the value of z2 for age group 7 days was higher than 2, pointing to variance misfit in an age interval of likely postnatal physiological adaptation. The same two age groups (28 mo and 34 mo) as observed for Model 2 indicated residual kurtosis.

Figure 48 shows the fit of the parameter curves for the full age range (0 to 71 months) using Model 3.

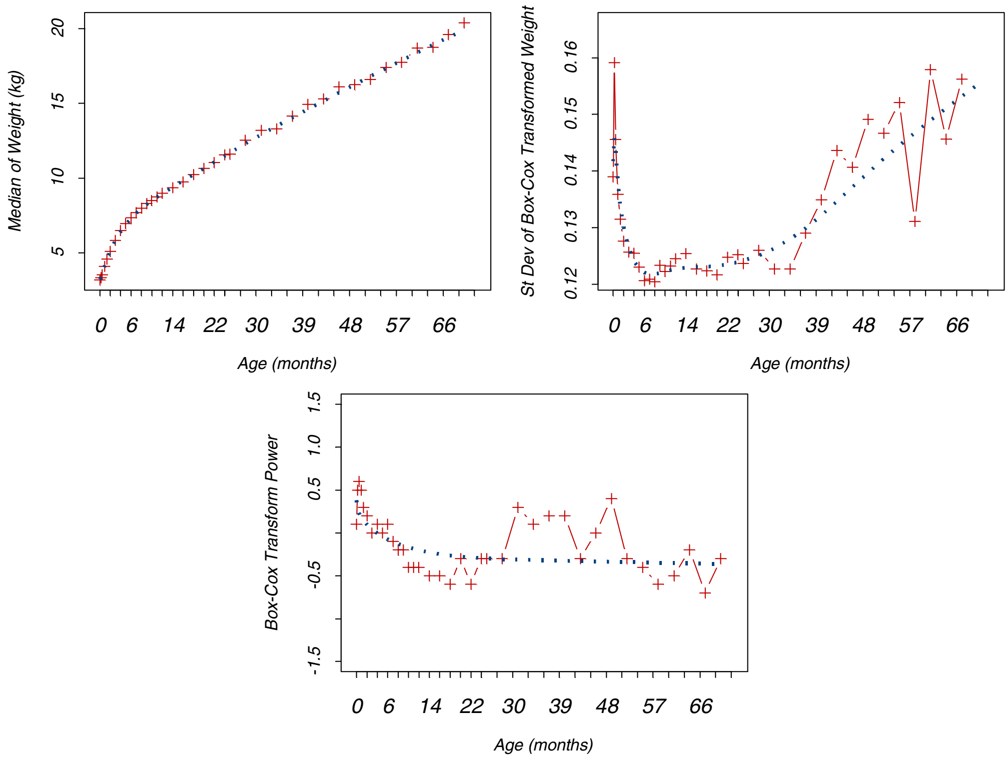


**Figure 48 Fitting of the μ, σ, and ν curves of Model 3 for weight-for-age for girls from 0 to 71 months (dotted line) and their respective sample estimates (points with solid line)**

Figures 49 and 50 present the distribution of the centile residuals for Model 3. The residuals around the median were very small, about 40 g from 0 to 24 months (Figure 49), and although there were more positive than negative points, their magnitude was of likely minor clinical significance. The 3rd centile had a clear pattern of positive residuals from 12 to 24 months, but no other centiles presented any clear pattern suggestive of bias. Overall, the patterns of residuals from 24 to 71 months showed no evidence of bias (Figure 50). As expected, outer centiles presented more unstable patterns, especially above 60 months.

Figure 51 presents worm plots for z-scores derived from Model 3 based on age groups as defined in Table 47. As expected, for a few age groups the worms indicated a misfit of the parameters: the age group 7 days presented a worm with a positive slope (indicating misfit of the variance) and the groups 28 mo and 34 mo presented S-shaped worms (indicating residual kurtosis). These findings were similar to those from the Q-test (Table 47).

Table 48 compares observed and expected proportions of children below each fitted centile. Results generally indicated no systematic pattern suggestive of bias or inadequacy of the fitted model.

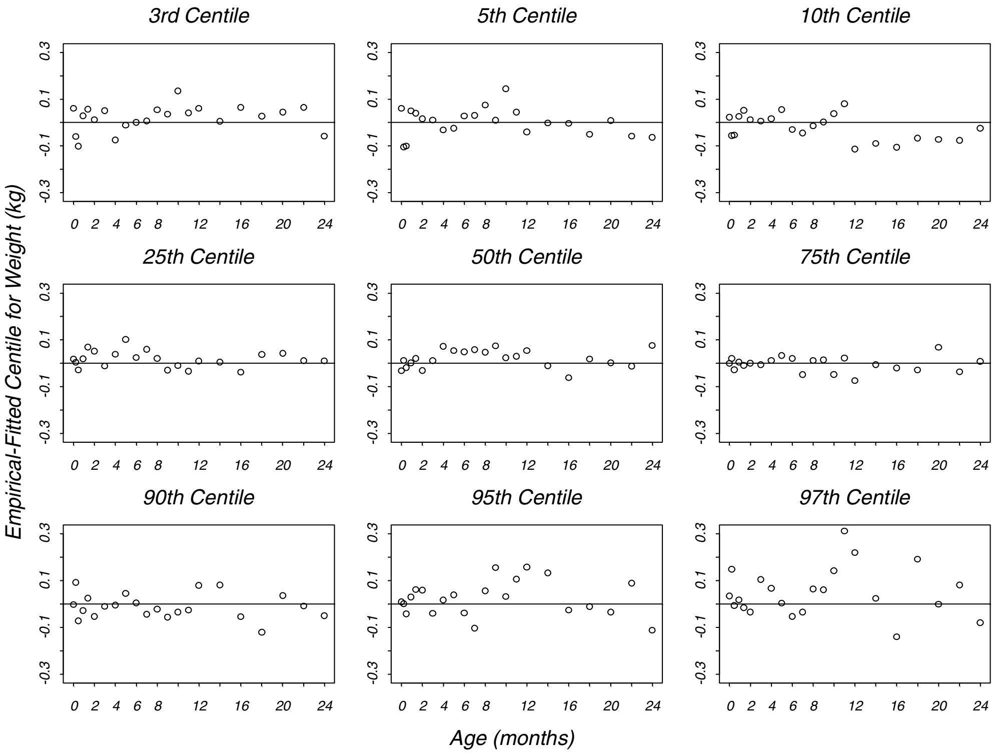


**Figure 49 Centile residuals from fitting Model 3 for weight-for-age from 0 to 24 months for girls**

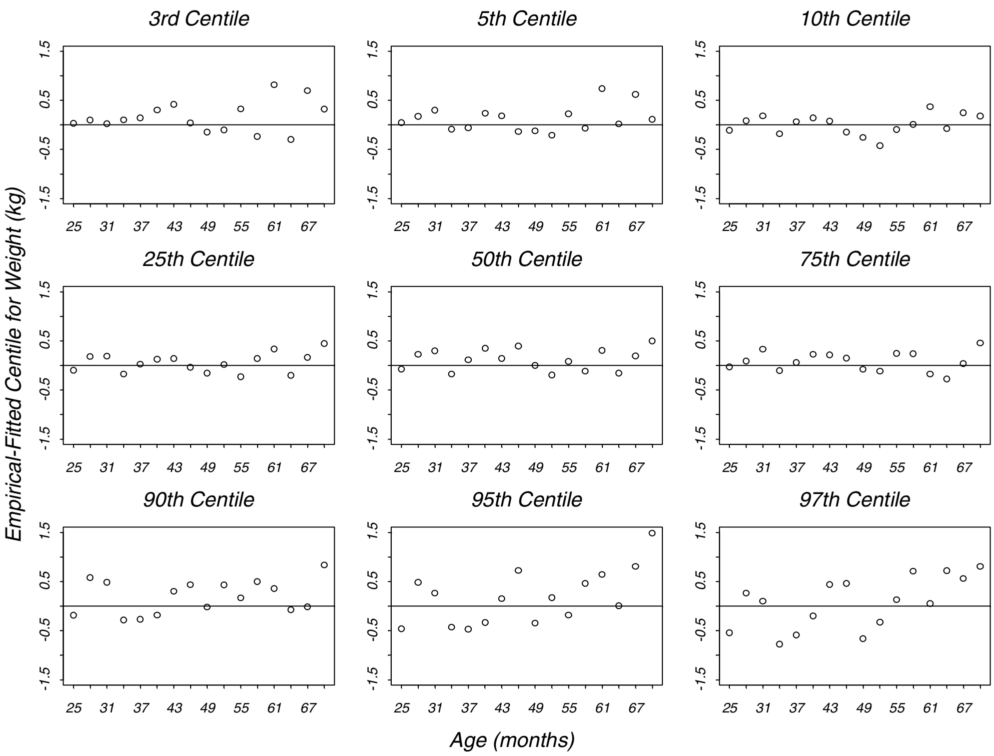


**Figure 50 Centile residuals from fitting Model 3 for weight-for-age from 24 to 71 months for girls**

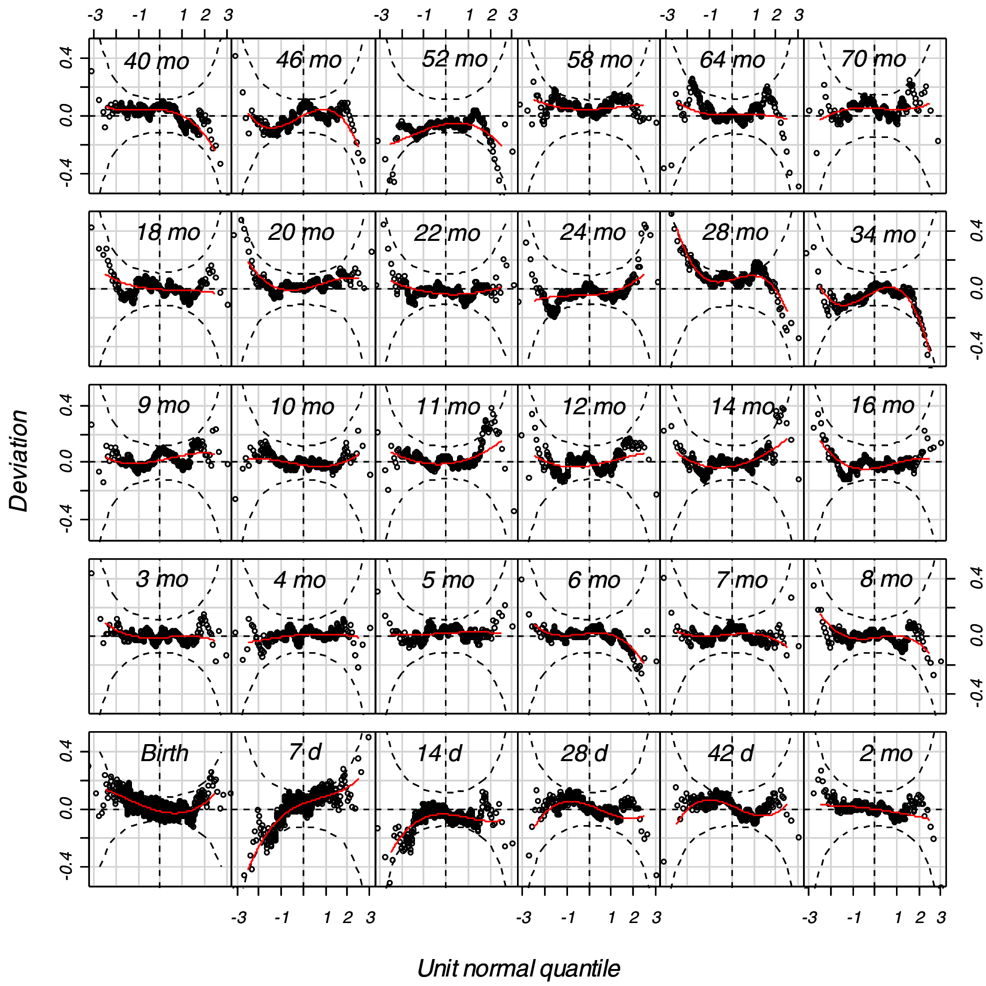


**Figure 51 Worm plots of z-scores for Model 3 for weight-for-age for girls**

The model was updated using df(ν)=3, and one more iteration was performed to re-search for the best df(μ) and df(σ). Results of *AIC* and *GAIC(3)* led to the same combination df(μ)=11 and df(σ)=7. The best λ value was then sought using the selected combination of degrees of freedom, i.e. df(μ)=11, df(σ)=7 and df(ν)=3. In this new iteration, the smallest values of global deviance were yielded by λ values between 0.25 and 0.30 (42 633.3 and 42 633.6, respectively). Yet differences in overall goodness of fit between those and the model using λ=0.35 (global deviance equal to 42 634.6) were very small. Thus, the model BCPE(x=age$^{0.35}$, df(μ)=11, df(σ)=7, df(ν)=3, τ=2) was selected for constructing the weight-for-age growth curves for girls. The fitted centile curves and empirical centiles are shown in Figures 52 to 55.

**Table 48 Observed proportions of children with measurements below the fitted centiles from Model 3, weight-for-age for girls**

| Expected | Birth | 7 d | 14 d | 28 d | 42 d | 2 mo | 3 mo | 4 mo | 5 mo | 6 mo | 7 mo |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 0.6 | 1.5 | 1.6 | 0.9 | 1.1 | 0.7 | 0.9 | 0.7 | 0.9 | 0.9 | 0.9 |
| **3** | 2.3 | 5.6 | 5.8 | 2.7 | 2.5 | 2.7 | 2.7 | 3.8 | 3.2 | 2.9 | 3.5 |
| **5** | 3.7 | 8.3 | 7.2 | 4.4 | 4.5 | 5.2 | 5.2 | 5.9 | 5.4 | 5.0 | 4.9 |
| **10** | 8.0 | 12.1 | 11.2 | 9.6 | 8.3 | 10.1 | 9.9 | 10.4 | 10.2 | 10.0 | 10.9 |
| **25** | 24.5 | 25.0 | 25.3 | 22.4 | 23.2 | 23.4 | 25.0 | 24.5 | 23.1 | 24.9 | 23.8 |
| **50** | 50.8 | 48.0 | 51.8 | 48.9 | 47.7 | 50.6 | 50.2 | 49.8 | 47.6 | 49.7 | 47.7 |
| **75** | 77.4 | 71.7 | 76.9 | 75.6 | 75.9 | 74.8 | 74.3 | 75.7 | 73.7 | 74.8 | 75.5 |
| **90** | 91.6 | 88.9 | 91.9 | 91.1 | 90.3 | 91.0 | 90.5 | 89.9 | 90.2 | 89.6 | 90.5 |
| **95** | 94.6 | 94.9 | 95.1 | 94.9 | 94.8 | 94.2 | 95.3 | 94.4 | 94.8 | 95.7 | 95.8 |
| **97** | 96.5 | 96.0 | 96.2 | 96.7 | 96.8 | 96.9 | 96.8 | 96.4 | 97.1 | 97.7 | 97.5 |
| **99** | 98.7 | 99.0 | 99.1 | 99.6 | 98.6 | 99.1 | 98.9 | 99.5 | 98.9 | 99.3 | 99.1 |
| **Expected** | **8 mo** | **9 mo** | **10 mo** | **11 mo** | **12 mo** | **14 mo** | **16 mo** | **18 mo** | **20 mo** | **22 mo** | **24 mo** |
| **1** | 0.7 | 0.7 | 0.9 | 1.0 | 0.4 | 0.7 | 0.4 | 0.4 | 0.2 | 0.6 | 1.2 |
| **3** | 2.8 | 2.7 | 2.7 | 2.7 | 2.7 | 3.1 | 2.5 | 2.8 | 2.6 | 2.6 | 4.4 |
| **5** | 5.3 | 5.0 | 4.5 | 4.2 | 5.5 | 5.4 | 5.6 | 5.8 | 4.7 | 5.3 | 6.9 |
| **10** | 10.6 | 9.8 | 9.0 | 9.0 | 12.0 | 12.1 | 12.1 | 11.9 | 10.9 | 10.1 | 10.9 |
| **25** | 25.7 | 25.3 | 25.9 | 26.3 | 24.2 | 25.3 | 25.7 | 24.1 | 24.0 | 25.7 | 26.8 |
| **50** | 49.0 | 47.4 | 49.8 | 48.5 | 47.9 | 51.0 | 51.0 | 49.9 | 49.2 | 51.0 | 50.5 |
| **75** | 74.9 | 74.9 | 76.8 | 74.6 | 76.7 | 75.4 | 75.8 | 75.9 | 73.2 | 77.1 | 77.0 |
| **90** | 91.5 | 90.4 | 91.2 | 90.2 | 89.4 | 89.0 | 90.4 | 91.7 | 88.5 | 90.5 | 90.8 |
| **95** | 94.5 | 93.8 | 95.7 | 94.4 | 94.5 | 94.2 | 94.9 | 95.3 | 94.9 | 95.0 | 95.5 |
| **97** | 96.8 | 95.7 | 97.1 | 95.4 | 95.8 | 96.6 | 97.1 | 96.8 | 96.0 | 96.9 | 96.8 |
| **99** | 99.3 | 99.1 | 99.1 | 97.9 | 98.7 | 97.8 | 98.9 | 98.5 | 98.7 | 98.9 | 98.7 |

**Table 48 Observed proportions of children with measurements below the fitted centiles from Model 3, weight-for-age for girls (continued)**

| Expected | 28 mo | 34 mo | 40 mo | 46 mo | 52 mo | 58 mo | 64 mo | 70 mo | Overall |
|---|---|---|---|---|---|---|---|---|---|
| **1** | 0.0 | 1.3 | 0.8 | 0.9 | 1.5 | 0.6 | 0.7 | 1.0 | 0.8 |
| **3** | 1.5 | 4.0 | 2.7 | 4.2 | 3.8 | 3.0 | 2.6 | 3.0 | 3.1 |
| **5** | 3.3 | 6.3 | 4.4 | 6.6 | 6.4 | 4.6 | 3.3 | 5.7 | 5.2 |
| **10** | 8.5 | 10.9 | 8.8 | 12.5 | 11.9 | 8.1 | 9.1 | 10.1 | 10.2 |
| **25** | 23.3 | 26.9 | 23.5 | 27.6 | 27.2 | 23.0 | 26.1 | 23.3 | 24.9 |
| **50** | 46.0 | 49.7 | 48.1 | 47.8 | 52.1 | 48.6 | 48.8 | 45.9 | 49.3 |
| **75** | 72.1 | 74.9 | 73.3 | 75.7 | 78.1 | 73.2 | 75.1 | 76.0 | 75.3 |
| **90** | 86.7 | 90.3 | 91.0 | 89.7 | 89.8 | 87.3 | 88.8 | 88.9 | 90.1 |
| **95** | 93.9 | 95.4 | 96.3 | 94.7 | 95.1 | 94.0 | 93.5 | 93.9 | 94.8 |
| **97** | 96.9 | 98.3 | 97.1 | 96.5 | 98.0 | 96.0 | 96.2 | 95.3 | 96.7 |
| **99** | 99.6 | 100.0 | 99.4 | 99.6 | 99.6 | 99.0 | 99.8 | 98.6 | 99.0 |

Note: Group labels correspond to the age intervals in Table 47.

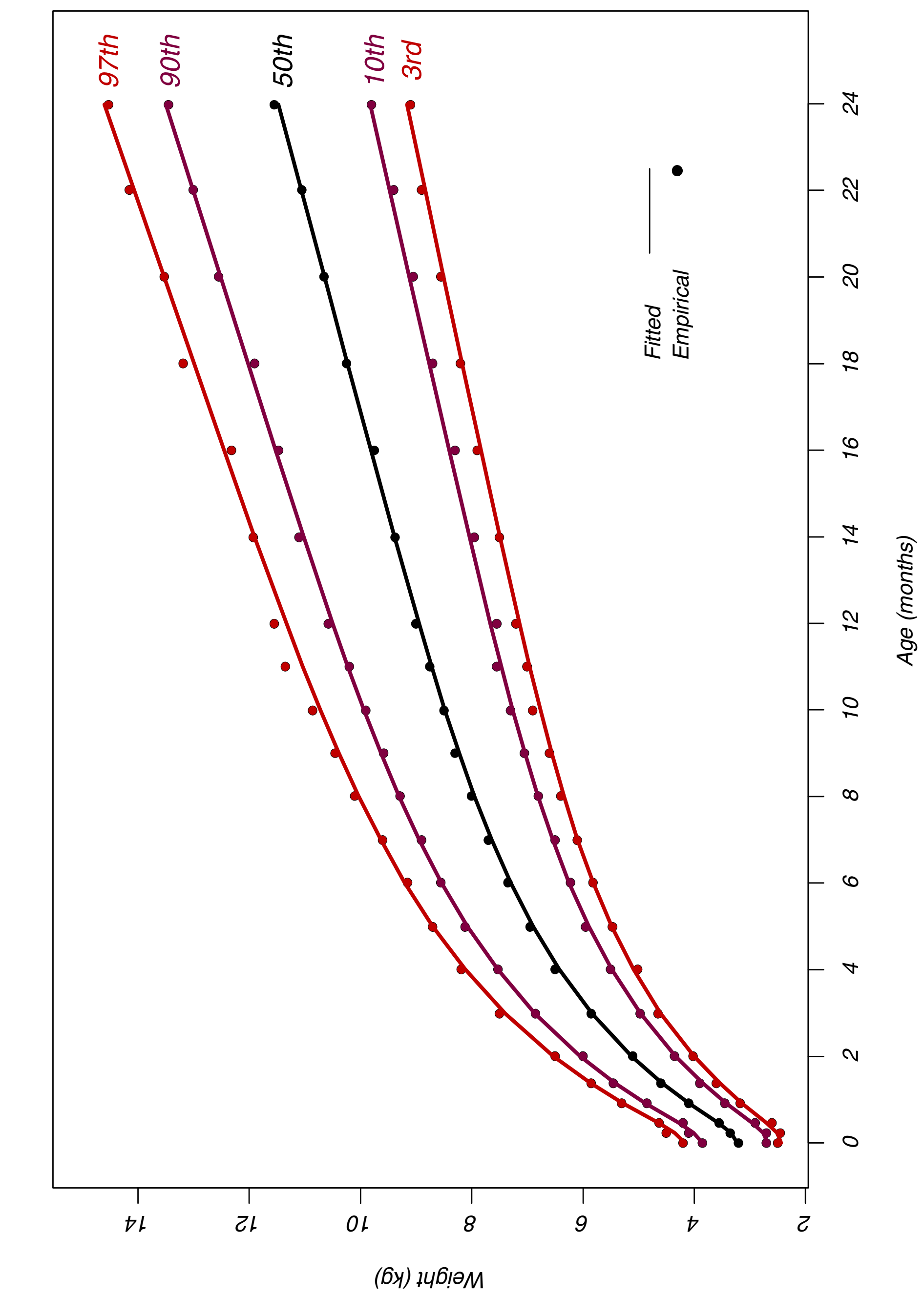


**Figure 52 3rd, 10th, 50th, 90th, 97th smoothed centile curves and empirical values: weight-for-age for girls from birth to 24 months**

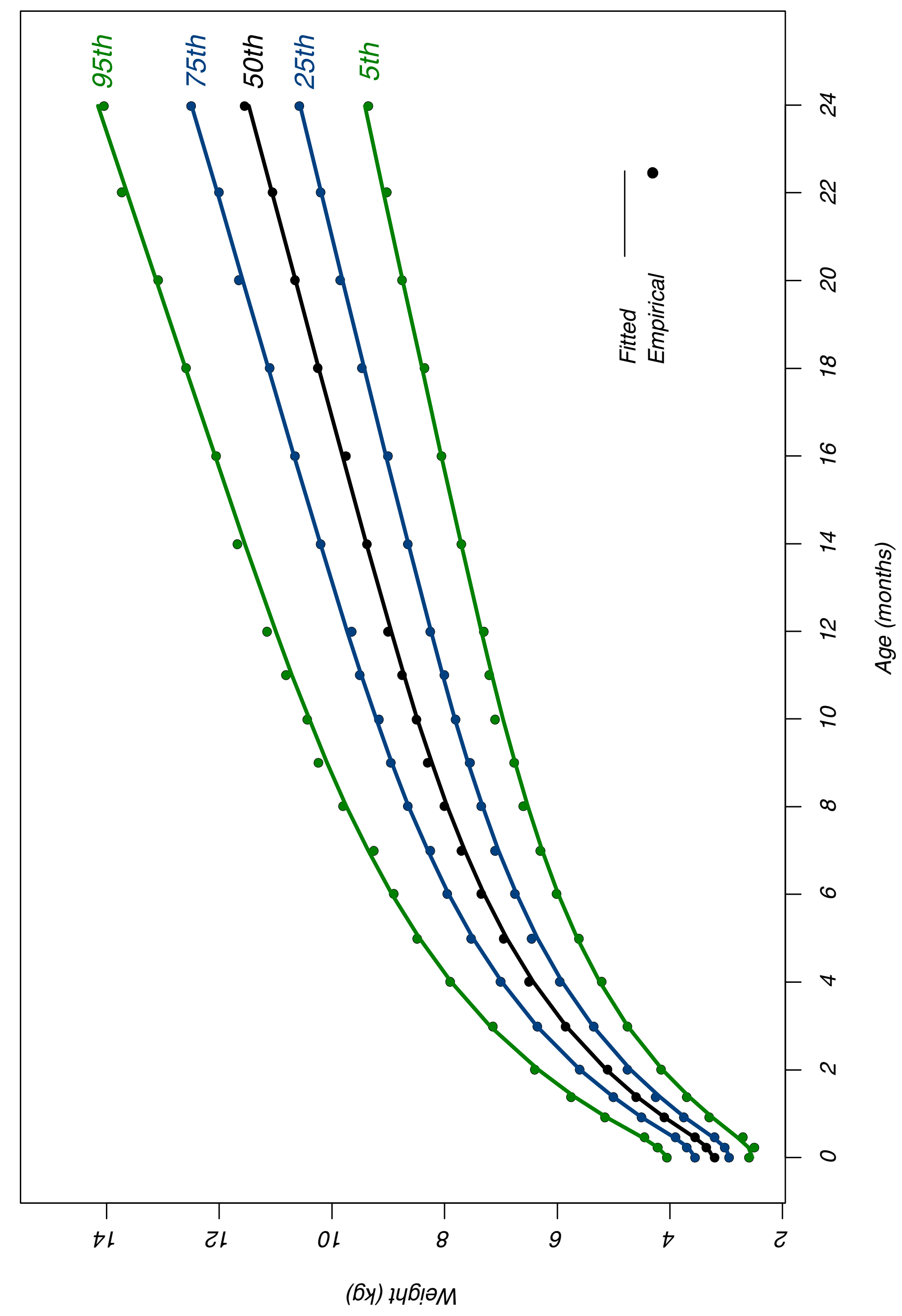


**Figure 53 5th, 25th, 50th, 75th, 95th smoothed centile curves and empirical values: weight-for-age for girls from birth to 24 months**

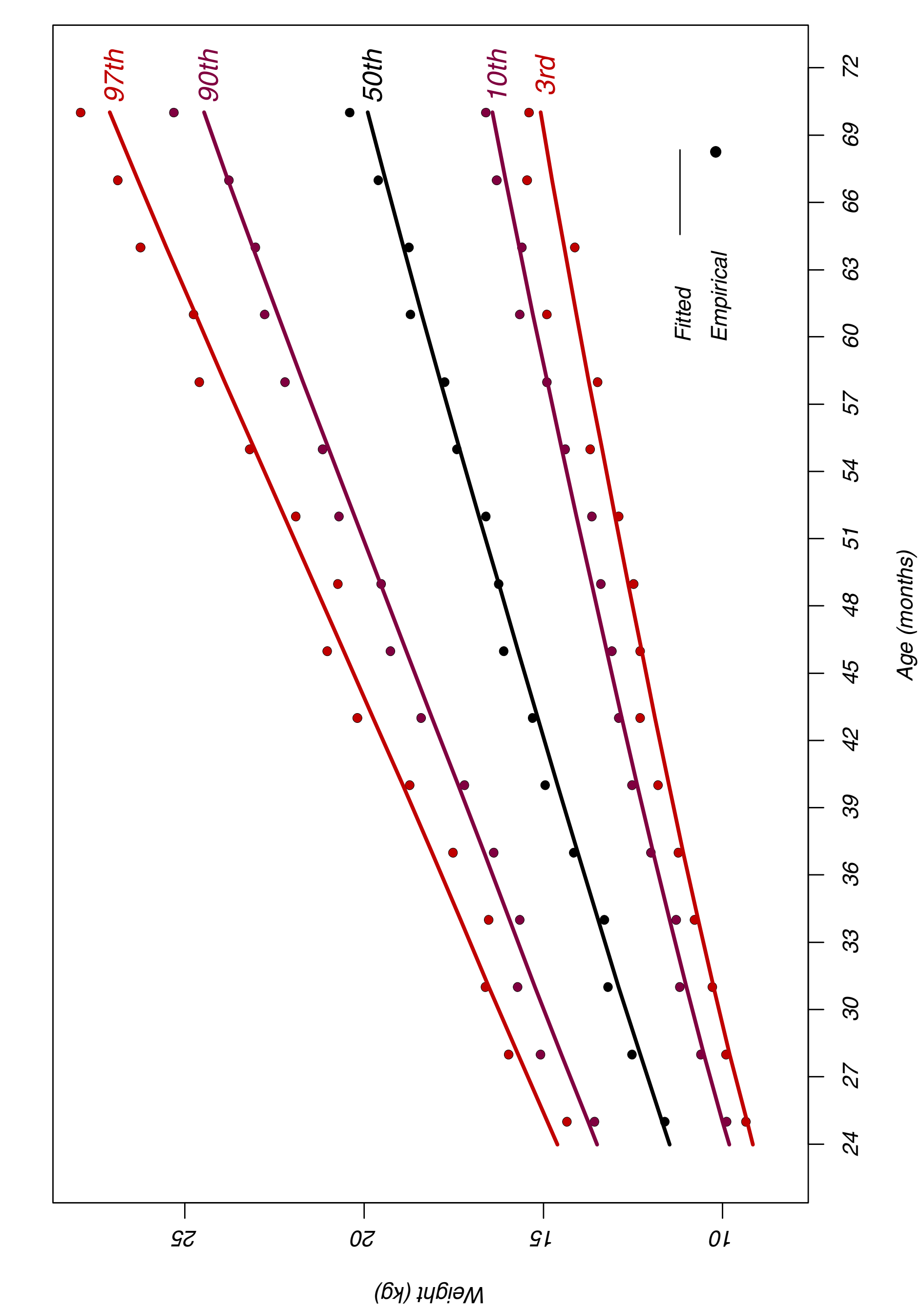


**Figure 54 3rd, 10th, 50th, 90th, 97th smoothed centile curves and empirical values: weight-for-age for girls from 24 to 71 months**

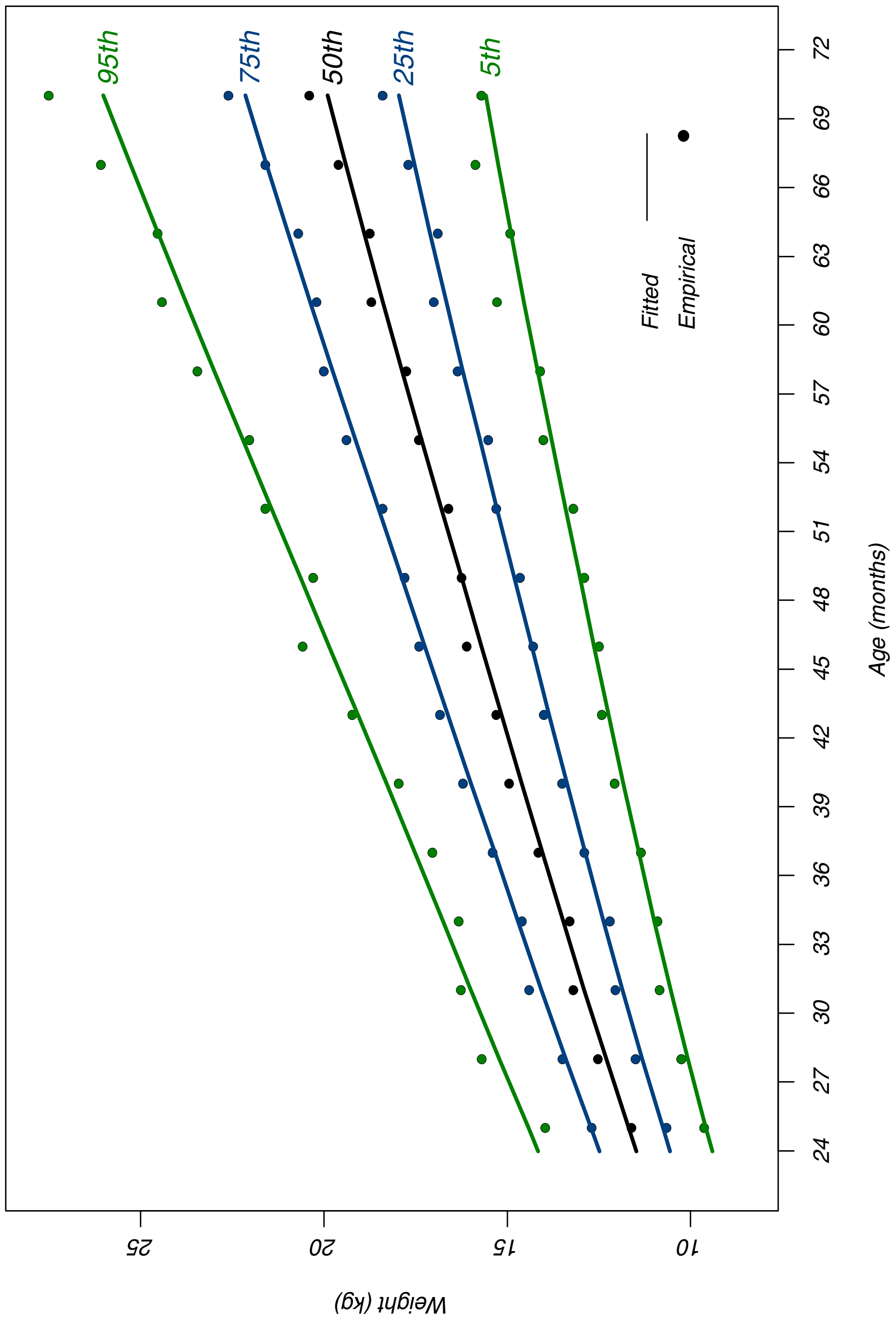


**Figure 55 5th, 25th, 50th, 75th, 95th smoothed centile curves and empirical values: weight-for-age for girls from 24 to 71 months**

### 4.3.3 WHO standards and their comparison with NCHS and CDC 2000 references

This section presents the final WHO weight-for-age z-score and percentile charts (Figures 56 and 57) and tables (Tables 49 and 50) for girls. It also provides the z-score comparisons of the WHO versus NCHS (Figure 58) and CDC 2000 (Figure 59) curves.

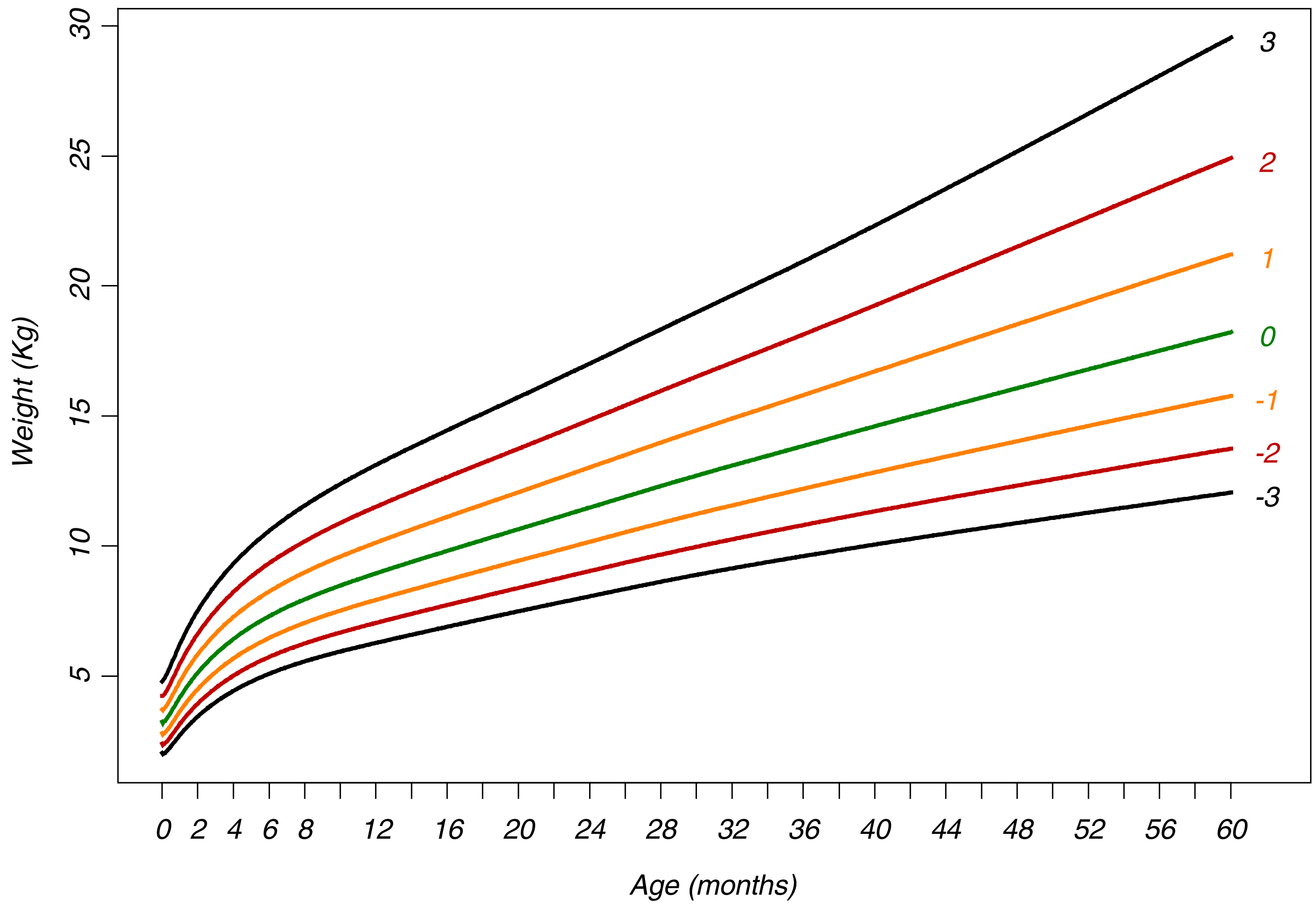


**Figure 56 WHO weight-for-age z-scores for girls from birth to 60 months**

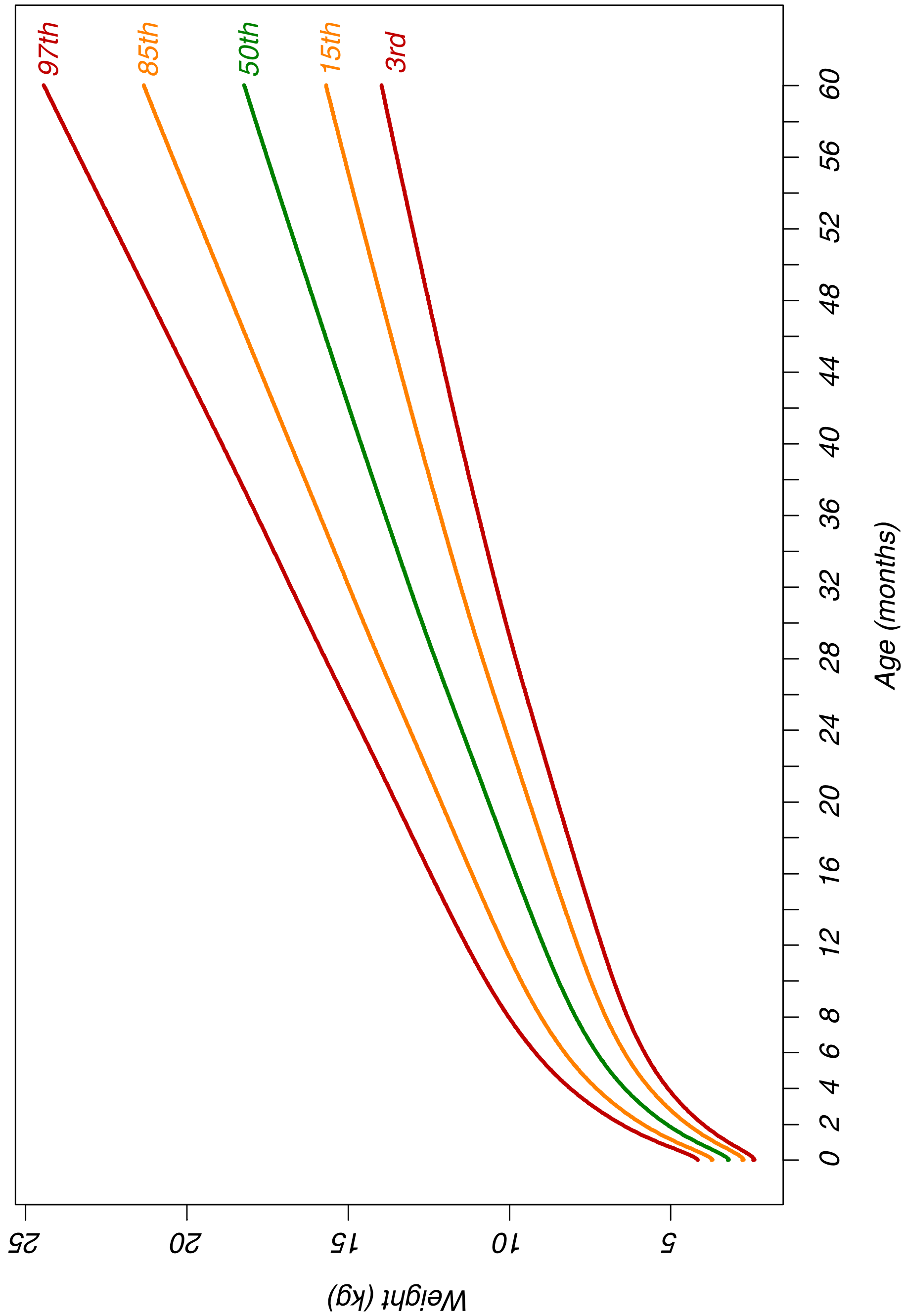


**Figure 57** **WHO weight-for-age percentiles for girls from birth to 60 months**

**Table 49 Weight-for-age for girls, age in weeks**

| | | | | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Week** | **L** | **M** | **S** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **0** | 0.3809 | 3.2322 | 0.14171 | 2.3 | 2.4 | 2.5 | 2.8 | 2.9 | 3.2 | 3.6 | 3.7 | 4.0 | 4.2 | 4.4 |
| **1** | 0.2671 | 3.3388 | 0.14600 | 2.3 | 2.5 | 2.6 | 2.9 | 3.0 | 3.3 | 3.7 | 3.9 | 4.2 | 4.4 | 4.6 |
| **2** | 0.2304 | 3.5693 | 0.14339 | 2.5 | 2.7 | 2.8 | 3.1 | 3.2 | 3.6 | 3.9 | 4.1 | 4.5 | 4.6 | 4.9 |
| **3** | 0.2024 | 3.8352 | 0.14060 | 2.7 | 2.9 | 3.0 | 3.3 | 3.5 | 3.8 | 4.2 | 4.4 | 4.8 | 5.0 | 5.3 |
| **4** | 0.1789 | 4.0987 | 0.13805 | 2.9 | 3.1 | 3.3 | 3.5 | 3.7 | 4.1 | 4.5 | 4.7 | 5.1 | 5.3 | 5.6 |
| **5** | 0.1582 | 4.3476 | 0.13583 | 3.1 | 3.3 | 3.5 | 3.8 | 4.0 | 4.3 | 4.8 | 5.0 | 5.4 | 5.6 | 5.9 |
| **6** | 0.1395 | 4.5793 | 0.13392 | 3.3 | 3.5 | 3.7 | 4.0 | 4.2 | 4.6 | 5.0 | 5.3 | 5.7 | 5.9 | 6.2 |
| **7** | 0.1224 | 4.7950 | 0.13228 | 3.5 | 3.7 | 3.8 | 4.2 | 4.4 | 4.8 | 5.2 | 5.5 | 5.9 | 6.1 | 6.5 |
| **8** | 0.1065 | 4.9959 | 0.13087 | 3.7 | 3.9 | 4.0 | 4.4 | 4.6 | 5.0 | 5.5 | 5.7 | 6.2 | 6.4 | 6.7 |
| **9** | 0.0918 | 5.1842 | 0.12966 | 3.8 | 4.1 | 4.2 | 4.5 | 4.7 | 5.2 | 5.7 | 5.9 | 6.4 | 6.6 | 7.0 |
| **10** | 0.0779 | 5.3618 | 0.12861 | 4.0 | 4.2 | 4.3 | 4.7 | 4.9 | 5.4 | 5.8 | 6.1 | 6.6 | 6.8 | 7.2 |
| **11** | 0.0648 | 5.5295 | 0.12770 | 4.1 | 4.3 | 4.5 | 4.8 | 5.1 | 5.5 | 6.0 | 6.3 | 6.8 | 7.0 | 7.4 |
| **12** | 0.0525 | 5.6883 | 0.12691 | 4.2 | 4.5 | 4.6 | 5.0 | 5.2 | 5.7 | 6.2 | 6.5 | 7.0 | 7.2 | 7.6 |
| **13** | 0.0407 | 5.8393 | 0.12622 | 4.3 | 4.6 | 4.7 | 5.1 | 5.4 | 5.8 | 6.4 | 6.7 | 7.2 | 7.4 | 7.8 |

**Table 49 Weight-for-age for girls, age in weeks (continued)**

| | | | | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Week** | **L** | **M** | **S** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **0** | 0.3809 | 3.2322 | 0.14171 | 2.0 | 2.4 | 2.8 | 3.2 | 3.7 | 4.2 | 4.8 |
| **1** | 0.2671 | 3.3388 | 0.14600 | 2.1 | 2.5 | 2.9 | 3.3 | 3.9 | 4.4 | 5.1 |
| **2** | 0.2304 | 3.5693 | 0.14339 | 2.3 | 2.7 | 3.1 | 3.6 | 4.1 | 4.7 | 5.4 |
| **3** | 0.2024 | 3.8352 | 0.14060 | 2.5 | 2.9 | 3.3 | 3.8 | 4.4 | 5.0 | 5.7 |
| **4** | 0.1789 | 4.0987 | 0.13805 | 2.7 | 3.1 | 3.6 | 4.1 | 4.7 | 5.4 | 6.1 |
| **5** | 0.1582 | 4.3476 | 0.13583 | 2.9 | 3.3 | 3.8 | 4.3 | 5.0 | 5.7 | 6.5 |
| **6** | 0.1395 | 4.5793 | 0.13392 | 3.0 | 3.5 | 4.0 | 4.6 | 5.2 | 6.0 | 6.8 |
| **7** | 0.1224 | 4.7950 | 0.13228 | 3.2 | 3.7 | 4.2 | 4.8 | 5.5 | 6.2 | 7.1 |
| **8** | 0.1065 | 4.9959 | 0.13087 | 3.3 | 3.8 | 4.4 | 5.0 | 5.7 | 6.5 | 7.3 |
| **9** | 0.0918 | 5.1842 | 0.12966 | 3.5 | 4.0 | 4.6 | 5.2 | 5.9 | 6.7 | 7.6 |
| **10** | 0.0779 | 5.3618 | 0.12861 | 3.6 | 4.1 | 4.7 | 5.4 | 6.1 | 6.9 | 7.8 |
| **11** | 0.0648 | 5.5295 | 0.12770 | 3.8 | 4.3 | 4.9 | 5.5 | 6.3 | 7.1 | 8.1 |
| **12** | 0.0525 | 5.6883 | 0.12691 | 3.9 | 4.4 | 5.0 | 5.7 | 6.5 | 7.3 | 8.3 |
| **13** | 0.0407 | 5.8393 | 0.12622 | 4.0 | 4.5 | 5.1 | 5.8 | 6.6 | 7.5 | 8.5 |

**Table 50 Weight-for-age for girls, age in years and months**

| | | | | | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **0: 0** | **0** | 0.3809 | 3.2322 | 0.14171 | 2.3 | 2.4 | 2.5 | 2.8 | 2.9 | 3.2 | 3.6 | 3.7 | 4.0 | 4.2 | 4.4 |
| **0: 1** | **1** | 0.1714 | 4.1873 | 0.13724 | 3.0 | 3.2 | 3.3 | 3.6 | 3.8 | 4.2 | 4.6 | 4.8 | 5.2 | 5.4 | 5.7 |
| **0: 2** | **2** | 0.0962 | 5.1282 | 0.13000 | 3.8 | 4.0 | 4.1 | 4.5 | 4.7 | 5.1 | 5.6 | 5.9 | 6.3 | 6.5 | 6.9 |
| **0: 3** | **3** | 0.0402 | 5.8458 | 0.12619 | 4.4 | 4.6 | 4.7 | 5.1 | 5.4 | 5.8 | 6.4 | 6.7 | 7.2 | 7.4 | 7.8 |
| **0: 4** | **4** | -0.0050 | 6.4237 | 0.12402 | 4.8 | 5.1 | 5.2 | 5.6 | 5.9 | 6.4 | 7.0 | 7.3 | 7.9 | 8.1 | 8.6 |
| **0: 5** | **5** | -0.0430 | 6.8985 | 0.12274 | 5.2 | 5.5 | 5.6 | 6.1 | 6.4 | 6.9 | 7.5 | 7.8 | 8.4 | 8.7 | 9.2 |
| **0: 6** | **6** | -0.0756 | 7.2970 | 0.12204 | 5.5 | 5.8 | 6.0 | 6.4 | 6.7 | 7.3 | 7.9 | 8.3 | 8.9 | 9.2 | 9.7 |
| **0: 7** | **7** | -0.1039 | 7.6422 | 0.12178 | 5.8 | 6.1 | 6.3 | 6.7 | 7.0 | 7.6 | 8.3 | 8.7 | 9.4 | 9.6 | 10.2 |
| **0: 8** | **8** | -0.1288 | 7.9487 | 0.12181 | 6.0 | 6.3 | 6.5 | 7.0 | 7.3 | 7.9 | 8.6 | 9.0 | 9.7 | 10.0 | 10.6 |
| **0: 9** | **9** | -0.1507 | 8.2254 | 0.12199 | 6.2 | 6.6 | 6.8 | 7.3 | 7.6 | 8.2 | 8.9 | 9.3 | 10.1 | 10.4 | 11.0 |
| **0:10** | **10** | -0.1700 | 8.4800 | 0.12223 | 6.4 | 6.8 | 7.0 | 7.5 | 7.8 | 8.5 | 9.2 | 9.6 | 10.4 | 10.7 | 11.3 |
| **0:11** | **11** | -0.1872 | 8.7192 | 0.12247 | 6.6 | 7.0 | 7.2 | 7.7 | 8.0 | 8.7 | 9.5 | 9.9 | 10.7 | 11.0 | 11.7 |
| **1: 0** | **12** | -0.2024 | 8.9481 | 0.12268 | 6.8 | 7.1 | 7.3 | 7.9 | 8.2 | 8.9 | 9.7 | 10.2 | 11.0 | 11.3 | 12.0 |
| **1: 1** | **13** | -0.2158 | 9.1699 | 0.12283 | 6.9 | 7.3 | 7.5 | 8.1 | 8.4 | 9.2 | 10.0 | 10.4 | 11.3 | 11.6 | 12.3 |
| **1: 2** | **14** | -0.2278 | 9.3870 | 0.12294 | 7.1 | 7.5 | 7.7 | 8.3 | 8.6 | 9.4 | 10.2 | 10.7 | 11.5 | 11.9 | 12.6 |
| **1: 3** | **15** | -0.2384 | 9.6008 | 0.12299 | 7.3 | 7.7 | 7.9 | 8.5 | 8.8 | 9.6 | 10.4 | 10.9 | 11.8 | 12.2 | 12.9 |
| **1: 4** | **16** | -0.2478 | 9.8124 | 0.12303 | 7.4 | 7.8 | 8.1 | 8.7 | 9.0 | 9.8 | 10.7 | 11.2 | 12.1 | 12.5 | 13.2 |
| **1: 5** | **17** | -0.2562 | 10.0226 | 0.12306 | 7.6 | 8.0 | 8.2 | 8.8 | 9.2 | 10.0 | 10.9 | 11.4 | 12.3 | 12.7 | 13.5 |
| **1: 6** | **18** | -0.2637 | 10.2315 | 0.12309 | 7.8 | 8.2 | 8.4 | 9.0 | 9.4 | 10.2 | 11.1 | 11.6 | 12.6 | 13.0 | 13.8 |
| **1: 7** | **19** | -0.2703 | 10.4393 | 0.12315 | 7.9 | 8.3 | 8.6 | 9.2 | 9.6 | 10.4 | 11.4 | 11.9 | 12.9 | 13.3 | 14.1 |
| **1: 8** | **20** | -0.2762 | 10.6464 | 0.12323 | 8.1 | 8.5 | 8.7 | 9.4 | 9.8 | 10.6 | 11.6 | 12.1 | 13.1 | 13.5 | 14.4 |
| **1: 9** | **21** | -0.2815 | 10.8534 | 0.12335 | 8.2 | 8.7 | 8.9 | 9.6 | 10.0 | 10.9 | 11.8 | 12.4 | 13.4 | 13.8 | 14.6 |
| **1:10** | **22** | -0.2862 | 11.0608 | 0.12350 | 8.4 | 8.8 | 9.1 | 9.8 | 10.2 | 11.1 | 12.0 | 12.6 | 13.6 | 14.1 | 14.9 |
| **1:11** | **23** | -0.2903 | 11.2688 | 0.12369 | 8.5 | 9.0 | 9.2 | 9.9 | 10.4 | 11.3 | 12.3 | 12.8 | 13.9 | 14.3 | 15.2 |
| **2: 0** | **24** | -0.2941 | 11.4775 | 0.12390 | 8.7 | 9.2 | 9.4 | 10.1 | 10.6 | 11.5 | 12.5 | 13.1 | 14.2 | 14.6 | 15.5 |

**Table 50 Weight-for-age for girls, age in years and months (continued)**

| | | | | | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **2: 1** | **25** | -0.2975 | 11.6864 | 0.12414 | 8.9 | 9.3 | 9.6 | 10.3 | 10.8 | 11.7 | 12.7 | 13.3 | 14.4 | 14.9 | 15.8 |
| **2: 2** | **26** | -0.3005 | 11.8947 | 0.12441 | 9.0 | 9.5 | 9.8 | 10.5 | 10.9 | 11.9 | 12.9 | 13.6 | 14.7 | 15.2 | 16.1 |
| **2: 3** | **27** | -0.3032 | 12.1015 | 0.12472 | 9.2 | 9.6 | 9.9 | 10.7 | 11.1 | 12.1 | 13.2 | 13.8 | 15.0 | 15.4 | 16.4 |
| **2: 4** | **28** | -0.3057 | 12.3059 | 0.12506 | 9.3 | 9.8 | 10.1 | 10.8 | 11.3 | 12.3 | 13.4 | 14.0 | 15.2 | 15.7 | 16.7 |
| **2: 5** | **29** | -0.3080 | 12.5073 | 0.12545 | 9.5 | 10.0 | 10.2 | 11.0 | 11.5 | 12.5 | 13.6 | 14.3 | 15.5 | 16.0 | 17.0 |
| **2: 6** | **30** | -0.3101 | 12.7055 | 0.12587 | 9.6 | 10.1 | 10.4 | 11.2 | 11.7 | 12.7 | 13.8 | 14.5 | 15.7 | 16.2 | 17.3 |
| **2: 7** | **31** | -0.3120 | 12.9006 | 0.12633 | 9.7 | 10.3 | 10.5 | 11.3 | 11.9 | 12.9 | 14.1 | 14.7 | 16.0 | 16.5 | 17.6 |
| **2: 8** | **32** | -0.3138 | 13.0930 | 0.12683 | 9.9 | 10.4 | 10.7 | 11.5 | 12.0 | 13.1 | 14.3 | 15.0 | 16.2 | 16.8 | 17.8 |
| **2: 9** | **33** | -0.3155 | 13.2837 | 0.12737 | 10.0 | 10.5 | 10.8 | 11.7 | 12.2 | 13.3 | 14.5 | 15.2 | 16.5 | 17.0 | 18.1 |
| **2:10** | **34** | -0.3171 | 13.4731 | 0.12794 | 10.1 | 10.7 | 11.0 | 11.8 | 12.4 | 13.5 | 14.7 | 15.4 | 16.8 | 17.3 | 18.4 |
| **2:11** | **35** | -0.3186 | 13.6618 | 0.12855 | 10.3 | 10.8 | 11.1 | 12.0 | 12.5 | 13.7 | 14.9 | 15.7 | 17.0 | 17.6 | 18.7 |
| **3: 0** | **36** | -0.3201 | 13.8503 | 0.12919 | 10.4 | 11.0 | 11.3 | 12.1 | 12.7 | 13.9 | 15.1 | 15.9 | 17.3 | 17.8 | 19.0 |
| **3: 1** | **37** | -0.3216 | 14.0385 | 0.12988 | 10.5 | 11.1 | 11.4 | 12.3 | 12.9 | 14.0 | 15.3 | 16.1 | 17.5 | 18.1 | 19.3 |
| **3: 2** | **38** | -0.3230 | 14.2265 | 0.13059 | 10.6 | 11.2 | 11.6 | 12.5 | 13.0 | 14.2 | 15.6 | 16.3 | 17.8 | 18.4 | 19.6 |
| **3: 3** | **39** | -0.3243 | 14.4140 | 0.13135 | 10.8 | 11.4 | 11.7 | 12.6 | 13.2 | 14.4 | 15.8 | 16.6 | 18.0 | 18.6 | 19.9 |
| **3: 4** | **40** | -0.3257 | 14.6010 | 0.13213 | 10.9 | 11.5 | 11.8 | 12.8 | 13.4 | 14.6 | 16.0 | 16.8 | 18.3 | 18.9 | 20.2 |
| **3: 5** | **41** | -0.3270 | 14.7873 | 0.13293 | 11.0 | 11.6 | 12.0 | 12.9 | 13.5 | 14.8 | 16.2 | 17.0 | 18.6 | 19.2 | 20.5 |
| **3: 6** | **42** | -0.3283 | 14.9727 | 0.13376 | 11.1 | 11.8 | 12.1 | 13.1 | 13.7 | 15.0 | 16.4 | 17.3 | 18.8 | 19.5 | 20.8 |
| **3: 7** | **43** | -0.3296 | 15.1573 | 0.13460 | 11.3 | 11.9 | 12.2 | 13.2 | 13.9 | 15.2 | 16.6 | 17.5 | 19.1 | 19.7 | 21.1 |
| **3: 8** | **44** | -0.3309 | 15.3410 | 0.13545 | 11.4 | 12.0 | 12.4 | 13.4 | 14.0 | 15.3 | 16.8 | 17.7 | 19.3 | 20.0 | 21.4 |
| **3: 9** | **45** | -0.3322 | 15.5240 | 0.13630 | 11.5 | 12.1 | 12.5 | 13.5 | 14.2 | 15.5 | 17.0 | 17.9 | 19.6 | 20.3 | 21.7 |
| **3:10** | **46** | -0.3335 | 15.7064 | 0.13716 | 11.6 | 12.3 | 12.6 | 13.7 | 14.3 | 15.7 | 17.3 | 18.2 | 19.9 | 20.6 | 22.0 |
| **3:11** | **47** | -0.3348 | 15.8882 | 0.13800 | 11.7 | 12.4 | 12.8 | 13.8 | 14.5 | 15.9 | 17.5 | 18.4 | 20.1 | 20.8 | 22.3 |
| **4: 0** | **48** | -0.3361 | 16.0697 | 0.13884 | 11.8 | 12.5 | 12.9 | 14.0 | 14.7 | 16.1 | 17.7 | 18.6 | 20.4 | 21.1 | 22.6 |

**Table 50 Weight-for-age for girls, age in years and months (continued)**

| | | | | | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **4: 1** | **49** | -0.3374 | 16.2511 | 0.13968 | 11.9 | 12.6 | 13.0 | 14.1 | 14.8 | 16.3 | 17.9 | 18.9 | 20.6 | 21.4 | 22.9 |
| **4: 2** | **50** | -0.3387 | 16.4322 | 0.14051 | 12.1 | 12.8 | 13.2 | 14.3 | 15.0 | 16.4 | 18.1 | 19.1 | 20.9 | 21.7 | 23.2 |
| **4: 3** | **51** | -0.3400 | 16.6133 | 0.14132 | 12.2 | 12.9 | 13.3 | 14.4 | 15.1 | 16.6 | 18.3 | 19.3 | 21.2 | 22.0 | 23.5 |
| **4: 4** | **52** | -0.3414 | 16.7942 | 0.14213 | 12.3 | 13.0 | 13.4 | 14.5 | 15.3 | 16.8 | 18.5 | 19.5 | 21.4 | 22.2 | 23.9 |
| **4: 5** | **53** | -0.3427 | 16.9748 | 0.14293 | 12.4 | 13.1 | 13.5 | 14.7 | 15.4 | 17.0 | 18.7 | 19.8 | 21.7 | 22.5 | 24.2 |
| **4: 6** | **54** | -0.3440 | 17.1551 | 0.14371 | 12.5 | 13.2 | 13.7 | 14.8 | 15.6 | 17.2 | 18.9 | 20.0 | 22.0 | 22.8 | 24.5 |
| **4: 7** | **55** | -0.3453 | 17.3347 | 0.14448 | 12.6 | 13.4 | 13.8 | 15.0 | 15.8 | 17.3 | 19.1 | 20.2 | 22.2 | 23.1 | 24.8 |
| **4: 8** | **56** | -0.3466 | 17.5136 | 0.14525 | 12.7 | 13.5 | 13.9 | 15.1 | 15.9 | 17.5 | 19.3 | 20.4 | 22.5 | 23.3 | 25.1 |
| **4: 9** | **57** | -0.3479 | 17.6916 | 0.14600 | 12.8 | 13.6 | 14.0 | 15.3 | 16.1 | 17.7 | 19.6 | 20.7 | 22.7 | 23.6 | 25.4 |
| **4:10** | **58** | -0.3492 | 17.8686 | 0.14675 | 12.9 | 13.7 | 14.2 | 15.4 | 16.2 | 17.9 | 19.8 | 20.9 | 23.0 | 23.9 | 25.7 |
| **4:11** | **59** | -0.3505 | 18.0445 | 0.14748 | 13.1 | 13.8 | 14.3 | 15.5 | 16.4 | 18.0 | 20.0 | 21.1 | 23.3 | 24.2 | 26.0 |
| **5: 0** | **60** | -0.3518 | 18.2193 | 0.14821 | 13.2 | 14.0 | 14.4 | 15.7 | 16.5 | 18.2 | 20.2 | 21.3 | 23.5 | 24.4 | 26.3 |

**Table 50 Weight-for-age for girls, age in years and months (continued)**

| Year: Month | Month | L | M | S | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | -3 SD | -2 SD | -1 SD | Median | 1 SD | 2 SD | 3 SD |
| **0: 0** | **0** | 0.3809 | 3.2322 | 0.14171 | 2.0 | 2.4 | 2.8 | 3.2 | 3.7 | 4.2 | 4.8 |
| **0: 1** | **1** | 0.1714 | 4.1873 | 0.13724 | 2.7 | 3.2 | 3.6 | 4.2 | 4.8 | 5.5 | 6.2 |
| **0: 2** | **2** | 0.0962 | 5.1282 | 0.13000 | 3.4 | 3.9 | 4.5 | 5.1 | 5.8 | 6.6 | 7.5 |
| **0: 3** | **3** | 0.0402 | 5.8458 | 0.12619 | 4.0 | 4.5 | 5.2 | 5.8 | 6.6 | 7.5 | 8.5 |
| **0: 4** | **4** | -0.0050 | 6.4237 | 0.12402 | 4.4 | 5.0 | 5.7 | 6.4 | 7.3 | 8.2 | 9.3 |
| **0: 5** | **5** | -0.0430 | 6.8985 | 0.12274 | 4.8 | 5.4 | 6.1 | 6.9 | 7.8 | 8.8 | 10.0 |
| **0: 6** | **6** | -0.0756 | 7.2970 | 0.12204 | 5.1 | 5.7 | 6.5 | 7.3 | 8.2 | 9.3 | 10.6 |
| **0: 7** | **7** | -0.1039 | 7.6422 | 0.12178 | 5.3 | 6.0 | 6.8 | 7.6 | 8.6 | 9.8 | 11.1 |
| **0: 8** | **8** | -0.1288 | 7.9487 | 0.12181 | 5.6 | 6.3 | 7.0 | 7.9 | 9.0 | 10.2 | 11.6 |
| **0: 9** | **9** | -0.1507 | 8.2254 | 0.12199 | 5.8 | 6.5 | 7.3 | 8.2 | 9.3 | 10.5 | 12.0 |
| **0:10** | **10** | -0.1700 | 8.4800 | 0.12223 | 5.9 | 6.7 | 7.5 | 8.5 | 9.6 | 10.9 | 12.4 |
| **0:11** | **11** | -0.1872 | 8.7192 | 0.12247 | 6.1 | 6.9 | 7.7 | 8.7 | 9.9 | 11.2 | 12.8 |
| **1: 0** | **12** | -0.2024 | 8.9481 | 0.12268 | 6.3 | 7.0 | 7.9 | 8.9 | 10.1 | 11.5 | 13.1 |
| **1: 1** | **13** | -0.2158 | 9.1699 | 0.12283 | 6.4 | 7.2 | 8.1 | 9.2 | 10.4 | 11.8 | 13.5 |
| **1: 2** | **14** | -0.2278 | 9.3870 | 0.12294 | 6.6 | 7.4 | 8.3 | 9.4 | 10.6 | 12.1 | 13.8 |
| **1: 3** | **15** | -0.2384 | 9.6008 | 0.12299 | 6.7 | 7.6 | 8.5 | 9.6 | 10.9 | 12.4 | 14.1 |
| **1: 4** | **16** | -0.2478 | 9.8124 | 0.12303 | 6.9 | 7.7 | 8.7 | 9.8 | 11.1 | 12.6 | 14.5 |
| **1: 5** | **17** | -0.2562 | 10.0226 | 0.12306 | 7.0 | 7.9 | 8.9 | 10.0 | 11.4 | 12.9 | 14.8 |
| **1: 6** | **18** | -0.2637 | 10.2315 | 0.12309 | 7.2 | 8.1 | 9.1 | 10.2 | 11.6 | 13.2 | 15.1 |
| **1: 7** | **19** | -0.2703 | 10.4393 | 0.12315 | 7.3 | 8.2 | 9.2 | 10.4 | 11.8 | 13.5 | 15.4 |
| **1: 8** | **20** | -0.2762 | 10.6464 | 0.12323 | 7.5 | 8.4 | 9.4 | 10.6 | 12.1 | 13.7 | 15.7 |
| **1: 9** | **21** | -0.2815 | 10.8534 | 0.12335 | 7.6 | 8.6 | 9.6 | 10.9 | 12.3 | 14.0 | 16.0 |
| **1:10** | **22** | -0.2862 | 11.0608 | 0.12350 | 7.8 | 8.7 | 9.8 | 11.1 | 12.5 | 14.3 | 16.4 |
| **1:11** | **23** | -0.2903 | 11.2688 | 0.12369 | 7.9 | 8.9 | 10.0 | 11.3 | 12.8 | 14.6 | 16.7 |
| **2: 0** | **24** | -0.2941 | 11.4775 | 0.12390 | 8.1 | 9.0 | 10.2 | 11.5 | 13.0 | 14.8 | 17.0 |

**Table 50 Weight-for-age for girls, age in years and months (continued)**

| Year: Month | Month | L | M | S | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | -3 SD | -2 SD | -1 SD | Median | 1 SD | 2 SD | 3 SD |
| **2: 1** | **25** | -0.2975 | 11.6864 | 0.12414 | 8.2 | 9.2 | 10.3 | 11.7 | 13.3 | 15.1 | 17.3 |
| **2: 2** | **26** | -0.3005 | 11.8947 | 0.12441 | 8.4 | 9.4 | 10.5 | 11.9 | 13.5 | 15.4 | 17.7 |
| **2: 3** | **27** | -0.3032 | 12.1015 | 0.12472 | 8.5 | 9.5 | 10.7 | 12.1 | 13.7 | 15.7 | 18.0 |
| **2: 4** | **28** | -0.3057 | 12.3059 | 0.12506 | 8.6 | 9.7 | 10.9 | 12.3 | 14.0 | 16.0 | 18.3 |
| **2: 5** | **29** | -0.3080 | 12.5073 | 0.12545 | 8.8 | 9.8 | 11.1 | 12.5 | 14.2 | 16.2 | 18.7 |
| **2: 6** | **30** | -0.3101 | 12.7055 | 0.12587 | 8.9 | 10.0 | 11.2 | 12.7 | 14.4 | 16.5 | 19.0 |
| **2: 7** | **31** | -0.3120 | 12.9006 | 0.12633 | 9.0 | 10.1 | 11.4 | 12.9 | 14.7 | 16.8 | 19.3 |
| **2: 8** | **32** | -0.3138 | 13.0930 | 0.12683 | 9.1 | 10.3 | 11.6 | 13.1 | 14.9 | 17.1 | 19.6 |
| **2: 9** | **33** | -0.3155 | 13.2837 | 0.12737 | 9.3 | 10.4 | 11.7 | 13.3 | 15.1 | 17.3 | 20.0 |
| **2:10** | **34** | -0.3171 | 13.4731 | 0.12794 | 9.4 | 10.5 | 11.9 | 13.5 | 15.4 | 17.6 | 20.3 |
| **2:11** | **35** | -0.3186 | 13.6618 | 0.12855 | 9.5 | 10.7 | 12.0 | 13.7 | 15.6 | 17.9 | 20.6 |
| **3: 0** | **36** | -0.3201 | 13.8503 | 0.12919 | 9.6 | 10.8 | 12.2 | 13.9 | 15.8 | 18.1 | 20.9 |
| **3: 1** | **37** | -0.3216 | 14.0385 | 0.12988 | 9.7 | 10.9 | 12.4 | 14.0 | 16.0 | 18.4 | 21.3 |
| **3: 2** | **38** | -0.3230 | 14.2265 | 0.13059 | 9.8 | 11.1 | 12.5 | 14.2 | 16.3 | 18.7 | 21.6 |
| **3: 3** | **39** | -0.3243 | 14.4140 | 0.13135 | 9.9 | 11.2 | 12.7 | 14.4 | 16.5 | 19.0 | 22.0 |
| **3: 4** | **40** | -0.3257 | 14.6010 | 0.13213 | 10.1 | 11.3 | 12.8 | 14.6 | 16.7 | 19.2 | 22.3 |
| **3: 5** | **41** | -0.3270 | 14.7873 | 0.13293 | 10.2 | 11.5 | 13.0 | 14.8 | 16.9 | 19.5 | 22.7 |
| **3: 6** | **42** | -0.3283 | 14.9727 | 0.13376 | 10.3 | 11.6 | 13.1 | 15.0 | 17.2 | 19.8 | 23.0 |
| **3: 7** | **43** | -0.3296 | 15.1573 | 0.13460 | 10.4 | 11.7 | 13.3 | 15.2 | 17.4 | 20.1 | 23.4 |
| **3: 8** | **44** | -0.3309 | 15.3410 | 0.13545 | 10.5 | 11.8 | 13.4 | 15.3 | 17.6 | 20.4 | 23.7 |
| **3: 9** | **45** | -0.3322 | 15.5240 | 0.13630 | 10.6 | 12.0 | 13.6 | 15.5 | 17.8 | 20.7 | 24.1 |
| **3:10** | **46** | -0.3335 | 15.7064 | 0.13716 | 10.7 | 12.1 | 13.7 | 15.7 | 18.1 | 20.9 | 24.5 |
| **3:11** | **47** | -0.3348 | 15.8882 | 0.13800 | 10.8 | 12.2 | 13.9 | 15.9 | 18.3 | 21.2 | 24.8 |
| **4: 0** | **48** | -0.3361 | 16.0697 | 0.13884 | 10.9 | 12.3 | 14.0 | 16.1 | 18.5 | 21.5 | 25.2 |

**Table 50 Weight-for-age for girls, age in years and months (continued)**

| | | | | | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **4: 1** | **49** | -0.3374 | 16.2511 | 0.13968 | 11.0 | 12.4 | 14.2 | 16.3 | 18.8 | 21.8 | 25.5 |
| **4: 2** | **50** | -0.3387 | 16.4322 | 0.14051 | 11.1 | 12.6 | 14.3 | 16.4 | 19.0 | 22.1 | 25.9 |
| **4: 3** | **51** | -0.3400 | 16.6133 | 0.14132 | 11.2 | 12.7 | 14.5 | 16.6 | 19.2 | 22.4 | 26.3 |
| **4: 4** | **52** | -0.3414 | 16.7942 | 0.14213 | 11.3 | 12.8 | 14.6 | 16.8 | 19.4 | 22.6 | 26.6 |
| **4: 5** | **53** | -0.3427 | 16.9748 | 0.14293 | 11.4 | 12.9 | 14.8 | 17.0 | 19.7 | 22.9 | 27.0 |
| **4: 6** | **54** | -0.3440 | 17.1551 | 0.14371 | 11.5 | 13.0 | 14.9 | 17.2 | 19.9 | 23.2 | 27.4 |
| **4: 7** | **55** | -0.3453 | 17.3347 | 0.14448 | 11.6 | 13.2 | 15.1 | 17.3 | 20.1 | 23.5 | 27.7 |
| **4: 8** | **56** | -0.3466 | 17.5136 | 0.14525 | 11.7 | 13.3 | 15.2 | 17.5 | 20.3 | 23.8 | 28.1 |
| **4: 9** | **57** | -0.3479 | 17.6916 | 0.14600 | 11.8 | 13.4 | 15.3 | 17.7 | 20.6 | 24.1 | 28.5 |
| **4:10** | **58** | -0.3492 | 17.8686 | 0.14675 | 11.9 | 13.5 | 15.5 | 17.9 | 20.8 | 24.4 | 28.8 |
| **4:11** | **59** | -0.3505 | 18.0445 | 0.14748 | 12.0 | 13.6 | 15.6 | 18.0 | 21.0 | 24.6 | 29.2 |
| **5: 0** | **60** | -0.3518 | 18.2193 | 0.14821 | 12.1 | 13.7 | 15.8 | 18.2 | 21.2 | 24.9 | 29.5 |

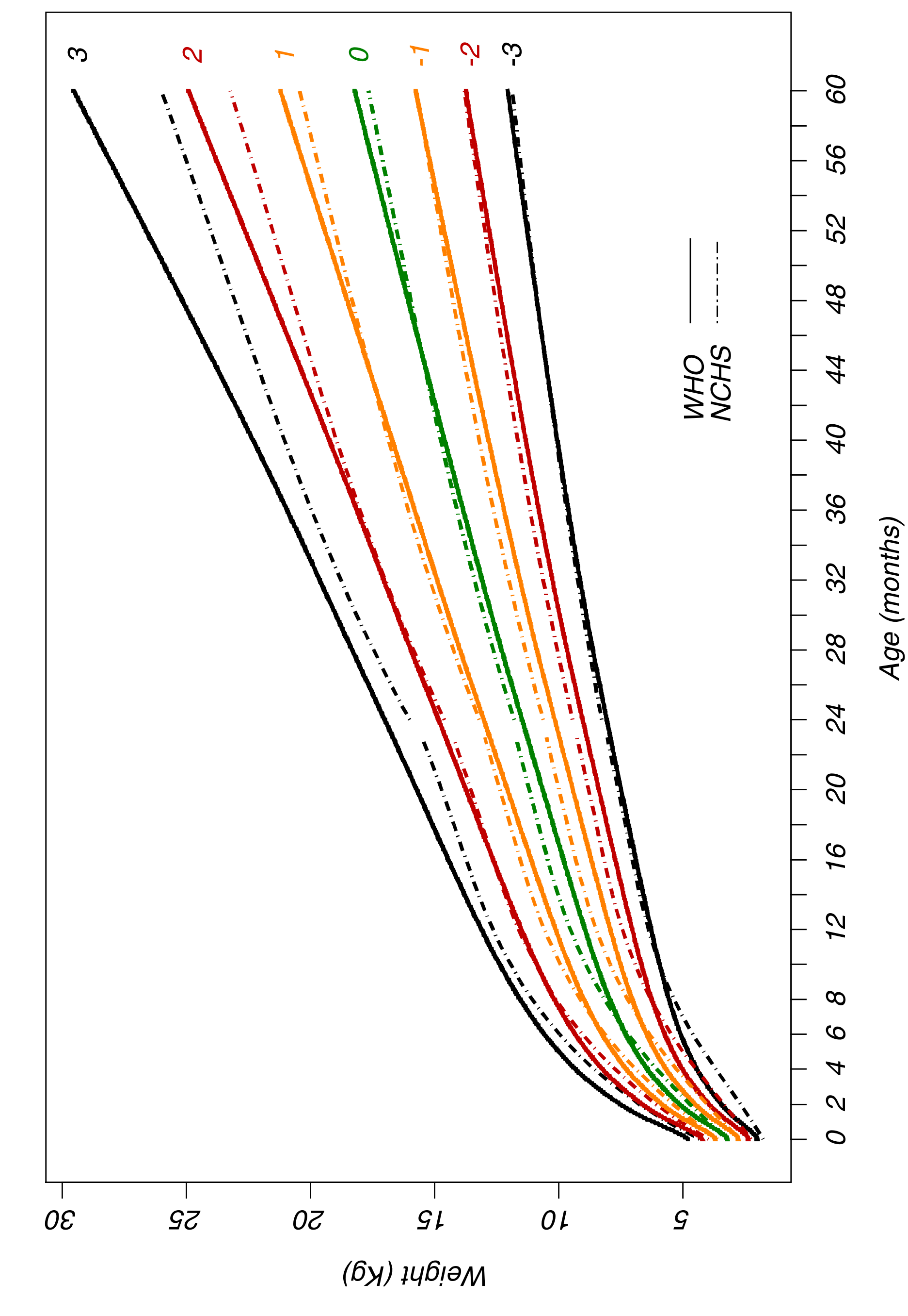


**Figure 58 Comparison of WHO with NCHS weight-for-age z-scores for girls**

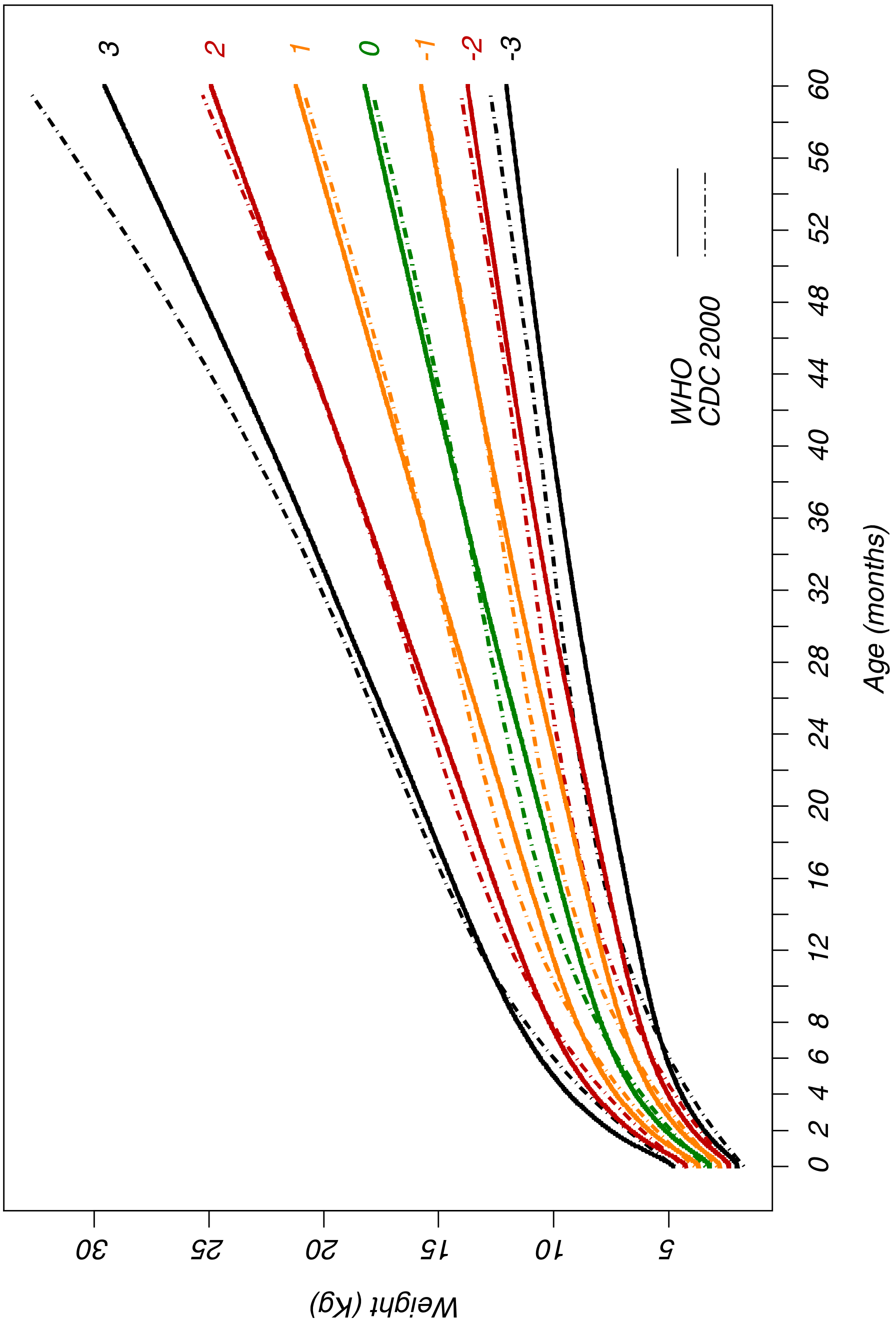


**Figure 59 Comparison of WHO with CDC 2000 weight-for-age z-scores for girls**

## 4.4 Comparisons between boys and girls

This section presents the weight-for-age z-score comparisons between boys and girls for WHO standards (Figure 60), and for NCHS (Figure 61) and CDC 2000 (Figure 62) references.

## 4.4.1 WHO

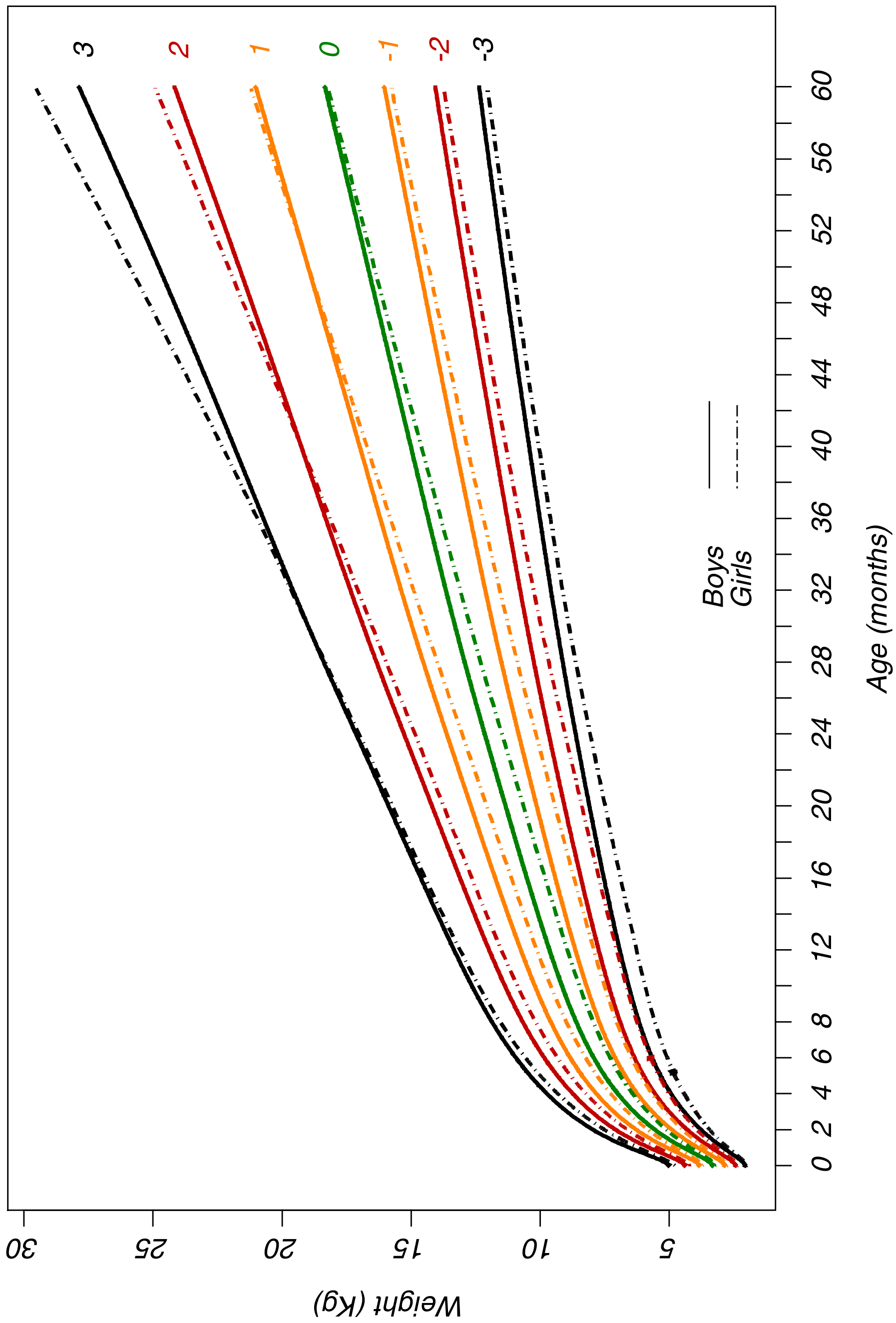


**Figure 60** **Comparison of boys' and girls' WHO weight-for-age z-scores**

### 4.4.2 NCHS

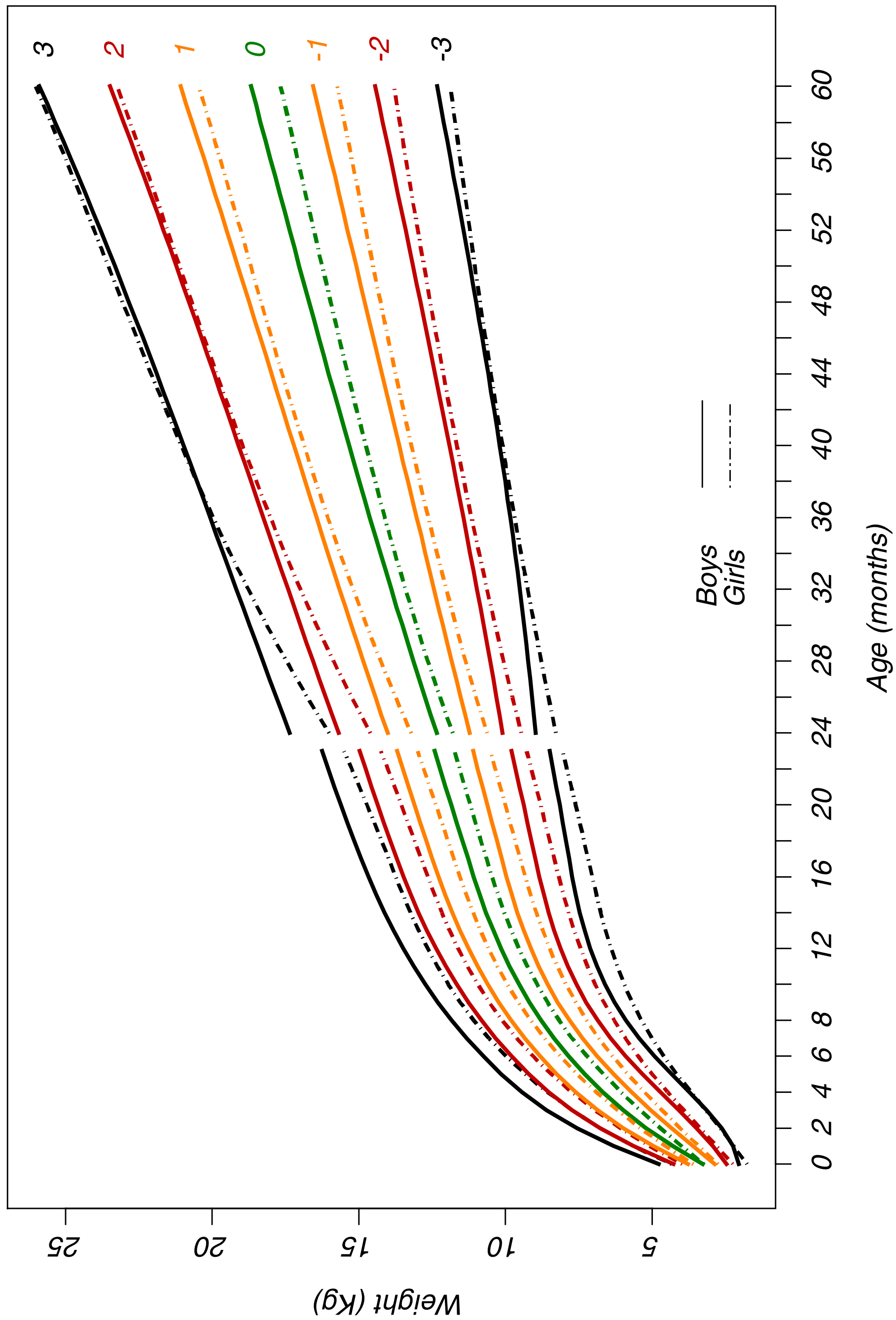


**Figure 61** Comparison of boys' and girls' NCHS weight-for-age z-scores

### 4.4.3 CDC 2000

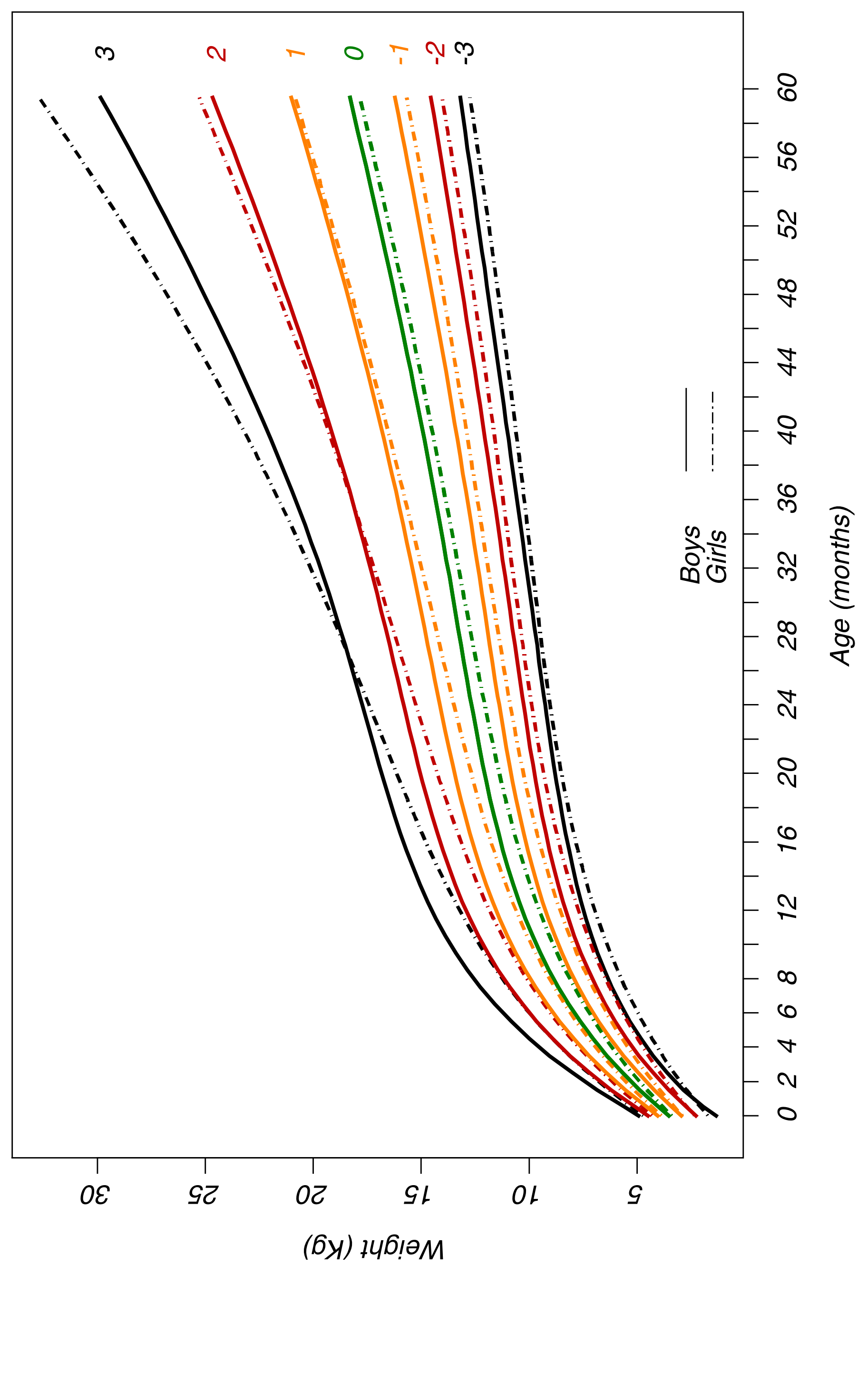


**Figure 62 Comparison of boys' and girls' CDC 2000 weight-for-age z-scores**

# 5. CONSTRUCTION OF THE WEIGHT-FOR-LENGTH AND WEIGHT-FOR-HEIGHT STANDARDS

## 5.1 Indicator-specific methodology

The construction of the weight-for-length (45 to 110 cm) and weight-for-height (65 to 120 cm) standards followed a procedure similar to that applied to constructing the length/height-for-age standards (see section 3.1). To fit a single model, 0.7 cm was added to the cross-sectional height values. This was the average difference found between length and height in 1625 children aged 18 to 30 months measured for both length and height. After the model was fitted, the weight-for-length centile curves in the length interval 65.7 to 120.7 cm were shifted back by 0.7 cm to derive the weight-for-height standards corresponding to the height range 65 cm to 120 cm.

There was an important distinction between age versus length/height as the x-axis variable. Although the study was designed to give a relatively constant number of observations per age group, this was not the case for length/height. Therefore, in contrast to the square tail of the uniform age distribution there was a light upper tail for the height distribution. The age-based indicator curves were constructed using all available data (0 to 71 months) but the resulting standards were truncated at 60 completed months to avoid the right-edge effect (Borghi et al., 2006). The construction of the weight-for-height standards followed this precedent by using the full range of available heights independently of age. The decision about where to set the upper limit for the weight-for-height standards was influenced by the need to accommodate the tallest children at age 60 months. The upper limit was set at 120 cm, approximately the +2 SD boys' height-for-age at 60 months. Few children in the MGRS sample were taller than 120 cm (91 boys and 72 girls) and the distribution of their heights distorted the trajectory of the median and other centiles because the sample was small and the observed weight values were clustered at the upper tail. Thus, observations with height values >120 cm were assigned a model weight=0 to avoid distorting the trajectory at the upper end of the height range. It was considered a sensible precaution to exclude height values above 120 cm from the modelling but retain them for the diagnostic tests and other types of assessment. The lower limit of the weight-for-length standards (45 cm) was chosen to cover up to approximately -2 SD girls' length at birth.

