Periodontal disease as a possible risk factor for atherosclerotic cardiovascular diseases in a Greek adult population

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Background: Several epidemiological studies have been carried out pointing towards an association between periodontal pathogens and various systemic disorders or diseases, such as atherosclerotic cardiovascular diseases (ACVD), respiratory diseases, allergies, diabetes mellitus and systemic infections. The mentioned systemic infections and inflammations mediate through biomarkers such an association. Based on the mentioned association it has also been proposed a possible relationship between periodontal disease and ACVD.

Methods: Data were collected from dental clinical examinations and the health questionnaires of 1,850 individuals, 938 males and 912 females, aged 49 to 80 years. The participants were inter-viewed and undergone an oral clinical examination. The questionnaire contained questions regarding oral health status of the participants, epidemiological variables and several types of ACVD. Stepwise logistic regression analyses were performed to estimate possible associations between all ACVD and their subgroups, heart attack (HA), coronary heart disease (CHD), cardiac arrhythmias (CA) and high blood pressure, and periodontal disease indices. In addition, odds ratios (ORs) were assessed after adjusting for gender, smoking, socioeconomic status, educational level and oral hygiene follow-up frequency.

Results: A significant association between gingival inflammation, (OR =6.14, P<0.000), clinical attachment loss (CAL) (OR =1.45, P=0.044), bleeding on probing (BOP) (OR =2.52, P=0.040), and ACVD was found, whereas no association was detected between deep periodontal pockets and ACVD.

Conclusions: Significant associations between investigated atherosclerotic cardiovascular disease and periodontal disease variables, such as gingival inflammation, CAL and BOP were assessed.

Keywords: Atherosclerotic cardiovascular diseases (ACVD); pocket depth; clinical attachment loss (CAL); periodontal disease; risk factors

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Introduction

A large amount of people in Greece have been affected by several types of periodontal disease, such as gingivitis and periodontitis. Recent studies have not been performed regarding the prevalence/incidence of PD in Greece, however, a recent one recorded that 27.5% of Greek adults aged 35–44 years old had shallow and deep pockets, whereas 9.5% of the subjects examined showed healthy periodontium. It was also showed that the prevalence of severe PD in Greek adults was not high and their periodontal health had improved since 1985, whereas a corresponding decrease in gingivitis prevalence was not
PD and especially periodontitis is a chronic progressive inflammatory disease and characterized by inflammation of the periodontal tissue and destruction of periodontal fibers and alveolar bone.

It has also been suggested that several bacteria and their antigens, endotoxins and inflammatory cytokines and chemokines show elevated levels due to chronic periodontitis and activate a systemic inflammatory reaction (2,3).

Several researchers and clinicians have observed that periodontal infection contributes to periodontitis and leads to systemic effects as significant associations have been recorded between PD and systemic diseases or disorders such as atherosclerotic cardiovascular diseases (ACVD), respiratory diseases and allergies, hypertension (HT), diabetes mellitus, endocrine disorders, cancer etc. (4).

ACVD is a group of vessels and heart disorders and include coronary heart disease and artery diseases (CHD/CAD) such as myocardial infarction and angina, cardiac arrhythmias (CA), stroke, hypertensive heart disease, cardiomyopathy, rheumatic heart disease, aortic aneurysms, endocarditis, cerebrovascular disease, etc. (5). ACVD consists also the main cause of death in economically developed countries (6), whereas genetic influences in combination with environmental and behavioural risk factors have been suggested as its pathogenic factors (7).

It is well-known that many risk factors, such as age, male gender, HT, marked obesity, abnormal lipid metabolism, diabetes mellitus (8,9), cigarette smoking and physical inactivity socio-economic status, diet (8) are involving in causing ACVD, however its etiology remains still unknown as many clinical and epidemiological aspects need to be clarified (10). The role of systemic chronic inflammation in ACVD pathogenesis has also been proposed (11).

Previous reports have recorded associations between male gender, smoking, diabetes mellitus, low socio-economic level and dyslipidemias as ACVD causative risk factors and PD development (12,13).

