Aging of the US population

The US aging population is increasing. The US older population, that is individuals aged 65 and older, reached 40.3 million in 2010. This is an increase of 5.3 million compared to the 2000 census. The percentage of the US population aged 65 and older also increased from 2000 to 2010. In 2010, the older population represented 13.0% of the total population, an increase from 12.4% in 2000 (Vincent & Velkoff, 2010). In the USA, by 2030 it is projected that there will be about 72.1 million older people, more than twice their number in 2000. Individuals aged 65 and older are expected to grow to become 19% of the US population by 2030 (Administration on Aging, 2012). By 2050, it is projected that there will be about 88.5 million older adults, 20.2% of the US population (US Census Bureau, 2008a).

Ethnic diversity

The US population is becoming increasingly diverse, and this is true for the aging population too. In the USA, among those aged 65 and older in 2050, 77% of the elder population are projected to be White-alone, down from 87% in 2010. Within the same age group, 12% are projected to be Black-alone and 9% are projected to be Asian-alone in 2050, up from 9% and 3%, respectively, in 2010. The Hispanic proportion of the older population is projected to quickly increase over the next four decades. By 2050, 20% of the US population aged 65 and over are projected to be Hispanic, up from 7% in 2010. The smallest race groups are projected to see the largest growth relative to their populations. Among the population aged 65 and older, it is projected that in 2050, the American Indian and Alaska Native-alone population will be 918,000, up from 235,000 in 2010, and the Native Hawaiian and Other Pacific Islander-alone population will be 219,000, up from 39,000 in 2010 (Vincent & Velkoff, 2010). There is also a trend of increasing number of old-old (age 75 and older) and oldest-old (age 85 and older) populations in the USA. The old-old and oldest-old carry much of the chronic disease burden in the population.

In the USA, among those aged 65 and older in 2050, the White-alone population will comprise approximately 77% of the aging population, whereas in 2010 the racial composition of the elder population was 87% White-alone, 9% Black, 3% Asian-alone, 7% as Hispanics, and 0.6% American Indian and Alaska Native. Between 2010 and 2030, the percentage of minority elders will increase much faster than the White population. The White population aged 65 and older is projected to increase by 59% compared with an average increase of 160% for older minorities, including Hispanics (202%), African Americans (114%), American Indians, Eskimos and Aleuts (145%), and Asians and Pacific Islanders (145%) (Administration on Aging, 2012).

While an increasing number of studies have examined oral health disparities across race/ethnicity in the USA, a limited number of such studies have been conducted for older adults. Policy makers, public health officials, and other healthcare providers need to better understand how social factors, along with medical conditions, may contribute to racial/ethnic disparities in oral health with the demographic
transitioning to a more diverse older population in the USA (US Census Bureau, 2008b).

A report from the Surgeon General (US Department of Health and Human Services, 2000) noted ongoing racial/ethnic disparities in oral health across all ages, and it stressed the need for research to explain these differences. The first step towards explaining the disparities is to know how oral health differs between the groups.

**Trends in oral health in older adults**

There is substantial evidence that oral health in the USA has significantly improved in the past four decades. Dye *et al.*, using data from the National Health and Nutrition Examination Survey (NHANES, III, 1988–1994) and NHANES 1999–2004, found that the oral health of the USA has substantially improved during this period (Dye *et al.*, 2007). Specifically, Dye *et al.* show that the rates of periodontal disease and caries have decreased for most age groups.

Edentulism, or complete tooth loss, is one of the most important indicators of oral health. Edentulism reflects both the accumulated burden of oral diseases and conditions and the result of dental extraction treatment (Sanders *et al.*, 2004). Studies suggest that edentulism significantly affects quality of life, self-esteem, and nutritional status (Nowjack-Raymer & Sheiham, 2003; Slade & Spencer, 1994; Starr & Hall, 2010). In economically developed countries, the trend of edentulism has declined consistently. For example, in England and Wales, the prevalence of edentulism for the adult population declined from 37% in 1968 to 12% in 1998 (Kelly *et al.*, 2000). In Australia, the prevalence of edentulism for the adult population declined from 20.5% in 1979 to 8.0% in 2002. Among Australian older adults aged 65 and older, the reduction for males was from 59.7% to 26.5%, and for females was from 71.5% to 40.3% (Sanders *et al.*, 2004). Similarly in the USA, the few studies available on middle-aged and older adults have shown that edentulism in these age groups has been dropping for the past several decades. One study revealed that within the period of 1971 and 2001, for those in a low socioeconomic position (SEP), the prevalence of edentulism declined from 50% to 32% in adults aged 55–64 and from 58% to 43% in adults aged 65–74; the comparable declines for these age groups for individuals in a high SEP were from 22% to 6% and from 30% to 9%, respectively (Cunha-Cruz *et al.*, 2007). A report conducted by the US National Centers for Health Statistics using the US National Health and Nutrition Surveys of 1988–1994 (NHANES III) and NHANES 1999–2004 found that the prevalence of edentulism declined in the USA over these two time periods from 34% to 27% among adults aged 65 and older (Dye *et al.*, 2007).

