



Oral Health in Patients with Psoriasis—A Prospective Study

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Psoriasis is associated with periodontitis, a chronic inflammation of the gingival tissue. However, data about periodontal and dental status of psoriasis patients are sparse. Therefore, we conducted a prospective study comparing psoriasis patients with control individuals. 100 psoriasis patients presenting at the outpatient service of a specialized psoriasis center and 101 nonpsoriatic control individuals were included in the study. Oral health was assessed with standardized measures including Bleeding on Probing, Community Periodontal Index, and dental parameters according to the DMFT index (a cumulative index in which teeth [T] are registered as decayed [D], missing [M], and filled [F]). For analysis, a postmatching strategy was applied with 53 pairs of psoriasis patients and nonpsoriatic individuals in which relevant factors with possible impact on oral health status were considered. Logistic regression analyses were executed on the entire psoriasis and control population. According to the results, the matched psoriasis group had significantly higher values on Bleeding on Probing and the Community Periodontal Index compared with matched control individuals. Logistic regression analyses identified significant correlations of the psoriasis group with high Bleeding on Probing and Community Periodontal Index values but not, however, with missing teeth. Psoriasis patients had significantly higher values for parameters addressing periodontal inflammation. Psoriasis management should, therefore, include regular dental checks on periodontal status and respective treatment where required.

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INTRODUCTION

Psoriasis is a lifelong chronic illness for which there is no cure. Apart from a genetic predisposition in a number of patients, trigger factors play an important role for first disease manifestation and subsequent flares. Periodontitis is a chronic inflammation of the gingival crevice. The relationship between psoriasis and periodontitis has already been subject of several studies. Some of these are retrospective cohort studies (Egeberg et al., 2017; Keller and Lin, 2012; Su et al., 2017), others are prospective case-control studies (Antal et al., 2014; Fadel et al., 2013; Ganzetti et al., 2015; Lazaridou et al., 2013; Preus et al., 2010; Sharma et al., 2015; Skudutyte-Rysstad et al., 2014), and one article is a systematic review and meta-analysis (Ungprasert et al., 2016).

Most published articles on the relationship between psoriasis and periodontitis describe a significant association between both diseases (Antal et al., 2014; Egeberg et al., 2017; Keller and Lin, 2012; Lazaridou et al., 2013; Preus et al., 2010; Sharma et al., 2015; Skudutyte-Rysstad et al., 2014; Ungprasert et al., 2016). In a case-control study, Ganzetti

et al. (2015) reported a higher prevalence of gingivitis and periodontitis in patients with psoriasis compared with control individuals, but without quoting the statistical significance. Fadel et al. (2013) and Su et al. (2017) observed a positive association between psoriasis and periodontitis without reaching the significance threshold.

Only a few studies investigating dental parameters showed a significantly higher number of missing teeth in patients with psoriasis compared with control groups (Fadel et al., 2013; Preus et al., 2010; Sharma et al., 2015; Skudutyte-Rysstad et al., 2014). Very limited data are available on the number of decayed and filled teeth, showing no differences between psoriasis patients and control individuals (Fadel et al., 2013).

The data on oral health parameters for psoriasis patients are not yet consistent and exhaustive. To enlarge the data basis for periodontal and dental health in psoriasis patients, we aimed to get a comprehensive oral status of a group of psoriasis patients (Pso) compared with a control group of individuals without psoriasis (nPso) in a prospective fashion.

RESULTS

For the case group, 100 patients with plaque psoriasis with a mean age \pm standard deviation (SD) of 47.4 ± 14.7 years (range = 19–79 years) were recruited, and for the control group, 101 nonpsoriatic individuals with a mean age \pm SD of 46.9 ± 16.8 years (range = 18–86 years) ($P = 0.61$). See Table 1 for further descriptive details of case and control groups.

