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Social Determinants of Health and Periodontitis in Postmenopausal Women

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Abstract

Objectives: Identify the social determinants of health (SDH) factors associated with the prevalence of severe periodontal disease in postmenopausal women (PMW) and to compare periodontal parameters with demographic, lifestyle factors, anthropometric measurements and pre-existing diseases in the northeast region of Ohio.

Methods: Retrospective, cross-sectional study was conducted using the Case Cleveland Clinic Postmenopausal Wellness Consortium (CCCPWC), a database of over 900 PMW. The periodontal parameters median probing depth (MPD), number of loss teeth (TL), bleeding on probing (BOP) were collected from charts as endpoint measurements. Recession (MR) was likewise collected as a supporting metric.

Results: PMW with diabetes had significantly higher TL (13 vs 5; $p < 0.001$) and BOP (86.2% vs 59.2%; p=0.02); those with osteoporosis had significantly higher TL (10 vs 5; $p < 0.001$) and significantly higher BOP (80% vs 59.9%; p=0.005). MPD was greater in smokers (2 mm vs. 1 mm, $p < 0.001$). PMW using MSU had significantly higher TL (9 vs 4; $p < 0.001$) PMW and significantly higher BOP (35.1% vs 20.9%; p=0.003). TL was significantly higher High School Graduate/GED compared to greater than High School, (8 vs 5; p=0.014) PMW with less than High School had significantly higher BOP ($p < 0.001$). TL was higher in White compared to Mexican American/Other Hispanics (8 vs 5, respectively; $p < 0.001$).

Conclusion: Social determinants play a role in tooth loss and oral inflammation. Strategies to counterbalance social determinants which have an impact on oral health require further investigation and implementation.

Keywords: Social Determinants of Health; Periodontitis; Womens health

Introduction

The health related impact of social, environmental, and economic conditions is increasingly recognized. Although disease treatment is obviously important to wellbeing,it hinges on disease identification diagnosis, and risk assessment. Risk assessment relates to conditions, systemic and behavioral, which may be offshoots the social, environmental and economic conditions. Taken together, these are Social Determinants of Health (SDH). They exist within the frame of social, environmental and economic factors [1].

The relationship between SDH such as race, gender, class and education and wellness outcomes is a complex one. The effect of these determinants can be seen in several chronic conditions such as cardiovascular disease, diabetes and chronic obstructive pulmonary disease [2].

Periodontitis is also chronic condition. Additionally, clinical attachment loss and tooth loss, the most debilitating effect of periodontitis, are cumulative through the course of their chronicity. Furthermore, periodontitis shares risk factors with other chronic systemic conditions. For instance smoking is a risk factor for periodontitis, cardiovascular diseaseand rheumatoid arthritis though common biologic mechanisms [3-4]. Furthermore, high BMI is a risk for several major chronic diseases including Cardiovascular disease and diabetes which are associated with Periodontitis [5]. Likewise, resent research has suggested a relation between socioeconomics, hypertension and periodontal disease [6]. Even though studies have reported these relationships in the overall population, a recent workshop on oral disease prevention noted, based on available literature, there remains a need to assess high risk subgroups within the population [7].

One such group is older women. Although overall, women have lower incidence of periodontitis than men, postmenopausal women have long since been identified as having risk for periodontitis and tooth loss, little investigation exists on the relationship between social determinants of health and Periodontitis [8-10]. Although evidence shows that

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overall periodontitis has lower prevalence in females versus males, this is not identified in older populations [11].

Women represent a growing proportion of older people. Living longer means increasing disability associated with chronic conditions. Such conditions include diabetes, cardiovascular disease and osteoporosis which are known to disproportionately affect older women [12]. Periodontitis has been shown detrimental toquality of life within this cohort [13]. Similarly, messaging about health promoting versus health risk behaviors has been shown to reach those most excluded from health care most slowly. Older women have been shown to be socially vulnerable, particularly if they outlive their male counterpart, and have limited resources for health literacy [14].

