Postprint: Disease Burden and Temporal Trends of Dental Caries in China, 1990–2019

Authors: Gang Huang[1], Guiying Cao[2], Min Liu[2],[3]*

Date: 2023-11-29T00:00:00+00:00

Abstract

Background: Dental caries is one of the common non-communicable diseases, affecting more than one-third of the global population. Analysis of its disease burden status and changing trends can provide valuable reference for prevention and treatment strategies of dental caries. Objective: To analyze the status and changing trends of incidence, prevalence, and years lived with disability (YLD) of dental caries in China from 1990 to 2019, and to provide evidence for formulating prevention and treatment strategies for dental caries in China. Methods: Data on incidence, prevalence, and YLD of primary teeth caries and permanent teeth caries in China from 1990 to 2019 were extracted from the Global Burden of Disease (GBD) Study 2019. Percentage changes in the number of incident cases, prevalent cases, and YLD person-years were calculated. The Joinpoint regression model was applied to analyze the annual percent change (APC) and average annual percent change (AAPC) of age-standardized incidence rates, prevalence rates, and YLD rates. Results: Compared with 1990, the number of incident cases, prevalent cases, and YLD person-years of primary teeth caries in China in 2019 decreased by 25.69%, 28.74%, and 28.63%, respectively; those of permanent teeth caries increased by 17.41%, 15.84%, and 15.07%, respectively. In 2019, among all age groups, the incidence rate of primary teeth caries was highest in children aged 5-9 years (118.96%), while the prevalence rate (53.08%) and YLD rate (20.40/100,000) of primary teeth caries were highest in children aged 1-4 years. The incidence rate (62.30%), prevalence rate (32.19%), and YLD rate (32.41/100,000) of permanent teeth caries were all highest in adults aged 20-24 years. The Joinpoint regression model showed that from 1990 to 2019, the age-standardized incidence rate (AAPC=0.21%, 95%CI=0.19%~0.22%), prevalence rate (AAPC=0.03%, 95%CI=0.01%~0.05%), and YLD rate (AAPC=0.03%, 95%CI=0.01%~0.05%) of primary teeth caries showed an overall upward trend; the age-standardized incidence rate (AAPC=-0.05%, 95%CI=-0.05%~-0.04%), prevalence rate (AAPC=-0.23%, 95%CI=-0.32%~-0.14%), and YLD rate

(AAPC=-0.22%, 95%CI=-0.31%~-0.13%) of permanent teeth caries showed an overall downward trend. Conclusion: From 1990 to 2019, the disease burden of primary teeth caries in China showed an increasing trend, while the disease burden of permanent teeth caries decreased but remains severe. Prevention of dental caries should not be limited to children but should include all age groups.

Full Text

Introduction

Dental caries is a chronic, progressive, and destructive disease of the hard dental tissues mediated by oral bacteria [1-2]. Throughout life, individuals may be affected by caries, with the risk of developing caries increasing from the eruption of the first primary tooth and remaining at high levels until old age [2-3]. Although largely preventable and treatable in early stages, untreated caries can lead to complications such as apical periodontitis, jawbone inflammation, and even tooth loss [4]. Moreover, the treatment of caries is often expensive, imposing a heavy economic burden on individuals, families, and society [5]. As one of the most common non-communicable diseases and major public health problems worldwide, caries affects more than one-third of the global population [3,6]. Studies have shown that untreated caries may cause recurrent pain, difficulty chewing and sleeping, thereby reducing quality of life and productivity, and may also lead to missed educational opportunities and poor academic performance [7-11]. Severe untreated caries associated with pulp infection and systemic inflammation is also a contributing factor to underweight and stunted growth in children [8,12-13]. Although the global prevalence of untreated caries has declined since 1990, the number of affected individuals has increased significantly with population growth, creating a substantial burden on health systems [3]. It is estimated that in 2019, approximately 2.03 billion people worldwide suffered from untreated permanent tooth caries, and about 520 million children had untreated primary tooth caries [14].

