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Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2020-042908
Article Type:	Original research
Date Submitted by the Author:	18-Jul-2020
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Keywords:	Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health economics < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Epidemiology < ONCOLOGY

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Association between socioeconomic status and dental caries among Chinese preschool children:

A cross-sectional national study

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Running Title: Socioeconomic status and dental caries

Keywords: Dental caries, oral health, social class, Preschool child

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Word count: 3016 words

Abstract count: 196 words

Abstract

Objectives: To assess the association between child caries status and socioeconomic status (SES) in China.

Methods: Data from the 4th National Oral Health Survey of China, which was done in 2015. The sampling process was conducted by a multistage stratified cluster method, comprising of 40,360 children aged 3-5 years. Caries indicators including untreated caries, dental pain and dmft. SES was measured by parental education level and household income. Inequality by education and income were estimated by using the relative index of inequality and slope index of inequality (RII and SII, respectively).

Results: There were significant associations between SES and all caries indicators ($p < 0.05$). And significant inequalities for all outcomes and SES indicators were identified with RII and SII with the exception of dental pain experience. Relative inequalities were larger relative inequalities in untreated caries by parental educational level. Children whose parents with the low education had higher prevalence of untreated caries (RII:1.64; 95% CI:1.46 to 1.84), and higher dmft (RII:1.55; 95% CI:1.38 to 1.74). Absolute inequalities were the same pattern as relative inequalities.

Conclusions: There were consistently wide socioeconomic inequalities in child oral health in China, posing challenges for designing public health strategies and social policies.

Strength and limitation

- The Fourth National Oral Health Survey of China use of a relatively large and representative sample of children, which ensured study results are likely to be generalizable across the mainland of China children.
- It was the first study to measure inequalities in child oral health by using SII and RII in China.
- The study design was the cross-sectional nature precluding inference about causality which limited to examine how socioeconomic inequalities in oral health changed as children grew into adolescents.

- Reliance on parental report of children's oral health and oral health behaviors.

Introduction

Currently, dental caries is still the greatest global oral health burden with 532 million children affected worldwide¹. Dental caries not only pose a threat on health and quality of life but also impose a substantial economic burden on the society². While World Health Organization (WHO) findings suggested that the prevalence of dental caries has been declined. However, the decline in caries was obvious in high-income but not in low or middle - income countries³⁻⁵, moreover the increase in caries had been seen in some of low or middle - income countries, suggesting that socioeconomic inequalities in oral health have remained. Children from socially disadvantaged families have higher risk of dental caries⁶.

Socioeconomic inequalities in child caries is a great concern in many countries⁶⁻⁸, and it is supposed to be an important determinant in child oral health⁹. Various studies have identified children from poor SES had higher dental caries and greater dental pain experience, including low household income, low mother's education, poor oral hygiene, high sugar consumption and living in socially disadvantaged families^{6-8 10-14}. Lower household income in childhood associated with higher dental caries was confirmed in Mongolia⁸. In India, A lagged analysis of a structural equation modeling showed that SES contribute to oral health status indirectly¹⁵. Poor SES can have a deleterious impact on child oral health as a result.

China is a rapidly developing country of 1.4 billion people in the world¹⁶, whose GDP ranking 2nd in the world¹⁷. China has undergone rapid economic development while also experiencing a processing of increasing inequalities in health¹⁸. Children from rural areas or poor families are more likely to be stunted than those from urban areas or rich families^{19 20}. Few previous studies have explored socioeconomic inequalities in oral health in Chinese preschool children^{21 22}. Meanwhile, there has been a lack of nationally representative data on oral health inequalities for Chinese preschool children. Hence, additional research to improve current understanding of socioeconomic inequalities in oral health in preschool children of China is needed.

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4 This study was to explore the association between SES and dental caries in 3-5
5 years old children, and evaluated the inequalities in dental caries among children around
6 the mainland of China, and to discover the correlations of socioeconomic factors in
7 dental inequalities.
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11 **Methods**

12 **Data source**

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14 We used data of 3-5 years old children from the Fourth National Oral Health
15 Survey of China carried out in 2015, which was based on a nationally representative
16 sample of 40,360 children, providing information on individual dental health and
17 socioeconomic status. The survey produced representative data enrolled all 31
18 provinces, autonomous regions and municipalities of the mainland of China at
19 national and regional levels by using a multistage, stratified, equal-capacity random
20 sampling design. Probability proportional to size (PPS) design was used to randomly
21 select two urban areas and two rural areas from in each province. A structured
22 parental questionnaire collected socioeconomic indicators including household
23 income and parental education attainment were conducted by face to face. Clinical
24 dental examination including dental caries experience was completed by trained and
25 calibrated dentists. Full details of the survey's design can be found in the
26 methodology²³. Ethics approval (Approval no. 2014-003) was obtained from the
27 Ethics Committee of Chinese Stomatological Association, and written consent was
28 obtained in every guardian of each child.
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45 **Study measures**

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47 Three oral health outcomes included (1) prevalence of untreated caries, defined as
48 $dt \geq 1$ (2) dental pain experience ("yes" or "no"), defined as having toothache in the last
49 12 months. (3) dmft, defined as mean number of decayed, missing and filled teeth and
50 used as a count variable.
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55 The social inequalities were measured by using two different dimensions of
56 socioeconomic status (SES), namely household income and parental education level.
57 Education was divided into 3 groups according to the number of years of schooling:
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4 low(≤ 9 years), middle (10 to 12 years), and high(> 12 years). Household income was
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6 categorized into five groups according to the quintiles: lowest ($< 30,000$ ¥/year);low
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8 ($\geq 30,000$ ¥ and $< 50,000$ ¥/year); middle ($\geq 50,000$ ¥ and $< 80,000$ ¥); high($\geq 80,000$
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10 ¥ and $< 100,000$ ¥);highest($\geq 100,000$ ¥). Place of residence was departed into
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12 urban and rural.
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16 Age, gender, ethnicity, place of residence, region and self-perceived general health
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18 were considered as covariates.
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20 **Statistical analysis**

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22 Data were analyzed on STATA MP 16.0 (Stata Corp., College Station, TX, USA).
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24 Descriptive statistics are used to characterize the study population. Statistical
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26 significance in sample characteristics were evaluated using Chi square tests, Mann-
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28 Whitney test and Kruskal-Wallis test.
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31 Since the proportion of household income with missing data was 37.2%, multiple
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33 imputation of missing data was carried out. This method uses the distribution of
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35 observed individual values to determine the values to be imputed²⁴, and 20 imputed
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37 datasets were generated. Association between SES indicators and prevalence of
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39 untreated caries, dental pain were evaluated using Poisson regression models for the
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41 reason of count data²⁵, and negative binomial regression was used to examine the
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43 association between SES indicators and children's dmft score because the latter was a
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45 count variable with over-dispersion²⁶. The association of parental educational level and
46
47 household income between prevalence of untreated caries, dmft, and dental pain
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49 experience was explored in both of unadjusted and adjusted models. Crude model was
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51 unadjusted. Model 1 was adjusted for children's age, gender, ethnicity and place of
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53 residence and self-perceived general health to exclude the effects of all covariates.
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55 Confounding can lead to an overestimate or underestimate of the true association
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57 between the explanatory variable and outcome and can even change the direction of the
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59 observed effect ²⁷. Therefore, the effects of the confounding variables should be
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adjusted for in order to get the true relationship between explanatory variable and the

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4 outcome variables. The incident rate ratio (IRR) and 95% CIs were calculated for the
5 discrete dependent variables to study the effect of independent variables on oral health
6 in the regression analysis.
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9 The relative index of inequality (RII) and slope index of inequality (SII) were
10 estimated to assess relative and absolute inequalities respectively²⁸. We included all the
11 above covariates in the models and took into account the survey weights and missing
12 data. RII estimated the prevalence ORs of the outcome between the highest and lowest
13 SES conversely. Values of RII>1 signify higher prevalence of caries, dental pain
14 experience, or higher dmft among those with lowest SES. The SII estimated the
15 absolute predicted difference in caries experience between the highest and lowest SES.
16 Values of SII >0 indicate inequality. The ridit score for estimating SII and RII was
17 calculated by the RIIGEN command in STATA²⁹. Using the ridit score and continuous
18 caries experience measurements, the ratio of the mean by Poisson regression was
19 considered as RII and the beta coefficient by linear regression was considered as SII.
20 The ridit score, RII, and SII were calculated for each of the 20 datasets and RII and SII
21 were integrated.
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35 Analyses were also conducted stratifying by place of residence (urban/rural). We
36 stratified by place of residence due to differences between urban and rural settings in
37 factors that could influence health inequalities. In all the analyses, the level of statistical
38 significance was set at $P < 0.05$.
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43 **Results**

44 Data were obtained on 40,360 children aged 3-5 years in China in 2015. About
45 three-quarters of children' parents reported child's general health as being good and
46 better. Nearly half of children (49.83%) resided in homes with low or lowest
47 household income. Both SES indicators were significantly associated with caries
48 outcomes. The highest levels of mean dmft were observed among those in the low
49 parental education attainment (3.91 ± 0.01), those in the lowest household income
50 (3.69 ± 0.02), and those parent-report self-perceived general health as fair and less
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4 (3.85±0.01). Moreover, significant differences were found in the demographic
5 characteristics, self-perceived general health (table 1).
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8 The regression models demonstrated that, caries outcomes by SES showed a
9 socioeconomic gradient, with the only exception of dental pain experience. IRR of dmft
10 was statistically significant rising after adjusting for demographic characteristics,
11 ethnicity, geographical location and parents-reported general health, with the
12 decreasing parental education (IRR of dmft was 1.13 (95% CI 1.09 to 1.17) in 9 to 12
13 schooling years, 1.20 (95% CI 1.17 to 1.24) in less than 9 schooling years. The only
14 exception from this observation was dental pain experience by both SES indicators.
15 There were stronger relationships between socioeconomic disadvantage and high
16 prevalence of untreated caries and high dmft. The prevalence of untreated caries and
17 dmft of children from the lowest household income families were 1.10 and 1.16 times
18 higher than those from the highest household income families respectively.
19 Furthermore, after adjusting for demographic characteristics, ethnicity, geographical
20 location and parents-reported general health, socioeconomic inequalities in the child
21 caries experience were consistently found by IRRs (table 2).
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35 RII and SII estimates showed significant relative and absolute inequalities for
36 caries indicators and SES indicators except for dental pain experience (table 3). There
37 were larger relative inequalities in prevalence of untreated caries and dmft by parental
38 educational level, with the low schooling years having higher prevalence of untreated
39 caries (RII:1.64; 95% CI:1.46 to 1.84), and having higher dmft (RII:1.55; 95% CI:1.38
40 to 1.74). Similarly, relative inequalities were as well as larger in prevalence of untreated
41 caries by household income (RII:1.38;95% CI:1.19 to 1.61), and in dmft by household
42 income (RII: 1.33; 95% CI:1.14 to 1.55) among the low SES groups. However, there
43 were no significant inequalities in dental pain experience by both SES groups. This
44 pattern was not in line with absolute inequalities by SII estimates. However, when
45 stratifying by place of residence, relative inequalities were observed in all caries
46 outcomes and SES indicators. Meanwhile, our findings revealed that inequalities tend
47 to be larger in rural area by parental educational attainment. Inequalities related to
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4 income were larger in urban area by household income on the contrary (table 4).
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6 **Discussion**

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8 In general, it was identified that both SES indicators was associated with the
9 prevalence of untreated caries, dental pain experience and dmft among children around
10 school age, and significant inequalities in dental caries were existed among Chinese
11 young children and parental educational attainment being the main contributors to the
12 identified inequalities. Besides, household income inequalities in child oral health were
13 generally larger in urban areas, while inequalities were larger in urban areas by parental
14 educational attainment. The study findings inform collective actions targeting parental
15 socioeconomic status to address this critical oral health inequalities.
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24 Our study showed that parental educational attainment was an obvious marker
25 relate to dental caries in children, as inequalities by parental educational attainment
26 tended to be high across all outcomes with the exception of dental pain experience. This
27 not only showed socioeconomic inequalities in child caries experience, supporting the
28 previous literature but also are in agreement with an earlier dental health inequality
29 study. Some previous studies showed that children from low SES families suffer from
30 more severe dental pain and higher prevalence of caries^{30 31}. Moreover, a study on 3-
31 year-old Japanese children confirmed that higher level of parental education decreased
32 the prevalence of dental caries³². Meanwhile, parental educational attainment was
33 related to childhood oral health related quality in life²². However, a study among
34 Mongolian children showed that parental educational attainment was not associated
35 with caries experience⁸. Similarly, a study on four provinces of China reported that
36 parental education was not related to children's dental caries³³. Moreover, an extended
37 path analysis in Hong Kong children showed that parental educational attainment did
38 not have impact on the caries experience³⁴.
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53 Results of this study also revealed household income as a traditional SES indicator
54 of children, affected the distribution of caries experience. Evidence from a current study
55 confirmed that household income was one of the most strongly factors related to oral
56 health-related quality of life³⁵. A cross-sectional study on Australian children proved
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4 that inequalities in dental caries were concentrated among children from lower income
5 families³⁶. A cohort study investigated trends in oral health from a life course data in
6 Hong Kong suggested that household income had an effect on children's oral health
7 status³⁴. However, the evidence on the relationship between income and oral health is
8 various and unclear³⁷.
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13 It is surprising to find that there was no inequality in dental pain experience among
14 children. Previous study from Brazil showed that dental pain in children was not related
15 to the socioeconomic characteristics³⁸, while a study on Mexican schoolchildren found
16 that the association of socioeconomic status with dental pain. Nevertheless, our findings
17 also revealed that inequality in dental pain was existed in high SES groups in rural areas.
18 This contradiction can be explained by the fact that the neglect of discomfort and pain
19 in children from low SES groups in rural areas. Children in rural areas also had higher
20 dmft and untreated caries than those in urban areas, which was keeping with the trend
21 of four provinces in China³³. The dmft in Chinese preschool children decreased from
22 3.5 to 3.35 slightly. Health services utilization is a proximal factor accounting for the
23 large inequalities in health between urban and rural residents in China^{39 40}. Existing
24 literature has found inequalities in health care not only existing in both rural and urban
25 areas of China⁴¹, but also existing in ethnic minorities and migrant children^{42 43}. People
26 living in the eastern developed areas are more likely to use outpatient care, while the
27 people living in western underdeveloped areas are more likely to use inpatient care⁴⁴,
28 which indicated that children living in low SES areas are less likely to go to a dental
29 clinic. Meanwhile, utilization of dental services did a positive impact on the caries
30 experience in children and adolescents³⁴.
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48 This study used only two measures of socioeconomic status. Nonetheless, these
49 variables represent considerable diversity in terms of their relationship to the broad
50 concept of SES. For example, education is a primary determinant of a person's labor
51 market position on the other hand, which in turn influences income, housing, and other
52 material resources. In addition, the strongest predictor of oral health in adulthood is oral
53 health in childhood⁴⁵. The appearance of inequalities in oral health in these very young
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4 children is important given the evidence that childhood oral health inequalities can
5 persist into adulthood irrespective of later changes in social position⁴⁵. However,
6 parental education, household income, and other socioeconomic factors are difficult to
7 modify in the short term. Therefore, strategies must be developed to increase child oral
8 health and parental knowledge and tools for prevention. Confirmation of this would
9 advance the argument for oral health promotion initiatives that engage parents of
10 children very early. For example, the positive effect of increased household income and
11 high parental educational attainment on child health implies that government provide
12 health service targeting the poor and the illiteracy may be an effective way to improve
13 the oral health of children from low SES families, and public welfare programs should
14 focus on rural areas, or considering the importance of child oral health in future life
15 quality, which implies a potential increasing oral health education in such an inequality
16 in child oral health.
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29 **Strength and limitation**

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31 A major strength of our study was the Fourth National Oral Health Survey of China
32 use of a relatively large and representative sample of children, which ensured study
33 results are likely to be generalizable across the mainland of China children. And it was
34 the first study to measure inequalities in child oral health by using SII and RII in China.
35 The study findings should be considered with a number of limitations. The study design
36 was the cross-sectional nature precluding inference about causality. We were not able
37 to examine how socioeconomic inequalities in oral health changed as children grew
38 into adolescents. Longitudinal studies of the oral health of representative samples of
39 Chinese children are rare, and that will provide stronger evidence of the potential causal
40 pathways underlying oral health inequalities as further longitudinal data become
41 available. A notable limitation of this study was the reliance on parental report of
42 children's oral health and oral health behaviors. A study suggested that parent-reported
43 single-item indicators of their children's oral health have satisfactory construct
44 validity⁴⁶ and are robust across socioeconomic circumstances⁴⁷. However, it has also
45 been suggested that the accuracy of such reports towards under-reporting children's
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4 oral health problems when children are very young⁴⁸. In addition, parental education
5 and household income were the only two measures of socioeconomic status collected
6 for this age group. Some other indicators should also be considered, such as occupation
7 and health insurance. It is conceivable that socioeconomic indicators may be more
8 sensitive and persuasive to measure socioeconomic inequalities in oral health in China.
9 For both these reasons, it is likely that the current study represents an under-estimation
10 of caries impact on children's life.
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17 **Conclusions**

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20 This study provides recent details of oral health examined nationally for some time.
21 It shows that children from the low SES families were less likely to engage in oral
22 health promoting behaviors and were more likely to have caries. Furthermore, the data
23 suggest that significant inequalities do exist at a very early age. Such findings further
24 strengthen calls for early life oral health prevention and promotion efforts. Our findings
25 of this research have policy implications for China. Policy makers need to be aware of
26 this challenge when they try to achieve and maintain equality in distribution of oral
27 health.
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35 **What is already known on this subject**

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37 ▶ Most previous studies on child oral health suggested that children from low SES
38 family suffer more dental caries experience. These can include parental educational
39 attainment, household income and parental occupation. There has been concern that
40 socioeconomic inequalities in child oral health could persist into adulthood and
41 exacerbate social inequality. Yet, there have been no national analysis measuring
42 socioeconomic inequalities in oral health among Chinese preschool children.
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49 **What this study adds**

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51 ▶ This study confirms that there were clear inequalities by parental socioeconomic
52 status in Chinese preschool children. This was most clearly seen for parental
53 educational attainment but less for household income. The findings from this paper
54 suggest that child from lower SES family are experiencing more caries and supports
55 calls for early life oral health prevention and promotion efforts to improve child oral
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4 health those at low SES.

