Relationship of Routine Inadequate Sleep Duration and Periodontitis in a Nationally Representative Sample

R. Constance Wiener

1Department of Dental Practice and Rural Health, School of Dentistry, West Virginia University, G110B HSC North, P.O. Box 9448, Morgantown, WV 26506, USA
2Department of Epidemiology, School of Public Health, West Virginia University, G110B HSC North, P.O. Box 9448, Morgantown, WV 26506, USA

Correspondence should be addressed to R. Constance Wiener; rwiener2@hsc.wvu.edu

Received 20 October 2015; Accepted 31 December 2015

Copyright © 2016 R. Constance Wiener. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Purpose. Previous research has indicated the public health impact of inadequate sleep duration on health, potentially through an immune-inflammation mechanism. This mechanism also has a role in periodontitis. The purpose of this study is to determine if there is an association of routine inadequate sleep and periodontitis.

Methods. Data from merged National Health and Nutrition Examination Survey years 2009-10 and 2011-12 were the data source for the study. The key outcome was periodontitis (yes, no), and the key variable of interest was usual sleep on weekday or workday nights. Chi square and logistic regression procedures were conducted. The study included 3,740 participants who were of ages 30 years and above.

Results. There were 52.7% of participants who had periodontitis. There were 35.7% who usually slept less than 7 hours on weekday or workday nights. In adjusted logistic regression the odds ratio for periodontal disease for participants who slept less than 7 hours on weekday or workday night was 1.00 [95% confidence interval: 0.83, 1.21; p = .9812].

Conclusions. The relationship of periodontitis and inadequate sleep duration in a nationally representative study of participants who were of ages 30 years and above failed to reach statistical significance in adjusted logistic regression analyses.

1. Introduction

Periodontitis involves inflammation of gingival tissue, clinical attachment loss of the periodontal ligament, and loss of alveolar bone support. Periodontitis is a public health concern since it is a major factor in tooth loss [1] and has associations with many systemic diseases which also involve inflammation. In periodontitis, the host response to microbial pathogens leads to inflammation. The inflammation has been shown to result from (1) plaque and local factors overwhelming the host responses; (2) an inadequate host response in individuals with limited plaque and local factors but are compromised/susceptible individuals [2], (including smokers, people who have diabetes, immunosuppressed individuals, older adults, individuals with genetic predisposition for an inadequate host response, and individuals with excessive stress [3, 4]), and (3) an overwhelming host response [5]. An appropriate host response is required for defense of the tissue; the host defense must not be inadequate or overwhelming [5]. Identifying and eliminating risk factors which influence inflammation may provide means by which to limit periodontal tissue destruction.

It is known that sleep is important to health and well-being. Inadequate sleep has effects on learning, memory processing, the repair of cell damage, brain development, neurobehavioral performance, hormonal regulation, risk of depression, increased cortisol, and ghrelin, impaired glucose metabolism, and increased inflammatory and proinflammatory markers among many other influences [6]. It is also known that there has been a worldwide decrease in the average number of hours that people sleep since the mid-1970s. Currently, the average number of hours that a person sleeps is less than seven hours a night [6]. Both adults and children are sleeping fewer hours than adults and children of the previous generation [6].
Since inflammation is characteristic of both periodontitis and inadequate sleep, sleep may have a role in periodontal disease. The purpose of this study is to determine if there is an association of sleeping less than 7 hours a night and periodontitis in individuals of ages 30 years and above.

2. Methods

The present study received West Virginia University Institutional Review Board acknowledgement (protocol number 15108802II).

2.1. Data Source. The data sources for the present study were National Health and Nutrition Examination Surveys (NHANES) 2009 to 2010 and NHANES 2011 to 2012. The Centers for Disease Control and Prevention researchers for the NHANES used stratified, multistage probability sampling designs for the surveys. The NHANES participants were civilians who were noninstitutionalized and lived in the US and Washington, DC. The researchers oversampled smaller subgroups to increase estimate accuracy. Data for the full mouth periodontal examination were collected in a mobile examination center by calibrated examination using Hu Friedy PCP-2 (Hu Friedy, Chicago, IL) periodontal probes with markings of 2–4 mm, 6 mm, and 10–12 mm parallel to the tooth’s long axis [7, 8]. The examiners were licensed dental hygienists in 2009-10 [8] and licensed dentists in 2011-12 [9]. Participants were of ages 30 years and above. The participants also responded to interview questions involving demographic information and questions regarding health and nutrition. Details of the NHANES study are available at the NHANES websites.