In China, four national oral epidemiological surveys have consistently shown that caries is also a widespread oral health problem [15-17]. The caries prevalence rates in primary teeth for the 3-, 4-, and 5-year-old age groups were 50.8%, 89.0%, 95.6%, and 98.0%, respectively [17]. Currently, domestic scholars have mostly analyzed the prevalence and influencing factors of caries based on national, provincial, or municipal survey data, but research on the disease burden and changing trends of caries in China is still lacking. Furthermore, due to significant differences in dietary habits, culture, and socioeconomic status between China and other countries, it is essential to study the disease burden of caries in the Chinese context. Therefore, this study, based on data from the 2019 Global Burden of Disease (GBD) study, comprehensively analyzed the current status and trends of the disease burden of caries in China to provide a reference for developing prevention and control strategies.

Methods

Data Sources

The data for this study were obtained from the 2019 GBD study, led by the Institute for Health Metrics and Evaluation (IHME) at the University of Washington. Using a unified methodology, the study assessed the disease burden of 328 diseases and injuries in 204 countries and territories, including evaluations of the disease burden of primary and permanent tooth caries in China [18-19]. The disease burden data for primary and permanent tooth caries in China from the 2019 GBD study included the 2002 World Health Survey, national oral epidemiological surveys, and previously conducted projects, published literature, or reports targeting multiple age groups across various regions [20]. All data included in the analysis underwent rigorous and standardized quality control to ensure reliability.

Study Indicators

We compiled and summarized data on incidence, prevalence, and years lived with disability (YLD) for primary and permanent tooth caries in China from 1990 to 2019 extracted from the GBD study. The indicators included incident cases, prevalent cases, and YLD person-years, age-specific incidence, prevalence, and YLD rates, as well as age-standardized incidence, prevalence, and YLD rates. In the GBD study, YLD was calculated using the formula: YLD = Prev $\times$ DW, where Prev represents the number of prevalent cases for a disease and DW represents the disability weight [21]. Age-standardized rates were calculated based on the world standard population structure [22].

Statistical Methods

This study used Excel to organize the data and calculate the percentage change in incident cases, prevalent cases, and YLD person-years for primary and permanent tooth caries from 1990 to 2019. The calculation formula was: Percentage change (%) = (2019 value - 1990 value) / 1990 value $\times$ 100%. Joinpoint Regression Program 4.7.0.0 software was used for regression analysis to calculate the annual percent change (APC) and average annual percent change (AAPC) with 95% confidence intervals (CI) for age-standardized incidence, prevalence, and YLD rates of primary and permanent tooth caries in China from 1990 to 2019, and to analyze and evaluate the trends and inflection points of each age-standardized rate. When the APC or AAPC and its 95% CI were both >0, both <0, or $P>0.05$, they indicated an upward trend, downward trend, or no significant change in the indicator during that time period, respectively [23]. If there were no turning points, then APC = AAPC, indicating that the age-standardized rate showed a monotonic upward or downward trend throughout the observation period [23].

Results

Current Burden of Primary Tooth Caries in China, 2019

In 2019, the incident cases, prevalent cases, and YLD person-years for primary tooth caries in China were 137 million, 67 million, and 25,900, respectively . The age-standardized incidence, prevalence, and YLD rates for primary tooth caries in China in 2019 were 17.54%, 8.40%, and 3.24 per 100,000, respectively . Among children aged 1-14 years, the highest incidence rate of primary tooth caries (118.96%) was observed in children aged 5-9 years, while the highest prevalence rate (53.08%) and YLD rate (20.40 per 100,000) were both found in children aged 1-4 years [Figure 1: see original paper].

Current Burden of Permanent Tooth Caries in China, 2019

In 2019, the incident cases, prevalent cases, and YLD person-years for permanent tooth caries in China were 581 million, 330 million, and 326,200, respectively . The age-standardized incidence, prevalence, and YLD rates for permanent tooth caries in China in 2019 were 39.19%, 21.61%, and 21.45 per 100,000, respectively . Among individuals aged 5 years and above, the incidence, prevalence, and YLD rates of permanent tooth caries increased with age initially and then decreased, reaching their peak at ages 20-24 years at 62.30%, 32.19%, and 32.41 per 100,000, respectively [Figure 1: see original paper].

