

# A Review of the Dental Caries Status of Ethnic Minority Children in China

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**Abstract** China has 55 ethnic minority groups comprised of 113 million persons, or 7.0 % of total population. Dental caries is a major health problem for children in China, and national oral health surveys currently report dental caries based on geographical location rather than by ethnic group. This study reviews the literature on dental caries in ethnic minority children in China. Publications were retrieved in Chinese and English from five electronic databases; thirty-eight studies from 1983 to 2012 met inclusion criteria and described 25 ethnic minority groups. Primary dentition median caries prevalence and experience were higher (51 % and dmft = 3.0, respectively) than permanent dentition caries prevalence and experience (39 % and DMFT = 0.8). Median caries prevalence was highest (80 %) for permanent dentition among aggregated ethnic minorities with population greater than 1 million. More work and research is needed to expand dental caries prevention and treatment measures for ethnic minority child populations in China.

**Keywords** Caries · Children · Ethnic · Minority · China

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## Introduction

China is the most populous country in the world with 1.4 billion people covering a land mass of 9.6 million square kilometers [1]. Its population includes a total of 56 ethnic groups with the clear majority being the Han ethnic group at 93 % of the Chinese population [1]. The populations of other ethnic minority groups vary from a few thousand to more than 16 million. These ethnic groups have diverse languages, religions and cultures (Table 1) and are widely scattered across the country (Fig. 1). Some live in the more developed eastern or central regions such as Manchu, but the majority live in the less developed mountainous inland or border districts in the western region [2]. The average per capita gross domestic product (GDP) in ethnic minority districts in 2010 was about US\$3500 [3], which was about 73 % of the national GDP (US\$4800) [4]. To reduce the adverse effects of this large population on the developing country, the central government implemented the one child policy in the 1970s to slow down the population growth. However, this one-child policy does not apply to ethnic minority groups. As a result, the population growth rate of the ethnic minorities in China has increased over the past two decades and reached 6.9 % in 2010 [1]. The ethnic minority population was approximately 113 million in 2010, which is greater than the population of any country in the European Union [1].

Race/ethnicity has been identified as a factor for oral health status. Many studies conducted overseas suggest that people from specific ethnic minorities often have poor oral health status and increased risk of dental decay [5, 6]. While socio-economic status is one of the most important factors in dental inequalities, underlying cultural beliefs and practices can influence oral health status through diet, dental care-seeking behavior, or the use of home remedies

**Table 1** Ethnic minorities in China by population, site, region and characteristics, arranged in order of descending population size

Ethnic group	Population estimate	Site (% of population)	Region	Characteristics
Zhuang	16,926,381	Guangxi (85) Yunnan (7)	Western	One of the aboriginal groups in southwestern China. Have own language and written characters
Hui	10,586,087	Ningxia (21) Gansu (12)	Western	Have the same origin as some tribes in central Asia. The majority are Muslim
Manchu	10,387,958	Liaoning (52) Hebei (22)	Eastern	Established during the Jin and Qing Dynasties. Have Manchu language and written characters
Uyгур	10,069,346	Xinjiang (99)	Western	Have the same origin as some tribes in central Asia. Have Uyгур language and written characters. The majority are Muslim
Miao	9,426,007	Guizhou (42) Hunan (22)	Western	One of the ancient ethnic minorities in southern China. Have own language. Mainly live by agriculture
Yi	8,714,393	Yunnan (58) Sichuan (33)	Western	One of the aboriginal groups in southwestern China. Have own language and written characters
Tujia	8,353,912	Hunan (32) Hubei (25)	Central	One of the ancient ethnic groups in China. Have Tujia language, but no written characters
Tibetan	6,282,187	Tibet (43) Sichuan (24)	Western	Aboriginals in northwestern China. They have their own language and written characters. Make a living by animal husbandry. Most of them are Buddhist
Mongol	5,981,840	Inner Mongolia (71) Liaoning (11)	Western	Mongolian origins. Mainly live by animal husbandry. Most of them are Buddhist
Buyei	2,870,034	Guizhou (87) Zhejiang (4)	Western	One of the aboriginal groups in southwestern China. Have Buyei language and written characters. Mainly supported by agriculture
Dong	2,879,974	Guizhou (50) Hunan (30)	Western	Their homeland is commonly called the “land of songs and poetry.” Sticky rice is one of the major crops
Yao	2,796,003	Guangxi (53) Hunan (26)	Western	One of the ancient ethnic groups. Have their own language. Mainly live by agriculture
Bai	1,933,510	Yunnan (81) Guizhou (9)	Western	Have Bai language and characters. Buddhist. Prefer sour, cold and spicy food
Korean	1,830,929	Jilin (59) Heilongjiang (18)	Central	Korean Chinese. Have their own language and characters
Hani	1,660,932	Yunnan (98)	Western	Mainly live in mountainous areas. Have their own language and characters
Hazak	1,462,588	Xinjiang (97)	Western	Have the same origin as the main ethnic group in Kazakhstan, central Asia
Li	1,463,064	Hainan (82) Guizhou (9)	Eastern	Have their own language. Customs similar to Zhuang, Buyei, Shui, Dong and Dai
Dai	1,261,311	Yunnan (97)	Western	Have the same origin as the main ethnic groups in Laos and Thailand, Southeast Asia
She	708,651	Fujian (52) Zhejiang (17)	Eastern	Have their language, but no written characters
Lisu	702,839	Yunnan (95)	Western	A transnational distributed ethnic group, e.g. Thailand, Myanmar and India. Have Lisu written and spoken language
Dongxiang	621,500	Gansu (88) Xinjiang (9)	Western	An integrated group of Mongol, Hui and Han. Have Dongxiang language, but no written characters. The majority are Muslim
Gelao	550,746	Guizhou (90)	Western	One of the ancient ethnic minorities in southwestern China. Have Gelao language, no written characters
Lahu	485,966	Yunnan (97)	Western	Have Lahu language, no written characters. They have the same origin as some of the ethnic groups in Thailand, Myanmar and Laos
Va	429,709	Yunnan (93)	Western	Va means “the people living on the top of the mountains.” They have the same origin as some tribes in Myanmar

