Oral health status of Lisu 12-year-old children in the Yunnan province of China: a cross-sectional study

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Abstract

Background

Lisu is an ethnic minority group living in Yunnan, a province in Southwest China. This study investigated the oral health status among 12-year-old Lisu children in Yunnan.

Method:

A multistage sampling method was adopted to recruit 12-year-old Lisu children from primary schools. A self-administrated questionnaire was distributed to the children to collect their sociodemographic background information and oral health-related behaviours. Two calibrated dentists performed the oral examinations in the primary schools. They examined dental caries, gingivitis and dental fluorosis using the diagnosis criteria recommended by the World Health Organization. A Chi-square test, the Mann-Whitney U test, zero-inflated negative binomial (ZINB) regression and multivariate logistic regression were used for statistical analysis.

Results

A total of 512 Lisu children were invited, and 482 children (48% boys) participated in the study (response rate: 94%). The caries prevalence was 35% and caries experience in mean (SD) DMFT scores was 0.63 (0.10). The mean (SD) DT score was 0.60 (1.10), consisting 95% of the mean DMFT scores. Gingivitis was found on 426 children (88%), while no dental fluorosis was observed. Results of ZINB model indicated sex and sugary-snacking habits were related to the dental caries experience (p < 0.05). The prevalence rate of gingivitis was associated with the mother's education level, the child's monthly-pocket money and daily toothbrushing frequency (p < 0.05).

Conclusion

Dental caries and gingivitis were prevalent among 12-year-old Lisu children in the Yunnan province in China, and most of the decayed teeth were unrestored. Dental fluorosis was not observed in the children.

Introduction

China is a vast country with 1.4 billion people, which consists of 56 ethnic groups [1]. The dominant ethnic group is Han which composes 92% of the population, as reported by the latest census [2]. The other 55 non-Han groups are regarded as ethnic minorities with a total population of more than 110 million people [3]. Ethnic minorities mainly reside in the west and the northeast part of China, particularly in underdeveloped and mountainous areas [4]. Yunnan is a southwest province of China that
borders Vietnam, Laos and Myanmar on the west. There are 25 ethnic minorities residing in Yunnan, one of which is the Lisu ethnic minority [5].

The Lisu people are a Tibeto-Burman ethnic group living in Myanmar, southwest China, Thailand and the Indian state of Arunachal Pradesh. It is estimated that there are 1.5 million Lisu people around the world. Nearly half of them (0.7 million) live in China, ranking as the 20th largest ethnic minority group in that country [6]. According to the fifth census, 96% of the Lisu ethnic minority in China lived in Yunnan, mainly in the mountainous areas along the border of Myanmar [7]. This population remained underdeveloped. In 2018, the disposable income per capita of Lisu people was reported to be 6,476 Chinese yuen (~ US$ 913) [8], an amount much lower than that of the national average (~ US$ 4,165) [9]. Besides, the Lisu people still believe the spiritual power and practice of animal sacrifices to pray for the relief of pain or suffering.

In recent years, the Chinese government has actively invested in Lisu’s infrastructure, agriculture, education and health services to support its community development. Oral health service is also an important part of health services. Before planning and implementing a beneficial oral health services scheme for Lisu people, it is necessary to understand their current oral health status. Recommended by World Health Organization (WHO), 12-year-old children are the index age group for monitoring oral health status [10]. At the age of 12, all permanent teeth except the third molar have been erupted. Thus, the oral health status information of 12-year-old Lisu children can be used not only to compare with the oral health situation of the same age group in other countries, but also to help dental researchers and local government design dental services for school children.