In the USA, minority elders have been identified as a key demographic group at greatest risk for edentulism (US Department of Health and Human Services, 2000). Black elders, in particular, have higher rates of edentulism than non-Hispanic Whites and Mexican Americans (Dye *et al.*, 2007; Schoenborn & Heyman, 2009; Wu *et al.*, 2011a). One study reported that the rates of edentulism among Blacks were declining, even though they were still higher than other ethnic groups (Dye *et al.*, 2007). This study reported that the rates of edentulism for Black elders declined from 38% in 1988–1994 to 33% in 1999–2004 (Dye *et al.*, 2007). For Whites, the percentages were much lower: 34% in 1988–1994 and 26% in 1999–2004. By comparison, Mexican American adults had even lower edentulism rates (27% and 24%, respectively).

Information regarding edentulism for Asian Americans and Native Americans is very limited. A recent report determined that 21% of Asian Americans aged 65 and older had lost all of their teeth compared to 25% of Whites. Asian Americans also had the lowest percentage of edentulism compared to other minority groups (Schoenborn & Heyman, 2009). The Third Oral Health Survey conducted by the Indian Health Service in 1999 found that 21% of Native American adults aged 55 and older were edentulous, representing a decrease of 5% over 15 years (Indian Health Services, 2001).

One recent study examined the trend of edentulism among adults aged 50 and older in five ethnic groups: Asians, Blacks, Hispanics, Native Americans, and non-Hispanic Whites (Wu *et al.*, 2012a). This study used the National Health Interview Survey (NHIS), which is a cross-sectional household interview survey conducted annually. Ten waves of NHIS data were aggregated from 1999 to 2008. Eligible
respondents were those aged 50 and older who completed the question on tooth loss. The sample included 616 Native Americans, 2666 Asians, 15,295 Blacks, 13,068 Hispanics, and 86,755 non-Hispanic Whites. Self-reported responses to a question about whether the individual had lost all upper and lower natural teeth were used to determine edentulism. Results show that for the past 10 years, there was an overall declining trend of edentulism for all racial and ethnic groups, except for Native Americans (Table 1.1). Table 1.1 presents the predicted rate of edentulism adjusting for time, sociodemographic characteristics and level of education. In 2008, Native Americans had the highest rate of edentulism (23.98%), followed by Blacks (19.39%), Whites (16.90%), Asians (14.22%), and Hispanics (14.18%). Figure 1.1 presents the trend of predicted rate of edentulism adjusting for time, sociodemographic characteristics and level of education.

This is the first study to provide national estimates for the rate of edentulism and associated trends over time for five major ethnic groups in the USA simultaneously: Native Americans, Asian Americans, Blacks, Hispanics, and non-Hispanic Whites. Significant

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**Table 1.1** Trend of edentulism by racial/ethnic groups (1999–2008) (%) (weighted)*

<table>
<thead>
<tr>
<th>Year</th>
<th>White</th>
<th>Black</th>
<th>Hispanic</th>
<th>Asian American</th>
<th>Native American</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>21.49</td>
<td>24.62</td>
<td>17.78</td>
<td>17.04</td>
<td>33.20</td>
</tr>
<tr>
<td>2000</td>
<td>21.18</td>
<td>23.74</td>
<td>17.60</td>
<td>13.54</td>
<td>34.02</td>
</tr>
<tr>
<td>2001</td>
<td>20.20</td>
<td>23.02</td>
<td>17.71</td>
<td>11.88</td>
<td>31.78</td>
</tr>
<tr>
<td>2002</td>
<td>19.77</td>
<td>22.42</td>
<td>16.68</td>
<td>13.55</td>
<td>29.72</td>
</tr>
<tr>
<td>2003</td>
<td>18.90</td>
<td>21.78</td>
<td>16.21</td>
<td>15.88</td>
<td>29.67</td>
</tr>
<tr>
<td>2004</td>
<td>18.80</td>
<td>20.60</td>
<td>15.44</td>
<td>14.09</td>
<td>30.18</td>
</tr>
<tr>
<td>2005</td>
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<td>20.65</td>
<td>15.13</td>
<td>13.57</td>
<td>27.07</td>
</tr>
<tr>
<td>2006</td>
<td>17.58</td>
<td>20.20</td>
<td>15.20</td>
<td>15.26</td>
<td>24.72</td>
</tr>
<tr>
<td>2007</td>
<td>17.05</td>
<td>19.58</td>
<td>14.74</td>
<td>14.08</td>
<td>27.07</td>
</tr>
</tbody>
</table>

*The predicted rates of edentulism were calculated adjusting for time, race/ethnicity, sociodemographic characteristics, and level of education.

