

## Chapter Four

# Other Measures of Nutritional Status

This chapter focuses on non-dietary measures of nutritional status. Information is provided on the percentage of school-age children who were overweight or at risk of becoming overweight, based on body mass index. Information is also presented on the percentage of school-age children who were underweight and the percentage who had growth retardation or stunted linear growth.

Laboratory data are used to assess the prevalence of abnormal nutritional biochemistries, including iron deficiency, iron-deficiency anemia, anemia, low red blood cell folate, low serum vitamin B<sub>12</sub>, and elevated lipids (cholesterol and related compounds).

### Prevalence of Overweight

The prevalence of overweight among children has more than doubled since the first Health Examination Survey (a precursor to the present NHANES survey) was conducted in 1963-65 (Troiano and Flegal, 1998). Being overweight or obese significantly increases the chances of developing many diseases, including type 2 diabetes, high blood pressure, coronary heart disease, stroke, gallbladder disease, respiratory problems, osteoarthritis, sleep apnea, and some types of cancer (U.S. DHHS, 2000a).

*Healthy People 2010* includes goals to decrease the proportion of children (as well as adults) who are overweight. Classifying children as overweight is fundamentally different from classifying adults as overweight (Cole, 2001). Adults have traditionally been classified as overweight on the basis of life insurance mortality data and data relating weight status to morbidity and mortality (Troiano and Flegal,

1998). Such criteria cannot be used to define overweight in childhood because childhood mortality is not associated with weight and weight-related morbidity in childhood is too low to define meaningful cutoffs (Barlow and Dietz, 1998). Therefore, the approach used to classify children as overweight relies on comparing children's weights and heights to appropriate reference populations.

Overweight is defined on the basis of body mass index (BMI). BMI is the index that is commonly accepted for classifying adiposity (or fatness) in adults and is now recommended for use as a screening tool for children over the age of 2 (Barlow and Dietz, 1998 and CDC, 2003).<sup>1</sup> For children, overweight is defined as a BMI above the 95th percentile on CDC growth charts, which define BMI percentile distributions by age and gender (see appendix B).

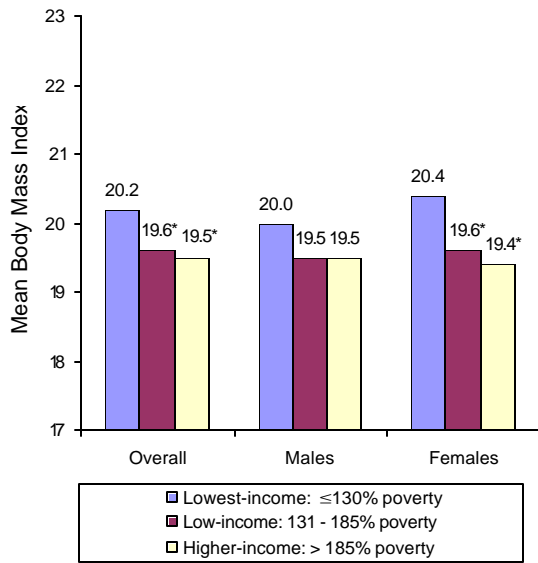
On average, children in the lowest-income group had a greater BMI than children in either of the other income groups (20.2 vs. 19.6 and 19.5) (figure 28). The difference was concentrated among females. Females in the lowest-income group had a mean BMI of 20.4, compared with means of 19.6 and 19.4 for females in the low- and higher-income groups. The difference between females in the lowest-income group and the higher-income group was attributable to differences among 11-13-year-olds (21.4 vs. 19.8) and 14-18-year-olds (23.8 vs. 21.7) (table D-62).

Overall, 11 percent of school-age children were overweight (table D-63). Prevalence was similar for males and females (11% and 10%). School-

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<sup>1</sup>BMI is equal to [weight in kilograms] / [height in meters]<sup>2</sup>.

**Figure 28—Mean Body Mass Index: School-age children**



\*Statistically significant difference from lowest-income group at the .05 level or better.  
Source: NHANES-III, 1988-94.

