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Emmanuel Wiernik, Adeline Renuy, Sofiane Kab, Philippe Gabriel Steg, Marcel Goldberg, et al.. Prevalence of self-reported severe periodontitis: Data from the population-based CONSTANCES cohort. Journal of Clinical Periodontology, 2024, 10.1111/jcpe.13969. hal-04567633

HAL Id: hal-04567633 https://hal.science/hal-04567633v1

Submitted on 3 May 2024

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ORIGINAL ARTICLE



Prevalence of self-reported severe periodontitis: Data from the population-based CONSTANCES cohort

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Funding information

Assistance Publique des Hopitaux de Paris; Agence Nationale de la Recherche, Grant/Award Number: ANR-16-RHUS-00010; Caisse nationale d'assurance maladie des travailleurs salari's; French Commissariat général à l'investissement, Grant/Award Number: ANR-11-INBS-0002

Abstract

Aim: To assess the prevalence of severe periodontitis based on the population-based CONSTANCES cohort using a validated self-reported questionnaire.

Materials and Methods: Individuals were selected from the adult population in France using a random sampling scheme. Analyses were restricted to those invited in 2013–2014 who completed the periodontal health questionnaire at the 2017 followup. The risk of severe periodontitis was assessed using the periodontal screening score (PESS) and weighting coefficients were applied to provide representative results in the general French population.

Results: The study included 19,859 participants (9204 men, mean age: 52.8 \pm 12.6 years). Based on a PESS \geq 5, 7106 participants were at risk of severe periodontitis, corresponding to a weighted prevalence of 31.6% (95% confidence interval: 30.6%–32.7%). This prevalence was higher among participants aged 55 and over, those with lower socio-economic status as well as current smokers, e-cigarette users and heavy drinkers. Among individuals at risk of severe periodontitis, only 18.8% (17.3%–20.4%) thought they had gum disease, although 50.5% (48.6%–52.5%) reported that their last dental visit was less than 6 months.

Conclusions: The present survey indicates that (1) self-reported severe periodontitis is highly prevalent with marked disparities between groups in the general French adult population, and (2) periodontitis could frequently be under-diagnosed given the low awareness.

KEYWORDS

epidemiology, population-based cohort, prevalence, severe periodontitis

Clinical Relevance

Scientific rationale for study: Periodontitis is a chronic, inflammatory disease highly prevalent in adult populations. Current data on the prevalence of severe periodontitis in European countries are limited.

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Principal findings: Using a validated self-reported questionnaire in a large French populationbased cohort, the weighted prevalence of severe periodontitis was 31.6% (95% confidence interval: 30.6%–32.7%). This prevalence was higher among participants aged 55 and over, those with lower socio-economic status as well as current smokers, e-cigarette users and heavy drinkers. Among individuals at risk of severe periodontitis, less than 20% thought they had gum disease, although half declared that their last dental visit was less than 6 months.

Practical implications: The prevalence of self-reported severe periodontitis is high in France, but with marked disparities between groups. Most participants reported having recently visited the dentist, indicating that many cases of periodontitis go unrecognized. It is important that public and professional health authorities take action to address this issue. Additionally, dental professionals should be aware of the significant number of undiagnosed patients.

1 | INTRODUCTION

Periodontitis is a chronic, inflammatory disease affecting the periodontium, the supporting apparatus of the tooth (Kinane et al., 2017). Severe periodontitis is characterized by extensive loss of the periodontium, which, if untreated, may result in tooth loss (Genco & Sanz, 2020). Moreover, untreated severe periodontitis can impact systemic health, being associated with all-cause mortality (Bond et al., 2023; Romandini et al., 2021) and several diseases, such as type-2 diabetes, cardiovascular diseases, inflammatory bowel disease, rheumatoid arthritis and adverse pregnancy outcomes (Genco & Borgnakke, 2020; Genco & Sanz, 2020; Hajishengallis & Chavakis, 2021). These oral and non-oral consequences of periodontitis may explain why the societal and economic impacts of periodontitis have been well demonstrated (The Economist Intelligence Unit Limited, 2021).

According to data from the Global Burden of Disease (GBD) Study in 2019, periodontitis is the seventh most prevalent disease worldwide, with 1.09 billion cases (Institute for Health Metrics and Evaluation [IHME], 2020). Since 1990, an increase in prevalence has been registered largely due to population growth and ageing (Chen et al., 2021). The age-standardized prevalence, which was estimated at 11.2% in 2010 (Kassebaum et al., 2014), raised to 13.1% in 2019 (Chen et al., 2021; Wu et al., 2022). However, these trends, as well as those of incidence and disease burden, differed according to sex, age and geographical region (Chen et al., 2021; Cui et al., 2023; Wu et al., 2022; Zhang et al., 2022). Data specific to the French population are scarce, but the age-standardized prevalence of severe periodontitis was estimated at 9.6% in the GBD study 2019 (Chen et al., 2021). This result is close to the 10.2% prevalence of periodontal pockets >5 mm found in the 2002–2003 National Periodontal and Systemic Examination Survey, conducted on a stratified quota sample of 2144 adults, aged 35-64 years in France (Bourgeois et al., 2007).

Clinical examination is the gold standard tool for the diagnosis of periodontal diseases (Holtfreter et al., 2015). However, it is time- and resource-consuming and hardly applicable at the population level. To overcome these limitations, self-reported questionnaires have been developed and validated in several countries as a valuable alternative to assess and monitor periodontitis in epidemiological studies (Abbood et al., 2016; Carra et al., 2018; Deng et al., 2021; Eke et al., 2020; Montero et al., 2020). Based on the validated French version of the CDC/AAP periodontal questionnaire, the periodontal screening score (PESS) has been developed to identify individuals at risk of severe periodontitis. It relies on five items of self-reported periodontal assessment, age and smoking (Table S1). PESS has shown a sensitivity of 78.9% and a specificity of 74.8% against a clinical diagnosis based on a full periodontal examination (Carra et al., 2018).