Geospatial analysis is identified as an effective strategy for addressing health trends; in fact, it has been said that geospatial factors are a stronger predictor of a person's health than their genetic code. Perhaps this is why health promotion initiatives focus on neighborhoods with social, environmental and economic barriers [14].

The aim of this study is to identify SDH that significantly affect the prevalence of periodontal disease in postmenopausal women. For the purpose of this study, SDH is categorized into four domains: anthropometric measurements, socioeconomic variables, lifestyle factors, and pre-existing diseases.

Methods

Study design

This was an IRB approved retrospective cross-sectional study that included participant charts obtained from the Case Cleveland Clinic Postmenopausal Wellness Consortium (CCCPWC), a database of over 996 postmenopausal women (PMW). PMW with known clinical attachment levels were included and unknown medical and dental history were excluded from the study. Based on disease severity and risk level patients were divided into healthy and periodontitis groups based on method reported by Page and Martin [16].

Periodontal parameters

The periodontal parameters were taken from the dental charting and included: median probing depth (MPD), number of loss teeth (TL), bleeding on probing (BOP), and median recession (MR): below and above CEJ were recorded with a complete clinical and periodontal description of all the teeth, including third molars. MPD: measured from free gingival margin (FGM) to the sulcus base, MR: measured by the distance between the (FGM) and the cementoenamel junction (CEJ). MPD and MR were evaluated using a graduated periodontal probe at mid-facial and mesio-facial, respectively. MR (below CEJ) was given a positive value when the FGM was apical to the CEJ, and MR (above CEJ) was given a negative value when the FGM was coronal to the CEJ, indicating gingival hyperplasia. BOP was assessed during and recorded after MPD was measured, by the dichotomous index ("Yes"/ "No").

Using Bonferroni post-hoc test, TL was significantly higher in PMW with High School Graduate/GED compared to greater than High School, (8 vs 5; p=0.014), respectively. After adjusting the p-values using standardized residuals, 67.7% of PMW with less than High School had significantly higher BOP ($p < 0.001$).

According to the post-hoc test, TL was higher in White compared to Mexican American/Other Hispanics (8 vs 5, respectively; $p < 0.001$). In addition, MR-below CEJ was significantly greater in Black compared to White (1.5 mm vs 1.0 mm)

Socio-economic variables

Household income was categorized in four groups: < $20,000, $20,000 - < $55,000, and $55,000 and above. Education level was grouped in three levels: < High School, High School Graduate/GED, and > High School. Ethnicity/Race was classified in four categories: Black, Mexican American/Other Hispanic, White, and Other.

Anthropometric measurements

Body mass index (BMI) was calculated as weight (kilograms) divided by the square of height (centimeters). Fracture risk assessment tool (FRAX) score, took into account weight, height, previous fractures, rheumatoid arthritis, smoking habits, diabetes and other factors. It measures the 10-year probability of a major osteoporotic fracture (clinical spine, forearm, hip or shoulder fracture)

Factor	Total
Race/Ethnicity	996
White	340
Black	198
Hispanic	411
Other	47
Household Income	
< $20000	241
$20000- < $55000	375
> $55000	212
Education Level	
<HS	200
HS/GED	119
› HS	213
Current Smoker	
Yes	101
No	727
Average Alcohol Consumption	
1 unit/day	112
2-3 units/day	116
> 3 units/day	68
Multivitamin Supplement Use	
Yes	91
No	890
Diabetes	
Yes	148
No	848
Osteoporosis	
Yes	118
No	878

Table 1: Participant Demographics

Modifiable Lifestyle factors

Average Alcohol Consumption (ACC) was assessed as the average frequency of alcohol consumption per day and grouped as 1 unit/day, 2-3 units/day, and > 3 units/day. Both smoking and Multivitamin Supplement Use (MSU) was self-reported as a dichotomous variable ("Yes"/ "No").