2.2. Study Population. The data used for the present study were of participants who were of ages 30 years and above who had complete periodontal and sleep data in the NHANES 2009 to 2012 data sets.

2.3. Key Outcome Variable. The key outcome variable was periodontitis (yes, no). The presence of any periodontitis was defined as at least 2 interproximal sites with an attachment loss of at least 3 mm and at least 2 interproximal sites with probing depths of at least 4 mm which are not on the same tooth or at least one site with a probing depth of at least 5 mm, suggested by the Centers for Disease Control and Prevention and the American Academy of Periodontology for use in research/surveillance of periodontitis for at least mild periodontitis [10].

2.4. Key Variable of Interest. The key variable of interest was routine adequate sleep. Participants were asked about the number of hours usually slept on a weekday or workday night. The self-reported responses were dichotomized at 7 hours based upon previous research using 7 hours [11] and for the premise of prevalent, routine inadequate sleep.

2.5. Other Variables. Participants were also asked during an interview to report age, sex, race, education level, and smoking status among other questions. The variables were categorized as follows: age (45 years to less than 55 years, 55 years to 69 years); sex (male, female); race/ethnicity (non-Hispanic White, non-Hispanic Black, Mexican-American, etc.); education level (high school graduate or less, some college/technical school or above); and smoking status (current smokers, former smokers, and never smokers). Body mass index was categorized as less than 25, 25 to less than 30, and 30 and above which corresponded to normal weight, overweight, and obesity.

2.6. Statistical Analyses. SAS® version 9.3 (SAS Institute, Inc., Cary, NC) was used to determine sample descriptions, bivariate associations of the variables of interest with periodontitis, and logistic regression of inadequate sleep on periodontitis in both unadjusted and adjusted analyses. The analyses accounted for stratification, eligibility, and sample weights.

3. Results

The sample size for the present study was 3,740 participants. There were 1,873 participants who were women, a weighted row percentage (wt%) of 50.8. There were 1,790 participants (71.7 wt%) who were non-Hispanic White. There were 1,454 participants (32.8 wt%) who were of ages 55 years and above. The majority of participants (60.9 wt%; n = 1,890) had some education beyond having graduated from high school. There were 728 participants (17.0 wt%) who were current smokers.

There were 1,646 participants (52.7 wt%) who had periodontitis. There were 1,484 participants (35.7 wt%) who usually slept less than 7 hours at night on weekdays or workdays. Details of the sample are presented in Table 1.

The results of the bivariate analysis of periodontitis and the sleep variable as well as the analyses of periodontal disease and other variables are presented in Table 2. There was a significant Rao Scott Chi square association of periodontitis and usually sleeping less than 7 hours at night on weekdays or workdays. Other significant relationships with periodontitis were with diabetes; older age; male sex; being non-Hispanic Black, Mexican American, or other (as compared with being non-Hispanic White); lacking insurance coverage; being a current or former smoker (as compared with being a never smoker); having a lower federal poverty level; and having an education of high school graduation or less as compared with some college, technical school, or more.

