## Supporting File 1

We show the calculation of the various BMI metrics for a 120-month-old boy whose BMI is 26.585, which is 120% of the 95th percentile. The 95th percentile of BMI for this sex/age in the CDC growth charts is 22.154.

**CDC BMIz**. The LMS transformation to construct z-scores is

(

# CDC BMIz =

BMI L

M ) −1

(1)

L · S

In which the values of the L (transformation for normality), M (median), and S (coefficient of variation) parameters vary by sex and month of age (1). For this boy, L= -2.766, M = 16.646, and S = 0.129, so BMIz is [(26.585 ÷ 16.646)(-2.766) − 1] ÷ (-2.766 × 0.120) = 2.19. Note that this is

above the 97th percentile (z = 1.88), the highest BMI percentile in the CDC growth charts used to estimate the LMS parameters.

**Extended BMIz**. Children with obesity in the CDC growth charts and more recent NHANES surveys were combined to increase the sample size. BMIs in this combined sample were then modeled as a half-normal distribution characterized by a single shape parameter, σ, that is proportional to both the mean and standard deviation (2). For boys, the smoothed estimates of 𝜎̂ can be calculated as 0.3728 + 0.5196 × age (y) - 0.0091 × age (y)2. For the 10-year-old boy, σ is

4.673. This allows for the calculation of any BMI percentile ≥ 95th as

𝐵𝑀𝐼−𝐵𝑀𝐼

95𝑡ℎ

# 90 + 10 Φ (

𝜎̂𝑠𝑚𝑜𝑜𝑡ℎ

) (2)

in which Φ is the cumulative distribution function (CDF) of a standard normal distribution. The last part of (2) expresses the distance a BMI is above the 95th percentile in terms of sigma. The CDF of this distance is then multiplied by 10 and added to 90. Thus, the 120-month-old boy has an extended BMI percentile of 90 + 10 × (0.948) = 98.3, and the corresponding extended BMIz is 2.12.

**%Median**. This child has a %median of 100 × (26.585 / 16.646) = 160%.

**Percent of the CDC 95th percentile (%95th)**. The 120-month-old boy has a %95th of 100 × (26.585 / 22.154) = 120%. Although initially proposed for very high BMIs (3), this metric can be used for all children. For example, a similarly aged girl boy a BMI at the 50th percentile (16.646 kg/m2 ) would have a %95th of 75%.

**Log %Median.** On the natural log scale, the %median is 100 \* loge(26.585/16.646) = 46.8%

For this 120-month-old boy, the values of the BMI metrics are:

1. BMI = 26.585 kg/m2
2. BMIz = 2.19 SDs
3. Extended BMIz = 2.12 SDs
4. %Median = 160%
5. %95th = 120%
6. Log %median = 46.8%

## References

1. Centers for Disease Control and Prevention (CDC). (2020). Percentile data files with LMS values. [WWW document]. URL <http://www.cdc.gov/growthcharts/percentile_data_files.htm>
2. Wei R, Ogden CL, Parsons VL, Freedman DS, Hales CM. A method for calculating BMI z-scores and percentiles above the 95th percentile of the CDC growth charts. *Annals of Human Biology* 2020:1–8.
3. Flegal KM, Wei R, Ogden CL, Freedman DS, Johnson CL, Curtin LR. Characterizing extreme values of body mass index-for-age by using the 2000 Centers for Disease Control and Prevention growth charts. *American Journal of Clinical Nutrition* 2009;90:1314–1320.