1. INTRODUCTION

Growth and development begin with pregnancy and continue through adolescence and early adulthood. Growth is defined as increases in cell size caused by processes of cell multiplication involving hyperplasia, hypertrophy, and accretion. Development involves a progressive maturation, differentiation, or specialization that results in a final physical, emotional, psychological, and cognitive biological state. The effects of nutrition are manifested throughout this process and in all tissues and structures in the body (1).

Both general nutrition and dietary intake of specific nutrients have been associated with oral growth and development. Dietary choices throughout life can have a primary effect on the tooth structure, whereas nutritional status exerts a systemic effect on the integrity and maintenance of other oral tissue (2). However, research in this area has been limited to animal studies and a few preliminary human investigations. Lack of an extensive body of evidence to identify associations between specific nutrients and optimum oral growth and development has resulted in limited interpretations of the precise interactions.

The purpose of this chapter is to examine the synergy between oral health development and nutritional status from conception to adolescence and to review past, present, and future research in this area according to stages of development that include pregnancy, infancy, early childhood, and school-aged children. Finally, this chapter identifies issues in managing oral health and promoting nutrition for special-needs individuals during pregnancy and childhood.

2. PRENATAL AND PERINATAL NUTRITION AND TOOTH DEVELOPMENT

The nutritional intake of the pregnant woman has specific and global effects on the dentition of her child. The specific effects are related to the formation of the enamel and dentin of the primary and permanent teeth during fetal development. The global effects are related to the amount of weight she gains, her diet’s overall nutritional quality, how much her infant weighs at birth, and the gestational age of her infant—that is, whether
the infant is delivered at term or preterm. Primary teeth begin to form at 6 wk of gestational age when cells in the fetal oral cavity begin to differentiate and form tooth buds. The dentin layer forms first and then the enamel layer is deposited (3). Mineralization begins at 4 mo in utero, and central incisors (the teeth that erupt first) have 83% of their enamel formed by the time of birth (3). Insults from teratogens or lack of crucial nutrients during pregnancy can have significant impact on the nearly developed primary teeth and the beginnings of the permanent teeth. Infants are born with all the primary teeth and many permanent unerupted teeth in varying stages of development (4,5). A review of early childhood caries (ECC) and hypoplasia in infants and children in developing countries revealed that these conditions were most closely associated with a general underlying nutritional deficiency state (malnutrition or undernutrition) in the perinatal period (6). A clear relationship has been found between specific dietary nutrients during critical periods of calcification and poorly calcified teeth, which reduces caries resistance (7).

2.1. Maternal Protein Energy Malnutrition

Maternal malnutrition, specifically protein energy malnutrition (PEM), has global effects. A pregnant woman needs to gain enough weight to support the fetus, placenta, and associated gain in maternal tissues to support pregnancy and lactation. Generally, a weight gain of 27.5 lbs (12.5 kg) is considered adequate, but the recommended weight gain for a specific woman depends on her prepregnancy body mass index (BMI) (8,9). The requirement for protein increases by 20%, to a total of approx 60 g per day (10) depending on body weight and age. A woman who enters pregnancy underweight with low protein stores and who does not gain sufficient weight during pregnancy to support the fetus and her increased metabolism is at risk of delivering a low birth weight (<2500 g) and/or preterm infant (11).

Low birth weight and preterm delivery are associated with enamel hypoplasia of the primary and permanent teeth. Nutritional deficiencies during pregnancy can affect tooth size, timing of tooth eruption, defects in enamel mineralization, and salivary gland formation and can create increased susceptibility to caries (12,13). Furthermore, developmental defects of enamel and enamel hypoplasia are seen as a result of malnutrition during pregnancy and early childhood (14–16). When nutritional deficiencies or toxicities occur during “critical periods” of oral tissue development, consequences can be permanent and irreversible (17). Turnover time for oral soft tissue is between 3 and 7 d. This is more rapid than in other tissue and may increase oral tissue needs for nutrients beyond those in tissue with longer turnover rates (3). Female rats fed a low-protein diet gave birth to rats with smaller molars, impaired salivary gland function (which affects caries resistance), and delayed eruption of the first and second molars (7). When female rats consumed protein- and calorie-deficient diets, the molars and incisors of the offspring weighed less than than those of the normally fed control group (18). These defects can be permanent and irreversible because of the absence of enamel and dentin regenerations once tooth eruption occurs (19,20). Eruption of primary teeth has been delayed in longitudinal studies of stunted infants compared to healthy infants and associated with a risk of caries later in life (21).

2.2. Maternal Micronutrient Malnutrition

Deficiencies in micronutrients such as vitamins A, C, and D and minerals such as calcium, phosphorus, fluoride, iron, and iodine have an effect on developing dentition (22).