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Periodontal disease and risk of psoriasis among nurses in the United States

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Abstract

Objective—Periodontal disease has been associated with systemic inflammation and may be a risk factor for autoimmune diseases. We evaluated the association between periodontal disease and the risk of incident psoriasis in a large prospective cohort study.

Material and methods—Self-reported history of periodontal bone loss, from 1998 to 2008, was evaluated as a risk factor for incident psoriasis among 60,457 women in the Nurses' Health Study. Secondary analyses examined associations between history of tooth loss and number of natural teeth and psoriasis risk. Cox proportional hazards models were used to assess multivariate estimates, adjusting for age, cigarette smoking, body mass index, alcohol intake and physical activity.

Results—We observed an increased multivariate risk of psoriasis for those with mild periodontal bone loss (RR 1.35, 95% CI: 1.03-1.75) and moderate to severe periodontal bone loss (RR 1.49, 95% CI: 1.08-2.05), as compared to those without periodontal bone loss, after adjusting for age, cigarette smoking, body mass index, alcohol intake, physical activity, and tooth loss. Number of natural teeth and tooth loss were not associated with risk of psoriasis in our study.

Conclusion—A history of periodontal bone loss may increase risk of subsequent psoriasis.

Keywords

Periodontal disease; psoriasis; number of teeth

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Introduction

Psoriasis is a chronic inflammatory disease, affecting 1-3% of the population [1]. Potential triggers for psoriasis include infections [2], medications, and stress [3]. Important risk factors for psoriasis are smoking, high body mass index [4,5,6] high alcohol intake [7], and low physical activity [8]. Psoriasis has no gender predisposition [1].

Periodontal disease affects 30%–35% of dentate US adults [9,10]. It represents an inflammatory response to polymicrobial colonization in the dental plaque [11]. Periodontal disease can be associated with a systemic response, increasing levels of inflammatory markers such as C-reactive protein and peripheral leukocyte counts [12]. Important risk factors for periodontal disease include older age, male gender, smoking, and diabetes [13,14].

Both psoriasis and periodontal disease involve an exaggerated immune response in epithelial surfaces and a dysregulation of the host inflammatory response [3,15,16]. A recent case-control study found that those with psoriasis had a significantly lower radiographic bone level ($p < 0.001$) and a significantly higher number of missing teeth ($p < 0.001$), compared to their age- and gender-matched controls [3]. Also, there have been case reports that describe psoriasis exacerbation accompanying increased periodontitis [17], and regression of palmoplantar pustulosis (PPP) after periodontitis treatment with topical antibiotics, tooth extraction, and shaping of alveolar bone [18,19]. There are no previous prospective studies evaluating the association between periodontal disease and psoriasis.

In this study, we hypothesized that those with periodontal disease, as measured by history of periodontal bone loss, are at greater risk for subsequent psoriasis, in a large cohort of US nurses. We also hypothesized that those with a history of tooth loss and a lower number of natural teeth are at greater risk of incident psoriasis.

Material and methods

Study design

This is a prospective cohort study of female nurses, in the setting of the Nurses' Health Study (NHS). The Nurses' Health Study (NHS), established in 1976, is a prospective cohort of 121,700 female nurses, aged 30–55 years, living in 11 states in the United States. The cohort is followed up with biennial questionnaires that ask about medical history and lifestyle factors. The follow-up rate through 2008 as a percentage of total possible person-years was 95.5% [20]. The main exposure in our study was self-reported periodontal bone loss in 1998 and the outcome was incident self-reported physician-diagnosed psoriasis through 2008. The research question for studying the association between periodontal disease and psoriasis risk, from 1998 to 2008, was determined *a priori*.

A total of 60,457 women (mean age 64 years) in the NHS self-reported on whether they had a history of periodontal bone loss in 1998 and were free of psoriasis at that time. Also, 60,320 and 60,709 reported on their number of natural teeth and tooth loss, respectively, in

1992 and were without psoriasis then. We excluded those with psoriasis at the time when dental measures were obtained, so that incident psoriasis may be measured.

Data collection

In 2008, participants self-reported physician-diagnosed psoriasis for the following time periods: 1997 or before, 1998-2001, 2002-2005, 2006-2007, or 2008 and after. While self-reported psoriasis was not confirmed in the NHS cohort, it was validated in a similar cohort, the NHS II. A subset of participants from the NHS II were asked to complete the Psoriasis Screening Tool (PST), a one-page self-administered psoriasis screen with a 99% sensitivity and 94% specificity when assessed in a dermatology clinic [21]. Of those who reported incident psoriasis, 86% were confirmed to have psoriasis by the PST [7].