A Psoriasis Area and Severity Index of less than 10 was present in 96% of the Pso group, and 4% had a Psoriasis Area and Severity Index greater than 10. In 9% of the Pso group, no psoriasis therapy was given, 25% were receiving topical therapy, and 66% were receiving systemic therapy (of those,

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Abbreviations: BMI, body mass index; BOP, Bleeding on Probing; CPI, Community Periodontal Index; DMFT index, decayed-missing-filled teeth; nPso, nonpsoriatic individuals (control group); Pso, psoriasis patients (case group); SD, standard deviation

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50% were receiving biologic agents, 21.2% methotrexate, 21.2% fumaric acid esters, 4.5% systemic combination therapy, 1.5% cyclosporine, and 1.5% other therapies).

Comparison between postmatched Pso and nPso groups

Bleeding on Probing (BOP). Patients in the Pso group had a significantly higher BOP ($P < 0.011$), with a mean \pm SD of $41.42\% \pm 25.57$ (range = 4.5%–85.7%) compared with $28.34\% \pm 20.25$ (range = 3.6%–80%) for the nPso group.

Highest Community Periodontal Index code of a dentition. Community Periodontal Index (CPI) in the Pso group differed highly significantly versus in the nPso group (Table 2). In the Pso group, 30.2% had a CPI code of 1 or 2, categorized as periodontally healthy, and 69.8% had a CPI code of 3 or 4, defined as presence of gingival or periodontal pockets with probing depth of 4 mm or greater. In the nPso group, 65.4% had a CPI code of 1 or 2, whereas 34.6% had a CPI code of 3 or 4.

Bleeding on toothbrushing. The matched Pso cohort showed significantly more bleeding on toothbrushing ($P < 0.013$). In 32.1% (valid, $n = 53$; missing, $n = 0$), bleeding on toothbrushing was reported as regularly existing compared with 11.8% in the nPso group (valid, $n = 51$; missing, $n = 2$).

Dental parameters of the decayed-missing-filled teeth (DMFT) index. Patients in the Pso group had a mean value \pm SD of 0.15 ± 0.72 for decayed teeth (nPso group mean value = 0, $P = 0.042$) (Table 3), 2.92 ± 4.88 for missing teeth (nPso mean value \pm SD = 1.64 ± 4.16 , $P = 0.099$) and 9.17 ± 6.74 for filled teeth (nPso mean value \pm SD = 10.49 ± 6.73 , $P = 0.34$). Therefore, the mean value \pm SD for the total DMFT index was 12.26 ± 7.08 for the Pso group and 12.13 ± 7.02 for the nPso group, without significant difference ($P = 0.862$).

Logistic regression analyses

Logistic regression analyses were executed with the entire case and control groups ($n = 100$ in the Pso group and $n = 101$ in the nPso group) with the parameters BOP, highest CPI code of a dentition, and missing teeth.

BOP. The following influencing factors were significant in the preanalyses and were taken into the main model (Table 4): age, body mass index (BMI), interdental cleaning, education level, and Pso group attribution. Table 4 presents the results of the initial and final stages of the regression analysis.

In the final stage of the regression analysis, the parameters age, BMI, Pso group with both mild (Pso-mild) and moderate/severe (Pso-moderate/severe) disease remained in the model. All these parameters had the greatest correlation with BOP greater than 30.8%. BMI-overweight ($P < 0.05$) and BMI-obese ($P = 0.002$) were significant, as were both Pso-mild and Pso-moderate/severe ($P < 0.01$, with adjusted odds ratios of 3.23 and 3.09, respectively). The significance value for Pso-moderate/severe was slightly higher than for Pso-mild. Age was no longer significant in the final stage ($P > 0.05$).

Highest CPI code of a dentition. In the preanalyses, the following influencing factors were identified as significant and therefore incorporated in the main model (Table 5): age, BMI, smoking status, education level, and Pso group.

