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## Prevalence and risk indicators of periodontitis: a population-based cross sectional epidemiological survey

Prevalenza ed indicatori di rischio della parodontite: studio epidemiologico cross-sectional su base di popolazione

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### Summary

Epidemiologic data on the prevalence of periodontitis in Europe are inconsistent due to the lack of uniformity in measurement criteria and sampling methods. Limited data are available in Italy. Therefore, the aim of the present investigation was to estimate the extent and severity of periodontitis in Turin and to investigate related risk indicators.

A population-based cross-sectional epidemiological survey was conducted between December 2009 and July 2010. A stratified two-stage probability design was applied to select a representative sample of the Turin (Italy) population. Full-mouth periodontal parameters were recorded by one calibrated examiner. The periodontal status was assessed on the CCD/AAP periodontitis case definition for population-based studies.

The prevalence of periodontitis was 75.72%. When data were stratified on disease severity the distribution of periodontitis was as follows: 40.78% moderate and 34.94% severe (11.46% generalized and 23.48% localized). The percentage of moderate periodontitis was comparable with data from the literature, whereas the prevalence of the severe periodontitis was nearly doubled. Most of the epidemiological studies use partial recording protocols which underestimate the prevalence of periodontitis, mainly of the localized form.

Age, level of oral hygiene and smoking habits were strongly associated to the presence and severity of periodontitis.

### Riassunto

*A causa della disomogeneità nei criteri di raccolta dei dati e nelle procedure di campionamento i valori relativi alla prevalenza della parodontite in Europa sono discordanti. In Italia abbiamo a disposizione un numero limitato di dati epidemiologici.*

*Gli obiettivi del presente lavoro sono stati stimare l'estensione e la gravità della parodontite nella popolazione torinese ed analizzare i relativi indicatori di rischio.*

*È stato condotto uno studio epidemiologico cross-sectional su base di popolazione nel periodo compreso tra dicembre 2009 e luglio 2010. È stato selezionato un campione rappresentativo della popolazione residente a Torino (Italia) mediante procedura di campionamento a due stadi con stratificazione delle unità di primo stadio. I dati clinici parodontali sono stati registrati su tutti gli elementi dentali da un unico operatore preventivamente calibrato. Si è fatto riferimento*



*alla definizione epidemiologica di parodontite proposta dalla CDC/AAP.*

*La prevalenza stimata della parodontite è pari al 75.72. Se si considera la forma di moderata gravità interessa il 40.78%, mentre nella forma severa colpisce il 34.94%, della popolazione torinese (11.46% generalizzata, 23.48% localizzata).*

*Mentre la percentuale di parodontite moderata è in linea coi dati della letteratura quella severa raggiunge valori di prevalenza quasi doppi. La maggior parte degli studi utilizza protocolli di registrazione parziale dei dati clinici che comportano una sottostima della prevalenza della malattia, soprattutto per la forma localizzata.*

*L'età, il livello di igiene orale ed il tabagismo sono i fattori più fortemente associati alla presenza ed alla severità della parodontite.*

## Introduction

As periodontal diseases is one of the primary cause of tooth loss and seem to be associated with health problems such as coronary heart disease, diabetes mellitus and premature births, the estimation of its prevalence in the population is of paramount importance as regards primary health care.<sup>1</sup> In addition, knowledge regarding the current prevalence, extent and severity of periodontitis may provide a basis for promoting preventive strategies, establishing insurance programs and further reducing personal and public costs for treating advanced periodontitis.<sup>2</sup> In Europe public health administrators are not always in a position to estimate the burden of the periodontal diseases and risk factors on the morbidity rates of the population.<sup>3</sup> This is partly attributable to the scarcity of data from epidemiological studies based on a representative sample of the population.<sup>4</sup> Another aspect to be considered is the wide range of measurements criteria and case definitions of periodontitis which markedly limits comparisons between countries and regions.<sup>4,5</sup> A systematic review of the literature discovered that only 15 studies, out of 3472, gave a definition of periodontitis and indicated how it was measured.<sup>6</sup> In this manner periodontal research has been biased by difficulties in diseases description, diagnosis, and score designation of clinical manifestations of periodontitis.<sup>7</sup>

For several years the Community Periodontal Index of Treatment Needs (CPITN), later renamed as the CPI, has been widely used for descriptive epidemiological studies in both industrialized and developing countries.<sup>8,9</sup> Results of CPITN/CPI surveys from Europe have shown that the proportion of adult with moderate (CPI 3) and severe periodontitis (CPI 4) is on average between 20-58% and below 15%, respectively.<sup>10</sup> It is important to point out that periodontal assessment was usually limited to selected index teeth. In addition, CPI does not measure tooth mobility, attachment loss or furcation involvement leading to underestimates of the extent and severity of previous periodontal destruction.<sup>5,11</sup>