Systemic conditions

Diabetes and secondary osteoporosis were reported as dichotomous variables ("Yes"/ "No") according to HbA1c levels and T- scores, respectively. HbA1c levels of 6.5 or above indicated type 2 diabetes. T-score of -1 was considered normal and T-score of -2.5 or less was considered osteoporotic.

Statistical Methods

Data are described descriptively, and by appropriate tables. Missing responses were excluded from the analysis. The magnitude of differences in social determinants of health with periodontal parameters was assessed with Mann-Whitney U, Pearson's Chi-square ($\chi 2$), and Krushkal-Wallis tests. Socio-demographic factors

Diabetes			
	Yes (n=148)	No (n=848)	*p-value*
	Median (Min- Max) or n (%)		
TL	13 (0-32)	5.0 (0-32)	U= -4.58p < 0.001
MPD (mm)	2.0 (1.0-2.0)	1.0 (0.5-4.0)	*U*= -0.01*ns*
MR- below CEJ (mm)	1.0 (0.0-2.0)	1.0 (0.0-2.5)	*U*=-0.31 *ns*
MR- above CEJ (mm)	-1.5 (-2.0 - (-1.5))	-2.0 (-5.0-(-0.5))	*U*= -0.05*ns*
BOP [b]			X2= 5.06 p=0.02
Yes	19 (86.2)	351 (59.2)	
No	4 (17.4)	242 (40.8)	
U-Mann Whitney U test; ns-not significant B Pearson's Chi-square test			
Osteoporosis			
	Yes (n=118)	No (n=878)	*p-value*
	Median (Min- Max) or n (%)		
TL	10 (0-32)	5.0 (0-32)	U= -4.84 p < 0.001
MPD (mm)	1.0 (1.0-4.0)	1.5 (0.5-4.0)	*U*= -0.39*ns*
MR- below CEJ (mm)	1.0 (0.0-2.5)	1.0 (0.0-2.0)	*U*= -1.70*ns*
MR- above CEJ (mm)	-3.0 (-3.0 - (-1.0))	-1.5 (-5.0-(-0.5))	*U*= -0.83*ns*
BOP [b]			X^2= 7.87 *p*=0.005
Yes	40 (80.0)	354 (59.9)	
No	10 (20.0)	237 (40.1)	
U-Mann Whitney U test; ns-not significant [b] Pearson's Chi-square test			

Table 2: Comparison of Periodontal Parameters with Risk Related Diseases

such as Race and Education were analyzed using repeated-measures Krushkal-Wallis, with the Bonferroni correction for post hoc comparison tests. Anthropometric variables were correlated with periodontal parameters using the Spearman's rho correlation. Descriptive statistics for all variables were conducted, including: median, min-max, and percentages. A significance level of alpha=0.05 was set for all tests ($p < 0.05$). Statistical analyses were performed using IBM SPSS v22 software (IBM Inc., Armonk, NY).

Results

Epidemiological analysis measuring the prevalence of PD in PMW was assessed for all 996 subjects. Patient demographics are shown (Table 1). The Shapiro-Wilk test showed that the data was not normally distributed.

PMW with diabetes had significantly higher TL (13 vs 5; $p < 0.001$) compare to non-diabetic subjects, respectively. PMW with diabetes had significantly higher BOP (86.2% vs 59.2%; p=0.02) compare to non-diabetic subjects, respectively. PMW with osteoporosis had significantly higher TL (10 vs 5; $p < 0.001$) compare to non-osteoporotic subjects, respectively. PMW with osteoporosis had significantly higher BOP (80% vs 59.9%; p=0.005) compared to non-osteoporotic subjects, respectively (Table 2).

MPD was greater in smokers than in non-smokers (2 mm vs. 1 mm, $p < 0.001$). 532 total participants shared their income. PMW with MSU had significantly higher TL (9 vs 4; $p < 0.001$) compare to non MSU users, respectively. PMW with MSU had significantly higher BOP (35.1% vs 20.9%; p=0.003) compare to non MSU users, respectively (Table 3).

