Risk of Peripheral Arterial Occlusive Disease with Periodontitis and Dental Scaling: A Nationwide Population-Based Cohort Study

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Abstract: Periodontitis (PD) is a common oral disease associated with various other diseases, particularly those affecting the cardiovascular system. This study explored whether peripheral artery occlusive disease (PAOD) is associated with PD and dental scaling. This study was a retrospective cohort study design from 2000 to 2018. The study population was newly diagnosed with periodontitis. The comparison group was defined as never diagnosed with periodontitis. The outcome variable was defined with the diagnosis of peripheral arterial occlusive disease (PAOD). The propensity score matching was performed by age, sex, comorbidities, and dental scaling between the two groups. Kaplan–Meier analysis was used to calculate the cumulative incidence of PAOD among the two groups. To perform the independent risk of the PAOD group, the multivariate Cox proportional hazard model was used to estimate the hazard ratios. First, 792,681 patients with PD and 458,521 patients with no history of PD were selected from Taiwan’s Longitudinal Health Insurance Database, which comprises the data of two million beneficiaries. After propensity score matching between the PD and non-PD groups for age, sex, comorbidities, and dental scaling, 357,106 patients in each group were analyzed for PAOD risk. The incidence density, relative risk, and cumulative incidence of PAOD were higher in the PD group than in the non-PD group. After adjusting for all variables, the risk of PAOD for the PD group was greater than for the non-PD group (adjusted hazard ratio = 1.03; 95% CI, 1.01–1.06). Undergoing at least one dental scaling procedure reduced the risk of PAOD. Age over 65 years was also a risk factor. In conclusion, patients with PD have an increased risk of PAOD. In addition, our results can lead to increased attention to oral hygiene, as dental scaling has a trend towards a lower risk of PAOD.

Keywords: periodontitis; peripheral arterial occlusive diseases; dental scaling

1. Introduction

Periodontitis (PD) is one of the most common and influential oral diseases in Taiwan. PD is classified into four stages on the basis of its (i) severity, (ii) complexity of management, (iii) extent, and (iv) distribution [1,2]. The severity of PD is evaluated with several
indices such as those for dental plaques, calculus, and pocket depth, bleeding on probing, attachment, and gum loss [3]. Chronic aggressive PD causes destruction of the periodontal ligament, alveolar bone reduction, and subsequent tooth loss [4]. Dozens of species of oral bacteria are associated with PD development. These bacteria have been classified into five complexes according to their relationship with and frequency of detection in PD in decreasing order: red, orange, yellow, green, blue, and purple [5,6]. Three species of bacteria, Porphyromonas gingivalis, Tannerella forsythia, and Treponema denticola, in the red complex are considered the main pathogens responsible for PD and are involved in disease progression and tissue destruction [7]. Other bacteria, such as Aggregatibacter actinomycetemcomitans, are the most likely causes of aggressive PD [8]. A retrospective nationwide population study indicated that the prevalence of PD significantly increased over a decade [9]. In addition, PD is common in middle-aged populations and highly prevalent among high school students aged 15 to 18 years [9].

Peripheral arterial occlusive disease (PAOD) is a blood circulation disturbance caused by arterial thrombosis [10]. For example, a recent study indicated that PAOD was associated with a higher risk of heart failure [11]. The pathogenesis of PAOD is similar to that of atherosclerosis, but PAOD always affects the lower limbs. The clinical signs of PAOD are not obvious; people do not notice the disease initially. One of the clinical signs of PAOD is intermittent claudication. Atherosclerosis severity can be determined through ultrasonic measurement of the ankle-brachial index, computed tomography, or magnetic resonance imaging [12–14]. PAOD can be divided into four stages based on the severity of symptoms. In stage IV, necrosis, ulcers, and gangrene always occur, even after minor trauma to the toes [15].