In the final stage of the regression analysis, the parameters age, smoking status, and both Pso-mild and Pso-moderate/severe remained in the model. Age was significant ($P < 0.001$) and active smoker status greater than 12 pack-years was very significant ($P = 0.006$). Pso-mild was significant ($P = 0.018$), and Pso-moderate/severe was also significant ($P < 0.001$), the latter with an adjusted odds ratio of 3.8.

Missing teeth. The following parameters were significant in the preanalyses and were incorporated in the main model (Table 6): age, BMI, smoking status, frequency of daily toothbrushing, and Pso group.

In the final stage of the regression analysis, the parameters age, BMI, smoking status, and frequency of daily toothbrushing remained in the model. In the final stage, the parameter Pso group was not included anymore, but age ($P < 0.001$), BMI-obese ($P = 0.018$), active smoker status greater than 12 pack-years ($P = 0.014$), and frequency of daily toothbrushing of 0–1 times was significant ($P = 0.024$).

DISCUSSION

The association between psoriasis and periodontitis is substantiated by a striking pathophysiologic similarity. Although this association has been shown in a number of epidemiological studies, little is known about the other parameters of oral/dental health. In this prospective study comparing psoriasis patients with nonpsoriatic control individuals, high values of the gingivitis index BOP and the periodontal screening index CPI were observed significantly more often in psoriasis patients compared with matched nonpsoriatic control individuals. The results of the parameter bleeding on toothbrushing were significantly higher in the matched Pso group and fit well to the results of the parameters BOP and highest CPI code of a dentition. In logistic regression models, the attribution to the groups Pso-mild and Pso-moderate/severe were significant factors for high scores in BOP (>30.8%) and CPI (code 3 or 4). Additionally, the P -value for Pso-moderate/severe showed a slightly stronger significance than the P -value for Pso-mild. The CPI values with their distributions in the matched Pso group, together with the gingival parameters BOP and bleeding on toothbrushing and the results of the logistic regression models for BOP and CPI, convincingly indicate an increased presence of periodontitis in the Pso group. The results of this study are in accordance with previous studies that showed a statistically significant relationship between psoriasis and periodontitis (Antal et al., 2014; Egeberg et al., 2017; Ganzetti et al., 2015; Keller and Lin, 2012; Lazaridou et al., 2013; Preus et al., 2010; Sharma et al., 2015; Skudutyte-Rysstad et al., 2014; Ungprasert et al., 2016).

Overweight and obesity were significant risk factors for high BOP in the logistic regression model in this study, which correlates to a significant association of overweight and obesity with periodontitis, according to the literature (de Moura-Grec et al., 2014; Suvan et al., 2011). Their significant correlation to a high BOP as a surrogate parameter for gingivitis being an established prestage for periodontitis appears conclusive. However, obesity did not appear as a

Table 1. Applied influencing factors on oral health with qualifications

Factor ¹	Pso (n = 100)	nPso (n = 101)	Matched Pso (n = 53)	Matched nPso (n = 53)
Age in years, mean ± SD	47.4 ± SD 14.7	46.9 ± SD 16.8	45.3 ± SD 14.09	44.6 ± SD 12.8
Sex, %				
Male	59	42.6	49.1	45.3
Female	41	57.4	50.9	54.7
BMI in kg/m ² , %				
Underweight/normal weight (BMI < 25)	31	56.4	37.7	45.3
Overweight (BMI 25– <30)	38	26.7	37.7	35.8
Obese (BMI ≥ 30)	31	16.8	24.5	18.9
Smoking status, %				
Nonsmoker	22	52.5	22.6	45.3
Former smoker	37	27.7	41.5	28.3
Active smoker	41	19.8	35.8	26.4
Diabetes, %				
No diabetes	94	96	98.1	100
Diabetes	6	4	1.9	0
Preventative dental visits, %				
Preventative	79	83 ²	88.7	86.8
Nonpreventative	21	17 ²	11.3	13.2
Frequency of daily toothbrushing, %				
≥2 times	66.7 ²	85.1	79.2	83
0–1 time	33.3 ²	14.9	20.8	17
Interdental cleaning, %				
Yes	41.4 ²	58 ²	45.3	53.8
No	58.6 ²	42 ²	54.7	46.2
Regular oral fluoride application, %				
Yes	98 ²	99 ²	98.1	100
No	2 ²	1 ²	1.9	0
Cariogenic nutrition, %				
Slightly cariogenic	29	21.8	26.4	22.6
Moderately cariogenic	29	29.7	30.2	28.3
Very cariogenic	42	48.5	43.4	49.1
Recent periodontitis therapy, %				
No	97	98	96.2	98.1
Yes	3	2	3.8	1.9
Education level, %				
High	12.8 ²	39.2 ²	16	30.2
Medium	53.2 ²	45.4 ²	64	60.4
Low	34 ²	15.5 ²	20	9.4