All exposure information was obtained by self-report from mailed questionnaires administered every 2 years. On the 1998 questionnaire, participants reported if they had a history of periodontal bone loss, and whether bone loss was mild or moderate to severe. Since self-reported history of periodontal bone loss has previously been found to be a valid measure for periodontal disease, among health professionals, it was used as a proxy for periodontal disease in this study [22]. Also, participants reported how many natural teeth they had, in the categories 0-10, 11-16, 17-24, or 25 or more, as well as whether they had any tooth loss in the last 2 years on the 1992 questionnaire. History of tooth loss in the last 2 years was also asked in 1996 and in the last 4 years was asked in 2000.

Date of birth and height were reported on the 1976 questionnaire. On the biennial mailed questionnaires, participants reported their current weight; smoking status and cigarettes per day. Alcohol intake was calculated in grams per day from the food frequency questionnaire, and physical activity was calculated in metabolic equivalents per week from recreational and leisure time activities. Previously, the accuracy of self-reported anthropometric measures was validated among 140 NHS participants. Self-reported and measured weights were highly correlated (r =0.97) [23]. Of note, diabetes was not used as a covariate because while psoriasis has been shown to be a risk factor for diabetes [24], the reverse has not been shown.

Statistical analysis

Age-standardized characteristics of the study population were calculated within categories of history of periodontal bone loss. Person-years of follow-up were accrued from 1998 for periodontal bone loss analyses and 1992 for the number of natural teeth and tooth loss analyses, up to 2008.

For analyses on the association between psoriasis and periodontal bone loss, participants were excluded if they had a diagnosis of psoriasis prior to the baseline of 1998. Therefore, those who reported that their diagnosis of psoriasis was prior to1997 or in the 1998 to 2001 time period were excluded from these analyses (to avoid reverse causation). For analyses with independent variables number of natural teeth and tooth loss, both first collected in 1992, those who reported a diagnosis of psoriasis in the range prior to 1997 were excluded. Tooth loss data was also collected in 1996 and 2000, and this variable was updated by data from these years in the analysis.

We used Cox proportional hazards regression models to estimate the age-adjusted and multivariate relative risk (RR) of incident psoriasis in women who reported periodontal bone loss, compared to those who did not. Similar analyses were conducted for the association between history of tooth loss and number of natural teeth, with psoriasis incidence. We categorized alcohol intake into the following 6 categories: none, 1 to 4 g/day, 5 to 9 g/day, 10 to 14 g/day, 15 to 29 g/day, and 30 g/day or more. BMI (calculated as weight in kilograms divided by height in meters squared) was categorized into the following 9 categories: lower than 21, 21-22.9, 23-24.9, 25-26.9, 27.0-29.9, 30.0-32.9, 33-34.9, and 35-39.9, and 40 or more kg/m^2. Smoking was categorized as: never, past, 1-14, 15-24 or 25 or more cigarettes per day. Smoking was also categorized into pack-years (analyses not shown). Physical activity was categorized into quintiles. Number of natural teeth was categorized into 0-24 and 25-32, to differentiate between those with all their teeth or most of their teeth and the rest, as much as possible given the constraints of the way data was collected (see data collection section above). Of note, for analyses where number of natural teeth was the exposure, all categorizations, including quartiles into 0-10, 11-16, 17-22, and 25 or more, were attempted for studying its association with psoriasis (data not shown). This variable was also used as a potential confounder for analyses with exposures history of periodontal bone loss. Periodontal bone loss was categorized as none, mild, or moderate to severe and was adjusted for in some of the models evaluating the association between psoriasis and number of teeth and tooth loss.

History of periodontal bone loss, tooth loss, and number of natural teeth were tested for interaction with age (<60, 60 years or more), smoking (never, ever), alcohol intake (non-drinkers, drinkers), BMI (<30, $30kg/m^2$ or more), and physical activity (10 or less, >10 mets-hrs/week), using the likelihood ratio test. For all RRs, we calculated 95% CI's and 2 sided P values. Statistical analyses were performed using SAS software, version 9.1 (SAS Institute Inc, Cary, North Carolina). The Institutional Review Board of Partners Health Care System approved this study.

