Periodontal disease: the portrait of an epidemic

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Background: This article aims to provide updated statistics on worldwide burden of periodontal disease.

Methods: An electronic search was carried out in Global Health Data Exchange (GHDx) database, using the keywords "periodontal disease", "metric", "year", "sex", "age" and "location". Search results were imported into a Microsoft Excel file and elaborated.

Results: Incidence, prevalence and disability-adjusted life year (DALYs) of periodontal disease have constantly increased during the past 3 decades, making it the 12th more prevalent pathology around the world. Women have a 13% higher risk of incident and prevalent disease, whilst values of both these epidemiological measures exponentially increase after 19 years of age. The highest burden of periodontal disease is recorded in South-East Asia and Western Pacific, whilst the prevalence is the lowest in Africa. Western Pacific has also displayed the largest increase during the past 3 decades.

Conclusions: The current epidemiological estimates of periodontal disease concur to define the portrait of a growing epidemic.

Keywords: Periodontal disease; periodontitis; epidemiology; prevalence

Introduction

Periodontal disease is conventionally defined as an inflammatory disorder involving both soft and hard periodontal structures (1). The early phase, conventionally defined as gingivitis, is characterized by a modest and self-limiting inflammation of periodontal structures. When the local inflammation progresses, the disease evolves towards periodontitis, which has been defined by the 1999 International Workshop on Classification of Periodontal Diseases as a microbially-associated and host-mediated inflammation, resulting in loss of periodontal attachment (2). In the following 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions, it was then specified that the diagnosis of periodontitis shall be based on clinical attachment loss (CAL) by circumferential assessment of erupted dentition using standardized periodontal probes with reference to cemento-enamel junction (3). According to the pathophysiological basis, periodontitis can be classified in three different forms, i.e., periodontitis, periodontitis associated with systemic diseases and necrotizing periodontitis. Periodontal disease progressively evolves when left untreated, thus causing several local complications such as the development of deep periodontal lesions, periodontal bone and tooth loss, up to masticatory failure (3).

It has been recently hypothesized that some bacteria responsible for periodontitis may actively enter the circulation from periodontal tissues, dislocate in many

organs and tissues, thus enhancing the risk of developing pathologies characterized by inflammatory/infectious components (4). These typically include various types of malignancies (especially digestive tract, pancreatic, prostate, breast, uterus, lung, esophagus and oropharyngeal cancers, along with lymphomas) (5), cardiovascular disease (6), venous thromboembolism (7), diabetes (8), rheumatic disorders (9), as well as dementia (10), which all cumulatively represent the most common worldwide pathologies (11). Such an increasingly strengthening association between periodontal disease and human pathologies shall hence drive the establishment of efficient healthcare interventions aimed at preventing the development of periodontitis as well as at mitigating its potential impact on human health and ultimately limiting its potentially adverse clinical, societal and economic consequences. Nevertheless, efficient planning of preventive and curative healthcare interventions always requires to be based on accurate epidemiological basis, so that the target populations could be more efficiently identified and managed.

Some generic articles have been published on the worldwide epidemiology of periodontal disease over the past two decades (12-16), whilst no recent and systematic overview, based on large and reliable disease repositories, exists to the best of our knowledge. Therefore, in this article we aim to provide an updated and comprehensive overview on the worldwide burden of periodontal disease.

Methods

Our approach for estimating the epidemiologic burden of periodontal disease encompassed an electronic search in the Global Health Data Exchange (GHDx) database, the largest worldwide repository of health-related information maintained by the Institute for Health Metrics and Evaluation (17). Briefly, this free online version of the Global Burden of Diseases, Injuries, and Risk Factors Study 2017 (GBD 2017) database now includes comprehensive information on 354 human pathologies garnered from 195 different countries and territories, in the period between the years 1990 and 2017 (18).

Specific electronic searches were hence performed in GHDx using the specific keyword "periodontal disease" [International Classification of Diseases (ICD)-10 codes K05.0 and K05.6, along with ICD-9 codes 523.0 and 523.9]. According to the GBD 2017 collaborators, data on periodontal disease has been collected using the definition provided by Page and Eke, in 2007 (19), from as many

as 441 site-years in 81 different countries belonging to all the main seven GBD super-regions (i.e., South-East Asia, East Asia & Oceania; South Asia; Central Europe, Eastern Europe & Central Asia; North Africa & Middle East; Sub-Saharan Africa; Latin America & Caribbean; High Income). Data have then been modelled using the Bayesian meta-regression tool DisMod-MR 2.1, adjusting the final estimates for prevalence of edentulism, whereby edentate subjects are systematically excluded from studies on periodontal disease (18).