5 6 **Funding**

7 This study was supported by “Scientific Research Fund of National Health
8 Commission of the People’s Republic of China (201502002)”.

9 10 11 **Author Contributions**

12 All authors meet the ICMJE authorship criteria. Tingting Zhang, Xiaojuan Zeng,
13 Jialan Hong and Xueting Yu conceived the study and developed the analysis strategy.
14 Tingting Zhang, Jialan Hong and Xueting Yu carried out the analysis. Tingting Zhang
15 drafted the manuscript. Xueting Yu, Qiulin Liu, Andi Li, Zhijing Wu and Xiaojuan
16 Zeng critically reviewed the drafts and gave text suggestions. All authors approved the
17 final manuscript.
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25 26 **Acknowledgements**

27 This paper uses confidentialized data from children in China. This study is conducted
28 in partnership between 35 colleges and university, Center of Disease Control (CDC) of
29 Chinese Health Commission of the People’s Republic of China, Chinese
30 Stomatological Association.
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35 **Conflicts of Interest:** The authors declare that there is no conflict of interest.

36 37 **References**

- 38
39 1. James. SL, Abate. D, Abate. KH, et al. Global, regional, and national incidence, prevalence,
40 and years lived with disability for 354 diseases and injuries for 195 countries and
41 territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study
42 2017. *The Lancet* 2018;392(10159):1789-858. doi: 10.1016/S0140-6736(18)32279-7
43
44
45
46
47
48
49 2. Righolt AJ, Jevdjevic M, Marcenes W, et al. Global-, regional-, and country-Level economic
50 impacts of dental diseases in 2015. *J Dent Res* 2018;97(5):501-07. doi:
51 10.1177/0022034517750572
52
53
54
55
56
57 3. Lagerweij M D, C. VL. Declining caries trends: are we satisfied? *Curr Oral Health Rep*
58
59
60

- 2015;2:212-17. doi: 10.1007/s40496-015-0064-9
4. Frencken J, E., Sharma P, Stenhouse L, et al. Global epidemiology of dental caries and severe periodontitis - a comprehensive review. *Journal of Clinical Periodontology* 2017;44:S94-S105. doi: 10.1111/jcpe.12677
5. Marthaler TM. Changes in dental caries 1953–2003. *Caries Res* 2004;38(3):173-81. doi: 10.1159/000077752
6. Rouxel P, Chandola T. Socioeconomic and ethnic inequalities in oral health among children and adolescents living in England, Wales and Northern Ireland. *Community Dent Oral Epidemiol* 2018;46(5):426-34. doi: 10.1111/cdoe.12390
7. Ha DH, Do LG, Roberts-Thomson K, et al. Risk indicators for untreated dental decay among Indigenous Australian children. *Community Dent Oral Epidemiol* 2019 doi: 10.1111/cdoe.12460
8. Chinzorig T, Aida J, Cooray U, et al. Inequalities in caries experience among mongolian children. *Int J Environ Res Public Health* 2019;16(20) doi: 10.3390/ijerph16203892
9. Fisher-Owens SA, Gansky SA, Platt LJ, et al. Influences on children's oral health: a conceptual model. *Pediatrics* 2007;120(3):e510-e20. doi: 10.1542/peds.2006-3084
10. Pinto-Sarmento TC, Abreu MH, Gomes MC, et al. Determinant factors of untreated dental caries and lesion activity in preschool children using ICDAS. *PLoS One* 2016;11(2):e0150116. doi: 10.1371/journal.pone.0150116
11. Kilpatrick N, M., Neumann A, Lucas N, et al. Oral health inequalities in a national sample of Australian children aged 2-3 and 6-7 years. *Aust Dent J* 2012;57(1):38-44. doi: 10.1111/j.1834-7819.2011.01644.x

- 1
2
3
4 12. LM. J, JM. A, KF. R-T. Oral health inequalities among indigenous and nonindigenous
5
6 children in the Northern Territory of Australia. *Community Dent Oral Epidemiol*
7
8
9 2006;34:267-76.
10
11
12 13. Kumar. S, Kroon. J, Lalloo. R. A systematic review of the impact of parental socio-economic
13
14 status and home environment characteristics on children's oral health related quality of
15
16 life. *Health and Quality of Life Outcomes* 2014;12(1):41.
17
18
19 14. Hong J, Whelton H, Douglas G, et al. Consumption frequency of added sugars and UK
20
21 children's dental caries. *Community Dent Oral Epidemiol* 2018;46(5):457-64. doi:
22
23 10.1111/cdoe.12413
24
25
26 15. E. G, Robinson P G, Marya C M, et al. Oral health inequalities: relationships between
27
28 environmental and individual factors. *J Dent Res* 2015;94(10):1362-68. doi:
29
30 10.1177/0022034515592880
31
32
33
34 16. Statistics NBo. Statistical bulletin of the People's Republic of China on national economic
35
36 and social development in 2019, 2020.
37
38
39 17. Bank TW. GDP ranking 2018 [Available from:
40
41 <https://datacatalog.worldbank.org/dataset/gdp-ranking> accessed 14 March 2020.
42
43
44
45 18. Fang P, Dong S, Xiao J, et al. Regional inequality in health and its determinants: evidence
46
47 from China. *Health Policy* 2010;94(1):14-25. doi: 10.1016/j.healthpol.2009.08.002
48
49
50 19. Liu H, Fang H, Zhao Z. Urban-rural disparities of child health and nutritional status in China
51
52 from 1989 to 2006. *Econ Hum Biol* 2013;11(3):294-309. doi:
53
54 10.1016/j.ehb.2012.04.010
55
56
57 20. Chen. Y, Ler. X, Zhou. L-a. Does raising family income cause better child health ? Evidence
58
59
60

- 1
2
3
4 from China. *Economic Development and Cultural Change* 2017;65(3):495-520.
5
6
7 21. Guan. Y, Zeng. X, Tai. B, et al. Socioeconomic inequalities in dental caries among 5-year-
8
9 olds in four Chinese provinces. *Community Dental Health* 2015;32:185-89. doi:
10
11 10.1922/CDH_3524Guan05
12
13
14 22. Wong HM, McGrath CPJ, King NM, et al. Oral health-related quality of Life in Hong Kong
15
16 preschool children. *Caries Res* 2011;45(4):370-76. doi: 10.1159/000330231
17
18
19 23. Lu. H, Tao. D, Lo. EC, et al. The 4th National Oral Health Survey in the mainland of China:
20
21 background and methology. *Chin J Dent Res* 2018;21(3):161-65.
22
23
24 24. Pedersen AB, Mikkelsen EM, Cronin-Fenton D, et al. Missing data and multiple imputation
25
26 in clinical epidemiological research. *Clin Epidemiol* 2017;9:157-66. doi:
27
28 10.2147/CLEP.S129785
29
30
31 25. MacDonald RBJM. Overdispersion and Poisson regression. *2008* 2008;24(3):269-84. doi:
32
33 10.1007/s10940-008-9048-4
34
35
36 26. Hilbe J M. Negative binomial regression: Cambridge University Press 2011:23-26.
37
38
39 27. Hennekens CH, Buring JE. Epidemiology in Medicine. Boston/Toronto: Little, Brown and
40
41 Company 1987.
42
43
44 28. Mackenbach J P, Kunst A, E. . Mearuring the magnitude of socio-economic inequalities in
45
46 health: an overview of available measures illustrated with two examples from Europe.
47
48
49
50
51 *Soc Sci Med* 1997;44(6):757-71.
52
53
54 29. RIIGEN: Stata module to generate variables to compute the Relative Index of Inequality
55
56 [program]. revised 21 Nov 2013 version: Boston College Department of Economics,
57
58 2013.
59
60

- 1
2
3
4 30. Peres M, A., Macpherson L, M, D., Weyant R, J., et al. Oral diseases: a global public health
5
6 challenge. *The Lancet* 2019;394:249-60. doi: 10.1016/s0140-6736(19)31146-8
7
8
9 31. Armfield J M. Socioeconomic inequalities in child oral health: a comparison of discrete and
10
11 composite area-based measures. *Journal of Public Health Dentistry* 2007;67(2):119-
12
13 25. doi: 10.1111/j.0022-4006.2007.00026.x
14
15
16 32. Kato. H, Tanaka. K, Shimizu. K, et al. Parental occupations, educational level, and income
17
18 and prevalence of dental caries in 3-year-old Japanese children. *Environmental Health*
19
20 *and Preventive Medicine* 2017;22(80) doi: <https://doi.org/10.1186/s12199-017-0688-6>
21
22
23
24 33. Anqi. S, Xiaojuan. Z, Min. C, et al. Inequalities in dental caries among 12-year-old Chinese
25
26 children. *Journal of Public Health Dentistry* 2015;75(3):210-17. doi:
27
28 10.1111/jphd.12091
29
30
31 34. Lu HX, Wong MC, Lo EC, et al. Trends in oral health from childhood to early adulthood: a
32
33 life course approach. *Community Dent Oral Epidemiol* 2011;39(4):352-60. doi:
34
35 10.1111/j.1600-0528.2011.00611.x
36
37
38 35. Kragt L, Wolvius EB, Raat H, et al. Social inequalities in children's oral health-related quality
39
40 of life: the Generation R Study. *Qual Life Res* 2017;26(12):3429-37. doi:
41
42 10.1007/s11136-017-1679-1
43
44
45 36. Do LG, Ha DH, Roberts-Thomson KF, et al. Race and income-related inequalities in oral
46
47 health in Australian children by fluoridation status. *JDR Clin Trans Res* 2018;3(2):170-
48
49 79. doi: 10.1177/2380084417751350
50
51
52 37. Singh A, Peres MA, Watt RG. The relationship between income and oral health: a critical
53
54 review. *J Dent Res* 2019;98(8):853-60. doi: 10.1177/0022034519849557
55
56
57
58
59
60

- 1
2
3
4 38. Freire M, Correa-Faria P, Costa LR. Effect of dental pain and caries on the quality of life of
5
6 Brazilian preschool children. *Rev Saude Publica* 2018;52:30. doi: 10.11606/S1518-
7
8 8787.2018052000093
9
10
11 39. Zhao Y, Zhang L, Fu Y, et al. Socioeconomic Disparities in Cancer Treatment, Service
12
13 Utilization and Catastrophic Health Expenditure in China: A Cross-Sectional Analysis.
14
15 *Int J Environ Res Public Health* 2020;17(4) doi: 10.3390/ijerph17041327
16
17
18 40. Zhang R, Chen Y, Liu S, et al. Progress of equalizing basic public health services in
19
20 Southwest China--- health education delivery in primary healthcare sectors. *BMC*
21
22 *Health Serv Res* 2020;20(1):247. doi: 10.1186/s12913-020-05120-w
23
24
25 41. Guo B, Xie X, Wu Q, et al. Inequality in the health services utilization in rural and urban
26
27 china. *Medicine* 2020;99(2):e18625. doi: 10.1097/md.00000000000018625
28
29
30 42. Huang Y, Shallcross D, Pi L, et al. Ethnicity and maternal and child health outcomes and
31
32 service coverage in western China: a systematic review and meta-analysis. *The Lancet*
33
34 *Global Health* 2018;6(1):e39-e56. doi: 10.1016/s2214-109x(17)30445-x
35
36
37 43. Sun X, Chen M, Chan KL. A meta-analysis of the impacts of internal migration on child
38
39 health outcomes in China. *BMC Public Health* 2016;16:66. doi: 10.1186/s12889-016-
40
41 2738-1
42
43
44 44. Sun J, Luo H. Evaluation on equality and efficiency of health resources allocation and health
45
46 services utilization in China. *International Journal for Equity in Health* 2017;16(1) doi:
47
48 10.1186/s12939-017-0614-y
49
50
51 45. WM. T, R. P, BJ. M, et al. Socioeconomic inequalities in oral health in childhood and
52
53 adulthood in a birth cohort. *Community Dent Oral Epidemiol* 2004;32:3345-53.
54
55
56
57
58
59
60

- 1
2
3
4 46. Talekar B, S. , Rozier R G, Slade G D, et al. Parental perceptions of their preschool-aged
5
6 children's oral health. *JADA* 2005;136(364-372)
7
8
9 47. Locker D. Validity of single-item parental ratings of child oral health. *International Journal*
10
11 *of Paediatric Dentistry* 2008;18(6):407-14. doi: 10.1111/j.1365-263X.2008.00926.x
12
13
14 48. Weyant RJ, Manz M, Corby P, et al. Factors associated with parents' and adolescents'
15
16 perceptions of oral health and need for dental treatment. *Community Dent Oral*
17
18 *Epidemiol* 2007;35(5):321-30. doi: 10.1111/j.1600-0528.2006.00336.x
19
20
21
22
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Table 1 Summary of the characteristics of the study participants. (n=40360)

Independent Category	Variable: n	Weighted %†	Untreated (%)†	caries	Dental pain (%)†	dmft($\bar{x}\pm s$)†
Sex				***	***	***
Male	20245	49.93	50.73		28.36	3.52±0.01
Female	20115	50.07	63.29		29.42	3.43±0.01
Age (years)				***	***	***
3	12390	29.89	50.73		17.90	2.33±0.01
4	13978	35.20	63.29		27.45	3.47±0.01
5	13992	34.91	72.26		39.63	4.47±0.01
Ethnicity				***	***	***
Han	36087	89.47	62.15		28.46	3.45±0.01
Non-Han	4273	10.53	67.07		32.51	3.73±0.02
Place of residence				***	***	***
Urban	20490	54.61	59.65		27.20	3.22±0.01
Rural	19870	45.39	66.30		30.95	3.79±0.01
Region				***	***	***

East	14127	46.28	65.21	29.90	3.90±0.01
Middle	10403	26.15	59.92	27.78	3.11±0.01
West	15830	27.22	60.99	28.24	3.12±0.01
Self-perceived general health			***	***	***
Good and better	28885	72.78	61.30	26.56	3.34±0.01
Fair and less	11475	27.22	66.33	35.26	3.85±0.01
Parental educational level			***	***	***
> 12 years	12615	35.85	56.56	27.16	2.95±0.01
9-12 years	9457	23.17	63.48	28.95	3.52±0.02
≤9 years	18278	40.99	67.54	30.41	3.91±0.01
Household income			***	***	***
Highest	4431	23.65	58.65	27.14	3.21±0.01
High	4319	18.04	61.65	28.31	3.41±0.02
Middle	5509	18.17	63.27	29.31	3.48±0.02
Low	4972	17.91	63.57	29.33	3.62±0.02
Lowest	6619	22.65	65.66	30.17	3.69±0.02

†Frequencies are weighted but counts are not after multiple imputation for household income.

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5 *P*-values were obtained using Mann-Whitney test and Kruskal-Wallis test for dmft, Pearson's chi-square test for categorical variables.

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7 †Frequencies and dmft are weighted after multiple imputation for household income.

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9 dmft, decayed, missing and filled primary teeth.

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11 **P* < 0.05, ***P* < 0.01, ****P* < 0.001.

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Table 2. Incidence Rate Ratio (IRR) and 95% confidence intervals (CIs) of untreated caries, dental pain and dmft for 3-5-year-olds by socioeconomic status in China.

Variables	Untreated caries		Dental pain		dmft	
	IRR ^a (95%CI)	IRR ^b (95%CI)	IRR ^a (95%CI)	IRR ^b (95%CI)	IRR ^a (95%CI)	IRR ^b (95%CI)
Parental educational level						
12 year or above	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
9-12 years	1.09(1.07, 1.12) ^{***}	1.08(1.06, 1.11) ^{***}	1.01(0.96, 1.06)	0.98(0.93, 1.03)	1.15(1.11, 1.19) ^{***}	1.13(1.09, 1.17) ^{***}
Up to 9 years	1.14(1.12, 1.16) ^{***}	1.12(1.10, 1.14) ^{***}	1.03(0.99, 1.08)	0.97(0.93, 1.01)	1.24(1.20, 1.28) ^{***}	1.20(1.17, 1.24) ^{***}
Household income						
Highest	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
High	1.07(1.03, 1.10) ^{***}	1.06(1.03, 1.10) ^{***}	1.05 (0.98, 1.12)	1.04(0.97, 1.11)	1.11(1.05, 1.17) ^{***}	1.10(1.05, 1.16) ^{***}
Middle	1.05(1.02, 1.09)	1.05(1.02, 1.09) ^{**}	1.05 (0.99, 1.04)	1.04(0.98, 1.11)	1.07(1.02, 1.12)	1.09(1.03, 1.15) ^{**}

	**		1.12)		1.13)*	1.15)**
Low	1.09(1.06, 1.13)***	1.09(1.05, 1.12)***	1.04(0.97, 1.11)	1.02(0.96, 1.09)	1.15(1.09, 1.21)***	1.15(1.09, 1.21)***
Lowest	1.11(1.07, 1.14)***	1.10(1.06, 1.14)***	1.09(1.03, 1.16)**	1.06(1.00, 1.12)	1.15(1.09, 1.21)***	1.16(1.09, 1.22)***

Survey weighted models include age, sex, ethnicity, place of residence, region, and socioeconomic measures.

Multiple imputation for household income.

^aCrude model: each SEE measure (parental education level and household income) and outcomes (untreated caries, dental pain and dmft).

^bModel II : adjusted for age, sex, ethnicity, place of residence, region and self-perceived general health.

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

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Table3 Relative and absolute inequalities in oral health outcomes by different SES measures.

	Untreated caries	Dental pain experience	dmft
SES	Relative inequalities—RII (95%CI)		
Parental educational level	1.64(1.46, 1.84) ***	1.06(0.93, 1.21)	1.55(1.38, 1.74) ***
Household income	1.38(1.19, 1.61) ***	0.90(0.78, 1.04)	1.33(1.14, 1.55) ***
	Absolute inequalities—SII (95%CI)		
Parental educational level	1.53(1.26, 1.85) ***	1.00(0.98, 1.01)	1.83(-0.09, 3.75)
Household income	1.11(0.98, 1.04)	0.96(0.76, 1.23)	1.13(0.84, 1.52)

Models adjusted by age, gender, ethnicity, place of residence, region and self-perceived general health.