PD is associated with cardiovascular diseases. Untreated PD is associated with early atherosclerotic carotid lesions (i.e., increased carotid artery intima-media wall thickness) and higher levels of inflammatory markers (i.e., C-reactive protein and leucocytes) [16]. Male patients with chronic PD have a higher risk of carotid atherosclerosis [17]. Periodontal pathogens may promote atherosclerosis by promoting inflammation and metabolism-related molecular mechanisms [18].

In this study, we enrolled patients with and without PD from the Longitudinal Health Insurance Database 2000 (LHID 2000) and investigated (i) the association between PD and PAOD and (ii) the relationship between dental scaling and PAOD.

2. Materials and Methods
2.1. Data Source

The LHID is regulated by the Health and Welfare Data Science Center of Taiwan. The database contains 2 million beneficiaries randomly selected from the population of the 2000 beneficiary registry. The database contains all outpatient and inpatient medical claims, including medications, medical operations, procedures, and fees from 2000 to 2018. This study was approved by the Ethics Review Board of Chung Shan Medical University Hospital (CS1-20056).

2.2. Study Group and Outcome

This study employed a retrospective cohort study design. Supplementary Table S1 lists the diseases corresponding to the code (International Classification of Diseases, Clinical Modification [ICD-CM]) numbers that define periodontal disease, peripheral arterial occlusive disease, and comorbidities. The study population comprised patients with newly diagnosed PD from 2002 to 2017. Two or more outpatient visits or one or more hospitalizations were necessary to ensure the accuracy of the diagnoses. The index date was considered the first date of a PD code. We excluded patients with PAOD diagnoses from before the index date to confirm new onset. Participants without a PD diagnosis between 2000 and 2018 were also analyzed.
2.3. Covariates and Matching

The baseline characteristics considered were age, sex, and hypertension, hyperlipidemia, chronic liver disease, chronic kidney disease, diabetes, chronic obstructive pulmonary disease, rheumatoid arthritis, ankylosing spondylitis, hepatitis B, hepatitis C, herpes zoster, and psoriasis. Two outpatient visits or one hospitalization for the comorbidities were required within 1 year before the index date. In addition, the frequency of dental scaling 1 year before the index date was recorded. In Taiwan, the 65-year-old was defined as the elderly population. We used the cutoff at 65 years.

Age and sex matching in a 1:4 ratio was used to provide an index date for participants with the same starting point. Then, a propensity score matching (PSM) for age, sex, comorbidities, and dental scaling between the 2 groups was performed. The propensity scores were estimated through logistic regression, with the binary variable being PAOD status. PSM helped to account for the heterogeneity of the 2 groups.

2.4. Statistical Analysis

PD and non-PD groups were compared using absolute standardized differences. The groups were considered to have similar characteristics when the absolute standardized difference was less than 0.1 [19]. The relative risk (RR) and 95% CIs were calculated using a Poisson regression model. Kaplan–Meier analysis was used to calculate the cumulative incidence of PAOD in the 2 groups. A log-rank test was used to test significance. A Cox proportional hazards model was used to estimate hazard ratios (HRs) for the independent risk of PAOD. The statistical software employed was SAS version 9.4 (SAS Institute, Cary, NC, USA).

3. Results

3.1. Characteristics of the Participants

In total, 792,681 patients with PD and 458,521 patients without PD were selected from the LHID. After patients with PAOD before the index date were excluded, 783,716 patients remained in the PD cohort. To evaluate the risk of PAOD by age, sex, comorbidities, and dental scaling in both cohorts, a 1:1 PSM was employed. Finally, 357,106 patients in the PD cohort and the same number of patients without PD in a matched cohort were analyzed for PAOD risk (Figure 1). The demographic characteristics of both study cohorts are presented in Table 1. The mean age in the PD and non-PD groups was 37.56 and 37.78 years, respectively. The majority of patients were male (57%). After PSM, all absolute standardized differences were less than 0.1, suggesting that the age, sex, comorbidities, and frequencies of dental scaling in the groups were similar (Table 1).

