

Position of the American Dietetic Association: Oral Health and Nutrition

ABSTRACT

It is the position of the American Dietetic Association that nutrition is an integral component of oral health. The American Dietetic Association supports the integration of oral health with nutrition services, education, and research. Collaboration between dietetics and dental professionals is recommended for oral health promotion and disease prevention and intervention. Scientific and epidemiological data suggest a lifelong synergy between nutrition and the integrity of the oral cavity in health and disease. Oral health and nutrition have a synergistic bidirectional relationship. Oral infectious diseases, as well as acute, chronic, and terminal systemic diseases with oral manifestations, impact the functional ability to eat as well as diet and nutrition status. Likewise, nutrition and diet may affect the development and integrity of the oral cavity as well as the progression of oral diseases. As we advance in our discoveries of the links between oral and nutrition health, practitioners of both disciplines must learn to provide screening, baseline education, and referral to each other as part of comprehensive client/patient care. Dietetics practice requires registered dietitians to provide medical nutrition therapy that incorporates a person's total health needs, including oral health. Inclusion of both didactic and clinical practice concepts that illustrate the role of nutrition in oral health is essential in both dental and dietetic education programs. Collaborative endeavors between dietetics and dentistry in research, education, and delineation of health provider practice roles are needed to ensure comprehensive health care. The multifaceted interac-

tions between diet, nutrition, and oral health in practice, education, and research in both dietetics and dentistry merit continued, detailed delineation. *J Am Diet Assoc.* 2007;107:1418-1428.

POSITION STATEMENT

It is the position of the American Dietetic Association that nutrition is an integral component of oral health. The American Dietetic Association supports the integration of oral health with nutrition services, education, and research. Collaboration between dietetics and dental professionals is recommended for oral health promotion and disease prevention and intervention.

As a body of knowledge, dietetics and nutrition has expanded to impact many segments of health care. Scientific and epidemiological data show a lifelong synergy between nutrition and the integrity of the oral cavity in health and disease (1-6). Paralleling this cross-disciplinary trend is a change in the health care system toward a patient-centered, interdisciplinary, team-based approach that requires collaborative effort among health care providers and emphasizes evidence-based practice (7). Thus, partnerships among registered dietitians (RDs), dental professionals, and other health professionals need to be strengthened, developed, and expanded to encourage integrated and comprehensive practice; subsequently, educational competencies need to be further developed that embrace this approach (7). The multifaceted interactions between diet, nutrition, and oral health in practice, education, and research in both dietetics and dentistry merit continued, detailed delineation.

Oral health and nutrition have a synergistic bidirectional relationship. Oral infectious diseases, as well as acute, chronic, and terminal systemic

diseases with oral manifestations, impact the functional ability to eat as well as diet and nutrition status. Likewise, nutrition and diet may affect the development and integrity of the oral cavity as well as the progression of oral diseases. The Surgeon General's "Oral Health in America" report and "National Call to Action to Promote Oral Health" highlight the roles of diet and nutrition as major multifactorial environmental factors in the etiology and pathogenesis of craniofacial diseases and disorders (1,2,4). The actualization of the synergistic bidirectional relationship can be accomplished through the roles of RDs as members of patient health care teams in health promotion and maintenance as well as disease management.

ORAL INFECTIOUS DISEASE

Dental Caries

Dental caries is a major cause of tooth loss in the United States. Nearly 42% of children and adolescents (ages 6 to 19 years) and approximately 90% of adults have experienced tooth decay (8). Although the prevalence and severity of caries has declined, there has been no observed reduction in the rate of early childhood caries in infants and preschool children (9). Feeding behaviors after prolonged bottle feeding or breastfeeding and patterns in the introduction of foods, when eating behaviors are being established, may influence prevention and treatment of this disease (8). Caries identified in children and young adults and root and coronal caries in the elderly cause unnecessary pain and expense (2,10). Children with craniofacial problems, neurological abnormalities, or impaired cognitive abilities are at greater risk for oral infectious diseases that can interfere with appropriate responses to feeding protocols (11).

Diet and nutrition have a direct in-

0002-8223/07/10708-0021\$32.00/0
doi: 10.1016/j.jada.2007.06.003

Anticariogenic: Foods or components of foods that can raise salivary pH to an alkaline level and protect the enamel.

Cariogenic: Foods/drinks containing fermentable carbohydrates that can cause a decrease in salivary pH to <5.5 and demineralization when in contact with microorganisms in the mouth.

Cariostatic: Foods that are not metabolized by microorganisms in plaque and do not subsequently cause a drop in salivary pH to <5.5 within 30 minutes.

Coronal caries: Decay on the pit and fissure surfaces of permanent teeth.

Dental caries (decay): An oral infectious disease of the teeth in which organic acid metabolites produced by the metabolism of oral microorganisms lead to demineralization and destruction of the tooth structure.

