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Literacy, Pregnancy and Potential Oral Health Changes: The Internet and Readability Levels

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Abstract

The purpose of this study is to evaluate the readability level and content of articles concerning pregnancy and the periodontium which are presented on internet websites. Websites were selected from Google, Yahoo, and Bing. The sites which were excluded were: commercial sites; blogs; dental office sites; sites with articles having fewer than 20 sentences; duplicated search results; and non-secure sites ($N = 137$). The grade level was determined from the SMOG reading index. Content was scored for specific pregnancy related periodontal content. The mean reading level was 8th grade. The mean number of words with 3 or more syllables in 20 sentences was 38.90. Articles written below the 8th grade level were more likely to recommend brushing twice a day and using a soft-bristled brush. Articles at or above the 8th grade level were more likely to discuss preterm birth and periodontal disease. One article from a national dental organization and 3 from government sites were returned from the searches. Internet articles are written across the literary spectrum. Dental organizations were not adequately represented. Many advertisements, .coms, and non-secure sites pose challenges in seeking health information. Although the internet is a useful tool, practitioners need to provide trustworthy, useful information during clinical visits and encourage national and state medical and dental organizations to provide content in response to search terms that would be typically used.

Keywords

Health literacy; Periodontal disease; Pregnancy

Introduction

The purpose of this study is to evaluate internet sites that reported specifically about pregnancy and periodontal changes. Readability levels (a measure of accessibility) and periodontal content are the criteria for the evaluation. Pregnancy is a time of potential periodontal change. Many factors influence and interact to result in poor periodontal health. During pregnancy, the gingival tissues may become symptomatic. Since the widespread availability of the internet, women of childbearing age often have turned to it as an easy, available source of health information. The following periodontal topics should be found when common terminology is used to begin a search concerning pregnancy and the periodontium: pregnancy gingivitis, pregnancy granulomas, periodontal disease, oral health care, nutrition, and pregnancy/preterm or low birth weight babies. These topics are highlighted below.

Pregnancy gingivitis is gingival inflammation resulting from plaque and exacerbated by sex steroid hormones [1]. Pregnancy's hormonal shifts alter the gingival tissue's immunological response, especially at the interdental papillae, and result in the enlarged/hyperplastic, tender gingiva. The mechanism is not known, however a transient increased gingival inflammatory response has been found which has not been associated with the amount of plaque present or salivary hormone levels [2]. The tissue bleeds easily which leads some women to avoid brushing. The lack of oral hygiene aggravates pregnancy gingivitis. Bacterial load increases with poor oral hygiene; *P. gingivalis*, in particular, has been associated with more severe pregnancy gingivitis during the 2nd and 3rd trimesters [1]. Oral management involves professional evaluation and treatment (removal of plaque, calculus, and restoration overhangs, etc.), and meticulous home care (brushing after eating/at least twice daily, using fluoridated toothpaste on a soft-bristled toothbrush, and daily flossing).

In 5 % of pregnant women, soft, red, vascular, localized, tender, hyperplastic gingival lesions develop [3]. The lesions are referred to as pregnancy granuloma, pyogenic granulomas of pregnancy, or granuloma gravidarum. They are usually self-limiting, reactive lesions [4]. They occur more frequently in the 2nd and 3rd trimesters, and the proposed mechanism suggests estrogen increases vascular endothelial growth factor in macrophages, which increases the growth of the lesion [3]. Oral management involves professional evaluation, the removal of calculus, plaque, and/or other irritants around the site, and meticulous home care. In cases in which trauma may occur to the pregnancy granuloma, the tissue may be surgically removed during the pregnancy.

When true periodontal disease occurs, periodontal tissue is irreversibly destroyed and other systemic consequences potentially occur. Periodontal disease and low birth weight babies (babies born at <2,500 g) and preterm babies (babies born at <37 weeks gestational age) have been associated [5]. One mechanism hypothesized is that oral bacteria enter the blood stream and into the amniotic fluid leading to chorioamniotic infections [6]. Another hypothesis is that periodontal disease increases production of cytokines (communicating or signaling chemicals) such as interleukin-1, interleukin-6, tumor necrosis factor- α , and/or prostaglandin E₂, and initiate birth prematurely [6]. A third hypothesis involves the fetus and mother's immune response interaction [6].