China has been conducting national oral health surveys every 10 years and the latest survey was conducted in 2015. The results indicated that more than one fourth of the 12-year-old Chinese children had dental caries experience, more than a half of them had gingivitis and 13% of the children were diagnosed as dental fluorosis [11–13]. Children who have dental caries may experience discomfort or pain, and their school performance and quality of life may also be affected [14]. Gingivitis, an inflammation of the gums or gingiva, can progress to periodontitis which can eventually lead to tooth loss [15]. Dental fluorosis is caused by the ingestion of excessive fluoride during the formation of the enamel. Teeth that have moderate to severe fluorosis are subject to attrition and the general form of the teeth may be affected [16]. However, the national survey was conducted based on provinces (geographical administration region) instead of ethnicity. There is no data about the 12-year-old Lisu children's oral health status until now. The present study aims to investigate the oral health status among the 12-year-old Lisu children in Yunnan. The status of dental caries, gingivitis and dental fluorosis were assessed. The secondary outcome of this study was the status of dental erosion and tetracycline stained teeth.

Method
This cross-sectional study was conducted in 2016 with the support from the Education Bureau of Yunnan Province. Ethical approval was obtained from the Kunming Medical University Institutional Review Board. Invitation letters were sent to legal guardians and written consents were collected. The report of this study follows the Statement of Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) (Additional file 1) [17].

**Sample size calculation and sample selection**

The sample size calculation was based on the prevalence of dental caries, the most common oral disease. According to a previous study on dental caries of 14-year-old Lisu children, the caries prevalence rate for 12-year-old Lisu children was estimated to be 50% [18]. With the confidence level of 95% and the confidence interval of 5% (confidence interval: 50 to 60%), sample size was calculated to be 383. Estimating a response rate of 80%, at least 479 children needed to be invited in the study.

This study adopted a multistage cluster sampling method. Yunnan has eight cities and eight autonomous prefectures. Most of the Lisu population resides in the western region, which includes three cities (Baoshan City, Lijiang City and Lincang City) and five autonomous prefectures (Chuxiong Yi Autonomous Prefecture, Dali Bai Autonomous Prefecture, Dehong Dai and Jingpo Autonomous Prefecture, Diqing Tibetan Autonomous Prefecture and Nujiang Lisu Autonomous Prefecture). Only a few Lisu are scattered in the eastern region, which consists of five cities and three autonomous prefectures. The distribution ratio of the Lisu population in the western region and eastern region was 8:1 [19]. Accordingly, the ratio of children invited from these two regions was determined. At least 426 children should be invited from the western region and 53 should be invited from the eastern region. Lists of primary schools in western and eastern regions were obtained and the schools were numbered sequentially. Then, schools were selected by a simple random sampling method with a list of random numbers generated by a computer. All 12-year-old Lisu children in the selected schools were invited until the number of invitations in that region was fulfilled. The inclusion criteria were 12-year-old Lisu children who were generally healthy and had parental consents. Children who were on long-term medications were excluded.

**Questionnaire survey**

Self-administrated questionnaires were distributed to the study children and collected with parental consents one day before the oral examination. A research assistant checked the responses and followed-up for missing data by phone. The questionnaire was adapted from one used in a previous epidemiological study [19]. It consisted of two parts as follows:

1. Child’s sociodemographic background information: sex, parental education levels and child’s monthly-pocket money; and
2. Child’s oral health-related behaviours: toothbrushing frequency (daily), sugary snacking habit, sour food snacking habit and dental attendance experience.
**Oral examination**

Two calibrated dentists (Y.L and S.Z) conducted the oral examination in the primary schools with the aid of Community Periodontal Index (CPI) probes, dental mirrors and light-emitting diode headlights for intra-oral illumination. S.Z is an experienced dental epidemiologist. Y.L was calibrated with S.Z in the same setting before the study commenced. On the examination day, children were required to brush their teeth before the oral examination.

