Prevalence and severity of gingivitis in American adults

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ABSTRACT: Purpose: To investigate prevalence and severity of gingivitis in representative American adults. **Methods:** Subjects (1,000) in Loma Linda, California; Seattle, Washington; and Boston, Massachusetts were examined for Löe-Silness Gingivitis Index (GI). Mann-Whitney rank sum test was used to determine significances in the GI between genders. The data among study sites and races were compared using the Kruskal-Wallis one-way ANOVA on ranks. The correlation of the GI and age was examined by the Spearman rank order correlation. Age differences among three sites were analyzed using the one-way ANOVA. **Results:** The race composition of the subjects (mean age 37.9) approximated to the 2004 U.S. Census data. The overall average GI was 1.055. Only 6.1% of subjects showed mean GI <0.50; most (93.9%) were ≥ 0.50, with 55.7% ≥ 1.00. There was a significant correlation ($P < 0.001$) between the age and GI. The males' GI was significantly higher ($P < 0.001$) than the females'; African-Americans showed a significantly higher GI ($P < 0.05$) than other races except for the Native-Americans. (*Am J Dent* 2010;23:9-13).

CLINICAL SIGNIFICANCE: The average GI in adults recruited in three cities is slightly ≥1.0; age, gender, race and subject source can influence the prevalence and severity of gingivitis. For gingivitis studies, proper subject source, age, gender and race compositions need to be considered for recruiting a representative study population.

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Introduction

Gingivitis is one of the most commonly seen diseases in humans.[1] It involves the inflammation of only the gingiva and is reversible when appropriate treatment measures are used.

Numerous methods and approaches, including dietary modifications, have been used for combating gingivitis. In addition to professional care, such as regular dental prophylaxis, a variety of oral hygiene products have been developed for controlling plaque-induced gingivitis. Studies have demonstrated that good oral hygiene practice, including brushing of teeth, and using proper mouthrinses, may reduce gingivitis.[2-4] With advances in science and technology, toothpastes and mouthrinses that have shown to be effective in controlling gingivitis have become available to the public.[5,6]

In clinical trials that evaluate the efficacy of oral hygiene products for controlling gingivitis, it is a common practice to specify a minimal average gingivitis index as one of the inclusion criteria when recruiting study subjects. However, in the reported studies such minimal average gingivitis index as a qualifying requirement varies widely. In addition, there appears to be a lack of a clear scientific rationale for choosing a particular minimal average gingivitis index score as an inclusion criterion in clinical studies. There have been a limited number of studies on the prevalence and/or severity of gingivitis in American adult populations; however, almost all involved study subjects of little diversity in race, age, and/or occupations, with limited number of subjects, and/or provided inadequate information on demographic characteristics of the study population.[7,8] Consequently, there is a need to determine the current prevalence and severity of gingivitis in American adults.

This three-center epidemiological study investigated the prevalence and severity of gingivitis in representative populations of adults that reflects the demographical composition of the United States.

Materials and Methods

Prior to the initiation of the study, the protocol and the letter of informed consent were approved by the Institutional Review Board (IRB) of Loma Linda University. A total of 1,000 subjects participated in the study. The participants were recruited from populations living in three different geographic areas of the United States, including: (1), 364 subjects at Loma Linda University, which is composed of health care schools and medical centers located in Loma Linda, California; (2), 300 subjects at University of Washington, which is a comprehensive university campus in Seattle, Washington; and (3), 336 subjects from an upper-middle class district in Boston, Massachusetts. Separate IRB approvals were also obtained for the sites of Seattle and Boston.

Study subjects were healthy male and female adults of ≥18 years old who had at least 20 natural teeth. Each study site recruited panelists by placing IRB-approved advertisements in local publications. The advertisements provided a brief synopsis of the study and instructed potential subjects to contact the research clinic for more information. The potential subjects were interviewed by telephone as to their eligibility, and if the person was interested in participating, he or she would be scheduled for the clinical visit. Each perspective participant was given a full explanation of the study, signed the informed consent and received a copy of the signed informed consent.

Demographic information (age, gender and race) and a brief medical questionnaire were collected from each subject, who then received the gingivitis examination. Individuals with gross pathological changes of gingival tissues were excluded from the study. The method of Löe-Silness[9] was used for evaluating the gingival health of all natural teeth, excluding third molars, according to the following criteria:

0 = Absence of inflammation;
1 = Mild inflammation: slight change in color and texture;

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Table 1. Demographic data of study subjects.

