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Epidemiological Measures of health and Disease

Epidemiological Indicators of Child Health

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1 Epidemiological Indicators of Neonatal Health

Health of a child is determined from the time of conception. Some diseases such as thalassemia and sickle cell anemia have their origin in genes. Several others, such as coronary artery disease and diabetes mellitus, possibly have a substantial genetic component. But an attempt to study the genetic profile is usually made only in cases in which a manifestation has occurred or is feared. Those apart, commonly used statistical measures of neonatal health are as follows.

Birth Weight

While ultrasonographic measurements can be used to assess the growth of the fetus, the first measurement of physical health of a child after birth is the weight. This generally declines for a few days after birth and is then regained. If the weight immediately after birth cannot be recorded, the weight on the seventh day in many cases would be a good approximation. The normal range is 3.2 to 3.7 kg. A birth weight less than 2.5 kg is conventionally considered 'low' in many countries. A low birth weight not only has been found to be associated with increased risk of early mortality but also is surmised to affect growth and development during adolescence and trigger adult diseases such as coronary artery disease and diabetes. A useful index for neonates is

$$\text{Ponderal Index (for neonates)} = \frac{\text{weight in gm}}{(\text{length in cm})^3} * 100.$$

A child with ponderal index 3.0 or more can be considered overweight but in some conditions such as in maternal smoking, reduced length may also be implicated. An index between 2.5 and 3.0 is considered normal, between 2.0 and 2.5 marginal, and a child with this index less than 2.0 is classified as small for gestational age (SGA). When weight and length are both low, this index may not reveal the deficiency, but the prognosis is poorer. Such a symmetric SGA child is generally classified as intrauterine growth retarded (IUGR). This is identified by a very low

weight but a nearly normal ponderal index. Some organizations do not distinguish between SGA and IUGR children, and both are identified only by low weight, generally below 10th percentile point for the gestational age, irrespective of the length of the child.

Another index of SGA is

$$\text{Birth weight ratio (BWR)} = \frac{\text{actual weight}}{\text{expected weight for gestational age and gender}}.$$

A statistical relationship (third-degree polynomial) is available to find the expected weight for gestational age and gender [1]. The categorization is as follows.

Normal	BWR ≥ 0.90
Mild SGA	0.75 ≤ BWR < 0.90
Severe SGA	BWR < 0.75

Apgar Score

This index quantifies the neonatal prognosis and is generally measured 1 minute and 5 minutes after birth. Apgar is the name of the scientist who first proposed this index but is now also an acronym for what it measures—**a**ppearance, **p**ulse rate, **g**rimace, **a**ctivity, and **r**espiration. Skin color, heart rate, response to stimulation, muscle tone, and respiration are graded on a scale of 0 to 2, generally only as 0, 1, or 2. The sum of these five scores is called the Apgar score. A low score is associated with risk of disability, even death, and thus calls for immediate attention. A score of 8 or more is considered normal, and 7 or less is an indication of asphyxia. An Apgar of 0-2 can be considered severe asphyxia, 3-4 moderate, and 5-7 mild asphyxia.

2 Epidemiological Indicators of Growth in Children

Physical growth of a child is assessed by anthropometric measurements such as weight, height, chest circumference, and head circumference. Mathematical models for growth in stature of children are discussed by Ledford and Cole [2].

Each of the anthropometric measurements can be independently assessed by the percentile point achieved by a child relative to the healthy children of that age and gender in the same population. Median is regarded as a reference value, and 3rd and 97th percentiles as thresholds to indicate abnormally low or abnormally high values. The norms are generally obtained for age intervals of 6 months after 2 years, i.e., age 2 years, 2½ years, 3 years, 3½ years, etc. Smaller age intervals are desirable for age-specific norms for younger children and infants.

Growth charts are drawn specific to the population since different populations follow different pattern of growth. But WHO has come up with charts that could be useful in all the countries, obviating the need to be population specific. These are based on cross-section of healthy children in several countries. Male–female differences are recognized and separate charts are invariably drawn for the two sexes

Interpretation of health of the children with measurements outside 3rd and 97th percentile can be difficult. No matter how healthy children are measured to construct the chart, 3 percent of them have weight less than the 3rd percentile curve. Thus, even some fully healthy children may show a weight in the 'low' category. This is an acknowledged limitation of a growth chart, but the chart is still useful. Note that low weight in such children is in a relative

sense only—relative to the other 97 percent healthy children. Thus, a low weight does not necessarily indicate poor health in an absolute sense.

Weight-for-Age

This is the most commonly used indicator but is more effective when the trend over age for the same child is studied. This trend is compared with the trend seen in healthy subjects in that population. The assessment is population specific. The difficulty with weight-for-age however is that it fails to distinguish a thin but tall child from a well-proportioned child.

Weight-for-Height and Height-for-Age

The weight-for-height index obviates the need to know age particularly if it is between 1 and 10 years, and can be safely used for children when age is in doubt. This index measures the balance between weight and height (Length in case of children less than two years). A weight less than the 3rd percentile point for a particular height indicates wasting (i.e., thinness) associated with failure to gain weight or loss of weight. This is considered an indicator of acute undernourishment. Weight-for-height fails to detect abnormalities when both height and weight are affected.

