

Oral Health in North Carolina: Relationship With General Health and Behavioral Risk Factors

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BACKGROUND Oral health is an integral part of general health, and loss of teeth may affect both physical and mental health. We examined how an individual's perception of his or her general health is related to oral care and loss of teeth, as well as how socioeconomic and behavioral factors are related to loss of teeth and oral care.

METHODS Logistic regression was used to analyze data from the North Carolina Behavioral Risk Factor Surveillance System (BRFSS) survey to investigate how oral health relates to general health. We examined the effects of loss of teeth and recency of dental clinic visits on perceived general health; we also examined the effects of demographic characteristics and health-related behavioral risk factors on oral health.

RESULTS Adults who had lost 6 or more teeth were more likely to report poor or fair general health, especially among those who were younger than 65 years (adjusted odds ratio = 3.59) compared to those who were 65 years or older (adjusted odds ratio = 1.87). Those who had not visited a dentist within the past year, those who had less education, those with lower incomes, and smokers were more likely to have lost 6 or more teeth.

LIMITATIONS BRFSS is a large-scale survey that collects self-reported data using random telephone methods; during the years included in this analysis, the sample included only households with landline phones that answered the survey. The measure of general health is subjective. As the BRFSS survey is a cross-sectional survey, causal relationships cannot be established.

CONCLUSIONS Loss of teeth and poor oral care are significant predictors of poor general health, indicating that oral health and oral care are integral parts of general health. Loss of teeth and oral care are affected by demographic factors such as educational attainment, income, and health-related risk factors.

Oral health is related to general health and quality of life in many ways. Dental infections or loss of teeth can exacerbate chronic diseases such as diabetes [1-5], kidney disease [6], and cardiovascular disease [7-9]. Poor oral health may also cause dental pain and discomfort that can significantly undermine a person's ability to live a normal life, and losing teeth affects an individual's general sense of health, quality of life [10-14], and even cognitive functioning in old age [15].

Since keeping as many of one's own teeth as possible has strong positive effects on general health, regular visits to a dentist should be regarded as an integral part of maintaining general health. However, residents of North Carolina do not have equal access to dental care and may have poor oral health practices. Disparities in access to oral health care are related to social and demographic factors such as income, education, race and ethnicity, and regions of residence within the state [16-20]. In addition to disparities in access to dental care, there are disparities in individual behaviors that affect oral health—such as smoking, alcohol consumption, and eating habits—as well as personal oral care habits, such as brushing and flossing [21].

The purposes of this study were to examine the relationship between general health and oral health among North Carolinians and to examine the demographic and behavioral variables that affect oral health using data from the Behavioral Risk Factor Surveillance System (BRFSS) survey

[22]. North Carolina is ranked below average in the nation in many health measures; according to America's Health Rankings, North Carolina is 35th in overall health statistics and 47th in availability of dentists [23]. While North Carolina may not be representative of the nation, analysis of the strength and variability of relationships within the state can provide a model for research elsewhere; the current study can also provide important information for health care providers and policy makers in North Carolina.

Figure 1 depicts the relationships between general health and oral health that we investigate in this study. Oral health was measured simply as the number of teeth removed, an outcome that is affected by oral care (dental clinic visits), chronic disease (diabetes), smoking, and demographic factors such as income, education, and race/ethnicity.

Methods

The data were obtained from the North Carolina BRFSS survey, a large-scale, state-based, random telephone survey on adult health supported by the Centers for Disease

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Control and Prevention [24, 25]. BRFSS collects data on self-reported health and health-related behaviors—such as regular check-ups, smoking, and diet—as well as demographic information. Currently all 50 states, the District of Columbia, and 3 US territories participate in the BRFSS survey. Questions regarding oral health are asked every other year. In this study, we combined the most recent 3 years of data on oral health in North Carolina (2006, 2008, and 2010) to obtain sufficient sample sizes for subgroup analyses.