Abbreviations: BMI, body mass index; nPso, nonpsoriasis group; Pso, psoriasis group; SD, standard deviation.

¹Reference groups for logistic regression analyses are printed in bold.

²For the following parameters, not all participants provided details: preventative dental visits/nPso: 100 valid, 1 missing; frequency of daily toothbrushing/Pso: 99 valid, 1 missing; interdental cleaning/Pso: 99 valid, 1 missing; interdental cleaning/nPso: 100 valid, 1 missing; regular oral fluoride application/Pso: 98 valid, 2 missing; regular oral fluoride application/nPso: 100 valid, 1 missing; education level/Pso: 94 valid, 6 missing; education level/nPso: 97 valid, 4 missing.

significant factor for CPI in the logistic regression analysis, possibly because of other stronger influencing factors considered in the model. Age and active smoker status greater than 12 pack-years were significant factors for a high CPI in the logistic regression analysis—without, however, outweighing the significance of Pso group—and both represent significant risk factors for periodontitis according to the literature (Albandar, 2002).

Periodontitis, meanwhile, is known as a comorbidity of psoriasis. Within the framework of this study, the causality of this comorbidity has not been investigated. Both conditions may have genetic factors, pathophysiologic overlaps, and risk factors in common. Gene polymorphisms for IL-1, IL-6, and

tumor necrosis factor- α are mentioned as risk factors for both psoriasis and periodontitis (Białecka et al., 2015; Ding et al., 2014; Hébert et al., 2014; Mathieu et al. 2007; McDevitt et al., 2000; Puri et al., 2015; Reich et al., 2002; Shao et al., 2009). Pathophysiologic similarity between psoriasis and periodontitis includes an activated innate immune cell compartment with neutrophil dominance and a cytokine milieu with the presence of IL-17/tumor necrosis factor- α (Boehncke, 2015; Girolomoni et al., 2012; Hajishengallis, 2014, 2015; Schön et al., 2017; Zenobia and Hajishengallis, 2015). Zenobia and Hajishengallis (2015) reported that in numerous clinical studies, enhanced levels of IL-17 had been detected in periodontitis patients. IL-17 is

Table 2. Highest CPI code of a dentition: comparison of Pso and nPso

Code	Definition	Pso ¹		nPso ²	
		n	%	n	%
0	Healthy periodontal tissue	0	0	0	0
1	Gingival bleeding on probing	7	13.2	21	40.4
2	Calculus above and/or below gingiva or iatrogenic marginal irritation; probing depth < 4 mm	9	17	13	25
3	Probing depth ≥ 4 mm	20	37.7	12	23.1
4	Probing depth ≥ 6 mm	17	32.1	6	11.5

Abbreviations: CPI, Community Periodontal Index; nPso, nonpsoriasis group; Pso, psoriasis group.

¹P-value for H₀ (Pso=nPso) < 0.002, Pearson’s chi-square test.

²nPso: valid 53, missing 0.

