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National and Subnational Trend of Dental Caries of Permanent Teeth in Iran, 1990–2017

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ABSTRACT

Objective: There are currently no integrated data on the trend of dental caries amongst distinct age groups in Iran. We aimed to assess the national and subnational trend of dental caries of permanent teeth in Iran from 1990 to 2017.

Methods: A literature search about dental caries and the decayed-missing-filled teeth index (DMFT) was performed in PubMed, Web of Science, Scopus, and 3 national databases (in Persian). All eligible national oral health surveys in these 28 years were included. We categorised and aggregated the DMFT values and their components based on age (5-year-based groups from 5 to 9 to 60+ years), sex, year, and province. The data for missing spots were estimated using the spatiotemporal Bayesian hierarchical model. We used the bootstrap method in multilevel models to predict the uncertainty interval (UI) of the modelled results.

Results: Nationally, the all-ages mean DMFT increased by nearly 58.0% (6.8 [95% UI, 4.1–10.5] in 1990 to 10.8 [95% UI, 7.5–14.5] in 2017). Decayed teeth (DT) and missing teeth (MT) rose by 84.5% and 31.6% during this period, respectively. Filled teeth (FT) showed almost a 2.6-fold increase in the same period from 0.6 (95% UI, 0.01–1.6) in 1990 to 1.7 (95% UI, 0.6–2.8) in 2017. The proportion of DT and FT continuously increased in both sexes. In 2017, the highest DT, MT, and FT were estimated in the 25–29 (4.9 [95% UI, 2.5–7.2]), 60+ (21.5 [95% UI, 17.5–25.4]), and 35–39 (2.6 [95% UI, 1.3–4.0]) year age groups.

Conclusions: Caries of permanent dentition levies a growing burden on the Iranian population. Considering the continuous increase in caries during the 1990–2017 period, Iranian policymakers should pay heed to these findings and react more proactively to mitigate this

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perpetuating issue. Implementing nationwide interventions such as sugar consumption management should be encouraged to achieve sustainable outcomes in this regards.

Introduction

Oral diseases have continuously been depicted as a critical health condition afflicting nearly 3.5 billion individuals worldwide in 2017.[1] Oral disorders can cause severe pain and discomfort,[2] be associated with general morbidities (including oral cancer, pulmonary diseases, diabetes, cardiovascular diseases, and chronic kidney disease),[3-10] and lessen oral health–related quality of life.[11] They impose a significant financial burden on health systems and are estimated to be the sixth most costly health condition.[11]

There have been some efforts, mostly in developed countries such as the US,[5] the UK,[6] and Sweden,[7] to develop decayed-missing-filled teeth index (DMFT)–based dental caries surveys and registries. Similar to European regions, other countries, including Iran, tangibly need such surveys to be informed about the oral health status of their populations instead of solely estimations. Hence, a regular national oral health surveillance programme is still lacking in Iran. Based on the current literature, only one published report is available, regarding a national oral health surveillance in Iran that was performed in 2012 and published in 2018.[12]

To the best of our knowledge, there are a lot of published and available data regarding dental caries in the Iranian population. For instance, a recent systematic review and meta-analysis has been performed to estimate the DMFT of the Iranian population. However, most of the included studies were conducted on children and young adolescents, and only 4 of the 69 included studies were conducted in the adult population. Also, the reported prevalence of untreated caries and mean DMFT differ from the results of the previously mentioned national survey.[13,14] Thus, due to the lack of surveys, lack of subnational data, lack of data for both sexes and different age groups, and noticeable heterogeneity in the validity of their findings, there is a limitation to assess the national and subnational burden of dental caries in Iran. Identifying major oral health challenges at both the national and the subnational level is necessary for oral health policymakers to guide their decision in future policy planning to improve the oral health of Iranian population. Hence, a national and subnational trend of dental caries can mitigate this problem and provide a better perspective of the current situation for oral health policymakers. The findings of such a descriptive report can serve as a baseline in monitoring the progress of policies seeking to address permanent dental caries status in Iran. As no previous study has reported the estimated trend of DMFT in Iran amongst the general population, we aimed to estimate the trend of dental caries in permanent teeth in the Iranian population at different ages from 1990 to 2017 by using the age-spatiotemporal statistical model.[15] This model uses advanced prediction analysis to estimate how a certain variable (in this case, DMFT and its components) varies across time, space, and age.

