Effect of fluoridated dentifrice on the number of missing teeth

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We analyzed the relation between the number of missing teeth (MT) and the rate of market share of fluoride containing dentifrice (RMSF) by birth year cohort. The data analysis used the results of 10 Japanese National Surveys of Oral Health from 1952 to 2011. The data of MT for those born from 1926 to 1973 were divided into 8 groups every six years. The changes in MT and RMSF over time were analyzed for each group of birth year cohorts. In the older subjects, MT increased with age, and RMSF was low. In subsequent generations of subjects, MT was low and RMSF high. We found that the decrease in MT correlated with the increase in RMSF, suggesting that the 8020 goal (Japanese 80 years old should have 20 teeth) will be accomplished after 15 years. (J Osaka Dent Univ 2014 ; 48 : 151–157)

Key words : Fluoridated dentifrice ; Missing teeth

INTRODUCTION

Since 1989, the 8020 (Eighty-Twenty) Campaign that people 80 years old should have at least 20 teeth has been promoted by the Japanese Ministry of Health, Labour and Welfare (MHLW) and the Japan Dental Association (JDA). The results of Surveys of Dental Diseases published by the MHLW showed an average of 14 teeth retained in 80-year-olds in 2011. This was an increase from an average of 10 teeth at the time of the survey in 2005, when 24.1% of the population attained the goal of 20 teeth, compared with 38.3% in 2011.[1] This signifies a continued reduction in the number of missing teeth (MT) in Japanese. Furthermore, dental caries, a precursor to tooth loss, has been decreasing among young people year by year.

Various factors are thought to contribute to the decrease in the number of caries worldwide ; however, the widespread use of water fluoridation is considered to be one of the principal reasons. The contribution of fluoride, including adjustment in the concentration of fluoride in the public water supply, fluoride toothpastes, fluoride mouth rinses, and fluoride varnishes, has been well documented in the literature as a way to decrease caries.[2–5] Kambara[6] examined how the decrease in decayed, missing and filled teeth (DMFT)

due to caries is related to tooth brushing.[6] Based on the two facts that in recent years more than 95% of the Japanese population brush their teeth one or more times per day, and that the number of people brushing two or more times has been increasing, Kambara interpreted the decrease in caries as not being due to the number of times of tooth brushing, but rather to an improvement in behaviors stemming from better attitudes toward dental health. From these observations, Kambara reported that the decrease in caries is related to the health consciousness of society as a whole.

The decrease in the number of caries and teeth lost appears to result from multiple factors. The current market share of fluoride toothpaste is over 90%, as fluoride toothpaste is widely used by all age groups. Furthermore, fluoride toothpaste appears to be implicated in the decrease in the number of MT in older people. However, little research currently exists examining the relationship between fluoride toothpaste use and the number of MT. It is clear that the prevention of tooth loss is a critical issue remaining to be solved for dentistry in Japan, a super-aging society.

The purpose of this study was to elucidate the effect of the widespread use of fluoride toothpaste on the number of MT by analyzing birth cohort data to esti-

mate the birth year of cohorts that will achieve the 8020 target.

MATERIALS AND METHODS

Number of MT according to birth cohort studies found in the Surveys of Dental Diseases (1957–2011)

The 10 past Surveys of Dental Diseases, published by the MHLW every six years from 1957 to 2011, were used in this study to calculate the mean number of MT at the time of the survey in subjects of eight birth cohort groups born over six year intervals from 1926 to 1973. Furthermore, subjects who reached the age of 80 at the time of the most recent survey in 2011 (those born in 1926 and 1931) until the youngest group (those born in 1968 and 1973) were studied (Table 1).
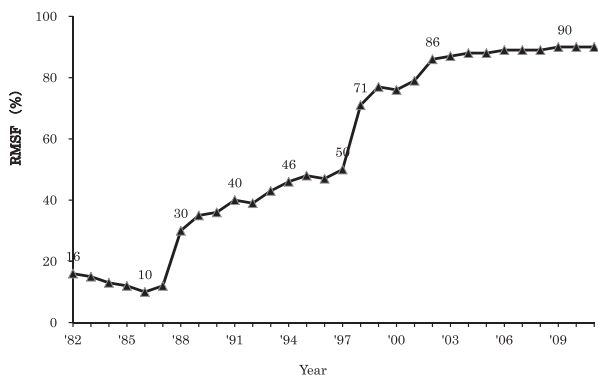

Fig. 1   Rate of market share of fluoride toothpaste in Japan.