**Table 1** continued

Ethnic group	Population estimate	Site (% of population)	Region	Characteristics
Shui	411,847	Guizhou (85)	Western	Have Shui language and written characters. Mainly live by agriculture
Naxi	326,295	Yunnan (95) Sichuan (3)	Western	Some live in a matrilineal society. They have their own Dongba religion and scripture
Qiang	309,576	Sichuan (96)	Western	Most live in hilly areas, have their own language and are mainly engaged in agriculture
Tu	289,565	Qinghai (71) Gansu (11)	Western	Mainly engaged in agriculture, supplemented with stock farming. Have Tu language and written characters. Most are Buddhist
Mulao	216,257	Guangxi (80) Guizhou (12)	Western	One of the aboriginal groups in southwestern China
Xibe	190,481	Liaoning (69) Xinjiang (18)	Eastern	Mainly live by hunting and fishing. Have Xibe language and written characters and are Buddhist
Kirgiz	186,708	Xinjiang (97)	Western	Have the same origin as most of the Kyrgyz people from central Asia. Most of them speak the Kirgiz language and are Muslim
Jinpo	147,828	Yunnan (97)	Western	Have the same origin as some of the ethnic groups in Myanmar
Daur	131,992	Inner Mongolia (58) Heilongjiang (31)	Western	Mainly live by fishing and animal husbandry, believe in Shaman. Have Daur language
Salar	130,607	Qinghai (82) Gansu (10)	Western	Have the same origin as some of the ethnic groups from central Asia. Have Salar language, no written characters. The majority are Muslim
Bulang	119,639	Yunnan (97)	Western	Have their own language but most speak Dai. The majority are Buddhist
Monan	101,192	Guangxi (65) Guizhou (27)	Western	Maonan language, no written characters
Tajik	51,069	Xinjiang (93)	Western	Have the same origin as the Tajikistan from central Asia. Have Tajik language, no written characters. Making a living mainly by animal husbandry
Pumi	42,861	Yunnan (98)	Western	Have Pumi language, no written characters. Some are Buddhist and the others believe in nature spirits
Achang	39,555	Yunnan (96)	Western	Have the same origin as some of the Myanmar
Nu	37,523	Yunnan (93)	Western	Have the same origin as some of the ethnic groups from Myanmar. Have own language, but no written characters
Erwenki	30,875	Inner Mongolia (84) Heilongjiang (9)	Western	Originated from Russia. Making a living by hunting
Jing	28,199	Guangxi (83) Guizhou (4)	Western	Have the same origin as some Vietnamese people. Mainly live by fishing and farming
Jino	23,143	Yunnan (98)	Western	The maternal uncle's authority is the most important in the family. Have Jino language, but no written characters
Deang	20,556	Yunnan(98)	Western	One of the oldest tribes living in the southwest frontier region. Have Deang language, no written characters. The majority are Buddhist
Bonan	20,074	Gansu (91)	Western	An integrated group of Mongol, Hui, Han, Tibetan and Tu people. Have Bonan language, no written characters. Most of them believe in Islam
Russ	15,393	Xinjiang (55) Inner Mongolia (30)	Western	They have the same origins as some ethnic minorities in Russia
Yugur	14,378	Gansu (90)	Western	Have two Yugur languages, no written characters. Mainly engaged in animal husbandry
Wuzibieke	10,569	Xinjiang (96)	Western	Originated from Uzbekistan, central Asia. Have own spoken and written language
Monba	10,561	Tibet (95)	Western	Have close historical and culture contacts with Tibetans. Have own language, but no written characters

**Table 1** continued

Ethnic group	Population estimate	Site (% of population)	Region	Characteristics
Oroqen	8,659	Heilongjiang (46) Inner Mongolia (42)	Central	Mainly live by hunting. Their language is very similar to the Evenki language
Derung	6,930	Yunnan (92)	Western	Live in an isolated canyon. Have Derung language, but no written characters
Hezhen	5,354	Heilongjiang (46) Inner Mongolia (42)	Central	Have Hezhe language. Mainly live by fishing
Gaoshan	4,009	Henan (19) Fujian (10)	Central	Most of the aboriginal people living in Taiwan
Lhoba	3,682	Tibet (95)	Western	Live mainly by hunting and gathering. Have Lhoba language, but no written characters

**Fig. 1** Provinces in China

[7], which are fundamental in framing appropriate oral health policies and the development of effective oral health services and oral health promotion activities [8].