Maxillary anterior caries or early childhood caries: Previously called baby bottle tooth decay or maxillary anterior caries. Early childhood caries is one or more primary maxillary incisors in children that is decayed, missing, or filled.

Edentulism: Without teeth; complete edentulism refers to missing all teeth. Partial edentulism refers to missing several teeth.

Gingivitis: Inflammation of the soft tissue component of the periodontium.

Periodontal disease: Oral disease characterized by inflammation and destruction of the attachment apparatus of the teeth, including the ligamentous attachment of the tooth to the surrounding alveolar bone.

Root caries (decay): Progressive lesions that are confined to the root surface, or involve the undermining of the cemento-enamel junction, but are clinically indicated to be initiated on the root surface.

Tooth erosion: The gradual loss of the outside, hard surface of the tooth due to chemical, not bacterial, processes. It is most commonly associated with frequent consumption of acidic beverages or frequent vomiting or regurgitation as occurs with bulimia or gastroesophageal reflux disease.

Figure 1. Definitions of oral health terms.

fluence on the progression of tooth decay, a communicable yet preventable oral infectious disease (1). The major components of a preventive dental regimen are designed to maintain an equilibrium in the dynamic demineralization–remineralization of the tooth surface (12). Included are diet counseling, fluoride therapy (12,13), use of sealants, and control of cariogenic bacteria (12,14). Nutrition education by dental professionals and nutrition counseling by RDs must address dietary risk factors associated with oral disease (15). The primary factors to consider in determining the cariogenic, cariostatic, and anticariogenic properties of the diet are food form (liquid, solid or sticky, slowly dissolving), frequency of consumption of sugar and other fermentable carbohydrates, nutrient composition, potential to stimulate saliva, sequence of food intake, and combinations of foods (15,16). See Figure 1 for a glossary of related terms.

Tooth erosion associated with eating disorders such as anorexia nervosa and bulimia nervosa (17), frequent consumption of acidic foods and beverages (18), and gastroesophageal reflux (19) can weaken tooth integrity

and increase caries risk. Diet education and counseling for caries prevention and control should address improved dietary habits for good oral health and general health and be routine components of comprehensive dental care (15,20). Medically complex patients with caries should be referred to an RD.

Periodontal Disease

Periodontal disease is an oral infectious disease involving inflammation and loss of bone and the supporting tissue of the teeth. Although the pathogenesis of periodontal disease involves bacteria and the host response to these bacteria, there are local, systemic, and behavioral factors that influence the severity and progression of the disease (6,21–23). Systemic influences on disease include types 1 and 2 diabetes mellitus, stress, cardiovascular disease, osteoporosis, immune status of the host, and presence of pathogens associated with periodontal disease in the subgingival flora (5,6,24–26). Behavioral risk factors associated with periodontal disease include poor oral hygiene, tobacco use, and diet (23,27). Select

nutrient deficiencies (eg, vitamin C and magnesium) may compromise the systemic response to inflammation and infection and alter nutrient needs (20,21,27).

Nutritional status has a direct influence on the synthesis and release of cytokines and their action. Malnutrition is associated with increased needs for calories and protein to promote repletion, wound healing, and an improved immune response (28). Malnutrition can cause adverse alterations in the volume, antibacterial, and physiochemical properties of saliva (29). A balanced diet consistent with MyPyramid (www.mypyramid.gov/professionals/index.html) and the *Dietary Guidelines for Americans 2005* (www.healthierus.gov/dietaryguidelines) provides for adequate intake of all nutrients including protein, vitamins C and D, folate, magnesium, and calcium. There is no evidence to support the use of supplemental intake of any nutrients beyond the Dietary Reference Intakes (DRIs) for the prevention or treatment of periodontal disease.

Positive relationships between periodontal disease and other chronic disease states, including cardiovascular disease and obesity, have been shown (6,24). To date, much of the evidence has been based on epidemiological and cross-sectional retrospective data. Further research is needed to explore these relationships with risk and extent of periodontal disease and the impact of alternations in oral tissues associated with aging.

MEDICALLY COMPROMISING CONDITIONS

The oral cavity is the entry portal to the gastrointestinal tract. Thus, risks for oral problems increase with many systemic and chronic disease states, changes in health status, and/or adoption of practices that also may affect diet and nutritional status (3).

As part of the comprehensive assessment of nutrition status, RDs must include a physical assessment of oral functional ability and the impact of any planned therapies on sensory and functional capacity of the oral cavity (30). When providing medical nutrition therapy (MNT), RDs should consider oral manifestations of diseases and impact of medications as well as potential oral problems faced by patients who wear oral prostheses such as dentures and experience-re-

lated problems (31). In patients with oropharyngeal cancer, diets may require alterations in diet consistency, temperature, and composition because of side effects of therapies. Dietary management of xerostomia must include strategies for reducing caries risk.

