

Burden of oral disorders, 1990–2019: estimates from the Global Burden of Disease Study 2019

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Submitted: 8 March 2023; Accepted: 8 May 2023

Online publication: 13 July 2023

Arch Med Sci 2023; 19 (4): 930–940

DOI: <https://doi.org/10.5114/aoms/165962>

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Abstract

Introduction: The aim of this study was to understand the global incidence and disability-adjusted life years (DALY) of oral disorders by age, gender, region, and Sociodemographic Index (SDI) from 1990 to 2019.

Material and methods: The estimated annual percentage change (EAPC) and 95% confidence intervals (CIs) were used to assess the trends in age-standardized incidence and DALY rates from 1990 to 2019.

Results: The global age-standardized incidence rate (EAPC = 0.01) of oral disorders increased slightly from 1990 to 2019. From 1990 to 2019, the age-standardized DALY rate decreased in high-SDI (EAPC = -0.43) and high-middle-SDI (EAPC = -0.14) regions, but it showed increasing trends in low-SDI (EAPC = 0.22), low-middle-SDI (EAPC = 0.36), and middle-SDI (EAPC = 0.17) regions. The EAPC in the age-standardized DALY rate was negatively correlated with the regional SDI value ($p = -0.402$, $p = 0.001$). From 1990 to 2019, the region with the largest increase in age-standardized DALY rate was South Asia (EAPC = 0.67), while the country with the greatest increase in age-standardized DALY rate was India (EAPC = 0.82).

Conclusions: From 1990 to 2019, the global age-standardized incidence rate of oral disorders showed a slight increasing trend. It is necessary to control the increase in DALY and the disease burden associated with oral disorders in low-, low-middle-, and middle-SDI regions, such as South Asia, particularly in India.

Key words: oral disorders, incidence, disability-adjusted life years, Sociodemographic Index, estimated annual percent change.

Introduction

According to the latest report of the Global Burden of Disease published in 2019 (GBD 2019), oral disorders, including dental caries, periodontitis, and tooth loss, affect more than 44.5% of the global population [1]. Serious disability caused by oral disorders leads to pain, sepsis, reduced school time, decreased work efficiency, and decreased overall quality of life [2, 3]. Although oral disorders can be prevented to a large extent, they are a neglected problem and are rarely regarded as a health policy priority [4].

The WHO has long listed oral health as one of the top 10 standards for human health, and its analysis report suggests that oral diseases have

become a decisive factor in human quality of life and a global public health burden [5, 6]. Although with the development of social economy and culture, people's overall health status continues to improve, and oral health has also improved, oral diseases are still a very common health problem. Moreover, rapid demographic, economic, and educational changes will inevitably have an impact on the epidemiology of dental caries, periodontal disease, and oral cancer [7]. Therefore, the severity of oral diseases varies significantly by region, ethnicity, age, and gender, with significant differences in oral health among different regions and populations. It is particularly worrisome that the incidence of oral disorders is increasing in many low-income and middle-income countries [8].

Information about disease burden is important for monitoring the macro health status and changes of a country's or region's population. The measurement of the burden of oral diseases helps us to understand the objective impact of oral diseases on health, and it can provide a strong decision-making basis for relevant health policies. However, due to a lack of comparable data, there are few comprehensive studies assessing inequalities in oral disorders between different countries and regions.

The GBD 2019 study assessed the burden of 369 diseases in 21 regions and 204 countries and regions globally. These data allow assessments of the burden and trends of oral disorders [9]. In this study, we evaluated the oral disorder data from the GBD 2019 study to estimate the distribution, burden (including incidence and disability adjusted life years (DALYs)), and trends of oral disorders in different regions and countries from 1990 to 2019. This is of great significance for accurately assessing the burden of oral disorders and rationally allocating limited healthcare resources.

Material and methods

Data sources

Using the Global Health Data Exchange of the GBD database for retrieval (<https://ghdx.healthdata.org/>), we collected the age-standardized incidence and DALY rate of oral disorders and their 95% uncertainty intervals (95% UIs) for 204 countries and regions from 1990 to 2019 by age, gender, country, and region [9]. We followed the Guidelines for Accurate and Transparent Health Estimates Reporting recommendations. The First Affiliated Hospital of Wenzhou Medical University reviewed and approved this study.

Definition of oral disorders

The oral disorders included in the analysis were caries of deciduous teeth, caries of permanent

teeth, chronic periodontal disease, and other oral disorders.

Sociodemographic Index

The Sociodemographic Index (SDI) is a comprehensive index, including gross domestic product per capita, the average years of education, and the fertility rate. The SDI value reflects social development and is an important variable used to assess the disease burden and healthy development of a region. The GBD study divided 204 countries and regions into 5 SDI quintiles (low, low-middle, middle, high-middle, and high) [10].

Statistical analysis

We used the World Health Organization 2000–2025 global standard to calculate age-standardized rates (per 100,000 people) as follows:

$$ASR = \frac{\sum_{i=1}^A a_i w_i}{\sum_{i=1}^A w_i} \times 100,000.$$

In this formula, a_i is the specific age rate in the i^{th} age group, w_i is the population (or weight) of the corresponding i^{th} age subgroup in the selected reference standard population, and A is the number of age groups.