Methods and materials

This is a part of a more extensive study aiming to assess the prevailing status of dental caries, periodontal disease, and severe tooth loss in different age groups in Iran. Seeking to assess dental caries in permanent teeth, we performed a systematic search of the literature in English and Persian databases to obtain all the relevant literature. Thereafter, we screened the eligible studies using 3 criteria: study type, study population, and sampling method. Data extraction was performed after assessing the quality of data using the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement.[16,17] Also, our study complies with the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER).

Data analyses and estimations were conducted using the spatiotemporal Bayesian hierarchical model. The detailed methodology of this study is available as a previously published protocol.[17,18] The authors have used the same methodology to estimate the trend of deciduous dental caries within the same time span that has been previously published.[17] A more comprehensive description of the data sources, quality assessment process, and statistical analysis is available in the aforementioned study.[17,18]

Data sources

The data sources used in this study include (1) national oral health surveys (1998, 2002, 2004, 2013, and 2016), (2) national health surveys (1990 and 1999), (3) Behvarz Health Study, and (4) published articles and gray literature. In the Behvarz Cohort Study, all employed and retired Iranian rural primary health care workers and the second-grade Behvarz students were recruited. The complete oral examinations in addition to the records of medical, anthropometric indices, self-administered questionnaires, Food Frequency Questionnaire, and laboratory tests were gathered.[17]

Available published literature

Literature published in English and Persian was searched in the following databases: PubMed, Web of Science, Scopus, and Iranian databases (IranMedex and SID [Scientific Information Database]). Further information regarding the search strategy, selection criteria, included studies, PRISMA flow diagram, and study characteristics is available in Appendix 1A and 1B.[17]

Quality assessment and data extraction

A comprehensive quality assessment form was used in 4 steps to assess the quality of articles with different sampling and measuring methods. We used a data extraction sheet to

prepare a summary of findings table based on sex, age, and sample size in related age and sex groups, prevalence, incidence, mean, standard deviation, standard error, and confidence intervals (Appendix 2 and 3).[17]

Statistical methods and analysis

Statistical analyses were performed using STATA V.14.0 and R V.3.5.2 (R Core Team, R Foundation for Statistical Computing) with Age-Spatial-Temporal Model V.0.1.0 package.[17] Further information regarding the statistical model we used is available in Appendix 4.

The present study is based on secondary data, and there is no specific ethical consideration. The NASBOD study was approved by the Ethical Committee of Endocrinology and Metabolism Research Institute, Tehran University of Medical Sciences, under code IR.TUMS.EMRI.REC.1397.022. As we used no individual data, the need for informed consent was waived by the Ethical Committee of Endocrinology and Metabolism Research Institute, Tehran University of Medical Sciences. This study was conducted in accordance with the Declaration of Helsinki.

Results

National DMFT in all ages and sexes

Overall, Iranians had caries experience in almost one-fourth of their teeth in 1990 (DMFT = 6.8 [95% UI, 4.1–10.5]); almost 63% was attributed to missing teeth (MT = 4.3 [95% UI, 2.4–7.0]) and less than 10% to filled teeth (FT = 0.6 [95% UI, 0.1–1.6]). From 1990 to 2017, DMFT and MT increased (in 2017, DMFT = 10.8 [95% UI, 7.5–14.5] and MT = 5.7 [95% UI, 3.4–9.0]) more than 57% and 31%, respectively. Besides, FT showed almost a 2.6-fold increase (2017 FT = 1.7 [95% UI, 0.6–2.8]) (Table). The sex difference in the DMFT was 0.02 in 1990 for all ages: 6.8 (95% UI, 4.1–10.5) and 6.9 (95% UI, 4.2–10.5) in males and females, respectively. Whilst remaining fairly close to each other, the DMFT values increased in both sexes in 2017: 10.80 (95% UI, 7.54–14.54) and 10.81 (95% UI, 7.56–14.55) in males and females, sequentially.

Children (5–9, 10–14, and 15–19 years)

The mean number of DMFT and decayed teeth (DT) stayed almost steady for the age groups younger than 19 from 1990 to 2017 (Figure 1, Table, Appendix 5).