Trends in Primary Tooth Caries Burden in China, 1990-2019

Compared with 1990, the incident cases, prevalent cases, and YLD person-years of primary tooth caries in China in 2019 decreased by 25.69%, 28.74%, and 28.63%, respectively . From 1990 to 2019, the age-standardized incidence (AAPC = 0.21%, 95% CI = 0.19%-0.22%), prevalence (AAPC = 0.03%, 95% CI = 0.01%-0.05%), and YLD rates (AAPC = 0.03%, 95% CI = 0.01%-0.05%) of primary tooth caries showed overall upward trends . The trend in age-standardized incidence of primary tooth caries in China showed five inflection points in 1995, 2000, 2005, 2010, and 2015. The age-standardized incidence decreased during 1990-1995 and 2000-2005, with APC values of -0.11% and -0.54% ($P < 0.05$), respectively; it increased during 1995-2000, 2005-2010, and 2010-2015, with APC values of 0.40%, 0.51%, and 0.96% ($P < 0.05$), respectively; and showed no significant change during 2015-2019 ($P > 0.05$) . The trend in age-standardized prevalence showed four inflection points in 2001, 2005, 2010, and 2017. The age-standardized prevalence decreased during 1990-2001, 2001-2005, and 2017-2019, with APC values of -0.11%, -0.41%, and -0.63% ($P < 0.05$), respectively; it increased during 2005-2010 and 2010-2017, with APC values of 0.64% and 0.24% ($P < 0.05$), respectively . The trend in age-standardized YLD rate showed four inflection points in 2001, 2005, 2010, and 2017. The age-standardized YLD rate decreased during 1990-2001, 2001-2005, and 2017-2019, with APC values of -0.11%, -0.40%, and -0.61% ($P < 0.05$), respectively; it increased during 2005-2010 and 2010-2017, with APC values of 0.65% and 0.23%

(P < 0.05), respectively .

Trends in Permanent Tooth Caries Burden in China, 1990-2019

Compared with 1990, the incident cases, prevalent cases, and YLD person-years of permanent tooth caries in China in 2019 increased by 17.41%, 15.84%, and 15.07%, respectively . From 1990 to 2019, the age-standardized incidence (AAPC = -0.05%, 95% CI = -0.05% to -0.04%), prevalence (AAPC = -0.23%, 95% CI = -0.32% to -0.14%), and YLD rates (AAPC = -0.22%, 95% CI = -0.31% to -0.13%) of permanent tooth caries showed overall downward trends . The trend in age-standardized incidence of permanent tooth caries showed five inflection points in 1996, 2003, 2010, 2014, and 2017. The age-standardized incidence decreased during 1990-1996, 1996-2003, 2003-2010, and 2014-2017, with APC values of -0.22%, -0.12%, -0.03%, and -0.22% (P < 0.05), respectively; it increased during 2010-2014 and 2017-2019, with APC values of 0.24% and 0.37% (P < 0.05), respectively . The trend in age-standardized prevalence showed five inflection points in 2001, 2004, 2010, 2014, and 2017. The age-standardized prevalence decreased during 1990-2001, 2001-2004, and 2004-2010, with APC values of -0.38%, -0.78%, and -0.19% (P < 0.05), respectively; it showed no significant change during 2010-2014, 2014-2017, and 2017-2019 (P > 0.05) . The trend in age-standardized YLD rate showed five inflection points in 2001, 2004, 2010, 2014, and 2017. The age-standardized YLD rate decreased during 1990-2001, 2001-2004, and 2004-2010, with APC values of -0.37%, -0.80%, and -0.17% (P < 0.05), respectively; it showed no significant change during 2010-2014, 2014-2017, and 2017-2019 (P > 0.05) .

Discussion

Caries is a prevalent chronic non-communicable disease and one of the major public health problems worldwide [2-3]. The development of caries is associated with a complex network of individual, family, and social factors, including social and physical environments, oral health behaviors, and oral health services [3,24]. However, the consumption of free sugars in food and beverages is the most important factor in caries development, with a clear dose-response relationship [25-27]. Self-care and personal oral hygiene practices can significantly reduce the occurrence of caries and slow its progression [2,28-29]. Compared with many chronic diseases, caries is preventable and controllable, and timely prevention or treatment can effectively reduce its adverse effects and improve quality of life. Therefore, this study utilized data from the 2019 GBD study to analyze the overall disease burden and age-specific burden of primary and permanent tooth caries in China in 2019, as well as trends from 1990 to 2019, aiming to provide scientific evidence for identifying prevention priorities and developing targeted strategies and measures.

