It is well established that birth weight has a significant and inverse relationship with systolic blood pressure. Rapid weight gain in early infancy after slow fetal growth promotes higher blood pressure and increased cardiovascular risk in later life. Accelerated weight gain during childhood also enhances the risk of elevated blood pressure associated with low birth weight. However, the exact contribution of weight gain during “distinct” periods of early life on later blood pressure and whether accelerated postnatal growth independent of birth weight is critical to a later increase in blood pressure remain unclear. In the current issue of Hypertension, Ben-Shlomo et al. used multiple measures of growth from birth to 5 years with an approach that modeled changes in growth velocity rather than anthropometry in relation to adult blood pressure. Use of this approach to model growth trajectories allowed them to investigate the inherent complexities of discrete periods of early growth on later blood pressure. In this study they demonstrated that rapid increases in postnatal weight in the first 6 months of life were critical to elevated adult systolic and diastolic blood pressure. Importantly, this finding was independent of fetal growth. In addition, an inverse association between birth weight and blood pressure was noted, and weight gain in childhood was positively associated with systolic blood pressure. Although several studies have noted an inverse relationship between birth weight and diastolic blood pressure, the prediction of diastolic blood pressure by immediate postnatal weight gain is novel. An increase in diastolic blood pressure in childhood is a significant predictor of cardiovascular risk. Therefore, this study by Ben-Shlomo et al. highlights the contribution of early accelerated growth on adult blood pressure and cardiovascular risk and indicates that growth during both the prenatal and postnatal periods is a critical determinant for adult blood pressure.

Because the postnatal period is more amenable for intervention, this study emphasizes the importance of investigating the consequences of accelerated growth in early postnatal life. During development, compensatory growth can occur after a period of nutritional deficit. Accelerated postnatal growth after slow fetal growth may reflect an effort to obtain approximately normal weight. Moreover, rapid early catch-up growth is associated with short-term benefits in small newborns. However, accelerated fetal growth may also reflect excess growth and the development of obesity. In a well-nourished cohort, catch-up growth between birth and 2 years was associated with greater body mass index and central fat distribution at 5 years of age in low birth weight children relative to other children. Another study noted that rapid weight gain in the first 6 months of life was a critical period of development associated with a risk of later obesity. Body weight is directly correlated with blood pressure, and excessive weight gain during any stage of childhood or adulthood is associated with an increase in adult blood pressure. Therefore, based on the vulnerability of children small at birth to develop excessive weight gain and the observation that accelerated weight gain during infancy and childhood in individuals born small leads to a further increase in later blood pressure, weight gain during early life may have important health implications for hypertension and cardiovascular risk.

The mechanism by which environmental influences in early life lead to an elevation in blood pressure has not been clearly elucidated. Obesity is associated with increased plasma leptin concentrations, and a chronic increase in circulating leptin leads to a marked increase in blood pressure. The long-term actions of leptin in the regulation of blood pressure are not clearly understood but are suggested to involve interactions with hypothalamic neuropeptides critical to appetite, energy homeostasis, and sympathetic nervous system outflow. Experimental studies indicate that prenatal undernutrition followed by postnatal nutritional excess leads to increased circulating levels of leptin, lep
tin resistance, and dysregulation of hypothalamic neuropeptides. Thus, a mismatch of adverse nutritional influences during prenatal and postnatal life may lead to long-term consequences on blood pressure through the developmental programming of the hypothalamic pathway and leptin resistance. Environmental influences during critical periods of development lead to changes in gene expression that do not involve modification of the basic DNA sequence, a process referred to as “epigenetics.” Thus, epigenetic modifications that occur in response to an insult during a critical period of development may be important determinants for adult blood pressure by altering the expression of genes critical to the hypothalamic regulation of appetite and energy homeostasis.

The concept of early events programming disease in later life began with population studies first proposed by Fors
dahl and later Barker and Osmond. Forsdahl initiated the theory that an adverse stimulus during childhood and adoles-

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**Slow Prenatal Growth and Accelerated Postnatal Growth**

**Critical Influences on Adult Blood Pressure**

Barbara T. Alexander, Norma B. Ojeda

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The opinions expressed in this editorial are not necessarily those of the editors or of the American Heart Association.

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ence could lead to an increased risk for cardiovascular disease in adulthood; Barker and Osmond advanced the concept to suggest that increased cardiovascular risk may originate during prenatal life. New insight from the study by Ben-Shlomo et al indicates both the prenatal and the immediate postnatal periods as sensitive windows for the developmental programming of blood pressure. This study provides additional support for the fetal origins hypothesis and the accelerated postnatal growth hypothesis and demonstrates the importance of research into the mechanisms linking early growth and adult blood pressure.

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