P* < 0.05, *P* < 0.01, ****P* < 0.001.

SES, socioeconomic status; RII, Relative Index of Inequality; SII, Slope Index of Inequality.

Table 4 Relative inequalities in oral health outcomes by different SES measures, place of residence.

	Untreated caries	Dental pain experience	dmft
	RII (95%CI)		
Urban areas			
Parental educational level	1.47(1.25, 1.73) ***	1.31(1.09, 1.58) **	1.37(1.17, 1.61) ***
Household income	1.50(1.23, 1.83) ***	1.03(0.82, 1.29)	1.42(1.17, 1.73) ***
Rural areas			
Parental educational level	1.85(1.56, 2.19) ***	0.69(0.57, 0.83) ***	1.82(1.54, 2.15) ***
Household income	1.26(1.02, 1.56) *	0.81(0.65, 1.00) **	1.24(1.00, 1.53) *

Models adjusted by age, gender, ethnicity, region and self-perceived general health.

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

SES, socioeconomic status; RII, Relative Index of Inequality.

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1-2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	1-2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4-5
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4-5
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	5-6
		(b) Describe any methods used to examine subgroups and interactions	5-6
		(c) Explain how missing data were addressed	5
		(d) If applicable, describe analytical methods taking account of sampling strategy	5-6
		(e) Describe any sensitivity analyses	5-6
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	No
		(c) Consider use of a flow diagram	No
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6-7
		(b) Indicate number of participants with missing data for each variable of interest	No
Outcome data	15*	Report numbers of outcome events or summary measures	6-7
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7

		(b) Report category boundaries when continuous variables were categorized	7
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	7
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	No
Discussion			
Key results	18	Summarise key results with reference to study objectives	8-9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	10-11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-10
Generalisability	21	Discuss the generalisability (external validity) of the study results	9-10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	12

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Association between socioeconomic status and dental caries among Chinese preschool children: a cross-sectional national study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2020-042908.R1
Article Type:	Original research
Date Submitted by the Author:	17-Jan-2021
Complete List of Authors:	Zhang, Tingting; Guangxi Medical University, College & Hospital of Stomatology, Dental Public Health Hong, Jialan; University College London, Department of Epidemiology & Public Health Yu, Xueting; Guangxi Medical University, College & Hospital of Stomatology, Dental Public Health Liu, Qiulin; Guangxi Medical University, College & Hospital of Stomatology, Dental Public Health Li, Andi; Guangxi Medical University, College & Hospital of Stomatology, Dental Public Health Wu, Zhijing; Guangxi Medical University, College & Hospital of Stomatology, Dental Public Health Zeng, Xiaojuan ; Guangxi Medical University, College & Hospital of Stomatology, Dental Public Health
Primary Subject Heading:	Dentistry and oral medicine
Secondary Subject Heading:	Epidemiology, Health policy
Keywords:	Community child health < PAEDIATRICS, Epidemiology < INFECTIOUS DISEASES, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

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1 Association between socioeconomic status and 2 dental caries among Chinese preschool children:

3 A cross-sectional national study

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11 **Running Title:** Socioeconomic status and dental caries

12
13 **Keywords:** Socioeconomic inequalities, dental caries, oral health, preschool children

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22
23 Word count: 2603 words

24 Abstract count: 230 words

1

2 **Abstract**

3 **Objectives:** Socioeconomic inequalities in oral health are often neglected in oral health
4 promotion. This cross-sectional study assessed the association between dental caries
5 and socioeconomic status (SES) among preschool children in China.

6 **Design** Cross-sectional study.

7 **Setting** Data from the Fourth National Oral Health Survey of China (2015), comprising
8 of 40,360 children aged 3-5 years was used.

9 **Methods:** Dental caries indicators including prevalence of dental caries, dental pain
10 experience and number of decayed, missing and filling teeth (dmft). SES indicators
11 included parental education and household income. The associations between SES and
12 dental caries were analyzed by using negative binomial regression or Poisson regression
13 models according to data distribution. Relative and absolute inequalities in dental caries
14 were quantified by using the relative index of inequality (RII) and slope index of
15 inequality (SII), respectively.

16 **Results:** There were significant associations between SES and prevalence of dental
17 caries and dmft ($P < 0.001$). Children from lower-educated (RII: 1.36, 95%CI 1.3 to 1.43;
18 SII: 0.97, 95%CI 0.81 to 1.13) and lower household income (RII: 1.17, 95%CI 1.11 to
19 1.24; SII: 0.55, 95%CI 0.35 to 0.75) families had higher dmft than those from well-
20 educated and most affluent families. Relative and absolute inequalities in dental caries
21 were larger in urban areas by household income, and in rural areas by parental education.

22 **Conclusions:** Association between dental caries and SES was demonstrated and
23 socioeconomic inequalities in dental caries existed among Chinese preschool children.

24 **Strength and limitation**

- 25 ● The first study to quantify socioeconomic inequalities in dental caries among
26 Chinese preschool children using relative and absolute inequality regression.
- 27 ● The data was from a relatively large cross-sectional national study.
- 28 ● Cross-sectional nature of the study design precluding inference about
29 causality.

1 Introduction

2 Currently, dental caries is still the greatest global oral health burden with 532
3 million children affected worldwide¹. Dental caries not only post a threat on health and
4 quality of life but also impose a substantial economic burden on the society². Although
5 World Health Organization (WHO) found that the prevalence of dental caries has been
6 declined over the past decade, the declining trend in dental caries was evident in high-
7 income countries but was nonsignificant in low and middle - income countries^{3 4}, even
8 the prevalence of dental caries have increased in some low and middle income countries,
9 suggesting that oral health inequalities remain across countries.

10 An individual's socioeconomic status (SES) is one of the most important
11 determinants in children's oral health⁵, and Evidence has been found that children with
12 low SES, including low household income, low mother's education and living in
13 socially disadvantaged families, were more likely to have higher prevalence of dental
14 caries and greater dental pain experience⁶⁻⁸. In India, a lagged analysis of a structural
15 equation modeling showed that SES contribute to oral health status indirectly⁹. Poor
16 SES can have a deleterious impact on child oral health as a result. Socioeconomic
17 inequality in child dental caries is a great concern in many countries^{7 8 10}. Considering
18 children's critical role in ensuring the well-being of oral health inequality, it is
19 important to explore the oral health in children.

20 China is the world's most populous country, having 1.4 billion people¹¹. China has
21 been undergoing rapid economic developments while also experiencing a processing of
22 increasing inequalities in health¹². For example, Chinese children from rural areas or
23 poorer families are more likely to be stunted than those from urban areas or wealthier
24 families^{13 14}. The inequalities in oral health were also observed in China, suggesting
25 that childhood oral health inequalities can persist into adulthood, irrespective of later
26 changes in social position¹⁵. However, few studies have explored the association
27 between SES and oral health in Chinese preschool children^{16 17}. Hence, additional
28 researches to improve current understanding of socioeconomic inequalities in oral
29 health in preschool children of China is needed.

1 This study was to explore the association between SES and dental caries, and
2 evaluated the socioeconomic inequalities in dental caries among children aged 3 to 5
3 years around the mainland of China.

4 **Methods**

5 **Data source**

6 We used data from the Fourth National Oral Health Survey of China conducted in
7 2015, which was based on a nationally representative sample of 40,360 children aged
8 3-5 years old, providing information on individual oral health status,
9 sociodemographic data and general health status. As previously described¹⁸, a
10 multistage cluster sampling method was used. Ethics approval (Approval no. 2014-
11 003) was obtained from the Ethics Committee of Chinese Stomatological Association,
12 and written consent was obtained by parents of each child to participate in the study.

13 Dental examination was completed by trained and calibrated dentists during the
14 national survey. Those with kappa values higher than 0.8 for the dmft index were
15 qualified. Dental caries diagnostic criteria were adopted according to the WHO
16 recommendation¹⁹. Socioeconomic information from the children's families was
17 obtained by structured questionnaire finished by their parents.

18 **Dependent variables**

19 The three main dependent variables of dental caries status were (1) prevalence of
20 dental caries. (2) dental pain experience ("yes" or "no"), defined as having toothache
21 in the last 12 months, reported by the parents. (3) dmft (count variable), the number of
22 decayed, missing and filled teeth.

23 **Independent variables**

24 Parental education and household income were considered as SES indicators.
25 Parental education was grouped into three categories: low level (secondary school
26 degree or below), middle level (high school degree), and high level (college degree or
27 above) according to the Chinese education system. Household income in the study year
28 (2015) was categorized into five groups according to National Income Quintiles of

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4 1 China: lowest ($\leq 4,000$ \$/year), low (4,000-9,000\$/year), middle (9,000-15,000\$/year),
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7 2 high(15,000-20,000\$/year), highest($> 20,000$ \$/year).

3 **Covariates**

4 Age, gender, ethnic (Han/other ethnics), place of residence (urban/rural) and
5 region (east/central/west) as well as parent-reported child general health (good or better,
6 fair or less) were considered as covariates.

7 **Statistical analysis**

8 Data were analyzed using STATA MP 16.0 (Stata Corp., College Station, TX,
9 USA). Descriptive results were conducted in order to identify the main patterns of data.
10 Proportional differences between different groups were compared by using Chi square
11 tests. Continuous data lack of normal distribution was analyzed using Mann-Whitney
12 test (two groups) or Kruskal-Wallis test (more than two groups).

13 Multiple imputation (MI) was carried out for incomplete data in parental education
14 and household income, which were 10 and 15010 respectively. Overall distribution of
15 available values were used to determine the values to be imputed²⁰, and 40 imputed
16 datasets were generated according to the proportion of missing data, which was at least
17 equal to the percentage of incomplete data²¹. The collinearity between income and
18 education was assessed. Their variance inflation factors (VIF) were both less than 10,
19 indicating these two SES indicators cannot be considered as a linear combination of
20 other independent variables.

21 Poisson regression was used to assessed the associations between SES indicators
22 and prevalence of dental caries or dental pain²². Since the proportion of “zero” caries
23 counts was only 37.5%²³, a negative binomial regression model was used to assess the
24 association between SES indicators and the log dmft . Odds ratios (ORs) for Poisson
25 regression and incidence rate ratio (IRR) for negative binomial regression with 95%
26 confidence intervals (CIs) were reported. Estimates were significantly different from
27 the reference if its 95%CIs do not include 1. Crude model and adjusted model were
28 built. Adjusted model further take consideration of the covariates.

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4 1 Considering the social structure of the population, the relative index of inequality
5 2 (RII) and slope index of inequality (SII) were used to assess relative and absolute
6 3 inequalities respectively²⁴. By disposing the SES indicators as a continuous variable,
7 4 RII and SII use all available data and are not limited to comparisons of extreme groups,
8 5 and finally result into two different types of measures of socioeconomic inequalities in
9 6 health, which are relative and absolute. The SII estimated the absolute predicted
10 7 difference in caries experience between the highest and lowest SES, interpreted as the
11 8 difference in predicted health rates at the two extremes of the socioeconomic spectrum,
12 9 and RII is their ratio. Values of $RII > 1$ or $SII > 0$ signify existence of a SES gradient in
13 10 oral health, and higher the score the greater the magnitude of the inequity. Considering
14 11 the survey weights and missing data, all the above covariates were included in the
15 12 models. The ridit score for estimating SII and RII was calculated²⁵. Using the ridit score
16 13 and continuous caries experience measurements, the ratio of the mean by Poisson
17 14 regression was considered as RII and the beta coefficient by linear regression was
18 15 considered as SII. The ridit score, RII, and SII were calculated for each of the 40
19 16 datasets and RII and SII were integrated.

20 17 Taking into account sampling method and the post stratification, all estimates were
21 18 weighted. Analyses were also conducted stratifying by urban areas and rural areas.

22 19 **Patient and public involvement**

23 20 Patients and the public were not involved in developing the research question,
24 21 study design or outcome measures. While direct dissemination of study results has not
25 22 been planned, they will be communicated through our institutional media services.

26 23 **Results**

27 24 Of the 40,360 children in the study, 50.2% were boys and 49.8% were girls.
28 25 Sociodemographic information was summarized in table 1. In addition, the prevalence
29 26 of dental caries and dental pain, and mean dmft in rural areas were higher than those
30 27 in urban areas, and there was an increasing trend with age, parental education, and
31 28 household income (Table 1).

32 29 The prevalence of dental caries and dental pain was 62.5% and 26.9%, respectively,
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1 and the mean dmft was 3.35 ± 0.02 (Table 2).

2 There were significant associations between oral health and both SES indicators
3 ($P < 0.001$). After adjusting for gender, age, ethnic, region, place of residence and
4 parent-reported child general health, the existence of social gradients in dental caries
5 indicators was confirmed, with the exceptions of dental pain. Figure 1 showed that
6 children from middle and low parental education group had higher dmft (IRR=1.13, 95%
7 CI: 1.09-1.17; and IRR=1.20, 95% CI: 1.17-1.24, respectively). This pattern was also
8 observed for prevalence of dental caries by parental education. Additionally, there was
9 a gradient in the association between household income and prevalence of dental caries
10 and dmft (Figure 1).

11 RII and SII estimates showed significant relative and absolute inequalities for oral
12 health and SES indicators except for dental pain experience. We observed higher dmft
13 among children in the lowest household income families (IRR=1.16, 95% CI:1.10-1.23)
14 than those from the highest household income families (Figure 1), with this being
15 reflected significantly in the relative and absolute index of inequality (RII=1.17,
16 95%CI:1.11-1.24 and SII=0.55, 95%CI: 0.35-0.75) (Figure 2), representing an excess
17 of 1.17 decayed, missing or filling teeth and 55 more children with decayed, missing or
18 filling teeth per 100 children in the lowest household income group compared with the
19 highest one respectively. Similarly, relative inequalities were as well as larger in
20 prevalence of dental caries and dmft by parental education (RII=1.17, 95% CI:1.13-
21 1.21 and RII=1.36, 95% CI:1.30-1.43, respectively). Significant absolute and relative
22 inequalities in dental pain were also observed when stratified by place of residence. In
23 rural areas, inequalities in dental caries in favor of those with lower household income
24 and lower parental education. However, parental education was only significantly
25 associated with prevalence of dental pain in rural areas (RII= 0.87, 95%CI: 0.79-0.95
26 and SII=-0.05, 95%CI: -0.08--0.03). Meanwhile, our findings revealed that
27 inequalities were larger in rural areas by parental education, while inequalities related
28 to household income were larger in urban areas (Figure 2).

29 Discussion

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4 1 In general, we identified a social gradient in oral health of children, with lower SES
5 2 being associated with a higher risk of dental caries and dental pain experience. In urban
6 3 areas, a positive gradient was observed with higher parental education being associated
7 4 with higher dental pain experience. Different from children in urban areas whose
8 5 inequalities in dental caries were larger by household income, inequalities in dental
9 6 caries of children in rural areas were more affected by parental education. This
10 7 characteristic should be considered in future oral health promotion programs.

11 8 Parental education and household income were obvious markers relating to oral
12 9 health in children, with lower parental education and household income being
13 10 significantly associated with higher prevalence of dental caries and higher dmft in this
14 11 study. This finding was in agreement with an earlier dental health inequality studies^{6,26}.
15 12 There was some evidence showed that children from lower SES families suffer from
16 13 more severe dental pain and higher prevalence of dental caries^{27,28}. Among 3-year-old
17 14 Japanese children, higher prevalence of dental caries was associated with lower level
18 15 of parental education²⁶. A cross-sectional study in Australia showed that parental
19 16 education with higher level were significantly inversely associated with dmft of
20 17 children aged 4 to 13 years old²⁹. On the other hand, no association was observed
21 18 between parental education and caries experience in Chinese³⁰ and Mongolian
22 19 children⁸, which may be due to small sample size and the time of data collection.

23 20 This study also revealed household income as a traditional SES indicator of
24 21 children, affected the distribution of caries experience. Evidence from a recent study
25 22 confirmed that household income was one of the strongest factors related to oral
26 23 health³¹. A cohort study on trends in oral health from a life course data in Hong Kong
27 24 suggested that household income had an effect on children's oral health status³².
28 25 Significant inverse associations between household income and dental caries were also
29 26 observed in Chinese¹⁶, American³³, Japanese²⁶, Australian^{6,29}, and Mongolian⁸ children.

30 27 Our findings also revealed that inequality by parental education was existed in
31 28 lower parental education in rural areas. And children in rural areas also had higher dmft
32 29 and prevalence of dental caries than those in urban areas, which keeping with the trend
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1 of a former study in China³⁰. Our finding is also consistent with a Thailand study which
2 examined the time trends in dental caries among children and indicated the prevalence
3 of dental caries was higher for the children who lived in rural areas³⁴. However, from
4 the perspective of household income, relative and absolute inequalities were larger in
5 urban areas in the results. We found that parental education was positively associated
6 with dental pain experience in urban areas. This might be explained by the fact that the
7 neglect of discomfort and pain in children from low parent educated groups, with
8 proportion of high educated parents being larger in urban areas, and larger inequalities
9 by household income in urban areas. Health services utilization is as well as a potential
10 factor accounting for the large inequalities in health between urban and rural residents
11 in China^{35 36}. Utilization of dental services had a positive impact on the caries
12 experience in children and adolescents³².

13 Parental SES might influence child oral health through oral health practice,
14 knowledge and attitude³⁷. Parents of higher education visited a dentist more frequently
15 not only when their children had dental pain, but also to bring their children in for
16 preventive checkups and learn oral health knowledge^{38 39}. Meanwhile, education is a
17 primary determinant of a person's labor market position on the other hand, which in
18 turn influences income, housing, and other material resources. And higher income
19 promotes improved living conditions, such as safe housing, ability to preferentially
20 attend public dental services and receive oral health advices compared with those from
21 lower income⁵.