## 5.2 Weight-for-length/height for boys

### 5.2.1 Sample size

There were 13 362 observations with both weight and length/height measurements. The longitudinal and cross-sectional samples were merged (after converting cross-sectional height values to length by adding 0.7 cm) and sample sizes by length interval are presented in Table 51.

**Table 51 Sample sizes for boys' weight-for-length/height by length[a] interval**

| Length (cm) | N | Length (cm) | N | Length (cm) | N | Length (cm) | N |
|---|---|---|---|---|---|---|---|
| <45 | 2 | 63 to <65 | 383 | 83 to <85 | 528 | 103 to <105 | 258 |
| 45 to <47 | 61 | 65 to <67 | 472 | 85 to <87 | 486 | 105 to <107 | 296 |
| 47 to <49 | 234 | 67 to <69 | 501 | 87 to <89 | 452 | 107 to <109 | 267 |
| 49 to <51 | 453 | 69 to <71 | 573 | 89 to <91 | 340 | 109 to <111 | 240 |
| 51 to <53 | 480 | 71 to <73 | 627 | 91 to <93 | 276 | 111 to <113 | 227 |
| 53 to <55 | 431 | 73 to <75 | 572 | 93 to <95 | 270 | 113 to <115 | 198 |
| 55 to <57 | 405 | 75 to <77 | 515 | 95 to <97 | 247 | 115 to <117 | 151 |
| 57 to <59 | 363 | 77 to <79 | 417 | 97 to <99 | 258 | 117 to <119 | 100 |
| 59 to <61 | 292 | 79 to <81 | 464 | 99 to <101 | 276 | 119 to <121 | 65 |
| 61 to <63 | 339 | 81 to <83 | 467 | 101 to <103 | 292 | ≥121 | 84 |

[a] Height values were converted to length before merging the data (length=height+0.7).

### 5.2.2 Model selection and results

There was no indication that a length/height transformation similar to that described for age was required for constructing the weight-for-length/height standards (i.e. global deviance values did not vary over the grid of λ values 0 to 1). Initial steps used the simplest model, i.e. the BCPE distribution with fixed ν=1 and τ=2 (the normal distribution). A search procedure for the best combination of df(μ) and df(σ) was carried out. Table 52 summarizes the goodness-of-fit statistics for various combinations of df(μ) and df(σ).

The models with df(μ)=13 or 14 and df(σ)=6 resulted in the best fit. Because the median curve with df(μ)=13 was slightly wiggly, the model with df(μ)=12 was fitted to assess if improvement in smoothing would compensate for the loss in goodness of fit. The resulting difference in the trajectory of the median curve was negligible. Other models with progressively lower degrees of freedom for the μ curve were tested until significant smoothing was visible, but this was accompanied by significant losses in goodness of fit. Therefore, the original model with df(μ)=13 and df(σ)=6 was adopted for further evaluation. The fact that the weight-for-length/height indicator combines different velocities for the two measurements involved (weight and length/height) at different ages likely explains the slight wiggle observed in the WHO standards and other references (CDC 2000 (Kuczmarski et al., 2002) and Swiss (Prader et al., 1989)).

**Table 52 Goodness-of-fit summary for models using the BCPE distribution with fixed ν=1 and τ=2 for weight-for-length/height for boys**

| df(μ) | df(σ) | GD[a] | AIC[a] | GAIC(3)[a] | Total df |
|---|---|---|---|---|---|
| | **4** | 1102.8 | 1132.8 | 1147.8 | 15 |
| | **5** | 1096.9 | 1128.9 | 1144.9 | 16 |
| **11** | **6** | 1093.3 | 1127.3 | 1144.3 | 17 |
| | **7** | 1091.3 | 1127.3 | 1145.3 | 18 |
| | **8** | 1090.1 | 1128.1 | 1147.1 | 19 |
| | **4** | 1097.5 | 1129.5 | 1145.5 | 16 |
| | **5** | 1091.6 | 1125.6 | 1142.6 | 17 |
| **12** | **6** | 1088.0 | 1124.0 | 1142.0 | 18 |
| | **7** | 1085.9 | 1123.9 | 1142.9 | 19 |
| | **8** | 1084.7 | 1124.7 | 1144.7 | 20 |
| | **4** | 1093.8 | 1127.8 | 1144.8 | 17 |
| | **5** | 1087.8 | 1123.8 | 1141.8 | 18 |
| **13** | **6** | 1084.2 | 1122.2 | 1141.2 | 19 |
| | **7** | 1082.1 | 1122.1 | 1142.1 | 20 |
| | **8** | 1080.8 | 1122.8 | 1143.8 | 21 |
| | **4** | 1090.9 | 1126.9 | 1144.9 | 18 |
| | **5** | 1085.0 | 1123.0 | 1142.0 | 19 |
| **14** | **6** | 1081.3 | 1121.3 | 1141.3 | 20 |
| | **7** | 1079.2 | 1121.2 | 1142.2 | 21 |
| | **8** | 1077.9 | 1121.9 | 1143.9 | 22 |
| | **4** | 1088.6 | 1126.6 | 1145.6 | 19 |
| | **5** | 1082.7 | 1122.7 | 1142.7 | 20 |
| **15** | **6** | 1079.0 | 1121.0 | 1142.0 | 21 |
| | **7** | 1076.9 | 1120.9 | 1142.9 | 22 |
| | **8** | 1075.6 | 1121.6 | 1144.6 | 23 |

GD, Global Deviance; AIC, Akaike Information Criterion;
GAIC(3), Generalized AIC with penalty equal to 3;
[a] In excess of 30 000.

**Model 1: BCPE(x=length (or height+0.7), df(μ)=13, df(σ)=6, ν=1, τ=2)**

Figure 63 shows the worm plots of the z-scores derived from Model 1. Intervals correspond to the length/height groups defined in Table 53. The worm plots were all U-shaped, indicating poor model fit due to skewness. Table 53 presents Q-test results of the z-scores from the same model. Almost all the length (or height+0.7) intervals presented absolute values of z3 larger than 2, confirming skewness in the data. No misfit was noted for the median or the variance (values of z1 and z2 within interval -2 to 2).

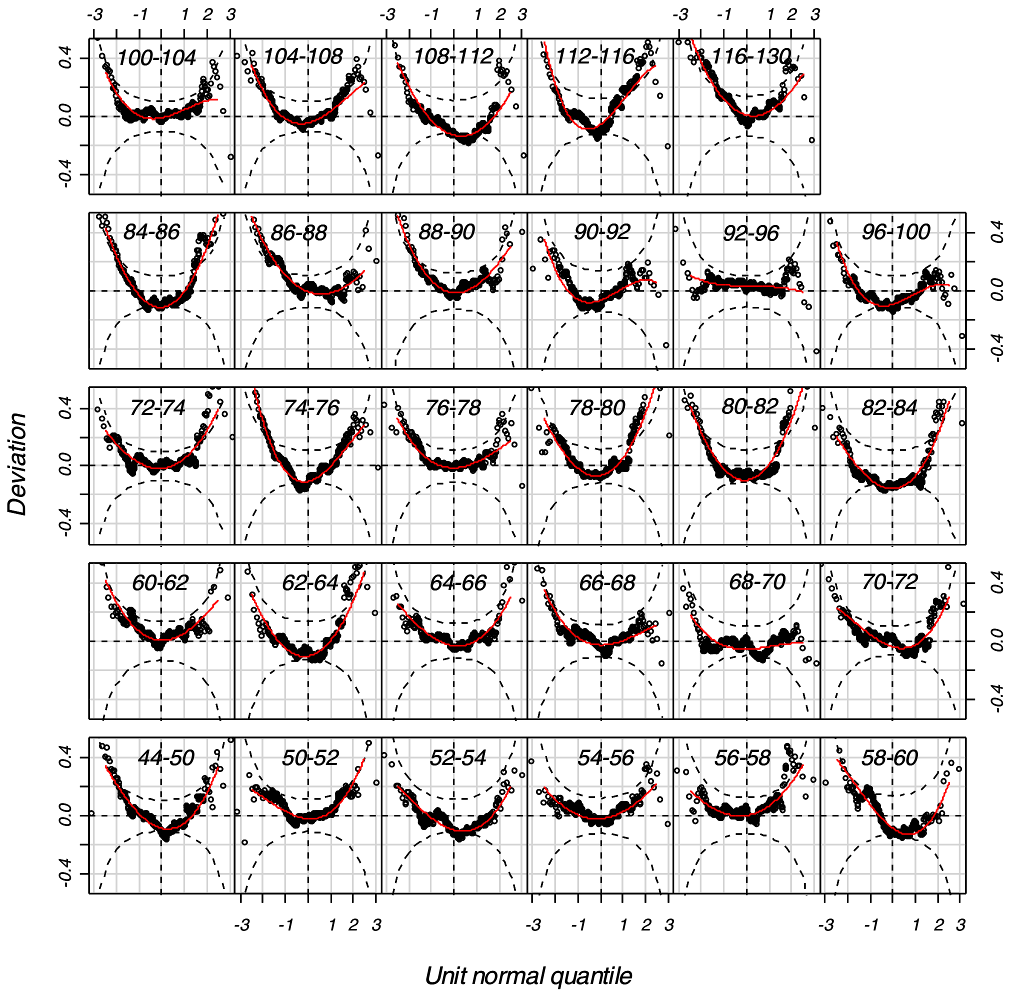


**Figure 63 Worm plots of z-scores for Model 1 for weight-for-length/height for boys**

Keeping df(μ) and df(σ) as specified in Model 1, the next step was to search for the best degrees of freedom for the parameter ν. Table 54 presents goodness-of-fit values for different degrees of freedom for the ν curve.

The best *GAIC(3)* was associated with df(ν)=1. It is worth noting that there is a difference between a model with ν=1 where the parameter ν is fixed at value 1, and a model with df(ν)=1 where a constant is estimated by the maximum pseudo-likelihood method across the whole length/height range to define the ν parameter curve. In the latter, the ν parameter estimation contributes one degree of freedom to the total, while in the former case ν does not add to the model's total degrees of freedom.

**Table 53 Q-test for z-scores from Model 1 [BCPE(x=length (or height+0.7), df(μ)=13, df(σ)=6, ν=1, τ=2)] for weight-for-length/height for boys**

| Length (cm) | N | z1 | z2 | z3 | z4 |
|---|---|---|---|---|---|
| **44 to <50** | 513 | -0.43 | -0.37 | 3.70 | 1.34 |
| **50 to <52** | 484 | 0.55 | 0.73 | 2.69 | 1.17 |
| **52 to <54** | 452 | -1.39 | -0.53 | 2.74 | 1.14 |
| **54 to <56** | 409 | 0.29 | 0.37 | 1.80 | 0.10 |
| **56 to <58** | 397 | 0.87 | 0.97 | 1.97 | 0.42 |
| **58 to <60** | 321 | -0.43 | -1.65 | 2.95 | 1.46 |
| **60 to <62** | 331 | 1.20 | -0.50 | 2.46 | 0.47 |
| **62 to <64** | 350 | -0.57 | 0.95 | 3.47 | 1.00 |
| **64 to <66** | 414 | 0.35 | -0.14 | 2.53 | 1.08 |
| **66 to <68** | 477 | 0.37 | -0.49 | 2.18 | -0.42 |
| **68 to <70** | 566 | -0.95 | -0.65 | 1.12 | -0.49 |
| **70 to <72** | 585 | 0.08 | -0.16 | 3.18 | 1.54 |
| **72 to <74** | 604 | 0.67 | 0.45 | 2.95 | 1.10 |
| **74 to <76** | 527 | -0.61 | -0.32 | 4.39 | -0.23 |
| **76 to <78** | 465 | 0.52 | -0.39 | 2.09 | -0.13 |
| **78 to <80** | 442 | 0.53 | 1.64 | 3.96 | 1.16 |
| **80 to <82** | 468 | -0.10 | 0.65 | 4.33 | 1.64 |
| **82 to <84** | 508 | -1.85 | 0.84 | 3.92 | 1.62 |
| **84 to <86** | 531 | -0.44 | 0.92 | 4.94 | 1.51 |
| **86 to <88** | 469 | 1.10 | -1.87 | 2.68 | 0.34 |
| **88 to <90** | 380 | 1.19 | -0.57 | 3.05 | 0.58 |
| **90 to <92** | 308 | -0.48 | 0.15 | 1.85 | -1.29 |
| **92 to <96** | 519 | 0.87 | -0.52 | 0.22 | -0.04 |
| **96 to <100** | 531 | -1.26 | -0.22 | 2.24 | -1.40 |
| **100 to <104** | 551 | 0.60 | 0.07 | 1.96 | -0.62 |
| **104 to <108** | 565 | 0.23 | 0.48 | 2.99 | -0.52 |
| **108 to <112** | 490 | -1.58 | -1.29 | 3.67 | 1.20 |
| **112 to <116** | 385 | 0.48 | 1.45 | 3.23 | -1.03 |
| **116 to 130** | 320 | 1.36 | -1.02 | 2.95 | 0.30 |
| **Overall Q stats** | **13 362** | **21.50** | **20.93** | **261.70** | **29.50** |
| **degrees of freedom** | | **16.0** | **25.5** | **29.0** | **29.0** |
| **p-value** | | **0.1598** | **0.7214** | **< 0.01** | **0.4394** |

Note: Absolute values of z1, z2, z3 or z4 larger than 2 indicate misfit of, respectively, mean, variance, skewness or kurtosis.

**Table 54 Goodness-of-fit summary for models BCPE(x=length (or height+0.7), df(μ)=13, df(σ)=6, df(ν)=?, τ=2) for weight-for-length/height for boys**

| df(ν) | GD[a] | GAIC(3)[a] | Total df |
|---|---|---|---|
| **1** | 835.1 | 895.1 | 20 |
| **2** | 834.5 | 897.6 | 21 |
| **3** | 833.2 | 899.2 | 22 |
| **4** | 830.4 | 899.4 | 23 |
| **5** | 826.9 | 898.9 | 24 |
| **6** | 823.8 | 898.8 | 25 |

GD, Global Deviance; GAIC(3), Generalized Akaike Information Criterion with penalty equal to 3;

[a] In excess of 30 000.

**Model 2: BCPE(x=length (or height+0.7), df(μ)=13, df(σ)=6, df(ν)=1, τ=2)**

The fitted curves of the parameters μ, σ and ν seemed adequate when compared to the empirical values (Figure 64). The distribution of the residuals from the fitted centile curves across length (or height+0.7) intervals (Figure 65) were investigated further to assess the fitted model's performance. The largest residuals were associated with the 97th centile in the two tallest groups. For all other centiles and length/height groups, the pattern of residuals indicated that the model's fit was most adequate.

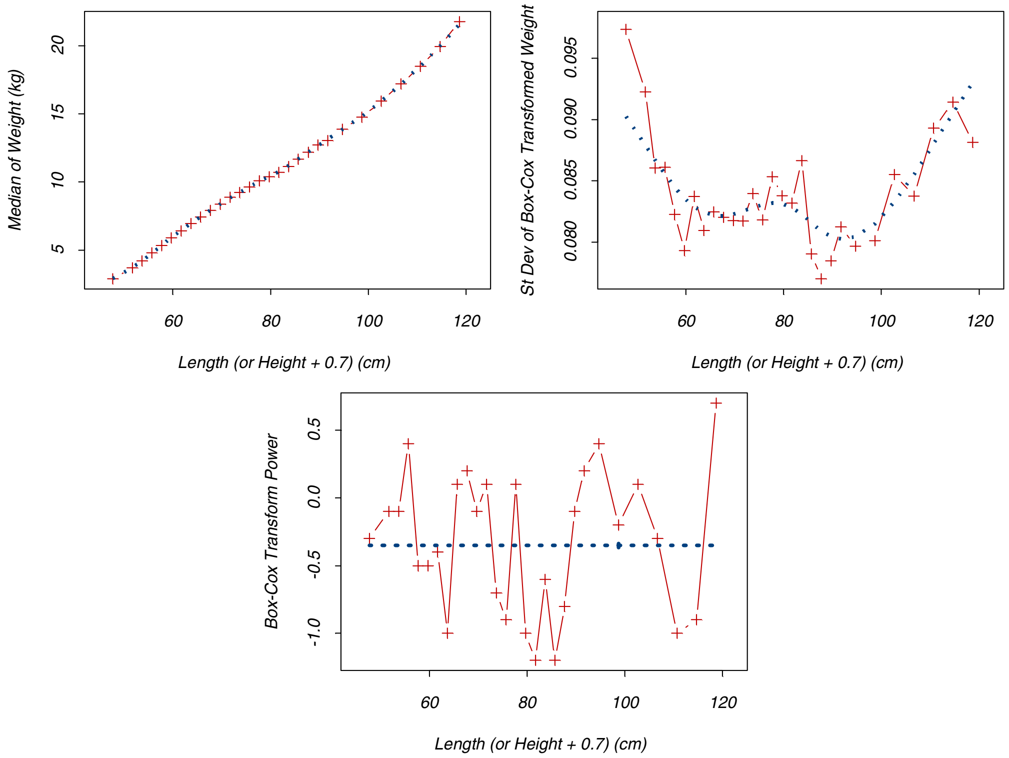


**Figure 64 Fitting of the μ, σ, and ν curves of Model 2 for weight-for-length/height for boys (dotted line) and their respective sample estimates (points with solid line)**

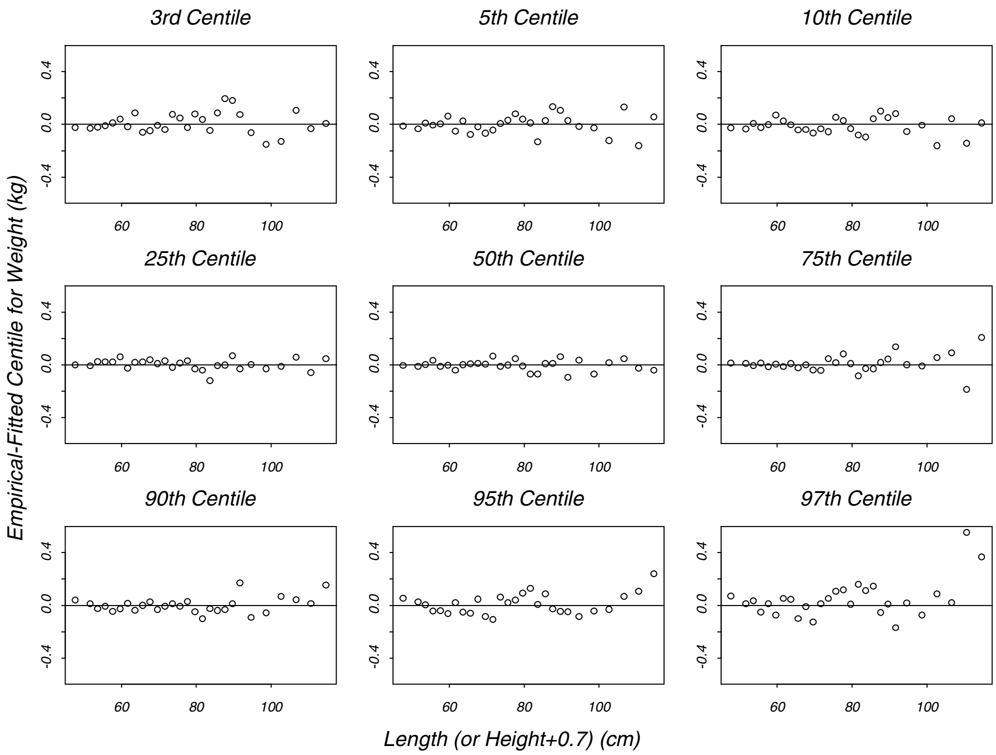


**Figure 65 Centile residuals from fitting Model 2 for weight-for-length/height for boys**

According to the Q-test results in Table 55, only three groups had residual skewness, i.e. with an absolute value of z3 larger than 2, and one group had residual kurtosis as indicated by the absolute value of z4 larger than 2. Worm plots for this model reflect departures from normality of the derived z-scores in the same groups indicated by the Q-test results (Figure 66). In addition, worms with non-flat shapes were noted in other groups but within their 95% confidence intervals. The worm for group 86 to 88 cm presented a steep slope, indicating misfit of the variance. The overall Q-test for kurtosis was not significant and since only one out of 29 length/height groups presented evidence of remaining kurtosis, increasing the model's complexity to include the modelling of the parameter $\tau$ was unwarranted.

**Table 55 Q-test for z-scores from Model 2 [BCPE(x=length (or height+0.7), df(μ)=13, df(σ)=6, df(ν)=1, τ=2)] for weight-for-length/height for boys**

| Length (cm) | N | z1 | z2 | z3 | z4 |
|---|---|---|---|---|---|
| **44 to <50** | 513 | -0.41 | -0.38 | 0.32 | 0.70 |
| **50 to <52** | 484 | 0.61 | 0.71 | -0.89 | 1.22 |
| **52 to <54** | 452 | -1.29 | -0.31 | -0.41 | 0.45 |
| **54 to <56** | 409 | 0.27 | 0.45 | -1.07 | 0.17 |
| **56 to <58** | 397 | 0.75 | 0.93 | -0.93 | 0.26 |
| **58 to <60** | 321 | -0.39 | -1.72 | 0.46 | 0.88 |
| **60 to <62** | 331 | 1.19 | -0.75 | 0.18 | -0.44 |
| **62 to <64** | 350 | -0.66 | 0.79 | 1.00 | -0.05 |
| **64 to <66** | 414 | 0.33 | -0.20 | -0.31 | 0.31 |
| **66 to <68** | 477 | 0.34 | -0.49 | -0.46 | -0.88 |
| **68 to <70** | 566 | -1.00 | -0.18 | -1.85 | -0.51 |
| **70 to <72** | 585 | 0.05 | -0.15 | -0.28 | 0.50 |
| **72 to <74** | 604 | 0.63 | 0.46 | -0.52 | 0.17 |
| **74 to <76** | 527 | -0.56 | -0.49 | 2.03 | -1.96 |
| **76 to <78** | 465 | 0.63 | -0.24 | -0.66 | -0.48 |
| **78 to <80** | 442 | 0.57 | 1.42 | 1.09 | 0.08 |
| **80 to <82** | 468 | 0.04 | 0.49 | 1.48 | -0.05 |
| **82 to <84** | 508 | -1.79 | 1.10 | 0.74 | 0.27 |
| **84 to <86** | 531 | -0.46 | 0.69 | 2.13 | -0.32 |
| **86 to <88** | 469 | 1.15 | -1.96 | 0.15 | -0.67 |
| **88 to <90** | 380 | 1.11 | -0.84 | 0.76 | -0.64 |
| **90 to <92** | 308 | -0.62 | 0.25 | -0.09 | -1.17 |
| **92 to <96** | 519 | 0.80 | -0.25 | -2.74 | 0.66 |
| **96 to <100** | 531 | -1.30 | -0.08 | -0.30 | -1.91 |
| **100 to <104** | 551 | 0.61 | 0.05 | -0.91 | -1.19 |
| **104 to <108** | 565 | 0.24 | 0.39 | 0.02 | -1.06 |
| **108 to <112** | 490 | -1.46 | -1.12 | 0.66 | 0.09 |
| **112 to <116** | 385 | 0.40 | 1.30 | 0.91 | -2.08 |
| **116 to 130** | 320 | 1.43 | -1.18 | 0.53 | -0.14 |
| **Overall Q stats** | **13 362** | **20.96** | **19.94** | **31.99** | **22.08** |
| **degrees of freedom** | | **16.0** | **25.5** | **28.0** | **29.0** |
| **p-value** | | **0.1801** | **0.7730** | **0.2749** | **0.8170** |

Note: Absolute values of z1, z2, z3 or z4 larger than 2 indicate misfit of, respectively, mean, variance, skewness or kurtosis.

Table 56 shows the percentage of children below the fitted centiles. Discrepancies between observed and expected proportions were small (except for the last group) and without any systematic pattern.

The foregoing considerations led to selection of the model BCPE(x=length (or height+0.7), df(μ)=13, df(σ)=6, df(ν)=1, τ=2) for constructing the weight-for-length/height growth curves for boys. One more iteration was done using df(ν)=1 to re-search for the best values of df(μ) and df(σ) for constructing the weight-for-length/height standards. The alternative model with df(μ)=15 and df(σ)=6 presented *AIC*= 30 873.8 and *GAIC(3)*=30 895.8 compared with Model 2's *AIC*=30 875.1 and *GAIC(3)*=30 895.1. In sum, since the performances of the two models were very similar, the decision was to retain Model 2.

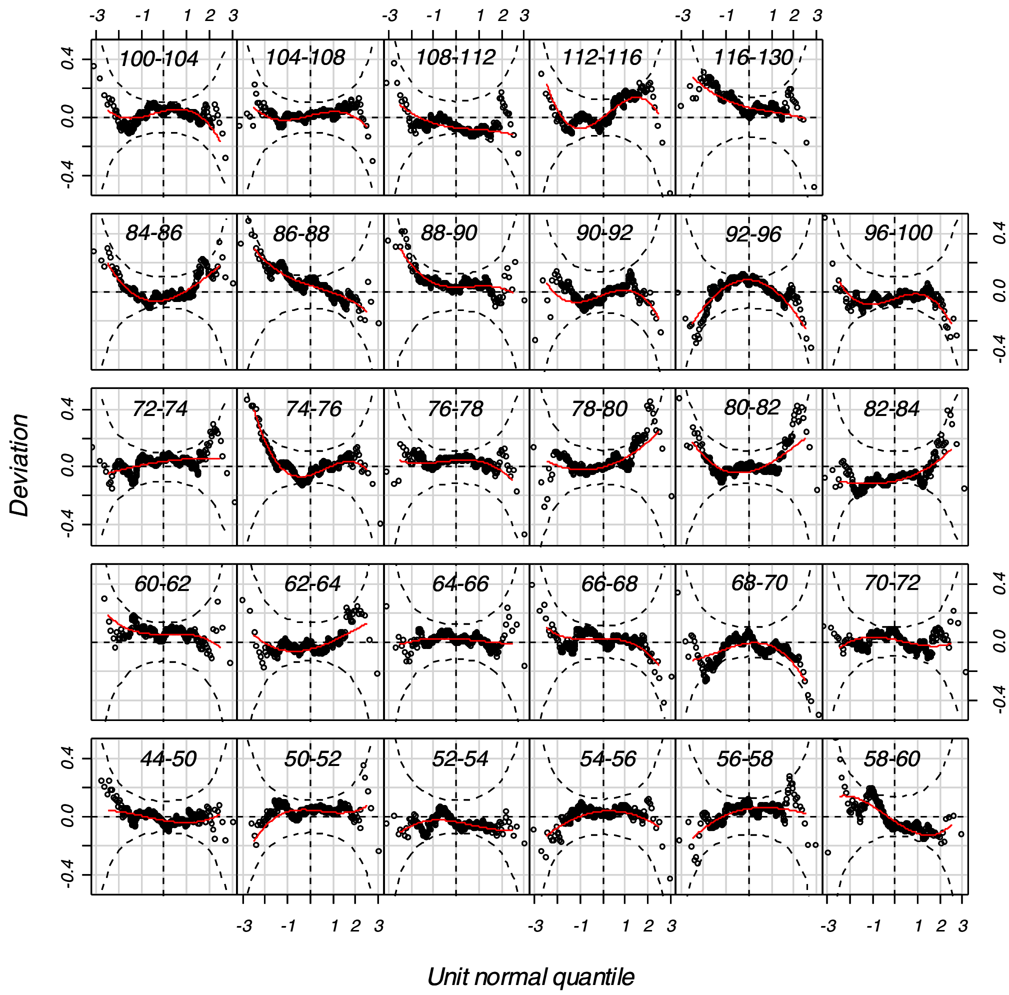


**Figure 66 Worm plots of z-scores for Model 2 for weight-for-length/height for boys**

To derive the weight-for-height standards in the range 65 to 120 cm, the weight-for-length centile curves in the length interval 65.7 to 120.7 cm were shifted back by 0.7 cm for the reason explained previously (see also section 5.1). Figures 67 and 68 present fitted centile curves plotted against empirical weight-for-length values derived from the longitudinal component. Similarly, Figures 69 and 70 present plots of fitted centiles against empirical weight-for-height values derived from the cross-sectional component.

**Table 56 Observed proportions of children with measurements below the fitted centiles from Model 2, weight-for-length/height for boys**

| Expected | 44 to <50 | 50 to <52 | 52 to <54 | 54 to <56 | 56 to <58 | 58 to <60 | 60 to <62 | 62 to <64 | 64 to <66 | 66 to <68 |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 0.8 | 1.2 | 1.3 | 1.5 | 1.5 | 0.3 | 0.3 | 1.1 | 1.0 | 0.4 |
| **3** | 2.5 | 2.9 | 3.3 | 3.7 | 3.3 | 2.8 | 2.7 | 3.4 | 3.1 | 3.6 |
| **5** | 4.7 | 4.8 | 6.0 | 5.4 | 5.5 | 4.7 | 4.5 | 6.3 | 4.6 | 5.5 |
| **10** | 10.7 | 8.5 | 11.3 | 10.0 | 11.1 | 9.0 | 7.6 | 10.9 | 9.7 | 10.7 |
| **25** | 24.0 | 25.8 | 23.9 | 24.2 | 23.2 | 21.8 | 22.4 | 25.7 | 23.4 | 23.5 |
| **50** | 52.2 | 47.9 | 53.5 | 49.6 | 46.9 | 52.3 | 48.9 | 51.4 | 49.8 | 49.9 |
| **75** | 76.4 | 73.8 | 77.9 | 73.6 | 72.5 | 77.9 | 72.5 | 76.6 | 74.6 | 73.6 |
| **90** | 90.8 | 89.5 | 91.8 | 89.5 | 89.9 | 91.9 | 88.8 | 90.6 | 90.1 | 90.4 |
| **95** | 94.5 | 94.0 | 95.6 | 94.6 | 95.0 | 96.3 | 95.5 | 94.3 | 95.2 | 95.0 |
| **97** | 97.1 | 96.9 | 97.1 | 97.1 | 95.7 | 98.1 | 97.9 | 94.9 | 97.1 | 96.9 |
| **99** | 98.8 | 98.8 | 99.1 | 99.3 | 98.5 | 99.1 | 98.8 | 98.0 | 98.6 | 99.8 |
| **Expected** | **68 to <70** | **70 to <72** | **72 to <74** | **74 to <76** | **76 to <78** | **78 to <80** | **80 to <82** | **82 to <84** | **84 to <86** | **86 to <88** |
| **1** | 1.2 | 1.4 | 1.2 | 0.2 | 0.6 | 1.4 | 0.6 | 1.0 | 0.6 | 0.2 |
| **3** | 4.1 | 3.1 | 2.8 | 2.1 | 2.8 | 2.5 | 2.4 | 4.5 | 2.3 | 1.5 |
| **5** | 6.9 | 5.5 | 5.8 | 4.2 | 4.7 | 4.5 | 4.7 | 6.9 | 4.9 | 3.8 |
| **10** | 11.7 | 11.5 | 11.1 | 9.9 | 9.9 | 10.6 | 12.2 | 11.8 | 10.0 | 7.9 |
| **25** | 24.7 | 23.9 | 23.0 | 27.3 | 23.4 | 26.2 | 26.5 | 27.8 | 28.6 | 23.5 |
| **50** | 48.9 | 48.0 | 47.7 | 52.4 | 48.4 | 50.7 | 49.8 | 53.3 | 52.2 | 46.5 |
| **75** | 77.9 | 76.6 | 74.3 | 74.6 | 73.5 | 71.9 | 75.6 | 77.0 | 76.3 | 73.6 |
| **90** | 91.0 | 89.9 | 90.9 | 90.1 | 90.8 | 89.1 | 90.8 | 91.3 | 90.4 | 90.8 |
| **95** | 95.4 | 95.0 | 95.0 | 94.7 | 95.3 | 92.5 | 94.4 | 94.9 | 94.0 | 95.5 |
| **97** | 97.9 | 96.2 | 96.4 | 96.8 | 97.2 | 95.7 | 95.9 | 96.5 | 95.3 | 97.2 |
| **99** | 99.6 | 98.8 | 98.3 | 99.1 | 99.1 | 97.7 | 97.9 | 98.8 | 98.7 | 99.4 |

**Table 56 Observed proportions of children with measurements below the fitted centiles from Model 2, weight-for-length/height for boys (continued)**

| Expected | 88 to <90 | 90 to <92 | 92 to <96 | 96 to <100 | 100 to <104 | 104 to <108 | 108 to <112 | 112 to <116 | 116 to 130 | Overall |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 0.5 | 1.3 | 1.7 | 0.9 | 0.7 | 0.7 | 0.6 | 0.8 | 0.6 | 0.9 |
| **3** | 1.1 | 2.3 | 3.7 | 3.4 | 3.6 | 3.0 | 3.5 | 3.1 | 1.6 | 3.0 |
| **5** | 3.7 | 4.9 | 5.0 | 5.8 | 6.4 | 4.8 | 5.3 | 6.0 | 2.8 | 5.2 |
| **10** | 8.7 | 11.0 | 10.2 | 11.7 | 10.5 | 11.3 | 11.0 | 10.6 | 6.9 | 10.4 |
| **25** | 23.4 | 26.9 | 22.2 | 27.7 | 23.6 | 25.5 | 24.5 | 25.2 | 20.6 | 24.7 |
| **50** | 47.9 | 52.6 | 46.8 | 53.5 | 48.8 | 49.4 | 52.7 | 51.2 | 49.7 | 50.1 |
| **75** | 73.7 | 75.0 | 73.2 | 75.5 | 73.1 | 73.6 | 79.0 | 71.9 | 73.8 | 74.9 |
| **90** | 89.5 | 88.6 | 90.9 | 90.2 | 89.5 | 89.4 | 92.4 | 87.0 | 88.4 | 90.2 |
| **95** | 95.3 | 95.5 | 95.6 | 95.5 | 95.3 | 94.0 | 95.5 | 93.5 | 94.4 | 94.9 |
| **97** | 97.1 | 97.1 | 96.9 | 97.7 | 96.6 | 96.5 | 97.3 | 95.3 | 95.9 | 96.7 |
| **99** | 98.7 | 100.0 | 99.6 | 99.4 | 98.7 | 99.1 | 99.0 | 98.2 | 99.1 | 98.9 |

Note: Group labels correspond to the length (or height+0.7) intervals in Table 55.

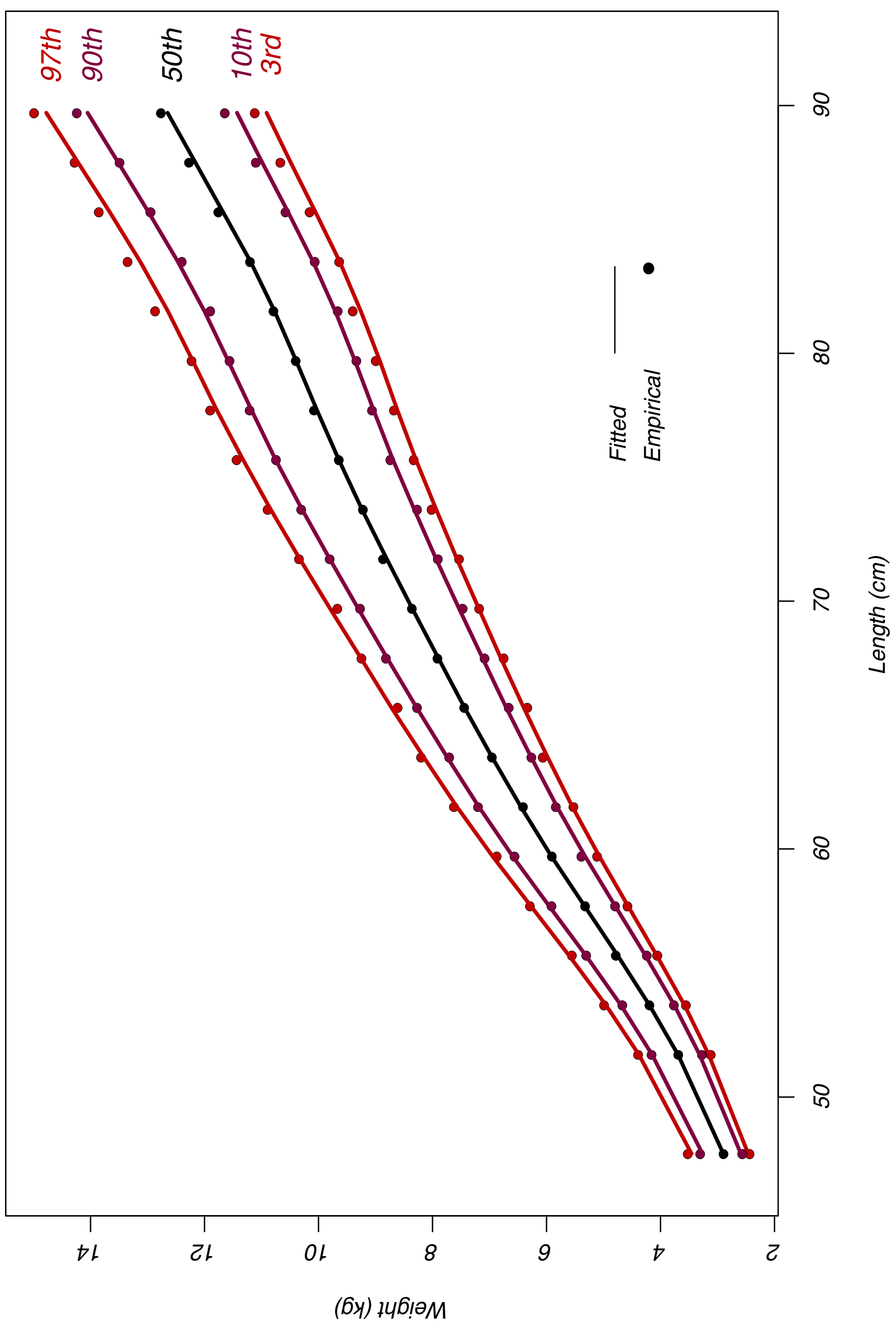


**Figure 67** **3rd, 10th, 50th, 90th, 97th smoothed centile curves and empirical values: weight-for-length for boys**

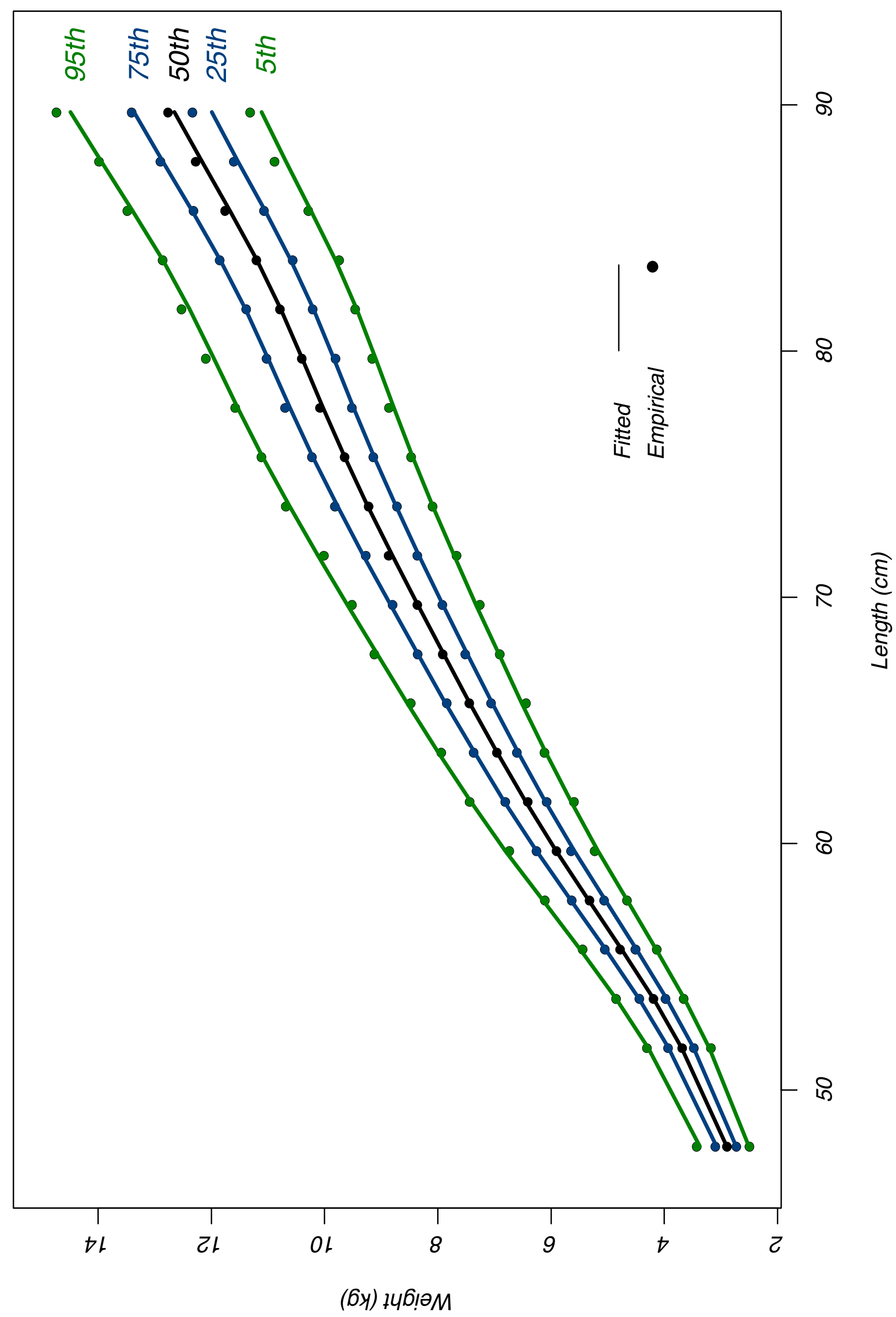


**Figure 68 5th, 25th, 50th, 75th, 95th smoothed centile curves and empirical values: weight-for-length for boys**

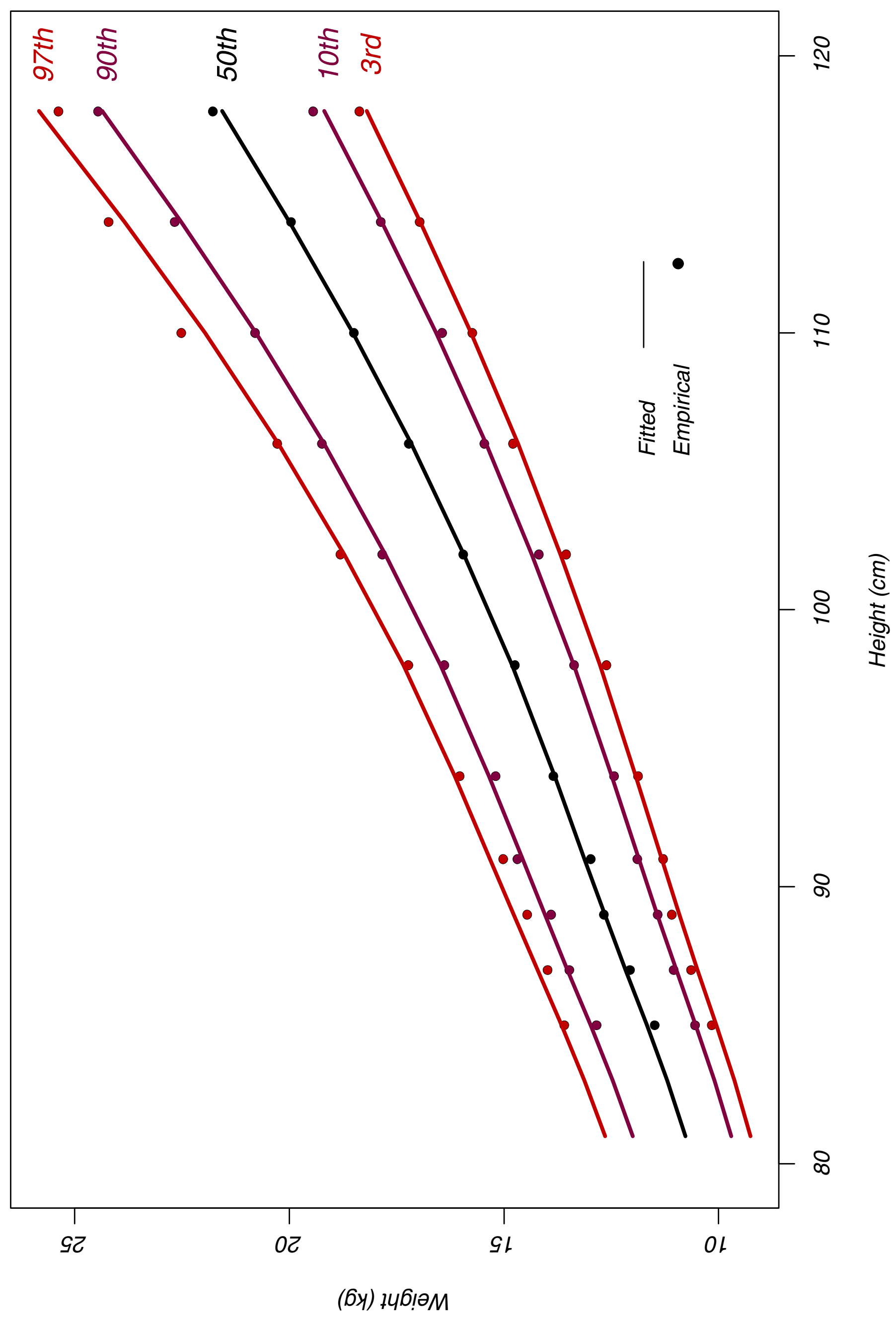


**Figure 69 3rd, 10th, 50th, 90th, 97th smoothed centile curves and empirical values: weight-for-height for boys**

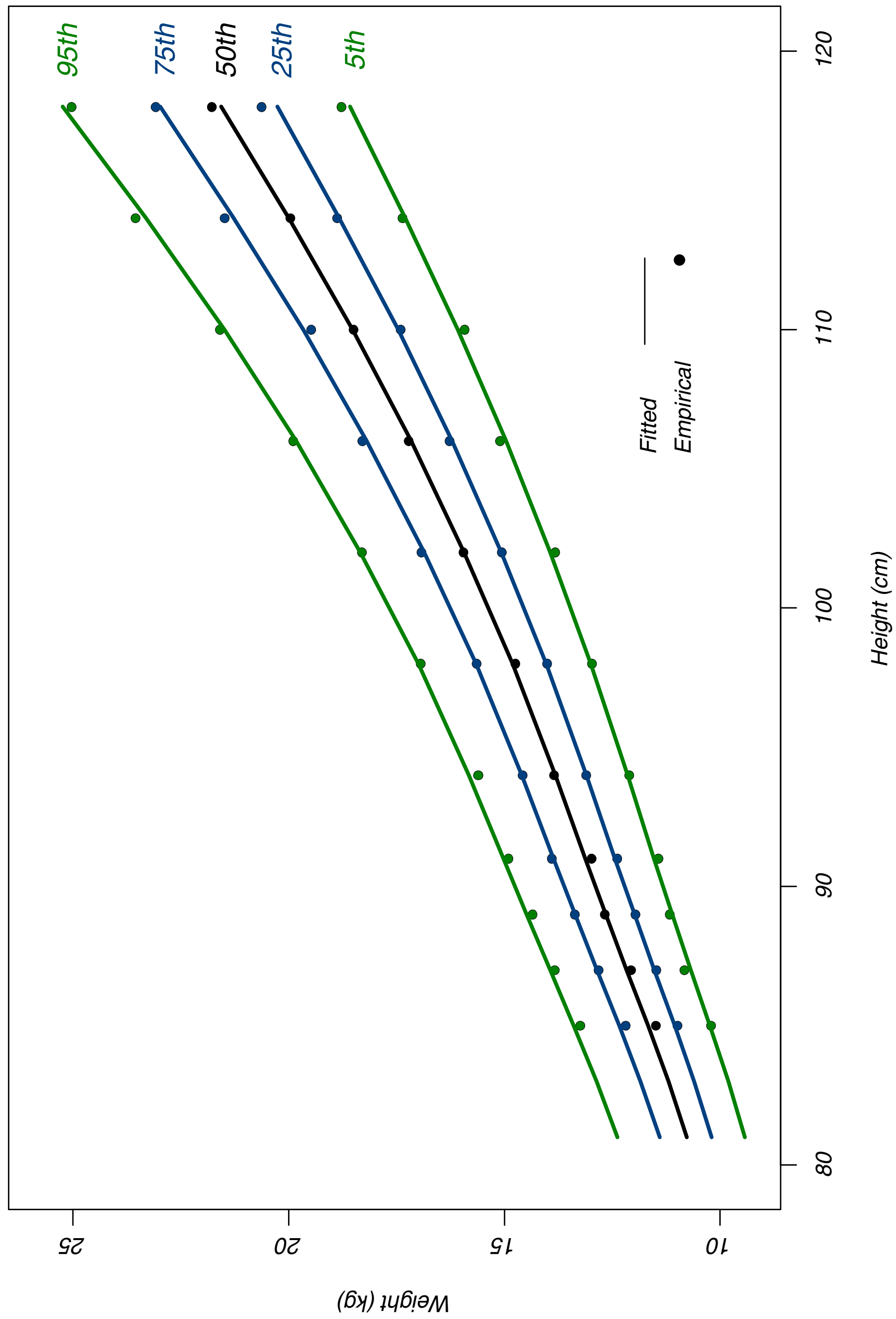


**Figure 70** **5th, 25th, 50th, 75th, 95th smoothed centile curves and empirical values: weight-for-height for boys**

### 5.2.3 WHO standards and their comparison with NCHS and CDC 2000 references

This section presents the final WHO weight-for-length and weight-for-height z-score and percentile charts (Figures 71 to 74) and tables (Tables 57 and 58) for boys. It also provides the z-score comparisons of the WHO versus NCHS (Figures 75 and 76) and CDC 2000 (Figures 77 and 78) curves.

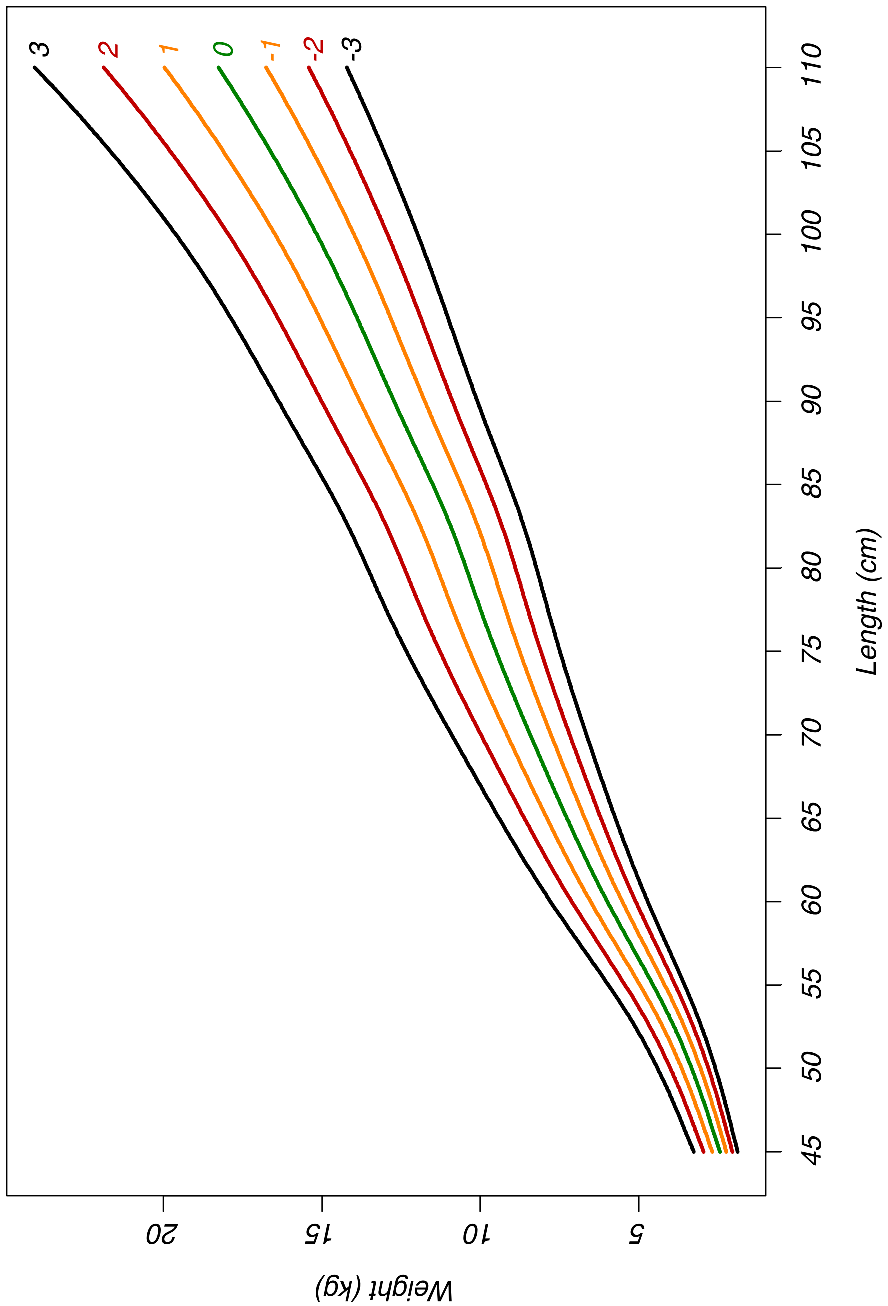


**Figure 71 WHO weight-for-length z-scores for boys from 45 to 110 cm**

*Charts*

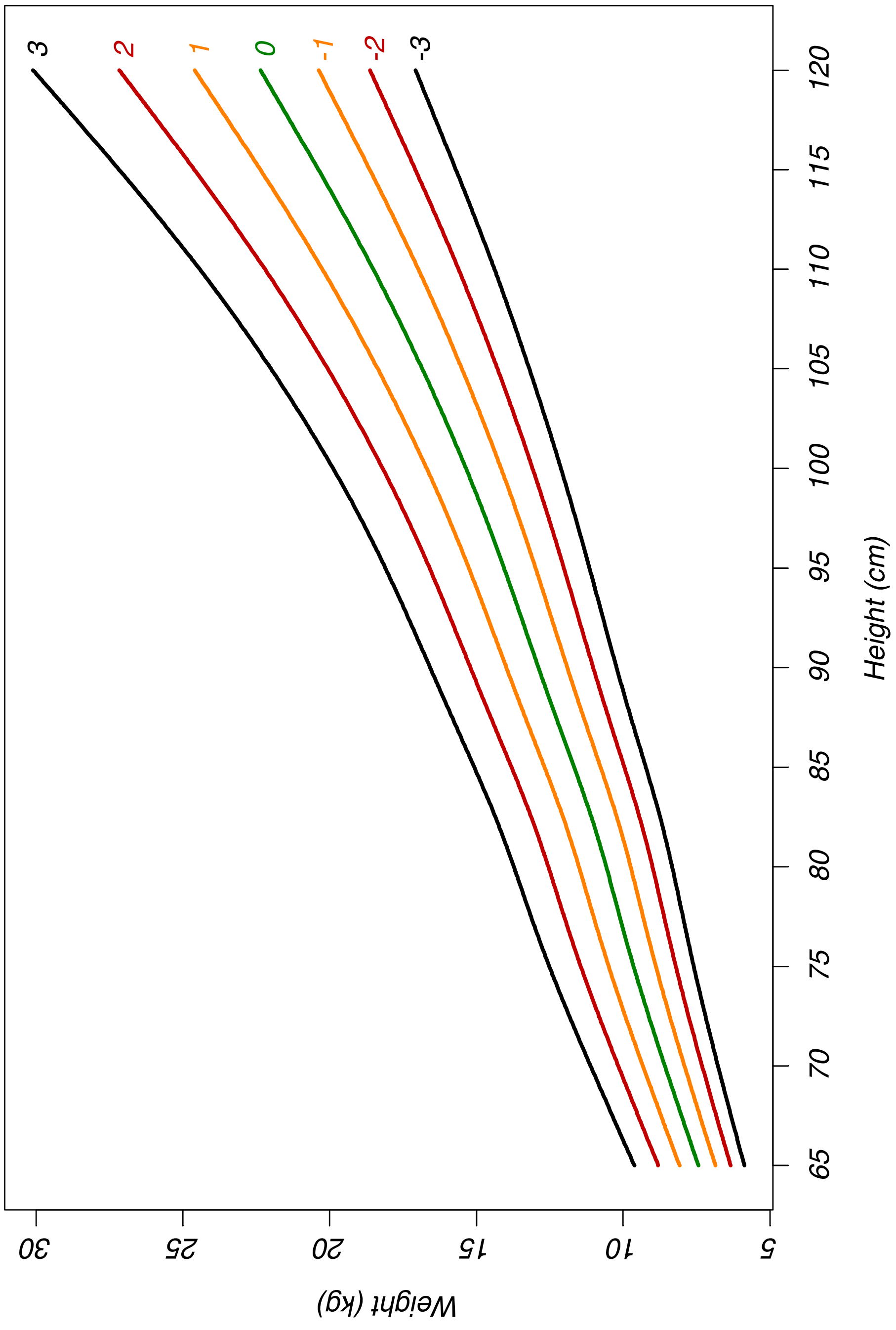


**Figure 72 WHO weight-for-height z-scores for boys from 65 to 120 cm**

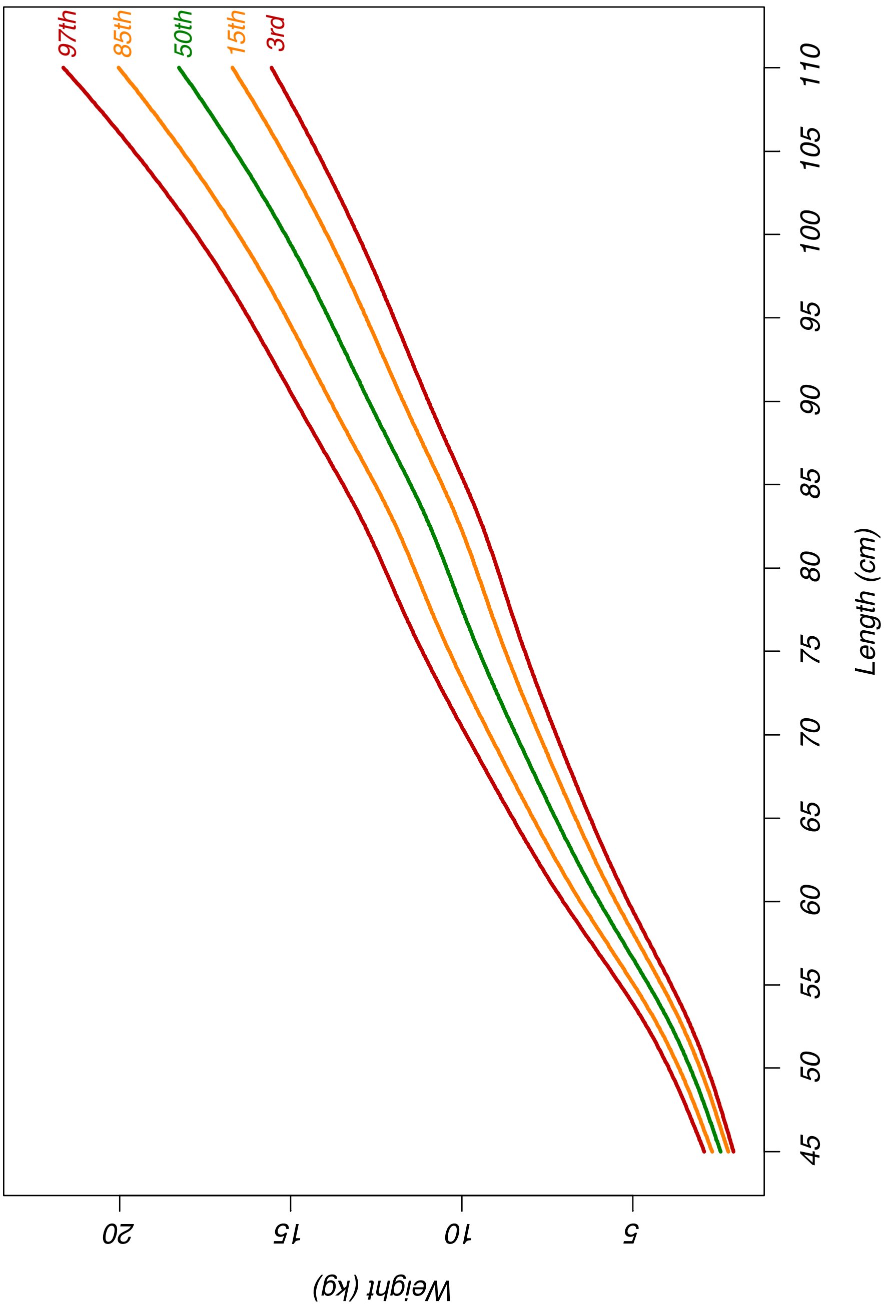


**Figure 73 WHO weight-for-length percentiles for boys from 45 to 110 cm**

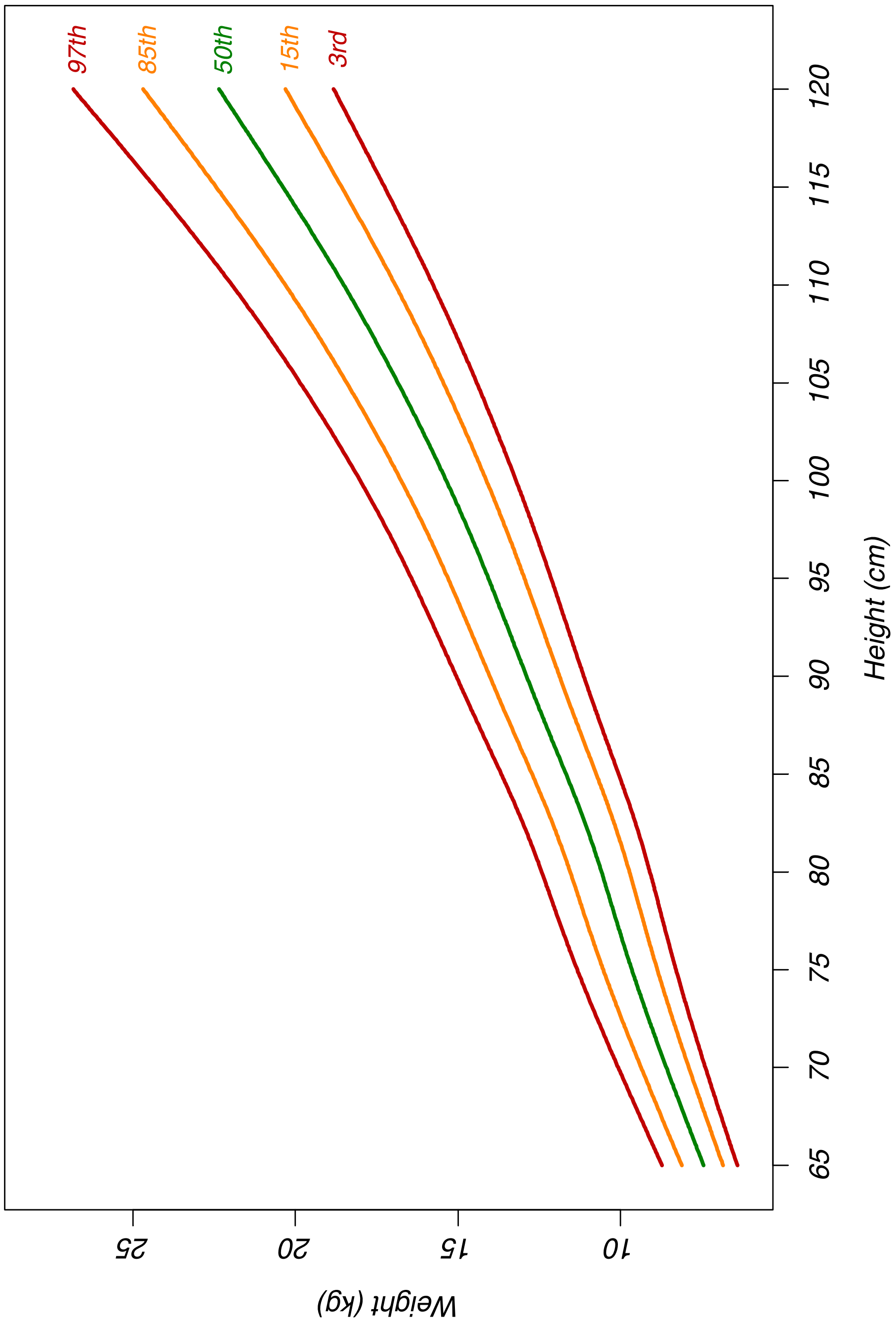


**Figure 74 WHO weight-for-height percentiles for boys from 65 to 120 cm**

**Table 57 Weight-for-length for boys**

| | | | | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Length (cm)** | **L** | **M** | **S** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **45.0** | -0.3521 | 2.4410 | 0.09182 | 2.0 | 2.1 | 2.1 | 2.2 | 2.3 | 2.4 | 2.6 | 2.7 | 2.9 | 2.9 | 3.0 |
| **45.5** | -0.3521 | 2.5244 | 0.09153 | 2.1 | 2.1 | 2.2 | 2.3 | 2.4 | 2.5 | 2.7 | 2.8 | 2.9 | 3.0 | 3.1 |
| **46.0** | -0.3521 | 2.6077 | 0.09124 | 2.1 | 2.2 | 2.3 | 2.4 | 2.5 | 2.6 | 2.8 | 2.9 | 3.0 | 3.1 | 3.3 |
| **46.5** | -0.3521 | 2.6913 | 0.09094 | 2.2 | 2.3 | 2.3 | 2.5 | 2.5 | 2.7 | 2.9 | 3.0 | 3.1 | 3.2 | 3.4 |
| **47.0** | -0.3521 | 2.7755 | 0.09065 | 2.3 | 2.4 | 2.4 | 2.5 | 2.6 | 2.8 | 3.0 | 3.1 | 3.2 | 3.3 | 3.5 |
| **47.5** | -0.3521 | 2.8609 | 0.09036 | 2.3 | 2.4 | 2.5 | 2.6 | 2.7 | 2.9 | 3.0 | 3.1 | 3.3 | 3.4 | 3.6 |
| **48.0** | -0.3521 | 2.9480 | 0.09007 | 2.4 | 2.5 | 2.6 | 2.7 | 2.8 | 2.9 | 3.1 | 3.2 | 3.4 | 3.5 | 3.7 |
| **48.5** | -0.3521 | 3.0377 | 0.08977 | 2.5 | 2.6 | 2.6 | 2.8 | 2.9 | 3.0 | 3.2 | 3.3 | 3.5 | 3.6 | 3.8 |
| **49.0** | -0.3521 | 3.1308 | 0.08948 | 2.6 | 2.7 | 2.7 | 2.9 | 2.9 | 3.1 | 3.3 | 3.4 | 3.6 | 3.7 | 3.9 |
| **49.5** | -0.3521 | 3.2276 | 0.08919 | 2.6 | 2.7 | 2.8 | 2.9 | 3.0 | 3.2 | 3.4 | 3.5 | 3.8 | 3.8 | 4.0 |
| **50.0** | -0.3521 | 3.3278 | 0.08890 | 2.7 | 2.8 | 2.9 | 3.0 | 3.1 | 3.3 | 3.5 | 3.7 | 3.9 | 4.0 | 4.1 |
| **50.5** | -0.3521 | 3.4311 | 0.08861 | 2.8 | 2.9 | 3.0 | 3.1 | 3.2 | 3.4 | 3.6 | 3.8 | 4.0 | 4.1 | 4.2 |
| **51.0** | -0.3521 | 3.5376 | 0.08831 | 2.9 | 3.0 | 3.1 | 3.2 | 3.3 | 3.5 | 3.8 | 3.9 | 4.1 | 4.2 | 4.4 |
| **51.5** | -0.3521 | 3.6477 | 0.08801 | 3.0 | 3.1 | 3.2 | 3.3 | 3.4 | 3.6 | 3.9 | 4.0 | 4.2 | 4.3 | 4.5 |
| **52.0** | -0.3521 | 3.7620 | 0.08771 | 3.1 | 3.2 | 3.3 | 3.4 | 3.5 | 3.8 | 4.0 | 4.1 | 4.4 | 4.5 | 4.6 |
| **52.5** | -0.3521 | 3.8814 | 0.08741 | 3.2 | 3.3 | 3.4 | 3.6 | 3.7 | 3.9 | 4.1 | 4.3 | 4.5 | 4.6 | 4.8 |
| **53.0** | -0.3521 | 4.0060 | 0.08711 | 3.3 | 3.4 | 3.5 | 3.7 | 3.8 | 4.0 | 4.3 | 4.4 | 4.6 | 4.7 | 4.9 |
| **53.5** | -0.3521 | 4.1354 | 0.08681 | 3.4 | 3.5 | 3.6 | 3.8 | 3.9 | 4.1 | 4.4 | 4.5 | 4.8 | 4.9 | 5.1 |
| **54.0** | -0.3521 | 4.2693 | 0.08651 | 3.5 | 3.6 | 3.7 | 3.9 | 4.0 | 4.3 | 4.5 | 4.7 | 4.9 | 5.0 | 5.3 |
| **54.5** | -0.3521 | 4.4066 | 0.08621 | 3.6 | 3.8 | 3.8 | 4.0 | 4.2 | 4.4 | 4.7 | 4.8 | 5.1 | 5.2 | 5.4 |
| **55.0** | -0.3521 | 4.5467 | 0.08592 | 3.7 | 3.9 | 4.0 | 4.2 | 4.3 | 4.5 | 4.8 | 5.0 | 5.3 | 5.4 | 5.6 |
| **55.5** | -0.3521 | 4.6892 | 0.08563 | 3.9 | 4.0 | 4.1 | 4.3 | 4.4 | 4.7 | 5.0 | 5.1 | 5.4 | 5.5 | 5.8 |
| **56.0** | -0.3521 | 4.8338 | 0.08535 | 4.0 | 4.1 | 4.2 | 4.4 | 4.6 | 4.8 | 5.1 | 5.3 | 5.6 | 5.7 | 5.9 |
| **56.5** | -0.3521 | 4.9796 | 0.08507 | 4.1 | 4.3 | 4.3 | 4.6 | 4.7 | 5.0 | 5.3 | 5.4 | 5.7 | 5.9 | 6.1 |

**Table 57 Weight-for-length for boys (continued)**

| | | | | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Length (cm)** | **L** | **M** | **S** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **57.0** | -0.3521 | 5.1259 | 0.08481 | 4.2 | 4.4 | 4.5 | 4.7 | 4.8 | 5.1 | 5.4 | 5.6 | 5.9 | 6.0 | 6.3 |
| **57.5** | -0.3521 | 5.2721 | 0.08455 | 4.4 | 4.5 | 4.6 | 4.8 | 5.0 | 5.3 | 5.6 | 5.8 | 6.1 | 6.2 | 6.5 |
| **58.0** | -0.3521 | 5.4180 | 0.08430 | 4.5 | 4.6 | 4.7 | 5.0 | 5.1 | 5.4 | 5.7 | 5.9 | 6.2 | 6.4 | 6.6 |
| **58.5** | -0.3521 | 5.5632 | 0.08406 | 4.6 | 4.8 | 4.9 | 5.1 | 5.3 | 5.6 | 5.9 | 6.1 | 6.4 | 6.5 | 6.8 |
| **59.0** | -0.3521 | 5.7074 | 0.08383 | 4.7 | 4.9 | 5.0 | 5.2 | 5.4 | 5.7 | 6.0 | 6.2 | 6.6 | 6.7 | 7.0 |
| **59.5** | -0.3521 | 5.8501 | 0.08362 | 4.8 | 5.0 | 5.1 | 5.4 | 5.5 | 5.9 | 6.2 | 6.4 | 6.7 | 6.9 | 7.2 |
| **60.0** | -0.3521 | 5.9907 | 0.08342 | 5.0 | 5.1 | 5.2 | 5.5 | 5.7 | 6.0 | 6.3 | 6.5 | 6.9 | 7.0 | 7.3 |
| **60.5** | -0.3521 | 6.1284 | 0.08324 | 5.1 | 5.3 | 5.4 | 5.6 | 5.8 | 6.1 | 6.5 | 6.7 | 7.1 | 7.2 | 7.5 |
| **61.0** | -0.3521 | 6.2632 | 0.08308 | 5.2 | 5.4 | 5.5 | 5.8 | 5.9 | 6.3 | 6.6 | 6.8 | 7.2 | 7.4 | 7.7 |
| **61.5** | -0.3521 | 6.3954 | 0.08292 | 5.3 | 5.5 | 5.6 | 5.9 | 6.1 | 6.4 | 6.8 | 7.0 | 7.4 | 7.5 | 7.8 |
| **62.0** | -0.3521 | 6.5251 | 0.08279 | 5.4 | 5.6 | 5.7 | 6.0 | 6.2 | 6.5 | 6.9 | 7.1 | 7.5 | 7.7 | 8.0 |
| **62.5** | -0.3521 | 6.6527 | 0.08266 | 5.5 | 5.7 | 5.8 | 6.1 | 6.3 | 6.7 | 7.0 | 7.3 | 7.6 | 7.8 | 8.1 |
| **63.0** | -0.3521 | 6.7786 | 0.08255 | 5.6 | 5.8 | 5.9 | 6.2 | 6.4 | 6.8 | 7.2 | 7.4 | 7.8 | 8.0 | 8.3 |
| **63.5** | -0.3521 | 6.9028 | 0.08245 | 5.7 | 5.9 | 6.0 | 6.3 | 6.5 | 6.9 | 7.3 | 7.5 | 7.9 | 8.1 | 8.4 |
| **64.0** | -0.3521 | 7.0255 | 0.08236 | 5.8 | 6.0 | 6.2 | 6.5 | 6.6 | 7.0 | 7.4 | 7.7 | 8.1 | 8.2 | 8.6 |
| **64.5** | -0.3521 | 7.1467 | 0.08229 | 5.9 | 6.1 | 6.3 | 6.6 | 6.8 | 7.1 | 7.6 | 7.8 | 8.2 | 8.4 | 8.7 |
| **65.0** | -0.3521 | 7.2666 | 0.08223 | 6.0 | 6.3 | 6.4 | 6.7 | 6.9 | 7.3 | 7.7 | 7.9 | 8.3 | 8.5 | 8.9 |
| **65.5** | -0.3521 | 7.3854 | 0.08218 | 6.1 | 6.4 | 6.5 | 6.8 | 7.0 | 7.4 | 7.8 | 8.1 | 8.5 | 8.7 | 9.0 |
| **66.0** | -0.3521 | 7.5034 | 0.08215 | 6.2 | 6.5 | 6.6 | 6.9 | 7.1 | 7.5 | 7.9 | 8.2 | 8.6 | 8.8 | 9.1 |
| **66.5** | -0.3521 | 7.6206 | 0.08213 | 6.3 | 6.6 | 6.7 | 7.0 | 7.2 | 7.6 | 8.1 | 8.3 | 8.8 | 8.9 | 9.3 |
| **67.0** | -0.3521 | 7.7370 | 0.08212 | 6.4 | 6.7 | 6.8 | 7.1 | 7.3 | 7.7 | 8.2 | 8.4 | 8.9 | 9.1 | 9.4 |
| **67.5** | -0.3521 | 7.8526 | 0.08212 | 6.5 | 6.8 | 6.9 | 7.2 | 7.4 | 7.9 | 8.3 | 8.6 | 9.0 | 9.2 | 9.6 |
| **68.0** | -0.3521 | 7.9674 | 0.08214 | 6.6 | 6.9 | 7.0 | 7.3 | 7.5 | 8.0 | 8.4 | 8.7 | 9.2 | 9.3 | 9.7 |
| **68.5** | -0.3521 | 8.0816 | 0.08216 | 6.7 | 7.0 | 7.1 | 7.4 | 7.7 | 8.1 | 8.5 | 8.8 | 9.3 | 9.5 | 9.8 |
| **69.0** | -0.3521 | 8.1955 | 0.08219 | 6.8 | 7.1 | 7.2 | 7.5 | 7.8 | 8.2 | 8.7 | 8.9 | 9.4 | 9.6 | 10.0 |
| **69.5** | -0.3521 | 8.3092 | 0.08224 | 6.9 | 7.1 | 7.3 | 7.6 | 7.9 | 8.3 | 8.8 | 9.1 | 9.5 | 9.7 | 10.1 |
| **70.0** | -0.3521 | 8.4227 | 0.08229 | 7.0 | 7.2 | 7.4 | 7.7 | 8.0 | 8.4 | 8.9 | 9.2 | 9.7 | 9.9 | 10.3 |
| **70.5** | -0.3521 | 8.5358 | 0.08235 | 7.1 | 7.3 | 7.5 | 7.8 | 8.1 | 8.5 | 9.0 | 9.3 | 9.8 | 10.0 | 10.4 |
| **71.0** | -0.3521 | 8.6480 | 0.08241 | 7.2 | 7.4 | 7.6 | 8.0 | 8.2 | 8.6 | 9.1 | 9.4 | 9.9 | 10.1 | 10.5 |
| **71.5** | -0.3521 | 8.7594 | 0.08248 | 7.3 | 7.5 | 7.7 | 8.1 | 8.3 | 8.8 | 9.3 | 9.6 | 10.1 | 10.3 | 10.7 |

**Table 57 Weight-for-length for boys (continued)**

| Length (cm) | L | M | S | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1st | 3rd | 5th | 15th | 25th | 50th | 75th | 85th | 95th | 97th | 99th |
| **72.0** | -0.3521 | 8.8697 | 0.08254 | 7.4 | 7.6 | 7.8 | 8.2 | 8.4 | 8.9 | 9.4 | 9.7 | 10.2 | 10.4 | 10.8 |
| **72.5** | -0.3521 | 8.9788 | 0.08262 | 7.5 | 7.7 | 7.9 | 8.3 | 8.5 | 9.0 | 9.5 | 9.8 | 10.3 | 10.5 | 11.0 |
| **73.0** | -0.3521 | 9.0865 | 0.08269 | 7.5 | 7.8 | 8.0 | 8.4 | 8.6 | 9.1 | 9.6 | 9.9 | 10.4 | 10.7 | 11.1 |
| **73.5** | -0.3521 | 9.1927 | 0.08276 | 7.6 | 7.9 | 8.0 | 8.4 | 8.7 | 9.2 | 9.7 | 10.0 | 10.6 | 10.8 | 11.2 |
| **74.0** | -0.3521 | 9.2974 | 0.08283 | 7.7 | 8.0 | 8.1 | 8.5 | 8.8 | 9.3 | 9.8 | 10.1 | 10.7 | 10.9 | 11.4 |
| **74.5** | -0.3521 | 9.4010 | 0.08289 | 7.8 | 8.1 | 8.2 | 8.6 | 8.9 | 9.4 | 9.9 | 10.3 | 10.8 | 11.0 | 11.5 |
| **75.0** | -0.3521 | 9.5032 | 0.08295 | 7.9 | 8.2 | 8.3 | 8.7 | 9.0 | 9.5 | 10.1 | 10.4 | 10.9 | 11.2 | 11.6 |
| **75.5** | -0.3521 | 9.6041 | 0.08301 | 8.0 | 8.2 | 8.4 | 8.8 | 9.1 | 9.6 | 10.2 | 10.5 | 11.0 | 11.3 | 11.7 |
| **76.0** | -0.3521 | 9.7033 | 0.08307 | 8.0 | 8.3 | 8.5 | 8.9 | 9.2 | 9.7 | 10.3 | 10.6 | 11.2 | 11.4 | 11.9 |
| **76.5** | -0.3521 | 9.8007 | 0.08311 | 8.1 | 8.4 | 8.6 | 9.0 | 9.3 | 9.8 | 10.4 | 10.7 | 11.3 | 11.5 | 12.0 |
| **77.0** | -0.3521 | 9.8963 | 0.08314 | 8.2 | 8.5 | 8.7 | 9.1 | 9.4 | 9.9 | 10.5 | 10.8 | 11.4 | 11.6 | 12.1 |
| **77.5** | -0.3521 | 9.9902 | 0.08317 | 8.3 | 8.6 | 8.7 | 9.2 | 9.5 | 10.0 | 10.6 | 10.9 | 11.5 | 11.7 | 12.2 |
| **78.0** | -0.3521 | 10.0827 | 0.08318 | 8.4 | 8.7 | 8.8 | 9.3 | 9.5 | 10.1 | 10.7 | 11.0 | 11.6 | 11.8 | 12.3 |
| **78.5** | -0.3521 | 10.1741 | 0.08318 | 8.4 | 8.7 | 8.9 | 9.3 | 9.6 | 10.2 | 10.8 | 11.1 | 11.7 | 12.0 | 12.4 |
| **79.0** | -0.3521 | 10.2649 | 0.08316 | 8.5 | 8.8 | 9.0 | 9.4 | 9.7 | 10.3 | 10.9 | 11.2 | 11.8 | 12.1 | 12.5 |
| **79.5** | -0.3521 | 10.3558 | 0.08313 | 8.6 | 8.9 | 9.1 | 9.5 | 9.8 | 10.4 | 11.0 | 11.3 | 11.9 | 12.2 | 12.7 |
| **80.0** | -0.3521 | 10.4475 | 0.08308 | 8.7 | 9.0 | 9.1 | 9.6 | 9.9 | 10.4 | 11.1 | 11.4 | 12.0 | 12.3 | 12.8 |
| **80.5** | -0.3521 | 10.5405 | 0.08301 | 8.7 | 9.1 | 9.2 | 9.7 | 10.0 | 10.5 | 11.2 | 11.5 | 12.1 | 12.4 | 12.9 |
| **81.0** | -0.3521 | 10.6352 | 0.08293 | 8.8 | 9.1 | 9.3 | 9.8 | 10.1 | 10.6 | 11.3 | 11.6 | 12.2 | 12.5 | 13.0 |
| **81.5** | -0.3521 | 10.7322 | 0.08284 | 8.9 | 9.2 | 9.4 | 9.9 | 10.2 | 10.7 | 11.4 | 11.7 | 12.3 | 12.6 | 13.1 |
| **82.0** | -0.3521 | 10.8321 | 0.08273 | 9.0 | 9.3 | 9.5 | 10.0 | 10.2 | 10.8 | 11.5 | 11.8 | 12.5 | 12.7 | 13.2 |
| **82.5** | -0.3521 | 10.9350 | 0.08260 | 9.1 | 9.4 | 9.6 | 10.1 | 10.3 | 10.9 | 11.6 | 11.9 | 12.6 | 12.8 | 13.3 |
| **83.0** | -0.3521 | 11.0415 | 0.08246 | 9.2 | 9.5 | 9.7 | 10.1 | 10.4 | 11.0 | 11.7 | 12.0 | 12.7 | 13.0 | 13.5 |
| **83.5** | -0.3521 | 11.1516 | 0.08231 | 9.3 | 9.6 | 9.8 | 10.3 | 10.6 | 11.2 | 11.8 | 12.2 | 12.8 | 13.1 | 13.6 |
| **84.0** | -0.3521 | 11.2651 | 0.08215 | 9.4 | 9.7 | 9.9 | 10.4 | 10.7 | 11.3 | 11.9 | 12.3 | 12.9 | 13.2 | 13.7 |
| **84.5** | -0.3521 | 11.3817 | 0.08198 | 9.5 | 9.8 | 10.0 | 10.5 | 10.8 | 11.4 | 12.0 | 12.4 | 13.1 | 13.3 | 13.9 |
| **85.0** | -0.3521 | 11.5007 | 0.08181 | 9.6 | 9.9 | 10.1 | 10.6 | 10.9 | 11.5 | 12.2 | 12.5 | 13.2 | 13.5 | 14.0 |
| **85.5** | -0.3521 | 11.6218 | 0.08163 | 9.7 | 10.0 | 10.2 | 10.7 | 11.0 | 11.6 | 12.3 | 12.7 | 13.3 | 13.6 | 14.1 |
| **86.0** | -0.3521 | 11.7444 | 0.08145 | 9.8 | 10.1 | 10.3 | 10.8 | 11.1 | 11.7 | 12.4 | 12.8 | 13.5 | 13.7 | 14.3 |
| **86.5** | -0.3521 | 11.8678 | 0.08128 | 9.9 | 10.2 | 10.4 | 10.9 | 11.2 | 11.9 | 12.5 | 12.9 | 13.6 | 13.9 | 14.4 |

**Table 57 Weight-for-length for boys (continued)**

| | | | | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Length (cm)** | **L** | **M** | **S** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **87.0** | -0.3521 | 11.9916 | 0.08111 | 10.0 | 10.3 | 10.5 | 11.0 | 11.4 | 12.0 | 12.7 | 13.1 | 13.7 | 14.0 | 14.6 |
| **87.5** | -0.3521 | 12.1152 | 0.08096 | 10.1 | 10.4 | 10.6 | 11.2 | 11.5 | 12.1 | 12.8 | 13.2 | 13.9 | 14.2 | 14.7 |
| **88.0** | -0.3521 | 12.2382 | 0.08082 | 10.2 | 10.6 | 10.7 | 11.3 | 11.6 | 12.2 | 12.9 | 13.3 | 14.0 | 14.3 | 14.9 |
| **88.5** | -0.3521 | 12.3603 | 0.08069 | 10.3 | 10.7 | 10.9 | 11.4 | 11.7 | 12.4 | 13.1 | 13.5 | 14.2 | 14.4 | 15.0 |
| **89.0** | -0.3521 | 12.4815 | 0.08058 | 10.4 | 10.8 | 11.0 | 11.5 | 11.8 | 12.5 | 13.2 | 13.6 | 14.3 | 14.6 | 15.2 |
| **89.5** | -0.3521 | 12.6017 | 0.08048 | 10.5 | 10.9 | 11.1 | 11.6 | 11.9 | 12.6 | 13.3 | 13.7 | 14.4 | 14.7 | 15.3 |
| **90.0** | -0.3521 | 12.7209 | 0.08041 | 10.6 | 11.0 | 11.2 | 11.7 | 12.1 | 12.7 | 13.4 | 13.8 | 14.6 | 14.9 | 15.4 |
| **90.5** | -0.3521 | 12.8392 | 0.08034 | 10.7 | 11.1 | 11.3 | 11.8 | 12.2 | 12.8 | 13.6 | 14.0 | 14.7 | 15.0 | 15.6 |
| **91.0** | -0.3521 | 12.9569 | 0.08030 | 10.8 | 11.2 | 11.4 | 11.9 | 12.3 | 13.0 | 13.7 | 14.1 | 14.8 | 15.1 | 15.7 |
| **91.5** | -0.3521 | 13.0742 | 0.08026 | 10.9 | 11.3 | 11.5 | 12.0 | 12.4 | 13.1 | 13.8 | 14.2 | 15.0 | 15.3 | 15.9 |
| **92.0** | -0.3521 | 13.1910 | 0.08025 | 11.0 | 11.4 | 11.6 | 12.2 | 12.5 | 13.2 | 13.9 | 14.4 | 15.1 | 15.4 | 16.0 |
| **92.5** | -0.3521 | 13.3075 | 0.08025 | 11.1 | 11.5 | 11.7 | 12.3 | 12.6 | 13.3 | 14.1 | 14.5 | 15.2 | 15.5 | 16.1 |
| **93.0** | -0.3521 | 13.4239 | 0.08026 | 11.2 | 11.6 | 11.8 | 12.4 | 12.7 | 13.4 | 14.2 | 14.6 | 15.4 | 15.7 | 16.3 |
| **93.5** | -0.3521 | 13.5404 | 0.08029 | 11.3 | 11.7 | 11.9 | 12.5 | 12.8 | 13.5 | 14.3 | 14.7 | 15.5 | 15.8 | 16.4 |
| **94.0** | -0.3521 | 13.6572 | 0.08034 | 11.4 | 11.8 | 12.0 | 12.6 | 12.9 | 13.7 | 14.4 | 14.9 | 15.6 | 16.0 | 16.6 |
| **94.5** | -0.3521 | 13.7746 | 0.08040 | 11.5 | 11.9 | 12.1 | 12.7 | 13.1 | 13.8 | 14.5 | 15.0 | 15.8 | 16.1 | 16.7 |
| **95.0** | -0.3521 | 13.8928 | 0.08047 | 11.6 | 12.0 | 12.2 | 12.8 | 13.2 | 13.9 | 14.7 | 15.1 | 15.9 | 16.2 | 16.9 |
| **95.5** | -0.3521 | 14.0120 | 0.08056 | 11.7 | 12.1 | 12.3 | 12.9 | 13.3 | 14.0 | 14.8 | 15.3 | 16.0 | 16.4 | 17.0 |
| **96.0** | -0.3521 | 14.1325 | 0.08067 | 11.8 | 12.2 | 12.4 | 13.0 | 13.4 | 14.1 | 14.9 | 15.4 | 16.2 | 16.5 | 17.2 |
| **96.5** | -0.3521 | 14.2544 | 0.08078 | 11.9 | 12.3 | 12.5 | 13.1 | 13.5 | 14.3 | 15.1 | 15.5 | 16.3 | 16.7 | 17.3 |
| **97.0** | -0.3521 | 14.3782 | 0.08092 | 12.0 | 12.4 | 12.6 | 13.2 | 13.6 | 14.4 | 15.2 | 15.7 | 16.5 | 16.8 | 17.5 |
| **97.5** | -0.3521 | 14.5038 | 0.08106 | 12.1 | 12.5 | 12.7 | 13.4 | 13.7 | 14.5 | 15.3 | 15.8 | 16.6 | 17.0 | 17.6 |
| **98.0** | -0.3521 | 14.6316 | 0.08122 | 12.2 | 12.6 | 12.8 | 13.5 | 13.9 | 14.6 | 15.5 | 15.9 | 16.8 | 17.1 | 17.8 |
| **98.5** | -0.3521 | 14.7614 | 0.08139 | 12.3 | 12.7 | 13.0 | 13.6 | 14.0 | 14.8 | 15.6 | 16.1 | 16.9 | 17.3 | 18.0 |
| **99.0** | -0.3521 | 14.8934 | 0.08157 | 12.4 | 12.8 | 13.1 | 13.7 | 14.1 | 14.9 | 15.7 | 16.2 | 17.1 | 17.4 | 18.1 |
| **99.5** | -0.3521 | 15.0275 | 0.08177 | 12.5 | 12.9 | 13.2 | 13.8 | 14.2 | 15.0 | 15.9 | 16.4 | 17.2 | 17.6 | 18.3 |
| **100.0** | -0.3521 | 15.1637 | 0.08198 | 12.6 | 13.0 | 13.3 | 13.9 | 14.4 | 15.2 | 16.0 | 16.5 | 17.4 | 17.8 | 18.5 |
| **100.5** | -0.3521 | 15.3018 | 0.08220 | 12.7 | 13.2 | 13.4 | 14.1 | 14.5 | 15.3 | 16.2 | 16.7 | 17.6 | 17.9 | 18.7 |
| **101.0** | -0.3521 | 15.4419 | 0.08243 | 12.8 | 13.3 | 13.5 | 14.2 | 14.6 | 15.4 | 16.3 | 16.8 | 17.7 | 18.1 | 18.8 |
| **101.5** | -0.3521 | 15.5838 | 0.08267 | 12.9 | 13.4 | 13.6 | 14.3 | 14.7 | 15.6 | 16.5 | 17.0 | 17.9 | 18.3 | 19.0 |

**Table 57 Weight-for-length for boys (continued)**

| | | | | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Length (cm)** | **L** | **M** | **S** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **102.0** | -0.3521 | 15.7276 | 0.08292 | 13.0 | 13.5 | 13.8 | 14.5 | 14.9 | 15.7 | 16.6 | 17.2 | 18.1 | 18.5 | 19.2 |
| **102.5** | -0.3521 | 15.8732 | 0.08317 | 13.2 | 13.6 | 13.9 | 14.6 | 15.0 | 15.9 | 16.8 | 17.3 | 18.3 | 18.6 | 19.4 |
| **103.0** | -0.3521 | 16.0206 | 0.08343 | 13.3 | 13.8 | 14.0 | 14.7 | 15.2 | 16.0 | 17.0 | 17.5 | 18.4 | 18.8 | 19.6 |
| **103.5** | -0.3521 | 16.1697 | 0.08370 | 13.4 | 13.9 | 14.1 | 14.8 | 15.3 | 16.2 | 17.1 | 17.7 | 18.6 | 19.0 | 19.8 |
| **104.0** | -0.3521 | 16.3204 | 0.08397 | 13.5 | 14.0 | 14.3 | 15.0 | 15.4 | 16.3 | 17.3 | 17.8 | 18.8 | 19.2 | 20.0 |
| **104.5** | -0.3521 | 16.4728 | 0.08425 | 13.6 | 14.1 | 14.4 | 15.1 | 15.6 | 16.5 | 17.4 | 18.0 | 19.0 | 19.4 | 20.2 |
| **105.0** | -0.3521 | 16.6268 | 0.08453 | 13.7 | 14.2 | 14.5 | 15.3 | 15.7 | 16.6 | 17.6 | 18.2 | 19.2 | 19.6 | 20.4 |
| **105.5** | -0.3521 | 16.7826 | 0.08481 | 13.9 | 14.4 | 14.6 | 15.4 | 15.9 | 16.8 | 17.8 | 18.4 | 19.4 | 19.8 | 20.6 |
| **106.0** | -0.3521 | 16.9401 | 0.08510 | 14.0 | 14.5 | 14.8 | 15.5 | 16.0 | 16.9 | 18.0 | 18.5 | 19.6 | 20.0 | 20.8 |
| **106.5** | -0.3521 | 17.0995 | 0.08539 | 14.1 | 14.6 | 14.9 | 15.7 | 16.2 | 17.1 | 18.1 | 18.7 | 19.7 | 20.2 | 21.0 |
| **107.0** | -0.3521 | 17.2607 | 0.08568 | 14.2 | 14.8 | 15.0 | 15.8 | 16.3 | 17.3 | 18.3 | 18.9 | 19.9 | 20.4 | 21.2 |
| **107.5** | -0.3521 | 17.4237 | 0.08599 | 14.4 | 14.9 | 15.2 | 16.0 | 16.5 | 17.4 | 18.5 | 19.1 | 20.1 | 20.6 | 21.4 |
| **108.0** | -0.3521 | 17.5885 | 0.08629 | 14.5 | 15.0 | 15.3 | 16.1 | 16.6 | 17.6 | 18.7 | 19.3 | 20.3 | 20.8 | 21.7 |
| **108.5** | -0.3521 | 17.7553 | 0.08660 | 14.6 | 15.2 | 15.5 | 16.3 | 16.8 | 17.8 | 18.8 | 19.5 | 20.5 | 21.0 | 21.9 |
| **109.0** | -0.3521 | 17.9242 | 0.08691 | 14.7 | 15.3 | 15.6 | 16.4 | 16.9 | 17.9 | 19.0 | 19.6 | 20.8 | 21.2 | 22.1 |
| **109.5** | -0.3521 | 18.0954 | 0.08723 | 14.9 | 15.4 | 15.7 | 16.6 | 17.1 | 18.1 | 19.2 | 19.8 | 21.0 | 21.4 | 22.3 |
| **110.0** | -0.3521 | 18.2689 | 0.08755 | 15.0 | 15.6 | 15.9 | 16.7 | 17.2 | 18.3 | 19.4 | 20.0 | 21.2 | 21.6 | 22.6 |

