Population-Based Growth Stunting

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Abstract

Growth stunting, defined as height for age below the fifth percentile on a reference growth curve, is traditionally used as an indicator of nutritional status in children. Growth stunting is a population-based indicator and can indicate the prevalence of malnutrition or nutrition-related disorders among an identified population of children. Among certain segments of the U.S. child population, most notably poor children, growth stunting occurs more often than expected, suggesting that inadequate nutrition may be a problem for these children. Available general population data are not recent enough to allow for an assessment of the impact of several major public programs designed to address the risk of inadequate nutrition among children. Analysis of data from these programs does show, however, a higher-than-expected-albeit-declining level of stunting among program participants. The serious consequences of growth stunting and malnutrition—particularly impaired cognitive development—suggest that careful consideration of the growth stunting indicator should remain an important part of policy discussions on public nutrition programs.

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In the early 1990s, according to parental reports, between two and four million children under 12 years of age in the United States sometimes or often did not get enough to eat.[1] Most of those who reported hunger were poor. Even participation in federal food programs did not always prevent hunger; as many as 20% of families with children who participated in the Food Stamp Program reported that their children sometimes went hungry.[1]

Going without food during childhood can have many deleterious consequences for a child, because physical, intellectual, and social development all depend on proper nutrition.[2] However, data that capture the extent of self-reported hunger at a given point in time may not correctly reflect the size and scope of malnutrition in a population. Instead, measures that reflect the extent to which children experience repeated or prolonged nutritional deficiencies are needed. This Child Indicators article focuses on such a measure: growth stunting (low height for age).

When food intake is inadequate, a child's body conserves energy by first limiting social activity and cognitive development (children become apa-

thetic and incurious; they do not play and learn), then by limiting the energy available for growth.[3] Growth stunting results from prolonged or repeated episodes of nutritional deficiency. While short stature in any individual child may reflect normal genetic variation and not chronic malnutrition, the growth stunting rate for a population of children can provide evidence of the extent to which children in that population are experiencing long-term nutritional deficiencies and suffering from other negative consequences of not getting enough to eat.[4]

This Child Indicators reviews the definition of growth stunting and the available data on the prevalence of growth stunting in the United States. It also examines the relevance of stunting prevalence to our understanding of children's health status and development and considers the impact of public programs on growth stunting. The evidence surveyed shows that, during the period from 1976 through 1980, poor children in the United States suffered growth stunting at about twice the rate that would be expected in a healthy, well-fed population. Although several major public programs designed to address the risk of inadequate nutrition in young children, most notably the Special Supplemental Food Program for Women, Infants, and Children (WIC), have evolved and grown substantially since the late 1970s, recent data with information on the prevalence of stunting among poor children in the United States are not yet available. Therefore, the impact of these programs on the population of children in the United States cannot be assessed.

Definition of Stunting

The Centers for Disease Control and Prevention's National Center for Health Statistics (NCHS) uses information on children's length, height, weight, and other characteristics such as age and sex to maintain reference growth curves for U.S. children from birth to 18 years.[5] These growth curves are based on the notion that, within each age group, the majority of children have heights and weights close to the mean, with a few attaining heights and weights well below or above the mean. Growth stunting is defined by comparing measurements of children's heights to the NCHS growth reference population: children who fall below the fifth percentile of the reference population in height for age are defined as stunted, regardless of the reason for their shortness. As an indicator of nutritional status, comparison of children's measurements with growth reference curves may be used differently for populations of children than for individual children. The fact that an individual child falls below the fifth percentile for height for age on a growth reference curve may reflect normal variation in growth within a population: the individual child may be short simply because both his parents were short and not because of inadequate nutrition. However, if substantially more than 5% of an identified child population have height for age that is less than the fifth percentile on the reference curve, then the population is said to have a higher-than-expected prevalence of stunting, and inadequate nutrition is generally the first cause considered.