![Figure 1. Flowchart of patient selection.](image-url)
Table 1. Demographic characteristics of periodontitis and non-periodontitis.

| Variables                      | Before PSM Matching | After PSM Matching |
|--------------------------------|---------------------|--------------------|
|                                | Non-Periodontitis   | Periodontitis      |
|                                | (N = 376,187)       | (N = 376,187)      |
|                                | n       %           | n       %          |
| Age                            | 1     0            | 1     0            |
| <20                            | 89,406     23.8   | 89,406     23.8   |
| 20–39                          | 114,868     30.5  | 114,868     30.5  |
| 40–64                          | 125,667     33.4  | 125,667     33.4  |
| ≥65                            | 46,246     12.3   | 46,246     12.3   |
| Mean ± SD                      | 38.27 ± 19.63    | 38.27 ± 19.63    |
| Sex                            | 1     0            | 1     0            |
| Female                         | 159,735     42.5  | 159,735     42.5  |
| Male                           | 216,452     57.5  | 216,452     57.5  |
| Hypertension                   | 35,598     9.5    | 41,973     11.2   |
| Hyperlipidemia                 | 12,091     3.2    | 18,269     4.9    |
| Chronic liver disease          | 9221       2.5    | 12,203     3.2    |
| Chronic kidney disease         | 2381       0.6    | 1657       0.4    |
| Diabetes                       | 17,654     4.7    | 17,941     4.8    |
| Rheumatoid arthritis           | 6740       1.8    | 7230       1.9    |
| Ankylosing spondylitis         | 829        0.2    | 950        0.3    |
| Hepatitis B                    | 315        0.1    | 503        0.1    |
| Hepatitis C                    | 1775       0.5    | 2940       0.8    |
| Herpes zoster                  | 1164       0.3    | 1384       0.4    |
| Psoriasis                      | 1272       0.3    | 1654       0.4    |
| Dental scaling                 | 682        0.2    | 895        0.2    |
| None                           | 353,026     93.8  | 339,245     90.2  |
| <2                           | 20,572     5.5    | 333,945     93.5  |
| ≥2                            | 2589       0.7    | 334,071     93.5  |

COPD: Chronic obstructive pulmonary disease.
3.2. Risk of PAOD between PD and Non-PD Group

Poisson regression was employed to compare the RR of PAOD in the PD and non-PD groups. The PD group had a higher PAOD incidence density (3.39) than the non-PD group (ID = 3.09). The RR was 1.11 (95% CI, 1.08–1.13; Table 2). The cumulative incidence of PAOD revealed that the risk of PAOD was higher in the PD group than in the non-PD group (log-rank test, p < 0.001; Figure 2).

Table 2. Poisson regression of relative risk of PAOD between periodontitis and non-periodontitis.

| Variables  | Non-Periodontitis | Periodontitis |
|------------|-------------------|--------------|
| N          | 357,106           | 357,106      |
| Person-years | 3,733,623       | 3,994,111      |
| No. of PAOD | 11,450            | 13,540        |
| ID (95% C.I.) | 3.07 (3.01–3.12) | 3.39 (3.33–3.45) |
| Relative risk (95% C.I.) | Reference | 1.11 (1.08–1.13) |

ID: incidence density (per 1000 person-years).

Figure 2. Kaplan–Meier curves of the cumulative proportions of PAOD in periodontitis and non-periodontitis patients.