Site	N	Gender Male	Gender Female	Age (Year) Range	Age (Year) (Mean ± SD)*
Boston	336	169	167	18-90	39.6 ± 15.4
Loma Linda	364	135	229	18-84	36.5 ± 14.3
Seattle	300	117	183	18-88	37.4 ± 15.7
All three sites	1000	421	579	18-90	37.9 ± 15.2

* Values connected with a vertical line are not significantly different.

2 = Moderate inflammation: moderate redness, edema, glazing, hypertrophy, bleeding on probing;
3 = Severe inflammation: marked redness and hypertrophy, a tendency to spontaneous bleeding, (elicited by air syringe) and/or ulceration.

The same examiner who had prior experience in the field conducted the examination of gingival index (GI) for all 1,000 subjects at all three sites. The subject enrollment was continuous until the predetermined number of subjects was reached at each site.

The data of age, gender, race and GI were compiled for each site as well as for all three sites. The category and definition of races (Native-American, African-American, Hispanic, White, Asian and Other/mixed) followed those described by the 2004 U.S. census.[10] Four age groups (≤ 30, 30 to 44, 45 to 59, and ≥ 59) were analyzed to examine the impact of age on the prevalence and severity of gingivitis. Statistical analyses of the data were performed at a 5% level of significance. One-way ANOVA was used to examine age differences among the three sites, while Kruskal-Wallis one-way ANOVA on ranks was performed to analyze the GI among the three study sites, four age groups and six race groups. The effect of gender and race on the GI was evaluated using the Mann-Whitney rank sum test. Spearman rank order correlation was used to examine the relationship between the GI and age. The site effect was examined using the general linear random effects model.

Results

Among the 1,000 study participants, there were 579 females (57.9%) and 421 males (42.1%), with an average age of 37.9 years ranging from 18 to 90 years (Table 1). The average age for the Boston population was approximately 3 years older ($P< 0.05$) than that of the other two sites; however, the age range and variations were similar among the three populations. The gender composition was comparable between the Loma Linda and Seattle groups (62.9% and 61.0% females, respectively); for the Boston population, the female proportion was slightly lower (49.7%). The general linear random effects model showed that there was a statistically significant center effect on GI ($F= 8.358$, $P< 0.0001$) as well as statistically significant center effect on age ($F= 4.864$, $P= 0.008$).

As presented in Fig. 1, the race composition of the study participants in general reflects that of the 2004 census data of the United States population.[10] The major difference was fewer Whites (52.2%) but more Asians (14.1%) in the present study compared to the 2004 U.S. census data (67.3% and 4.2% for Whites and Asians, respectively).

The overall average GI was 1.055 (SD = ±0.365), ranging from 0.16 to 2.43, for the 1,000 American adults examined in Boston, Massachusetts, Seattle, Washington, and Loma Linda, California. As presented in Fig. 2, only 6.1% of the subjects had a GI lower than 0.5, so that for 93.9% of the subjects the average GI was 0.5 or higher. For more than half (55.7%) of the subjects, their GI was 1.0 or higher.

There was a positive correlation (correlation coefficient at 0.308, $P< 0.001$) between the GI score and age (Fig. 3). Among the four age groups, subjects younger than 30 years of age had significantly lower GI scores ($P< 0.05$) than the three older groups (Fig. 4). While the average GI values were comparable between the 30-44-year and 45-59-year subjects as well as between those of 45-59-year and older than 59, the oldest group