The present study aimed to assess the prevalence of severe periodontitis using this validated self-reported questionnaire in a large French population-based cohort, in order to provide an updated epidemiological estimate of the disease at the population level.

2 | METHODS

2.1 | Study population

The CONSTANCES cohort included more than 200,000 volunteers aged between 18 and 69 years from 21 departments throughout metropolitan France recruited between 2012 and 2020; these departments are close to the population of France in terms of distribution by gender, age and sectors of economic activity (Zins et al., 2015). Eligible individuals were selected from the adult population covered by the general insurance system (representing 85% of the French population) using a random sampling scheme stratified on place of residence, age, sex, occupation and socio-economic status in order to be representative of the source population. At inclusion, participants underwent a clinical interview, examination, standard biology testing and completed questionnaires including sociodemographic characteristics. Follow-up was performed through yearly self-questionnaires and linkage to the National Health Data System, which is a reimbursement database including medications and hospitalizations.

The present analyses were restricted to individuals invited to participate in 2013–2014 who had completed the 2017 follow-up questionnaire, which included the questionnaire for the evaluation of periodontal health (Carra et al., 2018). This allowed for the use of weighting coefficients (detailed below) to provide a representative sample of the general French population aged 18–69 years covered by the general insurance scheme in the selected departments of CONSTANCES.

The CONSTANCES cohort obtained the authorization of the National Data Protection Authority (Commission Nationale de l'Informatique et des Libertés, no. 910486) and was approved by the Institutional Review Board of the National Institute for Medical Research-INSERM (no. 01-011). Written informed consent was received from all participants.

2.2 Periodontal assessment and periodontal screening score

Periodontal assessment was based on a self-reported evaluation by means of 12 questions on periodontal health mainly derived from the CDC/AAP questionnaire for the surveillance of periodontitis (Eke & Dye, 2009; Slade, 2007). They included self-perception of gum health and diseases, history of periodontal treatment, report of tooth mobility, bone loss, current abnormalities (gum swelling, pain, bad taste, etc.), gingival bleeding, food impaction, tooth loosening and gum retraction, together with the weekly frequency of inter-dental cleaning device or mouth rinse use (Carra et al., 2018). The diagnostic accuracy of the French version of the questionnaire has been tested against a clinical diagnosis and it showed a very good performance (sensitivity: 71.8% and specificity: 70.9%; area under ROC curve: 0.77). Moreover, the PESS was developed and validated to provide a user-friendly tool to screen for severe periodontitis at the population level (Carra et al., 2018). The PESS is calculated based on five items of the guestionnaire, which are related to self-reported gingival health, previous treatment for gum diseases, tooth mobility, bone loss and current abnormalities, in addition to age and smoking status (Table S1). The obtained score can range between 0 and 13, with 5 as the cut-off value with the best balance between sensitivity (78.9%) and specificity (74.8%) to identify individuals with severe periodontitis against a clinical diagnosis based on a full periodontal examination (Carra et al., 2018). Thus, in the present analysis, PESS was considered as a binary variable and dichotomized as <5 or ≥5 (i.e., severe periodontitis risk). The smoking status (i.e., current smokers vs. former or never smoker) was assessed based on the latest self-reported value in the inclusion or on the follow-up questionnaire until 2017.

2.3 Weighting coefficients

Weighted analyses were performed to provide results representative of the general population. To achieve this, two weighting coefficients were used. The product of these coefficients provided the final weight (Balagny et al., 2023). The first weight considers the survey weight and the correction for non-participation in the cohort. It uses an administrative medical database from a cohort of 400,000 nonparticipants drawn at random from the same sample as the participants (Santin et al., 2016). When administrative medical data were lacking because subjects denied participating or because participants' data were not available, the weighting coefficient could not be calculated. Nevertheless, the final correction factor for non-response in the

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FIGURE 1 Flow chart of the study population selection.

CONSTANCES cohort considers the non-availability of these data. The second weight was calculated to correct, among those included in the cohort, for non-response to the 2017 follow-up (including the dental questionnaire used in the analyses). This weight, which is an estimate of the probability of having responded to the 2017 guestionnaire, was based on sociodemographic variables (e.g., level of education) as well as health behaviours and health indicators (e.g., existence of a disability).

2.4 **Covariates**

The following covariates were considered: sex, age at the date of the 2017 guestionnaire and occupational status in the inclusion questionnaire, collected according to the French 'Occupations and Socio-occupational Categories' [Professions et Categories Socioprofessionnelles (PCS)] classification system (INSEE, n.d.; Wiernik et al., 2018). This included the following categories: executive and higher intellectual profession, intermediate profession, employee, manual worker and other. Household monthly income was defined by the last self-reported value in the inclusion or follow-up questionnaire in 2015 and categorized into less than 1500 euros, between 1500 and 2800 euros, more than 2800 euros, and other. Educational level was self-reported in the inclusion questionnaire and was categorized into three classes: less than or equal to high school diploma, undergraduate degree and postgraduate degree. When it was considered as covariate (not questionnaire component), last known smoking status in 2017 was categorized into three classes: no smokers, former smokers and current smokers. Current e-cigarette users were identified based on the latest self-reported value in the inclusion or follow-up questionnaire until 2017. Alcohol consumption was defined based on the latest self-reported value in the inclusion or follow-up questionnaire until 2017 and categorized into three categories: no consumption, moderate consumption (i.e., less than