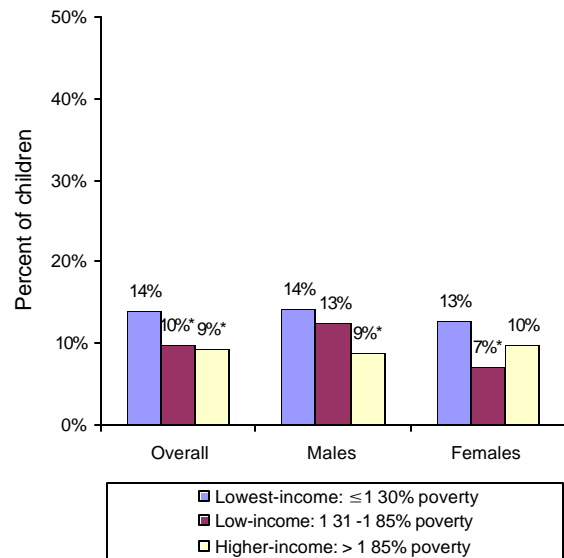
age children in the lowest-income group were significantly more likely than children in either of the other income groups to be overweight. Fourteen percent of children in the lowest-income group were overweight, compared with 9-10 percent of children in the low-income and higher-income groups (figure 29).

Differences between income groups varied by gender. Among school-age males, only the difference between the lowest-income group and the higher-income group was statistically significant (14% vs. 9%). Among females, only the difference between the lowest-income and low-income groups was statistically significant. Females in the lowest-income group were almost twice as likely as females in the low-income group to be overweight (13% vs. 7%).

### Risk of Overweight

Overall, 14 percent of school-age children were at risk of becoming overweight (defined as a BMI between the 85<sup>th</sup> and 95<sup>th</sup> percentile) (table D-63). Prevalence was comparable for males and females (figure 30). There were no signifi-

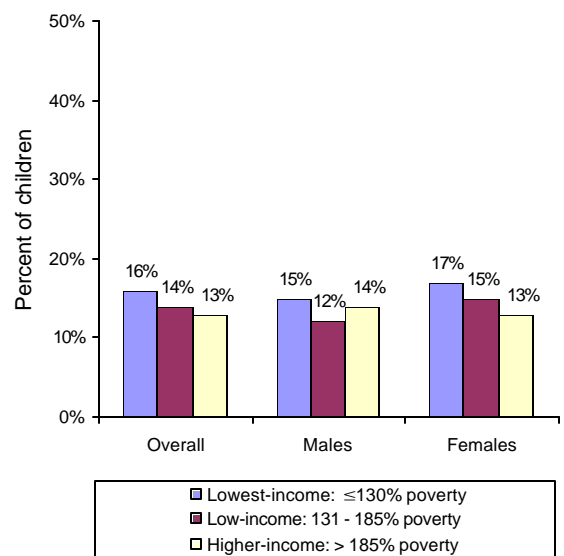
**Figure 29—Percent of school-age children who were overweight**



\*Statistically significant difference from lowest-income group at the .05 level or better.  
Source: NHANES-III, 1988-94.

cant differences between income groups, overall or by gender, in the prevalence of this problem. There was some variation by age. Among the youngest cohort of school-age children (5-10-year-olds), children in the lowest-income group were more likely than children in the low-income group to be at risk of overweight (13% vs. 8%)

**Figure 30—Percent of school-age children who were at risk of overweight**



No statistically significant differences between income groups.  
Source: NHANES-III, 1988-94.

(table D-63). In addition, among 11-13-year-olds, children in the lowest-income group were more likely than children in the higher-income group to be at risk of overweight (22% vs.13%). This difference was concentrated among females (22% vs. 12%).

### Prevalence of Underweight and Growth Retardation

Among school-age children, the prevalence of underweight, defined as BMI-for-age below the 5<sup>th</sup> percentile, was relatively rare. Overall, only 4 percent of school-age children were underweight (table D-64). This percentage is within normal expectations, given that, by definition, 5 percent of healthy children would be expected to fall below the 5<sup>th</sup> percentile due to normal biological variation (U.S. DHHS, 2000a). There were no significant differences in the prevalence of underweight along gender, age, or income lines.