According to the mentioned observations a role of PD in ACVD etiology (11) has been suggested, whereas a significant association has been observed between PD and elevated serum levels of chronic inflammation biomarkers such as cytokines and chemokines (14).

Recent cohort and case-control researches have reported an association between PD and ACVD (4,15-21) whereas, few ones have shown no associations between both diseases (22-27). A small number of previous studies have investigated the possible association between chronic periodontitis and HT, leading in inconsistent findings and focusing the need for more research (28-30).

A possible relationship between PD and ACVD could be attributed to the fact that both diseases characterized by common causative/risk factors, such as smoking, low socio-economic status and diabetes mellitus (31). Their pathogenesis also characterized by elevated serum levels of inflammatory biomarkers such as C reactive protein (CRP) and fibrinogen (32). Periodontal bacteria or their products affect directly the vascular endothelial cells because of bacteremia or indirectly because of the inflammatory reaction, conditions that can lead to ACVD pathogenesis (33).

It has also been suggested that genetic factors influence the biological progression of both diseases and based on that observation, the possible association between both diseases was suggested (34), although those factors remain to be discovered.

The purpose of the current research was to examine the possible relationship between periodontal diseases clinical variables and ACVD in a sample of Greek individuals.

**Methods**

**Study sample**

The current retrospective cross-sectional population-based study involved the cities of Patra, Rio, Kato Achaia and four surrounding villages. The participants were permanent inhabitants of the mentioned locations and based on each community population size were drawn at random. In order to be acquired a representative study sample the study population was stratified by age and gender. Thus, a sample of 1,850 individuals, 938 males and 912 females aged 49 to 80 years was invited to participate.

All the participants were patients of a private dental and two private medical practices, were interviewed by filled in a medical and a dental health questionnaire and undergone an oral clinical examination. The research was performed between December 2014 and November 2015.

**Patient selection criteria**

Participants’ selection criteria comprised age from 49 to 80 years old. The minimum number of the participants’ natural teeth should be at least 20, since less than 20 teeth could lead to over- or underestimation of the parameters and the possible relationships examined.

All participants ought not to have been received
conservative or surgical periodontal treatment during the previous six months or systemic antibiotics or anti-inflammatory or other systemic medication during the previous six weeks. Out-patients suffered from acute infections, malignant diseases, or received medication with systemic glucocorticoids treatment, were not included in the research. The mentioned criteria were determined in order to limit possible influences due to known or unknown confounders on the study variables examined and because of potential effects of those conditions on the oral and periodontal tissues. Third molars and remaining roots were also not included in the research.

Oral clinical examination

A well-trained and calibrated dentist was performed participants’ oral clinical examinations and the following clinical parameters were recorded: gingival index (GI), probing pocket depth (PPD), clinical attachment loss (CAL) and bleeding on probing (BOP) were measured by a William’s 12 PCP probe (PCP 10-SE, Hu-Friedy Mfg. Co. Inc., Chicago, IL, USA) at six sites (lingual, facial, disto-lingual, mesio-lingual, disto-facial and mesio-facial).

The severity of PPD and CAL was coded according to the criteria of 'clinically established periodontitis' (35).

The severity of gingivitis was coded according to the following clinical signs: no pathological condition of gingiva/mild gingival inflammation which refers to Löe and Silness (36) classification as score 0 and 1; moderate/severe gingival inflammation, which refers to Löe and Silness (36) classification as score 2 and 3.

The presence of PPD was coded according to the following clinical signs (37): score 0—periodontal pockets with moderate depth, 4–6.0 mm; score 1—advanced periodontal pockets with advanced depth, >6.0 mm.

The severity of CAL coded according to the following clinical signs (38): score 0—mild attachment loss, 1–2.0 mm; and score 1—moderate/severe attachment loss, ≥3.0 mm. PPD and CAL records were estimated according to the immediate full millimetre. The presence or absence of BOP was coded according to the following clinical signs: score 0—BOP absence; and score 1—BOP presence and determined as positive in case the reaction was occurred within 15 seconds of probing.