The results of the logistic regressions of the sleep variable on periodontitis are presented in Table 3. In an unadjusted analysis, usually sleeping less than 7 hours at night on weekdays or workdays was associated with periodontitis. The odds ratio was 1.34 [95% confidence interval: 1.18, 1.52; p < .0001]. The association was attenuated and failed to reach significance in adjusted analysis. The adjusted odds ratio was 1.00 [95% confidence interval: 0.83, 1.21; p = .9812]. The other
Table 1: Sample characteristics: NHANES Health and Nutrition Examination Surveys 2009–2012.

| Variable                        | Frequency | Weighted percent |
|---------------------------------|-----------|------------------|
| **Total**                       | 3,740     | 100              |
| **Periodontitis**               |           |                  |
| No                              | 1,646     | 52.7             |
| Yes                             | 2,094     | 47.3             |
| **Adequate sleep**              |           |                  |
| <7 hours                        | 1,484     | 35.7             |
| 7 or more hours                 | 2,256     | 64.3             |
| **Age groups**                  |           |                  |
| 30 to less than 45 years        | 1,341     | 38.5             |
| 45 to less than 55 years        | 945       | 28.7             |
| 55 years and above              | 1,454     | 32.8             |
| **Sex**                         |           |                  |
| Female                          | 1,873     | 50.8             |
| Male                            | 1,867     | 49.2             |
| **Race/ethnicity**              |           |                  |
| Non-Hispanic White              | 1,790     | 69.4             |
| Non-Hispanic Black              | 671       | 11.0             |
| Mexican American                | 676       | 8.0              |
| Other                           | 328       | 50.7             |
| **Education**                   |           |                  |
| HS graduate or less             | 1,841     | 39.1             |
| Some coll/tech/or more          | 1,890     | 60.9             |
| **Smoking**                     |           |                  |
| Current                         | 728       | 17.0             |
| Former                          | 952       | 26.0             |
| Never                           | 2,060     | 57.0             |
| **Number of missing teeth**     |           |                  |
| 0–5                             | 1,834     | 55.9             |
| 6–9                             | 903       | 24.7             |
| 10–20                           | 662       | 12.9             |
| More than 20                    | 341       | 6.4              |
| **Federal Poverty Level Index** |           |                  |
| 0 to less than 1.25             | 939       | 16.0             |
| 1.25 to less than 2.00          | 538       | 12.6             |
| 2.00 to less than 4.00          | 906       | 29.9             |
| 4.00 and above                  | 962       | 41.5             |
| **Insurance coverage**          |           |                  |
| Yes                             | 2,835     | 81.7             |
| No                              | 905       | 18.3             |
| **Diabetes**                    |           |                  |
| Yes                             | 559       | 11.3             |
| No                              | 3,181     | 88.7             |

Abbreviations: NHANES-National Health and Nutrition Examination Surveys; HS = high school; coll = college; tech = technical school.

variables remained significant in the adjusted analysis, except for diabetes.

4. Discussion

The purpose of this study was to determine if there was an association of sleeping less than 7 hours a night and periodontitis in individuals who were of ages 30 years and above. There was a significant positive adjusted association of inadequate sleep, defined as usually sleeping less than 7 hours a night on periodontitis in unadjusted analysis; however, the adjusted odds ratio failed to be significant. The adjusted logistic regression analysis included adjustments for age, sex, race, education, diabetes, insurance coverage, number of missing teeth, federal poverty level, and smoking.

4.1. Other Studies. There are few studies with which compare the results of this current study; however, studies of the quality of sleep (rather than sleep quantity) and severe periodontal disease (rather than no periodontitis versus any periodontitis) were found to be associated with periodontal disease:

(i) A study of 60 participants, ages 25 to 50 years living in Punjab, in which the mean Pittsburgh Sleep Quality Index results were highest for individuals with chronic periodontal disease [4].

(ii) A case-control study of individuals with newly diagnosed nonapnea sleep disorders (ages 18 to 95 years living in Taiwan), the incidence rate ratio of severe periodontal disease was 39% higher in the individuals with newly diagnosed nonapnea sleep disorders as compared with the control group, and the adjusted hazard ratio was 1.36 (95% CI: 1.04, 1.24; \(p < .001\)) [12].

(iii) A study of sleep disordered breathing in the Hispanic Community Health Study/Study of Latinos (ages 18–74 years, \(n = 12,469\)) in which researchers reported a positive relationship of severe periodontitis and increasing sleep disordered breathing \((p < .001)\) in an adjusted analysis [13].