After adjusting for all variables, the Cox proportional hazards model indicated that the PD group had a higher risk of PAOD than the non-PD group (HR = 1.03; 95% CI, 1.01–1.06) had. The risk of PAOD was also higher among patients 65 years of age (HR = 3.17; 95% CI, 3.07–3.27). Furthermore, comorbidities such as hypertension, hyperlipidemia, chronic liver disease, chronic kidney disease, diabetes, chronic obstructive pulmonary disease, rheumatoid arthritis, ankylosing spondylitis, hepatitis B, hepatitis C, herpes zoster, and psoriasis were risk factors for PAOD. Undergoing one dental scaling procedure was associated with a reduced risk of PAOD (Table 3).
Table 3. Cox proportional hazard model analysis for risk of PAOD.

| Variables               | Univariable HR (95% C.I.) | p Value | Multivariable HR (95% C.I.) | p Value |
|-------------------------|---------------------------|---------|----------------------------|---------|
| Group                   |                           |         |                            |         |
| Non-periodontitis       | Reference                 |         | Reference                  |         |
| Periodontitis           | 1.10 (1.08–1.13)          | <0.001  | 1.03 (1.01–1.06)           | 0.015   |
| Age                     |                           |         |                            |         |
| <65                     | Reference                 |         | Reference                  |         |
| ≥65                     | 5.33 (5.20–5.47)          | <0.001  | 3.17 (3.07–3.27)           | <0.001  |
| Sex                     |                           |         |                            |         |
| Female                  | Reference                 |         | Reference                  |         |
| Male                    | 0.78 (0.76–0.80)          | <0.001  | 0.87 (0.85–0.89)           | <0.001  |
| Hypertension            | 4.78 (4.65–4.91)          | <0.001  | 1.91 (1.84–1.97)           | <0.001  |
| Hyperlipidemia          | 3.79 (3.64–3.95)          | <0.001  | 1.14 (1.09–1.19)           | <0.001  |
| Chronic liver disease   | 2.49 (2.36–2.62)          | <0.001  | 1.42 (1.34–1.50)           | <0.001  |
| Chronic kidney disease  | 9.73 (8.97–10.55)         | <0.001  | 3.30 (3.04–3.58)           | <0.001  |
| Diabetes                | 5.65 (5.47–5.84)          | <0.001  | 2.22 (2.14–2.31)           | <0.001  |
| COPD                    | 3.64 (3.44–3.86)          | <0.001  | 1.40 (1.32–1.48)           | <0.001  |
| Rheumatoid arthritis    | 3.49 (3.01–4.04)          | <0.001  | 1.79 (1.54–2.07)           | <0.001  |
| Ankylosing spondylitis  | 1.86 (1.36–2.55)          | <0.001  | 1.56 (1.14–2.14)           | 0.005   |
| Hepatitis B             | 1.65 (1.43–1.91)          | <0.001  | 1.21 (1.04–1.40)           | 0.011   |
| Hepatitis C             | 2.93 (2.52–3.40)          | <0.001  | 1.21 (1.04–1.41)           | 0.015   |
| Herpes zoster           | 2.51 (2.19–2.88)          | <0.001  | 1.34 (1.17–1.54)           | <0.001  |
| Psoriasis               | 1.82 (1.47–2.25)          | <0.001  | 1.37 (1.11–1.70)           | 0.004   |
| Dental scaling          |                           |         |                            |         |
| None                    | Reference                 |         | Reference                  |         |
| 1                       | 0.68 (0.64–0.73)          | <0.001  | 0.84 (0.78–0.89)           | <0.001  |
| ≥2                      | 0.69 (0.57–0.84)          | <0.001  | 0.83 (0.68–1.00)           | 0.055   |

COPD: Chronic obstructive pulmonary disease. † Adjusted for all variables.

Subgroup analysis revealed that patients aged ≥ 65 had a greater risk of PAOD than those aged < 65 years (p = 0.0034) in the PD group. In the PD group, men had a higher risk of PAOD than women had (p = 0.0108; Table 4). However, dental scaling was not associated with the risk of PAOD in the PD group (Table 5).