A consensus report from the 5th European Workshop on Periodontology in 2005 emphasized that attachment loss should be the key outcome measure when describing risk factors for periodontitis and that attachment loss in combination with probing depths should characterize periodontal disease definitions.<sup>12</sup> In 2007 the Centers for Disease Control and Prevention and the American Academy of Periodontology (CDC/AAP) recommended the definition by Page & Eke<sup>13</sup> as standard case definitions for severe and moderate periodontitis in population-based epidemiological survey. The CDC/AAP definition has been recognized as the gold standard among the eligible definitions of periodontitis.<sup>14</sup>

To the best of our knowledge, only two epidemiological studies from Europe used the CDC/AAP definitions to obtain estimate of periodontitis and utilized a partial mouth periodontal assessment.<sup>15,16</sup>

Data from Italy are limited. The only epidemiological study on a representative sample of the Italian socioeconomic groups (the sampling method was not described) was conducted by Strohmer et al.<sup>17</sup> The prevalence of the periodontal diseases, recorded by means the CPITN



scoring method on 10 index teeth, amounted to 41% for the moderate and 10% for the severe periodontitis.

Thus, the primary aim of this project was to evaluate the periodontal status in a representative sample of the Turin population by means of the CDC/AAP definition. The secondary objectives were two-fold: first, to investigate possible risk indicators for periodontitis; and, second, to describe the association between periodontitis and some systemic conditions, such as diabetes mellitus and atherosclerotic cardiovascular diseases.

## Materials and Methods

### ***Study design and sampling method***

A population-based cross-sectional representative epidemiological survey was conducted by the Section of Periodontology, Department of Surgical Sciences, University of Turin (Italy) between December 2009 and July 2010. The population from which the sample was undertaken comprised adults, aged between 20 and 75 years, living in Turin (Italy). On the basis of the prevalence of 15% for severe periodontal disease in Europe<sup>10</sup> the sample size necessary to obtain a precision rate of 95% (confidence interval 95%) was calculated to be 800. According to data from the literature, a 50% non response rate was added to make the final sample size 1600.

A stratified two-stage probability design was applied using the Health Regional Register by the Section of Epidemiology of the University of Turin. For the stratification the four districts (ASL) in which the population is distributed were considered to ensure an even geographic and socioeconomic spread over the whole of Turin. In the first sampling stage, twenty medical officers were drawn at random, with a weight proportional to the medical patients size, and stratified by ASL. At the second sampling stage, from each of these, subjects were selected using simple random sampling technique and invited to participate in the study. The sample size was allocated proportionally according to the size of the corresponding ASL.

Examinations comprised a health-related interview, a periodontal examination, and a health- and risk factor-related questionnaire. An invitation letter and a questionnaire were sent to all sampled subjects. The letter explained the purpose of the study and included a thorough description of the dental visit and the date of the appointment at the medical office. Informed written consent was provided by each participant

### ***Questionnaire***

A structured questionnaire was completed by each subject and reported at the time of the dental visit. It included information about: 1) socio-demographic and lifestyle factors (educational level, smoking habits); 2) medical history (cardiovascular diseases, diabetes mellitus, use of medications); 3) oral hygiene habits (daily frequency of teeth brushing, use of interdental devices, frequency of professional oral hygiene sessions). In case of missing data the dental examiner completed the forms.

### ***Periodontal examination***

The clinical examinations were carried out by one experienced and calibrated (Kappa index 0.93) periodontist in the medical offices of the physicians. Each clinical examination required on average 45 min. No radiographic examination was made.

Clinical recordings were performed by means of a probe with 1-mm markings (PCP-UNC 15, Hu-Friedy, Chicago, IL, USA), and rounded up to the nearest mm. The following parameters were assessed at six sites around all present teeth (full mouth periodontal assessment): presence/absence of plaque, presence/absence of bleeding on probing (BoP), probing depth (PD), recession of the gingival margin (REC) and clinical attachment level (CAL). The percentages of total surfaces which revealed the presence of plaque or BoP within each subject were expressed as full mouth plaque score (FMPS) and full mouth bleeding score (FMBS). In addition, tooth mobility and furcation involvement were also recorded. At the end of the examination, patients



with diagnosed periodontal diseases were provided with a written report and advised to seek oral health consultation.