Diabetes Mellitus

Diabetes mellitus is a chronic disease with oral and systemic manifestations. Poorly controlled diabetes (characterized by hyperglycemia, elevated hemoglobin A1c level, and increased salivary glucose) is associated with greater risk of several diseases and conditions. Microangiopathies, altered vascular permeability, and altered host response mechanisms contribute to increased risk of periodontal disease. Individuals with diabetes mellitus also are at greater risk for compromised wound healing and increased risk and severity of local infectious diseases, including fungal infections, gingivitis, periodontal and oral mucosal diseases, and caries (6), as well as xerostomia, burning tongue/mouth sensations, and other dysesthesias. Caries risk is further exacerbated by xerostomia. Success of select dental procedures, including surgery and denture placements, are dependent on glycemic control, which is to a great degree contingent on diet and weight management. Periodontal disease can compromise the metabolic control of individuals with diabetes mellitus (6,32). The metabolic pathways responsible for these processes deal with the catabolic nature of infections, increasing serum glucose values, and other factors (6,32). Improved periodontal health in individuals with both type 1 and type 2 diabetes mellitus may lead to improved metabolic control and reduced risk of further sequelae.

Xerostomia results in a loss of protective mechanisms of saliva; salivary hyperglycemia provides a potential substrate for fungal growth. These contribute to the development of oral candidiasis, an opportunistic fungal infection commonly associated with hyperglycemia in individuals with diabetes mellitus. It is incumbent on dental professionals to screen patients with diabetes mellitus for nutrition risk and refer those at risk to an RD for MNT. The at-risk popula-

tion includes individuals with poor glycemic control and those for whom dental (oral) procedures affecting their functional ability to eat are planned.

Human Immunodeficiency Virus (HIV) Infection

The American Dietetic Association's position statement on nutrition intervention in the treatment of HIV infection supports the role of MNT as a component of health care provided to individuals with HIV infection (33). Because of the magnitude and impact of HIV-associated oral and systemic diseases on diet intake and nutritional status, dental intervention in conjunction with nutrition management is an essential component of care starting with diagnosis. People with HIV infection are at risk for oral diseases and their accompanying nutritional and systemic consequences, such as oral-pharyngeal fungal infections, which may cause a burning, painful mouth and dysphagia. Oral viral diseases, including herpes simplex and cytomegalovirus, may lead to chronic, painful ulcerations. These conditions, along with stomatitis, may be painful and can impact quality and quantity of oral intake (34). Esophagitis and oral and esophageal candidiasis result in painful biting, chewing, and swallowing and negatively affect appetite and intake. Kaposi's sarcoma comprises oral intake as well as increases nutrient needs.

Overweight and Obesity

Overweight and obesity in adults as well as at risk of overweight and overweight in children are risk factors for several chronic diseases, including type 2 diabetes mellitus, cardiovascular disease, hypertension, dyslipidemia, and metabolic syndrome. Relationships between weight status and oral health are a growing area of research. Genco and colleagues (6) proposed a model in which obesity is a predictor of periodontal disease and insulin resistance as a result of the proinflammatory state caused by obesity. Studies have shown significant positive correlations between abdominal obesity and body mass index with periodontal disease (35,36) in older adolescents (36) and adults (35). However, the research to date has been

cross-sectional in design (6,35,36). Despite the positive relationships between anthropometric indices of overweight and obesity and periodontal disease in older adolescents and adults, there is no identified causal relationship to date; potential mechanisms, including health habits, inflammatory markers, comorbidities, and hormonal factors, as well as other oral infectious and soft tissue diseases, need to be explored.

Oral and Pharyngeal Cancer

Oropharyngeal cancers are among the 10 most common cancers in the United States (37) and worldwide (38); they are more common in men and African Americans in the United States. The survival rate of these cancers in the United States is approximately 50% (34% among African Americans). Oropharyngeal cancers are associated with a high risk of second primary tumors (up to 20-fold) in the oral cavity (39). The most consistent findings on the role of diet and nutrition in the incidence of oropharyngeal cancers (40-41) are the protective effects of high consumption of fruits and vegetables. Pavia and colleagues (40) conducted a meta-analysis of relevant studies published through 2005; of the 16 studies that met the criteria for inclusion, a significant relationship between fruit (particularly citrus fruit) and vegetable consumption and reduced risk of oropharyngeal cancer was shown. Green tea polyphenols may have chemopreventive effects in prevention of oral leukoplakia and oral and gastrointestinal cancers (42). The lack of biomarkers to measure intermediate outcomes and a paucity of scientifically sound studies on the role of individual micronutrients in foods or supplement form support the need for prospective studies to determine biomarkers and examine the role of select food groups and nutrients in cancer prevention and management.