22 However, parental education and household income are difficult to modify in the
23 short term. Therefore, strategies must be developed to improve oral health of children,
24 facilitate parental knowledge and promote preventive tools. Our findings would
25 advance the argument for oral health promotion initiatives that engage parents of
26 children very early. For example, the positive effect of increased household income and
27 high parental education on child health implies that government provide health service
28 targeting the poor and the illiteracy may be an effective way to improve the oral health
29 of children from low SES families, and public welfare programs should focus on rural

1 areas, or considering the importance of child oral health in future life quality, which
2 implies a potential increasing oral health education in such an inequality in oral health
3 of children. Oral health inequalities are not unconquerable but need government support.
4 For example, socioeconomic inequalities in oral health of children were less
5 conspicuous in areas with water fluoridation compared to non-fluoridated places in
6 Australia⁴⁰. Policies targeting poverty to reduce socioeconomic inequalities may be
7 successful as well as the interventions in health utilization⁴¹. Interprofessional
8 collaboration between professional dentists, non-dentistry professionals and fellow-
9 health professionals should be established to jointly provide services aiming at low SES
10 groups at the same time⁴².

11 **Strength and limitation**

12 A major strength of our study was the Fourth National Oral Health Survey of China
13 use of a relatively large and representative sample of children, which ensured study
14 results are likely to be generalizable across the mainland of China children. And it was
15 the first study to measure inequalities in child oral health by using slope index of
16 inequality and relative index of inequality in China. The study findings should be
17 considered with number of limitations. The study design was the cross-sectional nature
18 precluding inference about causality. We were not able to examine how socioeconomic
19 inequalities in oral health changed as children grew into adolescents. Longitudinal
20 studies of the oral health of representative samples of Chinese children are rare, and
21 that will provide stronger evidence of the potential causal pathways underlying oral
22 health inequalities as further longitudinal data become available.

23 **Conclusions**

24 Children from the lower SES families were more likely to have dental caries.
25 Furthermore, significant inequalities can be found at a very early age.

26 **Acknowledgements** The authors are grateful to the study participants whose data has
27 made this study possible. This study is conducted in partnership between 35 colleges
28 and universities, Center of Disease Control (CDC) of Chinese Health Commission of
29 the People's Republic of China, Chinese Stomatological Association.

1 **Contributors** All authors meet the ICMJE authorship criteria. Tingting Zhang,
2 Xiaojuan Zeng, Jialan Hong and Xueting Yu conceived the study and developed the
3 analysis strategy. Tingting Zhang, Jialan Hong and Xueting Yu carried out the analysis.
4 Tingting Zhang drafted the manuscript. All authors critically reviewed the drafts, gave
5 text suggestions, and approved the final manuscript.

6 **Funding** This study was supported by “Scientific Research Fund of National Health
7 Commission of the People’s Republic of China (201502002)”.

8 **Conflicts of Interest:** None declared.

9 **Patient consent for publication** Not required.

10 **Ethics approval** Ethical approval was obtained from the Ethics Committee of Chinese
11 Stomatological Association (Approval no. 2014-003), and parents of each participant
12 were required to sign an informed consent form.

13 **Provenance and peer review** Not commissioned; externally per reviewed.

14 **Data sharing statement** Consent has not been obtained to share the data publicly.
15 However, data may be accessed on contacting the corresponding author. The same
16 principle applies for statistical analysis scripts.

17 **References**

- 18 1. James. SL, Abate. D, Abate. KH, et al. Global, regional, and national incidence, prevalence, and years
19 lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017:
20 a systematic analysis fo r the Global Burden of Disease Study 2017. *The Lancet*
21 2018;392(10159):1789-858. doi: 10.1016/S0140-6736(18)32279-7.
- 22 2. Righolt AJ, Jevdjevic M, Marcenes W, et al. Global-, regional-, and country-Level economic impacts
23 of dental diseases in 2015. *J Dent Res* 2018;97(5):501-07. doi: 10.1177/0022034517750572.
- 24 3. Lagerweij M D, C. VL. Declining caries trends: are we satisfied? *Curr Oral Healht Rep* 2015;2:212-
25 17. doi: 10.1007/s40496-015-0064-9.
- 26 4. Frencken J, E., Sharma P, Stenhouse L, et al. Global epidemiology of dental caries and severe
27 periodontitis - a comprehensive review. *Journal of Clinical Periodontology* 2017;44:S94-S105.
28 doi: 10.1111/jcpe.12677.
- 29 5. Fisher-Owens SA, Gansky SA, Platt LJ, et al. Influences on children's oral health: a conceptual model.
30 *Pediatrics* 2007;120(3):e510-e20. doi: 10.1542/peds.2006-3084.
- 31 6. Kilpatrick N, M., Neumann A, Lucas N, et al. Oral health inequalities in a national sample of
32 Australian children aged 2-3 and 6-7 years. *Aust Dent J* 2012;57(1):38-44. doi: 10.1111/j.1834-
33 7819.2011.01644.x.
- 34 7. Rouxel P, Chandola T. Socioeconomic and ethnic inequalities in oral health among children and
35 adolescents living in England, Wales and Northern Ireland. *Community Dent Oral Epidemiol*

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- 1 2018;46(5):426-34. doi: 10.1111/cdoe.12390.
- 2 8. Chinzorig T, Aida J, Cooray U, et al. Inequalities in caries experience among mongolian children. *Int*
3 *J Environ Res Public Health* 2019;16(20) doi: 10.3390/ijerph16203892.
- 4 9. E. G, Robinson P G, Marya C M, et al. Oral health inequalities: relationships between environmental
5 and individual factors. *J Dent Res* 2015;94(10):1362-68. doi: 10.1177/0022034515592880.
- 6 10. Ha DH, Do LG, Roberts-Thomson K, et al. Risk indicators for untreated dental decay among
7 Indigenous Australian children. *Community Dent Oral Epidemiol* 2019 doi:
8 10.1111/cdoe.12460.
- 9 11. Statistics NBo. Statistical bulletin of the People's Republic of China on national economic and social
10 development in 2019, 2020.
- 11 12. Fang P, Dong S, Xiao J, et al. Regional inequality in health and its determinants: evidence from China.
12 *Health Policy* 2010;94(1):14-25. doi: 10.1016/j.healthpol.2009.08.002.
- 13 13. Liu H, Fang H, Zhao Z. Urban-rural disparities of child health and nutritional status in China from
14 1989 to 2006. *Econ Hum Biol* 2013;11(3):294-309. doi: 10.1016/j.ehb.2012.04.010.
- 15 14. Chen. Y, Ler. X, Zhou. L-a. Does raising family income cause better child health ? Evidence from
16 China. *Economic Development and Cultural Change* 2017;65(3):495-520.
- 17 15. WM. T, R. P, BJ. M, et al. Socioeconomic inequalities in oral health in childhood and adulthood in
18 a birth cohort. *Community Dent Oral Epidemiol* 2004;32:3345-53.
- 19 16. Guan. Y, Zeng. X, Tai. B, et al. Socioeconomic inequalities in dental caries among 5-year-olds in
20 four Chinese provinces. *Community Dental Health* 2015;32:185-89. doi:
21 10.1922/CDH_3524Guan05.
- 22 17. Wong HM, McGrath CPJ, King NM, et al. Oral health-related quality of Life in Hong Kong preschool
23 children. *Caries Res* 2011;45(4):370-76. doi: 10.1159/000330231.
- 24 18. Lu. H, Tao. D, Lo. EC, et al. The 4th National Oral Health Survey in the mainland of China:
25 background and methodology. *Chin J Dent Res* 2018;21(3):161-65.
- 26 19. (WHO) WHO. Oral health surveys: basic methods. 5 edition. Geneva: World Health Organization
27 2013.
- 28 20. Pedersen AB, Mikkelsen EM, Cronin-Fenton D, et al. Missing data and multiple imputation in
29 clinical epidemiological research. *Clin Epidemiol* 2017;9:157-66. doi: 10.2147/CLEP.S129785.
- 30 21. White IR, Royston P, Wood AM. Multiple imputation using chained equations: issues and guidance
31 for practice. *Statistics in medicine* 2011;30(4):377-99.
- 32 22. MacDonald RBJM. Overdispersion and Poisson regression. *2008* 2008;24(3):269-84. doi:
33 10.1007/s10940-008-9048-4.
- 34 23. Coxe S, West SG, Aiken LS. The analysis of count data: A gentle introduction to Poisson regression
35 and its alternatives. *Journal of personality assessment* 2009;91(2):121-36.
- 36 24. Mackenbach J P, Kunst A, E. . Mearuring the magnitude of socio-economic inequalities in health: an
37 overview of available measures illustrated with two examples from Europe. *Soc Sci Med*
38 1997;44(6):757-71.
- 39 25. RIIGEN: Stata module to generate variables to compute the Relative Index of Inequality [program].
40 revised 21 Nov 2013 version: Boston College Department of Economics, 2013.
- 41 26. Kato. H, Tanaka. K, Shimizu. K, et al. Parental occupations, educational level, and income and
42 prevalence of dental caries in 3-year-old Japanese children. *Environmental Health and*
43 *Preventive Medicine* 2017;22(80) doi: <https://doi.org/10.1186/s12199-017-0688-6>.

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- 1 27. Peres M, A., Macpherson L, M, D., Weyant R, J., et al. Oral diseases: a global public health challenge. *The Lancet* 2019;394:249-60. doi: 10.1016/s0140-6736(19)31146-8.
 - 2 28. Armfield J M. Socioeconomic inequalities in child oral health: a comparison of discrete and composite area-based measures. *Journal of Public Health Dentistry* 2007;67(2):119-25. doi: 10.1111/j.0022-4006.2007.00026.x.
 - 3 29. LM. J, JM. A, KF. R-T. Oral health inequalities among indigenous and nonindigenous children in the Northern Territory of Australia. *Community Dent Oral Epidemiol* 2006;34:267-76.
 - 4 30. Anqi. S, Xiaojuan. Z, Min. C, et al. Inequalities in dental caries among 12-year-old Chinese children. *Journal of Public Health Dentistry* 2015;75(3):210-17. doi: 10.1111/jphd.12091.
 - 5 31. Kragt L, Wolvius EB, Raat H, et al. Social inequalities in children's oral health-related quality of life: the Generation R Study. *Qual Life Res* 2017;26(12):3429-37. doi: 10.1007/s11136-017-1679-1.
 - 6 32. Lu HX, Wong MC, Lo EC, et al. Trends in oral health from childhood to early adulthood: a life course approach. *Community Dent Oral Epidemiol* 2011;39(4):352-60. doi: 10.1111/j.1600-0528.2011.00611.x.
 - 7 33. Slade GD, Sanders AE. Two decades of persisting income-disparities in dental caries among US children and adolescents. *Journal of public health dentistry* 2018;78(3):187-91.
 - 8 34. Srisilapanan P, Nirunsittirat A, Roseman J. Trends over time in dental caries status in urban and rural Thai children. *J Clin Exp Dent* 2017;9(10):e1201.
 - 9 35. Zhao Y, Zhang L, Fu Y, et al. Socioeconomic Disparities in Cancer Treatment, Service Utilization and Catastrophic Health Expenditure in China: A Cross-Sectional Analysis. *Int J Environ Res Public Health* 2020;17(4) doi: 10.3390/ijerph17041327.
 - 10 36. Zhang R, Chen Y, Liu S, et al. Progress of equalizing basic public health services in Southwest China-- health education delivery in primary healthcare sectors. *BMC Health Serv Res* 2020;20(1):247. doi: 10.1186/s12913-020-05120-w.
 - 11 37. Zhang Y, Li KY, Lo ECM, et al. Structural equation model for parental influence on children's oral health practice and status. *BMC oral health* 2020;20(1):1-10.
 - 12 38. Gao X, Ding M, Xu M, et al. Utilization of dental services and associated factors among preschool children in China. *BMC oral health* 2020;20(1):1-10.
 - 13 39. Pieper K, Dressler S, Heinzl-Gutenbrunner M, et al. The influence of social status on pre-school children's eating habits, caries experience and caries prevention behavior. *International Journal of Public Health* 2012;57(1):207-15. doi: 10.1007/s00038-011-0291-3.
 - 14 40. Jason M. Armfield JS, Kaye F. Roberts-Thomson, Katrina Plastow. Water fluoridation and the association of sugar-sweetened beverage consumption and dental caries in Australian children. *American Journal of Public Health* 2013;103(3):494-500. doi: 10.2105/AJPH.2012.
 - 15 41. Borrell LN. Oral health inequities: An AJPH supplement to help close the gap: American Public Health Association, 2017.
 - 16 42. Harper HJ, Conicella ML, Cranston NC, et al. The Aetna-NDA Partnership for Achieving Racial and Ethnic Health Equity: American Public Health Association, 2017.

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7 **Figure Legends**

8 Figure 1. Odds ratio (OR), Incidence rate ratio (IRR) stratified by parental education
9 and household income.

10 Footnote: Odds ratio (OR), Incidence rate ratio (IRR) and 95% confidence intervals
11 (CIs) by parental education and household income are presented as well as the level of
12 significance. Crude model: each SES measure (parental education and household
13 income) and outcomes (dental caries, dental pain and dmft). Adjusted model: adjusted
14 for age, gender, ethnic, place of residence, region, and parent-reported child general
15 health. All estimates models are weighted. * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

16 Figure 2. Relative index of inequality (RII) and slope index of inequality (SII) for
17 urban and rural area by parental education and household income.

18 Footnote: Estimates and 95% confidence intervals (CIs) are presented as well as the
19 level of significance, adjusted by age, gender, ethnic, region and parent-reported child
20 general health. All estimates models are weighted. * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

21 **Supplementary fig 1** Odds ratio (OR), Incidence rate ratio (IRR) stratified by
22 parental education and household income.

23 Footnote: Odds ratio (OR), Incidence rate ratio (IRR) and 95% confidence intervals
24 (CIs) by parental education and household income are presented as well as the level of
25 significance. Crude model: each SES measure (parental education and household
26 income) and outcomes (dental caries, dental pain and dmft). Adjusted model: adjusted
27 for age, gender, ethnic, place of residence, region and parent-reported child general
28 health. All estimates models are weighted. * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

29 **Supplementary fig 2** Relative index of inequality (RII) and slope index of inequality
30 (SII) for urban and rural area by parental education and household income. Footnote:

1 Estimates and 95% confidence intervals (CIs) are presented as well as the level of
 2 significance, adjusted by age, gender, ethnic, region and parent-reported child general
 3 health. All estimates models are weighted. *P < 0.05, **P < 0.01, ***P < 0.001.

4
 5 Table 1 Summary of the characteristics of the study participants.

Category	n	%	caries		P value*	pain		P value*	dmft (mean ± SD)	P value*
			n	%		n	%			
Gender					<0.001			<0.001		<0.001
Male	20245	50.2	12598	62.7		5078	26.2		3.39 ± 0.03	
Female	20115	49.8	12545	62.4		5340	27.7		3.31 ± 0.03	
Age (years)					<0.001			<0.001		<0.001
3-7	12390	30.7	6292	50.8		2024	17.1		2.28 ± 0.03	
8-13	13978	34.6	8895	63.6		3420	25.5		3.40 ± 0.04	
14-17	13992	34.7	10056	71.9		4974	37.0		4.24 ± 0.04	
Ethnic					<0.001			<0.001		<0.001
Han	36087	89.4	22401	62.1		9231	26.7		3.32 ± 0.02	
Other ethnics	4273	10.6	2842	66.5		1187	28.9		3.63 ± 0.06	