Market share of fluoride toothpaste

Data for the rate of market share of fluoride toothpaste (RMSF) was obtained from surveys done by the Lion Foundation for Dental Health in Japan. These surveys have been published since 1982 ; the data from 1982 to 2011 was used in this study (Fig. 1).

Number of MT and RMSF for each birth cohort

The table in section 1 of Data and Methods shows the increase in MT for eight birth cohort groups classified by age and the mean RMSF for each cohort which were age-specifically calculated, plotted and analyzed.

Relationship between the numbers of teeth retained at age 80 and RMSF according to the Survey of Dental Diseases

Data for number of teeth retained in the subjects who were 80 years old (those born in 1907, 1913, 1919, 1925 and 1931) and who had been exposed to fluoride toothpaste at the time of the survey was selected. A 50% regression line was set for each cohort group to determine if exposure to fluoride toothpaste correlates with a reduction in MT. Curve fitting was later performed on the relationship between the number of teeth retained at age 80 and the age when the subjects reached 50% RMSF in order to determine when the 8020 target will be achieved. IBM® SPSS® Statistics Ver.19 (IBM, New York, USA) was used to process the data and perform statistical analysis.

Table 1   Eight birth cohort groups from the Survey of Dental Diseases

Birth year	Survey year									
	1957	1963	1969	1975	1981	1987	1993	1999	2005	2011
1926–1931	26–31	32–37	38–43	44–49	50–55	56–61	62–67	68–73	74–79	80–85
1932–1937	20–25	26–31	32–37	38–43	44–49	50–55	56–61	62–67	68–73	74–79
1938–1943	14–19	20–25	26–31	32–37	38–43	44–49	50–55	56–61	62–67	68–73
1944–1949	8–13	14–19	20–25	26–31	32–37	38–43	44–49	50–55	56–61	62–67
1950–1955		8–13	14–19	20–25	26–31	32–37	38–43	44–49	50–55	56–61
1956–1961			8–13	14–19	20–25	26–31	32–37	38–43	44–49	50–55
1962–1967				8–13	14–19	20–25	26–31	32–37	38–43	44–49
1968–1973					8–13	14–19	20–25	26–31	32–37	38–43

RESULTS

Relationship between RMSF trends and birth year of cohorts

The number of MT in birth cohorts shows an approximate linear trend with the age of the subjects. The slope of MT graphed against age decreases as the birth year of the cohorts is more recent (Fig. 2). Of course, RMSF started to increase at an earlier age in those cohorts born more recently. For example, the increase in RMSF for cohorts born during the period from 1926 to 1931 was 50 to 55 years of age at the time of the survey. For those born from 1932 to 1937 it was 44 to 49 years of age, for those born from 1938 to 1943 it was 38 to 43 years, for those born from 1944 to 1949 it was 32 to 37 years, for those born from 1950 to 1955 it was 26 to 31 years, for those born from 1956 to 1961 it was 20 to 25 years, for those born from 1962 to 1967 it was 14 to 19 years, and for those born from 1968 to 1973 it was 8 to 13 years. MT was lowest in subjects who had continuously used fluoride toothpaste since childhood (Fig. 3).

Prediction of achieving the 8020 target

Five generations showed a linear relationship between the number of teeth retained at age 80 and 50% RMSF. From this linear relationship, the regression equations for the birth years for reaching 50%, 40%, and 30% RMSF, and the number of teeth at age 80 were : y (age of reaching 50% RMSF) $= -2.11\,X$ (number of teeth) $+ 92.33$) (Fig. 4 A), y (age of reach-ing 40% RMSF) $= -2.11\,X$ (number of teeth) $+ 86.33$) (Fig. 4 B), y (age of reaching 30% RMSF) $= -2.11\,X$(number of teeth) $+ 83.33$) (Fig. 4 C), respectively. In all cases, $r^2 = 0.962$. The results of 50% RMSF data show that it is necessary to reach the age of 50.13 at the 50% RMSF level in order to achieve the 8020 target. RMSF reached 50% in 1997 (Fig. 1). Therefore, the cohort subjects born in 1947 should achieve the 8020 target. The birth year for attaining the 8020 target for 30% RMSF and 40% RMSF were similarly estimated to be 1947.