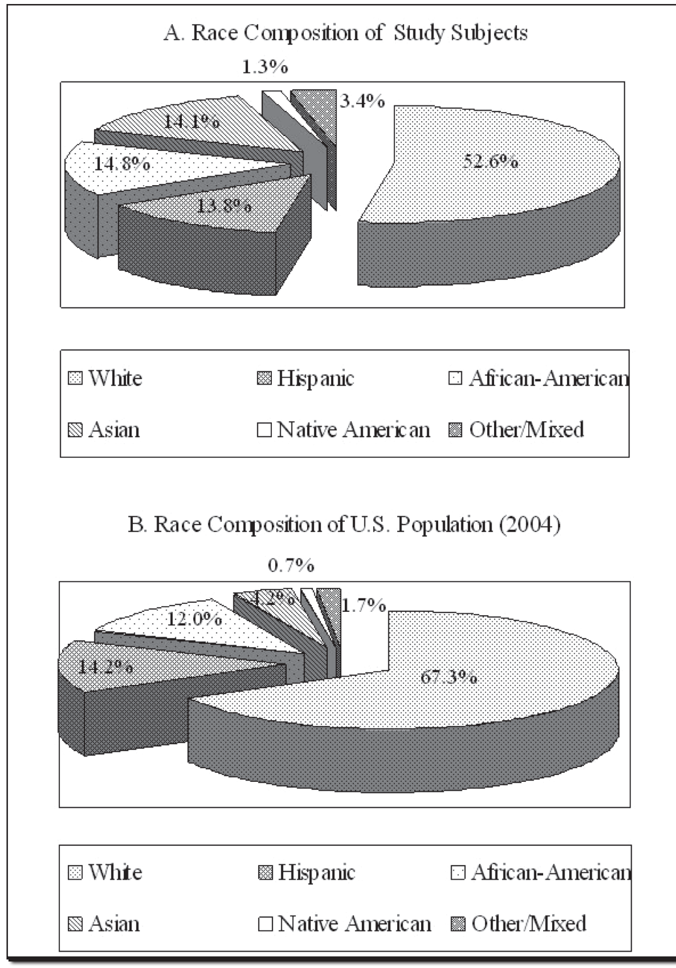

Fig. 1. Race composition of 1,000 study subjects (A) compared to 2004 Census data for U.S. Population (B).

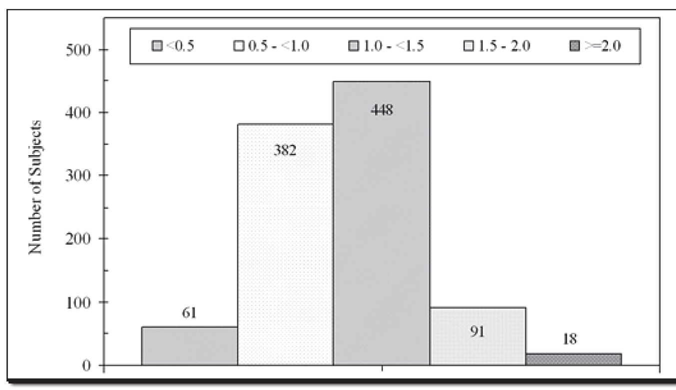

Fig. 2. Distribution of average Löe-Silness Gingivitis Index in 1,000 study subjects.

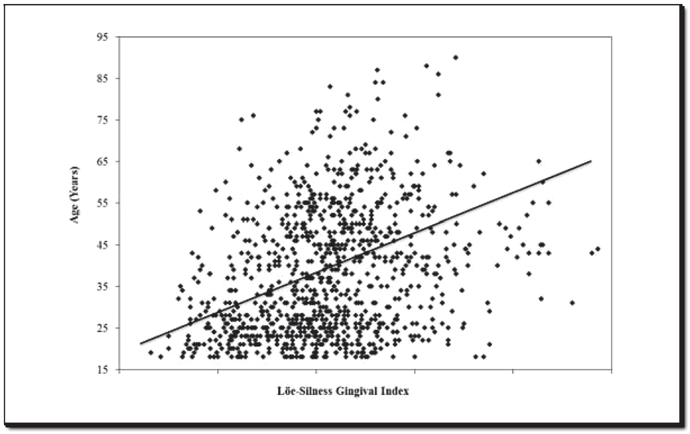

Fig. 3. Correlation of Löe-Silness Gingivitis Index to age of 1,000 subjects (Correlation coefficient at 0.308, P< 0.001).

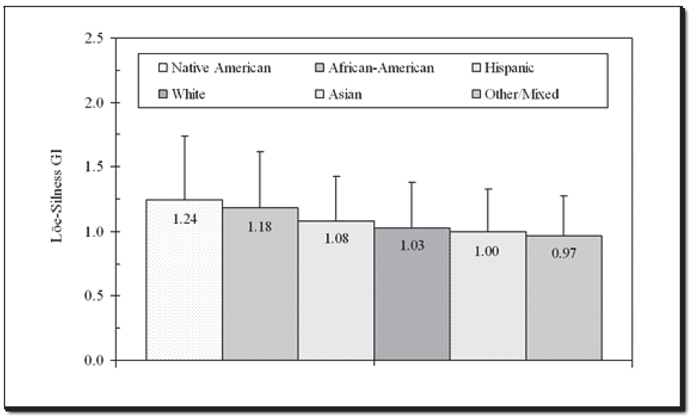

Fig. 5. Average Löe Silness Gingivitis Index in different ethnic groups.