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		Sex		Age		
	Total	Men	Women	<40 years old	40–55 years old	≥55 years old
PESS	$Missing\;data=0$					
PESS < 5	12,753	5900	6853	3554	5567	3632
	68.3 (67.3-69.4)	67.4 (65.9-68.9)	69.3 (67.9-70.7)	96.8 (95.8–97.6)	78.7 (76.9-80.4)	34.0 (32.5-35.5)
PESS ≥ 5	7106	3304	3802	91	1100	5915
	31.6 (30.6-32.7)	32.6 (31.1-34.2)	31.1 (29.3-32.1)	3.2 (2.4-4.2)	21.3 (19.6-23.1)	66.0 (64.5-67.5)
Self-reported gingival health	Missing data $=$ 16	5				
Excellent-to-good	13,347	6291	7056	2915	4783	5649
	66.3 (65.2–67.4)	66.5 (64.9-68.1)	66.1 (64.6-67.6)	78.5 (76.4-80.5)	67.2 (65.3-69.1)	55.0 (53.4-56.7)
Fair	5137	2299	2838	586	1491	3060
	25.8 (24.8–26.8)	25.3 (23.9–26.8)	26.2 (24.8-27.6)	17.2 (15.4–19.1)	25.0 (23.3-26.7)	33.8 (32.3-35.4)
Poor	1210	526	684	122	354	734
	7.9 (7.2-8.6)	8.1 (7.1-9.2)	7.7 (6.8-8.7)	4.3 (3.3–5.5)	7.8 (6.7-9.1)	11.1 (9.9–12.4)
Previous treatment for gum diseases	Missing data = 22	3				
No	17,281	8139	9142	3378	5982	7921
	88.7 (87.9–89.3)	89.9 (88.8-90.8)	87.5 (86.5-88.5)	92.7 (91.4-93.9)	89.3 (88.0-90.4)	84.5 (83.3-85.7)
Yes	2355	966	1389	245	649	1461
	11.3 (10.7-12.1)	10.1 (9.2-11.2)	12.5 (11.5–13.5)	7.3 (6.1-8.6)	10.7 (9.6-12.0)	15.5 (14.3–16.7)
Tooth mobility	Missing data $= 250$	D				
No	16,406	7509	8897	3357	5811	7238
	82.9 (82.0-83.8)	82.1 (80.8-83.4)	83.6 (82.4-84.7)	91.0 (89.5-92.3)	84.3 (82.7-85.7)	74.5 (73.0-76.0)
Yes	3203	1586	1617	267	824	2112
	17.1 (16.2–18.0)	17.9 (16.6-19.2)	16.4 (15.3-17.6)	9.0 (7.7-10.5)	15.7 (14.3-17.3)	25.5 (24.0-27.0)
Bone loss	Missing data $=$ 32	D				
No	17,686	8297	9389	3507	6152	8027
	91.5 (90.8-92.1)	92.3 (91.4-93.2)	90.7 (89.8-91.5)	96.7 (95.7–97.5)	92.1 (91.0-93.1)	86.3 (85.1-87.4)
Yes	1853	746	1107	109	477	1267
	8.5 (7.9–9.2)	7.7 (6.8-8.6)	9.3 (8.5–10.2)	3.3 (2.5-4.3)	7.9 (6.9-9.0)	13.7 (12.6-14.9)
Current abnormalities	Missing data $= 27$	5				
No	15,272	7346	7926	2857	5153	7262
	76.6 (75.6-77.6)	79.8 (78.3-81.1)	73.8 (72.3-75.2)	77.8 (75.7-79.7)	75.7 (73.9-77.3)	76.7 (75.2-78.1)
Yes	4312	1370	2582	762	1473	2077
	23.4 (22.4-24.4)	20.2 (18.9–21.7)	26.2 (24.8-27.7)	22.2 (20.3–24.3)	24.3 (22.7-26.1)	23.3 (21.9-24.8)

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Note: Data are *n* and % (95% CI), and % values are weighted in order to provide results representative of the French general population aged 18-69 years old, in the selected departments of CONSTANCES, and covered by the general insurance scheme. All *p* < .05 except for PESS according to sex (*p* = .75) and for current abnormalities according to age (*p* = .30).

or equal to 3/2 drinks per day in men/women) and excessive consumption (i.e., more than 3/2 drinks per day in men/women).

squared tests. All analyses were performed using STATA 15.1 (Statacorp College Station, Texas, USA).

2.5 | Statistical analyses

Categorical variables were described as numbers and percentages with their 95% confidence intervals (CIs). The prevalence of PESS and its periodontal components were reported in the entire study population and according to covariates (age, sex, socio-economic status and health behaviours). The other periodontal health-related variables were described in the whole population and by the presence of severe periodontitis risk (i.e., PESS \geq 5). Groups were compared using chi-

3 | RESULTS

Among 25,491 participants in the CONSTANCES cohort invited in 2013–2014 who responded to the 2017 follow-up questionnaire, weighted data were available for 19,859 (77.9%) participants (Figure 1). Mean age (SD) in 2017 was 52.8 (12.6) years and 9204 (46.3%) were men. The distribution of PESS is shown in Figure S1. In this population, 7106 participants were at risk of severe periodontitis (PESS \geq 5), corresponding to a weighted prevalence of 31.6% (30.6%–32.7%).

TABLE 2 Prevalence of periodontal screening score (PESS) and its components according to household income and educational level.