Table 4. Subgroup of Cox proportional hazard model analysis.

| Variables          | Non-Periodontitis | Periodontitis | N | No. of PAOD | HR (95% C.I.) | p Value |
|--------------------|-------------------|---------------|---|-------------|---------------|---------|
| Age                |                   |               | <65| 312,330     | 7296          | 1.00 (0.97–1.04) | 0.792 |
|                    |                   |               | ≥65| 44,776      | 4154          | 1.04 (1.00–1.08) | 0.065 |
| p for interaction  |                   |               |   |             | 0.0034        |         |
| Female             |                   |               |   | 153,011     | 5885          | 1.00 (0.95–1.02) | 0.527 |
| Male               |                   |               |   | 204,095     | 5565          | 1.04 (1.00–1.08) | 0.042 |
| p for interaction  |                   |               |   | 0.0108      |               |         |
| Hypertension       |                   |               | No| 322,790     | 7992          | 1.08 (1.05–1.11) | <0.001 |
|                    |                   |               | Yes| 34,316     | 3458          | 0.88 (0.85–0.93) | <0.001 |
| p for interaction  |                   |               |   | <0.001      |               |         |
| Hyperlipidemia     |                   |               | No| 345,118     | 10,157        | 1.05 (1.02–1.08) | <0.001 |
|                    |                   |               | Yes| 11,988     | 1293          | 0.75 (0.69–0.81) | <0.001 |
| p for interaction  |                   |               |   | <0.001      |               |         |
Table 4. Cont.

| Variables                  | Non-Periodontitis | Periodontitis | HR (95% C.I.) | p Value |
|----------------------------|-------------------|---------------|---------------|---------|
|                            | N No. of PAOD     | N No. of PAOD |               |         |
| Chronic liver disease      | 1                 |               |               |         |
| No                         | 348,020 10,762    | 346,981 12,751| 1.03 (1.00–1.06) | 0.028   |
| Yes                        | 9086 688          | 10,125 789    | 0.78 (0.70–0.87) | <0.001  |
| p for interaction < 0.001  |                   |               |               |         |
| Chronic kidney disease     | 1                 |               |               |         |
| No                         | 355,474 11,156    | 355,483 13,236| 1.03 (1.00–1.05) | 0.057   |
| Yes                        | 1632 294          | 1623 304      | 0.68 (0.58–0.81) | <0.001  |
| p for interaction < 0.001  |                   |               |               |         |
| Diabetes 1                 |                   |               |               |         |
| No                         | 341,183 9319      | 340,884 11,396| 1.09 (1.06–1.12) | <0.001  |
| Yes                        | 15,923 2131       | 16,222 2144   | 0.72 (0.68–0.76) | <0.001  |
| p for interaction < 0.001  |                   |               |               |         |
| Diabetes 1                 |                   |               |               |         |
| COPD 1                     |                   |               |               |         |
| No                         | 350,770 10,931    | 350,572 12,812| 1.02 (0.99–1.04) | 0.176   |
| Yes                        | 6336 519          | 6534 728      | 0.94 (0.84–1.06) | 0.318   |
| p for interaction = 0.1053 |                   |               |               |         |
| Rheumatoid arthritis 1    |                   |               |               |         |
| No                         | 356,312 11,357    | 356,308 13,456| 1.02 (0.99–1.04) | 0.199   |
| Yes                        | 794 93            | 798 84        | 0.75 (0.56–1.01) | 0.059   |
| p for interaction = 0.0192 |                   |               |               |         |
| Ankylosing spondylitis 2   |                   |               |               |         |
| No                         | 356,791 11,431    | 356,812 13,520| 1.02 (0.99–1.04) | 0.153   |
| Yes                        | 315 19            | 294 20        | 0.89 (0.47–1.69) | 0.713   |
| p for interaction = 0.7961 |                   |               |               |         |
| Hepatitis B 1              |                   |               |               |         |
| No                         | 355,334 11,364    | 355,161 13,442| 1.02 (0.99–1.04) | 0.217   |
| Yes                        | 1772 86           | 1945 98       | 0.83 (0.62–1.12) | 0.218   |
| p for interaction = 0.1435 |                   |               |               |         |
| Hepatitis C 3              |                   |               |               |         |
| No                         | 355,991 11,371    | 355,924 13,448| 1.02 (0.99–1.04) | 0.233   |
| Yes                        | 1115 79           | 1182 92       | 0.82 (0.61–1.11) | 0.202   |
| p for interaction = 0.2372 |                   |               |               |         |
| Herpes zoster 4            |                   |               |               |         |
| No                         | 355,841 11,364    | 355,688 13,421| 1.01 (0.99–1.04) | 0.269   |
| Yes                        | 1265 86           | 1418 119      | 1.04 (0.78–1.37) | 0.804   |
| p for interaction = 0.9721 |                   |               |               |         |
| Psoriasis 3                |                   |               |               |         |
| No                         | 356,431 11,407    | 356,328 13,497| 1.02 (0.99–1.04) | 0.227   |
| Yes                        | 675 43            | 778 43        | 0.73 (0.47–1.11) | 0.138   |
| p for interaction = 0.081  |                   |               |               |         |
| Dental scaling 5           |                   |               |               |         |
| None                       | 333,945 11,024    | 334,071 12,958| 1.01 (0.99–1.04) | 0.279   |
| 1                          | 20,572 379        | 20,702 526    | 1.05 (0.92–1.20) | 0.454   |
| ≥2                         | 2589 47           | 2333 56       | 0.78 (0.52–1.16) | 0.224   |
| p for interaction = 0.296  |                   |               |               |         |