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5	Place of residence				<0.001			<0.001	<0.001
6									
7									
8									
9	Urban	20490	50.8	12449	60.8	5166	26.2	3.14 ± 0.03	
10									
11									
12									
13	Rural	19870	49.2	12794	64.4	5252	27.7	3.57 ± 0.03	
14									
15									
16	Region				<0.001			<0.001	<0.001
17									
18									
19	East	14127	35.0	9385	66.4	3872	28.5	3.83 ± 0.04	
20									
21									
22									
23									
24	Middle	10403	25.8	6216	59.8	2654	27.0	3.09 ± 0.04	
25									
26									
27									
28									
29	West	15830	39.2	9642	60.9	3892	25.5	3.09 ± 0.03	
30									
31									
32	Parents-reported								
33									
34	Child general health				<0.001			<0.001	<0.001
35									
36									
37									
38									
39	Good or better	28885	71.6	17860	61.8	6954	25.0	3.25 ± 0.02	
40									
41									
42									
43	Fair or less	11475	28.4	7383	64.3	3464	32.0	3.60 ± 0.04	
44									
45									
46									
47	Parental education								
48									
49					<0.001			0.137	<0.001
50									
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53									
54	High	12615	36.1*	7326	58.1*	3208	26.3*	2.90 ± 0.04*	
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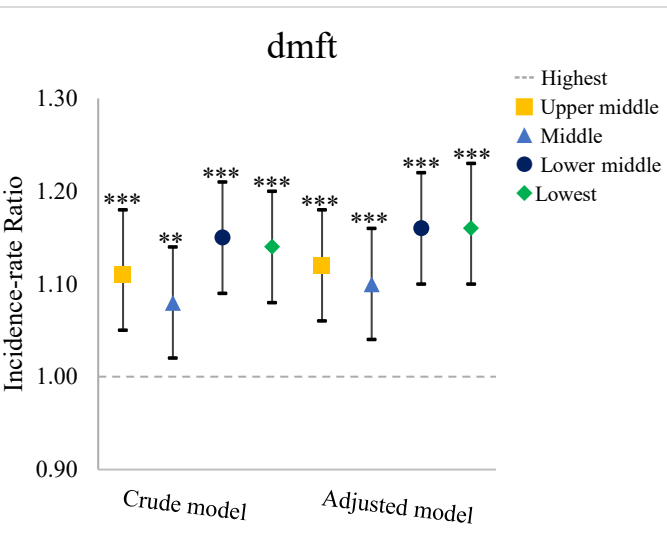
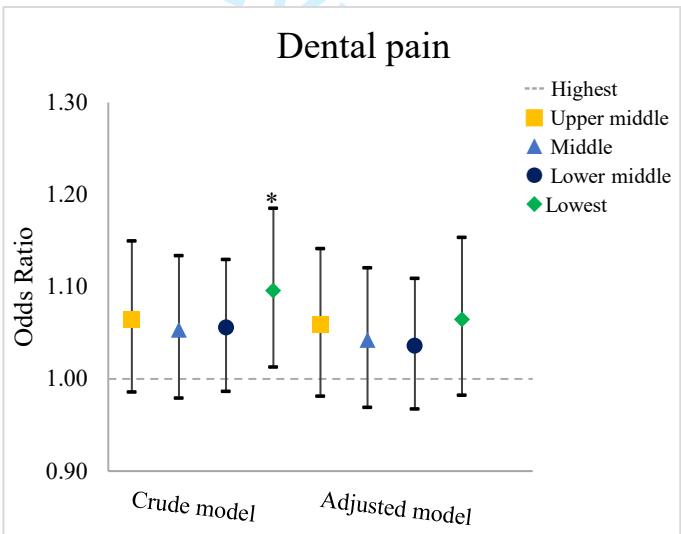
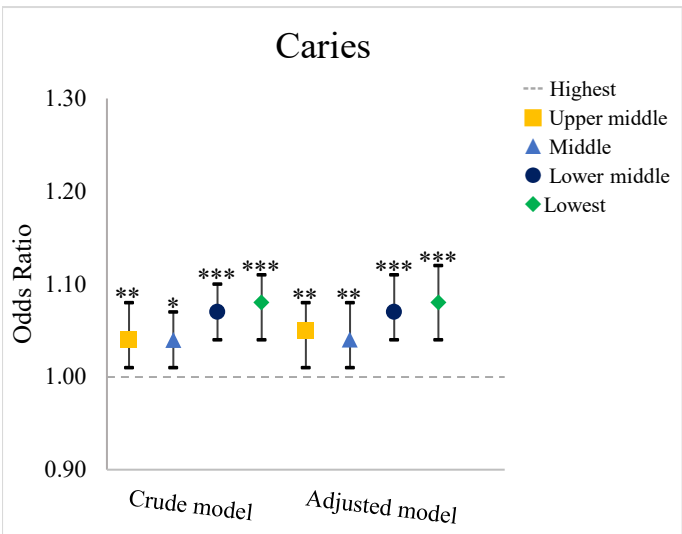
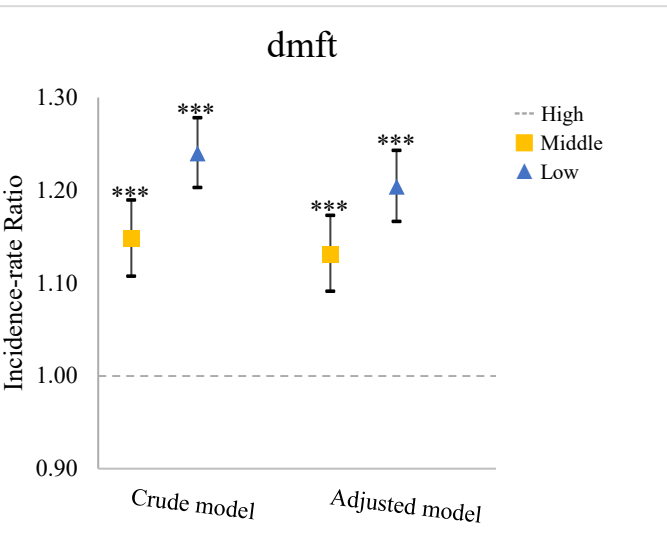
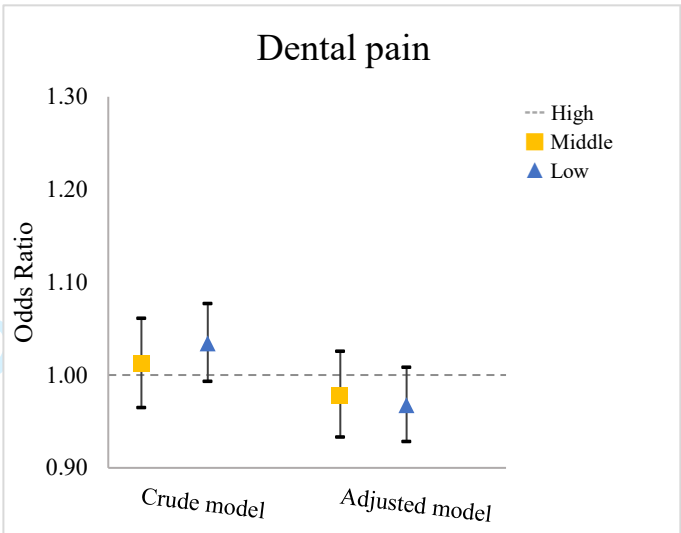
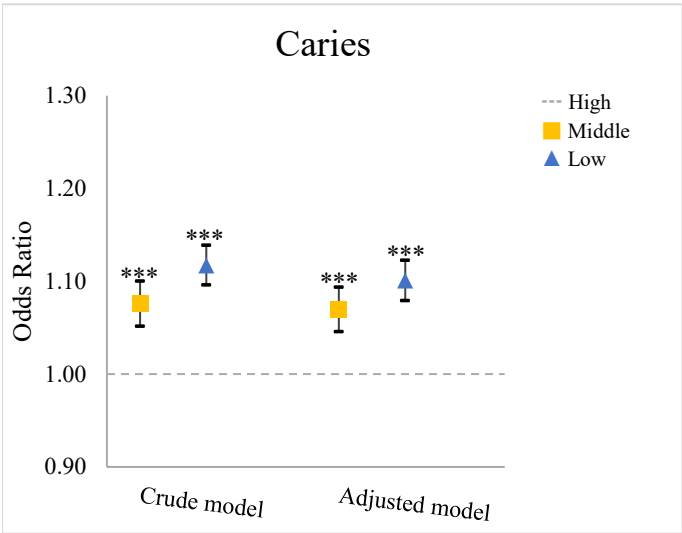
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5 Middle 9457 23.2* 5914 62.5* 2445 26.9* 3.34±0.04*
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10 Low 18278 40.7* 11998 65.6* 4762 27.4* 3.66±0.03*
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12 **Household income**
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36 Lowest 6619 13.6* 2825 65.1* 1131 28.2* 3.53±0.06*
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39 1 *Proportions and *P*-values are presented after multiple imputation for parental
40 2 education and household income.

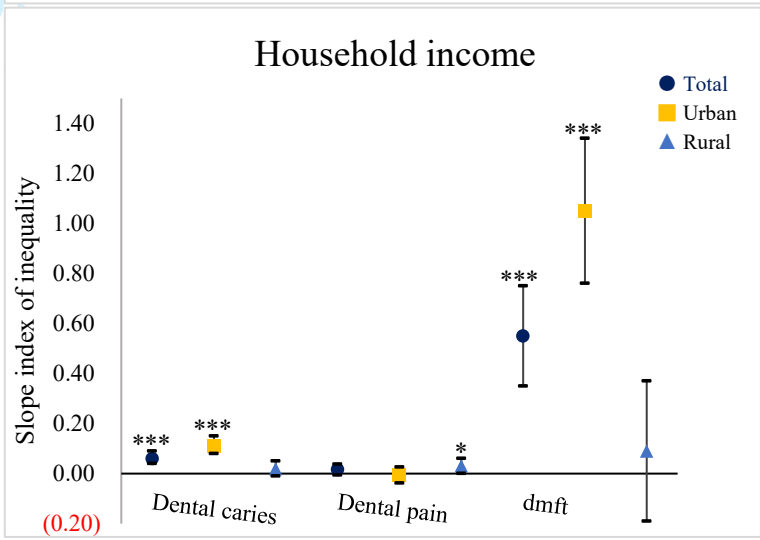
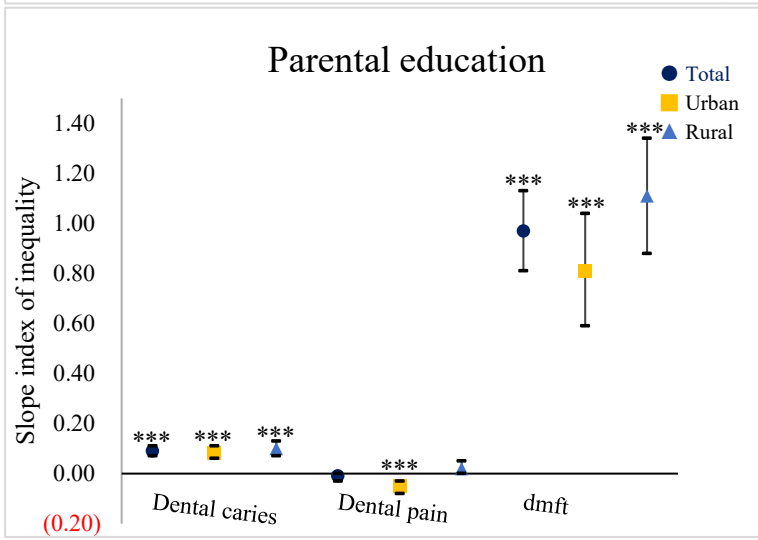
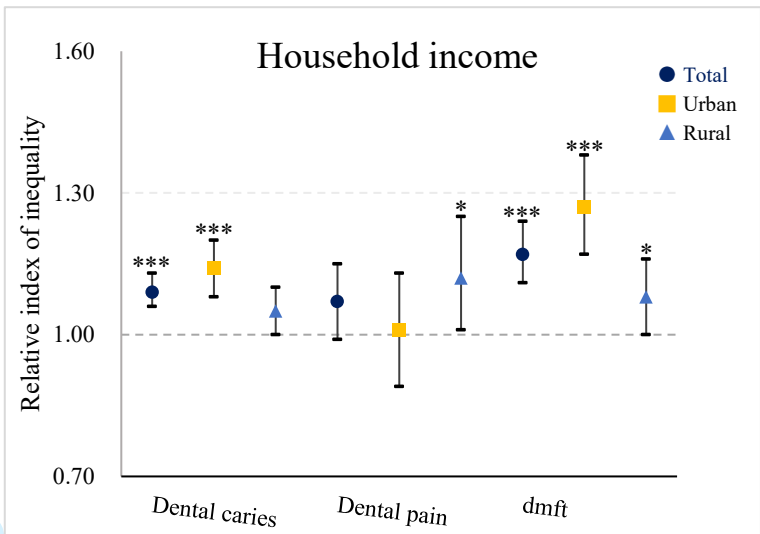
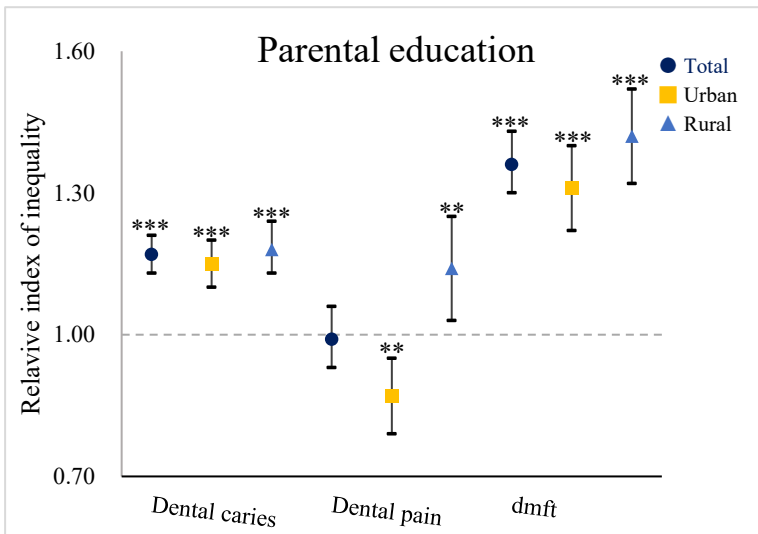
41 3 Table 2. Basic characteristics of dental caries indicators in the study participants.

Category	Overall	
	n	%
Caries	25243	62.5
Dental pain	10418	26.9
dmft(Mean±SD)	3.35±0.02	

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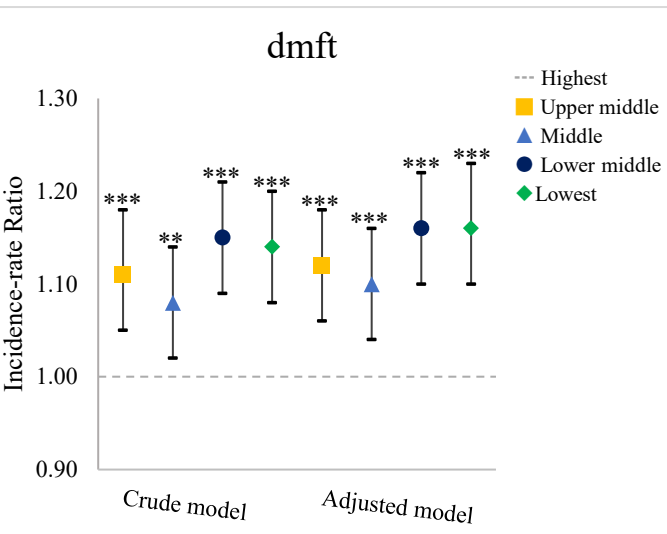
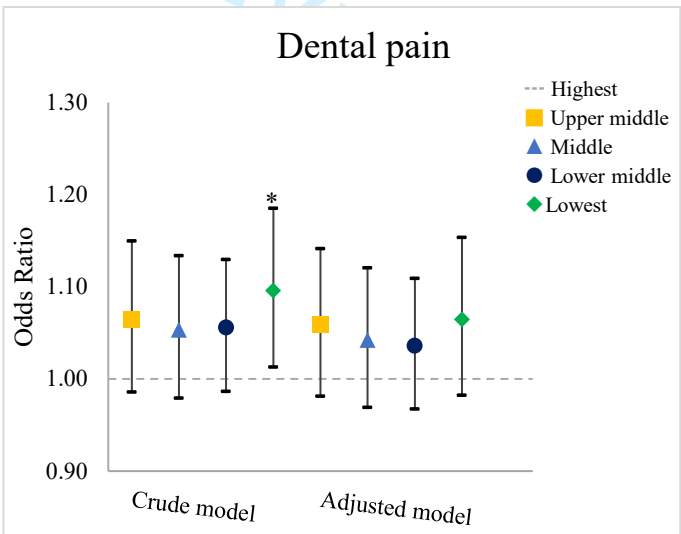
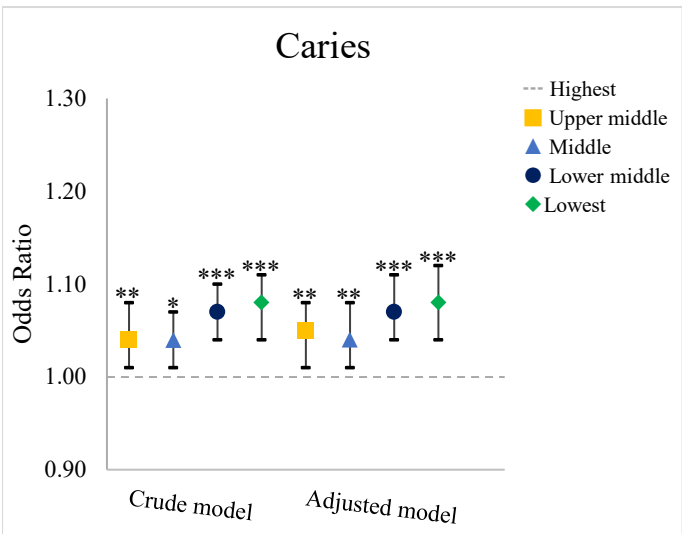
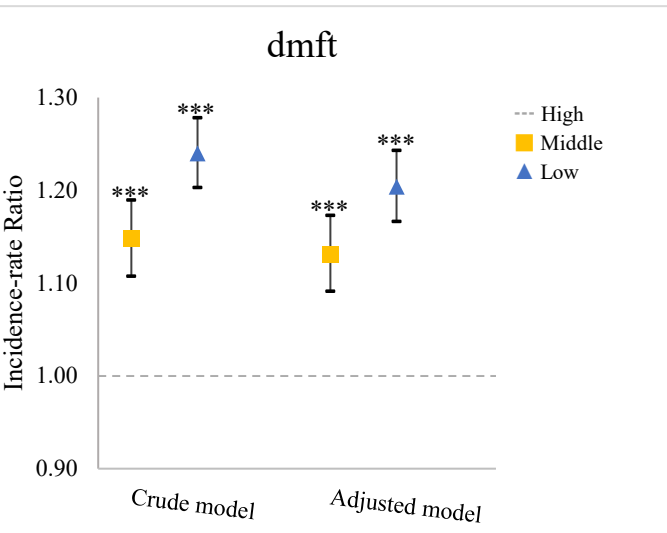
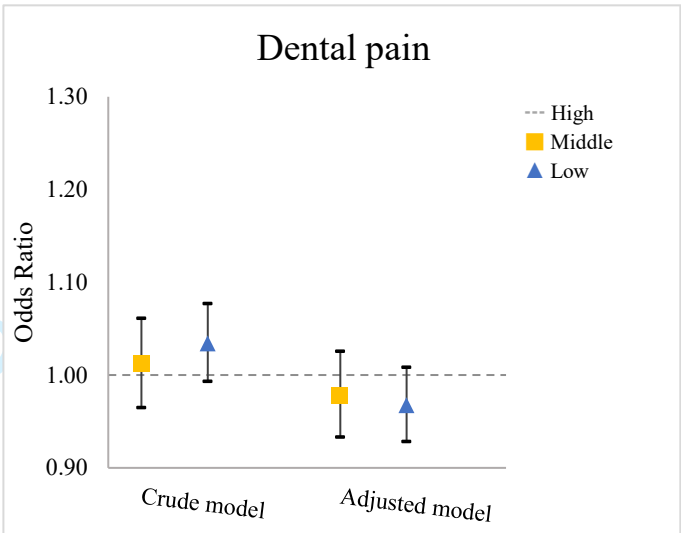
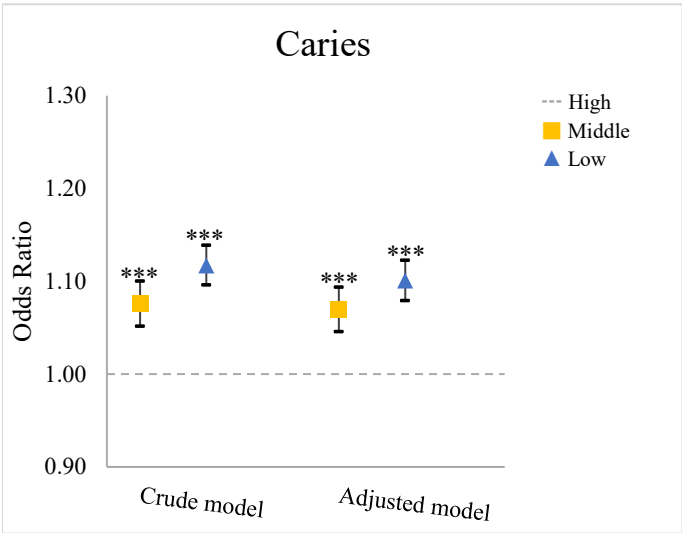