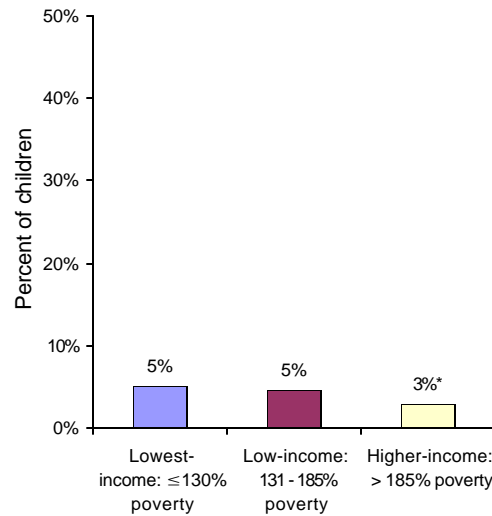
Growth retardation, defined as height-for-age below the 5<sup>th</sup> percentile was also rare among school-age children, occurring with roughly the same frequency as underweight (table D-64). This overall prevalence is within the realm of normal variation, as discussed above. Moreover, the problem of retarded linear growth is most significant among children under the age of 5 (U.S. DHHS, 2000a). Nonetheless, it is interesting to note that children in the lowest-income group were significantly more likely than children in the higher-income group to have retarded growth (5% vs. 3%) (figure 31). This difference was concentrated among males.

### Nutritional Biochemistries

#### Iron Deficiency and Iron Deficiency Anemia

Iron deficiency is the most common known form of nutritional deficiency (CDC, 1998). Iron deficiency can lead to developmental delays, behavioral problems, and decreases in verbal learning and memory. It can also affect immune

**Figure 31—Percent of school-age children with growth retardation**



\*Statistically significant difference from lowest-income group at the .05 level or better.  
Source: NHANES-III, 1988-94.

function, energy metabolism, and work performance (U.S. DHHS, 2000a, CDC, 1998, and Looker et al., 1997).

The terms anemia, iron deficiency, and iron-deficiency anemia are often used interchangeably, however, they are not equivalent (U.S. DHHS, 2000a). Although iron deficiency can contribute to anemia, anemia can also be caused by other factors, including other nutrient deficiencies, infection, inflammation, and hereditary anemias. When the prevalence of iron deficiency is high, anemia is a good predictor of iron deficiency. However, when the prevalence of iron deficiency is low, the majority of anemia is due to other causes (U.S. DHHS, 2000a).

This analysis assessed the prevalence of iron deficiency using the criterion defined in *Healthy People 2010* (U.S. DHHS, 2000a). This criterion defines iron deficiency as abnormal results on two or more of the following measures of iron status: serum transferrin saturation, erythrocyte protoporphorin, and serum ferritin. Iron-deficiency anemia was defined as documented iron deficiency (as defined above) plus an abnormally

low hemoglobin (Looker et al., 1997). Cutoff values used in the analysis are shown in appendix B. The analysis sample was limited to sample members with data for all relevant variables.

Overall, the prevalence of iron deficiency among school-age children was about 5 percent (table D-65). The prevalence among males was notably lower than the prevalence among females (3% vs. 7%) (statistical significance of gender-based difference not tested).

School-age children in the lowest-income group were significantly more likely than those in the higher-income group to be iron deficient (6% vs. 4%) (figure 32). This difference was attributable to a difference among females. Among school-age females, the prevalence of iron deficiency in the lowest-income group was twice that of the higher-income group (10% vs. 5%) (table D-65). Moreover, differences between the two groups of females were concentrated among 11-13-year-olds and 14-18-year-olds. Among 14-18-year-old females, the prevalence of iron defi-

ciency in the lowest-income group was significantly greater than the prevalence in either the low-income or higher-income groups (the point estimate for the lowest-income group is statistically unreliable).