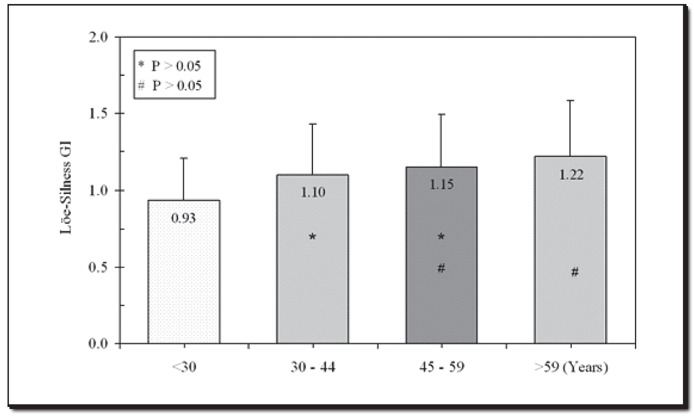

Fig. 4. Average Löe-Silness Gingivitis Index in four age groups.

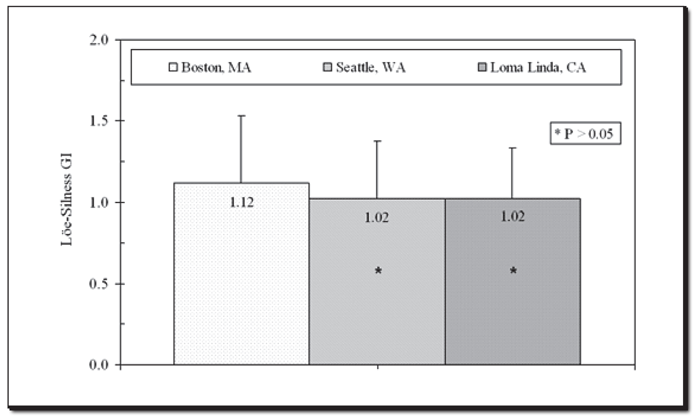

Fig. 6. Average Löe-Silness Gingivitis Index at three sites.

(> 59-year) had significantly higher GI values than the group of 30-44 years of age.

The average GI score for the males and females were 1.19 and 0.95, respectively. Statistical analysis of the data showed that the males' GI was significantly higher than that of the females (P< 0.001).

Figure 5 and Table 2 present the GI data in different race groups. The average GI was highest for Native-Americans (1.24; N=13), followed by African Americans (1.18; N=148), Hispanics (1.08; N=138), Whites (1.03; N=526), Asians (1.00; N=141) and Other/mixed (0.97; N=34). Statistical analysis of the data found that the African-American group had a significantly higher average GI score (P< 0.05) than other race groups except the Native-American group (P= 0.602), which had a significantly higher GI score (P< 0.05) than the White and Other/mixed groups (Table 2).

The average GI values for the Boston, Seattle and Loma Linda sites were 1.12, 1.02 and 1.02, respectively (Fig. 6). The average GI of the Boston site was significantly higher than that of both the Seattle and Loma Linda sites; the average GI was comparable between the Seattle and Loma Linda subjects.

Discussion

Gingivitis in adults is difficult to characterize due to the lack of comprehensive data; estimates of the general prevalence of adult gingivitis vary from approximately 50-100%.[11] The present study found that 93.9% of the 1,000 subjects examined had a GI at 0.50 or higher, and more than half (55.7%) had a GI at 1.0 or higher. A retrospective survey[8] of dental records of 1,107 U.S. Navy personnel found 76% exhibited gingivitis of varying severity. The subjects were young adults, most with routine professional dental prophylaxis; therefore, it is reasonable to expect that their prevalence and severity of gingivitis are lower than the general population. On the other hand, a recent study[7] involving 984 subjects of 18-65 years of age reported an average GI of 0.66. The reasons for a lower GI found in this population are unclear because it was reported in an abstract with limited information; however, the differences in the average GI compared with the present study may be attributed to the subject sources, examiner, and demographics, which, as shown by the results of the present study, can influence the outcome of the average GI in a population.

Table 2. Results of statistical analysis (P-value) of data in Fig. 5.

	African-American	Hispanic	White	Asian	Other/ mixed
Native American	0.602	0.217	0.031	0.071	0.029
African-American		0.040	<0.001	<0.001	0.006
Hispanic			0.098	0.101	0.092
White				0.496	0.352
Asian					0.575

The three study sites selected for the present study represent different study populations possibly used for clinical trials that evaluate antigingivitis efficacy of oral hygiene products. Loma Linda, in Southern California, is a small town with a medical university as one of its major employers, and its study subjects are primarily the residents in nearby communities and students and faculty of health care professional schools. The Seattle site is located on the campus of a comprehensive university, and its study populations include those from local communities as well as students and faculty of health care and non-health care institutions. Both the Loma Linda and Seattle sites routinely conduct clinical trials, and their study subjects are typical and representative of the majority of the similar studies reported in the literature.