A total of 43,622 adults residing in North Carolina responded to the interviews for these 3 years. SUDAAN statistical software was used to accommodate the complex sampling methods employed by BRFSS to adjust sampling biases [26]. The data were weighted according to population distributions of different demographic groups to adjust sampling biases.

Three questions in the survey about oral health were initially of interest to us. First, “How many of your permanent teeth have been removed because of tooth decay or gum disease? Do not include teeth lost for other reasons, such as injury or orthodontics.” Second, “How long has it been since you last visited a dentist or a dental clinic for any reason?” Third, “How long has it been since you had your teeth cleaned by a dentist or dental hygienist?” The measure of dental cleaning visits implies regular dental care, but it does not include dental clinic visits for dental treatment. Because of the multicollinearity inherent in the measures of recent dental visits and recent dental cleaning, we chose “dental visits for any reason” as a measure of adequacy of oral care. Number of teeth lost was used as a measure for oral health.

Our analysis was conducted in 2 stages. The first stage was to examine the association of perceived general health with poor oral health (the number of missing teeth) and adequacy of oral health care (dental visits). The second stage was to determine demographic, behavioral, and health factors that were predictors of many (6 or more) missing teeth.

General health was simply measured by the question that asks: “Would you say that in general your health is: excellent, very good, good, fair, or poor?” Responses to the general health question were collapsed into a dichotomy; those who reported their general health to be fair or poor were considered to have worse general health than those who reported their general health to be good, very good, or excellent. This is a subjective measure of assessing health, but previous studies showed close correlations between this self-reported general health measure and other health-related indicators [10, 27].

Multiple logistic regression was employed in the first stage of the analysis to obtain odds ratios (ORs) for measures of the number of missing teeth and dental visits as predictors of general health. Number of missing teeth was measured using response categories in the questionnaire: no missing teeth, 1–5 missing teeth, 6 or more but not all, and all. These data were entered in the regression as sepa-

rate nominal variables. Dental visits were measured by how recently a visit occurred: within the past year, within the past 2 years, within the past 5 years, 5 or more years ago, or never. Because age is strongly associated with general health and with oral health, we examined tooth loss for 2 age groups: individuals younger than 65 years, and 65 years or older.

A binary logistic regression analysis was performed with missing teeth as a predictor of general health, followed by logistic regression with dental visits and demographic, behavioral, and health factors as predictors of missing teeth. We then performed a multiple logistic regression analysis including number of teeth removed, dental visits, and demographic characteristics as predictors of general health to obtain adjusted ORs, which indicate the separate effects of the independent variables on perceived general health. Demographic data were taken from questions about race/ethnicity (white, African American, Hispanic, or Native American), education (not having completed high school, high school graduate, some post-high school education, or college or technical college), and annual household income (less than \$15,000, between \$15,000 and \$25,000, between \$25,000 and \$35,000, between \$35,000 and \$50,000, or \$50,000 or more). We performed separate analyses for those who were 65 years or older and for those under age 65 years.

In the second stage of the analysis, we examined the effects of oral care, demographic characteristics, and health-related behavioral variables on multiple tooth loss. Multiple tooth loss was defined as having 6 or more teeth removed. Oral care was measured by how recently a dental visit was reported (ie, within the past year, 2 years, 5 years, more than 5 years, or never). We first assessed the effect of dental visits alone on tooth loss by binary logistic regression, followed by an expanded model (multiple logistic regression) that included demographic characteristics and health-related behaviors. The health-related variables were smoking (current smoker, former smoker, never smoked) and diabetes (a doctor told that you have diabetes). Demographic variables were as previously defined. The multiple logistic regression analysis was run to calculate ORs of these risk factors for the loss of 6 or more teeth. Again, we did separate analyses for those who were 65 years or older and for those under age 65 years.