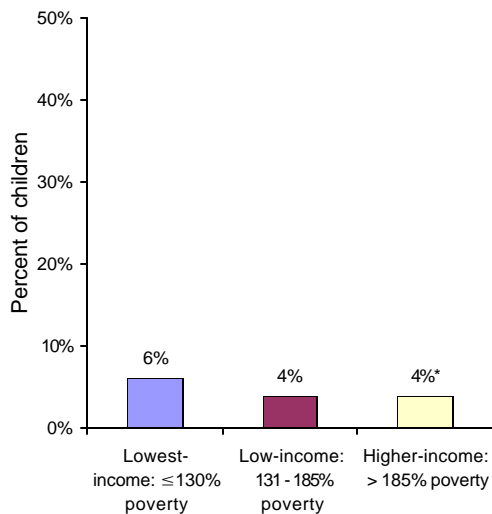
Iron-deficiency anemia was observed in less than 1 percent of school-age children overall (table D-69). Because of low prevalence, the point estimates for most subgroups are unreliable. Nonetheless, the data indicate clearly that the prevalence of iron-deficiency was greatest among 14-18-year-old females. Overall, about 3 percent of females in this age group had iron-deficiency anemia. There were no significant differences between income groups on this measure.

The prevalence of low levels of hemoglobin and hematocrit, commonly used to identify anemia in clinical settings, was substantially greater than the prevalence of iron-deficiency anemia as assessed in this analysis. Six percent of all school-age children had low levels of hemoglobin or hematocrit (tables D-70 and D-71). The prevalence of abnormal levels was slightly greater for females than males (7% vs. 5%) (statistical significance of gender-based difference not tested). There were scattered differences between income groups on these measures.

### Red Blood Cell (RBC) Folate

Overall, 6 percent of school-age children had low levels of red blood cell (RBC) folate, an indicator of long-term folate status (Wright et al., 1998) (table D-72). The prevalence of low levels of RBC folate was notably greater among females than males (5% vs. 8%). Moreover, the prevalence of inadequate folate status increased markedly with age (significance of gender- and age-based differences not tested). This pattern was observed for both males and females.

**Figure 32—Percent of school-age children with iron deficiency**

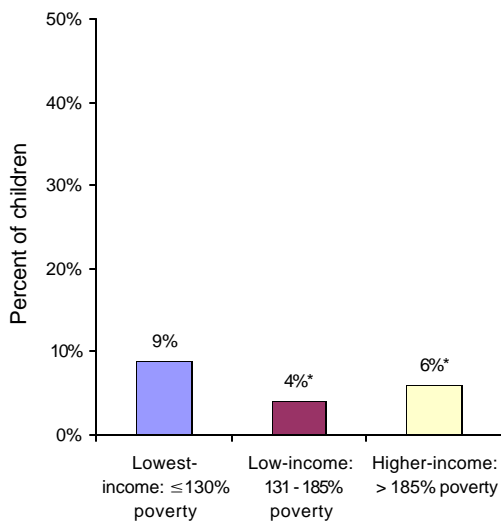


\*Statistically significant difference from lowest-income group at the .05 level or better.  
Source: NHANES-III, 1988-94.

School-age children in the lowest-income group were significantly more likely than school-age children in either the low-income or higher-income groups to have low levels of RBC folate (figure 33). Nine percent of children in the lowest-income group had inadequate folate status, compared with 4 percent of children in the low-income group and 6 percent of children in the higher-income group. This pattern was observed for both males and females (table D-72).

As noted previously, the prevalence of inadequate folate status increased markedly with age. Consequently, prevalence of this problem was greatest among 14-18-year-olds, especially females (table D-72). This is of special interest because females in this age group are entering their childbearing years and inadequate folate has been associated with neural tube defects in newborns (CDC, 1992). Overall, 14 percent of 14-18-year-old females had inadequate levels of RBC folate. The prevalence of this problem was significantly greater among 14-18-year-old females in the lowest-income group than among

**Figure 33—Percent of school-age children with low levels of RBC folate**



\*Statistically significant difference from lowest-income group at the .05 level or better.  
Source: NHANES-III, 1988-94.

their counterparts in the low-income group. Prevalence for the lowest-income group was 20 percent; the point estimate for the low-income group is statistically unreliable. The difference between the lowest-income and higher-income groups in the prevalence of low RBC folate, though substantial (20% vs. 12%), was not statistically significant.