Questionnaire

All individuals that participate in the study completed a medical and dental questionnaire which contained clinical parameters such as sex, age, smoking habits (current, previous/no-smokers), educational and socio-economic level and information that concerned their medical history, medication, several chronic or systematic diseases or pathological conditions and the frequency of participants’ dental follow-up. For the mentioned aim a modified University of Minnesota Dental School Medical Questionnaire (39) questionnaire was used and was included ACVD’s four subgroups that are CHD, heart attack (HA), HT and CA.

The main question for the participants was if they ever had a disease or disorder that had been diagnosed by a MD. Participants’ medical files were used in cases they were not able to mention details of their medical history concerned the clinical parameters examined.

In order to assess the intra-examiner variance, a randomly chosen sample consisted of 370 (20%) participants was undergone another clinical dental examination by the same dentist after 3 weeks. After consideration of the protocol numbers of the double examined individuals no differences were estimated between both clinical assessment (Cohen's Kappa =0.97) whereas no oral hygiene instructions were given to the study population for 3 weeks.

Ethical consideration

The present retrospective cross-sectional population-based study was an epidemiological study that was not based on experimental process, as in Greece authorized committees must approve issues regarding the ethical consideration e for experimental researches only.

Individuals who accepted the invitation to take part in the present research informed about the aims of it a consent form was signed by them. The present research has been carried out in full agreement with the World Medical Association Declaration of Helsinki.

Statistical analysis

The worst values of the indices examined at the six sites per tooth were assessed and coded as dichotomous variables for each participant.

Males individuals, current and previous smokers, subjects with a high educational (graduated from University/College) and socio-economic (income equivalent to or above 1,000 €/monthly) level and participants that had the proper frequency of a dental follow-up were coded as 1. A
multivariate regression analysis was applied out to test the associations between the dependent variable, ACVD and the mentioned medical conditions separately, and independent ones that were determined by the initial (enter) method. The model was also used to assess adjusted odds ratios (ORs) and 95% confidence interval (CI).

Finally, after performing of the stepwise method was assessed gradually which independent variables showed significant associations with ACVD that is the dependent one.

The statistical package of SPSS ver. 17.0 was used for performing of statistical analysis whereas a p value less than 5% (P<0.05) was determined to be statistically significant.

**Results**

The participants had a mean age of 58.4±2.8 years.

A total of 1,968 individuals were invited to participate in the present investigation. The 47 participants were not permanent inhabitants of Patra Rio, Kato Achaia and the surrounding villages and were not included in the study sample, 32 participants did not meet the mentioned inclusion criteria as they had less than 8 remaining teeth or they had received systemic antibiotics or anti-inflammatory drugs for a large period, whereas 39 participants kindly refused to take part in the study. Finally, the study sample consisted of 1,850 out-patients giving a response rate 94.0%. Current smokers reported 58.9% of the study sample, 32.5% males and 26.4% females.