DISCUSSION

Relationship between RMSF and birth year of cohorts

The number of MT decreased as RMSF increased during childhood. As Evans et al. have reported, regular use of the appropriate amount of fluoride toothpaste has a prophylactic effects on caries.[8] It seems that continued long-term use of fluoride toothpaste reduces MT. The use of fluoride toothpaste after eruption of primary and permanent teeth promotes enamel maturation, inhibiting caries. Older generations had very little exposure to fluoride, as the market share of fluoride toothpaste was low when their teeth were erupting, resulting in both high numbers of caries and MT. In other words, it is critical for fluoride to act on primary and permanent dentitions at their time of eruption to prevent caries. It will be valuable to have the survey results of cohorts that had exposure of both the primary and permanent dentitions to fluoride toothpaste in order to examine the effects of its continued use. The continued use of fluoride toothpaste seems to affect the oral cavity environment and oral tissues, bacteria associated with periodontal disease, root surfaces associated with gingival recession, and damage to the teeth through attrition and abrasion. Further research is necessary.

Prediction for achievement of the 8020 goal by birth year of the cohorts

It has been reported that tooth loss not only decreases oral function,[9, 10] but also affects quality of life (QOL) and Life Expectancy.[11–17] The publication Health Japan 21 (2 nd edition ; April, 2014) gives the basic pol-
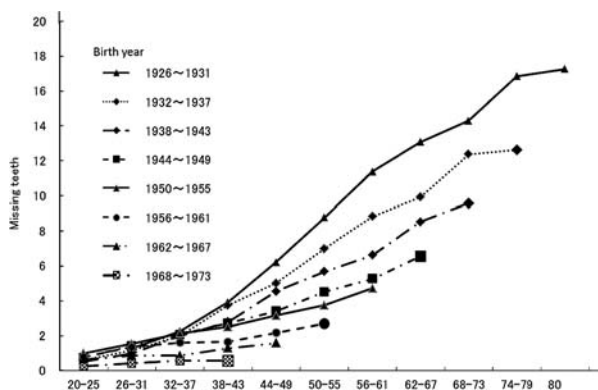
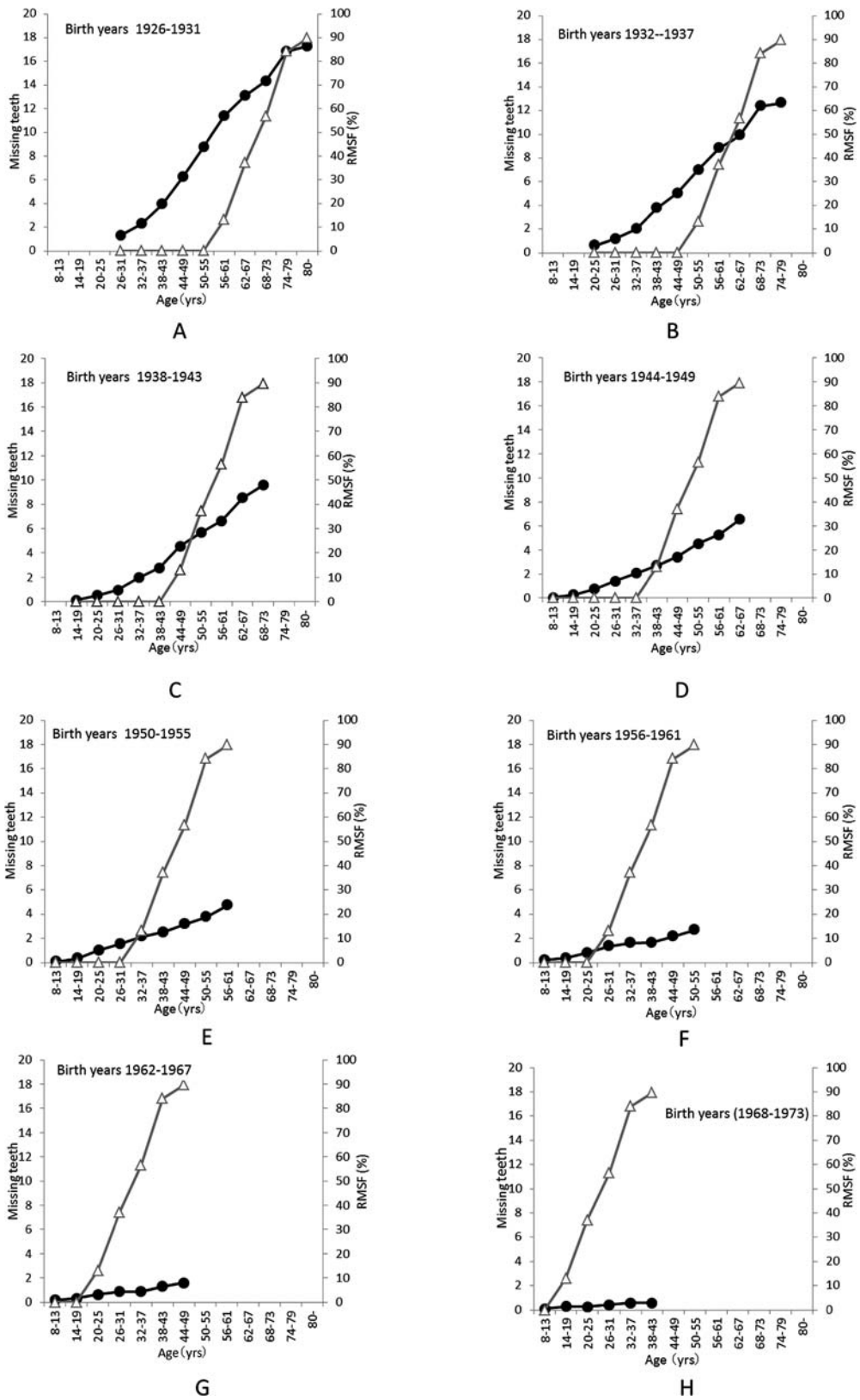**Fig. 2** Number of MT according to birth cohort studies found in the Surveys of Dental Diseases.
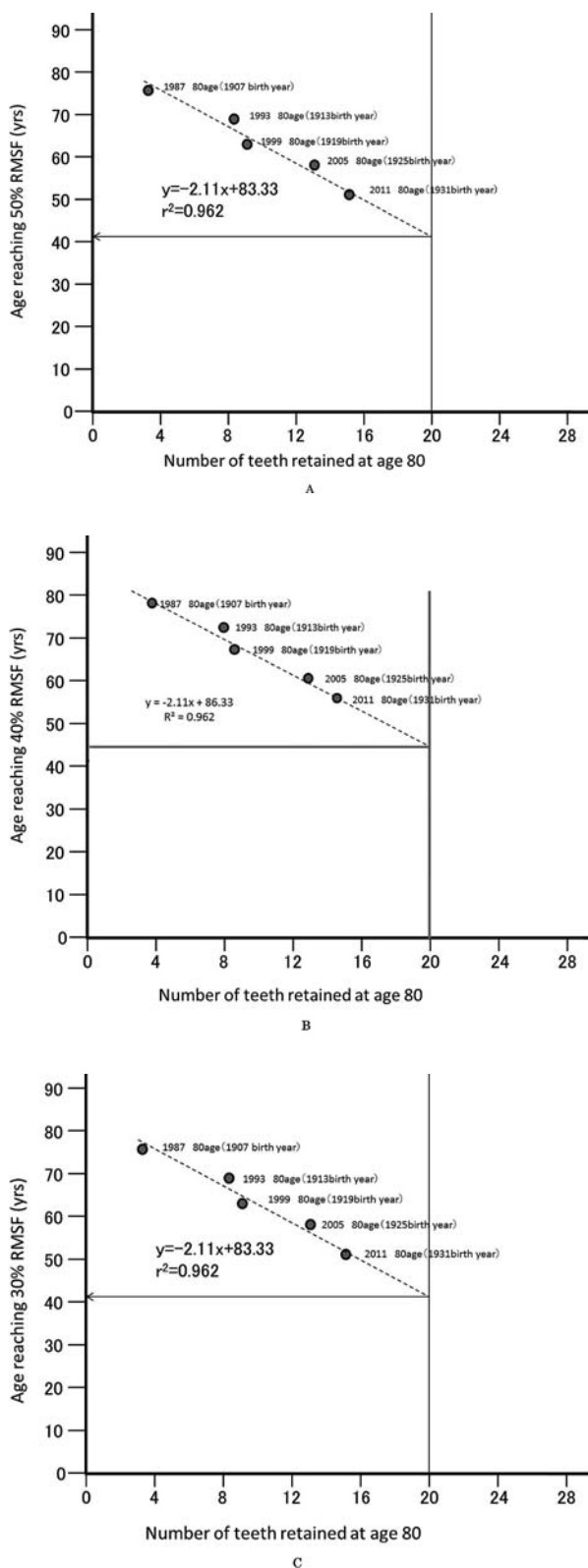
Fig. 3   Relationship between RMSF and birth year cohorts for various birth years.