General health care for children is always among the first priorities of national health policies, and oral health is an integral part of general health [9]. Poor dentition significantly affects children's nutrition, and consequently their growth, development and general health. Dental caries is a major health problem for children and has become a huge burden in China. Dental caries causes pain and

infection and advanced caries will progress into the tooth pulp and eventually form a dental abscess [10]. In the Philippines, the main reason for absence from school was dental caries [11] and an estimated 51,000,000 school hours were missed among children in the US in 2000 [12]. In China, three national oral health surveys were performed in 1983, 1995 and 2005 [13, 14]. Their findings indicate that although the prevalence of dental caries and caries experience among children in China has declined during the past two decades, dental caries is still a significant

health problem affecting many children [14]. The three national oral health surveys document the oral health of children geographically according to province, but ethnicity is not a routinely collected category.

Determining the oral health of children is important for planning and implementing services oriented toward meeting the needs of the population [15]. The oral health of children can also be used to predict adult oral health and oral health needs [16]. It is important to understand the dental caries status in a multicultural society with different social development to ensure effective delivery of interventions and optimal allocation of resources. A literature search found no reviews of this imperative issue in China. This paper reports a literature review of the studies on dental caries in ethnic minority children in China.

## Materials and Methods

### Search Strategy

To identify epidemiological studies on the ethnic minorities in China, a broad search of publications was conducted to include as many relevant publications as possible. The search was performed using a Chinese database (China Academic Journals Full-text Database) and two English electronic databases (PubMed, ISI Web of Science) between January 1980 and December 2012. Another two databases of Chinese theses (China Master's Theses Full-text Database, China Doctor Dissertations Full-text Database) from 1984 to 2012 were also included in the search (Fig. 2). The key words used for searching were (Chinese and English as appropriate) as follows: (dental caries OR caries OR decay) AND (ethnic minority OR ethnic groups) AND (China or Chinese) AND (child OR children OR adolescent OR student). If the publications contained the search thesaurus, they were selected to generate a list of potentially eligible studies to be included in this review.

### Study Selection

A manual search was carried out on the list of potentially eligible studies. The selected publications were screened by title and abstract. Duplicated reports or studies using the same data were excluded. Publications were included if they fulfilled the following inclusion criteria: (a) examining one or more ethnic minority groups; (b) assessing the primary teeth of children aged 3–6 years, or assessing the permanent teeth of children aged 11–14 years, and (c) reporting caries prevalence or caries experience. Caries prevalence in % reports the proportion of the population that is suffering from (untreated) dental decay; whereas

caries experience in number of teeth reports the proportion of the population that suffered (treated) or is suffering from dental decay. The caries experience of primary and permanent teeth are expressed in dmft and DMFT scores, respectively. The dmft and DMFT measure the sum of the number of decayed teeth (dt or DT), missing teeth due to decay (mt or MT) and filled teeth (ft or FT) in a child. Publications that reported the combined caries prevalence or combined mean caries experience DMFT and dmft scores or combined caries prevalence of primary and permanent dentition were excluded.