**Table 1** Frequencies of periodontal diseases parameters according to epidemiological variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>No.</th>
<th>Gingival inflammation (score 1), No. (%)</th>
<th>Deep periodontal pockets (score 1), No. (%)</th>
<th>Severe clinical attachment loss (score 1), No. (%)</th>
<th>Presence of bleeding on prob. (score 1), No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>938</td>
<td>88 (9.4)</td>
<td>84 (8.9)</td>
<td>96 (10.2)</td>
<td>94 (10.0)</td>
</tr>
<tr>
<td>Female</td>
<td>912</td>
<td>102 (11.2)</td>
<td>97 (10.6)</td>
<td>111 (12.2)</td>
<td>119 (13.0)</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>49–58</td>
<td>475</td>
<td>54 (11.4)</td>
<td>63 (13.2)</td>
<td>48 (10.1)</td>
<td>71 (14.9)</td>
</tr>
<tr>
<td>59–68</td>
<td>610</td>
<td>63 (10.3)</td>
<td>72 (11.8)</td>
<td>61 (10.0)</td>
<td>68 (11.1)</td>
</tr>
<tr>
<td>69–78</td>
<td>590</td>
<td>46 (7.8)</td>
<td>35 (5.9)</td>
<td>78 (13.2)</td>
<td>56 (9.5)</td>
</tr>
<tr>
<td>79+</td>
<td>175</td>
<td>27 (15.4)</td>
<td>11 (6.3)</td>
<td>20 (11.4)</td>
<td>18 (10.3)</td>
</tr>
<tr>
<td>Socioeconomic status</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>High</td>
<td>832</td>
<td>83 (9.9)</td>
<td>75 (9.0)</td>
<td>91 (10.9)</td>
<td>82 (9.9)</td>
</tr>
<tr>
<td>Low</td>
<td>1018</td>
<td>107 (10.5)</td>
<td>106 (10.4)</td>
<td>116 (11.4)</td>
<td>131 (12.9)</td>
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<tr>
<td>Educational level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>1126</td>
<td>79 (7.0)</td>
<td>78 (6.9)</td>
<td>87 (7.7)</td>
<td>85 (7.5)</td>
</tr>
<tr>
<td>Low</td>
<td>724</td>
<td>111 (15.3)</td>
<td>103 (14.2)</td>
<td>120 (16.6)</td>
<td>128 (17.7)</td>
</tr>
<tr>
<td>Dental follow-up</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td>777</td>
<td>73 (9.4)</td>
<td>71 (9.1)</td>
<td>83 (10.7)</td>
<td>91 (11.7)</td>
</tr>
<tr>
<td>Irregular</td>
<td>1073</td>
<td>117 (10.9)</td>
<td>110 (10.3)</td>
<td>124 (11.6)</td>
<td>122 (11.4)</td>
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<tr>
<td>Smoking status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1091</td>
<td>124 (11.4)</td>
<td>113 (10.4)</td>
<td>137 (12.6)</td>
<td>129 (11.8)</td>
</tr>
<tr>
<td>No</td>
<td>759</td>
<td>66 (8.7)</td>
<td>68 (8.9)</td>
<td>70 (9.2)</td>
<td>84 (11.1)</td>
</tr>
</tbody>
</table>

Table 1 presents oral variables frequencies of the total study-population that was answered the questionnaire and in the mentioned ACVD's subgroups. ACVD's frequencies of the parameters examined in all participants and in the subgroups are presented in **Table 2**.
Logistic regression analysis model showed an association between gingival inflammation and all ACVD, HT, and CHD. Associations were found between CAL and all ACVD, BOP and all ACVD, CAL and HA, CAL and CHD, BOP and HA, BOP and CHD, and BOP and HT (Table 3).

Associations were also recorded between smoking and all ACVD, higher educational level and all ACVD except for HT, and higher socio-economic status and HA and CHD. No associations were observed between all ACVD and gender, age and dental follow-up (Table 4).

**Discussion**

The present study showed that gingival inflammation could be an index of an increased risk of ACVD. Individuals with gingival inflammation had an OR of 6.14 to suffer from any kind of ACVD, such as CHD and HT. HT showed a particularly significant association with inflammatory gingiva. This observation is important, since it is one of the main risk factors for ACVD (40). A link between gingival inflammation and HT was also observed in a study by Buhlin et al. (41). Gingival inflammation was associated with CHD, observation that is in agreement with previous studies (42,43), whereas no association was observed between those variables in a report by Chrysanthakopoulos et al. in Greek adults (44).

No association was recorded between PPD and ACVD, finding that was confirmed by previous reports (41,42). Similarly, no associations were recorded between the subgroups of ACVD examined and periodontal pockets.

This observation suggests an association between
gingival inflammation and ACVD, but not between periodontitis and ACVD. Morrison et al. (45) showed that the relative risk of dying of CHD was higher in individuals suffered from mild or severe gingivitis than in those with periodontitis. Hung et al. (43) were recorded that PPD were observed in previous studies (43, 46, 51). Similar findings with ACVD, however, this association was most notably in those with periodontitis. Hung et al. (46) were observed a strong association between serum biomarkers of PPD and ACVD biomarkers such as lipoproteins.

Similarly, Starkhammar-Johansson et al. (47) found that CHD patients had significantly higher rates of deep periodontal pockets 4–6.00 mm. In another study, classified periodontitis (48), was found to be significantly associated with CHD presence (49). A case-control study by Latronico et al. (50) supported that deep periodontal pockets seemed to be important risk factors for ACVD.