**Table 57 Weight-for-length for boys (continued)**

| | | | | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Length (cm)** | **L** | **M** | **S** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **45.0** | -0.3521 | 2.4410 | 0.09182 | 1.9 | 2.0 | 2.2 | 2.4 | 2.7 | 3.0 | 3.3 |
| **45.5** | -0.3521 | 2.5244 | 0.09153 | 1.9 | 2.1 | 2.3 | 2.5 | 2.8 | 3.1 | 3.4 |
| **46.0** | -0.3521 | 2.6077 | 0.09124 | 2.0 | 2.2 | 2.4 | 2.6 | 2.9 | 3.1 | 3.5 |
| **46.5** | -0.3521 | 2.6913 | 0.09094 | 2.1 | 2.3 | 2.5 | 2.7 | 3.0 | 3.2 | 3.6 |
| **47.0** | -0.3521 | 2.7755 | 0.09065 | 2.1 | 2.3 | 2.5 | 2.8 | 3.0 | 3.3 | 3.7 |
| **47.5** | -0.3521 | 2.8609 | 0.09036 | 2.2 | 2.4 | 2.6 | 2.9 | 3.1 | 3.4 | 3.8 |
| **48.0** | -0.3521 | 2.9480 | 0.09007 | 2.3 | 2.5 | 2.7 | 2.9 | 3.2 | 3.6 | 3.9 |
| **48.5** | -0.3521 | 3.0377 | 0.08977 | 2.3 | 2.6 | 2.8 | 3.0 | 3.3 | 3.7 | 4.0 |
| **49.0** | -0.3521 | 3.1308 | 0.08948 | 2.4 | 2.6 | 2.9 | 3.1 | 3.4 | 3.8 | 4.2 |
| **49.5** | -0.3521 | 3.2276 | 0.08919 | 2.5 | 2.7 | 3.0 | 3.2 | 3.5 | 3.9 | 4.3 |
| **50.0** | -0.3521 | 3.3278 | 0.08890 | 2.6 | 2.8 | 3.0 | 3.3 | 3.6 | 4.0 | 4.4 |
| **50.5** | -0.3521 | 3.4311 | 0.08861 | 2.7 | 2.9 | 3.1 | 3.4 | 3.8 | 4.1 | 4.5 |
| **51.0** | -0.3521 | 3.5376 | 0.08831 | 2.7 | 3.0 | 3.2 | 3.5 | 3.9 | 4.2 | 4.7 |
| **51.5** | -0.3521 | 3.6477 | 0.08801 | 2.8 | 3.1 | 3.3 | 3.6 | 4.0 | 4.4 | 4.8 |
| **52.0** | -0.3521 | 3.7620 | 0.08771 | 2.9 | 3.2 | 3.5 | 3.8 | 4.1 | 4.5 | 5.0 |
| **52.5** | -0.3521 | 3.8814 | 0.08741 | 3.0 | 3.3 | 3.6 | 3.9 | 4.2 | 4.6 | 5.1 |
| **53.0** | -0.3521 | 4.0060 | 0.08711 | 3.1 | 3.4 | 3.7 | 4.0 | 4.4 | 4.8 | 5.3 |
| **53.5** | -0.3521 | 4.1354 | 0.08681 | 3.2 | 3.5 | 3.8 | 4.1 | 4.5 | 4.9 | 5.4 |
| **54.0** | -0.3521 | 4.2693 | 0.08651 | 3.3 | 3.6 | 3.9 | 4.3 | 4.7 | 5.1 | 5.6 |
| **54.5** | -0.3521 | 4.4066 | 0.08621 | 3.4 | 3.7 | 4.0 | 4.4 | 4.8 | 5.3 | 5.8 |
| **55.0** | -0.3521 | 4.5467 | 0.08592 | 3.6 | 3.8 | 4.2 | 4.5 | 5.0 | 5.4 | 6.0 |
| **55.5** | -0.3521 | 4.6892 | 0.08563 | 3.7 | 4.0 | 4.3 | 4.7 | 5.1 | 5.6 | 6.1 |
| **56.0** | -0.3521 | 4.8338 | 0.08535 | 3.8 | 4.1 | 4.4 | 4.8 | 5.3 | 5.8 | 6.3 |
| **56.5** | -0.3521 | 4.9796 | 0.08507 | 3.9 | 4.2 | 4.6 | 5.0 | 5.4 | 5.9 | 6.5 |
| **57.0** | -0.3521 | 5.1259 | 0.08481 | 4.0 | 4.3 | 4.7 | 5.1 | 5.6 | 6.1 | 6.7 |
| **57.5** | -0.3521 | 5.2721 | 0.08455 | 4.1 | 4.5 | 4.9 | 5.3 | 5.7 | 6.3 | 6.9 |
| **58.0** | -0.3521 | 5.4180 | 0.08430 | 4.3 | 4.6 | 5.0 | 5.4 | 5.9 | 6.4 | 7.1 |
| **58.5** | -0.3521 | 5.5632 | 0.08406 | 4.4 | 4.7 | 5.1 | 5.6 | 6.1 | 6.6 | 7.2 |
| **59.0** | -0.3521 | 5.7074 | 0.08383 | 4.5 | 4.8 | 5.3 | 5.7 | 6.2 | 6.8 | 7.4 |
| **59.5** | -0.3521 | 5.8501 | 0.08362 | 4.6 | 5.0 | 5.4 | 5.9 | 6.4 | 7.0 | 7.6 |

**Table 57 Weight-for-length for boys (continued)**

| Length (cm) | L | M | S | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | -3 SD | -2 SD | -1 SD | Median | 1 SD | 2 SD | 3 SD |
| **60.0** | -0.3521 | 5.9907 | 0.08342 | 4.7 | 5.1 | 5.5 | 6.0 | 6.5 | 7.1 | 7.8 |
| **60.5** | -0.3521 | 6.1284 | 0.08324 | 4.8 | 5.2 | 5.6 | 6.1 | 6.7 | 7.3 | 8.0 |
| **61.0** | -0.3521 | 6.2632 | 0.08308 | 4.9 | 5.3 | 5.8 | 6.3 | 6.8 | 7.4 | 8.1 |
| **61.5** | -0.3521 | 6.3954 | 0.08292 | 5.0 | 5.4 | 5.9 | 6.4 | 7.0 | 7.6 | 8.3 |
| **62.0** | -0.3521 | 6.5251 | 0.08279 | 5.1 | 5.6 | 6.0 | 6.5 | 7.1 | 7.7 | 8.5 |
| **62.5** | -0.3521 | 6.6527 | 0.08266 | 5.2 | 5.7 | 6.1 | 6.7 | 7.2 | 7.9 | 8.6 |
| **63.0** | -0.3521 | 6.7786 | 0.08255 | 5.3 | 5.8 | 6.2 | 6.8 | 7.4 | 8.0 | 8.8 |
| **63.5** | -0.3521 | 6.9028 | 0.08245 | 5.4 | 5.9 | 6.4 | 6.9 | 7.5 | 8.2 | 8.9 |
| **64.0** | -0.3521 | 7.0255 | 0.08236 | 5.5 | 6.0 | 6.5 | 7.0 | 7.6 | 8.3 | 9.1 |
| **64.5** | -0.3521 | 7.1467 | 0.08229 | 5.6 | 6.1 | 6.6 | 7.1 | 7.8 | 8.5 | 9.3 |
| **65.0** | -0.3521 | 7.2666 | 0.08223 | 5.7 | 6.2 | 6.7 | 7.3 | 7.9 | 8.6 | 9.4 |
| **65.5** | -0.3521 | 7.3854 | 0.08218 | 5.8 | 6.3 | 6.8 | 7.4 | 8.0 | 8.7 | 9.6 |
| **66.0** | -0.3521 | 7.5034 | 0.08215 | 5.9 | 6.4 | 6.9 | 7.5 | 8.2 | 8.9 | 9.7 |
| **66.5** | -0.3521 | 7.6206 | 0.08213 | 6.0 | 6.5 | 7.0 | 7.6 | 8.3 | 9.0 | 9.9 |
| **67.0** | -0.3521 | 7.7370 | 0.08212 | 6.1 | 6.6 | 7.1 | 7.7 | 8.4 | 9.2 | 10.0 |
| **67.5** | -0.3521 | 7.8526 | 0.08212 | 6.2 | 6.7 | 7.2 | 7.9 | 8.5 | 9.3 | 10.2 |
| **68.0** | -0.3521 | 7.9674 | 0.08214 | 6.3 | 6.8 | 7.3 | 8.0 | 8.7 | 9.4 | 10.3 |
| **68.5** | -0.3521 | 8.0816 | 0.08216 | 6.4 | 6.9 | 7.5 | 8.1 | 8.8 | 9.6 | 10.5 |
| **69.0** | -0.3521 | 8.1955 | 0.08219 | 6.5 | 7.0 | 7.6 | 8.2 | 8.9 | 9.7 | 10.6 |
| **69.5** | -0.3521 | 8.3092 | 0.08224 | 6.6 | 7.1 | 7.7 | 8.3 | 9.0 | 9.8 | 10.8 |
| **70.0** | -0.3521 | 8.4227 | 0.08229 | 6.6 | 7.2 | 7.8 | 8.4 | 9.2 | 10.0 | 10.9 |
| **70.5** | -0.3521 | 8.5358 | 0.08235 | 6.7 | 7.3 | 7.9 | 8.5 | 9.3 | 10.1 | 11.1 |
| **71.0** | -0.3521 | 8.6480 | 0.08241 | 6.8 | 7.4 | 8.0 | 8.6 | 9.4 | 10.2 | 11.2 |
| **71.5** | -0.3521 | 8.7594 | 0.08248 | 6.9 | 7.5 | 8.1 | 8.8 | 9.5 | 10.4 | 11.3 |
| **72.0** | -0.3521 | 8.8697 | 0.08254 | 7.0 | 7.6 | 8.2 | 8.9 | 9.6 | 10.5 | 11.5 |
| **72.5** | -0.3521 | 8.9788 | 0.08262 | 7.1 | 7.6 | 8.3 | 9.0 | 9.8 | 10.6 | 11.6 |
| **73.0** | -0.3521 | 9.0865 | 0.08269 | 7.2 | 7.7 | 8.4 | 9.1 | 9.9 | 10.8 | 11.8 |
| **73.5** | -0.3521 | 9.1927 | 0.08276 | 7.2 | 7.8 | 8.5 | 9.2 | 10.0 | 10.9 | 11.9 |
| **74.0** | -0.3521 | 9.2974 | 0.08283 | 7.3 | 7.9 | 8.6 | 9.3 | 10.1 | 11.0 | 12.1 |
| **74.5** | -0.3521 | 9.4010 | 0.08289 | 7.4 | 8.0 | 8.7 | 9.4 | 10.2 | 11.2 | 12.2 |

**Table 57 Weight-for-length for boys (continued)**

| | | | | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Length (cm)** | **L** | **M** | **S** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **75.0** | -0.3521 | 9.5032 | 0.08295 | 7.5 | 8.1 | 8.8 | 9.5 | 10.3 | 11.3 | 12.3 |
| **75.5** | -0.3521 | 9.6041 | 0.08301 | 7.6 | 8.2 | 8.8 | 9.6 | 10.4 | 11.4 | 12.5 |
| **76.0** | -0.3521 | 9.7033 | 0.08307 | 7.6 | 8.3 | 8.9 | 9.7 | 10.6 | 11.5 | 12.6 |
| **76.5** | -0.3521 | 9.8007 | 0.08311 | 7.7 | 8.3 | 9.0 | 9.8 | 10.7 | 11.6 | 12.7 |
| **77.0** | -0.3521 | 9.8963 | 0.08314 | 7.8 | 8.4 | 9.1 | 9.9 | 10.8 | 11.7 | 12.8 |
| **77.5** | -0.3521 | 9.9902 | 0.08317 | 7.9 | 8.5 | 9.2 | 10.0 | 10.9 | 11.9 | 13.0 |
| **78.0** | -0.3521 | 10.0827 | 0.08318 | 7.9 | 8.6 | 9.3 | 10.1 | 11.0 | 12.0 | 13.1 |
| **78.5** | -0.3521 | 10.1741 | 0.08318 | 8.0 | 8.7 | 9.4 | 10.2 | 11.1 | 12.1 | 13.2 |
| **79.0** | -0.3521 | 10.2649 | 0.08316 | 8.1 | 8.7 | 9.5 | 10.3 | 11.2 | 12.2 | 13.3 |
| **79.5** | -0.3521 | 10.3558 | 0.08313 | 8.2 | 8.8 | 9.5 | 10.4 | 11.3 | 12.3 | 13.4 |
| **80.0** | -0.3521 | 10.4475 | 0.08308 | 8.2 | 8.9 | 9.6 | 10.4 | 11.4 | 12.4 | 13.6 |
| **80.5** | -0.3521 | 10.5405 | 0.08301 | 8.3 | 9.0 | 9.7 | 10.5 | 11.5 | 12.5 | 13.7 |
| **81.0** | -0.3521 | 10.6352 | 0.08293 | 8.4 | 9.1 | 9.8 | 10.6 | 11.6 | 12.6 | 13.8 |
| **81.5** | -0.3521 | 10.7322 | 0.08284 | 8.5 | 9.1 | 9.9 | 10.7 | 11.7 | 12.7 | 13.9 |
| **82.0** | -0.3521 | 10.8321 | 0.08273 | 8.5 | 9.2 | 10.0 | 10.8 | 11.8 | 12.8 | 14.0 |
| **82.5** | -0.3521 | 10.9350 | 0.08260 | 8.6 | 9.3 | 10.1 | 10.9 | 11.9 | 13.0 | 14.2 |
| **83.0** | -0.3521 | 11.0415 | 0.08246 | 8.7 | 9.4 | 10.2 | 11.0 | 12.0 | 13.1 | 14.3 |
| **83.5** | -0.3521 | 11.1516 | 0.08231 | 8.8 | 9.5 | 10.3 | 11.2 | 12.1 | 13.2 | 14.4 |
| **84.0** | -0.3521 | 11.2651 | 0.08215 | 8.9 | 9.6 | 10.4 | 11.3 | 12.2 | 13.3 | 14.6 |
| **84.5** | -0.3521 | 11.3817 | 0.08198 | 9.0 | 9.7 | 10.5 | 11.4 | 12.4 | 13.5 | 14.7 |
| **85.0** | -0.3521 | 11.5007 | 0.08181 | 9.1 | 9.8 | 10.6 | 11.5 | 12.5 | 13.6 | 14.9 |
| **85.5** | -0.3521 | 11.6218 | 0.08163 | 9.2 | 9.9 | 10.7 | 11.6 | 12.6 | 13.7 | 15.0 |
| **86.0** | -0.3521 | 11.7444 | 0.08145 | 9.3 | 10.0 | 10.8 | 11.7 | 12.8 | 13.9 | 15.2 |
| **86.5** | -0.3521 | 11.8678 | 0.08128 | 9.4 | 10.1 | 11.0 | 11.9 | 12.9 | 14.0 | 15.3 |
| **87.0** | -0.3521 | 11.9916 | 0.08111 | 9.5 | 10.2 | 11.1 | 12.0 | 13.0 | 14.2 | 15.5 |
| **87.5** | -0.3521 | 12.1152 | 0.08096 | 9.6 | 10.4 | 11.2 | 12.1 | 13.2 | 14.3 | 15.6 |
| **88.0** | -0.3521 | 12.2382 | 0.08082 | 9.7 | 10.5 | 11.3 | 12.2 | 13.3 | 14.5 | 15.8 |
| **88.5** | -0.3521 | 12.3603 | 0.08069 | 9.8 | 10.6 | 11.4 | 12.4 | 13.4 | 14.6 | 15.9 |
| **89.0** | -0.3521 | 12.4815 | 0.08058 | 9.9 | 10.7 | 11.5 | 12.5 | 13.5 | 14.7 | 16.1 |
| **89.5** | -0.3521 | 12.6017 | 0.08048 | 10.0 | 10.8 | 11.6 | 12.6 | 13.7 | 14.9 | 16.2 |

**Table 57 Weight-for-length for boys (continued)**

| | | | | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Length (cm)** | **L** | **M** | **S** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **90.0** | -0.3521 | 12.7209 | 0.08041 | 10.1 | 10.9 | 11.8 | 12.7 | 13.8 | 15.0 | 16.4 |
| **90.5** | -0.3521 | 12.8392 | 0.08034 | 10.2 | 11.0 | 11.9 | 12.8 | 13.9 | 15.1 | 16.5 |
| **91.0** | -0.3521 | 12.9569 | 0.08030 | 10.3 | 11.1 | 12.0 | 13.0 | 14.1 | 15.3 | 16.7 |
| **91.5** | -0.3521 | 13.0742 | 0.08026 | 10.4 | 11.2 | 12.1 | 13.1 | 14.2 | 15.4 | 16.8 |
| **92.0** | -0.3521 | 13.1910 | 0.08025 | 10.5 | 11.3 | 12.2 | 13.2 | 14.3 | 15.6 | 17.0 |
| **92.5** | -0.3521 | 13.3075 | 0.08025 | 10.6 | 11.4 | 12.3 | 13.3 | 14.4 | 15.7 | 17.1 |
| **93.0** | -0.3521 | 13.4239 | 0.08026 | 10.7 | 11.5 | 12.4 | 13.4 | 14.6 | 15.8 | 17.3 |
| **93.5** | -0.3521 | 13.5404 | 0.08029 | 10.7 | 11.6 | 12.5 | 13.5 | 14.7 | 16.0 | 17.4 |
| **94.0** | -0.3521 | 13.6572 | 0.08034 | 10.8 | 11.7 | 12.6 | 13.7 | 14.8 | 16.1 | 17.6 |
| **94.5** | -0.3521 | 13.7746 | 0.08040 | 10.9 | 11.8 | 12.7 | 13.8 | 14.9 | 16.3 | 17.7 |
| **95.0** | -0.3521 | 13.8928 | 0.08047 | 11.0 | 11.9 | 12.8 | 13.9 | 15.1 | 16.4 | 17.9 |
| **95.5** | -0.3521 | 14.0120 | 0.08056 | 11.1 | 12.0 | 12.9 | 14.0 | 15.2 | 16.5 | 18.0 |
| **96.0** | -0.3521 | 14.1325 | 0.08067 | 11.2 | 12.1 | 13.1 | 14.1 | 15.3 | 16.7 | 18.2 |
| **96.5** | -0.3521 | 14.2544 | 0.08078 | 11.3 | 12.2 | 13.2 | 14.3 | 15.5 | 16.8 | 18.4 |
| **97.0** | -0.3521 | 14.3782 | 0.08092 | 11.4 | 12.3 | 13.3 | 14.4 | 15.6 | 17.0 | 18.5 |
| **97.5** | -0.3521 | 14.5038 | 0.08106 | 11.5 | 12.4 | 13.4 | 14.5 | 15.7 | 17.1 | 18.7 |
| **98.0** | -0.3521 | 14.6316 | 0.08122 | 11.6 | 12.5 | 13.5 | 14.6 | 15.9 | 17.3 | 18.9 |
| **98.5** | -0.3521 | 14.7614 | 0.08139 | 11.7 | 12.6 | 13.6 | 14.8 | 16.0 | 17.5 | 19.1 |
| **99.0** | -0.3521 | 14.8934 | 0.08157 | 11.8 | 12.7 | 13.7 | 14.9 | 16.2 | 17.6 | 19.2 |
| **99.5** | -0.3521 | 15.0275 | 0.08177 | 11.9 | 12.8 | 13.9 | 15.0 | 16.3 | 17.8 | 19.4 |
| **100.0** | -0.3521 | 15.1637 | 0.08198 | 12.0 | 12.9 | 14.0 | 15.2 | 16.5 | 18.0 | 19.6 |
| **100.5** | -0.3521 | 15.3018 | 0.08220 | 12.1 | 13.0 | 14.1 | 15.3 | 16.6 | 18.1 | 19.8 |
| **101.0** | -0.3521 | 15.4419 | 0.08243 | 12.2 | 13.2 | 14.2 | 15.4 | 16.8 | 18.3 | 20.0 |
| **101.5** | -0.3521 | 15.5838 | 0.08267 | 12.3 | 13.3 | 14.4 | 15.6 | 16.9 | 18.5 | 20.2 |
| **102.0** | -0.3521 | 15.7276 | 0.08292 | 12.4 | 13.4 | 14.5 | 15.7 | 17.1 | 18.7 | 20.4 |
| **102.5** | -0.3521 | 15.8732 | 0.08317 | 12.5 | 13.5 | 14.6 | 15.9 | 17.3 | 18.8 | 20.6 |
| **103.0** | -0.3521 | 16.0206 | 0.08343 | 12.6 | 13.6 | 14.8 | 16.0 | 17.4 | 19.0 | 20.8 |
| **103.5** | -0.3521 | 16.1697 | 0.08370 | 12.7 | 13.7 | 14.9 | 16.2 | 17.6 | 19.2 | 21.0 |
| **104.0** | -0.3521 | 16.3204 | 0.08397 | 12.8 | 13.9 | 15.0 | 16.3 | 17.8 | 19.4 | 21.2 |
| **104.5** | -0.3521 | 16.4728 | 0.08425 | 12.9 | 14.0 | 15.2 | 16.5 | 17.9 | 19.6 | 21.5 |

**Table 57 Weight-for-length for boys (continued)**

| Length (cm) | L | M | S | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | -3 SD | -2 SD | -1 SD | Median | 1 SD | 2 SD | 3 SD |
| **105.0** | -0.3521 | 16.6268 | 0.08453 | 13.0 | 14.1 | 15.3 | 16.6 | 18.1 | 19.8 | 21.7 |
| **105.5** | -0.3521 | 16.7826 | 0.08481 | 13.2 | 14.2 | 15.4 | 16.8 | 18.3 | 20.0 | 21.9 |
| **106.0** | -0.3521 | 16.9401 | 0.08510 | 13.3 | 14.4 | 15.6 | 16.9 | 18.5 | 20.2 | 22.1 |
| **106.5** | -0.3521 | 17.0995 | 0.08539 | 13.4 | 14.5 | 15.7 | 17.1 | 18.6 | 20.4 | 22.4 |
| **107.0** | -0.3521 | 17.2607 | 0.08568 | 13.5 | 14.6 | 15.9 | 17.3 | 18.8 | 20.6 | 22.6 |
| **107.5** | -0.3521 | 17.4237 | 0.08599 | 13.6 | 14.7 | 16.0 | 17.4 | 19.0 | 20.8 | 22.8 |
| **108.0** | -0.3521 | 17.5885 | 0.08629 | 13.7 | 14.9 | 16.2 | 17.6 | 19.2 | 21.0 | 23.1 |
| **108.5** | -0.3521 | 17.7553 | 0.08660 | 13.8 | 15.0 | 16.3 | 17.8 | 19.4 | 21.2 | 23.3 |
| **109.0** | -0.3521 | 17.9242 | 0.08691 | 14.0 | 15.1 | 16.5 | 17.9 | 19.6 | 21.4 | 23.6 |
| **109.5** | -0.3521 | 18.0954 | 0.08723 | 14.1 | 15.3 | 16.6 | 18.1 | 19.8 | 21.7 | 23.8 |
| **110.0** | -0.3521 | 18.2689 | 0.08755 | 14.2 | 15.4 | 16.8 | 18.3 | 20.0 | 21.9 | 24.1 |

**Table 58 Weight-for-height for boys**

| | | | | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Height (cm)** | **L** | **M** | **S** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **65.0** | -0.3521 | 7.4327 | 0.08217 | 6.2 | 6.4 | 6.5 | 6.8 | 7.0 | 7.4 | 7.9 | 8.1 | 8.5 | 8.7 | 9.1 |
| **65.5** | -0.3521 | 7.5504 | 0.08214 | 6.3 | 6.5 | 6.6 | 6.9 | 7.1 | 7.6 | 8.0 | 8.2 | 8.7 | 8.9 | 9.2 |
| **66.0** | -0.3521 | 7.6673 | 0.08212 | 6.4 | 6.6 | 6.7 | 7.1 | 7.3 | 7.7 | 8.1 | 8.4 | 8.8 | 9.0 | 9.3 |
| **66.5** | -0.3521 | 7.7834 | 0.08212 | 6.5 | 6.7 | 6.8 | 7.2 | 7.4 | 7.8 | 8.2 | 8.5 | 8.9 | 9.1 | 9.5 |
| **67.0** | -0.3521 | 7.8986 | 0.08213 | 6.6 | 6.8 | 6.9 | 7.3 | 7.5 | 7.9 | 8.4 | 8.6 | 9.1 | 9.3 | 9.6 |
| **67.5** | -0.3521 | 8.0132 | 0.08214 | 6.7 | 6.9 | 7.0 | 7.4 | 7.6 | 8.0 | 8.5 | 8.7 | 9.2 | 9.4 | 9.8 |
| **68.0** | -0.3521 | 8.1272 | 0.08217 | 6.8 | 7.0 | 7.1 | 7.5 | 7.7 | 8.1 | 8.6 | 8.9 | 9.3 | 9.5 | 9.9 |
| **68.5** | -0.3521 | 8.2410 | 0.08221 | 6.8 | 7.1 | 7.2 | 7.6 | 7.8 | 8.2 | 8.7 | 9.0 | 9.5 | 9.7 | 10.0 |
| **69.0** | -0.3521 | 8.3547 | 0.08226 | 6.9 | 7.2 | 7.3 | 7.7 | 7.9 | 8.4 | 8.8 | 9.1 | 9.6 | 9.8 | 10.2 |
| **69.5** | -0.3521 | 8.4680 | 0.08231 | 7.0 | 7.3 | 7.4 | 7.8 | 8.0 | 8.5 | 9.0 | 9.2 | 9.7 | 9.9 | 10.3 |
| **70.0** | -0.3521 | 8.5808 | 0.08237 | 7.1 | 7.4 | 7.5 | 7.9 | 8.1 | 8.6 | 9.1 | 9.4 | 9.9 | 10.1 | 10.5 |
| **70.5** | -0.3521 | 8.6927 | 0.08243 | 7.2 | 7.5 | 7.6 | 8.0 | 8.2 | 8.7 | 9.2 | 9.5 | 10.0 | 10.2 | 10.6 |
| **71.0** | -0.3521 | 8.8036 | 0.08250 | 7.3 | 7.6 | 7.7 | 8.1 | 8.3 | 8.8 | 9.3 | 9.6 | 10.1 | 10.3 | 10.7 |
| **71.5** | -0.3521 | 8.9135 | 0.08257 | 7.4 | 7.7 | 7.8 | 8.2 | 8.4 | 8.9 | 9.4 | 9.7 | 10.2 | 10.5 | 10.9 |
| **72.0** | -0.3521 | 9.0221 | 0.08264 | 7.5 | 7.8 | 7.9 | 8.3 | 8.5 | 9.0 | 9.5 | 9.8 | 10.4 | 10.6 | 11.0 |
| **72.5** | -0.3521 | 9.1292 | 0.08272 | 7.6 | 7.8 | 8.0 | 8.4 | 8.6 | 9.1 | 9.7 | 10.0 | 10.5 | 10.7 | 11.1 |
| **73.0** | -0.3521 | 9.2347 | 0.08278 | 7.7 | 7.9 | 8.1 | 8.5 | 8.7 | 9.2 | 9.8 | 10.1 | 10.6 | 10.8 | 11.3 |
| **73.5** | -0.3521 | 9.3390 | 0.08285 | 7.8 | 8.0 | 8.2 | 8.6 | 8.8 | 9.3 | 9.9 | 10.2 | 10.7 | 11.0 | 11.4 |
| **74.0** | -0.3521 | 9.4420 | 0.08292 | 7.8 | 8.1 | 8.3 | 8.7 | 8.9 | 9.4 | 10.0 | 10.3 | 10.9 | 11.1 | 11.5 |
| **74.5** | -0.3521 | 9.5438 | 0.08298 | 7.9 | 8.2 | 8.4 | 8.8 | 9.0 | 9.5 | 10.1 | 10.4 | 11.0 | 11.2 | 11.7 |
| **75.0** | -0.3521 | 9.6440 | 0.08303 | 8.0 | 8.3 | 8.4 | 8.9 | 9.1 | 9.6 | 10.2 | 10.5 | 11.1 | 11.3 | 11.8 |
| **75.5** | -0.3521 | 9.7425 | 0.08308 | 8.1 | 8.4 | 8.5 | 9.0 | 9.2 | 9.7 | 10.3 | 10.6 | 11.2 | 11.4 | 11.9 |
| **76.0** | -0.3521 | 9.8392 | 0.08312 | 8.2 | 8.5 | 8.6 | 9.0 | 9.3 | 9.8 | 10.4 | 10.7 | 11.3 | 11.6 | 12.0 |
| **76.5** | -0.3521 | 9.9341 | 0.08315 | 8.2 | 8.5 | 8.7 | 9.1 | 9.4 | 9.9 | 10.5 | 10.8 | 11.4 | 11.7 | 12.1 |
| **77.0** | -0.3521 | 10.0274 | 0.08317 | 8.3 | 8.6 | 8.8 | 9.2 | 9.5 | 10.0 | 10.6 | 10.9 | 11.5 | 11.8 | 12.3 |
| **77.5** | -0.3521 | 10.1194 | 0.08318 | 8.4 | 8.7 | 8.9 | 9.3 | 9.6 | 10.1 | 10.7 | 11.0 | 11.6 | 11.9 | 12.4 |
| **78.0** | -0.3521 | 10.2105 | 0.08317 | 8.5 | 8.8 | 8.9 | 9.4 | 9.7 | 10.2 | 10.8 | 11.1 | 11.7 | 12.0 | 12.5 |
| **78.5** | -0.3521 | 10.3012 | 0.08315 | 8.5 | 8.8 | 9.0 | 9.5 | 9.7 | 10.3 | 10.9 | 11.2 | 11.9 | 12.1 | 12.6 |
| **79.0** | -0.3521 | 10.3923 | 0.08311 | 8.6 | 8.9 | 9.1 | 9.5 | 9.8 | 10.4 | 11.0 | 11.3 | 12.0 | 12.2 | 12.7 |
| **79.5** | -0.3521 | 10.4845 | 0.08305 | 8.7 | 9.0 | 9.2 | 9.6 | 9.9 | 10.5 | 11.1 | 11.4 | 12.1 | 12.3 | 12.8 |

**Table 58 Weight-for-height for boys (continued)**

| | | | | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Height (cm)** | **L** | **M** | **S** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **80.0** | -0.3521 | 10.5781 | 0.08298 | 8.8 | 9.1 | 9.3 | 9.7 | 10.0 | 10.6 | 11.2 | 11.5 | 12.2 | 12.4 | 12.9 |
| **80.5** | -0.3521 | 10.6737 | 0.08290 | 8.9 | 9.2 | 9.3 | 9.8 | 10.1 | 10.7 | 11.3 | 11.6 | 12.3 | 12.5 | 13.0 |
| **81.0** | -0.3521 | 10.7718 | 0.08279 | 8.9 | 9.3 | 9.4 | 9.9 | 10.2 | 10.8 | 11.4 | 11.8 | 12.4 | 12.6 | 13.1 |
| **81.5** | -0.3521 | 10.8728 | 0.08268 | 9.0 | 9.3 | 9.5 | 10.0 | 10.3 | 10.9 | 11.5 | 11.9 | 12.5 | 12.8 | 13.3 |
| **82.0** | -0.3521 | 10.9772 | 0.08255 | 9.1 | 9.4 | 9.6 | 10.1 | 10.4 | 11.0 | 11.6 | 12.0 | 12.6 | 12.9 | 13.4 |
| **82.5** | -0.3521 | 11.0851 | 0.08241 | 9.2 | 9.5 | 9.7 | 10.2 | 10.5 | 11.1 | 11.7 | 12.1 | 12.7 | 13.0 | 13.5 |
| **83.0** | -0.3521 | 11.1966 | 0.08225 | 9.3 | 9.6 | 9.8 | 10.3 | 10.6 | 11.2 | 11.8 | 12.2 | 12.9 | 13.1 | 13.6 |
| **83.5** | -0.3521 | 11.3114 | 0.08209 | 9.4 | 9.7 | 9.9 | 10.4 | 10.7 | 11.3 | 12.0 | 12.3 | 13.0 | 13.3 | 13.8 |
| **84.0** | -0.3521 | 11.4290 | 0.08191 | 9.5 | 9.8 | 10.0 | 10.5 | 10.8 | 11.4 | 12.1 | 12.5 | 13.1 | 13.4 | 13.9 |
| **84.5** | -0.3521 | 11.5490 | 0.08174 | 9.6 | 9.9 | 10.1 | 10.6 | 10.9 | 11.5 | 12.2 | 12.6 | 13.3 | 13.5 | 14.1 |
| **85.0** | -0.3521 | 11.6707 | 0.08156 | 9.7 | 10.1 | 10.2 | 10.7 | 11.1 | 11.7 | 12.3 | 12.7 | 13.4 | 13.7 | 14.2 |
| **85.5** | -0.3521 | 11.7937 | 0.08138 | 9.8 | 10.2 | 10.3 | 10.9 | 11.2 | 11.8 | 12.5 | 12.8 | 13.5 | 13.8 | 14.3 |
| **86.0** | -0.3521 | 11.9173 | 0.08121 | 9.9 | 10.3 | 10.5 | 11.0 | 11.3 | 11.9 | 12.6 | 13.0 | 13.7 | 13.9 | 14.5 |
| **86.5** | -0.3521 | 12.0411 | 0.08105 | 10.0 | 10.4 | 10.6 | 11.1 | 11.4 | 12.0 | 12.7 | 13.1 | 13.8 | 14.1 | 14.6 |
| **87.0** | -0.3521 | 12.1645 | 0.08090 | 10.1 | 10.5 | 10.7 | 11.2 | 11.5 | 12.2 | 12.9 | 13.2 | 13.9 | 14.2 | 14.8 |
| **87.5** | -0.3521 | 12.2871 | 0.08076 | 10.2 | 10.6 | 10.8 | 11.3 | 11.6 | 12.3 | 13.0 | 13.4 | 14.1 | 14.4 | 14.9 |
| **88.0** | -0.3521 | 12.4089 | 0.08064 | 10.3 | 10.7 | 10.9 | 11.4 | 11.8 | 12.4 | 13.1 | 13.5 | 14.2 | 14.5 | 15.1 |
| **88.5** | -0.3521 | 12.5298 | 0.08054 | 10.5 | 10.8 | 11.0 | 11.5 | 11.9 | 12.5 | 13.2 | 13.6 | 14.4 | 14.6 | 15.2 |
| **89.0** | -0.3521 | 12.6495 | 0.08045 | 10.6 | 10.9 | 11.1 | 11.7 | 12.0 | 12.6 | 13.4 | 13.8 | 14.5 | 14.8 | 15.4 |
| **89.5** | -0.3521 | 12.7683 | 0.08038 | 10.7 | 11.0 | 11.2 | 11.8 | 12.1 | 12.8 | 13.5 | 13.9 | 14.6 | 14.9 | 15.5 |
| **90.0** | -0.3521 | 12.8864 | 0.08032 | 10.8 | 11.1 | 11.3 | 11.9 | 12.2 | 12.9 | 13.6 | 14.0 | 14.8 | 15.1 | 15.6 |
| **90.5** | -0.3521 | 13.0038 | 0.08028 | 10.9 | 11.2 | 11.4 | 12.0 | 12.3 | 13.0 | 13.7 | 14.1 | 14.9 | 15.2 | 15.8 |
| **91.0** | -0.3521 | 13.1209 | 0.08025 | 11.0 | 11.3 | 11.5 | 12.1 | 12.4 | 13.1 | 13.9 | 14.3 | 15.0 | 15.3 | 15.9 |
| **91.5** | -0.3521 | 13.2376 | 0.08024 | 11.0 | 11.4 | 11.6 | 12.2 | 12.5 | 13.2 | 14.0 | 14.4 | 15.2 | 15.5 | 16.1 |
| **92.0** | -0.3521 | 13.3541 | 0.08025 | 11.1 | 11.5 | 11.7 | 12.3 | 12.7 | 13.4 | 14.1 | 14.5 | 15.3 | 15.6 | 16.2 |
| **92.5** | -0.3521 | 13.4705 | 0.08027 | 11.2 | 11.6 | 11.8 | 12.4 | 12.8 | 13.5 | 14.2 | 14.7 | 15.4 | 15.7 | 16.3 |
| **93.0** | -0.3521 | 13.5870 | 0.08031 | 11.3 | 11.7 | 11.9 | 12.5 | 12.9 | 13.6 | 14.4 | 14.8 | 15.6 | 15.9 | 16.5 |
| **93.5** | -0.3521 | 13.7041 | 0.08036 | 11.4 | 11.8 | 12.0 | 12.6 | 13.0 | 13.7 | 14.5 | 14.9 | 15.7 | 16.0 | 16.6 |
| **94.0** | -0.3521 | 13.8217 | 0.08043 | 11.5 | 11.9 | 12.1 | 12.7 | 13.1 | 13.8 | 14.6 | 15.0 | 15.8 | 16.1 | 16.8 |
| **94.5** | -0.3521 | 13.9403 | 0.08051 | 11.6 | 12.0 | 12.2 | 12.8 | 13.2 | 13.9 | 14.7 | 15.2 | 16.0 | 16.3 | 16.9 |

**Table 58 Weight-for-height for boys (continued)**

| Height (cm) | L | M | S | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1st | 3rd | 5th | 15th | 25th | 50th | 75th | 85th | 95th | 97th | 99th |
| **95.0** | -0.3521 | 14.0600 | 0.08060 | 11.7 | 12.1 | 12.4 | 12.9 | 13.3 | 14.1 | 14.9 | 15.3 | 16.1 | 16.4 | 17.1 |
| **95.5** | -0.3521 | 14.1811 | 0.08071 | 11.8 | 12.2 | 12.5 | 13.1 | 13.4 | 14.2 | 15.0 | 15.4 | 16.2 | 16.6 | 17.2 |
| **96.0** | -0.3521 | 14.3037 | 0.08083 | 11.9 | 12.3 | 12.6 | 13.2 | 13.6 | 14.3 | 15.1 | 15.6 | 16.4 | 16.7 | 17.4 |
| **96.5** | -0.3521 | 14.4282 | 0.08097 | 12.0 | 12.4 | 12.7 | 13.3 | 13.7 | 14.4 | 15.2 | 15.7 | 16.5 | 16.9 | 17.5 |
| **97.0** | -0.3521 | 14.5547 | 0.08112 | 12.1 | 12.5 | 12.8 | 13.4 | 13.8 | 14.6 | 15.4 | 15.9 | 16.7 | 17.0 | 17.7 |
| **97.5** | -0.3521 | 14.6832 | 0.08129 | 12.2 | 12.7 | 12.9 | 13.5 | 13.9 | 14.7 | 15.5 | 16.0 | 16.8 | 17.2 | 17.9 |
| **98.0** | -0.3521 | 14.8140 | 0.08146 | 12.3 | 12.8 | 13.0 | 13.6 | 14.0 | 14.8 | 15.7 | 16.1 | 17.0 | 17.3 | 18.0 |
| **98.5** | -0.3521 | 14.9468 | 0.08165 | 12.4 | 12.9 | 13.1 | 13.8 | 14.2 | 14.9 | 15.8 | 16.3 | 17.2 | 17.5 | 18.2 |
| **99.0** | -0.3521 | 15.0818 | 0.08185 | 12.5 | 13.0 | 13.2 | 13.9 | 14.3 | 15.1 | 15.9 | 16.4 | 17.3 | 17.7 | 18.4 |
| **99.5** | -0.3521 | 15.2187 | 0.08206 | 12.7 | 13.1 | 13.3 | 14.0 | 14.4 | 15.2 | 16.1 | 16.6 | 17.5 | 17.8 | 18.5 |
| **100.0** | -0.3521 | 15.3576 | 0.08229 | 12.8 | 13.2 | 13.5 | 14.1 | 14.5 | 15.4 | 16.2 | 16.7 | 17.6 | 18.0 | 18.7 |
| **100.5** | -0.3521 | 15.4985 | 0.08252 | 12.9 | 13.3 | 13.6 | 14.2 | 14.7 | 15.5 | 16.4 | 16.9 | 17.8 | 18.2 | 18.9 |
| **101.0** | -0.3521 | 15.6412 | 0.08277 | 13.0 | 13.4 | 13.7 | 14.4 | 14.8 | 15.6 | 16.5 | 17.1 | 18.0 | 18.4 | 19.1 |
| **101.5** | -0.3521 | 15.7857 | 0.08302 | 13.1 | 13.6 | 13.8 | 14.5 | 14.9 | 15.8 | 16.7 | 17.2 | 18.2 | 18.5 | 19.3 |
| **102.0** | -0.3521 | 15.9320 | 0.08328 | 13.2 | 13.7 | 13.9 | 14.6 | 15.1 | 15.9 | 16.9 | 17.4 | 18.3 | 18.7 | 19.5 |
| **102.5** | -0.3521 | 16.0801 | 0.08354 | 13.3 | 13.8 | 14.1 | 14.8 | 15.2 | 16.1 | 17.0 | 17.6 | 18.5 | 18.9 | 19.7 |
| **103.0** | -0.3521 | 16.2298 | 0.08381 | 13.4 | 13.9 | 14.2 | 14.9 | 15.3 | 16.2 | 17.2 | 17.7 | 18.7 | 19.1 | 19.9 |
| **103.5** | -0.3521 | 16.3812 | 0.08408 | 13.6 | 14.0 | 14.3 | 15.0 | 15.5 | 16.4 | 17.3 | 17.9 | 18.9 | 19.3 | 20.1 |
| **104.0** | -0.3521 | 16.5342 | 0.08436 | 13.7 | 14.2 | 14.4 | 15.2 | 15.6 | 16.5 | 17.5 | 18.1 | 19.1 | 19.5 | 20.3 |
| **104.5** | -0.3521 | 16.6889 | 0.08464 | 13.8 | 14.3 | 14.6 | 15.3 | 15.8 | 16.7 | 17.7 | 18.2 | 19.2 | 19.7 | 20.5 |
| **105.0** | -0.3521 | 16.8454 | 0.08493 | 13.9 | 14.4 | 14.7 | 15.4 | 15.9 | 16.8 | 17.8 | 18.4 | 19.4 | 19.9 | 20.7 |
| **105.5** | -0.3521 | 17.0036 | 0.08521 | 14.0 | 14.5 | 14.8 | 15.6 | 16.1 | 17.0 | 18.0 | 18.6 | 19.6 | 20.1 | 20.9 |
| **106.0** | -0.3521 | 17.1637 | 0.08551 | 14.2 | 14.7 | 15.0 | 15.7 | 16.2 | 17.2 | 18.2 | 18.8 | 19.8 | 20.3 | 21.1 |
| **106.5** | -0.3521 | 17.3256 | 0.08580 | 14.3 | 14.8 | 15.1 | 15.9 | 16.4 | 17.3 | 18.4 | 19.0 | 20.0 | 20.5 | 21.3 |
| **107.0** | -0.3521 | 17.4894 | 0.08611 | 14.4 | 14.9 | 15.2 | 16.0 | 16.5 | 17.5 | 18.5 | 19.1 | 20.2 | 20.7 | 21.5 |
| **107.5** | -0.3521 | 17.6550 | 0.08641 | 14.5 | 15.1 | 15.4 | 16.2 | 16.7 | 17.7 | 18.7 | 19.3 | 20.4 | 20.9 | 21.7 |
| **108.0** | -0.3521 | 17.8226 | 0.08673 | 14.7 | 15.2 | 15.5 | 16.3 | 16.8 | 17.8 | 18.9 | 19.5 | 20.6 | 21.1 | 22.0 |
| **108.5** | -0.3521 | 17.9924 | 0.08704 | 14.8 | 15.3 | 15.6 | 16.5 | 17.0 | 18.0 | 19.1 | 19.7 | 20.8 | 21.3 | 22.2 |
| **109.0** | -0.3521 | 18.1645 | 0.08736 | 14.9 | 15.5 | 15.8 | 16.6 | 17.1 | 18.2 | 19.3 | 19.9 | 21.1 | 21.5 | 22.4 |
| **109.5** | -0.3521 | 18.3390 | 0.08768 | 15.1 | 15.6 | 15.9 | 16.8 | 17.3 | 18.3 | 19.5 | 20.1 | 21.3 | 21.7 | 22.7 |

**Table 58 Weight-for-height for boys (continued)**

| Height (cm) | L | M | S | Percentiles (weight in kg) 1st | 3rd | 5th | 15th | 25th | 50th | 75th | 85th | 95th | 97th | 99th |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **110.0** | -0.3521 | 18.5158 | 0.08800 | 15.2 | 15.8 | 16.1 | 16.9 | 17.5 | 18.5 | 19.7 | 20.3 | 21.5 | 22.0 | 22.9 |
| **110.5** | -0.3521 | 18.6948 | 0.08832 | 15.3 | 15.9 | 16.2 | 17.1 | 17.6 | 18.7 | 19.9 | 20.5 | 21.7 | 22.2 | 23.1 |
| **111.0** | -0.3521 | 18.8759 | 0.08864 | 15.5 | 16.1 | 16.4 | 17.2 | 17.8 | 18.9 | 20.1 | 20.7 | 21.9 | 22.4 | 23.4 |
| **111.5** | -0.3521 | 19.0590 | 0.08896 | 15.6 | 16.2 | 16.5 | 17.4 | 18.0 | 19.1 | 20.3 | 20.9 | 22.1 | 22.6 | 23.6 |
| **112.0** | -0.3521 | 19.2439 | 0.08928 | 15.7 | 16.3 | 16.7 | 17.6 | 18.1 | 19.2 | 20.5 | 21.1 | 22.4 | 22.9 | 23.9 |
| **112.5** | -0.3521 | 19.4304 | 0.08960 | 15.9 | 16.5 | 16.8 | 17.7 | 18.3 | 19.4 | 20.7 | 21.4 | 22.6 | 23.1 | 24.1 |
| **113.0** | -0.3521 | 19.6185 | 0.08991 | 16.0 | 16.6 | 17.0 | 17.9 | 18.5 | 19.6 | 20.9 | 21.6 | 22.8 | 23.4 | 24.4 |
| **113.5** | -0.3521 | 19.8081 | 0.09022 | 16.2 | 16.8 | 17.1 | 18.1 | 18.7 | 19.8 | 21.1 | 21.8 | 23.1 | 23.6 | 24.6 |
| **114.0** | -0.3521 | 19.9990 | 0.09054 | 16.3 | 17.0 | 17.3 | 18.2 | 18.8 | 20.0 | 21.3 | 22.0 | 23.3 | 23.8 | 24.9 |
| **114.5** | -0.3521 | 20.1912 | 0.09085 | 16.5 | 17.1 | 17.5 | 18.4 | 19.0 | 20.2 | 21.5 | 22.2 | 23.5 | 24.1 | 25.2 |
| **115.0** | -0.3521 | 20.3846 | 0.09116 | 16.6 | 17.3 | 17.6 | 18.6 | 19.2 | 20.4 | 21.7 | 22.4 | 23.8 | 24.3 | 25.4 |
| **115.5** | -0.3521 | 20.5789 | 0.09147 | 16.8 | 17.4 | 17.8 | 18.7 | 19.4 | 20.6 | 21.9 | 22.7 | 24.0 | 24.6 | 25.7 |
| **116.0** | -0.3521 | 20.7741 | 0.09177 | 16.9 | 17.6 | 17.9 | 18.9 | 19.5 | 20.8 | 22.1 | 22.9 | 24.3 | 24.8 | 25.9 |
| **116.5** | -0.3521 | 20.9700 | 0.09208 | 17.1 | 17.7 | 18.1 | 19.1 | 19.7 | 21.0 | 22.3 | 23.1 | 24.5 | 25.1 | 26.2 |
| **117.0** | -0.3521 | 21.1666 | 0.09239 | 17.2 | 17.9 | 18.3 | 19.3 | 19.9 | 21.2 | 22.5 | 23.3 | 24.7 | 25.3 | 26.5 |
| **117.5** | -0.3521 | 21.3636 | 0.09270 | 17.4 | 18.0 | 18.4 | 19.4 | 20.1 | 21.4 | 22.8 | 23.6 | 25.0 | 25.6 | 26.7 |
| **118.0** | -0.3521 | 21.5611 | 0.09300 | 17.5 | 18.2 | 18.6 | 19.6 | 20.3 | 21.6 | 23.0 | 23.8 | 25.2 | 25.8 | 27.0 |
| **118.5** | -0.3521 | 21.7588 | 0.09331 | 17.7 | 18.4 | 18.7 | 19.8 | 20.4 | 21.8 | 23.2 | 24.0 | 25.5 | 26.1 | 27.3 |
| **119.0** | -0.3521 | 21.9568 | 0.09362 | 17.8 | 18.5 | 18.9 | 20.0 | 20.6 | 22.0 | 23.4 | 24.2 | 25.7 | 26.3 | 27.5 |
| **119.5** | -0.3521 | 22.1549 | 0.09393 | 17.9 | 18.7 | 19.1 | 20.1 | 20.8 | 22.2 | 23.6 | 24.5 | 26.0 | 26.6 | 27.8 |
| **120.0** | -0.3521 | 22.3530 | 0.09424 | 18.1 | 18.8 | 19.2 | 20.3 | 21.0 | 22.4 | 23.8 | 24.7 | 26.2 | 26.8 | 28.1 |

**Table 58 Weight-for-height for boys (continued)**

| | | | | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Height (cm) | L | M | S | -3 SD | -2 SD | -1 SD | Median | 1 SD | 2 SD | 3 SD |
| **65.0** | -0.3521 | 7.4327 | 0.08217 | 5.9 | 6.3 | 6.9 | 7.4 | 8.1 | 8.8 | 9.6 |
| **65.5** | -0.3521 | 7.5504 | 0.08214 | 6.0 | 6.4 | 7.0 | 7.6 | 8.2 | 8.9 | 9.8 |
| **66.0** | -0.3521 | 7.6673 | 0.08212 | 6.1 | 6.5 | 7.1 | 7.7 | 8.3 | 9.1 | 9.9 |
| **66.5** | -0.3521 | 7.7834 | 0.08212 | 6.1 | 6.6 | 7.2 | 7.8 | 8.5 | 9.2 | 10.1 |
| **67.0** | -0.3521 | 7.8986 | 0.08213 | 6.2 | 6.7 | 7.3 | 7.9 | 8.6 | 9.4 | 10.2 |
| **67.5** | -0.3521 | 8.0132 | 0.08214 | 6.3 | 6.8 | 7.4 | 8.0 | 8.7 | 9.5 | 10.4 |
| **68.0** | -0.3521 | 8.1272 | 0.08217 | 6.4 | 6.9 | 7.5 | 8.1 | 8.8 | 9.6 | 10.5 |
| **68.5** | -0.3521 | 8.2410 | 0.08221 | 6.5 | 7.0 | 7.6 | 8.2 | 9.0 | 9.8 | 10.7 |
| **69.0** | -0.3521 | 8.3547 | 0.08226 | 6.6 | 7.1 | 7.7 | 8.4 | 9.1 | 9.9 | 10.8 |
| **69.5** | -0.3521 | 8.4680 | 0.08231 | 6.7 | 7.2 | 7.8 | 8.5 | 9.2 | 10.0 | 11.0 |
| **70.0** | -0.3521 | 8.5808 | 0.08237 | 6.8 | 7.3 | 7.9 | 8.6 | 9.3 | 10.2 | 11.1 |
| **70.5** | -0.3521 | 8.6927 | 0.08243 | 6.9 | 7.4 | 8.0 | 8.7 | 9.5 | 10.3 | 11.3 |
| **71.0** | -0.3521 | 8.8036 | 0.08250 | 6.9 | 7.5 | 8.1 | 8.8 | 9.6 | 10.4 | 11.4 |
| **71.5** | -0.3521 | 8.9135 | 0.08257 | 7.0 | 7.6 | 8.2 | 8.9 | 9.7 | 10.6 | 11.6 |
| **72.0** | -0.3521 | 9.0221 | 0.08264 | 7.1 | 7.7 | 8.3 | 9.0 | 9.8 | 10.7 | 11.7 |
| **72.5** | -0.3521 | 9.1292 | 0.08272 | 7.2 | 7.8 | 8.4 | 9.1 | 9.9 | 10.8 | 11.8 |
| **73.0** | -0.3521 | 9.2347 | 0.08278 | 7.3 | 7.9 | 8.5 | 9.2 | 10.0 | 11.0 | 12.0 |
| **73.5** | -0.3521 | 9.3390 | 0.08285 | 7.4 | 7.9 | 8.6 | 9.3 | 10.2 | 11.1 | 12.1 |
| **74.0** | -0.3521 | 9.4420 | 0.08292 | 7.4 | 8.0 | 8.7 | 9.4 | 10.3 | 11.2 | 12.2 |
| **74.5** | -0.3521 | 9.5438 | 0.08298 | 7.5 | 8.1 | 8.8 | 9.5 | 10.4 | 11.3 | 12.4 |
| **75.0** | -0.3521 | 9.6440 | 0.08303 | 7.6 | 8.2 | 8.9 | 9.6 | 10.5 | 11.4 | 12.5 |
| **75.5** | -0.3521 | 9.7425 | 0.08308 | 7.7 | 8.3 | 9.0 | 9.7 | 10.6 | 11.6 | 12.6 |
| **76.0** | -0.3521 | 9.8392 | 0.08312 | 7.7 | 8.4 | 9.1 | 9.8 | 10.7 | 11.7 | 12.8 |
| **76.5** | -0.3521 | 9.9341 | 0.08315 | 7.8 | 8.5 | 9.2 | 9.9 | 10.8 | 11.8 | 12.9 |
| **77.0** | -0.3521 | 10.0274 | 0.08317 | 7.9 | 8.5 | 9.2 | 10.0 | 10.9 | 11.9 | 13.0 |
| **77.5** | -0.3521 | 10.1194 | 0.08318 | 8.0 | 8.6 | 9.3 | 10.1 | 11.0 | 12.0 | 13.1 |
| **78.0** | -0.3521 | 10.2105 | 0.08317 | 8.0 | 8.7 | 9.4 | 10.2 | 11.1 | 12.1 | 13.3 |
| **78.5** | -0.3521 | 10.3012 | 0.08315 | 8.1 | 8.8 | 9.5 | 10.3 | 11.2 | 12.2 | 13.4 |
| **79.0** | -0.3521 | 10.3923 | 0.08311 | 8.2 | 8.8 | 9.6 | 10.4 | 11.3 | 12.3 | 13.5 |
| **79.5** | -0.3521 | 10.4845 | 0.08305 | 8.3 | 8.9 | 9.7 | 10.5 | 11.4 | 12.4 | 13.6 |

**Table 58 Weight-for-height for boys (continued)**

| | | | | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Height (cm)** | **L** | **M** | **S** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **80.0** | -0.3521 | 10.5781 | 0.08298 | 8.3 | 9.0 | 9.7 | 10.6 | 11.5 | 12.6 | 13.7 |
| **80.5** | -0.3521 | 10.6737 | 0.08290 | 8.4 | 9.1 | 9.8 | 10.7 | 11.6 | 12.7 | 13.8 |
| **81.0** | -0.3521 | 10.7718 | 0.08279 | 8.5 | 9.2 | 9.9 | 10.8 | 11.7 | 12.8 | 14.0 |
| **81.5** | -0.3521 | 10.8728 | 0.08268 | 8.6 | 9.3 | 10.0 | 10.9 | 11.8 | 12.9 | 14.1 |
| **82.0** | -0.3521 | 10.9772 | 0.08255 | 8.7 | 9.3 | 10.1 | 11.0 | 11.9 | 13.0 | 14.2 |
| **82.5** | -0.3521 | 11.0851 | 0.08241 | 8.7 | 9.4 | 10.2 | 11.1 | 12.1 | 13.1 | 14.4 |
| **83.0** | -0.3521 | 11.1966 | 0.08225 | 8.8 | 9.5 | 10.3 | 11.2 | 12.2 | 13.3 | 14.5 |
| **83.5** | -0.3521 | 11.3114 | 0.08209 | 8.9 | 9.6 | 10.4 | 11.3 | 12.3 | 13.4 | 14.6 |
| **84.0** | -0.3521 | 11.4290 | 0.08191 | 9.0 | 9.7 | 10.5 | 11.4 | 12.4 | 13.5 | 14.8 |
| **84.5** | -0.3521 | 11.5490 | 0.08174 | 9.1 | 9.9 | 10.7 | 11.5 | 12.5 | 13.7 | 14.9 |
| **85.0** | -0.3521 | 11.6707 | 0.08156 | 9.2 | 10.0 | 10.8 | 11.7 | 12.7 | 13.8 | 15.1 |
| **85.5** | -0.3521 | 11.7937 | 0.08138 | 9.3 | 10.1 | 10.9 | 11.8 | 12.8 | 13.9 | 15.2 |
| **86.0** | -0.3521 | 11.9173 | 0.08121 | 9.4 | 10.2 | 11.0 | 11.9 | 12.9 | 14.1 | 15.4 |
| **86.5** | -0.3521 | 12.0411 | 0.08105 | 9.5 | 10.3 | 11.1 | 12.0 | 13.1 | 14.2 | 15.5 |
| **87.0** | -0.3521 | 12.1645 | 0.08090 | 9.6 | 10.4 | 11.2 | 12.2 | 13.2 | 14.4 | 15.7 |
| **87.5** | -0.3521 | 12.2871 | 0.08076 | 9.7 | 10.5 | 11.3 | 12.3 | 13.3 | 14.5 | 15.8 |
| **88.0** | -0.3521 | 12.4089 | 0.08064 | 9.8 | 10.6 | 11.5 | 12.4 | 13.5 | 14.7 | 16.0 |
| **88.5** | -0.3521 | 12.5298 | 0.08054 | 9.9 | 10.7 | 11.6 | 12.5 | 13.6 | 14.8 | 16.1 |
| **89.0** | -0.3521 | 12.6495 | 0.08045 | 10.0 | 10.8 | 11.7 | 12.6 | 13.7 | 14.9 | 16.3 |
| **89.5** | -0.3521 | 12.7683 | 0.08038 | 10.1 | 10.9 | 11.8 | 12.8 | 13.9 | 15.1 | 16.4 |
| **90.0** | -0.3521 | 12.8864 | 0.08032 | 10.2 | 11.0 | 11.9 | 12.9 | 14.0 | 15.2 | 16.6 |
| **90.5** | -0.3521 | 13.0038 | 0.08028 | 10.3 | 11.1 | 12.0 | 13.0 | 14.1 | 15.3 | 16.7 |
| **91.0** | -0.3521 | 13.1209 | 0.08025 | 10.4 | 11.2 | 12.1 | 13.1 | 14.2 | 15.5 | 16.9 |
| **91.5** | -0.3521 | 13.2376 | 0.08024 | 10.5 | 11.3 | 12.2 | 13.2 | 14.4 | 15.6 | 17.0 |
| **92.0** | -0.3521 | 13.3541 | 0.08025 | 10.6 | 11.4 | 12.3 | 13.4 | 14.5 | 15.8 | 17.2 |
| **92.5** | -0.3521 | 13.4705 | 0.08027 | 10.7 | 11.5 | 12.4 | 13.5 | 14.6 | 15.9 | 17.3 |
| **93.0** | -0.3521 | 13.5870 | 0.08031 | 10.8 | 11.6 | 12.6 | 13.6 | 14.7 | 16.0 | 17.5 |
| **93.5** | -0.3521 | 13.7041 | 0.08036 | 10.9 | 11.7 | 12.7 | 13.7 | 14.9 | 16.2 | 17.6 |
| **94.0** | -0.3521 | 13.8217 | 0.08043 | 11.0 | 11.8 | 12.8 | 13.8 | 15.0 | 16.3 | 17.8 |
| **94.5** | -0.3521 | 13.9403 | 0.08051 | 11.1 | 11.9 | 12.9 | 13.9 | 15.1 | 16.5 | 17.9 |

**Table 58 Weight-for-height for boys (continued)**

| | | | | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Height (cm)** | **L** | **M** | **S** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **95.0** | -0.3521 | 14.0600 | 0.08060 | 11.1 | 12.0 | 13.0 | 14.1 | 15.3 | 16.6 | 18.1 |
| **95.5** | -0.3521 | 14.1811 | 0.08071 | 11.2 | 12.1 | 13.1 | 14.2 | 15.4 | 16.7 | 18.3 |
| **96.0** | -0.3521 | 14.3037 | 0.08083 | 11.3 | 12.2 | 13.2 | 14.3 | 15.5 | 16.9 | 18.4 |
| **96.5** | -0.3521 | 14.4282 | 0.08097 | 11.4 | 12.3 | 13.3 | 14.4 | 15.7 | 17.0 | 18.6 |
| **97.0** | -0.3521 | 14.5547 | 0.08112 | 11.5 | 12.4 | 13.4 | 14.6 | 15.8 | 17.2 | 18.8 |
| **97.5** | -0.3521 | 14.6832 | 0.08129 | 11.6 | 12.5 | 13.6 | 14.7 | 15.9 | 17.4 | 18.9 |
| **98.0** | -0.3521 | 14.8140 | 0.08146 | 11.7 | 12.6 | 13.7 | 14.8 | 16.1 | 17.5 | 19.1 |
| **98.5** | -0.3521 | 14.9468 | 0.08165 | 11.8 | 12.8 | 13.8 | 14.9 | 16.2 | 17.7 | 19.3 |
| **99.0** | -0.3521 | 15.0818 | 0.08185 | 11.9 | 12.9 | 13.9 | 15.1 | 16.4 | 17.9 | 19.5 |
| **99.5** | -0.3521 | 15.2187 | 0.08206 | 12.0 | 13.0 | 14.0 | 15.2 | 16.5 | 18.0 | 19.7 |
| **100.0** | -0.3521 | 15.3576 | 0.08229 | 12.1 | 13.1 | 14.2 | 15.4 | 16.7 | 18.2 | 19.9 |
| **100.5** | -0.3521 | 15.4985 | 0.08252 | 12.2 | 13.2 | 14.3 | 15.5 | 16.9 | 18.4 | 20.1 |
| **101.0** | -0.3521 | 15.6412 | 0.08277 | 12.3 | 13.3 | 14.4 | 15.6 | 17.0 | 18.5 | 20.3 |
| **101.5** | -0.3521 | 15.7857 | 0.08302 | 12.4 | 13.4 | 14.5 | 15.8 | 17.2 | 18.7 | 20.5 |
| **102.0** | -0.3521 | 15.9320 | 0.08328 | 12.5 | 13.6 | 14.7 | 15.9 | 17.3 | 18.9 | 20.7 |
| **102.5** | -0.3521 | 16.0801 | 0.08354 | 12.6 | 13.7 | 14.8 | 16.1 | 17.5 | 19.1 | 20.9 |
| **103.0** | -0.3521 | 16.2298 | 0.08381 | 12.8 | 13.8 | 14.9 | 16.2 | 17.7 | 19.3 | 21.1 |
| **103.5** | -0.3521 | 16.3812 | 0.08408 | 12.9 | 13.9 | 15.1 | 16.4 | 17.8 | 19.5 | 21.3 |
| **104.0** | -0.3521 | 16.5342 | 0.08436 | 13.0 | 14.0 | 15.2 | 16.5 | 18.0 | 19.7 | 21.6 |
| **104.5** | -0.3521 | 16.6889 | 0.08464 | 13.1 | 14.2 | 15.4 | 16.7 | 18.2 | 19.9 | 21.8 |
| **105.0** | -0.3521 | 16.8454 | 0.08493 | 13.2 | 14.3 | 15.5 | 16.8 | 18.4 | 20.1 | 22.0 |
| **105.5** | -0.3521 | 17.0036 | 0.08521 | 13.3 | 14.4 | 15.6 | 17.0 | 18.5 | 20.3 | 22.2 |
| **106.0** | -0.3521 | 17.1637 | 0.08551 | 13.4 | 14.5 | 15.8 | 17.2 | 18.7 | 20.5 | 22.5 |
| **106.5** | -0.3521 | 17.3256 | 0.08580 | 13.5 | 14.7 | 15.9 | 17.3 | 18.9 | 20.7 | 22.7 |
| **107.0** | -0.3521 | 17.4894 | 0.08611 | 13.7 | 14.8 | 16.1 | 17.5 | 19.1 | 20.9 | 22.9 |
| **107.5** | -0.3521 | 17.6550 | 0.08641 | 13.8 | 14.9 | 16.2 | 17.7 | 19.3 | 21.1 | 23.2 |
| **108.0** | -0.3521 | 17.8226 | 0.08673 | 13.9 | 15.1 | 16.4 | 17.8 | 19.5 | 21.3 | 23.4 |
| **108.5** | -0.3521 | 17.9924 | 0.08704 | 14.0 | 15.2 | 16.5 | 18.0 | 19.7 | 21.5 | 23.7 |
| **109.0** | -0.3521 | 18.1645 | 0.08736 | 14.1 | 15.3 | 16.7 | 18.2 | 19.8 | 21.8 | 23.9 |
| **109.5** | -0.3521 | 18.3390 | 0.08768 | 14.3 | 15.5 | 16.8 | 18.3 | 20.0 | 22.0 | 24.2 |

**Table 58 Weight-for-height for boys (continued)**

| | | | | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Height (cm)** | **L** | **M** | **S** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **110.0** | -0.3521 | 18.5158 | 0.08800 | 14.4 | 15.6 | 17.0 | 18.5 | 20.2 | 22.2 | 24.4 |
| **110.5** | -0.3521 | 18.6948 | 0.08832 | 14.5 | 15.8 | 17.1 | 18.7 | 20.4 | 22.4 | 24.7 |
| **111.0** | -0.3521 | 18.8759 | 0.08864 | 14.6 | 15.9 | 17.3 | 18.9 | 20.7 | 22.7 | 25.0 |
| **111.5** | -0.3521 | 19.0590 | 0.08896 | 14.8 | 16.0 | 17.5 | 19.1 | 20.9 | 22.9 | 25.2 |
| **112.0** | -0.3521 | 19.2439 | 0.08928 | 14.9 | 16.2 | 17.6 | 19.2 | 21.1 | 23.1 | 25.5 |
| **112.5** | -0.3521 | 19.4304 | 0.08960 | 15.0 | 16.3 | 17.8 | 19.4 | 21.3 | 23.4 | 25.8 |
| **113.0** | -0.3521 | 19.6185 | 0.08991 | 15.2 | 16.5 | 18.0 | 19.6 | 21.5 | 23.6 | 26.0 |
| **113.5** | -0.3521 | 19.8081 | 0.09022 | 15.3 | 16.6 | 18.1 | 19.8 | 21.7 | 23.9 | 26.3 |
| **114.0** | -0.3521 | 19.9990 | 0.09054 | 15.4 | 16.8 | 18.3 | 20.0 | 21.9 | 24.1 | 26.6 |
| **114.5** | -0.3521 | 20.1912 | 0.09085 | 15.6 | 16.9 | 18.5 | 20.2 | 22.1 | 24.4 | 26.9 |
| **115.0** | -0.3521 | 20.3846 | 0.09116 | 15.7 | 17.1 | 18.6 | 20.4 | 22.4 | 24.6 | 27.2 |
| **115.5** | -0.3521 | 20.5789 | 0.09147 | 15.8 | 17.2 | 18.8 | 20.6 | 22.6 | 24.9 | 27.5 |
| **116.0** | -0.3521 | 20.7741 | 0.09177 | 16.0 | 17.4 | 19.0 | 20.8 | 22.8 | 25.1 | 27.8 |
| **116.5** | -0.3521 | 20.9700 | 0.09208 | 16.1 | 17.5 | 19.2 | 21.0 | 23.0 | 25.4 | 28.0 |
| **117.0** | -0.3521 | 21.1666 | 0.09239 | 16.2 | 17.7 | 19.3 | 21.2 | 23.3 | 25.6 | 28.3 |
| **117.5** | -0.3521 | 21.3636 | 0.09270 | 16.4 | 17.9 | 19.5 | 21.4 | 23.5 | 25.9 | 28.6 |
| **118.0** | -0.3521 | 21.5611 | 0.09300 | 16.5 | 18.0 | 19.7 | 21.6 | 23.7 | 26.1 | 28.9 |
| **118.5** | -0.3521 | 21.7588 | 0.09331 | 16.7 | 18.2 | 19.9 | 21.8 | 23.9 | 26.4 | 29.2 |
| **119.0** | -0.3521 | 21.9568 | 0.09362 | 16.8 | 18.3 | 20.0 | 22.0 | 24.1 | 26.6 | 29.5 |
| **119.5** | -0.3521 | 22.1549 | 0.09393 | 16.9 | 18.5 | 20.2 | 22.2 | 24.4 | 26.9 | 29.8 |
| **120.0** | -0.3521 | 22.3530 | 0.09424 | 17.1 | 18.6 | 20.4 | 22.4 | 24.6 | 27.2 | 30.1 |

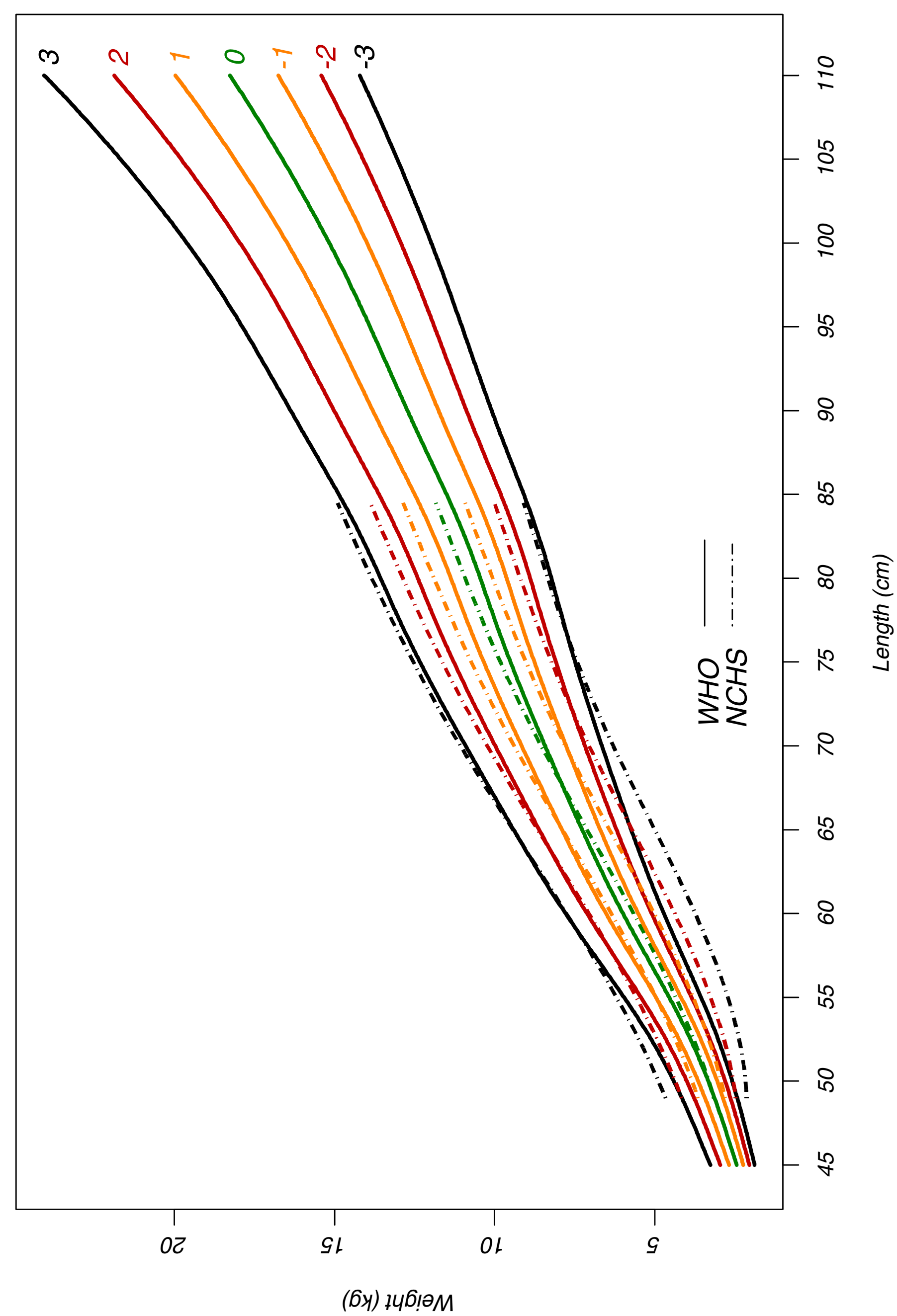


**Figure 75 Comparison of WHO with NCHS weight-for-length z-scores for boys**

*Comparison with NCHS*

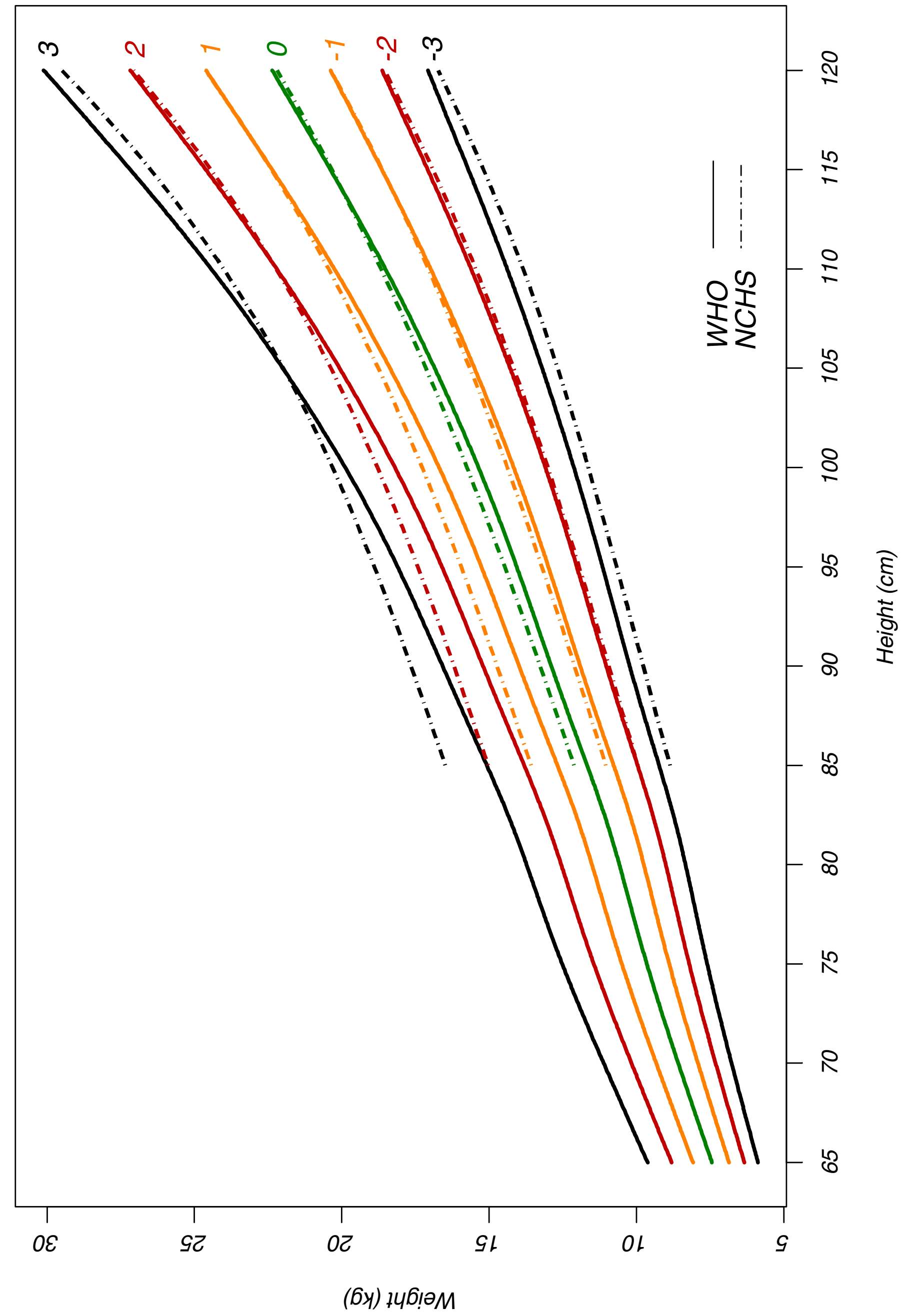


**Figure 76 Comparison of WHO with NCHS weight-for-height z-scores for boys**

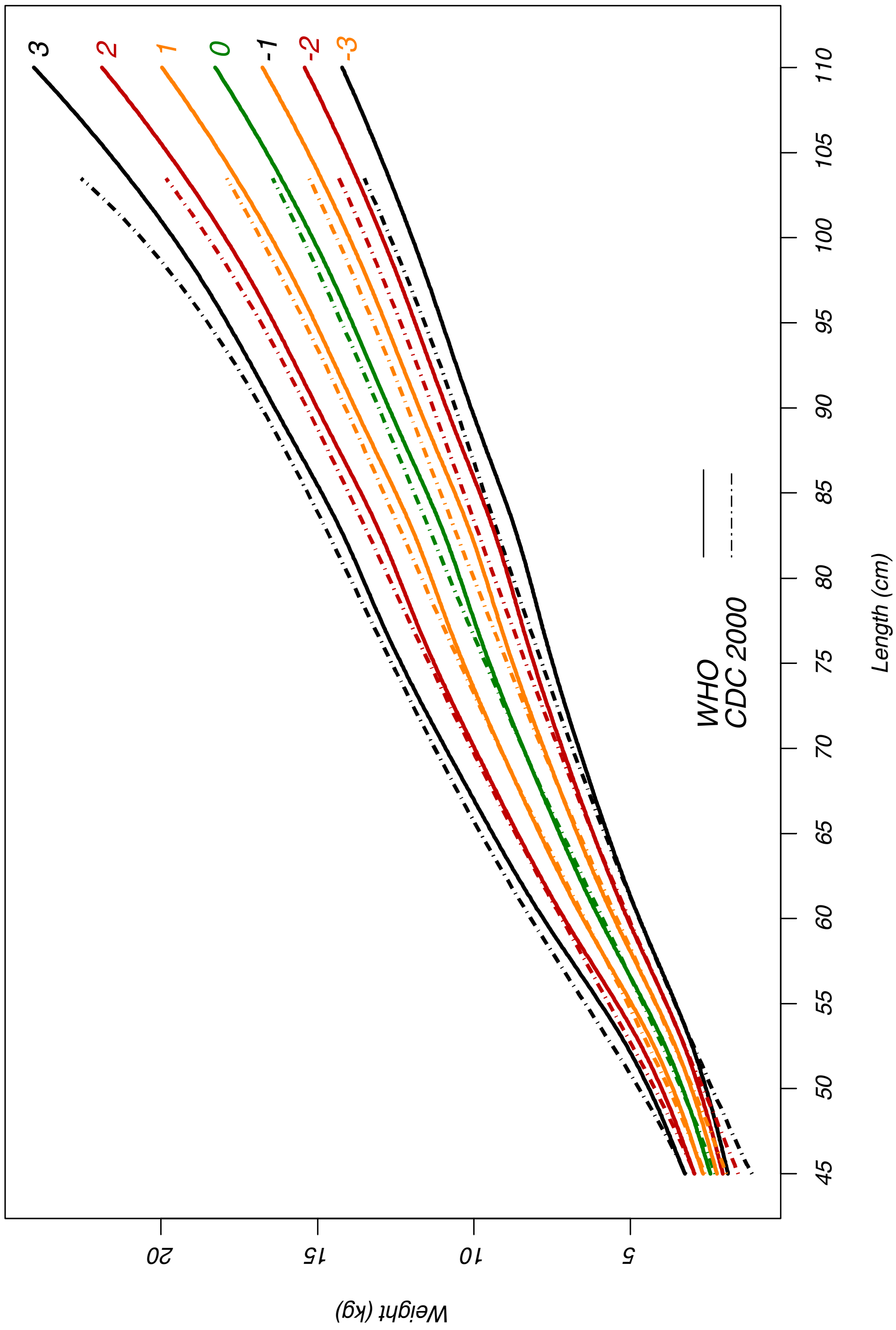


**Figure 77 Comparison of WHO with CDC 2000 weight-for-length z-scores for boys**

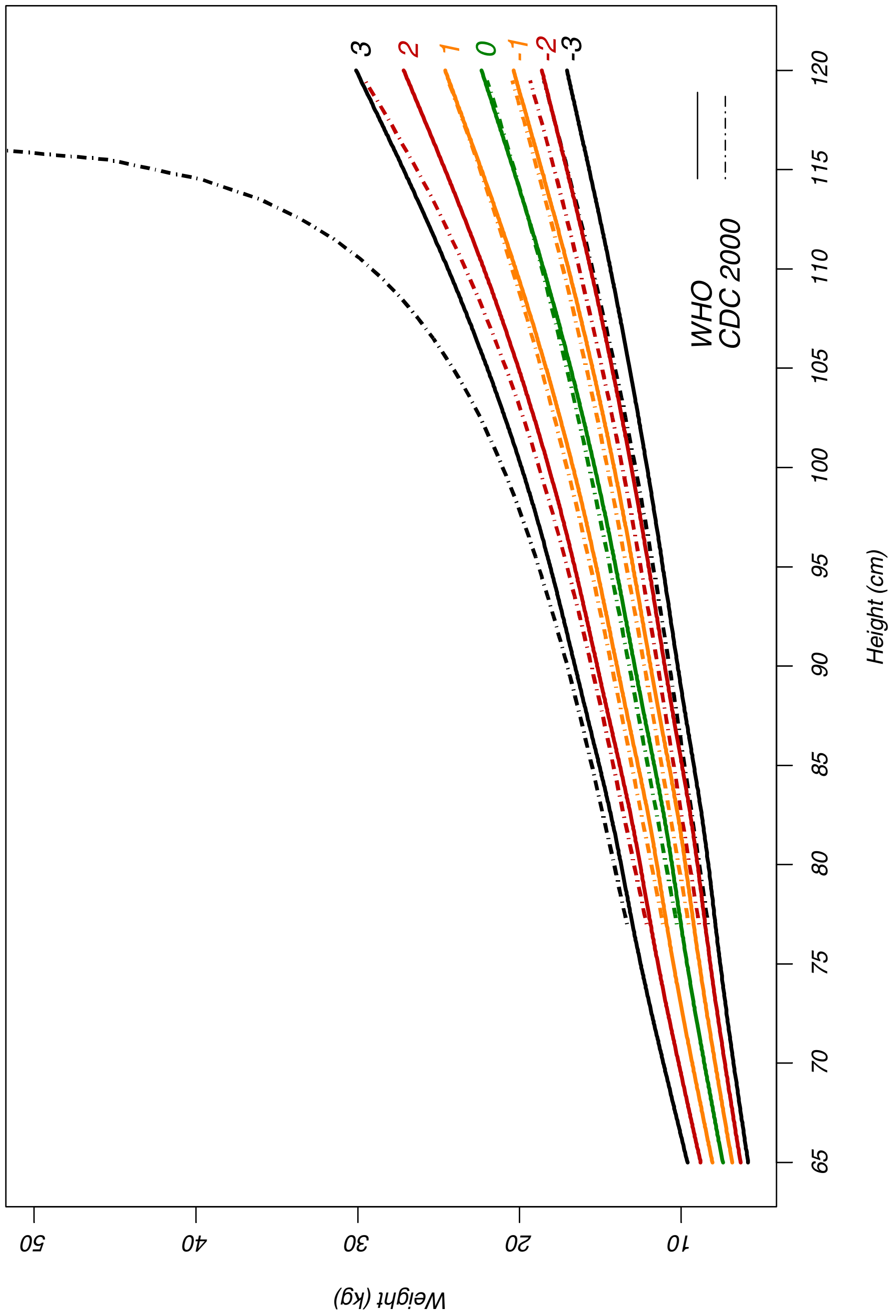


**Figure 78 Comparison of WHO with CDC 2000 weight-for-height z-scores for boys**

## 5.3 Weight-for-length/height for girls

The choice of the model for constructing weight-for-length/height standards for girls followed similar steps as described for the analogous standards for boys (see section 5.1).

### 5.3.1 Sample size

There was a total of 13 623 records with weight and length/height measurements from both the longitudinal and cross-sectional samples. The sample sizes by length interval are presented in Table 59.

**Table 59 Sample sizes for girls' weight-for-length/height by length[a] interval**

| Length (cm) | N | Length (cm) | N | Length (cm) | N | Length (cm) | N |
|---|---|---|---|---|---|---|---|
| <45 | 10 | 63 to <65 | 494 | 83 to <85 | 508 | 103 to <105 | 282 |
| 45 to <47 | 83 | 65 to <67 | 564 | 85 to <87 | 454 | 105 to <107 | 267 |
| 47 to <49 | 330 | 67 to <69 | 592 | 87 to <89 | 357 | 107 to <109 | 249 |
| 49 to <51 | 520 | 69 to <71 | 638 | 89 to <91 | 282 | 109 to <111 | 248 |
| 51 to <53 | 484 | 71 to <73 | 618 | 91 to <93 | 234 | 111 to <113 | 209 |
| 53 to <55 | 481 | 73 to <75 | 540 | 93 to <95 | 220 | 113 to <115 | 151 |
| 55 to <57 | 436 | 75 to <77 | 472 | 95 to <97 | 228 | 115 to <117 | 147 |
| 57 to <59 | 389 | 77 to <79 | 448 | 97 to <99 | 233 | 117 to <119 | 95 |
| 59 to <61 | 368 | 79 to <81 | 482 | 99 to <101 | 229 | 119 to <121 | 58 |
| 61 to <63 | 423 | 81 to <83 | 510 | 101 to <103 | 223 | ≥121 | 67 |

[a] Height values were converted to length before merging the data (length=height+0.7).

### 5.3.2 Model selection and results

As was the case for boys, there was no need to transform length (or height) and $\lambda$ was thus set to 1. Model selection followed with a search for the best combination of df($\mu$) and df($\sigma$), using models with fixed $\nu$=1 and $\tau$=2. Table 60 summarizes the goodness-of-fit statistics for various combinations of df($\mu$) and df($\sigma$). Since the models with df($\mu$)=12 to 14 and df($\sigma$)=4 resulted in comparable goodness of fit, the combination df($\mu$)=12 and df($\sigma$)=4, which had the lowest total degrees of freedom, was selected for further evaluation.

**Table 60 Goodness-of-fit summary for models using the BCPE distribution with fixed ν=1 and τ=2 for weight-for-length/height for girls**

| df(μ) | df(σ) | GD[a] | AIC[a] | GAIC(3)[a] | Total df |
|---|---|---|---|---|---|
| | **2** | 1215.0 | 1241.1 | 1254.1 | 13 |
| | **3** | 1208.4 | 1236.4 | 1250.4 | 14 |
| **11** | **4** | 1203.8 | 1233.8 | 1248.8 | 15 |
| | **5** | 1202.0 | 1234.0 | 1250.0 | 16 |
| | **6** | 1200.7 | 1234.7 | 1251.7 | 17 |
| | **2** | 1209.7 | 1237.8 | 1251.8 | 14 |
| | **3** | 1203.2 | 1233.2 | 1248.2 | 15 |
| **12** | **4** | 1198.7 | 1230.7 | 1246.7 | 16 |
| | **5** | 1196.8 | 1230.8 | 1247.8 | 17 |
| | **6** | 1195.5 | 1231.5 | 1249.5 | 18 |
| | **2** | 1206.2 | 1236.3 | 1251.4 | 15 |
| | **3** | 1199.7 | 1231.7 | 1247.7 | 16 |
| **13** | **4** | 1195.3 | 1229.3 | 1246.3 | 17 |
| | **5** | 1193.4 | 1229.4 | 1247.4 | 18 |
| | **6** | 1192.1 | 1230.1 | 1249.1 | 19 |
| | **2** | 1203.8 | 1235.9 | 1252.0 | 16 |
| | **3** | 1197.4 | 1231.4 | 1248.4 | 17 |
| **14** | **4** | 1192.9 | 1228.9 | 1246.9 | 18 |
| | **5** | 1191.1 | 1229.1 | 1248.1 | 19 |
| | **6** | 1189.8 | 1229.8 | 1249.8 | 20 |
| | **2** | 1202.1 | 1236.2 | 1253.2 | 17 |
| | **3** | 1195.6 | 1231.6 | 1249.6 | 18 |
| **15** | **4** | 1191.2 | 1229.2 | 1248.2 | 19 |
| | **5** | 1189.3 | 1229.3 | 1249.3 | 20 |
| | **6** | 1188.1 | 1230.1 | 1251.1 | 21 |

GD, Global Deviance; AIC, Akaike Information Criterion;
GAIC(3), Generalized AIC with penalty equal to 3;
[a] In excess of 31 000.

**Model 1: BCPE(x= length (or height+0.7), df(μ)=12, df(σ)=4, ν=1, τ=2)**

Results of the Q-test indicated well fitted μ and σ curves, but residual skewness remained across almost all length groups (Table 61). Therefore, a new model including the modelling of parameter ν was sought.

**Table 61 Q-test for z-scores from Model 1 [BCPE(x=length (or height+0.7), df(μ)=12, df(σ)=4, ν=1, τ=2)] for weight-for-length/height for girls**

| Length (cm) | N | z1 | z2 | z3 | z4 |
|---|---|---|---|---|---|
| **43 to <50** | 685 | 0.05 | 0.32 | 2.53 | -0.47 |
| **50 to <52** | 502 | -0.32 | -1.22 | 3.67 | 0.96 |
| **52 to <54** | 486 | -0.13 | -0.45 | 2.70 | 0.02 |
| **54 to <56** | 458 | 0.27 | -0.09 | 1.93 | -0.94 |
| **56 to <58** | 405 | -0.37 | -0.18 | 1.43 | -1.57 |
| **58 to <60** | 364 | 0.92 | 0.21 | 1.20 | -1.12 |
| **60 to <62** | 393 | -0.19 | 1.74 | 1.42 | -1.70 |
| **62 to <64** | 474 | -0.36 | 1.61 | 2.84 | -1.47 |
| **64 to <66** | 524 | 0.01 | -0.10 | 2.06 | -2.00 |
| **66 to <68** | 599 | 0.49 | -0.66 | 2.79 | -1.12 |
| **68 to <70** | 599 | -0.04 | -0.88 | 3.27 | -0.44 |
| **70 to <72** | 643 | -0.41 | -0.06 | 3.25 | -0.24 |
| **72 to <74** | 585 | 0.47 | -0.78 | 3.24 | 0.15 |
| **74 to <76** | 484 | 0.64 | 2.02 | 5.05 | 1.42 |
| **76 to <78** | 472 | -0.49 | 0.52 | 4.49 | 1.31 |
| **78 to <80** | 457 | -0.30 | 0.56 | 3.78 | 1.01 |
| **80 to <82** | 509 | -0.29 | -0.20 | 3.67 | 1.18 |
| **82 to <84** | 493 | -1.18 | -1.03 | 3.10 | 0.10 |
| **84 to <86** | 486 | -0.20 | -0.74 | 3.19 | 0.21 |
| **86 to <88** | 425 | 1.13 | -0.34 | 4.53 | 2.17 |
| **88 to <90** | 309 | 0.99 | -0.11 | 3.96 | 2.07 |
| **90 to <92** | 242 | -0.31 | 0.67 | 1.96 | 1.38 |
| **92 to <96** | 460 | 0.57 | 0.16 | 3.35 | -0.50 |
| **96 to <100** | 455 | -0.21 | -0.94 | 1.46 | -2.26 |
| **100 to <104** | 482 | -0.59 | -0.36 | 1.56 | -0.85 |
| **104 to <108** | 522 | 0.39 | -0.29 | 4.01 | 0.46 |
| **108 to <112** | 496 | -0.77 | 0.12 | 3.29 | -0.43 |
| **112 to <116** | 318 | -0.53 | 0.98 | 3.65 | 0.59 |
| **116 to 134** | 296 | 1.81 | 1.37 | 2.48 | -0.94 |
| **Overall Q stats** | **13 623** | **11.58** | **20.15** | **283.57** | **41.09** |
| **degrees of freedom** | | **17.0** | **26.5** | **29.0** | **29.0** |
| **p-value** | | **0.8247** | **0.8052** | **<0.01** | **0.0676** |

Note: Absolute values of z1, z2, z3 or z4 larger than 2 indicate misfit of, respectively, mean, variance, skewness or kurtosis.

Table 62 presents goodness of fit for various df(ν) values, with the degrees of freedom for μ and σ from Model 1 and fixing τ=2.

Although the model with df(ν)=2 yielded the smallest *GAIC(3)*, the fitted ν curve — in this case a straight line with a negative slope — resulted in fitted values that caused the distribution to be excessively skewed at high height values. Since models with df(ν)=2 and df(ν)=1 presented similar *GAIC(3)*, the latter was chosen because it resulted in a smoother ν curve.

**Table 62 Goodness-of-fit summary for models BCPE(x=length (or height+0.7), df(μ)=12, df(σ)=4, df(ν)=?, τ=2) for weight-for-length/height for girls**

| df(ν) | GD[a] | GAIC(3)[a] | Total df |
|---|---|---|---|
| **1** | 902.0 | 953.0 | 17 |
| **2** | 898.0 | 952.0 | 18 |
| **3** | 895.4 | 952.5 | 19 |
| **4** | 892.9 | 953.0 | 20 |
| **5** | 890.5 | 953.5 | 21 |
| **6** | 888.9 | 954.9 | 22 |
| **7** | 887.9 | 956.9 | 23 |

GD, Global Deviance; GAIC(3), Generalized Akaike Information Criterion with penalty equal to 3;
[a] In excess of 31 000.

**Model 2: BCPE(x=length (or height+0.7), df(μ)=12, df(σ)=4, df(ν)=1, τ=2)**

Figure 79 shows the parameter curve fittings. The patterns of residuals, i.e. empirical centiles minus fitted centiles (Figure 80), do not indicate any systematic biases.

