ORIGINAL PAPER

THE PREVALENCE AND SEVERITY OF PERIODONTITIS IN A POLISH CROSS-SECTIONAL GERODONTOLOGICAL STUDY

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ABSTRACT

Introduction: Evaluation of the prevalence and severity of periodontitis as a significant aspect in the overall assessment of oral health and needs of integrated treatment in gerodontology was performed.

Objectives: In the population aged 65-74 evaluation of prevalence and severity of periodontitis as definied by CDC/AAP in the Polish cross-sectional epidemiological study.

Material and methods: A total of 1,200 people aged 65-74, living in a city (Wrocław, 630,000 population) and in a small town (Oława, 33,000 population) located in southwestern Poland were randomly selected to participate in the study. 285 people from Wrocław and 102 from Oława took part in the epidemiological study. In a clinical dental examination the following aspects were assessed: the number of teeth, bleeding on probing (BoP), pocket probing depth (PPD) and the clinical attachment level (CAL) for all teeth at 4 measurement points. A periodontal diagnosis was made according to the CDC/AAP criteria. In the anamnestic study, variables related to the socio-economic status, systemic conditions and behavioral factors related to selected oral health behaviors were determined.

Results: The prevalence of periodontitis was 47.9% (20.8% moderately advanced and 21.2% severely advanced). Statistically, periodontitis occurred more frequently in persons with current nicotine addiction, with a history of a cardiovascular incident and also in men. In the multifactorial model it was found that the significant protection against periodontitis is related to the highest personal income, the correct pattern of daily tooth brushing and self-financed dental treatment, whereas the history of a cardiovascular incident is associated with its occurrence.

Conclusions: The prevalence of periodontitis in seniors of Lower Silesia is lower, while the presence of its severe form is comparable to the findings of foreign regional studies.

Key words: periodontitis, prevalence, severity, elderly, risk factors.

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INTRODUCTION

A characteristic feature of periodontitis is its chronic course leading to the irreversible destruction of tissues surrounding the tooth. The rate of disease progression shows individual variability. However, the most frequent feature is the slow destruction of tissues surrounding the tooth with periods of remission and relapse. The peak in incidence of advanced periodontitis occurs around 38 years of age [1]. It corresponds to the maximum prevalence of the disease, occurring around the age of 40 and remaining at a steady level in subsequent years [2]. The results of epidemiological studies demonstrate that the global incidence and prevalence

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of advanced chronic periodontitis have not changed in recent decades [1]. The periodontal health status of Europeans is very poor [3]. In the group aged 60-65, problems with periodontium affect 70-85% of people [4].

Teeth loss in the course of periodontitis may be reflected in the decrease in the growth dynamics of the incidence of the most advanced forms of this disease in the elderly. Periodontitis remains one of the most important gerodontological problems, and its effective treatment is one of the constant challenges of comprehensive oral treatment of the elderly.

The definition of periodontitis according to Page and Eke proposed in 2007 distinguishes 3 diagnoses: the absence of periodontitis or mild periodontitis, moderate and severe periodontitis [5]. On this basis, the prevalence and incidence of periodontitis could not be estimated in cohort studies.

Only the definition proposed by Eke *et al.* in 2012 [6], including the suggestions of the American Center for Disease Control and Prevention (CDC) and the American Academy of Periodontology (AAP), offers the following categories: no periodontitis and all forms of periodontitis (TP), which included mild, moderate and severely advanced types, according to the 2007 criteria. In our own cross-sectional regional study this classification was used in order to show the prevalence and severity of periodontitis and the impact of potential risk factors on bi- and multifactorial analyses.

OBJECTIVES

The aim of the cross-sectional epidemiological study was to assess the prevalence and severity of periodontitis according to the CDC/AAP definition in people aged 65 to 74 living in a large and small city in southwestern Poland and to compare the findings to current regional foreign surveys. We also attempted to establish what factors in the examined group are most-related to the prevalence of periodontitis as defined by the CDC/AAP criteria.