Younger adults (20–24, 25–29, and 30–34 years)

Amongst the younger adults, the mean DMFT increased from 1990 to 2017, with the highest and lowest increases being in the 30–34 (DMFT increase = 1.0) and 20–24 (DMFT increase = 0.6) year age groups, respectively. Males had lower mean DMFT in all the age groups in 1990 whilst it altered in 2017 among the 25-29 age group. Whilst the number of MT decreased from 3.6 (0.3–7.2) during 1990 to 1.4 (0–5.2) 2017, the numbers of DT [1990: 3 (0.8–5.2), 2017: 4.9 (2.5–7.2)] and FT [1990: 1.2 (0.1–2.5), 2017: 2.3 (1–3.7)] increased (Figure 1 and Table).

Middle age (35–39, 40–44, and 45–49 years)

Almost one-third of DMFT belonged to the MT in the 35–39 year age group. In these age groups, DMFT slightly increased during 1990–2017 (45–49: 13.9 [95% UI, 10.1–17.7] in 1990 and 15.2 [95% UI, 11.4–18.9] in 2017). These rises were due to increased DT and FT, whereas the number of MT decreased. Although males had a lower number of FT in all 3 age groups, their DMFT, DT, and MT were higher than females' (Figure 1 and Table).

Older adults (50–54 and 55–59 years)

The DMFT in older adults showed a slight increase from 1990 to 2017 (1990: 15.2 [95% UI, 11.4–19.0]; 2017: 17.2 [95% UI, 13.3–20.9]). In older adults, more than three-fourths of the DMFT is attributed to MT in 2017. Males had a lower FT than females, whereas the number of missing DMFT, DT, and MT was higher in males (Figure 1 and Table).

Elderly adults (60+ years)

The DMFT amongst this population increased from 22.6 (95% UI, 18.8–26.4) in 1990 to 24.9 (95% UI, 21.1–28.7) in 2017. More than 86% of the DMFT is attributed to missing teeth in 2017. Males had a slightly higher DMFT than females —25.3 (95% UI, 21.5–29.0) vs 24.9 (95% UI, 21.2–28.7) in 2017. The figure for MT was nearly 2 units higher in males (Figure 1 and Table).

Provinces

Age-standardised DMFT increased in 30 provinces from 1990 to 2017. The highest and lowest differences in age-standardised DMFT values during 28 years were observed in Hormozgan, with 2 increases (7.5 in 1990 and 9.5 in 2017), and Semnan, with 0.8 decrease (10.4 in 1990 and 9.6 in 2017). Southern provinces (Bushehr, Sistan and Baluchistan, and Khuzestan) showed the least age-standardised DMFT, whereas northwestern provinces (Kurdistan, East Azerbaijan, and Ardabil) had the highest age-standardised DMFT in Iran, in 2017 (Figure 2).

When examining DMFT components (DT, MT, and FT), the mean of age-standardised MT decreased in all provinces whilst the mean of DT and FT significantly increased (Figure 2 and 3 and Appendix 6–9). The most notable increase happened in the FT and MT subcategories, converting from 1.2 to 1.4 between 1990 and 2017; these values were constant for the DT (1.9 in 1990 and 2017).

Discussion

This is the first national study to estimate the trend of permanent dental caries in Iran. Despite several studies on the status of dental caries amongst certain age groups in different locations in Iran, none evaluated the trend of dental caries in Iran.[12,14,19,20] According to our findings, the overall figure of

Table 1 – Mean number of decayed, missing, and filled teeth and caries experience (DMFT) for Iran, 1990–2017