Results

Risk Factors for Fair or Poor General Health

Table 1 shows the results of the separate regression analyses revealing unadjusted ORs and adjusted ORs for number of teeth removed (oral health) and recency of dental visits (oral care) as predictors of fair or poor general health. The sample sizes for categories and weighted percentages are also shown among those who reported fair or poor health in response to the general health question.

There are large differences in the impact of losing teeth

TABLE 1.
Relationship of General Health to Teeth Removed and Dental Visits

		No.	Poor or fair general health		Adjusted OR ^b (95% CI)
			Percent ^a	OR (95% CI)	
Age <65 years					
Number of teeth removed	All	737	10.8%	9.85 (8.29-11.70)	4.57 (3.71-5.62)
	6 or more, not all	1,428	21.5%	6.01 (5.28-6.84)	3.59 (3.08-4.18)
	1-5	1,774	35.2%	2.51 (2.22-2.82)	1.93 (1.68-2.21)
	None	1,327	32.4%	1.00	1.00
Dental visits	Never	96	3.6%	4.26 (2.95-6.15)	1.83 (1.13-2.95)
	5 or more years ago	1,155	22.2%	4.21 (3.70-4.80)	1.66 (1.40-1.97)
	Within the past 5 years	719	14.6%	2.54 (2.17-2.97)	1.27 (1.05-1.53)
	Within the past 2 years	702	13.1%	1.82 (1.58-2.10)	1.17 (0.99-1.39)
	Within the past year	2,615	46.5%	1.00	1.00
Age ≥ 65 years					
Number of teeth removed	All	1,260	33.1%	3.88 (3.22-4.66)	1.94 (1.54-2.44)
	6 or more, not all	1,254	33.3%	2.22 (2.11-3.02)	1.87 (1.52-2.29)
	1-5	838	21.3%	1.24 (1.03-1.49)	1.22 (1.00-1.48)
	None	445	12.4%	1.00	1.00
Dental visits	Never	37	0.9%	2.52 (1.44-4.42)	1.12 (0.52-2.44)
	5 or more years ago	1,152	29.1%	2.93 (2.57-3.33)	1.31 (1.09-1.58)
	Within the past 5 years	421	12.6%	2.37 (1.95-2.88)	1.32 (1.06-1.65)
	Within the past 2 years	385	10.0%	1.82 (1.53-2.17)	1.13 (0.91-1.40)
	Within the past year	1,875	47.5%	1.00	1.00

Note. CI, confidence interval; OR, odds ratio.

Source: Data are from the North Carolina Behavioral Risk Factor Surveillance System surveys for 2006, 2008, and 2010.

^aWeighted percentage according to population demographics.

^bAdjusted for education, income and race/ethnicity.

on perceived general health by age. One-third (33.1%) of those 65 years or older who reported their health to be fair or poor had lost all of their teeth. The OR of those 65 years or older who reported fair or poor health if all teeth had been removed is almost 4 times that of those who reported having no teeth removed (OR = 3.88; 95% confidence interval [CI], 3.22-4.66); adjusting for demographic characteristics, the OR is 1.94 (95% CI, 1.54-2.44). In contrast, while only about one-tenth (10.8%) of those younger than 65 years had lost all their teeth, they were almost 10 times as likely to be in poor or fair health (OR = 9.85; 95% CI, 8.29-11.70); after adjusting for demographic characteristics, they were still about 5 times as likely to be in poor or fair health (OR = 4.57; 95% CI, 3.71-5.62). This substantial difference by age is also apparent for those who lost 6 or more teeth but not all of their teeth. For those who were younger than 65 years and had lost 6 or more teeth but not all, the adjusted OR of being in poor or fair health was 3.59 (95% CI, 3.08-4.18) compared to those who had lost no teeth; for those 65 years or older, the OR for this comparison was 1.87 (95% CI, 1.52-2.29).