	Household incon	ne			Educational level		
	>2800 euros	1500-2800 euros	<1500 euros	Other	Postgraduate degree	Undergraduate degree	≤high school diploma
PESS	Missing data $=$ 9	7			Missing data $= 2$	70	
PESS < 5	8269	3082	864	480	3661	4679	4293
	72.5 (71.2-73.7)	67.0 (65.0-69.0)	56.8 (53.3-60.3)	68.0 (62.7-72.8)	81.1 (79.5-82.6)	74.4 (72.7-75.9)	58.8 (57.0-60.5)
PESS ≥ 5	4001	2013	757	296	1199	2197	3560
	27.5 (26.3–28.8)	33.0 (31.0-35.0)	43.2 (39.7-46.7)	32.0 (27.2-37.3)	18.9 (17.4-20.5)	25.6 (24.1-27.3)	41.2 (39.5-43.0)
Self-reported gingival health	Missing data $= 2$	61			Missing data $= 43$	30	
Excellent-to-good	8756	3146	859	524	3706	4725	4767
	71.7 (70.4-73.0)	62.8 (60.7-64.9)	54.2 (50.6-57.8)	66.3 (60.5-71.6)	78.1 (76.2-79.8)	69.4 (67.5-71.1)	59.1 (57.3-60.9)
Fair	2866	1532	518	192	942	1701	2404
	23.1 (21.9-24.3)	28.4 (26.5-30.4)	30.4 (27.2-33.8)	25.7 (20.9-31.1)	17.4 (15.9–19.0)	23.8 (22.2–25.5)	30.9 (29.2-32.6)
Poor	580	373	205	47	188	400	596
	5.2 (4.6-6.0)	8.8 (7.5-10.2)	15.4 (12.9-18.3)	8.0 (5.1-12.4)	4.5 (3.6-5.7)	6.8 (5.8–8.0)	10.0 (8.9-11.3)
Previous treatment for gum diseases	Missing data $=$ 3	19			Missing data $= 4^{\circ}$	90	
No	10,764	4420	1347	671	4288	5988	6783
	89.8 (88.9-90.6)	87.8 (86.2-89.2)	86.9 (84.5-89.0)	88.4 (84.5-91.4)	89.7 (88.4-90.9)	89.0 (87.7-90.1)	88.2 (87.0-89.3)
Yes	1397	608	238	95	541	822	947
	10.2 (9.4–11.1)	12.2 (10.8-13.8)	13.1 (11.0-15.5)	11.6 (8.6-15.5)	10.3 (9.1–11.6)	11.0 (9.9–12.3)	11.8 (10.7-13.0)
Tooth mobility	Missing data $= 3$	46			Missing data $= 5$	16	
No	10,404	4082	1191	648	4255	5814	6129
	86.4 (85.4-87.4)	81.6 (79.8-83.2)	72.3 (68.9-75.5)	84.4 (79.7-88.3)	89.4 (88.1-90.6)	85.2 (83.7-86.6)	78.3 (76.7-79.7)
Yes	1741	948	386	113	561	989	1595
	13.6 (12.6-14.6)	18.4 (16.8-20.2)	27.7 (24.5-31.1)	15.6 (11.7–20.3)	10.6 (9.4-11.9)	14.8 (13.4-16.3)	21.7 (20.3–23.3)
Bone loss	Missing data $=$ 4	15			Missing data $= 58$	84	
No	10,966	4532	1412	684	4374	6122	6965
	91.9 (91.1-92.6)	91.2 (90.0-92.3)	90.8 (88.6-92.6)	90.3 (86.6-93.0)	91.7 (90.4-92.8)	91.4 (90.3-92.4)	91.7 (90.7-92.6)
Yes	1140	477	161	72	427	673	714
	8.1 (7.4–8.9)	8.8 (7.7-10.0)	9.2 (7.4–11.4)	9.7 (7.0-13.4)	8.3 (7.2-9.6)	8.6 (7.6-9.7)	8.3 (7.4-9.3)
Current abnormalities	Missing data = 3	70			Missing data $= 54$	41	
No	9683	3759	1137	611	3859	5228	5981
	80.0 (78.8-81.1)	73.4 (71.4-75.3)	69.6 (66.1-72.8)	80.2 (75.4-84.3)	80.4 (78.6-82.0)	75.0 (73.2-76.7)	76.0 (74.4-77.6)
Yes	2447	1244	450	158	956	1565	1729
	20.0 (18.9–21.2)	26.6 (24.7–28.6)	30.4 (27.2-33.9)	19.8 (15.7–24.6)	19.6 (18.0-21.4)	25.0 (23.3–26.8)	24.0 (22.4–25.6)

Note: Data are n and % (95% CI), and % values are weighted in order to provide results representative of the French general population aged 18–69 years old, in the selected departments of CONSTANCES, and covered by the general insurance scheme. All p < .05 except for previous treatment for gum diseases according to educational level (p = .19) and for bone loss according to household income (p = .78) and educational level (p = .17).

3.1 | Prevalence of periodontitis by age and sex

The weighted prevalence of PESS and its components according to sex and age are presented in Table 1. In the total population, the majority of individuals reported excellent-to-good gingival health, with only a small percentage indicating poor gingival health (7.9% [7.2%-8.6%]) although 23.4% (22.4%-24.4%) of participants mentioned having current abnormalities. The other prevalence data were 11.3% (10.7%-12.1%), 17.1% (16.2%-18.0%) and 8.5% (7.9%-9.2%) for previous treatment, tooth mobility and bone loss, respectively. The

weighted prevalence of being at risk for severe periodontitis was highest among participants in the older age group (66.0% [64.5%-67.5%]), as expected because age is used to calculate PESS. However, each periodontal component of the score, excluding current abnormalities, was also consistently higher in the older age group.