### **Periodontal disease classification**

Periodontal conditions were evaluated in all subjects. Edentulous subjects were excluded from analysis due to missing periodontal measurements. The periodontal status was assessed on the CCD/AAP case definition.<sup>13</sup> Extent by severity was characterized as localized (< 30% of sites involved) or generalized ( $\geq$  30% of sites involved) according to the classification by Armitage<sup>18</sup>. The Community Periodontal Index (CPI) was recorded in sextants according to WHO guidelines.<sup>8</sup> The highest score among the six sextants was adopted to represent the CPI status for each individual.

### **Statistical Analysis**

When each visit was completed, with the information on periodontal examination, socio-demographic, medical and habits factors, the form was checked for completeness and correctness. The information was entered to feed a computer database specifically prepared for this study. Consistency tests were then performed to identify errors with are corrected after checking the correspondent information in the clinical records.

The overall response rate was 47%. In order to produce unbiased estimates, adjustment for non-response was performed using the post-stratification method. Sample weights were adjusted for different probabilities of subject selection with reference to the base population in Turin (ISTAT January 01 2010) accounting for differences in gender and age. The adjustment procedure was applied both on the CDC/AAP and the CPI diagnosis.

Agreement between the periodontitis diagnosis by the CCD/AAP classification (no periodontitis, moderate and severe periodontitis) and by the CPI index (CPI <3, CPI 3, CPI 4) was tested through a kappa test.

Univariate logistic regression models were used to determine factors associated with periodontal disease. For the binomial regression analysis the absence/presence of periodontitis was used as outcome variable. In the multinomial analysis periodontitis was entered as categorical (no periodontitis, moderate, severe periodontitis). The explanatory variables taken from the questionnaire were age (continuous variable), gender, educational level, tobacco use (smoking yes/no, light smoking and heavy smoking), diabetes mellitus, cardiovascular diseases, comorbidity. The educational level was categorized in low ( $\leq$  8 years), middle (9-13 years), and high (> 13 years). From the clinical examination was considered as explanatory variable the FMPS% (continuous and in quartiles). Those with  $p < 0.05$  were selected for the multivariate logistic regression to eliminate those that would make little contribution to the model. The age and the gender were entered as control variables. Multivariate analyses were performed to estimate the independent contribution of each variable considered.

Data were expressed as crude and adjusted odds ratio and two-sided 95% confidence intervals. Confidence limits were calculated using unconditional maximum likelihood methods with Wald's limits. A  $p$ -value < 0.05 was considered statistically significant. Statistical analysis was conducted using the Statistical Package STATA/SE 10.0 (Stata Corp LP, College Station, TX, USA).

## **Results**

### **Prevalence of periodontitis**

Overall, 1600 subjects aged 20–75 years were sampled. Because of several reasons (74 had died or had moved away, 724 refused to participate) 798 subjects were removed resulting in 802 subjects being invited. Because 8 individuals were edentulous and 58 refused periodontal examination the net random sample included 736 adults. The distribution of sampled adults by age group and gender is shown in Table 1.

Table 1. Demographic characteristics of the sample

Age (years)	Sample		Females		Men	
	N	%	N	%	N	%
20-29	80	10.87	47	10.80	33	10.96
30-39	116	15.76	78	17.93	38	12.63
40-49	159	21.60	101	23.22	58	19.27
50-59	190	25.81	113	25.98	77	25.58
60-75	191	25.96	96	22.07	95	31.56
<b>Total</b>	<b>736</b>	<b>100</b>	<b>435</b>	<b>59.11</b>	<b>301</b>	<b>40.89</b>

The overall prevalence of periodontitis amounted to 75.72% (95% CI 72.25-79.18%). Population estimates indicated that 40.78% (95% CI 36.83-44.73%) had moderate periodontitis and 34.94% (95% CI 31.23-38.65%) severe periodontitis. The prevalence of the localized and generalized severe periodontitis amounted to 23.48% (95% IC 20.19-26.76%) and to 11.46% (95% IC 9.09-13.83%), respectively.

In the total population the percentage of persons with moderate periodontitis increased among strata (fig. 1) up to the 30-39-year-old age group (49.15%, 95% IC 40.04-58.24%) and then decreased slightly (50-59-year-old-age group 36.13%, 95% IC 29.31-42.94%). The prevalence of severe periodontitis increased steadily with age: 52.63% (95% IC 45.53-45.53%) of persons aged 50–59 years, but only 6.25% (95% IC 0.95-11.55%) of the youngest persons had severe periodontitis.

The agreement between the periodontal diagnosis based on the CDC/AAP criteria and the CPI index was 0.69.