From Wu et al. (2012a).
disparities in edentulism exist across these ethnic groups. Relative to Whites, Blacks and Native Americans had a higher rate of edentulism, whereas the rate of edentulism was lower among Hispanics and Asians. After controlling for covariates (e.g., sociodemographic characteristics, smoking, and common chronic conditions), Blacks and Hispanics were less likely to be edentulous than White respondents, while Native Americans were still more likely to be edentulous. In contrast, when covariates were included in the models, no significant differences were found between Asian Americans and Whites in edentulous rates. Overall, there was a significant downward trend in edentulism rates between 1999 and 2008; however, oral health disparities, as measured by rates of edentulism, increased among Native Americans over time compared to Whites.

The improvement in tooth retention was not equally distributed across the five racial and ethnic groups examined in this study. Native Americans, in particular, were at a significant disadvantage. Compared to Whites, Native Americans were more likely to lose natural teeth over time, but the risk became smaller after controlling for individuals’ socioeconomic status, health behaviors, and medical conditions. This study found that edentulism has continued to decline across the USA during the past decade. This comprehensive study supports previous reports about edentulism among adult populations collected in earlier time periods and across selected racial/ethnic groups (Dye et al., 2007; Indian Health Services, 2001; Schoenborn & Heyman, 2009).

One study found that current smoking and fewer years of education were two of the covariates most strongly associated with being edentulous (Wu et al., 2012a). Others have attributed the declining edentulous rate to the decrease in smoking and the increasing years of education among more recent cohorts (Cunha-Cruz et al., 2007). The authors also found that selected medical conditions were associated with edentulism; these were generally consistent with previous research (Holm-Pedersen et al., 2008). Self-reported memory problems and needing assistance with routine activities were also associated with increased risk of edentulism. Given the fact that the information on covariates was not collected prospectively, the authors cannot determine whether the factor preceded the edentulism. Many other factors could also contribute to the decrease of the edentulous rate, such as the introduction of fluoridation through community water treatment (Adair et al., 2001) and fluoridated toothpaste and mouth rinse (Featherstone, 1999; Marthaler, 2004). Health practices such as dietary supplements, and professionally applied or prescribed fluoride gel, foam, and varnish may also contribute to improved tooth retention (Adair et al., 2001; Marthaler, 2004; Weyant, 2004). Others point to advancements in dental technologies and treatment modalities, changes in patient and provider attitudes and treatment preferences (Starr & Hall, 2010), improved oral hygiene, and regular use of dental services (Eklund, 1999; Starr & Hall, 2010; Truman et al., 2002).

Oral health disparities in older adults

Some studies have reported that older Hispanic and Black Americans have more missing teeth, and decayed teeth than their White counterparts (Kiyak et al., 2002; Quandt et al., 2009; Randolph et al., 2001; Watson & Brown, 1995). Using the US National Health and Nutrition Examination Survey (NHANES 1999–2004), a Centers for Disease Control and Prevention (CDC) report found that both Blacks and Mexican Americans have a higher prevalence of untreated tooth decay and missing teeth than Whites (Dye et al., 2007). However, Mexican American adults were least likely to have lost all teeth compared to Whites and African Americans (Dye et al., 2007). In fact, a few studies have suggested that older Black adults have even worse oral health than Hispanics (Borrell et al., 2004; Craig et al., 2001; Kiyak et al., 2002). Many of the previous studies used small convenience samples or only individuals with low socioeconomic status; some were not able to compare the three racial/ethnic groups in the same sample, and some did not evaluate potential confounders that may help to explain differences among the racial/ethnic groups.