The estimated annual percent change (EAPC) is a recognized metric to describe the trends in age-standardized rates within a regression model [11, 12]. It calculates the average annual change in the age-standardized rate for all specific intervals. Linear regression was used to estimate the EAPC, using the equation $y = \alpha + \beta x + \varepsilon$, where $y = \ln(\text{age standardized rate})$ and $x = \text{the Gregorian calendar year}$. The EAPC was calculated using the formula $100 \times [\exp(\beta) - 1]$, and the 95% confidence interval (CI) was calculated using the linear regression model. When the EAPC value and its 95% CI were greater than 0, it was defined as an increasing trend. Conversely, when the EAPC value and its 95% CI were less than 0, it was defined as a decreasing trend. The age standardized rate has been shown to be relatively stable over a specific period. The 95% UI was used to describe the absolute numbers for incidence, mortality, and DALYs, and the corresponding rates (per 100,000 people) [13].

All statistical analyses were performed using the R program (V4.0.4, <https://www.r-project.org/>), and $p < 0.05$ was considered statistically significant.

Results

Oral disorders globally

Globally, the age-standardized incidence rate of oral disorders increased from 57,146 in 1990 to 57,481 in 2019 (Table I). The age-standardized

Table I. The age-standardized incidence rate (ASIR) of oral disorders in 1990 and 2019 and its temporal trends

Characteristics	1990		2019		1990–2019	
	ASIR (per 100000)		ASIR (per 100000)		Change in Number No. (%)	EAPC No. (95% CI)
	No. (95% UI)	Male/female ratio	No. (95% UI)	Male/female ratio		
Global	57146.82 (50624.72, 63887.83)	1.002211699	57481.59 (50918.26, 64254.61)	0.994019991	0.37 (0.34, 0.40)	0.01 (0.00, 0.03)
Sex:						
Male	57205.73 (50639.26, 63860.33)	–	57304.41 (50743.18, 64030.12)	–	0.36 (0.33, 0.39)	0.01 (–0.01, 0.02)
Female	57079.49 (50577.31, 63702.46)	–	57649.16 (51146.89, 64466.72)	–	0.38 (0.34, 0.41)	0.01 (–0.01, 0.02)
Sociodemographic index:						
Low SDI	56588.06 (49778.92, 63369.10)	1.010540585	56889.62 (50207.16, 63741.93)	1.004033777	1.02 (0.99, 1.05)	0.01 (0.00, 0.01)
Low-middle SDI	57968.43 (51150.51, 64832.26)	1.007327766	58087.59 (51312.87, 64787.01)	0.999476649	0.45 (0.40, 0.50)	0.00 (–0.01, 0.01)
Middle SDI	57726.83 (51050.42, 64627.95)	1.001418117	57860.69 (51309.35, 64570.64)	0.992611731	0.24 (0.20, 0.28)	0.02 (0.01, 0.04)
High-middle SDI	56699.75 (50438.69, 63119.84)	1.003391911	57512.21 (51024.54, 64143.49)	0.990530251	0.15 (0.11, 0.19)	0.04 (0.01, 0.07)
High SDI	54954.92 (48834.85, 61202.10)	0.994777801	55671.68 (49365.42, 62242.28)	0.986565085	0.17 (0.14, 0.19)	0.00 (–0.02, 0.02)
Region:						
Andean Latin America	54580.91 (47700.25, 61637.14)	0.988490839	54669.97 (47697.05, 62115.46)	0.997337711	0.54 (0.48, 0.61)	0.09 (0.06, 0.12)
Australasia	53001.91 (45577.13, 60422.45)	0.982143327	54392.98 (47050.20, 61562.38)	0.991902671	0.41 (0.33, 0.50)	0.14 (0.03, 0.25)
Caribbean	55798.15 (48902.56, 62703.80)	0.993205199	56093.14 (49529.02, 63095.87)	0.999008603	0.25 (0.21, 0.29)	0.01 (0.00, 0.02)
Central Asia	57510.30 (50473.14, 64731.61)	1.008985592	57553.97 (50754.18, 64593.11)	1.010588781	0.30 (0.26, 0.34)	0.01 (–0.01, 0.02)
Central Europe	54186.80 (47612.15, 60875.08)	1.013874404	55880.82 (49153.46, 62700.28)	1.002937671	–0.12 (–0.15, –0.09)	0.12 (0.11, 0.13)
Central Latin America	55426.74 (48691.22, 62727.90)	0.993062553	53590.03 (47189.08, 60453.33)	0.998649828	0.33 (0.28, 0.39)	–0.11 (–0.13, –0.09)
Central sub-Saharan Africa	55835.32 (48546.18, 63135.88)	1.004968113	55887.77 (48622.31, 63363.44)	1.005451528	1.38 (1.32, 1.45)	0.00 (–0.01, 0.01)
East Asia	57393.21 (50975.13, 64112.23)	1.004875935	57851.88 (51695.31, 64338.17)	0.982505079	0.07 (0.02, 0.13)	0.04 (0.00, 0.07)
Eastern Europe	58491.70 (51470.38, 65432.28)	1.00860063	59163.57 (52248.09, 66108.29)	1.000478606	–0.12 (–0.14, –0.09)	0.04 (0.01, 0.06)
Eastern sub-Saharan Africa	54767.39 (48113.29, 61356.42)	1.010377193	55604.19 (48775.32, 62526.10)	1.004680114	1.18 (1.13, 1.23)	0.01 (–0.01, 0.03)
High-income Asia Pacific	56838.41 (50133.93, 63686.61)	0.984546441	57100.91 (50351.48, 63982.04)	0.992339747	–0.05 (–0.09, 0.00)	–0.04 (–0.05, –0.03)
High-income North America	57644.12 (51108.35, 64263.79)	0.998531192	57654.11 (50855.25, 64244.16)	0.976017497	0.22 (0.19, 0.26)	–0.02 (–0.06, 0.02)
North Africa and middle East	56371.63 (49668.48, 63343.18)	1.008089639	57114.60 (50459.52, 63819.80)	1.002362502	0.65 (0.58, 0.72)	0.06 (0.05, 0.07)
Oceania	56416.58 (49508.31, 63454.23)	1.023223833	56725.58 (49652.89, 63859.08)	1.001484994	1.00 (0.93, 1.08)	0.04 (0.02, 0.06)