Results

The characteristics of the NHS participants in 2000 are shown in Table I, within categories of history of periodontal bone loss. Participants with periodontal disease were more likely to smoke and have higher alcohol consumption. Among those with periodontal bone loss, the age-adjusted relative risk (RR) of developing psoriasis was 1.47 (95% CI 1.19, 1.82), when compared to those without periodontal bone loss (Table II). After adjusting for age, BMI, smoking status and intensity, alcohol intake, physical activity, and number of teeth, this association was preserved, with a RR of 1.40 (95% CI 1.13, 1.73). In addition, there was a dose-response, with a multivariate-adjusted RR of 1.35 (95%CI 1.03, 1.75) among those with mild periodontal bone loss, and a multivariate-adjusted RR of 1.49 (95%CI 1.08, 2.05) for those with moderate to severe periodontal bone loss, when compared to those without periodontal bone loss. Participants with fewer natural teeth and those with tooth loss were not at greater risk of psoriasis in our study, before or after adjusting for age, bmi, smoking status and intensity, alcohol intake, physical activity, and periodontal bone loss (Table III). Also, when periodontal bone loss was excluded from the multivariate analyses for the association between psoriasis and number of teeth and tooth loss, there was also no

statistical significant association, RR 1.03 (95% CI 0.81,1.31) and RR 0.99 (95% CI 0.85,1.16), respectively. When number of natural teeth was categorized in other ways, an association was also not found with psoriasis (data not shown). Of note, when smoking was placed as a continuous variable using pack-years in all the models above for all exposures, there was little to no change in the associations.

We found a significant interaction between periodontal bone loss and alcohol intake, for risk of psoriasis. Among non-drinkers, those with periodontal bone loss had an increased multivariate-adjusted risk of psoriasis, RR of 1.87 (95%CI 1.34, 2.60), whereas drinkers did not, RR of 1.07 (95% CI 0.79,1.45), p for interaction was 0.02.

Comment

This prospective study showed that women with periodontal disease, as measured by self-reported periodontal bone loss, may have a higher risk of developing psoriasis, even after adjustment for age, BMI, alcohol intake, physical activity, smoking status, and number of natural teeth.

The link between periodontal disease and psoriasis has been previously demonstrated with a case-control from Norway that reviewed the dental bite-wing X-rays of 155 patients with psoriasis and their age- and gender-matched controls. The study showed that those with psoriasis had significantly lower radiographic bone level, as compared to their age- and gender-matched controls (78% vs. 17%, $p < 0.001$) [3]. Another more recent case-control study from Sweden, found that those with mild to moderate plaque psoriasis (89 patients) had lower radiographic alveolar bone level compared to non-psoriatics (54m patients), but after controlling for gender the association was no longer significant [25]. Interestingly, the association remained significant for males, but not females. It is possible that their study was not powered enough to detect an association after controlling for gender. Therefore, since our study only had females, it is possible that if our population included men a greater association between periodontal bone loss and psoriasis would have been found.

Infections are a well known trigger for psoriasis, for example Streptococcus pyogenes commonly triggers guttate psoriasis, as well as other types of psoriasis [2]. Therefore, future research on the association between periodontal disease and psoriasis may benefit from differentiating types of psoriasis when measuring the study outcome. Another condition that shares features with psoriasis and involves immune dysfunction, reactive arthritis (previously known as Reiter's disease), has also been associated with infectious triggers [26]. Therefore, it possible that periodontal disease provides a similar infectious burden and acts as a trigger or risk factor for psoriasis.

The mechanism by which periodontal disease may lead to greater risk of psoriasis remains uncertain. Periodontal disease involves a bacterial infection with a range of gram negative bacteria that invade superficial and deep ginigival tissues [27]. These microbes and their products may stimulate the psoriasis pathway directly or through a systemic inflammatory response. This may involve the proinflammatory cytokine IL 17, which has been found to be elevated in both psoriatic skin [28] and the gums of patients with chronic periodontitis [29]. Another proposed mechanism by Preus et al. (2010) is that the innate immune system, which