In order to address many of the methodologic issues noted earlier in this chapter, one study compared racial/ethnic differences in oral health among community dwelling non-Hispanic White, non-Hispanic Black, and Mexican American older adults aged 60 and older using NHANES (1999–2004) (Wu
The descriptive results of the study showed that in comparison with Whites and Mexican Americans, Blacks had a significantly higher number of missing teeth, with an average of 3.5 more than whites (12.7 missing teeth) \( (P<0.05) \) and 4.3 more than Mexican Americans (12.0 missing teeth) \( (P<0.01) \). Blacks also had significantly higher rates of edentulism (28.6%) than both Whites (24.5%) and Mexican Americans (18.1%). However, Mexican Americans had the lowest rate of edentulism (18.06%) among the three groups but the highest number of decayed teeth by comparison. Additionally, minorities had many fewer filled teeth than Whites, particularly Blacks who had 2.7 filled teeth compared with 7.3 for Whites and 4.7 for Mexican Americans. (Fig. 1.1)

The findings from this multivariate analysis (Wu et al., 2011a) also showed that Blacks and Mexican Americans had significantly higher numbers of decayed teeth but fewer numbers of filled teeth than Whites, even controlling for many confounding variables. The results also found that Blacks were more likely to have a higher number of missing teeth than Whites; nonetheless, they were less likely to be edentulous. Compared with Whites, Mexican Americans were less likely to be edentulous, and dentate respondents were also less likely to lose their natural teeth. Further, the study reported that racial/ethnic differences were confounded by other health-related and social factors that often differ by race/ethnicity. Overall, oral health disparities across racial/ethnic groups persisted even after controlling for other covariates.

In this study (Wu et al., 2011a), racial/ethnic differences remained even after controlling for all other covariates. The findings reflect a historic lack of access to dental care for racial/ethnic minorities (Davidson & Andersen, 1997; Manski & Magder, 1998). Minority elders often demonstrate a low use of dental services, particularly preventative services. Racial/ethnic disparities in dental care could be partially explained by differential treatment as a result of limited dental coverage and inadequate participation of dentists in the Medicaid program (Doty & Weech-Maldonado, 2003).

Oral health is associated with individual’s socioeconomic status (Borrell et al., 2004). This association is often explained by the fact that individuals with higher income and a higher level of education are more likely than others to seek preventive dental care, have healthy behaviors, or to have access to dental services when they are needed. Another study confirmed the finding that individuals with higher level of education and income and education had better oral health outcomes, even controlling for the factors on health behaviors and preventive dental care (Wu et al., 2011a). The authors suspect that the results may arise from unmeasured differences in the quality of dental care currently received. Another possibility is that the cross-sectional data do not capture the cumulative effects of access to dental care throughout the life course (Wu et al., 2011a).

The observed disparities may also reflect current or lifetime dietary habits, and current or lifetime smoking habits and other negative health behaviors among minorities. Additionally, the results presented in this study could reflect unmeasured racial/ethnic differences in oral health beliefs and oral hygiene practice, and a lack of dental knowledge. Other researchers have suggested that clinicians should be aware that minorities may be less likely than Whites to believe in the benefits of preventative practices (Nakazono et al., 1997).

Using the same NHANES data (1999–2004), one study also examined racial/ethnic differences in self-reported oral health (Wu et al., 2011b). This study found that Blacks and Hispanics reported poorer self-rated oral health than Whites. In separate dentate and edentulous groups, socioeconomic status, social support, physical health, clinical oral health outcomes, and dental checkups accounted for much of the difference in self-rated oral health in Blacks, but significant differences remained for Hispanics. In addition to some potential reasons discussed earlier, other cultural factors could also contribute to the differences in self-rated oral health. Perception of health is socially constructed (Kaplan & Baron-Epel, 2003). Health beliefs and perceptions are rooted in social and cultural contexts and are influenced by prevailing social and medical ideologies. Responses to the self-rated oral health question may be the product of multiple present and past experiences. Factors such as differences in cultural perception and interpretation of overall health, and perceived needs of dental care, could contribute to the differences in self-rated oral health.
These cited studies suggest that reducing racial/ethnic oral health disparities requires multiple clinical approaches. First, it is important to improve access for dental care for minority elders. Second, it is critical to increase older adults’ knowledge of the importance of oral health, including the linkage between oral health, referred to as “dental literacy”, and systemic medical conditions, oral hygiene, and preventive dental care services. Third, programs are needed to improve individuals’ overall health behaviors – perhaps through encouraging positive behaviors that can help older Americans retain their natural teeth and maintain good oral health later in life. Fourth, develop and improve culturally competent services for minority communities by recruiting more underrepresented minorities to the dental professions, and enrich dental education curriculum (Lopez, N. et al., 2003; Wu et al., 2011a).