Table I. Cont.

Characteristics	1990		2019		1990–2019	
	ASIR (per 100000)		ASIR (per 100000)		Change in Number No. (%)	EAPC No. (95% CI)
	No. (95% UI)	Male/female ratio	No. (95% UI)	Male/female ratio		
South Asia	59181.42 (52356.18, 65823.30)	1.006861831	59437.92 (52881.78, 66066.71)	0.999390956	0.54 (0.49, 0.60)	0.01 (0.00, 0.01)
Southeast Asia	57666.80 (51130.94, 64250.10)	0.99696412	58236.21 (51405.93, 64968.17)	0.993354831	0.34 (0.29, 0.38)	0.04 (0.04, 0.05)
Southern Latin America	54101.86 (46564.96, 61305.70)	0.997667303	54334.88 (47770.15, 61286.29)	0.970390003	0.26 (0.21, 0.33)	0.00 (-0.05, 0.05)
Southern sub-Saharan Africa	55091.42 (48124.04, 62158.01)	1.01400348	57129.94 (50219.59, 64377.55)	1.008166144	0.47 (0.42, 0.53)	0.12 (0.10, 0.13)
Tropical Latin America	57874.58 (51353.20, 64676.77)	0.994452934	57387.11 (50685.73, 64234.64)	0.988941238	0.30 (0.25, 0.36)	-0.07 (-0.22, 0.07)
Western Europe	50488.30 (44882.19, 56266.10)	0.999030881	53285.14 (46898.45, 60155.93)	0.992655557	0.12 (0.09, 0.16)	0.08 (0.03, 0.12)
Western sub- Saharan Africa	55634.95 (48685.84, 62879.80)	0.998005903	55992.62 (49037.79, 63071.27)	1.000899983	1.40 (1.37, 1.43)	0.03 (0.02, 0.05)

ASIR – age-standardized incidence rate, UI – uncertainty interval, EAPC – estimated annual percentage change.

DALY rate associated with oral disorders was 295 in 1990 and 284 in 2019 (Table II).

At the global level, from 1990 to 2019, the age-standardized incidence rate of oral disorders showed an upward trend (Figure 1 A). Furthermore, the age-standardized rates and their trends varied between different regions (Figure 1 A, Supplementary Table SI, and Supplementary Figure S1 A). The 3 countries with the largest increases in oral disorder incidence from 1990 to 2019 were India, China, and the United States (Supplementary Table SII). China also showed the largest increase in oral disorder-related DALYs from 1990 to 2019 (Supplementary Table SII, Figure 2).

Oral disorder incidence

As reported in Supplementary Table SIII, the greatest decrease in the age-standardized incidence rate of oral disorder was in Colombia (total: EAPC = -0.75; females: EAPC = -0.77; males: EAPC = -0.73), while the greatest increase was in Spain (total: EAPC = 0.64; females: EAPC = 0.73; males: EAPC = 0.57). The greatest increase in the age-standardized incidence rate of oral disorders in males was in Belgium (EAPC = 0.61). The region with the greatest change in the incidence of oral disorders from 1990 to 2019 was South Asia, whereas the region with the smallest change was Oceania (Supplementary Table SI).

The greatest increase in the age-standardized incidence rate of oral disorders from 1990 to 2019 was observed in countries in the high-middle SDI quintile (EAPC = 0.04; 95% CI: 0.01–0.07; Table I). Low-middle-SDI countries had the highest age-standardized incidence rate (57,968 in 1990

and 58,087 in 2019), whereas high-SDI countries had the lowest age-standardized incidence rate (54,954 in 1990 and 55,671 in 2019; Table I).

The EAPC in the age-standardized incidence rate of oral disorders was found to be positively correlated with the age-standardized incidence rate of oral disorders ($\rho = 0.023$, $p = 0.001$, Supplementary Figure S2 A) but negatively correlated with the SDI value ($\rho = -0.960$, $p = 0.171$, Supplementary Figure S2 B). We also found that regions with higher SDI values had lower proportions of oral disorder cases in young people, and regions in which the SDI value increased from 1990 to 2019 had a higher proportion of oral disorder cases in younger adults (Supplementary Figures S3 A and S3 B). The annual proportions of oral disorder cases in young people and older adults were relatively stable from year to year (Supplementary Figure S4 A). The age distribution of the incidence (per 100,000) of oral disorders in different countries in 2019 is shown in Supplementary Table SIV and Supplementary Figure S5.