Using Bonferroni post-hoc test, TL was significantly higher in PMW with High School Graduate/GED compared to greater than High School, (8 vs 5; p=0.014), respectively. After adjusting the p-values

Smoking			
	Yes (n=101)	No (n=727)	*p-value*
	Median (Min- Max) or n (%)		
TL	4 (0-32)	6 (0-32)	U= -1.77ns
MPD (mm)	2.0 (1.0-4.0)	1.0 (0.5-4.0)	U= -3.64 p < 0.001
MR- below CEJ (mm)	1.0 (0.0-2.0)	1.0 (0.0-2.5)	U= -1.26 ns
MR- above CEJ (mm)	-1.5 (-3.0 – (-1.0))	-1.8 (-5.0 – (-0.5))	U= -0.30ns
BOP [b]			X^2= 0.12 ns
Yes	52 (59.8)	342 (61.7)	
No	35 (40.2)	212 (38.3)	
U-Mann Whitney U test; *ns*-not significant [b] Pearson's Chi-square test			
Average Alcohol Consumption			
	1 unit/day (n=112)	2-3 units/day (n=116)	> 3 units/day (n=68)
	Median (Min- Max) or n (%)		
TL	8 (0 - 32)	7 (0 - 32)	7 (0 - 32)
MPD (mm)	1.5 (1.0 – 3.0)	2.0 (1.0 - 3.0)	1.0 (1.0 - 3.0)
MR- below CEJ (mm)	1.0 (0.0-2.0)	1.0 (0.0 - 2.0)	1.0 (1.0 - 2.0)
MR- above CEJ (mm)	-2.0 (-2.0 – (-2.0))	-1.5 (-2.5 – (-1.0))	-2.0 (-5.0 – (-1.0))
BOP [b]			
Yes	34 (50.7)	45 (56.2)	28 (51.9)
No	33 (49.3)	35 (43.8)	26 (48.1)
U-Mann Whitney U test; *ns*-not significant [b] Pearson's Chi-square test			
Multivitamin Supplement Use			
	Yes (n=91)	No (n=890)	p-value
	Median (Min- Max) or n (%)		
TL	9 (0-32)	4 (0-32)	U= -6.5 < 0.001
MPD (mm)	2.0 (1.0-4.0)	1.0 (0.5-4.0)	U = -1.3 ns
MR- below CEJ (mm)	1.0 (0.0-2.5)	1.0 (0.0-2.0)	U= -1.4 ns
MR- above CEJ (mm)	-2.0 (-4.0 – (-1.0))	-1.5 (-5.0 – (-0.5))	U= -1. ns
BOP [b]			X^2= 9.40.003
Yes	65 (35.1)	39 (20.9)	
No	120 (64.9)	148 (79.1)	
U-Mann Whitney U test; *ns*-not significant [b] Pearson's Chi-square test			

Table 3: Comparison of Periodontal Parameters in PMW with Lifestyle Factors

using standardized residuals, 67.7% of PMW with less than High School had significantly higher BOP ($p < 0.001$) (Tables 4.1 and 4.2).

According to the post-hoc test, TL was higher in White compared to Mexican American/Other Hispanics (8 vs 5, respectively; $p < 0.001$). In addition, MR-below CEJ was significantly greater in Black compared to White (1.5 mm vs 1.0 mm) (Table 5).

Spearman's rho correlations between BMI, and FRAX score with periodontal parameters showed a positive correlation between FRAX score and TL, and BOP (r=0.427; $p < 0.001$ and r=0.095; $p < 0.023$,) respectively. However, a strong negative correlation was found between FRAX score and MR, below CEJ, (r=-0.385; $p < 0.001$. Regarding BMI, the study showed that there was a negative correlation between BMI and TL (r=-0.148; $p < 0.001$).