**Functional status and oral health**

The aging population is at increased risk for physical disability. Among people aged 65 and older, 18.1 million people (51.8%) had a disability, defined as having at least one disability of Activities of Daily Living (ADL) or Instrumental Activities of Daily Living (IADL). About 12.9 million people aged 65 and older (36.9%) had a severe disability. The prevalence of disability increases as people get older. For those aged 65 and those aged 69, 37.4% had disability and 7% need personal assistance with ADL or IADL. For individuals aged 80 and older, the percentage increases to 71% and 29.2%, respectively (Brault, 2008). Disability leads to reduced quality of life for individuals and increased costs to society in the provision of services. It is likely that disabled older adults are at higher risk of oral diseases. One reason is that disability may affect individual’s ability to maintain good oral hygiene and restrict their access to necessary dental care. Several cross-sectional studies have shown that elders with functional disability have more untreated caries, higher prevalence of edentulism, and use dental services less regularly than their counterparts (Gift & Newman, 1993; Jette et al., 1993; Philip et al., 2012; Wu et al., 2007). One longitudinal study conducted among Swedish elders found that individuals with recent decrease in functional status were associated with root caries while more severely disabled elders that needed personal assistance were more likely to have coronal caries (Avlund et al., 2004). These findings suggest that those individuals with more severe functional impairment were more likely to have coronal caries while those with less severe level of functional impairment were associated with root caries. One possible explanation for the finding is that people who need help in daily activities (i.e., those with a more advanced stage of impairment) have had these problems over a longer period of time, and the development of coronal caries reflects a past caries burden that has been present over a period of time. A general decline in functional status may be regarded as an early sign of later deterioration, which is reflected in root caries, a condition that may reflect a caries burden in a period closer to the time of the examination. One factor that explains the association between functional impairment and poor oral health is that decline in functional performance could result in a decline in the quality and regularity of oral hygiene, which in turn, affects oral health. Using data from a randomized trial of community dwelling adults aged 75 and older, one study reported that functional status was positively correlated with frequency of dental visits over time (Dolan et al., 1998). The findings suggest that functionally impaired older adults underutilize dental services. The authors’ assumption is that these individuals’ higher utilization of medical services due to health problems may cause them to use less dental care. Functionally disabled elders may see dental care as a lower priority for many reasons, including time availability, access to transportation, perceived importance of dental care, financial resources, and energy to seek dental care.

As indicated previously, functional disability may affect the individual’s regular dental visits and ability to perform oral hygiene. Adherence to the American Dental Association’s and the US Surgeon General’s Oral Hygiene Self-care recommendations to brush twice and floss at least once a day and receive regular prophylactic dental hygiene visits have been associated with reducing the plaque-mediated conditions of periodontal disease and dental caries, as well as improving tooth retention (Kressin et al., 2003; Sharma et al., 2004; Sniehotta et al., 2007). Biofilm is the aggregation of any cluster of microorganisms on
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a surface; in the oral cavity, removal of the biofilm that forms on teeth is associated with better oral health. Studies indicate that oral hygiene self-care can manage biofilm by mechanically removing the oral plaque biofilm mass, lowering the bacterial load, oxygenating the site, and changing the ecology of the biofilm (Schaudinn et al., 2009). The process can be achieved with good oral hygiene practice, such as brushing, rinsing, scraping, and flossing, or using other interdental cleaning (Schaudinn et al., 2009). One study conducted among community dwelling dentate individuals age 70 and older indicated a need for older adults to improve in their frequency of oral hygiene behavior, particularly for elderly men (Wiener et al., 2012). The study reported that a higher proportion of older adult women brushed their teeth more frequently than their male counterparts. Eighty-one percent of women reported brushing their teeth twice a day, while the percentage for males was 52%. Compared to brushing, all participants reported lower frequency of flossing and mouth rinsing. Forty-four percent of males and 32% females reported flossing intermittently, and the percentage for mouth rinsing was 41% and 37% respectively.

Xerostomia, medications, and oral health

Saliva provides a crucial role in oral health. It buffers acids, has antibodies, helps to prevent gingival mucosal erosions and ulcerations, and aids in remineralization of teeth. When salivary function is diminished, there is more risk for caries, denture discomfort, and diseases such as candidiasis (Guggenheimer & Moore, 2003; Turner et al., 2008).

Xerostomia is a person’s complaint (subjective perception) of oral dryness/hyposalivation (Navazesh & Kumar, 2008). Hyposalivation is the condition of having a reduced production of saliva. Xerostomia is a common problem in older adults. One review article reported older adults to have rates between 17 and 29%, with more prevalence in women (Guggenheimer & Moore, 2003). Another study reported 46% of participants experienced xerostomia (Narhi, 1994). One recent study conducted among community dwelling elders aged 70 and older found that 20.5% of the participants reported having xerostomia (Wiener et al., 2010).