MATERIAL AND METHODS

An epidemiological study was carried out to assess the population aged 65-74, living in a city (Wrocław, 638,000 inhabitants) and a small town (Oława, 33,000 inhabitants) in the Lower Silesia Voivodship in southwest Poland.

At the Ministry of the Interior and Administration in Warsaw, a group of 1200 people (800 and 400 for Wrocław and Oława, respectively) was selected in a two-tier draw (sex and age, respectively), thus forming a group with the symmetrical structure of sex and age. A letter of invitation to participate in a free examination of oral health was sent to all the randomly selected people. Persons for whom a valid phone number was established were additionally notified by telephone.

The study was carried out at the Department of Periodontology of the Medical University in Wrocław and in a private specialist dental clinic in Oława (Praktyka Prywatna, Dentyści Oława). The persons reporting to take part in the study signed the statement approved by the Bioethics Commission at the Medical University of Wroclaw (opinion no. KB-712/2017), thereby agreeing to participate in the study and on the processing of obtained data. The applied exclusion criteria were general (including the history of bacterial endocarditis) and local (including acute odontogenic inflammation) contraindications for the dental examination.

In the period between 25th June and 30th October 2017, 387 people (136 men and 149 women from Wrocław, and 50 men and 52 women from Oława) were examined. The response rate for research was 32.8% (35.6% for a large city and 25.5% for a small town).

The following information was obtained in the interview: place of residence (Wrocław or Oława); age, gender, education (elementary, secondary, higher); general diseases: cardiovascular diseases (conditions without an incident, e.g. coronary heart disease, cardiac arrhythmias or thrombotic diseases and with an incident, i.e. a myocardial infarction or stroke), hypertension, diabetes, osteoporosis – with pharmacological treatment of the declared disease taken as the diagnostic criterion; the genetic load in the form of periodontitis in the history (the survey question whether family members such as grandparents, parents or siblings had lost their teeth because of progressive mobility); body weight and height along with the BMI index based on these measurements; nicotine addiction: non-smokers (people who had never smoked or had smoked fewer than 100 cigarettes throughout their lives), ex-smokers (people who used to smoke regularly, but had been free of addiction for a year at least at the time of examination), and current smokers (people who had been smoking a minimum of 1 cigarette a day during the 6 months preceding the examination; for this subgroup the pack-year index was determined, being the product of multiplying the number of packs of cigarettes smoked per day by the number of years the person had smoked); income per capita in the household: the lowest (up to 800 zł per month, approximately), the average (801-2500 zł per month, approximately) and the highest (above 2500 zł per month, approximately); oral health behaviors: average number of visits to a dental clinic during the previous 5 years (at least 2 visits per year were considered regular); the frequency of brushing natural teeth or prostheses (brushing at least twice daily was considered regular); the frequency of replacing a toothbrush per year (at least once every 3 months is considered regular brush replacement); daily additional cleaning of the interdental spaces with dental floss or a special brush (yes, no); forms of dental treatment funding: only in state-financed facilities, only in private facilities, or the mixed way.

The clinical examination was performed in LED lighting, using a dental mirror and the Hu-Friedy PCPUNC

15 periodontal probe. Before the examination, the periodontology specialists participating in the study were calibrated. Particular attention was paid to the reproducibility and repeatability of measuring the PD, the CEJ-GM distance (cemento-enamel junction and gingival margin) and the amount of the gingival recession. 82% consistency in measurement reproducibility in the range of 1 mm was obtained with respect to a researcher. The measurement repeatability in the range of 1 mm was 91%.

The following aspects were assessed in the clinical dental examination: the number of remaining natural teeth with the exclusion of third molars; the incidence of dental caries and its consequences, which were expressed numerically by the DMFT index and its components; the extent of inflammation expressed by the bleeding on probing rate (BoP) according to Ainamo and Bay [7] at 4 measurement points around the tooth (distal-buccal, mesial-buccal, mid-buccal, mid-lingual); the sulcus/pocket depth (PPD) at these 4 points around each tooth: for each subject, the average PD value was calculated with all the measurements (PD_{MEAN}) and the number of periodontal pockets deeper than 5 mm (PD > 5); the clinical attachment level (CAL) at these 4 points around each tooth: for each subject the number of sites with clinical loss of attachment on the interproximal surfaces of at least 3 mm (CAL ≥ 3 mm) and above 5 mm (CAL > 5 mm) was calculated.