Oral-disorder-related DALYs

From 1990 to 2019, the age-standardized DALY rate of oral disorders showed different trends globally and between different regions (Figure 1 B, Supplementary Table SI, and Supplementary Figure S1 B). As shown in Supplementary Table SII, Peru (total: 457; females: 495; males: 416) had the highest age-standardized DALY rate in 2019. As shown in Supplementary Table SV, the greatest decrease in the age-standardized DALY rate was observed in Spain (total: EAPC = -0.94; females: EAPC = -0.96; males: EAPC = -0.86, Figure 3),

Table II. The age-standardized DALY rate of oral disorder in 1990 and 2019 and its temporal trends

Characteristics	1990		2019		1990–2019	
	Age-standardized DALY rate (per 100000)		Age-standardized DALY rate (per 100000)		Change in Number No. (%)	EAPC No. (95% CI)
	No. (95% UI)	Male/female ratio	No. (95% UI)	Male/female ratio		
Global	295.41 (176.24, 460.69)	0.867180811	284.62 (167.72, 459.25)	0.877224995	0.75 (0.72, 0.78)	0.02 (-0.04, 0.08)
Sex:						
Male	57205.73 (50639.26, 63860.33)	–	265.21 (152.87, 431.62)	–	0.76 (0.72, 0.79)	0.03 (-0.02, 0.08)
Female	314.86 (189.65, 487.76)	–	302.33 (180.01, 477.80)	–	0.74 (0.71, 0.78)	0.02 (-0.05, 0.09)
Sociodemo-graphic index:						
Low SDI	280.70 (157.17, 458.18)	0.960065893	279.51 (155.91, 459.90)	0.964642053	1.24 (1.21, 1.26)	0.22 (0.13, 0.31)
Low-middle SDI	278.90 (161.51, 451.83)	0.903612508	277.45 (158.75, 455.27)	0.904577056	0.96 (0.91, 0.99)	0.36 (0.22, 0.49)
Middle SDI	288.72 (171.77, 450.41)	0.853556501	285.10 (168.74, 453.22)	0.859051078	0.94 (0.88, 0.99)	0.17 (0.08, 0.26)
High-middle SDI	303.68 (183.67, 470.99)	0.825096742	284.62 (169.96, 445.14)	0.83315459	0.56 (0.52, 0.59)	-0.14 (-0.21, -0.07)
High SDI	299.10 (180.18, 465.97)	0.917227975	275.25 (164.37, 432.06)	0.921113102	0.40 (0.38, 0.43)	-0.43 (-0.62, -0.24)
Region:						
Andean Latin America	465.68 (287.08, 706.28)	0.857388727	444.63 (272.47, 679.51)	0.850067876	1.21 (1.15, 1.29)	-0.17 (-0.22, -0.11)
Australasia	424.14 (273.16, 623.55)	0.773748406	322.87 (197.86, 494.04)	0.825299376	0.37 (0.20, 0.55)	-0.29 (-0.65, 0.08)
Caribbean	344.92 (203.30, 554.51)	0.82703535	331.87 (196.35, 527.02)	0.832950255	0.65 (0.61, 0.71)	-0.15 (-0.17, -0.13)
Central Asia	386.14 (240.02, 584.72)	0.872372159	375.17 (233.21, 570.45)	0.870144289	0.53 (0.49, 0.56)	-0.16 (-0.20, -0.12)
Central Europe	343.56 (209.60, 527.71)	0.870994899	314.71 (190.95, 486.98)	0.882298355	0.12 (0.09, 0.15)	-0.35 (-0.41, -0.29)
Central Latin America	358.03 (214.17, 563.02)	0.761450856	350.37 (207.79, 557.17)	0.772502115	1.15 (1.08, 1.22)	-0.16 (-0.21, -0.10)
Central sub-Saharan Africa	313.62 (174.16, 507.95)	1.114365961	310.32 (171.87, 500.82)	1.107411904	1.46 (1.41, 1.52)	-0.06 (-0.08, -0.04)
East Asia	242.17 (141.25, 388.96)	0.847199012	234.97 (137.17, 376.51)	0.837061891	0.80 (0.72, 0.88)	0.22 (-0.02, 0.46)
Eastern Europe	346.92 (210.52, 532.83)	0.835131201	344.86 (208.88, 530.22)	0.842938304	0.12 (0.10, 0.15)	-0.02 (-0.06, 0.01)
Eastern sub-Saharan Africa	252.23 (134.43, 424.95)	0.964057124	249.37 (131.97, 422.16)	0.96365951	1.27 (1.23, 1.29)	-0.05 (-0.06, -0.03)
High-income Asia Pacific	263.15 (157.62, 413.88)	0.989078071	244.64 (142.97, 387.74)	1.062142455	0.51 (0.44, 0.59)	-0.25 (-0.54, 0.04)
High-income North America	300.85 (182.53, 462.39)	0.938363488	268.90 (163.01, 418.51)	0.911231993	0.38 (0.34, 0.43)	-0.66 (-0.95, -0.37)
North Africa and middle East	361.02 (221.83, 554.46)	0.9992721	346.60 (210.99, 533.84)	0.998224471	1.23 (1.18, 1.28)	-0.18 (-0.23, -0.14)

Table II. Cont.