Age group, y	Year	DMFT	DT	MT	FT
5–9	1990	0 (0–3.3)	0 (0–0)	0 (0–0)	0 (0–0)
	2000	0.1 (0–3.9)	0.1 (0–0.8)	0 (0–1)	0 (0–0.4)
	2010	0.1 (0–3.8)	0.1 (0–0.4)	0 (0–0.5)	0 (0–0.2)
	2017	0 (0–3.4)	0 (0–0)	0 (0–0)	0 (0–0)
10–14	1990	1.6 (0–5.4)	1.4 (0.1–2.9)	0 (0–2.5)	0.2 (0–1.1)
	2000	2.1 (0–5.9)	1.7 (0–4)	0 (0–3.8)	0.3 (0–1.7)
	2010	2 (0–5.8)	1.5 (0–3.5)	0 (0–2.9)	0.4 (0–1.6)
	2017	1.6 (0–5.4)	1.2 (0.1–2.4)	0 (0–1.4)	0.4 (0–1.1)
15–19	1990	3.6 (0.2–7.5)	2.4 (0.5–4.2)	0.8 (0–3.9)	0.5 (0–1.6)
	2000	4.1 (0.4–7.8)	2.7 (0.4–5.1)	0.6 (0–4.5)	0.7 (0–2.1)
	2010	4 (0.3–7.8)	3 (0.7–5.3)	0 (0–3.7)	1 (0–2.3)
	2017	3.6 (0.2–7.4)	2.7 (0.9–4.4)	0 (0–1.9)	1 (0.1–2)
20–24	1990	5.7 (1.9–9.5)	2.8 (0.8–4.8)	2.2 (0–5.6)	0.8 (0–2)
	2000	6.3 (2.5–10.1)	3.3 (0.9–5.6)	1.9 (0–5.9)	1.1 (0.1–2.5)
	2010	6.4 (2.6–10.2)	3.9 (1.5–6.3)	1.1 (0–5.1)	1.4 (0.2–2.8)
	2017	6.3 (2.5–10)	4.3 (2.1–6.6)	0.2 (0–3.7)	1.7 (0.4–3)
25–29	1990	7.8 (4–11.6)	3 (0.8–5.2)	3.6 (0.3–7.2)	1.2 (0.1–2.5)
	2000	8.5 (4.6–12.3)	3.4 (1–5.9)	3.5 (0.1–7.5)	1.6 (0.3–2.9)
	2010	8.7 (4.9–12.5)	4.1 (1.7–6.5)	2.6 (0–6.6)	2 (0.6–3.4)
	2017	8.6 (4.8–12.3)	4.9 (2.5–7.2)	1.4 (0–5.2)	2.3 (1–3.7)
30–34	1990	9.3 (5.5–13.1)	2.9 (0.7–5.1)	5 (1.4–8.7)	1.3 (0.3–2.6)
	2000	10.1 (6.3–13.9)	3.3 (0.9–5.7)	5.1 (1.2–9.1)	1.7 (0.4–3.1)
	2010	10.4 (6.5–14.2)	4 (1.6–6.5)	4.2 (0.5–8.2)	2.2 (0.8–3.6)
	2017	10.3 (6.5–14.1)	4.8 (2.5–7.2)	2.9 (0.1–6.8)	2.6 (1.2–3.9)
35–39	1990	10.8 (7.1–14.6)	2.8 (0.6–4.9)	6.7 (3–10.3)	1.4 (0.3–2.7)
	2000	11.7 (7.9–15.5)	3.2 (0.8–5.5)	6.7 (2.8–10.7)	1.8 (0.5–3.2)
	2010	12.1 (8.3–15.9)	3.9 (1.5–6.3)	5.9 (1.9–9.9)	2.2 (0.9–3.6)