Our study data show that among children aged 1-14 years, the incidence rate of primary tooth caries was highest in children aged 5-9 years, while the prevalence and YLD rates were highest in children aged 1-4 years. This may be primarily

related to the timing of primary tooth eruption and the degree of cooperation during dental treatment. The first primary tooth typically erupts between 6-30 months of age, and permanent teeth begin to replace primary teeth from ages 5-13 years. Therefore, children aged 5-9 years may have a complete primary dentition and be in the early stage of tooth replacement, facing higher risks of primary tooth caries [30-33]. Additionally, research indicates that children's ability to cooperate during dental treatment depends on their developmental stage, with younger children being less cooperative and more likely to refuse treatment, resulting in a higher likelihood of untreated primary tooth caries in younger children aged 1-4 years [34]. Currently, there is limited available data and research findings on permanent tooth caries across all age groups in China [35-40]. This study found that the incidence, prevalence, and YLD rates of permanent tooth caries in China increased with age, peaked at ages 20-24 years, and then declined but remained at relatively high levels, suggesting that caries prevention should not be limited to children but should include all age groups. Since both primary and permanent teeth are at risk of caries once erupted and cannot heal spontaneously under current conditions, strengthening primary prevention is essential to effectively reduce the disease burden of caries.

In terms of trends in the disease burden of caries, compared with 1990, the absolute numbers of incident cases, prevalent cases, and YLD for primary tooth caries in China in 2019 decreased by 25.69%, 28.74%, and 28.63%, respectively, while those for permanent tooth caries increased by 17.41%, 15.84%, and 15.07%, respectively. Although the age-standardized incidence, prevalence, and YLD rates of both primary and permanent tooth caries in China fluctuated between 1990 and 2019, the overall trends showed increases for primary tooth caries and decreases for permanent tooth caries. These patterns may be primarily related to China's population base and lifestyle changes. In 2019, China's total population was 1.41 billion, 1.23 times the 1990 population of 1.142 billion, while the number of children aged 0-14 years decreased from 317 million at the end of 1990 to 237 million at the end of 2019, a reduction of 25.24% [41]. This is the direct reason for the increase in incident cases, prevalent cases, and YLD for permanent tooth caries and the decrease for primary tooth caries. With economic development, lifestyle changes, food refinement, and increasing sugar consumption may elevate the risk of caries. Studies have reported that among Chinese children aged 8-14 years, daily consumption of sugar-sweetened beverages increased from 329.1 mL to 528.8 mL between 1998 and 2008 [42]. Additionally, data from the China Health and Nutrition Survey show an increasing trend in the frequency of sugar-sweetened beverage consumption among Chinese children and adolescents aged 6-17 years, rising from 76.5% in 2004 to 91.5% in 2011 [43]. Since sugar-sweetened beverages are the main source of added sugar intake for children and adolescents, the increased consumption and frequency may be the primary reason for the upward trends in age-standardized incidence, prevalence, and YLD rates of primary tooth caries. A previous study analyzing added sugar consumption from sugar-sweetened beverages in nine Chinese provinces from 2004-2009 found that added sugar intake among Chinese adults

was relatively low compared with other developed countries and did not exceed recommendations from the World Health Organization and American Heart Association, but the overall consumption rate continued to rise [44]. Meanwhile, with rapid economic development and continuous improvement of the medical security system, residents' self-care and personal oral hygiene practices have also improved, including increased frequency of toothbrushing, use of fluoride toothpaste, and consumption of fluoridated water, which help prevent caries and slow its progression [45-47]. These may be the main reasons for the declining age-standardized incidence, prevalence, and YLD rates of permanent tooth caries.