Several important age-related differences and discontinuities in the reference growth curves are used to measure stunting in the United States. First, for children less than 24 months of age, growth is determined by measuring the length of a recumbent child. After 24 months, growth is determined by measuring the height of a standing child. Because length and height measurements are not equivalent, there is a natural discontinuity between growth curves for children below and above 24 months of age. Second, the reference curves for children from birth to 24 months of age are based on a sample of children from Yellow Springs, Ohio, who happened to be taller, on average, than the U.S. population of children in that age group.[6] As a result, for children less than two years old, the expected rate of stunting is higher than 5% when the fifth percentile on

the growth curves is used to determine low height for age. (The growth curves for this age group are currently being revised using a nationally representative sample of children aged zero to 24 months.) Because, however, the reference curves for older children are based on a representative sample of the U.S. population, the expected rate of stunting in this age group is 5% based on the fifth percentile cutpoints.

Causes of Growth Stunting

Inadequate nutrition is just one of several causes of growth stunting. Other contributors to stunting include chronic or recurrent infections, sometimes in combination with intestinal parasites. The prevalence of growth stunting, particularly among children under two years of age, can also reflect the prevalence of low birth weight in a population. Finally, in rare cases, growth stunting may reflect extreme psychosocial stress without nutritional deficiencies.[7]

The contributions of each of these causes to the growth stunting prevalence rate are only partly understood. One study concluded that from 20% to 40% of the prevalence of growth stunting in the first two years of life can be attributed to low birth weight.[8] However, inadequate nutrition may still be implicated because some low weight births may be due to maternal nutritional deficiencies during pregnancy.[9]

Just as low birth weight and nutritional deficiencies are interrelated, so also are inadequate nutrition and the chronic or recurrent infections that are believed to contribute to growth stunting. There is evidence that even mild nutritional deficits can alter the immune response in children, before clinical signs of malnutrition occur, and that nutritional deficiencies during pregnancy can impair the infant's immune response after birth.[10] Thus, the reasons for any given child's growth impairment may be complex. However, inadequate nutrition is a common theme that suggests a key focus for a policy response to the problem of growth stunting.

Measuring Stunting

The primary sources of anthropometric data (measurements of height and weight) on children are the three National Health and Nutrition Examination Surveys (NHANES), and the Centers for Disease Control and Prevention's Pediatric Nutrition Surveillance System (PedNSS). The NHANES, conducted during the periods 1971–1974 (NHANES I), 1976–1980 (NHANES II), and 1988–1994 (NHANES III), were nationwide surveys that included a physical examination during which information about the height and weight of respondents was collected.[11] Between 15,000 and 21,000 respondents participated in the physical examination during each NHANES.[12] Children aged 2 months to 19 years were included in the physical examinations.[13] Because NHANES did not survey homeless persons or migrant workers and their families, groups that are more likely than average to experience malnutrition, rates of stunting based on NHANES data may be understated.

The PedNSS, in operation since 1973, collects information each year about children from newborn to 18 years of age who participate in any one or a combination of multiple public health programs, including the Special Supplemental Food Program for Women, Infants, and Children (WIC), Head Start, and the early and periodic screening, diagnosis, and treatment (EPSDT) program. Health information (including anthropometric measurements) for each child is reported to the PedNSS by the clinic at which the child is screened for, and evaluated during, participation in the public health programs.

From 1976 through 1980, poor children in the United States suffered growth stunting at about twice the rate that would be expected in a healthy, well-fed population.

While the PedNSS offers a rich source of information about program participants, its grounding in these programs limits its usefulness as a source of information about the general population of children or even the subpopulation of poor children. First, since program nonparticipants, including those ineligible for public health programs because they were not sufficiently at risk, are not represented, the PedNSS population is more likely than the overall low-income population to exhibit health problems such as growth stunting. Second, PedNSS is based

on encounter data from participating clinics. Therefore, a child with multiple visits will have multiple records in the system (an average of 2.1 records per child).[6] To the extent that children with more severe health or nutrition programs have more visits, they will be overrepresented in PedNSS. Third, the majority of PedNSS records come from the WIC program (69% of records in 1991), and a large proportion of records provided by the other contributing programs include children who were also served by WIC.[6] Because eligibility for WIC requires being at risk for poor nutritional outcomes, the heavy representation of WIC participants in PedNSS suggests that data set will present a biased picture of the nutritional status of children in the United States. In addition, because of program requirements, PedNSS data are dominated by very young children. Among children older than four years, only those with health and nutrition risk factors are retained. Last, participation of states in the PedNSS has fluctuated considerably over the years: the number of states contributing data increased from 5 in 1973 to 41 in 1991. Fluctuations in participation make interpretation of trends difficult.