4.2. Biological Plausibility. Sleep interferes with the immune system and the inflammatory response [4] and in a study of 30 adults who were sleep deprived (sleep limited to 3 a.m. to 7 a.m.), researchers found monocyte production of interleukin-6 and tumor necrosis factor alpha to be significantly increased [14]; however, in a study of 19 participants who underwent 40 hours of total sleep deprivation, although there was a significant increase in interleukin-1beta and interleukin-1ra, there was a significant decrease in c-reactive protein and interleukin-6 [15]. There is a need to further study the influence of routine sleep patterns upon the biological markers.

4.3. Limitations and Strengths. A cross-sectional design does not include temporality or causation. There may be potential
Table 2: Bivariate relationships with periodontitis, NHANES 2009–2012.

| Periodontitis                        | No | wt row% | Yes | wt row% | p value |
|--------------------------------------|----|---------|-----|---------|---------|
| Adequate sleep                       |    |         |     |         | <.0001  |
| 7 hours                              | 609| 48.6    | 875 | 51.4    |         |
| 7 or more hours                      | 1037| 55.0  | 1219| 45.0    |         |
| Age groups                           |    |         |     |         | <.0001  |
| 30 to less than 45 years             | 837| 69.6    | 504 | 30.4    |         |
| 45 to less than 55 years             | 394| 49.9    | 551 | 50.1    |         |
| 55 years and above                   | 415| 35.4    | 1039| 64.6    |         |
| Sex                                  |    |         |     |         | <.0001  |
| Female                               | 1015| 61.6  | 858 | 38.4    |         |
| Male                                 | 631 | 43.6    | 1236| 56.4    |         |
| Race/ethnicity                       |    |         |     |         | <.0001  |
| Non-Hispanic White                   | 914 | 57.3   | 876 | 42.3    |         |
| Non-Hispanic Black                   | 245 | 41.2    | 426 | 58.8    |         |
| Mexican American                     | 212 | 33.4    | 464 | 66.6    |         |
| Other                                | 275 | 49.3    | 328 | 50.7    |         |
| Education                            |    |         |     |         | <.0001  |
| HS graduate/less                     | 610 | 40.4   | 1231| 59.6    |         |
| Some coll/tech/more                  | 1033| 60.7   | 857 | 39.3    |         |
| Smoking                              |    |         |     |         | <.0001  |
| Current                              | 221 | 35.7   | 507 | 64.3    |         |
| Former                               | 372 | 47.5   | 580 | 52.5    |         |
| Never                                | 1053| 60.2   | 1007| 39.8    |         |
| Number of missing teeth              |    |         |     |         | <.0001  |
| 0–5                                  | 1,023| 63.3  | 811 | 36.7    |         |
| 6–9                                  | 388 | 50.3   | 515 | 49.7    |         |
| 10–20                                | 152 | 25.3   | 510 | 74.7    |         |
| More than 20                         | 83  | 25.1   | 258 | 74.9    |         |
| Federal Poverty Level Index          |    |         |     |         | <.0001  |
| 0 to less than 1.25                  | 312 | 35.7   | 627 | 64.3    |         |
| 1.25 to less than 2.00               | 228 | 44.3   | 355 | 55.7    |         |
| 2.00 to less than 4.00               | 393 | 49.8   | 513 | 50.2    |         |
| 4.00 and above                       | 573 | 64.6   | 389 | 14.7    |         |
| Insurance coverage                   |    |         |     |         | <.0001  |
| Yes                                  | 1349| 56.2   | 1486| 43.8    |         |
| No                                   | 297 | 37.0   | 608 | 63.0    |         |
| Diabetes                             |    |         |     |         | <.0001  |
| Yes                                  | 151 | 33.4   | 408 | 66.6    |         |
| No                                   | 1495| 55.2   | 1686| 44.8    |         |

Confounders that have not been considered in the adjusted analysis. Nevertheless, this study used 2009–2012 data from a large, nationally representative survey in which the periodontal examinations were performed by calibrated, licensed dentists and dental hygienists and questionnaires were presented by trained examiners.  