There is also a strong relationship between oral care (dental visits) and general health. However, the effects became much smaller after controlling for demographic variables (education, income, and race/ethnicity), suggesting that socioeconomic factors contribute more to perceived general health than do dental visits. Among adults who were under age 65 years, those who had never visited a dentist and those who had visited a dentist 5 or more years

ago were 4.26 times (95% CI, 2.95-6.15) and 4.21 times (95% CI, 3.70-4.80) as likely to report fair or poor health, respectively, compared to those who had visited a dentist within the past year. The relationship of dental visits to general health remains when demographic factors are considered, but the strength of the relationship was reduced; the ORs were 1.83 (95% CI, 1.13-2.95) and 1.66 (95% CI, 1.40-1.97), respectively.

Risk Factors for Poor Oral Health

Factors associated with poor oral health, defined as the loss of 6 or more teeth, were revealed by the multiple logistic regression analyses performed to assess the effects of dental visits, demographic characteristics, and health factors (smoking and diabetes) on loss of teeth. The logistic analyses with dental visits as a sole predictor variable and also with other demographic, behavioral, and health variables were performed separately for adults who were under age 65 years and for those who were 65 years or older (See Table 2).

Recency of dental visits had a significant effect on loss of teeth; however, loss of teeth is also greatly affected by demographic and behavioral factors. Individuals 65 years or older who had not visited a dentist within the past 5 years were almost 6 times as likely to have lost 6 or more teeth (OR = 5.78; 95% CI, 4.73-7.06) compared to those who had visited a dentist within the past year; among those younger than 65 years, the adjusted OR for this comparison was only 2.23 (95% CI, 1.92-2.60). Less than 1% of adults under

TABLE 2.
Predictors of Having 6 or More Teeth Removed

		Age <65 years		Age ≥65 years	
		Percent ^a	OR (95% CI)	Percent ^a	OR (95% CI)
Dental visits	Never	0.51%	0.38 (0.20–0.72)	0.99%	2.25 (1.00–5.08)
	5 or more years	24.52%	2.23 (1.92–2.60)	33.09%	5.78 (4.73–7.06)
	Within the past 5 years	14.25%	1.59 (1.34–1.88)	13.03%	2.71 (2.17–3.38)
	Within the past 2 years	13.63%	1.38 (1.17–1.64)	10.17%	1.67 (1.34–2.08)
	Within the past year	47.09%	1.00	42.71%	1.00
Education	Less than high school	25.34%	4.66 (3.79–5.72)	34.57%	3.79 (3.00–4.78)
	High school	40.21%	2.58 (2.20–3.03)	34.90%	2.47 (2.06–2.97)
	Some post high school	23.85%	1.90 (1.62–2.24)	18.93%	1.76 (1.46–2.12)
	College or higher	11.04%	1.00	11.6%	1.00
Household income	Less than \$15,000	21.2%	2.96 (2.45–3.58)	25.48%	1.95 (1.55–2.45)
	\$15,000–\$25,000	26.87%	2.27 (1.91–2.70)	32.08%	1.77 (1.46–2.14)
	\$25,000–\$35,000	15.94%	2.13 (1.78–2.55)	15.48%	1.24 (1.01–1.51)
	\$35,000–\$50,000	15.42%	1.66 (1.41–1.95)	12.25%	1.22 (0.99–1.49)
	\$50,000 or more	20.56%	1.00	14.71%	1.00
Smoking	Current	41.74%	2.42 (2.12–2.75)	13.93%	2.82 (2.26–3.51)
	Former	28.38%	2.46 (2.17–2.80)	45.38%	1.86 (1.63–2.12)
	Never	29.88%	1.00	40.69%	1.00
Diabetes	Yes	19.11%	2.77 (2.41–3.19)	27.58%	1.33 (1.14–1.55)
	No	80.89%	1.00	72.42%	1.00
Race	Non-Hispanic African American	28.17%	1.34 (1.16–1.54)	23.57%	1.97 (1.57–2.48)
	Native American	2.82%	1.07 (0.79–1.44)	1.73%	1.37 (0.79–1.57)
	Hispanic	4.04%	0.20 (0.15–0.28)	1.79%	1.18 (0.54–2.59)
	Non-Hispanic white	64.97%	1.00	72.91%	1.00

Note. CI, confidence interval; OR, odds ratio.