A recent literature review showed conflicting results of the effectiveness of professional periodontal management and pregnancy outcomes [6]; however, not all of the studies in the review considered completed periodontal treatment, and with such consideration, there was a strong relationship of successful periodontal care and full-term birth [7]. Preterm, low birth weight babies are concerning as they are more likely to have neurodevelopmental, behavioral, and chronic health problems than full-term babies [8, 9]. The 2020 Healthy People objectives are to reduce the number of low birth weight births from the 2007 level of 8.2 % to a goal of 7.8 %; and to reduce the number of preterm babies from the 2007 level of 12.7–11.4 % [10]. Oral management may help. It involves professional evaluation and treatment, and meticulous home care during pregnancy.

The internet is a prime source of health information. An estimated 33 million people in the US used the internet for medical information [9]. Pregnant women with sore, bleeding, or swollen gingival tissue may turn to it for periodontal advice/recommendations before, or instead of, seeking professional dental care/advice. However, the health education information on the internet may not be accurate; it may not be complete enough to be useful; or it may not be at an appropriate reading level for the user. Additionally, a lack of oral health website analysis exists. A literature search of PubMed and Cochrane Libraries with the search terms “dental health website,” “oral health website,” and “oral health website analysis,” resulted in articles primarily relating to establishing websites for dental practice marketing [11–15], and online instruction for dental students and dental practitioners [16, 17]. In one article, the authors analyzed oral health and the internet in an historical perspective, considering challenges and the future [18]. Little research exists concerning literacy analysis of online oral health related materials for the public.

The US Institute of Medicine defines *health* literacy as “the degree to which individuals can obtain, process, and understand the basic health information and services they need to make appropriate health decisions” [19]. Low health literacy is related to patients taking medicines improperly, missing appointments, and failing to grasp expectations due to misunderstood or complex instructions [20]. It is also associated with less health knowledge, worse self-care, higher hospitalization rates, poor physical and mental health, increased mortality risk, and increased health care costs [21]. The overall literacy levels are estimated to be 3–5 years below the highest grade attained [22]. Confidentiality/privacy policies on the internet are more likely to be at the 14.7 (second year of college, second semester) grade level [10]. Medically related patient education material on the internet is more likely to be written at or above the 10th grade level [23]. Medical literacy presents additional concerns in that difficulty in reading is also impacted by words and terms which are unfamiliar. The comprehension/reading level of health related materials may need to be rated higher than determined through typical readability formulae [22].

Good population level health education materials are characterized as having a less than 8th grade reading level, the presence of illustrations or photographs, recency, quality content (information reported is accurate), quality production, being culturally appropriate, having an appropriate tone, and length, delivering a believable message with a call to action, and using an appropriately large font (12 point or larger) [24, 25]. The public needs good health education material on the internet. Little research has been conducted about health care

literacy; dental health care literacy; and specifically dental health care literacy related to pregnancy, the periodontium, and poor periodontal sequale, which are of significant public health concerns in terms of low birth weight and preterm babies. This study's intent is to evaluate internet sites presenting pregnancy and periodontal health content.

The research hypothesis is: internet articles written below the 8th grade level do not provide adequate health information concerning periodontal changes, consequences, and control during pregnancy as compared with those written at or above the 8th grade level.

Methods

The key words, "pregnancy and gums," were used in this study as they are likely words that pregnant women with sore, bleeding, or swollen gingival tissue would use. Also, the most widely used, top three search engines, Google, Yahoo, and Bing, were searched. The first 9 pages returned from the searches were analyzed (redundancy occurred beyond 9 pages). Commercial sites, blogs, dental office sites, articles with fewer than 20 sentences, duplicate sites, non-English and non-secure sites were excluded (N = 137). There were 58 websites included in the study, each coded and analyzed by RCW. Each website was evaluated for reading level using the McLauglin SMOG Readability Formula for short passages. Previous research indicates that SMOG is among the 40 different readability methods with acceptable, accurate grade level results (± 1 grade level, 68 % confidence) [22]. SMOG was validated against the McCall-Crabbs passages with a 100 % correct-score criterion [26]. SMOG is a commonly used readability measure for health information and is valid for grades 3 and above [22]. However, it has been reported that the SMOG consistently rated materials 2–3 grade levels higher than the also commonly used Flesch-Kincaid method [27] and two grades higher than the Dale-Chall formula [26].

