The Global Burden of Oral Disease: Research and Public Health Significance

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We live in an age where we are inundated with statistics. More often than not, most of these numbers barely register any significance with us. But for any of us involved in providing oral health care, advocating for improved oral health, or conducting oral health research, 3.5 billion is a number that should resonate with us—representing the number of people affected by the burden of untreated dental caries, severe periodontitis, and edentulism worldwide (Kassebaum et al. 2017).

For dental epidemiologists, calculating oral disease statistics has frequently been challenging. Conducting examinations in less-than-ideal conditions, varying detection methodologies and changing assumptions of case definitions, and the overall resource intensiveness of the enterprise have historically hindered our efforts. Although a few countries have successfully launched a national survey or implemented a surveillance system to document oral health status, most countries have not. There have been some attempts in the past to quantify global dental disease prevalence, but it has been nearly impossible to quantify the global burden of oral diseases. This changed in 2013, when Marcenes and colleagues published in this journal the first paper estimating global oral disease burden from data generated from the Global Burden of Disease (GBD) study, giving us our first reasonable estimate of the overall oral disease burden worldwide. More recently, the GBD study collaborative group published newer information providing updated estimates including years up to 2015 (GBD 2015 DALYs and HALE Collaborators 2016). In this month's *Journal of Dental Research*, Marcenes and colleagues (Kassebaum et al. 2017) provide updated information on global oral health problems coinciding with the latest release of GBD 2015 estimates.

The GBD study was initiated in the early 1990s to help provide the world's policy makers, public health advocates, and health researchers with accurate information pertaining to the health of populations globally. The GBD study uses information collected from ongoing data collection systems throughout the world, such as national disease registries, census findings, vital records, and health surveys, as well as systematic reviews of the literature. Information is transposed into data and undergoes a series of complex calculations required for the GBD estimates. Periodically, newer information is incorporated into the process, and updated estimates of disease, injury, and impairment along with subsequent burden are calculated. In essence, the GBD study is an ongoing global epidemiologic study based on Big Data science to provide timely information on changes in the distribution of diseases and adverse health conditions in the worldwide population.

An essential function of epidemiology is the study of the distribution and determinants of disease and health-related conditions to help gain insight into the causes or events that lead to poor health. To help understand changes in health status because of the effect of time or place, estimates are typically expressed in rates. A significant contribution made by the GBD study to this effort was the development of the disability-adjusted life year (DALY) for use as a rate (Murray and Lopez 2013). The DALY represents years of a healthy life lost because of early death and disability, and it is calculated as the sum of years of life lost (YLLs) and years lived with disability (YLDs). Using DALYs as the key measure of disease burden facilitates the comparison of very different health problems across differing geographic areas. This is best exemplified by the efforts of the GBD study to compare the changing prevalence of infectious and noncommunicable diseases over time and by higher- and lower-income countries and regions.

The 2015 GBD update is noteworthy for 2 concepts that have direct relevance to oral health. First, the global burden of infectious diseases has declined from 1990 to 2015, as achieved by substantial reductions in the global burden of HIV/AIDS and malaria in the past decade. Additionally, as countries continue to transition from less to more economically developed states, health problems transition as well, and this affects disease and disability. The 2015 GBD report describes this evolution as a global "epidemiologic transition," and it is a response to improving levels of economic development that often results in an increase in the prevalence of chronic diseases (Institute for Health Metrics and Evaluation 2016b). For example, lower respiratory diseases (communicable disease) were the leading cause of YLLs in 1990, whereas heart disease (noncommunicable disease) is the leading cause of YLLs in 2015. Interestingly, there was little change among the 10 leading causes of YLDs during this 25-y period—except for 1 notable change: oral diseases are now ranked in the top 10 leading causes of YLDs globally.

Although not a new concept, this epidemiologic transition will affect oral health globally. Oral diseases and a number of other noncommunicable diseases share some common risk factors (e.g., tobacco use and poor diet) and similar pathophysiologic

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Figure 1. Global estimated prevalence rate for oral cancer, oral diseases, and other disorders by sociodemographic index (SDI) status, 2015, for both sexes and all ages. Source: Institute for Health Metrics and Evaluation (2016a).