has been found to be important in the pathogenesis of both psoriasis and periodontal disease [30,31], may affect inflammatory components such as dendritic cells and Toll-like receptor (TLR) expression, predisposing patients to both psoriasis and periodontal disease. This is based on studies that demonstrated an upregulation of TLR-2 in psoriatic skin [28] and in the periodontium of patients with periodontitis [32], as well as studies in the Yaa mouse model that showed an increase in TLR genes can induce autoimmunity [33]. Also, a study by Ishihara et al. (2000) found that the IgG levels against bacterial heat shock proteins (HSP) in PPP patients were significantly higher than in controls, suggesting that some HSP found in oral bacteria may induce some of the causative factors of PPP [34]. Another study on PPP patients found that those who had tonsillectomies or dental treatments had significant improvement in skin lesions, and their tonsils showed increased expression of a co-stimulatory receptor on activated t-cells, inducible co-stimulator, when compared to tonsils of controls [19]. The authors suggest that activation of T-cells via this co-stimulatory receptor, in focal infections, may trigger proinflammatory cytokines and chemokines that stimulate dendritic and Langerhan cells in skin, leading to activation of inflammatory pathways and the migration of T-cells in the skin of patients with PPP. It is possible that a similar mechanism is involved in the link between periodontal disease and other kinds of psoriasis.

Because little is known about the mechanism of the association between periodontal measures and risk of psoriasis, the significant interaction we found between periodontal bone loss and less alcohol intake for risk of psoriasis is difficult to interpret. It is possible that increased alcohol intake changes the periodontal disease microflora or inflammatory response in such a way that periodontal disease becomes less of a risk factor for psoriasis.

In our study, we did not find that those with fewer teeth (0-24 vs. 25-32) or history of tooth loss were at greater risk of psoriasis. In the case-control study by Preus et al. (2010), those with psoriasis had a higher number of missing teeth when compared to their age- and gender-matched controls (51% vs. 26%, $p < 0.001$) [3]. However they did not adjust for other confounders such as alcohol and smoking. Another more recent case-control study by Fadel et al. also found a significant difference between the mean number of remaining teeth in psoriatic and non-psoriatic patients (24 vs. 26, respectively) [25]. Our results in the context of those by Preus et al. and Fadel et al., suggest that while having fewer teeth may be associated with psoriasis, it is possible that it does no precede it, as we did not find an association between fewer teeth and subsequent risk of psoriasis. Since the most common reason for tooth extraction in older adults is periodontal disease [20], removing a tooth may indicate elimination of the oral infection and inflammation as well as the risk of subsequent psoriasis. Still, it is also possible that an association with psoriasis may have been detected if we had continuous data on the exposure number of natural teeth.

One of the main limitations of our study is that our dental measures were not validated in our population. Past literature on the validity of self-reported dental measures reveal mixed results [35-37]. Fortunately, there are a few validity studies on questions that specifically inquire about periodontal bone loss. A study by Joshipura et al. (2002), using a cohort of health professionals (veterinarians, optometrists, osteopaths, pharmacists and podiatrist), found that self reported periodontal bone loss had a positive predictive value (PPV) of 83%

and a negative predictive value (NPV) of 69% for periodontal disease, when compared to measured alveolar bone loss [22]. A study by Pitiphat et al. (2002) found that when adult men from the Veterans Affairs Longitudinal Study, aged 51-86, were asked in a telephone interview if they were told by a dentist that they have periodontal disease or gum disease with bone loss, the sensitivity and specificity of their answers was 32.7% and 90.7%, respectively, as compared to radiographic alveolar bone loss [39]. The same paper also reported that when first-time patients, at the Harvard School of Dental Medicine student clinic, responded to a self-administered questionnaire asking if they have periodontal disease or gum disease with bone loss, their answers had a sensitivity of 39.3% and specificity of 100%, as compared to clinical and radiographic exams. These responders were also asked to classify the severity of their periodontal disease or gum disease with bone loss, and their answers showed an r of only 0.56 [39]. Therefore, it appears that questions that include inquiry about periodontal bone loss may have low sensitivity but high specificity and participants cannot accurately diagnose their exact severity. Pitiphat et al. (2002) also found a strong correlation between self-reported and clinically assessed number of teeth, among first time patients to a dental clinic (r=0.74-1.0) [39]. While previous literature on the validity of these dental measures is helpful, it cannot substitute for validating these measures in our population and thus we acknowledge that our results must be considered in this context.

Similar to other epidemiological studies of psoriasis [40-43], we did not confirm the nurses' self-reported physician diagnosis of psoriasis clinically with an examination by a dermatologist. Previous validation studies in the NHS II for another skin condition gave 92% confirmation rate among responders [44,45]. While we expect the overall accuracy of self-reported physician diagnosis of psoriasis to be high among registered nurses, the corresponding accuracy against a dermatologist's examination is not available. Confirming our results using more specific case definitions of psoriasis and evaluating for various psoriasis subtypes, severity, and treatment effects would be valuable.