5. Conclusion

The relationship of periodontitis and routine inadequate sleep duration in a nationally representative study of participants who were of ages 30 years and above failed to reach statistical significance in adjusted analyses.
Table 3: Logistic regressions of adequate sleep on periodontitis, NHANES 2009–2012.

|                                      | Unadjusted odds ratio [95% confidence interval] | p value | Adjusted odds ratio [95% confidence interval] | p value |
|--------------------------------------|-------------------------------------------------|---------|-----------------------------------------------|---------|
| Adequate sleep                       |                                                 |         |                                               |         |
| 7 hours or more                      | Reference                                       | <.0001  | Reference                                     | .9812   |
| Less than 7 hours                    | 1.34 [1.18, 1.52]                               |         | 1.00 [0.83, 1.21]                             |         |
| Age group                            |                                                 |         |                                               |         |
| 30 to less than 45 years             | Reference                                       | <.0001  | Reference                                     |         |
| 45 to less than 55 years             | 2.77 [2.04, 3.76]                               |         | 5.49 [3.77, 8.01]                             |         |
| 55 years and above                   |                                                 |         |                                               |         |
| Sex                                  |                                                 |         |                                               | <.0001  |
| Female                               | Reference                                       |         | Reference                                     |         |
| Male                                 | 2.60 [2.17, 3.12]                               |         |                                               |         |
| Race/ethnicity                       |                                                 |         |                                               |         |
| Non-Hispanic white                   | Reference                                       |         |                                               |         |
| Non-Hispanic black                   | 1.88 [1.20, 2.96]                               | .0060   | 1.88 [1.20, 2.96]                             |         |
| Hispanic                             | 2.94 [2.18, 3.97]                               | <.0001  | 2.94 [2.18, 3.97]                             | <.0001  |
| Other                                | 1.65 [1.13, 2.41]                               | .0092   | 1.65 [1.13, 2.41]                             |         |
| Education                            |                                                 |         |                                               | <.0001  |
| HS graduate/less                     | Reference                                       |         |                                               |         |
| Some coll/tech/more                  | 1.34 [1.09, 1.65]                               |         | 1.34 [1.09, 1.65]                             |         |
| Smoking                              |                                                 |         |                                               | <.0001  |
| Current                             | 2.74 [1.98, 3.80]                               | <.0001  | Reference                                     |         |
| Former                              | 1.43 [1.15, 1.79]                               | .0016   | Reference                                     |         |
| Never                               | Reference                                       |         |                                               |         |
| Number of missing teeth              |                                                 |         |                                               |         |
| 0–5                                 | Reference                                       |         |                                               |         |
| 6–9                                 | 1.44 [1.14, 1.82]                               | .0024   | 1.44 [1.14, 1.82]                             | .0024   |
| 10–20                               | 2.64 [2.02, 3.44]                               | <.0001  | 2.64 [2.02, 3.44]                             | <.0001  |
| More than 20                         | 2.18 [1.02, 4.65]                               | .0445   | 2.18 [1.02, 4.65]                             | .0445   |
| Federal Poverty Level Index          |                                                 |         |                                               | .0001   |
| 0 to less than 1.25                  | 1.82 [1.23, 2.71]                               | .0028   | 1.82 [1.23, 2.71]                             | .0028   |
| 1.25 to less than 2.00               | 1.62 [1.15, 2.26]                               | .0053   | 1.62 [1.15, 2.26]                             | .0053   |
| 2.00 to less than 4.00               | 1.60 [1.07, 2.39]                               | .0213   | 1.60 [1.07, 2.39]                             | .0213   |
| 4.00 and above                       | Reference                                       |         |                                               |         |
| Insurance coverage                   |                                                 |         |                                               | <.0001  |
| Yes                                 | Reference                                       |         |                                               |         |
| No                                  | 1.73 [1.43, 2.10]                               | .1567   | 1.73 [1.43, 2.10]                             | .1567   |
| Diabetes                            |                                                 |         |                                               |         |
| Yes                                 | 1.41 [0.88, 2.26]                               |         | 1.41 [0.88, 2.26]                             |         |
| No                                  | reference                                       |         |                                               |         |

Wald test p-value was <.0001 for unadjusted and adjusted models.
Abbreviations: NHANES—National Health and Nutrition Examination Surveys; HS = high school; coll = college; tech = technical school.