Medications with antisialagogic (inhibiting salivary flow) side-effects are the most frequent causes of xerostomia. These medications include anticholinergics, antidepressants, antipsychotics, diuretics, antihypertensives, sedative and anxiolytics, muscle relaxants, antihistamines, opioid analgesics, and nonsteroidal anti-inflammatories (Narhi, 1994; Navazesh & Kumar, 2008). Some biologic causes of xerostomia include a previous history of radiation to the head and neck, diseases of the salivary gland, diabetes, alcohol use, cystic fibrosis, hormonal imbalance, autoimmune diseases, and other diseases. Psychologic and social factors, such as depression, anxiety, and stress are also causes (Fox, 1996; Navazesh & Kumar, 2008).

As chronic conditions are more prevalent in later life, medication intake also increases. Based on a national survey, 81% of the adult population had taken at least one medication during the previous week (Kaufman et al., 2002). Rates of medication use increase with age and are greater in women. Among female individuals aged 65 and older, 94% had taken at least 1 medication during the previous week, 57% took 5 or more, and 12% took 10 or more; while for male counterparts, the percentage was 91%, 44%, and 12% respectively. The increasing number of prescribed and/or over the counter medications taken increases the risk of dry mouth, which in turn have potential negative impact on oral health.

Case study 1

Your patient is a 78-year-old woman who lives alone at her home in an urban community who comes to your office for routine check-up. She has multiple chronic conditions including hypertension, diabetes, and depression. She has been taking Exforge® to treat her hypertension and selective serotonin reuptake inhibitors (SSRIs) to treat her depressive symptoms. She tells you that she feels her eyes, mouth, and lips are dry. She has to sip liquids to aid in swallowing food or avoids certain food. She frequently feels thirsty at night and she has to get up to drink water. As a dental professional, what would you recommend to this patient to alleviate the symptoms? What would you do to communicate with the patient’s primary care provider?
Cognitive function and oral health

Cognitive impairment is common among older adults. It is reported that between 2.6 million and 5.1 million Americans may suffer from the condition (National Institutes of Health, 2010), and the numbers are expected to more than double by 2050 (Hebert et al., 2003). In addition, an estimated 5.4 million people in the USA aged 71 and older (22.2%) have cognitive impairment without dementia (mild manifestations of impairment) (Plassman et al., 2008).

Evidence from clinical samples suggests that the elderly have an increased incidence of oral disease and that the frequency of oral health problems increases significantly in cognitively impaired older adults, primarily those with dementia. The few studies to examine the relationship between cognitive function and oral health have primarily focused on patients with Alzheimer’s disease (AD) or other dementias. Results from three longitudinal studies have consistently shown higher rates of oral conditions such as salivary dysfunction (King, 1992; Ship & Puckett, 1994), coronal and root caries (Chalmers et al., 2002; Chalmers et al., 2004; Jones et al., 1993), and other oral diseases (Chalmers et al., 2002; Chalmers et al., 2004) in individuals with dementia compared to the nondemented controls. These findings involving individuals with diagnosed dementia may not apply to older individuals across the full range of cognitive function, including the large number of people with undiagnosed dementia (Callahan et al., 2002) or with cognitive impairment not severe enough to meet criteria for dementia (Lopez O.L. et al., 2003). To address this point, a few studies have investigated the association between cognitive status and oral health in later life. These studies provide preliminary support for an association between performance on brief cognitive status measures and poorer oral health based on the presence of more decayed teeth (Beck, 1990), greater dental functional impairment (Osterberg et al., 1990), and a trend toward more coronal and root caries (Avlund et al., 2004). However, interpretation of these studies has been limited by the use of cognitive measures insensitive to the full range of cognitive ability, inability to control for key variables associated with oral health, or a small sample size.

More recently, several epidemiologic studies have examined the relationship between cognitive function and oral health. Using data from NHANES III, Stewart et al. (2008) investigated the association between oral health and cognitive function in early, mid-, and late-adult life. A total of 5138 people aged 20–59 and 1555 people aged 70 participated in the study. The study included three measures of oral health: gingival bleeding, loss of periodontal attachment, and loss of teeth. Cognitive function was measured by the Symbol Digit Substitution Test (SDST), and the Serial Digit Learning Test (SDLT) (both in participants aged 20–59), and a Story Recall Test (in participants aged 70). The results show that worse scores on all three measures of oral health status were significantly associated with poorer performance on cognitive function. After adjustment for covariates (including individual’s socioeconomic status and medical conditions), gingival bleeding (%), and loss of periodontal attachment (%) remained associated with relative impairment on SDST score, and gingival bleeding was associated with relative impairment on SDLT.