Since our study was predominantly restricted to white women, we cannot generalize these results to men or other racial groups. Given that our study was observational, it is susceptible to residual confounding, so that there may have been unmeasured factors that contributed to the observed associations. Also, misclassification of the exposure and outcome measures may have biased our associations toward the null, so that the actual associations may be larger. We did not control for surveillance bias, with information on who recently saw a dentist and could more accurately report on their periodontal health, as this was not available.

A major strength of the study is that the research question was determined *a priori,* and it represents the first cohort study conducted on this association. Data on periodontal disease was collected prior to onset of psoriasis, so that temporality could be established for the association between periodontal bone loss and incident psoriasis. Also, the association shows a dose-response and is biologically plausible, given previously known relationships between infectious triggers and diseases of immune dysregulation or autoimmunity [2,26]. Additionally, detailed information was collected on confounders, including BMI, smoking status, alcohol intake, and physical activity, prior to onset of psoriasis.

In conclusion, our prospective study found that women with periodontal disease, as measured by periodontal bone loss, have an increased risk of incident psoriasis. We did not find an association between history of tooth loss or number of teeth and risk of psoriasis. The former finding suggests that periodontal disease may be a risk factor for psoriasis. Further research is needed to better understand the mechanisms underlying this association and to explore whether periodontal disease therapy can reduce the risk for psoriasis. Providers caring for patients at risk for psoriasis may consider promoting healthy dentition.

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Table I

The age-adjusted characteristics of women in the NHS, categorized by reported periodontal bone loss in 1998

	Periodontal bone loss	
	No (n=70,020)	**Yes (n=11,358)**
Age, year	64.6(7.2)	64.7(6.9)
Body mass index, kg/m^2	26.7(5.3)	26.2(5.1)
Alcohol, g/day	4.8(8.9)	6.0(10.1)
Physical Activity, MET-hrs/week	17.1(21.4)	17.4(21.1)
Pack-years, among ever smokers	23.9(21.2)	30.3(22.3)
Current smokers, %	9	17
No of teeth (25-32), %	57	49
Tooth loss, %	24	42

Table II

Relative risks of psoriasis by reported history of oral conditions

	Cases	Person-years	Age-adjusted RR (95%CI)	P-value	Multivariate* RR (95%CI)	P-value
Periodontal bone loss						
No	447	639,651	1.00		1.00	
Yes	107	103,370	1.47 (1.19-1.82)	0.0003	1.40 (1.13-1.73)	0.002
Periodontal bone loss severity						
Mild	65	65,051	1.40 (1.08-1.82)	0.01	1.35 (1.03-1.75)	0.03
Moderate-severe	42	38,319	1.60 (1.16-2.20)	0.004	1.49 (1.08-2.05)	0.016

*Adjusted for age, bmi (<21, 21-22.9, 23-24.9, 25-26.9, 27.0-29.9, 30.0-32.9, 33-34.9, and 35-39.9, and 40 or more k/m^2), smoking status/intensity (as never, past, current 1-14,15-24 or 25 or more cigarettes per day), alcohol intake (none, 1-4, 5-9, 10-14, 15-29, 30 or more grams per day), and physical activity (met-hours/week, grouped in quintiles), and number of teeth(0-24,25-32).

Table III

Relative risks of psoriasis by reported history of number of teeth and tooth loss.

	Cases	Person-years	Age-adjusted RR (95%CI)	P-value	Multivariate* RR (95%CI)	P-value
Number of teeth						
25-32	499	791,234	1.00		1.00	
0-24	271	478,716	1.06 (0.84-1.34)	0.63	1.03 (0.81-1.31)	0.82
Tooth loss						
None	525	927,175	1.00		1.00	
1 or more	280	381,339	0.99 (0.79-1.23)	0.91	0.96 (0.76-1.22)	0.76

*Adjusted for age, bmi (<21, 21-22.9, 23-24.9, 25-26.9, 27.0-29.9, 30.0-32.9, 33-34.9, and 35-39.9, and 40 or more k/m^2), smoking status/intensity (as never, past, current 1-14,15-24 or 25 or more cigarettes per day), alcohol intake (none, 1-4, 5-9, 10-14, 15-29, 30 or more grams per day), physical activity (met-hours/week, grouped in quintiles), and periodontal bone loss (as none, mild, or moderate to severe).