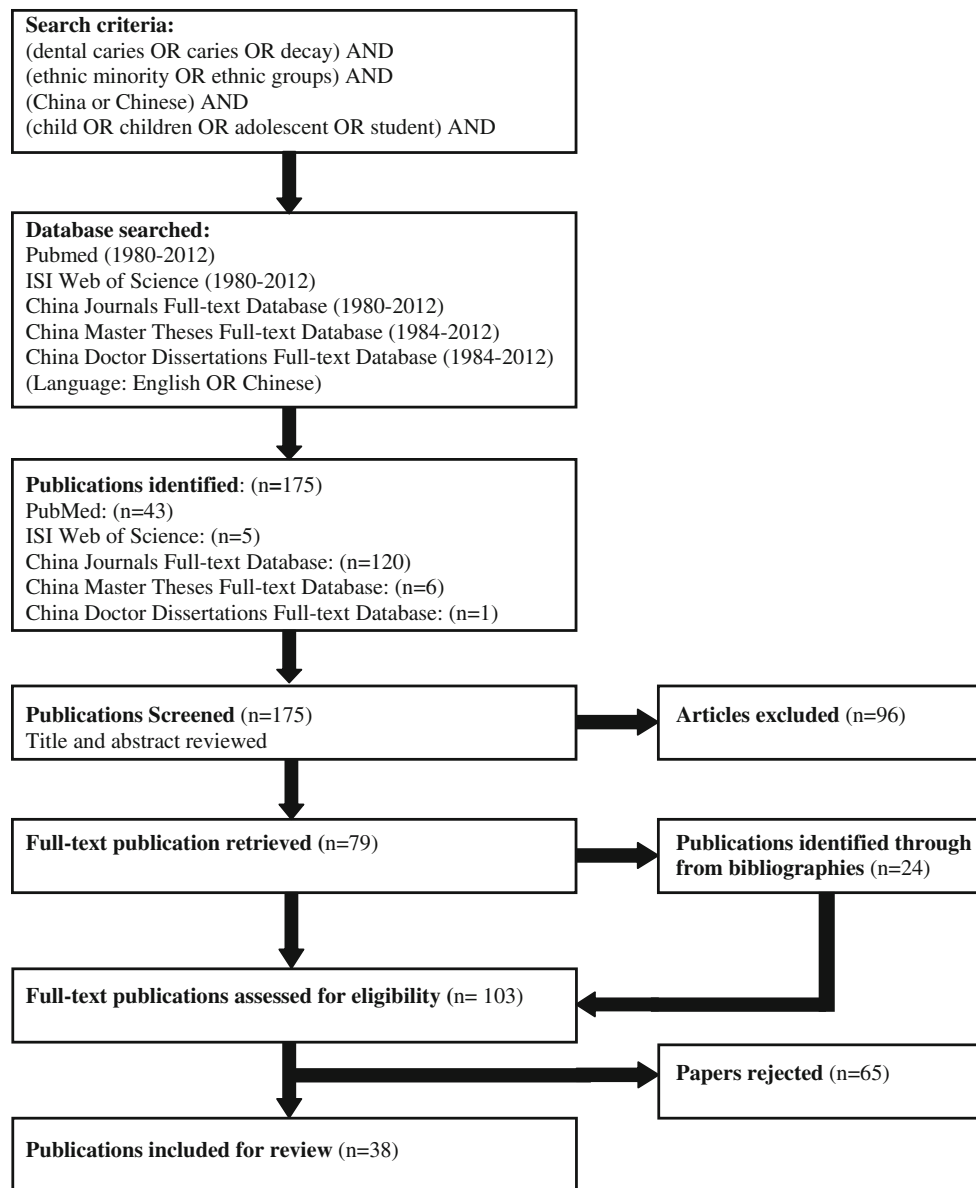
### Synthesis of Data

The full papers of the selected publications were obtained. The bibliographies of the publications deemed eligible were searched manually and additional relevant publications were included in the review. The results of these studies were grouped into two groups according to the age of the survey children: 3–6 years old for primary dentition and 11–14 years old for permanent dentition. A summary was made for each publication, according to (a) ethnic group, (b) investigators and year of publication, (c) survey site, (d) children's age range, (e) sample size, (f) sampling method, and (g) dental caries prevalence and experience.

## Results

The initial search identified 175 reports in the five databases (Fig. 2). Duplicate reports in different databases were not counted. Most of the selected publications were found in the China Journals Full-text Database ( $N = 120$ ) and PubMed ( $N = 43$ ). These 175 publications were screened manually by abstract and title. Seventeen studies were found to be duplications of another study and thus were excluded. Seventy-nine reports were found to be unrelated to reporting of dental caries status among children of ethnic minority groups in China and they were also excluded. Consequently, 79 publications were identified, and their full papers were obtained. A further 24 publications were identified from the bibliographies and were included in the review. However, 65 publications were excluded. The majority of the studies (52/65) were excluded because the age of the sample was not mentioned or the caries assessment was on mixed dentition, or not specific to primary or permanent dentition. Thirteen studies reported the caries status of at least two ethnic groups or the status of Han and other ethnic groups. Finally, 38 publications were included in this literature review.

All 38 publications were cross-sectional studies published between 1983 and 2012. Two studies were published in the 1980s, 15 in the 1990s and 21 from 2000 onward.



**Fig. 2** Flowchart of literature search and selection

These studies evaluated the dental caries status of children from 25 ethnic minorities. More than half (14/25) of the studies referred to ethnic groups with populations of more than 1 million. There were 20 ethnic groups among the 3- to 6-year-old children included in studies of primary dentition (Table 2). The median caries prevalence and caries experience in dmft for these children were 51 % and 3.0, respectively. There were 23 ethnic groups among the 11- to 14-year-old children included in studies of permanent dentition. The median caries prevalence and caries experience in DMFT for 11- to 14-year-old children were 39 % and 0.8. The findings according to ethnic group are summarized in Table 3 for primary dentition and in Table 4 for permanent dentition.

### Primary Dentition

The Korean children living in Jilin province in central China had the highest caries prevalence (94 %) in their primary teeth (Table 3), whereas Mongolian children living in Qinghai province in northwestern China had the lowest prevalence (11 %). The highest caries experience in primary teeth was found in Dongxiang children living in northwestern China (dmft = 7.5) and Bulang children living in southwestern China had the lowest caries experience (dmft = 0.1). Only one study reported decayed teeth (dt), missing teeth due to caries (mt) and filled teeth (ft) [33]. Six studies mentioned that most of the decayed teeth were left untreated [18, 19, 27, 28, 32, 33].