Source: Data are from the North Carolina Behavioral Risk Factor Surveillance System surveys for 2006, 2008, and 2010.

^aWeighted percentage according to population demographics.

age 65 years reported that they had never visited a dentist; despite the small number, the OR was statistically significant (OR = 0.38; 95% CI, 0.20–0.72).

Among demographic variables, education had a very strong effect on the loss of teeth. Among individuals under age 65 years, those with less than a high school education were 4.66 times (95% CI, 3.79–5.72) as likely to have lost 6 or more teeth compared to those with college or higher education; for those 65 years or older, the OR was 3.79 (95% CI, 3.00–4.78). Among those under age 65 years, those who had a high school diploma were 2.58 times (95% CI, 2.20–3.03) as likely to have lost 6 or more teeth compared to those who had college or higher education; for those 65 years or older, the OR was 2.47 (95% CI, 2.06–2.97).

Household income also had a strong effect. Compared to those who had household incomes of \$50,000 or more, those younger than 65 years whose household income was less than \$15,000 were 2.96 times (95% CI, 2.45–3.58) as likely to have lost 6 or more teeth, and those 65 years or older were 1.95 times (95% CI, 1.55–2.45) as likely to have lost 6 or more teeth. Those younger than 65 years with a household income of more than \$15,000 but less than \$25,000 were 2.27 times (95% CI, 1.91–2.70) as likely to have lost 6 or more teeth, and those 65 years or older were 1.77 times (95% CI, 1.46–2.14) as likely to have lost 6 or more teeth.

Another variable strongly associated with oral health is smoking. Current smokers younger than 65 years were 2.42

times (95% CI, 2.12–2.75) as likely to have lost 6 or more teeth compared to those who had never smoked; current smokers who were 65 years or older were 2.82 times as likely (95% CI, 2.26–3.51) to have lost 6 or more teeth compared to those who had never smoked. Former smokers who were younger than 65 years had a risk 2.46 times (95% CI, 2.17–2.80) that of those who never smoked; the risk for former smokers 65 years or older was 1.86 times (95% CI, 1.63–2.12) that of those who had never smoked.

The association of diabetes with loss of multiple teeth is also significant. Those who reported having diabetes and who were younger than 65 years were 2.77 times as likely to have lost 6 or more teeth compared to those who did not report having diabetes (95% CI, 2.41–3.19). Those who reported having diabetes and who were 65 years or older were 1.33 times as likely to have lost 6 or more teeth (95% CI, 1.14–1.55).

The association of race/ethnicity with loss of multiple teeth, adjusted for other factors, is not particularly strong but is still of interest to report. For those under age 65 years, loss of multiple teeth seems less likely if one is Hispanic (OR = 0.20; 95% CI, 0.15–0.28) but slightly more likely if one is Non-Hispanic African American (OR = 1.34; 95% CI, 1.16–1.54), compared to non-Hispanic whites. There was a differential effect of race/ethnicity for the older population than the younger one. Older African Americans showed the highest risk for loss of multiple teeth (OR = 1.97; 95% CI, 1.57–2.48).

Discussion

The goal of Healthy North Carolina 2020 is to decrease the percentage of adults who have had permanent teeth removed due to tooth decay or gum disease; this percentage is currently 47.8%, and the Healthy North Carolina 2020 target is 38.4% [28]. The results of this study show that keeping many of one's own teeth, a measure of oral health, is strongly associated with good general health. More adults who had lost teeth reported fair or poor health instead of excellent to good health compared to those who had kept their teeth.