The prevalence of stunting in the PedNSS has declined fairly consistently in recent years from 11.1% in 1982 to 8.3% in 1995, a decline of 25%.

The Prevalence of Growth Stunting

NHANES

Data from NHANES I, NHANES II, and the first segment of NHANES III (for 1988–1991) indicate that the prevalence of growth stunting among the overall child population of the United States did not vary much from the expected 5% during the 1970s and 1980s.[14] However, further analysis of the NHANES data by population subgroups does reveal something more about children's nutritional status.

Data on the prevalence of stunting from NHANES II (1976–1980) have been analyzed by poverty status and show stunting prevalences among children in poverty that are consistently higher than those in the overall child population.[15] The prevalence of stunting among children living above poverty is consistently near or below the expected 5% level (see Figure 1), while children below poverty experience stunting at rates much higher than the expected 5%—from 7% to 13%.[16] However, the data shown in Figure 1 do not reflect data collected in the most recent survey, NHANES III (1988–1994). The NHANES II data in Figure 1 reflect a period when enrollments in the WIC program, the federal food program most directly focused on nutritional deficiencies in pregnant women and young children, were still small relative to enrollments today.[17] Unfortunately, the corresponding NHANES III data have not yet been analyzed by poverty status.

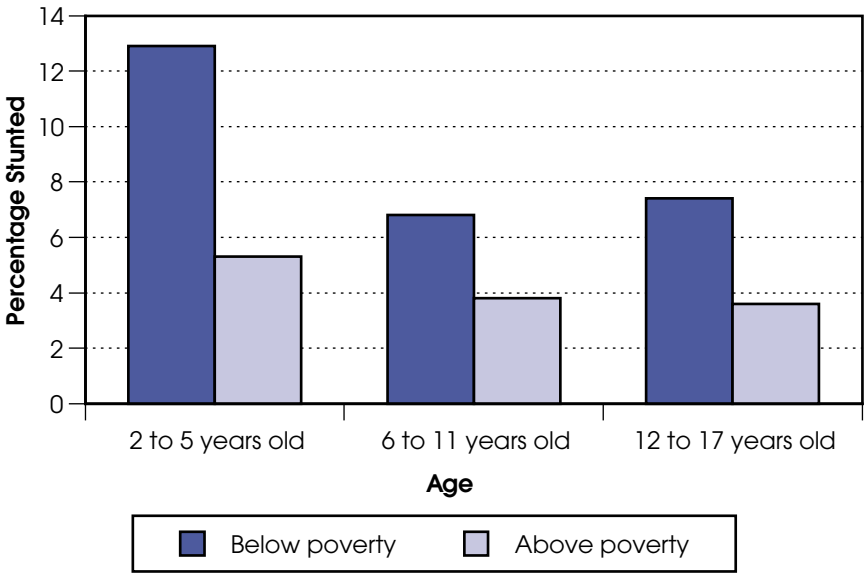
PedNSS

Although it is a restricted data set, representing only low-income children enrolled in public health programs, the PedNSS is a rich data source on poverty-related growth deficiencies because of a large sample and the CDC's efforts to provide meaningful tabulations of the data. Figure 2 reports the percentages of children participating in public health programs who were stunted based on data from the PedNSS for the years 1978–1995. The prevalence of stunting in the PedNSS varied between 8.3% and 11.4% over the 1974–1995 period, rates consistent with the NHANES II stunting prevalence for children in poverty. The figure also shows that the prevalence of stunting in the PedNSS has declined fairly consistently in recent years from 11.1% in 1982 to 8.3% in 1995, a decline of 25%.