**Table 2** Caries status of 5- and 12-year-old minority children by ethnic group population

<i>Primary dentition—3–6-year-old children</i>			
Population of ethnic group	<1,000,000	≥1,000,000	All
No. of publications	14	22	36
No. of ethnic groups studied	7	13	20
Caries prevalence			
Median	66 %	39 %	51 %
Q1–Q3	24 %	32 %	34 %
Range	51–79 %	11–94 %	11–94 %
Caries experience—no. of tooth (dmft)			
Median	4.4	2.6	3.0
Q1–Q3	4.0	3.0	1.8
Range	2.4–7.5	0.3–4.7	0.3–7.5
<i>Permanent dentition—11–14-year-old children</i>			
Population of ethnic group	<1,000,000	≥1,000,000	All
No. of publications	13	21	34
No. of ethnic groups studied	10	13	23
Caries prevalence			
Median	41 %	80 %	39 %
Q1–Q3	22 %	27 %	26 %
Range	14–71 %	7–84 %	7–84 %
Caries experience—no. of tooth (DMFT)			
Median	0.9	0.8	0.8
Q1–Q3	0.9	0.7	0.8
Range	0.2–2.3	0.2–2.6	0.2–2.6

Three studies reported the dental caries experience according to gender [21, 22, 27]. None of them found significant gender difference [21, 22, 27]. Five surveys compared the dental caries status of ethnic minority children with that of Han children. Zhuang children living in western China had higher dmft scores than Han children (3.4 vs. 2.7) [33]. Their frequent bottle feeding habit with sugary products was attributed as one of the main reasons for the high caries prevalence. Higher caries prevalence was also found in Uygur children in northwestern China than in Han children (67 vs. 54 %) [31]. Three studies reported that Hui (33 vs. 95 %), Tibetan (46 vs. 81 %), Uygur (39 vs. 90 %) and Yi children (36 vs. 95 %) had a lower prevalence of dental caries than that of Han children [21, 26, 30].

#### Permanent Dentition

The highest caries prevalence in permanent teeth (84 %) was found among 11- to 14-year-old Tibetan children in Tibet province in northwestern China, whereas the lowest prevalence (7 %) was found in Tujia children in Hubei province in central China (Table 4). The highest caries experience in mean DMFT was 2.3 among the Naxi

children living in Yunnan province in southwestern China [44]. Bulang children in Yunnan province had the lowest caries experience, and their mean DMFT was 0.1 [20]. Two studies reported that girls had higher caries prevalence than boys in Dongxiang (26 vs. 18 %) and Kirgiz children (73 vs. 65 %) [35, 38]. One study found the caries prevalence and caries experience to be higher in Tibetan children than in Han children (44 vs. 24 %) [46]. Another study found that the caries prevalence of Dongxiang (41 %), Bonan (44 %) and Yugu children (46 %) living in northwestern China was higher than that of Han children (19 %) living in the same province [34].

#### Discussion

The national oral health surveys in China report dental caries according to geographic location. As the Han population dominates in majority of the provinces [4], reporting the caries status by province does not reflect the dental caries status of ethnic minorities in China. Dental caries is a multifactor disease and the possible roles of socio-economic and cultural factors have been highlighted [55]. The ethnic minority population in China is more than 110 million, thus it is essential to study dental caries according to ethnic group. This is the first article to review the literature on dental caries in ethnic minority children in China. The sources used in this review were thought to be exhaustive. They are regarded to be major databases that include the most prominent biomedical studies. The source used also contains supplemental information which published in non-medical journals. Databases in Chinese were also used in this review that include not only journal articles in Chinese but also most if not all of the master's and doctoral theses published by all dental schools and universities in China. The great majority of the studies on the caries status of children in China were assumed to be published in either Chinese or English.

This review shows that studies on the oral health of ethnic minority children in China are generally disorganized and sporadic. The total number of publications is small and covers less than half of the ethnic minority groups. There was no dental caries information on children from 30 ethnic minorities: Achang, Buyei, Daur, Deang, Derung, Dong, Erwenki, Gaoshan, Gelao, Hazak, Hezhen, Jing, Lhoba, Manchu, Monan, Monba, Mulao, Nu, Oroqen, Pumi, Qiang, Russ, Salar, She, Shui, Tajik, Tatar, Va, Wuzibieke and Xibe.

The caries status of children is a major indicator of oral health [56]. The World Health Organization (WHO) selected 5- and 12-year-old children as the indicator age groups for assessing the caries status of primary and permanent dentition in children [56]. This should help to



**Table 3** Caries status in primary dentition of ethnic minority children in China (minority groups are listed in alphabetical order)