Education				
	<High School (n=200)	High School Graduate/GED (n=119)	> High School (n=213)	*p-value*
	Median (Min- Max) or n (%)			
TL	7 (0-32)	8 (0-32)	5 (0-32)	X2 =8.57 p=0.014
MPD (mm)	2.0 (0.5-4.0)	2.0 (1.0-4.0)	1.0 (1.0-3.0)	X^2=5.65ns
MR- below CEJ (mm)	1.0 (0.0-2.5)	1.0 (0.0-2.0)	1.0 (0.0-2.0)	X^2=1.11ns
MR- above CEJ (mm)	-2.0 (-5.0 – (-1.0)	-1.5 (-3.0 – (-0.5))	-1.0 (-3.0 - (-1.0))	X^2=2.78ns
BOP [b]				X^2 =18.32 p < 0.001
Yes	86 (67.7)*	54 (72)	64 (46.4)	
No	41 (32.3)*	21 (28)	74 (53.6)	
	< $20,000 (n=241)	**$20,000 - < $55,000 (n=375)**	**>$55,000 and above (n=212)**	***p-value***
	Median (Min- Max) or n (%)			
TL	5 (0-32)	6 (0-32)	6 (0-32)	X^2= 0.77 ns
MPD (mm)	1.0 (1.0-3.0)	1.5 (0.5-4.0)	2.0 (1.0 - 4.0)	X^2= 0.69 ns
MR- below CEJ (mm)	1.0 (0.0-2.0)	1.0 (0.0- 2.5)	1.0 (0.0-2.0)	X^2= 2.86 ns
MR- above CEJ (mm)	-3.0 (-4.0 - (-1.5))	-2.0 (-3.0 - (-1.0))	-1.0 (-1.50 - (-0.5))	X^2= 5.83 ns
BOP [b]				X^2= 3.82 ns
Yes	75 (55.1)	147 (61.8)	97 (66.4)	
No	97 (66.4)	91 (38.2)	49 (33.6)	

X^2-Kruskal-Wallis test; ns-not significant
[B] Pearson's Chi-square test
X^2- Kruskal-Wallis test;ns-not significant
[a]Adjustment for multiple comparisons (Bonferroni): 0: < High School; 1: High School Graduate/GED; 2: >High School
[b]Pearson's Chi-square test
*indicates significant adjusted standardized residuals

Table 4.1: Comparison of Periodontal Parameters in PMW with Socioeconomic Status

	<$20,000 (n=241)	$20,000 - <$55,000(n=375)	>$55,000 and above (n=212)	*p-value*
	Median (Min- Max) or n (%)			
TL	5 (0-32)	6 (0-32)	7 (0-32)	X^2= 0.77 ns
MPD (mm)	1.0 (1.0-3.0)	1.5 (0.5-4.0)	2.0 (1.0 - 4.0)	X^2= 0.69ns
MR- below CEJ (mm)	1.0 (0.0-2.0)	1.0 (0.0- 2.5)	1.0 (0.0-2.0)	X^2= 2.86 ns
MR- above CEJ (mm)	-3.0 (-4.0 - (-1.5))	-2.0 (-3.0 - (-1.0))	-1.0 (-1.50 - (-0.5))	X^2= 5.83ns
BOP [b]				X^2=3.82ns
Yes	75 (55.1)	147 (61.8)	97 (66.4)	
No	61 (44.9)	91 (38.2)	49 (33.6)	

X^2-Kruskal-Wallis test; *ns*-not significant
[b] Pearson's Chi-square test

Table 4.2: Household Income

Discussion

Previous studies have demonstrated social determinants of periodontitis, and that postmenopausal women are at risk for periodontitis and tooth loss, but this study describes the contributions of anthropomorphic, socioeconomic, lifestyle, and related diseases.

Our results support the assertion, which is true for the population at large, that diabetes is a risk for periodontitis. Participants with diabetes had significantly higher greater inflammation scores and more missing teeth [17].