Previous studies showed that perceived general health is strongly affected by demographic factors such as household income, education, and race/ethnicity [29, 30]. After controlling for these demographic variables, loss of teeth emerged as a significant risk factor for perceived general health. The effect of loss of teeth was significantly stronger for adults younger than 65 years than for adults 65 years or older. Compared to those who had lost none of their teeth, younger adults who lost all of their teeth were more than 4 times as likely to report fair or poor health, while adults 65 years or older were about twice as likely to report fair or poor health. For older adults, the impact of tooth loss might be relatively weakened as they have to deal with other health issues and problems.

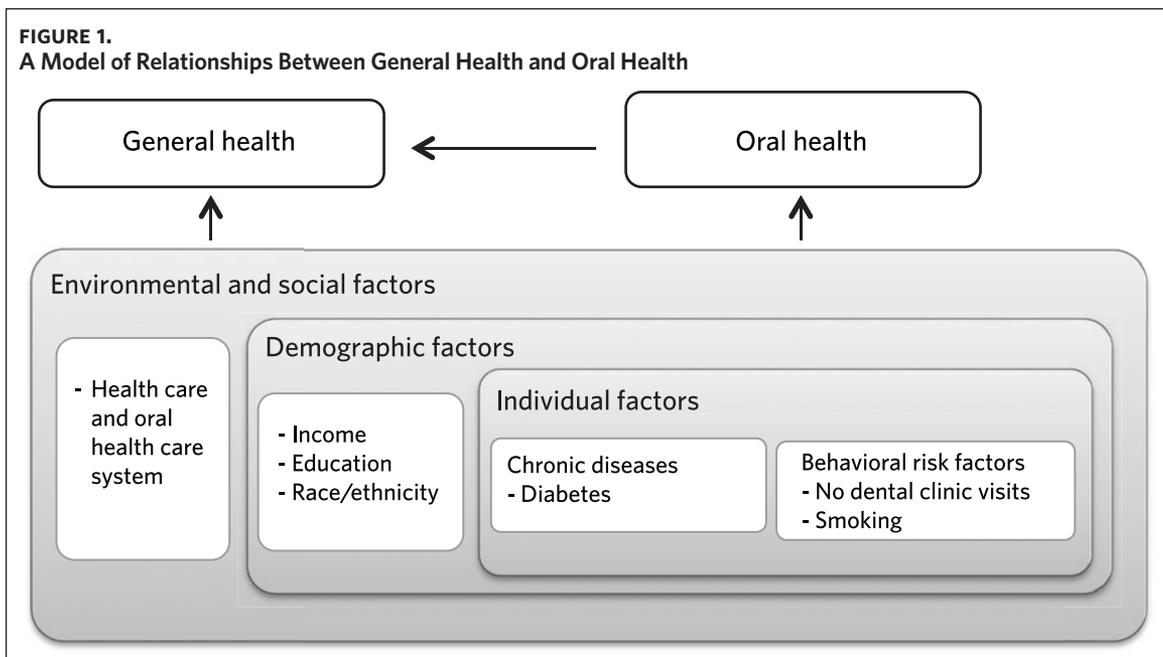
In our model of oral health and general health, general health is thought to be affected by oral health as well as by environmental/social and individual/behavioral factors (See Figure 1). Recency of dental visits, a measure of oral care, is thought to be a predictor of perceived general health. Overall, the effect of dental visits on general health was especially strong for individuals younger than 65 years.

However, when analyses controlled for demographic variables, the effect of dental care on general health became much smaller; thus demographic and behavioral factors also affect oral health.

In the second stage of the analysis, we examined factors affecting oral health (losing 6 or more teeth). In the logistic regression model, education had the strongest effect; dental visits, household income, smoking, and diabetes also had significant effects, with ORs ranging from 2.96 to 1.33. Race/ethnicity had a lesser effect for adults younger than 65 years. In this analysis, we saw differences between the younger and older groups in the effect of education and income on loss of teeth. Specifically, adults younger than 65 years with lower educational attainment and lower incomes were more at risk of losing 6 or more teeth. An unexpected finding was that those under age 65 years who had never visited a dentist were less likely to have lost 6 or more teeth than were those who had seen a dentist within the past year. There are several possible reasons for this finding: it might be an artifact of the small sample size in that category; these individuals may be very young; or they may have simply taken good care of their teeth. The older group had much larger ORs for dental visits than the younger group, but a causal relationship cannot be asserted. Some older adults might not have visited a dentist in more than 5 years because they had lost all of their teeth. Smoking and diabetes also had significant effects.