Characteristics	1990		2019		1990–2019	
	Age-standardized DALY rate (per 100000)		Age-standardized DALY rate (per 100000)		Change in Number No. (%)	EAPC No. (95% CI)
	No. (95% UI)	Male/female ratio	No. (95% UI)	Male/female ratio		
Oceania	263.08 (167.14, 388.69)	0.940155722	255.60 (161.68, 375.59)	0.947529383	1.18 (1.14, 1.22)	–0.09 (–0.10, –0.08)
South Asia	268.88 (152.46, 441.88)	0.939930391	267.82 (150.47, 444.36)	0.943946281	1.06 (1.01, 1.11)	0.67 (0.41, 0.94)
Southeast Asia	269.46 (162.88, 416.72)	0.790275444	258.15 (154.36, 403.35)	0.796367456	0.89 (0.83, 0.95)	–0.15 (–0.17, –0.13)
Southern Latin America	314.18 (186.87, 494.05)	0.819835951	299.08 (174.47, 482.34)	0.832827066	0.55 (0.51, 0.58)	–0.16 (–0.21, –0.11)
Southern sub-Saharan Africa	401.01 (238.34, 620.82)	0.89162646	363.61 (210.83, 567.78)	0.931473422	0.67 (0.61, 0.73)	–0.33 (–0.47, –0.20)
Tropical Latin America	406.32 (254.03, 608.86)	0.816215898	407.85 (252.35, 619.97)	0.816917668	1.25 (1.18, 1.32)	0.02 (–0.17, 0.21)
Western Europe	306.78 (185.85, 470.12)	0.852741739	286.27 (171.59, 444.21)	0.855297628	0.26 (0.23, 0.30)	–0.44 (–0.67, –0.21)
Western sub- Saharan Africa	288.78 (154.57, 493.42)	0.940248588	286.61 (152.85, 491.30)	0.948990142	1.39 (1.35, 1.41)	–0.05 (–0.10, 0.00)

DALY – disability adjusted life-years.

while the greatest increase was observed in India (total: EAPC = 0.82; females: EAPC = 0.89; males: EAPC = 0.73; Figure 3, Supplementary Table SII).

The 3 regions with the highest age-standardized DALY rate of oral disorders in 2019 were Andean Latin America (444), Tropical Latin America (407), and Central Asia (375; Table II, Supplementary Table SI), whereas those with the lowest age-standardized DALY rates were East Asia (234), high-income Asia Pacific (244), and Eastern Sub-Saharan Africa (249; Table II, Supplementary Table SI). The greatest increase in the age-standardized DALY rate was in South Asia (total: EAPC = 0.67; females: EAPC = 0.73; males: EAPC = 0.61), while the largest decrease was in high-income North America (total: EAPC = –0.66; females: EAPC = –0.59; males: EAPC = –0.73; Table II, Supplementary Table SI).

The highest age-standardized DALY rates of oral disorders were observed in high-middle-SDI regions in 1990 (303) but in middle-SDI regions in 2019 (285). The lowest age-standardized DALY rates were in low-middle-SDI regions (278) in 1990 and in high-SDI regions (275) in 2019 (Table II).

The EAPC in the age-standardized DALY rate of oral disorders was found to be positively correlated with the age-standardized DALY rate of oral disorders ($\rho = 0.037$, $p = 0.599$, Supplementary Figure S2 C) but negatively correlated with the SDI value of the region ($\rho = -0.402$, $p = 0.001$, Supplementary Figure S2 D). In 2019, low-SDI regions had the

highest proportion of oral-disorder-related DALYs in young people (15–49 years old), and regions in which the SDI value increased from 1990 to 2019 had a higher proportion of DALYs in older adults than regions that showed no increase in the SDI value (Supplementary Figures S3 C and S3 D). The annual proportions of oral-disorder-related DALYs increased in young people but decreased from year to year in older adults (Supplementary Figure S4 B). The age distribution of DALYs (per 100,000) for colon and rectal cancer in different countries in 2019 are shown in Supplementary Table SVI and Supplementary Figures S5 and S6.

Discussion

We used the latest GBD data to analyse the incidence and DALYs of oral disorders by sex, age, and SDI value from 1990 to 2019. Our results showed that the age-standardized incidence of oral disorders experienced a slight increasing trend globally from 1990 to 2019, while the age-standardized DALY rate did not change significantly. This indicates that the loss of life due to non-lethal causes is the main reason for the burden of oral disorders, and that oral health has not significantly improved globally in the past 30 years. Oral disorders are chronic and progressive in nature. For example, dental caries (tooth decay) can affect very young children but is a life-long disease that runs through adolescence and