Cancer therapies may cause oral complications that compromise appetite and intake and consequently nutritional status. Radiation treatment of the oropharyngeal area may result in tooth loss, painful stomatitis, xerostomia, fibrosis of the muscles of mastication, and loss of sense of taste. Surgical resections and reconstruction, depending on the extent and se-

verity, can cause temporary and permanent alterations in masticatory and swallowing function and significantly increases energy and nutrient needs for healing (43). Chemotherapy regimens may affect the integrity of the oral cavity and the subsequent ability to eat and drink. RDs' comprehensive nutrition assessment must include physical assessment of oral sensory and functional abilities, nutrition-related quality of life, appetite, and nutrient needs (30,43). Enteral tube feedings may be necessary to manage and prevent malnutrition and dehydration following reconstructive surgery or during and after radiation therapy.

Osteoporosis

According to the Surgeon General's report on "Bone Health and Osteoporosis" (44), by the year 2020, one in two American adults over the age of 50 will have or will be at high risk of developing osteoporosis. Bone resorption and loss are common denominators for periodontal disease and osteoporosis. Cross-sectional (45) and longitudinal studies (25) have shown significant relationships between tooth loss, periodontal disease, low calcium intake, and osteoporosis in older men and women. Dietrich (45) found that higher serum 25(OH)D3 levels are associated with a lower rate of periodontal attachment loss in adults over the age of 50 years. Several theories linking periodontal disease and osteoporosis beyond the common denominator of bone loss and resorption have been postulated (26,27). Although studies have shown positive correlations between bone mineral density of the mandible with that of the lumbar spine and femoral neck (27,46), a causal relationship has not been found. Further research is needed to determine the nature of the relationship between bone mineral density and bone loss with the onset of periodontal disease and the roles of calcium and vitamin D in periodontal disease risk reduction and management.

Surgical Conditions

Oral Surgery. Diet and nutrient needs for oral surgery are to a large extent dependent on the extent of the surgical procedure, extent of impairment

on oral function, duration of any impairment, and nutritional well-being of the individual before surgery. The dental professional should provide diet guidelines to surgical patients on a balanced diet and appropriate texture or consistency modifications for wound healing. Patients who may not be able to meet all of their needs by oral diet alone or who have an acute or chronic disease affecting their diet or nutrient needs should be referred to an RD for MNT. Nutrient deficiencies may compromise the integrity of the immune response, resistance to infection, and wound healing (47); however, there is a paucity of scientifically sound research that supports nutrient supplementation beyond the DRIs in well-nourished individuals. Micronutrients and antioxidants including vitamins E and C and zinc play an important role in wound healing; supplemental use of these nutrients has not been shown to enhance response to surgery or promote wound healing. Nutrient needs after surgery are an active research area in systemic health; such research also is needed in relation to oral surgery.

Implants. Dental implants are an alternative to dental bridges, crowns, and dentures. A dental implant is a titanium metal post surgically placed in the alveolar bone that is then allowed to osseointegrate into the bone (fuse). Once osseointegration is complete, a plastic or porcelain crown or bridge is placed over the metal posts. Diet and nutrition relative to dental implants merits consideration in several areas, including surgical wound healing, integrity of the alveolar bone, nutritional status of the patient, and the patient's ability to eat after the surgery (short term and long term). There is no published research supporting the need for nutrients beyond the DRI for individuals undergoing implant surgery. Diet modification in the immediate days after surgery depends on the number and location of implants placed. Anterior implants may impact the ability to bite food, whereas posterior ones may hamper chewing ability. Oral opening may be limited because of the location and extent of sutures placed. Diet guidelines should address food texture and consistency in the context of a balanced diet adequate in fluids.

The long-term impact of implant-

supported dentures in comparison to traditional dentures on masticatory function and diet quality has been studied with mixed results (48-50). Although some studies have found that patients with implant-supported dentures consumed more varied and nutritionally adequate diets, others have found no significant difference between the diets of those using implant-supported dentures vs traditional dentures. The initial diet after placement of traditional or implant-supported dentures should be a nutritionally adequate diet with gradual advancement in food texture and consistency from finely cut, easily masticated foods that do not disperse easily in the mouth (such as rice) to a varied diet of whole foods.

HIGH-RISK GROUPS THROUGHOUT THE LIFE SPAN

Infants and Children

Adequate nutrients are needed prenatally, perinatally, and postnatally for normal growth and development of the oral cavity (2,20,51). Craniofacial malformations in infants and children such as cleft lip with or without cleft palate have been associated with cigarette smoking and folate deficiency in pregnant women. Women of childbearing age should consume adequate folate to meet the DRI or take a folic acid supplement to decrease the incidence of cleft lip/palate in infants (52). One episode of mild to moderate malnutrition in the first year of life is associated with both increased incidence of caries in primary and permanent teeth later in life and salivary gland atrophy and reduced saliva, important in reducing dental plaque acid activity (51). Maxillary anterior caries manifested in early childhood caries caused by feeding practices is the major nutrition-related oral disease found in young children and the socially disadvantaged (minority, poor, rural, immigrant) (51,53). A combination of infant/child feeding practices and repeated sequential consumption of fermentable carbohydrates, such as sweetened beverages or highly processed starchy/sugary foods increases caries risk. The American Academy of Pediatrics and the American Academy of Pediatric Dentistry support breastfeeding during the first year, recommend limited access to sweet-

ened low-nutrient-quality beverages, and recommend a dental evaluation after the first 6 months of life (54).