Limitations

Limitations of this study lie in the use of cross-sectional survey data. The cross-sectional nature of the BRFSS survey would not allow causal relationships to be established. Although the cross-sectional survey data had inherent



limitations, the use of the large-scale BRFSS data has an advantage of representing different demographic groups. The validity of the results was also limited to the frame of the questions used. For example, poor oral health was defined as losing 6 or more teeth, but this definition would leave out other variables regarding oral health. Another limitation concerns the subjective nature of the survey. The accuracy of the BRFSS survey could be compromised by the accuracy of the self-reported data, and this study is also limited by the questions on oral health that were asked in the survey. Although efforts were taken to adjust for sampling biases, the telephone contacts for the BRFSS survey years analyzed were limited to landline phones, thus excluding cell phone-only households and likely leaving out younger and poorer people.

Conclusion

This study provides evidence to support the assertion that oral health is an integral part of general health, even after controlling for demographic variables such as education, household income, and race/ethnicity. Poor oral health, defined as losing 6 or more teeth, was strongly affected by dental visits, education, household income, and health variables such as smoking and diabetes. **NCMJ**

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References

- Javed F, Al-Askar M, Al-Rasheed A, Babay N, Galindo-Moreno P, Al-Hezaimi K. Comparison of self-perceived oral health, periodontal inflammatory conditions and socioeconomic status in individuals with and without prediabetes. *Am J Med Sci*. 2012;344(2):100-104.
- Khader YS, Dauod AS, El-Qaderi SS, Alkafajei A, Batayha WQ. Periodontal status of diabetics compared with nondiabetics: a meta-analysis. *J Diabetes Complications*. 2006;20(1):59-68.
- Teeuw WJ, Gerdes VE, Loos BG. Effect of periodontal treatment on glycemic control of diabetic patients: a systematic review and meta-analysis. *Diabetes Care*. 2010;33(2):421-427.
- Al-Habashneh R, Barghout N, Humbert L, Khader Y, Alwaeli H. Diabetes and oral health: doctors' knowledge, perception and practices. *J Eval Clin Pract*. 2010;16(5):976-980.
- Bastos AS, Graves DT, Loureiro AP, et al. Lipid peroxidation is associated with the severity of periodontal disease and local inflammatory markers in patients with type 2 diabetes. *J Clin Endocrinol Metab*. 2012;97(8):E1353-E1362.
- Ioannidou E, Swede H, Dongari-Bagtzoglou A. Periodontitis predicts elevated C-reactive protein levels in chronic kidney disease. *J Dent Res*. 2011;90(12):1411-1415.
- Lam OL, Zhang W, Samaranyake LP, Li LS, McGrath C. A systematic review of the effectiveness of oral health promotion activities among