However, other reports did not confirm such findings (24, 51, 52). A link between HT and PPD was recorded in a previous report (53), finding that was not in agreement with the current report and similar ones (41, 51, 52) whereas a small number of previous studies have investigated the possible association between chronic periodontitis and HT leading to inconsistent results and highlighting the need for further research (28–30).

The current study revealed an association between HA and PPD, finding that was in accordance with the one of a recent report (53). CAL was found to be associated with ACVD, however, this association was most notably in individuals suffered from CHD and HA. Similar findings were recorded in previous studies (43, 46, 51). In addition, Tuominen et al. (54) recorded a significant association between CAL and HT and CAL and HA, however, other reports did not confirm such observations (42, 44, 52).

The current study also recorded that, a total of 11.5% showed BOP, in both males and females and a strong association between BOP and ACVD was recorded. The mentioned association was most marked in patients with CHD, HT and HA but not in those with CA.

Similar results regarding all ACVD and BOP, and HT and BOP were observed in a previous report (41), whereas Pejcic et al. (46) found an association between CHD and BOP, and Chrysanthakopoulos et al. (52) observed an association between ACVD and BOP, whereas in the same study no associations were observed between BOP and HT.

Those contradictory results, with OR's ranging between over 1.0 and almost 1.0 indicate that the possible association examined is complicated and several factors have been involved. Those factors must be methodically clarified before an association between ACVD and periodontitis can be conclusively recorded.

Tobacco smoking was associated with ACVD and particularly strong associations were observed in individuals suffered from CHD and HA. This finding shows that ACVD is a strong incitement for cessation of smoking.

Similarly, higher educational level was associated with all subgroups of ACVD except for HT, whereas higher socio-economic status was associated with CHD and HA. Previous reports have recorded either no association after adjustment for parameters considered to be confounders or non-significant positive trends (54, 55) whereas Bokhari and Khan (23) suggested that the available researches regarding the link between of PD and ACVD are inconclusive and
most of their data is based on epidemiological and not on experimental investigations.

The current study has certain limitations that should be considered during the procedure of interpreting the results section. In a retrospective study, like the present, the reliability is not as high as for prospective ones since the inter-examiner variability is most likely higher. In addition, random and recall biases and the effect of known and unknown confounders are likely higher. Another limitation was that the study information based on the individuals’ responses to the questionnaire. Therefore, the participants could not respond to some of the questions or could over- or under-estimate their potential medical problems and this situation could lead to restrictions on the study validity during the results interpretation. Despite the fact that participants’ data collection could be collected by their own medical files this procedure could lead to epidemiological biases regarding results validity. Finally, it