### Serum Vitamin B12

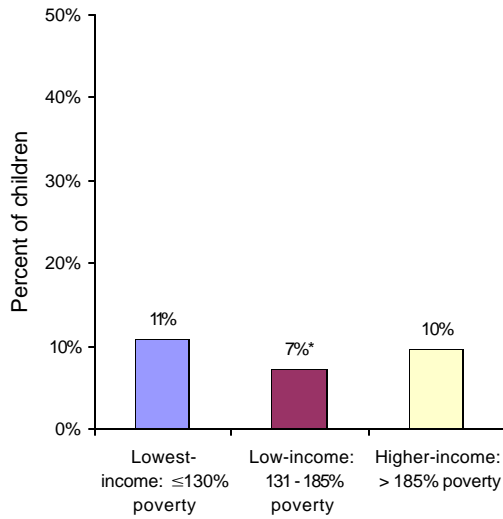
The prevalence of low serum levels of vitamin B<sub>12</sub> was rare among school-age children (this condition is much more common in older adults). Overall, only 1 percent of school-age children exhibited this problem (table D-73). There were no significant between-group differences on this measure.

### Serum Cholesterol and Related Measures

Elevated serum cholesterol levels have been associated with an increased risk of coronary heart disease in adults. Further, there is evidence that the process of atherosclerosis, or the build-up of fatty deposits in the arteries, begins early in childhood. For children up to the age of 19, the National Cholesterol Education Campaign (NCEP) considers a serum cholesterol of 200 mg. or more to be high and levels between 170 and 199 mg. to be borderline high (National Institutes of Health (NIH), 1991).

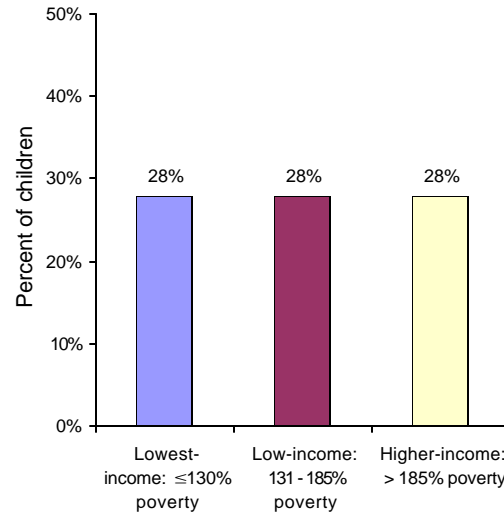
Overall, 10 percent of school-age children had a high cholesterol level (table D-74). The prevalence of high cholesterol levels were roughly equivalent for males and females. School-age children in the lowest-income group were significantly more likely than those in the low-income group to have high serum cholesterol (11% vs. 7%) (figure 34). However, this finding was significant at the 5 percent level and was not repeated in the gender- or age-specific analyses or in any of the gender-and-age-specific subgroup analyses.

**Figure 34—Percent of school-age children with high levels of total cholesterol**



\*Statistically significant difference from lowest-income group at the .05 level or better.  
Source: NHANES-III, 1988-94.

**Figure 35—Percent of school-age children with borderline high levels of total cholesterol**



No statistically significant differences between income groups.  
Source: NHANES-III, 1988-94.

Twenty-eight percent of all school-age children had cholesterol levels that were borderline-high (figure 35 and table D-75). There were no significant between-group differences in the prevalence of borderline-high cholesterol levels. Nor were there any significant between-group differences, overall, in the prevalence of high or borderline-high LDL (“bad”) cholesterol levels, low HDL (“good”) cholesterol levels, or high triglyceride levels (tables D-76–D-79).<sup>2</sup>