The periodontal health status was categorized on the basis of the CDC/AAP classification by Ecke *et al.* [6]. The following were distinguished: no periodontitis (TP 0) – the criteria for mild periodontitis are not met; mild periodontitis – when ≥ 2 teeth with CAL ≥ 3 mm on the interproximal surfaces, and ≥ 2 teeth with PD ≥ 4 mm, or 1 tooth with PD ≥ 5 mm on the interproximal surface are found; moderate periodontitis – when ≥ 2 teeth with CAL ≥ 4 mm on the interproximal surfaces, or ≥ 2 teeth with PD ≥ 5 mm on the interproximal surface are found; severe periodontitis (SP) – when ≥ 2 teeth with CAL ≥ 6 mm on the interproximal surfaces and ≥ 1 teeth with PD ≥ 5 mm on the interproximal surface are found. The diagnosis of any form of periodontitis according to the CDC/AAP classification was defined as TP1 (total periodontitis 1).

The studied continuous features were characterized by the parameters of their distribution, i.e. the mean value and standard deviation (SD) and the size of the sample N. Additionally, median values, quantiles Q1, Q3 and range (min, max) were determined due to the fact that these features generally do not have a normal distribution. Normal distribution of variables was verified by the classic tests of Kolmogorov-Smirnov and Wilk. In order to verify the influence of individual, socioeconomic, health, dental and periodontal factors on TP1, 2 models of univariate analysis were used: classic, in which the value of each factor separately was tested for the equality of the mean values of the tested features with nonparametric tests, including with the Mann-Whitney test for 2 means; and the multiple regression model in which all factors are involved simultaneously as independent variables in a linear correlation.

In order to verify the influence of the studied factors on categorized features, 2 models were used: classic, in which the frequency of occurrence of the categorized feature for the values of individual factors was verified by the χ^2 test, including four-cell tables with Yates correction; and multiple logit regression for binomial distribution, in which at the same time, the factors studied are taken as independent variables. After the logit transformation, they describe a dichotomous dependent variable with a linear equation. The essence of this model is to find such a set (subset) of factors for which all linear equation coefficients significantly differ from the zero value. Each of the coefficients of this equation for the determined factor makes it possible to determine the odds ratio (OR) and its 95% confidence interval.

The permissible error of statistical evaluation was adopted at the level of 5%, signifying it as the level of statistical significance $p \leq 0.05$. The statistical analysis was carried out using the Statistica 13.1 software.

RESULTS

There were 55 edentulous patients in the study group, who were excluded from the observation. Therefore the study was finally carried out in a group of 332 people (250 inhabitants of Wrocław and 82 of Oława).

The average number of teeth in this group was 15.23 (SD = 6.9, median 16). The average DMFT index was 17.59 (SD = 5.5, median 17) and its components were as follows: D = 1.22 (2.02 and 1), M = 11.09 (6.6 and 10), and F = 5.23 (4.1, 5), respectively. The average value of the BoP index was 36.77 (SD = 26.2), and the average value of PD was 2.52 (SD = 0.7). Periodontal pockets with PD greater than 5 mm occurred in 101 people (30.4%) and this concerned 2% of the remaining teeth. The presence of attachment loss of at least 3 mm on contact surfaces was noted in 150 people (45.2%), whereas CAL > 5 mm on these surfaces was found in 103 subjects (31%) on 2% of the remaining teeth. The presence of a family history of periodontitis was found in 85 people (25.6%) in the interview.