There was no significant sex difference for the PESS, but the analysis of each component showed a higher prevalence in men for poor self-reported gingival health and tooth mobility and in women for previous periodontal treatment, bone loss and current abnormalities.

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	Smoking status			E-cigarette use		Daily alcohol consur	nption	
	No smokers	Ex-smokers	Current smokers	No	Yes	No	Moderate	Excessive
PESS	Missing data $= 472$			${\sf Missing \ data}=150$		$Missing \; data = 581$		
PESS < 5	6542	4948	1068	12,355	338	2375	8673	1414
	77.2 (75.8–78.5)	66.2 (64.5-67.8)	53.9 (50.8–57.0)	68.9 (67.8–69.9)	62.2 (56.1–68.0)	69.9 (67.4-72.2)	71.3 (70.1-72.5)	58.3 (55.2–61.3)
PESS ≥ 5	2565	3065	1199	6775	241	1177	4409	1230
	22.8 (21.5-24.2)	33.8 (32.2-35.5)	46.1 (43.0-49.2)	31.1 (30.1-32.2)	37.8 (32.0-43.9)	30.1 (27.8-32.6)	28.7 (27.5–29.9)	41.7 (38.7–44.8)
Self-reported gingival health	Missing data = 633			$Missing \; data = 313$		Missing data = 724		
Excellent-to-good	6502	5269	1329	12,951	319	2330	9043	1663
	72.4 (70.9-73.9)	65.5 (63.7-67.2)	54.9 (51.7–58.0)	66.9 (65.8–68.0)	56.4 (50.1-62.5)	63.2 (60.6–65.8)	69.2 (67.9-70.5)	61.7 (58.6-64.8)
Fair	2149	2149	653	4897	182	936	3251	765
	22.5 (21.2-23.9)	26.6 (25.0-28.2)	30.5 (27.7-33.6)	25.4 (24.4–26.5)	31.6 (26.2-37.9)	27.9 (25.5-30.3)	24.2 (23.0-25.4)	27.6 (24.9–30.6)
Poor	395	539	241	1130	67	252	698	197
	5.1 (4.3-6.0)	8.0 (7.0-9.1)	14.6 (12.3-17.2)	7.7 (7.0-8.4)	12.0 (8.7-16.2)	8.9 (7.3-10.8)	6.5 (5.8-7.4)	10.6 (8.7–13.0)
Previous treatment for gum diseases	Missing data $= 674$			Missing data $= 369$		Missing data = 787		
No	8103	6884	1921	16,673	478	3084	11,486	2226
	90.2 (89.1-91.1)	87.8 (86.7-88.9)	87.6 (85.4–89.5)	88.9 (88.2–89.6)	83.8 (78.6–87.9)	88.7 (87.0-90.3)	89.4 (88.6–90.2)	85.7 (83.3-87.8)
Yes	920	1060	297	2250	89	432	1463	381
	9.8 (8.9–10.9)	12.2 (11.1–13.3)	12.4 (10.5-14.6)	11.1 (10.4–11.8)	16.2 (12.1-21.4)	11.3 (9.7–13.0)	10.6 (9.8–11.4)	14.3 (12.2-16.7)
Tooth mobility	Missing data $= 708$			$Missing \; data = 396$		$Missing \; data = 814$		
No	7890	6469	1686	15,587	441	2956	10,9 <i>67</i>	2048
	88.0 (86.9–89.0)	81.3 (79.8-82.6)	73.8 (70.9-76.6)	83.1 (82.2-84.0)	79.5 (74.1-84.0)	83.4 (81.3-85.3)	84.3 (83.2–85.3)	78.2 (75.4-80.8)
Yes	1117	1459	530	3043	122	554	1957	563
	12.0 (11.0-13.1)	18.7 (17.4–20.2)	26.2 (23.4-29.1)	16.9 (16.0-17.8)	20.5 (16.0–25.9)	16.6 (14.7–18.7)	15.7 (14.7–16.8)	21.8 (19.2-24.6)
Bone loss	Missing data $= 774$			Missing data = 465		$Missing \; data = 882$		
oZ	8365	7009	1912	17,081	478	3192	11,726	2268
	93.8 (92.9–94.5)	90.2 (89.2-91.1)	88.6 (86.6-90.4)	91.6 (91.0-92.2)	88.8 (84.8-91.9)	92.3 (90.9–93.6)	91.8 (91.0–92.5)	89.1 (87.1-90.8)
Yes	623	889	287	1755	80	311	1157	323
	6.2 (5.5–7.1)	9.8 (8.9–10.8)	11.4 (9.6–13.4)	8.4 (7.8-9.0)	11.2 (8.1–15.2)	7.7 (6.4-9.1)	8.2 (7.5–9.0)	10.9 (9.2-12.9)
Current abnormalities	Missing data = 729			Missing data = 416		Missing data $= 832$		
No	7214	6119	1607	14,747	411	2678	10,228	1948
	79.7 (78.3–81.0)	76.4 (74.8-77.9)	69.6 (66.6-72.5)	76.9 (75.9-77.9)	70.8 (64.6-76.4)	75.4 (73.0-77.6)	78.2 (77.0-79.4)	72.2 (69.3–75.0)
Yes	1790	1798	602	4130	155	836	2679	658
	20.3 (19.0–21.7)	23.6 (22.1–25.2)	30.4 (27.5-33.4)	23.1 (22.1-24.1)	29.2 (23.6-35.4)	24.6 (22.4–27.0)	21.8 (20.6-23.0)	27.8 (25.0-30.7)

Prevalence of periodontal screening score (PESS) and its components according to smoking status, e-cigarette use and daily alcohol consumption. **TABLE 3**

Note: Data are n and % (95% Cl), and % values are weighted in order to provide results representative of the French general population aged 18–69 years old, in the selected departments of CONSTANCES, and covered by the general insurance scheme. All p < 0.05.