Increased intake of sugar-sweetened beverages among children has been identified as a risk factor for dental disease (55). For school-age children, meal and snack behaviors should involve healthful food and beverage choices that promote oral health (55). Other conditions that may affect oral health include developmental anomalies that alter eating ability and require specialized feeding strategies (12,56) and craniofacial surgery, which causes increased energy, protein, and nutrient needs for wound healing and may require multiple feeding modes, including oral supplements and tube feedings.

Adolescents and Young Adults

Eating patterns associated with lifestyles of adolescents can contribute to caries risk. Frequent consumption of caffeinated, carbonated beverages has been shown to be associated with increased caries risk (57). Consumption of sports drinks to complement physical activities should be addressed (58-60). Although total consumption alone has not been definitively associated with dental erosion (58), frequent consumption of such acidic beverages can increase risk of tooth erosion (59,60). Snacking patterns to meet increased energy needs of teens and young adults should address oral health promotion.

Eating disorders are the "third most common chronic illness in adolescent females" (61); the relationship between eating disorders, in particular bulimia, and integrity of the oral cavity is based on local factors. The increased insult of acidic gastrointestinal contents from "purging" can lead to tooth erosion of the lingual and occlusal surfaces on maxillary teeth. In addition to erosion, enlarged parotid glands may be evident. For further information on eating disorders, specifically anorexia nervosa and bulimia, the reader is referred to the 2006 American Dietetic Association position on eating disorders (61).

Older Adults

Older adults are the fastest growing population segment in the United States. Elderly patients frequently

have one or more chronic diseases and/or other conditions that can affect their dental treatment. Impaired dentition defined by the number of pairs of occluding teeth and evidence of complete dentures has been associated with compromised nutritional status (62,63). Because today's older adults tend to retain more of their natural teeth, new patterns of oral diseases, including root and coronal decay, are becoming more common. Oral manifestations of chronic diseases, xerostomia, side effects of polypharmacy on the oral cavity, osteoporosis, menopause, and eating problems associated with denture placement are examples of the scope of oral nutrition problems faced by older adults (5,62-65). The negative effect of tooth loss, edentulism, and removable prostheses on eating habits, masticatory function, sense of taste, and gastrointestinal disorders has been documented (64). Moynihan and colleagues (65) found that complete denture wearers have about 20% the chewing ability of their dentate counterparts. Salivary flow and composition do not change in healthy, unmedicated older adults; however, disease processes and polypharmacy can result in diminution in saliva that can alter mastication and swallowing (65). Despite clear evidence of the relationship between diet and nutritional status and oral problems faced by older adults, diet intervention is not a routine part of dental care of the elderly. Dietary quality can be achieved when diet education is a routine component of dental practice (65).

EVOLVING ISSUES IN NUTRITION AND ORAL HEALTH

Dietary Supplements

Dietary supplements of concern relative to oral health include those with local effects that are antimicrobial or anti-inflammatory in nature and those with systemic impacts that affect immune status, serve as metabolic stimulators, have an anticoagulant effect, or affect cognition. Herbs that are metabolized using the P450 enzyme pathway can show pharmacodynamic or pharmacokinetic interactions with drugs. Supplements with anticoagulant properties (eg, ginkgo biloba, garlic, vitamin E, n-3 fatty acids) can enhance the action of antico-

agulants in patients taking both. Similarly, metabolic stimulants such as guarana may enhance actions of epinephrine. It may be prudent in dentistry to follow the recommendations used by physicians regarding dietary supplement use and surgery; it is recommended that patients discontinue all dietary supplements 2 to 3 weeks before any scheduled surgery (66). RDs and dental professionals should ask patients about the use of all dietary supplements, be familiar with resources on these products, and guide patients appropriately about potential side effects and risks caused by disease, medication, or oral manifestations as a result of their use.

Catechins in tea have antistreptococcal activity against cariogenic bacteria such as *Streptococcus mutans* and *Streptococcus sobrinus*; although the evidence on the degree of activity is varied, it does support that these catechins may have inhibitory and bactericidal action (42). Translational and outcomes research trials in humans are needed before making any practical recommendations regarding the role of tea as a chemopreventive agent.