The prevalence of periodontitis as defined by CDC/AAP (TP1) was 47.9% (159 people), including mild stage cases that accounted for 5.4% (18 people), moderately advanced stage cases – 20.8% (69 people), and severely advanced stage cases (SP) – 21.7% (72 people).

Periodontitis (TP1) occurred significantly more often in people with nicotine addiction ($p = 0.002$ in comparison to patients who never smoked), with a history of cardiovascular events ($p = 0.012$ in relation to persons without a history of cardiovascular disease) and in men ($p = 0.0495$). Its severe form was also more common in current nicotine addicts ($p < 0.0001$ compared to the participants who had never smoked) and with

TABLE 1. The prevalence of periodontitis (TP 1) and severe periodontitis (SP) according to the CDC/AAP definition depending on the anamnestic variables ($N = 332$)

Variable	Compared variables				*p*	Compared variables				*p*
	N_{TP0-1}	People with TP 1, *n* (%)	N_{TP0-1}	People with TP 1, *n* (%)		N_{TP0-1}	People with SP, *n* (%)	N_{TP0-1}	People with SP, *n* (%)	
Place of residence	252	Wrocław	80	Oława	0.27	252	Wrocław	80	Oława	0.67
		125 (49.6)		34 (42.5)			56 (22.1)		16 (20.0)	
Sex	169	Women	163	Men	**0.0495**	169	Women	163	Men	0.07
		72 (42.6)		87 (53.4)			30 (17.8)		42 (25.8)	
Education	65	Elementary	97	Higher	0.31	65	Elementary	97	Higher	0.45
		30 (46.1)		52 (53.6)			16 (24.6)		19 (19.6)	
Income	38	Lowest	59	Highest	0.16	38	Lowest	59	Highest	0.27
		17 (44.7)		35 (59.3)			10 (26.3)		11 (18.6)	
Smoking status	184	Never	52	Current	**0.002**	184	Never	52	Current	**0.0001**
		73 (39.7)		36 (69.2)			28 (15.2)		21 (40.4)	
BMI	86	Normal weight	90	Obesity	0.21	86	Normal weight	90	Obesity	0.67
		38 (44.2)		48 (53.3)			18 (20.9)		21 (23.3)	
Diabetes	61	Yes	271	No	0.73	61	Yes	271	No	0.17
		28 (45.9)		131 (48.3)			16 (26.2)		56 (20.6)	
Cardiovascular disease	59	Yes	238	No	0.92	59	Yes	238	No	0.2
		26 (44.1)		109 (45.8)			9 (15.3)		50 (21.0)	
Cardiovascular disease with incidence	35	Yes	238	No	**0.012**	35	Yes	238	No	**0.0344**
		24 (68.6)		109 (45.8)			13 (37.1)		50 (21.0)	
Osteoporosis	38	Yes	294	No	0.68	38	Yes	294	No	0.46
		17 (44.7)		142 (48.3)			10 (26.3)		62 (21.1)	
Hypertension	150	Yes	182	No	0.63	150	Yes	182	No	0.14
		74 (49.3)		85 (46.7)			27 (18.0)		45 (24.7)	
Genetic load of periodontitis (based on the interview)	85	Yes	247	No	0.80	85	Yes	247	No	0.29
		42 (49.4)		117 (47.4)			22 (25.8)		50 (20.2)	
Effectiveness of teeth brushing	100	PI < 30%	100	PI > 70%	0.065	100	PI < 30%	100	PI > 70%	**0.0047**
		40 (40)		53 (53)			12 (12)		28 (28)	
Effectiveness of hygienic procedures in interdental spaces	22	API < 25%	163	API > 70%	0.70	22	API < 25%	163	API > 70%	**0.0004**
		12 (54.5)		83 (50.9)			1 (4.5)		43 (29.3)	
Dental appointments	134	Regularly	198	Irregularly	0.74	134	Regularly	198	Irregularly	0.84
		62 (46.3)		97 (48.9)			28 (20.8)		44 (22.2%)	
Brushing teeth	247	Regularly	85	Irregularly	0.11	247	Regularly	85	Irregularly	0.28
		112 (45.3)		47 (55.2)			50 (20.2)		22 (25.9%)	
Form of dental treatment	92	Public 37 (40.2)	130	Private 65 (50)	0.15	92	Public 19 (20.6)	130	Private 26 (20.0)	0.9

a history of a myocardial infarction or stroke ($p = 0.034$ compared to those without a history of cardiovascular diseases), and additionally in persons more effectively cleaning interdental spaces ($p = 0.0004$) and effectively brushing their teeth ($p = 0.0047$) (Table 1). The effect of the socio-economic gradient on these diagnoses has not been demonstrated.