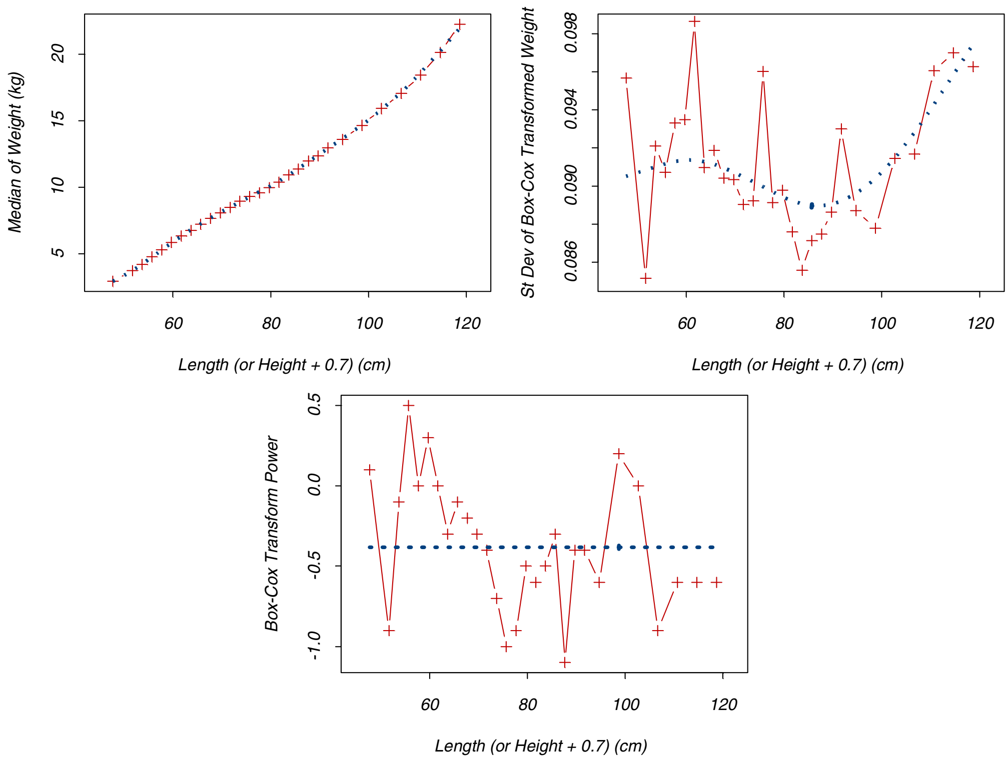


**Figure 79 Fitting of the μ, σ, and ν curves of Model 2 for weight-for-length/height for girls (dotted line) and their respective sample estimates (points with solid line)**

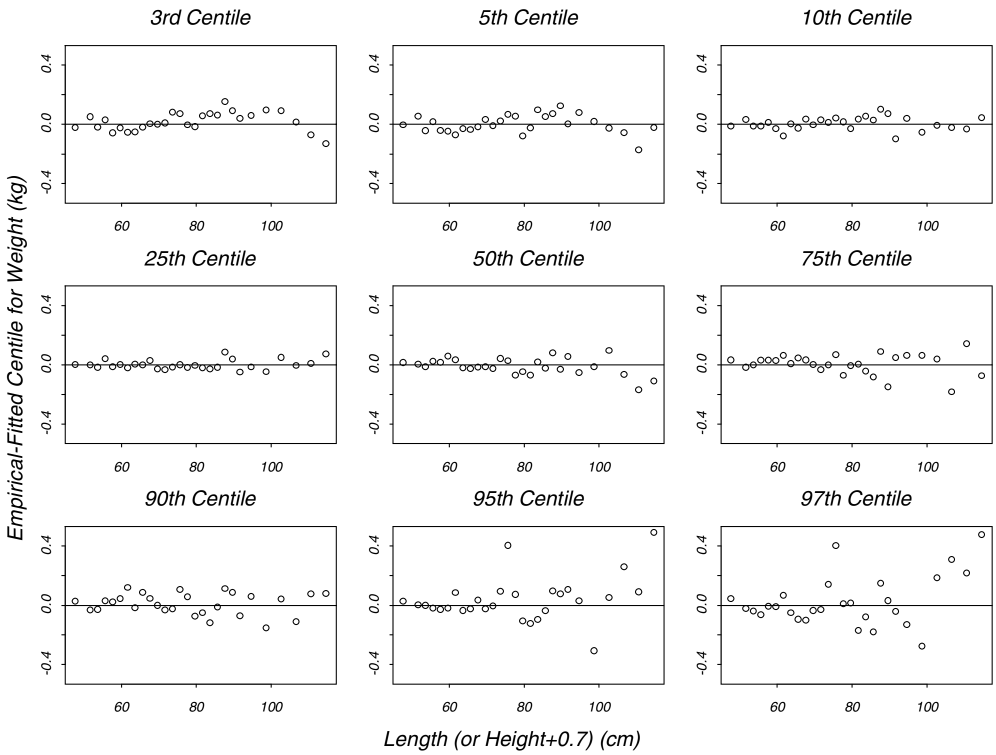


**Figure 80 Centile residuals from fitting Model 2 for weight-for-length/height for girls**

Results of the Q-test for Model 2 are summarized in Table 63. Departures from normality and indications of misfit appeared in four of the 29 groups, with absolute values of z4 greater than 2, indicating residual kurtosis. However, the overall test for kurtosis was non-significant. The worm plots for this model indicated residual kurtosis for the same four length groups, as is evident in the S-shaped worms in Figure 81. No misfits in means, variances and skewness were observed.

Potential improvements in adjusting for kurtosis were investigated by modelling τ. The smoothing functions of Model 2 for the other three parameters were used. Values of df(τ) between 1 and 8 were considered. The model with the smallest *GAIC(3)* was associated with the smoothing function *f(τ)=2.13* (*GAIC(3)*= 31 945.9). However, the difference between τ=2 and τ=2.13 had a negligible impact on the final centiles, despite the Q-test results for this model showing improvement and no residual kurtosis across all groups (Table 64). Moreover, results were slightly worse in terms of residual skewness in at least one group (74 to 76 cm), for which the resulting value of z3 was above 2. Plots of centile residuals for the model with τ=2.13 (not shown) demonstrated no significant changes in the fitted centiles compared to those produced by Model 2. There were two disadvantages of varying the parameter τ from 2: first, it would increase complexity in application of the standards, i.e. calculation of z-scores or centiles would require using a distribution other than a transform-to-normal distribution; second, it would create inconsistency between sexes. This alternative model fitting the fourth parameter was therefore discarded.

**Table 63 Q-test for z-scores from Model 2 [BCPE(x=length (or height+0.7), df(μ)=12, df(σ)=4, df(ν)=1, τ=2)] for weight-for-length/height for girls**

| Length (cm) | N | z1 | z2 | z3 | z4 |
|---|---|---|---|---|---|
| **43 to <50** | 685 | 0.06 | 0.35 | -1.21 | -0.38 |
| **50 to <52** | 502 | -0.47 | -1.44 | 0.54 | -0.23 |
| **52 to <54** | 486 | -0.29 | -0.50 | -0.39 | -0.52 |
| **54 to <56** | 458 | 0.23 | -0.07 | -0.97 | -0.78 |
| **56 to <58** | 405 | -0.27 | 0.01 | -1.16 | -1.21 |
| **58 to <60** | 364 | 1.12 | 0.24 | -1.42 | -0.55 |
| **60 to <62** | 393 | -0.10 | 1.96 | -1.18 | -2.04 |
| **62 to <64** | 474 | -0.30 | 1.59 | 0.11 | -2.53 |
| **64 to <66** | 524 | 0.08 | 0.04 | -0.79 | -2.03 |
| **66 to <68** | 599 | 0.49 | -0.69 | -0.32 | -1.63 |
| **68 to <70** | 599 | -0.07 | -0.87 | 0.06 | -1.03 |
| **70 to <72** | 643 | -0.49 | 0.10 | -0.24 | -0.95 |
| **72 to <74** | 585 | 0.59 | -0.79 | -0.02 | -1.04 |
| **74 to <76** | 484 | 0.65 | 1.48 | 1.94 | 0.03 |
| **76 to <78** | 472 | -0.38 | 0.36 | 1.46 | -0.15 |
| **78 to <80** | 457 | -0.28 | 0.54 | 0.68 | -0.18 |
| **80 to <82** | 509 | -0.32 | -0.14 | 0.39 | -0.14 |
| **82 to <84** | 493 | -1.25 | -0.73 | 0.14 | -0.65 |
| **84 to <86** | 486 | -0.27 | -0.62 | 0.15 | -0.12 |
| **86 to <88** | 425 | 1.10 | -0.77 | 1.54 | 0.46 |
| **88 to <90** | 309 | 0.99 | -0.50 | 1.22 | 1.08 |
| **90 to <92** | 242 | -0.40 | 0.90 | -0.69 | 0.46 |
| **92 to <96** | 460 | 0.53 | 0.00 | 0.68 | -1.50 |
| **96 to <100** | 455 | -0.24 | -0.60 | -1.03 | -2.14 |
| **100 to <104** | 482 | -0.68 | 0.11 | -1.47 | -0.75 |
| **104 to <108** | 522 | 0.40 | -0.49 | 0.84 | -0.44 |
| **108 to <112** | 496 | -0.73 | 0.31 | 0.20 | -0.93 |
| **112 to <116** | 318 | -0.51 | 0.93 | 0.99 | -0.11 |
| **116 to 134** | 296 | 1.86 | 1.17 | 0.08 | -1.47 |
| **Overall Q stats** | **13 623** | **12.60** | **18.88** | **24.67** | **35.97** |
| **degrees of freedom** | | **17.0** | **26.5** | **28.0** | **29.0** |
| **p-value** | | **0.7621** | **0.8585** | **0.6456** | **0.1745** |

Note: Absolute values of z1, z2, z3 or z4 larger than 2 indicate misfit of, respectively, mean, variance, skewness or kurtosis.

Table 65 compares expected and observed proportions of children below fitted centiles using Model 2. No systematic patterns of deviation were observed for any of the centiles across the length (or height+0.7) groups.

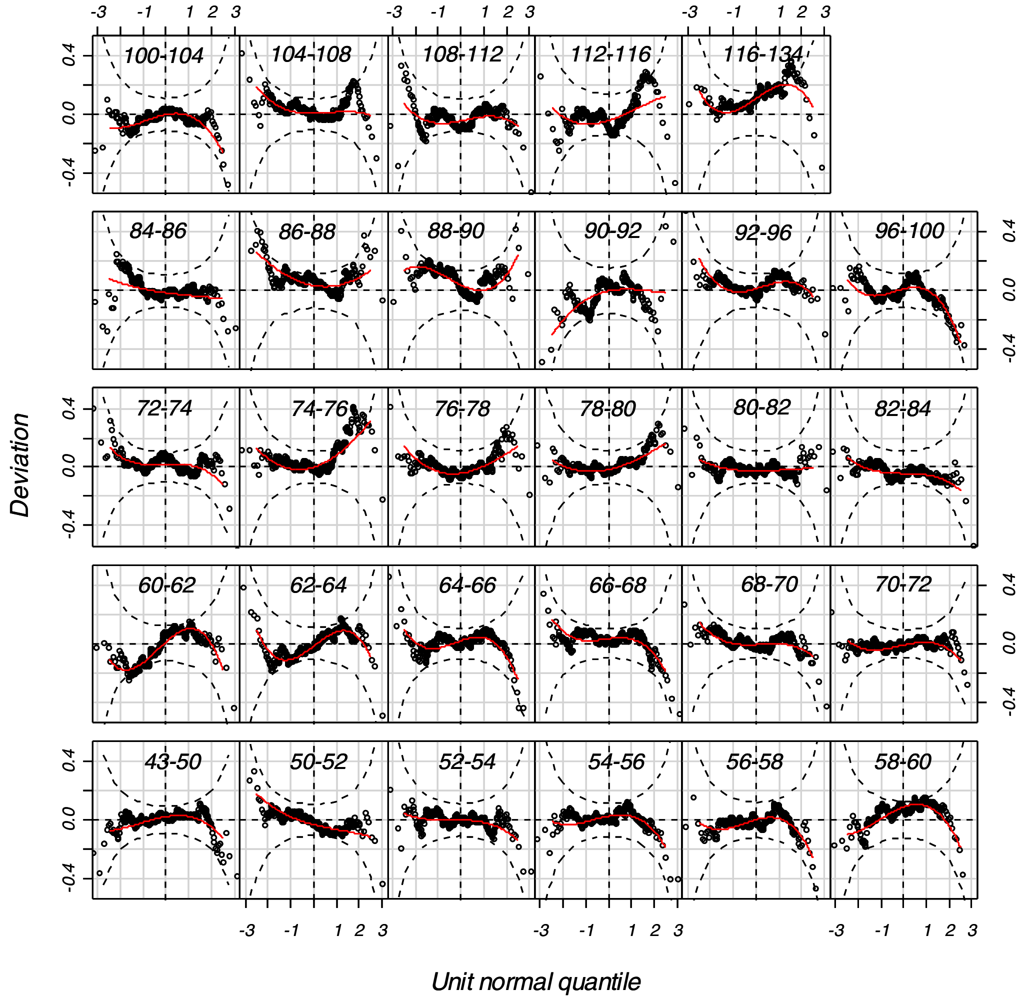


**Figure 81 Worm plots of z-scores for Model 2 for weight-for-length/height for girls**

**Table 64 Q-test for z-scores from model BCPE(x=length (or height+0.7), df(μ)=12, df(σ)=4, df(ν)=1, τ=2.13) for weight-for-length/height for girls**

| Length (cm) | N | z1 | z2 | z3 | z4 |
|---|---|---|---|---|---|
| **43 to <50** | 685 | 0.07 | 0.36 | -1.32 | 0.31 |
| **50 to <52** | 502 | -0.47 | -1.46 | 0.58 | 0.25 |
| **52 to <54** | 486 | -0.28 | -0.51 | -0.43 | 0.03 |
| **54 to <56** | 458 | 0.26 | -0.08 | -1.06 | -0.19 |
| **56 to <58** | 405 | -0.23 | 0.01 | -1.27 | -0.69 |
| **58 to <60** | 364 | 1.16 | 0.25 | -1.50 | -0.07 |
| **60 to <62** | 393 | -0.06 | 2.00 | -1.23 | -1.49 |
| **62 to <64** | 474 | -0.27 | 1.61 | 0.11 | -1.95 |
| **64 to <66** | 524 | 0.07 | 0.02 | -0.85 | -1.49 |
| **66 to <68** | 599 | 0.47 | -0.71 | -0.35 | -1.05 |
| **68 to <70** | 599 | -0.09 | -0.89 | 0.02 | -0.44 |
| **70 to <72** | 643 | -0.51 | 0.10 | -0.28 | -0.31 |
| **72 to <74** | 585 | 0.56 | -0.83 | 0.06 | -0.47 |
| **74 to <76** | 484 | 0.63 | 1.56 | 2.06 | 0.54 |
| **76 to <78** | 472 | -0.43 | 0.38 | 1.53 | 0.37 |
| **78 to <80** | 457 | -0.33 | 0.56 | 0.71 | 0.35 |
| **80 to <82** | 509 | -0.37 | -0.14 | 0.42 | 0.43 |
| **82 to <84** | 493 | -1.28 | -0.77 | 0.08 | -0.08 |
| **84 to <86** | 486 | -0.30 | -0.66 | 0.08 | 0.50 |
| **86 to <88** | 425 | 1.08 | -0.78 | 1.73 | 0.95 |
| **88 to <90** | 309 | 0.98 | -0.47 | 1.31 | 1.48 |
| **90 to <92** | 242 | -0.43 | 0.93 | -0.71 | 0.95 |
| **92 to <96** | 460 | 0.54 | -0.03 | 0.72 | -0.95 |
| **96 to <100** | 455 | -0.23 | -0.67 | -1.11 | -1.49 |
| **100 to <104** | 482 | -0.68 | 0.10 | -1.58 | -0.17 |
| **104 to <108** | 522 | 0.39 | -0.50 | 0.89 | 0.05 |
| **108 to <112** | 496 | -0.80 | 0.31 | 0.13 | -0.37 |
| **112 to <116** | 318 | -0.58 | 0.97 | 0.97 | 0.26 |
| **116 to 134** | 296 | 1.77 | 1.18 | 0.13 | -1.03 |
| **Overall Q stats** | **13 623** | **12.62** | **19.94** | **28.25** | **19.92** |
| **degrees of freedom** | | **17.0** | **26.5** | **28.0** | **28.0** |
| **p-value** | | **0.7612** | **0.8144** | **0.4513** | **0.8672** |

Note: Absolute values of z1, z2, z3 or z4 larger than 2 indicate misfit of, respectively, mean, variance, skewness or kurtosis.

A new iteration was done using df(ν)=1 to re-search for the best combination of df(μ) and df(σ). Model 2 still presented the smallest value of *GAIC(3)* and very close *AIC* (31 936.0) to the model with smallest *AIC*, i.e. with df(μ)=14 and df(σ)=4 (31 934.7). Thus, there was no necessity to update Model 2.

In conclusion, the model BCPE(x=length (or height+0.7), df(μ)=12, df(σ)=4, df(ν)=1, τ=2) was used to construct the weight-for-length and weight-for-height growth curves for girls. The centile curves for weight-for-height were constructed in the same way as described for boys, i.e. centiles were shifted back by 0.7 cm in the range 65.7 to 120.7 cm. Figures 82 and 83 show the weight-for-length centile curves, and Figures 84 and 85 show the weight-for-height centile curves for girls, including the empirical centiles.

**Table 65** Observed proportions of children with measurements below the fitted centiles from Model 2, weight-for-length/height for girls

| Expected | 43 to <50 | 50 to <52 | 52 to <54 | 54 to <56 | 56 to <58 | 58 to <60 | 60 to <62 | 62 to <64 | 64 to <66 | 66 to <68 |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 1.3 | 0.4 | 1.0 | 0.9 | 1.5 | 1.1 | 1.5 | 0.6 | 1.0 | 1.0 |
| **3** | 2.8 | 2.8 | 3.5 | 2.8 | 4.0 | 4.1 | 4.1 | 4.4 | 3.8 | 2.8 |
| **5** | 4.8 | 4.6 | 5.1 | 4.1 | 5.4 | 4.9 | 7.9 | 6.5 | 6.5 | 5.8 |
| **10** | 10.4 | 10.0 | 9.7 | 9.6 | 10.4 | 9.3 | 13.0 | 11.2 | 10.1 | 9.0 |
| **25** | 25.8 | 23.9 | 25.3 | 25.3 | 24.4 | 22.3 | 26.0 | 27.4 | 24.2 | 22.7 |
| **50** | 49.5 | 51.8 | 50.0 | 48.9 | 49.1 | 45.9 | 47.6 | 51.3 | 51.5 | 49.6 |
| **75** | 74.2 | 77.5 | 74.7 | 73.1 | 74.3 | 70.9 | 72.3 | 73.4 | 74.0 | 73.1 |
| **90** | 89.6 | 91.0 | 91.8 | 89.7 | 89.6 | 87.9 | 87.8 | 88.4 | 89.1 | 88.5 |
| **95** | 93.9 | 95.2 | 95.1 | 95.6 | 96.0 | 95.1 | 94.9 | 94.1 | 94.8 | 95.2 |
| **97** | 96.8 | 96.8 | 97.3 | 96.9 | 98.3 | 96.4 | 96.7 | 96.8 | 97.1 | 97.5 |
| **99** | 99.6 | 98.8 | 99.2 | 99.8 | 99.8 | 99.7 | 99.0 | 98.9 | 99.8 | 99.5 |
| **Expected** | **68 to <70** | **70 to <72** | **72 to <74** | **74 to <76** | **76 to <78** | **78 to <80** | **80 to <82** | **82 to <84** | **84 to <86** | **86 to <88** |
| **1** | 0.7 | 0.9 | 0.5 | 1.0 | 0.8 | 0.7 | 0.8 | 0.8 | 1.2 | 0.5 |
| **3** | 2.7 | 3.1 | 2.2 | 2.5 | 3.2 | 2.8 | 3.3 | 3.0 | 2.1 | 1.6 |
| **5** | 4.2 | 5.1 | 4.8 | 5.2 | 4.9 | 5.3 | 5.7 | 5.3 | 3.5 | 4.7 |
| **10** | 9.7 | 9.8 | 9.9 | 9.3 | 9.5 | 10.1 | 9.2 | 10.1 | 9.3 | 9.2 |
| **25** | 24.0 | 26.3 | 25.0 | 25.8 | 26.1 | 25.6 | 25.1 | 28.2 | 26.1 | 22.4 |
| **50** | 51.3 | 51.2 | 47.0 | 51.0 | 52.5 | 52.1 | 51.5 | 52.3 | 50.6 | 47.1 |
| **75** | 76.3 | 74.0 | 75.2 | 75.4 | 76.3 | 74.4 | 75.2 | 76.7 | 75.7 | 75.8 |
| **90** | 89.3 | 90.5 | 90.8 | 87.0 | 89.6 | 90.6 | 90.6 | 91.9 | 89.5 | 89.9 |
| **95** | 94.7 | 95.2 | 94.5 | 92.8 | 93.9 | 95.0 | 95.3 | 96.1 | 94.9 | 94.1 |
| **97** | 97.8 | 96.6 | 96.9 | 94.8 | 96.6 | 96.3 | 97.2 | 97.6 | 97.3 | 96.0 |
| **99** | 99.5 | 98.9 | 98.8 | 98.1 | 98.1 | 98.5 | 98.8 | 99.2 | 99.2 | 98.4 |

**Table 65 Observed proportions of children with measurements below the fitted centiles from Model 2, weight-for-length/height for girls (continued)**

| Expected | 88 to <90 | 90 to <92 | 92 to <96 | 96 to <100 | 100 to <104 | 104 to <108 | 108 to <112 | 112 to <116 | 116 to 134 | Overall |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 0.3 | 1.2 | 0.9 | 0.9 | 1.0 | 1.1 | 0.4 | 1.9 | 0.7 | 0.9 |
| **3** | 2.6 | 2.9 | 2.6 | 2.4 | 3.3 | 2.1 | 3.8 | 3.8 | 2.7 | 3.0 |
| **5** | 3.9 | 5.0 | 4.3 | 4.0 | 6.6 | 4.6 | 6.7 | 5.7 | 4.7 | 5.2 |
| **10** | 7.4 | 12.4 | 8.9 | 11.0 | 11.4 | 9.2 | 11.3 | 9.7 | 9.1 | 10.0 |
| **25** | 21.7 | 27.7 | 25.7 | 25.5 | 26.1 | 22.8 | 25.4 | 26.1 | 23.6 | 25.1 |
| **50** | 49.8 | 49.2 | 53.0 | 49.9 | 48.8 | 49.4 | 53.4 | 55.7 | 46.6 | 50.3 |
| **75** | 77.0 | 74.4 | 73.0 | 71.4 | 75.1 | 75.7 | 74.6 | 76.1 | 69.9 | 74.6 |
| **90** | 88.7 | 90.5 | 87.8 | 90.3 | 91.1 | 89.5 | 88.7 | 87.7 | 87.5 | 89.6 |
| **95** | 93.2 | 95.9 | 94.6 | 95.4 | 95.4 | 93.9 | 94.8 | 92.8 | 91.6 | 94.7 |
| **97** | 95.8 | 97.9 | 97.0 | 98.5 | 96.9 | 95.6 | 96.6 | 95.0 | 93.9 | 96.8 |
| **99** | 99.0 | 99.2 | 99.1 | 99.6 | 99.8 | 99.0 | 99.2 | 98.4 | 98.3 | 99.1 |

Note: Group labels correspond to the length (or height+0.7) intervals in Table 64.

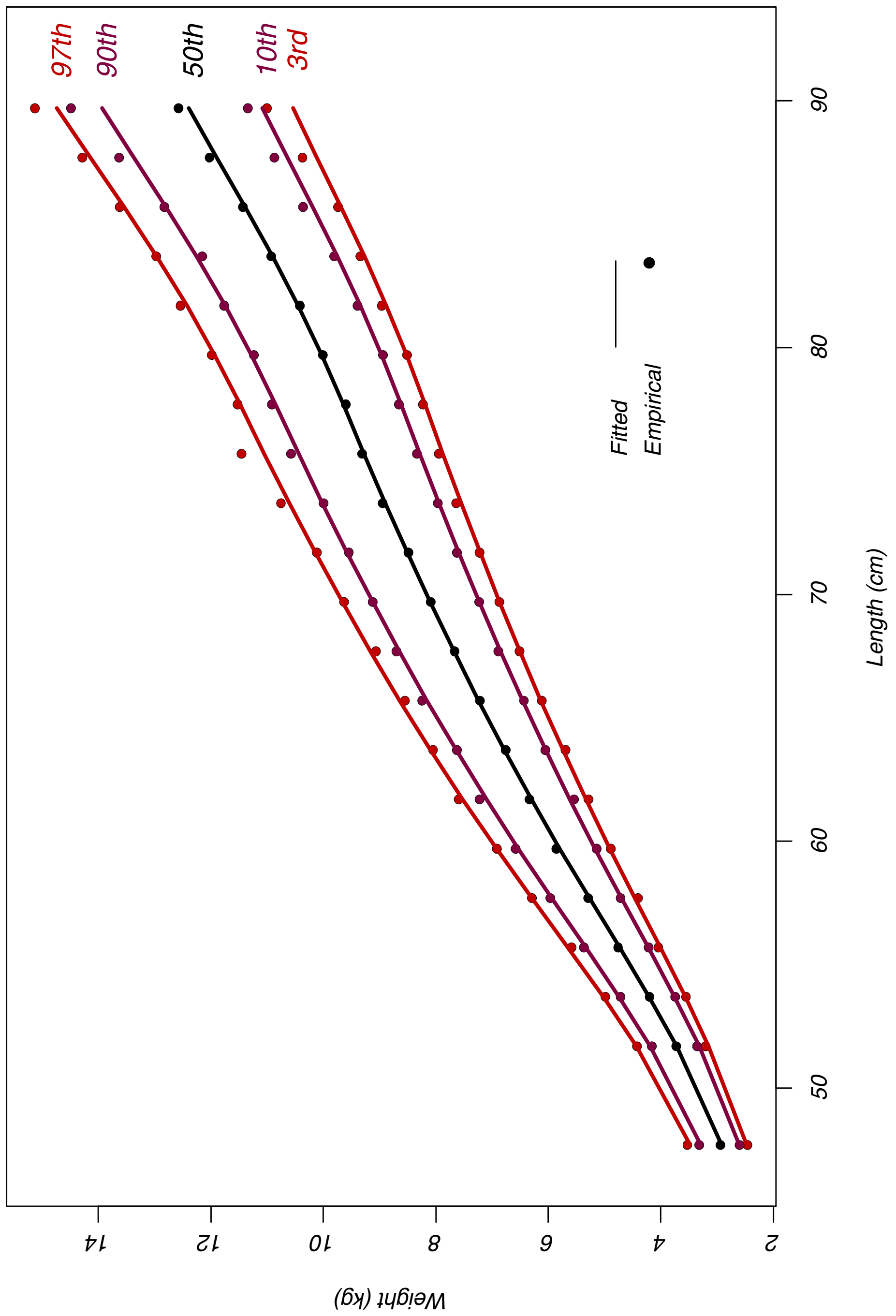


**Figure 82** **3rd, 10th, 50th, 90th, 97th smoothed centile curves and empirical values: weight-for-length for girls**

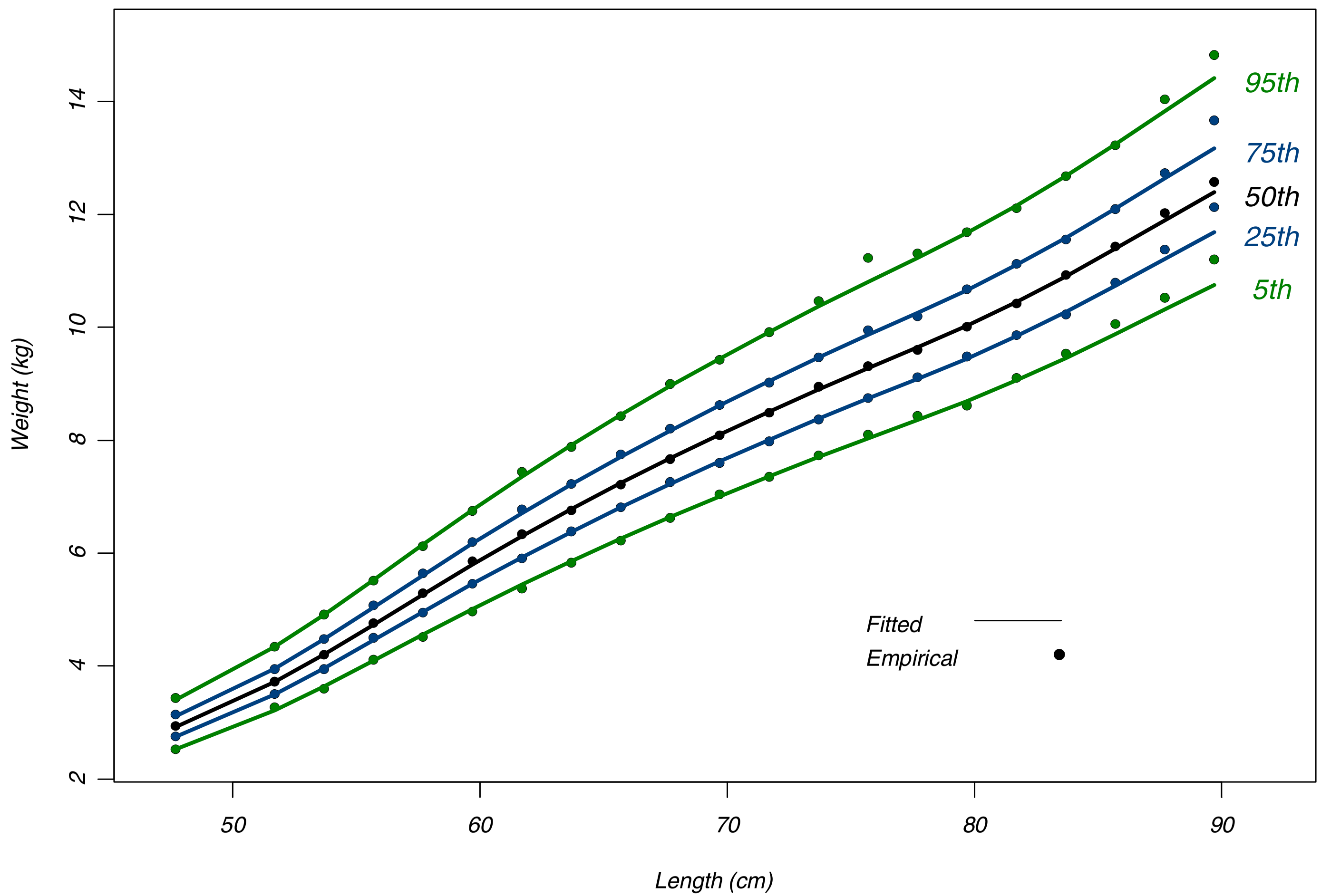


**Figure 83** 5th, 25th, 50th, 75th, 95th smoothed centile curves and empirical values: weight-for-length for girls

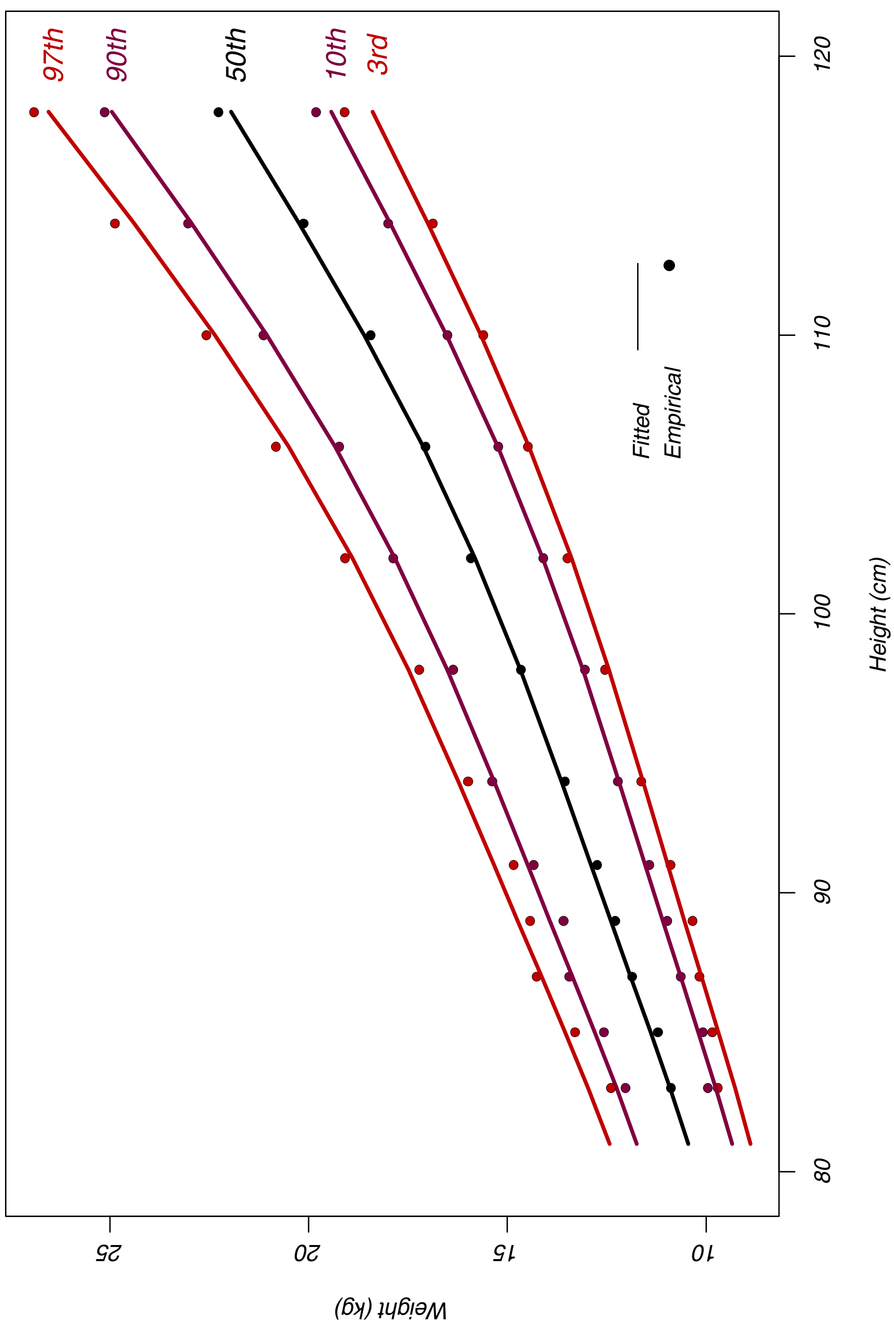


**Figure 84** **3rd, 10th, 50th, 90th, 97th smoothed centile curves and empirical values: weight-for-height for girls**

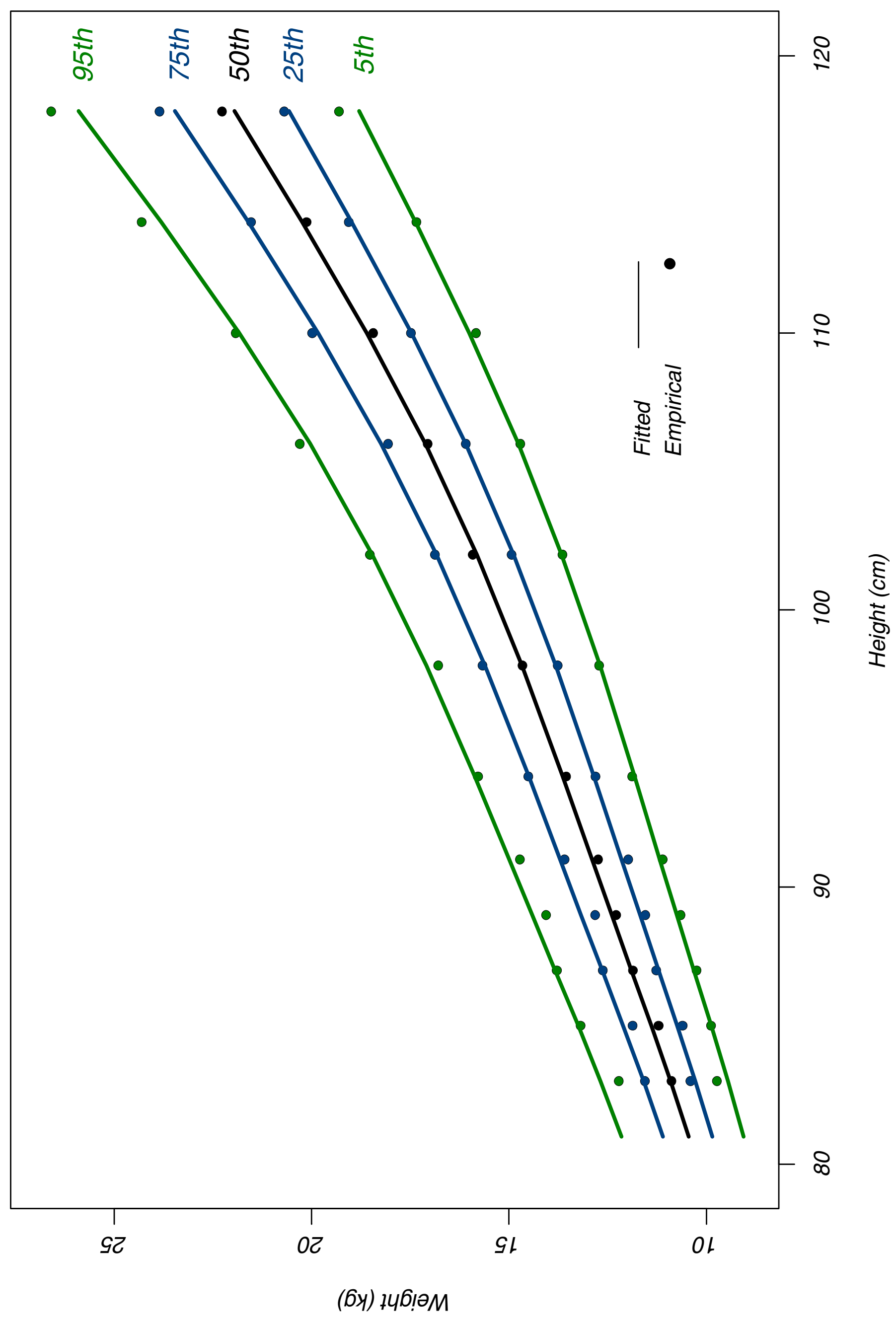


**Figure 85** 5th, 25th, 50th, 75th, 95th smoothed centile curves and empirical values: weight-for-height for girls

### 5.3.3 WHO standards and their comparison with NCHS and CDC 2000 references

This section presents the final WHO weight-for-length and weight-for-height z-score and percentile charts (Figures 86 to 89) and tables (Tables 66 and 67) for girls. It also provides the z-score comparisons of the WHO versus NCHS (Figures 90 and 91) and CDC 2000 (Figures 92 and 93) curves.

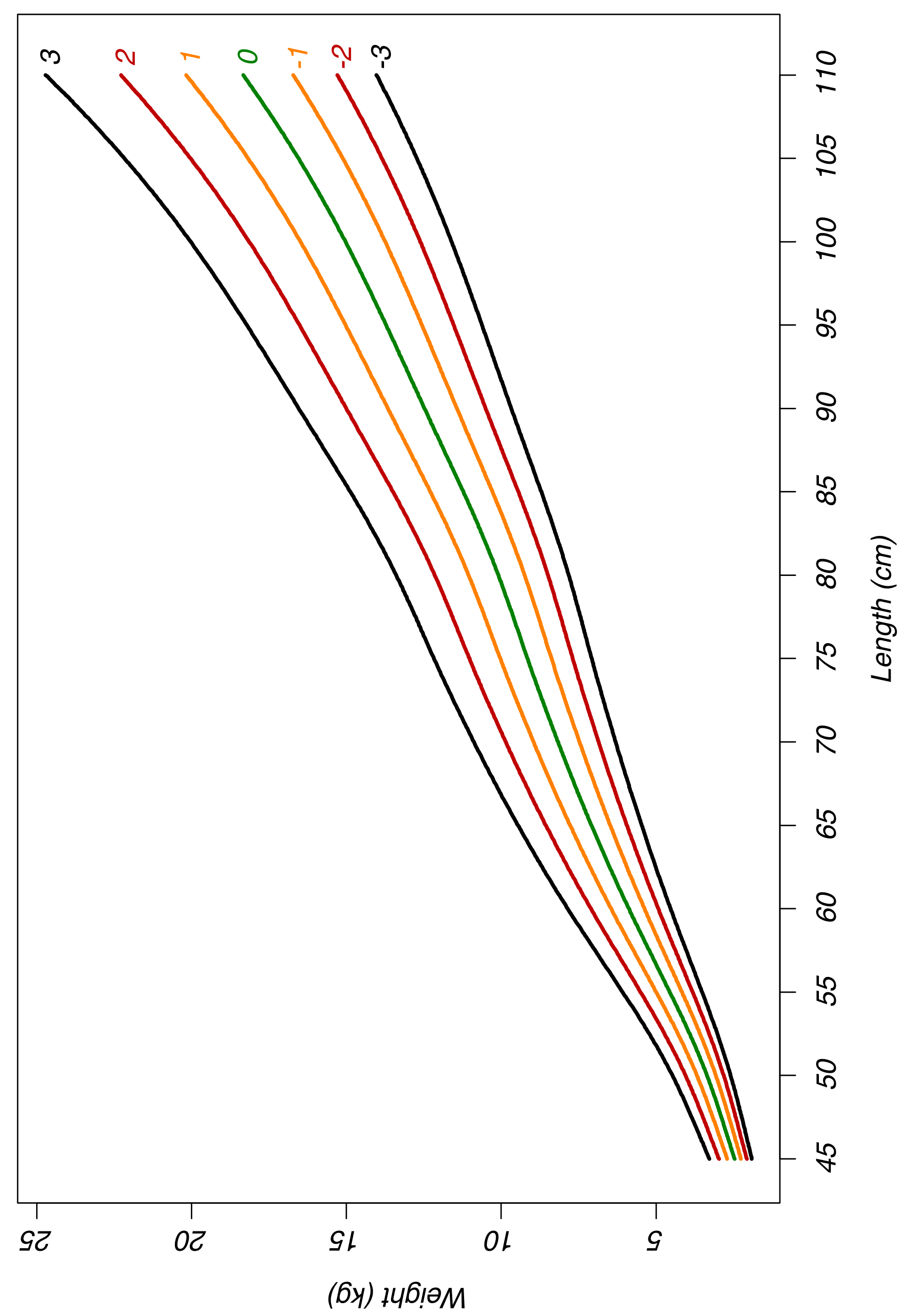


**Figure 86 WHO weight-for-length z-scores for girls**

*Charts*

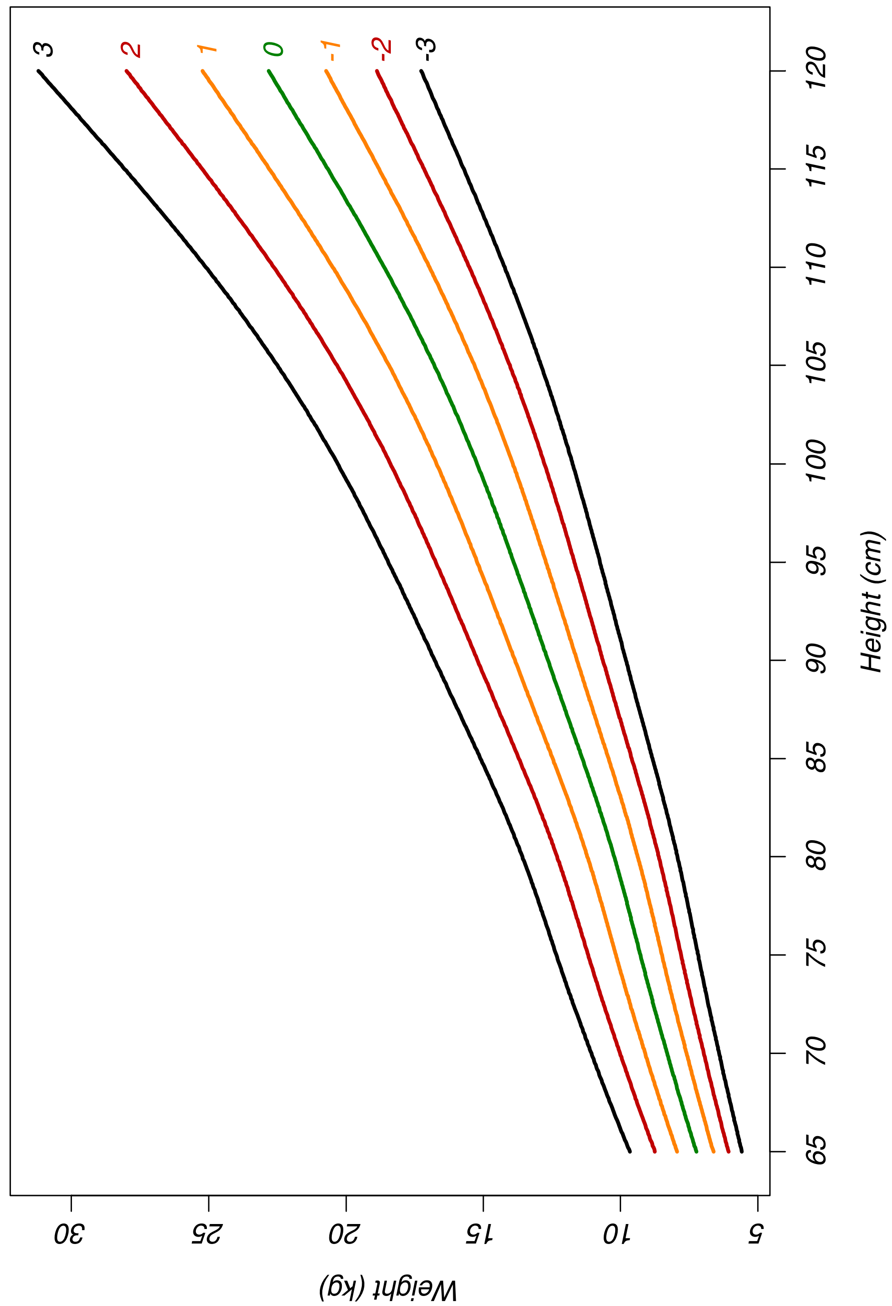


**Figure 87 WHO weight-for-height z-scores for girls**

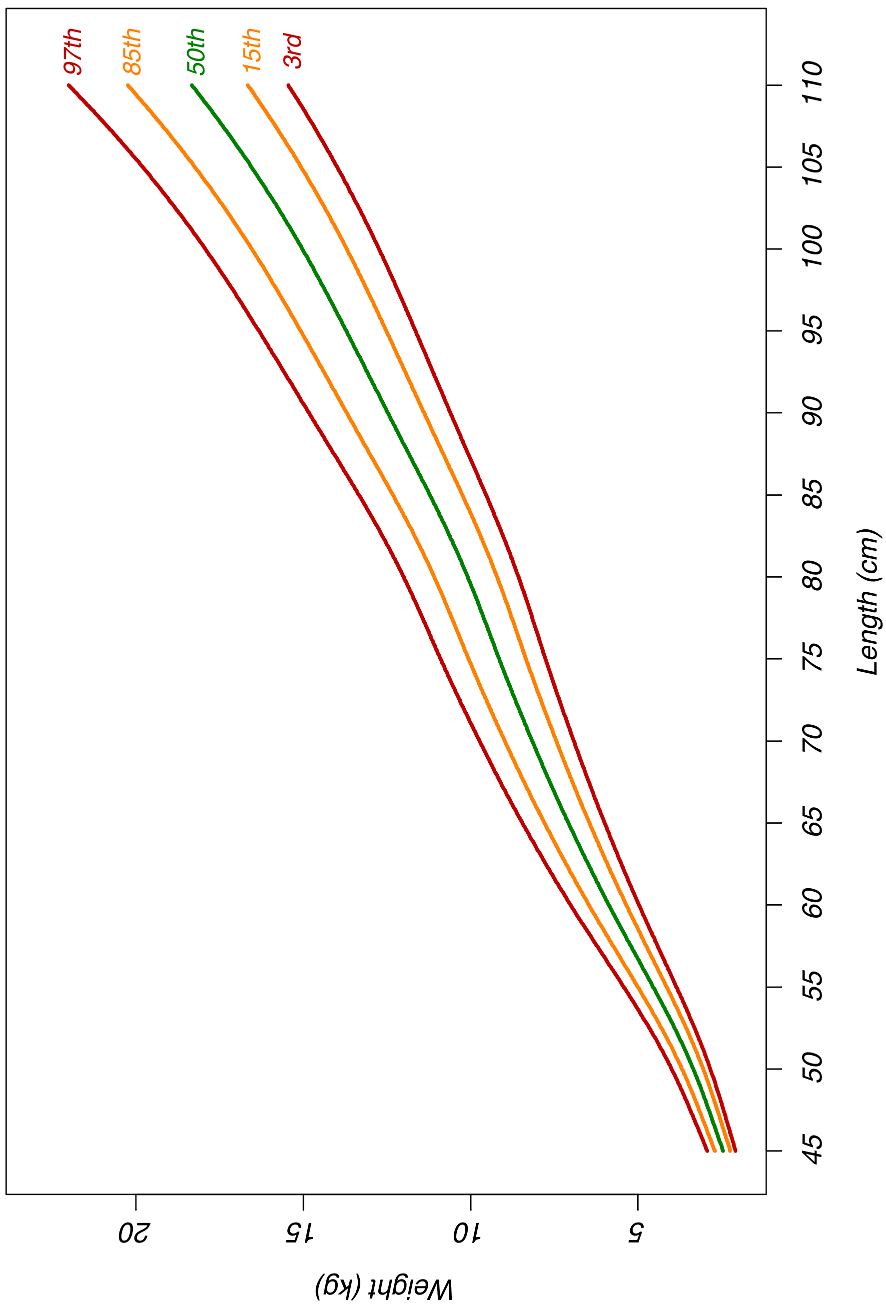


**Figure 88 WHO weight-for-length percentiles for girls**

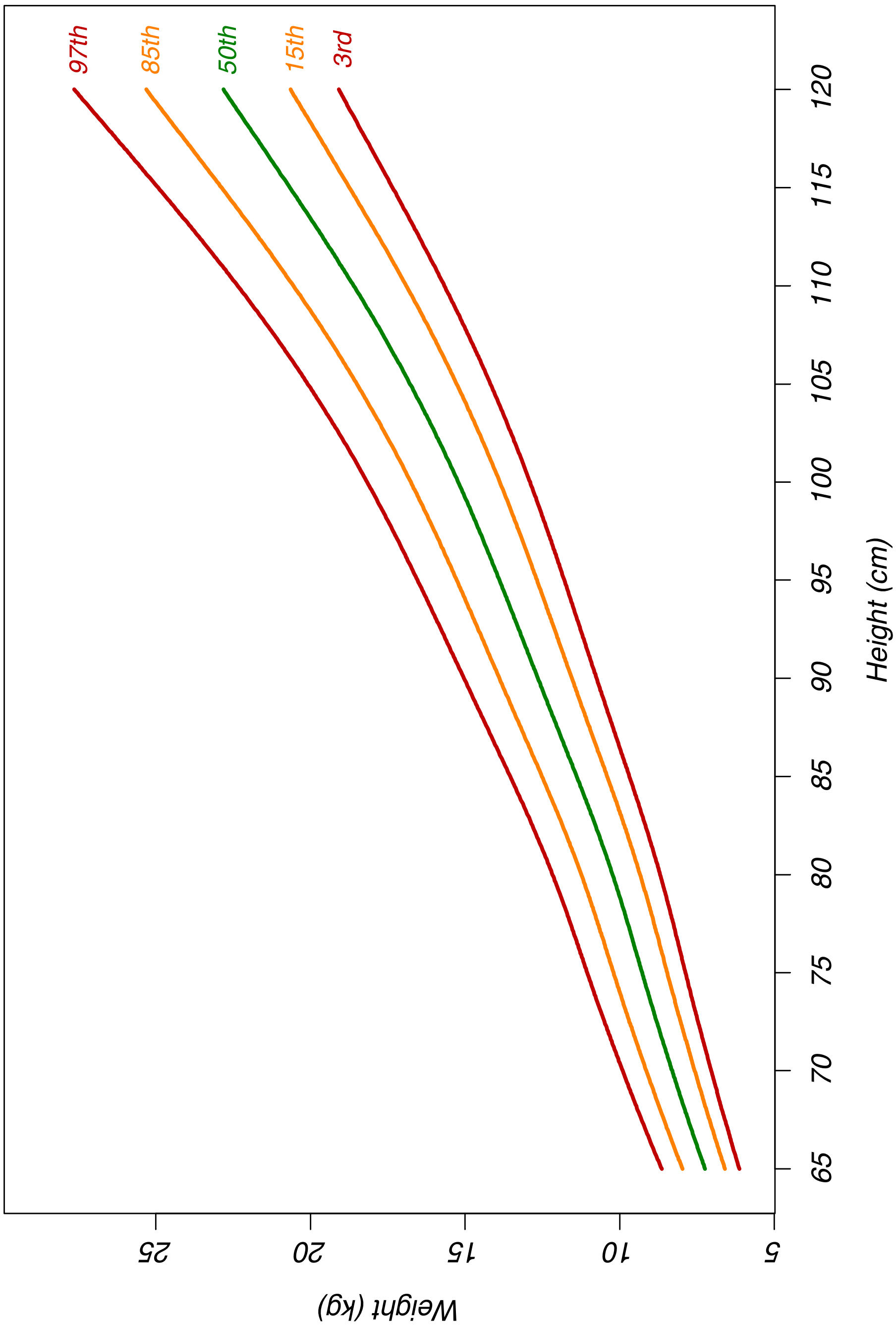


**Figure 89 WHO weight-for-height percentiles for girls**

*Tables*

**Table 66 Weight-for-length for girls**

| Length (cm) | L | M | S | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1st | 3rd | 5th | 15th | 25th | 50th | 75th | 85th | 95th | 97th | 99th |
| **45.0** | -0.3833 | 2.4607 | 0.09029 | 2.0 | 2.1 | 2.1 | 2.2 | 2.3 | 2.5 | 2.6 | 2.7 | 2.9 | 2.9 | 3.1 |
| **45.5** | -0.3833 | 2.5457 | 0.09033 | 2.1 | 2.2 | 2.2 | 2.3 | 2.4 | 2.5 | 2.7 | 2.8 | 3.0 | 3.0 | 3.2 |
| **46.0** | -0.3833 | 2.6306 | 0.09037 | 2.1 | 2.2 | 2.3 | 2.4 | 2.5 | 2.6 | 2.8 | 2.9 | 3.1 | 3.1 | 3.3 |
| **46.5** | -0.3833 | 2.7155 | 0.09040 | 2.2 | 2.3 | 2.3 | 2.5 | 2.6 | 2.7 | 2.9 | 3.0 | 3.2 | 3.2 | 3.4 |
| **47.0** | -0.3833 | 2.8007 | 0.09044 | 2.3 | 2.4 | 2.4 | 2.6 | 2.6 | 2.8 | 3.0 | 3.1 | 3.3 | 3.3 | 3.5 |
| **47.5** | -0.3833 | 2.8867 | 0.09048 | 2.4 | 2.4 | 2.5 | 2.6 | 2.7 | 2.9 | 3.1 | 3.2 | 3.4 | 3.4 | 3.6 |
| **48.0** | -0.3833 | 2.9741 | 0.09052 | 2.4 | 2.5 | 2.6 | 2.7 | 2.8 | 3.0 | 3.2 | 3.3 | 3.5 | 3.5 | 3.7 |
| **48.5** | -0.3833 | 3.0636 | 0.09056 | 2.5 | 2.6 | 2.7 | 2.8 | 2.9 | 3.1 | 3.3 | 3.4 | 3.6 | 3.7 | 3.8 |
| **49.0** | -0.3833 | 3.1560 | 0.09060 | 2.6 | 2.7 | 2.7 | 2.9 | 3.0 | 3.2 | 3.4 | 3.5 | 3.7 | 3.8 | 3.9 |
| **49.5** | -0.3833 | 3.2520 | 0.09064 | 2.7 | 2.8 | 2.8 | 3.0 | 3.1 | 3.3 | 3.5 | 3.6 | 3.8 | 3.9 | 4.1 |
| **50.0** | -0.3833 | 3.3518 | 0.09068 | 2.7 | 2.8 | 2.9 | 3.1 | 3.2 | 3.4 | 3.6 | 3.7 | 3.9 | 4.0 | 4.2 |
| **50.5** | -0.3833 | 3.4557 | 0.09072 | 2.8 | 2.9 | 3.0 | 3.2 | 3.3 | 3.5 | 3.7 | 3.8 | 4.0 | 4.1 | 4.3 |
| **51.0** | -0.3833 | 3.5636 | 0.09076 | 2.9 | 3.0 | 3.1 | 3.2 | 3.4 | 3.6 | 3.8 | 3.9 | 4.2 | 4.3 | 4.4 |
| **51.5** | -0.3833 | 3.6754 | 0.09080 | 3.0 | 3.1 | 3.2 | 3.4 | 3.5 | 3.7 | 3.9 | 4.0 | 4.3 | 4.4 | 4.6 |
| **52.0** | -0.3833 | 3.7911 | 0.09085 | 3.1 | 3.2 | 3.3 | 3.5 | 3.6 | 3.8 | 4.0 | 4.2 | 4.4 | 4.5 | 4.7 |
| **52.5** | -0.3833 | 3.9105 | 0.09089 | 3.2 | 3.3 | 3.4 | 3.6 | 3.7 | 3.9 | 4.2 | 4.3 | 4.6 | 4.7 | 4.9 |
| **53.0** | -0.3833 | 4.0332 | 0.09093 | 3.3 | 3.4 | 3.5 | 3.7 | 3.8 | 4.0 | 4.3 | 4.4 | 4.7 | 4.8 | 5.0 |
| **53.5** | -0.3833 | 4.1591 | 0.09098 | 3.4 | 3.5 | 3.6 | 3.8 | 3.9 | 4.2 | 4.4 | 4.6 | 4.9 | 5.0 | 5.2 |
| **54.0** | -0.3833 | 4.2875 | 0.09102 | 3.5 | 3.6 | 3.7 | 3.9 | 4.0 | 4.3 | 4.6 | 4.7 | 5.0 | 5.1 | 5.3 |
| **54.5** | -0.3833 | 4.4179 | 0.09106 | 3.6 | 3.7 | 3.8 | 4.0 | 4.2 | 4.4 | 4.7 | 4.9 | 5.2 | 5.3 | 5.5 |
| **55.0** | -0.3833 | 4.5498 | 0.09110 | 3.7 | 3.9 | 3.9 | 4.1 | 4.3 | 4.5 | 4.8 | 5.0 | 5.3 | 5.4 | 5.7 |
| **55.5** | -0.3833 | 4.6827 | 0.09114 | 3.8 | 4.0 | 4.0 | 4.3 | 4.4 | 4.7 | 5.0 | 5.2 | 5.5 | 5.6 | 5.8 |
| **56.0** | -0.3833 | 4.8162 | 0.09118 | 3.9 | 4.1 | 4.2 | 4.4 | 4.5 | 4.8 | 5.1 | 5.3 | 5.6 | 5.8 | 6.0 |
| **56.5** | -0.3833 | 4.9500 | 0.09121 | 4.0 | 4.2 | 4.3 | 4.5 | 4.7 | 5.0 | 5.3 | 5.5 | 5.8 | 5.9 | 6.2 |

**Table 66 Weight-for-length for girls (continued)**

| Length (cm) | L | M | S | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1st | 3rd | 5th | 15th | 25th | 50th | 75th | 85th | 95th | 97th | 99th |
| **57.0** | -0.3833 | 5.0837 | 0.09125 | 4.1 | 4.3 | 4.4 | 4.6 | 4.8 | 5.1 | 5.4 | 5.6 | 5.9 | 6.1 | 6.3 |
| **57.5** | -0.3833 | 5.2173 | 0.09128 | 4.3 | 4.4 | 4.5 | 4.8 | 4.9 | 5.2 | 5.6 | 5.7 | 6.1 | 6.2 | 6.5 |
| **58.0** | -0.3833 | 5.3507 | 0.09130 | 4.4 | 4.5 | 4.6 | 4.9 | 5.0 | 5.4 | 5.7 | 5.9 | 6.2 | 6.4 | 6.7 |
| **58.5** | -0.3833 | 5.4834 | 0.09132 | 4.5 | 4.6 | 4.7 | 5.0 | 5.2 | 5.5 | 5.8 | 6.0 | 6.4 | 6.5 | 6.8 |
| **59.0** | -0.3833 | 5.6151 | 0.09134 | 4.6 | 4.8 | 4.9 | 5.1 | 5.3 | 5.6 | 6.0 | 6.2 | 6.6 | 6.7 | 7.0 |
| **59.5** | -0.3833 | 5.7454 | 0.09135 | 4.7 | 4.9 | 5.0 | 5.2 | 5.4 | 5.7 | 6.1 | 6.3 | 6.7 | 6.9 | 7.2 |
| **60.0** | -0.3833 | 5.8742 | 0.09136 | 4.8 | 5.0 | 5.1 | 5.4 | 5.5 | 5.9 | 6.3 | 6.5 | 6.9 | 7.0 | 7.3 |
| **60.5** | -0.3833 | 6.0014 | 0.09137 | 4.9 | 5.1 | 5.2 | 5.5 | 5.6 | 6.0 | 6.4 | 6.6 | 7.0 | 7.2 | 7.5 |
| **61.0** | -0.3833 | 6.1270 | 0.09137 | 5.0 | 5.2 | 5.3 | 5.6 | 5.8 | 6.1 | 6.5 | 6.7 | 7.2 | 7.3 | 7.6 |
| **61.5** | -0.3833 | 6.2511 | 0.09136 | 5.1 | 5.3 | 5.4 | 5.7 | 5.9 | 6.3 | 6.7 | 6.9 | 7.3 | 7.5 | 7.8 |
| **62.0** | -0.3833 | 6.3738 | 0.09135 | 5.2 | 5.4 | 5.5 | 5.8 | 6.0 | 6.4 | 6.8 | 7.0 | 7.4 | 7.6 | 8.0 |
| **62.5** | -0.3833 | 6.4948 | 0.09133 | 5.3 | 5.5 | 5.6 | 5.9 | 6.1 | 6.5 | 6.9 | 7.2 | 7.6 | 7.8 | 8.1 |
| **63.0** | -0.3833 | 6.6144 | 0.09131 | 5.4 | 5.6 | 5.7 | 6.0 | 6.2 | 6.6 | 7.0 | 7.3 | 7.7 | 7.9 | 8.3 |
| **63.5** | -0.3833 | 6.7328 | 0.09129 | 5.5 | 5.7 | 5.8 | 6.1 | 6.3 | 6.7 | 7.2 | 7.4 | 7.9 | 8.0 | 8.4 |
| **64.0** | -0.3833 | 6.8501 | 0.09126 | 5.6 | 5.8 | 5.9 | 6.2 | 6.4 | 6.9 | 7.3 | 7.5 | 8.0 | 8.2 | 8.5 |
| **64.5** | -0.3833 | 6.9662 | 0.09123 | 5.7 | 5.9 | 6.0 | 6.3 | 6.6 | 7.0 | 7.4 | 7.7 | 8.1 | 8.3 | 8.7 |
| **65.0** | -0.3833 | 7.0812 | 0.09119 | 5.8 | 6.0 | 6.1 | 6.5 | 6.7 | 7.1 | 7.5 | 7.8 | 8.3 | 8.5 | 8.8 |
| **65.5** | -0.3833 | 7.1950 | 0.09115 | 5.9 | 6.1 | 6.2 | 6.6 | 6.8 | 7.2 | 7.7 | 7.9 | 8.4 | 8.6 | 9.0 |
| **66.0** | -0.3833 | 7.3076 | 0.09110 | 6.0 | 6.2 | 6.3 | 6.7 | 6.9 | 7.3 | 7.8 | 8.0 | 8.5 | 8.7 | 9.1 |
| **66.5** | -0.3833 | 7.4189 | 0.09106 | 6.1 | 6.3 | 6.4 | 6.8 | 7.0 | 7.4 | 7.9 | 8.2 | 8.7 | 8.9 | 9.3 |
| **67.0** | -0.3833 | 7.5288 | 0.09101 | 6.1 | 6.4 | 6.5 | 6.9 | 7.1 | 7.5 | 8.0 | 8.3 | 8.8 | 9.0 | 9.4 |
| **67.5** | -0.3833 | 7.6375 | 0.09096 | 6.2 | 6.5 | 6.6 | 7.0 | 7.2 | 7.6 | 8.1 | 8.4 | 8.9 | 9.1 | 9.5 |
| **68.0** | -0.3833 | 7.7448 | 0.09090 | 6.3 | 6.6 | 6.7 | 7.1 | 7.3 | 7.7 | 8.2 | 8.5 | 9.0 | 9.2 | 9.7 |
| **68.5** | -0.3833 | 7.8509 | 0.09085 | 6.4 | 6.7 | 6.8 | 7.2 | 7.4 | 7.9 | 8.4 | 8.6 | 9.2 | 9.4 | 9.8 |
| **69.0** | -0.3833 | 7.9559 | 0.09079 | 6.5 | 6.7 | 6.9 | 7.3 | 7.5 | 8.0 | 8.5 | 8.8 | 9.3 | 9.5 | 9.9 |
| **69.5** | -0.3833 | 8.0599 | 0.09074 | 6.6 | 6.8 | 7.0 | 7.3 | 7.6 | 8.1 | 8.6 | 8.9 | 9.4 | 9.6 | 10.0 |
| **70.0** | -0.3833 | 8.1630 | 0.09068 | 6.7 | 6.9 | 7.1 | 7.4 | 7.7 | 8.2 | 8.7 | 9.0 | 9.5 | 9.7 | 10.2 |
| **70.5** | -0.3833 | 8.2651 | 0.09062 | 6.7 | 7.0 | 7.1 | 7.5 | 7.8 | 8.3 | 8.8 | 9.1 | 9.6 | 9.9 | 10.3 |
| **71.0** | -0.3833 | 8.3666 | 0.09056 | 6.8 | 7.1 | 7.2 | 7.6 | 7.9 | 8.4 | 8.9 | 9.2 | 9.8 | 10.0 | 10.4 |
| **71.5** | -0.3833 | 8.4676 | 0.09050 | 6.9 | 7.2 | 7.3 | 7.7 | 8.0 | 8.5 | 9.0 | 9.3 | 9.9 | 10.1 | 10.5 |

**Table 66 Weight-for-length for girls (continued)**

| | | | | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Length (cm)** | **L** | **M** | **S** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **72.0** | -0.3833 | 8.5679 | 0.09043 | 7.0 | 7.3 | 7.4 | 7.8 | 8.1 | 8.6 | 9.1 | 9.4 | 10.0 | 10.2 | 10.7 |
| **72.5** | -0.3833 | 8.6674 | 0.09037 | 7.1 | 7.4 | 7.5 | 7.9 | 8.2 | 8.7 | 9.2 | 9.5 | 10.1 | 10.3 | 10.8 |
| **73.0** | -0.3833 | 8.7661 | 0.09031 | 7.2 | 7.4 | 7.6 | 8.0 | 8.3 | 8.8 | 9.3 | 9.6 | 10.2 | 10.4 | 10.9 |
| **73.5** | -0.3833 | 8.8638 | 0.09025 | 7.2 | 7.5 | 7.7 | 8.1 | 8.3 | 8.9 | 9.4 | 9.7 | 10.3 | 10.6 | 11.0 |
| **74.0** | -0.3833 | 8.9601 | 0.09018 | 7.3 | 7.6 | 7.8 | 8.2 | 8.4 | 9.0 | 9.5 | 9.9 | 10.4 | 10.7 | 11.2 |
| **74.5** | -0.3833 | 9.0552 | 0.09012 | 7.4 | 7.7 | 7.8 | 8.3 | 8.5 | 9.1 | 9.6 | 10.0 | 10.5 | 10.8 | 11.3 |
| **75.0** | -0.3833 | 9.1490 | 0.09005 | 7.5 | 7.8 | 7.9 | 8.3 | 8.6 | 9.1 | 9.7 | 10.1 | 10.7 | 10.9 | 11.4 |
| **75.5** | -0.3833 | 9.2418 | 0.08999 | 7.6 | 7.8 | 8.0 | 8.4 | 8.7 | 9.2 | 9.8 | 10.2 | 10.8 | 11.0 | 11.5 |
| **76.0** | -0.3833 | 9.3337 | 0.08992 | 7.6 | 7.9 | 8.1 | 8.5 | 8.8 | 9.3 | 9.9 | 10.3 | 10.9 | 11.1 | 11.6 |
| **76.5** | -0.3833 | 9.4252 | 0.08985 | 7.7 | 8.0 | 8.2 | 8.6 | 8.9 | 9.4 | 10.0 | 10.4 | 11.0 | 11.2 | 11.7 |
| **77.0** | -0.3833 | 9.5166 | 0.08979 | 7.8 | 8.1 | 8.2 | 8.7 | 9.0 | 9.5 | 10.1 | 10.5 | 11.1 | 11.3 | 11.8 |
| **77.5** | -0.3833 | 9.6086 | 0.08972 | 7.9 | 8.2 | 8.3 | 8.8 | 9.1 | 9.6 | 10.2 | 10.6 | 11.2 | 11.4 | 11.9 |
| **78.0** | -0.3833 | 9.7015 | 0.08965 | 7.9 | 8.2 | 8.4 | 8.9 | 9.1 | 9.7 | 10.3 | 10.7 | 11.3 | 11.5 | 12.1 |
| **78.5** | -0.3833 | 9.7957 | 0.08959 | 8.0 | 8.3 | 8.5 | 8.9 | 9.2 | 9.8 | 10.4 | 10.8 | 11.4 | 11.7 | 12.2 |
| **79.0** | -0.3833 | 9.8915 | 0.08952 | 8.1 | 8.4 | 8.6 | 9.0 | 9.3 | 9.9 | 10.5 | 10.9 | 11.5 | 11.8 | 12.3 |
| **79.5** | -0.3833 | 9.9892 | 0.08946 | 8.2 | 8.5 | 8.7 | 9.1 | 9.4 | 10.0 | 10.6 | 11.0 | 11.6 | 11.9 | 12.4 |
| **80.0** | -0.3833 | 10.0891 | 0.08940 | 8.3 | 8.6 | 8.7 | 9.2 | 9.5 | 10.1 | 10.7 | 11.1 | 11.7 | 12.0 | 12.5 |
| **80.5** | -0.3833 | 10.1916 | 0.08934 | 8.3 | 8.7 | 8.8 | 9.3 | 9.6 | 10.2 | 10.8 | 11.2 | 11.9 | 12.1 | 12.7 |
| **81.0** | -0.3833 | 10.2965 | 0.08928 | 8.4 | 8.8 | 8.9 | 9.4 | 9.7 | 10.3 | 10.9 | 11.3 | 12.0 | 12.2 | 12.8 |
| **81.5** | -0.3833 | 10.4041 | 0.08923 | 8.5 | 8.8 | 9.0 | 9.5 | 9.8 | 10.4 | 11.1 | 11.4 | 12.1 | 12.4 | 12.9 |
| **82.0** | -0.3833 | 10.5140 | 0.08918 | 8.6 | 8.9 | 9.1 | 9.6 | 9.9 | 10.5 | 11.2 | 11.6 | 12.2 | 12.5 | 13.1 |
| **82.5** | -0.3833 | 10.6263 | 0.08914 | 8.7 | 9.0 | 9.2 | 9.7 | 10.0 | 10.6 | 11.3 | 11.7 | 12.4 | 12.6 | 13.2 |
| **83.0** | -0.3833 | 10.7410 | 0.08910 | 8.8 | 9.1 | 9.3 | 9.8 | 10.1 | 10.7 | 11.4 | 11.8 | 12.5 | 12.8 | 13.3 |
| **83.5** | -0.3833 | 10.8578 | 0.08906 | 8.9 | 9.2 | 9.4 | 9.9 | 10.2 | 10.9 | 11.5 | 11.9 | 12.6 | 12.9 | 13.5 |
| **84.0** | -0.3833 | 10.9767 | 0.08903 | 9.0 | 9.3 | 9.5 | 10.0 | 10.3 | 11.0 | 11.7 | 12.1 | 12.8 | 13.1 | 13.6 |
| **84.5** | -0.3833 | 11.0974 | 0.08900 | 9.1 | 9.4 | 9.6 | 10.1 | 10.5 | 11.1 | 11.8 | 12.2 | 12.9 | 13.2 | 13.8 |
| **85.0** | -0.3833 | 11.2198 | 0.08898 | 9.2 | 9.5 | 9.7 | 10.2 | 10.6 | 11.2 | 11.9 | 12.3 | 13.0 | 13.3 | 13.9 |
| **85.5** | -0.3833 | 11.3435 | 0.08897 | 9.3 | 9.6 | 9.8 | 10.4 | 10.7 | 11.3 | 12.1 | 12.5 | 13.2 | 13.5 | 14.1 |
| **86.0** | -0.3833 | 11.4684 | 0.08895 | 9.4 | 9.8 | 9.9 | 10.5 | 10.8 | 11.5 | 12.2 | 12.6 | 13.3 | 13.6 | 14.2 |
| **86.5** | -0.3833 | 11.5940 | 0.08895 | 9.5 | 9.9 | 10.1 | 10.6 | 10.9 | 11.6 | 12.3 | 12.7 | 13.5 | 13.8 | 14.4 |

**Table 66 Weight-for-length for girls (continued)**

| | | | | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Length (cm)** | **L** | **M** | **S** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **87.0** | -0.3833 | 11.7201 | 0.08895 | 9.6 | 10.0 | 10.2 | 10.7 | 11.0 | 11.7 | 12.5 | 12.9 | 13.6 | 13.9 | 14.5 |
| **87.5** | -0.3833 | 11.8461 | 0.08895 | 9.7 | 10.1 | 10.3 | 10.8 | 11.2 | 11.8 | 12.6 | 13.0 | 13.8 | 14.1 | 14.7 |
| **88.0** | -0.3833 | 11.9720 | 0.08896 | 9.8 | 10.2 | 10.4 | 10.9 | 11.3 | 12.0 | 12.7 | 13.2 | 13.9 | 14.2 | 14.9 |
| **88.5** | -0.3833 | 12.0976 | 0.08898 | 9.9 | 10.3 | 10.5 | 11.0 | 11.4 | 12.1 | 12.9 | 13.3 | 14.1 | 14.4 | 15.0 |
| **89.0** | -0.3833 | 12.2229 | 0.08900 | 10.0 | 10.4 | 10.6 | 11.2 | 11.5 | 12.2 | 13.0 | 13.4 | 14.2 | 14.5 | 15.2 |
| **89.5** | -0.3833 | 12.3477 | 0.08903 | 10.1 | 10.5 | 10.7 | 11.3 | 11.6 | 12.3 | 13.1 | 13.6 | 14.4 | 14.7 | 15.3 |
| **90.0** | -0.3833 | 12.4723 | 0.08906 | 10.2 | 10.6 | 10.8 | 11.4 | 11.8 | 12.5 | 13.3 | 13.7 | 14.5 | 14.8 | 15.5 |
| **90.5** | -0.3833 | 12.5965 | 0.08909 | 10.3 | 10.7 | 10.9 | 11.5 | 11.9 | 12.6 | 13.4 | 13.8 | 14.6 | 15.0 | 15.6 |
| **91.0** | -0.3833 | 12.7205 | 0.08913 | 10.4 | 10.8 | 11.0 | 11.6 | 12.0 | 12.7 | 13.5 | 14.0 | 14.8 | 15.1 | 15.8 |
| **91.5** | -0.3833 | 12.8443 | 0.08918 | 10.5 | 10.9 | 11.1 | 11.7 | 12.1 | 12.8 | 13.7 | 14.1 | 14.9 | 15.3 | 15.9 |
| **92.0** | -0.3833 | 12.9681 | 0.08923 | 10.6 | 11.0 | 11.2 | 11.8 | 12.2 | 13.0 | 13.8 | 14.2 | 15.1 | 15.4 | 16.1 |
| **92.5** | -0.3833 | 13.0920 | 0.08928 | 10.7 | 11.1 | 11.3 | 12.0 | 12.3 | 13.1 | 13.9 | 14.4 | 15.2 | 15.6 | 16.3 |
| **93.0** | -0.3833 | 13.2158 | 0.08934 | 10.8 | 11.2 | 11.5 | 12.1 | 12.5 | 13.2 | 14.0 | 14.5 | 15.4 | 15.7 | 16.4 |
| **93.5** | -0.3833 | 13.3399 | 0.08941 | 10.9 | 11.3 | 11.6 | 12.2 | 12.6 | 13.3 | 14.2 | 14.7 | 15.5 | 15.9 | 16.6 |
| **94.0** | -0.3833 | 13.4643 | 0.08948 | 11.0 | 11.4 | 11.7 | 12.3 | 12.7 | 13.5 | 14.3 | 14.8 | 15.7 | 16.0 | 16.7 |
| **94.5** | -0.3833 | 13.5892 | 0.08955 | 11.1 | 11.5 | 11.8 | 12.4 | 12.8 | 13.6 | 14.4 | 14.9 | 15.8 | 16.2 | 16.9 |
| **95.0** | -0.3833 | 13.7146 | 0.08963 | 11.2 | 11.6 | 11.9 | 12.5 | 12.9 | 13.7 | 14.6 | 15.1 | 16.0 | 16.3 | 17.0 |
| **95.5** | -0.3833 | 13.8408 | 0.08972 | 11.3 | 11.8 | 12.0 | 12.6 | 13.0 | 13.8 | 14.7 | 15.2 | 16.1 | 16.5 | 17.2 |
| **96.0** | -0.3833 | 13.9676 | 0.08981 | 11.4 | 11.9 | 12.1 | 12.7 | 13.2 | 14.0 | 14.9 | 15.4 | 16.3 | 16.6 | 17.4 |
| **96.5** | -0.3833 | 14.0953 | 0.08990 | 11.5 | 12.0 | 12.2 | 12.9 | 13.3 | 14.1 | 15.0 | 15.5 | 16.4 | 16.8 | 17.5 |
| **97.0** | -0.3833 | 14.2239 | 0.09000 | 11.6 | 12.1 | 12.3 | 13.0 | 13.4 | 14.2 | 15.1 | 15.6 | 16.6 | 16.9 | 17.7 |
| **97.5** | -0.3833 | 14.3537 | 0.09010 | 11.7 | 12.2 | 12.4 | 13.1 | 13.5 | 14.4 | 15.3 | 15.8 | 16.7 | 17.1 | 17.9 |
| **98.0** | -0.3833 | 14.4848 | 0.09021 | 11.8 | 12.3 | 12.5 | 13.2 | 13.6 | 14.5 | 15.4 | 15.9 | 16.9 | 17.3 | 18.0 |
| **98.5** | -0.3833 | 14.6174 | 0.09033 | 11.9 | 12.4 | 12.7 | 13.3 | 13.8 | 14.6 | 15.5 | 16.1 | 17.0 | 17.4 | 18.2 |
| **99.0** | -0.3833 | 14.7519 | 0.09044 | 12.0 | 12.5 | 12.8 | 13.5 | 13.9 | 14.8 | 15.7 | 16.2 | 17.2 | 17.6 | 18.4 |
| **99.5** | -0.3833 | 14.8882 | 0.09057 | 12.2 | 12.6 | 12.9 | 13.6 | 14.0 | 14.9 | 15.8 | 16.4 | 17.4 | 17.8 | 18.5 |
| **100.0** | -0.3833 | 15.0267 | 0.09069 | 12.3 | 12.7 | 13.0 | 13.7 | 14.1 | 15.0 | 16.0 | 16.5 | 17.5 | 17.9 | 18.7 |
| **100.5** | -0.3833 | 15.1676 | 0.09083 | 12.4 | 12.9 | 13.1 | 13.8 | 14.3 | 15.2 | 16.1 | 16.7 | 17.7 | 18.1 | 18.9 |
| **101.0** | -0.3833 | 15.3108 | 0.09096 | 12.5 | 13.0 | 13.2 | 14.0 | 14.4 | 15.3 | 16.3 | 16.9 | 17.9 | 18.3 | 19.1 |
| **101.5** | -0.3833 | 15.4564 | 0.09110 | 12.6 | 13.1 | 13.4 | 14.1 | 14.5 | 15.5 | 16.4 | 17.0 | 18.0 | 18.5 | 19.3 |

**Table 66 Weight-for-length for girls (continued)**

| Length (cm) | L | M | S | Percentiles (weight in kg) 1st | 3rd | 5th | 15th | 25th | 50th | 75th | 85th | 95th | 97th | 99th |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **102.0** | -0.3833 | 15.6046 | 0.09125 | 12.7 | 13.2 | 13.5 | 14.2 | 14.7 | 15.6 | 16.6 | 17.2 | 18.2 | 18.6 | 19.5 |
| **102.5** | -0.3833 | 15.7553 | 0.09139 | 12.8 | 13.3 | 13.6 | 14.4 | 14.8 | 15.8 | 16.8 | 17.4 | 18.4 | 18.8 | 19.7 |
| **103.0** | -0.3833 | 15.9087 | 0.09155 | 13.0 | 13.5 | 13.7 | 14.5 | 15.0 | 15.9 | 16.9 | 17.5 | 18.6 | 19.0 | 19.9 |
| **103.5** | -0.3833 | 16.0645 | 0.09170 | 13.1 | 13.6 | 13.9 | 14.6 | 15.1 | 16.1 | 17.1 | 17.7 | 18.8 | 19.2 | 20.1 |
| **104.0** | -0.3833 | 16.2229 | 0.09186 | 13.2 | 13.7 | 14.0 | 14.8 | 15.3 | 16.2 | 17.3 | 17.9 | 19.0 | 19.4 | 20.3 |
| **104.5** | -0.3833 | 16.3837 | 0.09203 | 13.3 | 13.9 | 14.1 | 14.9 | 15.4 | 16.4 | 17.4 | 18.1 | 19.1 | 19.6 | 20.5 |
| **105.0** | -0.3833 | 16.5470 | 0.09219 | 13.5 | 14.0 | 14.3 | 15.1 | 15.6 | 16.5 | 17.6 | 18.2 | 19.3 | 19.8 | 20.7 |
| **105.5** | -0.3833 | 16.7129 | 0.09236 | 13.6 | 14.1 | 14.4 | 15.2 | 15.7 | 16.7 | 17.8 | 18.4 | 19.5 | 20.0 | 20.9 |
| **106.0** | -0.3833 | 16.8814 | 0.09254 | 13.7 | 14.3 | 14.6 | 15.4 | 15.9 | 16.9 | 18.0 | 18.6 | 19.7 | 20.2 | 21.1 |
| **106.5** | -0.3833 | 17.0527 | 0.09271 | 13.9 | 14.4 | 14.7 | 15.5 | 16.0 | 17.1 | 18.2 | 18.8 | 20.0 | 20.4 | 21.4 |
| **107.0** | -0.3833 | 17.2269 | 0.09289 | 14.0 | 14.5 | 14.8 | 15.7 | 16.2 | 17.2 | 18.4 | 19.0 | 20.2 | 20.6 | 21.6 |
| **107.5** | -0.3833 | 17.4039 | 0.09307 | 14.1 | 14.7 | 15.0 | 15.8 | 16.4 | 17.4 | 18.5 | 19.2 | 20.4 | 20.9 | 21.8 |
| **108.0** | -0.3833 | 17.5839 | 0.09326 | 14.3 | 14.8 | 15.1 | 16.0 | 16.5 | 17.6 | 18.7 | 19.4 | 20.6 | 21.1 | 22.1 |
| **108.5** | -0.3833 | 17.7668 | 0.09344 | 14.4 | 15.0 | 15.3 | 16.2 | 16.7 | 17.8 | 18.9 | 19.6 | 20.8 | 21.3 | 22.3 |
| **109.0** | -0.3833 | 17.9526 | 0.09363 | 14.6 | 15.1 | 15.5 | 16.3 | 16.9 | 18.0 | 19.1 | 19.8 | 21.0 | 21.5 | 22.5 |
| **109.5** | -0.3833 | 18.1412 | 0.09382 | 14.7 | 15.3 | 15.6 | 16.5 | 17.0 | 18.1 | 19.3 | 20.0 | 21.3 | 21.8 | 22.8 |
| **110.0** | -0.3833 | 18.3324 | 0.09401 | 14.9 | 15.4 | 15.8 | 16.7 | 17.2 | 18.3 | 19.5 | 20.2 | 21.5 | 22.0 | 23.0 |

**Table 66 Weight-for-length for girls (continued)**

| | | | | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Length (cm)** | **L** | **M** | **S** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **45.0** | -0.3833 | 2.4607 | 0.09029 | 1.9 | 2.1 | 2.3 | 2.5 | 2.7 | 3.0 | 3.3 |
| **45.5** | -0.3833 | 2.5457 | 0.09033 | 2.0 | 2.1 | 2.3 | 2.5 | 2.8 | 3.1 | 3.4 |
| **46.0** | -0.3833 | 2.6306 | 0.09037 | 2.0 | 2.2 | 2.4 | 2.6 | 2.9 | 3.2 | 3.5 |
| **46.5** | -0.3833 | 2.7155 | 0.09040 | 2.1 | 2.3 | 2.5 | 2.7 | 3.0 | 3.3 | 3.6 |
| **47.0** | -0.3833 | 2.8007 | 0.09044 | 2.2 | 2.4 | 2.6 | 2.8 | 3.1 | 3.4 | 3.7 |
| **47.5** | -0.3833 | 2.8867 | 0.09048 | 2.2 | 2.4 | 2.6 | 2.9 | 3.2 | 3.5 | 3.8 |
| **48.0** | -0.3833 | 2.9741 | 0.09052 | 2.3 | 2.5 | 2.7 | 3.0 | 3.3 | 3.6 | 4.0 |
| **48.5** | -0.3833 | 3.0636 | 0.09056 | 2.4 | 2.6 | 2.8 | 3.1 | 3.4 | 3.7 | 4.1 |
| **49.0** | -0.3833 | 3.1560 | 0.09060 | 2.4 | 2.6 | 2.9 | 3.2 | 3.5 | 3.8 | 4.2 |
| **49.5** | -0.3833 | 3.2520 | 0.09064 | 2.5 | 2.7 | 3.0 | 3.3 | 3.6 | 3.9 | 4.3 |
| **50.0** | -0.3833 | 3.3518 | 0.09068 | 2.6 | 2.8 | 3.1 | 3.4 | 3.7 | 4.0 | 4.5 |
| **50.5** | -0.3833 | 3.4557 | 0.09072 | 2.7 | 2.9 | 3.2 | 3.5 | 3.8 | 4.2 | 4.6 |
| **51.0** | -0.3833 | 3.5636 | 0.09076 | 2.8 | 3.0 | 3.3 | 3.6 | 3.9 | 4.3 | 4.8 |
| **51.5** | -0.3833 | 3.6754 | 0.09080 | 2.8 | 3.1 | 3.4 | 3.7 | 4.0 | 4.4 | 4.9 |
| **52.0** | -0.3833 | 3.7911 | 0.09085 | 2.9 | 3.2 | 3.5 | 3.8 | 4.2 | 4.6 | 5.1 |
| **52.5** | -0.3833 | 3.9105 | 0.09089 | 3.0 | 3.3 | 3.6 | 3.9 | 4.3 | 4.7 | 5.2 |
| **53.0** | -0.3833 | 4.0332 | 0.09093 | 3.1 | 3.4 | 3.7 | 4.0 | 4.4 | 4.9 | 5.4 |
| **53.5** | -0.3833 | 4.1591 | 0.09098 | 3.2 | 3.5 | 3.8 | 4.2 | 4.6 | 5.0 | 5.5 |
| **54.0** | -0.3833 | 4.2875 | 0.09102 | 3.3 | 3.6 | 3.9 | 4.3 | 4.7 | 5.2 | 5.7 |
| **54.5** | -0.3833 | 4.4179 | 0.09106 | 3.4 | 3.7 | 4.0 | 4.4 | 4.8 | 5.3 | 5.9 |
| **55.0** | -0.3833 | 4.5498 | 0.09110 | 3.5 | 3.8 | 4.2 | 4.5 | 5.0 | 5.5 | 6.1 |
| **55.5** | -0.3833 | 4.6827 | 0.09114 | 3.6 | 3.9 | 4.3 | 4.7 | 5.1 | 5.7 | 6.3 |
| **56.0** | -0.3833 | 4.8162 | 0.09118 | 3.7 | 4.0 | 4.4 | 4.8 | 5.3 | 5.8 | 6.4 |
| **56.5** | -0.3833 | 4.9500 | 0.09121 | 3.8 | 4.1 | 4.5 | 5.0 | 5.4 | 6.0 | 6.6 |
| **57.0** | -0.3833 | 5.0837 | 0.09125 | 3.9 | 4.3 | 4.6 | 5.1 | 5.6 | 6.1 | 6.8 |
| **57.5** | -0.3833 | 5.2173 | 0.09128 | 4.0 | 4.4 | 4.8 | 5.2 | 5.7 | 6.3 | 7.0 |
| **58.0** | -0.3833 | 5.3507 | 0.09130 | 4.1 | 4.5 | 4.9 | 5.4 | 5.9 | 6.5 | 7.1 |
| **58.5** | -0.3833 | 5.4834 | 0.09132 | 4.2 | 4.6 | 5.0 | 5.5 | 6.0 | 6.6 | 7.3 |
| **59.0** | -0.3833 | 5.6151 | 0.09134 | 4.3 | 4.7 | 5.1 | 5.6 | 6.2 | 6.8 | 7.5 |
| **59.5** | -0.3833 | 5.7454 | 0.09135 | 4.4 | 4.8 | 5.3 | 5.7 | 6.3 | 6.9 | 7.7 |

**Table 66 Weight-for-length for girls (continued)**

| Length (cm) | L | M | S | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | -3 SD | -2 SD | -1 SD | Median | 1 SD | 2 SD | 3 SD |
| **60.0** | -0.3833 | 5.8742 | 0.09136 | 4.5 | 4.9 | 5.4 | 5.9 | 6.4 | 7.1 | 7.8 |
| **60.5** | -0.3833 | 6.0014 | 0.09137 | 4.6 | 5.0 | 5.5 | 6.0 | 6.6 | 7.3 | 8.0 |
| **61.0** | -0.3833 | 6.1270 | 0.09137 | 4.7 | 5.1 | 5.6 | 6.1 | 6.7 | 7.4 | 8.2 |
| **61.5** | -0.3833 | 6.2511 | 0.09136 | 4.8 | 5.2 | 5.7 | 6.3 | 6.9 | 7.6 | 8.4 |
| **62.0** | -0.3833 | 6.3738 | 0.09135 | 4.9 | 5.3 | 5.8 | 6.4 | 7.0 | 7.7 | 8.5 |
| **62.5** | -0.3833 | 6.4948 | 0.09133 | 5.0 | 5.4 | 5.9 | 6.5 | 7.1 | 7.8 | 8.7 |
| **63.0** | -0.3833 | 6.6144 | 0.09131 | 5.1 | 5.5 | 6.0 | 6.6 | 7.3 | 8.0 | 8.8 |
| **63.5** | -0.3833 | 6.7328 | 0.09129 | 5.2 | 5.6 | 6.2 | 6.7 | 7.4 | 8.1 | 9.0 |
| **64.0** | -0.3833 | 6.8501 | 0.09126 | 5.3 | 5.7 | 6.3 | 6.9 | 7.5 | 8.3 | 9.1 |
| **64.5** | -0.3833 | 6.9662 | 0.09123 | 5.4 | 5.8 | 6.4 | 7.0 | 7.6 | 8.4 | 9.3 |
| **65.0** | -0.3833 | 7.0812 | 0.09119 | 5.5 | 5.9 | 6.5 | 7.1 | 7.8 | 8.6 | 9.5 |
| **65.5** | -0.3833 | 7.1950 | 0.09115 | 5.5 | 6.0 | 6.6 | 7.2 | 7.9 | 8.7 | 9.6 |
| **66.0** | -0.3833 | 7.3076 | 0.09110 | 5.6 | 6.1 | 6.7 | 7.3 | 8.0 | 8.8 | 9.8 |
| **66.5** | -0.3833 | 7.4189 | 0.09106 | 5.7 | 6.2 | 6.8 | 7.4 | 8.1 | 9.0 | 9.9 |
| **67.0** | -0.3833 | 7.5288 | 0.09101 | 5.8 | 6.3 | 6.9 | 7.5 | 8.3 | 9.1 | 10.0 |
| **67.5** | -0.3833 | 7.6375 | 0.09096 | 5.9 | 6.4 | 7.0 | 7.6 | 8.4 | 9.2 | 10.2 |
| **68.0** | -0.3833 | 7.7448 | 0.09090 | 6.0 | 6.5 | 7.1 | 7.7 | 8.5 | 9.4 | 10.3 |
| **68.5** | -0.3833 | 7.8509 | 0.09085 | 6.1 | 6.6 | 7.2 | 7.9 | 8.6 | 9.5 | 10.5 |
| **69.0** | -0.3833 | 7.9559 | 0.09079 | 6.1 | 6.7 | 7.3 | 8.0 | 8.7 | 9.6 | 10.6 |
| **69.5** | -0.3833 | 8.0599 | 0.09074 | 6.2 | 6.8 | 7.4 | 8.1 | 8.8 | 9.7 | 10.7 |
| **70.0** | -0.3833 | 8.1630 | 0.09068 | 6.3 | 6.9 | 7.5 | 8.2 | 9.0 | 9.9 | 10.9 |
| **70.5** | -0.3833 | 8.2651 | 0.09062 | 6.4 | 6.9 | 7.6 | 8.3 | 9.1 | 10.0 | 11.0 |
| **71.0** | -0.3833 | 8.3666 | 0.09056 | 6.5 | 7.0 | 7.7 | 8.4 | 9.2 | 10.1 | 11.1 |
| **71.5** | -0.3833 | 8.4676 | 0.09050 | 6.5 | 7.1 | 7.7 | 8.5 | 9.3 | 10.2 | 11.3 |
| **72.0** | -0.3833 | 8.5679 | 0.09043 | 6.6 | 7.2 | 7.8 | 8.6 | 9.4 | 10.3 | 11.4 |
| **72.5** | -0.3833 | 8.6674 | 0.09037 | 6.7 | 7.3 | 7.9 | 8.7 | 9.5 | 10.5 | 11.5 |
| **73.0** | -0.3833 | 8.7661 | 0.09031 | 6.8 | 7.4 | 8.0 | 8.8 | 9.6 | 10.6 | 11.7 |
| **73.5** | -0.3833 | 8.8638 | 0.09025 | 6.9 | 7.4 | 8.1 | 8.9 | 9.7 | 10.7 | 11.8 |
| **74.0** | -0.3833 | 8.9601 | 0.09018 | 6.9 | 7.5 | 8.2 | 9.0 | 9.8 | 10.8 | 11.9 |
| **74.5** | -0.3833 | 9.0552 | 0.09012 | 7.0 | 7.6 | 8.3 | 9.1 | 9.9 | 10.9 | 12.0 |