	2017	12 (8.2–15.8)	4.7 (2.3–7)	4.7 (1–8.6)	2.6 (1.3–4)
40–44	1990	12.4 (8.6–16.2)	2.6 (0.5–4.7)	8.6 (4.9–12.2)	1.3 (0.3–2.5)
	2000	13.3 (9.5–17.1)	2.9 (0.6–5.3)	8.7 (4.8–12.6)	1.7 (0.4–3)
	2010	13.6 (9.8–17.4)	3.6 (1.2–6)	7.9 (3.9–12)	2.1 (0.7–3.4)
	2017	13.5 (9.7–17.3)	4.3 (2–6.7)	6.8 (2.8–10.7)	2.4 (1.1–3.7)
45–49	1990	13.9 (10.1–17.7)	2.4 (0.3–4.5)	10.3 (6.8–13.9)	1.2 (0.3–2.4)
	2000	14.8 (11–18.6)	2.7 (0.4–5)	10.6 (6.7–14.5)	1.5 (0.3–2.8)
	2010	15.2 (11.4–19)	3.4 (1–5.8)	10 (6–14)	1.8 (0.5–3.2)
	2017	15.2 (11.4–18.9)	4.1 (1.7–6.5)	8.9 (5–12.9)	2.1 (0.8–3.5)
50–54	1990	15.2 (11.4–19)	2.1 (0.2–4.1)	12.2 (8.8–15.6)	0.9 (0.2–2.1)
	2000	16.3 (12.5–20.1)	2.4 (0.2–4.6)	12.8 (9–16.6)	1.1 (0.1–2.4)
	2010	17 (13.1–20.8)	3 (0.7–5.4)	12.6 (8.6–16.5)	1.4 (0.2–2.7)
	2017	17.2 (13.3–20.9)	3.7 (1.4–6.1)	11.8 (7.9–15.7)	1.6 (0.4–3)
55–59	1990	17.7 (13.9–21.5)	1.9 (0.1–4)	15.1 (11.6–18.6)	0.7 (0–1.9)
	2000	19 (15.2–22.8)	2.1 (0.2–4.4)	16 (12.2–19.9)	0.8 (0–2.1)
	2010	19.4 (15.6–23.3)	2.7 (0.5–5.1)	15.7 (11.7–19.7)	1.1 (0.1–2.4)
	2017	19.4 (15.6–23.2)	3.3 (1–5.7)	14.7 (10.8–18.7)	1.3 (0.2–2.7)
60+	1990	22.6 (18.8–26.4)	1.9 (0.2–4.1)	20.4 (16.7–24.1)	0.4 (0–1.7)
	2000	24.6 (20.8–28.4)	1.8 (0.1–4.2)	22.2 (18.3–26.2)	0.5 (0–1.9)
	2010	25.3 (21.4–29.1)	2.2 (0.3–4.6)	22.4 (18.3–26.4)	0.8 (0–2.2)
	2017	24.9 (21.2–28.7)	2.5 (0.5–4.9)	21.5 (17.5–25.4)	1 (0.1–2.4)
All ages	1990	6.8 (4.1–10.5)	1.9 (0.4–3.5)	4.3 (2.5–7)	0.6 (0.1–1.6)
	2000	8.4 (5.3–12.2)	2.4 (0.5–4.5)	5 (2.9–8.6)	1 (0.2–2.2)
	2010	10 (6.7–13.8)	3 (1–5.2)	5.6 (3.3–9.2)	1.4 (0.3–2.6)
	2017	10.8 (7.5–14.5)	3.4 (1.5–5.5)	5.7 (3.4–8.9)	1.7 (0.6–2.8)