A

B

C

Fig. 4 Linear relationship between the number of teeth retained at age 80 and (A) 50% RMSF, (B) 40% RMSF and (C) 30% RMSF for five generations.

icy for promoting comprehensive health in Japan, and lists the percentage of people who have 20 or more teeth at age 80 as 25% in 2005. It recommended a target of 50% by 2022. Japan ranks first in the world in life expectancy, with an average of over 80 years. As the decreasing trend in MT shows, the number of people over the age of 80 who use toothpaste to brush their remaining teeth is expected to continue to increase in the future. The results of this research show that the 8020 target should be achieved by 2027, and suggest that life expectancy will increase as the number of MT continues to decrease.[18]

How to prevent tooth loss

Caries and periodontal disease account for 90% of tooth loss.[19–21] It has also been reported, however, that periodontal disease is not necessarily a major factor in tooth loss.[22] Various factors contribute to tooth loss. It has been concluded that tooth loss is due to a complex relationship of factors from the time of eruption, such as a history of caries, presence and severity of periodontal disease, dental care (including the type of treatment and healthcare system), the person's general condition of health (such as health history and the habitual use of drugs), lifestyle (tooth brushing and eating habits), and awareness of oral health.

The number of MT reflects an individual's lifetime history of oral health and serves as an index of the total oral health. Furthermore, differences in the number of MT in each generation seem to be driven not only by the use of fluoride toothpaste, but also by school health education, the national health system, the medical examination system, universal health coverage, the dental care system, and advances in dental care that have influenced the Japanese oral health system. We will continue to comprehensively examine the multiple factors affecting tooth loss, including time factors.

Prevention of tooth loss can be broadly divided into four stages : the primary dentition, eruption of the permanent teeth, adulthood, and old age. It is assumed that toothbrushing is common to all life stages, as it has been reported that in recent years, 94.9% of Japanese brush their teeth everyday.[23]

According to the 8020 Promotion Foundation, the

rate of fluoride toothpaste use by students in Japan from 6 to 14 years of age was 88% in 2005 and 89% in 2010.[6] It can thus be said that brushing with fluoride toothpaste has become widespread. The frequency of brushing seems to influence tooth loss. It has been reported that as the number of people who brush their teeth two or more times a day increases, tooth loss decreases.[23]

From our results, which show that the long-term use use of fluoride toothpaste leads to a low number of MT, we recommend brushing with fluoride toothpaste two or more times per day as well as the combined use of the appropriate toothbrush and auxiliary dental cleaning devices. In addition, prophylactic measures such as regular scaling and teeth cleaning, as well as receiving professional care, have been shown to be important in preventing tooth loss.[17, 21]

Epidemiologic studies[22–25] have shown that risk factors for periodontal disease include smoking, use of interdental cleaning tools, alcohol abuse, regular dental exams, eating habits, and the number of times the teeth are brushed each day. Nursing care required for elderly patients can possibly affect these factors, making it necessary to adjust the medical insurance system for aged people. Kambara has reported the relationship of the number of MT with various factors such as the number of dentists, dental hygienists, and dental clinics.[6] Watt has also noted socio-economic factors that affect the number of teeth lost.[26, 27] Furthermore, Yoshino has reported that tooth loss tends to further progress when 20 or fewer teeth remain.[28]

Although many risk factors contribute to tooth loss, our research suggests that the long-term continued use of fluoride toothpaste has prophylactic effects on tooth loss. The prevention of tooth loss is the major outcome of the prevention of caries and periodontal disease. It is believed that we should be able to increase the 8020 target to 8028 within a few decades.

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