**Table 66 Weight-for-length for girls (continued)**

| | | | | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Length (cm)** | **L** | **M** | **S** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **75.0** | -0.3833 | 9.1490 | 0.09005 | 7.1 | 7.7 | 8.4 | 9.1 | 10.0 | 11.0 | 12.2 |
| **75.5** | -0.3833 | 9.2418 | 0.08999 | 7.1 | 7.8 | 8.5 | 9.2 | 10.1 | 11.1 | 12.3 |
| **76.0** | -0.3833 | 9.3337 | 0.08992 | 7.2 | 7.8 | 8.5 | 9.3 | 10.2 | 11.2 | 12.4 |
| **76.5** | -0.3833 | 9.4252 | 0.08985 | 7.3 | 7.9 | 8.6 | 9.4 | 10.3 | 11.4 | 12.5 |
| **77.0** | -0.3833 | 9.5166 | 0.08979 | 7.4 | 8.0 | 8.7 | 9.5 | 10.4 | 11.5 | 12.6 |
| **77.5** | -0.3833 | 9.6086 | 0.08972 | 7.4 | 8.1 | 8.8 | 9.6 | 10.5 | 11.6 | 12.8 |
| **78.0** | -0.3833 | 9.7015 | 0.08965 | 7.5 | 8.2 | 8.9 | 9.7 | 10.6 | 11.7 | 12.9 |
| **78.5** | -0.3833 | 9.7957 | 0.08959 | 7.6 | 8.2 | 9.0 | 9.8 | 10.7 | 11.8 | 13.0 |
| **79.0** | -0.3833 | 9.8915 | 0.08952 | 7.7 | 8.3 | 9.1 | 9.9 | 10.8 | 11.9 | 13.1 |
| **79.5** | -0.3833 | 9.9892 | 0.08946 | 7.7 | 8.4 | 9.1 | 10.0 | 10.9 | 12.0 | 13.3 |
| **80.0** | -0.3833 | 10.0891 | 0.08940 | 7.8 | 8.5 | 9.2 | 10.1 | 11.0 | 12.1 | 13.4 |
| **80.5** | -0.3833 | 10.1916 | 0.08934 | 7.9 | 8.6 | 9.3 | 10.2 | 11.2 | 12.3 | 13.5 |
| **81.0** | -0.3833 | 10.2965 | 0.08928 | 8.0 | 8.7 | 9.4 | 10.3 | 11.3 | 12.4 | 13.7 |
| **81.5** | -0.3833 | 10.4041 | 0.08923 | 8.1 | 8.8 | 9.5 | 10.4 | 11.4 | 12.5 | 13.8 |
| **82.0** | -0.3833 | 10.5140 | 0.08918 | 8.1 | 8.8 | 9.6 | 10.5 | 11.5 | 12.6 | 13.9 |
| **82.5** | -0.3833 | 10.6263 | 0.08914 | 8.2 | 8.9 | 9.7 | 10.6 | 11.6 | 12.8 | 14.1 |
| **83.0** | -0.3833 | 10.7410 | 0.08910 | 8.3 | 9.0 | 9.8 | 10.7 | 11.8 | 12.9 | 14.2 |
| **83.5** | -0.3833 | 10.8578 | 0.08906 | 8.4 | 9.1 | 9.9 | 10.9 | 11.9 | 13.1 | 14.4 |
| **84.0** | -0.3833 | 10.9767 | 0.08903 | 8.5 | 9.2 | 10.1 | 11.0 | 12.0 | 13.2 | 14.5 |
| **84.5** | -0.3833 | 11.0974 | 0.08900 | 8.6 | 9.3 | 10.2 | 11.1 | 12.1 | 13.3 | 14.7 |
| **85.0** | -0.3833 | 11.2198 | 0.08898 | 8.7 | 9.4 | 10.3 | 11.2 | 12.3 | 13.5 | 14.9 |
| **85.5** | -0.3833 | 11.3435 | 0.08897 | 8.8 | 9.5 | 10.4 | 11.3 | 12.4 | 13.6 | 15.0 |
| **86.0** | -0.3833 | 11.4684 | 0.08895 | 8.9 | 9.7 | 10.5 | 11.5 | 12.6 | 13.8 | 15.2 |
| **86.5** | -0.3833 | 11.5940 | 0.08895 | 9.0 | 9.8 | 10.6 | 11.6 | 12.7 | 13.9 | 15.4 |
| **87.0** | -0.3833 | 11.7201 | 0.08895 | 9.1 | 9.9 | 10.7 | 11.7 | 12.8 | 14.1 | 15.5 |
| **87.5** | -0.3833 | 11.8461 | 0.08895 | 9.2 | 10.0 | 10.9 | 11.8 | 13.0 | 14.2 | 15.7 |
| **88.0** | -0.3833 | 11.9720 | 0.08896 | 9.3 | 10.1 | 11.0 | 12.0 | 13.1 | 14.4 | 15.9 |
| **88.5** | -0.3833 | 12.0976 | 0.08898 | 9.4 | 10.2 | 11.1 | 12.1 | 13.2 | 14.5 | 16.0 |
| **89.0** | -0.3833 | 12.2229 | 0.08900 | 9.5 | 10.3 | 11.2 | 12.2 | 13.4 | 14.7 | 16.2 |
| **89.5** | -0.3833 | 12.3477 | 0.08903 | 9.6 | 10.4 | 11.3 | 12.3 | 13.5 | 14.8 | 16.4 |

**Table 66 Weight-for-length for girls (continued)**

| | | | | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Length (cm)** | **L** | **M** | **S** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **90.0** | -0.3833 | 12.4723 | 0.08906 | 9.7 | 10.5 | 11.4 | 12.5 | 13.7 | 15.0 | 16.5 |
| **90.5** | -0.3833 | 12.5965 | 0.08909 | 9.8 | 10.6 | 11.5 | 12.6 | 13.8 | 15.1 | 16.7 |
| **91.0** | -0.3833 | 12.7205 | 0.08913 | 9.9 | 10.7 | 11.7 | 12.7 | 13.9 | 15.3 | 16.9 |
| **91.5** | -0.3833 | 12.8443 | 0.08918 | 10.0 | 10.8 | 11.8 | 12.8 | 14.1 | 15.5 | 17.0 |
| **92.0** | -0.3833 | 12.9681 | 0.08923 | 10.1 | 10.9 | 11.9 | 13.0 | 14.2 | 15.6 | 17.2 |
| **92.5** | -0.3833 | 13.0920 | 0.08928 | 10.1 | 11.0 | 12.0 | 13.1 | 14.3 | 15.8 | 17.4 |
| **93.0** | -0.3833 | 13.2158 | 0.08934 | 10.2 | 11.1 | 12.1 | 13.2 | 14.5 | 15.9 | 17.5 |
| **93.5** | -0.3833 | 13.3399 | 0.08941 | 10.3 | 11.2 | 12.2 | 13.3 | 14.6 | 16.1 | 17.7 |
| **94.0** | -0.3833 | 13.4643 | 0.08948 | 10.4 | 11.3 | 12.3 | 13.5 | 14.7 | 16.2 | 17.9 |
| **94.5** | -0.3833 | 13.5892 | 0.08955 | 10.5 | 11.4 | 12.4 | 13.6 | 14.9 | 16.4 | 18.0 |
| **95.0** | -0.3833 | 13.7146 | 0.08963 | 10.6 | 11.5 | 12.6 | 13.7 | 15.0 | 16.5 | 18.2 |
| **95.5** | -0.3833 | 13.8408 | 0.08972 | 10.7 | 11.6 | 12.7 | 13.8 | 15.2 | 16.7 | 18.4 |
| **96.0** | -0.3833 | 13.9676 | 0.08981 | 10.8 | 11.7 | 12.8 | 14.0 | 15.3 | 16.8 | 18.6 |
| **96.5** | -0.3833 | 14.0953 | 0.08990 | 10.9 | 11.8 | 12.9 | 14.1 | 15.4 | 17.0 | 18.7 |
| **97.0** | -0.3833 | 14.2239 | 0.09000 | 11.0 | 12.0 | 13.0 | 14.2 | 15.6 | 17.1 | 18.9 |
| **97.5** | -0.3833 | 14.3537 | 0.09010 | 11.1 | 12.1 | 13.1 | 14.4 | 15.7 | 17.3 | 19.1 |
| **98.0** | -0.3833 | 14.4848 | 0.09021 | 11.2 | 12.2 | 13.3 | 14.5 | 15.9 | 17.5 | 19.3 |
| **98.5** | -0.3833 | 14.6174 | 0.09033 | 11.3 | 12.3 | 13.4 | 14.6 | 16.0 | 17.6 | 19.5 |
| **99.0** | -0.3833 | 14.7519 | 0.09044 | 11.4 | 12.4 | 13.5 | 14.8 | 16.2 | 17.8 | 19.6 |
| **99.5** | -0.3833 | 14.8882 | 0.09057 | 11.5 | 12.5 | 13.6 | 14.9 | 16.3 | 18.0 | 19.8 |
| **100.0** | -0.3833 | 15.0267 | 0.09069 | 11.6 | 12.6 | 13.7 | 15.0 | 16.5 | 18.1 | 20.0 |
| **100.5** | -0.3833 | 15.1676 | 0.09083 | 11.7 | 12.7 | 13.9 | 15.2 | 16.6 | 18.3 | 20.2 |
| **101.0** | -0.3833 | 15.3108 | 0.09096 | 11.8 | 12.8 | 14.0 | 15.3 | 16.8 | 18.5 | 20.4 |
| **101.5** | -0.3833 | 15.4564 | 0.09110 | 11.9 | 13.0 | 14.1 | 15.5 | 17.0 | 18.7 | 20.6 |
| **102.0** | -0.3833 | 15.6046 | 0.09125 | 12.0 | 13.1 | 14.3 | 15.6 | 17.1 | 18.9 | 20.8 |
| **102.5** | -0.3833 | 15.7553 | 0.09139 | 12.1 | 13.2 | 14.4 | 15.8 | 17.3 | 19.0 | 21.0 |
| **103.0** | -0.3833 | 15.9087 | 0.09155 | 12.3 | 13.3 | 14.5 | 15.9 | 17.5 | 19.2 | 21.3 |
| **103.5** | -0.3833 | 16.0645 | 0.09170 | 12.4 | 13.5 | 14.7 | 16.1 | 17.6 | 19.4 | 21.5 |
| **104.0** | -0.3833 | 16.2229 | 0.09186 | 12.5 | 13.6 | 14.8 | 16.2 | 17.8 | 19.6 | 21.7 |
| **104.5** | -0.3833 | 16.3837 | 0.09203 | 12.6 | 13.7 | 15.0 | 16.4 | 18.0 | 19.8 | 21.9 |

**Table 66 Weight-for-length for girls (continued)**

| | | | | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Length (cm)** | **L** | **M** | **S** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **105.0** | -0.3833 | 16.5470 | 0.09219 | 12.7 | 13.8 | 15.1 | 16.5 | 18.2 | 20.0 | 22.2 |
| **105.5** | -0.3833 | 16.7129 | 0.09236 | 12.8 | 14.0 | 15.3 | 16.7 | 18.4 | 20.2 | 22.4 |
| **106.0** | -0.3833 | 16.8814 | 0.09254 | 13.0 | 14.1 | 15.4 | 16.9 | 18.5 | 20.5 | 22.6 |
| **106.5** | -0.3833 | 17.0527 | 0.09271 | 13.1 | 14.3 | 15.6 | 17.1 | 18.7 | 20.7 | 22.9 |
| **107.0** | -0.3833 | 17.2269 | 0.09289 | 13.2 | 14.4 | 15.7 | 17.2 | 18.9 | 20.9 | 23.1 |
| **107.5** | -0.3833 | 17.4039 | 0.09307 | 13.3 | 14.5 | 15.9 | 17.4 | 19.1 | 21.1 | 23.4 |
| **108.0** | -0.3833 | 17.5839 | 0.09326 | 13.5 | 14.7 | 16.0 | 17.6 | 19.3 | 21.3 | 23.6 |
| **108.5** | -0.3833 | 17.7668 | 0.09344 | 13.6 | 14.8 | 16.2 | 17.8 | 19.5 | 21.6 | 23.9 |
| **109.0** | -0.3833 | 17.9526 | 0.09363 | 13.7 | 15.0 | 16.4 | 18.0 | 19.7 | 21.8 | 24.2 |
| **109.5** | -0.3833 | 18.1412 | 0.09382 | 13.9 | 15.1 | 16.5 | 18.1 | 20.0 | 22.0 | 24.4 |
| **110.0** | -0.3833 | 18.3324 | 0.09401 | 14.0 | 15.3 | 16.7 | 18.3 | 20.2 | 22.3 | 24.7 |

**Table 67 Weight-for-height for girls**

| | | | | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Height (cm)** | **L** | **M** | **S** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **65.0** | -0.3833 | 7.2402 | 0.09113 | 5.9 | 6.1 | 6.3 | 6.6 | 6.8 | 7.2 | 7.7 | 8.0 | 8.4 | 8.6 | 9.0 |
| **65.5** | -0.3833 | 7.3523 | 0.09109 | 6.0 | 6.2 | 6.4 | 6.7 | 6.9 | 7.4 | 7.8 | 8.1 | 8.6 | 8.8 | 9.2 |
| **66.0** | -0.3833 | 7.4630 | 0.09104 | 6.1 | 6.3 | 6.5 | 6.8 | 7.0 | 7.5 | 7.9 | 8.2 | 8.7 | 8.9 | 9.3 |
| **66.5** | -0.3833 | 7.5724 | 0.09099 | 6.2 | 6.4 | 6.5 | 6.9 | 7.1 | 7.6 | 8.1 | 8.3 | 8.8 | 9.0 | 9.4 |
| **67.0** | -0.3833 | 7.6806 | 0.09094 | 6.3 | 6.5 | 6.6 | 7.0 | 7.2 | 7.7 | 8.2 | 8.5 | 9.0 | 9.2 | 9.6 |
| **67.5** | -0.3833 | 7.7874 | 0.09088 | 6.4 | 6.6 | 6.7 | 7.1 | 7.3 | 7.8 | 8.3 | 8.6 | 9.1 | 9.3 | 9.7 |
| **68.0** | -0.3833 | 7.8930 | 0.09083 | 6.4 | 6.7 | 6.8 | 7.2 | 7.4 | 7.9 | 8.4 | 8.7 | 9.2 | 9.4 | 9.8 |
| **68.5** | -0.3833 | 7.9976 | 0.09077 | 6.5 | 6.8 | 6.9 | 7.3 | 7.5 | 8.0 | 8.5 | 8.8 | 9.3 | 9.5 | 10.0 |
| **69.0** | -0.3833 | 8.1012 | 0.09071 | 6.6 | 6.9 | 7.0 | 7.4 | 7.6 | 8.1 | 8.6 | 8.9 | 9.4 | 9.7 | 10.1 |
| **69.5** | -0.3833 | 8.2039 | 0.09065 | 6.7 | 7.0 | 7.1 | 7.5 | 7.7 | 8.2 | 8.7 | 9.0 | 9.6 | 9.8 | 10.2 |
| **70.0** | -0.3833 | 8.3058 | 0.09059 | 6.8 | 7.0 | 7.2 | 7.6 | 7.8 | 8.3 | 8.8 | 9.1 | 9.7 | 9.9 | 10.3 |
| **70.5** | -0.3833 | 8.4071 | 0.09053 | 6.9 | 7.1 | 7.3 | 7.7 | 7.9 | 8.4 | 8.9 | 9.3 | 9.8 | 10.0 | 10.5 |
| **71.0** | -0.3833 | 8.5078 | 0.09047 | 6.9 | 7.2 | 7.4 | 7.8 | 8.0 | 8.5 | 9.0 | 9.4 | 9.9 | 10.1 | 10.6 |
| **71.5** | -0.3833 | 8.6078 | 0.09041 | 7.0 | 7.3 | 7.4 | 7.9 | 8.1 | 8.6 | 9.2 | 9.5 | 10.0 | 10.3 | 10.7 |
| **72.0** | -0.3833 | 8.7070 | 0.09035 | 7.1 | 7.4 | 7.5 | 7.9 | 8.2 | 8.7 | 9.3 | 9.6 | 10.1 | 10.4 | 10.8 |
| **72.5** | -0.3833 | 8.8053 | 0.09028 | 7.2 | 7.5 | 7.6 | 8.0 | 8.3 | 8.8 | 9.4 | 9.7 | 10.3 | 10.5 | 11.0 |
| **73.0** | -0.3833 | 8.9025 | 0.09022 | 7.3 | 7.6 | 7.7 | 8.1 | 8.4 | 8.9 | 9.5 | 9.8 | 10.4 | 10.6 | 11.1 |
| **73.5** | -0.3833 | 8.9983 | 0.09016 | 7.4 | 7.6 | 7.8 | 8.2 | 8.5 | 9.0 | 9.6 | 9.9 | 10.5 | 10.7 | 11.2 |
| **74.0** | -0.3833 | 9.0928 | 0.09009 | 7.4 | 7.7 | 7.9 | 8.3 | 8.6 | 9.1 | 9.7 | 10.0 | 10.6 | 10.8 | 11.3 |
| **74.5** | -0.3833 | 9.1862 | 0.09003 | 7.5 | 7.8 | 8.0 | 8.4 | 8.7 | 9.2 | 9.8 | 10.1 | 10.7 | 10.9 | 11.4 |
| **75.0** | -0.3833 | 9.2786 | 0.08996 | 7.6 | 7.9 | 8.0 | 8.5 | 8.7 | 9.3 | 9.9 | 10.2 | 10.8 | 11.1 | 11.5 |
| **75.5** | -0.3833 | 9.3703 | 0.08989 | 7.7 | 8.0 | 8.1 | 8.6 | 8.8 | 9.4 | 10.0 | 10.3 | 10.9 | 11.2 | 11.7 |
| **76.0** | -0.3833 | 9.4617 | 0.08983 | 7.7 | 8.0 | 8.2 | 8.6 | 8.9 | 9.5 | 10.1 | 10.4 | 11.0 | 11.3 | 11.8 |
| **76.5** | -0.3833 | 9.5533 | 0.08976 | 7.8 | 8.1 | 8.3 | 8.7 | 9.0 | 9.6 | 10.2 | 10.5 | 11.1 | 11.4 | 11.9 |
| **77.0** | -0.3833 | 9.6456 | 0.08969 | 7.9 | 8.2 | 8.4 | 8.8 | 9.1 | 9.6 | 10.3 | 10.6 | 11.2 | 11.5 | 12.0 |
| **77.5** | -0.3833 | 9.7390 | 0.08963 | 8.0 | 8.3 | 8.4 | 8.9 | 9.2 | 9.7 | 10.4 | 10.7 | 11.3 | 11.6 | 12.1 |
| **78.0** | -0.3833 | 9.8338 | 0.08956 | 8.0 | 8.4 | 8.5 | 9.0 | 9.3 | 9.8 | 10.5 | 10.8 | 11.4 | 11.7 | 12.2 |
| **78.5** | -0.3833 | 9.9303 | 0.08950 | 8.1 | 8.4 | 8.6 | 9.1 | 9.4 | 9.9 | 10.6 | 10.9 | 11.6 | 11.8 | 12.3 |
| **79.0** | -0.3833 | 10.0289 | 0.08943 | 8.2 | 8.5 | 8.7 | 9.2 | 9.4 | 10.0 | 10.7 | 11.0 | 11.7 | 11.9 | 12.5 |
| **79.5** | -0.3833 | 10.1298 | 0.08937 | 8.3 | 8.6 | 8.8 | 9.2 | 9.5 | 10.1 | 10.8 | 11.1 | 11.8 | 12.1 | 12.6 |

**Table 67 Weight-for-height for girls (continued)**

| | | | | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Height (cm)** | **L** | **M** | **S** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **80.0** | -0.3833 | 10.2332 | 0.08932 | 8.4 | 8.7 | 8.9 | 9.3 | 9.6 | 10.2 | 10.9 | 11.2 | 11.9 | 12.2 | 12.7 |
| **80.5** | -0.3833 | 10.3393 | 0.08926 | 8.5 | 8.8 | 9.0 | 9.4 | 9.7 | 10.3 | 11.0 | 11.4 | 12.0 | 12.3 | 12.8 |
| **81.0** | -0.3833 | 10.4477 | 0.08921 | 8.6 | 8.9 | 9.1 | 9.5 | 9.8 | 10.4 | 11.1 | 11.5 | 12.2 | 12.4 | 13.0 |
| **81.5** | -0.3833 | 10.5586 | 0.08916 | 8.6 | 9.0 | 9.2 | 9.6 | 9.9 | 10.6 | 11.2 | 11.6 | 12.3 | 12.6 | 13.1 |
| **82.0** | -0.3833 | 10.6719 | 0.08912 | 8.7 | 9.1 | 9.3 | 9.7 | 10.1 | 10.7 | 11.3 | 11.7 | 12.4 | 12.7 | 13.2 |
| **82.5** | -0.3833 | 10.7874 | 0.08908 | 8.8 | 9.2 | 9.4 | 9.9 | 10.2 | 10.8 | 11.5 | 11.9 | 12.5 | 12.8 | 13.4 |
| **83.0** | -0.3833 | 10.9051 | 0.08905 | 8.9 | 9.3 | 9.5 | 10.0 | 10.3 | 10.9 | 11.6 | 12.0 | 12.7 | 13.0 | 13.5 |
| **83.5** | -0.3833 | 11.0248 | 0.08902 | 9.0 | 9.4 | 9.6 | 10.1 | 10.4 | 11.0 | 11.7 | 12.1 | 12.8 | 13.1 | 13.7 |
| **84.0** | -0.3833 | 11.1462 | 0.08899 | 9.1 | 9.5 | 9.7 | 10.2 | 10.5 | 11.1 | 11.8 | 12.2 | 13.0 | 13.3 | 13.8 |
| **84.5** | -0.3833 | 11.2691 | 0.08897 | 9.2 | 9.6 | 9.8 | 10.3 | 10.6 | 11.3 | 12.0 | 12.4 | 13.1 | 13.4 | 14.0 |
| **85.0** | -0.3833 | 11.3934 | 0.08896 | 9.3 | 9.7 | 9.9 | 10.4 | 10.7 | 11.4 | 12.1 | 12.5 | 13.2 | 13.5 | 14.1 |
| **85.5** | -0.3833 | 11.5186 | 0.08895 | 9.4 | 9.8 | 10.0 | 10.5 | 10.9 | 11.5 | 12.2 | 12.7 | 13.4 | 13.7 | 14.3 |
| **86.0** | -0.3833 | 11.6444 | 0.08895 | 9.5 | 9.9 | 10.1 | 10.6 | 11.0 | 11.6 | 12.4 | 12.8 | 13.5 | 13.8 | 14.4 |
| **86.5** | -0.3833 | 11.7705 | 0.08895 | 9.6 | 10.0 | 10.2 | 10.8 | 11.1 | 11.8 | 12.5 | 12.9 | 13.7 | 14.0 | 14.6 |
| **87.0** | -0.3833 | 11.8965 | 0.08896 | 9.7 | 10.1 | 10.3 | 10.9 | 11.2 | 11.9 | 12.6 | 13.1 | 13.8 | 14.1 | 14.8 |
| **87.5** | -0.3833 | 12.0223 | 0.08897 | 9.9 | 10.2 | 10.4 | 11.0 | 11.3 | 12.0 | 12.8 | 13.2 | 14.0 | 14.3 | 14.9 |
| **88.0** | -0.3833 | 12.1478 | 0.08899 | 10.0 | 10.3 | 10.5 | 11.1 | 11.4 | 12.1 | 12.9 | 13.3 | 14.1 | 14.4 | 15.1 |
| **88.5** | -0.3833 | 12.2729 | 0.08901 | 10.1 | 10.4 | 10.6 | 11.2 | 11.6 | 12.3 | 13.0 | 13.5 | 14.3 | 14.6 | 15.2 |
| **89.0** | -0.3833 | 12.3976 | 0.08904 | 10.2 | 10.5 | 10.8 | 11.3 | 11.7 | 12.4 | 13.2 | 13.6 | 14.4 | 14.7 | 15.4 |
| **89.5** | -0.3833 | 12.5220 | 0.08907 | 10.3 | 10.6 | 10.9 | 11.4 | 11.8 | 12.5 | 13.3 | 13.8 | 14.6 | 14.9 | 15.5 |
| **90.0** | -0.3833 | 12.6461 | 0.08911 | 10.4 | 10.8 | 11.0 | 11.5 | 11.9 | 12.6 | 13.4 | 13.9 | 14.7 | 15.0 | 15.7 |
| **90.5** | -0.3833 | 12.7700 | 0.08915 | 10.5 | 10.9 | 11.1 | 11.7 | 12.0 | 12.8 | 13.6 | 14.0 | 14.9 | 15.2 | 15.9 |
| **91.0** | -0.3833 | 12.8939 | 0.08920 | 10.6 | 11.0 | 11.2 | 11.8 | 12.1 | 12.9 | 13.7 | 14.2 | 15.0 | 15.3 | 16.0 |
| **91.5** | -0.3833 | 13.0177 | 0.08925 | 10.7 | 11.1 | 11.3 | 11.9 | 12.3 | 13.0 | 13.8 | 14.3 | 15.1 | 15.5 | 16.2 |
| **92.0** | -0.3833 | 13.1415 | 0.08931 | 10.8 | 11.2 | 11.4 | 12.0 | 12.4 | 13.1 | 14.0 | 14.4 | 15.3 | 15.6 | 16.3 |
| **92.5** | -0.3833 | 13.2654 | 0.08937 | 10.9 | 11.3 | 11.5 | 12.1 | 12.5 | 13.3 | 14.1 | 14.6 | 15.4 | 15.8 | 16.5 |
| **93.0** | -0.3833 | 13.3896 | 0.08944 | 11.0 | 11.4 | 11.6 | 12.2 | 12.6 | 13.4 | 14.2 | 14.7 | 15.6 | 15.9 | 16.6 |
| **93.5** | -0.3833 | 13.5142 | 0.08951 | 11.1 | 11.5 | 11.7 | 12.3 | 12.7 | 13.5 | 14.4 | 14.9 | 15.7 | 16.1 | 16.8 |
| **94.0** | -0.3833 | 13.6393 | 0.08959 | 11.2 | 11.6 | 11.8 | 12.4 | 12.8 | 13.6 | 14.5 | 15.0 | 15.9 | 16.2 | 16.9 |
| **94.5** | -0.3833 | 13.7650 | 0.08967 | 11.3 | 11.7 | 11.9 | 12.6 | 13.0 | 13.8 | 14.6 | 15.1 | 16.0 | 16.4 | 17.1 |

**Table 67 Weight-for-height for girls (continued)**

| | | | | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Height (cm)** | **L** | **M** | **S** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **95.0** | -0.3833 | 13.8914 | 0.08975 | 11.4 | 11.8 | 12.0 | 12.7 | 13.1 | 13.9 | 14.8 | 15.3 | 16.2 | 16.5 | 17.3 |
| **95.5** | -0.3833 | 14.0186 | 0.08984 | 11.5 | 11.9 | 12.1 | 12.8 | 13.2 | 14.0 | 14.9 | 15.4 | 16.3 | 16.7 | 17.4 |
| **96.0** | -0.3833 | 14.1466 | 0.08994 | 11.6 | 12.0 | 12.3 | 12.9 | 13.3 | 14.1 | 15.0 | 15.6 | 16.5 | 16.9 | 17.6 |
| **96.5** | -0.3833 | 14.2757 | 0.09004 | 11.7 | 12.1 | 12.4 | 13.0 | 13.4 | 14.3 | 15.2 | 15.7 | 16.6 | 17.0 | 17.8 |
| **97.0** | -0.3833 | 14.4059 | 0.09015 | 11.8 | 12.2 | 12.5 | 13.1 | 13.6 | 14.4 | 15.3 | 15.8 | 16.8 | 17.2 | 17.9 |
| **97.5** | -0.3833 | 14.5376 | 0.09026 | 11.9 | 12.3 | 12.6 | 13.3 | 13.7 | 14.5 | 15.5 | 16.0 | 16.9 | 17.3 | 18.1 |
| **98.0** | -0.3833 | 14.6710 | 0.09037 | 12.0 | 12.4 | 12.7 | 13.4 | 13.8 | 14.7 | 15.6 | 16.1 | 17.1 | 17.5 | 18.3 |
| **98.5** | -0.3833 | 14.8062 | 0.09049 | 12.1 | 12.6 | 12.8 | 13.5 | 13.9 | 14.8 | 15.7 | 16.3 | 17.3 | 17.7 | 18.4 |
| **99.0** | -0.3833 | 14.9434 | 0.09062 | 12.2 | 12.7 | 12.9 | 13.6 | 14.1 | 14.9 | 15.9 | 16.4 | 17.4 | 17.8 | 18.6 |
| **99.5** | -0.3833 | 15.0828 | 0.09075 | 12.3 | 12.8 | 13.0 | 13.8 | 14.2 | 15.1 | 16.0 | 16.6 | 17.6 | 18.0 | 18.8 |
| **100.0** | -0.3833 | 15.2246 | 0.09088 | 12.4 | 12.9 | 13.2 | 13.9 | 14.3 | 15.2 | 16.2 | 16.8 | 17.8 | 18.2 | 19.0 |
| **100.5** | -0.3833 | 15.3687 | 0.09102 | 12.5 | 13.0 | 13.3 | 14.0 | 14.5 | 15.4 | 16.4 | 16.9 | 17.9 | 18.3 | 19.2 |
| **101.0** | -0.3833 | 15.5154 | 0.09116 | 12.7 | 13.1 | 13.4 | 14.1 | 14.6 | 15.5 | 16.5 | 17.1 | 18.1 | 18.5 | 19.4 |
| **101.5** | -0.3833 | 15.6646 | 0.09131 | 12.8 | 13.3 | 13.5 | 14.3 | 14.7 | 15.7 | 16.7 | 17.2 | 18.3 | 18.7 | 19.5 |
| **102.0** | -0.3833 | 15.8164 | 0.09146 | 12.9 | 13.4 | 13.7 | 14.4 | 14.9 | 15.8 | 16.8 | 17.4 | 18.5 | 18.9 | 19.7 |
| **102.5** | -0.3833 | 15.9707 | 0.09161 | 13.0 | 13.5 | 13.8 | 14.5 | 15.0 | 16.0 | 17.0 | 17.6 | 18.7 | 19.1 | 19.9 |
| **103.0** | -0.3833 | 16.1276 | 0.09177 | 13.1 | 13.6 | 13.9 | 14.7 | 15.2 | 16.1 | 17.2 | 17.8 | 18.8 | 19.3 | 20.2 |
| **103.5** | -0.3833 | 16.2870 | 0.09193 | 13.3 | 13.8 | 14.1 | 14.8 | 15.3 | 16.3 | 17.3 | 17.9 | 19.0 | 19.5 | 20.4 |
| **104.0** | -0.3833 | 16.4488 | 0.09209 | 13.4 | 13.9 | 14.2 | 15.0 | 15.5 | 16.4 | 17.5 | 18.1 | 19.2 | 19.7 | 20.6 |
| **104.5** | -0.3833 | 16.6131 | 0.09226 | 13.5 | 14.0 | 14.3 | 15.1 | 15.6 | 16.6 | 17.7 | 18.3 | 19.4 | 19.9 | 20.8 |
| **105.0** | -0.3833 | 16.7800 | 0.09243 | 13.6 | 14.2 | 14.5 | 15.3 | 15.8 | 16.8 | 17.9 | 18.5 | 19.6 | 20.1 | 21.0 |
| **105.5** | -0.3833 | 16.9496 | 0.09261 | 13.8 | 14.3 | 14.6 | 15.4 | 15.9 | 16.9 | 18.1 | 18.7 | 19.8 | 20.3 | 21.2 |
| **106.0** | -0.3833 | 17.1220 | 0.09278 | 13.9 | 14.5 | 14.8 | 15.6 | 16.1 | 17.1 | 18.2 | 18.9 | 20.0 | 20.5 | 21.4 |
| **106.5** | -0.3833 | 17.2973 | 0.09296 | 14.1 | 14.6 | 14.9 | 15.7 | 16.3 | 17.3 | 18.4 | 19.1 | 20.2 | 20.7 | 21.7 |
| **107.0** | -0.3833 | 17.4755 | 0.09315 | 14.2 | 14.7 | 15.1 | 15.9 | 16.4 | 17.5 | 18.6 | 19.3 | 20.5 | 21.0 | 21.9 |
| **107.5** | -0.3833 | 17.6567 | 0.09333 | 14.3 | 14.9 | 15.2 | 16.1 | 16.6 | 17.7 | 18.8 | 19.5 | 20.7 | 21.2 | 22.1 |
| **108.0** | -0.3833 | 17.8407 | 0.09352 | 14.5 | 15.0 | 15.4 | 16.2 | 16.8 | 17.8 | 19.0 | 19.7 | 20.9 | 21.4 | 22.4 |
| **108.5** | -0.3833 | 18.0277 | 0.09371 | 14.6 | 15.2 | 15.5 | 16.4 | 16.9 | 18.0 | 19.2 | 19.9 | 21.1 | 21.6 | 22.6 |
| **109.0** | -0.3833 | 18.2174 | 0.09390 | 14.8 | 15.4 | 15.7 | 16.6 | 17.1 | 18.2 | 19.4 | 20.1 | 21.4 | 21.9 | 22.9 |
| **109.5** | -0.3833 | 18.4096 | 0.09409 | 14.9 | 15.5 | 15.8 | 16.7 | 17.3 | 18.4 | 19.6 | 20.3 | 21.6 | 22.1 | 23.1 |

**Table 67 Weight-for-height for girls (continued)**

| | | | | Percentiles (weight in kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Height (cm)** | **L** | **M** | **S** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **110.0** | -0.3833 | 18.6043 | 0.09428 | 15.1 | 15.7 | 16.0 | 16.9 | 17.5 | 18.6 | 19.8 | 20.6 | 21.8 | 22.4 | 23.4 |
| **110.5** | -0.3833 | 18.8015 | 0.09448 | 15.2 | 15.8 | 16.2 | 17.1 | 17.7 | 18.8 | 20.1 | 20.8 | 22.1 | 22.6 | 23.7 |
| **111.0** | -0.3833 | 19.0009 | 0.09467 | 15.4 | 16.0 | 16.3 | 17.3 | 17.8 | 19.0 | 20.3 | 21.0 | 22.3 | 22.8 | 23.9 |
| **111.5** | -0.3833 | 19.2024 | 0.09487 | 15.5 | 16.2 | 16.5 | 17.4 | 18.0 | 19.2 | 20.5 | 21.2 | 22.6 | 23.1 | 24.2 |
| **112.0** | -0.3833 | 19.4060 | 0.09507 | 15.7 | 16.3 | 16.7 | 17.6 | 18.2 | 19.4 | 20.7 | 21.5 | 22.8 | 23.4 | 24.5 |
| **112.5** | -0.3833 | 19.6116 | 0.09527 | 15.9 | 16.5 | 16.8 | 17.8 | 18.4 | 19.6 | 20.9 | 21.7 | 23.1 | 23.6 | 24.7 |
| **113.0** | -0.3833 | 19.8190 | 0.09546 | 16.0 | 16.7 | 17.0 | 18.0 | 18.6 | 19.8 | 21.2 | 21.9 | 23.3 | 23.9 | 25.0 |
| **113.5** | -0.3833 | 20.0280 | 0.09566 | 16.2 | 16.8 | 17.2 | 18.2 | 18.8 | 20.0 | 21.4 | 22.2 | 23.6 | 24.1 | 25.3 |
| **114.0** | -0.3833 | 20.2385 | 0.09586 | 16.3 | 17.0 | 17.4 | 18.4 | 19.0 | 20.2 | 21.6 | 22.4 | 23.8 | 24.4 | 25.6 |
| **114.5** | -0.3833 | 20.4502 | 0.09606 | 16.5 | 17.2 | 17.5 | 18.5 | 19.2 | 20.5 | 21.8 | 22.6 | 24.1 | 24.7 | 25.8 |
| **115.0** | -0.3833 | 20.6629 | 0.09626 | 16.7 | 17.3 | 17.7 | 18.7 | 19.4 | 20.7 | 22.1 | 22.9 | 24.3 | 24.9 | 26.1 |
| **115.5** | -0.3833 | 20.8766 | 0.09646 | 16.8 | 17.5 | 17.9 | 18.9 | 19.6 | 20.9 | 22.3 | 23.1 | 24.6 | 25.2 | 26.4 |
| **116.0** | -0.3833 | 21.0909 | 0.09666 | 17.0 | 17.7 | 18.1 | 19.1 | 19.8 | 21.1 | 22.5 | 23.4 | 24.9 | 25.5 | 26.7 |
| **116.5** | -0.3833 | 21.3059 | 0.09686 | 17.2 | 17.9 | 18.3 | 19.3 | 20.0 | 21.3 | 22.8 | 23.6 | 25.1 | 25.7 | 27.0 |
| **117.0** | -0.3833 | 21.5213 | 0.09707 | 17.3 | 18.0 | 18.4 | 19.5 | 20.2 | 21.5 | 23.0 | 23.8 | 25.4 | 26.0 | 27.3 |
| **117.5** | -0.3833 | 21.7370 | 0.09727 | 17.5 | 18.2 | 18.6 | 19.7 | 20.4 | 21.7 | 23.2 | 24.1 | 25.6 | 26.3 | 27.5 |
| **118.0** | -0.3833 | 21.9529 | 0.09747 | 17.7 | 18.4 | 18.8 | 19.9 | 20.6 | 22.0 | 23.5 | 24.3 | 25.9 | 26.5 | 27.8 |
| **118.5** | -0.3833 | 22.1690 | 0.09767 | 17.8 | 18.6 | 19.0 | 20.1 | 20.8 | 22.2 | 23.7 | 24.6 | 26.2 | 26.8 | 28.1 |
| **119.0** | -0.3833 | 22.3851 | 0.09788 | 18.0 | 18.7 | 19.1 | 20.3 | 21.0 | 22.4 | 23.9 | 24.8 | 26.4 | 27.1 | 28.4 |
| **119.5** | -0.3833 | 22.6012 | 0.09808 | 18.2 | 18.9 | 19.3 | 20.5 | 21.2 | 22.6 | 24.2 | 25.1 | 26.7 | 27.4 | 28.7 |
| **120.0** | -0.3833 | 22.8173 | 0.09828 | 18.3 | 19.1 | 19.5 | 20.6 | 21.4 | 22.8 | 24.4 | 25.3 | 27.0 | 27.6 | 29.0 |

**Table 67 Weight-for-height for girls (continued)**

| | | | | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Height (cm)** | **L** | **M** | **S** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **65.0** | -0.3833 | 7.2402 | 0.09113 | 5.6 | 6.1 | 6.6 | 7.2 | 7.9 | 8.7 | 9.7 |
| **65.5** | -0.3833 | 7.3523 | 0.09109 | 5.7 | 6.2 | 6.7 | 7.4 | 8.1 | 8.9 | 9.8 |
| **66.0** | -0.3833 | 7.4630 | 0.09104 | 5.8 | 6.3 | 6.8 | 7.5 | 8.2 | 9.0 | 10.0 |
| **66.5** | -0.3833 | 7.5724 | 0.09099 | 5.8 | 6.4 | 6.9 | 7.6 | 8.3 | 9.1 | 10.1 |
| **67.0** | -0.3833 | 7.6806 | 0.09094 | 5.9 | 6.4 | 7.0 | 7.7 | 8.4 | 9.3 | 10.2 |
| **67.5** | -0.3833 | 7.7874 | 0.09088 | 6.0 | 6.5 | 7.1 | 7.8 | 8.5 | 9.4 | 10.4 |
| **68.0** | -0.3833 | 7.8930 | 0.09083 | 6.1 | 6.6 | 7.2 | 7.9 | 8.7 | 9.5 | 10.5 |
| **68.5** | -0.3833 | 7.9976 | 0.09077 | 6.2 | 6.7 | 7.3 | 8.0 | 8.8 | 9.7 | 10.7 |
| **69.0** | -0.3833 | 8.1012 | 0.09071 | 6.3 | 6.8 | 7.4 | 8.1 | 8.9 | 9.8 | 10.8 |
| **69.5** | -0.3833 | 8.2039 | 0.09065 | 6.3 | 6.9 | 7.5 | 8.2 | 9.0 | 9.9 | 10.9 |
| **70.0** | -0.3833 | 8.3058 | 0.09059 | 6.4 | 7.0 | 7.6 | 8.3 | 9.1 | 10.0 | 11.1 |
| **70.5** | -0.3833 | 8.4071 | 0.09053 | 6.5 | 7.1 | 7.7 | 8.4 | 9.2 | 10.1 | 11.2 |
| **71.0** | -0.3833 | 8.5078 | 0.09047 | 6.6 | 7.1 | 7.8 | 8.5 | 9.3 | 10.3 | 11.3 |
| **71.5** | -0.3833 | 8.6078 | 0.09041 | 6.7 | 7.2 | 7.9 | 8.6 | 9.4 | 10.4 | 11.5 |
| **72.0** | -0.3833 | 8.7070 | 0.09035 | 6.7 | 7.3 | 8.0 | 8.7 | 9.5 | 10.5 | 11.6 |
| **72.5** | -0.3833 | 8.8053 | 0.09028 | 6.8 | 7.4 | 8.1 | 8.8 | 9.7 | 10.6 | 11.7 |
| **73.0** | -0.3833 | 8.9025 | 0.09022 | 6.9 | 7.5 | 8.1 | 8.9 | 9.8 | 10.7 | 11.8 |
| **73.5** | -0.3833 | 8.9983 | 0.09016 | 7.0 | 7.6 | 8.2 | 9.0 | 9.9 | 10.8 | 12.0 |
| **74.0** | -0.3833 | 9.0928 | 0.09009 | 7.0 | 7.6 | 8.3 | 9.1 | 10.0 | 11.0 | 12.1 |
| **74.5** | -0.3833 | 9.1862 | 0.09003 | 7.1 | 7.7 | 8.4 | 9.2 | 10.1 | 11.1 | 12.2 |
| **75.0** | -0.3833 | 9.2786 | 0.08996 | 7.2 | 7.8 | 8.5 | 9.3 | 10.2 | 11.2 | 12.3 |
| **75.5** | -0.3833 | 9.3703 | 0.08989 | 7.2 | 7.9 | 8.6 | 9.4 | 10.3 | 11.3 | 12.5 |
| **76.0** | -0.3833 | 9.4617 | 0.08983 | 7.3 | 8.0 | 8.7 | 9.5 | 10.4 | 11.4 | 12.6 |
| **76.5** | -0.3833 | 9.5533 | 0.08976 | 7.4 | 8.0 | 8.7 | 9.6 | 10.5 | 11.5 | 12.7 |
| **77.0** | -0.3833 | 9.6456 | 0.08969 | 7.5 | 8.1 | 8.8 | 9.6 | 10.6 | 11.6 | 12.8 |
| **77.5** | -0.3833 | 9.7390 | 0.08963 | 7.5 | 8.2 | 8.9 | 9.7 | 10.7 | 11.7 | 12.9 |
| **78.0** | -0.3833 | 9.8338 | 0.08956 | 7.6 | 8.3 | 9.0 | 9.8 | 10.8 | 11.8 | 13.1 |
| **78.5** | -0.3833 | 9.9303 | 0.08950 | 7.7 | 8.4 | 9.1 | 9.9 | 10.9 | 12.0 | 13.2 |
| **79.0** | -0.3833 | 10.0289 | 0.08943 | 7.8 | 8.4 | 9.2 | 10.0 | 11.0 | 12.1 | 13.3 |
| **79.5** | -0.3833 | 10.1298 | 0.08937 | 7.8 | 8.5 | 9.3 | 10.1 | 11.1 | 12.2 | 13.4 |

**Table 67 Weight-for-height for girls (continued)**

| | | | | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Height (cm)** | **L** | **M** | **S** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **80.0** | -0.3833 | 10.2332 | 0.08932 | 7.9 | 8.6 | 9.4 | 10.2 | 11.2 | 12.3 | 13.6 |
| **80.5** | -0.3833 | 10.3393 | 0.08926 | 8.0 | 8.7 | 9.5 | 10.3 | 11.3 | 12.4 | 13.7 |
| **81.0** | -0.3833 | 10.4477 | 0.08921 | 8.1 | 8.8 | 9.6 | 10.4 | 11.4 | 12.6 | 13.9 |
| **81.5** | -0.3833 | 10.5586 | 0.08916 | 8.2 | 8.9 | 9.7 | 10.6 | 11.6 | 12.7 | 14.0 |
| **82.0** | -0.3833 | 10.6719 | 0.08912 | 8.3 | 9.0 | 9.8 | 10.7 | 11.7 | 12.8 | 14.1 |
| **82.5** | -0.3833 | 10.7874 | 0.08908 | 8.4 | 9.1 | 9.9 | 10.8 | 11.8 | 13.0 | 14.3 |
| **83.0** | -0.3833 | 10.9051 | 0.08905 | 8.5 | 9.2 | 10.0 | 10.9 | 11.9 | 13.1 | 14.5 |
| **83.5** | -0.3833 | 11.0248 | 0.08902 | 8.5 | 9.3 | 10.1 | 11.0 | 12.1 | 13.3 | 14.6 |
| **84.0** | -0.3833 | 11.1462 | 0.08899 | 8.6 | 9.4 | 10.2 | 11.1 | 12.2 | 13.4 | 14.8 |
| **84.5** | -0.3833 | 11.2691 | 0.08897 | 8.7 | 9.5 | 10.3 | 11.3 | 12.3 | 13.5 | 14.9 |
| **85.0** | -0.3833 | 11.3934 | 0.08896 | 8.8 | 9.6 | 10.4 | 11.4 | 12.5 | 13.7 | 15.1 |
| **85.5** | -0.3833 | 11.5186 | 0.08895 | 8.9 | 9.7 | 10.6 | 11.5 | 12.6 | 13.8 | 15.3 |
| **86.0** | -0.3833 | 11.6444 | 0.08895 | 9.0 | 9.8 | 10.7 | 11.6 | 12.7 | 14.0 | 15.4 |
| **86.5** | -0.3833 | 11.7705 | 0.08895 | 9.1 | 9.9 | 10.8 | 11.8 | 12.9 | 14.2 | 15.6 |
| **87.0** | -0.3833 | 11.8965 | 0.08896 | 9.2 | 10.0 | 10.9 | 11.9 | 13.0 | 14.3 | 15.8 |
| **87.5** | -0.3833 | 12.0223 | 0.08897 | 9.3 | 10.1 | 11.0 | 12.0 | 13.2 | 14.5 | 15.9 |
| **88.0** | -0.3833 | 12.1478 | 0.08899 | 9.4 | 10.2 | 11.1 | 12.1 | 13.3 | 14.6 | 16.1 |
| **88.5** | -0.3833 | 12.2729 | 0.08901 | 9.5 | 10.3 | 11.2 | 12.3 | 13.4 | 14.8 | 16.3 |
| **89.0** | -0.3833 | 12.3976 | 0.08904 | 9.6 | 10.4 | 11.4 | 12.4 | 13.6 | 14.9 | 16.4 |
| **89.5** | -0.3833 | 12.5220 | 0.08907 | 9.7 | 10.5 | 11.5 | 12.5 | 13.7 | 15.1 | 16.6 |
| **90.0** | -0.3833 | 12.6461 | 0.08911 | 9.8 | 10.6 | 11.6 | 12.6 | 13.8 | 15.2 | 16.8 |
| **90.5** | -0.3833 | 12.7700 | 0.08915 | 9.9 | 10.7 | 11.7 | 12.8 | 14.0 | 15.4 | 16.9 |
| **91.0** | -0.3833 | 12.8939 | 0.08920 | 10.0 | 10.9 | 11.8 | 12.9 | 14.1 | 15.5 | 17.1 |
| **91.5** | -0.3833 | 13.0177 | 0.08925 | 10.1 | 11.0 | 11.9 | 13.0 | 14.3 | 15.7 | 17.3 |
| **92.0** | -0.3833 | 13.1415 | 0.08931 | 10.2 | 11.1 | 12.0 | 13.1 | 14.4 | 15.8 | 17.4 |
| **92.5** | -0.3833 | 13.2654 | 0.08937 | 10.3 | 11.2 | 12.1 | 13.3 | 14.5 | 16.0 | 17.6 |
| **93.0** | -0.3833 | 13.3896 | 0.08944 | 10.4 | 11.3 | 12.3 | 13.4 | 14.7 | 16.1 | 17.8 |
| **93.5** | -0.3833 | 13.5142 | 0.08951 | 10.5 | 11.4 | 12.4 | 13.5 | 14.8 | 16.3 | 17.9 |
| **94.0** | -0.3833 | 13.6393 | 0.08959 | 10.6 | 11.5 | 12.5 | 13.6 | 14.9 | 16.4 | 18.1 |
| **94.5** | -0.3833 | 13.7650 | 0.08967 | 10.7 | 11.6 | 12.6 | 13.8 | 15.1 | 16.6 | 18.3 |

**Table 67 Weight-for-height for girls (continued)**

| Height (cm) | L | M | S | Z-scores (weight in kg) -3 SD | -2 SD | -1 SD | Median | 1 SD | 2 SD | 3 SD |
|---|---|---|---|---|---|---|---|---|---|---|
| **95.0** | -0.3833 | 13.8914 | 0.08975 | 10.8 | 11.7 | 12.7 | 13.9 | 15.2 | 16.7 | 18.5 |
| **95.5** | -0.3833 | 14.0186 | 0.08984 | 10.8 | 11.8 | 12.8 | 14.0 | 15.4 | 16.9 | 18.6 |
| **96.0** | -0.3833 | 14.1466 | 0.08994 | 10.9 | 11.9 | 12.9 | 14.1 | 15.5 | 17.0 | 18.8 |
| **96.5** | -0.3833 | 14.2757 | 0.09004 | 11.0 | 12.0 | 13.1 | 14.3 | 15.6 | 17.2 | 19.0 |
| **97.0** | -0.3833 | 14.4059 | 0.09015 | 11.1 | 12.1 | 13.2 | 14.4 | 15.8 | 17.4 | 19.2 |
| **97.5** | -0.3833 | 14.5376 | 0.09026 | 11.2 | 12.2 | 13.3 | 14.5 | 15.9 | 17.5 | 19.3 |
| **98.0** | -0.3833 | 14.6710 | 0.09037 | 11.3 | 12.3 | 13.4 | 14.7 | 16.1 | 17.7 | 19.5 |
| **98.5** | -0.3833 | 14.8062 | 0.09049 | 11.4 | 12.4 | 13.5 | 14.8 | 16.2 | 17.9 | 19.7 |
| **99.0** | -0.3833 | 14.9434 | 0.09062 | 11.5 | 12.5 | 13.7 | 14.9 | 16.4 | 18.0 | 19.9 |
| **99.5** | -0.3833 | 15.0828 | 0.09075 | 11.6 | 12.7 | 13.8 | 15.1 | 16.5 | 18.2 | 20.1 |
| **100.0** | -0.3833 | 15.2246 | 0.09088 | 11.7 | 12.8 | 13.9 | 15.2 | 16.7 | 18.4 | 20.3 |
| **100.5** | -0.3833 | 15.3687 | 0.09102 | 11.9 | 12.9 | 14.1 | 15.4 | 16.9 | 18.6 | 20.5 |
| **101.0** | -0.3833 | 15.5154 | 0.09116 | 12.0 | 13.0 | 14.2 | 15.5 | 17.0 | 18.7 | 20.7 |
| **101.5** | -0.3833 | 15.6646 | 0.09131 | 12.1 | 13.1 | 14.3 | 15.7 | 17.2 | 18.9 | 20.9 |
| **102.0** | -0.3833 | 15.8164 | 0.09146 | 12.2 | 13.3 | 14.5 | 15.8 | 17.4 | 19.1 | 21.1 |
| **102.5** | -0.3833 | 15.9707 | 0.09161 | 12.3 | 13.4 | 14.6 | 16.0 | 17.5 | 19.3 | 21.4 |
| **103.0** | -0.3833 | 16.1276 | 0.09177 | 12.4 | 13.5 | 14.7 | 16.1 | 17.7 | 19.5 | 21.6 |
| **103.5** | -0.3833 | 16.2870 | 0.09193 | 12.5 | 13.6 | 14.9 | 16.3 | 17.9 | 19.7 | 21.8 |
| **104.0** | -0.3833 | 16.4488 | 0.09209 | 12.6 | 13.8 | 15.0 | 16.4 | 18.1 | 19.9 | 22.0 |
| **104.5** | -0.3833 | 16.6131 | 0.09226 | 12.8 | 13.9 | 15.2 | 16.6 | 18.2 | 20.1 | 22.3 |
| **105.0** | -0.3833 | 16.7800 | 0.09243 | 12.9 | 14.0 | 15.3 | 16.8 | 18.4 | 20.3 | 22.5 |
| **105.5** | -0.3833 | 16.9496 | 0.09261 | 13.0 | 14.2 | 15.5 | 16.9 | 18.6 | 20.5 | 22.7 |
| **106.0** | -0.3833 | 17.1220 | 0.09278 | 13.1 | 14.3 | 15.6 | 17.1 | 18.8 | 20.8 | 23.0 |
| **106.5** | -0.3833 | 17.2973 | 0.09296 | 13.3 | 14.5 | 15.8 | 17.3 | 19.0 | 21.0 | 23.2 |
| **107.0** | -0.3833 | 17.4755 | 0.09315 | 13.4 | 14.6 | 15.9 | 17.5 | 19.2 | 21.2 | 23.5 |
| **107.5** | -0.3833 | 17.6567 | 0.09333 | 13.5 | 14.7 | 16.1 | 17.7 | 19.4 | 21.4 | 23.7 |
| **108.0** | -0.3833 | 17.8407 | 0.09352 | 13.7 | 14.9 | 16.3 | 17.8 | 19.6 | 21.7 | 24.0 |
| **108.5** | -0.3833 | 18.0277 | 0.09371 | 13.8 | 15.0 | 16.4 | 18.0 | 19.8 | 21.9 | 24.3 |
| **109.0** | -0.3833 | 18.2174 | 0.09390 | 13.9 | 15.2 | 16.6 | 18.2 | 20.0 | 22.1 | 24.5 |
| **109.5** | -0.3833 | 18.4096 | 0.09409 | 14.1 | 15.4 | 16.8 | 18.4 | 20.3 | 22.4 | 24.8 |

**Table 67 Weight-for-height for girls (continued)**

| | | | | Z-scores (weight in kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Height (cm)** | **L** | **M** | **S** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **110.0** | -0.3833 | 18.6043 | 0.09428 | 14.2 | 15.5 | 17.0 | 18.6 | 20.5 | 22.6 | 25.1 |
| **110.5** | -0.3833 | 18.8015 | 0.09448 | 14.4 | 15.7 | 17.1 | 18.8 | 20.7 | 22.9 | 25.4 |
| **111.0** | -0.3833 | 19.0009 | 0.09467 | 14.5 | 15.8 | 17.3 | 19.0 | 20.9 | 23.1 | 25.7 |
| **111.5** | -0.3833 | 19.2024 | 0.09487 | 14.7 | 16.0 | 17.5 | 19.2 | 21.2 | 23.4 | 26.0 |
| **112.0** | -0.3833 | 19.4060 | 0.09507 | 14.8 | 16.2 | 17.7 | 19.4 | 21.4 | 23.6 | 26.2 |
| **112.5** | -0.3833 | 19.6116 | 0.09527 | 15.0 | 16.3 | 17.9 | 19.6 | 21.6 | 23.9 | 26.5 |
| **113.0** | -0.3833 | 19.8190 | 0.09546 | 15.1 | 16.5 | 18.0 | 19.8 | 21.8 | 24.2 | 26.8 |
| **113.5** | -0.3833 | 20.0280 | 0.09566 | 15.3 | 16.7 | 18.2 | 20.0 | 22.1 | 24.4 | 27.1 |
| **114.0** | -0.3833 | 20.2385 | 0.09586 | 15.4 | 16.8 | 18.4 | 20.2 | 22.3 | 24.7 | 27.4 |
| **114.5** | -0.3833 | 20.4502 | 0.09606 | 15.6 | 17.0 | 18.6 | 20.5 | 22.6 | 25.0 | 27.8 |
| **115.0** | -0.3833 | 20.6629 | 0.09626 | 15.7 | 17.2 | 18.8 | 20.7 | 22.8 | 25.2 | 28.1 |
| **115.5** | -0.3833 | 20.8766 | 0.09646 | 15.9 | 17.3 | 19.0 | 20.9 | 23.0 | 25.5 | 28.4 |
| **116.0** | -0.3833 | 21.0909 | 0.09666 | 16.0 | 17.5 | 19.2 | 21.1 | 23.3 | 25.8 | 28.7 |
| **116.5** | -0.3833 | 21.3059 | 0.09686 | 16.2 | 17.7 | 19.4 | 21.3 | 23.5 | 26.1 | 29.0 |
| **117.0** | -0.3833 | 21.5213 | 0.09707 | 16.3 | 17.8 | 19.6 | 21.5 | 23.8 | 26.3 | 29.3 |
| **117.5** | -0.3833 | 21.7370 | 0.09727 | 16.5 | 18.0 | 19.8 | 21.7 | 24.0 | 26.6 | 29.6 |
| **118.0** | -0.3833 | 21.9529 | 0.09747 | 16.6 | 18.2 | 19.9 | 22.0 | 24.2 | 26.9 | 29.9 |
| **118.5** | -0.3833 | 22.1690 | 0.09767 | 16.8 | 18.4 | 20.1 | 22.2 | 24.5 | 27.2 | 30.3 |
| **119.0** | -0.3833 | 22.3851 | 0.09788 | 16.9 | 18.5 | 20.3 | 22.4 | 24.7 | 27.4 | 30.6 |
| **119.5** | -0.3833 | 22.6012 | 0.09808 | 17.1 | 18.7 | 20.5 | 22.6 | 25.0 | 27.7 | 30.9 |
| **120.0** | -0.3833 | 22.8173 | 0.09828 | 17.3 | 18.9 | 20.7 | 22.8 | 25.2 | 28.0 | 31.2 |

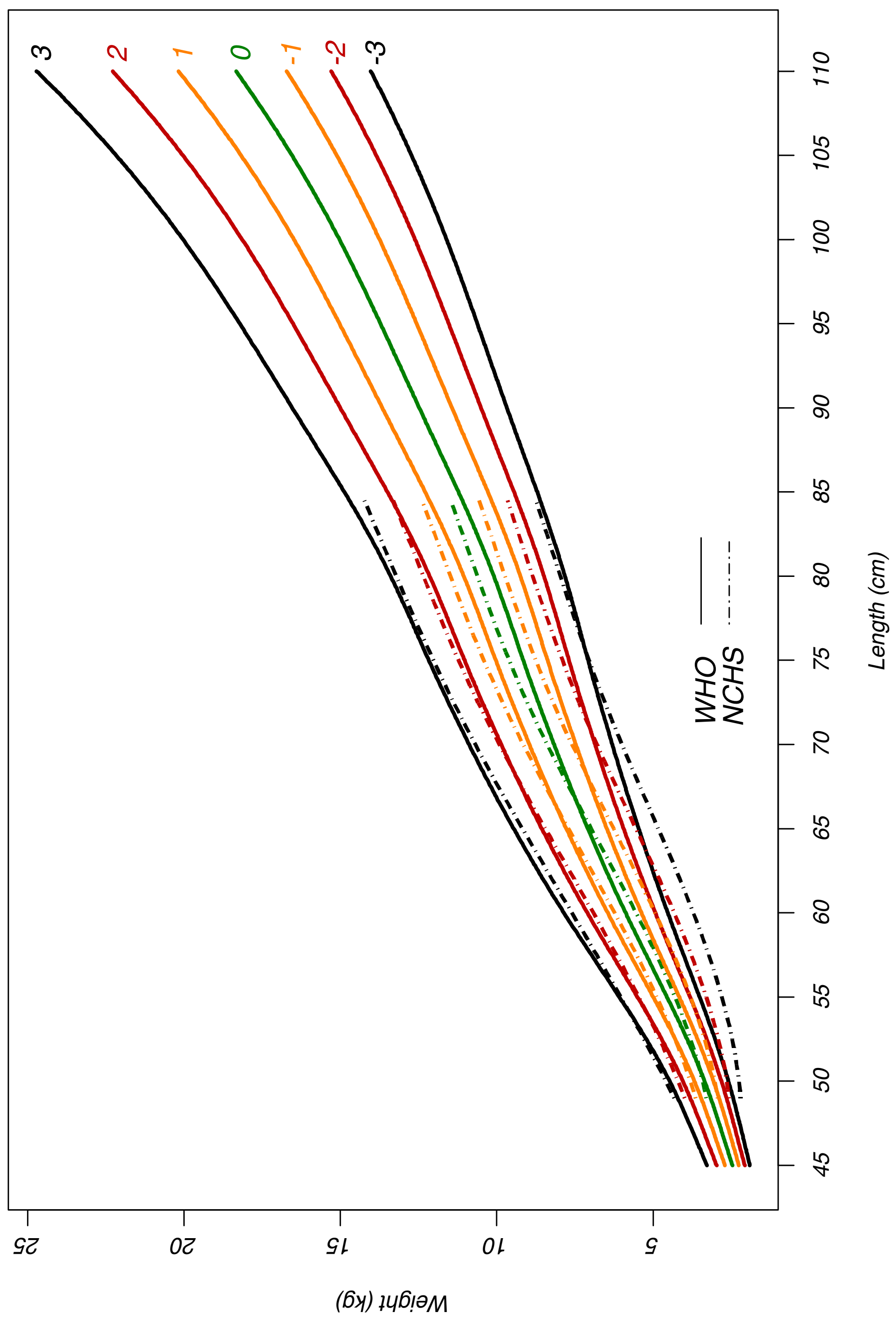


**Figure 90 Comparison of WHO with NCHS weight-for-length z-scores for girls**

*Comparison with NCHS*

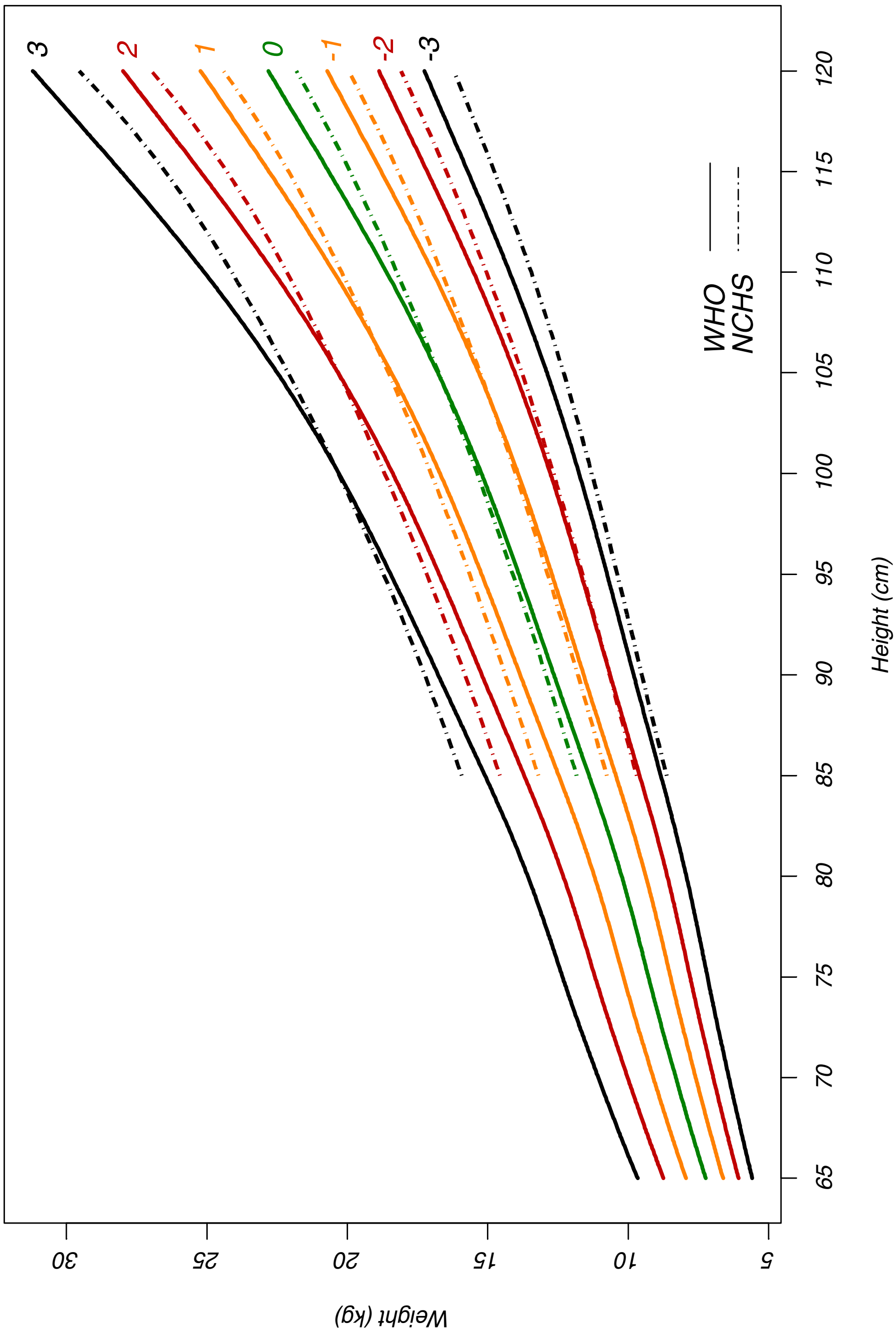


**Figure 91** Comparison of WHO with NCHS weight-for-height z-scores for girls

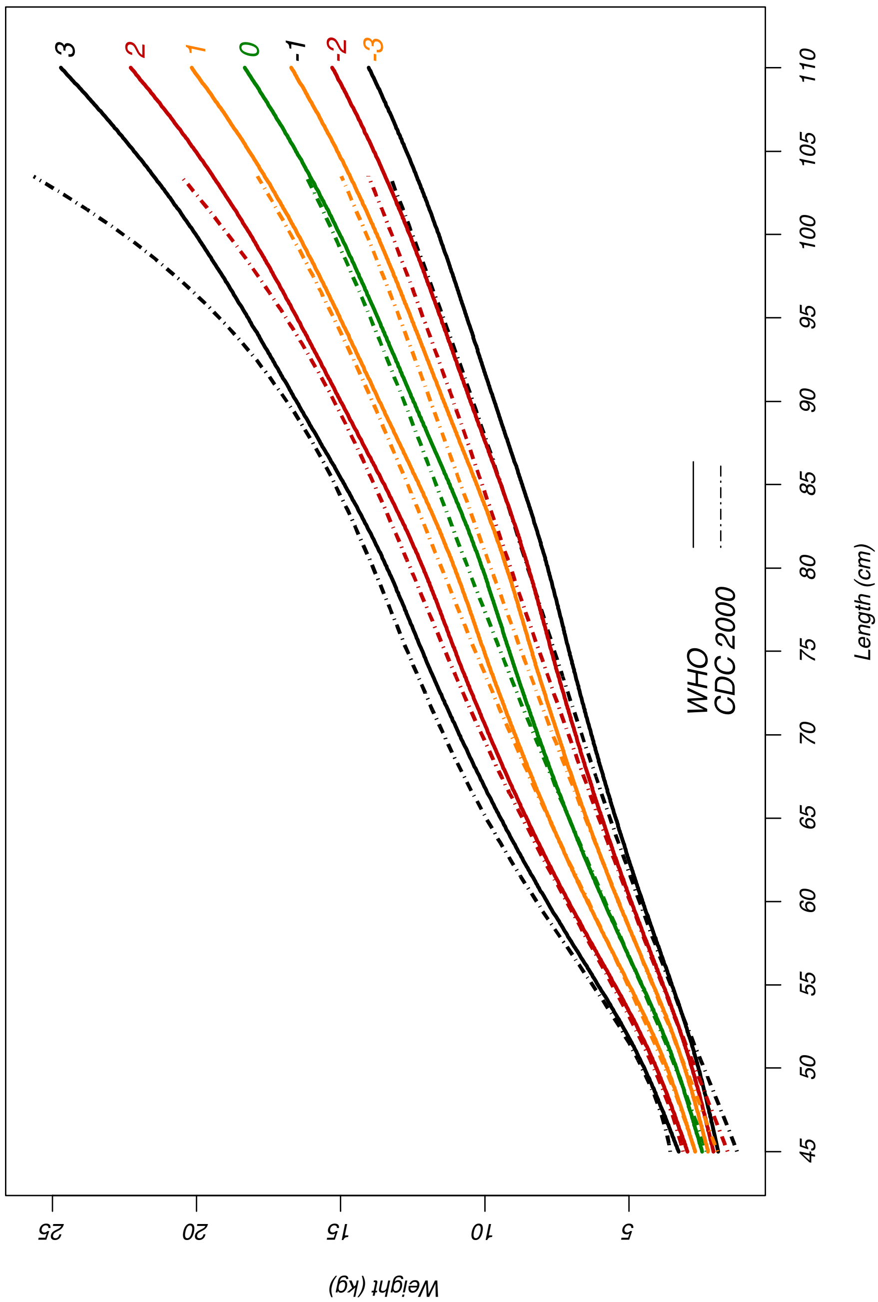


**Figure 92 Comparison of WHO with CDC 2000 weight-for-length z-scores for girls**

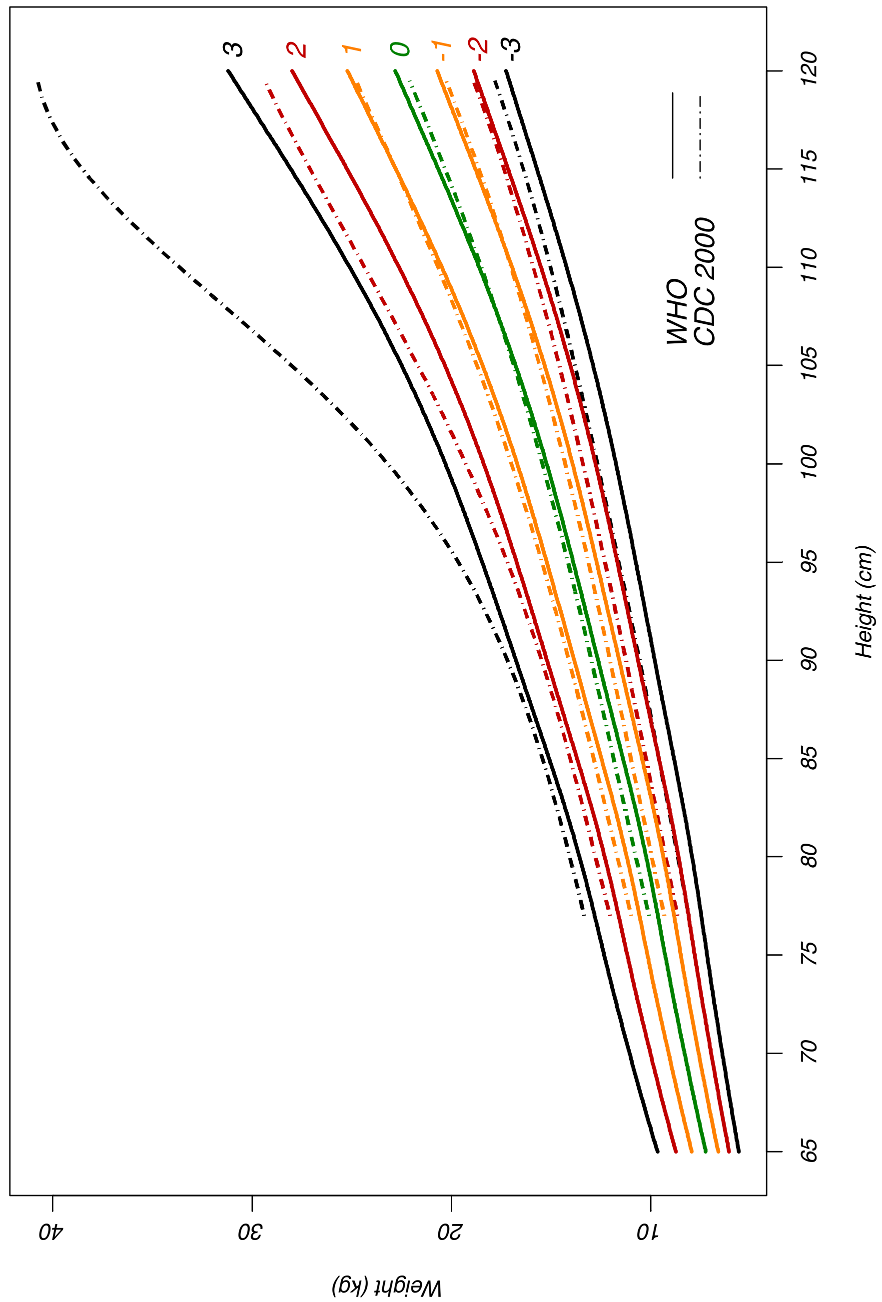


**Figure 93 Comparison of WHO with CDC 2000 weight-for-height z-scores for girls**

## 5.4 Comparisons between boys and girls

This section presents the weight-for-length and weight-for-height z-score comparisons between boys and girls for WHO standards (Figures 94 and 95), and for NCHS (Figures 96 and 97) and CDC 2000 (Figures 98 and 99) references.

## 5.4.1 WHO

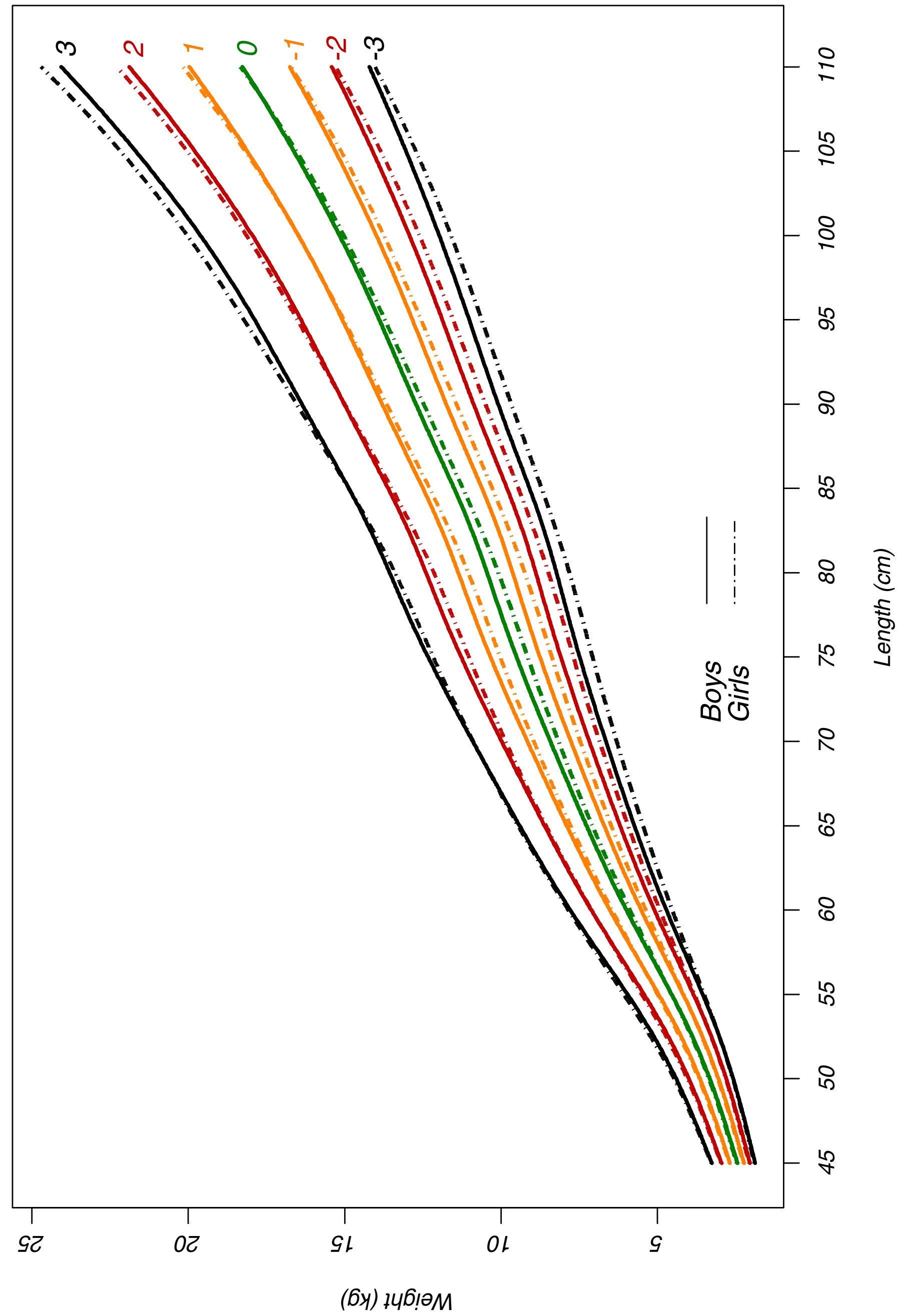


**Figure 94** **Comparison of boys' and girls' WHO weight-for-length z-scores**

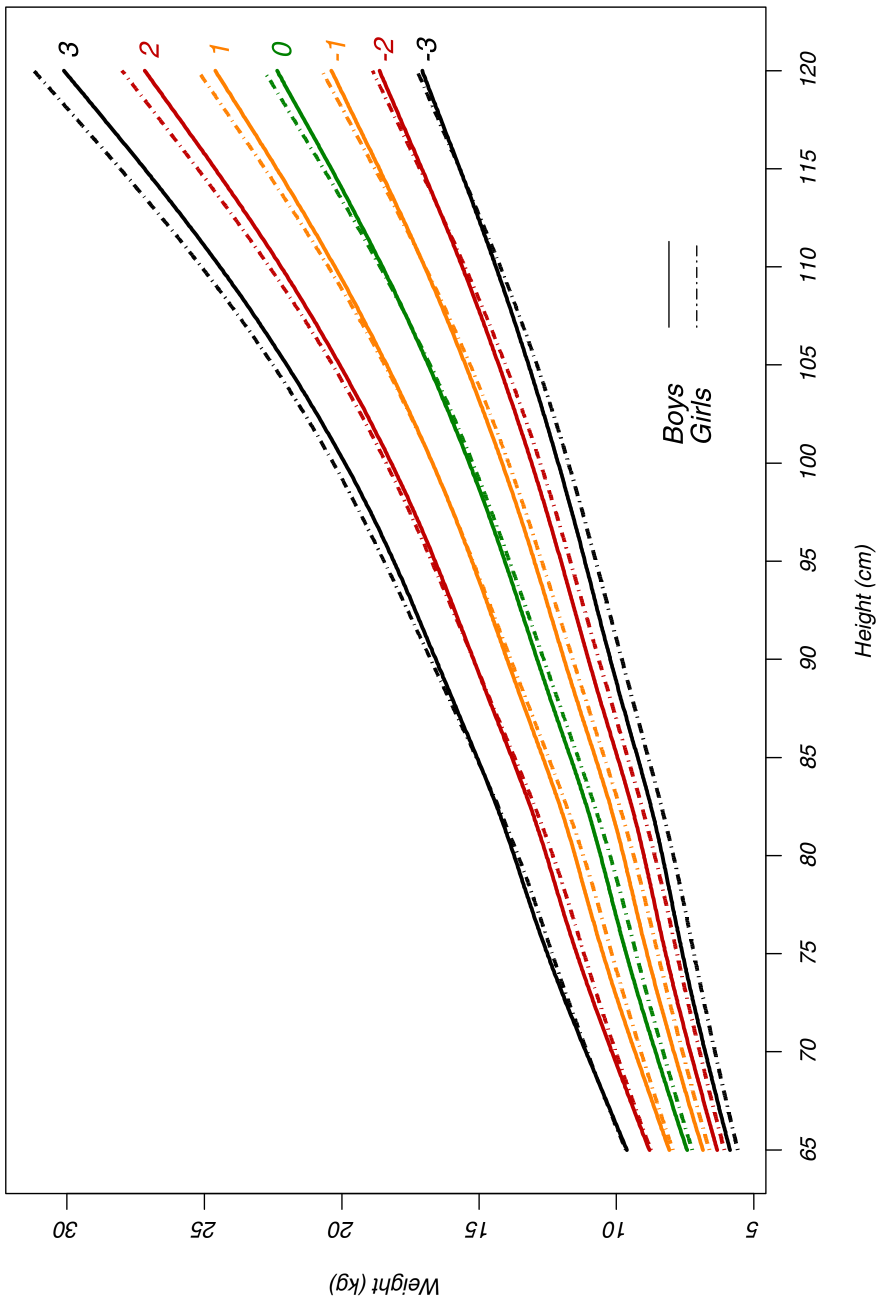


**Figure 95 Comparison of boys' and girls' WHO weight-for-height z-scores**

### 5.4.2 NCHS

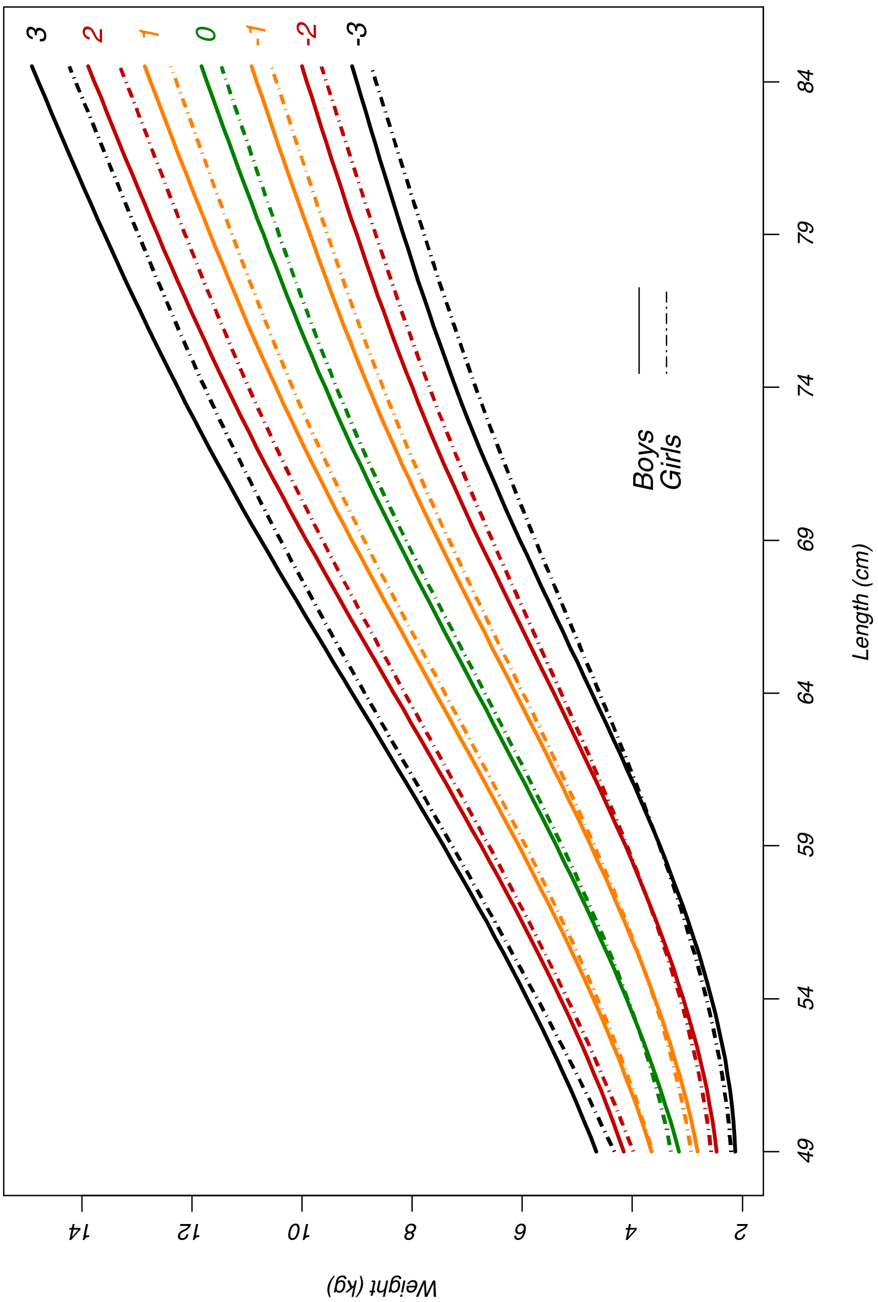


**Figure 96 Comparison of boys' and girls' NCHS weight-for-length z-scores**

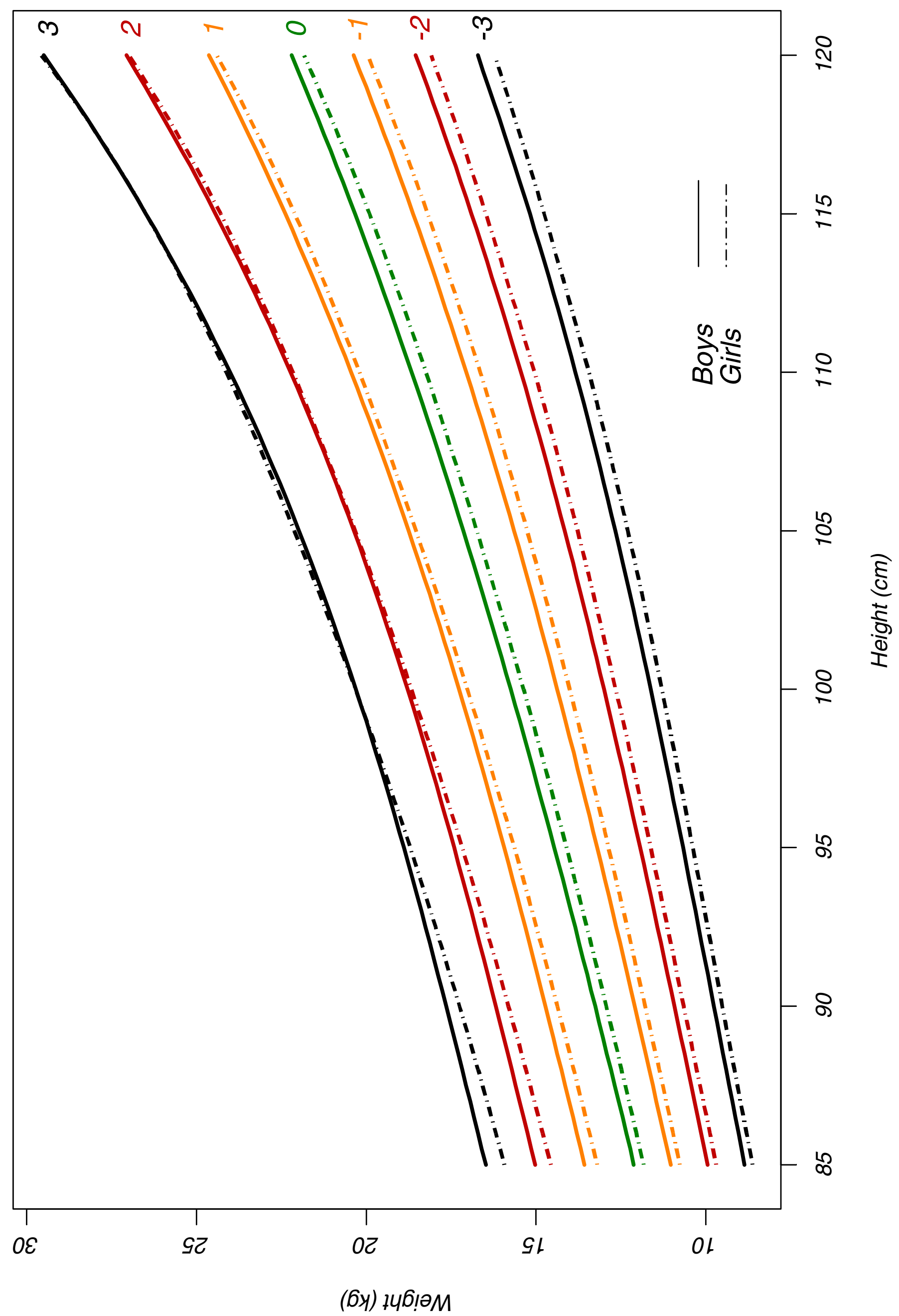


**Figure 97 Comparison of boys' and girls' NCHS weight-for-height z-scores**

### 5.4.3 CDC 2000

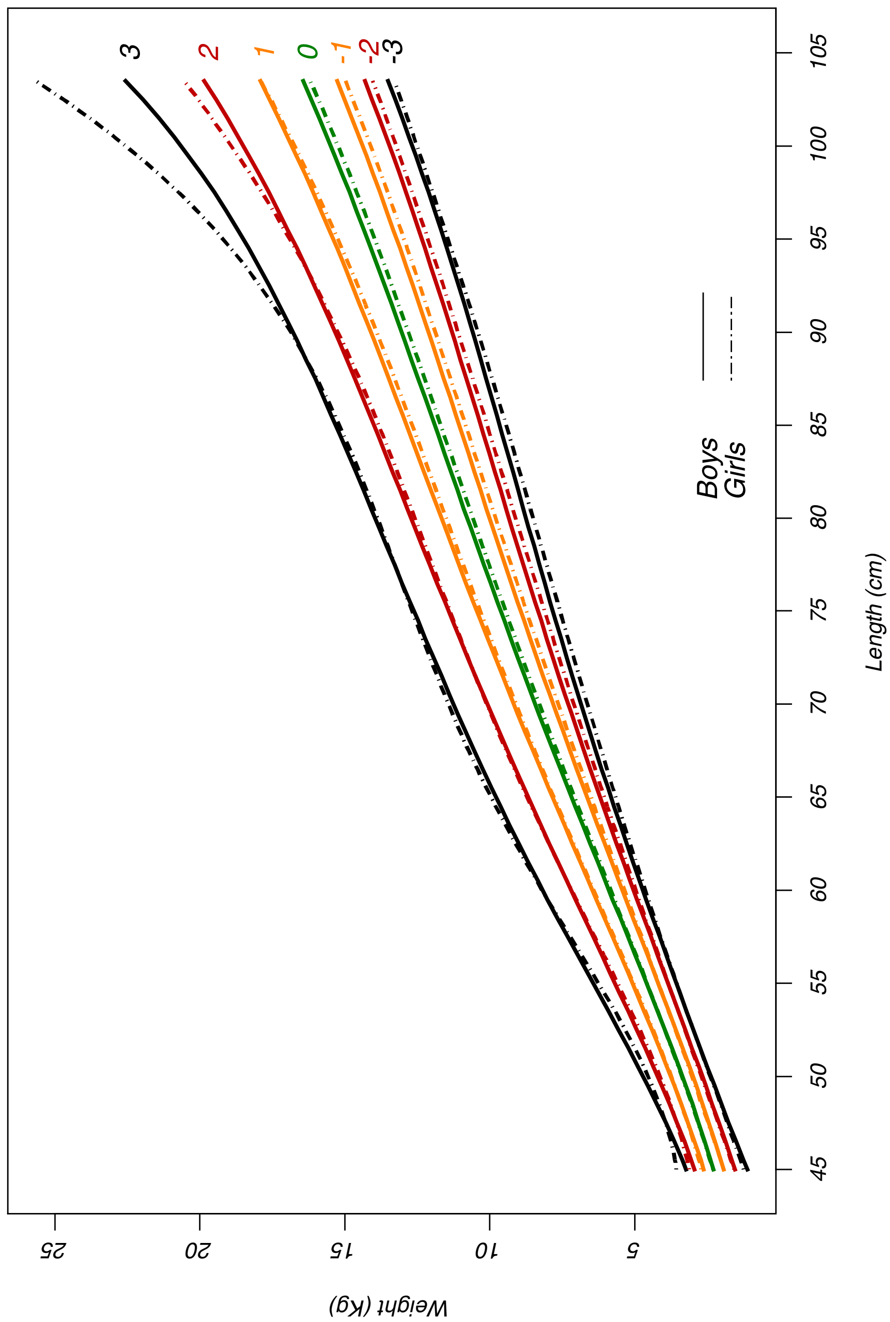


**Figure 98 Comparison of boys' and girls' CDC 2000 weight-for-length z-scores**

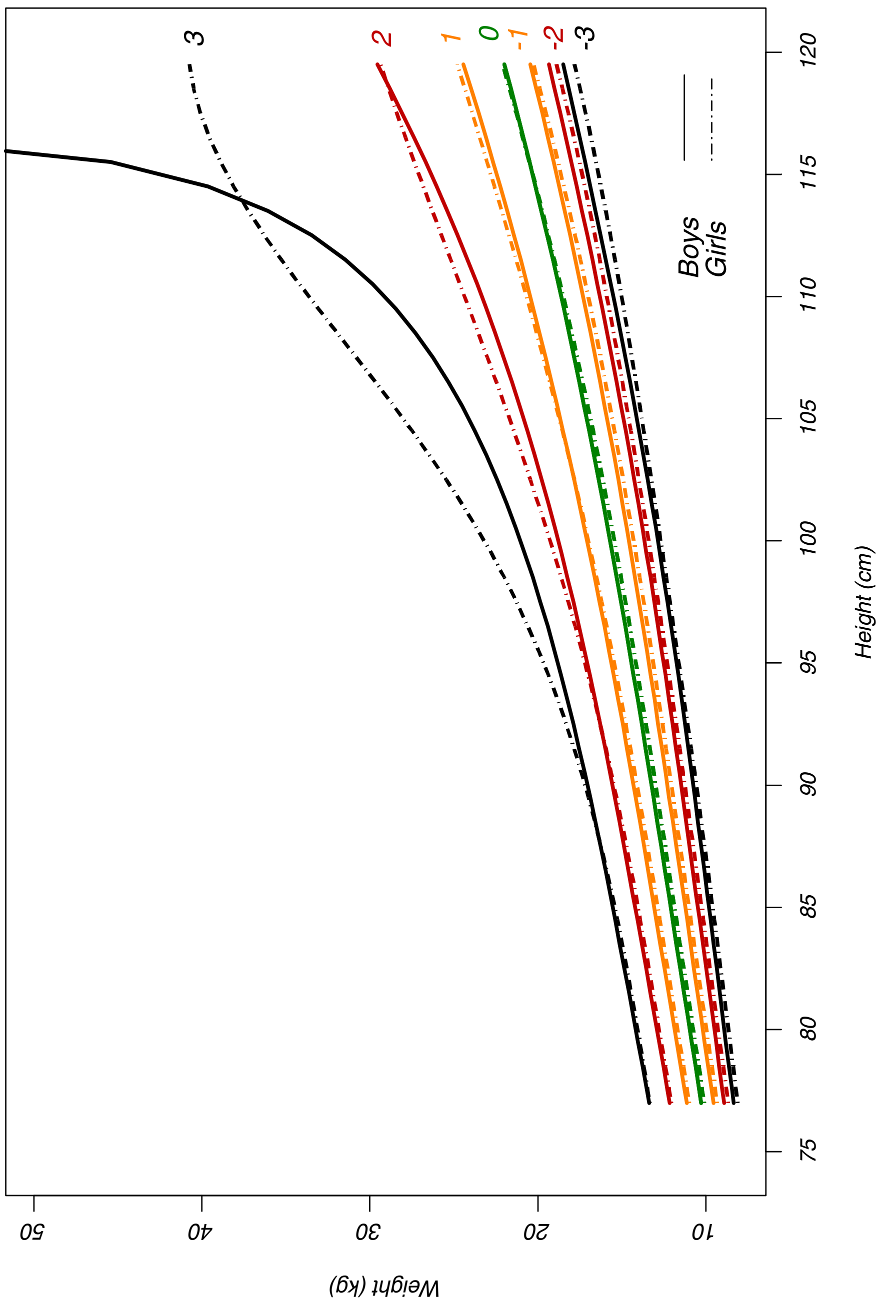


**Figure 99** **Comparison of boys' and girls' CDC 2000 weight-for-height z-scores**

# 6. CONSTRUCTION OF THE BODY MASS INDEX-FOR-AGE STANDARDS

## 6.1 Indicator-specific methodology

Body mass index (BMI) is the ratio *weight (in kg)/recumbent length or standing height (in $m^2$)*. To address the difference between length and height, the approach used for constructing the BMI-for-age standards was different from that described for length/height-for-age. Because BMI is a ratio with squared length or height in the denominator, adding 0.7 cm to the height values and back-transforming them after fitting was not feasible. The solution adopted was to construct the standards for the younger and the older children separately based on two sets of data with an overlapping range of ages below and above 24 months. To construct the BMI-for-age standard based on length (birth to 2 years), the longitudinal sample's length data and the cross-sectional sample's height data (18 to 30 months) were combined after adding 0.7 cm to the height values. Analogously, to construct the standard from 2 to 5 years, the cross-sectional sample's height plus longitudinal sample's length data (18 to 24 months) were combined after subtracting 0.7 cm from the length values. Thus, a common set of data from 18 to 30 months was used to generate the BMI standards for the younger and the older children. The resulting disjunction between the two standards thus in essence reflects the 0.7 cm difference between length and height. This does not mean, however, that a child at a specific age will have the same length- and height-based BMI-for-age z-score as this is mathematically impossible given the nature of the BMI ratio. The WHO length- and height-based BMI-for-age standards do not overlap, i.e. the length-based interval ends at 730 days and the height-based interval starts at 731 days.