³Pso: valid 52, missing 1.

assumed to have proinflammatory and pro-osteoclastic properties (Zenobia and Hajishengallis, 2015). Increased levels of IL-17 in psoriasis and periodontitis may generate a vicious cycle. In the literature, obesity, diabetes, and smoking are named as risk factors for both psoriasis and periodontitis (de Moura-Grec et al., 2014; Gerdes et al., 2011, 2012; Keller et al., 2015; Naldi et al., 2005; Preshaw et al., 2012; Suvan et al., 2011, 2015). In this study, obesity, smoking, and diabetes had already been taken into account as influencing factors in the data analyses and, therefore, cannot fully explain the association between psoriasis and periodontitis. However, this does not exclude the possibility that these risk factors may support such an association.

Psoriasis patients in this study did not show a worse dental status compared with the control group. In the matched-pair analysis, the Pso group had a modestly higher number of missing teeth than the nPso group. These findings follow the results of earlier studies, which reported a significantly higher number of missing teeth for psoriasis patients compared with control individuals (Fadel et al., 2013; Preus et al., 2010; Sharma et al., 2015; Skudutyte-Rysstad et al., 2014). In the logistic regression model on missing teeth, attribution to the Pso group was significant in the preanalyses but not, however, in the main model. Age, obesity, active smoking status

of more than 12 pack-years, and poor oral hygiene were significant factors for the parameter missing teeth. Caries and periodontitis are the most common reasons for tooth loss (Beltran-Aguilar and Beltran-Neira, 2004). Obesity is discussed in the literature as a possible risk factor for periodontitis (Keller et al., 2015), and both active smoking status and poor oral hygiene represent risk factors for periodontitis (Abdellatif and Burt, 1987; Albandar, 2002). Poor oral hygiene is also a well-proven risk factor for caries (Løe, 2000; Selwitz et al., 2007). Regarding the parameter number of decayed teeth, the mean was 0 in the matched nPso group and 0.15 in the matched Pso group. This significant difference may be due to an outlier—a patient with five decayed teeth next to three patients with one decayed tooth each in the Pso group. The number of filled teeth and values of the DMFT index were quite similar in the matched Pso and matched nPso groups.

A limitation of this study may be the postmatching process, which reduced the number participants in both groups by nearly half. However, the results of the postmatching process were in line with the results of the regression analyses executed for all recruits. The requirement of the postmatching process resulted from the high disparity between the Pso and nPso groups regarding important factors of oral health like smoking status and BMI. Previous studies have shown that smoking status and BMI are higher in psoriasis cohorts compared with control populations (Herron et al., 2005; Kimball et al., 2014). However, after matching, the difference in the confounding factor smoking status between the matched Pso and nPso groups was remarkably reduced but remained at a low level of significance (P = 0.048). Another limitation of this study is that one exclusion criterion was treatment with immunosuppressive drugs, unless they are used for the treatment of psoriasis or psoriatic arthritis. Immunosuppressive drugs may have an impact on the periodontal status (Alani and Seymour, 2014). However, according to current guidelines, patients with moderate/severe psoriasis are usually treated with systemic medication. It would be very difficult to recruit study participants who have moderate to severe psoriasis but are not receiving systemic therapy. The logistic regression models with the target parameters BOP and CPI indicate that patients with moderate to severe psoriasis (hence, mostly receiving systemic therapy)

Table 3. Dental parameters for Pso and nPso

Parameter	D		M		F		DMFT	
	Pso	nPso	Pso	nPso	Pso	nPso	Pso	nPso
Valid, n	53	53	53	53	53	53	53	53
Missing, n	0	0	0	0	0	0	0	0
Mean, n	0.15	0	2.92	1.64	9.17	10.49	12.26	12.13
Standard deviation	0.72	0	4.88	4.16	6.74	6.73	7.08	7.02
Minimum	0	0	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	5	0	21.00	28.00	28.00	25.00	28.00	28.00
Percentile								
25	0	0	0.00	0.00	2.00	5.00	8.50	7.00
50	0	0	1.00	0.00	10.00	10.00	13.00	13.00
75	0	0	4.00	2.00	13.00	15.00	17.00	17.00

Abbreviations: D, decayed teeth; DMFT, decayed-missing-filled teeth; F, filled teeth; M, missing teeth; nPso, nonpsoriasis group; Pso, psoriasis group.