- patients with cardiovascular disease. *Int J Cardiol*. 2011;151(3):261-267.
- Pessoa L, Galvão V, Santos-Neto L. Periodontal disease as a risk factor for cardiovascular disease: suggestion of a further link in systemic lupus erythematosus. *Med Hypotheses*. 2011;77(2):286-289.
- Cotti E, Dessi C, Piras A, Mercurio G. Can a chronic dental infection be considered a cause of cardiovascular disease? A review of the literature. *Int J Cardiol*. 2011;148(1):4-10.
- Benyamini Y, Leventhal H, Leventhal EA. Self-rated oral health as an independent predictor of self-rated general health, self-esteem and life satisfaction. *Soc Sci Med*. 2004;59(5):1109-1116.
- Brennan DS, Spencer AJ, Roberts-Thomson KF. Tooth loss, chewing ability and quality of life. *Qual Life Res*. 2008;17(2):227-235.
- Zini A, Vered Y, Sgan-Cohen HD. The association between demographic and oral health-related quality of life factors and dental care attendance among underprivileged older people. *Australas J Ageing*. 2011;30(2):70-76.
- McGrath C, Bedi R. A national study of the importance of oral health to life quality to inform scales of oral health related quality of life. *Qual Life Res*. 2004;13(4):813-818.
- Gift HC, Atchison KA. Oral health, health, and health-related quality of life. *Med Care*. 1995;33(11 Suppl):NS57-NS77.
- Ingram SS, Seo PH, Sloane R, et al. The association between oral health and general health and quality of life in older male cancer patients. *J Am Geriatr Soc*. 2005;53(9):1504-1509.
- Rozier RG. Oral health in North Carolina: innovations, opportunities, and challenges. *N C Med J*. 2012;73(2):100-107.
- Imai S. Oral health in North Carolina: regional and demographic disparities in dentist visits, teeth cleaning and teeth extraction. East Carolina University website. <http://www.ecu.edu/cs-dhs/chsrd/Pubs/upload/Oral-Health-NC-revised-062412.pdf>. Published March 2012. Accessed August 1, 2013.
- Lee JY. Access to dental health care for children in North Carolina. *N C Med J*. 2012;73(2):115-116.
- Fraher E, McGee V, Hom J, Lyons J, Gaul K. We're not keeping up with the Joneses: North Carolina has fewer dentists per capita than neighboring (and most other) states. *N C Med J*. 2012;73(2):111-114.
- Casey MW. Medicaid coverage for adults in North Carolina: what would a reduction in funding mean? *N C Med J*. 2012;73(2):120-123.
- Sabbah W, Tsakos G, Sheiham A, Watt RG. The role of health-related behaviors in the socioeconomic disparities in oral health. *Soc Sci Med*. 2009;68(2):298-303.
- North Carolina State Center for Health Statistics (SCHS). Behavioral Risk Factor Surveillance System (BRFSS). SCHS website. <http://www.schs.state.nc.us/units/stat/brfss/>. Accessed November 14, 2012.
- United Health Foundation. America's Health Rankings website. <http://www.americashealthrankings.org/rankings>. Accessed January 10, 2013.
- North Carolina State Center for Health Statistics (SCHS). Statistics and Reports: Vital Statistics. SCHS website. <http://www.schs.state.nc.us/data/vital.cfm>. Accessed November 14, 2012.
- Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System. <http://www.cdc.gov/brfss/>. Accessed November 14, 2012.
- SUDAAN [computer program]. Release 9.0. Research Triangle Park, NC: Research Triangle Institute; 2002.
- Tsai J, Ford ES, Li C, Zhao G, Pearson WS, Balluz LS. Multiple healthy behaviors and optimal self-rated health: findings from the 2007 Behavioral Risk Factor Surveillance System Survey. *Prev Med*. 2010;51(3-4):268-274.
- North Carolina Division of Public Health (DPH). Healthy North Carolina 2020: A Better State of Health. DPH website. <http://www.publichealth.nc.gov/hnc2020/>. Accessed January 12, 2014.
- Imai S. Disparities in health status and health risk factors in Eastern North Carolina: data from the Behavioral Risk Factor Surveillance System, 2005-2009 aggregated. East Carolina University website. <http://www.ecu.edu/cs-dhs/chsrd/BehRiskFactors/upload/BRFSS-disparities-in-health-and-risk-factors-2005-09.pdf>. Published May 2011. Accessed August 1, 2013.
- Gizlice Z, Huston S. Health risks and conditions among American Indians in North Carolina. North Carolina Department of Health and Human Services website. <http://www.schs.state.nc.us/SCHS/pdf/SCHS146.pdf>. Published December 2004. Accessed May 1, 2013.