Fig. 1 Prevalence of moderate periodontitis by age

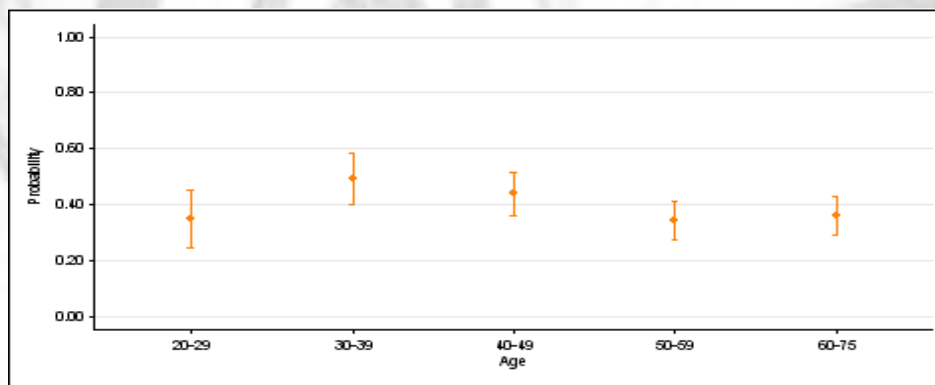
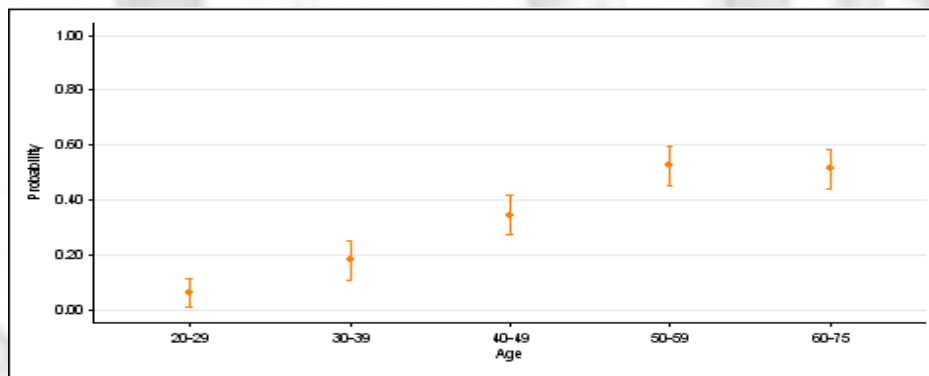


Fig. 2 Prevalence of severe periodontitis by age



**Risk indicators of periodontitis**

The Table 2 shows the crude OR for each possible factor associated with the risk for periodontitis. The socio-economic variables and the oral hygiene were the variables most strongly associated



to the diagnosis of periodontitis ( $p < 0.001$ ). In particular, individuals with medium and high education were 43% and 60% ( $p < 0.001$ ), respectively, less likely to be affected by periodontitis ( $p = 0.008$ ) compared with those with a low educational level. For each 1% increase in FMPS, the odds of having periodontitis increased by 4%. Smoking habits were positively associated with periodontitis (OR 1.81), but only heavy smoking contributed to the statistically significant association (OR 3.07,  $p < 0.001$ ).

With regards to medical history, the odds of having periodontitis increased almost 3 and 2 times among subjects affected by comorbidity and diabetes mellitus, respectively. Cardiovascular diseases did not appear to be a predictor of periodontitis although the association was not longer to be statistically significant ( $p = 0.07$ ).

Of the control variables, age was the most important predictor of periodontitis (OR 1.06), while gender did not (OR 1.33,  $p = 0.121$ ).

When controlling for gender and the other significant explanatory variables (Table 3) by multivariate logistic regression analysis (model 1), the association between education and periodontitis was attenuated and became non statistically significant. The effect of oral hygiene level was also attenuated, but remained significantly associated with periodontitis ( $p < 0.001$ ). The effect of age remained unchanged with respect to the univariate model (OR 1.06), while the effect of smoking habits slightly increased (from 1.81 to 1.91).

When cardiovascular diseases (model 2), diabetes mellitus (model 3) and comorbidity (model 4) were entered as covariates in the logistic regression model the adjusted odds ratio for periodontitis did not change. In contrast to the univariate models, the diabetes mellitus (model 3) and the comorbidity (model 4) were yet not risk indicators for the presence of periodontitis. In particular, the diabetics were 2-fold more likely to have periodontitis than non diabetics, but the confidence interval was too wide to reach statistical significance.