SMOG criteria for 20 sentences consists: of (1) determining the *initial count* by counting the number of polysyllabic words (words of 3 or more syllables) in the 20 sentences; (2)determining the *mean* by dividing the initial count by 20; (3)creating an *adjustment* for the short passage by multiplying the mean by an adjusting factor (for 20 sentences, the factor is 10); (4) determining the *total count* by adding the initial count and adjustment; (5) comparing the total count with the "Total Polysyllabic Word Count" in the SMOG Conversion Table and selecting the associated grade level [26]. An "average" reading level is defined as between sixth and eighth grade reading levels on the conversion table.

Content criteria were evaluated with the presence of specific oral hygiene recommendations of the American Dental Association and specific periodontal issues. These recommendations included: the ADA actionable recommendations (to brush with a fluoridated toothpaste at least twice a day/after meals and snacks; to use a soft-bristled toothbrush, to floss daily, to see a dentist during pregnancy, and to discuss nutrition during pregnancy [28]); definitions and explanations (of pregnancy gingivitis and pregnancy granulomas); and associations (hormonal changes and pregnancy, preterm birth/low birth weight babies and periodontal disease, and role of progesterone and periodontal disease). These indicators are referred to as the study's content indicators.

Data analysis utilized SAS 9.3 (Carey, NC). Chi square testing was employed with $p = 0.05$ as the significance level. This study did not involve human subjects and did not require IRB ethics approval.

Results

Table 1 presents the characteristics of the 58 internet sites in readability and content. There were 6 articles written at the 6th grade level (10.3 %); 21 written at the 7th grade level (36.2 %); 21 written at the 8th grade level (36.2 %); 9 written at the 9th grade level (15.5 %) and 1 written at the 11th grade level (1.7 %). The mean reading level of the material on the internet sites was grade 8 (specifically, grade 7.63 [standard deviation, 0.99]). The mean number of content indicators was 4.91 [standard deviation, 2.32] per article. There was one article from a national dental organization and one from a state dental organization. There were 2 “.net’s” and “.in’s”; there were 3 “.org’s” and “.gov’s”. One site was a “.uk,” one was a “.gr,” and one was a “.aspx”; 2 were taken down and the remaining were “.com’s.” A picture of a toothbrush/floss/tooth brushing occurred in 7 articles, one of which had excess toothpaste. A picture of a woman flossing occurred in 2 articles, both of which showed improper flossing technique. A photograph of a pregnant woman being examined by a dentist was in 1 article, however the dentist was shown with improper use of personal protective equipment. Close-up photographs of teeth were shown in 3 articles, one of which included bleeding gingiva. There was one picture of a premature baby. 39 articles had no photographs, or did not have dentally related photographs.

Table 2 presents the presence or absence of the key content indicators in the study dichotomized to below 8th grade vs. 8th grade and above. Brushing at least twice a day was addressed in 20 of the 27 sites with less than an 8th grade reading level and in 19 of the 31 sites with an 8th grade and above reading level. The use of a soft tooth brush was recommended in 14 of the less than grade 8 articles and in 6 of the grade 8 and above articles. Flossing was discussed in 18 of the below 8th grade reading level articles and 20 of the higher ones.

Preterm birth and periodontal disease was discussed in 10 of the sites with a less than 8th grade reading level and in 22 of the sites with an 8th grade and greater reading level. Hormonal change and periodontal status was discussed in 16 of the sites with below 8th grade reading level and in 13 of the sites at 8th grade and above.

Table 3 presents the odds ratios for the absence of recommendations and explanations concerning periodontal status and pregnancy in which less than 8th grade reading level are compared against 8th grade reading levels and above. There were two significant results: a soft-bristled brush was more likely to be recommended in an internet article written below the 8th grade reading level (odds ratio: 0.22; 95 % CI 0.07, 0.72; $p = 0.0098$), and preterm birth and pregnancy were more likely to be explained in articles written at or above the 8th grade reading level (odds ratio: 4.16; 95 % CI 1.38, 12.49; $p = 0.0095$).