Ethnic group	Authors, year	Province, area	Age	No.	Sampling method	Main findings
Bai	Lu et al. [17]	Yunnan, urban and rural areas	3–6	456	Not stated	Caries prevalence: 24 %
Bonan	Dong [18]	Gansu, not stated	5	100	Cluster	Caries prevalence: 78 % Mean dmft: 4.8
	Chen et al. [19]	Gansu, rural areas	5	110	Cluster	Caries prevalence: 56 % Mean dmft: 2.4
Bulang	Zhang et al. [20]	Yunnan, rural areas	6	122	Not stated	Mean dmft: 0.1
Dai	Lu et al. [17]	Yunnan, urban and rural areas	3–6	1,421	Not stated	Caries prevalence: 58 %
Dongxiang	Dong [18]	Gansu, not stated	5	100	Cluster	Caries prevalence: 79 % Mean dmft: 7.5
	Chen et al. [19]	Gansu, rural areas	5	102	Cluster	Caries prevalence: 76 % Mean dmft: 3.9
Hani	Zhang et al. [20]	Yunnan, rural areas	6	102	Not stated	Mean dmft: 0.4
	Lu et al. [17]	Yunnan, urban and rural areas	3–6	1,272	Not stated	Caries prevalence: 32 %
Hui	Lu et al. [17]	Yunnan, urban and rural areas	3–6	262	Not stated	Caries prevalence: 44 %
	Huang et al. [21]	Yunnan, urban and rural areas	3–6	237	Not stated	Caries prevalence: 33 % Mean dmft: 4.4
Jinpo	Lu et al. [17]	Yunnan, urban and rural areas	3–6	235	Not stated	Caries prevalence: 58 %
Korean	Fang et al. [22]	Jilin, not stated	5	408	Not stated	Caries prevalence: 94 % Mean dmft: 4.7
Li	Wu and He [23]	Hainan, urban areas	6	248	Not stated	Caries prevalence: 38 % Mean dmft: 3.1(1.2)
Lisu	Lu et al. [17]	Yunnan, urban and rural areas	3–6	799	Not stated	Caries prevalence: 51 %
Miao	Zhu [24]	Hunan, urban and rural areas	5	305	Random sample	Caries prevalence: 32 %
	Lu et al. [17]	Yunnan, urban and rural areas	3–6	490	Not stated	Caries prevalence: 22 %
Mongol	Luo [25]	Qinghai, rural areas	6	183	Cluster	Caries prevalence: 11 % Mean dmft: 0.3
Naxi	Lu et al. [17]	Yunnan, urban and rural areas	3–6	864	Not stated	Caries prevalence: 51 %
Tibetan	Wen and Zhou [26]	Qinghai, not stated	3–5	166	Not stated	Caries prevalence: 34 % Mean dmft: 1.0
	Chen [27]	Qinghai, rural areas	3–6	252	Cluster	Caries prevalence: 77 % Mean dmft: 2.8
	Ma et al. [28]	Gansu, urban and rural areas	5–6	421	Multistage	Caries prevalence: 77 % Mean dmft: 4.0
Tujia	Liu [29]	Hubei, rural areas	6	339	Random	Mean dmft: 2.6
Uygur	Ayiguli and Asiya [30]	Xinjiang, urban areas	3–6	215	Not stated	Caries prevalence: 64 %
	Nurbiye et al. [31]	Xinjiang, urban areas	3–5	180	Random	Caries prevalence: 67 % Mean dmft: 2.3
Yi	Li [32]	Sichuan, rural areas	6	265	Multistage	Caries prevalence: 40 % Mean dmft: 1.1
	Lu et al. [17]	Yunnan, urban and rural areas	3–6	601	Not stated	Caries prevalence: 40 %
	Huang et al. [21]	Yunnan, urban and rural areas	3–6	348	Not stated	Caries prevalence: 36 % Mean dmft: 4.1
Yugur	Dong [18]	Gansu, not stated	5	100	Cluster	Caries prevalence: 66 % Mean dmft: 3.4
	Chen et al. [19]	Gansu, rural areas	5	148	Cluster	Caries prevalence: 67 % Mean dmft: 3.2
Zhuang	Zeng et al. [33]	Guangx, urban and rural areas	3–5	470	Multistage	Caries prevalence: 62 % Mean dmft: 3.4
	Lu et al. [17]	Yunnan, urban and rural areas	3–6	1,296	Not stated	Caries prevalence: 31 %



**Table 4** Caries status in permanent dentition of ethnic minority children in China (minority groups are listed in alphabetical order)