In relation to young Lower Silesian seniors without periodontitis in TP1, there was significantly higher BoP ($p = 0.021$) and PD_{MEAN} ($p < 0.0001$); the situation in SP

TABLE 2. Values of periodontal and cariological parameters, pack-year and BMI indices depending on the CDC/AAP definition of periodontitis

Variables	Diagnosis according to CDC/AAP			*p*
	TP0 (1)	TP1 (2)	SP (3)	
BoP mean	29.39 ± 24.14	44.80 ± 26.11	55.64 ± 26.81	**0.0001**; difference between 1st and 3rd 0.0001, 1st and 2nd 0.021, 2nd and 3rd 0.0001
PD mean	2.14 ± 0.25	2.95 ± 0.81	3.44 ± 0.90	**0.0001**; difference between all $p < 0.0001$
PD > 5 mm median	0 (0-0)	1 (0-44)	4.5 (2-44)	Difference between 2nd and 3rd 0.0001
CAL > 5 mm median	0 (0-0)	1 (0-33)	4 (2-41)	**0.0001**; difference between all $p < 0.0001$
Number of teeth (mean and median)	15.08 ± 7.50; 16 (1-27)	15.40 ± 6.20; 16 (1-28)	13.76 ± 6.10; 14 (4-28)	**0.0147**; difference between 2nd and 3rd 0.011
DMFT	18.38 ± 5.40; 17 (1-28)	16.74 ± 5.60; 17 (1-28)	16.25 ± 5.90; 17 (2-28)	0.0555
DT	1.09 ± 1.75; 0 (0-8)	1.36 ± 2.27; 1 (0-18)	1.51 ± 2.57; 1 (0-15)	0.17
MT	11.96 ± 7.12; 10 (0-27)	10.14 ± 5.83; 10 (0-27)	9.88 ± 5.77; 10 (0-23)	0.1
FT	5.29 ± 4.32; 5 (0-18)	5.15 ± 3.79; 5 (0-15)	4.60 ± 3.71; 4 (0-14)	0.25
Pack-years	42.10 ± 149.90	102.34 ± 227.10	119.96 ± 226.6	**0.007**; difference between 1st and 3rd 0.05
BMI value	27.89 ± 4.55	28.44 ± 4.39	28.49 ± 4.33	0.29

TABLE 3. Adjusted odds radio (OR)* and 95% confidence interval (95% CI) for prevalence of periodontitis (TP1) depending on the significant variables in logistic regression models

Variable	OR	Lower confidence interval	Higher confidence interval	*p*
Income				
< 2500 zł	1.0 (ref)	0.116	0.564	0.001
≥ 2500 zł	0.256			
Cardiovascular disease with incidence				
Yes	2.295	1.038	5.072	0.04
No	1.0 (ref)			
Brushing teeth				
Irregular	1.0 (ref)	0.228	0.838	0.013
Regular	0.437			
Form of dental treatment				
Public	1.0 (ref)	0.296	0.726	0.001
Private	0.464			

**OR was adjusted for place of residence, sex, education, BMI, smoking status, diabetes, genetic load, regularity of dental visits, cleaning of interdental spaces*

was similar for these 2 parameters: BoP ($p < 0.0001$) and PD_{MEAN} ($p < 0.0001$). In severe periodontitis, the following periodontological parameters were significantly higher compared to TP: BoP ($p = 0.0001$), PD_{MEAN} ($p < 0.0001$), the number of pockets with PD > 5 mm ($p < 0.0001$) and the number of places with CAL > 5 mm on approximal surfaces ($p < 0.0001$). In SP, the level of nicotine addiction given in pack-years was also significantly higher than in those not meeting the criteria of periodontitis ($p = 0.05$); moreover, the number of teeth was significantly lower ($p = 0.0147$) with respect to TP1 and this was not due to the caries-related extractions (Table 2). Caries exponents did not differ significantly between people with periodontal diagnoses according to CDC/AAP.