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6 95% confidence intervals (CIs) by parental education and household income are presented as well as the level of significance. Crude model: each SES
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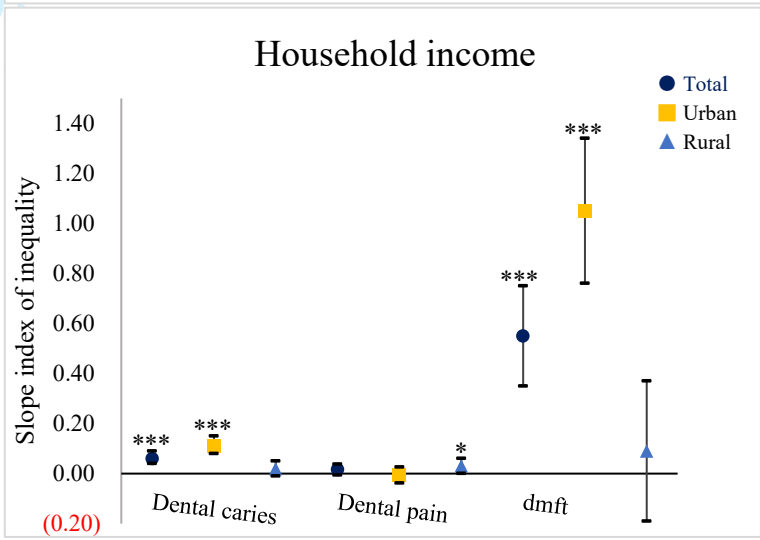
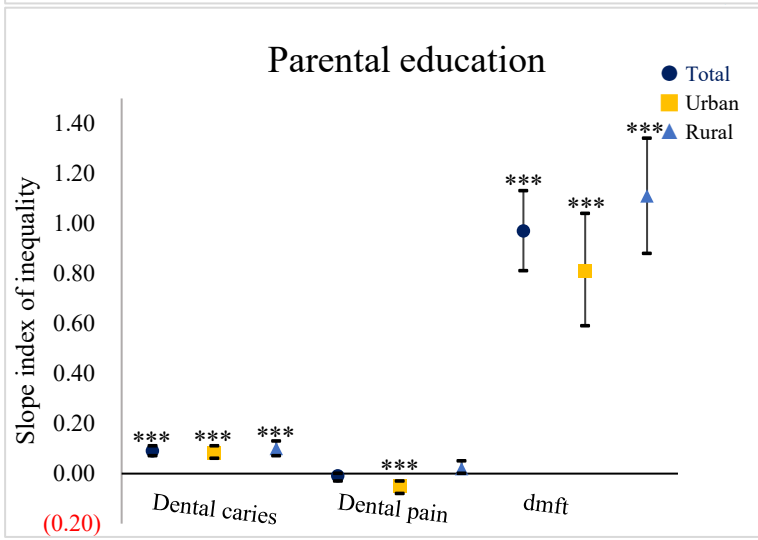
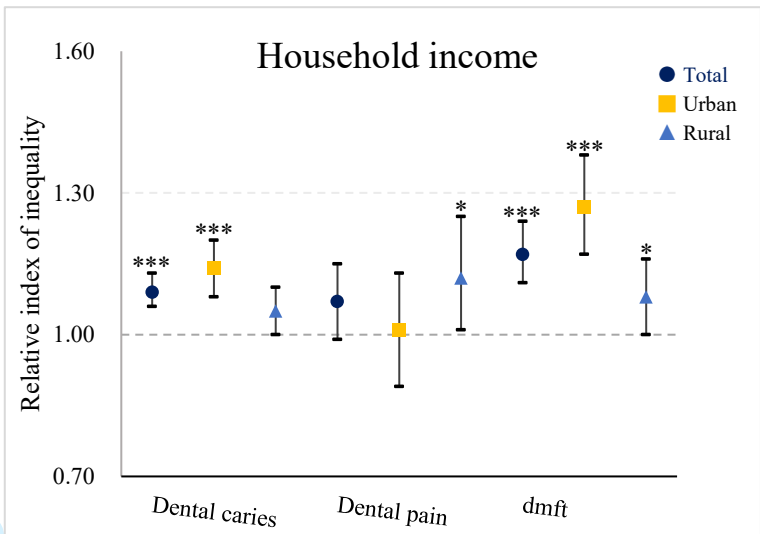
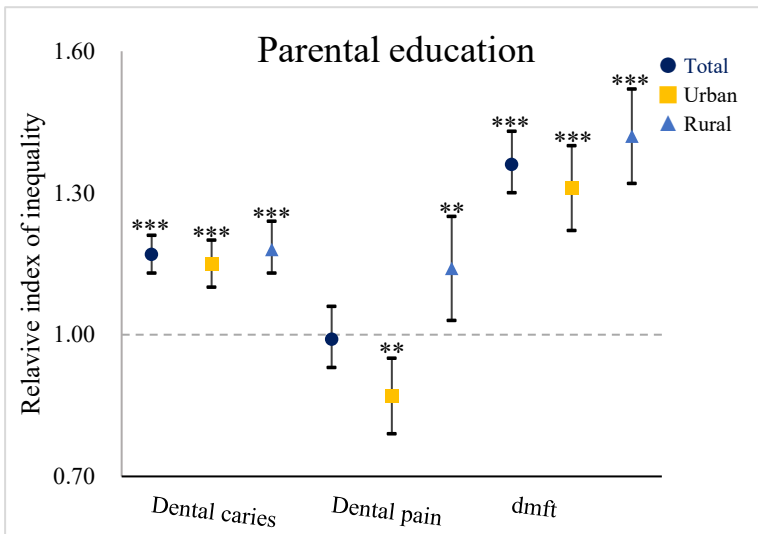


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5 Figure 2. Relative index of inequality (RII) and slope index of inequality (SII) for urban and rural area by parental education and household income.
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For peer review only



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STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1-2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	1-2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4-5
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4-5
Bias	9	Describe any efforts to address potential sources of bias	4-5
Study size	10	Explain how the study size was arrived at	4-5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4-5
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	5-6
		(b) Describe any methods used to examine subgroups and interactions	5-6
		(c) Explain how missing data were addressed	5
		(d) If applicable, describe analytical methods taking account of sampling strategy	5-6
		(e) Describe any sensitivity analyses	5
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	No
		(c) Consider use of a flow diagram	No
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6-7
		(b) Indicate number of participants with missing data for each variable of interest	No
Outcome data	15*	Report numbers of outcome events or summary measures	6-7
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7

		(b) Report category boundaries when continuous variables were categorized	7
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	7
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	No
Discussion			
Key results	18	Summarise key results with reference to study objectives	8-9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-10
Generalisability	21	Discuss the generalisability (external validity) of the study results	9-10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	10

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Association between socioeconomic status and dental caries among Chinese preschool children: a cross-sectional national study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2020-042908.R2
Article Type:	Original research
Date Submitted by the Author:	27-Apr-2021
Complete List of Authors:	Zhang, Tingting; Guangxi Medical University, College & Hospital of Stomatology, Dental Public Health Hong, Jialan; University College London, Department of Epidemiology & Public Health Yu, Xueting; Guangxi Medical University, College & Hospital of Stomatology, Dental Public Health Liu, Qiulin; Guangxi Medical University, College & Hospital of Stomatology, Dental Public Health Li, Andi; Guangxi Medical University, College & Hospital of Stomatology, Dental Public Health Wu, Zhijing; Guangxi Medical University, College & Hospital of Stomatology, Dental Public Health Zeng, Xiaojuan ; Guangxi Medical University, College & Hospital of Stomatology, Dental Public Health
Primary Subject Heading:	Dentistry and oral medicine
Secondary Subject Heading:	Epidemiology, Health policy
Keywords:	Community child health < PAEDIATRICS, Epidemiology < INFECTIOUS DISEASES, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

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4 1 **Association between socioeconomic status and**
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7 2 **dental caries among Chinese preschool children:**
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9 3 **A cross-sectional national study**

11 4 Tingting Zhang¹, Jialan Hong², Xueting Yu¹, Qiulin Liu¹, Andi Li¹, Zhijing Wu¹,
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25 11 **Running Title:** Socioeconomic status and dental caries

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29 13 **Keywords:** Socioeconomic inequalities, dental caries, oral health, preschool children

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47 22
48 23 Word count: 2602 words

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50 24 Abstract count: 230 words

1

2 **Abstract**

3 **Objectives:** Socioeconomic inequalities in oral health are often neglected in oral health
4 promotion. This cross-sectional study assessed the association between dental caries
5 and socioeconomic status (SES) among preschool children in China.

6 **Design** Cross-sectional study.

7 **Setting** Data from the Fourth National Oral Health Survey of China (2015), comprising
8 of 40,360 children aged 3-5 years was used.

9 **Methods:** Dental caries indicators including prevalence of dental caries, dental pain
10 experience and number of decayed, missing and filling teeth (dmft). SES indicators
11 included parental education and household income. The associations between SES and
12 dental caries were analyzed by using negative binomial regression or Poisson regression
13 models according to data distribution. Relative and absolute inequalities in dental caries
14 were quantified by using the relative index of inequality (RII) and slope index of
15 inequality (SII), respectively.

16 **Results:** There were significant associations between SES and prevalence of dental
17 caries and dmft ($P < 0.001$). Children from lower-educated (RII: 1.36, 95%CI 1.3 to 1.43;
18 SII: 0.97, 95%CI 0.81 to 1.13) and lower household income (RII: 1.17, 95%CI 1.11 to
19 1.24; SII: 0.55, 95%CI 0.35 to 0.75) families had higher dmft than those from well-
20 educated and most affluent families. Relative and absolute inequalities in dental caries
21 were larger in urban areas by household income, and in rural areas by parental education.

22 **Conclusions:** Association between dental caries and SES was demonstrated and
23 socioeconomic inequalities in dental caries existed among Chinese preschool children.

24 **Strength and limitation**

- 25 ● The first study to quantify socioeconomic inequalities in dental caries among
26 Chinese preschool children using relative and absolute inequality regression.
- 27 ● The data was from a relatively large cross-sectional national study.
- 28 ● Cross-sectional nature of the study design precluding inference about
29 causality.

1 Introduction

2 Currently, dental caries is still the greatest global oral health burden with 532
3 million children affected worldwide¹. Dental caries not only post a threat on health and
4 quality of life but also impose a substantial economic burden on the society². Although
5 World Health Organization (WHO) found that the prevalence of dental caries has been
6 declined over the past decade, the declining trend in dental caries was evident in high-
7 income countries but was nonsignificant in low and middle - income countries^{3 4}, even
8 the prevalence of dental caries has increased in some low and middle income countries,
9 suggesting that oral health inequalities remain across countries.

10 An individual's socioeconomic status (SES) is one of the most important
11 determinants in children's oral health⁵, and Evidence has been found that children with
12 low SES, including low household income, low mother's education and living in
13 socially disadvantaged families, were more likely to have higher prevalence of dental
14 caries and greater dental pain experience⁶⁻⁸. In India, a lagged analysis of a structural
15 equation modeling showed that SES contribute to oral health status indirectly⁹. Poor
16 SES can have a deleterious impact on child oral health as a result. Socioeconomic
17 inequality in child dental caries is a great concern in many countries^{7 8 10}. Considering
18 children's critical role in ensuring the well-being of oral health inequality, it is
19 important to explore the oral health in children.

20 China is the world's most populous country, having 1.4 billion people¹¹. China has
21 been undergoing rapid economic developments while also experiencing a processing of
22 increasing inequalities in health¹². For example, Chinese children from rural areas or
23 poorer families are more likely to be stunted than those from urban areas or wealthier
24 families^{13 14}. The inequalities in oral health were also observed in China, suggesting
25 that childhood oral health inequalities can persist into adulthood, irrespective of later
26 changes in social position¹⁵. However, few studies have explored the association
27 between SES and oral health in Chinese preschool children^{16 17}. Hence, additional
28 research to improve current understanding of socioeconomic inequalities in oral health
29 in preschool children of China is needed.

1 This study was to explore the association between SES and dental caries, and
2 evaluated the socioeconomic inequalities in dental caries among children aged 3 to 5
3 years around the mainland of China.

4 **Methods**

5 **Data source**

6 We used data from the Fourth National Oral Health Survey of China conducted
7 in 2015, which was based on a nationally representative sample of 40,360 children
8 aged 3-5 years old, providing information on individual oral health status,
9 sociodemographic data and general health status. As previously described¹⁸, a
10 multistage cluster sampling method was used. Ethics approval (Approval no. 2014-
11 003) was obtained from the Ethics Committee of Chinese Stomatological Association,
12 and written consent was obtained by parents of each child to participate in the study.

13 Dental examination was completed by trained and calibrated dentists during the
14 national survey. Those with kappa values higher than 0.8 for the dmft index were
15 qualified. Dental caries diagnostic criteria were adopted according to the WHO
16 recommendation¹⁹. Socioeconomic information from the children's families was
17 obtained by structured questionnaire finished by their parents.

18 **Dependent variables**

19 The three main dependent variables of dental caries status were (1) prevalence of
20 dental caries. (2) dental pain experience ("yes" or "no"), defined as having toothache
21 in the last 12 months, reported by the parents. (3) dmft (count variable), the number of
22 decayed, missing and filled teeth.

23 **Independent variables**

24 Parental education and household income were considered as SES indicators.
25 Parental education was grouped into three categories: low level (secondary school
26 degree or below), middle level (high school degree), and high level (college degree or
27 above) according to the Chinese education system. Household income in the study year
28 (2015) was categorized into five groups according to National Income Quintiles of

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4 1 China: lowest ($\leq 4,000$ \$/year), low (4,000-9,000\$/year), middle (9,000-15,000\$/year),
5
6 2 high(15,000-20,000\$/year), highest($> 20,000$ \$/year).
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9 3 **Covariates**

10 4 Age, gender, ethnic (Han/other ethnics), place of residence (urban/rural) and
11 5 region (east/central/west) as well as parent-reported child general health (good or better,
12 6 fair or less) were considered as covariates.
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14 7 **Statistical analysis**

15 8 Data were analyzed using STATA MP 16.0 (Stata Corp., College Station, TX,
16 9 USA). Descriptive results were conducted in order to identify the main patterns of data.
17 10 Proportional differences between different groups were compared by using Chi square
18 11 tests. Continuous data lack of normal distribution was analyzed using Mann-Whitney
19 12 test (two groups) or Kruskal-Wallis test (more than two groups).
20

21 13 Multiple imputation (MI) was carried out for incomplete data in parental education
22 14 and household income, which were 10 and 15010 respectively. Overall distribution of
23 15 available values was used to determine the values to be imputed²⁰, and 40 imputed
24 16 datasets were generated according to the proportion of missing data, which was at least
25 17 equal to the percentage of incomplete data²¹. The collinearity between income and
26 18 education was assessed. Their variance inflation factors (VIF) were both less than 10,
27 19 indicating these two SES indicators cannot be considered as a linear combination of
28 20 other independent variables.
29

30 21 Poisson regression was used to assess the associations between SES indicators and
31 22 prevalence of dental caries or dental pain²². Since the proportion of “zero” caries counts
32 23 was only 37.5%²³, a negative binomial regression model was used to assess the
33 24 association between SES indicators and the log dmft. Odds ratios (ORs) for Poisson
34 25 regression and incidence rate ratio (IRR) for negative binomial regression with 95%
35 26 confidence intervals (CIs) were reported. Estimates were significantly different from
36 27 the reference if its 95%CIs do not include 1. Crude model and adjusted model were
37 28 built. Adjusted model further take consideration of the covariates.
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4 1 Considering the social structure of the population, the relative index of inequality
5 2 (RII) and slope index of inequality (SII) were used to assess relative and absolute
6 3 inequalities respectively²⁴. By disposing the SES indicators as a continuous variable,
7 4 RII and SII use all available data and are not limited to comparisons of extreme groups,
8 5 and finally result into two different types of measures of socioeconomic inequalities in
9 6 health, which are relative and absolute. The SII estimated the absolute predicted
10 7 difference in caries experience between the highest and lowest SES, interpreted as the
11 8 difference in predicted health rates at the two extremes of the socioeconomic spectrum,
12 9 and RII is their ratio. Values of $RII > 1$ or $SII > 0$ signify existence of a SES gradient in
13 10 oral health, and higher the score the greater the magnitude of the inequity. Considering
14 11 the survey weights and missing data, all the above covariates were included in the
15 12 models. The ridit score for estimating SII and RII was calculated²⁵. Using the ridit score
16 13 and continuous caries experience measurements, the ratio of the mean by Poisson
17 14 regression was considered as RII and the beta coefficient by linear regression was
18 15 considered as SII. The ridit score, RII, and SII were calculated for each of the 40
19 16 datasets and RII and SII were integrated.

20 17 Taking into account sampling method and the post stratification, all models were
21 18 survey-weighted. Analyses were also conducted stratifying by urban areas and rural
22 19 areas.

20 **Patient and public involvement**

21 21 Patients and the public were not involved in developing the research question,
22 22 study design or outcome measures. While direct dissemination of study results has not
23 23 been planned, they will be communicated through our institutional media services.

24 **Results**

25 25 Of the 40,360 children in the study, 50.2% were boys and 49.8% were girls.
26 26 Sociodemographic information was summarized in table 1. In addition, the prevalence
27 27 of dental caries and dental pain, and mean dmft in rural areas were higher than those
28 28 in urban areas, and there was an increasing trend with age, parental education, and
29 29 household income (Table 1).

1 The prevalence of dental caries and dental pain was 62.5% and 26.9%, respectively,
2 and the mean dmft was 3.35±0.02 (Table 2).