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- Journal of Clinical Periodontology TABLE 4 Periodontal health characteristics in the total population and according to periodontal screening score (PESS).

	Total		PESS < 5, N	l = 12,753	PESS ≥ 5, N = 7106		
Time since last dental visit	N	% (95% Cl)	N	% (95% Cl)	N	% (95% CI)	
<6 months	8899	40.9 (39.8-42.0)	5098	36.5 (35.2-37.8)	3801	50.5 (48.6-52.5)	
>6 months and <1 year	4681	22.5 (21.6-23.4)	3235	24.1 (23.0-25.3)	1446	18.9 (17.5–20.4)	
>1 year and <2 years	3683	19.2 (18.4–20.2)	2636	21.4 (20.3-22.5)	1047	14.6 (13.3-16.0)	
>2 years and <3 years	1317	8.1 (7.5-8.8)	956	9.1 (8.3-10.0)	361	6.0 (5.1-7.1)	
>3 years and <5 years	632	4.1 (3.7-4.6)	435	4.1 (3.6-4.8)	197	4.0 (3.3-5.0)	
>5 years	432	3.7 (3.2-4.2)	257	3.3 (2.8–3.9)	175	4.6 (3.7–5.7)	
Never been	15	0.2 (0.1–0.3)	11	0.2 (0.1–0.4)	4	0.1 (0.0-0.4)	
l do not know	106	1.2 (0.9–1.6)	75	1.3 (0.9–1.8)	31	1.1 (0.7–1.8)	
Missing	94		50		44		
Self-reported gum disease							
Yes	1610	8.4 (7.8–9.0)	428	3.7 (3.2–4.2)	1182	18.8 (17.3–20.4)	
No	15,458	78.2 (77.2-79.1)	11,015	85.4 (84.4-86.4)	4443	62.1 (60.1-64.0)	
l do not know	2321	13.5 (12.7–14.3)	1110	10.9 (10.0-11.9)	1211	19.1 (17.6–20.8)	
Missing	470		200		270		
Weekly use of an inter-dental c	leaning device						
0 day	10,865	61.2 (60.1-62.2)	7876	66.6 (65.3-67.9)	2989	48.9 (47.0-50.9)	
1–3 days	4331	20.7 (19.8-21.6)	2719	20.2 (19.1–21.3)	1612	22.0 (20.5-23.6)	
4–6 days	1532	6.9 (6.4-7.5)	784	5.4 (4.9-6.1)	748	10.1 (9.0–11.3)	
Every day	2726	11.2 (10.6-11.9)	1211	7.8 (7.1-8.5)	1515	18.9 (17.5–20.5)	
Missing	405		163		242		
Weekly use of a mouth rinse							
0 day	14,419	72.9 (71.9-74.0)	10,042	78.5 (77.3–79.7)	4377	60.4 (58.5-62.4)	
1–3 days	3078	16.7 (15.9–17.6)	856	6.6 (6.0-7.3)	590	8.7 (7.7-9.8)	
4-6 days	743	4.3 (3.8-4.8)	518	4.9 (4.3-5.6)	455	7.5 (6.4-8.7)	
Every day	1109	6.0 (5.5-6.6)	482	4.1 (3.6-4.7)	627	10.4 (9.2–11.8)	
Missing	510		222		288		
Gingival bleeding							
Yes	4957	27.3 (26.2-28.3)	2943	26.4 (25.2-27.7)	2014	29.1 (27.4-30.9)	
No	14,505	71.6 (70.5-72.6)	9626	72.6 (71.3-73.8)	4879	69.4 (67.6-71.2)	
l do not know	214	1.2 (0.9-1.4)	120	1.0 (0.8–1.3)	94	1.5 (1.1-2.1)	
Missing	183		64		119		
Food impaction							
Yes	9804	46.6 (45.5-47.8)	5328	39.2 (37.8-40.5)	4476	63.0 (61.1-64.9)	
No	9301	49.9 (48.8-51.0)	6982	57.4 (56.0-58.7)	2319	33.6 (31.7-35.4)	
I don't know	536	3.5 (3.0-4.0)	356	3.5 (3.0-4.1)	180	3.4 (2.7-4.3)	
Missing	218		87		131		
Tooth loosening							
Yes	3333	16.2 (15.4–17.0)	971	7.4 (6.7-8.1)	2362	35.6 (33.8-37.6)	
No	15,496	79.4 (78.5-80.3)	11,336	89.5 (88.6-90.3)	4160	57.3 (55.3-59.2)	
I don't know	789	4.4 (3.9-4.9)	358	3.1 (2.6-3.7)	431	7.1 (6.1-8.3)	
Missing	241	·	88	·	153	-	
Gum retraction							
Yes	4661	21.1 (20.2-22.0)	2112	15.1 (14.2-16.1)	2549	34.2 (32.4-36.0)	
No	13,470	70.4 (69.4-71.4)	9855	78.5 (77.3-79.6)	3615	52.7 (50.7-54.6)	

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(Continues)

TABLE 4 (Continued)

	Total		PESS < 5, N	l = 12,753	PESS ≥ 5, N = 7106	
Time since last dental visit	N	% (95% Cl)	N	% (95% Cl)	N	% (95% CI)
l do not know	1551	8.5 (7.9–9.2)	738	6.4 (5.7–7.2)	813	13.1 (11.8–14.6)
Missing	177					

Note: Data are n and % (95% CI), and % values are weighted in order to provide results representative of the French general population aged 18–69 years old, in the selected departments of CONSTANCES, and covered by the general insurance scheme. All p < .05.