Tables 4 and 5 summarize the univariate and multivariate logistic models in which the dependent variable was the severity of periodontitis. The baseline group was the absence of periodontitis. By comparing binomial (table 2) and multinomial models (table 4) some differences raised. In the univariate analysis (Table 4) the only factors significantly associated with both moderate and severe periodontitis were the age, the plaque index and the presence of comorbidity. The association was stronger for the severe periodontitis (OR<sub>comorbidity-moderate periodontitis</sub> 1.61 vs OR<sub>comorbidity-severe periodontitis</sub> 2.75). Smoking habits (OR 2.14) and diabetes mellitus (OR 3.51) remained risk indicators, but only for the severe form of periodontitis. In addition, the gender became a significant predictor for severe periodontitis. Men had a 1.69-fold higher odds of having severe periodontitis than women.

In the multivariate analysis (Table 5), after adjusting for gender and years of education, the only independent factors significantly associated with both moderate and severe periodontitis remained age and plaque index (model 1). Smoking habits were yet associated with severe periodontitis. When the variables concerning the individual medical history were inserted in the model (models 2 through 4) the adjusted ORs did not change. However, after adjusting for the other predictors, the relationship between severe periodontitis, diabetes mellitus (model 3) and comorbidity (model 4) was not longer statistically significant.

Table 2. Univariate logistic model (presence/absence of periodontitis as dependent variable)

	OR	IC al 95%	P-value
Gender (male vs female)	1.33	[0.93,1.89]	0.121
Age (years)	1.06	[1.05,1.08]	<0001
Education (middle vs low)	0.57	[0.38,0.86]	0.008
Education (high vs low)	0.40	[0.25,0.63]	<0001
Smoking habits (yes vs no)	1.81	[1.15,2.84]	0.010
Light smoker vs non smoker	1.06	[0.61,1.85]	0.83
Heavy smoker vs non smoker	3.07	[1.55,6.05]	0.001
FMPS (%)	1.04	[1.03,1.04]	<0001
FMPS% (25-50 vs 0-25)	3.40	[2.07,5.59]	<0001
FMPS% (50-75 vs 0-25)	7.45	[4.16,13.33]	<0001
FMPS% (75-100 vs 0-25)	12.14	[6.72,21.94]	<0001
Cardiovascular diseases	2.61	[0.91,7.47]	0.073
Diabetes	3.02	[1.06,8.59]	0.038
Comorbidity	2.08	[1.46,2.97]	<0001

Table 3. Multivariate logistic models (presence/absence of periodontitis as dependent variable)

	Model 1		Model 2		Model 3		Model 4	
	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI
Gender (Man vs Female)	1.12	[0.74,1.69]	1.11	[0.74,1.68]	1.1	[0.73,1.66]	1.12	[0.74,1.68]
Age (years)	1.06***	[1.04,1.08]	1.06***	[1.04,1.08]	1.06***	[1.04,1.08]	1.06***	[1.04,1.08]
Education (middle vs low)	1.05	[0.64,1.74]	1.05	[0.64,1.74]	1.04	[0.63,1.72]	1.05	[0.64,1.74]
Education (high vs low)	0.86	[0.49,1.52]	0.86	[0.49,1.53]	0.85	[0.48,1.50]	0.86	[0.48,1.52]
Smoking habits (yes vs no)	1.91*	[1.14,3.20]	1.91*	[1.14,3.20]	1.90*	[1.13,3.19]	1.91*	[1.14,3.21]
FMPS % (25-50 vs 0-25)	2.93***	[1.71,5.04]	2.93***	[1.71,5.04]	2.98***	[1.73,5.13]	2.94***	[1.71,5.06]
FMPS % (50-75 vs 0-25)	5.63***	[3.01,10.54]	5.61***	[3.00,10.52]	5.72***	[3.04,10.74]	5.63***	[3.01,10.54]
FMPS % (75-100 vs 0-25)	9.80***	[5.10,18.83]	9.77***	[5.08,18.78]	9.89***	[5.13,19.06]	10.03***	[5.20,19.35]
Cardiovascular diseases			1.13	[0.37,3.43]				
Diabetes mellitus					2.17	[0.69,6.85]		
Comorbidity							0.87	[0.55,1.37]
Cons	0.05***	[0.02,0.14]	0.05***	[0.02,0.14]	0.05***	[0.02,0.15]	0.05***	[0.02,0.14]
AIC	646.3616		648.3173		646.3457		647.9992	
Likelihood ratio Chi Square	166.3473		166.3916		168.3632		166.7097	

\* p&lt;0.05, \*\* p&lt;0.01, \*\*\* p&lt;0.001



Table 4. Univariate models (severity of periodontitis as dependent variable)