3 There were significant associations between oral health and both SES indicators
4 ($P<0.001$). After adjusting for gender, age, ethnic, region, place of residence and
5 parent-reported child general health, the existence of social gradients in dental caries
6 indicators was confirmed, with the exceptions of dental pain. Figure 1 showed that
7 children from middle and low parental education group had higher dmft (IRR=1.13, 95%
8 CI: 1.09-1.17; and IRR=1.20, 95% CI: 1.17-1.24, respectively). This pattern was also
9 observed for prevalence of dental caries by parental education. Additionally, there was
10 a gradient in the association between household income and prevalence of dental caries
11 and dmft (Figure 1).

12 RII and SII estimates showed significant relative and absolute inequalities for oral
13 health and SES indicators except for dental pain experience. We observed higher dmft
14 among children in the lowest household income families (IRR=1.16, 95% CI:1.10-1.23)
15 than those from the highest household income families (Figure 1), with this being
16 reflected significantly in the relative and absolute index of inequality (RII=1.17,
17 95%CI:1.11-1.24 and SII=0.55, 95%CI: 0.35-0.75) (Figure 2), representing an excess
18 of 1.17 decayed, missing or filling teeth and 55 more children with decayed, missing or
19 filling teeth per 100 children in the lowest household income group compared with the
20 highest one respectively. Similarly, relative inequalities were as well as larger in
21 prevalence of dental caries and dmft by parental education (RII=1.17, 95% CI:1.13-
22 1.21 and RII=1.36, 95% CI:1.30-1.43, respectively). Significant absolute and relative
23 inequalities in dental pain were also observed when stratified by place of residence. In
24 rural areas, inequalities in dental caries in favor of those with lower household income
25 and lower parental education. However, parental education was only significantly
26 associated with prevalence of dental pain in rural areas (RII= 0.87, 95%CI: 0.79-0.95
27 and SII=-0.05, 95%CI: -0.08--0.03). Meanwhile, our findings revealed that inequalities
28 were larger in rural areas by parental education, while inequalities related to household
29 income were larger in urban areas (Figure 2).

1 Discussion

2 In general, we identified a social gradient in oral health of children, with lower SES
3 being associated with a higher risk of dental caries and dental pain experience. In urban
4 areas, a positive gradient was observed with higher parental education being associated
5 with higher dental pain experience. Different from children in urban areas whose
6 inequalities in dental caries were larger by household income, inequalities in dental
7 caries of children in rural areas were more affected by parental education. This
8 characteristic should be considered in future oral health promotion programs.

9 Parental education and household income were obvious markers relating to oral
10 health in children, with lower parental education and household income being
11 significantly associated with higher prevalence of dental caries and higher dmft in this
12 study. This finding was in agreement with an earlier dental health inequality studies^{6,26}.
13 There was some evidence showed that children from lower SES families suffer from
14 more severe dental pain and higher prevalence of dental caries^{27,28}. Among 3-year-old
15 Japanese children, higher prevalence of dental caries was associated with lower level
16 of parental education²⁶. A cross-sectional study in Australia showed that parental
17 education with higher level were significantly inversely associated with dmft of
18 children aged 4 to 13 years old²⁹. On the other hand, no association was observed
19 between parental education and caries experience in Chinese³⁰ and Mongolian
20 children⁸, which may be due to small sample size and the time of data collection.

21 This study also revealed household income as a traditional SES indicator of
22 children, affected the distribution of caries experience. Evidence from a recent study
23 confirmed that household income was one of the strongest factors related to oral
24 health³¹. A cohort study on trends in oral health from a life course data in Hong Kong
25 suggested that household income had an effect on children's oral health status³².
26 Significant inverse associations between household income and dental caries were also
27 observed in Chinese¹⁶, American³³, Japanese²⁶, Australian^{6,29}, and Mongolian⁸ children.

28 Our findings also revealed that inequality by parental education was existed in
29 lower parental education in rural areas. And children in rural areas also had higher dmft

1 and prevalence of dental caries than those in urban areas, which keeping with the trend
2 of a former study in China³⁰. Our finding is also consistent with a Thailand study which
3 examined the time trends in dental caries among children and indicated the prevalence
4 of dental caries was higher for the children who lived in rural areas³⁴. However, from
5 the perspective of household income, relative and absolute inequalities were larger in
6 urban areas in the results. We found that parental education was positively associated
7 with dental pain experience in urban areas. This might be explained by the fact that the
8 neglect of discomfort and pain in children from low parent educated groups, with
9 proportion of high educated parents being larger in urban areas, and larger inequalities
10 by household income in urban areas. Health services utilization is as well as a potential
11 factor accounting for the large inequalities in health between urban and rural residents
12 in China^{35 36}. Utilization of dental services had a positive impact on the caries
13 experience in children and adolescents³².

14 Parental SES might influence child oral health through oral health practice,
15 knowledge and attitude³⁷. Parents of higher education visited a dentist more frequently
16 not only when their children had dental pain, but also to bring their children in for
17 preventive checkups and learn oral health knowledge^{38 39}. Meanwhile, education is a
18 primary determinant of a person's labor market position on the other hand, which in
19 turn influences income, housing, and other material resources. And higher income
20 promotes improved living conditions, such as safe housing, ability to preferentially
21 attend public dental services and receive oral health advice compared with those from
22 lower income⁵.

23 However, parental education and household income are difficult to modify in the
24 short term. Therefore, strategies must be developed to improve oral health of children,
25 facilitate parental knowledge and promote preventive tools. Our findings would
26 advance the argument for oral health promotion initiatives that engage parents of
27 children very early. For example, the positive effect of increased household income and
28 high parental education on child health implies that government provide health service
29 targeting the poor and the illiteracy may be an effective way to improve the oral health

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4 1 of children from low SES families, and public welfare programs should focus on rural
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6 2 areas, or considering the importance of child oral health in future life quality, which
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8 3 implies a potential increasing oral health education in such an inequality in oral health
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10 4 of children. Oral health inequalities are not unconquerable but need government support.
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12 5 For example, socioeconomic inequalities in oral health of children were less
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14 6 conspicuous in areas with water fluoridation compared to non-fluoridated places in
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16 7 Australia⁴⁰. Policies targeting poverty to reduce socioeconomic inequalities may be
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18 8 successful as well as the interventions in health utilization⁴¹. Interprofessional
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20 9 collaboration between professional dentists, non-dentistry professionals and fellow-
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22 10 health professionals should be established to jointly provide services aiming at low SES
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24 11 groups at the same time⁴².

25 12 **Strength and limitation**

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27 13 A major strength of our study was the Fourth National Oral Health Survey of
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29 14 China use of a relatively large and representative sample of children, which ensured
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31 15 study results are likely to be generalizable across the mainland of China children. And
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33 16 it was the first study to measure inequalities in child oral health by using slope index of
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35 17 inequality and relative index of inequality in China. The study findings should be
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37 18 considered with number of limitations. The study design was the cross-sectional nature
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39 19 precluding inference about causality. We were not able to examine how socioeconomic
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41 20 inequalities in oral health changed as children grew into adolescents. Longitudinal
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43 21 studies of the oral health of representative samples of Chinese children are rare, and
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45 22 that will provide stronger evidence of the potential causal pathways underlying oral
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47 23 health inequalities as further longitudinal data become available.

48 24 **Conclusions**

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51 25 Children from the lower SES families were more likely to have dental caries.
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53 26 Furthermore, significant inequalities can be found at a very early age.

54
55 27 **Acknowledgements** The authors are grateful to the study participants whose data has
56
57 28 made this study possible. This study is conducted in partnership between 35 colleges
58
59 29 and universities, Center of Disease Control (CDC) of Chinese Health Commission of
60

1 the People's Republic of China, Chinese Stomatological Association.

2 **Contributors** All authors meet the ICMJE authorship criteria. Tingting Zhang,
3 Xiaojuan Zeng, Jialan Hong and Xueting Yu conceived the study and developed the
4 analysis strategy. Tingting Zhang, Jialan Hong and Xueting Yu carried out the analysis.
5 Tingting Zhang drafted the manuscript. Qiulin Liu, Andi Li and Zhijing Wu critically
6 reviewed the drafts, gave text suggestions, and approved the final manuscript.

7 **Funding** This study was supported by "Scientific Research Fund of National Health
8 Commission of the People's Republic of China (201502002)".

9 **Conflicts of Interest:** None declared.

10 **Patient consent for publication** Not required.

11 **Ethics approval** Ethical approval was obtained from the Ethics Committee of Chinese
12 Stomatological Association (Approval no. 2014-003), and parents of each participant
13 were required to sign an informed consent form.

14 **Provenance and peer review** Not commissioned; externally peer reviewed.

15 **Data sharing statement** Consent has not been obtained to share the data publicly.
16 However, data may be accessed on contacting the corresponding author. The same
17 principle applies for statistical analysis scripts.

18 **References**

- 19 1. James. SL, Abate. D, Abate. KH, et al. Global, regional, and national incidence, prevalence, and years
20 lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017:
21 a systematic analysis for the Global Burden of Disease Study 2017. *The Lancet*
22 2018;392(10159):1789-858. doi: 10.1016/S0140-6736(18)32279-7.
- 23 2. Righolt AJ, Jevdjevic M, Marcenes W, et al. Global-, regional-, and country-Level economic impacts
24 of dental diseases in 2015. *J Dent Res* 2018;97(5):501-07. doi: 10.1177/0022034517750572.
- 25 3. Lagerweij M D, C. VL. Declining caries trends: are we satisfied? *Curr Oral Health Rep* 2015;2:212-
26 17. doi: 10.1007/s40496-015-0064-9.
- 27 4. Frencken J, E., Sharma P, Stenhouse L, et al. Global epidemiology of dental caries and severe
28 periodontitis - a comprehensive review. *Journal of Clinical Periodontology* 2017;44:S94-S105.
29 doi: 10.1111/jcpe.12677.
- 30 5. Fisher-Owens SA, Gansky SA, Platt LJ, et al. Influences on children's oral health: a conceptual model.
31 *Pediatrics* 2007;120(3):e510-e20. doi: 10.1542/peds.2006-3084.
- 32 6. Kilpatrick N, M., Neumann A, Lucas N, et al. Oral health inequalities in a national sample of
33 Australian children aged 2-3 and 6-7 years. *Aust Dent J* 2012;57(1):38-44. doi: 10.1111/j.1834-
34 7819.2011.01644.x.
- 35 7. Rouxel P, Chandola T. Socioeconomic and ethnic inequalities in oral health among children and

- 1 adolescents living in England, Wales and Northern Ireland. *Community Dent Oral Epidemiol* 2018;46(5):426-34. doi: 10.1111/cdoe.12390.
- 2
- 3 1 adolescents living in England, Wales and Northern Ireland. *Community Dent Oral Epidemiol*
- 4 2018;46(5):426-34. doi: 10.1111/cdoe.12390.
- 5
- 6 8. Chinzorig T, Aida J, Cooray U, et al. Inequalities in caries experience among mongolian children. *Int*
- 7 *J Environ Res Public Health* 2019;16(20) doi: 10.3390/ijerph16203892.
- 8
- 9 9. E. G, Robinson P G, Marya C M, et al. Oral health inequalities: relationships between environmental
- 10 and individual factors. *J Dent Res* 2015;94(10):1362-68. doi: 10.1177/0022034515592880.
- 11
- 12 10. Ha DH, Do LG, Roberts-Thomson K, et al. Risk indicators for untreated dental decay among
- 13 Indigenous Australian children. *Community Dent Oral Epidemiol* 2019 doi:
- 14 10.1111/cdoe.12460.
- 15
- 16 11. Statistics NBo. Statistical bulletin of the People's Republic of China on national economic and social
- 17 development in 2019, 2020.
- 18
- 19 12. Fang P, Dong S, Xiao J, et al. Regional inequality in health and its determinants: evidence from China.
- 20 *Health Policy* 2010;94(1):14-25. doi: 10.1016/j.healthpol.2009.08.002.
- 21
- 22 13. Liu H, Fang H, Zhao Z. Urban-rural disparities of child health and nutritional status in China from
- 23 1989 to 2006. *Econ Hum Biol* 2013;11(3):294-309. doi: 10.1016/j.ehb.2012.04.010.
- 24
- 25 14. Chen. Y, Ler. X, Zhou. L-a. Does raising family income cause better child health ? Evidence from
- 26 China. *Economic Development and Cultural Change* 2017;65(3):495-520.
- 27
- 28 15. WM. T, R. P, BJ. M, et al. Socioeconomic inequalities in oral health in childhood and adulthood in
- 29 a birth cohort. *Community Dent Oral Epidemiol* 2004;32:3345-53.
- 30
- 31 16. Guan. Y, Zeng. X, Tai. B, et al. Socioeconomic inequalities in dental caries among 5-year-olds in
- 32 four Chinese provinces. *Community Dental Health* 2015;32:185-89. doi:
- 33 10.1922/CDH_3524Guan05.
- 34
- 35 17. Wong HM, McGrath CPJ, King NM, et al. Oral health-related quality of Life in Hong Kong preschool
- 36 children. *Caries Res* 2011;45(4):370-76. doi: 10.1159/000330231.
- 37
- 38 18. Lu. H, Tao. D, Lo. EC, et al. The 4th National Oral Health Survey in the mainland of China:
- 39 background and methodology. *Chin J Dent Res* 2018;21(3):161-65.
- 40
- 41 19. (WHO) WHO. Oral health surveys: basic methods. 5 edition. Geneva: World Health Organization
- 42 2013.
- 43
- 44 20. Pedersen AB, Mikkelsen EM, Cronin-Fenton D, et al. Missing data and multiple imputation in
- 45 clinical epidemiological research. *Clin Epidemiol* 2017;9:157-66. doi: 10.2147/CLEP.S129785.
- 46
- 47 21. White IR, Royston P, Wood AM. Multiple imputation using chained equations: issues and guidance
- 48 for practice. *Statistics in medicine* 2011;30(4):377-99.
- 49
- 50 22. MacDonald RBJM. Overdispersion and Poisson regression. *2008* 2008;24(3):269-84. doi:
- 51 10.1007/s10940-008-9048-4.
- 52
- 53 23. Coxe S, West SG, Aiken LS. The analysis of count data: A gentle introduction to Poisson regression
- 54 and its alternatives. *Journal of personality assessment* 2009;91(2):121-36.
- 55
- 56 24. Mackenbach J P, Kunst A, E. . Mearuring the magnitude of socio-economic inequalities in health: an
- 57 overview of available measures illustrated with two examples from Europe. *Soc Sci Med*
- 58 1997;44(6):757-71.
- 59
- 60 25. RIIGEN: Stata module to generate variables to compute the Relative Index of Inequality [program].
- revised 21 Nov 2013 version: Boston College Department of Economics, 2013.
26. Kato. H, Tanaka. K, Shimizu. K, et al. Parental occupations, educational level, and income and
- prevalence of dental caries in 3-year-old Japanese children. *Environmental Health and*

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- 1 *Preventive Medicine* 2017;22(80) doi: <https://doi.org/10.1186/s12199-017-0688-6>.
27. Peres M, A., Macpherson L, M, D., Weyant R, J., et al. Oral diseases: a global public health challenge. *The Lancet* 2019;394:249-60. doi: 10.1016/s0140-6736(19)31146-8.
28. Armfield J M. Socioeconomic inequalities in child oral health: a comparison of discrete and composite area-based measures. *Journal of Public Health Dentistry* 2007;67(2):119-25. doi: 10.1111/j.0022-4006.2007.00026.x.
29. LM. J, JM. A, KF. R-T. Oral health inequalities among indigenous and nonindigenous children in the Northern Territory of Australia. *Community Dent Oral Epidemiol* 2006;34:267-76.
30. Anqi. S, Xiaojuan. Z, Min. C, et al. Inequalities in dental caries among 12-year-old Chinese children. *Journal of Public Health Dentistry* 2015;75(3):210-17. doi: 10.1111/jphd.12091.
31. Kragt L, Wolvius EB, Raat H, et al. Social inequalities in children's oral health-related quality of life: the Generation R Study. *Qual Life Res* 2017;26(12):3429-37. doi: 10.1007/s11136-017-1679-1.
32. Lu HX, Wong MC, Lo EC, et al. Trends in oral health from childhood to early adulthood: a life course approach. *Community Dent Oral Epidemiol* 2011;39(4):352-60. doi: 10.1111/j.1600-0528.2011.00611.x.
33. Slade GD, Sanders AE. Two decades of persisting income-disparities in dental caries among US children and adolescents. *Journal of public health dentistry* 2018;78(3):187-91.
34. Srisilapanan P, Nirunsittirat A, Roseman J. Trends over time in dental caries status in urban and rural Thai children. *J Clin Exp Dent* 2017;9(10):e1201.
35. Zhao Y, Zhang L, Fu Y, et al. Socioeconomic Disparities in Cancer Treatment, Service Utilization and Catastrophic Health Expenditure in China: A Cross-Sectional Analysis. *Int J Environ Res Public Health* 2020;17(4) doi: 10.3390/ijerph17041327.
36. Zhang R, Chen Y, Liu S, et al. Progress of equalizing basic public health services in Southwest China-- health education delivery in primary healthcare sectors. *BMC Health Serv Res* 2020;20(1):247. doi: 10.1186/s12913-020-05120-w.
37. Zhang Y, Li KY, Lo ECM, et al. Structural equation model for parental influence on children's oral health practice and status. *BMC oral health* 2020;20(1):1-10.
38. Gao X, Ding M, Xu M, et al. Utilization of dental services and associated factors among preschool children in China. *BMC oral health* 2020;20(1):1-10.
39. Pieper K, Dressler S, Heinzl-Gutenbrunner M, et al. The influence of social status on pre-school children's eating habits, caries experience and caries prevention behavior. *International Journal of Public Health* 2012;57(1):207-15. doi: 10.1007/s00038-011-0291-3.
40. Jason M. Armfield JS, Kaye F. Roberts-Thomson, Katrina Plastow. Water fluoridation and the association of sugar-sweetened beverage consumption and dental caries in Australian children. *American Journal of Public Health* 2013;103(3):494-500. doi: 10.2105/AJPH.2012.
41. Borrell LN. Oral health inequities: An AJPH supplement to help close the gap: American Public Health Association, 2017.
42. Harper HJ, Conicella ML, Cranston NC, et al. The Aetna-NDA Partnership for Achieving Racial and Ethnic Health Equity: American Public Health Association, 2017.