In the multiple regression model, the largest match of variables independent of the TP1 diagnosis was demonstrated for the persons with a history of a cardiovascular incidents, for income and method of financing dental treatment and the declared pattern of daily tooth brushing. The mentioned past incident more than doubled the probability of its comorbidity with periodontitis, while the highest income, self-financing of dental treatment and regular brushing of teeth reduced the likelihood of its occurrence (Table 3).

TABLE 4. The prevalence and severe of periodontitis according Page and Eke or CDC/AAP definition in studies of people aged 65 to 74 years

Author and year	Study place	*n*	Prevalence of periodontitis	Severity of periodontitis	Other data
Schützhold *et al*. (2012) [8]	Study of Health in Pomerania (SHIP)	554	n.d.	Moderate 52.3% Severe 30%	–
Aimetti *et al*. (2010) [9]	Turin	191	n.d.	Moderate 36.1 Severe 51.3%	Severe more often in men
Desvarieux *et al*. (2003) [10]	New York INVEST study	670	n.d.	Moderate 48.6 Severe 16.8%	–
Kocher and Holtfreter (2014) [11]	Germany	829	n.d.	Moderate 44.8% Severe 19.8%	Severe more often in men
Present study	Wrocław, Oława	387	TP 47.9%	Moderate 20.8% Severe 21.7%	TP more often in men
Lipkiewicz (2014) [12]	Szczecin Police, Łobez	259	TP 70.7%	Moderate 44.8% Severe 19.3%	TP more often in big city
Eke *et al*. (2012) [13]	USA, NHANES	897	TP 71.5%	Severe 11.8%	Severe more often in men

DISCUSSION

In the cross-sectional epidemiological study carried out to assess the periodontal health status, the methodology of the full-mouth examination of the oral cavity was applied, along with the modification concerning 4 measurement points (in all teeth there were 112 measurement points).

This methodology is currently considered the gold standard of epidemiological study of periodontal health status, as it allows one to refer to the definition of periodontitis based on PD and CAL measurements. It is recommended that the full-mouth periodontal examination protocol include 6 measurement points per tooth, that is 168 points in total for all teeth. Eke *et al.* [6] have shown that using a different periodontal examination protocol than the full-mouth one may lead to underestimating the prevalence of periodontitis by as much as 50%.

Table 4 presents the available results of regional and national studies [8-13] on prevalence and severity of periodontitis according to the criteria presented by Page and Eke [5] and CDC/AAP [6]. It is noteworthy that there have been quite a limited number of them – only 7 (5 regional and 2 national), in 4 of which one cannot definitively determine the prevalence of periodontitis. A comparative analysis of these studies requires great caution, as they concern various populations (e.g. in American studies, the occurrence and course of periodontopathy is extremely influenced by the racial factor), and were conducted according to significantly divergent study protocols: in the American [10, 13] and Italian [9] studies the full-mouth examination involving 164 potential measurement points was used; the Polish research involved 112 potential measurement points; while the German studies [8, 11] were conducted according to the partial-mouth protocol involving 36 or 56 measurement points.

In the regional studies, the prevalence of TP varied significantly (47.9% in our observations, by comparison to 70.7% in the West Pomeranian Voivodship [12]), whereas the prevalence of severe periodontitis was similar (21.7% vs. 19.3%).