	<b>OR</b>	<b>95%CI</b>
<b>MODERATE PERIODONTITIS</b>		
<b>Gender (male vs female)</b>	1.11	[0.75,1.64]
<b>Age (years)</b>	1.04***	[1.03,1.06]
<b>Education (middle vs low)</b>	0.64*	[0.41,1.00]
<b>Education (high vs low)</b>	0.49**	[0.30,0.82]
<b>Smoking habits (yes vs no)</b>	1.52	[0.92,2.49]
<b>Light smoker vs no-smoker</b>	1.19	[0.65,2.19]
<b>Heavy smoker vs no-smoker</b>	2.17	[1.02,4.69]
<b>FMPS % (25-50 vs 0-25)</b>	2.90***	[1.71,4.91]
<b>FMPS% (50-75 vs 0-25)</b>	4.28***	[2.29,8.00]
<b>FMPS% (75-100 vs 0-25)</b>	5.19***	[2.74,9.83]
<b>Cardiovascular diseases</b>	2.72	[0.91,8.19]
<b>Diabetes mellitus</b>	2.56	[0.85,7.75]
<b>Comorbidity</b>	1.61*	[1.09,2.37]
<b>SEVERE PERIODONTITIS</b>		
<b>Gender (male vs female)</b>	1.69**	[1.14,2.50]
<b>Age (years)</b>	1.09***	[1.07,1.10]
<b>Education (middle vs low)</b>	0.52**	[0.33,0.81]
<b>Education (high vs low)</b>	0.31***	[0.18,0.52]
<b>Smoking habits (yes vs no)</b>	2.14**	[1.31,3.47]
<b>Light smoker vs non smoker</b>	0.95	[0.50,1.82]
<b>Heavy smoker vs non smoker</b>	4.51**	[2.16,9.41]
<b>FMPS % (25-50 vs 0-25)</b>	5.50***	[2.41,12.58]
<b>FMPS% (50-75 vs 0-25)</b>	20.51***	[8.64,48.70]
<b>FMPS% (75-100 vs 0-25)</b>	40.79***	[17.20,96.76]
<b>Cardiovascular diseases</b>	2.49	[0.82,7.59]
<b>Diabetes mellitus</b>	3.51*	[1.19,10.37]
<b>Comorbidity</b>	2.75***	[1.85,4.08]

\* p&lt;0.05, \*\* p&lt;0.01, \*\*\* p&lt;0.001



Table 5. Multivariate logistic models (severity of periodontitis as dependent variable)

	Model 1		Model 2		Model 3		Model 4	
	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI
<b>Moderate periodontitis</b>								
<b>Gender (male vs female) (Uomo vs Donna)</b>	1.03	[0.67,1.58]	1.01	[0.66,1.56]	1.01	[0.65,1.55]	1.02	[0.67,1.57]
<b>Age (years)</b>	1.04***	[1.02,1.06]	1.04***	[1.02,1.06]	1.04***	[1.02,1.06]	1.05***	[1.02,1.07]
<b>Education (middle vs low)</b>	0.96	[0.57,1.63]	0.97	[0.58,1.65]	0.96	[0.56,1.62]	0.96	[0.57,1.63]
<b>Education (high vs low)</b>	0.82	[0.45,1.49]	0.83	[0.46,1.51]	0.81	[0.44,1.46]	0.82	[0.45,1.48]
<b>Smoking habits (yes vs no)</b>	1.63	[0.95,2.81]	1.64	[0.95,2.82]	1.62	[0.94,2.80]	1.64	[0.95,2.82]
<b>FMPS% (25-50 vs 0-25)</b>	2.63***	[1.51,4.58]	2.62***	[1.50,4.57]	2.67***	[1.53,4.67]	2.64***	[1.51,4.60]
<b>FMPS% (50-75 vs 0-25)</b>	3.69***	[1.91,7.10]	3.65***	[1.89,7.04]	3.75***	[1.94,7.24]	3.68***	[1.91,7.09]
<b>FMPS% (75-100 vs 0-25)</b>	5.05***	[2.55,10.02]	5.00***	[2.52,9.94]	5.09***	[2.56,10.13]	5.17***	[2.59,10.31]
<b>Cardiovascular diseases</b>			1.42	[0.45,4.50]				
<b>Diabetes</b>					2.2	[0.67,7.19]		
<b>Comorbidity</b>							0.87	[0.54,1.39]
<b>_cons</b>	0.09***	[0.03,0.26]	0.09***	[0.03,0.26]	0.09***	[0.03,0.26]	0.09***	[0.03,0.25]
<b>Severe periodontitis</b>								
<b>Gender (male vs female) (Uomo vs Donna)</b>	1.26	[0.78,2.04]	1.29	[0.79,2.08]	1.24	[0.77,2.01]	1.26	[0.78,2.03]
<b>Age (years)</b>	1.09***	[1.06,1.11]	1.09***	[1.07,1.11]	1.09***	[1.06,1.11]	1.09***	[1.07,1.12]
<b>Education (middle vs low)</b>	1.19	[0.67,2.11]	1.18	[0.67,2.09]	1.18	[0.67,2.09]	1.19	[0.67,2.10]
<b>Education (high vs low)</b>	0.89	[0.45,1.75]	0.88	[0.45,1.74]	0.87	[0.44,1.73]	0.88	[0.45,1.75]
<b>Smoking habits (yes vs no)</b>	2.55**	[1.41,4.58]	2.54**	[1.41,4.57]	2.53**	[1.41,4.57]	2.56**	[1.42,4.60]
<b>FMPS% (25-50 vs 0-25)</b>	4.57***	[1.89,11.07]	4.56***	[1.88,11.04]	4.66***	[1.92,11.32]	4.58***	[1.89,11.09]
<b>FMPS% (50-75 vs 0-25)</b>	16.01***	[6.33,40.48]	16.09***	[6.36,40.70]	16.30***	[6.42,41.37]	15.97***	[6.32,40.36]
<b>FMPS% (75-100 vs 0-25)</b>	35.11***	[13.71,89.92]	35.09***	[13.70,89.90]	35.48***	[13.81,91.17]	35.79***	[13.94,91.90]
<b>Cardiovascular diseases</b>			0.97	[0.24,2.62]				
<b>Diabetes</b>					2.09	[0.61,7.12]		
<b>Comorbidity</b>							0.89	[0.53,1.50]
<b>_cons</b>	0.00***	[0.00,0.01]	0.00***	[0.00,0.01]	0.00***	[0.00,0.01]	0.00***	[0.00,0.01]
<b>AIC</b>	1354.1397		1355.7479		1356.157		1357.7762	
<b>Likelihood ratio Chi Square</b>	267.8083		270.2001		269.791		268.1719	