Table 4. Logistic regression analysis for BOP-dichotomous (BOP > 30.8%)¹

Influencing Factors	aOR	95% CI	P
Initial stage			
Age	1.03	1.00–1.05	0.031
BMI (underweight/normal weight)	1.00		
BMI (overweight)	2.08	0.98–4.43	0.057
BMI (obese)	3.38	1.41–8.09	0.006
Interdental cleaning	1.51	0.77–2.94	0.227
Educational level (high)	1.00		
Educational level (medium)	0.85	0.38–1.90	0.687
Educational level (low)	1.61	0.61–4.28	0.34
nPso group	1.00		
Mild Pso group	2.85	1.14–7.12	0.025
Moderate/severe Pso group	2.86	1.35–6.06	0.006
Final stage			
Age	1.02	1.00–1.04	0.056
BMI (underweight/normal weight)	1.00		
BMI (overweight)	2.13	1.01–4.46	0.046
BMI (obese)	3.84	1.65–8.92	0.002
nPso group	1.00		
Mild Pso group	3.23	1.33–7.80	0.009
Moderate/severe Pso group	3.09	1.50–6.36	0.002

Abbreviations: aOR, adjusted odds ratio; BMI, body mass index; CI, confidence interval.

¹Valid, n = 189; missing, n = 12.

have slightly higher levels of significance and a tendency to have higher rates of gingival and periodontal diseases compared with patients with mild psoriasis. Modifiable risk factors for poor oral hygiene status, like frequency of tooth-brushing and interdental cleaning, are more common in the Pso group than in the nPso group. This may also apply to unmeasured influencing factors like stress. Furthermore, data on genetic disposition as one major influencing factor for periodontitis could not be collected meaningfully within the scale of this study. For the rest, all other major influencing factors discussed in the literature were incorporated.

The results of this investigation, together with recently published data, provide a sound basis to recommend regular dental checks on periodontal status and to initiate periodontal treatment when required. Conventional treatment of periodontitis is based on a mechanical root debridement (entering the periodontal pocket with specific instruments and removing dental plaque on the root surface) and, if indicated, additional access flap surgery; this will lead to stabilization of the periodontal destruction process and prevent further tooth loss during a supportive periodontal therapy (Graetz et al., 2017). Future studies should be conducted on a long-term basis to investigate if and to what extent an improvement in periodontal status correlates with the clinical course of psoriasis. A possible approach could be an assessment of psoriasis severity before and shortly after the termination of systematic periodontitis therapy, when the active periodontal inflammation has decreased (Lang and Lindhe, 2015). A follow-up could be executed 6–8 weeks after termination of the systematic periodontitis therapy, when the periodontal healing process should have advanced (Lang and Lindhe, 2015).

Table 5. Logistic regression analysis for highest CPI code of a dentition-dichotomous (CPI code 3 or 4)¹

Influencing Factors	aOR	95% CI	P
Initial stage			
Age	1.04	1.02–1.07	<0.001
BMI (underweight/normal weight)	1.00		
BMI (overweight)	1.03	0.46–2.30	0.937
BMI (obese)	1.69	0.67–4.24	0.262
Smoking status (nonsmoker)	1.00		
Smoking status (former smoker)	1.59	0.71–3.53	0.260
Smoking status (active smoker ≤12 py)	1.60	0.55–4.69	0.392
Smoking status (active smoker >12 py)	5.24	1.48–18.61	0.010
Education level (high)	1.00		
Education level (medium)	1.18	0.51–2.71	0.703
Education level (low)	1.96	0.70–5.43	0.198
nPso group	1.00		
Mild Pso group	2.93	1.06–8.11	0.038
Moderate/severe Pso group	3.25	1.43–7.39	0.005
Final stage			
Age	1.05	1.02–1.07	<0.001
Smoking status (nonsmoker)	1.00		
Smoking status (former smoker)	1.62	0.73–3.56	0.234
Smoking status (active smoker ≤12 py)	1.70	0.60–4.83	0.323
Smoking status (active smoker >12 py)	5.64	1.63–19.56	0.006
nPso group	1.00		
Mild Pso group	3.28	1.23–8.80	0.018
Moderate/severe Pso group	3.77	1.74–8.17	<0.001