The diagnosis criteria of dental caries followed WHO recommendations. Dental caries experience was measured by the decayed, missing and filled teeth (DMFT) index. If a tooth had an unmistakable cavity, undermined enamel or detectable softened floor or wall, it was recorded as a decayed tooth (DT). If a tooth was extracted due to dental caries, it was recorded as a missing tooth (MT). If a tooth was permanently filled without dental caries, it was recorded as a filled tooth (FT). The diagnosis of gingivitis was determined by the presence of gingival bleeding on probing. All teeth were examined by gently inserting the tip of the CPI probe between gingiva and the tooth [10]. Dean's index criteria were used to assess dental fluorosis as recommended by WHO [20]. Enamel surface that had white flecks, occasional spots, paper-white areas or brown staining was regarded as dental fluorosis [20]. Basic Erosive Wear Examination (BEWE) criteria were adopted in this study to assess the status of dental erosion [21]. All tooth surfaces in six sextants (17 – 14, 13–23, 24–27, 37 – 34, 33–43 and 44–47) were screened and the most severely affected tooth surface in each sextant were scored. The scoring consists of four levels: (0) no loss of the tooth surface, (1) initial loss of enamel texture, (2) distinct defect with hard tissue less than 50% of the tooth surface area, and (3) hard tissue loss of more than 50% of the tooth surface area. The cumulative scores of all six sextants were calculated to assess the patient's risk level. There were four risk levels including none (BEWE score ≤ 2), low (BEWE score = 3 to 8), medium (BEWE score = 9 to 13) and high (BEWE score ≥ 14). Tetracycline-stained teeth were diagnosed by assessing the tetracycline discoloration of the tooth's crown in the daylight [22]. A 10% random sample of the children were selected to assess the inter- and intra-examiner agreements on the same day.

**Data analysis**

Data were analyzed by IBM SPSS version 25.0 (IBM Corp., NY, USA) and SAS® OnDemand for Academics (SAS Inst., NC, USA). A Chi-square test was conducted to test the association between independent variables and the prevalence of oral conditions (dental caries and gingivitis). The Mann–Whitney U test was performed to analyze the distribution of DMFT scores according to different independent variables. Independent variables with p-value less than 0.1 in the univariate analysis were studied as effect modifiers in the regression models. This study considered the zero-inflated negative binomial regression model (ZINB) to study the relationships between the DMFT scores and effect modifiers [19]. The Vuong’s test was employed to test the model fit. A multivariate logistic regression model was considered to study the relationship between the prevalence of gingivitis and the effect modifiers. Insignificant effect modifiers were removed from the models by backward stepwise selection until all remaining effect modifiers had a p-value less than 0.05.
Result

This study invited 512 12-year-old Lisu children from nine primary schools to participate, and 482 children (48% boys) were successfully recruited. All invited schools agreed to participate. Thirty invited children were absent from their respective schools and did not return the parental consent forms. Thus, the response rate was 94%. Among the participating schools, seven were from the western region and two from the eastern region. The ratio of recruited children in the western region and the eastern region was 8:1 (430:52). The intra- and inter-examiners reliability were excellent with the intraclass correlation above 0.90 for the assessment of dental caries, gingivitis, tetracycline-stained teeth and dental fluorosis. The children's background information and their oral health-related behaviours are presented in Table 1.
Table 1
Socio-demographic background and oral health-related behaviours of the study Lisu children (N = 482).

| Variables                          | DMFT > 0 (%) | p-value     | Gingivitis (%) | p-value     |
|------------------------------------|--------------|-------------|----------------|-------------|
| **Socio-demographic background**   |              |             |                |             |
| Sex                                | 27%          | < 0.001*    | 88%            | 0.791       |
| Boy (233)                          | 42%          |             | 89%            |             |
| Girl (249)                         |              |             |                |             |
| Father's education level           |              |             |                |             |
| Primary school level, ≤ 6 years    | 33%          | 0.345       | 92%            | 0.003*      |
| Secondary school level or above, > | 37%          |             | 83%            |             |
| 6 years                            |              |             |                |             |
| Mother's education level           |              |             |                |             |
| Primary school level, ≤ 6 years    | 33%          | 0.361       | 93%            | < 0.001*    |
| Secondary school level or above, > | 37%          |             | 82%            |             |
| 6 years                            |              |             |                |             |
| Monthly pocket money               |              |             |                |             |
| Less than 50RMB (~ US$ 7)          | 32%          | 0.120       | 94%            | < 0.001*    |
| (325)                              | 39%          |             | 77%            |             |
| More than 50RMB (~ US$ 7)          |              |             |                |             |
| (157)                              |              |             |                |             |
| **Oral health-related behaviours** |              |             |                |             |
### Variables