Nutrition in Dental Education

The Institute of Medicine and the Pew Health Professions Commission (67) support comprehensive training of dental professionals to ensure that they can manage "the whole patient" (68) as well as the need for preventive health measures, including improved feeding practices (68). Competencies (69) for predoctoral dental education by the American Dental Association's Commission on Dental Accreditation (70) are broad-based competency statements that do not address specific sciences such as nutrition. However, they do state that schools must "ensure an in-depth understanding of basic biological principles, consisting of a core of information on fundamental structures, functions and interrelationships of the body systems" (69). In-depth information must be provided to develop understanding of oral and oral-related disorder epidemiology, etiology, diagnosis, prevention, and treatment with no specificity to the clinical sciences such as nutrition that provide the knowledge base for related skills and values. [Figure 2](#) outlines didactic topics and clin-

Dietetics education	Dental education
<p>1. Baccalaureate program</p> <p>a. Didactic topics</p> <ul style="list-style-type: none"> ● Oral anatomy and physiology ● Oral manifestations of acute, chronic, terminal, and systemic diseases ● Oral sequelae of medications, chemo and radiation therapies ● Primary diseases of the oral cavity and their effects on taste, smell, and mastication <p>b. Clinical experiences</p> <ul style="list-style-type: none"> ● Field visits to dental schools/clinics ● Work with dental students/professionals in clinical/community settings ● Oral health screening questions as a component of nutrition assessment activities 	<p>1. Predoctoral program</p> <p>a. Didactic topics</p> <ul style="list-style-type: none"> ● Nutritional biochemistry ● Nutrition and oral health throughout the lifespan ● Diet education and intervention relative to oral health/disease ● Effect(s) of oral disease(s), symptomatology and their treatment(s) on diet and nutrition status ● Relationship between diet/nutrition and oral health in acute and chronic diseases and disorders ● Diet/nutrition screening, education and referral in dental practice ● Diet/nutrition risk factors and management strategies of high risk patients <p>b. Clinical and research experiences</p> <ul style="list-style-type: none"> ● Self evaluation of diet ● Education and training in patient diet evaluation and education ● Nutrition risk screening and diet education relative to oral health of patients ● Consultation and supervised practice with registered dietitians and or dietetic technicians, registered in diet evaluation and education ● Participate in oral health and nutrition/diet research
<p>2. Dietetic internship/coordinated program competencies</p> <ul style="list-style-type: none"> ● Conduct nutrition screening and diet counseling in dental school and community dental clinic rotations ● Integrate oral health screening questions into nutrition care process tasks (screening, assessment, intervention, monitoring) ● Integrate appropriate oral health guidelines into the conduct of diet counseling and education ● Participate in oral health and nutrition research ● Perform basic physical assessment including oral and cranial nerve screening exams ● Design nutrition care plans for patients with compromised oral health 	
<p>3. Graduate education</p> <ul style="list-style-type: none"> ● Design, conduct, and participate in oral health and nutrition research ● Perform oral physical assessment exams including intra/extra oral screening and cranial nerve examinations ● As appropriate, partner with dental students/professionals in clinical experiences 	<p>3. Graduate programs</p> <ul style="list-style-type: none"> ● Design, conduct, and participate in oral health and nutrition research ● Integration of nutrition screening and diet education into dental and oral disease specialty practice ● Collaborative education endeavors on related topics with dietetics programs
<p>4. Continuing professional education</p> <ul style="list-style-type: none"> ● Collaboration between food and nutrition and dental professionals in case presentations, multidisciplinary care meetings, conferences about diseases and the lifespan, multidisciplinary seminars, and publications ● Training opportunities using different media (eg, distance learning, CD-ROMs, videotapes/DVDs) 	<p>4. Continuing professional education</p> <ul style="list-style-type: none"> ● Collaboration between dietetics and dental professionals in case presentations, multidisciplinary care meetings, conferences about diseases and the lifespan, multidisciplinary seminars, and publications ● Training opportunities using different media (eg, distance learning, CD-ROMs, videotapes/DVDs)

Figure 2. Didactic and practice components of a curriculum model for dietetics and dental education programs to promote collaboration and multiskilling in nutrition and oral health.

ical and research experiences based on these competencies and recommendations from professional associations and initiatives and prior research (67,68,71). Knowledge of the principles and clinical application of diet and nutrition for health promotion, disease prevention, and as part of comprehensive care provides the underpinning for several of the dental education competencies. A core curriculum that integrates didactic coursework with clinical training in nutrition (Figure 2) over the 4 years of predoctoral work is needed. Although the fundamentals of macronutrients and micronutrients in human metabolism and oral health are taught in biochemistry and pathology courses, integration into the other basic and clinical science courses can provide an orientation and translation of nutrition and diet into clinical dental practice.

Accreditation standards for the advanced specialty postdoctoral education programs vary in the specificity with which they address nutrition (72-74). Periodontics and pediatric dentistry postdoctoral programs specify nutrition knowledge in relation to patient evaluation, disease processes, wound healing, and caries prevention and intervention, respectively (72,73). Although other program competencies do not specify nutrition, it is implied within stated competencies addressing comprehensive management of medically compromised and surgical patients (74).