Three errors were noted in 3 separate articles written at or above the 8th grade level: the recommendation to use a firm tooth brush; the use of the word “module” for nodule in

discussing pregnancy granuloma; and the use of the word “planning” for [root] planing. The description that progesterone “softens gums” was in an article written below the 8th grade level. In the sample of articles relating periodontal health and pregnancy, soft-bristled brushes were more likely to be recommended when articles were written below the 8th grade level; however, one article written at the 8th grade level inappropriately recommended the use of a hard-bristled brush. Preterm birth was more likely to be discussed in internet articles discussing pregnancy and periodontal health in the materials which were written at or above the 8th grade level. There were more “actionable” content indicators on sites below the 8th grade level and more “association” indicators discussed on sites with higher grade levels. More articles were commercial sites, blogs, dental office sites, articles with fewer than 20 sentences, duplicate sites, non-English sites and non-secure sites (n = 137) than were informative websites (n = 58) in the sequential search of 9 screens of three search engines. Redundancy increased with each screen of the search. The articles written below the 8th grade level were more likely to include more content indicators, while the articles written above the 8th grade level were more focused on a particular issue.

Discussion

The internet is typically becoming the source of medical and dental knowledge. However, finding quality information is challenging. There were 137 internet sites returned from the 3 search engines used in this study which were not useful, one of which inserted a computer virus. Of the selected websites, 4 had errors in the written articles, and 3 had errors in the photographs. Having population level reading materials on the internet is important, but accuracy is very important. Also, national dental professional organizations were not adequately represented on the search returns (only 1 was identified).

Study limitations include the possibility that the samples were not representative of all of the potential health related sites discussing periodontal health and pregnancy. However, the top listed sites were those most likely to be viewed and the sample was drawn from that group. Another limitation was that other facets of readability were not explored—color, bold/emphasis, “busy-ness,” the difficulty to navigate the site, the number of selections needed to locate information, or formatting. There have been criticisms of the SMOG calculations as being dependent upon sentence length and syllables in that context cues may help people to use the information provided despite the presentation of complex terminology [9].

Few articles have been written concerning dental literacy and pregnancy. The literature search of PubMed and Cochrane Libraries specifically for oral health literacy and pregnancy resulted in one historical perspective, considering challenges and the future [18]. Research in dental literacy is in its infancy. Studies exist developing and testing tools such as the Test of Functional Health Literacy in Dentistry and the Rapid Estimate of Adult Literacy in Dentistry (REALD), however predictive validity and internal consistency are not to the level for widespread use [29]. A modified version of the REALD, the REALD-99, has promise as a measure of dental literacy [30].

Future research is needed for better tools to determine reading levels and content indicators. Few options exist to otherwise systematically evaluate readability. The Institute of Medicine

Health Literacy 2004 report identified the need for research in new measures of health literacy and research in health literacy in general [21]. Additionally, research is needed to determine how women of child-bearing age, especially underserved pregnant women or high risk pregnant women, obtain oral health information and what methods could be introduced to improve the access and quality of the material. The public has few means available to help find relevant information in the abundance of data available online [31]. This study found an excessive number of websites not to be useful. Similarly, other researchers have found questionable quality [31]. It is unlikely that national *dental* organization websites would be selected rather than a general online search. It may be more likely that a pregnant woman would search a *medical* professional, national website; therefore, accurate oral health information should be available at such sites. Policy research is also needed to determine the effectiveness of and access to government websites. Government websites need to be returned in general searches, easy to navigate, and have appropriate content. Three “.gov” websites were returned in the searches presented in this study.

The internet provides many articles written in plain language and in complex styles. In the sites selected for this study, the information was generally appropriate. The articles with a reading level below grade 8 had greater thoroughness of dental issues relating to periodontal health and pregnancy. However, many non-informative sites with advertisements, promotions, etc. were excluded. The national dental organizations had a lack of presence with the search parameters of this study.

Although the internet is a useful tool, practitioners need to provide trustworthy, useful information during clinical visits and encourage national organizations and government websites to be websites which are found when general search terms are used.