| DMFT > 0 (%) | p-value | Gingivitis (%) | p-value |
|--------------|---------|----------------|---------|
| Toothbrushing frequency (daily) | | | |
| Less than twice (315) | 34% | 0.667 | 93% | < 0.001* |
| Twice or above (167) | 36% | | 80% | |
| Sugary snacking habits | | | |
| No (335) | 33% | 0.142 | 90% | 0.129 |
| Yes (147) | 40% | | 85% | |
| Sour food snacking habits | | | |
| No (360) | 33% | 0.298 | 90% | 0.057 |
| Yes (122) | 39% | | 84% | |

### Oral health status

Among the study children, 167 (34.6%) had dental caries experience. The girls had a higher dental caries prevalence rate than boys (42% vs. 27%, p < 0.001). The mean (standard deviation [SD]) DMFT score was calculated to be 0.63 (1.10). The majority (95.2%) of the mean DMFT score consisted of unrestored cavities with the mean DT score of 0.60 (SD:1.10). The mean (SD) MT score was 0.02 (0.13), and the mean (SD) FT score was 0.01 (0.16). Dental caries prevalence rates according to different tooth locations are presented in Fig. 1. First molars had the highest dental caries prevalence rate (58.8%), while canines were the least affected ones (0.4%). The prevalence rate for all incisors and premolars were lower than 10%.

For gingivitis, 426 children (88.4%) had gingival bleeding by probing. No significant difference was found between boys and girls regarding the prevalence of gingivitis (Table 1). The prevalence rates of gingivitis according to different tooth locations are presented in Fig. 2. First molars presented the highest prevalence rate of gingivitis (65.3%) and canines had the lowest prevalence rate (24.3%). However, unlike that of dental caries, all four lower incisors presented high prevalence rates, meaning over 30%. This study found no relationship between gingivitis and dental caries (p = 0.438). None of the study children had dental fluorosis.

There were 53 children who were not cooperative during the dental erosion status assessment. Therefore, dental erosion was assessed for 429 children. All study children had dental erosion, but none of them had severe erosion (BEWE score = 3). Twenty-three children (5.4%) had at least one sextant that had distinct
defect of the tooth surface (BEWE score = 2), and 428 children (99.8%) had at least one sextant with an initial loss of enamel surface texture (BEWE score = 1). The cumulative scores of all sextants ranged from 2 to 12. Only one child had no risk with the cumulative BEWE score equaled to two. Almost all children (n = 425, 99%) had low risk with the cumulative BEWE score between three and eight, while three were at medium risk with the score between 9 and 12. The mean (SD) of the cumulative BEWE score was calculated to be 6.1 (0.5) and no significant difference was found between boys and girls (p = 0.965) (Table 2). No other independent variables were found to be related to the mean cumulative BEWE scores. Almost all of the study children did not have tetracycline-stained teeth (99.3%). The three children (0.7%) who had tetracycline-stained teeth were all from the western region but in different cities/autonomous prefectures.
Table 2
Mean cumulative BEWE scores according to independent variables (N = 429).