Almost all these previous epidemiologic studies used cross-sectional data. It is critical to conduct longitudinal studies to examine the linkages between cognitive function and oral health in older adults. Although the processes underlying this association remain unclear, there are some underline assumptions on the impact of cognitive impairment on oral health. Studies have shown that an individual’s socioeconomic status (as represented by years of education) is strongly related to oral health. It is possible that the association between cognitive function and oral health, even after controlling for education, still may reflect unmeasured differences in life-course socioeconomic status. Cognitive function may reflect not only the level of educational attainment but also the quality of education and cumulative effect of socioeconomic status (e.g., previous or current occupational status, wealth, and cognition in childhood, etc.) across the life span (Froehlich et al., 2001; Moody-Ayers et al., 2005).

Dental care utilization likely serves as a mediating variable between cognitive function and oral health. Dental care utilization has a strong association with oral health outcomes such as number of decayed teeth, missing teeth, and filled teeth (Vargas et al., 2003). One study also found that cognitive function has a significant impact on dental care utilization.
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Individuals with lower cognitive function may not view dental care as a high priority and may have limited self-awareness of dental care needs. In addition, a decline in cognition may be reflected as a decline in IADL performance, specifically a decline in the quality and regularity of oral hygiene. These changes may partially explain the association between cognition and oral health.

One study used longitudinal data from community dwelling elders to examine cognitive impairment’s impact on oral hygiene (Wu et al., 2012b). This study suggests that incident decline in oral hygiene practices, such as transitioning from brushing to not brushing teeth, is often associated with concurrent declines in cognition, which can be classified as incident cognitive impairment in many individuals. These findings add to the growing body of literature that indicates that decline in both oral hygiene and oral health may begin prior to the time an individual has advanced dementia and significant impaired function.

On the other hand, there are several potential reasons why poor oral health may itself be a risk factor for cognitive decline. Periodontal disease, at times resulting in tooth decay and loss, is a common source of chronic infection in humans and is associated with elevated levels of inflammatory markers (Li et al., 2000). Even a low-grade infection in the oral cavity may be associated with a moderate, subclinical systemic inflammatory response, but appropriate treatment reduces the levels of inflammatory markers (D’Aiuto & Tonetti, 2004; Taylor et al., 2006).

Chronic inflammation, as measured by serum interleukin-6 and C-reactive protein, is reportedly a risk factor for cardiovascular disease (D’Aiuto & Tonetti, 2004), cognitive decline (Weaver et al., 2002; Yaffe et al., 2003), and AD (Schmidt et al., 2002). Current theories posit that inflammatory processes play a major role in the etiology of AD (Finch & Crimmins, 2004; McGeer & McGeer, 1995). Consistent with this, one study found that among monozygotic twin pairs, twins who reported the loss of all of their teeth prior to age 35 were more likely to develop dementia than their co-twins who retained half or more of their teeth (Gatz et al., 2006). Furthermore, tooth loss is also associated with dietary changes (Nowjack-Raymer & Sheiham, 2003), which may cause cognitive impairment due to potential nutritional deficiency. Finally, poor oral health is associated with systemic diseases such as cardiovascular disease and diabetes (Lamster et al., 2008; Lockhart et al., 2012) and smoking (Laxman & Annaji, 2008) that are risk factors for cognitive impairment.

Case study 2

A 74-year-old man was a regular visitor to your dental office for the past 20 years. Recently, he missed some dental appointments. In his most recent visit, his wife accompanied him to his dental visit. The dentist observed that the patient’s oral hygiene had declined and that he had developed some new coronal and root caries. His wife told the dental hygienist that sometimes he forgets to brush his teeth. What advice would you give to the patient and his wife on how to improve the patient’s oral health status?

Clinical and policy implications

Oral health problems (e.g., missing teeth, dental caries, and periodontal diseases) accumulate throughout the life span, but they occur with increasing frequency in later life. These differences may be partially due to cohort effects; younger cohorts may have higher levels of education and income, which are factors associated with better oral health status. However, many of these differences could be age-related. Genetic and biologic factors likely play a major role in deterioration of oral health in elders, but social, psychologic, and behavioral factors may also be important determinants. As discussed earlier, some major factors related to oral health deterioration in older adults include: (i) poor oral hygiene due to functional and cognitive impairment or other medical conditions; (ii) medications taken that may cause dry mouth; (iii) declining use of dental care services; and (iv) chronic illnesses. Given that increasing numbers of individuals are retaining their natural teeth, the issue of maintaining healthy teeth in later life is becoming more critical.