\* p&lt;0.05, \*\* p&lt;0.01, \*\*\* p&lt;0.001

## Conclusions

This is the first population-based representative epidemiological study reporting the prevalence and risk indicators of periodontitis among adults in Italy. Data were collected in Turin, an industrialized city in the northern part of Italy.

The overall prevalence of periodontitis amounted to 75.72%. When data were stratified on the disease severity, the 40.78% and the 39.94% of the adult population in Turin was affected by the moderate and severe form of periodontitis, respectively.

The comparison with previous investigations is complicated due to different definitions for periodontitis, methodological and recording disparities across studies.<sup>4,5</sup>

In the present survey clinical parameters were collected by the same calibrated and experienced examiner using a full-mouth periodontal assessment (six sites per tooth). In most epidemiological studies periodontal examination was performed by means of half-mouth or partial-mouth recording protocols.<sup>19</sup> Utilization of partial recording protocols implicates a biased estimation of disease prevalence and extent.<sup>20</sup> Partial mouth assessments underestimate the prevalence of periodontal destruction in populations with less susceptibility or overestimate the prevalence when the index teeth selected are first molars and lower incisors.<sup>21</sup>

Another aspect to be addressed is the case definition of periodontitis.<sup>6</sup> It has been emphasized that periodontitis required recording of probing depth and clinical attachment loss, representing current pathology and previous cumulative tissue destruction.<sup>12</sup>

Based on the recommendation by the AAP and the CDC working group the diagnosis of periodontitis was made according to the case definition proposed by Page & Eke which considers CAL and PD values at different levels to diagnose moderate and severe periodontitis.<sup>13,14</sup>

Recently, two studies from Europe reported epidemiological data according to the CDC/AAP definition.<sup>15,16</sup> The Pomerania study reported a prevalence of 33.33% and of 17.60% for the moderate and severe periodontitis, respectively.<sup>15</sup> In the Germany survey the prevalence was 50% for the moderate and 28% for the severe disease.<sup>16</sup>

When compared with the present data, the prevalence of the severe periodontitis ranked lower. It was important to point out that the periodontal parameters were recorded only at the mesiobuccal and distobuccal sites of half-mouth teeth<sup>15</sup> and at 12 index teeth<sup>16</sup>. The sensitivity of a half-mouth protocol was estimated between 0.41 and 0.87 for CAL.<sup>4,20</sup> When applied to the CDC/AAP case definition of severe periodontitis the sensitivity of an half-mouth protocol decreased to about 55%.<sup>20</sup> This might result in an underestimate of the prevalence of the periodontal disease. Due to the importance of disease extent in both the therapeutic and prognostic evaluations, in the current study the severe periodontitis was characterized as localized and generalized according to the criteria by Armitage.<sup>18</sup> The 11.46% among the adult population in Turin was affected by a generalized and the 23.48% by a localized severe periodontitis. Epidemiological data from the literature underestimate the localized form of severe periodontitis.<sup>15,16</sup>