| Variables                                      | Mean (SD) cumulative BEWE score | p-value |
|------------------------------------------------|---------------------------------|---------|
| Socio-demographic background                   |                                 |         |
| Sex                                            |                                 |         |
| Boy (204)                                      | 6.1 (0.5)                       | 0.965   |
| Girl (225)                                     | 6.1 (0.5)                       |         |
| Father's education level                       |                                 |         |
| Primary school level, ≤ 6 years (249)          | 6.1 (0.5)                       | 0.056   |
| Secondary school level or above, > 6 years (180) | 6.0 (0.4)                       |         |
| Mother's education level                       |                                 |         |
| Primary school level, ≤ 6 years (267)          | 6.1 (0.4)                       | 0.400   |
| Secondary school level or above, > 6 years (162) | 6.0 (0.6)                       |         |
| Monthly pocket money                           |                                 |         |
| Less than 50RMB (~ US$ 7) (311)                 | 6.1 (0.6)                       | 0.395   |
| More than 50RMB (~ US$ 7) (118)                | 6.0 (0.2)                       |         |
| Oral health-related behaviours                 |                                 |         |
| Toothbrushing frequency (daily)                | 6.1 (0.5)                       | 0.208   |
| Twice or less (293)                            | 6.1 (0.4)                       |         |
| More than twice (136)                          |                                 |         |
| Sugary snacking habits                         | 6.1 (0.4)                       | 0.832   |
| No (309)                                       | 6.1 (0.7)                       |         |
| Yes (120)                                      |                                 |         |
| Sour food snacking habits                      | 6.1 (0.5)                       | 0.744   |
| Less than once (327)                           | 6.1 (0.3)                       |         |
| Once or above (102)                            |                                 |         |
Oral health-related behaviours and risk factors for oral conditions

All questionnaires were returned, and missing data followed-up. A considerable number (35%) of the study children reported that they brushed their teeth less than twice daily. There were 70% of study children indicated they ate sugary snacks every day, and 74% stated they had sour food snacks daily. These children were considered to have sugary snacking habits, and sour food snacking habits. Besides, nearly half of the study children (48%) had never visited a dentist.

In the Chi-square test of independent variables and the prevalence of dental caries, only sex had a p-value less than 0.10. In the Mann-Whitney U test of independent variables and the mean rank of the median DMFT scores, sex and sugary snacking habits were found to have a p-value less than 0.10 (Table 3). These mentioned independent variables were studied as effect modifiers in the ZINB model. The results of the Youg test showed that the ZINB model is the best-fit model when compared to other count models (p < 0.05). In the final model, girls were found to have less chance to have no dental caries when compared to boys (Odds ratio [OR] = 0.35, p = 0.012). In the negative binomial portion of the model, children who had a sugary snacking habit presented higher DMFT scores compared to those who did not (Incidence risk ratio [IRR] = 1.55, p = 0.005).
Table 3
Mean rank of median DMFT scores and independent variables (N = 482).

| Variables                                    | Rank of median DMFT score | p-value |
|----------------------------------------------|---------------------------|---------|
| **Socio-demographic background**             |                           |         |
| Sex                                          |                           |         |
| Boy (233)                                    | 223                       | 0.001*  |
| Girl (249)                                   | 257                       |         |
| Father’s education level                     |                           |         |
| Primary school level, ≤ 6 years (271)        | 239                       | 0.553   |
| Secondary school level or above, > 6 years (211) | 245                       |         |
| Mother’s education level                     |                           |         |
| Primary school level, ≤ 6 years (282)        | 237                       | 0.336   |
| Secondary school level or above, > 6 years (200) | 248                       |         |
| Monthly pocket money                         |                           |         |
| Less than 50RMB (~ US$ 7) (325)              | 237                       | 0.180   |
| More than 50RMB (~ US$ 7) (157)              | 252                       |         |
| **Oral health-related behaviours**           |                           |         |
| Toothbrushing frequency (daily)              |                           |         |
| Less than twice (315)                        | 240                       | 0.662   |
| Twice or above (167)                         | 245                       |         |
| Sugary snacking habits                       |                           |         |
| No (335)                                     | 234                       | 0.041*  |
| Yes (147)                                    | 258                       |         |
| Sour food snacking habits                    |                           |         |
| No (360)                                     | 237                       | 0.160   |
| Yes (122)                                    | 254                       |         |
Table 4
Dental caries risk factors of the 12-year-old Lisu children (Zero inflated negative binomial regression model, N = 482).

| Zero-inflated portion (DMFT = 0) | Effect modifiers | Odds ratio (95% C.I) | p-value |
|----------------------------------|------------------|----------------------|---------|
| Sex                              |                  |                      |         |
| Girl                             | 0.35 (0.15, 0.79)| 0.012                |         |
| Boy                              |                  |                      |         |

| Negative binomial portion (DMFT > 0) | Effect modifiers | Incidence rate ratio (95% C.I) | p-value |
|-------------------------------------|------------------|-------------------------------|---------|
| Sugary snacking habits              |                  | 1.55 (1.14,2.11)             | 0.005   |
| Yes                                 |                  |                               |         |
| No                                  |                  |                               |         |

#Reference group.