Ethnic group	Authors, year	Province, areas	Age	No.	Sampling method	Main findings
Bonan	Dong [18]	Gansu, not stated	12	100	Cluster	Caries prevalence: 34 % Mean DMFT: 0.7
	Zhou et al. [34]	Gansu, not stated	12	140	Random	Caries prevalence: 44 % Mean DMFT: 0.9
Bulang	Zhang et al. [20]	Yunnan, rural areas	11–12	216	Not stated	Caries prevalence: Not stated Mean DMFT: 0.1
Dai	Zhang et al. [20]	Yunnan, rural areas	11–12	173	Not stated	Caries prevalence: Not stated Mean DMFT: 0.6
Dongxiang	Li and Lian [35]	Gansu, rural areas	12	199	Cluster	Caries prevalence: 19 % Mean DMFT: 0.3
	Dong [18]	Gansu, not stated	12	100	Cluster	Caries prevalence: 28 % Mean DMFT: 0.5
	Zhou et al. [34]	Gansu, not stated	12	153	Random	Caries prevalence: 41 % Mean DMFT: 0.9
Hani	Zhang et al. [20]	Yunnan, rural areas	11–12	203	Not stated	Caries prevalence: Not stated Mean DMFT: 0.7
Hui	Xu [36]	Ningxia, not stated	12–14	182	Cluster	Caries prevalence: Not stated Caries prevalence: 18 %
Jino	Zhang and Li [37]	Yunnan, not stated	12	141	Not stated	Caries prevalence: Not stated Mean DMFT: 0.9
Kirgiz	Xuehereti et al. [38]	Xinjiang, urban and rural areas	12	200	Cluster	Caries prevalence: 41 % Mean DMFT: 0.7
Korean	Liu [39]	Jilin, urban areas	12	398	Convenient	Caries prevalence: 63 % Mean DMFT: 1.9
Lahu	Zhang and Li [37]	Yunnan, not stated	12	147	Not stated	Caries prevalence: Not stated Mean DMFT: 2.2
Li	Zhang and Chen [40]	Hainan, rural areas	12	317	Cluster	Caries prevalence: 19 % Mean DMFT: 0.4
	Wu and He [23]	Hainan, urban areas	11–12	395	Not stated	Caries prevalence: 23 % Mean DMFT: 0.7
Lisu	Wang and Chen 1993[41]	Yunnan, rural areas	14	113	Not stated	Caries prevalence: 55 % Mean DMFT: 1.7
Miao	Zhu [24]	Hunan, urban and rural areas	12	240	Random	Caries prevalence: 16 % Mean DMFT: Not stated
Mongol	Su et al. [42]	Inner Mongolia, not stated	11–12	194	Not stated	Caries prevalence: 19 % Mean DMFT: 0.2
	Luo et al. [25]	Qinghai, rural areas	12	152	Cluster	Caries prevalence: 32 % Mean DMFT: 1.8
Naxi	Luo and Yang [43]	Yunnan, rural areas	12–14	278	Not stated	Caries prevalence: 53 % Mean DMFT: 1.4
	Liu et al. [44]	Yunnan, rural areas	12	134	Cluster	Caries prevalence: 71 % Mean DMFT: 2.3
Tibetan	Xue et al. [45]	Tibet, rural areas	12	189	Not stated	Caries prevalence: 84 % Mean DMFT: Not stated
	Lo et al. [46]	Tibet, rural areas	11–13	207	Cluster	Caries prevalence: 44 % Mean DMFT: 0.8
	Gao et al. [47]	Tibet, not stated	12–14	200	Not stated	Caries prevalence: 48 % Mean DMFT: Not stated

**Table 4** continued

Ethnic group	Authors, year	Province, areas	Age	No.	Sampling method	Main findings
Tu	Liao et al. [48]	Qinghai, urban and rural areas	11–12	220	Not stated	Caries prevalence: 39 % Mean DMFT: 0.8
Tujia	Li et al. [49]	Hubei, urban and rural areas	12	349	Not stated	Caries prevalence: 7 % Mean DMFT: Not stated
	Liu [29]	Hubei, rural areas	12	229	Cluster	Caries prevalence: Not stated Mean DMFT: 1.3
	Lin [50]	Chongqing, urban and rural areas	12	289	Cluster	Caries prevalence: 27 % Mean DMFT: Not stated
Uygur	Fen and Liu [51]	Xinjiang, not stated	12	235	Not stated	Caries prevalence: 44 % Mean DMFT: 0.8
	Di et al. [52]	Xinjiang, urban areas	11–12	227	Not stated	Caries prevalence: 48 % Mean DMFT: 0.9
Yao	Zhang and Li [37]	Yunnan, not stated	11–12	132	Not stated	Caries prevalence: Not stated Mean DMFT: 2.6
Yi	Li [32]	Sichuan, rural areas	12	230	Multistage	Caries prevalence: 36 % Mean DMFT: 0.8
	Fu et al. [53]	Yunnan, rural areas	11–13	124	Not stated	Caries prevalence: 39 % Mean DMFT: 0.6
Yugur	Dong [18]	Gansu, not stated	12	100	Cluster	Caries prevalence: 14 % Mean DMFT: 0.5
	Zhou et al. [34]	Gansu, not stated	12	155	Random	Caries prevalence: 46 % Mean DMFT: 1.1
Zhuang	Huang [54]	Guangxi, urban and rural areas	12	392	Cluster	Caries prevalence: 26 % Mean DMFT: 0.5

standardize the data collected and allows comparison of the dental caries status of primary and permanent dentition between studies. However, more than half of the publications identified did not follow the recommendation. Many studies reported the combined caries status of primary and permanent dentition and hence could not be included in the review. This study included surveys reporting the dental caries status of children aged 3–6 for primary teeth, with the aim of including more publications in the literature search. Children younger than 3 were not included as their teeth might not have erupted. Children older than 6 were not included because their primary teeth might have exfoliated and were not available for assessment. An extended age range of 11–14 years old was adopted for searching the caries status of permanent dentition. Children younger than 11 would probably be in the mixed dentition stage and by 14 the second molar should have erupted for assessment. Some surveys collectively reported the caries status of children of more than one ethnic group, perhaps due to small sample sizes. The results of these studies were not included in the review.