Figure 2. Global estimated burden (disability-adjusted life years [DALYs]) due to oral cancer, oral diseases, and other disorders by sociodemographic index (SDI) status, 2015, for both sexes and all ages. Source: Institute for Health Metrics and Evaluation (2016a).

mechanisms (e.g., infection and chronic inflammation response). As countries continue to advance in development, the prevalence of noncommunicable diseases, including oral diseases, will likely continue to rise as well, and this will likely increase the contribution of oral disorders to the global total DALY burden.

The other notable topic relevant to oral health is the introduction of the sociodemographic index (SDI) by the GBD 2015 collaborative group (Institute for Health Metrics and Evaluation 2016b). The SDI metric is an attempt to include more information to characterize a country's level of development, as opposed to relying on a dichotomous econometric measure or descriptor, such as "developed/developing." The information utilized to create the SDI quintile scale is educational attainment, per capita income, and fertility rate.

Understanding the difference between how prevalence and DALYs affect the burden of oral disorders is very important. The current Marcenes study (Kassebaum et al. 2017) reports that untreated caries in permanent teeth is the most prevalent condition, affecting 2.5 billion people globally. Figure 1 shows the prevalence rate of oral disorders by SDI, and untreated dental caries accounts for a substantial amount of the overall prevalent cases regardless of SDI status. Figure 2 shows burden when DALYs are considered instead of prevalence. In this approach, edentulism is now responsible for a significant proportion of the burden, and this burden is clearly more substantial in high versus low SDI countries. Therefore, as countries continue to grow economically and development improves, not only may the burden of oral disorders account for a larger proportion of the overall DALYs, but the indirect impact of chronic dental diseases and edentulism may also have the unintended effect of exacerbating population-level differences within the country. We have known for some time that population-level oral health differences exist by some sociodemographic factors. These population-level differences, or "health disparities" as they are more commonly known as, are strongly influenced by some sociodemographic factors, with income and education serving as important determinants for health (Lee and Divaris 2014).

Although the SDI metric introduces a new way to explore social and economic determinants of health, its potential value to evaluate public health interventions at the global level is very important. Last year, the Sustainable Development Goals initiative was launched by the United Nations (2016) following commitments from >190 world leaders in September 2015. Among the 17 goals, 1 focuses on improving global health and well-being (goal 3). Other goals indirectly affect health and well-being, such as economic growth, improvement in education, and reduction in poverty. Although there are no oral health-specific targets associated with goal 3, with the 2015 GBD study serving as baseline information, the SDI metric could be used to assess for improvement in oral health at unique geospatial levels that are strongly affected by public policy initiatives across the world.

There are important opportunities ahead for health service researchers using GBD data. Assessing the performance of health systems based on expenditures and the impact on DALYs is just one example. Indeed, the potential contribution of the ongoing GBD efforts toward advancing our knowledge of the factors that promote disease and influence health is so promising that *The Lancet* made an unprecedented commitment starting with GBD 2015 to publish 4 signature papers annually covering mortality, YLDs, DALYs, and risk factors (GBD 2015: from . . . 2016). Given this, Marcenes and colleagues' (Kassebaum et al. 2017) contribution to the *Journal of Dental Research* this month should be read and interpreted more as the beginning of a series of forthcoming works originating from GBD collaborators and others that will significantly broaden our knowledge of the factors affecting oral health globally.

It is now evident that oral disorders are highly prevalent and that a dental epidemiologic transition is underway at the global level. The sizable burden of oral disorders (measured as DALYs) and their socioeconomic impact make them an important global public health issue. Improving our understanding of the contribution of behavioral and physiologic risk factors, social and economic determinants, and health delivery systems to oral health and well-being at the population level may not be an easy task, but untangling this complex web will help reduce disease burden and enhance life. Although there are

many challenges affecting oral health research, there are opportunities. We should not forget the “3.5 billion” statistic; we should remember that we have a responsibility to continue to learn, to improve, and to measure on.

Author Contributions

B.A. Dye, contributed to conception, design, data acquisition, analysis, and interpretation, drafted and critically revised the manuscript. The author gave final approval and agrees to be accountable for all aspects of the work.

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