The BMI curve's steep rise from birth to 6 or 7 months required a power transformation of age with power very close to zero to stretch the x-axis before fitting the model. This created a large gap between the observations at birth and at 14 days on the transformed age scale. This fact, combined with the use of flexible cubic splines to model the median curve, resulted in an artificial pattern in that age interval when back-transformed to the original age scale. To avoid this problem and ensure that the curves remained closely patterned on the empirical values, an alternative choice was to create individual BMI values at age 7 days and then linearly interpolate between birth and 7 days, and between 7 and 14 days. Although weight was measured at 7 days, there was no corresponding length measurement to calculate BMI at that age. Therefore to create BMI values for age 7 days, individual lengths for that age were estimated by linear interpolation, i.e. the mid point between length at birth and at 14 days was used.

Q-test, worm plots and comparisons of observed and expected proportions of children with BMI values below fitted centiles presented hereafter included the interpolated values for age group 7 days. It was reassuring to see that the empirical centiles remained very close to the fitted values at the observed ages, birth and 14 days, when the model included the interpolated values.

## 6.2 BMI-for-age for boys

Steps similar to those used to fit the weight-for-age standard were used to select the best model for the BMI-for-age standards for boys. The diagnostic tools to evaluate and compare different models also were the same.

### 6.2.1 Sample size

There were 13 362 records with both weight and length/height for boys. The longitudinal and cross-sectional sample sizes by visit and age are presented in the Tables 68 and 69.

**Table 68 Longitudinal sample sizes for BMI-for-age for boys**

| Visit | Birth | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| **Age** | **0** | **2 wk** | **4 wk** | **6 wk** | **2 mo** | **3 mo** | **4 mo** |
| N | 890 | 424 | 423 | 422 | 423 | 419 | 411 |
| **Visit** | **7** | **8** | **9** | **10** | **11** | **12** | **13** |
| **Age** | **5 mo** | **6 mo** | **7 mo** | **8 mo** | **9 mo** | **10 mo** | **11 mo** |
| N | 413 | 417 | 415 | 415 | 410 | 407 | 418 |
| **Visit** | **14** | **15** | **16** | **17** | **18** | **19** | **20** |
| **Age** | **12 mo** | **14 mo** | **16 mo** | **18 mo** | **20 mo** | **22 mo** | **24 mo** |
| N | 416 | 415 | 418 | 416 | 422 | 417 | 420 |

**Table 69 Cross-sectional sample sizes for BMI-for-age for boys**

| Age (mo) | <18 | 18–20 | 21–23 | 24–26 | 27–29 | 30–32 | 33–35 |
|---|---|---|---|---|---|---|---|
| N | 3 | 171 | 180 | 231 | 254 | 223 | 254 |
| **Age (mo)** | **36–38** | **39–41** | **42–44** | **45–47** | **48–50** | **51–53** | **54–56** |
| N | 267 | 249 | 255 | 238 | 237 | 221 | 228 |
| **Age (mo)** | **57–59** | **60–62** | **63–65** | **66–68** | **69–71** | **>71** | |
| N | 241 | 228 | 215 | 218 | 214 | 4 | |

### 6.2.2 Model selection and results

*Length-based BMI-for-age for boys*

The model BCPE(x=age$^{\lambda}$, df($\mu$)=9, df($\sigma$)=4, df($\nu$)=4, $\tau$=2) was used initially to assess variations in the age-transformation power $\lambda$ and to determine the best fit as reflected by global deviance. Table 70 shows the global deviance for a grid of $\lambda$ values between 0 and 0.5. The smallest global deviance was associated with the age-transformation power $\lambda$=0.01. However, $\lambda$=0.05 was selected because the problem caused in fitting cubic splines in the transformed age scale and back-transforming afterwards was worse with $\lambda$=0.01 than with $\lambda$=0.05, yet the global deviance for the latter was not much larger.

**Table 70 Global deviance (GD) for models within the class BCPE(x=age$^{\lambda}$, df($\mu$)=9, df($\sigma$)=4, df($\nu$)=4, $\tau$=2) for length-based BMI-for-age for boys**

| λ | **0.01** | **0.05** | **0.10** | **0.15** | **0.20** | **0.25** |
|---|---|---|---|---|---|---|
| GD[a] | 702.7 | 704.2 | 706.4 | 709.0 | 711.5 | 713.9 |
| **λ** | **0.30** | **0.35** | **0.40** | **0.45** | **0.50** | |
| GD[a] | 716.0 | 718.4 | 722.7 | 731.0 | 745.4 | |

[a] In excess of 35 000.

The search for the best df($\mu$) and df($\sigma$) was carried out using $\lambda$=0.05 as the age-transformation power and comparing the goodness of fit of various models with fixed parameters $\nu$=1 and $\tau$=2. All possible combinations of df($\mu$) 7 to 15 and df($\sigma$) 2 to 10 were considered. Partial results are presented in Table 71. The best combination of *AIC* and *GAIC(3)* corresponded to df($\mu$)=10 and df($\sigma$)=4. Worm plots and Q-test for this model also were examined.

**Table 71 Goodness-of-fit summary for models using the BCPE distribution with fixed $\nu$=1 and $\tau$=2 for length-based BMI-for-age for boys**

| df(μ) | df(σ) | GD[a] | AIC[a] | GAIC(3)[a] | Total df |
|---|---|---|---|---|---|
| **8** | **3** | 899.3 | 921.3 | 932.3 | 11 |
| | **4** | 892.9 | 916.9 | 928.9 | 12 |
| | **5** | 890.7 | 916.7 | 929.7 | 13 |
| | **6** | 889.6 | 917.6 | 931.6 | 14 |
| **9** | **3** | 892.9 | 916.9 | 928.9 | 12 |
| | **4** | 886.4 | 912.4 | 925.4 | 13 |
| | **5** | 884.2 | 912.2 | 926.2 | 14 |
| | **6** | 883.1 | 913.1 | 928.1 | 15 |
| **10** | **3** | 889.4 | 915.4 | 928.4 | 13 |
| | **4** | 883.0 | 911.0 | 925.0 | 14 |
| | **5** | 880.8 | 910.8 | 925.8 | 15 |
| | **6** | 879.7 | 911.7 | 927.7 | 16 |
| **11** | **3** | 887.3 | 915.3 | 929.3 | 14 |
| | **4** | 880.9 | 910.9 | 925.9 | 15 |
| | **5** | 878.6 | 910.6 | 926.6 | 16 |
| | **6** | 877.5 | 911.5 | 928.5 | 17 |
| **12** | **3** | 885.7 | 915.7 | 930.7 | 15 |
| | **4** | 879.3 | 911.3 | 927.3 | 16 |
| | **5** | 877.0 | 911.0 | 928.0 | 17 |
| | **6** | 875.9 | 911.9 | 929.9 | 18 |

GD, Global Deviance; AIC, Akaike Information Criterion;
GAIC(3), Generalized AIC with penalty equal to 3;
[a] In excess of 35 000.

**Model 1: BCPE(x=age$^{0.05}$, df(μ)=10, df(σ)=4, ν=1, τ=2)**

Worm plots (Figure 100) and Q-test results (Table 72) indicated misfit across various age intervals due to residual skewness and/or kurtosis. The worms were U-shaped for many of the age groups, indicating residual skewness. In the Q-test results most of the groups had absolute values of z3 larger than 2, suggesting residual skewness, and three age groups presented values of z4 larger than 2, indicating residual kurtosis. The overall tests for both skewness and kurtosis combining all age groups were significant.

This model was therefore considered inadequate. The next step involved fitting the parameter ν, to adjust for skewness, using the BCPE distribution and fixing only the parameter τ=2. Table 73 shows *GAIC(3)* values for various choices of df(ν), maintaining df(μ) and df(σ) as selected for Model 1.

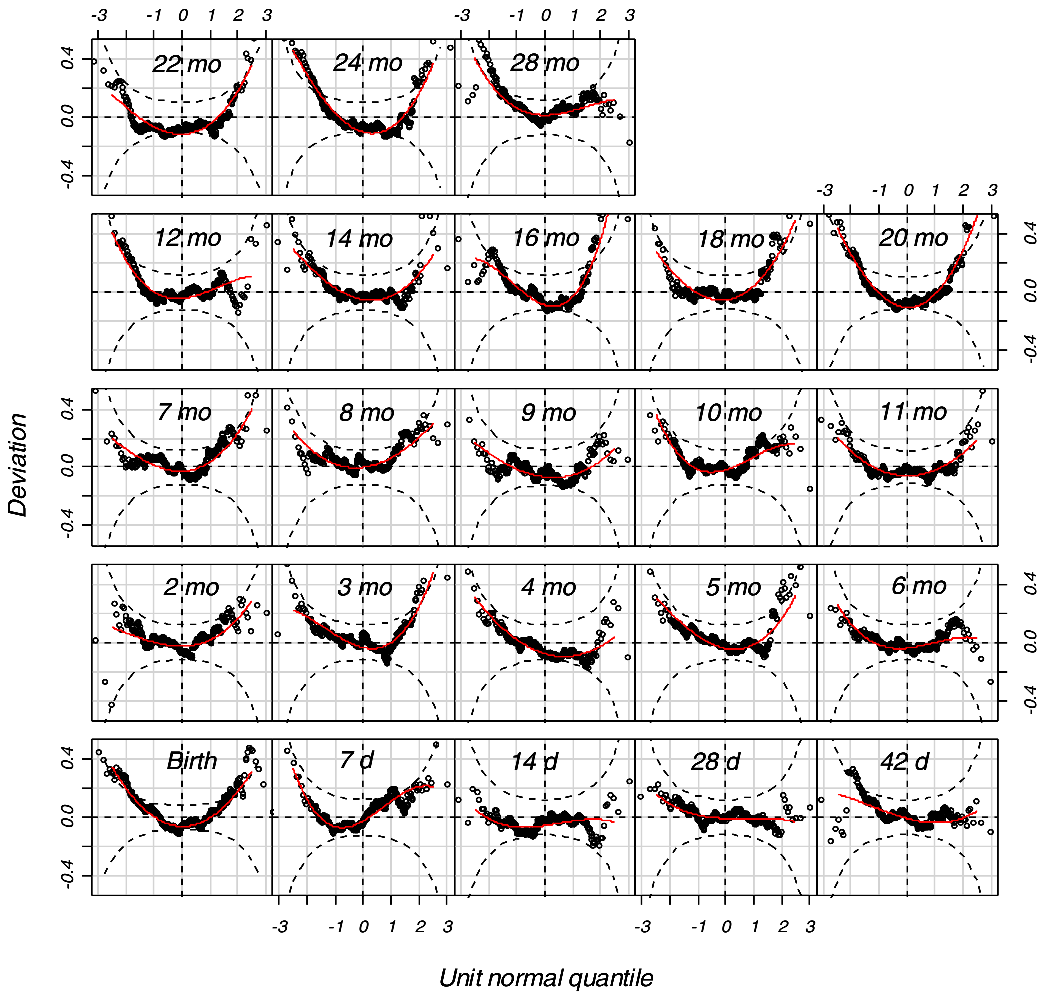


**Figure 100 Worm plots of z-scores for Model 1 for length-based BMI-for-age for boys**

**Table 72 Q-test for z-scores from Model 1 [BCPE(x=age$^{0.05}$, df(μ)=10, df(σ)=4, ν=1, τ=2)] for length-based BMI-for-age for boys**

| Age (days) | Group | N | z1 | z2 | z3 | z4 |
|---|---|---|---|---|---|---|
| 0 | **Birth** | 890 | 0.00 | -0.01 | 4.45 | 0.76 |
| 1 to 11 | **7 d** | 387 | 0.45 | 1.36 | 1.90 | -1.50 |
| 12 to 16 | **14 d** | 418 | -0.98 | 0.20 | 0.59 | -0.57 |
| 17 to 34 | **28 d** | 426 | 0.14 | -0.63 | 0.56 | -0.47 |
| 35 to 49 | **42 d** | 421 | 0.18 | -1.05 | 0.85 | 0.50 |
| 50 to 69 | **2 mo** | 423 | 0.14 | 0.63 | 1.69 | 0.63 |
| 70 to 99 | **3 mo** | 419 | 0.49 | 0.22 | 3.25 | 1.91 |
| 100 to 129 | **4 mo** | 408 | -0.82 | -1.50 | 2.15 | 0.47 |
| 130 to 159 | **5 mo** | 410 | 0.37 | -0.53 | 2.96 | 1.32 |
| 160 to 189 | **6 mo** | 411 | -0.39 | -0.61 | 1.26 | -0.67 |
| 190 to 219 | **7 mo** | 406 | 0.43 | 0.79 | 2.53 | 0.83 |
| 220 to 249 | **8 mo** | 420 | 0.90 | 0.62 | 1.97 | 0.06 |
| 250 to 279 | **9 mo** | 392 | -0.72 | -0.34 | 1.89 | 0.41 |
| 280 to 309 | **10 mo** | 400 | 0.68 | 0.58 | 2.01 | -1.25 |
| 310 to 349 | **11 mo** | 461 | -0.39 | -0.01 | 2.12 | 0.37 |
| 350 to 379 | **12 mo** | 411 | 0.14 | -0.47 | 2.28 | -0.46 |
| 380 to 439 | **14 mo** | 417 | 0.03 | -0.48 | 2.73 | 1.05 |
| 440 to 499 | **16 mo** | 416 | 0.08 | 0.73 | 4.70 | 3.00 |
| 500 to 559 | **18 mo** | 442 | 0.46 | 1.11 | 3.49 | 1.27 |
| 560 to 619 | **20 mo** | 518 | -0.20 | 0.47 | 5.05 | 2.10 |
| 620 to 679 | **22 mo** | 545 | -1.17 | 0.81 | 3.44 | 1.71 |
| 680 to 749 | **24 mo** | 587 | -0.61 | -1.05 | 5.04 | 2.32 |
| 750 to 913 | **28 mo** | 429 | 1.14 | -0.72 | 1.93 | -0.71 |
| **Overall Q stats** | | **10 457** | **7.89** | **12.90** | **188.82** | **37.77** |
| **degrees of freedom** | | | **13.0** | **20.5** | **23.0** | **23.0** |
| **p-value** | | | **0.8510** | **0.8978** | **< 0.01** | **0.0269** |

Note: Absolute values of z1, z2, z3 or z4 larger than 2 indicate misfit of, respectively, mean, variance, skewness or kurtosis.

**Table 73 Goodness-of-fit summary for models BCPE(x=age$^{0.05}$, df(μ)=10, df(σ)=4, df(ν)=?, τ=2) for length-based BMI-for-age for boys**

| df(ν) | GD[a] | GAIC(3)[a] | Total df |
|---|---|---|---|
| **1** | 720.7 | 765.7 | 15 |
| **2** | 720.4 | 768.4 | 16 |
| **3** | 702.8 | 753.8 | 17 |
| **4** | 700.9 | 754.9 | 18 |
| **5** | 699.4 | 756.4 | 19 |
| **6** | 697.5 | 757.5 | 20 |

GD, Global Deviance; GAIC(3), Generalized Akaike Information Criterion with penalty equal to 3;
[a] In excess of 35 000.

The smallest *GAIC(3)* was associated with df(ν)=3 and this model's goodness-of-fit was investigated further.

**Model 2: BCPE(x=age$^{0.05}$, df(μ)=10, df(σ)=4, df(ν)=3, τ=2)**

Figure 101 shows the fitting of the parameters μ, σ and ν for Model 2 with their respective sample estimates. The fitted σ curve underestimated the high peak in the empirical curve (the St Dev Box-Cox transformed BMI) at 7 days. The smoothing function of the Box-Cox transformation power (ν curve) did not follow the unstable pattern of the empirical curve, and thus partially controlled the skewness associated with parameter ν at the end of the 0 to 24 month age interval.

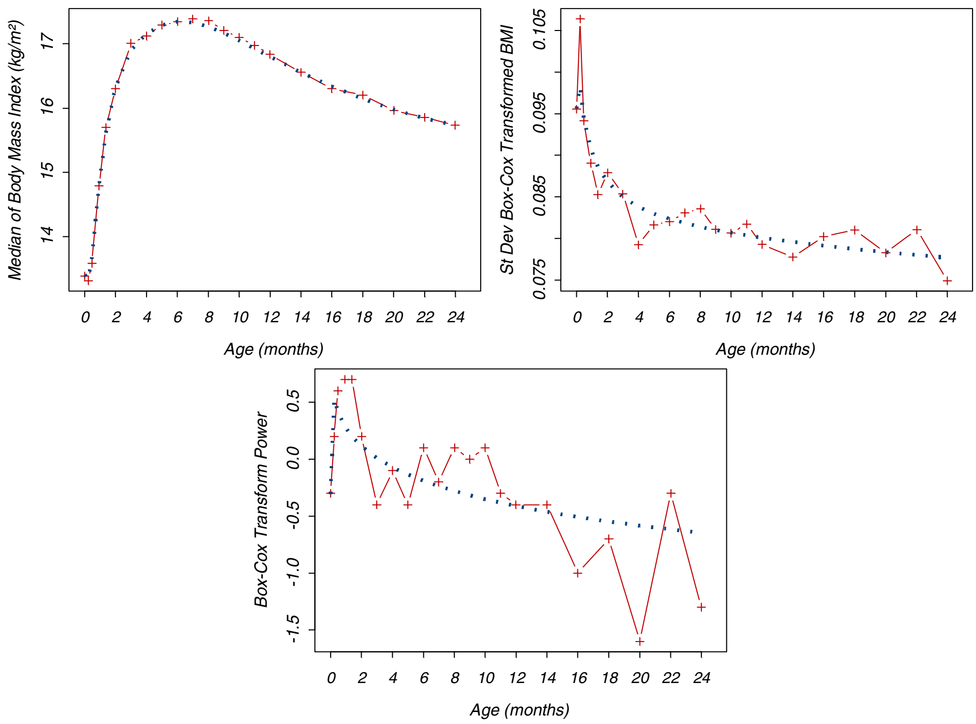


**Figure 101 Fitting of the μ, σ, and ν curves of Model 2 for length-based BMI-for-age from 0 to 24 months for boys (dotted line) and their respective sample estimates (points with solid line)**

Figure 102 shows the distribution of the centile residuals, i.e. empirical minus fitted centiles, for the longitudinal sample (0 to 24 months). There was no evidence of systematic bias. The worm plots for this model (Figure 103) showed that adjustment for skewness corrected the previous model's misfit (Figure 100), i.e. U-shaped worms flattened fairly well. Few age groups still retained slightly S-shaped worms but all constrained within the 95% confidence intervals.

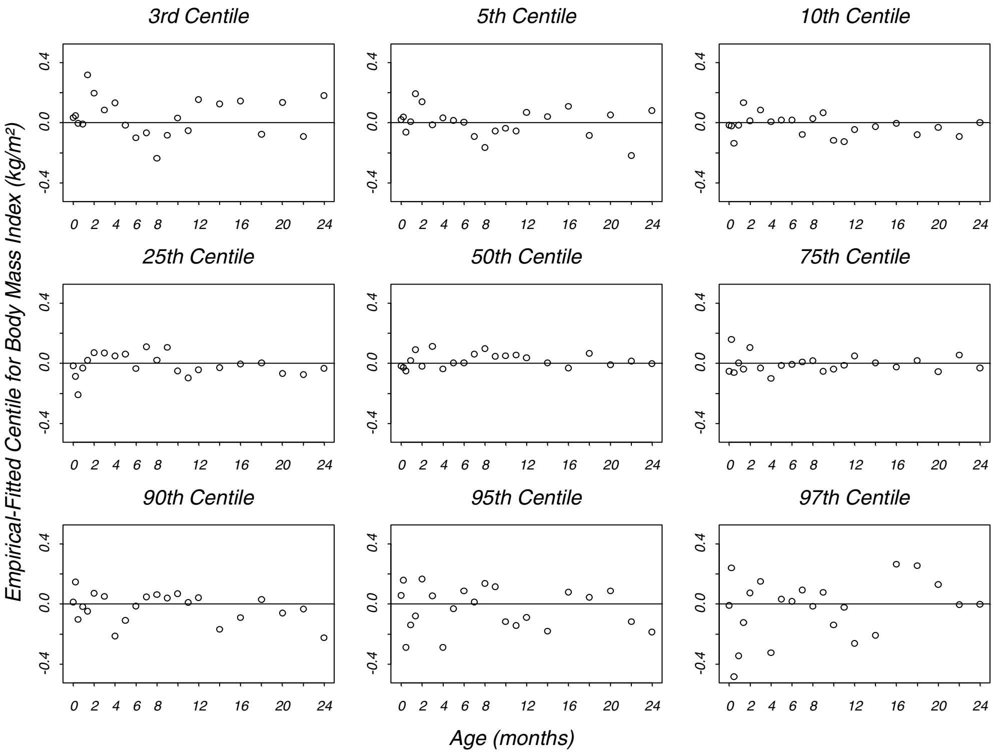


**Figure 102 Centile residuals from fitting Model 2 for length-based BMI-for-age from 0 to 24 months for boys**

Q-test results of the z-scores from Model 2 are shown in Table 74. All absolute values for the statistics z1, z2, z3 and z4 were smaller than 2, apart from one z4 value at age 7 days indicating residual kurtosis. P-values for overall tests were all non-significant, indicating adequate fit for the BMI-for-age growth curves for boys. Table 75 presents observed percentages below the fitted centiles, which give no indication of systematic bias.

Since residual kurtosis was indicated for only one out of 23 age groups and the overall test was not significant, modelling the parameter τ and thus increasing the model's complexity was considered unnecessary.

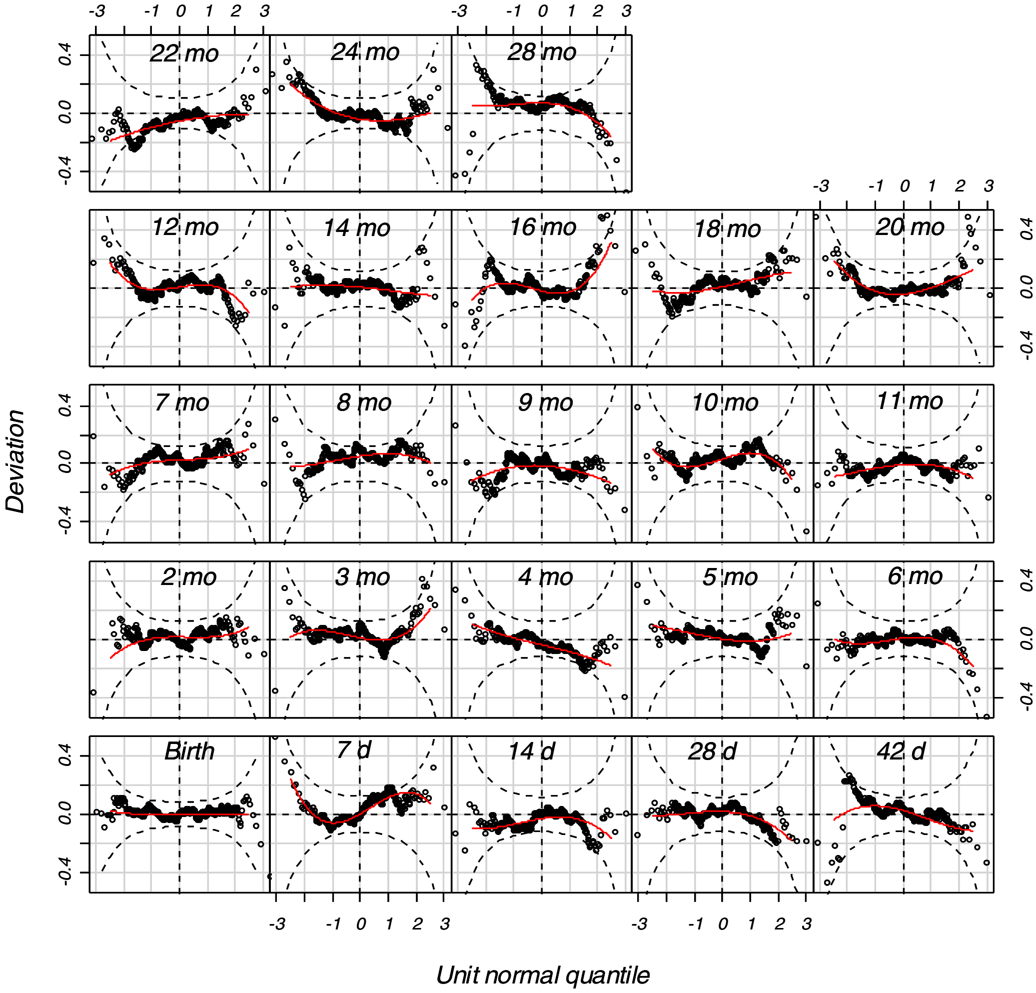


**Figure 103 Worm plots of z-scores for Model 2 for length-based BMI-for-age for boys**

Model 2, BCPE(x= age$^{0.05}$, df(μ)=10, df(σ)=4 ,df(ν)=3, τ=2), was selected to fit the BMI-for-age growth curves for boys from birth to 24 months. This model adjusts only for skewness and belongs to the same class of models used for the LMS method. A further iteration was done, fixing df(ν)=3 and re-searching for the best combination of df(μ) and df(σ), but Model 2 still presented the best performance in both *AIC* and *GAIC(3)*. Then, using the selected degrees of freedom for μ, σ and ν curves, the best λ was re-searched. Results confirmed that values of λ close to zero resulted in the lowest global deviance. However, for reasons stated previously (see discussion in connection with Table 70) λ was kept at value 0.05.

The final centile curves are shown in Figures 104 and 105 plotted with the empirical centiles.

**Table 74 Q-test for z-scores from Model 2 [BCPE(x=age$^{0.05}$, df(μ)=10, df(σ)=4, df(ν)=3, τ=2)] for length-based BMI-for-age for boys**

| Age (days) | Group | N | z1 | z2 | z3 | z4 |
|---|---|---|---|---|---|---|
| 0 | **Birth** | 890 | 0.00 | -0.02 | 0.11 | -0.06 |
| 1 to 11 | **7 d** | 387 | 0.56 | 1.22 | 0.99 | -2.01 |
| 12 to 16 | **14 d** | 418 | -0.98 | 0.30 | -0.70 | -0.66 |
| 17 to 34 | **28 d** | 426 | 0.07 | -0.59 | -0.95 | -0.40 |
| 35 to 49 | **42 d** | 421 | 0.17 | -0.99 | -1.01 | 0.96 |
| 50 to 69 | **2 mo** | 423 | 0.13 | 0.63 | -0.44 | 0.95 |
| 70 to 99 | **3 mo** | 419 | 0.44 | -0.01 | 0.91 | 1.21 |
| 100 to 129 | **4 mo** | 408 | -0.87 | -1.42 | 0.08 | -0.15 |
| 130 to 159 | **5 mo** | 410 | 0.31 | -0.69 | 0.59 | 0.50 |
| 160 to 189 | **6 mo** | 411 | -0.39 | -0.40 | -0.92 | -0.63 |
| 190 to 219 | **7 mo** | 406 | 0.40 | 0.73 | -0.09 | 0.36 |
| 220 to 249 | **8 mo** | 420 | 0.91 | 0.59 | -0.57 | -0.30 |
| 250 to 279 | **9 mo** | 392 | -0.68 | -0.11 | -0.66 | 0.00 |
| 280 to 309 | **10 mo** | 400 | 0.66 | 0.56 | -0.23 | -1.57 |
| 310 to 349 | **11 mo** | 461 | -0.39 | 0.21 | -0.73 | -0.27 |
| 350 to 379 | **12 mo** | 411 | 0.19 | -0.43 | -0.07 | -1.63 |
| 380 to 439 | **14 mo** | 417 | 0.11 | -0.42 | -0.19 | 0.25 |
| 440 to 499 | **16 mo** | 416 | 0.11 | 0.41 | 1.19 | 1.84 |
| 500 to 559 | **18 mo** | 442 | 0.48 | 0.98 | 0.30 | -0.11 |
| 560 to 619 | **20 mo** | 518 | -0.13 | 0.16 | 1.81 | -0.12 |
| 620 to 679 | **22 mo** | 545 | -1.25 | 1.15 | -0.39 | 0.12 |
| 680 to 749 | **24 mo** | 587 | -0.57 | -1.17 | 1.46 | 0.10 |
| 750 to 913 | **28 mo** | 429 | 1.07 | -0.59 | -1.09 | 0.02 |
| **Overall Q stats** | | **10 457** | **7.90** | **11.76** | **15.31** | **17.50** |
| **degrees of freedom** | | | **13.0** | **20.5** | **20.0** | **23.0** |
| **p-value** | | | **0.8499** | **0.9358** | **0.7584** | **0.7841** |

Note: Absolute values of z1, z2, z3 or z4 larger than 2 indicate misfit of, respectively, mean, variance, skewness or kurtosis.

**Table 75 Observed proportions of children with measurements below the fitted centiles from Model 2, length-based BMI-for-age for boys**

| Expected | Birth | 7 d | 14 d | 28 d | 42 d | 2 mo | 3 mo | 4 mo | 5 mo | 6 mo | 7 mo | 8 mo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 1.0 | 0.3 | 1.0 | 0.7 | 1.4 | 0.7 | 0.5 | 0.7 | 1.0 | 1.2 | 1.2 | 1.4 |
| **3** | 2.4 | 2.6 | 3.6 | 3.1 | 1.9 | 2.8 | 2.9 | 2.7 | 2.9 | 3.6 | 3.7 | 3.6 |
| **5** | 4.8 | 4.7 | 6.2 | 4.5 | 2.9 | 5.2 | 5.3 | 4.7 | 4.4 | 5.4 | 5.9 | 5.5 |
| **10** | 10.3 | 10.9 | 10.5 | 10.1 | 8.8 | 11.3 | 9.5 | 10.3 | 9.3 | 10.5 | 10.1 | 9.5 |
| **25** | 25.8 | 26.1 | 28.2 | 25.1 | 25.7 | 24.1 | 23.9 | 24.5 | 23.7 | 26.8 | 22.9 | 24.0 |
| **50** | 50.4 | 50.4 | 50.2 | 49.1 | 47.5 | 51.8 | 48.4 | 52.2 | 49.3 | 50.9 | 48.0 | 45.0 |
| **75** | 76.0 | 71.3 | 75.4 | 74.4 | 76.0 | 74.2 | 76.4 | 76.5 | 74.9 | 75.7 | 74.6 | 73.8 |
| **90** | 89.8 | 86.6 | 90.4 | 90.6 | 90.3 | 88.9 | 89.5 | 92.2 | 92.2 | 90.5 | 88.7 | 88.3 |
| **95** | 94.8 | 94.3 | 96.7 | 96.5 | 96.0 | 94.1 | 94.5 | 96.6 | 95.1 | 95.1 | 94.1 | 93.3 |
| **97** | 97.1 | 96.6 | 98.3 | 97.9 | 97.6 | 96.5 | 96.4 | 97.5 | 96.8 | 97.3 | 96.3 | 96.9 |
| **99** | 98.9 | 98.7 | 99.0 | 99.3 | 99.3 | 98.6 | 98.3 | 99.3 | 98.8 | 99.5 | 98.8 | 98.8 |
| **Expected** | **9 mo** | **10 mo** | **11 mo** | **12 mo** | **14 mo** | **16 mo** | **18 mo** | **20 mo** | **22 mo** | **24 mo** | **28 mo** | **Overall** |
| **1** | 1.0 | 1.0 | 0.9 | 0.5 | 0.5 | 1.4 | 0.9 | 0.6 | 1.1 | 0.3 | 0.9 | 0.9 |
| **3** | 4.3 | 2.8 | 3.7 | 1.9 | 2.4 | 2.4 | 3.8 | 2.3 | 5.0 | 1.9 | 1.6 | 2.9 |
| **5** | 6.1 | 5.0 | 5.2 | 3.9 | 4.8 | 3.4 | 6.1 | 4.1 | 7.3 | 3.9 | 3.3 | 4.9 |
| **10** | 10.7 | 11.5 | 11.9 | 11.2 | 10.3 | 10.1 | 11.3 | 11.2 | 11.4 | 9.9 | 8.6 | 10.4 |
| **25** | 25.0 | 25.5 | 26.7 | 26.5 | 25.2 | 25.0 | 24.2 | 25.9 | 28.6 | 26.7 | 22.8 | 25.4 |
| **50** | 49.5 | 47.5 | 47.9 | 49.4 | 48.7 | 51.4 | 48.0 | 50.4 | 51.0 | 50.1 | 48.5 | 49.5 |
| **75** | 78.1 | 73.8 | 75.5 | 74.2 | 73.6 | 75.7 | 74.0 | 75.5 | 74.7 | 77.2 | 71.8 | 75.0 |
| **90** | 90.3 | 87.3 | 90.5 | 89.5 | 92.1 | 90.9 | 89.6 | 90.2 | 91.0 | 91.1 | 89.5 | 90.0 |
| **95** | 94.9 | 94.5 | 95.9 | 95.4 | 95.7 | 94.5 | 93.7 | 94.4 | 95.6 | 95.7 | 94.4 | 95.0 |
| **97** | 96.7 | 97.0 | 97.6 | 98.3 | 97.1 | 95.9 | 95.5 | 96.5 | 97.1 | 96.8 | 97.2 | 97.0 |
| **99** | 99.5 | 99.0 | 99.1 | 99.3 | 98.3 | 98.1 | 98.4 | 98.5 | 98.9 | 98.8 | 99.5 | 98.9 |

Note: Group labels correspond to the age intervals in Table 74.

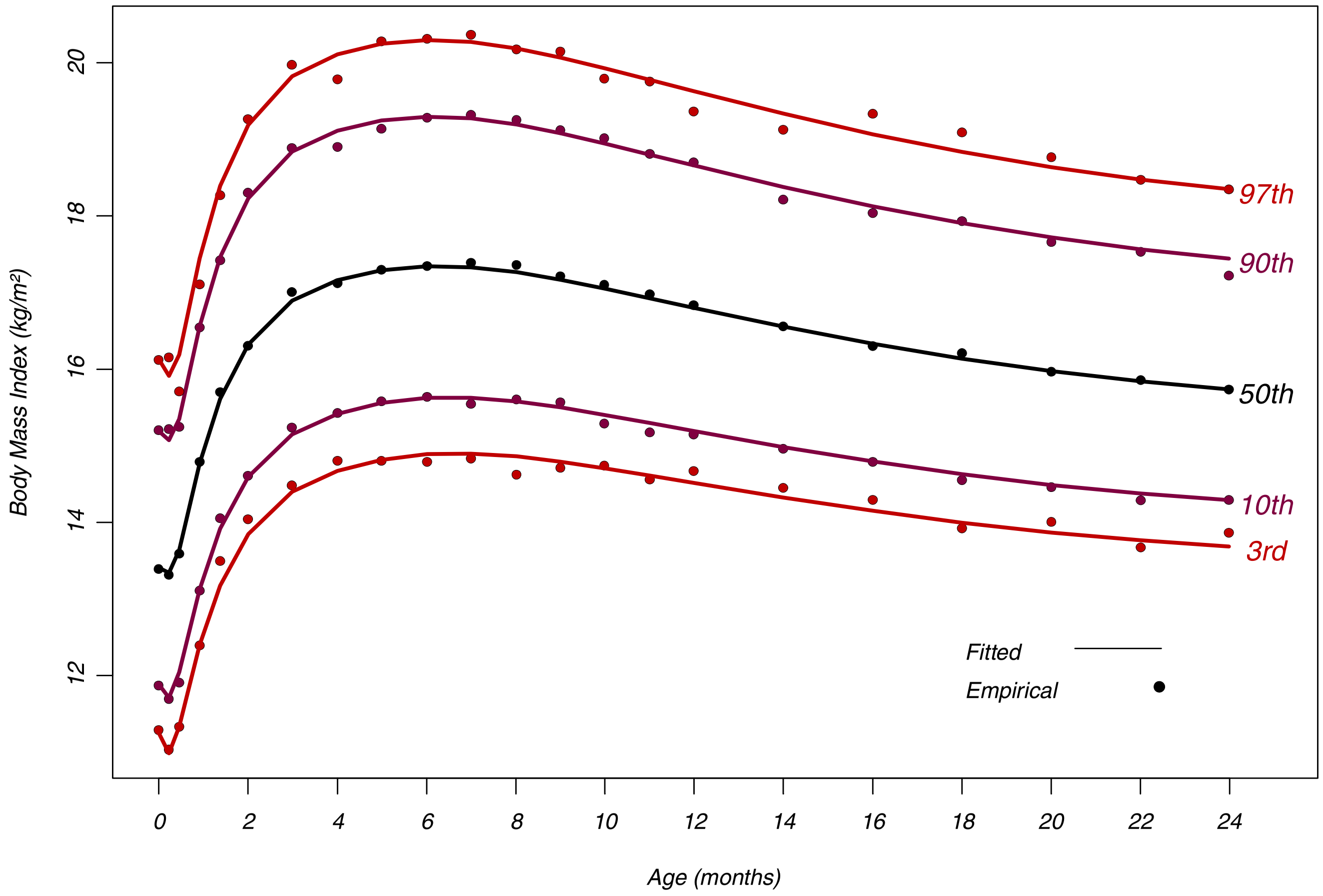


**Figure 104** 3rd, 10th, 50th, 90th, 97th smoothed centile curves and empirical values: length-based BMI-for-age for boys from birth to 24 months

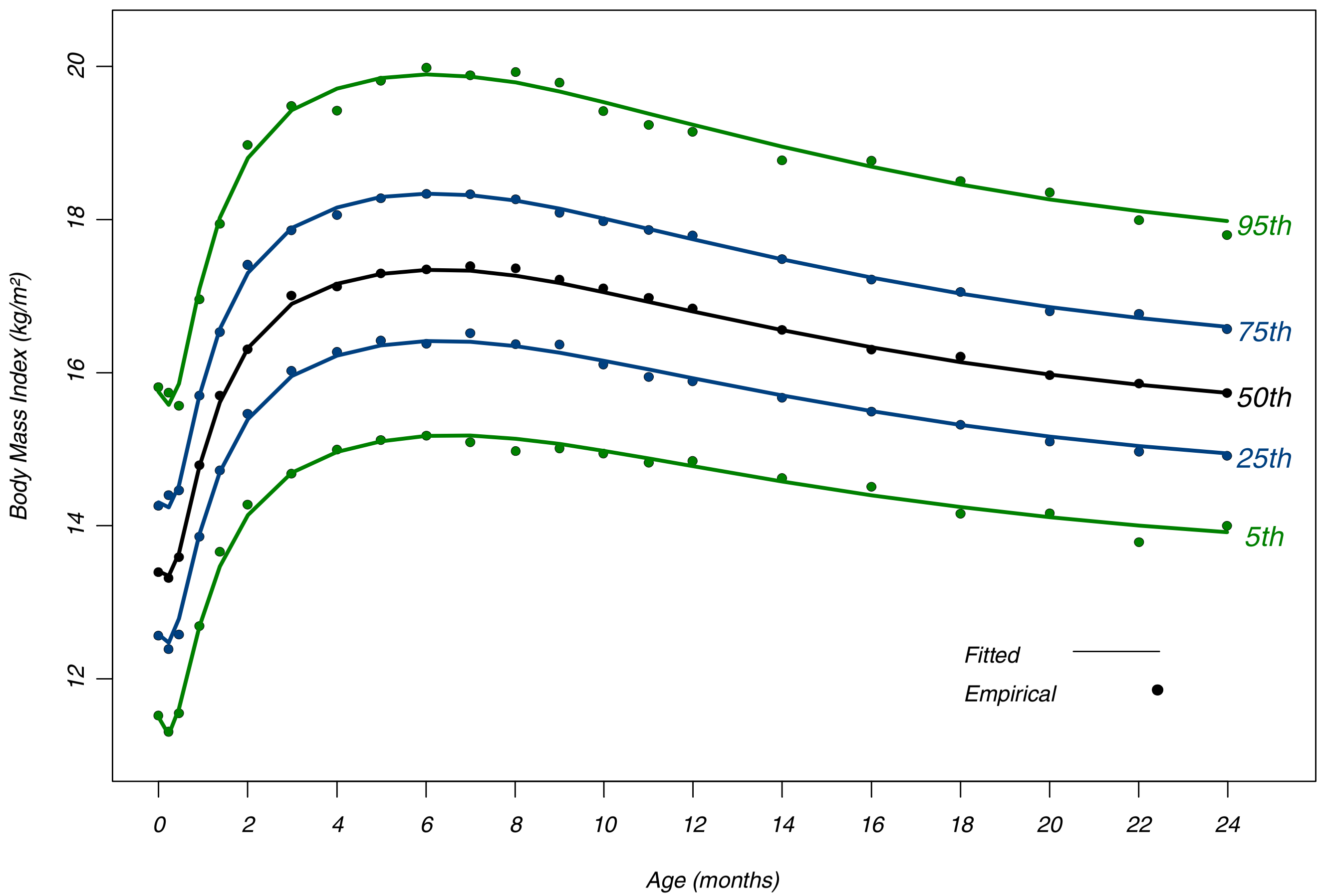


**Figure 105 5th, 25th, 50th, 75th, 95th smoothed centile curves and empirical values: length-based BMI-for-age for boys from birth to 24 months**

*Height-based BMI-for-age for boys*

To construct the BMI-for-age growth standard using height, the need for an age-transformation power λ before fitting the model was evaluated. Results indicated that no age transformation was necessary. The class of models selected for constructing the length-based standard was the first option to be considered for constructing the height-based BMI-for-age standard.

Using the BCPE distribution, the μ and σ parameter curves were modelled and parameters ν and τ were fixed at values 1 and 2, respectively. The search for the best df(μ) and df(σ) was carried out by comparing the goodness of fit of various models. All possible combinations of df(μ) 3 to 10 and df(σ) 2 to 6 were considered. Partial results are presented in Table 76. The best combination of *AIC* and *GAIC(3)* corresponded to df(μ)=4 and df(σ)=3. This model was used as a first step to search for the best degrees of freedom for the parameter ν. Table 77 shows a summary of the goodness-of-fit results from various models.

**Table 76 Goodness-of-fit summary for models using the BCPE distribution with fixed ν=1 and τ=2 for height-based BMI-for-age for boys**

| df(μ) | df(σ) | GD[a] | AIC[a] | GAIC(3)[a] | Total df |
|---|---|---|---|---|---|
| 3 | 2 | 184.3 | 194.5 | 199.5 | 5 |
| | 3 | 177.6 | 189.6 | 195.6 | 6 |
| | 4 | 176.5 | 190.5 | 197.5 | 7 |
| | 5 | 175.8 | 191.8 | 199.8 | 8 |
| 4 | 2 | 178.0 | 190.1 | 196.2 | 6 |
| | 3 | 171.8 | 185.8 | 192.8 | 7 |
| | 4 | 170.7 | 186.7 | 194.7 | 8 |
| | 5 | 169.9 | 187.9 | 196.9 | 9 |
| 5 | 2 | 176.3 | 190.5 | 197.5 | 7 |
| | 3 | 170.2 | 186.2 | 194.2 | 8 |
| | 4 | 169.1 | 187.1 | 196.1 | 9 |
| | 5 | 168.3 | 188.3 | 198.3 | 10 |
| 6 | 2 | 174.7 | 190.8 | 198.9 | 8 |
| | 3 | 168.5 | 186.5 | 195.5 | 9 |
| | 4 | 167.4 | 187.4 | 197.4 | 10 |
| | 5 | 166.7 | 188.7 | 199.7 | 11 |
| 7 | 2 | 173.1 | 191.2 | 200.3 | 9 |
| | 3 | 166.8 | 186.9 | 196.9 | 10 |
| | 4 | 165.7 | 187.7 | 198.7 | 11 |
| | 5 | 165.0 | 189.0 | 201.0 | 12 |

GD, Global Deviance; AIC, Akaike Information Criterion;
GAIC(3), Generalized AIC with penalty equal to 3;
[a] In excess of 19 000.

**Table 77 Goodness-of-fit summary for models BCPE(x=age, df(μ)=4, df(σ)=3, df(ν)=?, τ=2) for height-based BMI-for-age for boys**

| df(ν) | GD[a] | GAIC(3)[a] | Total df |
|---|---|---|---|
| **1** | 30.8 | 54.8 | 8 |
| **2** | 30.1 | 57.3 | 9 |
| **3** | 25.6 | 55.6 | 10 |
| **4** | 24.7 | 57.7 | 11 |
| **5** | 24.4 | 60.4 | 12 |
| **6** | 24.0 | 63.0 | 13 |

GD, Global Deviance; GAIC(3), Generalized Akaike Information Criterion with penalty equal to 3;
[a] In excess of 19 000.

Although the smallest *GAIC(3)* corresponded to df(ν)=1, the fitting of a constant led to the underestimation of this parameter, resulting in an overestimation of skewness in the age interval of interest, i.e. 24 to 60 months. Therefore, the option df(ν)=3, which was associated with the second smallest GAIC(3) value (Table 77), was selected. This model's goodness-of-fit was investigated further.

**Model 1: BCPE(x=age, df(μ)=4, df(σ)=3, df(ν)=3, τ=2)**

Figure 106 shows the fitting of the parameters μ, σ and ν for Model 1 with their respective sample estimates.

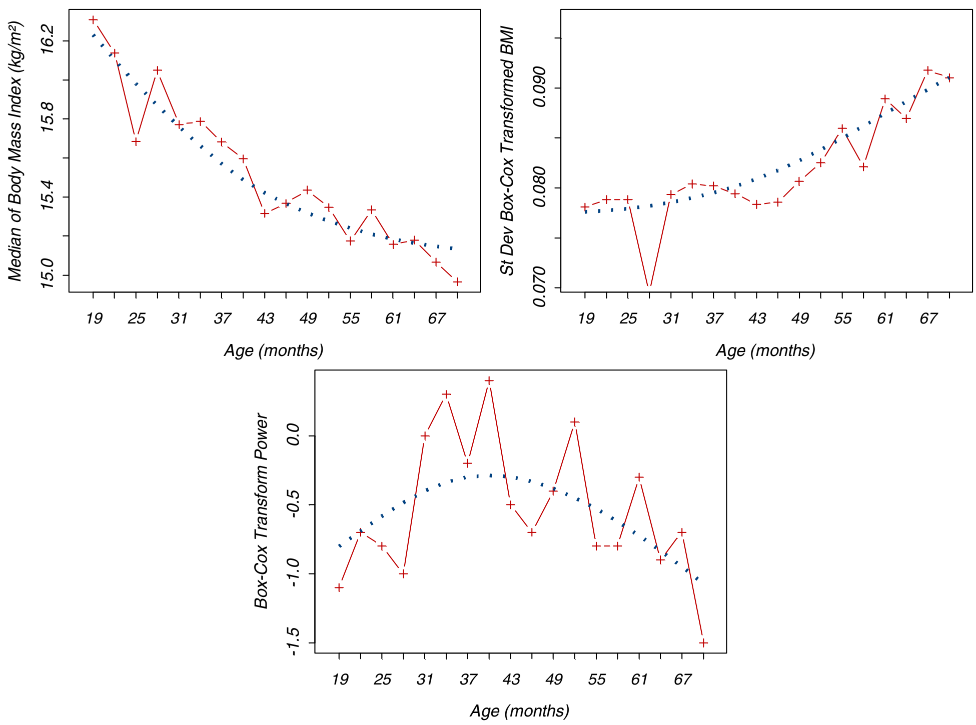


**Figure 106 Fitting of the μ, σ, and ν curves of Model 1 for height-based BMI-for-age from 18 to 71 months for boys (dotted line) and their respective sample estimates (points with solid line)**

Figure 107 shows the distribution of the centile residuals, i.e. the difference between empirical and fitted centiles, using only the cross-sectional sample from 18 to 71 months. There was a tendency to slightly underestimate values of the central centiles (25th, 50th and 75th) at the beginning of the age interval. But this indication of bias was not confirmed by the proportions of children with observed BMI values below fitted centiles (Table 78). The results in Table 78 show no evidence of bias in any of the centiles.

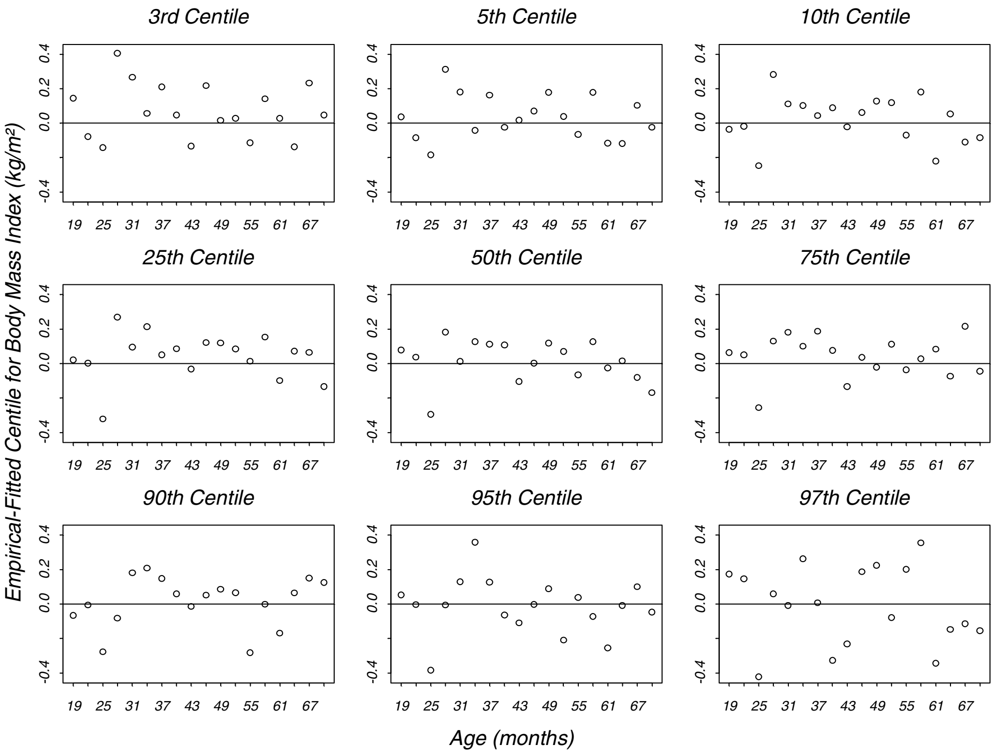


**Figure 107 Centile residuals from fitting Model 1 for height-based BMI-for-age from 18 to 71 months for boys**

**Table 78 Observed proportions of children with measurements below the fitted centiles from Model 1, height-based BMI-for-age for boys**

| Expected | 18–19 mo | 20–22 mo | 23–25 mo | 26–28 mo | 29–31 mo | 32–34 mo | 35–37 mo | 38–40 mo | 41–43 mo | 44–46 mo |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 0.7 | 0.8 | 0.3 | 1.2 | 1.3 | 1.2 | 1.5 | 0.8 | 0.4 | 1.2 |
| **3** | 2.9 | 4.1 | 1.6 | 2.0 | 2.7 | 3.3 | 2.9 | 4.6 | 2.4 | 3.1 |
| **5** | 4.7 | 6.1 | 3.9 | 3.5 | 4.9 | 5.3 | 5.1 | 5.9 | 5.6 | 4.3 |
| **10** | 9.7 | 11.4 | 10.1 | 9.8 | 10.7 | 10.7 | 10.2 | 11.8 | 10.9 | 9.3 |
| **25** | 24.3 | 26.4 | 26.2 | 24.8 | 20.5 | 25.4 | 25.1 | 27.3 | 27.4 | 23.6 |
| **50** | 49.0 | 49.1 | 51.1 | 47.6 | 50.0 | 50.4 | 49.5 | 49.2 | 55.6 | 47.3 |
| **75** | 72.3 | 74.5 | 78.9 | 72.0 | 73.7 | 72.5 | 74.2 | 76.5 | 77.8 | 75.2 |
| **90** | 88.6 | 90.8 | 91.6 | 90.2 | 89.7 | 86.9 | 92.4 | 88.2 | 92.7 | 87.6 |
| **95** | 94.0 | 95.5 | 96.4 | 94.5 | 94.2 | 93.4 | 97.1 | 96.2 | 95.6 | 92.6 |
| **97** | 96.1 | 96.8 | 97.5 | 96.9 | 96.4 | 95.9 | 98.5 | 97.5 | 96.8 | 95.3 |
| **99** | 98.7 | 98.7 | 99.1 | 99.6 | 99.1 | 98.8 | 99.3 | 99.2 | 99.2 | 98.4 |
| **Expected** | **47–49 mo** | **50–52 mo** | **53–55 mo** | **56–58 mo** | **59–61 mo** | **62–64 mo** | **65–67 mo** | **68–71 mo** | **Overall** | |
| **1** | 1.3 | 0.9 | 0.0 | 0.4 | 0.5 | 0.9 | 0.9 | 0.3 | 0.8 | |
| **3** | 3.9 | 3.5 | 1.8 | 3.2 | 5.1 | 3.6 | 2.2 | 3.1 | 3.1 | |
| **5** | 5.6 | 5.7 | 2.7 | 6.9 | 6.0 | 5.0 | 5.3 | 3.8 | 5.0 | |
| **10** | 10.0 | 9.6 | 6.6 | 12.9 | 9.8 | 10.9 | 14.2 | 8.7 | 10.4 | |
| **25** | 22.1 | 25.3 | 22.6 | 25.8 | 26.5 | 20.8 | 27.1 | 22.7 | 25.0 | |
| **50** | 48.5 | 49.3 | 49.6 | 51.2 | 47.4 | 52.0 | 55.6 | 50.3 | 50.0 | |
| **75** | 73.6 | 72.1 | 76.5 | 73.0 | 75.3 | 71.5 | 74.2 | 76.6 | 74.7 | |
| **90** | 90.9 | 88.2 | 91.2 | 89.1 | 90.7 | 87.8 | 90.7 | 87.1 | 89.9 | |
| **95** | 96.1 | 95.2 | 95.1 | 95.6 | 94.9 | 92.3 | 96.0 | 94.4 | 95.1 | |
| **97** | 97.0 | 96.5 | 96.5 | 96.8 | 98.6 | 95.9 | 97.8 | 95.8 | 96.8 | |
| **99** | 98.7 | 98.3 | 99.1 | 98.0 | 99.5 | 99.1 | 98.7 | 99.0 | 98.9 | |

Note: Group labels correspond to the age intervals in Table 79.

**Table 79 Q-test for z-scores from Model 1 [BCPE(x=age, df(μ)=4, df(σ)=3, df(ν)=3, τ=2)] for height-based BMI-for-age for boys**

| Age (months) | N | z1 | z2 | z3 | z4 |
|---|---|---|---|---|---|
| **18–19** | 596 | 1.23 | 0.76 | 0.68 | -0.75 |
| **20–22** | 870 | -0.44 | 0.89 | -0.50 | -0.17 |
| **23–25** | 634 | -0.97 | -2.01 | 1.35 | -0.02 |
| **26–28** | 254 | 0.42 | -0.08 | -0.84 | -0.01 |
| **29–31** | 224 | 0.54 | 0.16 | -0.76 | -0.13 |
| **32–34** | 244 | 0.45 | 1.30 | -0.18 | -0.94 |
| **35–37** | 275 | -0.36 | -0.79 | -1.09 | -0.60 |
| **38–40** | 238 | -0.83 | 0.18 | -0.32 | -0.26 |
| **41–43** | 248 | -1.23 | -0.97 | 0.64 | -0.77 |
| **44–46** | 258 | 0.86 | 0.18 | 0.17 | -0.30 |
| **47–49** | 231 | 0.40 | -0.49 | -0.78 | 0.27 |
| **50–52** | 229 | 0.22 | 0.63 | -0.14 | 0.23 |
| **53–55** | 226 | 0.62 | -1.65 | 1.17 | -0.15 |
| **56–58** | 248 | -0.47 | 1.03 | 0.36 | -1.27 |
| **59–61** | 215 | -0.39 | -0.16 | -0.87 | -1.01 |
| **62–64** | 221 | 0.81 | 0.69 | -0.03 | -0.57 |
| **65–67** | 225 | -0.94 | 0.59 | -0.06 | -1.46 |
| **68–71** | 286 | 0.50 | -0.44 | 0.76 | 0.09 |
| **Overall Q stats** | **5722** | **9.13** | **14.21** | **9.06** | **7.84** |
| **degrees of freedom** | | **14.0** | **16.0** | **15.0** | **18.0** |
| **p-value** | | **0.8224** | **0.5830** | **0.8743** | **0.9809** |

Note: Absolute values of z1, z2, z3 or z4 larger than 2 indicate misfit of, respectively, mean, variance, skewness or kurtosis.

Q-test results of the z-scores from the selected model are shown in Table 79. No indication of misfit was noted for any of the four distributional parameters. Only one age group (23–25 mo) had an absolute value of z2 slightly above 2. This was likely the result of smoothing out the irregularity at the merging point of the longitudinal and cross-sectional sub-samples. Figure 108 shows the worm plots for the z-scores derived from Model 1. The plots show no evidence of departure from the normal distribution or misfit of the selected model. Worms were fairly flat across all age groups, apart from two groups (23–25 and 53–55 mo) whose worms had slopes indicating a slight misfit of the variance. No adjustment for kurtosis appeared to be necessary.

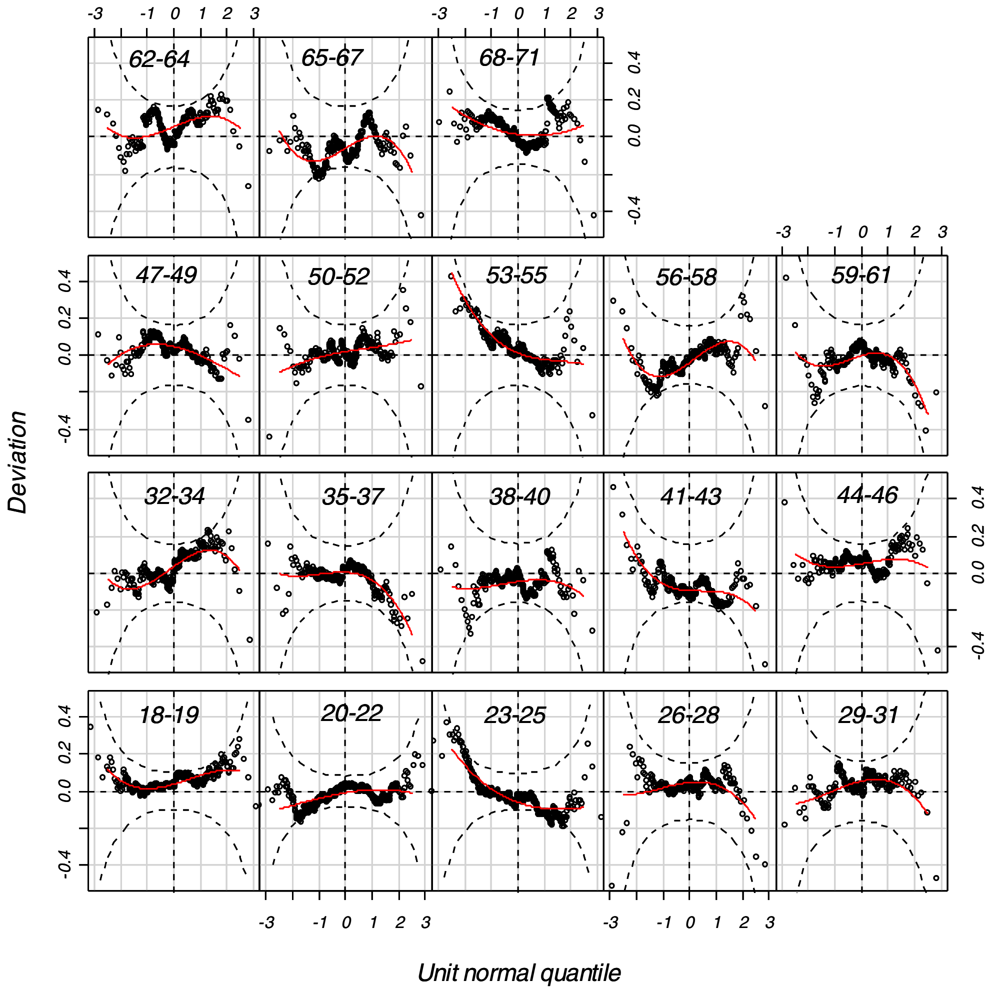


**Figure 108 Worm plots of z-scores for Model 1 for height-based BMI-for-age for boys**

A new iteration to re-search for the best values of df(μ) and df(σ) with respect to *AIC* and *GAIC(3)* was done using df(ν)=3, but the previous choice was confirmed and there was no need to update the model. In conclusion, the model selected for the height-based BMI-for-age curves for boys was BCPE(x=age, df(μ)=4, df(σ)=3,df(ν)=3,τ=2). The standard's fitted centile curves and empirically derived centiles are shown in Figures 109 and 110.

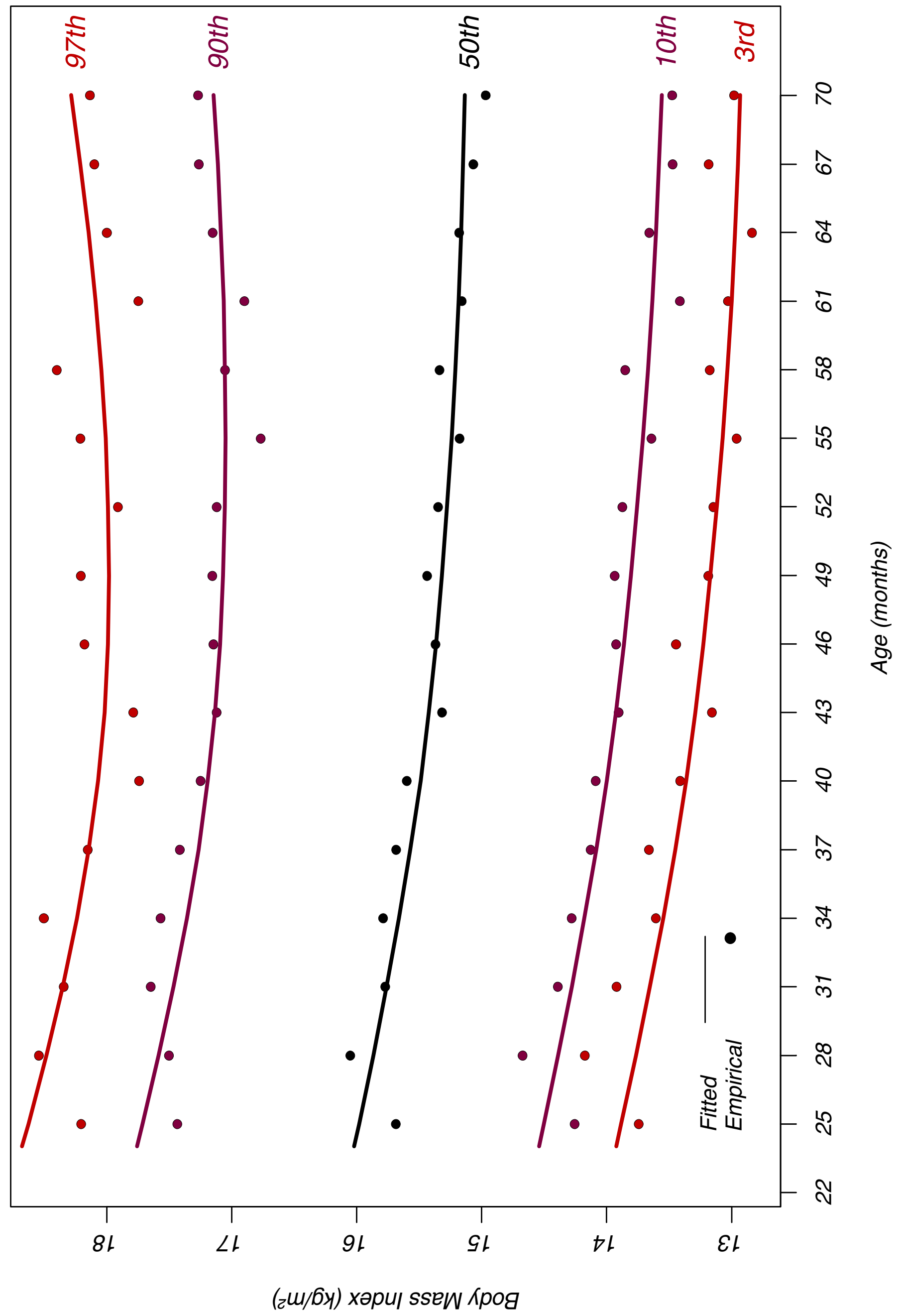


**Figure 109 3rd, 10th, 50th, 90th, 97th smoothed centile curves and empirical values: height-based BMI-for-age for boys from 24 to 71 months**

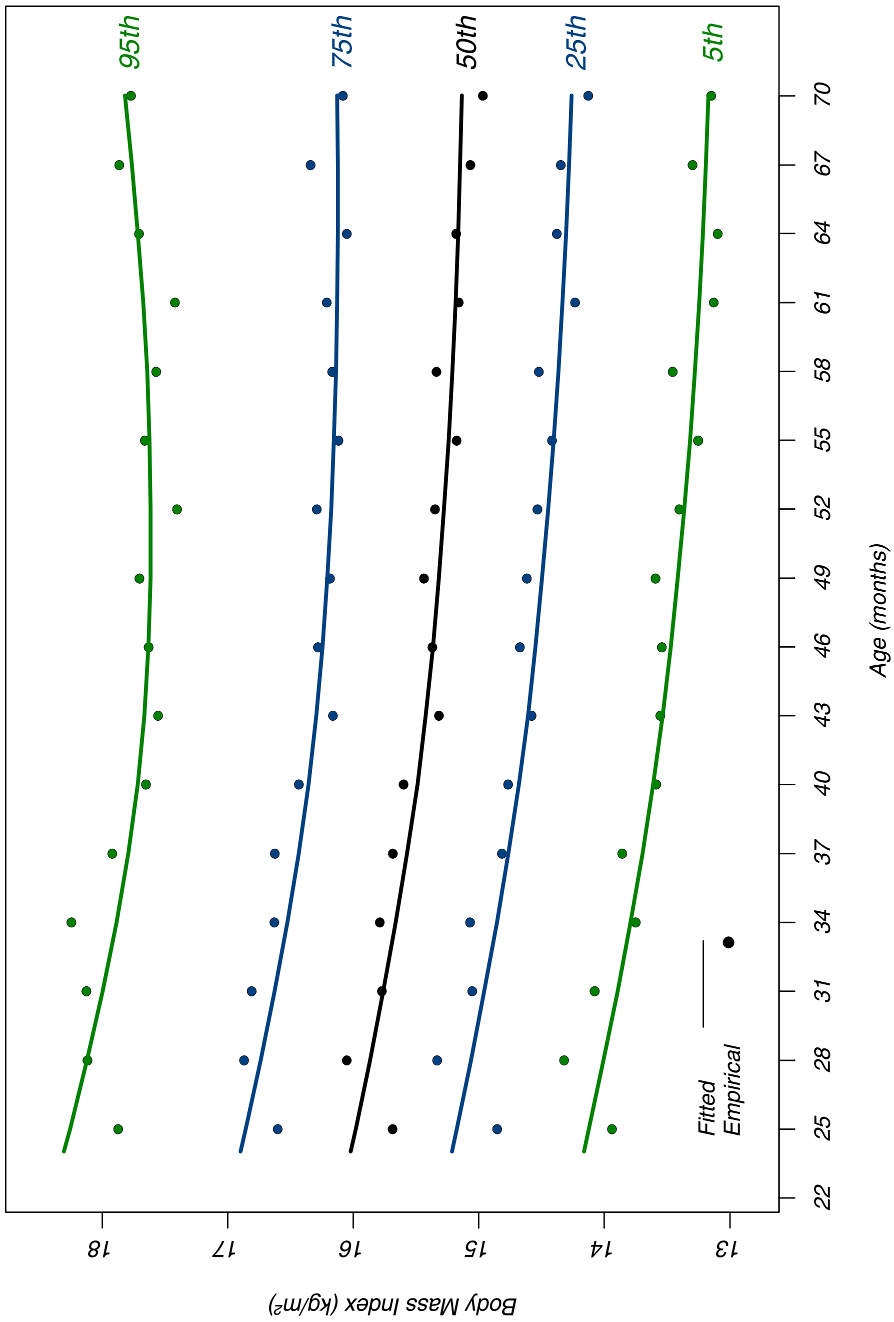


**Figure 110 5th, 25th, 50th, 75th, 95th smoothed centile curves and empirical values: height-based BMI-for-age for boys from 24 to 71 months**

### 6.2.3 WHO standards and their comparison with CDC 2000 reference

This section presents the final WHO BMI-for-age z-score and percentile charts (Figures 111 to 114) and tables (Tables 80 to 82) for boys. It also provides the z-score comparison of the WHO versus CDC 2000 curves (Figure 115).

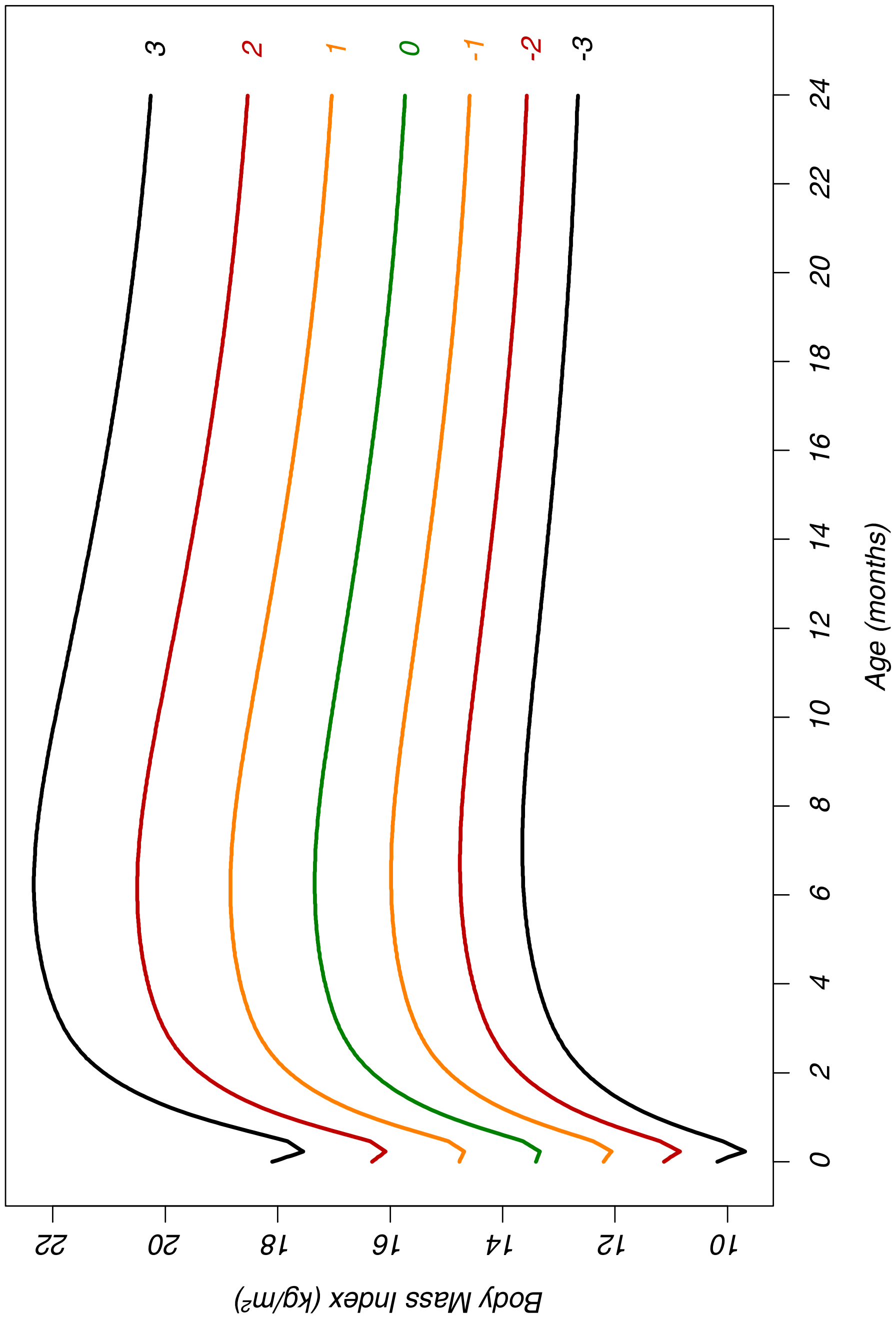


**Figure 111 WHO length-based BMI-for-age z-scores for boys from birth to 24 months**

*Charts*

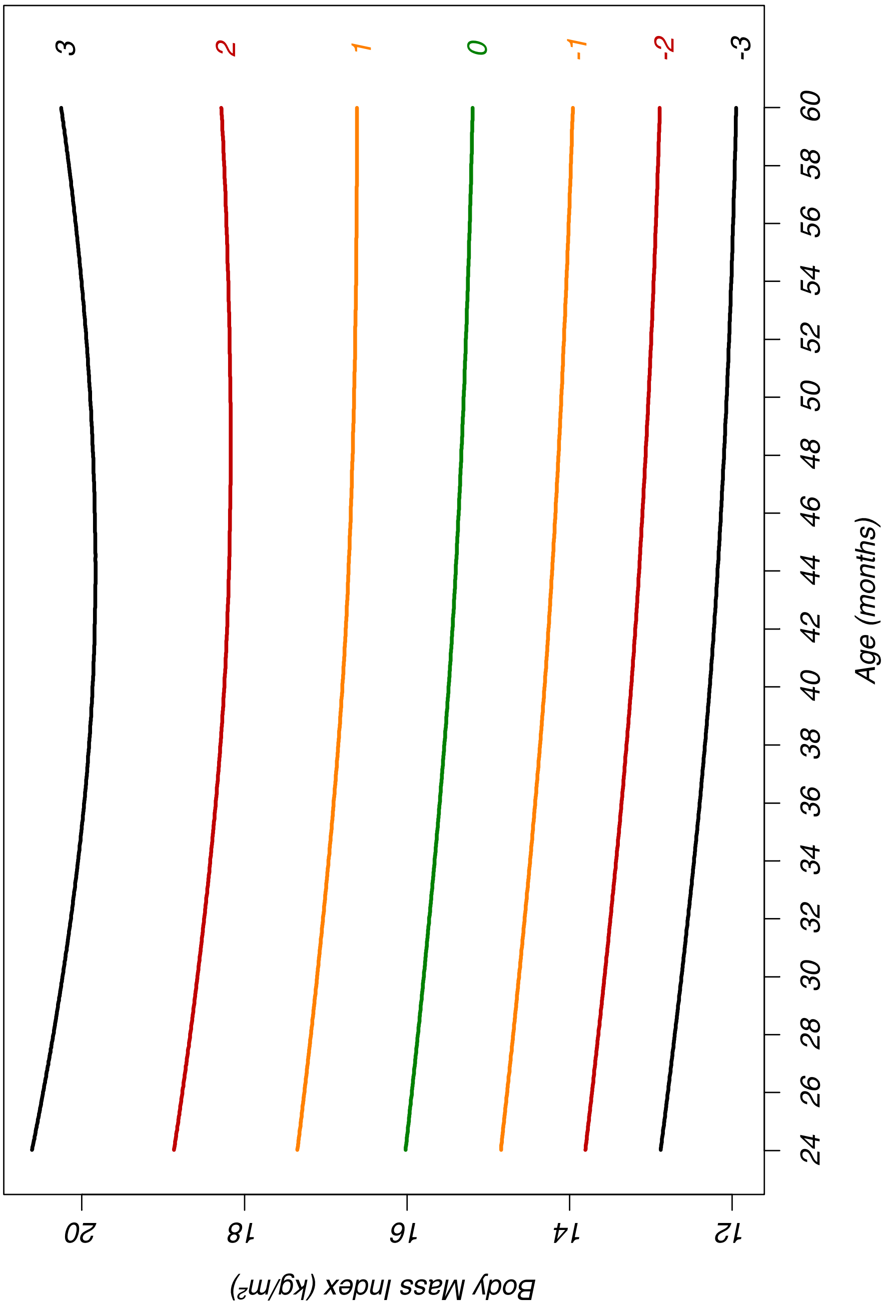


**Figure 112 WHO height-based BMI-for-age z-scores for boys from 24 to 60 months**

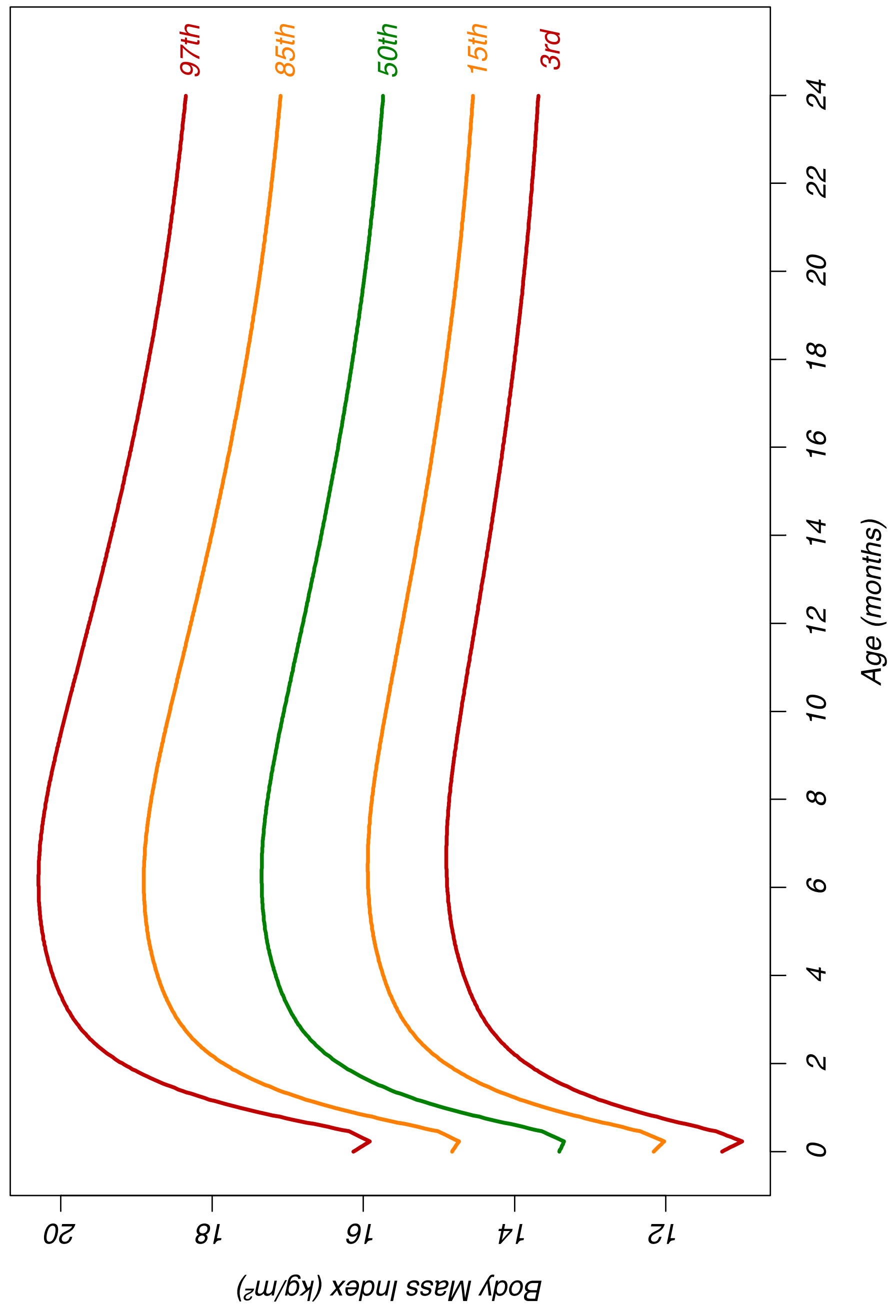


**Figure 113 WHO length-based BMI-for-age percentiles for boys from birth to 24 months**

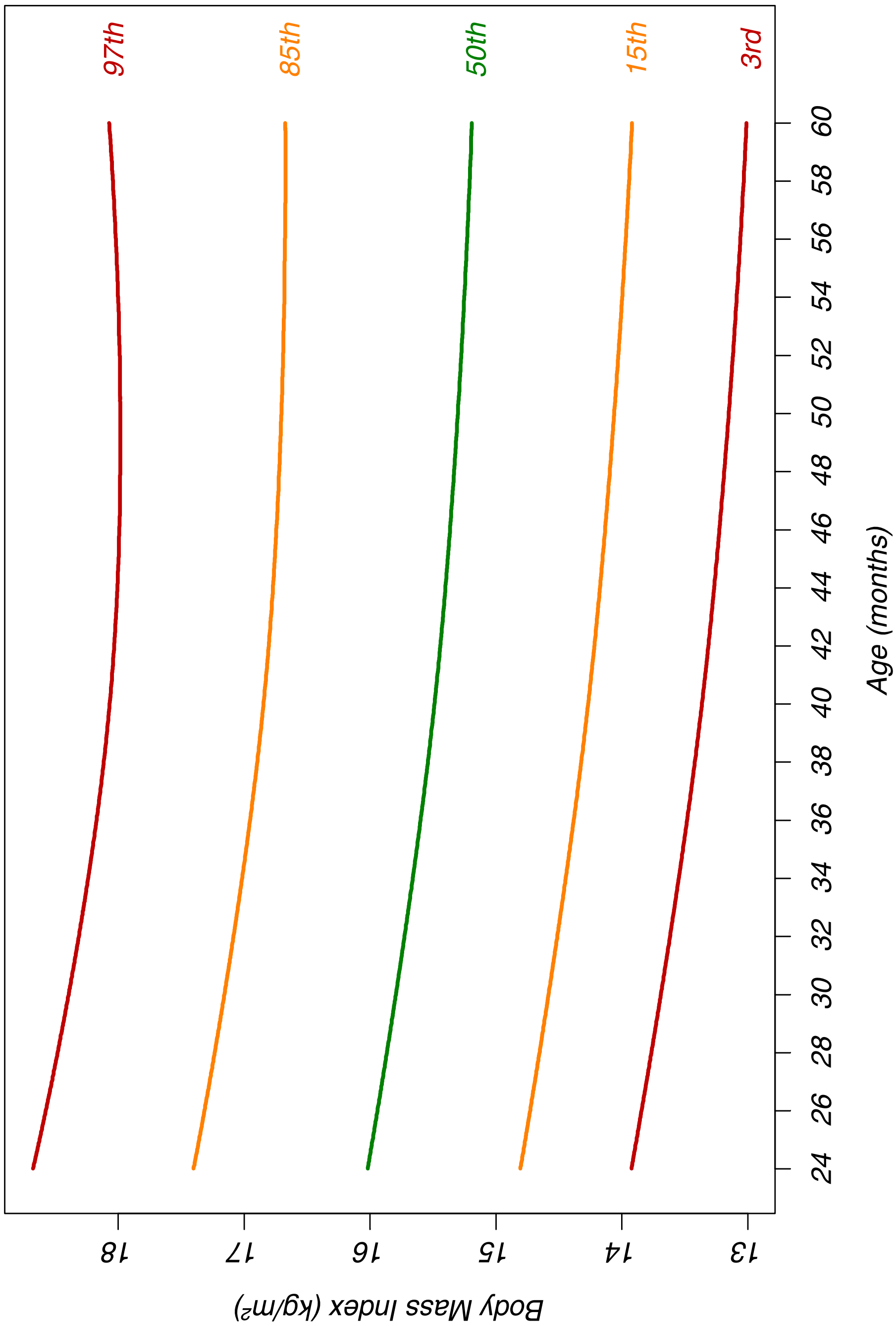


**Figure 114 WHO height-based BMI-for-age percentiles for boys from 24 to 60 months**

**Table 80 Length-based BMI-for-age for boys, age in weeks**

| | | | | Percentiles (BMI in kg/m²) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Week** | **L** | **M** | **S** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **0** | -0.3053 | 13.4069 | 0.09560 | 10.8 | 11.3 | 11.5 | 12.2 | 12.6 | 13.4 | 14.3 | 14.8 | 15.8 | 16.1 | 16.9 |
| **1** | 0.5247 | 13.3421 | 0.09821 | 10.5 | 11.0 | 11.3 | 12.0 | 12.5 | 13.3 | 14.2 | 14.7 | 15.6 | 15.9 | 16.6 |
| **2** | 0.4177 | 13.6377 | 0.09454 | 10.8 | 11.3 | 11.6 | 12.3 | 12.8 | 13.6 | 14.5 | 15.0 | 15.9 | 16.2 | 16.8 |
| **3** | 0.3449 | 14.2241 | 0.09230 | 11.4 | 11.9 | 12.2 | 12.9 | 13.4 | 14.2 | 15.1 | 15.6 | 16.5 | 16.8 | 17.5 |
| **4** | 0.2881 | 14.7714 | 0.09072 | 11.9 | 12.4 | 12.7 | 13.4 | 13.9 | 14.8 | 15.7 | 16.2 | 17.1 | 17.4 | 18.1 |
| **5** | 0.2409 | 15.2355 | 0.08953 | 12.3 | 12.8 | 13.1 | 13.9 | 14.3 | 15.2 | 16.2 | 16.7 | 17.6 | 18.0 | 18.7 |
| **6** | 0.2003 | 15.6107 | 0.08859 | 12.6 | 13.2 | 13.5 | 14.2 | 14.7 | 15.6 | 16.6 | 17.1 | 18.0 | 18.4 | 19.1 |
| **7** | 0.1645 | 15.9169 | 0.08782 | 12.9 | 13.5 | 13.8 | 14.5 | 15.0 | 15.9 | 16.9 | 17.4 | 18.4 | 18.7 | 19.5 |
| **8** | 0.1324 | 16.1698 | 0.08717 | 13.2 | 13.7 | 14.0 | 14.8 | 15.2 | 16.2 | 17.1 | 17.7 | 18.6 | 19.0 | 19.8 |
| **9** | 0.1032 | 16.3787 | 0.08661 | 13.4 | 13.9 | 14.2 | 15.0 | 15.4 | 16.4 | 17.4 | 17.9 | 18.9 | 19.3 | 20.0 |
| **10** | 0.0766 | 16.5494 | 0.08612 | 13.5 | 14.1 | 14.4 | 15.1 | 15.6 | 16.5 | 17.5 | 18.1 | 19.1 | 19.4 | 20.2 |
| **11** | 0.0520 | 16.6882 | 0.08569 | 13.7 | 14.2 | 14.5 | 15.3 | 15.7 | 16.7 | 17.7 | 18.2 | 19.2 | 19.6 | 20.3 |
| **12** | 0.0291 | 16.8016 | 0.08531 | 13.8 | 14.3 | 14.6 | 15.4 | 15.9 | 16.8 | 17.8 | 18.4 | 19.3 | 19.7 | 20.5 |
| **13** | 0.0077 | 16.8950 | 0.08496 | 13.9 | 14.4 | 14.7 | 15.5 | 16.0 | 16.9 | 17.9 | 18.4 | 19.4 | 19.8 | 20.6 |

**Table 80 Length-based BMI-for-age for boys, age in weeks (continued)**

| Week | L | M | S | Z-scores (BMI in kg/m²) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | -3 SD | -2 SD | -1 SD | Median | 1 SD | 2 SD | 3 SD |
| **0** | -0.3053 | 13.4069 | 0.09560 | 10.2 | 11.1 | 12.2 | 13.4 | 14.8 | 16.3 | 18.1 |
| **1** | 0.5247 | 13.3421 | 0.09821 | 9.7 | 10.8 | 12.1 | 13.3 | 14.7 | 16.1 | 17.5 |
| **2** | 0.4177 | 13.6377 | 0.09454 | 10.1 | 11.2 | 12.4 | 13.6 | 15.0 | 16.4 | 17.8 |
| **3** | 0.3449 | 14.2241 | 0.09230 | 10.6 | 11.8 | 13.0 | 14.2 | 15.6 | 17.0 | 18.5 |
| **4** | 0.2881 | 14.7714 | 0.09072 | 11.1 | 12.3 | 13.5 | 14.8 | 16.2 | 17.6 | 19.2 |
| **5** | 0.2409 | 15.2355 | 0.08953 | 11.5 | 12.7 | 13.9 | 15.2 | 16.6 | 18.2 | 19.8 |
| **6** | 0.2003 | 15.6107 | 0.08859 | 11.9 | 13.0 | 14.3 | 15.6 | 17.0 | 18.6 | 20.2 |
| **7** | 0.1645 | 15.9169 | 0.08782 | 12.2 | 13.3 | 14.6 | 15.9 | 17.4 | 18.9 | 20.6 |
| **8** | 0.1324 | 16.1698 | 0.08717 | 12.4 | 13.6 | 14.8 | 16.2 | 17.6 | 19.2 | 20.9 |
| **9** | 0.1032 | 16.3787 | 0.08661 | 12.6 | 13.8 | 15.0 | 16.4 | 17.9 | 19.4 | 21.2 |
| **10** | 0.0766 | 16.5494 | 0.08612 | 12.7 | 13.9 | 15.2 | 16.5 | 18.0 | 19.6 | 21.4 |
| **11** | 0.0520 | 16.6882 | 0.08569 | 12.9 | 14.0 | 15.3 | 16.7 | 18.2 | 19.8 | 21.5 |
| **12** | 0.0291 | 16.8016 | 0.08531 | 13.0 | 14.2 | 15.4 | 16.8 | 18.3 | 19.9 | 21.7 |
| **13** | 0.0077 | 16.8950 | 0.08496 | 13.1 | 14.3 | 15.5 | 16.9 | 18.4 | 20.0 | 21.8 |

**Table 81 Length-based BMI-for-age for boys, age in years and months**

| | | | | | Percentiles (BMI in kg/m$^2$) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **0: 0** | **0** | -0.3053 | 13.4069 | 0.09560 | 10.8 | 11.3 | 11.5 | 12.2 | 12.6 | 13.4 | 14.3 | 14.8 | 15.8 | 16.1 | 16.9 |
| **0: 1** | **1** | 0.2708 | 14.9441 | 0.09027 | 12.0 | 12.6 | 12.8 | 13.6 | 14.1 | 14.9 | 15.9 | 16.4 | 17.3 | 17.6 | 18.3 |
| **0: 2** | **2** | 0.1118 | 16.3195 | 0.08677 | 13.3 | 13.8 | 14.1 | 14.9 | 15.4 | 16.3 | 17.3 | 17.8 | 18.8 | 19.2 | 19.9 |
| **0: 3** | **3** | 0.0068 | 16.8987 | 0.08495 | 13.9 | 14.4 | 14.7 | 15.5 | 16.0 | 16.9 | 17.9 | 18.5 | 19.4 | 19.8 | 20.6 |
| **0: 4** | **4** | -0.0727 | 17.1579 | 0.08378 | 14.1 | 14.7 | 15.0 | 15.7 | 16.2 | 17.2 | 18.2 | 18.7 | 19.7 | 20.1 | 20.9 |
| **0: 5** | **5** | -0.1370 | 17.2919 | 0.08296 | 14.3 | 14.8 | 15.1 | 15.9 | 16.4 | 17.3 | 18.3 | 18.9 | 19.8 | 20.2 | 21.0 |
| **0: 6** | **6** | -0.1913 | 17.3422 | 0.08234 | 14.4 | 14.9 | 15.2 | 15.9 | 16.4 | 17.3 | 18.3 | 18.9 | 19.9 | 20.3 | 21.1 |
| **0: 7** | **7** | -0.2385 | 17.3288 | 0.08183 | 14.4 | 14.9 | 15.2 | 15.9 | 16.4 | 17.3 | 18.3 | 18.9 | 19.9 | 20.3 | 21.1 |
| **0: 8** | **8** | -0.2802 | 17.2647 | 0.08140 | 14.4 | 14.9 | 15.1 | 15.9 | 16.3 | 17.3 | 18.2 | 18.8 | 19.8 | 20.2 | 21.0 |
| **0: 9** | **9** | -0.3176 | 17.1662 | 0.08102 | 14.3 | 14.8 | 15.1 | 15.8 | 16.3 | 17.2 | 18.1 | 18.7 | 19.7 | 20.1 | 20.8 |
| **0:10** | **10** | -0.3516 | 17.0488 | 0.08068 | 14.2 | 14.7 | 15.0 | 15.7 | 16.2 | 17.0 | 18.0 | 18.6 | 19.5 | 19.9 | 20.7 |
| **0:11** | **11** | -0.3828 | 16.9239 | 0.08037 | 14.1 | 14.6 | 14.9 | 15.6 | 16.0 | 16.9 | 17.9 | 18.4 | 19.4 | 19.8 | 20.5 |
| **1: 0** | **12** | -0.4115 | 16.7981 | 0.08009 | 14.0 | 14.5 | 14.8 | 15.5 | 15.9 | 16.8 | 17.7 | 18.3 | 19.2 | 19.6 | 20.4 |
| **1: 1** | **13** | -0.4382 | 16.6743 | 0.07982 | 13.9 | 14.4 | 14.7 | 15.4 | 15.8 | 16.7 | 17.6 | 18.1 | 19.1 | 19.5 | 20.2 |
| **1: 2** | **14** | -0.4630 | 16.5548 | 0.07958 | 13.9 | 14.3 | 14.6 | 15.3 | 15.7 | 16.6 | 17.5 | 18.0 | 18.9 | 19.3 | 20.1 |
| **1: 3** | **15** | -0.4863 | 16.4409 | 0.07935 | 13.8 | 14.2 | 14.5 | 15.2 | 15.6 | 16.4 | 17.4 | 17.9 | 18.8 | 19.2 | 19.9 |
| **1: 4** | **16** | -0.5082 | 16.3335 | 0.07913 | 13.7 | 14.2 | 14.4 | 15.1 | 15.5 | 16.3 | 17.2 | 17.8 | 18.7 | 19.1 | 19.8 |
| **1: 5** | **17** | -0.5289 | 16.2329 | 0.07892 | 13.6 | 14.1 | 14.3 | 15.0 | 15.4 | 16.2 | 17.1 | 17.6 | 18.6 | 18.9 | 19.7 |
| **1: 6** | **18** | -0.5484 | 16.1392 | 0.07873 | 13.6 | 14.0 | 14.2 | 14.9 | 15.3 | 16.1 | 17.0 | 17.5 | 18.5 | 18.8 | 19.6 |
| **1: 7** | **19** | -0.5669 | 16.0528 | 0.07854 | 13.5 | 13.9 | 14.2 | 14.8 | 15.2 | 16.1 | 16.9 | 17.4 | 18.4 | 18.7 | 19.5 |
| **1: 8** | **20** | -0.5846 | 15.9743 | 0.07836 | 13.4 | 13.9 | 14.1 | 14.8 | 15.2 | 16.0 | 16.9 | 17.4 | 18.3 | 18.6 | 19.4 |
| **1: 9** | **21** | -0.6014 | 15.9039 | 0.07818 | 13.4 | 13.8 | 14.1 | 14.7 | 15.1 | 15.9 | 16.8 | 17.3 | 18.2 | 18.6 | 19.3 |
| **1:10** | **22** | -0.6174 | 15.8412 | 0.07802 | 13.3 | 13.8 | 14.0 | 14.6 | 15.0 | 15.8 | 16.7 | 17.2 | 18.1 | 18.5 | 19.2 |
| **1:11** | **23** | -0.6328 | 15.7852 | 0.07786 | 13.3 | 13.7 | 14.0 | 14.6 | 15.0 | 15.8 | 16.7 | 17.1 | 18.0 | 18.4 | 19.1 |
| **2: 0** | **24**[a] | -0.6473 | 15.7356 | 0.07771 | 13.3 | 13.7 | 13.9 | 14.5 | 14.9 | 15.7 | 16.6 | 17.1 | 18.0 | 18.3 | 19.1 |

[a] 24 months corresponds to 730 days.