The Commission on Dental Education's *Accreditation Standards for Dental Hygiene Education Programs* (75) specify that the curriculum include nutrition risk assessment and counseling. Patient care competencies specific to nutrition (Standard 2-19) state that graduates must be able to conduct nutrition risk assessments and counseling. Dental hygienists as well as other allied dental and dietetics personnel are cogent members of the oral health care team in health maintenance and disease management.

Oral Health in Dietetics Education

Oral health education is not outlined as a specific competency or criterion requirement for entry-level practice in the American Dietetic Association's Commission on Accreditation for Die-

tetics Education standards (76). The standards do require that entry-level dietetics education programs with a nutrition therapy emphasis address competency in the performance of basic physical assessment (76). However, because oral health is essential for normal mastication and digestion, oral health concepts should be incorporated into didactic coursework and clinical training in baccalaureate, preprofessional, and graduate levels of dietetics education at differing degrees (Figure 2). Given the functional and sensory roles of the structures of the head, neck, and oral cavity in diet and nutrition, basic physical assessment education and training should include a screening examination of the head, neck, and oral cavity (77,78). The outcomes of the examination for entry-level training should include identification of nutrition and diet-related risk factors (nonnormal conditions of the hard and soft tissue affecting the ability to eat or drink) to incorporate into MNT or referral to a dentist for further intervention. Competencies for the conduct of oral screening examinations (head/neck, intraoral/extraoral assessment, and cranial nerves) are needed for students in the preprofessional setting in conjunction with the standardized language diagnostic codes and related oral-defining characteristics (30). Dietetic interns and coordinated program students should be given opportunities to work with dental students/residents in the clinical setting to provide nutrition and diet intervention as a component of oral health management. Graduate and continuing education programs should include research and applications as they relate to medical and nutrition management of patients with oral diseases or oral manifestations of systemic diseases.

Collaborative Approach to Nutrition and Oral Health Education

The changing social and economic realities of today's health care system have had a dramatic effect on the preparation and training of health providers, including RDs, dentists, and allied dental personnel (7,67,68). A joint World Health Organization/Food and Agricultural Organization expert consultant's recommendation encouraged international organizations (79) to recognize nutrition as an essential part of training for dental, dietetic, and other

health professionals (79). Oral health and nutrition educators should assume leadership roles in promoting this dual content area in their respective curricula. The 1995 Institute of Medicine report "Dental Education at the Crossroads" recommends: "To prepare future practitioners for more medically based modes of oral health care and more medically complicated patients, dental educators should work with their colleagues in medical schools and academic health centers" (68). Knowledge of the synergy between oral health and diet and nutrition should be promoted in health education programs and practice (1,2,38,71). Dental professionals and RDs are key professionals who can advance initiatives that promote the roles of oral health and nutrition in relation to systemic health.

Nutrition and Oral Health Research

It is essential that a body of knowledge that supports practice in dietetics and dentistry be delineated to ensure health promotion and comprehensive health care. The determination of biomarkers and behavioral and outcomes markers are needed along with translational and outcomes research to explore and demonstrate relationships between nutrition, diet, and oral health and disease in prevention and intervention (56,80,81). Nutrigenomics and metabolomics are growing areas of research (80) and will undoubtedly lead to applications relative to oral health and nutrition.

The bidirectional relationships between oral health/disease and nutrition/diet need to be explored in translational research and outcomes studies. Concepts such as optimal diet management of dental implants and other reconstructive surgeries and determination of outcomes markers to qualify and quantify both sides of the bidirectional relationship between diet and nutrition and oral health merit further research, which will undoubtedly advance both professions.

Partnerships in Practice

Collaborative efforts within the oral health and nutrition disciplines will foster successful strategies related to oral health and nutrition. The integration of oral and nutrition health care management, including assessment and counseling as part of the treatment provided by both food