DT, decayed teeth; MT, missing teeth; FT, filled teeth.
Values in parentheses represent ____95% UI_____.

DMFT in Iran increased by more than 58% from 1990 to 2017 for both sexes and all ages. Furthermore, the trend was similarly incremental in each component (ie, DT, MT, or FT). Preventive strategies are strongly emphasised to tackle this rising trend.[2,21,22]

Our results are not generally in line with previous studies reporting the DMFT. Soltani et al[14] conducted a meta-analysis on nonrandomised studies from 1998 to 2018. The mean DMFT in their study was notably higher than our figures in all of the age groups. However, making comparisons was difficult due to the different age categorisation between the 2 studies. They reported a significant amount of heterogeneity in their studies after data synthesis, suggesting the low quality of the included studies.

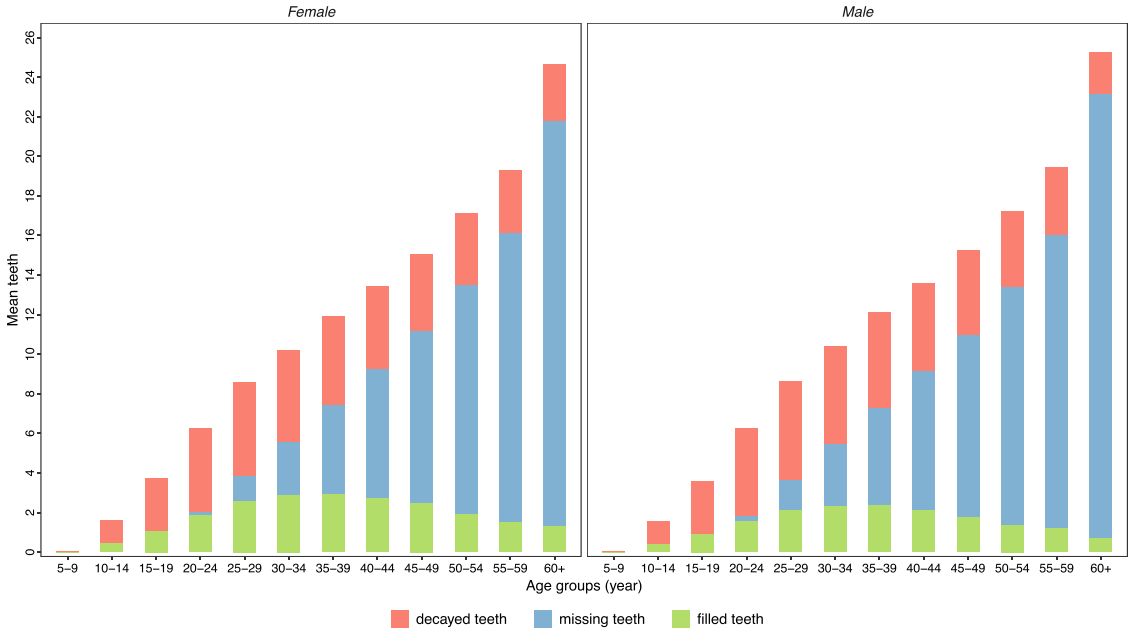

Fig. 1 – Stacked bar chart for decayed, missing, and filled teeth (DMFT) and its components in each age group 1990–2017.

Interestingly, the GBD 2017 data sources for caries of permanent teeth in Iran included 6 studies, 5 of which were conducted in distinct provinces (subnational levels). One of these studies, conducted by Bayat-Movahed et al,[23] was on a national scale. Whilst their age group did not match with ours, their reported DMFT values were lower compared to our figures in the corresponding age groups. Hessari et al[19] conducted a national survey in Iran to assess oral health status amongst adult age groups (35- to 44-year-olds) in 2002. Our reported DMFT was similar to this study. According to a national report from the Iranian National Oral Health Survey in 2012, the DMFT values were 5.1, 2.1, 3.3, 13.2, and 25.7 for the following age groups: 5- to 6-, 12-, 15-, 35- to 44-, and 65- to 74-year-olds).

Similar studies from the neighbouring countries are scarce. Most of the conducted studies have focussed on the oral health status and prevalence of dental caries amongst 12-year-old and younger children.[24-26] Few studies have reported the dental caries status of the adult population. Based on the latest national oral health surveillance in Turkey,[27] the DMFT of 35- to 44-year-old and 65- to 74-year-old adults were 10.8 and 25.8, respectively. Compared to the

Location	dmft	Location	dmft	Location	dmft	Location	dmft
National	10.8	Alborz	10.6	Mazandaran	11.1	Kermanshah	11.6
Bushehr	7.9	Gilan	10.8	Razavi Khorasan	11.2	Kerman	11.7
Sistan and Baluchistan	8.9	Qom	10.8	Ilam	11.2	Golestan	11.7
Khuzestan	9.0	Kohgiluyeh and Boyer-Ahmad	10.9	South Khorasan	11.2	Zanjan	11.8
Hormozgan	9.5	Lorestan	10.9	North Khorasan	11.3	West Azerbaijan	11.9
Semnan	9.6	Qazvin	11.0	Markazi	11.4	Ardabil	11.9
Fars	10.3	Yazd	11.0	Hamadan	11.5	East Azerbaijan	11.9
Tehran	10.4	Isfahan	11.0	Chahar Mahaal and Bakhtiari	11.5	Kurdistan	11.9

Fig. 2 – Subnational decayed, missing, and filled teeth (DMFT) in 2017 (age-standardised).