Maintaining oral health status in older adults needs multiple approaches which should focus on
both prevention (use of professional dental care, use of preventive dental care products, oral health education, and improvement of self-care skills) and dental treatment. The use of professional dental care by US elders, which is critical to oral health, has increased steadily and rapidly during the past several decades. The proportion of Americans aged 65 and older who reported at least one dental visit during the preceding year rose from 15% in 1950 to 55% in 2003 (Brown, 2008). Despite this increase, rates of utilization remain lower in elders than in other age groups. Elders are more likely than the general population to have difficulty accessing dental care due to frailty, medical comorbidity, and functional and cognitive impairment.

Many elders report needing dental services and the needs are even higher for racial/ethnic minority elders. Cost is certainly a big concern with regard to dental use. Nonetheless, geriatric dental services also need to improve access and utilization by reducing barriers such as inadequate geriatric training, lack of culturally competent services, and a lack of portable dental equipment. While most elders with chronic diseases can get dental care from private dental offices, having dentists and dental hygienists provide mobile dental services at an individual’s home, institutional care facility, or at a mobile unit would be very helpful to those who cannot easily access a dental clinic. In the meantime, increasing the number of dentists with geriatric training is an important step toward improving the quality of dental care for elders.

Despite the availability of a broad array of preventive measures for oral diseases, many elders are not aware of or do not use proven preventive procedures. Many do not realize that most oral diseases can be prevented or controlled by improved oral hygiene and the use of fluoride and other cost-effective measures. Thus, there is a clear need to provide education on the importance of oral health and prevention of oral health problems. It has been shown that generic oral health education has a consistent positive effect on knowledge level and a small positive (although temporary) effect on plaque accumulation and gingivitis (Boundouki et al., 2004; Renz et al., 2007). While such programs should be an integral part of interventions to improve oral health in older adults, the development of tailored behavioral interventions deserves further attention. Given the heterogeneity of the elderly population, tailored educational messages may be more effective in prevention of oral diseases. Depending on individual needs, educational programs can cover topics such as evidence-based recommendations on oral hygiene behaviors; signs of oral diseases and conditions that require immediate attention (e.g., cancer and abscess); strategies for reducing symptoms of minor oral conditions; cueing techniques for daily oral hygiene; diet and nutrition; and information about adverse effects of tobacco and certain medications.

Given that many older adults do not or cannot afford to use the oral healthcare system, interventions to improve oral health in older adults need to be readily accessible, easily incorporated into daily routines, and economical. Innovative interventions need to be implemented to empower elders and their family members with knowledge of oral health, and improve dental self-care skills. A recent US Department of Health and Human Services report (US Department of Health and Human Services, 2010) emphasized the importance of using proven self-care management approaches that include informing and motivating patients and treating them as partners in their own care. The report stressed that even the highest quality care for individuals with chronic conditions cannot guarantee improved health outcomes, and also pointed to the important role played by families and other caregivers in providing assistance with self-care tasks to individuals with significant declines in physical and cognitive function. Its conclusions support the importance of involving family members or informal caregivers to help implement oral health interventions for older adults with functional/cognitive impairment or chronic disease. The list of daily activities for which spouses, adult children, or friends provide assistance and regular reminders should include oral hygiene tasks, which are all too often neglected. Well-established practices from the field of occupational therapy show that with sufficient repetition, hygiene tasks (e.g., tooth brushing) can become automatic when triggered by cues, events, or other environmental factors (Levy & Burns, 2005), and can be maintained even with advancing cognitive decline.
DISCUSSION QUESTIONS

1. If you are the director of the dental office in your statue, what would you do to increase the use of dental care services for older adults in various settings (residential homes, senior centers, public housing, nursing homes)?
2. An increasing number of elders are from minority groups and/or are first-generation immigrants; many of them do not seek dental care on a regular basis. What systems would you establish to increase the use of dental care for these elders?
3. For older adults that reside at home with functional and cognitive impairment, what suggestions would you like to make to improve, or at least maintain their oral health status?
4. Many of the homebound elders have difficulty visiting dentists regularly due to physical constraints. What can nondental professionals do to improve oral health care for these homebound elders?

A. How would you establish networking structures for dental referrals by nondental professionals?
B. How can a trained nondentist perform an initial assessment of dental care needs? How can they provide preventive needs? Can you design a checklist to assist nondental providers in these functions?
C. What can dental professionals do to train family members to assist in helping these frail elders to improve or at least maintain oral health status?

References


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