The secondary objectives of the current study were to investigate risk indicators for periodontitis. The independent predictors most strongly related to increased presence and severity of periodontitis were age, oral hygiene and smoking habits.<sup>22</sup> The male gender was increased risk indicator only for the severe periodontitis (OR 1.69, 95% IC 1.14-2.50). The fact that women had substantially less documented periodontal disease might be due to differences in dental and general health behavior.<sup>23</sup> The attitudes toward oral health and dental-visit behavior, for example, were different across genders, favoring females.<sup>24</sup> This was confirmed by the multivariate analysis. After adjusting for oral hygiene the association between gender and periodontitis was not longer statistically significant.

In agreement with data from the literature the prevalence of periodontitis increased with age.<sup>25</sup> In univariate models, for each 1 year increase in age the odds of having periodontitis increased by 6%. With regards to the disease severity, the odds of having a moderate and a severe



periodontitis increased by 4% and 9%. The age-specific increase in the prevalence and severity of the periodontitis was attributed to the cumulative effect of periodontal breakdown over time.<sup>26</sup> This is particularly evident when the periodontal damage is expressed in term of CAL. In contrast with data from the literature<sup>10</sup> in the current study, that considers CAL in the diagnostic criteria, the OR age/periodontitis did not change after adjusting for the other explicatory variables.

Among the behavioral factors smoking habits are the most important risk indicators/factors for periodontitis in both cross-sectional and longitudinal investigations.<sup>27</sup> In the present study smoking habits were strongly associated only to the severe periodontitis (adjusted OR 2.55, 95%IC 1.41-4.58). In the literature the OR values ranged between 2 and 3.<sup>28</sup>

It has been widely demonstrated that smoking exerts a dose-dependent effect.<sup>29</sup> We observed that the odds of having severe periodontitis was similar for light smokers (< 10 cigarettes daily) and no smokers (OR 0.95, 95% IC 0.50-1.82), whereas heavy smokers ( $\geq$  10 cigarettes daily) had an odds 4.51-fold greater (95% IC 2.16-9.41). Grossi et al. reported OR value of 4.8 for clinical attachment loss and heavy smoking.<sup>23</sup>

The oral hygiene is an important risk indicator for periodontitis.<sup>10</sup> In the present investigation the FMPS was divided in quartiles. It was interesting to point out that the effect of poor oral hygiene (FMPS  $\geq$  75%) was 7-fold greater on the severe periodontitis compared with the moderate one (adjusted OR<sub>FMPS-moderate periodontitis</sub> 5.05 versus OR<sub>FMPS-severe periodontitis</sub> 35.11).

In the last years the interest for possible relationship between periodontitis and systemic diseases, such as diabetes mellitus and atherosclerotic cardiovascular diseases have progressively increased.<sup>30</sup> Cross-sectional and longitudinal studies have demonstrated that diabetes is an important risk factor for the periodontitis and periodontitis represents a side-effect of the diabetes.<sup>31</sup> The odds of having periodontitis is estimated 2- or 3-fold greater for an adult diabetic compared to a non diabetic subject and 5-fold greater for an adoloescent.<sup>32</sup> A recent metanalysis on case-control studies reported that diabetic subjects were more likely to suffer from severe periodontitis, but the disease prevalence was similar to that of subjects without diabetes.<sup>33</sup> In the present investigation the prevalence of periodontitis was greater among diabetics (2.38% versus 6.87%) and there was a statistically significant association with the severity of periodontitis. In the univariate models subjects with diabetes had an odds of having severe periodontitis 3.51 times greater than healthy subjects. However, after adjusting for age, gender, years of education, smoking habits and oral hygiene the association did not remain statistically significant. This could be attributable to the limited number of affected individuals in the sample. It is important to emphasize that the diagnosis of diabetes was self-reported and not confirmed by any hematologic analysis.

A number of chronic inflammatory diseases, such as the periodontal disease, have been supposed to promote atherogenesis and, thus, to increase the risk for cardiovascular and cerebrovascular accidents to occur.<sup>34</sup> However, data are conflicting.<sup>35,36</sup> In the present study the percentage of atherosclerotic events was nearly doubled (5.99% verso 2.38%) among periodontitis subjects compared to healthy individuals. The OR was 2.6 at the limits of the statistical significance (p=0.07). This relationship should be investigated in studies with a large sample size or with a case-control design.

In conclusions, moderate and severe periodontitis are highly prevalent in the Turin population. The age, the level of oral hygiene and smoking habits correlated most significantly with the presence and the severity of periodontitis.

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