**Table 81 Length-based BMI-for-age for boys, age in years and months (continued)**

| | | | | | Z-scores (BMI in kg/m$^2$) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **0: 0** | **0** | -0.3053 | 13.4069 | 0.09560 | 10.2 | 11.1 | 12.2 | 13.4 | 14.8 | 16.3 | 18.1 |
| **0: 1** | **1** | 0.2708 | 14.9441 | 0.09027 | 11.3 | 12.4 | 13.6 | 14.9 | 16.3 | 17.8 | 19.4 |
| **0: 2** | **2** | 0.1118 | 16.3195 | 0.08677 | 12.5 | 13.7 | 15.0 | 16.3 | 17.8 | 19.4 | 21.1 |
| **0: 3** | **3** | 0.0068 | 16.8987 | 0.08495 | 13.1 | 14.3 | 15.5 | 16.9 | 18.4 | 20.0 | 21.8 |
| **0: 4** | **4** | -0.0727 | 17.1579 | 0.08378 | 13.4 | 14.5 | 15.8 | 17.2 | 18.7 | 20.3 | 22.1 |
| **0: 5** | **5** | -0.1370 | 17.2919 | 0.08296 | 13.5 | 14.7 | 15.9 | 17.3 | 18.8 | 20.5 | 22.3 |
| **0: 6** | **6** | -0.1913 | 17.3422 | 0.08234 | 13.6 | 14.7 | 16.0 | 17.3 | 18.8 | 20.5 | 22.3 |
| **0: 7** | **7** | -0.2385 | 17.3288 | 0.08183 | 13.7 | 14.8 | 16.0 | 17.3 | 18.8 | 20.5 | 22.3 |
| **0: 8** | **8** | -0.2802 | 17.2647 | 0.08140 | 13.6 | 14.7 | 15.9 | 17.3 | 18.7 | 20.4 | 22.2 |
| **0: 9** | **9** | -0.3176 | 17.1662 | 0.08102 | 13.6 | 14.7 | 15.8 | 17.2 | 18.6 | 20.3 | 22.1 |
| **0:10** | **10** | -0.3516 | 17.0488 | 0.08068 | 13.5 | 14.6 | 15.7 | 17.0 | 18.5 | 20.1 | 22.0 |
| **0:11** | **11** | -0.3828 | 16.9239 | 0.08037 | 13.4 | 14.5 | 15.6 | 16.9 | 18.4 | 20.0 | 21.8 |
| **1: 0** | **12** | -0.4115 | 16.7981 | 0.08009 | 13.4 | 14.4 | 15.5 | 16.8 | 18.2 | 19.8 | 21.6 |
| **1: 1** | **13** | -0.4382 | 16.6743 | 0.07982 | 13.3 | 14.3 | 15.4 | 16.7 | 18.1 | 19.7 | 21.5 |
| **1: 2** | **14** | -0.4630 | 16.5548 | 0.07958 | 13.2 | 14.2 | 15.3 | 16.6 | 18.0 | 19.5 | 21.3 |
| **1: 3** | **15** | -0.4863 | 16.4409 | 0.07935 | 13.1 | 14.1 | 15.2 | 16.4 | 17.8 | 19.4 | 21.2 |
| **1: 4** | **16** | -0.5082 | 16.3335 | 0.07913 | 13.1 | 14.0 | 15.1 | 16.3 | 17.7 | 19.3 | 21.0 |
| **1: 5** | **17** | -0.5289 | 16.2329 | 0.07892 | 13.0 | 13.9 | 15.0 | 16.2 | 17.6 | 19.1 | 20.9 |
| **1: 6** | **18** | -0.5484 | 16.1392 | 0.07873 | 12.9 | 13.9 | 14.9 | 16.1 | 17.5 | 19.0 | 20.8 |
| **1: 7** | **19** | -0.5669 | 16.0528 | 0.07854 | 12.9 | 13.8 | 14.9 | 16.1 | 17.4 | 18.9 | 20.7 |
| **1: 8** | **20** | -0.5846 | 15.9743 | 0.07836 | 12.8 | 13.7 | 14.8 | 16.0 | 17.3 | 18.8 | 20.6 |
| **1: 9** | **21** | -0.6014 | 15.9039 | 0.07818 | 12.8 | 13.7 | 14.7 | 15.9 | 17.2 | 18.7 | 20.5 |
| **1:10** | **22** | -0.6174 | 15.8412 | 0.07802 | 12.7 | 13.6 | 14.7 | 15.8 | 17.2 | 18.7 | 20.4 |
| **1:11** | **23** | -0.6328 | 15.7852 | 0.07786 | 12.7 | 13.6 | 14.6 | 15.8 | 17.1 | 18.6 | 20.3 |
| **2: 0** | **24[a]** | -0.6473 | 15.7356 | 0.07771 | 12.7 | 13.6 | 14.6 | 15.7 | 17.0 | 18.5 | 20.3 |

[a] 24 months corresponds to 730 days.

**Table 82 Height-based BMI-for-age for boys, age in years and months**

| Year: Month | Month | L | M | S | Percentiles (BMI in kg/m²) 1st | 3rd | 5th | 15th | 25th | 50th | 75th | 85th | 95th | 97th | 99th |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2: 0 | 24[a] | -0.6187 | 16.0189 | 0.07785 | 13.5 | 13.9 | 14.2 | 14.8 | 15.2 | 16.0 | 16.9 | 17.4 | 18.3 | 18.7 | 19.4 |
| 2: 1 | 25 | -0.5840 | 15.9800 | 0.07792 | 13.5 | 13.9 | 14.1 | 14.8 | 15.2 | 16.0 | 16.9 | 17.4 | 18.3 | 18.6 | 19.4 |
| 2: 2 | 26 | -0.5497 | 15.9414 | 0.07800 | 13.4 | 13.8 | 14.1 | 14.7 | 15.1 | 15.9 | 16.8 | 17.3 | 18.2 | 18.6 | 19.3 |
| 2: 3 | 27 | -0.5166 | 15.9036 | 0.07808 | 13.4 | 13.8 | 14.0 | 14.7 | 15.1 | 15.9 | 16.8 | 17.3 | 18.2 | 18.5 | 19.2 |
| 2: 4 | 28 | -0.4850 | 15.8667 | 0.07818 | 13.3 | 13.8 | 14.0 | 14.7 | 15.1 | 15.9 | 16.7 | 17.2 | 18.1 | 18.5 | 19.2 |
| 2: 5 | 29 | -0.4552 | 15.8306 | 0.07829 | 13.3 | 13.7 | 14.0 | 14.6 | 15.0 | 15.8 | 16.7 | 17.2 | 18.1 | 18.4 | 19.1 |
| 2: 6 | 30 | -0.4274 | 15.7953 | 0.07841 | 13.3 | 13.7 | 13.9 | 14.6 | 15.0 | 15.8 | 16.7 | 17.2 | 18.0 | 18.4 | 19.1 |
| 2: 7 | 31 | -0.4016 | 15.7606 | 0.07854 | 13.2 | 13.7 | 13.9 | 14.5 | 15.0 | 15.8 | 16.6 | 17.1 | 18.0 | 18.4 | 19.1 |
| 2: 8 | 32 | -0.3782 | 15.7267 | 0.07867 | 13.2 | 13.6 | 13.9 | 14.5 | 14.9 | 15.7 | 16.6 | 17.1 | 18.0 | 18.3 | 19.0 |
| 2: 9 | 33 | -0.3572 | 15.6934 | 0.07882 | 13.1 | 13.6 | 13.8 | 14.5 | 14.9 | 15.7 | 16.6 | 17.0 | 17.9 | 18.3 | 19.0 |
| 2:10 | 34 | -0.3388 | 15.6610 | 0.07897 | 13.1 | 13.5 | 13.8 | 14.4 | 14.9 | 15.7 | 16.5 | 17.0 | 17.9 | 18.2 | 18.9 |
| 2:11 | 35 | -0.3231 | 15.6294 | 0.07914 | 13.1 | 13.5 | 13.8 | 14.4 | 14.8 | 15.6 | 16.5 | 17.0 | 17.9 | 18.2 | 18.9 |
| 3: 0 | 36 | -0.3101 | 15.5988 | 0.07931 | 13.0 | 13.5 | 13.7 | 14.4 | 14.8 | 15.6 | 16.5 | 17.0 | 17.8 | 18.2 | 18.9 |
| 3: 1 | 37 | -0.3000 | 15.5693 | 0.07950 | 13.0 | 13.5 | 13.7 | 14.4 | 14.8 | 15.6 | 16.4 | 16.9 | 17.8 | 18.1 | 18.8 |
| 3: 2 | 38 | -0.2927 | 15.5410 | 0.07969 | 13.0 | 13.4 | 13.7 | 14.3 | 14.7 | 15.5 | 16.4 | 16.9 | 17.8 | 18.1 | 18.8 |
| 3: 3 | 39 | -0.2884 | 15.5140 | 0.07990 | 12.9 | 13.4 | 13.6 | 14.3 | 14.7 | 15.5 | 16.4 | 16.9 | 17.7 | 18.1 | 18.8 |
| 3: 4 | 40 | -0.2869 | 15.4885 | 0.08012 | 12.9 | 13.4 | 13.6 | 14.3 | 14.7 | 15.5 | 16.4 | 16.8 | 17.7 | 18.1 | 18.8 |
| 3: 5 | 41 | -0.2881 | 15.4645 | 0.08036 | 12.9 | 13.3 | 13.6 | 14.2 | 14.7 | 15.5 | 16.3 | 16.8 | 17.7 | 18.0 | 18.7 |
| 3: 6 | 42 | -0.2919 | 15.4420 | 0.08061 | 12.9 | 13.3 | 13.6 | 14.2 | 14.6 | 15.4 | 16.3 | 16.8 | 17.7 | 18.0 | 18.7 |
| 3: 7 | 43 | -0.2981 | 15.4210 | 0.08087 | 12.8 | 13.3 | 13.5 | 14.2 | 14.6 | 15.4 | 16.3 | 16.8 | 17.7 | 18.0 | 18.7 |
| 3: 8 | 44 | -0.3067 | 15.4013 | 0.08115 | 12.8 | 13.3 | 13.5 | 14.2 | 14.6 | 15.4 | 16.3 | 16.8 | 17.7 | 18.0 | 18.7 |
| 3: 9 | 45 | -0.3174 | 15.3827 | 0.08144 | 12.8 | 13.2 | 13.5 | 14.2 | 14.6 | 15.4 | 16.3 | 16.8 | 17.6 | 18.0 | 18.7 |
| 3:10 | 46 | -0.3303 | 15.3652 | 0.08174 | 12.8 | 13.2 | 13.5 | 14.1 | 14.5 | 15.4 | 16.2 | 16.7 | 17.6 | 18.0 | 18.7 |
| 3:11 | 47 | -0.3452 | 15.3485 | 0.08205 | 12.8 | 13.2 | 13.5 | 14.1 | 14.5 | 15.3 | 16.2 | 16.7 | 17.6 | 18.0 | 18.7 |
| 4: 0 | 48 | -0.3622 | 15.3326 | 0.08238 | 12.7 | 13.2 | 13.4 | 14.1 | 14.5 | 15.3 | 16.2 | 16.7 | 17.6 | 18.0 | 18.7 |

**Table 82 Height-based BMI-for-age for boys, age in years and months (continued)**

| | | | | | Percentiles (BMI in kg/m$^2$) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **4: 1** | **49** | -0.3811 | 15.3174 | 0.08272 | 12.7 | 13.2 | 13.4 | 14.1 | 14.5 | 15.3 | 16.2 | 16.7 | 17.6 | 18.0 | 18.7 |
| **4: 2** | **50** | -0.4019 | 15.3029 | 0.08307 | 12.7 | 13.2 | 13.4 | 14.1 | 14.5 | 15.3 | 16.2 | 16.7 | 17.6 | 18.0 | 18.7 |
| **4: 3** | **51** | -0.4245 | 15.2891 | 0.08343 | 12.7 | 13.1 | 13.4 | 14.0 | 14.5 | 15.3 | 16.2 | 16.7 | 17.6 | 18.0 | 18.7 |
| **4: 4** | **52** | -0.4488 | 15.2759 | 0.08380 | 12.7 | 13.1 | 13.4 | 14.0 | 14.4 | 15.3 | 16.2 | 16.7 | 17.6 | 18.0 | 18.7 |
| **4: 5** | **53** | -0.4747 | 15.2633 | 0.08418 | 12.7 | 13.1 | 13.3 | 14.0 | 14.4 | 15.3 | 16.2 | 16.7 | 17.6 | 18.0 | 18.7 |
| **4: 6** | **54** | -0.5019 | 15.2514 | 0.08457 | 12.6 | 13.1 | 13.3 | 14.0 | 14.4 | 15.3 | 16.2 | 16.7 | 17.6 | 18.0 | 18.8 |
| **4: 7** | **55** | -0.5303 | 15.2400 | 0.08496 | 12.6 | 13.1 | 13.3 | 14.0 | 14.4 | 15.2 | 16.2 | 16.7 | 17.6 | 18.0 | 18.8 |
| **4: 8** | **56** | -0.5599 | 15.2291 | 0.08536 | 12.6 | 13.1 | 13.3 | 14.0 | 14.4 | 15.2 | 16.1 | 16.7 | 17.6 | 18.0 | 18.8 |
| **4: 9** | **57** | -0.5905 | 15.2188 | 0.08577 | 12.6 | 13.0 | 13.3 | 14.0 | 14.4 | 15.2 | 16.1 | 16.7 | 17.6 | 18.0 | 18.8 |
| **4:10** | **58** | -0.6223 | 15.2091 | 0.08617 | 12.6 | 13.0 | 13.3 | 13.9 | 14.4 | 15.2 | 16.1 | 16.7 | 17.6 | 18.0 | 18.8 |
| **4:11** | **59** | -0.6552 | 15.2000 | 0.08659 | 12.6 | 13.0 | 13.3 | 13.9 | 14.4 | 15.2 | 16.1 | 16.7 | 17.7 | 18.1 | 18.9 |
| **5: 0** | **60** | -0.6892 | 15.1916 | 0.08700 | 12.6 | 13.0 | 13.3 | 13.9 | 14.3 | 15.2 | 16.1 | 16.7 | 17.7 | 18.1 | 18.9 |

[a] 24 months corresponds to 731 days.

**Table 82 Height-based BMI-for-age for boys, age in years and months (continued)**

| | | | | | Z-scores (BMI in kg/m²) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **2: 0** | **24**[a] | -0.6187 | 16.0189 | 0.07785 | 12.9 | 13.8 | 14.8 | 16.0 | 17.3 | 18.9 | 20.6 |
| **2: 1** | **25** | -0.5840 | 15.9800 | 0.07792 | 12.8 | 13.8 | 14.8 | 16.0 | 17.3 | 18.8 | 20.5 |
| **2: 2** | **26** | -0.5497 | 15.9414 | 0.07800 | 12.8 | 13.7 | 14.8 | 15.9 | 17.3 | 18.8 | 20.5 |
| **2: 3** | **27** | -0.5166 | 15.9036 | 0.07808 | 12.7 | 13.7 | 14.7 | 15.9 | 17.2 | 18.7 | 20.4 |
| **2: 4** | **28** | -0.4850 | 15.8667 | 0.07818 | 12.7 | 13.6 | 14.7 | 15.9 | 17.2 | 18.7 | 20.4 |
| **2: 5** | **29** | -0.4552 | 15.8306 | 0.07829 | 12.7 | 13.6 | 14.7 | 15.8 | 17.1 | 18.6 | 20.3 |
| **2: 6** | **30** | -0.4274 | 15.7953 | 0.07841 | 12.6 | 13.6 | 14.6 | 15.8 | 17.1 | 18.6 | 20.2 |
| **2: 7** | **31** | -0.4016 | 15.7606 | 0.07854 | 12.6 | 13.5 | 14.6 | 15.8 | 17.1 | 18.5 | 20.2 |
| **2: 8** | **32** | -0.3782 | 15.7267 | 0.07867 | 12.5 | 13.5 | 14.6 | 15.7 | 17.0 | 18.5 | 20.1 |
| **2: 9** | **33** | -0.3572 | 15.6934 | 0.07882 | 12.5 | 13.5 | 14.5 | 15.7 | 17.0 | 18.5 | 20.1 |
| **2:10** | **34** | -0.3388 | 15.6610 | 0.07897 | 12.5 | 13.4 | 14.5 | 15.7 | 17.0 | 18.4 | 20.0 |
| **2:11** | **35** | -0.3231 | 15.6294 | 0.07914 | 12.4 | 13.4 | 14.5 | 15.6 | 16.9 | 18.4 | 20.0 |
| **3: 0** | **36** | -0.3101 | 15.5988 | 0.07931 | 12.4 | 13.4 | 14.4 | 15.6 | 16.9 | 18.4 | 20.0 |
| **3: 1** | **37** | -0.3000 | 15.5693 | 0.07950 | 12.4 | 13.3 | 14.4 | 15.6 | 16.9 | 18.3 | 19.9 |
| **3: 2** | **38** | -0.2927 | 15.5410 | 0.07969 | 12.3 | 13.3 | 14.4 | 15.5 | 16.8 | 18.3 | 19.9 |
| **3: 3** | **39** | -0.2884 | 15.5140 | 0.07990 | 12.3 | 13.3 | 14.3 | 15.5 | 16.8 | 18.3 | 19.9 |
| **3: 4** | **40** | -0.2869 | 15.4885 | 0.08012 | 12.3 | 13.2 | 14.3 | 15.5 | 16.8 | 18.2 | 19.9 |
| **3: 5** | **41** | -0.2881 | 15.4645 | 0.08036 | 12.2 | 13.2 | 14.3 | 15.5 | 16.8 | 18.2 | 19.9 |
| **3: 6** | **42** | -0.2919 | 15.4420 | 0.08061 | 12.2 | 13.2 | 14.3 | 15.4 | 16.8 | 18.2 | 19.8 |
| **3: 7** | **43** | -0.2981 | 15.4210 | 0.08087 | 12.2 | 13.2 | 14.2 | 15.4 | 16.7 | 18.2 | 19.8 |
| **3: 8** | **44** | -0.3067 | 15.4013 | 0.08115 | 12.2 | 13.1 | 14.2 | 15.4 | 16.7 | 18.2 | 19.8 |
| **3: 9** | **45** | -0.3174 | 15.3827 | 0.08144 | 12.2 | 13.1 | 14.2 | 15.4 | 16.7 | 18.2 | 19.8 |
| **3:10** | **46** | -0.3303 | 15.3652 | 0.08174 | 12.1 | 13.1 | 14.2 | 15.4 | 16.7 | 18.2 | 19.8 |
| **3:11** | **47** | -0.3452 | 15.3485 | 0.08205 | 12.1 | 13.1 | 14.2 | 15.3 | 16.7 | 18.2 | 19.9 |
| **4: 0** | **48** | -0.3622 | 15.3326 | 0.08238 | 12.1 | 13.1 | 14.1 | 15.3 | 16.7 | 18.2 | 19.9 |

**Table 82 Height-based BMI-for-age for boys, age in years and months (continued)**

| | | | | | Z-scores (BMI in kg/m²) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **4: 1** | **49** | -0.3811 | 15.3174 | 0.08272 | 12.1 | 13.0 | 14.1 | 15.3 | 16.7 | 18.2 | 19.9 |
| **4: 2** | **50** | -0.4019 | 15.3029 | 0.08307 | 12.1 | 13.0 | 14.1 | 15.3 | 16.7 | 18.2 | 19.9 |
| **4: 3** | **51** | -0.4245 | 15.2891 | 0.08343 | 12.1 | 13.0 | 14.1 | 15.3 | 16.6 | 18.2 | 19.9 |
| **4: 4** | **52** | -0.4488 | 15.2759 | 0.08380 | 12.0 | 13.0 | 14.1 | 15.3 | 16.6 | 18.2 | 19.9 |
| **4: 5** | **53** | -0.4747 | 15.2633 | 0.08418 | 12.0 | 13.0 | 14.1 | 15.3 | 16.6 | 18.2 | 20.0 |
| **4: 6** | **54** | -0.5019 | 15.2514 | 0.08457 | 12.0 | 13.0 | 14.0 | 15.3 | 16.6 | 18.2 | 20.0 |
| **4: 7** | **55** | -0.5303 | 15.2400 | 0.08496 | 12.0 | 13.0 | 14.0 | 15.2 | 16.6 | 18.2 | 20.0 |
| **4: 8** | **56** | -0.5599 | 15.2291 | 0.08536 | 12.0 | 12.9 | 14.0 | 15.2 | 16.6 | 18.2 | 20.1 |
| **4: 9** | **57** | -0.5905 | 15.2188 | 0.08577 | 12.0 | 12.9 | 14.0 | 15.2 | 16.6 | 18.2 | 20.1 |
| **4:10** | **58** | -0.6223 | 15.2091 | 0.08617 | 12.0 | 12.9 | 14.0 | 15.2 | 16.6 | 18.3 | 20.2 |
| **4:11** | **59** | -0.6552 | 15.2000 | 0.08659 | 12.0 | 12.9 | 14.0 | 15.2 | 16.6 | 18.3 | 20.2 |
| **5: 0** | **60** | -0.6892 | 15.1916 | 0.08700 | 12.0 | 12.9 | 14.0 | 15.2 | 16.6 | 18.3 | 20.3 |

[a] 24 months corresponds to 731 days.

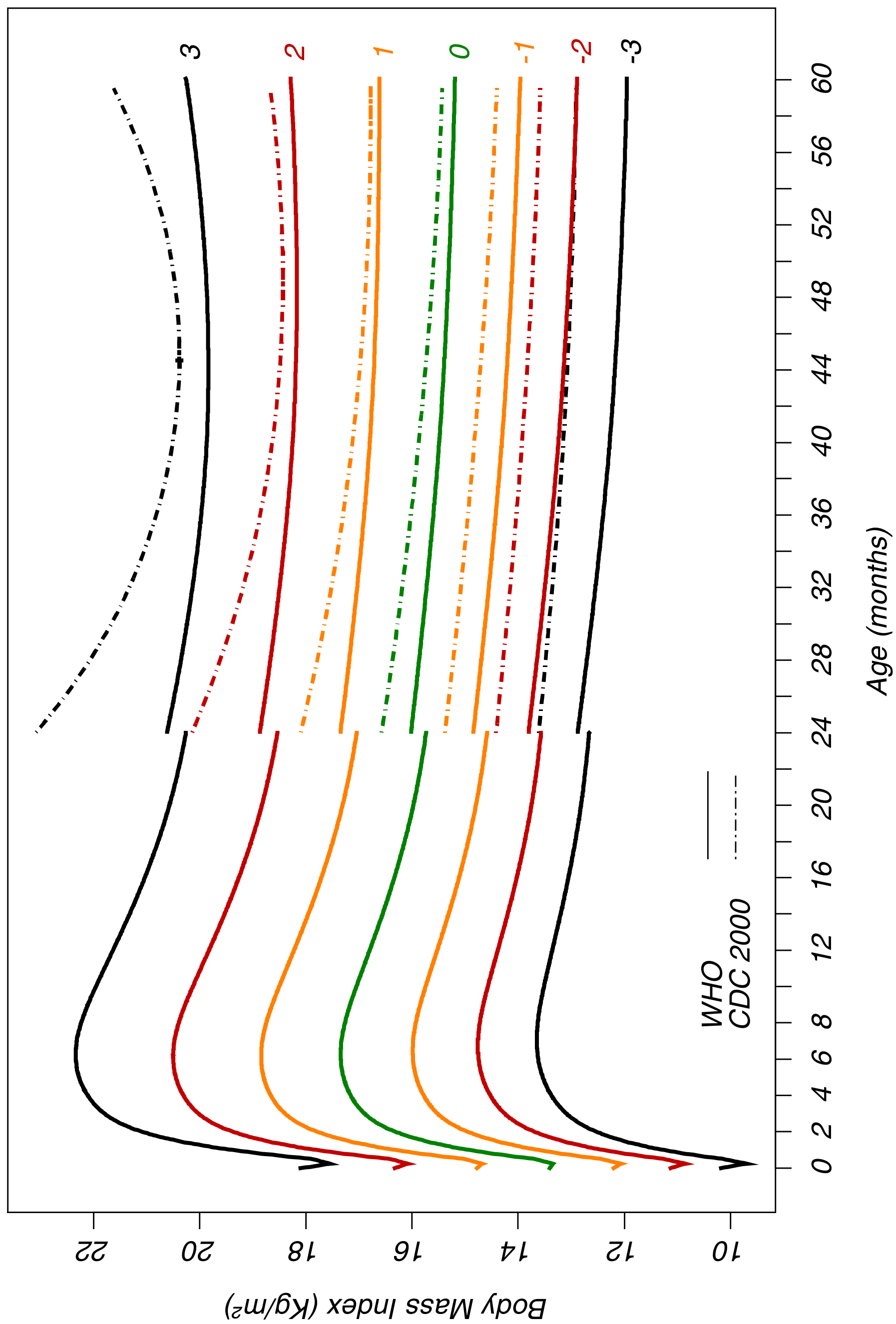


**Figure 115 Comparison of WHO with CDC 2000 BMI-for-age z-scores for boys**

## 6.3 BMI-for-age for girls

Steps similar to those used for fitting the equivalent standards for boys were followed to select the best model to fit the BMI-for-age growth standards for girls. The diagnostic tools used to evaluate and compare different models were the same.

### 6.3.1 Sample size

A total of 13 623 records with both weight and length/height were available for constructing the BMI-for-age curves for girls. The longitudinal and cross-sectional sample sizes by visit and age are presented in the Tables 83 and 84.

**Table 83 Longitudinal sample sizes for BMI-for-age for girls**

| **Visit** | **Birth** | **1** | **2** | **3** | **4** | **5** | **6** |
|---|---|---|---|---|---|---|---|
| **Age** | **0** | **2 wk** | **4 wk** | **6 wk** | **2 mo** | **3 mo** | **4 mo** |
| N | 838 | 449 | 447 | 447 | 447 | 446 | 444 |
| **Visit** | **7** | **8** | **9** | **10** | **11** | **12** | **13** |
| **Age** | **5 mo** | **6 mo** | **7 mo** | **8 mo** | **9 mo** | **10 mo** | **11 mo** |
| N | 447 | 445 | 444 | 440 | 446 | 444 | 443 |
| **Visit** | **14** | **15** | **16** | **17** | **18** | **19** | **20** |
| **Age** | **12 mo** | **14 mo** | **16 mo** | **18 mo** | **20 mo** | **22 mo** | **24 mo** |
| N | 449 | 449 | 440 | 447 | 442 | 437 | 448 |

**Table 84 Cross-sectional sample sizes for BMI-for-age for girls**

| **Age (mo)** | **<18** | **18–20** | **21–23** | **24–26** | **27–29** | **30–32** | **33–35** |
|---|---|---|---|---|---|---|---|
| N | 2 | 158 | 164 | 235 | 213 | 229 | 224 |
| **Age (mo)** | **36–38** | **39–41** | **42–44** | **45–47** | **48–50** | **51–53** | **54–56** |
| N | 223 | 235 | 247 | 209 | 224 | 201 | 231 |
| **Age (mo)** | **57–59** | **60–62** | **63–65** | **66–68** | **69–71** | **>71** | |
| N | 241 | 217 | 205 | 225 | 201 | 0 | |

### 6.3.2 Model selection and results

*Length-based BMI-for-age for girls*

The model BCPE(x=age$^{\lambda}$, df($\mu$)=9, df($\sigma$)=4, df($\nu$)=4, $\tau$=2) was used to begin the search for the best age-transformation power $\lambda$. Table 85 shows the global deviance for a grid of values of $\lambda$ between 0 and 0.5. As for boys, the smallest global deviance corresponded to an age-transformation power of $\lambda$=0.01 but $\lambda$=0.05 yielded very close global deviance. For the same reasons described earlier for the boys' corresponding standard, the age-transformation power $\lambda$=0.05 was selected.

**Table 85 Global deviance (GD) for models within the class BCPE(x=age$^{\lambda}$, df($\mu$)=9, df($\sigma$)=4, df($\nu$)=4, $\tau$=2) for length-based BMI-for-age for girls**

| $\lambda$ | **0.01** | **0.05** | **0.10** | **0.15** | **0.20** | **0.25** |
|---|---|---|---|---|---|---|
| GD[a] | 375.9 | 376.1 | 376.6 | 377.4 | 378.4 | 379.4 |
| $\lambda$ | **0.30** | **0.35** | **0.40** | **0.45** | **0.50** | |
| GD[a] | 380.4 | 381.7 | 384.4 | 390.0 | 400.0 | |

[a] In excess of 38 000.

Using $\lambda$=0.05 as the age-transformation power, the search for the best df($\mu$) and df($\sigma$) was carried out by comparing the goodness of fit of various models, fixing $\nu$=1 and $\tau$=2. All possible combinations of df($\mu$) 7 to 15 and df($\sigma$) 2 to 10 were considered. Partial results are presented in Table 86.

**Table 86 Goodness-of-fit summary for models using the BCPE distribution with fixed $\nu$=1 and $\tau$=2 for length-based BMI-for-age for girls**

| df($\mu$) | df($\sigma$) | GD[a] | AIC[a] | GAIC(3)[a] | Total df |
|---|---|---|---|---|---|
| **8** | **2** | 607.9 | 627.9 | 637.9 | 10 |
| | **3** | 575.6 | 597.6 | 608.6 | 11 |
| | **4** | 573.2 | 597.2 | 609.2 | 12 |
| | **5** | 569.7 | 595.7 | 608.7 | 13 |
| | **6** | 566.8 | 594.8 | 608.8 | 14 |
| | **7** | 565.4 | 595.4 | 610.4 | 15 |
| **9** | **2** | 601.0 | 623.0 | 634.0 | 11 |
| | **3** | 568.8 | 592.8 | 604.8 | 12 |
| | **4** | 566.4 | 592.4 | 605.4 | 13 |
| | **5** | 563.0 | 591.0 | 605.0 | 14 |
| | **6** | 560.2 | 590.2 | 605.2 | 15 |
| | **7** | 558.8 | 590.8 | 606.8 | 16 |
| **10** | **2** | 597.1 | 621.1 | 633.1 | 12 |
| | **3** | 565.0 | 591.0 | 604.0 | 13 |
| | **4** | 562.7 | 590.7 | 604.7 | 14 |
| | **5** | 559.3 | 589.3 | 604.3 | 15 |
| | **6** | 556.5 | 588.5 | 604.5 | 16 |
| | **7** | 555.2 | 589.2 | 606.2 | 17 |
| **11** | **2** | 594.4 | 620.4 | 633.4 | 13 |
| | **3** | 562.6 | 590.6 | 604.6 | 14 |
| | **4** | 560.2 | 590.2 | 605.2 | 15 |
| | **5** | 556.9 | 588.9 | 604.9 | 16 |
| | **6** | 554.1 | 588.1 | 605.1 | 17 |
| | **7** | 552.8 | 588.8 | 606.8 | 18 |
| **12** | **2** | 593.1 | 621.1 | 635.1 | 14 |
| | **3** | 560.8 | 590.8 | 605.8 | 15 |
| | **4** | 558.4 | 590.4 | 606.4 | 16 |
| | **5** | 555.1 | 589.1 | 606.1 | 17 |
| | **6** | 552.3 | 588.3 | 606.3 | 18 |
| | **7** | 551.0 | 589.0 | 608.0 | 19 |

GD, Global Deviance; AIC, Akaike Information Criterion;
GAIC(3), Generalized AIC with penalty equal to 3;
[a] In excess of 38 000.

The smallest value of *AIC* corresponded to df(μ)=11 and df(σ)=6, while the smallest value of *GAIC(3)* was associated with df(μ)=10 and df(σ)=3. Using 6 degrees of freedom to fit the σ curve resulted in a very irregular pattern (Figure 116) compared to the boys' curve (Figure 101). The model that appeared to have the best smoothing outcome in the centile curves (df(μ)=10 and df(σ)=3) was therefore evaluated further.

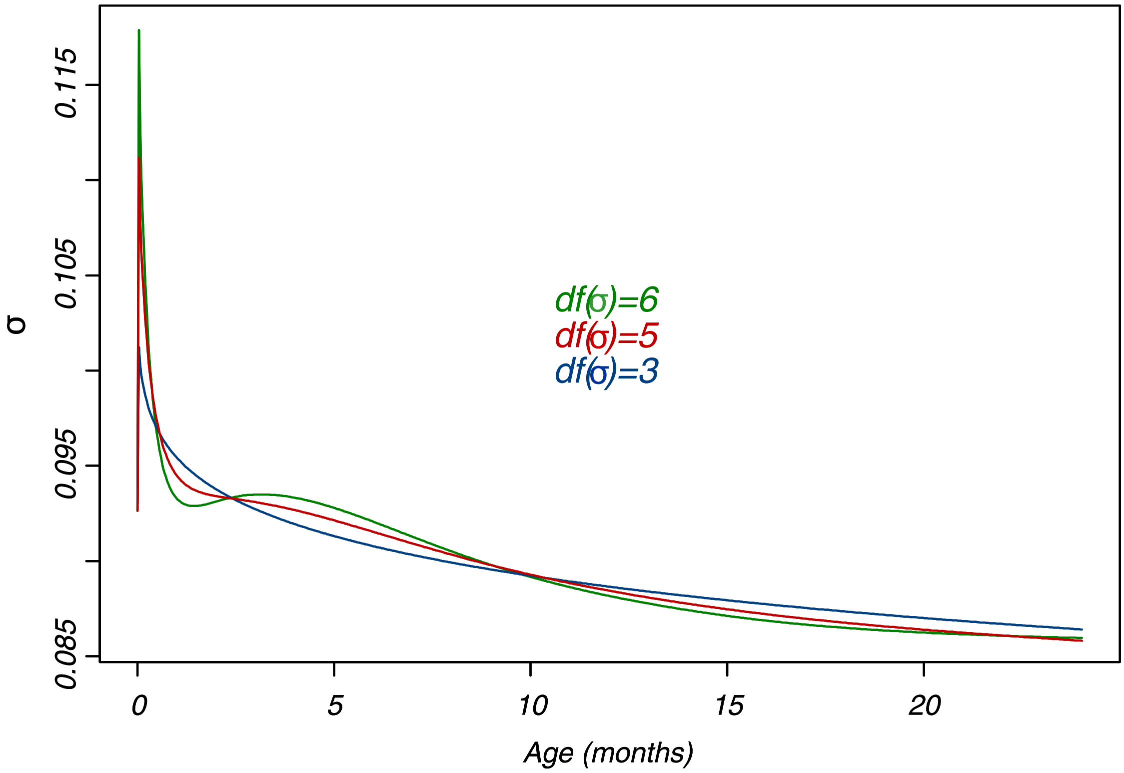


**Figure 116 Cubic splines fitted for the σ curve with varying numbers of degrees of freedom**

**Model 1: BCPE(x= age$^{0.05}$, df(μ)=10, df(σ)=3, ν=1, τ=2)**

Q-test results (Table 87) showed that, for 14 out of 23 age groups, absolute values of z3 were above 2, showing residual skewness. Only one age group (7 days) had an absolute value of z2 above 2, which indicated misfit of variance, and another group (24 mo) had an absolute value of z4 larger than 2, pointing to residual kurtosis.

**Table 87 Q-test for z-scores from Model 1 [BCPE(x=age$^{0.05}$, df(μ)=10, df(σ)=3, ν=1, τ=2)] for length-based BMI-for-age for girls**

| Age (days) | Group | N | z1 | z2 | z3 | z4 |
|---|---|---|---|---|---|---|
| 0 | **Birth** | 838 | 0.02 | -0.16 | 3.55 | 0.75 |
| 1 to 11 | **7 d** | 392 | 0.23 | 2.25 | 0.87 | -0.64 |
| 12 to 16 | **14 d** | 446 | -0.73 | -0.66 | 1.04 | -0.17 |
| 17 to 34 | **28 d** | 449 | 0.35 | -1.01 | 1.76 | 0.88 |
| 35 to 49 | **42 d** | 444 | 0.33 | -0.91 | 1.16 | -0.23 |
| 50 to 69 | **2 mo** | 445 | -0.08 | -0.22 | 1.27 | -1.08 |
| 70 to 99 | **3 mo** | 444 | -0.11 | 0.59 | 1.00 | -1.09 |
| 100 to 129 | **4 mo** | 444 | -0.51 | 0.66 | 1.78 | -1.27 |
| 130 to 159 | **5 mo** | 441 | -0.23 | 1.37 | 2.29 | -0.71 |
| 160 to 189 | **6 mo** | 441 | 0.20 | 0.18 | 1.49 | -1.97 |
| 190 to 219 | **7 mo** | 432 | 0.40 | 0.83 | 1.97 | -0.88 |
| 220 to 249 | **8 mo** | 435 | 0.07 | 0.31 | 2.68 | -1.01 |
| 250 to 279 | **9 mo** | 439 | 0.68 | -0.79 | 2.69 | -1.26 |
| 280 to 309 | **10 mo** | 444 | -0.41 | -0.26 | 3.57 | 0.82 |
| 310 to 349 | **11 mo** | 479 | 0.29 | 0.02 | 3.91 | 0.32 |
| 350 to 379 | **12 mo** | 451 | -0.13 | -0.03 | 2.99 | 0.03 |
| 380 to 439 | **14 mo** | 446 | -0.04 | 0.36 | 3.81 | 1.36 |
| 440 to 499 | **16 mo** | 442 | -0.11 | -0.99 | 3.25 | 0.30 |
| 500 to 559 | **18 mo** | 469 | 0.04 | -1.08 | 2.97 | 1.10 |
| 560 to 619 | **20 mo** | 542 | 0.71 | -0.20 | 3.94 | 1.02 |
| 620 to 679 | **22 mo** | 539 | -0.73 | -0.04 | 4.32 | 1.74 |
| 680 to 749 | **24 mo** | 591 | -1.01 | 0.39 | 4.26 | 2.62 |
| 750 to 913 | **28 mo** | 409 | 1.03 | -0.25 | 2.66 | -0.90 |
| **Overall Q stats** | | **10 902** | **5.22** | **14.10** | **180.60** | **29.23** |
| **degrees of freedom** | | | **13.0** | **21.0** | **23.0** | **23.0** |
| **p-value** | | | **0.9699** | **0.8652** | **< 0.01** | **0.1726** |

Note: Absolute values of z1, z2, z3 or z4 larger than 2 indicate misfit of, respectively, mean, variance, skewness or kurtosis.

Worm plots mostly supported the findings of the Q-test results (Figure 117). The majority of the worms were U-shaped and the group at 7 days presented a worm with a slope. The group with absolute value of z4 larger than 2 in the Q-test did not have an S-shaped worm, likely due to the fact that the residual kurtosis was an effect of the misfit in the skewness. Model 1 was thus considered inadequate. The search for the best model proceeded with the modelling of the ν curve in addition to μ and σ**.**

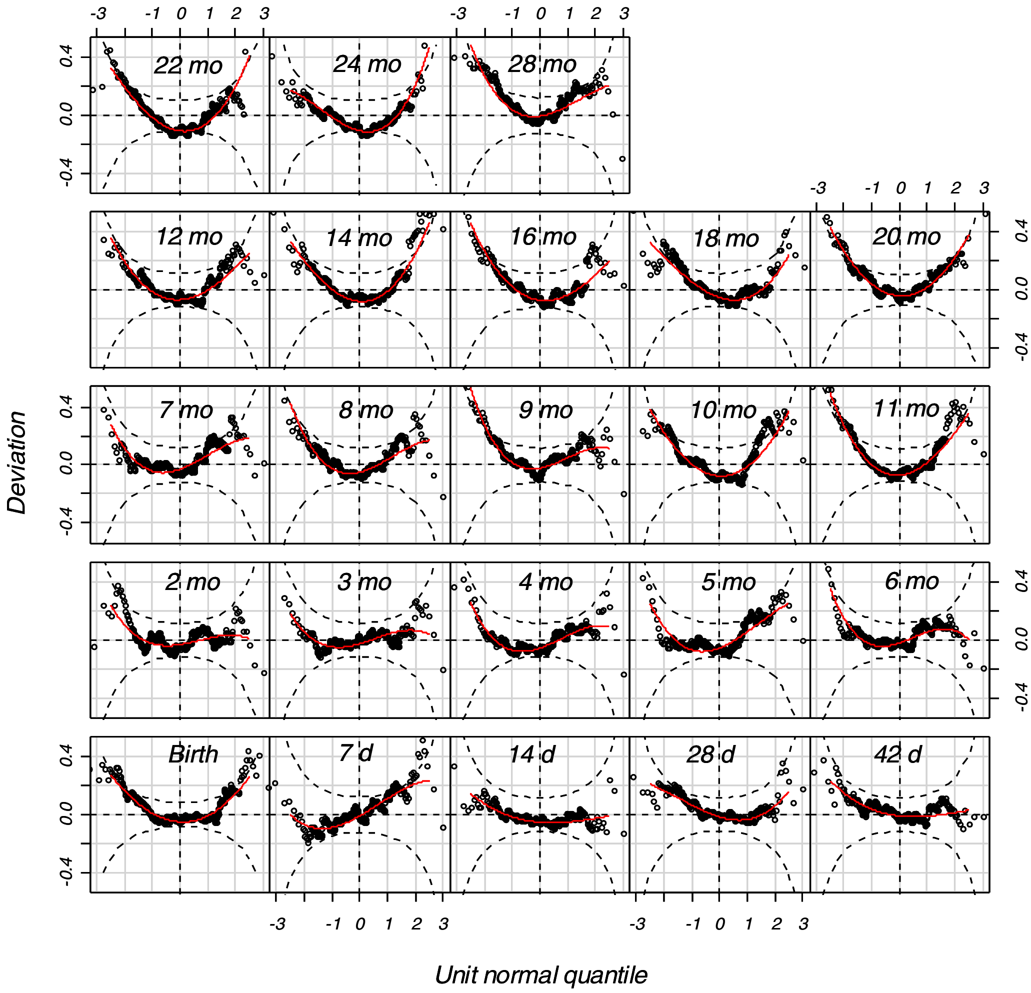


**Figure 117 Worm plots of z-scores for Model 1 for length-based BMI-for-age for girls**

The summary statistics in Table 88 show that the best combination of *AIC* and *GAIC(3)* corresponded to df(ν)=3. An evaluation of this model followed by comparing fitted with empirical values, examining worm plots and assessing Q-test results.

**Table 88 Goodness-of-fit summary for models BCPE(x=age$^{0.05}$, df(μ)=10, df(σ)=3, df(ν)=?, τ=2) for length-based BMI-for-age for girls**

| df(ν) | GD[a] | GAIC(3)[a] | Total df |
|---|---|---|---|
| **1** | 398.3 | 440.3 | 14 |
| **2** | 396.8 | 441.7 | 15 |
| **3** | 376.1 | 424.1 | 16 |
| **4** | 374.9 | 425.9 | 17 |
| **5** | 373.8 | 427.8 | 18 |
| **6** | 373.0 | 430.0 | 19 |

GD, Global Deviance; GAIC(3), Generalized Akaike Information Criterion with penalty equal to 3;
[a] In excess of 38 000.

**Model 2: BCPE(x=age$^{0.05}$, df(μ)=10, df(σ)=3, df(ν)=3, τ=2)**

Figure 118 compares the fitting of the parameters μ, σ and ν for Model 2 with their respective empirical estimates.

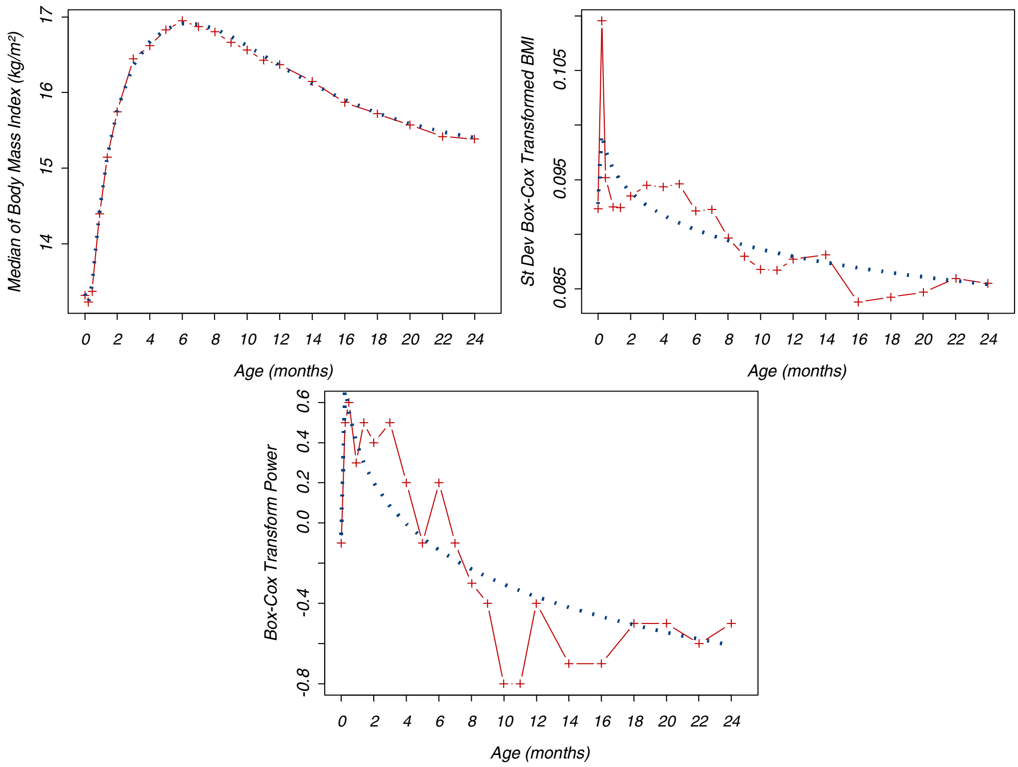


**Figure 118 Fitting of the μ, σ, and ν curves of Model 2 for length-based BMI-for-age from 0 to 24 months for girls (dotted line) and their respective sample estimates (points with solid line)**

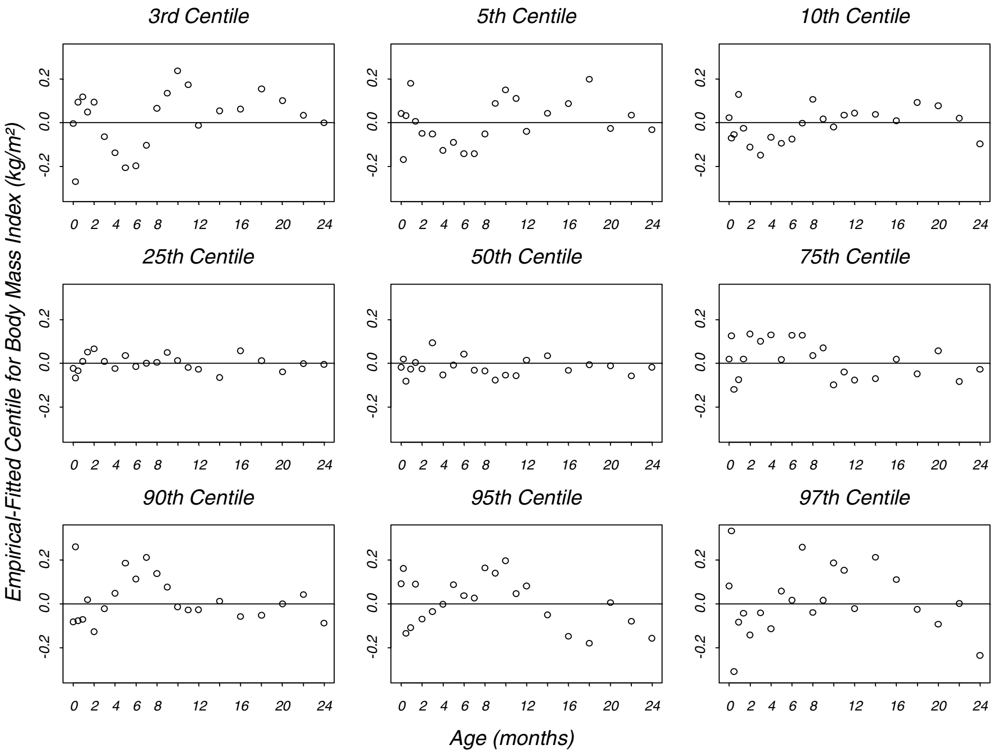


**Figure 119 Centile residuals from fitting Model 2 for length-based BMI-for-age from 0 to 24 months for girls**

Figure 119 shows the distribution of the centile residuals, i.e. the difference between empirical and fitted centiles for the longitudinal sample. Although the 50th centile curve tends to be overestimated, the average bias is very small (around 0.05 kg/m$^2$).

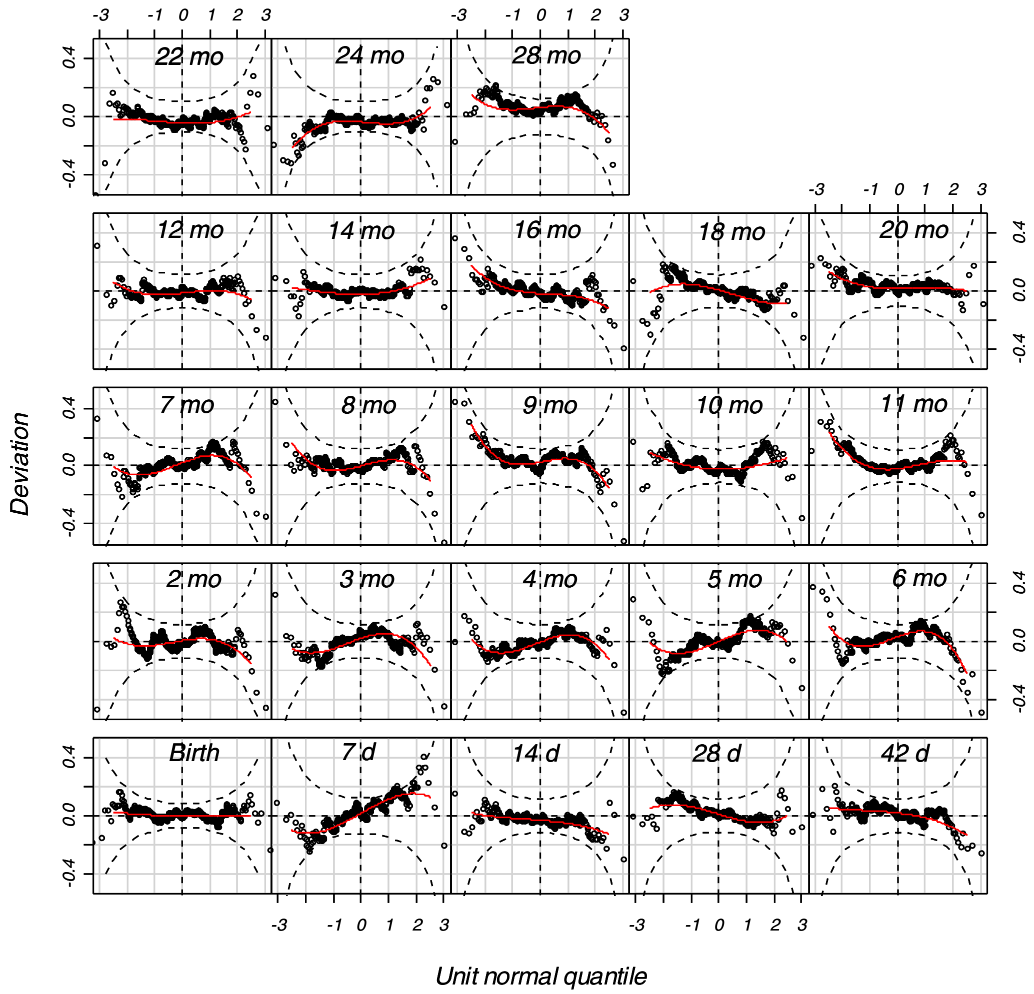


**Figure 120 Worm plots of z-scores for Model 2 for length-based BMI-for-age for girls**

The worm plots for Model 2 (Figure 120) are mostly flat, i.e. with no obvious indication of misfit. Worms with slight slopes were noted for a few groups, the most evident being at 7 days, the imputed age group. Q-test results for the z-scores from Model 2 are shown in Table 89. For the selected age groups, there were no absolute values larger than 2 for any of the statistics z1 and z3, indicating no misfit of the median or skewness. For only one age group (7 days), the test indicated misfit of the variance, and for two age groups (6 and 9 mo) results suggested mild residual kurtosis (i.e. absolute values of z4 marginally above 2). The overall tests' p-values were all non-significant, indicating an adequate fit of this model for the BMI-for-age for girls from birth to 2 years. Table 90 presents the observed percentages of the sample that were below the fitted centiles. No indications of systematic bias were noted for any of the centiles.

**Table 89 Q-test for z-scores from Model 2 [BCPE(x=age$^{0.05}$, df(μ)=10, df(σ)=3, df(ν)=3, τ=2)] for length-based BMI-for-age for girls**

| Age (days) | Group | N | z1 | z2 | z3 | z4 |
|---|---|---|---|---|---|---|
| 0 | **Birth** | 838 | 0.00 | -0.17 | 0.15 | -0.02 |
| 1 to 11 | **7 d** | 392 | 0.34 | 2.18 | 0.00 | -0.72 |
| 12 to 16 | **14 d** | 446 | -0.77 | -0.65 | -0.14 | -0.20 |
| 17 to 34 | **28 d** | 449 | 0.26 | -1.08 | 0.12 | 0.73 |
| 35 to 49 | **42 d** | 444 | 0.26 | -0.89 | -0.52 | -0.19 |
| 50 to 69 | **2 mo** | 445 | -0.09 | -0.12 | -0.51 | -0.78 |
| 70 to 99 | **3 mo** | 444 | -0.05 | 0.79 | -0.99 | -1.31 |
| 100 to 129 | **4 mo** | 444 | -0.40 | 0.81 | -0.30 | -1.55 |
| 130 to 159 | **5 mo** | 441 | -0.16 | 1.44 | -0.02 | -1.15 |
| 160 to 189 | **6 mo** | 441 | 0.32 | 0.32 | -0.65 | -2.07 |
| 190 to 219 | **7 mo** | 432 | 0.43 | 0.89 | -0.47 | -1.05 |
| 220 to 249 | **8 mo** | 435 | 0.09 | 0.28 | 0.33 | -1.51 |
| 250 to 279 | **9 mo** | 439 | 0.74 | -0.91 | 0.47 | -2.07 |
| 280 to 309 | **10 mo** | 444 | -0.43 | -0.33 | 0.75 | 0.13 |
| 310 to 349 | **11 mo** | 479 | 0.24 | -0.22 | 1.22 | -0.87 |
| 350 to 379 | **12 mo** | 451 | -0.20 | -0.01 | 0.16 | -0.63 |
| 380 to 439 | **14 mo** | 446 | -0.17 | 0.22 | 0.65 | 0.17 |
| 440 to 499 | **16 mo** | 442 | -0.16 | -1.01 | 0.40 | -0.70 |
| 500 to 559 | **18 mo** | 469 | 0.00 | -0.98 | -0.52 | 0.73 |
| 560 to 619 | **20 mo** | 542 | 0.63 | -0.41 | 0.46 | -0.45 |
| 620 to 679 | **22 mo** | 539 | -0.80 | -0.04 | 0.48 | 0.59 |
| 680 to 749 | **24 mo** | 591 | -1.08 | 0.58 | -0.36 | 1.24 |
| 750 to 913 | **28 mo** | 409 | 1.14 | -0.36 | -0.25 | -0.88 |
| **Overall Q stats** | | **10 902** | **5.73** | **15.17** | **6.17** | **24.20** |
| **degrees of freedom** | | | **13.0** | **21.0** | **20.0** | **23.0** |
| **p-value** | | | **0.9555** | **0.8142** | **0.9987** | **0.3927** |

Note: Absolute values of z1, z2, z3 or z4 larger than 2 indicate misfit of, respectively, mean, variance, skewness or kurtosis.

Since residual kurtosis was noted for only two out of the 23 age groups and the overall test was not significant, as with the boys' curves, modelling parameter τ was not considered necessary.

The model BCPE(x=age$^{0.05}$, df(μ)=10, df(σ)=3, df(ν)=3, τ=2) was used to fit the BMI-for-age curves for girls from birth to 24 months. A new iteration was then done, fixing df(ν)=3 and re-searching for the best combination of df(μ) and df(σ), but Model 2 still presented the smallest value of *GAIC(3)* and its performance was very close to that of the model with the smallest *AIC*. A re-search was then done for the best λ value with the selected degrees of freedom for the μ, σ and ν curves. Results confirmed that λ values closest to zero were associated with the lowest global deviance, but for the reasons stated earlier for boys, λ=0.05 was selected in preference to λ=0.01. Thus, Model 2 was not updated.

The fitted curves are compared to empirical centiles in Figures 121 and 122.

**Table 90 Observed proportions of children with measurements below the fitted centiles from Model 2 for length-based BMI-for-age for girls**

| Expected | Birth | 7 d | 14 d | 28 d | 42 d | 2 mo | 3 mo | 4 mo | 5 mo | 6 mo | 7 mo | 8 mo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 0.8 | 1.5 | 1.1 | 1.3 | 1.1 | 0.9 | 1.1 | 0.9 | 1.1 | 0.5 | 1.6 | 0.9 |
| **3** | 3.2 | 4.3 | 2.5 | 2.4 | 2.7 | 1.6 | 3.6 | 3.8 | 4.1 | 3.6 | 4.2 | 2.5 |
| **5** | 4.4 | 7.1 | 4.7 | 4.2 | 5.0 | 4.9 | 7.0 | 6.3 | 6.6 | 5.4 | 5.8 | 5.3 |
| **10** | 9.4 | 10.7 | 10.5 | 8.0 | 10.6 | 11.7 | 12.2 | 10.8 | 12.0 | 10.4 | 10.0 | 9.7 |
| **25** | 25.5 | 26.5 | 25.8 | 24.3 | 23.0 | 23.1 | 25.0 | 25.7 | 24.0 | 24.9 | 23.8 | 26.0 |
| **50** | 50.2 | 49.0 | 52.0 | 50.6 | 50.2 | 51.2 | 48.6 | 51.4 | 50.8 | 48.8 | 49.5 | 51.0 |
| **75** | 74.5 | 72.7 | 77.4 | 75.3 | 74.5 | 72.8 | 74.1 | 73.2 | 74.1 | 72.8 | 73.6 | 74.5 |
| **90** | 90.9 | 87.2 | 90.8 | 90.9 | 89.6 | 90.3 | 90.3 | 88.5 | 87.5 | 88.9 | 87.3 | 88.3 |
| **95** | 94.7 | 93.6 | 95.5 | 95.3 | 94.6 | 95.3 | 95.3 | 95.0 | 94.6 | 94.8 | 94.2 | 93.6 |
| **97** | 96.8 | 96.4 | 98.0 | 97.6 | 97.3 | 97.3 | 97.5 | 97.5 | 96.6 | 96.6 | 96.3 | 97.2 |
| **99** | 98.8 | 98.2 | 99.3 | 98.7 | 99.5 | 99.6 | 99.1 | 99.1 | 98.6 | 99.5 | 99.3 | 99.1 |
| **Expected** | **9 mo** | **10 mo** | **11 mo** | **12 mo** | **14 mo** | **16 mo** | **18 mo** | **20 mo** | **22 mo** | **24 mo** | **28 mo** | **Overall** |
| **1** | 0.2 | 0.9 | 0.4 | 0.9 | 1.3 | 0.5 | 1.5 | 0.6 | 0.6 | 1.7 | 1.0 | 1.0 |
| **3** | 1.8 | 2.5 | 2.3 | 3.1 | 2.7 | 2.5 | 2.1 | 2.4 | 2.6 | 3.6 | 2.2 | 2.9 |
| **5** | 4.1 | 4.3 | 3.8 | 5.5 | 4.7 | 4.1 | 4.3 | 5.2 | 4.8 | 6.3 | 3.7 | 5.1 |
| **10** | 8.9 | 10.8 | 9.4 | 9.3 | 10.1 | 10.2 | 8.1 | 8.9 | 10.2 | 10.7 | 8.8 | 10.0 |
| **25** | 23.7 | 24.3 | 26.3 | 25.5 | 26.5 | 23.5 | 23.7 | 24.9 | 26.0 | 25.4 | 22.5 | 24.8 |
| **50** | 51.9 | 51.4 | 50.7 | 49.7 | 49.6 | 50.5 | 50.5 | 50.6 | 52.3 | 52.1 | 49.6 | 50.6 |
| **75** | 72.0 | 78.6 | 75.2 | 76.5 | 76.7 | 74.2 | 76.3 | 73.4 | 77.4 | 76.0 | 73.3 | 74.8 |
| **90** | 89.7 | 89.9 | 90.0 | 90.2 | 89.7 | 90.5 | 90.8 | 89.1 | 89.4 | 90.5 | 88.0 | 89.6 |
| **95** | 93.8 | 94.1 | 94.4 | 94.5 | 95.1 | 95.5 | 95.7 | 94.5 | 95.4 | 95.3 | 94.4 | 94.8 |
| **97** | 97.0 | 96.4 | 96.0 | 96.9 | 96.4 | 96.6 | 97.2 | 96.7 | 97.2 | 97.1 | 96.8 | 96.9 |
| **99** | 99.1 | 99.1 | 98.7 | 99.1 | 98.4 | 99.3 | 98.9 | 99.3 | 99.1 | 99.0 | 99.3 | 99.0 |

Note: Group labels correspond to the age intervals in Table 89.

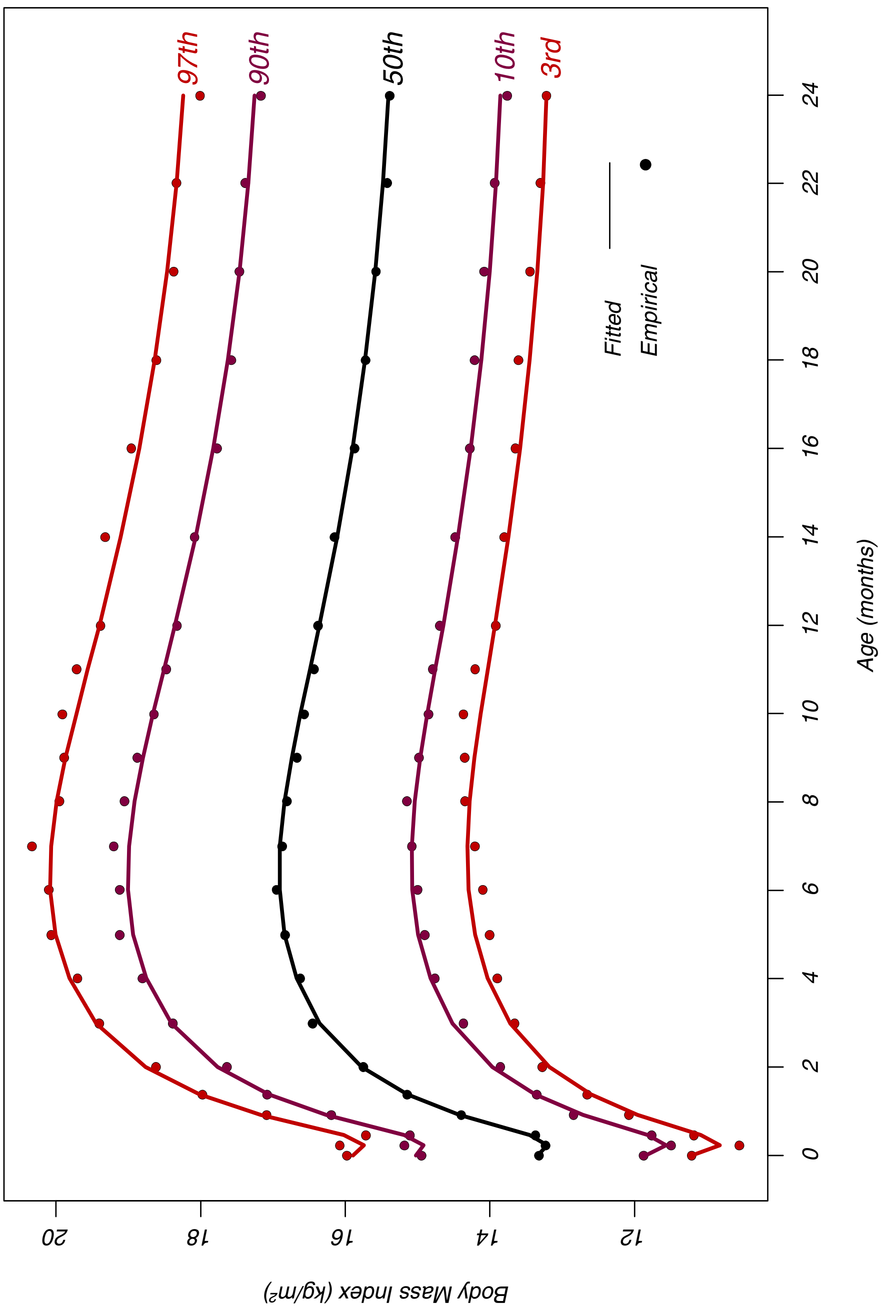


**Figure 121** 3rd, 10th, 50th, 90th, 97th smoothed centile curves and empirical values: length-based BMI-for-age for girls from birth to 24 months

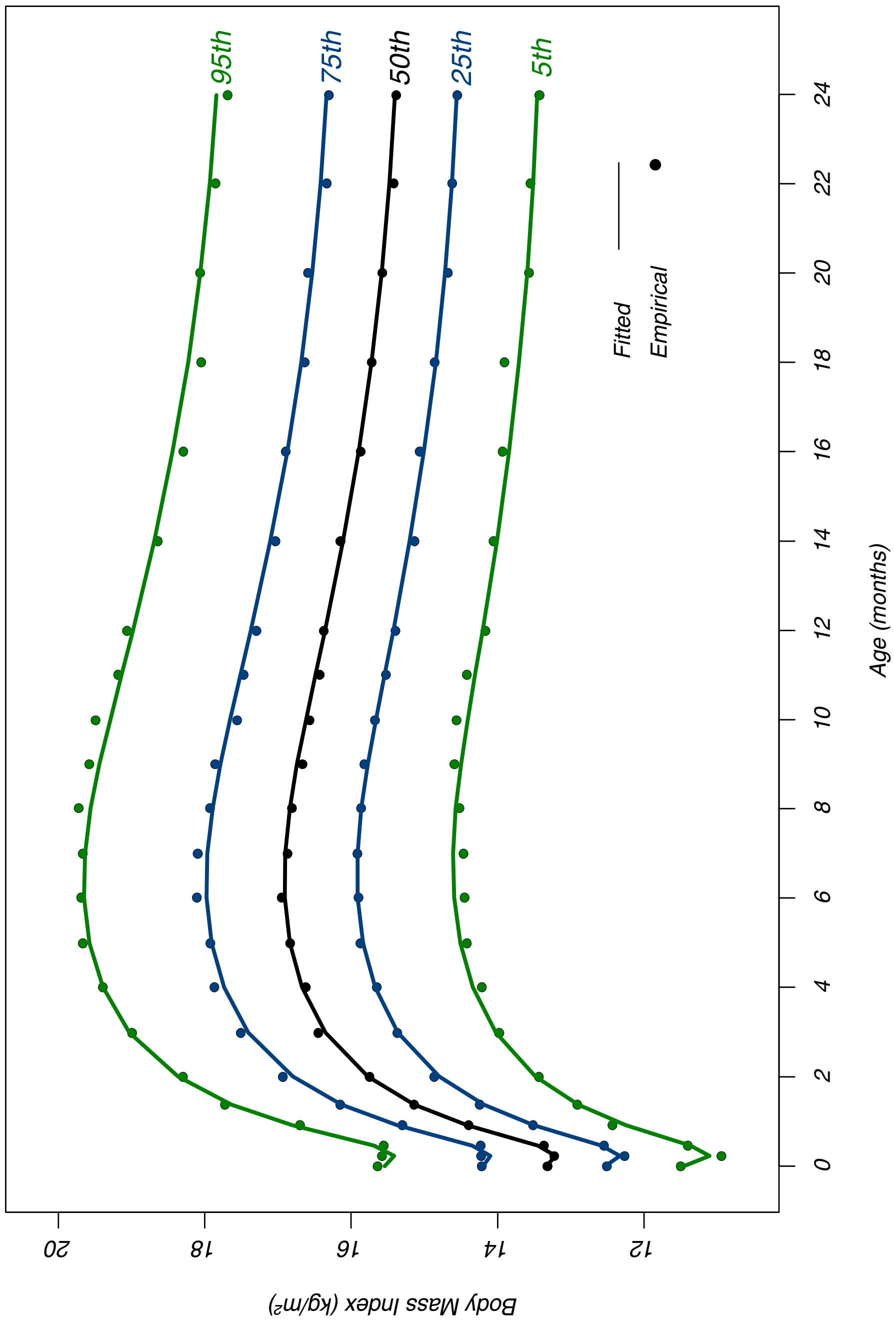


**Figure 122 5th, 25th, 50th, 75th, 95th smoothed centile curves and empirical values: length-based BMI-for-age for girls from birth to 24 months**

*Height-based BMI-for-age for girls*

As with the boys' height-based BMI-for-age standards, no age transformation was necessary prior to fitting the model for girls. The search for the best model was restricted initially to the same class of models selected for the first 2 years of age. A thorough evaluation was carried out to assess the model's adequacy.

As was the case for boys, there was no need to transform age and λ was thus set to 1. The BCPE distribution was used, and to initiate the search for the best df(μ) and df(σ) the μ and σ parameter curves were modelled with fixed ν=1 and τ=2. This was carried out by comparing the goodness of fit of models with all possible combinations of df(μ) 3 to 10 and df(σ) 2 to 6. Partial results are presented in Table 91.

**Table 91 Goodness-of-fit summary for models using the BCPE distribution with fixed ν=1 and τ=2 for height-based BMI-for-age for girls**

| df(μ) | df(σ) | GD[a] | AIC[a] | GAIC(3)[a] | Total df |
|---|---|---|---|---|---|
| 3 | 2 | 574.5 | 584.6 | 589.7 | 5 |
| | 3 | 568.8 | 580.8 | 586.8 | 6 |
| | 4 | 566.0 | 580.0 | 587.0 | 7 |
| | 5 | 564.0 | 580.0 | 588.0 | 8 |
| 4 | 2 | 569.0 | 581.1 | 587.2 | 6 |
| | 3 | 563.8 | 577.8 | 584.7 | 7 |
| | 4 | 560.9 | 576.9 | 584.9 | 8 |
| | 5 | 558.8 | 576.8 | 585.8 | 9 |
| 5 | 2 | 566.7 | 580.8 | 587.8 | 7 |
| | 3 | 561.5 | 577.5 | 585.5 | 8 |
| | 4 | 558.6 | 576.6 | 585.6 | 9 |
| | 5 | 556.5 | 576.5 | 586.5 | 10 |
| 6 | 2 | 563.5 | 579.7 | 587.7 | 8 |
| | 3 | 558.3 | 576.3 | 585.3 | 9 |
| | 4 | 555.3 | 575.3 | 585.3 | 10 |
| | 5 | 553.2 | 575.2 | 586.2 | 11 |
| 7 | 2 | 559.4 | 577.5 | 586.6 | 9 |
| | 3 | 554.0 | 574.0 | 584.0 | 10 |
| | 4 | 551.0 | 573.0 | 584.0 | 11 |
| | 5 | 548.7 | 572.7 | 584.8 | 12 |
| 8 | 2 | 554.8 | 574.9 | 585.0 | 10 |
| | 3 | 549.2 | 571.2 | 582.2 | 11 |
| | 4 | 546.1 | 570.1 | 582.1 | 12 |
| | 5 | 543.8 | 569.8 | 582.8 | 13 |
| 9 | 2 | 550.4 | 572.5 | 583.6 | 11 |
| | 3 | 544.6 | 568.6 | 580.6 | 12 |
| | 4 | 541.4 | 567.4 | 580.4 | 13 |
| | 5 | 539.1 | 567.1 | 581.1 | 14 |

GD, Global Deviance; AIC, Akaike Information Criterion;
GAIC(3), Generalized AIC with penalty equal to 3;
[a] In excess of 19 000.

Although best fitting according to the selected criteria *AIC* and *GAIC(3)* was associated with larger values of df(μ), 4 was the maximum number of degrees of freedom for which the model produced a smooth median curve. Values of df(μ) greater than 4 resulted in median curves with varying degrees of zigzag pattern (Figure 123).

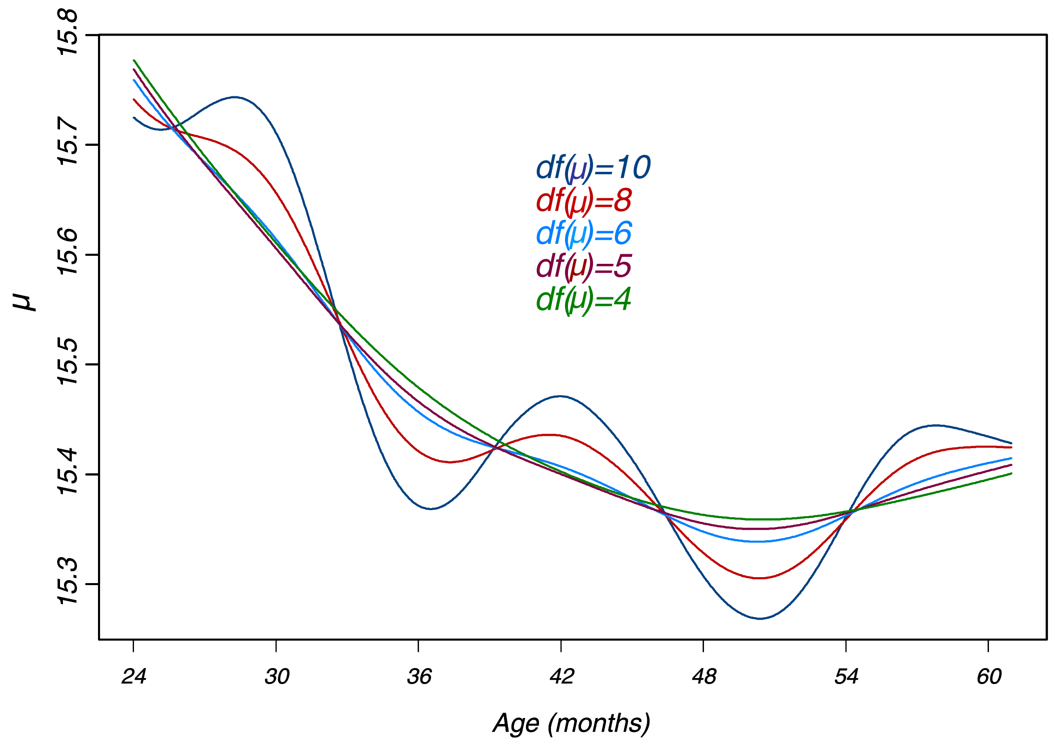


**Figure 123 Cubic splines fitted for the μ curve with varying numbers of degrees of freedom**

Thus, the combination df(μ)=4 and df(σ)=4 was selected to proceed with the search for the best degrees of freedom for the parameter ν and subsequent steps to the final model's selection. Table 92 shows a summary of goodness of fit for models with various specifications of df(ν). The smallest value of *GAIC(3)* corresponded to df(ν)=1, which fits a constant value throughout the age interval of interest and this model was further evaluated. It should be noted that there is a difference between a model with ν=1, where the parameter ν is fixed at value 1, and a model with df(ν)=1, where a constant is estimated by the maximum pseudo-likelihood method across the whole length/height range to define the ν parameter curve. In the latter case, the ν parameter estimation contributes one degree of freedom to the total, while in the former ν does not add to the model's total degrees of freedom.

**Table 92 Goodness-of-fit summary for models BCPE(x=age, df(μ)=4, df(σ)=4, df(ν)=?, τ=2) for height-based BMI-for-age for girls**

| df(ν) | GD[a] | GAIC(3)[a] | Total df |
|---|---|---|---|
| **1** | 403.4 | 430.4 | 9 |
| **2** | 402.6 | 432.8 | 10 |
| **3** | 401.7 | 434.7 | 11 |
| **4** | 400.9 | 436.9 | 12 |
| **5** | 400.2 | 439.2 | 13 |
| **6** | 399.6 | 441.6 | 14 |

GD, Global Deviance; GAIC(3), Generalized Akaike Information Criterion with penalty equal to 3;
[a] In excess of 19 000.

**Model 1: BCPE(x=age, df(μ)=4, df(σ)=4, df(ν)=1, τ=2)**

Figure 124 illustrates the fitting of parameters μ, σ and ν using Model 1 and their respective empirical estimates. One group's median empirical value (around 46 months) departed widely from the fitted value and its neighbouring groups' medians. One advantage of the method used is that it fits the median and other parameters continuously on age, thus this age group's deviation did not much affect the fitted median trajectory.

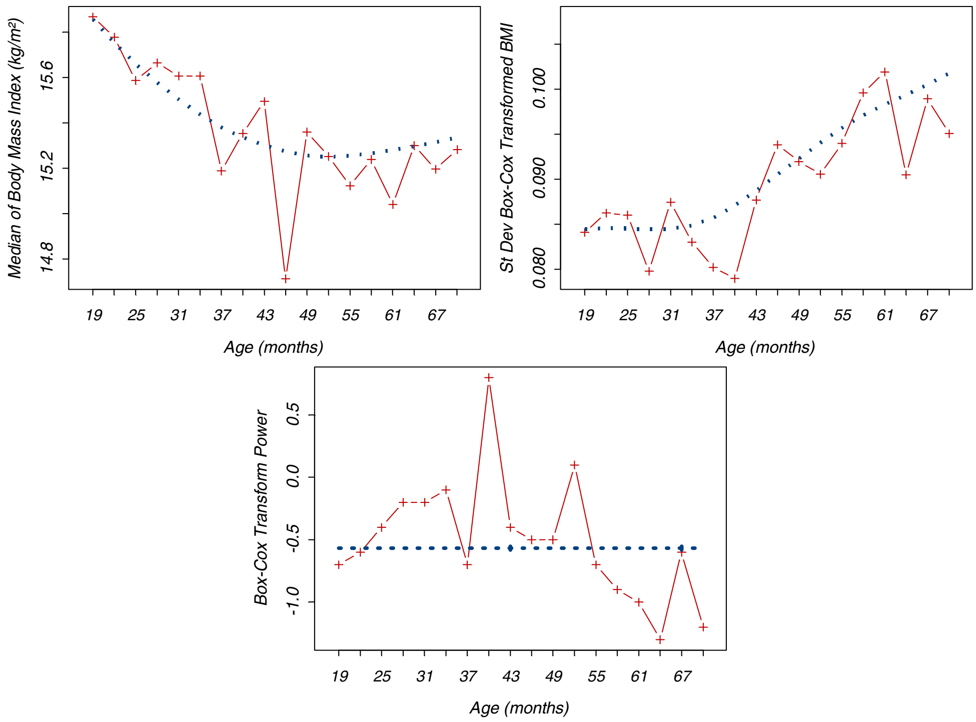


**Figure 124 Fitting of the μ, σ, and ν curves of Model 1 for height-based BMI-for-age from 18 to 71 months for girls (dotted line) and their respective sample estimates (points with solid line)**

Figure 125 shows the distribution of the centile residuals, i.e. the difference between empirical and fitted centiles for the cross-sectional sample from 18 to 71 months. Residuals for the centiles above the 50th were scattered more randomly than those for the lower-half centiles. There was a tendency to underestimate the 3rd, 5th and 10th centiles. These deviations, however, were small (on average around 0.2 kg/m$^2$) except for the age group around 46 months (see also Figures 127 and 128).

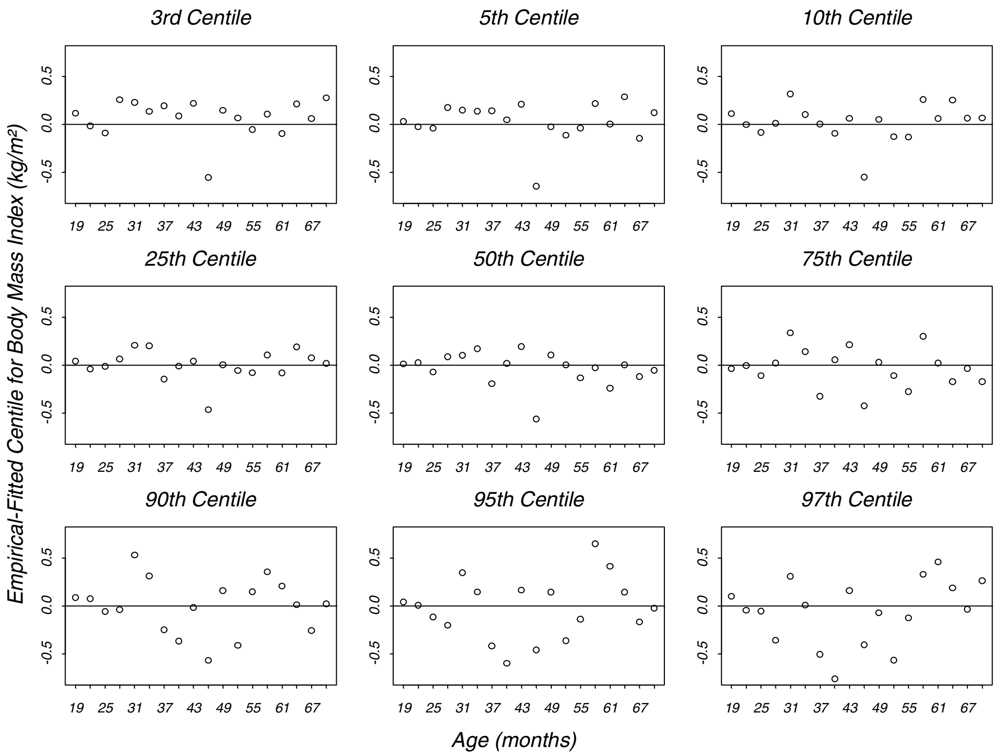


**Figure 125 Centile residuals from fitting Model 1 for height-based BMI-for-age from 18 to 71 months for girls**

Figure 126 shows the worm plots for the z-scores derived from Model 1. There is evidence of misfit of the median for age group 29–31 mo, i.e. this group's worm plot exhibited an upward shift. The same diagnosis can be made from the Q-test results (Table 93), i.e. z1 value was 2.96 for the same age group. The worm plot corresponding to the age interval 44–46 mo was S-shaped, indicating residual kurtosis, but likely related to the misfit of variance suggested by the Q-test results for this same group (Table 93). Both Q-test results and worm plots pointed to residual skewness in age group 35–37 mo, the absolute value of z3 being larger than 2 and the worm U-shaped. Although overall Q-test statistics indicated significant misfit of the median curve (p-value<0.05), this was evidently due to only one age group. The loss in goodness of fit was compensated by the gain in smoothness of the final curves. Apart from the median, the other overall Q-test statistics were non-significant.

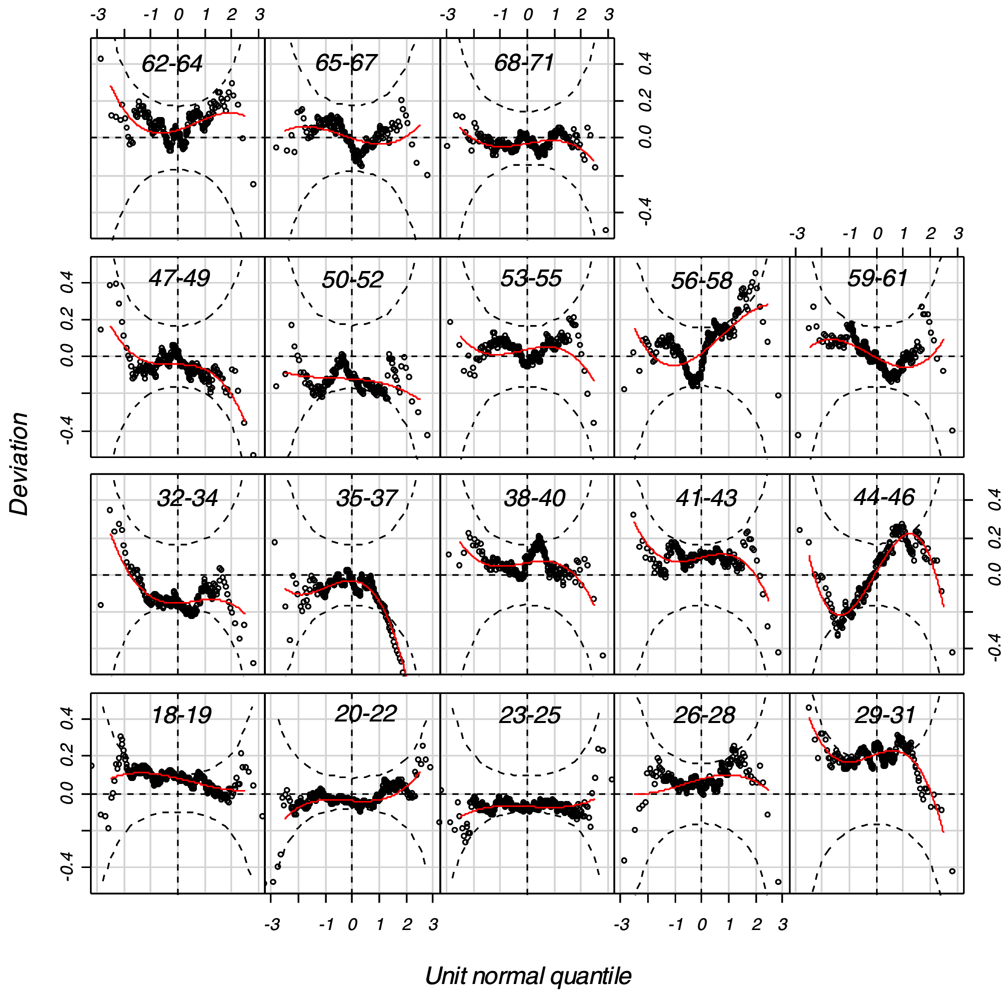


**Figure 126 Worm plots of z-scores for Model 1 for height-based BMI-for-age for girls**

**Table 93 Q-test for z-scores from Model 1 [BCPE(x=age, df(μ)=4, df(σ)=4, df(ν)=1, τ=2)] for height-based BMI-for age for girls**

| Age (months) | N | z1 | z2 | z3 | z4 |
|---|---|---|---|---|---|
| **18–19** | 628 | 1.92 | -0.87 | -0.37 | 0.48 |
| **20–22** | 869 | -1.01 | 0.80 | 0.31 | 1.26 |
| **23–25** | 654 | -1.83 | 0.19 | -0.08 | 0.53 |
| **26–28** | 229 | 1.01 | 0.49 | -0.34 | -0.06 |
| **29–31** | 215 | 2.96 | -0.60 | -0.61 | -1.93 |
| **32–34** | 230 | -1.91 | -0.76 | 0.92 | -0.88 |
| **35–37** | 230 | -1.59 | -1.68 | -2.50 | -0.91 |
| **38–40** | 232 | 0.86 | -0.36 | -0.28 | -1.12 |
| **41–43** | 231 | 1.38 | -0.40 | -0.11 | -1.15 |
| **44–46** | 215 | 0.12 | 2.30 | -0.24 | -3.33 |
| **47–49** | 219 | -0.76 | -1.00 | -0.33 | -1.06 |
| **50–52** | 210 | -1.84 | -0.37 | -0.21 | -0.16 |
| **53–55** | 230 | 0.45 | -0.09 | -0.14 | -0.58 |
| **56–58** | 240 | 0.76 | 1.62 | 1.11 | -0.82 |
| **59–61** | 232 | 0.09 | -0.74 | 0.48 | 1.07 |
| **62–64** | 206 | 0.96 | 0.23 | 0.87 | -0.71 |
| **65–67** | 193 | 0.09 | -0.42 | 0.34 | 0.46 |
| **68–71** | 296 | -0.52 | -0.07 | 0.03 | -0.74 |
| **Overall Q stats** | **5559** | **32.65** | **15.58** | **10.48** | **25.66** |
| **degrees of freedom** | | **14.0** | **15.5** | **17.0** | **18.0** |
| **p-value** | | **0.0032** | **0.4468** | **0.8823** | **0.1077** |

Note: Absolute values of z1, z2, z3 or z4 larger than 2 indicate misfit of, respectively, mean, variance, skewness or kurtosis.

Table 94 presents observed percentages of the sample below the fitted centiles. Although discrepancies between observed and expected proportions were sizable in some cases (e.g. age group 29–31 mo), no systematic patterns were noted over the age range.

The height-based BMI-for-age curves for girls were thus fitted using the model BCPE(x=age, df(μ)=4, df(σ)=4, df(ν)=1, τ=2). This model smoothed out observed irregular patterns, and for this reason no additional iteration was done fixing df(ν)=1 and re-searching for the best combination of df(μ) and df(σ).

The fitted centile curves and corresponding empirical values are shown in Figures 127 to 128.

**Table 94 Observed proportions of children with measurements below the fitted centiles from Model 1 for height-based BMI-for-age for girls**

| Expected | 18–19 mo | 20–22 mo | 23–25 mo | 26–28 mo | 29–31 mo | 32–34 mo | 35–37 mo | 38–40 mo | 41–43 mo | 44–46 mo |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 1.0 | 1.3 | 1.7 | 1.3 | 0.0 | 0.4 | 1.3 | 0.9 | 0.0 | 0.5 |
| **3** | 1.8 | 3.5 | 3.4 | 2.2 | 1.9 | 1.7 | 3.9 | 1.7 | 2.2 | 3.7 |
| **5** | 4.1 | 5.6 | 5.8 | 4.4 | 2.3 | 4.8 | 6.1 | 3.4 | 4.8 | 8.4 |
| **10** | 8.3 | 10.1 | 11.6 | 8.7 | 6.5 | 12.6 | 11.3 | 9.1 | 10.0 | 13.0 |
| **25** | 23.2 | 26.1 | 26.3 | 23.6 | 19.5 | 30.9 | 26.5 | 23.7 | 22.1 | 27.4 |
| **50** | 46.7 | 52.1 | 53.8 | 49.3 | 43.3 | 56.5 | 51.7 | 48.3 | 46.3 | 49.8 |
| **75** | 73.7 | 77.1 | 76.8 | 73.8 | 67.9 | 79.1 | 75.7 | 68.1 | 71.4 | 69.8 |
| **90** | 89.3 | 88.8 | 91.4 | 86.5 | 84.2 | 91.3 | 95.7 | 89.7 | 88.3 | 84.7 |
| **95** | 95.4 | 94.8 | 95.9 | 92.6 | 94.0 | 94.8 | 99.6 | 94.8 | 93.9 | 93.0 |
| **97** | 97.3 | 96.5 | 97.4 | 96.1 | 96.7 | 98.3 | 100.0 | 96.6 | 95.2 | 95.8 |
| **99** | 98.9 | 99.1 | 99.2 | 98.7 | 99.1 | 99.6 | 100.0 | 98.7 | 99.6 | 98.6 |
| **Expected** | **47–49 mo** | **50–52 mo** | **53–55 mo** | **56–58 mo** | **59–61 mo** | **62–64 mo** | **65–67 mo** | **68–71 mo** | **Overall** | |
| **1** | 0.5 | 1.0 | 1.3 | 1.3 | 0.9 | 1.0 | 1.0 | 0.7 | 1.0 | |
| **3** | 1.4 | 4.3 | 3.0 | 2.5 | 2.6 | 1.9 | 2.1 | 2.7 | 2.7 | |
| **5** | 5.9 | 7.1 | 4.8 | 5.0 | 4.3 | 5.3 | 4.7 | 5.1 | 5.1 | |
| **10** | 11.9 | 14.3 | 9.1 | 9.2 | 9.1 | 7.3 | 9.3 | 11.5 | 10.1 | |
| **25** | 26.0 | 28.1 | 22.2 | 26.3 | 22.0 | 23.8 | 21.8 | 26.4 | 25.0 | |
| **50** | 49.3 | 54.8 | 52.2 | 52.1 | 49.1 | 47.6 | 53.9 | 50.3 | 50.6 | |
| **75** | 76.7 | 80.0 | 73.5 | 68.8 | 78.0 | 71.8 | 76.2 | 76.4 | 74.7 | |
| **90** | 91.3 | 91.4 | 88.7 | 87.5 | 90.5 | 88.3 | 89.1 | 89.2 | 89.4 | |
| **95** | 96.8 | 96.7 | 93.9 | 92.1 | 94.4 | 92.7 | 94.3 | 95.6 | 94.9 | |
| **97** | 97.7 | 97.1 | 95.7 | 93.8 | 95.7 | 95.6 | 96.4 | 97.0 | 96.7 | |
| **99** | 100.0 | 99.5 | 100.0 | 97.5 | 99.1 | 98.1 | 99.5 | 99.0 | 99.1 | |

Note: Group labels correspond to the age intervals in Table 93.