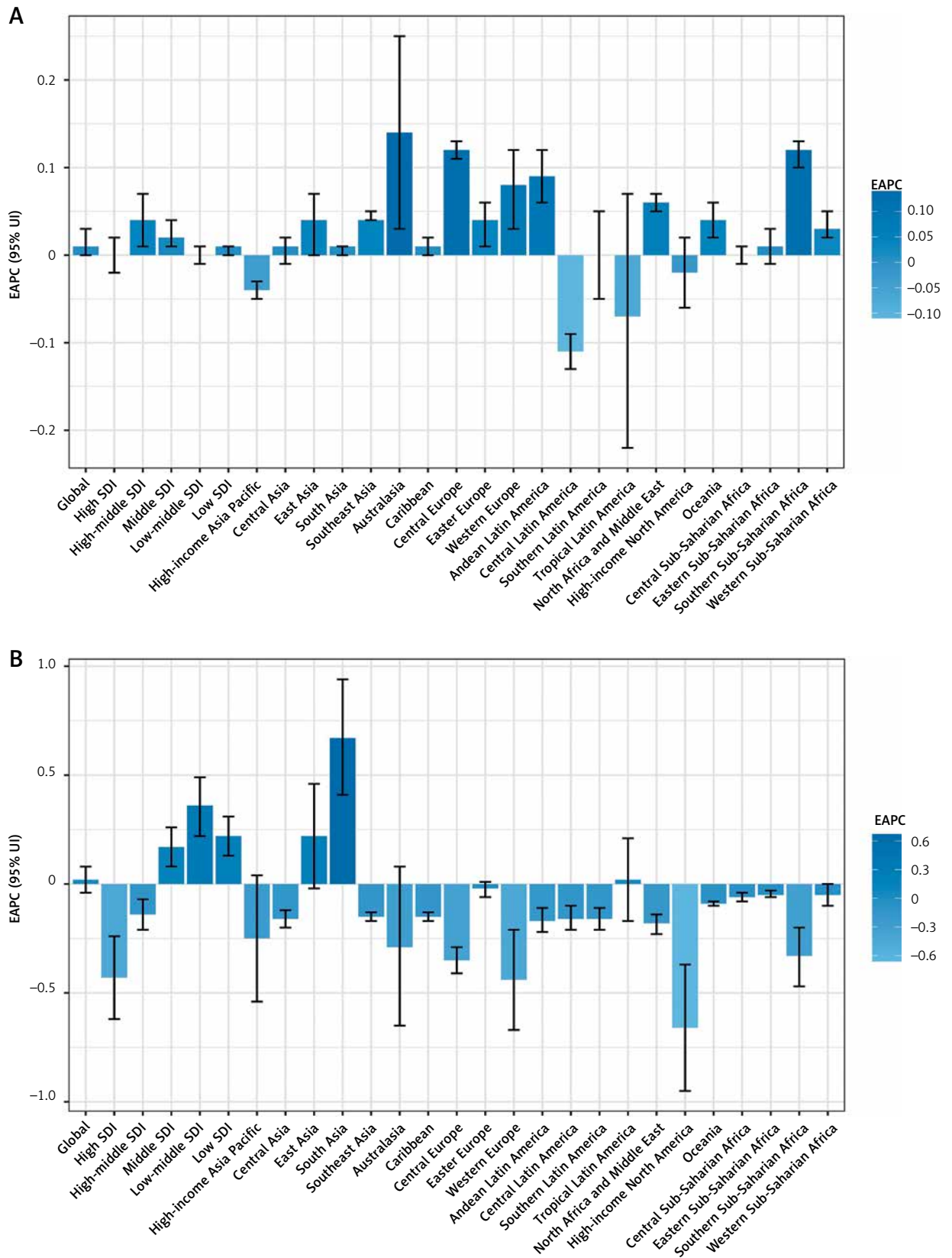


Figure 1. The EAPC of oral disorder ASRs from 1990 to 2019, by region. **A** – The EAPC of ASIR. **B** – The EAPC of age-standardized DALY rate

EAPC – estimated annual percentage change, ASRs – age-standardized rates, ASIR – age-standardized incidence rate, DALY – disability-adjusted life-years.