The electronic searches were complemented with additional keywords such as "metric" ("rate", expressed as cases per 100,000), "measure" ("incidence", "prevalence" and "DALYs", i.e., disability-adjusted life year), "year" (from year "1992" to year "2017"), "sex" ("both", "male" and "female"), "age" (from "<1" to "≥90" years) and "location" (WHO regions, encompassing "Africa", "Eastern Mediterranean", "Europe", "Americas", "South-East Asia" and "Western Pacific"). The results of our searches were imported into a Microsoft Excel file (Microsoft, Redmond, WA, USA) and then analyzed using MedCalc statistical software (MedCalc Software, Ostend, Belgium). When necessary, the risk of periodontal disease was expressed as odds ratio (OR) and 95% confidence interval (95% CI). The study was performed in accordance with the Declaration of Helsinki, under the terms of relevant local legislation. Ethics board approval is unnecessary at the local institution (University of Verona) for articles based on electronic searches in free scientific databases.

Results

The temporal trend of periodontal disease during the past 3 decades in both sexes is shown in *Figure 1*. Incidence, prevalence and DALYs curves follow a virtually identical path, with estimates that have constantly increased during the past 3 decades. The cumulative incidence has grown from 740 to 936 cases per 100,000 (+26%), exhibiting a slightly higher escalation in women (from 772 to 992 cases per 100,000; +28%) than in men (from 708 to 880 cases per 100,000; +24%). The cumulative prevalence has also increased by 34% during the past 3 decades (from 7,762 to 10,420 cases per 100,000), again with a slightly higher escalation in women (from 8,002 to 11,009 cases per 100,000; +38%) than in men (from 7,572 to 9,835 cases per 100,000; +31%). This remarkable epidemiologic burden now makes periodontal disease the 12th more prevalent pathology around the world. The temporal trend of DALYs
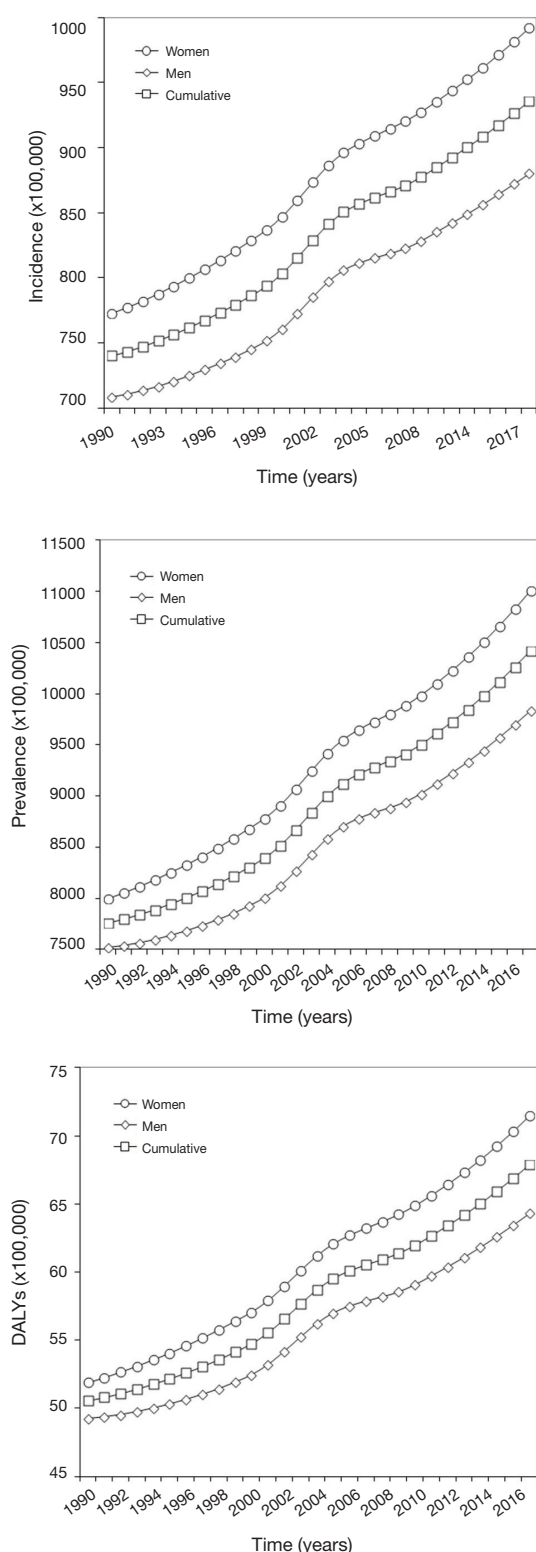
Figure 1 Temporal trend of periodontal disease recorded during the past 3 decades, in both sexes.