The majority of the studies (34/38) basically used the dental caries diagnosis criteria recommended by WHO. However, many studies (23/38) did not provide details of

the sampling methods and none reported the sample size estimation, which is essential for making inferences about the studied population. In addition, most publications (34/38) did not mention the training and calibration of the examiners, the number of examiners and the agreement between their dental caries assessments. Therefore, the validity and reliability of examiners in diagnosing the dental caries could be problematic. Only two studies duplicated the examinations and reported the inter-examiner agreement [33, 46]. It is essential to develop a standardized survey method to ensure the repeatability, comparability and validity of the results obtained by different studies. The training and calibration of examiners is important to achieve good validity and reproducibility.

Few studies were performed on children of ethnic minorities with populations of less than 1 million. However, the prevalence and experience of caries was higher in these ethnic groups. For example, the caries prevalence of Dongxiang children was 79 % [18] and Naxi was 71 % [44]. The caries status of primary and permanent dentition varied substantially between ethnic groups in the same region [18, 19]. One study reported that children of an ethnic group living in isolated areas had little decay [57].

The study found 75 % of the 5-year-olds Lahu children and 85 % of the 12-year-olds had no caries experience.

No consistent conclusions could be drawn from studies comparing the dental caries status of the ethnic minority groups and Han children. Only one study conducted a multifactorial analysis and found that the caries experience of children was associated with bottle feeding in babyhood and ethnicity [33]. Future studies should examine the relationship between dental caries status and potential risk factors such as language barriers, religion, oral health beliefs etc. Most studies found no significant difference between the dental caries status of boys and girls in primary dentition. This finding is similar to those of the second and third national surveys [13, 14]. A higher prevalence of caries in the permanent dentition of children was found in girls. This finding also concurs with that of the national surveys and most local surveys on Han children. Moreover, it is known that green tea, white tea, black tea, pu-er tea, oolong tea etc. are largely consumed by adults in China. Many different types of tea contain substantial amount of fluoride but its consumption by children is unknown. Further studies should be carried out to investigate the drinking of tea by children and its effect on dental caries.

In general, studies conducted after 2000 reported a higher caries experience in ethnic minority children than the figure reported by the national oral health survey. This is consistent with the increased consumption of sugar and inadequate exposure to professional fluoride application [58]. Basic dental hygiene education such as twice daily tooth brushing and use of fluoride toothpaste, toothbrushes and floss are very important in ethnic minority children. The children should have access to these items, and should be educated in schools or at home. This prevention is one of the most important steps especially in low resource areas that cannot support municipal fluoridation and qualified dentists. The caries experiences in the primary dentition of ethnic minority children reported in the 1990s were all lower than those of the second national oral health survey in 1995. Nevertheless, some studies published after 2000 reported a higher caries experience in ethnic minority children than in Han children [18, 19, 21, 22, 28]. Two studies conducted in the 1990s reported the caries experience of permanent teeth in Yao, Lisu and Lahu children was higher than that reported in the second national survey [20, 37]. Several studies [18, 23, 34, 38, 39] reported the caries experience of permanent teeth in Bonan, Dongxiang, Krigiz, Korean, Li, Naxi and Yugur children was higher than that reported in the third national oral health survey in 2005 [14]. The oral health promotion program and school-based dental sealant placement program target large cities or affluent areas in China [59]. There are no organized caries prevention programs for children living in rural areas

in China [60]. The ethnic minority children have limited access to dental care services and resources because most of them, particularly those with low populations, live in isolated rural areas.

Only one study [33] reported the percentage of untreated decayed teeth (dt), although many studies commented that most decayed teeth were left untreated [18, 23, 34, 38, 39, 42, 44]. The dentist to population ratio has been reported to be around 1:100,000 [61]. The great shortage of dentists in China, especially in rural areas, is likely to be one of the main reasons for the lack of treatment. Treating the massive amount of caries in children in these areas is challenging. The cost of conventional dental treatment and the shortage of dental health care workers make it difficult to manage caries in children [61]. Treatment that slows down or ceases caries progression is a pragmatic way of minimizing children's discomfort and problems due to caries. The provincial governments should perform epidemiological surveys to identify communities with higher caries prevalence and allocate resources to prevent and control dental caries among children. Reporting the oral health of people in mainland China according to their ethnic minority group in future national oral health surveys would also be helpful. This information would help to identify and address the unique oral health needs of culturally diverse children. The government and professional societies should also attract dentists to work in areas where ethnic minorities live. Dental training should be provided so that simple dental treatments such as topical fluoride applications and atraumatic restorative treatment can be performed to control caries among children. In the long term, oral health promotion strategies including water fluoridation should be considered to promote the quality of oral health among these children.

## Conclusions

There are 55 ethnic minorities with a total population of more than 110 million living in predominantly rural areas of China. Dental caries is the one of the major health problems for children and has become a huge burden in China. The past three national surveys reported dental diseases based on geographical location but not ethnic group. Ethnicity is likely to be an important factor in dental caries. Various ethnic groups have different cultures and life styles, which can be important confounding factors affecting the distribution of dental caries among children. An epidemiological survey based on ethnic groups is crucial for planning, implementing and monitoring community programs to improve the oral health of children in China. Although oral health surveys have been conducted on 25 of the minority groups, the survey methods of these studies

were not standardized, thus comparison between studies is difficult. More studies with appropriate design should be carried out to identify high risk groups for early intervention.

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