For gingivitis, five independent variables had a p-value less than 0.10 in the Chi-square test of independent variables and gingivitis (Table 1). They were studied as effect modifiers in the multivariate logistic regression model. In the final model, three effect modifiers were significantly related to the prevalence of gingivitis (Table 5). Children whose mothers had a lower education level and those who had less pocket money had a higher chance of having gingivitis (OR = 2.51, p = 0.003 and OR = 3.75, p < 0.001, respectively). Moreover, children who brushed their teeth less than twice daily had a higher chance of having gingivitis (OR = 2.41, p = 0.004).
Table 5  
Gingivitis risk factors of the 12-year-old Lisu children (Multivariate logistic regression model, N = 482).

| Effect modifiers                                      | Odds ratio (95% C.I.) | p-value |
|------------------------------------------------------|-----------------------|---------|
| Mother's education level                              |                       |         |
| Primary school level, ≤ 6 years                       | 2.51 (1.32, 3.53)     | 0.003   |
| Secondary school level or above, > 6 years#           |                       |         |
| Monthly pocket money                                  |                       |         |
| Less than 50RMB (~US$ 7)                              | 3.75 (2.05, 6.86)     | <0.001  |
| More than 50RMB (~US$ 7) #                           |                       |         |
| Toothbrushing frequency (daily)                       | 2.41 (1.33, 4.39)     | 0.004   |
| Less than twice                                       |                       |         |
| Twice or above#                                       |                       |         |

#Reference group.

Discussion

This study is the first epidemiological study to investigate the oral health status among 12-year-old Lisu children in China. To maintain the representativeness, this study employed a multistage sampling method to recruit children in primary schools as home schooling is not common in China. This sampling technique is convenient and cost-effective in terms of recruitment, especially for the Lisu population who resides in remote and mountainous villages. However, this sampling technique may not be as precise as a simple random sampling [10]. Despite this, this study successfully recruited children from primary schools in different cities/autonomous prefectures and achieved a high response rate. In addition, to maintain the reliability and validity, two examiners underwent sufficient calibration training in the same setting before the study commenced, and they obtained very good inter- and intra-examiner agreements. This study found that dental caries, gingivitis and dental erosion were prevalent among 12-year-old Lisu children, while tetracycline-stained teeth and dental fluorosis were not prevalent.

When compared to the national data of 12-year-old children in China, Lisu children presented higher prevalence rates in dental caries and gingivitis. The dental caries prevalence rate of Lisu children was 35%, which is slightly higher than that of the national average (24%) [11]. Along with this, over 95% of the cavities were unrestored. For gingivitis, the prevalence rate of Lisu children was much higher than the national data (88% vs. 58%) [12]. The high prevalence rate of dental caries and gingivitis suggested that...
inequalities in oral health might exist among the Lisu children. Generally, these Lisu children were from the low socio-economic class in terms of family disposable income per capita and area-level socio-economic status (rural villages) [8, 9]. Besides, dental treatment or clinical prevention treatment may be neither available nor affordable for the Lisu children in the mountainous area. The barrier to dental care also increased the inequality in oral health [24]. Around half of the children in this study had never visited a dentist. Therefore, there is an urgent need to reduce the oral health inequalities among the Lisu ethnic minority for the purpose of fairness and social justice. In 2016, The General Office of the State Council of China issued the Healthy China Plan for 2030, which provides oral health education, oral hygiene instruction and pit and fissure sealant to all seven- to nine-year-old children in China [25]. The effectiveness of this oral health promotion programme on Lisu children’s oral health needs to be confirmed.