In summary, from 1990 to 2019, the disease burden of primary tooth caries in China showed an increasing trend, while the burden of permanent tooth caries showed a decreasing trend but remained serious. Caries prevention should not be limited to children but should include all age groups. The goal of caries prevention is to maintain the intact structure of teeth, prevent enamel demineralization, and enable early detection and treatment. Intervention measures can be implemented at the population level, and oral health can be promoted through health policies, laws and regulations, and public health measures to raise public awareness of oral health [4]. A sound oral health care system provides accessible oral health care and treatment for residents. Reducing the amount and frequency of sugar intake, especially the frequency, is more effective in preventing dental caries [45]. Fluoride in drinking water, mouthwash, or toothpaste, as well as professionally applied fluoride, can prevent caries [47-48]. Promoting good oral hygiene maintenance habits and regular dental check-ups helps prevent caries. Similar to these approaches, individuals must also pay attention to caries and adopt interventions including daily toothbrushing, controlling sugar intake and frequency, using sugar substitutes, using fluoride toothpaste, regular dental check-ups, pit and fissure sealants, and clinical treatment.

References

[1] FEJERSKOV O, KIDD E. Dental caries: the disease and its clinical management, 2nd edn [M]. Oxford: Blackwell Monksgaard, 2008: 4-6.

[2] SELWITZ R H, ISMAIL A I, PITTS N B. Dental caries [J]. Lancet, 2007, 369(9555): 51-59. DOI: 10.1016/S0140-6736(07)60031-2.

[3] World Health Organization. Global oral health status report: towards universal health coverage for oral health by 2030 [EB/OL]. (2022-11-18) [2023-01-12]. https://www.who.int/publications/i/item/9789240061484.

[4] PITTS N B, ZERO D T, MARSH P D, et al. Dental caries [J]. Nat Rev Dis Primers, 2017, 3: 17030. DOI: 10.1038/nrdp.2017.30.

[5] PITTS N B. Caries and collaborations in context [J]. Br Dent J, 2021, 231(12): 737-740. DOI: 10.1038/s41415-021-3731-3.

[6] World Health Organization. Sugars and dental caries [EB/OL]. (2017-11-09)

[2023-01-12]. https://www.who.int/news-room/fact-sheets/detail/sugars-and-dental-caries.

[7] HARFORD J, CHRISOPOULOS S. Productivity losses from dental problems [J]. Aust Dent J, 2012, 57(3): 393-397. DOI: 10.1111/j.1834-7819.2012.01718.x.

[8] SHEIHAM A. Dental caries affects body weight, growth and quality of life in pre-school children [J]. Br Dent J, 2006, 201(10): 625-626. DOI: 10.1038/sj.bdj.4814259.

[9] RUFF R R, SENTHI S, SUSSER S R, et al. Oral health, academic performance, and school absenteeism in children and adolescents: a systematic review and meta-analysis [J]. J Am Dent Assoc, 2019, 150(2): 111-121.e4. DOI: 10.1016/j.adaj.2018.09.023.

[10] HAYES A, AZARPAZHOOH A, DEMPSTER L, et al. Time loss due to dental problems and treatment in the Canadian population: analysis of a nationwide cross-sectional survey [J]. BMC Oral Health, 2013, 13: 17. DOI: 10.1186/1472-6831-13-17.

[11] GUARNIZO-HERRREÑO C C, WEHBY G L. Children's dental health, school performance, and psychosocial well-being [J]. J Pediatr, 2012, 161(6): 1153-1159. DOI: 10.1016/j.jpeds.2012.05.025.

[12] BENZIAN H, MONSE B, HEINRICH-WELTZIEN R, et al. Untreated severe dental decay: a neglected determinant of low Body Mass Index in 12-year-old Filipino children [J]. BMC Public Health, 2011, 11: 558. DOI: 10.1186/1471-2458-11-558.

[13] DUIJSTER D, SHEIHAM A, HOBDELL M H, et al. Associations between oral health-related impacts and rate of weight gain after extraction of pulpally involved teeth in underweight preschool Filipino children [J]. BMC Public Health, 2013, 13: 533. DOI: 10.1186/1471-2458-13-533.

[14] QIN X F, ZI H, ZENG X J. Changes in the global burden of untreated dental caries from 1990 to 2019: a systematic analysis for the Global Burden of Disease study [J]. Heliyon, 2022, 8(9): e10714. DOI: 10.1016/j.heliyon.2022.e10714.

[15] National Dental Disease Prevention and Control Group. Second National Oral Health Epidemiological Sampling Survey [M]. Beijing: People's Medical Publishing House, 1999: 1-5.

[16] QI X Q. Third National Oral Health Epidemiological Survey Report [M]. Beijing: People's Medical Publishing House, 2008: 1-2.