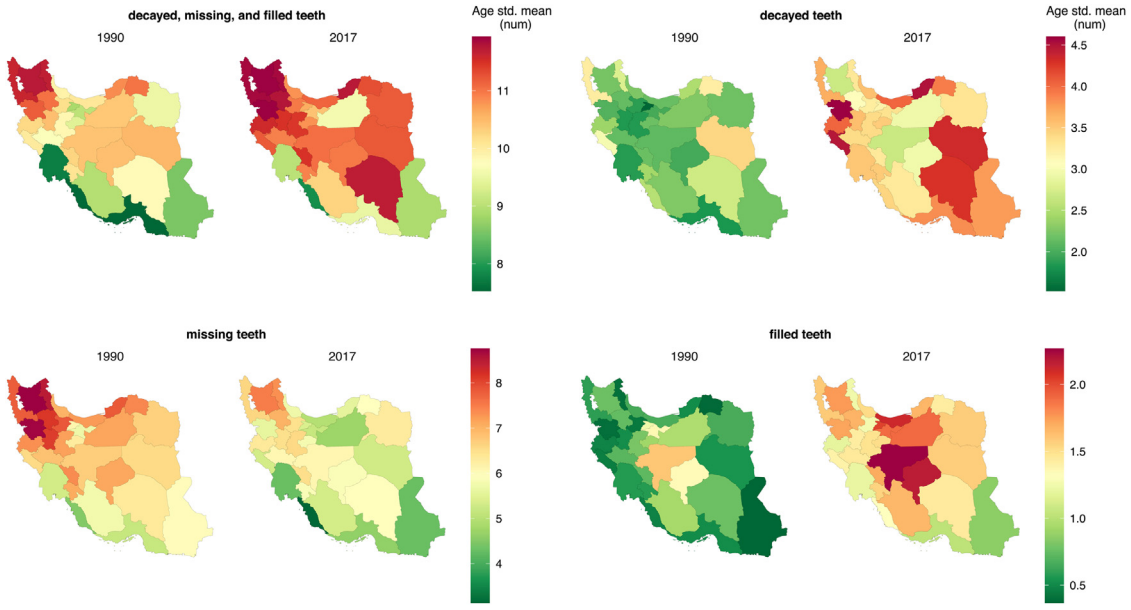

Fig. 3 – Map chart for decayed, missing, and filled teeth (DMFT) and its components in 1990 and 2017 (age-standardised).

same age groups in our study, the DMFT of the middle-aged adult population is higher in Iran and the DMFT of the elderly is approximately the same. Similar to our study, the rural participants had experienced higher DMFT in both Iran and Turkey.[27,28] Similar results were obtained from a systematic review study in Saudi Arabia. However, this study did not perform a meta-analysis. A rising trend was found from 1992 to 2006 amongst 35- to 44-year-old adults. The DMFT increased from 8 to 13.24. Only 2 studies were found regarding the DMFT of the elder population in Saudi Arabia, and the reported DMFT for this population was 24.3 and 18.6.[29] Another national report from Armenia reported the DMFT of 11.90 for 35- to 44-year-old adults.[30] National trend or reported DMFT were not found for Pakistan or Iraq.

Policy implications

There is growing evidence stating that oral health interventions need to be radically altered to achieve the goals of burden mitigation for oral disorders worldwide.[31,32] In this regard, national-scale interventions have been heeded the most by the health care systems in recent years.[33-38] The cost-effectiveness of community water fluoridation is substantiated by several studies as well.[13,39] Iran has applied a temporary national policy for targeted delivery of fluoride to children in elementary schools[40,41]; however, this programme was stopped shortly afterwards. This was mainly due to incompetency in intersectoral collaborations to ensure the implementation of these policies. According to a study by Abtahi et al[42] in 2018, nearly 20% of the national dental caries disability-adjusted life years (DALYs) was preventable by water fluoridation. Additionally, the national DALYs preventable by water fluoridation considerably increased by age. However, water fluoridation cannot be rigorously suggested as a national action plan for dental caries prevention due to its questionable environmental consequences.

Screening programmes for adolescents and adults have been another critical aspect of Iran's preventive policies in tackling dental caries in the last decade.[12,43,44] Targeted screening for specific subgroups by mid-level workforce in the oral health sector (eg, dental hygienists) has been recommended.[45] Also, screening programmes have been suggested for caries detection amongst the schoolchildren; however, the effectiveness of such screening programmes amongst the schoolchildren in preventing dental caries and improving oral health has recently been disputed.[46] The cost-effectiveness of screening programmes is another issue concerning their practicality when performed on a population-wide scale.[47]