Evidence from several studies indicates that obesity and weight gain are associated with morbidity and mortality in the United States [18].

Because of broad impacts on behavior, diet, lifestyle, effects of social determinants are a known challenge to health. In 1964 a National Urban League report first highlighted the relationship between health and wealth which was more pronounced in older adults of color for many reasons of which two are diet and exercise lifestyle [19]. But today, it remains to be investigated whether these directly effect the risk of chronic diseases such as periodontitis or effect the risk through indirect means such as through insulin regulation.

Strategies to prevent underlying diabetes suggest the need for stronger emphasis on weight control before midlife and prior to the transition of life experiencing menopause. It has been suggested that such early strategies promoting active lifestyle through transition to menopause may have benefits in multiple chronic conditions [20].

Our results also follow the assertion that periodontitis is worse in smokers [21]. Periodontitis in smokers is well researched. In 1968 it was reported that women between aged 20-39 reportedly have approximately twice the chance of periodontitis or tooth loss versus non-smokers [22]. Our findings in women currently in middle to elderly age groups underscore the consistency in the same demographic over a period of 50 years. What is most important about this consistency is that smoking is modifiable. Strategies to support cessation are likely to impact periodontitis in women of younger and older ages.

Systematic reviews show there is an association between low

	Black (n=198)	Mexican American/Other Hispanic (n=411)	White (n=340)	Other (n=47)	*p-value*	Post Hoc Test[a]
	Median (Min- Max) or n (%)					
TL	6 (0-32)	5 (0-32)	8 (0-32)	5 (1-32)	X^2= 18.05p<0.001	2 > 1
MPD (mm)	2.0 (1.0-4.0)	1.5 (0.5-4.0)	1.0 (1.0-3.0)	2.0 (1.0-3.0)	X^2= 6.38*ns*	
MR- below CEJ (mm)	1.5 (0.0-2.0)	1.0 (0.0-2.0)	1.0 (0.0-2.0)	1.0 (0.0-2.5)	X^2= 10.63p= 0.014	0 > 2
MR- above CEJ (mm)	-1.5 (-5.0 – (-1.0)	-1.8 (-3.0 – (-1.0))	-1.0 (-3.0-(-0.5))	-4.0 (-4.0-(-4.0))	X^2= 3.18*ns*	
BOP [b]					X^2=0.66*ns*	
Yes	85 (62.5)	170 (62.7)	120 (59.4)	19 (59.4)		
No	51 (37.5)	101 (37.3)	82 (40.6)	13 (40.6)		

X^2- Kruskal-Wallis test; ns-not significant

[a] **Adjustment for multiple comparisons (Bonferroni):** 0: Black; 1: Mexican American/Other Hispanic; 2: White; 3: Other

[b] Pearson's Chi-square test

Table 5: Ethnicity/Race

socio-economic status and higher prevalence of periodontics [23]. Likewise the results of the current study showed that participants with education limited to high school or GED had more missing teeth and more periodontal inflammation. Our finding that tooth loss was higher in high school graduates/GED holders points to a potential of more dentists visits within this group, since missing a tooth is a signal that a dentist visit took place. Similarly, TL was greater in whites than other racial groups. It has been reported that whites have greater utilization of dental care than other groups [24].

Such disparity in utilization may support language support programs and increase diversity of dental professionals among minorities to encourage their visits. This and other interventions are required to counterbalance health and socioeconomic inequalities that restrict sections of the pop from enjoying meaning full and satisfying lives in older age. This is especially true to protect against the adverse effects of lower socioeconomic status [25].

Conclusion

Despite racial and ethnic differences in periodontitis incidence among postmenopausal women, some variability can be attributed to social determinants. Some of these are under the patient's own control, such as smoking, healthy diet and active life style. Others such as education, income, diseases such as osteoporosis, high BMI, high FRAX risk are only partially under the patient's control. Risk reduction strategies can be applied to all groups to affect periodontitis and its endpoint, tooth loss.

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