Changes within the Asian population represented in the PedNSS appear to account for a portion of the decline in the prevalence of stunting in the PedNSS data. Beginning in the late 1970s, an influx of refugees from war-torn Southeast Asian countries raised the proportion of children enrolled in PedNSS public health programs who were from extremely deprived socioeconomic backgrounds.[18] The high prevalence of growth stunting among these refugee children pushed the overall prevalence rate among the PedNSS population upward over the period 1978–1982, as seen in Figure 2. After 1982, the Asian PedNSS population showed a rapid decline in stunting prevalence, which

Figure 1

Percentage of All Children Who Were Below the Fifth Percentile of Height for Age, by Age and Poverty Status, 1976 to 1980



Growth stunting is defined as height below the fifth percentile on a reference height-for-age growth curve. The percentage of children living in families with incomes below the official federal poverty threshold who were below the fifth percentile in height for age (stunted) varied, depending on the age group, between 6.8% and 12.9%, while the percentages of children living above the poverty threshold who were stunted fell within a much lower range, 3.8% to 5.3%.

Source: U.S. Department of Health and Human Services and U.S. Department of Agriculture. *Nutrition monitoring in the United States: A Report from the Joint Nutrition Monitoring Evaluation Committee.* PHS-86-1255. Washington, DC: U.S. Government Printing Office, July 1986, p. 325.

is thought to reflect the substantial improvement in the socioeconomic and nutritional status of the refugee children once they reached the United States.[6] Overall the prevalence of stunting among Asian children less than five years of age declined by approximately 50% between 1982 and 1991.[6] Because Asian children accounted for approximately 3% of children in the PedNSS, the decline in stunting among Asian children accounted for approximately 0.3 to 0.4 points of the 2.2-percentage-point decline in the prevalence of stunting in the PedNSS population over that period.[6]

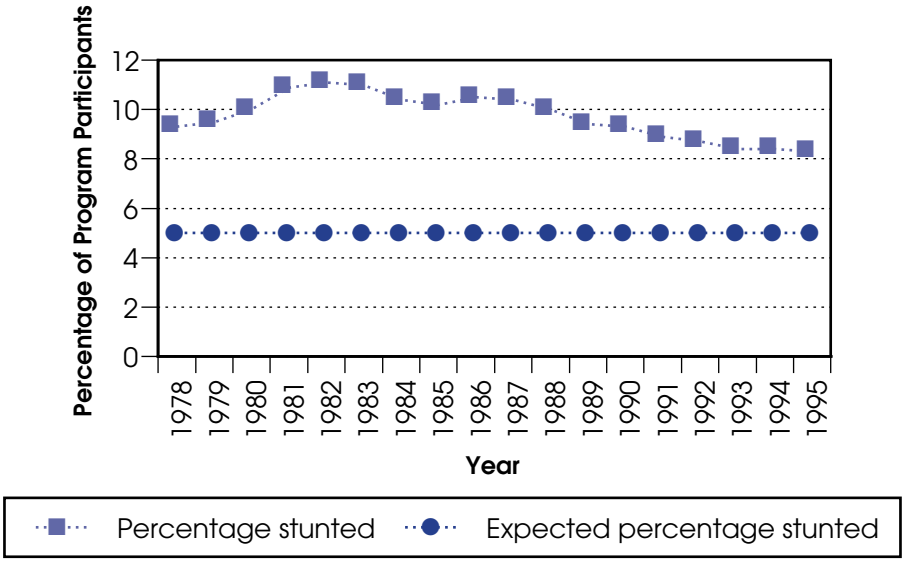
In 1991, the most recent year for which detailed data by age and race/ethnicity are available, the overall prevalence of stunting in the PedNSS was 8.9%. For children less than 24 months of age, the prevalence of stunting in the 1991 PedNSS data was 10%, twice the expected level of 5%.[6] Some of the elevated prevalence of shortness in this age group can be attributed to the taller-than-average sample used for the growth reference in this age group. For children two to five years of age, the 1991 prevalence of stunting was only slightly higher than the expected 5% level. Among blacks and Native American children in this age group, the prevalence of stunting was 5% to 6%; for whites and Hispanics, the prevalence was 7% to 8%; and for Asians, the rate remained elevated at about 12%.[6]

Growth Stunting and Intellectual Development

A review of the literature on children's nutritional status and cognitive development reveals many studies which found that

Figure 2

Percentage of Children Participating in Government-Funded Public Health Programs Who Were Stunted, 1978 to 1995



The percentage of infants, children, and adolescents (from birth to 17 years of age) participating in government-funded public health programs whose height for age was below the fifth percentile on the NCHS growth curve varied between 8.3% and 11.4% between 1978 and 1995. The rate of stunting has declined gradually but consistently over recent years.