From a socioeconomic ranking perspective, Sistan and Baluchistan, Kurdistan, and West Azerbaijan are the 3 provinces with the lowest human development index in Iran, respectively.[48] Based on our results, Kurdistan and West Azerbaijan ranked first and fourth for the age-standardised DMFT values in 2017. This is supporting the role of socioeconomic determinants in dental caries. However, Sistan and Baluchistan ranked 30th (amongst 31 provinces) for DMFT values. According to the WHO STEPwise approach to noncommunicable diseases risk factor surveillance (STEPs) 2016 study, people who live in this province had the lowest body mass index mean and prevalence of obesity, which can be a consequence of a diet low in sugar.[49] Another plausible reason for the low level of DMFT in this province might be its relatively high fluoride content in drinking water. The south and southeast provinces of Iran generally have higher fluoride content in drinking water due to their proximity to the Persian Gulf and Oman Sea.[50]

When assessing dental caries amongst distinct age groups, a noticeable decrease in the proportion of FT and an increase in the MT were noted with advancing age. On the other hand, in both males and females, the mean number of FT increased from 10- to 14-year-olds and peaked at 35- to 39-year-olds. This figure then decreased with advancing age. These trends

imply a possible change in the pattern of dental treatments in Iran during the last decades. The patient care-seeking behaviour and the practitioner treatment approach have moved towards a more conservative approach: Minimal intervention dentistry strives to keep the dentition intact as much as possible whilst avoiding the "tooth death spiral."[2] This approach, along with the prevention-focussed care delivery, can eventually decrease the costs of more complex treatments and pave the way for a universal health coverage agenda.[2,51]

Based on the findings of our study and review of the literature, the future research and policy plans should focus on 3 ground concepts to assess and improve the oral health of the Iranian population. First, oral health policymakers should allocate resources for regular national oral health surveys. Also, the previously mentioned preventive measures such as targeted delivery of fluoride and preventive treatments that are offered for children and young adolescents should be evaluated regarding efficacy and cost-effectiveness. And finally, re-evaluation of our oral health system and implenting the necessary changes based on the findings of the aformentioned surveys and studies.

Strengths and limitations

We believe our data represent the most extensive collections of age- and sex-specific trends of national and subnational dental caries of permanent teeth estimates for Iran. A comprehensive systematic search was conducted which led to including all qualified sources, in addition to all national surveys.

Our study has some limitations that should be noted as well. Whilst we aimed to provide the most accurate DMFT data in the Iranian population, data scarcity and low quality of data in some cases represented the main challenges of this study. In this regard, estimates for provinces with low-quality and scarce data relied on statistical methodologies. This is reflected in the wide compatibility intervals in some of the estimations. We also did not report the DMFT values in rural and urban areas separately, and the age groups older than 60 years were aggregated due to the lack of data for elderly age groups. Also, the comparison of our results with previous national surveys in 2012 pinpoints under- and overestimations in some age groups. Such discrepancies have been adjusted by using covariates and rigorous eligibility criteria of the included studies; however, it may have affected our results in terms of minor or major under- or overestimation. However, our results can satisfactorily inform oral health policies on the status of dental caries in permanent dentition.

Conclusion

The DMFT values notably increased from 1990 to 2017 amongst all ages in both males and females in Iran. No significant sex difference was noted in the DMFT values, either on a national or provincial scale. In order to mitigate the burden of dental caries in the future, oral health policymakers should prioritise nationwide interventions (eg, water fluoridation, sugar consumption management, and oral health education programmes) in Iran.

Conflict of interest

None disclosed.

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Author contributions

All authors have read and approved the manuscript. Detailed contributions are as follows: SS: conceptualisation, investigation, data gathering, interpreting the data, and revising the manuscript. MM: formal analysis, data curation, writing the original draft, and visualisation. SSM: formal analysis, data gathering, data cleaning, interpreting the data, writing the original draft, revising the manuscript, and visualisation. ASM: interpreting the data, writing the original draft, and revising the manuscript. HH: data gathering, interpreting the data, and revising the manuscript. ES: interpreting the data, writing the original draft, and revising the manuscript. M-HH: interpreting the data, writing the original draft, and revising the manuscript. BL: conceptualisation and revising the manuscript. HF: methodology and revising the manuscript. FF: conceptualisation, methodology, revising the manuscript, and supervision.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.identj.2023.07.012.

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