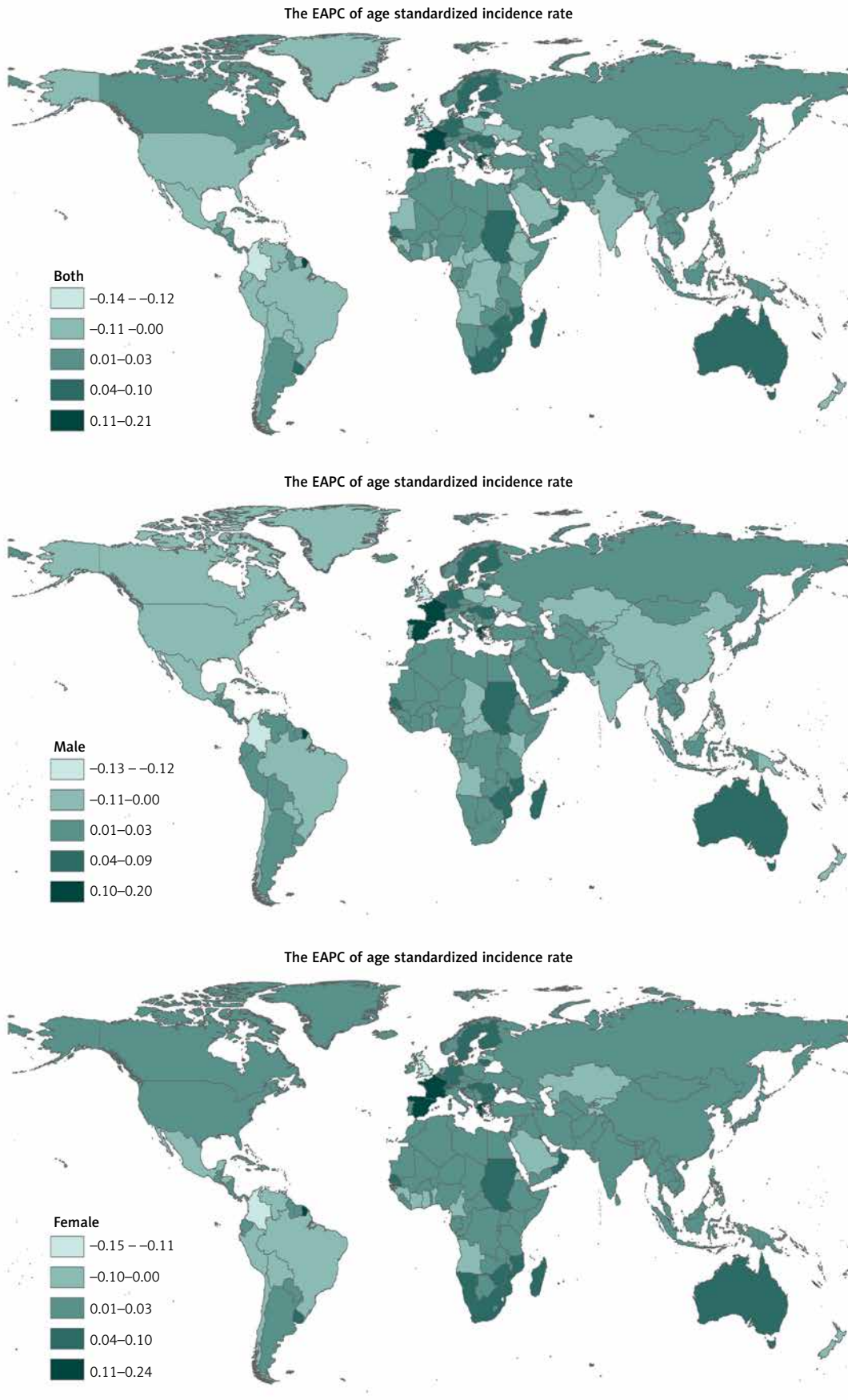


Figure 2. The EAPC of ASIR

EAPC – estimated annual percentage change, ASIR – age-standardized incidence rate.

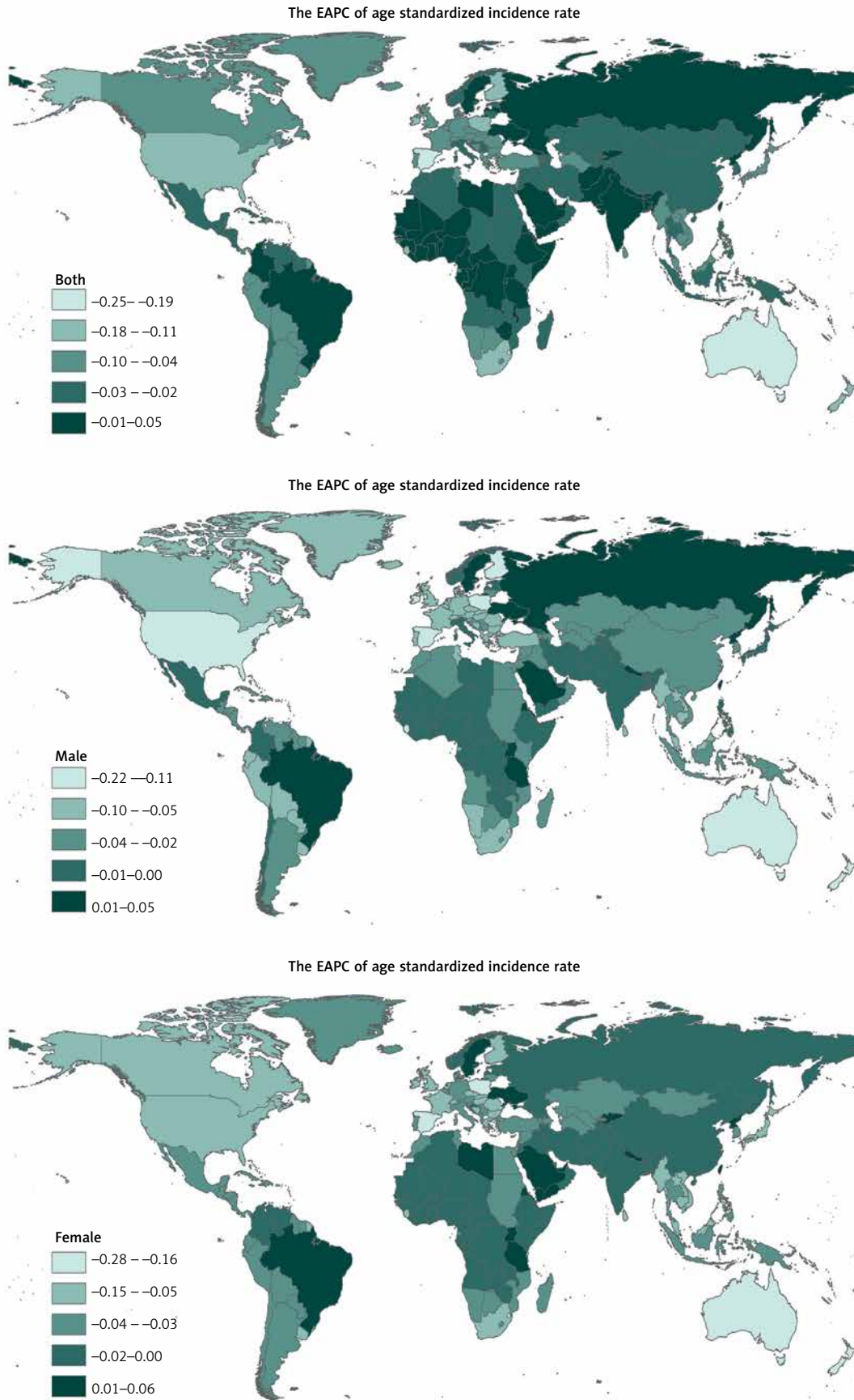


Figure 3. The EAPC of age-standardized DALY rate
EAPC – estimated annual percentage change, DALY – disability-adjusted life-years.

adulthood until old age [14]. Early screening and oral protection are necessary to prevent oral disorders. The changes in the age-standardized DALY rates for men and women were consistent with the changes in the general population. Moreover, the age-standardized incidence and DALY rates for 2019 were similar between men and women, indicating that there is no gender difference in the disease burden caused by oral disorders globally.