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4 **1 Figure Legends**

5 **2 Figure 1.** Odds ratio (OR), Incidence rate ratio (IRR) stratified by parental education
6 and household income.
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10 Footnote: Odds ratio (OR), Incidence rate ratio (IRR) and 95% confidence intervals
11 (CIs) by parental education and household income are presented as well as the level of
12 significance. Crude model: each SES measure (parental education and household
13 income) and outcomes (dental caries, dental pain and dmft). Adjusted model: adjusted
14 for age, gender, ethnic, place of residence, region, and parent-reported child general
15 health. All models are weighted. * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.
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22 **10 Figure 2.** Relative index of inequality (RII) and slope index of inequality (SII) for
23 urban and rural area by parental education and household income.
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26 Footnote: Estimates and 95% confidence intervals (CIs) are presented as well as the
27 level of significance, adjusted by age, gender, ethnic, region and parent-reported child
28 general health. All models are weighted. * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.
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1 Table 1 Summary of the characteristics of the study participants.

Category	n (%)	caries	P	pain	P	dmft	P
		n (%)	value*	n (%)	value*	(mean±SD)	value*
Gender			<0.001		<0.001		<0.001
Male	20245(50.2)	12598(62.7)		5078(26.2)		3.39±0.03	
Female	20115(49.8)	12545(62.4)		5340(27.7)		3.31±0.03	
Age (years)			<0.001		<0.001		<0.001
3	12390(30.7)	6292(50.8)		2024(17.1)		2.28±0.03	
4	13978(34.6)	8895(63.6)		3420(25.5)		3.40±0.04	
5	13992(34.7)	10056(71.9)		4974(37.0)		4.24±0.04	
Ethnic			<0.001		<0.001		<0.001
Han	36087(89.4)	22401(62.1)		9231(26.7)		3.32±0.02	
Other ethnics	4273(10.6)	2842(66.5)		1187(28.9)		3.63±0.06	
Place of residence			<0.001		<0.001		<0.001
Urban	20490(50.8)	12449(60.8)		5166(26.2)		3.14±0.03	
Rural	19870(49.2)	12794(64.4)		5252(27.7)		3.57±0.03	
Region			<0.001		<0.001		<0.001
East	14127(35.0)	9385(66.4)		3872(28.5)		3.83±0.04	
Middle	10403(25.8)	6216(59.8)		2654(27.0)		3.09±0.04	
West	15830(39.2)	9642(60.90)		3892(25.5)		3.09±0.03	
Parents-reported child general health			<0.001		<0.001		<0.001
Good or better	28885(71.6)	17860(61.8)		6954(25.0)		3.25±0.02	
Fair or less	11475(28.4)	7383(64.3)		3464(32.0)		3.60±0.04	
Parental education			<0.001		0.137		<0.001
High	12615(36.1*)	7326(58.1*)		3208(26.3*)		2.90±0.04*	

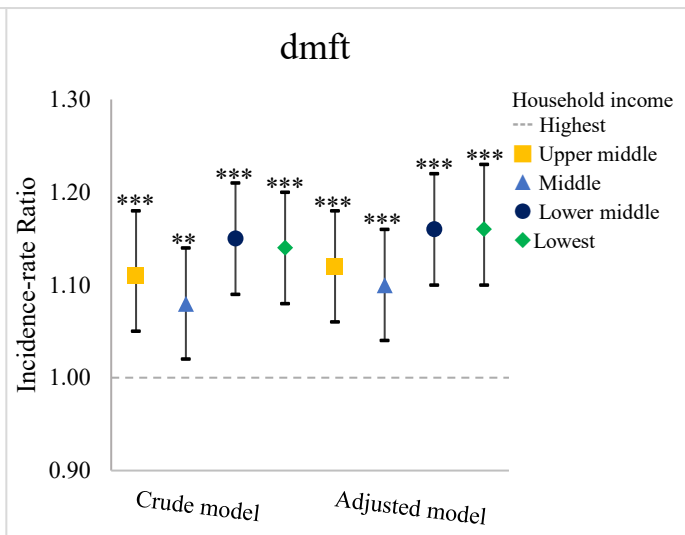
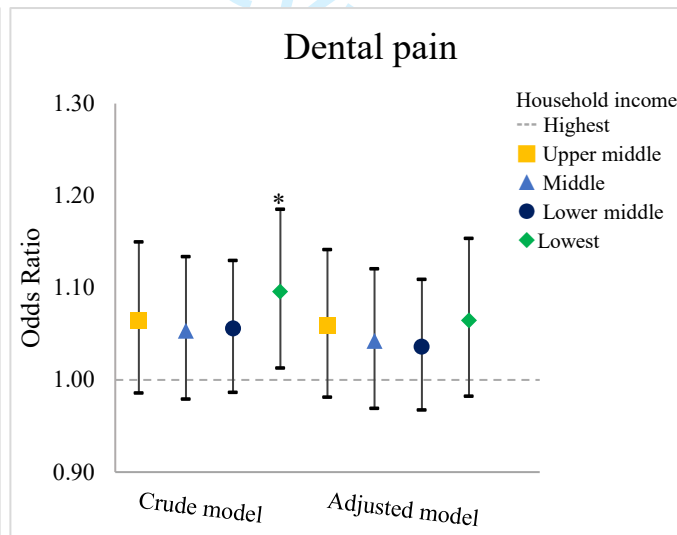
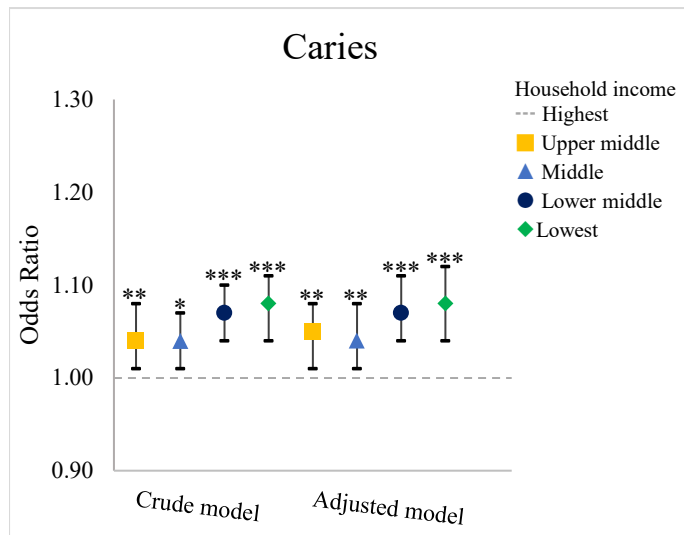
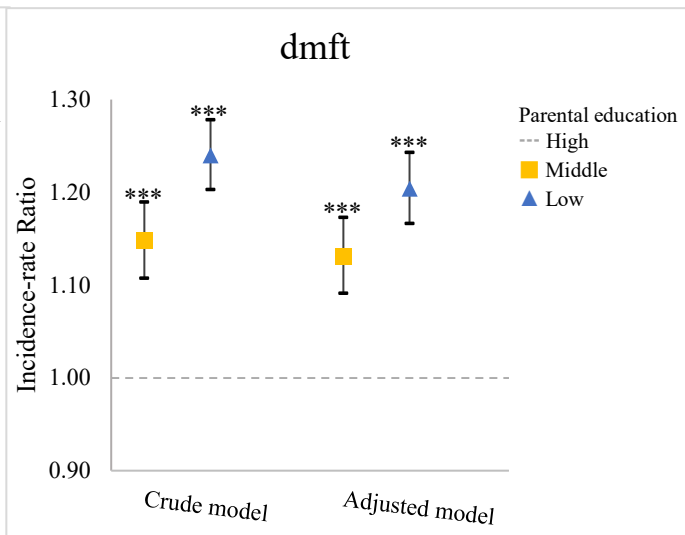
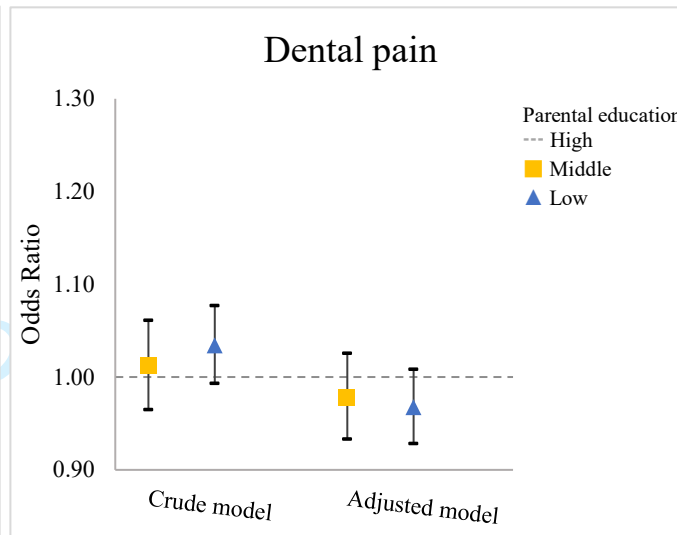
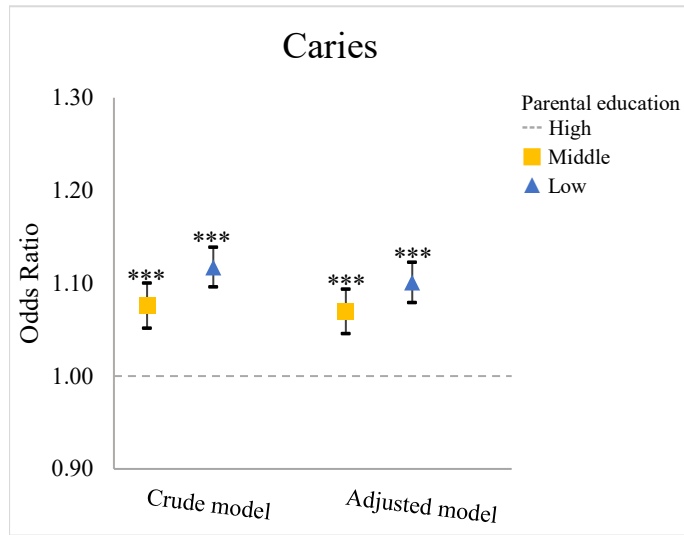
Middle	9457(23.2*)	5914(62.5*)	2445(26.9*)	3.34±0.04*
Low	18278(40.7*)	11998(65.6*)	4762(27.4*)	3.66±0.03*
Household income				
		<0.001	0.011	<0.001
Highest	4431(17.7*)	1942(59.2*)	753(25.2*)	3.01±0.06*
High	4319(21.7*)	3037(62.1*)	1233(27.1*)	3.37±0.05*
Middle	5509(20.9*)	3256(61.6*)	1326(27.0*)	3.27±0.05*
Low	4972(26.2*)	4638(63.9*)	1812(27.1*)	3.48±0.04*
Lowest	6619(13.6*)	2825(65.1*)	1131(28.2*)	3.53±0.06*

1 *Proportions and *P*-values are presented after multiple imputation for parental education and household
 2 income.

3 Table 2. Basic characteristics of dental caries indicators in the study participants.

Category	Overall	
	n	%
Caries	25243	62.5
Dental pain	10418	26.9
dmft(Mean±SD)	3.35±0.02	

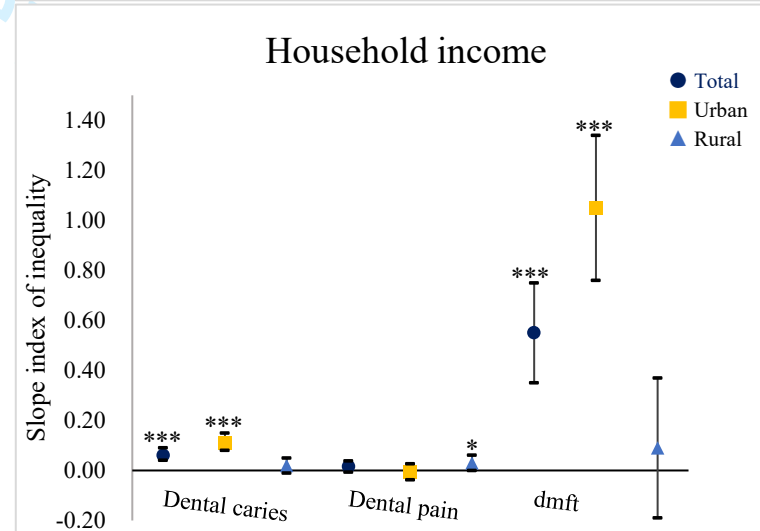
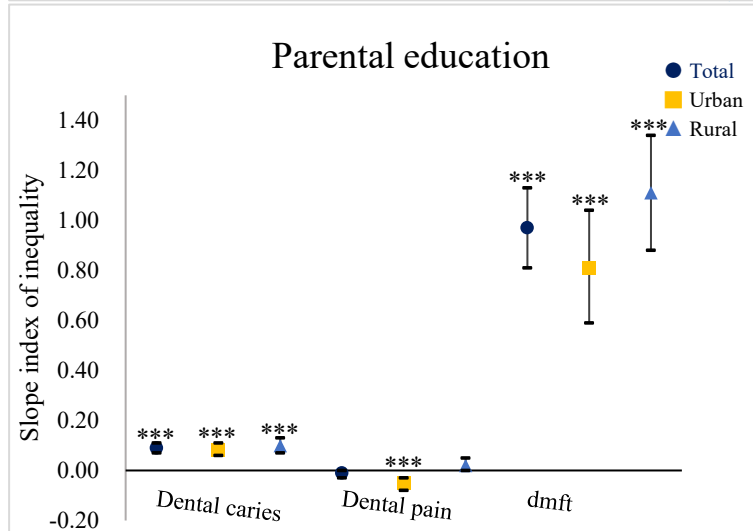
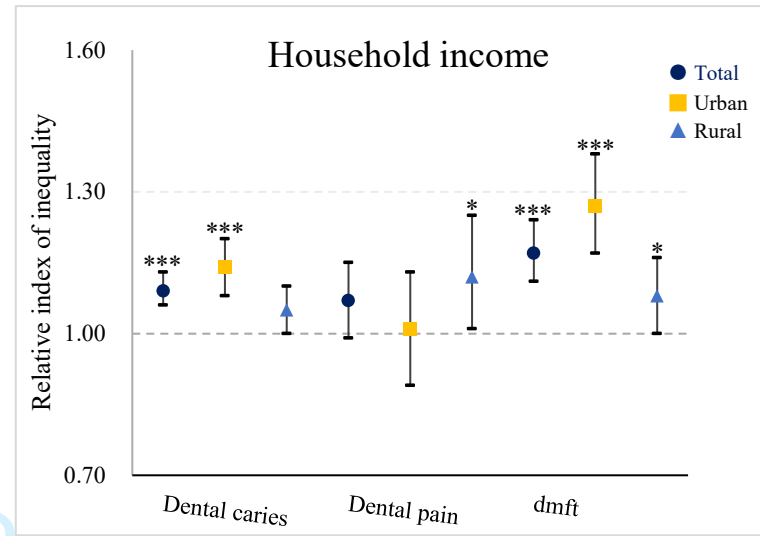
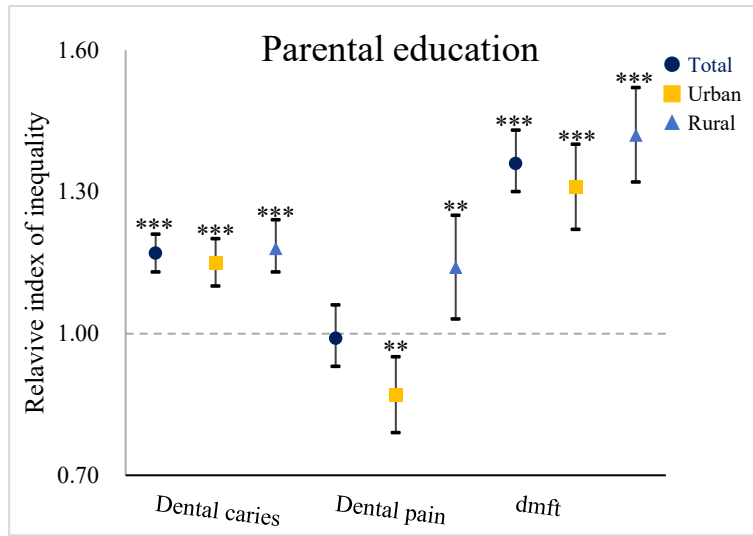
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Figure 1. Odds ratio (OR), Incidence rate ratio (IRR) stratified by parental education and household income. Odds ratio (OR), Incidence rate ratio (IRR) and 95% confidence intervals (CIs) by parental education and household income are presented as well as the level of significance. Crude model: each SES measure (parental education and household income) and outcomes (dental caries, dental pain and dmft). Adjusted model: adjusted for age, gender, ethnic, place of residence, region and parent-reported child general health. All models are weighted. * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

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5 Figure 2. Relative index of inequality (RII) and slope index of inequality (SII) for urban and rural area by parental education and household income.
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7 Estimates and 95% confidence intervals (CIs) are presented as well as the level of significance, adjusted by age, gender, ethnic, region and parent-
8 reported child general health. All models are weighted. * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.
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STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1-2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	1-2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4-5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4-5
Bias	9	Describe any efforts to address potential sources of bias	4-5
Study size	10	Explain how the study size was arrived at	4-5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4-5
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	5-6
		(b) Describe any methods used to examine subgroups and interactions	5-6
		(c) Explain how missing data were addressed	5
		(d) If applicable, describe analytical methods taking account of sampling strategy	5-6
		(e) Describe any sensitivity analyses	5
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	No
		(c) Consider use of a flow diagram	No
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6-7
		(b) Indicate number of participants with missing data for each variable of interest	No
Outcome data	15*	Report numbers of outcome events or summary measures	6-7
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7

		(b) Report category boundaries when continuous variables were categorized	7
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	7
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	No
Discussion			
Key results	18	Summarise key results with reference to study objectives	8-9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-10
Generalisability	21	Discuss the generalisability (external validity) of the study results	9-10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	10

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.