Disclaimer

The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Conflict of Interests

The author declares that there is no conflict of interests regarding the publication of this paper.

Acknowledgment

Research reported in this publication was supported by the National Institute of General Medical Sciences of the National Institutes of Health under Award no. U54GM104942, WVCTSI.

References

[1] H. Murray, D. Locker, and E. J. Kay, “Patterns of and reasons for tooth extractions in general dental practice in Ontario, Canada,”
Community Dentistry and Oral Epidemiology, vol. 24, no. 3, pp. 196–200, 1996.

[2] B. A. Burt and S. A. Eklund, Dental Practice and the Community, Elsevier, St. Louis, Mo, USA, 6th edition, 2005.

[3] G. E. Salvi, B. Yalda, J. G. Collins et al., “Inflammatory mediator response as a potential marker for periodontal diseases in IDDM patients,” Journal of Periodontology, vol. 68, no. 2, pp. 127–135, 1997.

[4] V. Grover, R. Malhotra, and H. Kaur, “Exploring association between sleep deprivation and chronic periodontitis: a pilot study,” Journal of Indian Society of Periodontology, vol. 19, no. 3, pp. 304–307, 2015.

[5] M. T. Pöllänen, J. I. Salonen, and V.-J. Uitto, “Structure and function of the tooth-epithelial interface in health and disease; Periodontology 2000, vol. 31, pp. 12–31, 2003.

[6] L. AlDabal and A. S. Bhammam, “Metabolic, endocrine, and immune consequences of sleep deprivation,” Open Respiratory Medicine Journal, vol. 5, no. 1, pp. 31–43, 2011.

[7] National Health and Nutrition Examination Survey (NHANES) Oral Health Examiners Manual 2009-2010, http://www.cdc.gov/nchs/data/nhanes/nhanes09-10/OralHealth_Examiners.pdf.

[8] Anon, “National Health and Nutrition Examination National Health and Nutrition Examination Survey 2009-2010 Data Documentation, Codebook, and Frequencies,” Periodontal, 2012, http://wwwn.cdc.gov/Nchs/Nhanes/2009-2010/OHXPER_F.htm.

[9] National Health and Nutrition Examination, National Health and Nutrition Examination Survey 2011-2012 Data Documentation, Codebook, and Frequencies, Periodontal, http://wwwn.cdc.gov/Nchs/Nhanes/2011-2012/OHXPER_G.htm.

[10] P. I. Eke, R. C. Page, L. Wei, G. Thornton-Evans, and R. J. Genco, “Update of the case definitions for population-based surveillance of periodontitis,” Journal of Periodontology, vol. 83, no. 12, pp. 1449–1454, 2012.

[11] C. Sabanayagam and A. Shankar, “Sleep duration and cardiovascular disease: results from the National Health Interview Survey,” SLEEP, vol. 33, no. 8, pp. 1037–1042, 2010.

[12] C.-F. Lee, M.-C. Lin, C.-L. Lin et al., “Non-apnea sleep disorder increases the risk of periodontal disease: a retrospective population-based cohort study,” Journal of Periodontology, vol. 85, no. 4, pp. e65–e71, 2014.

[13] A. E. Sanders, G. K. Essick, J. D. Beck et al., “Periodontitis and sleep disordered breathing in the Hispanic Community Health Study/Study of Latinos,” SLEEP, vol. 38, no. 8, pp. 1195–1203, 2015.

[14] M. R. Irwin, M. Wang, C. O. Campomayor, A. Collado-Hidalgo, and S. Cole, “Sleep deprivation and activation of morning levels of cellular and genomic markers of inflammation,” Archives of Internal Medicine, vol. 166, no. 16, pp. 1756–1762, 2006.

[15] D. J. Frey, M. Fleshner, and K. P. Wright Jr., “The effects of 40 hours of total sleep deprivation on inflammatory markers in healthy young adults,” Brain, Behavior, and Immunity, vol. 21, no. 8, pp. 1050–1057, 2007.