(cumulative DALYs are 68 per 100,000 in 2017, 71 in women and 64 in men, respectively) closely mirrors that of prevalence. According to these figures, women have 13% higher risk of incident (OR, 1.13; 95% CI, 1.03–1.24; P=0.009) and prevalent (OR, 1.13; 95% CI, 1.10–1.17; P<0.001) periodontal disease, respectively. The age distribution of both incidence and prevalence of periodontal disease is shown in *Figure 2*. Both epidemiologic curves exponentially increase after 19 years of age. Prevalence clearly peaks between 60–64 years and then gradually decreases, whilst incidence remains virtually stable after 40 years of age throughout the elderly. The risk of suffering from periodontitis is hence 67% higher in older people (i.e., aged 65 years or older) than in younger subjects (OR, 1.67; 95% CI, 1.63–1.71; P<0.001).
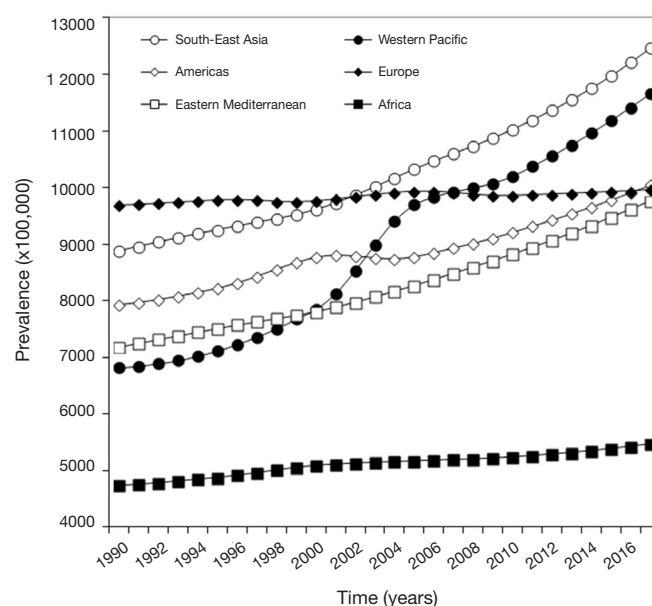
The geographical evolution of the prevalence of periodontal disease during the past 3 decades is summarized in *Figure 3*, which clearly shows that the highest disease burden is now recorded in South-East Asia (12,463 cases per 100,000) and Western Pacific (11,653 cases per 100,000), followed by the Americas (10,047 cases per 100,000), Europe (9,965 cases per 100,000) and Eastern Mediterranean (9,757 cases per 100,000), whilst the prevalence is the lowest in Africa (5,469 cases per 100,000). Regarding the temporal trend, Western Pacific has displayed the largest increase during the past 3 decades (+70%), followed by South-East Asia (+40%), Eastern Mediterranean (+36%), Americas (+27%) and Africa (+15%), whilst the prevalence has remained virtually stable in Europe (+3%).

Discussion

Taken together, the current epidemiological estimates of periodontal disease identified with our analysis concur to define the portrait of a growing epidemic, with incidence, prevalence and years lost for ill-health or disability that have all constantly increased during the past three decades. According to the data of GHDx repository, the largest database of human pathologies worldwide, periodontal disease is now the 12th more prevalent condition around the world, being included among the top ten more prevalent pathologies in all WHO regions except Africa. Its burden is slightly higher in the female sex and tends to gradually increase in parallel with ageing, with a definitive prevalence that is 67% higher in the elderly. Although it may seem that the degree of "unhealthy life" due to periodontal
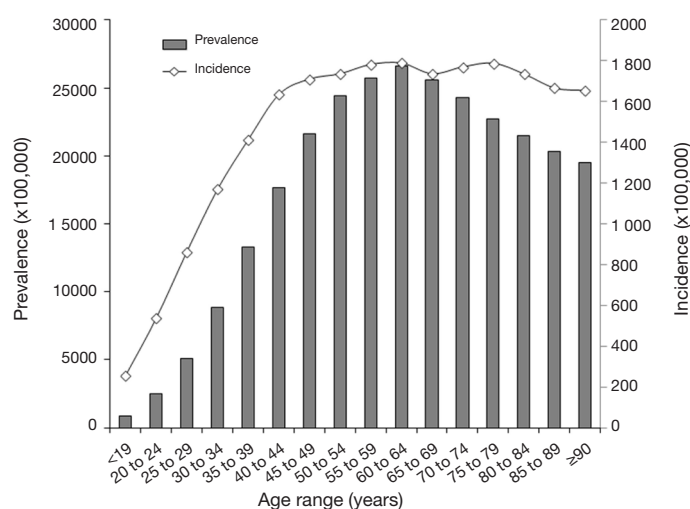
Figure 2 Age distribution of incidence and prevalence of periodontal disease.