This study also had some meaningful findings on the risk factors of these prevalent oral diseases. Two effect modifiers were found to be related to the prevalence of dental caries, including sex and sugary snacking habits. Females were typically found to have a higher prevalence rate due to their hormonal fluctuations [26]. For sugary snacks habits, these study Lisu children live in the subtropical zone where sugar is produced, and the readily available sweet foods or drinks in their daily life was likely to increase the risk of dental caries [27]. Apart from these two factors, the first molar was found to have the highest prevalence of dental caries. This may be explained by its anatomic characteristics and long duration of exposure to cariogenic bacteria [28]. All these risk factors should be taken into consideration for the Lisu population’s best benefit. Special dental care for female, sugar control and prevention strategies for susceptible occlusal tooth surfaces should be supported by the local government. For gingivitis, the frequency of toothbrushing was related to the prevalence. Gingivitis is a non-destructive type of periodontal disease and reversible by maintaining good oral hygiene, and toothbrushing is the most common oral-hygiene practice [15]. However, more than half of the study children did not have regular twice-daily toothbrushing habits. Therefore, a school-based oral healthcare instruction and regular reinforcement in toothbrushing should be considered to improve the situation [29]. But the oral hygiene status (the presence of dental plaque) of the study children was unable to assess, which was the limitation of this study. The reason was all children were required to brush their teeth before the oral examination to assess the color of tooth crown for tetracycline-stained teeth and dental fluorosis. Along with this, the relationship between dental plaque and dental caries or gingivitis among the study children was unable to be analysed.

Another issue to be aware of is that all of the study Lisu children had dental erosion, though none of them were diagnosed as severe dental erosion and just a few were moderate dental erosion. Further studies should be conducted to investigate the reason for this epidemic oral condition and prevention strategies should be developed. Some children did not finish the dental erosion assessment due to the length of oral procedure, which might have influenced the results. But the representativeness should still be maintained with a large sample size. In addition, some Lisu children did have tetracycline-stained teeth even though tetracycline was not used commonly in recent years due to the side effects [23]. Restrictions on prescriptions of this kind of antibiotics for young children should be imposed. For dental fluorosis,
cautions should be taken when interpreting the results. Sampling in this study collected information from a part of the whole Lisu population and it might be unable to gather information for every member of the population. Therefore, dental fluorosis might still present on a small number of children. Nevertheless, this study still adds information to the literature, and stakeholders can have a better understanding of the oral health status of 12-year-old Lisu children.

**Conclusion**

Dental caries and gingivitis were prevalent among 12-year-old Lisu children in the Yunnan province of China, and most of the decayed teeth were unrestored. Dental fluorosis was not observed in the children.

**Abbreviations**

BEWE
Basic Erosive Wear Examination
CPI
Community Periodontal Index
DMFT
decayed, missing and filled teeth
DT
decayed tooth
FT
filled tooth
MT
missing tooth
SD
standard deviation
STROBE
Statement of Strengthening the Reporting of Observational Studies in Epidemiology
US$
United States dollar
WHO
World Health Organization
ZINB
zero-inflated negative binomial regression

**Declarations**

**Ethics approval**

This study was approved by the Ethics Committee of Kunming Medical University.
**Ethical consent**

Written informed consent was obtained from children's legal guardians before the study. Children's individual person's data were not contained in this article, and publication consent is not applicable.

**Availability of data and materials**

The datasets used for the current study are available from the first author on reasonable request.

**Competing interests**

The authors declare that they have no competing interests.

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**Authors' contributions**

KJC: performing data analysis and writing the manuscript. YL: conducted the clinical examination and questionnaire survey. BX, JL and YL: assisted in project coordination. SZ: training and supervising fieldworkers, performing the dental examination, performing critical revision of the manuscript and supervision of field work project coordination. CHC: performing critical revision of the manuscript for important intellectual content. All authors read and approved the final manuscript.

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Figures
**Figure 1**

Dental caries prevalence according to tooth locations
Figure 2

Gingivitis prevalence according to tooth locations