1 Adjusted for all variables. 2 Adjusted for all variables, excluding chronic kidney disease, rheumatoid arthritis, hepatitis C, herpes zoster, and psoriasis. 3 Adjusted for all variables, excluding ankylosing spondylitis, and herpes zoster. 4 Adjusted for all variables, excluding ankylosing spondylitis, hepatitis C, and psoriasis. 5 Adjusted for all variables, excluding rheumatoid arthritis, ankylosing spondylitis, and psoriasis.
Table 5. Cox proportional hazard model analysis for risk of PAOD with and without dental scaling.

| Variables | Univariable | Multivariable † |
|-----------|-------------|----------------|
|           | N           | No. of PAOD   | HR (95% C.I.) | p Value | HR (95% C.I.) | p Value |
| Group     |              |               |               |         |               |         |
| Non PD Non DS | 333,945 | 11,024 | Reference | Reference |
| Non PD 1  | 20,572 | 379 | 0.63 (0.57–0.70) | <0.001 | 0.95 (0.86–1.06) | 0.344 |
| Non PD ≥ 2 | 2589 | 47 | 0.70 (0.53–0.94) | 0.016 | 1.13 (0.85–1.51) | 0.400 |
| PD Non DS | 334,071 | 12,958 | 1.10 (1.07–1.13) | <0.001 | 1.01 (0.99–1.04) | 0.300 |
| PD 1      | 20,702 | 526 | 0.79 (0.73–0.87) | <0.001 | 1.01 (0.93–1.11) | 0.777 |
| PD ≥ 2    | 2333 | 56 | 0.75 (0.58–0.98) | 0.032 | 0.88 (0.67–1.14) | 0.319 |

| Group     |              |               |               |         |               |         |
| Non PD Non DS | 333,945 | 11,024 | Reference | Reference |
| Non PD DS | 23,161 | 426 | 0.64 (0.58–0.70) | <0.001 | 0.97 (0.88–1.07) | 0.519 |
| PD Non DS | 334,071 | 12,958 | 1.10 (1.07–1.13) | <0.001 | 1.01 (0.99–1.04) | 0.299 |
| PD DS     | 23,035 | 582 | 0.79 (0.73–0.86) | <0.001 | 1.00 (0.92–1.09) | 0.956 |

† Adjusted for all variables. Non PD: non-periodontitis. Non DS: non-dental scaling.

4. Discussion

This study analyzed 357,106 patients with PD and an equal number of patients without PD and evaluated the risk of PAOD in both groups after PSM. The PD group had a higher risk of PAOD than the non-PD group. Male patients in the PD group and patients with PD aged older than 65 years had increased risks of PAOD.