The Boston site was purposely selected at a residential and business area located in the upper-middle class district to determine whether, if any, the prevalence and severity of its population are different from the typical medical center/university campus sites. The results indicate that the average GI of the Boston subjects (1.12) was indeed higher than those in the Loma Linda and Seattle sites, for which both have a statistically lower average GI score (1.02). The present study did not include sites and populations of known economical, social, physical and mental challenges or disadvantages, which are generally recognized to have relatively poor oral hygiene and lower accessibility to professional oral care. Therefore, there is a possibility that the average GI for American adults may be higher than 1.055 obtained from the 1,000 subjects examined in the present study.

In addition to the subject source, the results of the present study show that the age, gender and race composition of a study population can influence the outcome of the prevalence and severity of gingivitis, as measured using the GI. The average GI tends to increase for older subjects (Fig. 3). The difference is especially evident between subjects younger than 30 years of age and those older than 60; the older group has an approximately 31% higher GI. The gender can have a similar impact on the average GI of a study population. It is perceivable that the disproportion of the age and gender mix in a study population may significantly distort the average GI and misrepresent the population of intended product users.

The GI results obtained from the six different races are of particular interest, largely because of the paucity of such data in the literature. As illustrated in Fig. 1, the race composition of the present study in general approximates the 2004 U.S. census data, except for a lower percentage of Whites and a higher proportion of Asians in the present study. This deviation, however, does not appear to have a significant impact on the overall average GI of the present study population, as the results are comparable between the whites (1.03) and Asians (1.00). On the other hand, while the Native-American group had the highest average GI (1.24), its sample size (13) was small, resulting in statistical differences only from that of the White and Other/mixed groups (Table 2). However, the higher average GI in African-Americans (1.18), which is significantly different from that of other races except the Native-Americans, is more convincing. As the present study did not assess the economic and social factors nor personal oral hygiene practice, no conclusions can be made regarding possible factors that contribute to this finding. Nevertheless, the data clearly indicate that a proper race composition is important for clinical studies on gingivitis.

In addition to numerous oral hygiene products available on the market, new products are being actively developed for combating gingivitis. This continuous increase in the number of choices in the marketplace for antigingivitis products makes it more difficult to evaluate their efficacy. It is known that the choice of different indices, such as the GI, MGI (Modified Gingival Index), BI (Bleeding Index) and a combination of the GI and BI, can influence the outcome of a clinical antigingivitis study.[12] The MGI uses a 5 (0 to 4) point index, which is a wider scale than the GI (0 to 3). Studies have shown that, when used properly, the MGI appears to help detect the difference in antigingivitis effects of the oral hygiene products without distorting the overall data.[6,13-19] The results of the present study have demonstrated that the possible impact of characteristics of a subject population on the accuracy and reliability of the efficacy data in such an investigation cannot be neglected. The importance of using an appropriate study population is not limited to meeting the requirements that the study population should be representative of the intended users of the test product.[20,21] Results from a misrepresented study population may also provide erroneous or misleading conclusions on the antigingivitis efficacy of a product. Based on the data from the present study, a study population of primarily female Whites and Asians younger than 30 years of age will likely have a GI significantly lower than 1.0; however, the relevancy of the antigingivitis efficacy detected in this population to the general population is questionable. Even more of a concern is the possible exaggeration of the antigingivitis efficacy in a study population of an average GI lower than usual when using the percentage reduction of the GI. For example, a reduction of 0.1 GI can be interpreted as a 20% antigingivitis efficacy if a study population with an average baseline GI of 0.5 is used. Therefore, for clinical trials on the antigingivitis efficacy of an oral hygiene product, it is imperative to recruit a study population that is representative of the intended users of the product, and when interpreting the data for the antigingivitis efficacy, possible impact of the characteristics of the study population, including the source and demographic compositions, should be considered.

In conclusion, the average GI in a representative American adult population that approximates recent U.S. Census is 1.055, with 93.9% subjects having a GI $\geq$ 0.50 and 55.7% $\geq$ 1.00. For GI studies, proper subject source, age, gender and race composition need to be considered for meaningful results and assessments of the antigingivitis efficacy of an oral hygiene product.

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