Abbreviations: aOR, adjusted odds ratio; BMI, body mass index; CI, confidence interval; CPI, Community Periodontal Index; py, pack-years.

¹Valid, n = 185; missing, n = 16.

MATERIALS AND METHODS

After we received ethics approval (reference number: D570/15), we consecutively recruited 100 psoriasis patients presenting at the outpatient service of the Psoriasis Center at the Department of Dermatology, University Medical Center Schleswig-Holstein, Campus Kiel and 101 nonpsoriatic control individuals. Written, informed consent was obtained from patients and controls. The control individuals were from the general outpatient service of the department, from patients and their companions of dermatologists in private practice, and from staff of the Department of Dermatology and of private practice dermatologists. The following exclusion criteria were defined for the Pso group: an inflammatory or autoimmune skin disease in addition to psoriasis; another chronic inflammatory disease; an autoimmune disease; treatment with immunosuppressive drugs, if used for a disease other than psoriasis and psoriasis arthritis; cancer; and an enhanced risk of endocarditis. For the control group, the following exclusion criteria were used: psoriasis or any other inflammatory or autoimmune skin disease, chronic inflammatory diseases, autoimmune diseases, treatment with immunosuppressive drugs, cancer, and an enhanced risk of endocarditis. A board-certified dentist (SW) assessed the periodontal and dental status. The following parameters were used: BOP, which is the generally acknowledged index for identifying gingivitis (Chapple et al., 2018; Lang and Bartold, 2018; Trombelli et al.,

Table 6. Logistic regression analysis for missing teeth-dichotomous (>1 missing tooth)¹

Influencing Factors	aOR	95% CI	P
Initial stage			
Age	1.09	1.06–1.12	<0.001
BMI (underweight/ normal weight)	1.00		
BMI (overweight)	1.46	0.63–3.39	0.085
BMI (obese)	2.85	1.16–7.19	0.027
Smoking status (nonsmoker)	1.00		
Smoking status (former smoker)	1.82	0.74–4.45	0.193
Smoking status (active smoker ≤12 py)	1.92	0.58–6.40	0.288
Smoking status (active smoker >12 py)	3.44	1.12–10.58	0.031
Frequency of daily toothbrushing (0–1 time)	2.55	1.06–6.15	0.037
Final stage			
Age	1.09	1.06–1.12	<0.001
BMI (underweight/ normal weight)	1.00		
BMI (overweight)	1.53	0.67–3.52	0.315
BMI (obese)	2.99	1.21–7.43	0.018
Smoking status (nonsmoker)	1.00		
Smoking status (former smoker)	1.99	0.84–4.72	0.116
Smoking status (active smoker ≤12 py)	2.17	0.69–6.85	0.185
Smoking status (active smoker >12 py)	3.90	1.32–11.58	0.014
Frequency of daily toothbrushing (0–1 time)	2.70	1.14–6.43	0.024

Abbreviations: aOR, adjusted odds ratio; BMI, body mass index; CI, confidence interval; CPI, Community Periodontal Index; py, pack-years.

¹Valid, n = 196; missing, n = 5.