The worst condition of the periodontium was observed in the regional Italian study of the inhabitants of Turin: the SP affected over 50% of the participants [9]. The results of German studies may be significantly underestimated due to the application of the partial-mouth examination protocol. The prevalence of periodontitis as defined by CDC/AAP criteria among young seniors in Lower Silesia is lower, while the course and occurrence of the severe form are comparable to the findings of other Polish and foreign regional studies. Epidemiological studies of periodontal disease in line with the classification proposed by CDC/AAP should be continued using the full-mouth periodontal examination protocol.

In the analysis of the elderly from the Lower Silesia province, periodontitis (TP1) was more frequent in men, in subjects with nicotine addiction and with a history of cardiovascular events. Severe periodontitis (SP) occurred in turn significantly more frequently in nicotine addicts, in persons ineffectively brushing teeth and cleaning interdental spaces and also in persons with a history of cardiovascular events. The significant impact of nicotine exposure on exacerbation of periodontitis was confirmed by showing the highest average pack-year index in SP. Moreover, in the recent national studies of young seniors in Germany – DMS V [11] – and in the USA [13], more frequent prevalence of TP1 periodontitis and its severe types was observed in people with current nicotine addiction. The influence of existing nicotine addiction on the formation and clinical course of periodontitis [14, 15] is completely negative. There is an agreement on the causal nature of existing

nicotine addiction on the formation of periodontitis (compliance of many studies, moderate strength of the compound, dose-effect correlation, reversibility). Particularly important is the information about the rapidly diminishing negative impact of nicotine addiction on the periodontium along with the discontinuation of the addiction [13], which points to the importance of minimal anti-smoking intervention in the secondary prevention of periodontitis.

The persistence of nicotine addiction is particularly dangerous for periodontium in postmenopausal women, in whom the interaction with osteoporosis exerts a synergistic effect on the resorption of the alveolar bone [16]. Recently, a very significant effect of passive smoking on the formation of periodontitis was also demonstrated [17]. In the future, one should expect a gradual improvement in the periodontal health status due to the decrease in the population of nicotine addicts (most often, the elderly quit smoking after a sudden medical event). The American [13] and German [11] national studies in the group of young seniors confirm our own observation about the more frequent occurrence of periodontitis in men. This correlation is probably due to the higher prevalence of nicotine addiction and generally worse oral hygiene (which was also confirmed in our own study). In addition, Eke *et al.* [16] in recent American national studies noticed the obliteration of the difference in the occurrence of periodontitis according to the CDC/AAP definition between the sexes, attributing this to the postmenopausal condition of women, in which the estrogen deficiency intensifies the processes of periodontal destruction. The significant dependence in our group regarding the higher prevalence of SP in people inefficiently brushing teeth and cleaning interdental spaces and the highest mean values of PI and API in this diagnosis complement the correlation of this diagnosis with behavioral conditions, observed in DMS V (absence of cleaning interdental spaces, poor tooth brushing pattern and irregular dental appointments) [11].

In a multi-factorial analysis based on the regional study of young seniors from Turin [9], only a significant correlation between current nicotine addiction and moderately and severely advanced periodontitis was confirmed (OR = 2.06: 1.26-3.37).

The logistic regression model regarding the influence of variables on the diagnosis of TP in the recent national American study NHANES 2009-2012 [16] indicated the following important conditions (apart from the racial one): current nicotine addiction (OR = 1.54: 1.45-1.65), male gender (OR = 1.47: 1.38-1.58) and 2 socio-economic factors, namely the lowest income (OR = 1.41: 1.25-1.59) and the lowest level of education (OR = 1.29: 1.17- 1.42). Other American studies [6, 13, 17] show the significance of the classic conditions such as income and education and also very diverse racial-ethnic factors, even marital status (with the greatest negative effect in the divorced) and the frequency of visits to the dental office (the worse condition of periodontium in the more frequently treated persons). The latter seemingly surprising observation results from the fact that American seniors undergo periodontal treatment.