You have seen the ponderal index for neonates in one of the preceding paragraphs. A general form of the ponderal index is weight/(height)^b, where b is estimated from the regression of log(weight) on log(height) separately for each age. Freeman et al. [3], for example, found that $b = 2.08$ for boys of 7 years, $b = 2.20$ for girls of 7 years, $b = 2.44$ for boys of 16 years, and $b = 1.75$ for girls of this age in the United Kingdom. This varies from population to population.

Another index for assessing growth is height-for-age. Low height–for–age is an indicator of stunting (i.e. shortness) when weight for height is normal. This is frequently associated with chronic undernourishment resulting mostly from a poor overall economic condition and/or repeated illness.

Z-Scores and Percent of Median

The interpretation of anthropometric measurements sometimes becomes easier when the *Z*-score is computed. This is given by

$$Z\text{-score} = \frac{\text{weight-mean}}{\text{SD}},$$

where mean and SD are calculated for reference healthy children of that age or that height. A *Z*-score below –2 is considered low and below –3 exceedingly low. These *Z*-scores can be obtained for almost all anthropometric measurements.

The other index used to assess growth is 'percent of median'. If the median weight of healthy children of height 1.10 m is 21.0 kg, and the weight of a child of this height coming to a clinic is 18.5 kg, this is $18.5/21 \times 100 = 88$ percent of the median. A measurement above 80 percent of the median is regarded as normal, between 71 percent and 80 percent as indicating undernutrition of grade I, between 61 and 70 percent of grade II, and below 60 percent of grade III. Each population can evolve its own classification. The parents are advised of suitable corrective steps depending on the grade of undernutrition found in a child.

Example 1 *Z*-scores and percent of median

Healthy children from well-to-do families were surveyed for their height, weight, age, and gender. The distribution of 450 girls by weight, taken within a week of their seventh birthday, is as follows.

Weight (kg)	14-16	16-18	18-20	20-22	22-24	24-26	26-28
No. of girls	4	36	85	182	96	40	7

Mean = 21.1 kg and SD = 2.3 kg. A girl who is nearly 7 years old comes to a clinic from the same area. Her weight is 18.3 kg. Can she be considered underweight?

$$Z\text{-score for the girl} = \frac{18.3 - 21.1}{2.3}$$
$$= -1.22.$$

$$\text{Weight as percent of median} = \frac{18.3}{21.1} \times 100$$
$$= 87.$$

A negative *Z*-score and weight less than 100% of median both indicate that the girl's weight is less than the average. However, because the *Z*-score is not less than –2 and the percent of the median is not less than 80, the weight can be regarded as within the normal variation and the girl is not classified as underweight. Thus, there is no cause for alarm. Important in this case is longitudinal follow-up to monitor that the pattern remains on normal trajectory.

Growth Velocity

Velocity is the rate of growth per unit of time. This is higher at the beginning of life and tapers off as age increases. There is a slight upswing, called mid-growth, around 6 or 7 years of age in some cases. A definite spurt is seen in adolescence. Velocity is indicated by the steepness of the curve and represents the incremental growth per unit of time. This is another indicator used to monitor growth and requires longitudinal measurements. A velocity less than normal for a particular age indicates failure to thrive. Conventional velocity charts involve two charts and so are difficult to adopt in practice. A 3-in-1 weight-monitoring chart has been devised [4] for infants. It consists of conventional weight centiles complemented with extra lines called thrive lines, where the slope defines a cutoff for failure to thrive. The weight must be measured at 4-week intervals. This chart is still to be field-tested.

Weight velocity and height velocity can be used as indicators of growth in the immediate past and thus to detect acute malnutrition. A sudden decline in weight velocity (or in weight gain) in a particular child may provide better insight into the existence of a health problem than a weight-for-age measurement. Weight-for-age is relatively slow to react and slow to show a decline. Height-for-age and weight-for age are also affected by hereditary, particularly the size of the parents. Velocity, on the other hand, when compared with the previous velocity of the same child, is relatively independent of heredity.

Skinfold Thickness

A large part of body fat is deposited under the skin. Tools such as Harpenden calipers are used to measure skinfold thickness. Soft tissue radiography can also be used to delineate subcutaneous fat. Skinfold is generally measured at the mid-triceps, biceps, and subscapular and superiliac regions. The sum of these four measurements should not generally exceed 40 mm in boys and 50 mm in girls between 5 and 10 years of age. Widely acceptable reference data for subcutaneous fat are not yet available. But for this, the skinfold is an appropriate measure of adiposity and thus is a good indicator of obesity.

Most common site for measuring skinfold thickness is triceps. In females, this continuously increases upto the age of nearly 30 years, remains stable between 30 and 50 years

at around 25-30 mm, and then declines. In contrast, in males it stabilizes quickly at age 20 years at around 15 mm.

Skinfold thickness in the newborns could be a marker for mother's nutritional status because this is not generally determined by genetic factors. Other anthropometric measurements such as birth weight, crown-heel length and head circumference have substantial genetic component.

Development

Development in the case of children refers to achieving milestones such as walking and talking. Its assessment can be done in several different ways. One popular method is the Denver development screening test (DDST). This can be used for children one month to 6 years of age. The test is mainly concerned with the measurement of attainment of various milestones in motor, language, adaptive behavior, and social behavior. Baley scale is used with children 2 to 30 months of age for testing cognitive and gross motor skills. There are many others.

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