Oral disorders are currently one of the key chronic non communicable diseases to be prevented and treated. Because dental disease does not cause death, unlike for example cardiovascular and cerebrovascular diseases, cancer and diabetes, and its severity is far from being recognized [15], the task of prevention and treatment of dental disease is very difficult. The WHO lists oral disorders as the second largest disease besides cancer and cardiovascular disease, and disease prevention and treatment work has been given more and more attention by all countries [5, 6]. This indicates that the harm of oral disorders to human health has attracted attention, and the prevention and treatment of oral disorders is an important topic for future research.

The burden of oral disorders was found to be different in regions with different SDI values. In 2019, the highest age-standardized incidence rate occurred in middle-SDI regions, and the highest age-standardized DALY rate occurred in middle- and low-SDI regions. From 1990 to 2019, the age-standardized incidence rate of oral disorders did not change significantly in high-SDI countries, but the age-standardized DALY rate decreased. Meanwhile, the age-standardized incidence and DALY rates in low- and middle-SDI areas showed an increasing trend. Previous studies have shown that the patterns and trends of oral disorders in developing countries, underdeveloped countries, and developed countries reflect different risk profiles and differences in the establishment of preventive oral health care plans [16, 17]. The risk of oral disorders is related to environmental factors, unhealthy lifestyles (i.e., poor diet, nutrition, and oral hygiene, and the use of tobacco and alcohol), and the limited availability and accessibility of oral healthcare services. These factors have relatively low exposure rates in high-income regions [8]. In low- and middle-income countries, there is little emphasis on health promotion, early intervention provided outside traditional dental clinics, or upstream policy solutions for social determinants [18]. Therefore, it is necessary to improve our understanding of oral disorders and their associated risk factors, to strengthen self-management practices, and to formulate and implement evidence-based recommendations for cost-effective interventions (“best buy”) against oral dis-

orders to address the serious inequality in oral health [12].

We found that the biggest increase in the burden of oral-disorder-related diseases between 1990 and 2019 occurred in South Asia, mainly due to the contribution of India. This is mainly due to a lack of equitable access to health maintenance resources, health service accessibility, and oral-health-related policies. For example, in India, due to limitations of medical insurance coverage, patients are usually required to pay out of pocket to receive treatment from public and private dentists, and health resources are scarce, and oral health departments have no separate budget allocation [19, 20]. Moreover, existing prevention interventions do not prioritize the most common oral disorders and risk factors (such as cavities and tobacco use), even though there is sufficient evidence for the public health benefits of such prioritization [21, 22]. Therefore, it is urgent to develop new population-based models to promote oral health according to national and regional characteristics.

Lip and oral cancer is a complex multifactorial disease, and a comprehensive estimation and comparison of the disease burden attributed to various controllable risk factors can help in the development of specific and effective disease prevention and control strategies. Research has shown that behaviour and bad habits, as well as environmental and biological factors, are closely related to the occurrence of lip and oral cancer, such as smoking, drinking alcohol, chewing betel nuts, etc. [23–25]. However, there have been no studies on the risk factors of lip and oral cancer attributed to disease burden analysis.

To the best of our knowledge, this is the first study to describe the latest data on the prevalence of oral disorders by sex, age, and SDI value at global, regional, and national levels, and to determine the trend in oral disorders. The advantage of this study is that we systematically analysed the latest GBD data to assess the incidence of oral disorders and associated DALYs in various regions of the world from 1990 to 2019.

Although our research was based on GBD 2019 data and methods, there are still some limitations. First, the accuracy and robustness of GBD estimations largely depend on the quality and quantity of the data used in the modelling, but the original data did not cover all countries and regions in the world. Second, due to the differences in data sources and estimation methods used in GBD studies, our estimates may be higher than those in other studies. Third, the diseases analysed in this study did not include oral cancer, congenital malformations (including maxillofacial cleft), or temporomandibular joint disorders.

In the past 30 years, global oral health has not improved significantly, the age-standardized incidence of oral disorders has shown a slight increasing trend, and the age-standardized DALY rate has not changed significantly. The global distribution and trends in oral disorders are similar between genders, but there are differences at different SDI, regional, and national levels. It is necessary to control the increase in the incidence and disease burden of oral disorders in low- and medium-SDI regions, especially in South Asia.

Acknowledgments

The datasets generated during and/or analysed during the current study are available at the website of Global Health Data Exchange (<https://ghdx.healthdata.org/>).

The work was supported by the Basic Scientific Research Projects of Wenzhou (Y2020601, Y2020995), China.

We thank all authors for their contributions to the article.

Chengwei Tu and GeGe Wang have contributed equally to this work and share first authorship.

Conflict of interest

The authors declare no conflict of interest.

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