The association between PD and the risk of PAOD has been discussed since 1998. Two recent systematic reviews and a prospective population-based cross-sectional cohort study have investigated this association [20–22]. Their results indicated that PD could increase the risk of PAOD. The mechanism was considered to be oral bacteria causing thrombosis in the lower limb arteries and provoking an inflammatory response. However, all of these studies lacked information on whether dental scaling could reduce the risk of PAOD in patients with PD. Our study indicated that patients who underwent at least one dental scaling procedure had a lower risk of PAOD.

In the subgroup analysis, patients older than 65 years had a higher risk of PAOD than those younger than 65 years in the PD group. In one cross-sectional analysis, age was demonstrated to be a risk factor, especially for asymptomatic PAOD; other factors such as smoking status, hypertension, and diabetes were strongly associated with PAOD [23]. In addition, a 15% to 20% prevalence of PAOD among individuals aged over 70 years was reported in the United States [15]. Our results are consistent with those of the aforementioned studies.

Despite age, sex disparity was also a risk factor for PAOD. In the subgroup analysis, our results showed that men had a higher risk of PAOD than women had in the PD group. By contrast, a study in the United States demonstrated that women have a higher risk of PAOD [24]. A similar result was also discovered in patients with type 2 diabetes and symptomatic PAOD [25]. These results are probably due to the higher blood concentrations of the C-reactive protein in women than in men. In addition, women have more favorable long-term outcomes than men after percutaneous endovascular revascularization for PAOD treatment [26].

The Cox proportional hazards model revealed that dental scaling reduced the risk of PAOD. However, in the subgroup analysis, the interaction between dental scaling and PAOD in the PD group was not statistically significant, implying that dental scaling might reduce the risk of PAOD in the general population. Dental scaling is a process for dental plaque and calculus removal, but it is not a prescribed therapeutic intervention for PD. However, we did not analyze root planning, periodontal flap surgery, guided tissue
regeneration, or other procedures. These therapeutic procedures are typically applied for more severe PD when dental scaling is not completely curative.

Associations between PD and atherosclerotic conditions other than PAOD have been observed over the past decade. For example, the carotid artery intima-media walls were thicker in untreated patients with PD than in patients with PD who received standard treatment [16]. In a nationwide population-based cohort study, male patients with chronic PD had a higher risk of carotid atherosclerosis [17]. Furthermore, PD was also associated with transient ischemic attack and minor ischemic stroke in juveniles [27]. Therefore, a close relationship between PD and PAOD is expected.

The increased risk of PAOD might be due to multiple or indirect mechanisms. In addition to the formation of atherosclerotic lesions in the peripheral arteries due to cholesterol and low-density lipoproteins, other factors promote PAOD. First, patients with PD have long-term inflammation [28]. Several studies have revealed that the blood levels of the C-reactive protein and other inflammatory mediators are strongly associated with PAOD [29,30]. Second, oral bacteremia may be a risk factor for PAOD [18]. Recent studies have identified periodontal pathogen DNA in the atherosclerotic plaques of patients with PAOD [31–33]. *P. gingivalis* and *A. actinomycetemcomitans* are the most prevalent periodontal pathogens in atherosclerotic plaques [34].

This study has some limitations. First, the LHID does not provide information about the severity of PD, which could affect the risk of PAOD. Second, data on smoking, alcohol consumption, physical activity, and diet were not obtained from the database; such personal behaviors are potential confounders. However, we included related comorbidities and performed PSM to address these factors. Third, the study was a retrospective cohort study; therefore, we could not infer causality.

5. Conclusions

Our study demonstrates that PD is associated with PAOD risk, especially in patients older than 65 years. Although no specific interaction of dental scaling with PD affected PAOD risk in the subgroup analysis, dental scaling may generally reduce the risk of PAOD.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/ijerph191610057/s1, Table S1: Disease with relative ICD codes correspond.

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