2018); the CPI, which is recommended by the World Health Organization (2013) as a screening index for determining gingival and periodontal disease; bleeding on toothbrushing according to a questionnaire; and the DMFT index, as recommended by the World Health Organization (2013). Demographic factors, including BMI, diabetes, preventive dental visits, frequency of daily toothbrushing, interdental cleaning, regular oral fluoride application, cariogenic nutrition, education level, smoking status, and recent periodontitis therapy, were obtained through questionnaires. For the demographic factor education level a simplified threefold categorization high/medium/low was used according to the “International Standard Classification of Education” (ISCED) (UNESCO Institute for Statistics, 2012). In the Pso group, the severity level was recorded and measured by the Psoriasis Area and Severity Index. Additionally, the current treatment of psoriasis was documented using patients’ records.

To best compare the Pso group with healthy control individuals, a postmatching strategy was applied: matching a patient (case) and a healthy individual (control) belonging to the same age group (five age groups: <35 years, 35–44 years, 45–64 years, 65–74 years,

and ≥75 years). Subsequently, the following 11 factors with a possible impact on oral health status were tested: sex, BMI, diabetes, preventive dental visits, frequency of daily toothbrushing, interdental cleaning, regular oral fluoride application, cariogenic nutrition, education level, smoking status, and recent periodontitis therapy. A discrepancy in up to two factors between case and control individuals was accepted. A total of 53 pairs of psoriasis and non-psoriatic patients were identified for whom, apart from smoking status, all factors were aligned.

In addition to the postmatching strategy, logistic regression analyses were used to consider and level out different influencing factors. These logistic regressions analyses were executed for the entire unmatched psoriasis and control populations and with the target parameters BOP, highest CPI code of a dentition, and missing teeth. In Table 1, 10 influencing factors in addition to age and sex, with their individual qualifications used for the logistic regression analyses, are presented. Because of the high impact of the influencing factor smoking status, the additional subdivision of active smoker at 12 pack-years or less versus more than 12 pack-years was introduced to account for smoking dose. One additional influencing factor was considered: nPso, Pso-mild, or Pso-moderate/severe group attribution.

For the logistic regression analyses on the BOP parameter, this metric variable was converted into a dichotomous variable, *BOP-dichotomous*. On the basis of the median of 30.8% for the BOP parameter, all study participants were divided into two groups, namely, participants with a BOP of 30.8% or less and participants with a BOP greater than 30.8%. In the pre-phase, logistic regression analyses were run with the target parameter BOP-dichotomous for each of the following 11 influencing factors, adjusted by the additional factors age and sex: BMI, smoking status, diabetes, preventive dental visits, frequency of daily toothbrushing, interdental cleaning, regular oral fluoride application, cariogenic nutrition, recent periodontitis therapy, education level, and Pso group. Preanalyses served to identify the impact of the various influencing factors on the target parameter BOP-dichotomous.

For the regression analyses on highest CPI code of a dentition, this variable was converted into a dichotomous variable, *highest CPI code of a dentition-dichotomous*. The following classification was applied: study participants with a CPI code of 0–2 were attributed to the first group (periodontally healthy). All participants with a CPI code of 3 or 4 were attributed to the second group (presence of gingival or periodontal pockets). The preanalyses were conducted as described for the parameter BOP-dichotomous.

For the logistic regression analyses on missing teeth, this variable was converted into a dichotomous variable, *missing teeth-dichotomous*. On the basis of the median of 1 for the parameter missing teeth, two groups were created. Participants with no missing teeth or one missing tooth belonged to the first group and participants with more than one missing tooth belonged to the second group. Analogous to the procedure for BOP-dichotomous described, preanalyses were performed.

All statistical calculations, univariate analyses, and logistic regression analyses were prepared with SPSS 22 (IBM, Armonk, New York). For the univariate analyses the null hypothesis H_0 was, that Pso and nPso are equal in relation to a certain parameter of oral health. The alternative hypothesis H_1 was, that Pso and nPso are not equal in

relation to this parameter of oral health. Categorical variables were analyzed by cross tables and Pearson's chi-square test or Fisher's exact test and continuous variables by Mann-Whitney test.

CONFLICT OF INTEREST

The authors state no conflict of interest. This study was self-funded by the authors and their institutions.

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