3.2 | Prevalence of periodontitis by socioeconomic status

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Table 2 displays the results by household income and level of education. The highest weighted prevalence for PESS \geq 5 was in the lowest socio-economic categories (e.g., 41.2% [39.5%-43.0%], 25.6% [24.1%-27.3%] and 18.9% [17.4%-20.5%] for the participants with no more than a high school diploma, those with an undergraduate degree and those with postgraduate degree, respectively). These gradients were similar for each component of PESS, except for bone loss and for previous periodontal treatment according to educational level, where no difference was found. In addition, the intermediate education category had the highest prevalence of current abnormalities. Prevalence data stratified by occupational status also showed results consistent with a socio-economic gradient, with the lowest prevalence in the most advantaged group, except for previous treatment for gum diseases, where no difference was found (Table S2). Furthermore, the prevalence of bone loss was lowest among employees.

3.3 | Prevalence of periodontitis by health behaviours

Table 3 shows that current smokers had a higher prevalence of severe periodontitis than ex-smokers and non-smokers (46.1% [43.0%-49.2%], 33.8% [32.2%-35.5%] and 22.8% [21.5%-24.2%], respectively). The result for smokers was expected, given that it is a component of PESS. However, the prevalence of each component of the PESS followed the same gradient. Current e-cigarette users also had the highest prevalence, as did participants with excessive daily alcohol consumption. It should be noted that for all variables except bone loss, the lowest prevalence was among moderate consumers (Table 3).

3.4 | PESS and periodontal health items

The other periodontal health characteristics in the total population and according to the presence of severe periodontitis (i.e., PESS \geq 5) are displayed in Table 4. While more than 60% of participants reported having visited their dentist in the last year (including nearly 41% in the last 6 months), less than 10% declared that it had been more than 3 years since their last visit. The prevalence for participants with a PESS \geq 5 was both greater for 'a visit to the dentist in the last 6 months' and also in 'more than 5 years'. Overall, 8.4% (7.8%-9.1%) reported to have gum disease, but this prevalence was 18.8% (17.3%-20.4%) in participants with severe periodontitis risk (vs. 3.7% [3.2%-4.2%] for those avec PESS < 5).

Individuals with PESS \geq 5 used additional inter-dental cleaning devices and/or mouth rinse more frequently than those with PESS < 5. All the other variables relating to periodontal symptoms (i.e., gingival bleeding, food impaction, tooth loosening and gum retraction) were increased for participants with a PESS \geq 5, in particular for tooth loosening where the prevalence was multiplied by almost five times.

4 | DISCUSSION

The present study allows to assess the prevalence of severe periodontitis in the French general population as estimated by calculating the PESS. Data from each participant were weighted following a modelling process that allows to extend conclusions from this study to the French general population aged 18–69 years in the selected departments of the CONSTANCES cohort. The present data show that 31.6% of individuals were at risk of severe periodontitis, with a higher prevalence among participants aged 55 and over, those with lower socio-economic status as well as current smokers, e-cigarette users and heavy drinkers.

The observed prevalence of severe periodontitis is higher than the previously published national estimates in France (Bourgeois et al., 2007; Chen et al., 2021) and from other industrialized countries (Frencken et al., 2017). Prevalence data provided by the GBD study (Chen et al., 2021; Trindade et al., 2023) are based on miscellaneous periodontal classifications and mainly rely upon the assessment of the Community Periodontal Index Treatment Needs (CPITN), whose reliability is debatable due to the use of a non-confident case definition of the disease (Trindade et al., 2023). Notwithstanding this limitation, the GBD study data show a steady trend towards an increase in the prevalence rate of severe periodontitis worldwide, in which population growth and ageing are important contributing factors. In France, the only survey assessing the prevalence of periodontitis was conducted 20 years ago and used a case definition that is now outdated (Bourgeois et al., 2007), but it already reported a prevalence of severe attachment loss (≥5 mm) of 32.31% (95% CI: 31.81-32.81), with a 26.4% of generalized forms of severe clinical attachment loss. A regional study on a representative urban population in Northern

Italy, based on a clinical examination and applying the CDC/AAP case definition for periodontitis, reported a prevalence of severe periodontitis of 34.9% (Aimetti et al., 2015), which is consistent with the present results. Finally, a recent meta-analysis of studies published between 2011 and 2020 reported a worldwide prevalence of 23.6%, but with substantial heterogeneity due in particular to the case definition used (Trindade et al., 2023).

Certain groups with the highest prevalence corresponded to known risk factors for periodontitis, such as age or smoking. While male sex was also identified in several studies as a risk factor, the higher prevalence in men was only found for some indicators. The higher frequency of periodontitis in participants with a low socio-economic status is in line with most recent reviews (Khajavi et al., 2022; Singh et al., 2019). Although the effects of e-cigarette on periodontal health are still debated (Robbins & Ali, 2022; Wasfi et al., 2022), it cannot be ruled out that the higher prevalence of severe periodontitis risk among e-cigarette users in our sample could be explained by the fact that the vast majority of adult e-cigarette users are current or former smokers. Finally, the higher prevalence of severe periodontitis in participants with excessive alcohol consumption is consistent with recent studies investigating this association (Baumeister et al., 2021). The intermediate prevalence found among non-drinkers could be explained by the presence in this group of abstainers, who probably previously guit drinking for health reasons (Balagny et al., 2023; Stockwell et al., 2016). However, in a US study based on NHANES data (Gay et al., 2018), individuals who reported no alcohol consumption were not at higher risk for periodontitis. Although the aim of this study was not to investigate the risk factors for periodontitis, it allows us to indicate in which population groups the highest prevalence is found. From a public health point of view, these results may be useful for developing information and prevention campaigns aimed at the general public and targeting specific groups at greater risk.