[17] Oral Health Status of Chinese Residents—Report of the Fourth National Oral Health Epidemiological Survey [C]//Proceedings of the 18th Annual Meeting of the Chinese Stomatological Association for Preventive Dentistry. Xi'an, 2018: 14.

[18] GBD DISEASES AND INJURIES COLLABORATORS. Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: a system-

atic analysis for the Global Burden of Disease Study 2019 [J]. Lancet, 2020, 396(10258): 1204-1222. DOI: 10.1016/S0140-6736(20)30925-9.

[19] Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2019 (GBD 2019) Results [EB/OL]. [2022-11-11]. https://vizhub.healthdata.org/gbd-results/.

[20] WANG Z, HE J, JI K, et al. Analysis of prevalence and disability-adjusted life years of oral diseases in Sichuan Province from 1990 to 2015 [J]. Chin J Prev Contr Chron Dis, 2017, 25(7): 485-488. DOI: 10.16386/j.cjpccd.issn.1004-6194.2017.07.005.

[21] GBD DISEASE AND INJURY INCIDENCE AND PREVALENCE COLLABORATORS. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017 [J]. Lancet, 2018, 392(10159): 1789-1858. DOI: 10.1016/S0140-6736(18)32279-7.

[22] Ahmad OB, Boschi-Pinto C, Lopez AD, et al. Age standardization of rates: a new WHO standard [EB/OL]. (2001-10-10) [2022-10-12]. https://cdn.who.int/media/docs/default-source/gho-documents/global-health-estimates/gpe_{{{discussion}}*{{paper}}*{{{series}}*{{paper31}}*{{{2001}}*{{age}}*{{{standardization}}_{

[23] ILIC I, SIPETIC GRUJICIC S, GRUJICIC J, et al. Long-term trend of liver cancer mortality in Serbia, 1991-2015: an age-period-cohort and joinpoint regression analysis [J]. Healthcare, 2020, 8(3): 283. DOI: 10.3390/healthcare8030283.

[24] BAKER S R, FOSTER PAGE L, THOMSON W M, et al. Structural determinants and children's oral health: a cross-national study [J]. J Dent Res, 2018, 97(10): 1129-1136. DOI: 10.1177/0022034518767401.

[25] MOYNIHAN P, PETERSEN P E. Diet, nutrition and the prevention of dental diseases [J]. Public Health Nutr, 2004, 7(1A): 201-226. DOI: 10.1079/phn2003589.

[26] VALENZUELA M J, WATERHOUSE B, AGGARWAL V R, et al. Effect of sugar-sweetened beverages on oral health: a systematic review and meta-analysis [J]. Eur J Public Health, 2021, 31(1): 122-129. DOI: 10.1093/eurpub/ckaa147.

[27] TOUGER-DECKER R, VAN LOVEREN C. Sugars and dental caries [J]. Am J Clin Nutr, 2003, 78(4): 881S-892S. DOI: 10.1093/ajcn/78.4.881S.

[28] TWETMAN S. The evidence base for professional and self-care prevention—caries, erosion and sensitivity [J]. BMC Oral Health, 2015, 15(Suppl 1): S4. DOI: 10.1186/1472-6831-15-S1-S4.

[29] CHEN Z, ZHU J H, ZHAO J, et al. Dental caries status and its associated factors among schoolchildren aged 6-8 years in Hangzhou, China: a cross-

sectional study [J]. BMC Oral Health, 2023, 23(1): 94. DOI: 10.1186/s12903-023-02795-5.

[30] World Health Organization. Ending childhood dental caries: WHO implementation manual [EB/OL]. (2022-1-28) [2022-10-12]. https://www.who.int/publications/i/item/ending-childhood-dental-caries-who-implementation-manual.

[31] MOSLEMI M. An epidemiological survey of the time and sequence of eruption of permanent teeth in 4-15-year-olds in Tehran, Iran [J]. Int J Paediatr Dent, 2004, 14(6): 432-438. DOI: 10.1111/j.1365-263X.2004.00586.x.

[32] AGARWAL K N, GUPTA R, FARIDI M M, et al. Permanent dentition in Delhi boys of age 5-14 years [J]. Indian Pediatr, 2004, 41(10): 1031-1035.