Figure 3 Geographical evolution of prevalence of periodontal disease recorded during the past 3 decades.

disease is relatively modest (i.e., 68 DALYs per 100,000), this estimate is now almost identical to that caused by lip and oral cavity cancer (69 DALYs per 100,000) and higher than that of other conditions such as rheumatoid arthritis (46 DALYs per 100,000), larynx (43 DALYs per 100,000), uterus (28 DALYs per 100,000) and thyroid (15 DALYs per 100,000) cancers (17), which are typically perceived as more invalidating conditions by the general population as well as by many policymakers, healthcare administrators and

healthcare professionals.

These concerning estimates, both in terms of current prevalence as well as considering the recent escalating burden of periodontal disease, contribute to raise many healthcare concerns associated with the important local (oral cavity) consequences, but also for the notable associations that have recently been reported between periodontitis and severe organic diseases. Several lines of evidence now support the existence of a strong association between

periodontal and cardiovascular diseases. The results of the recent Periodontitis and Its Relation to Coronary Artery Disease (PAROKRANK) study, which included as many as 1,610 subjects (half being diagnosed with myocardial infarction) undergoing standardized dental examination, showed that periodontal disease was more frequent in patients than in controls (43% *vs.* 33%; P<0.001) (20). In fully-adjusted multivariable analysis, the risk of myocardial infarction was found to be 28% higher in subjects with periodontal disease than in those without (OR, 1.28; 95% CI, 1.03–1.60). A possible association between periodontal disease and venous thromboembolism has also been described by Cowan *et al.* Briefly, the 7,856 participants to the Atherosclerosis Risk in Communities (ARIC) study were followed up for a mean period of 12.9 years (7). Periodontal disease was found to be more frequent in patients with incident venous thromboembolism than in those without, so that periodontitis was associated with a ~90% higher cumulative risk of venous thrombosis [hazard ratio (HR), 1.91; 95% CI, 1.19–3.08]. In another study, Winning *et al.* carried out detailed periodontal examinations in 1,331 diabetes-free subjects, who were then followed up for a mean period of 7.8 years (21). In multivariate analysis the risk of incident diabetes was 69% higher in patients with moderate or severe periodontitis than in those without (HR, 1.69; 95% CI, 1.06–2.69). Interestingly, an association between periodontal disease and gestational diabetes mellitus has also been recently evidenced by Kumar *et al.* (22). Briefly, 584 primigravidae enrolled between 12–14 weeks of gestation were concomitantly subjected to periodontal examination and 75 g oral glucose tolerance test (OGTT). Notably, not only the fully-adjusted risk of gestational diabetes mellitus was 2.8-fold higher (HR, 2.85; 95% CI, 1.47–5.53) in women with periodontal disease than in those without, but the presence of periodontitis was also associated with 2.2-fold higher risk (HR, 2.20; 95% CI, 0.86–5.60) of developing pre-eclampsia. As regards cancer, Corbella *et al.* have recently published the results of a comprehensive meta-analysis (5), in which they have explored the potential association between periodontal and malignant diseases according to available literature data. The results of this meta-analysis convincingly showed that periodontitis is associated with a 14% higher risk (HR, 1.14; 95% CI, 1.04–1.24) of developing all types of cancers, especially malignancies of oesophagus and oropharynx (HR, 2.25; 95% CI, 1.30–3.90), uterus (HR, 2.20; 95% CI, 1.16–4.18), pancreas (HR, 1.74; 95% CI, 1.21–2.52), digestive tract (HR, 1.34; 95% CI, 1.05–1.72), prostate

(HR, 1.25; 95% CI, 1.04–1.51), lung (HR, 1.24; 95% CI, 1.06–1.45), and breast (HR, 1.11; 95% CI, 1.00–1.23), as well as with enhanced risk of lymphomas (HR, 1.30; 95% CI, 1.11–1.52) and other hematological cancers (HR, 1.30; 95% CI, 1.11–1.53).

Conclusions

In conclusion, the combination of our analysis on the GHDx repository with the growing evidence that periodontal disease is associated with both local and generalized complications is in keeping with the current view of periodontitis as a major public healthcare issue (23), and further contributes to reinforce the concept that a holistic preventive and curative approach shall be planned for lowering the otherwise unfavourable clinical, societal and economic consequences of periodontal disease.

Footnote

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The data in this article are taken from a public database, so ethical review is exempt.

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