In addition to the results on the prevalence of severe periodontitis, this study also showed a relevant discrepancy between this prevalence, the awareness of the disease and the frequency of dental visits. Among the participants with PESS ≥5, less than 20% thought they had gum disease although half declared having visited their dentist in the past 6 months (and almost 70% in the past year), suggesting a very low awareness of the disease that is likely under-diagnosed by dental professional. This striking difference may also explain the observed high prevalence and severity of the disease at the population level.

The present study has limitations. First, the population studied was limited to people aged under 69 at inclusion, hampering the possibility of estimating the prevalence of periodontitis in older adults. Second, because the study was cross-sectional and the analyses were unadjusted, it is not possible to draw conclusions about the direction of the relationship between the variables. However, the aim of the study was primarily descriptive. Third, severe periodontitis was estimated using self-reported evaluation, and no clinical examination was performed. Thus, the available data may not reflect the clinical picture, and potential self-reported bias cannot be ruled out. Notwithstanding, previous studies have shown that validated self-reported measures are valuable tools in populationbased studies and they perform even better than partial mouth periodontal examination in terms of diagnostic accuracy (Abbood et al., 2016; Eke

et al., 2010; Reiniger et al., 2020). As previously mentioned, self-reported approaches are convenient tools, cheaper and easy to implement in large epidemiological cohorts and cannot be seen only as a limitation.

In addition, the estimates in the present study are based on a self-reported questionnaire that was validated on the recommended CDC/AAP case definition for periodontitis (Holtfreter et al., 2015). It should also be noted that the prevalence of clinical signs strongly associated with severe periodontitis, such as gingival bleeding, food impaction or gum recession, is much higher in the group of patients with PESS \geq 5, which supports the validity of the score used.

Several strengths can also be acknowledged. We analysed a population-based sample constituting the CONSTANCES cohort, the large size of which enabled us to conduct analyses stratified by sociodemographic variables and health behaviours. We used weighting coefficients at inclusion and follow-up to estimate the prevalence among French adults aged between 18 and 69 years, living in the selected departments of CONSTANCES and covered by the general health insurance scheme. The current study is the latest survey conducted in France estimating the prevalence of severe periodontitis and reporting the participants' self-perception of their periodontal health in details. These data could be used by the national professional institutions to improve the screening protocols of periodontitis, and may lead to useful comparisons between countries and over time.

5 | CONCLUSIONS

Based on the present population-based cohort study and according to a validated self-reported questionnaire, almost one third of participants was at risk of severe periodontitis, with marked disparities between different sociodemographic groups and in relation to certain lifestyle habits, such as smoking and alcohol consumption. It also appears that most individuals were not aware of their disease despite regular visits to the dentist. This suggests that periodontitis is largely undiagnosed. As the global burden of periodontitis continues to increase due to population growth and ageing, screening for periodontitis and educating patients on its symptoms are likely to be the most effective ways to reduce its prevalence over time.

AUTHOR CONTRIBUTIONS

EW contributed to the design of the study, performed the statistical analyses and drafted the manuscript. AR and SK contributed to data collection, data interpretation and statistical revisions. PGS and GC contributed to study design, data interpretation and critical revisions. MG and MZ initiated the CONSTANCES cohort, contributed to data collection, data interpretation and manuscript drafting. PB and MCC contributed to study design, data collection, data interpretation, drafted the manuscript. All authors provided criticism and revised the final version of the manuscript before submission.

FUNDING INFORMATION

The present study was sponsored by AP-HP (Paris, France), supported by the Recherche Hospitalo-Universitaire iVASC grant (www.ivasc.eu) \perp WILEY_

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(ANR-16-RHUS-00010) from the French National Research Agency (ANR) as part of the 'Investissements d'Avenir' programme. The CONSTANCES Cohort Study was funded by the Caisse nationale d'assurance maladie des travailleurs salariés (CNAMTS), and benefits from a grant from the French Commissariat général à l'investissement (ANR-11-INBS-0002). CONSTANCES also receives funding from MSD, AstraZeneca, Lundbeck and l'Oréal managed by INSERM-Transfert.

CONFLICT OF INTEREST STATEMENT

All authors declare no conflicts of interest in relation to the matter of this study.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

ETHICS STATEMENT

The CONSTANCES cohort obtained the authorization of the National Data Protection Authority (Commission Nationale de l'Informatique et des Libertés, no. 910486) and was approved by the Institutional Review Board of the National Institute for Medical Research—INSERM (no. 01–011).

INFORMED CONSENT

Written informed consent was received from all participants.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Wiernik, E., Renuy, A., Kab, S., Steg, P. G., Goldberg, M., Zins, M., Caligiuri, G., Bouchard, P., & Carra, M. C. (2024). Prevalence of self-reported severe periodontitis: Data from the population-based CONSTANCES cohort. *Journal of Clinical Periodontology*, 1–11. <u>https://doi.org/10.1111/jcpe.13969</u> 11

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