In the multifactorial model of the assessment regarding the impact of variables on the diagnosis of TP in the national Danish study [18] there was found a very strong correlation with current nicotine addiction (OR = 4.39: 3.18-6.08), as well as with past nicotine addiction (OR = 2.39: 1.88 -3.05), and the lowest level of the international educational standard (OR = 1.31: 1.05-1.66). In our own multifactor model it was found that – before TP was diagnosed – the following factors displayed a significant protective influence, in order of strength: the highest personal income threshold, self-financing of dental treatment, the appropriate brushing pattern, and the significant effect of comorbidity of cardiovascular events (OR = 2.295: 1.04-5.07).

Surprising in this model is the lack of detecting a significant impact of nicotine addiction, and the selection of the importance of the economic and behavioral factor. Perhaps the multifactorial models for an independent dichotomous variable created in relation to regional populations point to these important interactions, which are of the greatest importance to them.

The cross-sectional study does not resolve the issue of the direction of the influence of comorbidity. However, current studies indicate that periodontitis may have an impact on atherosclerotic cardiovascular diseases and incidents in the form of myocardial infarctions and ischemic strokes and even mortality associated with them [19-22]. In a cross-sectional regional study of young seniors from the West Pomeranian Voivodship [12] it was found that in the group of people with cardiovascular diseases, the absence of periodontitis was less frequently diagnosed, and the course of periodontitis was more severe in this group. Our own observations indicate that in the presence of TP the risk of a cardiovascular incident is about 230%. Ryden *et al.* [19] in the PAROKRANK study of people with the mean age of 62 ± 8 years showed that the adjusted odds ratio for the correlation between myocardial infarction and periodontitis identified in a panoramic X-ray was 1.28 (1.03-1.6). A meta-analysis of 3 cohort studies showed that the cumulative relative risk for the correlation between periodontitis and ischemic stroke was 2.52 (1.77-3.58) [20]. The analysis of 12 studies (including 6 cohort studies) of 1998-2008 regarding the correlation between periodontitis and incidents in the form of infarctions, strokes and peripheral vascular diseases showed that the incidence of periodontitis is significantly higher [21]. However, these dependencies were reported for the group of younger people, under 65, and were more frequent in men. Our own observations indicated that this correlation may also occur in the population of young seniors, despite the increasing accumulation of confounding factors. How important it is to adjust the likelihood measures of the correlation for

common risk factors is shown by the Polish case-control studies [22], in which the odds ratio of severe periodontitis as defined by Page and Eke and myocardial infarction shifted from a significant 3.2 in the absence of adjustment to negligible 0.9 when adjusting the influence of the largest number of variables.

The recommendation by the American Society of Cardiology [23] indicates that in the light of scientific evidence, the correlation between periodontitis and atherosclerotic cardiovascular diseases, along with their complications, may be of an independent nature. Periodontitis belongs to the group of non-classical risk factors for these diseases, alongside the ankle-arm flow index and serum CRP levels. However, no definite confirmation of causality is possible, as there is no evidence from randomized clinical intervention studies.

In our own study and in another Polish cross-sectional regional study [12], as well as in the national American [13] and Danish [18] studies, no significant correlation was observed between the incidence of periodontitis and diabetes or obesity. This absence of the latter correlation is also consistent with the findings of other authors [24, 25]. Even in a meta-analysis [26] showing a significant link between clinical exponents of periodontitis and obesity, this correlation was weaker in the elderly, which was associated with the lack of ability to control all the factors interfering with observation (diabetes, metabolic syndrome, nicotine addiction, gender, hygiene of oral cavity). Such a significant link with periodontological exponents was also absent in the case of the most frequent disease in the studied population of Lower Silesian seniors, namely arterial hypertension (treated). Opinions about correlations between the condition of periodontium and hypertension are divergent. A meta-analysis of 12 cross-sectional studies of 2007-2016, taking into account the confounding factor-adjusted risk measures, showed a significant 16% increase in the risk of developing hypertension in the presence of periodontitis [27]. In turn, in a 9-year cohort study of 5,895 people over 65 years of age, no significant correlation between the dental parameter and hypertension was found [28].

CONFLICT OF INTEREST

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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