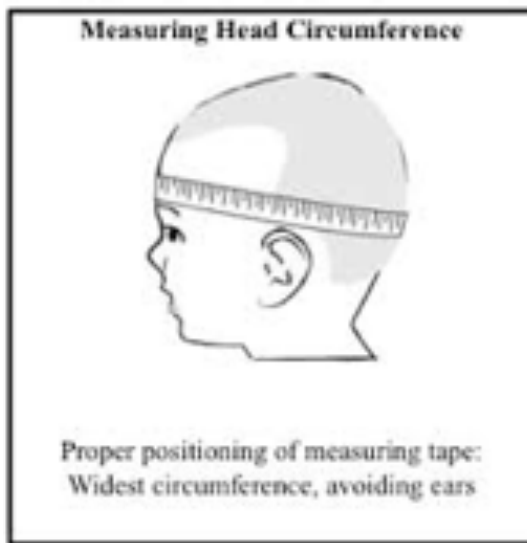


**Background:** Between the years of 1997 and 2003, the World Health Organization collected data on head circumference, arm circumference, and other body measurements for 8440 children from Brazil, Ghana, India, Norway, Oman and the USA. All of the children were healthy and breastfed by mothers who did not smoke. Children in the sample lived in socioeconomic conditions favorable to normal physical growth. Variables such as parental education level and income level were used to exclude children whose growth was “environmentally constrained”; however, low-weight full term babies were included if their mothers met socioeconomic and nutritional criteria. In short, the study design attempted to include healthy children from a wide range of ethnic and cultural groups whose home environments reasonably assured the conditions for healthy physical growth.

This data was used to produce growth charts that are part of every pediatrician’s toolkit for monitoring a child’s overall health. Governments and the United Nations also rely on growth charts to describe a country’s overall health.

([http://www.who.int/childgrowth/standards/second\\_set/technical\\_report\\_2.pdf](http://www.who.int/childgrowth/standards/second_set/technical_report_2.pdf))

*In this project we will focus on the head circumference data. Body measurements are usually bell-shaped, so we will use a normal model to represent the distribution of head circumferences in each of the following problems.*



**For full credit, show your work. Include calculations and/or a sketch of the normal curve with area shaded. State whether you used the StatCrunch Normal Calculator or the OLI Normal Calculator or the Empirical Rule.**

- 1) According to the WHO report, girls who are one month old have a mean head circumference of 36.55 centimeters with a standard deviation of 1.17 cm.
  - a) Ann is concerned that her daughter's head is small. Her daughter has a head circumference of 34.25 centimeters when she is one-month old. If we consider measurements more than 2 standard deviations from the mean as unusual, is Ann's daughter's head measurement unusually small? Support your answer.
  - b) According to Medscape.com, microcephaly is a head circumference more than two standard deviations below the mean. What percentage of 1-month old girls will be categorized as having microcephaly? How do you know?
- 2) According to the WHO report, girls who are 2-years old have a mean head circumference of 47.18 cm with a standard deviation of 1.40 cm. A two-year old girl with Down's Syndrome has a head circumference of 44.5 cm. Children with Down's Syndrome typically have smaller heads, so this is not surprising.
  - a) Relative to the WHO data, what is this girl's z-score? What does the z-score tell us?
  - b) Using the WHO data in a normal model, what percentage of the girls has a head circumference that is smaller than the girl with Down's Syndrome?