These data cannot be used to measure stunting in the general population because risk for malnutrition is an important criterion for enrollment in the programs represented in the data.

Source: Federation of American Societies for Experimental Biology, Life Sciences Research Office. *Third report on nutrition monitoring in the United States.* Vol. 2. Prepared for the Interagency Board for Nutrition Monitoring and Related Research. Washington, DC: U.S. Government Printing Office, 1995, p. VA-217, Table A.F7-14, with data for 1993–1995 provided by Ibrahim Parvanta, Division of Nutrition, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, from the unpublished Table 11, 1995 Annual Summaries.

chronic malnutrition in childhood (using anthropometric measures as an indicator) is associated with lower scores on tests of cognitive development.[2] While there is also substantial evidence that factors related to poverty other than inadequate nutrition also contribute to poor performance on tests of cognitive ability, studies that controlled for these confounding effects still revealed an important relationship between nutrition and mental development.[2] Recent research on the mechanisms by which malnutrition impairs cognitive growth has revealed two other important points.

First, the long-accepted belief that malnutrition does the majority of its damage to cognitive ability during the first two years of life, when the brain grows to roughly 80% of its adult size, has been belied. Recent research has shown that an improvement in diet after age two can restore near-normal mental development and that malnutrition after age two can be damaging just as it is before age two.[19]

Second, in the 1960s the observation that middle-class children who were mildly undernourished due to medical conditions did not experience delayed mental development while mildly underfed poor children did led researchers to reexamine the mechanism by which malnutrition affects cognitive development. Research with rodents

revealed that the reduced cognitive capabilities in malnourished animals were in large part the result of reduced social and exploratory activity on the part of those animals, which in turn were the result of energy deficits due to insufficient food. Extrapolating from the animal studies, researchers speculated that malnourished children lack the energy to play and, thus, learn more slowly. In addition, because they grow more slowly than properly nourished children, they appear younger and are less likely to be challenged to talk, explore, and expand their capabilities by their caretaking adults.[19] These findings suggest that it is the combination of inadequate nutrition and environmental deprivation that may impair cognitive development in some poor children.[19]

Discussion

The best available information about the prevalence of growth stunting among children in the United States shows evidence of a relationship between poverty and growth stunting: the stunting rate among poor children is approximately twice the expected rate. However, that best available information (from NHANES II) suffers from an important drawback: it is now more than 15 years old.

Over that 15-year period, varying programs designed to address inadequate nutrition in poor children have grown substantially. For example, the number of infants and children enrolled in WIC, a program specifically designed to address nutritional problems, increased from 1.5 million in 1980 to 5.3 million in 1995. Accordingly, extrapolation from NHANES II data about the prevalence of stunting in poor children today is inappropriate. Detailed analyses of NHANES III data are not yet available;[20] however, analyses of overall stunting prevalence rates from NHANES III for 1988–1991 suggest that stunting has not increased in the population despite an increase in the child poverty rate.

More recent data from the PedNSS does not represent the overall child population and, thus, cannot be used to measure the prevalence of stunting in the general population. At present, the only conclusion to be drawn from the available PedNSS data is that growth stunting and malnutrition may be a problem among children enrolled in some large federal programs.

The consequences of growth stunting and malnutrition are serious—cognitive development may be impaired. While poor nutrition may not be the only cause, providing proper nutrition is a clear first step toward ensuring that all children develop to their physical and mental potentials. The evidence that growth stunting rates among poor children who participate in some federal programs may be higher than would be expected in a healthy, well-fed population argues in favor of careful consideration of the consequences of reductions in any of the currently established federal nutrition programs.