[33] KUTESA A, NKAMBA E M, MUWAZI L, et al. Weight, height and eruption times of permanent teeth of children aged 4-15 years in Kampala, Uganda [J]. BMC Oral Health, 2013, 13: 15. DOI: 10.1186/1472-6831-13-15.

[34] SUN Q, LIANG S. Investigation on the cooperation degree and influencing factors of children aged 3-7 years with caries at initial diagnosis [C]//Chinese Nursing Association. Proceedings of the National Symposium on New Advances in Oral Care. Beijing: Chinese Nursing Association, 2011: 5.

[35] ZHANG Y X, WU X J, GUO Z J, et al. Epidemiological study of caries in Chinese adults and elderly [J]. Chin J Clinicians, 2007, 35(6): 49-51.

[36] LUAN W M, CHEN X, WU X J. Longitudinal observation of tooth loss and caries status in adults in Gucheng Village [J]. Chin J Stomatol, 1994, 29(3): 152-155.

[37] CHU L N, ZHU W H, ZHOU H L, et al. Investigation and analysis of caries status in elderly people in Xicheng District of Beijing [J]. Beijing J Stomatol, 2005, 13(3): 189-190, 192. DOI: 10.3969/j.issn.1006-673X.2005.03.021.

[38] WU M, YU H, HE L P, et al. Investigation of oral health status of 1620 retired military cadres in Shenyang area [J]. Chin J Conserv Dent, 2007, 17(2): 107-108. DOI: 10.3969/j.issn.1005-2593.2007.02.014.

[39] YANG B Q, LIU Y. Investigation of oral status in 727 elderly people [J]. J Clin Stomatol, 2005, 21(9): 572-573. DOI: 10.3969/j.issn.1003-1634.2005.09.025.

[40] WU Y Z, LIU C P, HUANG B. Census analysis of dental diseases in 624 rural elderly people [J]. Stomatol, 2005, 25(5): 319-320.

[41] National Bureau of Statistics. China Statistical Yearbook-2021 [M]. Beijing: China Statistics Press, 2021: 31.

[42] LIU A L, DUAN Y F, HU X Q, et al. Analysis of changes in snack consumption behavior among urban children over 10 years [J]. Chin J School Health, 2011, 32(12): 1415-1417. DOI: 10.16835/j.cnki.1000-9817.2011.12.004.

[43] YANG L L, MA C W, LIANG Y J, et al. Effect of sugar-sweetened beverage consumption frequency on blood pressure levels in children and adolescents [J]. Chin J School Health, 2016, 37(10): 1456-1459. DOI: 10.16835/j.cnki.1000-9817.2016.10.005.

[44] LI D H, YU D M, ZHAO L Y. Trend analysis of sugar-sweetened beverage consumption and added sugar intake among adults in nine provinces of China [J]. J Hyg Res, 2014, 43(1): 70-72. DOI: 10.19813/j.cnki.weishengyanjiu.2014.01.015.

[45] VAN LOVEREN C. Sugar restriction for caries prevention: amount and frequency. which is more important? [J]. Caries Res, 2019, 53(2): 168-175. DOI: 10.1159/000489571.

[46] STANGVALTAITE-MOUHAT L, PURIENE A, STANKEVICIENE I, et al. Fluoride in the drinking water and dental caries experience by tooth surface susceptibility among adults [J]. BMC Oral Health, 2021, 21(1): 234. DOI: 10.1186/s12903-021-01598-w.

[47] WALSH T, WORTHINGTON H V, GLENNY A M, et al. Fluoride toothpastes of different concentrations for preventing dental caries [J]. Cochrane Database Syst Rev, 2019, 3(3): CD007868. DOI: 10.1002/14651858.CD007868.pub3.

[48] WEINTRAUB J A. Sustainable oral health interventions [J]. J Public Health Dent, 2011, 71(Suppl 1): S95-S96. DOI: 10.1111/j.1752-7325.2011.00230.x.

Author Contributions: LIU Min conceptualized and designed the study. HUANG Gang and CAO Guiying were responsible for data collection and organization, statistical analysis, chart preparation, and drafting the initial manuscript. LIU Min revised the manuscript. LIU Min was responsible for quality control and review of the article, overall accountability, and supervision.

Conflicts of Interest: None declared.

Note: Figure translations are in progress. See original paper for figures.