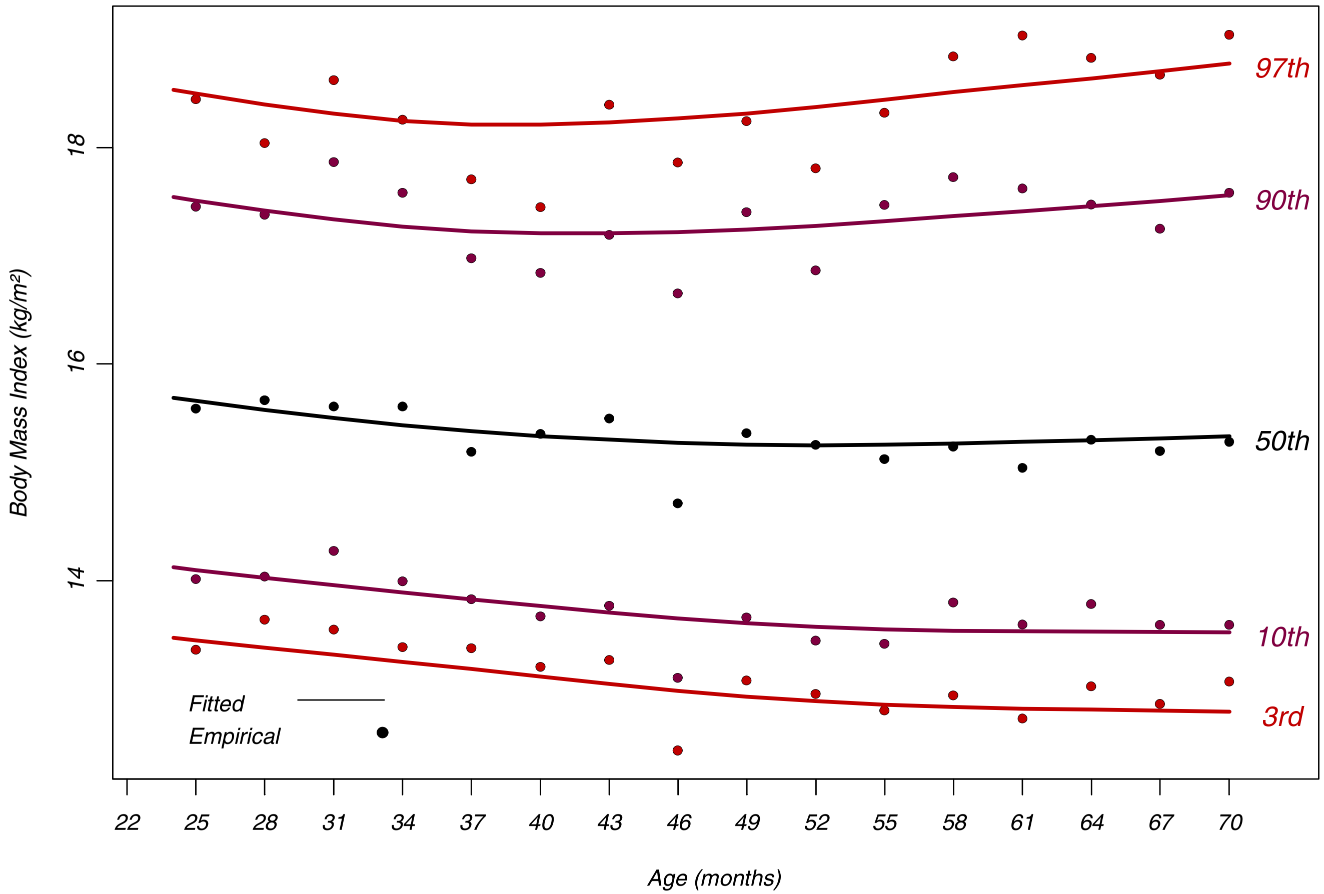


**Figure 127 3rd, 10th, 50th, 90th, 97th smoothed centile curves and empirical values: height-based BMI-for-age for girls from 24 to 71 months**

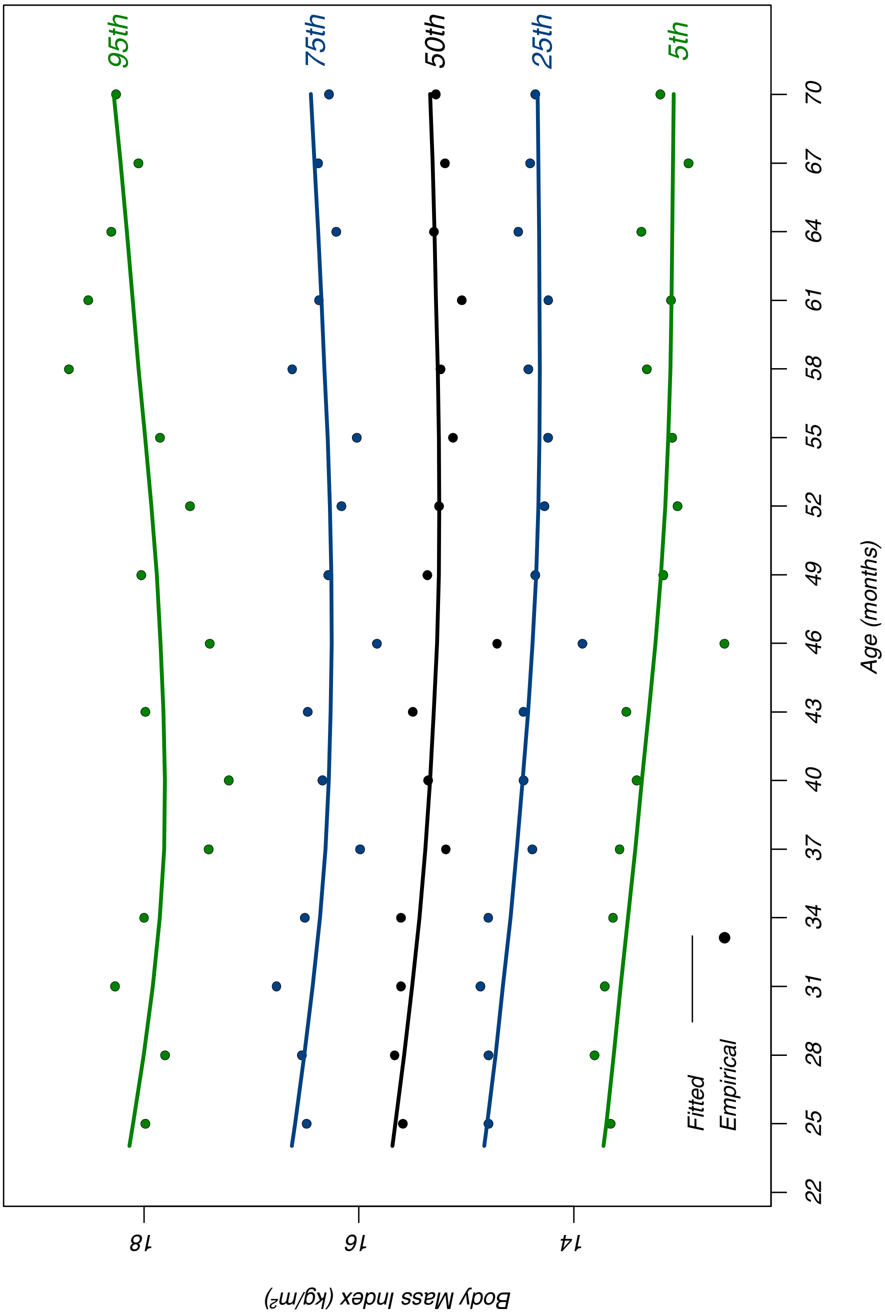


**Figure 128 5th, 25th, 50th, 75th, 95th smoothed centile curves and empirical values: height-based BMI-for-age for girls from 24 to 71 months**

### 6.3.3 WHO standards and their comparison with CDC 2000 reference

This section presents the final WHO BMI-for-age z-score and percentile charts (Figures 129 to 132) and tables (Tables 95 to 97) for girls. It also provides the z-score comparison of the WHO versus CDC 2000 curves (Figure 133).

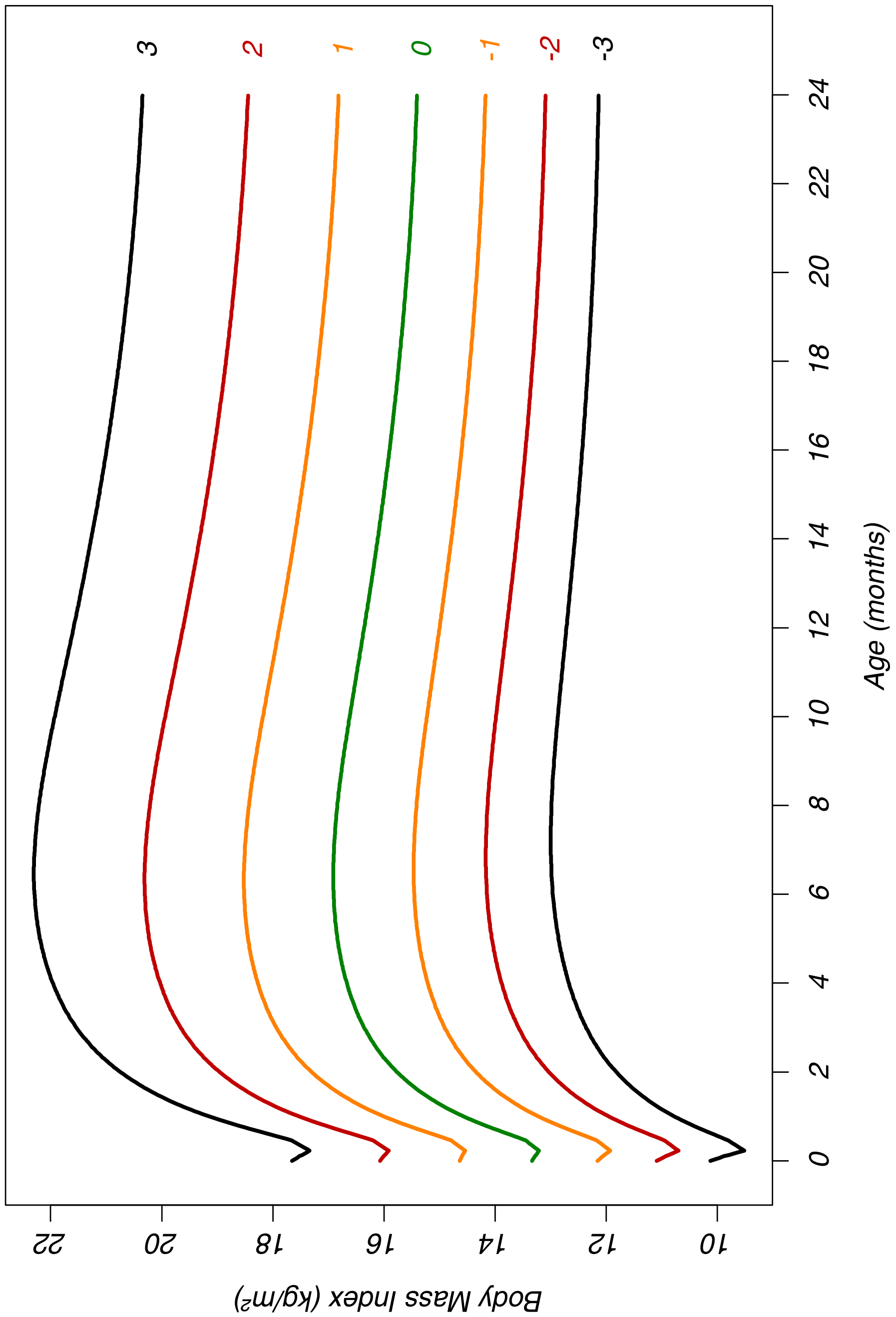


**Figure 129 WHO length-based BMI-for-age z-scores for girls from birth to 24 months**

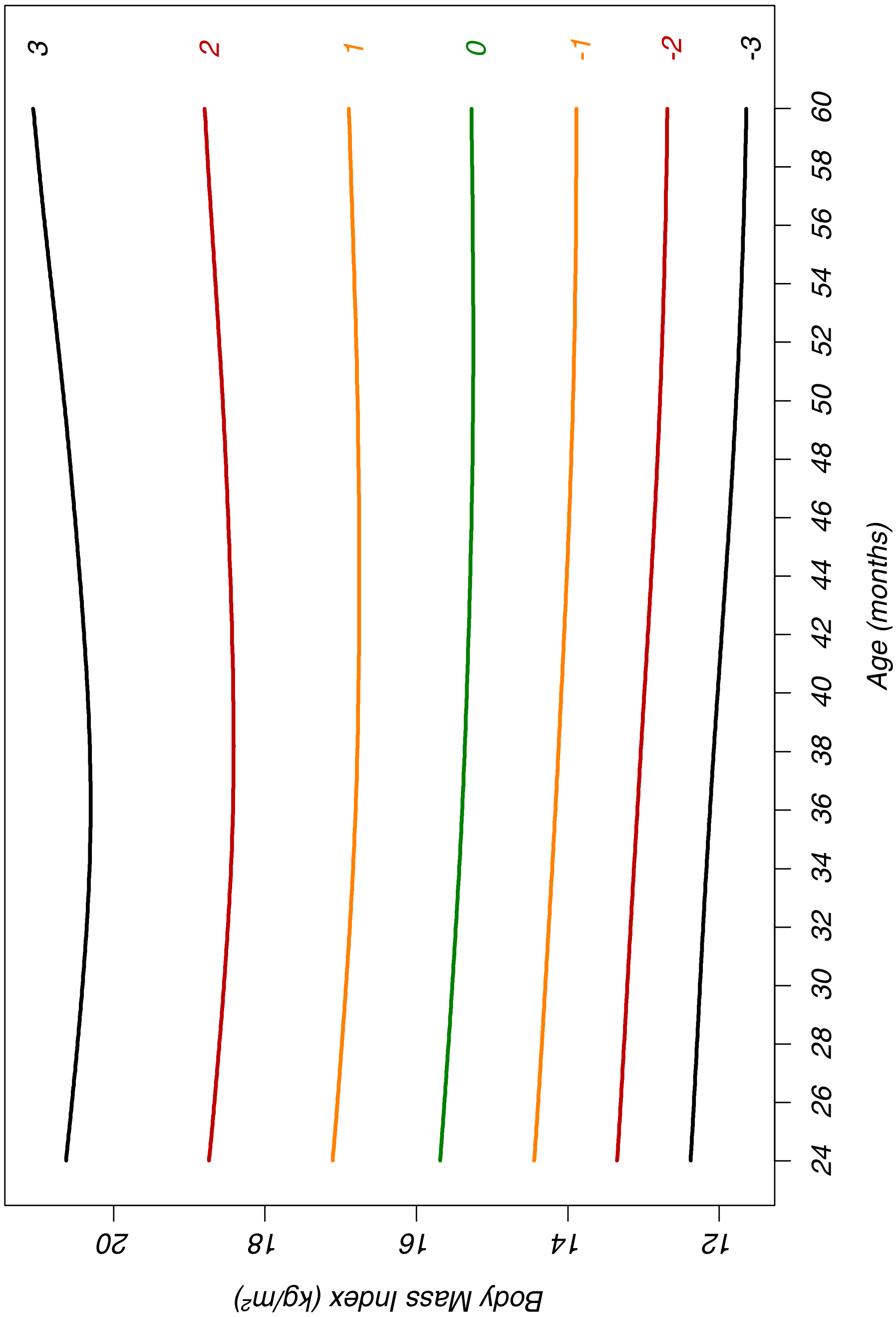


**Figure 130 WHO height-based BMI-for-age z-scores for girls from 24 to 60 months**

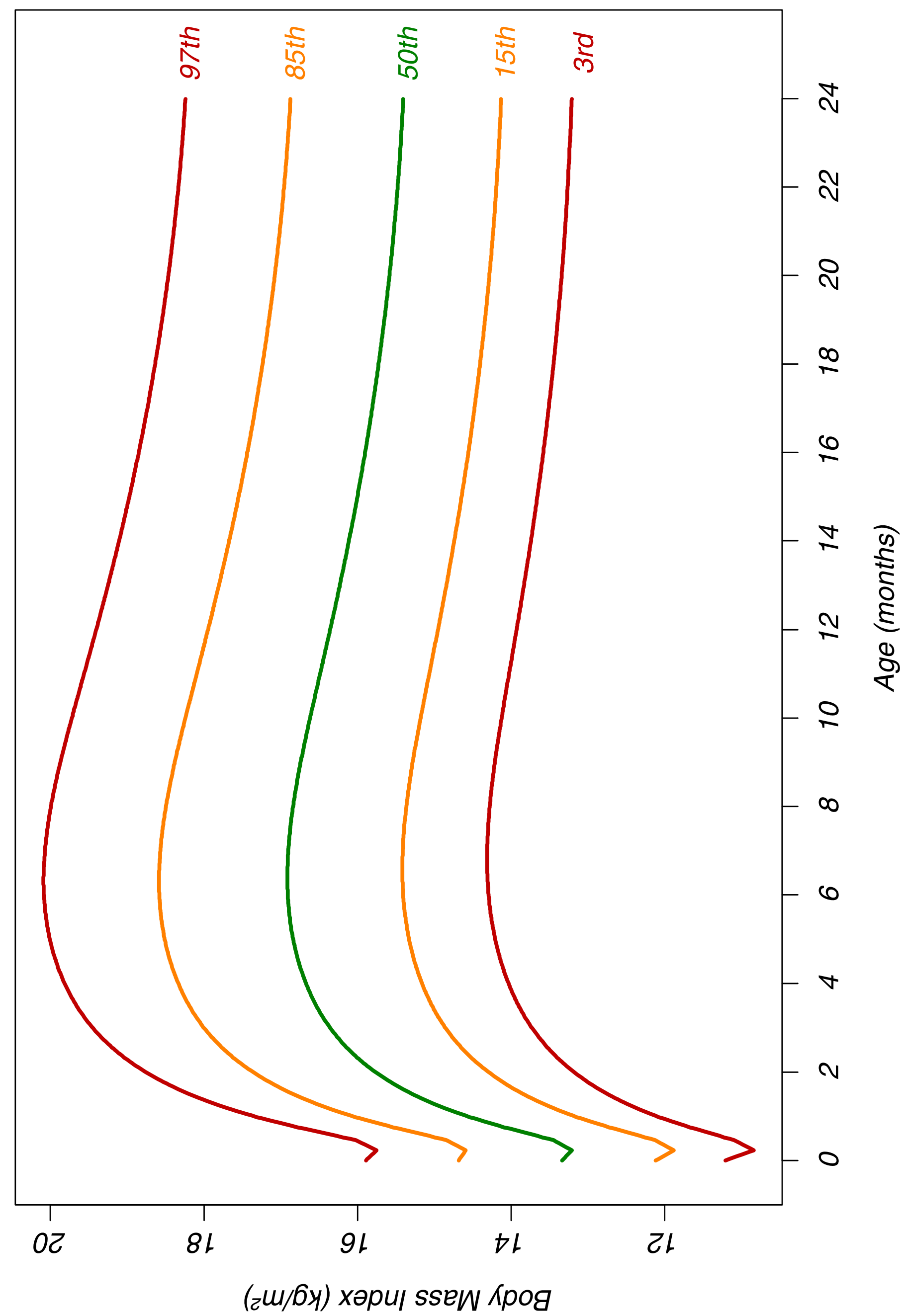


**Figure 131 WHO length-based BMI-for-age percentiles for girls from birth to 24 months**

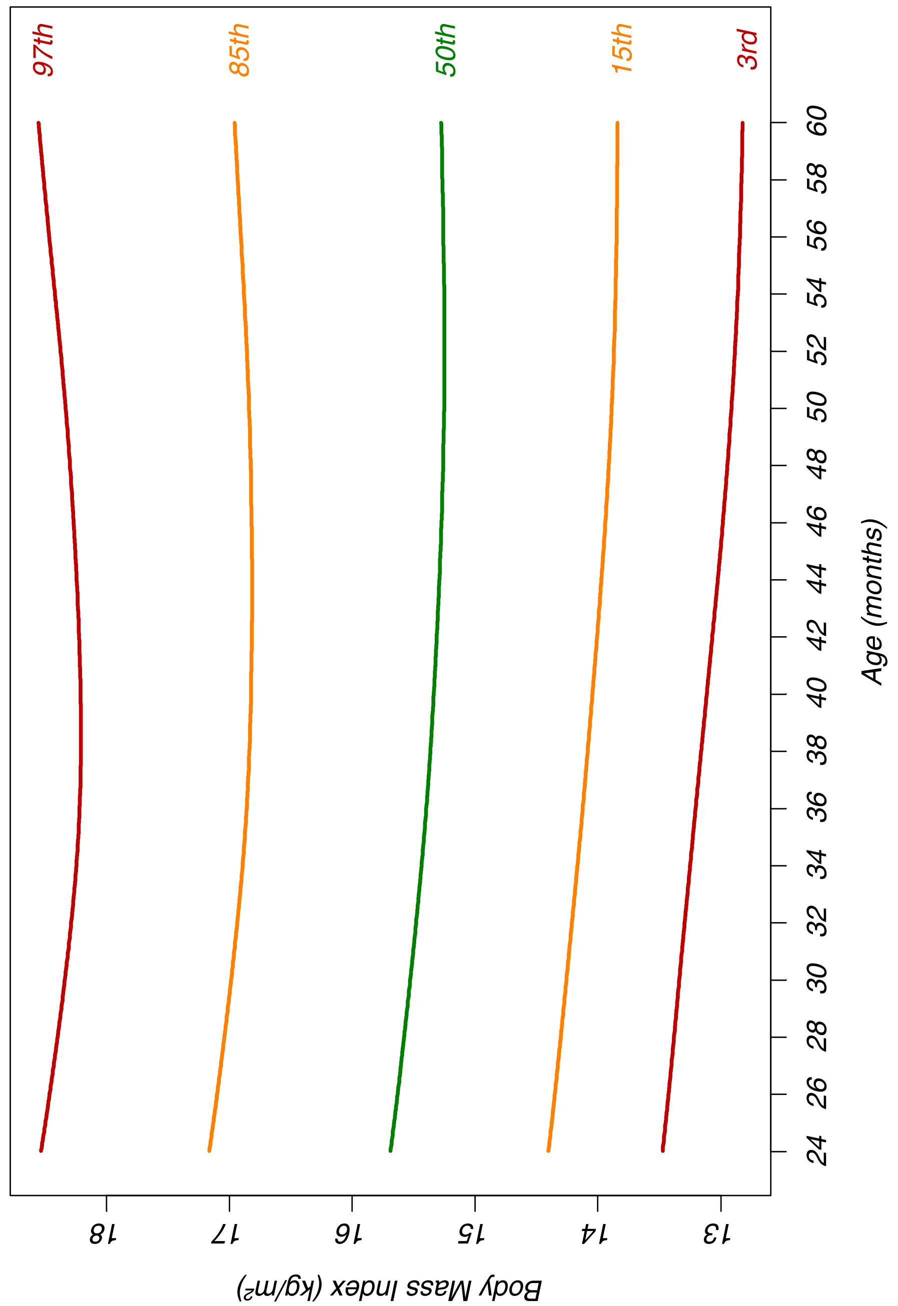


**Figure 132 WHO height-based BMI-for-age percentiles for girls from 24 to 60 months**

*Tables*

**Table 95 Length-based BMI-for-age for girls, age in weeks**

| Week | L | M | S | Percentiles (BMI in kg/m$^2$) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1st | 3rd | 5th | 15th | 25th | 50th | 75th | 85th | 95th | 97th | 99th |
| **0** | -0.0631 | 13.3363 | 0.09272 | 10.8 | 11.2 | 11.5 | 12.1 | 12.5 | 13.3 | 14.2 | 14.7 | 15.5 | 15.9 | 16.6 |
| **1** | 0.6319 | 13.2113 | 0.09887 | 10.3 | 10.8 | 11.1 | 11.9 | 12.3 | 13.2 | 14.1 | 14.6 | 15.4 | 15.8 | 16.4 |
| **2** | 0.5082 | 13.4501 | 0.09741 | 10.6 | 11.1 | 11.4 | 12.1 | 12.6 | 13.5 | 14.3 | 14.8 | 15.7 | 16.0 | 16.7 |
| **3** | 0.4263 | 13.9505 | 0.09647 | 11.0 | 11.5 | 11.8 | 12.6 | 13.1 | 14.0 | 14.9 | 15.4 | 16.3 | 16.6 | 17.3 |
| **4** | 0.3637 | 14.4208 | 0.09577 | 11.4 | 12.0 | 12.3 | 13.0 | 13.5 | 14.4 | 15.4 | 15.9 | 16.8 | 17.2 | 17.9 |
| **5** | 0.3124 | 14.8157 | 0.09520 | 11.8 | 12.3 | 12.6 | 13.4 | 13.9 | 14.8 | 15.8 | 16.3 | 17.3 | 17.6 | 18.4 |
| **6** | 0.2688 | 15.1380 | 0.09472 | 12.1 | 12.6 | 12.9 | 13.7 | 14.2 | 15.1 | 16.1 | 16.7 | 17.6 | 18.0 | 18.8 |
| **7** | 0.2306 | 15.4063 | 0.09431 | 12.3 | 12.9 | 13.2 | 14.0 | 14.4 | 15.4 | 16.4 | 17.0 | 17.9 | 18.3 | 19.1 |
| **8** | 0.1966 | 15.6311 | 0.09394 | 12.5 | 13.1 | 13.4 | 14.2 | 14.7 | 15.6 | 16.6 | 17.2 | 18.2 | 18.6 | 19.4 |
| **9** | 0.1658 | 15.8232 | 0.09361 | 12.7 | 13.2 | 13.5 | 14.3 | 14.9 | 15.8 | 16.8 | 17.4 | 18.4 | 18.8 | 19.6 |
| **10** | 0.1377 | 15.9874 | 0.09332 | 12.8 | 13.4 | 13.7 | 14.5 | 15.0 | 16.0 | 17.0 | 17.6 | 18.6 | 19.0 | 19.8 |
| **11** | 0.1118 | 16.1277 | 0.09304 | 13.0 | 13.5 | 13.8 | 14.6 | 15.1 | 16.1 | 17.2 | 17.8 | 18.8 | 19.2 | 20.0 |
| **12** | 0.0877 | 16.2485 | 0.09279 | 13.1 | 13.6 | 13.9 | 14.8 | 15.3 | 16.2 | 17.3 | 17.9 | 18.9 | 19.3 | 20.1 |
| **13** | 0.0652 | 16.3531 | 0.09255 | 13.2 | 13.7 | 14.0 | 14.9 | 15.4 | 16.4 | 17.4 | 18.0 | 19.0 | 19.4 | 20.3 |

**Table 95 Length-based BMI-for-age for girls, age in weeks (continued)**

| | | | | Z-scores (BMI in kg/m²) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Week** | **L** | **M** | **S** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **0** | -0.0631 | 13.3363 | 0.09272 | 10.1 | 11.1 | 12.2 | 13.3 | 14.6 | 16.1 | 17.7 |
| **1** | 0.6319 | 13.2113 | 0.09887 | 9.5 | 10.7 | 11.9 | 13.2 | 14.5 | 15.9 | 17.3 |
| **2** | 0.5082 | 13.4501 | 0.09741 | 9.8 | 11.0 | 12.2 | 13.5 | 14.8 | 16.2 | 17.7 |
| **3** | 0.4263 | 13.9505 | 0.09647 | 10.2 | 11.4 | 12.6 | 14.0 | 15.3 | 16.8 | 18.3 |
| **4** | 0.3637 | 14.4208 | 0.09577 | 10.6 | 11.8 | 13.1 | 14.4 | 15.8 | 17.4 | 19.0 |
| **5** | 0.3124 | 14.8157 | 0.09520 | 11.0 | 12.2 | 13.5 | 14.8 | 16.3 | 17.8 | 19.5 |
| **6** | 0.2688 | 15.1380 | 0.09472 | 11.3 | 12.5 | 13.8 | 15.1 | 16.6 | 18.2 | 19.9 |
| **7** | 0.2306 | 15.4063 | 0.09431 | 11.5 | 12.7 | 14.0 | 15.4 | 16.9 | 18.5 | 20.3 |
| **8** | 0.1966 | 15.6311 | 0.09394 | 11.7 | 12.9 | 14.2 | 15.6 | 17.2 | 18.8 | 20.6 |
| **9** | 0.1658 | 15.8232 | 0.09361 | 11.9 | 13.1 | 14.4 | 15.8 | 17.4 | 19.0 | 20.8 |
| **10** | 0.1377 | 15.9874 | 0.09332 | 12.0 | 13.2 | 14.6 | 16.0 | 17.5 | 19.2 | 21.0 |
| **11** | 0.1118 | 16.1277 | 0.09304 | 12.1 | 13.4 | 14.7 | 16.1 | 17.7 | 19.4 | 21.2 |
| **12** | 0.0877 | 16.2485 | 0.09279 | 12.3 | 13.5 | 14.8 | 16.2 | 17.8 | 19.5 | 21.4 |
| **13** | 0.0652 | 16.3531 | 0.09255 | 12.4 | 13.6 | 14.9 | 16.4 | 17.9 | 19.7 | 21.5 |

**Table 96 Length-based BMI-for-age for girls, age in years and months**

| | | | | | Percentiles (BMI in kg/m$^2$) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **0: 0** | **0** | -0.0631 | 13.3363 | 0.09272 | 10.8 | 11.2 | 11.5 | 12.1 | 12.5 | 13.3 | 14.2 | 14.7 | 15.5 | 15.9 | 16.6 |
| **0: 1** | **1** | 0.3448 | 14.5679 | 0.09556 | 11.6 | 12.1 | 12.4 | 13.2 | 13.6 | 14.6 | 15.5 | 16.1 | 17.0 | 17.3 | 18.0 |
| **0: 2** | **2** | 0.1749 | 15.7679 | 0.09371 | 12.6 | 13.2 | 13.5 | 14.3 | 14.8 | 15.8 | 16.8 | 17.4 | 18.4 | 18.8 | 19.5 |
| **0: 3** | **3** | 0.0643 | 16.3574 | 0.09254 | 13.2 | 13.7 | 14.0 | 14.9 | 15.4 | 16.4 | 17.4 | 18.0 | 19.0 | 19.4 | 20.3 |
| **0: 4** | **4** | -0.0191 | 16.6703 | 0.09166 | 13.5 | 14.0 | 14.3 | 15.2 | 15.7 | 16.7 | 17.7 | 18.3 | 19.4 | 19.8 | 20.6 |
| **0: 5** | **5** | -0.0864 | 16.8386 | 0.09096 | 13.7 | 14.2 | 14.5 | 15.3 | 15.8 | 16.8 | 17.9 | 18.5 | 19.6 | 20.0 | 20.8 |
| **0: 6** | **6** | -0.1429 | 16.9083 | 0.09036 | 13.7 | 14.3 | 14.6 | 15.4 | 15.9 | 16.9 | 18.0 | 18.6 | 19.6 | 20.1 | 20.9 |
| **0: 7** | **7** | -0.1916 | 16.9020 | 0.08984 | 13.8 | 14.3 | 14.6 | 15.4 | 15.9 | 16.9 | 18.0 | 18.6 | 19.6 | 20.1 | 20.9 |
| **0: 8** | **8** | -0.2344 | 16.8404 | 0.08939 | 13.7 | 14.3 | 14.6 | 15.4 | 15.9 | 16.8 | 17.9 | 18.5 | 19.6 | 20.0 | 20.8 |
| **0: 9** | **9** | -0.2725 | 16.7406 | 0.08898 | 13.7 | 14.2 | 14.5 | 15.3 | 15.8 | 16.7 | 17.8 | 18.4 | 19.4 | 19.9 | 20.7 |
| **0:10** | **10** | -0.3068 | 16.6184 | 0.08861 | 13.6 | 14.1 | 14.4 | 15.2 | 15.7 | 16.6 | 17.7 | 18.2 | 19.3 | 19.7 | 20.6 |
| **0:11** | **11** | -0.3381 | 16.4875 | 0.08828 | 13.5 | 14.0 | 14.3 | 15.1 | 15.5 | 16.5 | 17.5 | 18.1 | 19.1 | 19.6 | 20.4 |
| **1: 0** | **12** | -0.3667 | 16.3568 | 0.08797 | 13.4 | 13.9 | 14.2 | 15.0 | 15.4 | 16.4 | 17.4 | 17.9 | 19.0 | 19.4 | 20.2 |
| **1: 1** | **13** | -0.3932 | 16.2311 | 0.08768 | 13.3 | 13.8 | 14.1 | 14.8 | 15.3 | 16.2 | 17.2 | 17.8 | 18.8 | 19.2 | 20.1 |
| **1: 2** | **14** | -0.4177 | 16.1128 | 0.08741 | 13.3 | 13.7 | 14.0 | 14.7 | 15.2 | 16.1 | 17.1 | 17.7 | 18.7 | 19.1 | 19.9 |
| **1: 3** | **15** | -0.4407 | 16.0028 | 0.08716 | 13.2 | 13.7 | 13.9 | 14.6 | 15.1 | 16.0 | 17.0 | 17.5 | 18.6 | 19.0 | 19.8 |
| **1: 4** | **16** | -0.4623 | 15.9017 | 0.08693 | 13.1 | 13.6 | 13.8 | 14.6 | 15.0 | 15.9 | 16.9 | 17.4 | 18.4 | 18.8 | 19.7 |
| **1: 5** | **17** | -0.4825 | 15.8096 | 0.08671 | 13.0 | 13.5 | 13.8 | 14.5 | 14.9 | 15.8 | 16.8 | 17.3 | 18.3 | 18.7 | 19.5 |
| **1: 6** | **18** | -0.5017 | 15.7263 | 0.08650 | 13.0 | 13.4 | 13.7 | 14.4 | 14.8 | 15.7 | 16.7 | 17.2 | 18.2 | 18.6 | 19.4 |
| **1: 7** | **19** | -0.5199 | 15.6517 | 0.08630 | 12.9 | 13.4 | 13.6 | 14.3 | 14.8 | 15.7 | 16.6 | 17.2 | 18.1 | 18.5 | 19.3 |
| **1: 8** | **20** | -0.5372 | 15.5855 | 0.08612 | 12.9 | 13.3 | 13.6 | 14.3 | 14.7 | 15.6 | 16.5 | 17.1 | 18.1 | 18.5 | 19.3 |
| **1: 9** | **21** | -0.5537 | 15.5278 | 0.08594 | 12.8 | 13.3 | 13.6 | 14.2 | 14.7 | 15.5 | 16.5 | 17.0 | 18.0 | 18.4 | 19.2 |
| **1:10** | **22** | -0.5695 | 15.4787 | 0.08577 | 12.8 | 13.3 | 13.5 | 14.2 | 14.6 | 15.5 | 16.4 | 17.0 | 17.9 | 18.3 | 19.1 |
| **1:11** | **23** | -0.5846 | 15.4380 | 0.08560 | 12.8 | 13.2 | 13.5 | 14.2 | 14.6 | 15.4 | 16.4 | 16.9 | 17.9 | 18.3 | 19.1 |
| **2: 0** | **24**[a] | -0.5989 | 15.4052 | 0.08545 | 12.8 | 13.2 | 13.5 | 14.1 | 14.6 | 15.4 | 16.3 | 16.9 | 17.8 | 18.2 | 19.0 |

[a] 24 months corresponds to 730 days.

**Table 96 Length-based BMI-for-age for girls, age in years and months (continued)**

| | | | | | Z-scores (BMI in kg/m²) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **0: 0** | **0** | -0.0631 | 13.3363 | 0.09272 | 10.1 | 11.1 | 12.2 | 13.3 | 14.6 | 16.1 | 17.7 |
| **0: 1** | **1** | 0.3448 | 14.5679 | 0.09556 | 10.8 | 12.0 | 13.2 | 14.6 | 16.0 | 17.5 | 19.1 |
| **0: 2** | **2** | 0.1749 | 15.7679 | 0.09371 | 11.8 | 13.0 | 14.3 | 15.8 | 17.3 | 19.0 | 20.7 |
| **0: 3** | **3** | 0.0643 | 16.3574 | 0.09254 | 12.4 | 13.6 | 14.9 | 16.4 | 17.9 | 19.7 | 21.5 |
| **0: 4** | **4** | -0.0191 | 16.6703 | 0.09166 | 12.7 | 13.9 | 15.2 | 16.7 | 18.3 | 20.0 | 22.0 |
| **0: 5** | **5** | -0.0864 | 16.8386 | 0.09096 | 12.9 | 14.1 | 15.4 | 16.8 | 18.4 | 20.2 | 22.2 |
| **0: 6** | **6** | -0.1429 | 16.9083 | 0.09036 | 13.0 | 14.1 | 15.5 | 16.9 | 18.5 | 20.3 | 22.3 |
| **0: 7** | **7** | -0.1916 | 16.9020 | 0.08984 | 13.0 | 14.2 | 15.5 | 16.9 | 18.5 | 20.3 | 22.3 |
| **0: 8** | **8** | -0.2344 | 16.8404 | 0.08939 | 13.0 | 14.1 | 15.4 | 16.8 | 18.4 | 20.2 | 22.2 |
| **0: 9** | **9** | -0.2725 | 16.7406 | 0.08898 | 12.9 | 14.1 | 15.3 | 16.7 | 18.3 | 20.1 | 22.1 |
| **0:10** | **10** | -0.3068 | 16.6184 | 0.08861 | 12.9 | 14.0 | 15.2 | 16.6 | 18.2 | 19.9 | 21.9 |
| **0:11** | **11** | -0.3381 | 16.4875 | 0.08828 | 12.8 | 13.9 | 15.1 | 16.5 | 18.0 | 19.8 | 21.8 |
| **1: 0** | **12** | -0.3667 | 16.3568 | 0.08797 | 12.7 | 13.8 | 15.0 | 16.4 | 17.9 | 19.6 | 21.6 |
| **1: 1** | **13** | -0.3932 | 16.2311 | 0.08768 | 12.6 | 13.7 | 14.9 | 16.2 | 17.7 | 19.5 | 21.4 |
| **1: 2** | **14** | -0.4177 | 16.1128 | 0.08741 | 12.6 | 13.6 | 14.8 | 16.1 | 17.6 | 19.3 | 21.3 |
| **1: 3** | **15** | -0.4407 | 16.0028 | 0.08716 | 12.5 | 13.5 | 14.7 | 16.0 | 17.5 | 19.2 | 21.1 |
| **1: 4** | **16** | -0.4623 | 15.9017 | 0.08693 | 12.4 | 13.5 | 14.6 | 15.9 | 17.4 | 19.1 | 21.0 |
| **1: 5** | **17** | -0.4825 | 15.8096 | 0.08671 | 12.4 | 13.4 | 14.5 | 15.8 | 17.3 | 18.9 | 20.9 |
| **1: 6** | **18** | -0.5017 | 15.7263 | 0.08650 | 12.3 | 13.3 | 14.4 | 15.7 | 17.2 | 18.8 | 20.8 |
| **1: 7** | **19** | -0.5199 | 15.6517 | 0.08630 | 12.3 | 13.3 | 14.4 | 15.7 | 17.1 | 18.8 | 20.7 |
| **1: 8** | **20** | -0.5372 | 15.5855 | 0.08612 | 12.2 | 13.2 | 14.3 | 15.6 | 17.0 | 18.7 | 20.6 |
| **1: 9** | **21** | -0.5537 | 15.5278 | 0.08594 | 12.2 | 13.2 | 14.3 | 15.5 | 17.0 | 18.6 | 20.5 |
| **1:10** | **22** | -0.5695 | 15.4787 | 0.08577 | 12.2 | 13.1 | 14.2 | 15.5 | 16.9 | 18.5 | 20.4 |
| **1:11** | **23** | -0.5846 | 15.4380 | 0.08560 | 12.2 | 13.1 | 14.2 | 15.4 | 16.9 | 18.5 | 20.4 |
| **2: 0** | **24**[a] | -0.5989 | 15.4052 | 0.08545 | 12.1 | 13.1 | 14.2 | 15.4 | 16.8 | 18.4 | 20.3 |

[a] 24 months corresponds to 730 days.

**Table 97 Height-based BMI-for-age for girls, age in years and months**

| Year: Month | Month | L | M | S | Percentiles (BMI in $kg/m^2$) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1st | 3rd | 5th | 15th | 25th | 50th | 75th | 85th | 95th | 97th | 99th |
| **2: 0** | **24**[a] | -0.5684 | 15.6881 | 0.08454 | 13.0 | 13.5 | 13.7 | 14.4 | 14.8 | 15.7 | 16.6 | 17.2 | 18.1 | 18.5 | 19.3 |
| **2: 1** | **25** | -0.5684 | 15.6590 | 0.08452 | 13.0 | 13.4 | 13.7 | 14.4 | 14.8 | 15.7 | 16.6 | 17.1 | 18.1 | 18.5 | 19.3 |
| **2: 2** | **26** | -0.5684 | 15.6308 | 0.08449 | 13.0 | 13.4 | 13.7 | 14.4 | 14.8 | 15.6 | 16.6 | 17.1 | 18.1 | 18.5 | 19.3 |
| **2: 3** | **27** | -0.5684 | 15.6037 | 0.08446 | 13.0 | 13.4 | 13.7 | 14.3 | 14.8 | 15.6 | 16.5 | 17.1 | 18.0 | 18.4 | 19.2 |
| **2: 4** | **28** | -0.5684 | 15.5777 | 0.08444 | 12.9 | 13.4 | 13.6 | 14.3 | 14.7 | 15.6 | 16.5 | 17.0 | 18.0 | 18.4 | 19.2 |
| **2: 5** | **29** | -0.5684 | 15.5523 | 0.08443 | 12.9 | 13.4 | 13.6 | 14.3 | 14.7 | 15.6 | 16.5 | 17.0 | 18.0 | 18.4 | 19.2 |
| **2: 6** | **30** | -0.5684 | 15.5276 | 0.08444 | 12.9 | 13.3 | 13.6 | 14.3 | 14.7 | 15.5 | 16.5 | 17.0 | 17.9 | 18.3 | 19.1 |
| **2: 7** | **31** | -0.5684 | 15.5034 | 0.08448 | 12.9 | 13.3 | 13.6 | 14.2 | 14.7 | 15.5 | 16.4 | 17.0 | 17.9 | 18.3 | 19.1 |
| **2: 8** | **32** | -0.5684 | 15.4798 | 0.08455 | 12.8 | 13.3 | 13.5 | 14.2 | 14.6 | 15.5 | 16.4 | 16.9 | 17.9 | 18.3 | 19.1 |
| **2: 9** | **33** | -0.5684 | 15.4572 | 0.08467 | 12.8 | 13.3 | 13.5 | 14.2 | 14.6 | 15.5 | 16.4 | 16.9 | 17.9 | 18.3 | 19.0 |
| **2:10** | **34** | -0.5684 | 15.4356 | 0.08484 | 12.8 | 13.2 | 13.5 | 14.2 | 14.6 | 15.4 | 16.4 | 16.9 | 17.9 | 18.2 | 19.0 |
| **2:11** | **35** | -0.5684 | 15.4155 | 0.08506 | 12.8 | 13.2 | 13.5 | 14.1 | 14.6 | 15.4 | 16.3 | 16.9 | 17.8 | 18.2 | 19.0 |
| **3: 0** | **36** | -0.5684 | 15.3968 | 0.08535 | 12.8 | 13.2 | 13.5 | 14.1 | 14.5 | 15.4 | 16.3 | 16.9 | 17.8 | 18.2 | 19.0 |
| **3: 1** | **37** | -0.5684 | 15.3796 | 0.08569 | 12.7 | 13.2 | 13.4 | 14.1 | 14.5 | 15.4 | 16.3 | 16.8 | 17.8 | 18.2 | 19.0 |
| **3: 2** | **38** | -0.5684 | 15.3638 | 0.08609 | 12.7 | 13.2 | 13.4 | 14.1 | 14.5 | 15.4 | 16.3 | 16.8 | 17.8 | 18.2 | 19.0 |
| **3: 3** | **39** | -0.5684 | 15.3493 | 0.08654 | 12.7 | 13.1 | 13.4 | 14.1 | 14.5 | 15.3 | 16.3 | 16.8 | 17.8 | 18.2 | 19.0 |
| **3: 4** | **40** | -0.5684 | 15.3358 | 0.08704 | 12.7 | 13.1 | 13.4 | 14.0 | 14.5 | 15.3 | 16.3 | 16.8 | 17.8 | 18.2 | 19.0 |
| **3: 5** | **41** | -0.5684 | 15.3233 | 0.08757 | 12.6 | 13.1 | 13.3 | 14.0 | 14.5 | 15.3 | 16.3 | 16.8 | 17.8 | 18.2 | 19.0 |
| **3: 6** | **42** | -0.5684 | 15.3116 | 0.08813 | 12.6 | 13.1 | 13.3 | 14.0 | 14.4 | 15.3 | 16.3 | 16.8 | 17.8 | 18.2 | 19.0 |
| **3: 7** | **43** | -0.5684 | 15.3007 | 0.08872 | 12.6 | 13.0 | 13.3 | 14.0 | 14.4 | 15.3 | 16.3 | 16.8 | 17.8 | 18.2 | 19.1 |
| **3: 8** | **44** | -0.5684 | 15.2905 | 0.08931 | 12.6 | 13.0 | 13.3 | 14.0 | 14.4 | 15.3 | 16.3 | 16.8 | 17.8 | 18.2 | 19.1 |
| **3: 9** | **45** | -0.5684 | 15.2814 | 0.08991 | 12.5 | 13.0 | 13.3 | 14.0 | 14.4 | 15.3 | 16.3 | 16.8 | 17.8 | 18.3 | 19.1 |
| **3:10** | **46** | -0.5684 | 15.2732 | 0.09051 | 12.5 | 13.0 | 13.2 | 13.9 | 14.4 | 15.3 | 16.3 | 16.8 | 17.8 | 18.3 | 19.1 |
| **3:11** | **47** | -0.5684 | 15.2661 | 0.09110 | 12.5 | 13.0 | 13.2 | 13.9 | 14.4 | 15.3 | 16.3 | 16.8 | 17.9 | 18.3 | 19.1 |
| **4: 0** | **48** | -0.5684 | 15.2602 | 0.09168 | 12.5 | 12.9 | 13.2 | 13.9 | 14.4 | 15.3 | 16.3 | 16.8 | 17.9 | 18.3 | 19.2 |

**Table 97 Height-based BMI-for-age for girls, age in years and months (continued)**

| | | | | | Percentiles (BMI in kg/m$^2$) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **1st** | **3rd** | **5th** | **15th** | **25th** | **50th** | **75th** | **85th** | **95th** | **97th** | **99th** |
| **4: 1** | **49** | -0.5684 | 15.2556 | 0.09227 | 12.5 | 12.9 | 13.2 | 13.9 | 14.4 | 15.3 | 16.3 | 16.8 | 17.9 | 18.3 | 19.2 |
| **4: 2** | **50** | -0.5684 | 15.2523 | 0.09286 | 12.4 | 12.9 | 13.2 | 13.9 | 14.3 | 15.3 | 16.3 | 16.8 | 17.9 | 18.3 | 19.2 |
| **4: 3** | **51** | -0.5684 | 15.2503 | 0.09345 | 12.4 | 12.9 | 13.2 | 13.9 | 14.3 | 15.3 | 16.3 | 16.8 | 17.9 | 18.4 | 19.2 |
| **4: 4** | **52** | -0.5684 | 15.2496 | 0.09403 | 12.4 | 12.9 | 13.1 | 13.9 | 14.3 | 15.2 | 16.3 | 16.9 | 17.9 | 18.4 | 19.3 |
| **4: 5** | **53** | -0.5684 | 15.2502 | 0.09460 | 12.4 | 12.9 | 13.1 | 13.9 | 14.3 | 15.3 | 16.3 | 16.9 | 17.9 | 18.4 | 19.3 |
| **4: 6** | **54** | -0.5684 | 15.2519 | 0.09515 | 12.4 | 12.9 | 13.1 | 13.9 | 14.3 | 15.3 | 16.3 | 16.9 | 18.0 | 18.4 | 19.3 |
| **4: 7** | **55** | -0.5684 | 15.2544 | 0.09568 | 12.4 | 12.9 | 13.1 | 13.9 | 14.3 | 15.3 | 16.3 | 16.9 | 18.0 | 18.4 | 19.4 |
| **4: 8** | **56** | -0.5684 | 15.2575 | 0.09618 | 12.4 | 12.8 | 13.1 | 13.8 | 14.3 | 15.3 | 16.3 | 16.9 | 18.0 | 18.5 | 19.4 |
| **4: 9** | **57** | -0.5684 | 15.2612 | 0.09665 | 12.4 | 12.8 | 13.1 | 13.8 | 14.3 | 15.3 | 16.3 | 16.9 | 18.0 | 18.5 | 19.4 |
| **4:10** | **58** | -0.5684 | 15.2653 | 0.09709 | 12.3 | 12.8 | 13.1 | 13.8 | 14.3 | 15.3 | 16.3 | 16.9 | 18.0 | 18.5 | 19.4 |
| **4:11** | **59** | -0.5684 | 15.2698 | 0.09750 | 12.3 | 12.8 | 13.1 | 13.8 | 14.3 | 15.3 | 16.3 | 16.9 | 18.1 | 18.5 | 19.5 |
| **5: 0** | **60** | -0.5684 | 15.2747 | 0.09789 | 12.3 | 12.8 | 13.1 | 13.8 | 14.3 | 15.3 | 16.3 | 17.0 | 18.1 | 18.6 | 19.5 |

[a] 24 months corresponds to 731 days.

**Table 97 Height-based BMI-for-age for girls, age in years and months (continued)**

| Year: Month | Month | L | M | S | Z-scores (BMI in kg/m²) -3 SD | -2 SD | -1 SD | Median | 1 SD | 2 SD | 3 SD |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **2: 0** | **24**[a] | -0.5684 | 15.6881 | 0.08454 | 12.4 | 13.3 | 14.4 | 15.7 | 17.1 | 18.7 | 20.6 |
| **2: 1** | **25** | -0.5684 | 15.6590 | 0.08452 | 12.4 | 13.3 | 14.4 | 15.7 | 17.1 | 18.7 | 20.6 |
| **2: 2** | **26** | -0.5684 | 15.6308 | 0.08449 | 12.3 | 13.3 | 14.4 | 15.6 | 17.0 | 18.7 | 20.6 |
| **2: 3** | **27** | -0.5684 | 15.6037 | 0.08446 | 12.3 | 13.3 | 14.4 | 15.6 | 17.0 | 18.6 | 20.5 |
| **2: 4** | **28** | -0.5684 | 15.5777 | 0.08444 | 12.3 | 13.3 | 14.3 | 15.6 | 17.0 | 18.6 | 20.5 |
| **2: 5** | **29** | -0.5684 | 15.5523 | 0.08443 | 12.3 | 13.2 | 14.3 | 15.6 | 17.0 | 18.6 | 20.4 |
| **2: 6** | **30** | -0.5684 | 15.5276 | 0.08444 | 12.3 | 13.2 | 14.3 | 15.5 | 16.9 | 18.5 | 20.4 |
| **2: 7** | **31** | -0.5684 | 15.5034 | 0.08448 | 12.2 | 13.2 | 14.3 | 15.5 | 16.9 | 18.5 | 20.4 |
| **2: 8** | **32** | -0.5684 | 15.4798 | 0.08455 | 12.2 | 13.2 | 14.3 | 15.5 | 16.9 | 18.5 | 20.4 |
| **2: 9** | **33** | -0.5684 | 15.4572 | 0.08467 | 12.2 | 13.1 | 14.2 | 15.5 | 16.9 | 18.5 | 20.3 |
| **2:10** | **34** | -0.5684 | 15.4356 | 0.08484 | 12.2 | 13.1 | 14.2 | 15.4 | 16.8 | 18.5 | 20.3 |
| **2:11** | **35** | -0.5684 | 15.4155 | 0.08506 | 12.1 | 13.1 | 14.2 | 15.4 | 16.8 | 18.4 | 20.3 |
| **3: 0** | **36** | -0.5684 | 15.3968 | 0.08535 | 12.1 | 13.1 | 14.2 | 15.4 | 16.8 | 18.4 | 20.3 |
| **3: 1** | **37** | -0.5684 | 15.3796 | 0.08569 | 12.1 | 13.1 | 14.1 | 15.4 | 16.8 | 18.4 | 20.3 |
| **3: 2** | **38** | -0.5684 | 15.3638 | 0.08609 | 12.1 | 13.0 | 14.1 | 15.4 | 16.8 | 18.4 | 20.3 |
| **3: 3** | **39** | -0.5684 | 15.3493 | 0.08654 | 12.0 | 13.0 | 14.1 | 15.3 | 16.8 | 18.4 | 20.3 |
| **3: 4** | **40** | -0.5684 | 15.3358 | 0.08704 | 12.0 | 13.0 | 14.1 | 15.3 | 16.8 | 18.4 | 20.3 |
| **3: 5** | **41** | -0.5684 | 15.3233 | 0.08757 | 12.0 | 13.0 | 14.1 | 15.3 | 16.8 | 18.4 | 20.4 |
| **3: 6** | **42** | -0.5684 | 15.3116 | 0.08813 | 12.0 | 12.9 | 14.0 | 15.3 | 16.8 | 18.4 | 20.4 |
| **3: 7** | **43** | -0.5684 | 15.3007 | 0.08872 | 11.9 | 12.9 | 14.0 | 15.3 | 16.8 | 18.4 | 20.4 |
| **3: 8** | **44** | -0.5684 | 15.2905 | 0.08931 | 11.9 | 12.9 | 14.0 | 15.3 | 16.8 | 18.5 | 20.4 |
| **3: 9** | **45** | -0.5684 | 15.2814 | 0.08991 | 11.9 | 12.9 | 14.0 | 15.3 | 16.8 | 18.5 | 20.5 |
| **3:10** | **46** | -0.5684 | 15.2732 | 0.09051 | 11.9 | 12.9 | 14.0 | 15.3 | 16.8 | 18.5 | 20.5 |
| **3:11** | **47** | -0.5684 | 15.2661 | 0.09110 | 11.8 | 12.8 | 14.0 | 15.3 | 16.8 | 18.5 | 20.5 |
| **4: 0** | **48** | -0.5684 | 15.2602 | 0.09168 | 11.8 | 12.8 | 14.0 | 15.3 | 16.8 | 18.5 | 20.6 |

**Table 97 Height-based BMI-for-age for girls, age in years and months (continued)**

| | | | | | Z-scores (BMI in kg/m$^2$) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year: Month** | **Month** | **L** | **M** | **S** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | **1 SD** | **2 SD** | **3 SD** |
| **4: 1** | **49** | -0.5684 | 15.2556 | 0.09227 | 11.8 | 12.8 | 13.9 | 15.3 | 16.8 | 18.5 | 20.6 |
| **4: 2** | **50** | -0.5684 | 15.2523 | 0.09286 | 11.8 | 12.8 | 13.9 | 15.3 | 16.8 | 18.6 | 20.7 |
| **4: 3** | **51** | -0.5684 | 15.2503 | 0.09345 | 11.8 | 12.8 | 13.9 | 15.3 | 16.8 | 18.6 | 20.7 |
| **4: 4** | **52** | -0.5684 | 15.2496 | 0.09403 | 11.7 | 12.8 | 13.9 | 15.2 | 16.8 | 18.6 | 20.7 |
| **4: 5** | **53** | -0.5684 | 15.2502 | 0.09460 | 11.7 | 12.7 | 13.9 | 15.3 | 16.8 | 18.6 | 20.8 |
| **4: 6** | **54** | -0.5684 | 15.2519 | 0.09515 | 11.7 | 12.7 | 13.9 | 15.3 | 16.8 | 18.7 | 20.8 |
| **4: 7** | **55** | -0.5684 | 15.2544 | 0.09568 | 11.7 | 12.7 | 13.9 | 15.3 | 16.8 | 18.7 | 20.9 |
| **4: 8** | **56** | -0.5684 | 15.2575 | 0.09618 | 11.7 | 12.7 | 13.9 | 15.3 | 16.8 | 18.7 | 20.9 |
| **4: 9** | **57** | -0.5684 | 15.2612 | 0.09665 | 11.7 | 12.7 | 13.9 | 15.3 | 16.9 | 18.7 | 21.0 |
| **4:10** | **58** | -0.5684 | 15.2653 | 0.09709 | 11.7 | 12.7 | 13.9 | 15.3 | 16.9 | 18.8 | 21.0 |
| **4:11** | **59** | -0.5684 | 15.2698 | 0.09750 | 11.6 | 12.7 | 13.9 | 15.3 | 16.9 | 18.8 | 21.0 |
| **5: 0** | **60** | -0.5684 | 15.2747 | 0.09789 | 11.6 | 12.7 | 13.9 | 15.3 | 16.9 | 18.8 | 21.1 |

[a] 24 months corresponds to 731 days.

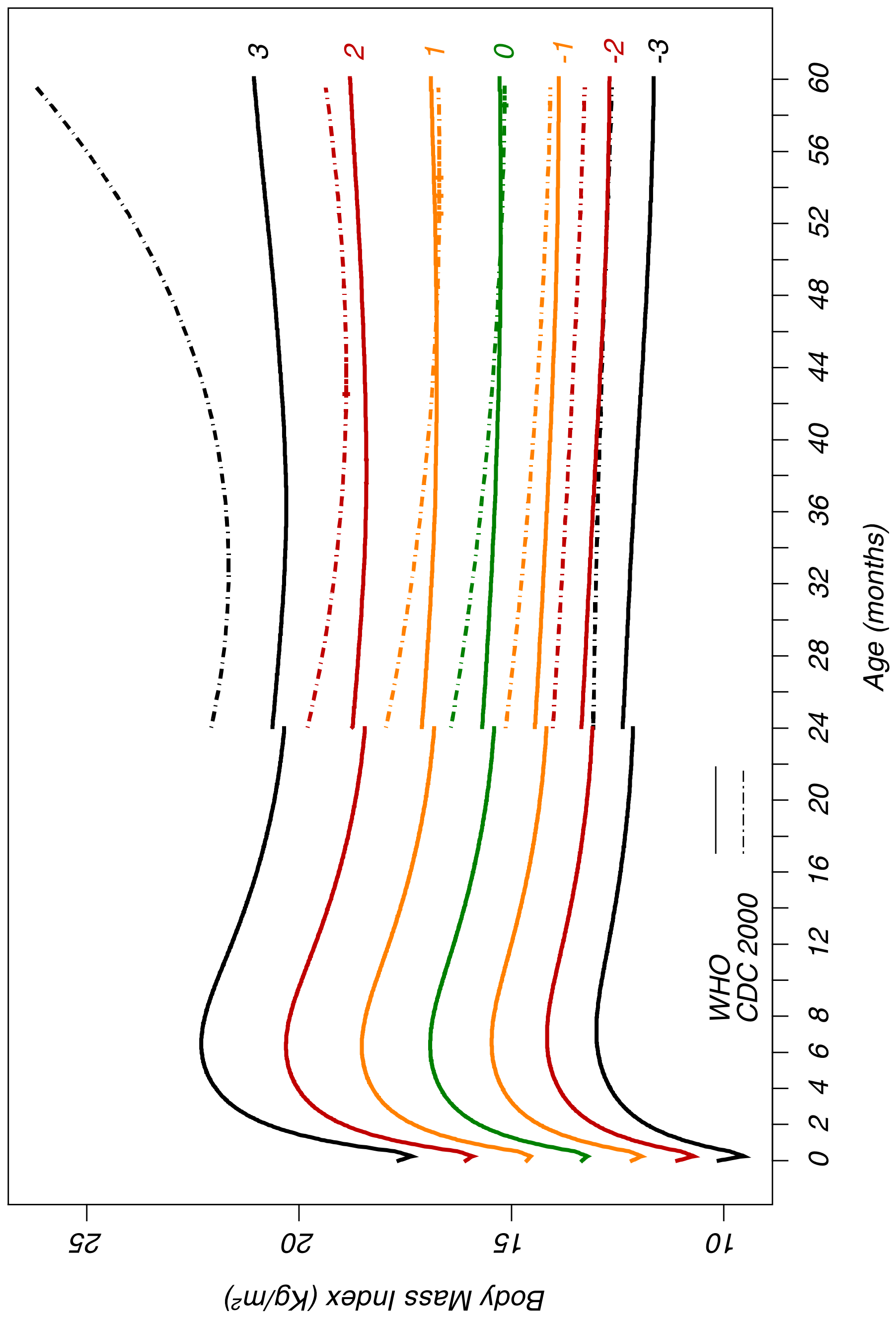


**Figure 133 Comparison of WHO with CDC 2000 BMI-for-age z-scores for girls**

## 6.4 Comparisons between boys and girls

This section presents the BMI-for-age z-score comparisons between boys and girls for WHO standards (Figure 134), and for CDC 2000 references (Figure 135).

### 6.4.1 WHO

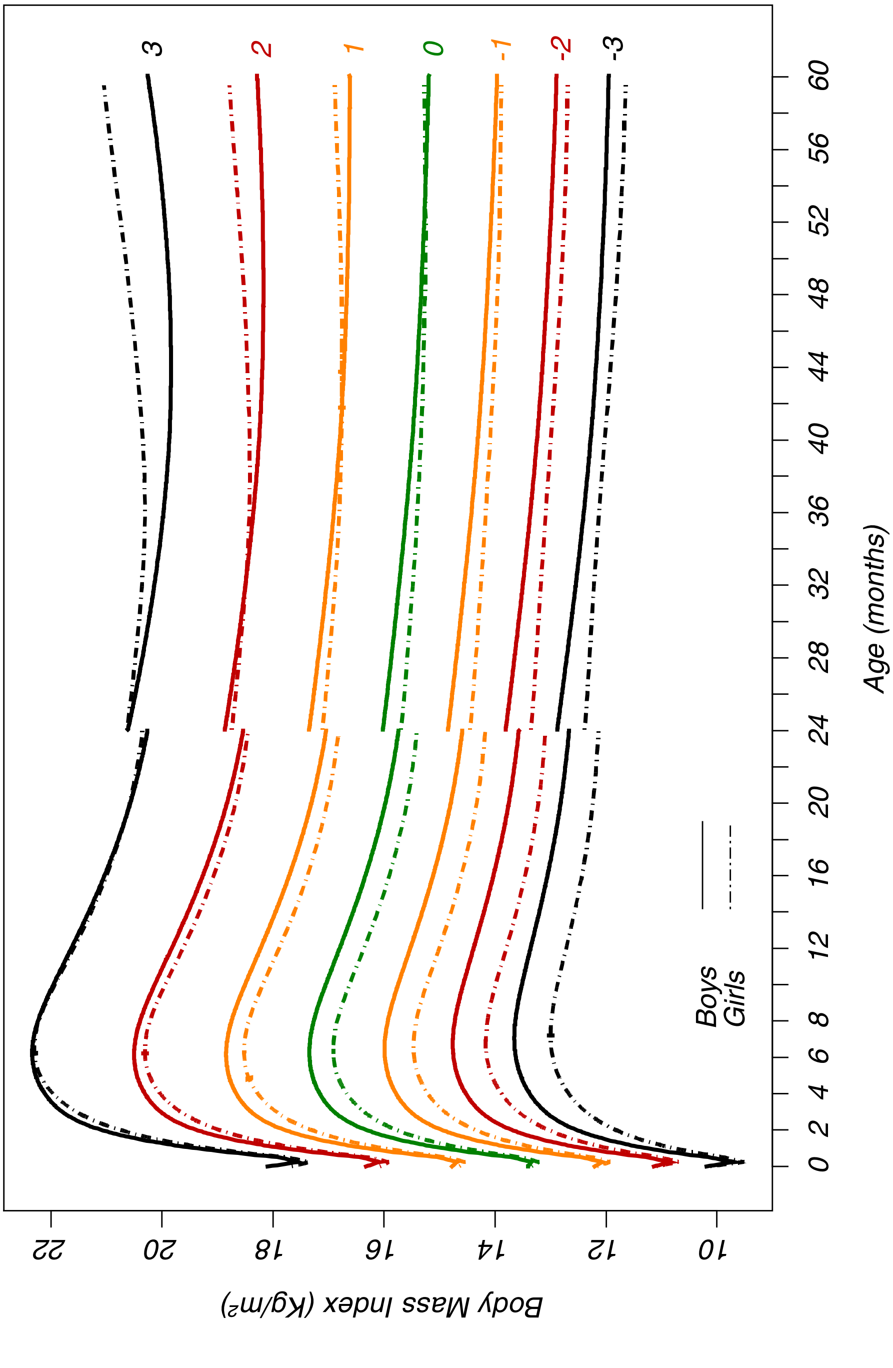


**Figure 134 Comparison of boys' and girls' WHO BMI-for-age z-scores**

### 6.4.2 CDC 2000

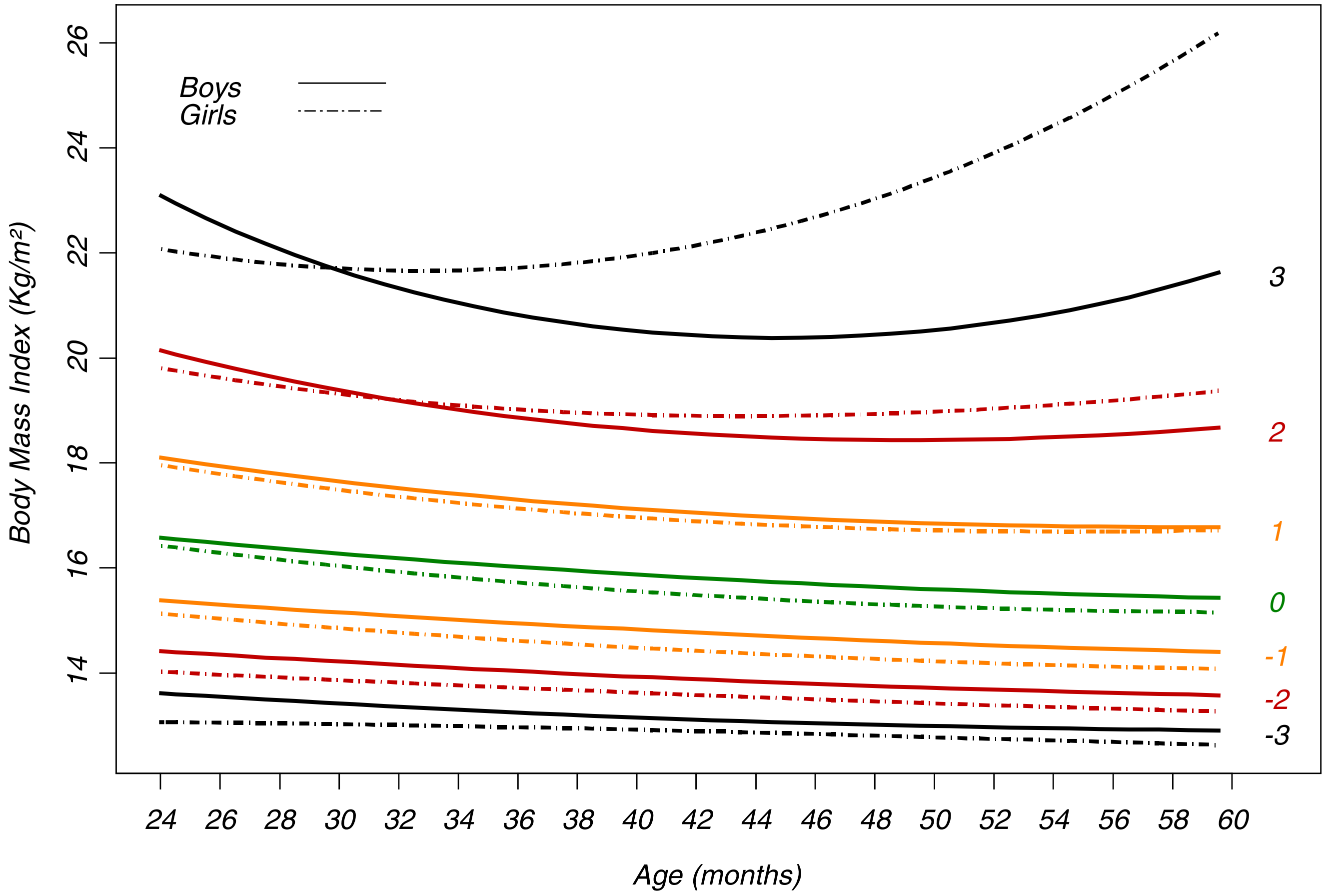


**Figure 135 Comparison of boys' and girls' CDC 2000 BMI-for-age z-scores**

## 7. COMPUTATION OF CENTILES AND Z-SCORES FOR LENGTH/HEIGHT-FOR-AGE, WEIGHT-FOR-AGE, WEIGHT-FOR-LENGTH, WEIGHT-FOR-HEIGHT AND BMI-FOR-AGE

The method used to construct the standards based on weight, length/height and age, generally relied on GAMLSS with the Box-Cox power exponential distribution (Rigby and Stasinopoulos, 2004a). However, the final selected models simplified to the LMS model (Cole and Green, 1992) since none of the standards required adjustment for kurtosis. As a result, the computation of percentiles and z-scores for these standards uses formulae based on the LMS method. However, a restriction was imposed on all indicators to enable the derivation of percentiles only within the interval corresponding to z-scores between -3 and 3. The underlying reasoning is that percentiles beyond ±3 SD are invariant to changes in equivalent z-scores. The loss accruing to this restriction is small since the inclusion range corresponds to the 0.135th to 99.865th percentiles.

For all indicators, the tabulated fitted values of Box-Cox power, median and coefficient of variation corresponding to age (or length/height) *t* are denoted by *L(t)*, *M(t)* and *S(t)*, respectively.

*Centiles and z-scores for length/height-for-age*

For this indicator, *L(t)* is equal to 1, simplifying the Box-Cox normal distribution used in the LMS method to the normal distribution. Therefore, differences between adjacent standard deviations (e.g. between 2 SD and 3 SD) were constant for a specific age but varied at different ages.

In this case, the centiles at age *t* can be estimated from:

$$\begin{aligned} C_{100\alpha}(t) &= M(t)\left[1 + L(t)S(t)Z_\alpha\right]^{1/L(t)} = M(t)\left[1 + S(t)Z_\alpha\right] \\ &= M(t) + StDev(t)Z_\alpha, \qquad -3 \le Z_\alpha \le 3 \end{aligned}$$

where $Z_\alpha$ is the normal equivalent deviate for tail area α, C100α(t) is the 100α-th centile, and *StDev(t)* is the standard deviation at age *t* (derived from multiplying *S(t)* by *M(t)*).

The z-score for a measurement *y* at age *t* was computed as:

$$z_{ind} = \frac{\left[y / M(t)\right]^{L(t)} - 1}{S(t)L(t)} = \frac{y - M(t)}{StDev(t)}$$

*Centiles and z-scores for weight-for-age, weight-for-length, weight-for-height and BMI-for-age*

The weight-based indicators presented right-skewed distributions. When modelled correctly, right skewness in data has the effect of making distances between positive z-scores increase progressively the farther away they are from the median, while distances between negative z-scores decrease progressively. The LMS method fits skewed data adequately by using a Box-Cox normal distribution, which follows the empirical data closely. The drawback, however, is that the outer tails of the distribution are highly affected by extreme data points even if only very few (e.g. less than 1%). A restricted application of the LMS method was thus used for the construction of the WHO weight-based indicators, limiting the Box-Cox normal distribution to the interval corresponding to z-scores where empirical data were available (i.e. between -3 SD and 3 SD). Beyond these limits, the standard deviation at each age (or length/height) was fixed to the distance between ±2 SD and ±3 SD, respectively. This approach avoids making assumptions about the distribution of data beyond the limits of the observed values.

As a result of this adjustment, the z-score distribution can depart slightly from normality at the extreme tails (beyond ±3 SD), although the expected practical impact is minimal.

The centiles were calculated as follows:

$$C_{100\alpha}(t) = M(t)\left[1 + L(t)S(t)Z_\alpha\right]^{1/L(t)}, \qquad -3 \le Z_\alpha \le 3$$

The following procedure is recommended to calculate a z-score for an individual child with measurement $y$ at age (or length/height) $t$:

**1.** Calculate

$$z_{ind} = \frac{\left[\frac{y}{M(t)}\right]^{L(t)} - 1}{S(t)L(t)}$$

**2.** Compute the final z-score $\left(z_{ind}^{*}\right)$ of the child for that indicator as:

$$z_{ind}^{*} = \begin{cases} z_{ind} & \text{if} \quad |z_{ind}| \le 3 \\ 3 + \left(\dfrac{y - SD3pos}{SD23pos}\right) & \text{if} \quad z_{ind} > 3 \\ -3 + \left(\dfrac{y - SD3neg}{SD23neg}\right) & \text{if} \quad z_{ind} < -3 \end{cases}$$

where

$SD3pos$ is the cut-off 3 SD calculated at *t* by the LMS method:

$$SD3pos = M(t)[1 + L(t) * S(t) * (3)]^{1/L(t)};$$

$SD3neg$ is the cut-off -3 SD calculated at *t* by the LMS method:

$$SD3neg = M(t)[1 + L(t) * S(t) * (-3)]^{1/L(t)};$$

$SD23pos$ is the difference between the cut-offs 3 SD and 2 SD calculated at *t* by the LMS method:

$$SD23pos = M(t)[1 + L(t) * S(t) * (3)]^{1/L(t)} - M(t)[1 + L(t) * S(t) * (2)]^{1/L(t)};$$

and $SD23neg$ is the difference between the cut-offs -2 SD and -3 SD calculated at *t* by the LMS method:

$$SD23neg = M(t)[1 + L(t) * S(t) * (-2)]^{1/L(t)} - M(t)[1 + L(t) * S(t) * (-3)]^{1/L(t)}$$

To illustrate the procedure, an example with BMI-for-age for boys is provided below and displayed in Figure 136.

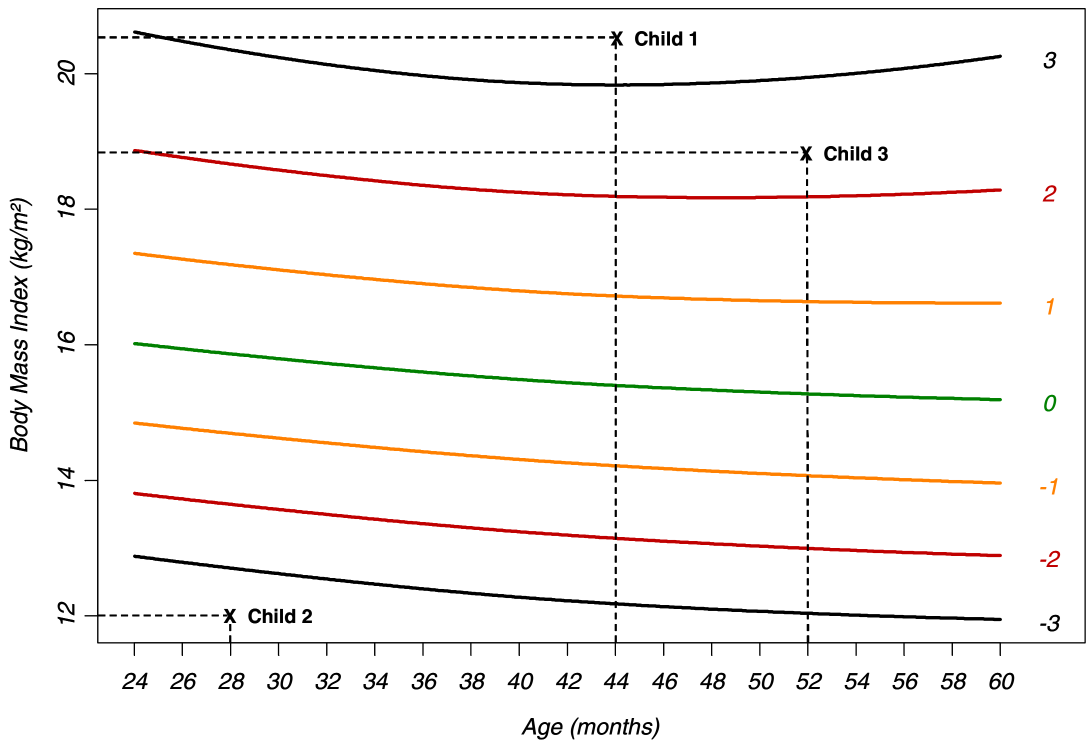


**Figure 136 Examples of children ranked according to the WHO BMI-for-age standards**

**Child 1:** 44 month-old boy with BMI=20.5.

L=-0.3067; M=15.4013; S=0.08115;

$$z_{ind} = \frac{\left[{}^{20.5}\!\diagup_{15.4013}\right]^{(-0.3067)} - 1}{0.08115 * (-0.3067)} = 3.37 \quad \mathbf{>3}$$

$$SD3pos = 15.4013 * [1 + (-0.3067) * 0.08115 * (3)]^{1/(-0.3067)} = 19.84$$
$$SD2pos = 15.4013 * [1 + (-0.3067) * 0.08115 * (2)]^{1/(-0.3067)} = 18.19$$
$$SD23pos = 19.84 - 18.19 = 1.65$$
$$\Rightarrow \quad z^*_{ind} = 3 + \left(\frac{20.5 - 19.84}{1.65}\right) = 3.40$$

**Child 2:** 28 month-old boy with BMI=12.

L=-0.4850; M=15.8667; S=0.07818;

$$z_{ind} = \frac{\left[{}^{12.0}\!\diagup_{15.8667}\right]^{(-0.4850)} - 1}{0.07818 * (-0.4850)} = -3.83 \quad \mathbf{<-3}$$

$$SD2neg = 15.8667 * [1 + (-0.4850) * 0.07818 * (-2)]^{1/(-0.4850)} = 13.65$$
$$SD3neg = 15.8667 * [1 + (-0.4850) * 0.07818 * (-3)]^{1/(-0.4850)} = 12.71$$
$$SD23neg = 13.65 - 12.71 = 0.94$$
$$\Rightarrow \quad z^*_{ind} = -3 + \left(\frac{12.0 - 12.71}{0.94}\right) = -3.76$$

**Child 3:** 52 month-old boy with BMI=18.8

L=-0.4488; M=15.2759; S=0.08380;

$$z_{ind} = \frac{\left[{}^{18.8}\!\diagup_{15.2759}\right]^{(-0.4488)} - 1}{0.08380 * (-0.4488)} = 2.37 \quad \mathbf{\geq -3 \text{ and } \leq 3 \quad (LMS\ z\text{-}score)}$$

## 8. CONCLUSION

The goal of the MGRS was to describe the growth of healthy children. Well-defined criteria were applied in the study design to achieve this aim. Screening at enrolment using site-specific socioeconomic criteria and maternal non-smoking status excluded children likely to experience constrained growth. Morbidities that affect growth (e.g. repeated bouts of infectious diarrhoea and Crohn disease) were identified and affected children were excluded from the sample. Application of these criteria resulted in the exclusion of all detectable undernutrition from both the longitudinal and cross-sectional samples.

In the longitudinal sample, the criterion of breastfeeding through 12 months and its close monitoring throughout data collection yielded a sample of children with no evidence of overnutrition (i.e. no excessive right skewness). In the cross-sectional sample, however, despite the criterion of at least 3 months of any breastfeeding, the sample was exceedingly skewed to the right, indicating the need to identify and exclude excessively high weights for height if the goal of constructing a standard was to be achieved. A similar prescriptive approach was taken by the developers of the CDC 2000 growth charts for the USA when, for the weight and BMI growth charts, they excluded data from the last national survey (i.e. NHANES III) for children aged ≥6 years. Without this exclusion, the 95th and 85th percentile curves of the CDC charts would have been higher, and fewer children would have been classified as overweight or at risk of overweight (Kuczmarski et al., 2002).

The construction of the child growth curves followed a careful, methodical process. Rigorous methods of data collection, standardized across sites, were followed during the entire study. Sound procedures for data management and cleaning were applied (Onyango et al., 2004). As a result, the anthropometric data available for analysis were of the highest possible quality. The selection of the best statistical approach to construct the standards followed a broad consultative process that included a thorough review of 30 available methods. State-of-the-art statistical methodologies were then employed to generate the standards (Borghi et al., 2006).

The Box-Cox-power-exponential (BCPE) method (Rigby and Stasinopoulos, 2004a), with curve smoothing by cubic splines, was selected as the approach for constructing the growth curves. The BCPE accommodates various kinds of distributions, from normal to skewed or kurtotic, as necessary. There was wide variability in the degrees of freedom required for the cubic splines to achieve the best models. Except for length/height-for-age, which followed a normal distribution, all other standards required the modelling of skewness but not kurtosis. A set of diagnostic tools was used to detect possible biases in estimated percentile or z-score curves. These included examining patterns of differences between empirical and fitted centiles, and comparing observed and expected proportions of children with measurements below selected percentile curves. Percentile and z-score curves for boys and girls aged 0–60 months were generated for length/height-for-age, weight-for-age, weight-for-length (45 to 110 cm), weight-for-height (65 to 120 cm) and body mass index-for-age. The last indicator is an addition to the previously available set of indicators in the NCHS/WHO reference. Appendix A summarizes the specifications of the BCPE models for each of the standards.

It was possible to construct both length-for-age (birth to 2 years) and height-for-age (2 to 5 years) standards fitting a unique model, yet still reflect the average difference between recumbent length and standing height. The cross-sectional component included the measurement of both length and height in 1625 children aged 18 to 30 months, and from these data it was estimated that length was larger by 0.7 cm on average. To fit a single model for the whole age range, 0.7 cm was therefore added to the cross-sectional height values. After the model was fitted, the final curves were shifted downwards by 0.7 cm for ages 2 years and above to create the height-for-age standards. Coefficient of variation values were adjusted to reflect this back-transformation using the shifted medians and standard deviations. The length-for-age standard was derived directly from the fitted model. A similar approach was followed in generating the weight-for-length (45 to 110 cm) and weight-for-height (65 to 120 cm) standards.

The difference between length and height was handled differently in constructing the BMI-for-age standards. Because BMI is a ratio with squared length or height in the denominator, adding 0.7 cm to the height values and back-transforming them after fitting was not feasible. The solution adopted was to construct the standards for the younger and the older children separately based on two sets of data with an overlapping range of ages below and above 24 months. To construct the BMI-for-age standard based on length (birth to 2 years), the longitudinal sample's length data and the cross-sectional sample's height data (18 to 30 months) were combined after adding 0.7 cm to the height values. Analogously, to construct the standard from 2 to 5 years, the cross-sectional sample's height plus longitudinal sample's length data (18 to 24 months) were combined after subtracting 0.7 cm from the length values. Thus, a common set of data from 18 to 30 months was used to generate the BMI standards for the younger and the older children.

Overall, concordance between smoothed curves and empirical centiles was excellent and free of bias in both the median range and the tails, indicating that the resulting curves are an adequate description of the true growth of healthy children. The length- and height-for-age standards had the best fit, and the performance was almost as good for the standards based on combinations of weight and length. For example, the average absolute difference between smoothed and empirical centiles was 0.13 cm for boys' length-for-age (Figure 7) and 0.16 kg for girls' weight-for-height (Figure 84). Taking the sign into account, the average differences are close to zero: -0.03 cm and -0.02 kg, respectively, which indicates lack of bias in the fit between smoothed and empirical percentiles.

Differences between the previously recommended NCHS/WHO international reference and the new WHO standards have been illustrated in this report. As expected, there are notable differences that vary by age, sex, anthropometric measure and specific percentile or z-score curve. Differences are particularly important in infancy. Impact on population estimates of child malnutrition will depend on age, sex, anthropometric indicator considered, and population-specific anthropometric characteristics. Thus, it is impossible to construct an algorithm that can derive prevalence estimates based on the WHO standards directly from estimates obtained from the NCHS/WHO reference. A noteworthy effect is that estimates of stunting will be higher throughout childhood when assessed using the new WHO standards compared to the previous international reference. The growth pattern of breastfed infants compared to the NCHS/WHO reference will result in a substantial increase in underweight rates during the first half of infancy (i.e. 0–6 months) and a decrease thereafter. For wasting, the main difference between the new standards and the old reference is during infancy (i.e. up to about 70 cm length) when wasting rates will be substantially higher using the new WHO standards. With respect to overweight, use of the new WHO standards will result in a greater prevalence that will vary by age, sex and nutritional status of the index population.

To interpret differences between the WHO standards and the NCHS/WHO reference it is important to understand that they reflect differences not only in the populations used but also in the methodologies applied to construct the two sets of growth curves. To address the significant skewness of the NCHS/WHO samples' weight-for-age and weight-for-height, the developers of the reference calculated separate standard deviations for distributions below and above the median for each of the two indicators (Dibley et al., 1987). This approach is limited in fitting skewed data, especially at the extreme tails of the distribution, since it only partially adjusts for the skewness inherent in the weight-based indicators. When modelled correctly, the right skewness in data has the effect of making distances between positive z-scores increase progressively the farther away they are from the median, while distances between negative z-scores decrease progressively. To fit the skewed data adequately, the LMS method (Cole and Green, 1992) fits a Box-Cox normal distribution, which follows the empirical data closely. The drawback of this method is that the outer tails of the distribution are highly affected by extreme data points even if very few (e.g. less than 1%). A restricted application of the LMS method was thus used for the construction of the WHO weight-based indicators, limiting the Box-Cox normal distribution to the interval corresponding to z-scores where empirical data were available (i.e. between -3 SD and 3 SD). Beyond these limits, the standard deviation was fixed to the distance between ±2 SD and ±3 SD, respectively. This approach avoids making assumptions about the distribution of the data beyond the limits of the actual data (e.g. the 3 SD corresponds to the 99.9th percentile). The construction of the CDC 2000 growth charts (Kuczmarski, 2002) was also based on the LMS method and, therefore, differences seen in the comparisons between this reference and the WHO standards are largely a reflection of differences in the populations on which the two sets of curves are based.

The WHO Child Growth Standards provide a technically robust tool for assessing the well-being of infants and young children. They were derived from children who were raised in environments that minimized constraints to growth such as poor diets and infection. In addition, their mothers followed healthy practices such as breastfeeding their children and not smoking during and after pregnancy. The standards depict normal early childhood growth under optimal environmental conditions and can be used to assess children everywhere, regardless of ethnicity, socioeconomic status and type of feeding. Replacing the NCHS/WHO growth reference, which is based on children from a single country, with one based on an international group of children recognizes the fact that children the world over grow similarly when their health and care needs are met. In the same way, linking physical growth to motor development underscores the importance of looking at child development comprehensively. Together, three new elements — a *prescriptive* approach that moves beyond the development of growth references towards a standard, inclusion of children from around the world, and links between physical growth and motor development — provide a solid instrument for helping to meet the health and nutritional needs of the world's children.

## 9. BIBLIOGRAPHY

Akaike H (1974). A new look at the statistical model identification. *IEEE Transactions on Automatic Control*, 19:716–723.

Bhandari N, Bahl R, Taneja S, de Onis M, Bhan MK (2002). Growth performance of affluent Indian children is similar to that in developed countries. *Bulletin of the World Health Organization,* 80:189–195.

Borghi E, de Onis M, Garza C, Van den Broeck J, Frongillo EA, Grummer-Strawn L, van Buuren S, Pan H, Molinari L, Martorell R, Onyango AW, Martines JC for the WHO Multicentre Growth Reference Study Group (2006). Construction of the World Health Organization child growth standards: selection of methods for attained growth curves. *Statistics in Medicine*, 25:247–265.

Cole TJ, Green PJ (1992). Smoothing reference centile curves: the LMS method and penalized likelihood. *Statistics in Medicine*, 11:1305–1319.

Cole TJ, Freeman JV, Preece MA (1998). British 1990 Growth reference centiles for weight, height, body mass index and head circumference fitted by maximum penalized likelihood. *Statistics in Medicine*, 17:407–429.

Daniels SR, Arnett DK, Eckel RH, Gidding SS, Hayman LL, Kumanyika S, Robinson TN, Scott BJ, St Jeor S, Williams CL (2005). AHA Scientific Statement. Overweight in children and adolescents: Pathophysiology, consequences, prevention and treatment. *Circulation*, 111:1999–2012.

de Onis M, Habicht JP (1996). Anthropometric reference data for international use: recommendations from a World Health Organization Expert Committee. *American Journal of Clinical Nutrition*, 64:650–658.

de Onis M, Yip R (1996). The WHO growth chart: historical considerations and current scientific issues. *Bibliotheca Nutritio et Dieta*, 53:74–89.

de Onis M, Garza C, Victora CG, Bhan MK, Norum KR, eds (2004a). WHO Multicentre Growth Reference Study (MGRS): Rationale, planning and implementation. *Food and Nutrition Bulletin*, 25(Suppl 1):S1–S89.

de Onis M, Garza C, Victora CG, Onyango AW, Frongillo EA, Martines J, for the WHO Multicentre Growth Reference Study Group (2004b). The WHO Multicentre Growth Reference Study: planning, study design and methodology. *Food and Nutrition Bulletin*, 25(Suppl 1):S15–S26.

de Onis M, Onyango AW, Van den Broeck J, Chumlea WC, Martorell R, for the WHO Multicentre Growth Reference Study Group (2004c). Measurement and standardization protocols for anthropometry used in the construction of a new international growth reference. *Food and Nutrition Bulletin*, 25(Suppl 1):S27–S36.

Dibley MJ, Goldsby JB, Staehling NW, Trowbridge FL (1987). Development of normalized curves for the international growth reference: historical and technical considerations. *American Journal of Clinical Nutrition*, 46:736–748.

Garza C, de Onis M, for the WHO Multicentre Growth Reference Study Group (2004). Rationale for developing a new international growth reference. *Food and Nutrition Bulletin*, 25(Suppl 1):S5–S14.

Johnson NL (1949). Systems of frequency curves generated by methods of translation. *Biometrika*, 36:149–176.

Jorde LB, Wooding SP (2004). Genetic variation, classification and 'race'. *Nature Genetics*, 36(Suppl 11):S28–S33.

King MC, Motulsky AG (2002). Mapping Human History. *Science*, 298:2342–2343.

Koplan JP, Liverman CT, Kraak VI, eds (2005). Preventing childhood obesity: health in the balance. Washington, DC: National Academy Press.

Kuczmarski RJ, Ogden CL, Guo SS, Grummer-Strawn LM, Flegal KM, Mei Z, Wei R, Curtin LR, Roche AF, Johnson CL (2002). 2000 CDC growth charts for the United States: methods and development. National Center for Health Statistics. *Vital and Health Statistics*, Series 11 No. 246.

Mohamed AJ, Onyango AW, de Onis M, Prakash N, Mabry RM, Alasfoor DH (2004). Socioeconomic predictors of unconstrained child growth in Muscat, Oman. *Eastern Mediterranean Health Journal*, 10:295–302.

Onyango AW, Pinol AJ, de Onis M, for the WHO Multicentre Growth Reference Study Group (2004). Managing data for a multicountry longitudinal study: Experience from the WHO Multicentre Growth Reference Study. *Food and Nutrition Bulletin*, 25 Suppl 1:S46–S52.

Owusu WB, Lartey A, de Onis M, Onyango AW, Frongillo EA (2004). Factors associated with unconstrained growth among affluent Ghanaian children. *Acta Paediatrica*, 93:1115–1119.

Pan H, Cole TJ (2004). A comparison of goodness of fit tests for age-related reference ranges. *Statistics in Medicine*, 23:1749–1765.

Prader A, Largo RH, Molinari L, Issler C (1989). Physical growth of Swiss children from birth to 20 years of age. First Zurich longitudinal study of growth and development. *Helvetica Paediatrica Acta*, 52(Suppl Jun):1–125.

Rigby RA, Stasinopoulos DM (2004a). Smooth centile curves for skew and kurtotic data modelled using the Box-Cox power exponential distribution. *Statistics in Medicine*, 23:3053–3076.

Rigby RA, Stasinopoulos DM (2004b). Box-Cox t distribution for modelling skew and leptokurtotic data. Technical Report 01/04. London: STORM Research Centre, London Metropolitan University.

Rigby RA, Stasinopoulos DM (2005). Generalized additive models for location, scale and shape. *Journal of the Royal Statistical Society - Series C - Applied Statistics*, 54:507–544.

Rosenberg NA, Pritchard JK, Weber JL, Cann HM, Kidd KK, Zhivotovsky LA, Feldman MW (2002). Genetic structure of human populations. *Science*, 298:2381–2385.

Royston P, Wright EM (1998). A method for estimating age-specific reference intervals ('normal ranges') based on fractional polynomials and exponential transformation. *Journal of the Royal Statistical Society - Series A*, 161:79–101.

Royston P, Wright EM (2000). Goodness-of-fit statistics for age-specific reference intervals. *Statistics in Medicine*, 19:2943–2962.

Stasinopoulos DM, Rigby RA, Akantziliotou C (2004). Instructions on how to use the GAMLSS package in R. Technical Report 02/04. London: STORM Research Centre, London Metropolitan University.

van Buuren S, Fredriks M (2001). Worm plot. A simple diagnostic device for modelling growth reference curves. *Statistics in Medicine*, 20:1259–1277.

WHO (1983). Measuring change in Nutritional Status. Geneva: World Health Organization.

WHO (1995). Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. Technical Report Series No. 854. Geneva: World Health Organization.

WHO Multicentre Growth Reference Study Group (2006a). Assessment of differences in linear growth among populations in the WHO Multicentre Growth Reference Study. *Acta Paediatrica*, Suppl 450:57–66.

WHO Multicentre Growth Reference Study Group (2006b). Breastfeeding in the WHO Multicentre Growth Reference Study. *Acta Paediatrica*, Suppl 450:16–27.

WHO Multicentre Growth Reference Study Group (2006c). WHO Motor Development Study: Windows of achievement for six gross motor development milestones. *Acta Paediatrica*, Suppl 450:87–96.

WHO Multicentre Growth Reference Study Group (2006d). Enrolment and baseline characteristics in the WHO Multicentre Growth Reference Study. *Acta Paediatrica*, Suppl 450:7–15.

WHO Multicentre Growth Reference Study Group (2006e). Reliability of anthropometric measurements in the WHO Multicentre Growth Reference Study. *Acta Paediatrica*, Suppl 450:39–47.

WHO Working Group on Infant Growth (1994). An evaluation of infant growth. Geneva: World Health Organization.

Wright E, Royston P (1996). Age-specific reference intervals ("normal ranges"). *Stata Technical Bulletin*, 34:24–34.

## Appendix A. Model specifications of the WHO child growth standards

**Table A1 Degrees of freedom for fitting the parameters of the Box-Cox-power exponential (BCPE) distribution for the models with the best fit to generate standards based on age, length and weight in children 0–60 months of age**

| Standards | Sex | $\lambda$[a] | df($\mu$)[b] | df($\sigma$)[c] | df($\nu$)[d] | $\tau$[e] |
|---|---|---|---|---|---|---|
| Length/height, 0–60 mo | Boys | 0.35 | 12 | 6 | 0[f] | 2 |
| | Girls | 0.35 | 10 | 5 | 0[f] | 2 |
| Weight, 0–60 mo | Boys | 0.35 | 11 | 7 | 2 | 2 |
| | Girls | 0.35 | 11 | 7 | 3 | 2 |
| Weight for length/height, 0–60 mo | Boys | None | 13 | 6 | 1 | 2 |
| | Girls | None | 12 | 4 | 1 | 2 |
| BMI, 0–24 mo | Boys | 0.05 | 10 | 4 | 3 | 2 |
| | Girls | 0.05 | 10 | 3 | 3 | 2 |
| BMI, 24–60 mo | Boys | None | 4 | 3 | 3 | 2 |
| | Girls | None | 4 | 4 | 1 | 2 |

[a] Age transformation power.
[b] Degrees of freedom for the cubic splines fitting the median ($\mu$).
[c] Degrees of freedom for the cubic splines fitting the coefficient of variation ($\sigma$).
[d] Degrees of freedom for the cubic splines fitting the Box-Cox transformation power ($\nu$).
[e] Parameter related to the kurtosis fixed ($\tau$=2).
[f] $\nu$=1: Normal distribution.

In 1993 the World Health Organization (WHO) undertook a comprehensive review of the uses and interpretation of anthropometric references. The review concluded that the NCHS/WHO growth reference, which had been recommended for international use since the late 1970s, did not adequately represent early childhood growth and that new growth curves were necessary. The World Health Assembly endorsed this recommendation in 1994. The WHO Multicentre Growth Reference Study (MGRS) was undertaken in response to that endorsement and implemented between 1997 and 2003 to generate new curves for assessing the growth and development of children the world over. The MGRS collected primary growth data and related information from 8440 healthy breastfed infants and young children from diverse ethnic backgrounds and cultural settings (Brazil, Ghana, India, Norway, Oman and USA). The growth standards developed based on these data and presented in this report provide a technically robust tool that represents the best description of physiological growth for children under five years of age. The standards depict normal early childhood growth under optimal environmental conditions and can be used to assess children everywhere, regardless of ethnicity, socioeconomic status and type of feeding.

ISBN 92 4 154693 X

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