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1. Lewit, E., and Kerrebrock, N. Child indicators: Childhood hunger. *The Future of Children* (Spring 1997) 7,1:128–37.
2. Korenman, S., Miller, J., and Sjaastad, J. Long term poverty and child development in the United States: Results from the NLSY. *Children and Youth Services Review* (1995) 17,1/2:127–55.
3. Center on Hunger, Poverty and Nutrition Policy, Tufts University. *The link between nutrition and cognitive development in children.* Medford, MA: Tufts University School of Nutrition, 1995, p. 5.
4. These other negative consequences include fatigue, dizziness, frequent headaches, frequent colds and infections, and difficulty concentrating. See Food Research and Action Center. *Community Childhood Hunger Identification Project: A survey of childhood hunger in the United States.* Washington, DC: FRAC, July 1995, p. 22.
5. Federation of American Societies for Experimental Biology, Life Sciences Research Office. *Third report on nutrition monitoring in the United States.* Vol. 1. Prepared for the Interagency Board for Nutrition Monitoring and Related Research. Washington, DC: U.S. Government Printing Office, 1995, p. 171.

6. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention. Pediatric Nutrition Surveillance System—United States, 1980–1991. *Morbidity and Mortality Weekly Report* (November 27, 1992) 41,SS-7:1–24.

7. Skuse, D., Albanese, A., Stanhope, R., et al. A new stress-related syndrome of growth failure and hyperphagia in children, associated with reversibility of growth-hormone insufficiency. *The Lancet* (August 10, 1996) 348,9024:353–58.

8. Gayle, H., Dibley, M., Marks, J., and Trowbridge, F. Malnutrition in the first two years of life. *American Journal of Diseases of Children* (May 1987) 141,5:531–34.

9. Chomitz, V.R., Cheung, L.W.Y., and Lieberman, E. The role of lifestyle in preventing low birth weight. *The Future of Children* (Spring 1995) 5,1:123.

10. Kotch, J., and Shackelford, J. *The nutritional status of low-income preschool children in the United States: A review of the literature.* Prepared for the Food Research and Action Center. Washington, DC: FRAC, June 1989, p. 24.

11. Only data from the first section of NHANES III (1988–1991) were available for use in this article.

12. Federation of American Societies for Experimental Biology, Life Sciences Research Office. *Third report on nutrition monitoring in the United States.* Vol. 1. Prepared for the Interagency Board for Nutrition Monitoring and Related Research. Washington, DC: U.S. Government Printing Office, 1995, Appendix IV.

13. In NHANES I, infants under one year were excluded; in NHANES II, infants under six months were excluded; and in NHANES III, infants under two months were excluded.

14. Federation of American Societies for Experimental Biology, Life Sciences Research Office. *Third report on nutrition monitoring in the U.S.* Vol. 2. Prepared for the Interagency Board for Nutrition Monitoring and Related Research. Washington, DC: U.S. Government Printing Office, 1995, p. VA-216, Table A.F7-11,12,13.

15. Poverty is defined as family income no greater than the official federal poverty threshold.

16. Other studies of the relationship between poverty and stunting include: Miller, J., and Korenman, S. Poverty and children's nutritional status in the United States. *American Journal of Epidemiology* (1994) 140,3:233–43; and Jones, D.Y., Nesheim, M.C., and Habicht, J.P. Influences in child growth associated with poverty in the 1970s: An examination of HANES I and HANES II, cross-sectional U.S. national surveys. *American Journal of Clinical Nutrition* (October 1985) 42,4:714–24.

17. In 1977, the total number of infants and children enrolled in WIC was one-fifth what it was in 1990; 1980 enrollment was less than half of the 1990 enrollment. See U.S. House of Representatives, Ways and Means Committee. *Overview of entitlement programs: 1994 green book.* Washington, DC: U.S. Government Printing Office, 1994, p. 829, Table 18-32.

18. Cambodia, Laos, and Vietnam. See Yip, R., Scanlon, K., and Trowbridge, R. Improving growth status of Asian refugee children in the U.S. *Journal of the American Medical Association* (February 19, 1992) 267,7:938.

19. Brown, J.L., and Pollitt, E. Malnutrition, poverty and intellectual development. *Scientific American* (February 1996) 274,2:38–39.

20. Ogden, Cynthia, Nutrition Monitoring Staff, National Center for Health Statistics, Hyattsville, MD. Personal communication, March 6, 1997.