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total ACVD, OR (95% CI)</th>
<th>Hypertension, OR (95% CI)</th>
<th>Coronary heart disease, OR (95% CI)</th>
<th>Heart attack, OR (95% CI)</th>
<th>Arrhythmia, OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>0.299</td>
<td>0.311</td>
<td>0.229</td>
<td>0.064</td>
<td>0.302</td>
</tr>
<tr>
<td>Males</td>
<td>1.40</td>
<td>1.22</td>
<td>1.65</td>
<td>1.83</td>
<td>1.45</td>
</tr>
<tr>
<td>Females</td>
<td>1 (0.74–2.66)</td>
<td>1 (0.83–1.81)</td>
<td>1 (0.64–2.21)</td>
<td>1 (0.75–2.96)</td>
<td>1 (0.71–2.95)</td>
</tr>
<tr>
<td>Age (per year)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>0.406</td>
<td>0.068</td>
<td>0.339</td>
<td>0.643</td>
<td>0.551</td>
</tr>
<tr>
<td>0.64</td>
<td>1.72</td>
<td>2.21</td>
<td>1.39</td>
<td>0.74</td>
<td></td>
</tr>
<tr>
<td>1 (0.14–1.28)</td>
<td>1 (0.29–2.58)</td>
<td>1 (0.86–3.41)</td>
<td>1 (0.67–2.12)</td>
<td>1 (0.30–2.03)</td>
<td></td>
</tr>
<tr>
<td>Socioeconomic status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>0.604</td>
<td>0.134</td>
<td>0.052</td>
<td>0.001*</td>
<td>0.480</td>
</tr>
<tr>
<td>High</td>
<td>1.20</td>
<td>1.73</td>
<td>2.58</td>
<td>6.11</td>
<td>0.38</td>
</tr>
<tr>
<td>Low</td>
<td>1 (0.61–2.36)</td>
<td>1 (0.48–1.10)</td>
<td>1 (0.99–6.70)</td>
<td>1 (2.06–18.17)</td>
<td>1 (0.63–2.70)</td>
</tr>
<tr>
<td>Educational level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>0.001*</td>
<td>0.626</td>
<td>0.002*</td>
<td>0.038*</td>
<td>0.002*</td>
</tr>
<tr>
<td>High</td>
<td>0.29</td>
<td>0.89</td>
<td>1.09</td>
<td>1.08</td>
<td>1.17</td>
</tr>
<tr>
<td>Low</td>
<td>1 (0.14–0.60)</td>
<td>1 (0.56–1.42)</td>
<td>1 (0.23–2.11)</td>
<td>1 (0.58–2.93)</td>
<td>1 (0.83–3.65)</td>
</tr>
<tr>
<td>Dental follow-up</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>0.113</td>
<td>0.900</td>
<td>0.366</td>
<td>0.570</td>
<td>0.680</td>
</tr>
<tr>
<td>Irregular</td>
<td>1.78</td>
<td>1.03</td>
<td>1.67</td>
<td>1.37</td>
<td>1.17</td>
</tr>
<tr>
<td>Regular</td>
<td>1 (0.87–2.64)</td>
<td>1 (0.66–1.60)</td>
<td>1 (0.55–2.07)</td>
<td>1 (0.46–2.08)</td>
<td>1 (0.37–2.30)</td>
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<tr>
<td>Smoking status</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>0.058</td>
<td>0.082</td>
<td>0.082</td>
<td>0.002*</td>
<td>0.010*</td>
</tr>
<tr>
<td>Smokers</td>
<td>2.06</td>
<td>0.70</td>
<td>3.23</td>
<td>2.81</td>
<td>1.28</td>
</tr>
<tr>
<td>Non-smokers</td>
<td>1 (0.99–4.28)</td>
<td>1 (0.47–1.05)</td>
<td>1 (0.02–0.14)</td>
<td>1 (0.14–4.27)</td>
<td>1 (0.97–3.13)</td>
</tr>
</tbody>
</table>

*, results indicate statistical significance (P≤0.05). OR, odds ratios; 95% CI, 95% confidence interval; ACVD, atherosclerotic cardiovascular diseases.
was not clear whether gingivitis or periodontitis precede ACVD and because of that, it is difficult to establish a causal relationship between diseases examined.

Based on the fact that gingivitis or periodontitis precede ACVD it is of vital importance to take into account that the period from exposure to disease appearance is at best short in relation to the CV system alterations. In addition, a possible underestimation of older individuals who suffered from PD and who may have lost their teeth due to periodontal reasons could be occurred because of the decision to be included in the study sample protocol older participants who had at least 20 remaining natural teeth. Another limitation was that in the present study were recorded conventional periodontal parameters, whereas in similar studies different and more reliable PD parameters such as alveolar bone height or loss or the total number of remaining or missing teeth have been used.

**Conclusions**

The current investigation recorded an association between ACVD and gingival inflammation, CAL and BOP, without indicating the nature of such an association, or the possible causal role of PD in ACVD development. For that reason further research is needed.

**Acknowledgements**

None.

**Footnote**

_Conflicts of Interest:_ The authors have no conflicts of interest to declare.

_Ethical Statement:_ The study needs no approval of the Institutional Review Board (IRB) as it was not an experimental one and based on questionnaires and simple dental examinations. All enrolled patients had not been examined by clinical examination as the diagnosis of several ACVD forms had been set before the study design.

**References**