Food and nutrition professional	Dental professional
<p>Clinical setting</p> <ul style="list-style-type: none"> ● Include oral health screening as a component of nutrition care process tasks—nutrition screening, nutrition assessment (eg, cranial nerve function, occlusion, soft tissue, edentulism, masticatory ability, swallowing, salivary adequacy, intervention, and monitoring) ● Recognize oral manifestations of systemic diseases and provide patients with guidelines to maximize oral intake ● Confer with and refer patients (via consults) to dental practitioners for management of oral diseases and or risk factors for oral diseases ● Consult with dental professionals in interpretation of oral-nutrition assessment findings and planning in the long-term care setting 	<p>Clinical setting</p> <ul style="list-style-type: none"> ● Include diet screening, education, and referral for oral infectious disease prevention/control, optimal masticatory function and management of other oral diseases/treatments as a component of comprehensive dental care ● Collaborate with food and nutrition professionals in delivery of oral health care in long-term care settings ● Provide diet and nutrition guidelines for health promotion and disease prevention to patients and provide guidelines for diet to maximize oral intake ● Consult with and refer patients (via consult) to food and nutrition professionals for management of nutrition risk factors and diet due to compromised oral health (eg, caries, immunosuppressive disorders, xerostomia, diabetes, oral surgery, cancer)
<p>Community setting</p> <ul style="list-style-type: none"> ● Establish partnerships with dental professionals in community and private practice settings ● Develop and implement collaborative oral health and nutrition screening/education programs in schools, worksites, community events, and health maintenance organizations ● Promote collaborative education and practice regarding nutrition and oral health among food and nutrition and dental professionals ● Develop nutrition education messages that encourage oral health ● Promote oral health in school and community nutrition programs 	<p>Community setting</p> <ul style="list-style-type: none"> ● Establish partnerships with food and nutrition professionals in community and private practice settings to promote nutrition/diet screening and education in dental practice ● Develop and implement collaborative oral health and nutrition screening/education initiatives in schools, worksites, and health care organizations ● Promote collaborative education on nutrition and oral health among food and nutrition and dental professionals ● Develop oral health messages that integrate nutrition and diet education ● Promote diet and nutrition as a component of school and community oral health programs
<p>Research setting</p> <ul style="list-style-type: none"> ● Promote collaborative nutrition and oral health research initiatives ● Design, conduct, and participate in nutrition/diet components of oral health research initiatives ● Identify and support integration of oral health issues (eg, screening, disease, management, education) as a component of nutrition research 	<p>Research setting</p> <ul style="list-style-type: none"> ● Promote collaborative oral health and nutrition research initiatives ● Design, conduct, and participate in oral health component of nutrition/diet research initiatives ● Identify and support integration of nutrition topics as a component of oral health research as appropriate

Figure 3. Food and nutrition and dental professionals role modeling to achieve effective integration of oral health and nutrition service in health promotion and in disease prevention and intervention.

and nutrition and dental professionals, is an excellent example of collaborative, comprehensive, and cost-effective care. Figure 3 presents strategies for RDs and dental professionals to use in addressing oral health and nutrition issues in practice. RDs can use these strategies in counseling when caries risk is high, as a component of MNT for diabetes mellitus, or as a component of healthful lifestyle counseling (30,77,78). When counseling women regarding osteoporosis management or risk reduction, RDs should emphasize the importance of bone health for oral health. Likewise, the dental professional can address the dietary guidelines and healthful weight

management as components of oral health maintenance education as well as adequate dietary calcium for oral and systemic health. In patients with orally compromising conditions impacting eating ability or nutrition status, the dental professional should determine diet/nutrition risk, educate patients on diet relative to oral health, and, when in-depth nutrition evaluation and diet counseling is needed, refer patients to an RD for MNT.

The US Department of Health and Human Services' *Healthy People 2010 Objectives for the Nation* (81) specifically addresses the prevention and control of oral and craniofacial diseases/conditions/injuries and access to re-

lated services. Alleviating physical, cultural, racial, ethnic, social, educational, health care delivery, and environmental barriers that prevent people from achieving healthful oral functioning, and research exploring new ways of improving oral health, are included in this report as well as in the US Surgeon General's "National Call to Action to Promote Oral Health" (80). Health promotion and disease prevention initiatives by national dental organizations, federal and state agencies, and private foundations to meet these objectives will contribute to improved nutritional status (2,4,44,81). Opportunities to carry nutrition into the oral health arena are open to RDs.

SUMMARY AND FUTURE DIRECTIONS

Credentialed RDs and dental professionals should pursue opportunities to create a conceptual framework that integrates optimal oral and nutrition health care to improved oral, nutritional, and systemic health status (Figures 2 and 3). To prepare professionals with the skills and knowledge that exemplify this paradigm in practice, dietetics and dental educators must assume responsibility for integrating oral health, diet, and nutrition topics and clinical/community experiences in education, respectively. Figure 2 provides a foundation for these initiatives. Changes in the epidemiology of oral disease and oral manifestations of systemic diseases, new findings in nutrition/diet and oral health research, along with population shifts, advances in pharmacological and surgical management of diseases and disorders, and new technology, have major implications for the future of dentistry and dietetics.

Collaboration between dietetics and dentistry in research, education, and practice is needed to ensure comprehensive health care to persons with oral infectious disease and/or oral manifestations of systemic diseases. The burden of responsibility for health professionals to provide comprehensive health care is rapidly increasing (4,7,67,68,81). As we advance in our discoveries of the links between oral and nutrition health, professionals of both disciplines must learn to provide screening, baseline education, and referrals to each other as part of comprehensive client/patient care (Figure 3). Continued collaborative research will provide the critical findings needed to continue to advance oral health and nutrition in practice and education.

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ADA Position adopted by the House of Delegates on October 29, 1995, and reaffirmed on June 22, 2000, and June 30, 2005. This position is in effect until December 31, 2010. The American Dietetic Association authorizes republication of the position statement/support paper, in its entirety, provided full and proper credit is given. Requests to use portions of the position must be directed to ADA Headquarters at 800/877-1600, ext 4835, or ppapers@eatright.org.

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