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Table 1

Sample description of internet sites relating pregnancy and periodontal status N = 58

	Number of website	Percent
<i>Reading level</i>		
6th grade	6	10.34
7th grade	21	36.21
8th grade	21	36.21
9th grade	9	15.52
11th grade	1	1.72
Mean grade level	7.64 (standard deviation 0.99)	
<i>Amount of content presented</i>		
1 item	3	5.17
2 items	3	5.17
3 items	10	17.24
4 items	12	20.69
5 items	6	10.34
6 items	7	12.07
7 items	7	12.07
8 items	6	10.34
9 items	1	1.72
10 items	2	3.45
Mean	4.91 (standard deviation 2.32)	

Content based upon 10 items: actionable recommendations to brush at least twice a day/after meals and snacks with a fluoridated toothpaste, for using a soft-bristled toothbrush, for daily use of floss, for seeing a dentist during pregnancy, for the discussion of nutrition during pregnancy; definitions and explanations of pregnancy gingivitis and pregnancy granulomas; and the associations between hormonal changes and pregnancy, preterm birth weight/low birth weight babies and periodontal disease, and role of progesterone and periodontal disease

Table 2

Descriptions of recommendations and explanations for periodontal health during pregnancy and in the internet material (by reading level) (n = 58)

Reading level	Less than 8th grade N (row percent(%))	8th grade and above N (row percent (%))
<i>Actionable Recommendations to</i>		
Brushing 2×/day or after meals and snacks		
No	7 (36.84)	12 (63.16)
Yes	20 (51.28)	19 (48.72)
Use a soft-bristled toothbrush		
No	13 (34.21)	25 (65.79)
Yes	14 (70.00)	6 (30.00)
Floss daily		
No	9 (45.00)	11 (55.00)
Yes	18 (47.37)	20 (52.63)
See a dentist during pregnancy		
No	2 (33.33)	4 (66.67)
Consume healthful nutrition		
No	13 (44.83)	16 (55.17)
Yes	14 (48.28)	15 (51.72)
<i>Definitions and explanations</i>		
Pregnancy gingivitis		
No	16 (43.24)	21 (56.76)
Yes	11 (52.38)	10 (47.62)
Pregnancy granuloma		
No	20 (42.55)	27 (57.45)
Yes	7 (63.64)	4 (36.36)
<i>Associations with periodontal disease</i>		
Preterm birth		
No	17 (65.38)	9 (34.62)
Yes	10 (31.25)	22 (68.75)
Hormone change		
No	11 (37.93)	18 (62.07)
Yes	16 (55.17)	13 (44.83)
Proposed role of progesterone		
No	23 (52.27)	21 (47.73)
Yes	4 (28.57)	10 (17.24)
<i>More than 4 of the above topics</i>		
No	11 (37.93)	18 (62.07)
Yes	16 (55.17)	13 (44.83)

Table 3

Odds ratios for recommendations and explanations of periodontal health during pregnancy and early motherhood in the internet material (by reading level) (n = 58)

Comparison of less than 8th grade vs. above 8th grade reading level	odds ratio	95 % confidence interval	p value
<i>Actionable Recommendations (no vs. yes)</i>			
Brush teeth 2×/day or after eating	0.55	(0.18, 1.71)	.3008
Use a soft-bristled toothbrush	0.22	(0.07, 0.72)	.0098
Using floss daily	0.91	(0.31, 2.70)	.8635
See a dentist during pregnancy *	0.54	(0.09, 3.21)	.4930
Nutrition	0.87	(0.31, 2.44)	.7924
<i>Definition content indicators (no vs. yes)</i>			
Pregnancy gingivitis	0.69	(0.24, 2.03)	.5025
Pregnancy granuloma	0.42	(0.11, 1.65)	.2070
<i>Association content indicators (no vs. yes)</i>			
Preterm birth/low birth weight	4.16	(1.38, 12.49)	.0095
Impact of hormonal change	0.50	(0.17, 1.42)	.1881
Proposed role of progesterone	0.50	(0.17, 1.42)	.1881
<i>Summary</i>			
More than 4 of the topics of interest	2.74	(0.74, 10.06)	.1215

p values from Pearson Chi square

*
p value from Fisher exact