

Original Article

Evaluating the Effect of Socio-Economic Status on DMFT Index in Children Aged 12 in Iran through Zero-Inflated Poisson Regression

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Abstract

Introduction: The most common index in dental studies is the decayed, missing, or filled teeth (dmft)/DMFT. Risk factor evaluation in order to investigate the significant factors that affect this DMFT in children has an important role in dental epidemiological studies. The aim of this study was to investigate the association between socioeconomic factors and dental caries.

Materials and Methods: This cross-sectional study was a part of a national survey for assessing the oral health status of Iranian citizens in 2012. The target population was children aged. The data and oral examination results were collected by the clinical examination form and trained calibrated dental group (dentists and hygienists). A zero-inflated Poisson regression model (ZIP) with a random effect was utilized for evaluating the effect of socioeconomic status on DMFT.

Results: In general, 1564 subjects were studied. From the entire subject in this study, the frequency of zero was 4176 (67%). The result of the ZIP model with random effect in zero part showed that socioeconomic status (OR = 1.97; P-value <0.001) had a significant effect on zero DMFT occurrences. The variance component of the random intercept in zero part was significant too ($\sigma^2 = 17.11$, $P < 0.001$).

Conclusion: The zero-inflated Poisson model with random effect in zero part was fitted to this data. Children from lower socioeconomic classes experienced more DMFT.

Keywords: Zero-inflated, Dental Caries, DMFT

1. Introduction

Oral health is an important component of overall health and is essential for well-being [1]. Dental caries is a widely-spread disease of childhood which can be related to socio-economic and quality of life consequences and can persist over lifetime[2]. Dental caries, well known as a cumulative and progressive disease causes pain as well as local infection and possible disfigurement, especially in children[3].

In 2010, the national oral health of the U.S. reported some of the common diseases in children such as asthma, hay fever, chronic bronchitis, and dental caries. Among these disorders, dental caries was the most common disease which was up to eight times more prevalent than asthma [4]. Also, the World Health Organization (WHO) reported that 60-90% of school-aged children were affected by dental caries, and the prevalence of dental caries is tending to

increase among 12-year-old children in developed and developing countries [5].

Decayed, missing, or filled teeth (DMFT) index is the most popular index in epidemiological dental studies which illustrates the severity of dental problems in a person or a population. DMFT index is a count variable and in practice, it is common to observe a high proportion of zero's. When the proportion of the observed zero is highly greater than the proportion of expected zero, the zero-inflation has occurred [6]. Zero-inflation can lead to inaccurate results if it is not taken into account in the analysis. The main problem which may be raised due zero-inflation is overdispersion. Overdispersion occurred when immoderate variation is observed in the dataset relative to the expected from Poisson distribution as a standard distribution for count data. Thus, the Poisson regression is not proper to be used for analysis when zero-inflation exists. Recently, some statistical models were suggested for analyzing zero-inflated count data such as zero-inflated Poisson (ZIP) regression, zero-inflated negative binomial (ZINB) regression, and Zero-inflated binomial (ZIB) regression [7-11].

Inequality in oral health has been widely studied in developed countries. However, in developing countries, the relationship between the socio-economic variable and dental health factors were less evaluated and it is important to do more research in this field and provide more information for policymakers [12]. As dental caries addition to pain and infection has a high burden on family income, it needs to investigate the population-based programs to control and reduce dental caries experiments especially in low and middle-income countries.

The aim of this study was to evaluate the relationship between the socio-economic factor and dental caries. To reach this aim, a mixed effect Zero-inflated Poisson regression has been used to assess the effects of socioeconomic status on DMFT.

2. Materials and Methods

This study was based on a national survey dataset from a national survey of the oral health status of Iranian citizens, performed in 2012. Children, 12 to 13 years of age were used for evaluation of oral health status. Based on WHO suggestion, 300 sample sizes were required in each age group for DMFT studies [13]. From each province, participants with no referral no were removed from the study after a few days. Finally, 1365 observations were aggregated from all provinces of Iran.

The sampling method used for selecting children was multi-stage stratified cluster sampling. In this method, provinces were considered as stratified and then, rural and urban by proportion to size. Selective clusters were chosen separately by systematic random sampling in each province for rural and urban, with each cluster having one or more blocks. Sampling frame to select samples in each cluster was based on 10 - digit zip codes: it means households were arrived in the study according to digit zip code. Each participant which agreed to participate, filled out the consent form.

The main factors examined in this study include gender, sugar score, and SES (Socio-Economic Status). Sugar score and SES were calculated from combined variables through principal component analysis (PCA) method. The DMFT index was evaluated into 4 sides, including side 1, side 2, side 3, and side 4, known as mandible right, mandible left, maxilla right, and maxilla left respectively.

2.1. Statistical Methods

The DMFT variables are not generally approximated by a normal distribution [14] and tend to exhibit over-dispersion due to the large proportion of zeros [8]. A Zero-Inflated Poisson regression model was used for accounting this over-dispersion. For accounting the correlation structure between subjects, a random effect with normal distribution was added to the model. The

model had 2 distinguished parts (zero-inflated part and binomial part); hence, a normal random effect was added to the zero-inflated part. All P values less than 0.05 were considered significant. SAS 9.4 software was employed to fit models.

3. Results

In an overall view, 1564 subjects were enrolled in this study, with about 838 (53.6%) girls and 726 (46.4%) boys. Sugar score and SES had mean (SD) 0.88 (0.45) and 0.82 (0.95) respectively (Table 1).

Table 1. Descriptive statistics of explanatory variables

Categorical Variable		
	N	%
Sex		
girl	838	53.6
boy	726	46.4
Continuous Variable		
	Mean	Standard Deviation
Sugar score	.88	.45
SES	.82	.95

The DMFT index in 4 sides has a different amount, the detail of descriptive statistics of side 1 to side 4 were reported in Table 2.

Table 2. Distribution of DMFT for permanent teeth in each sides of oral area

DMFT Permanent				
Sides		DMFT	N	%
1	Valid	0	1135	72.6
		1	349	22.3
		2	60	3.8
		3	12	.8
		4	6	.4
		5	1	.1
		6	1	.1
		Total	1564	100.0
2	Valid	0	1114	71.2
		1	357	22.8
		2	72	4.6
		3	15	1.0
		4	5	.3
		7	1	.1
			Total	1564
	3	Valid	0	957
1			528	33.8
2			67	4.3
3			10	.6
4			2	.1
		Total	1564	100.0
4	Valid	0	970	62.0
		1	516	33.0
		2	63	4.0
		3	15	1.0
			Total	1564

The mean of DMFT of females and males in 31 provinces of Iran are presented in Figure 1.

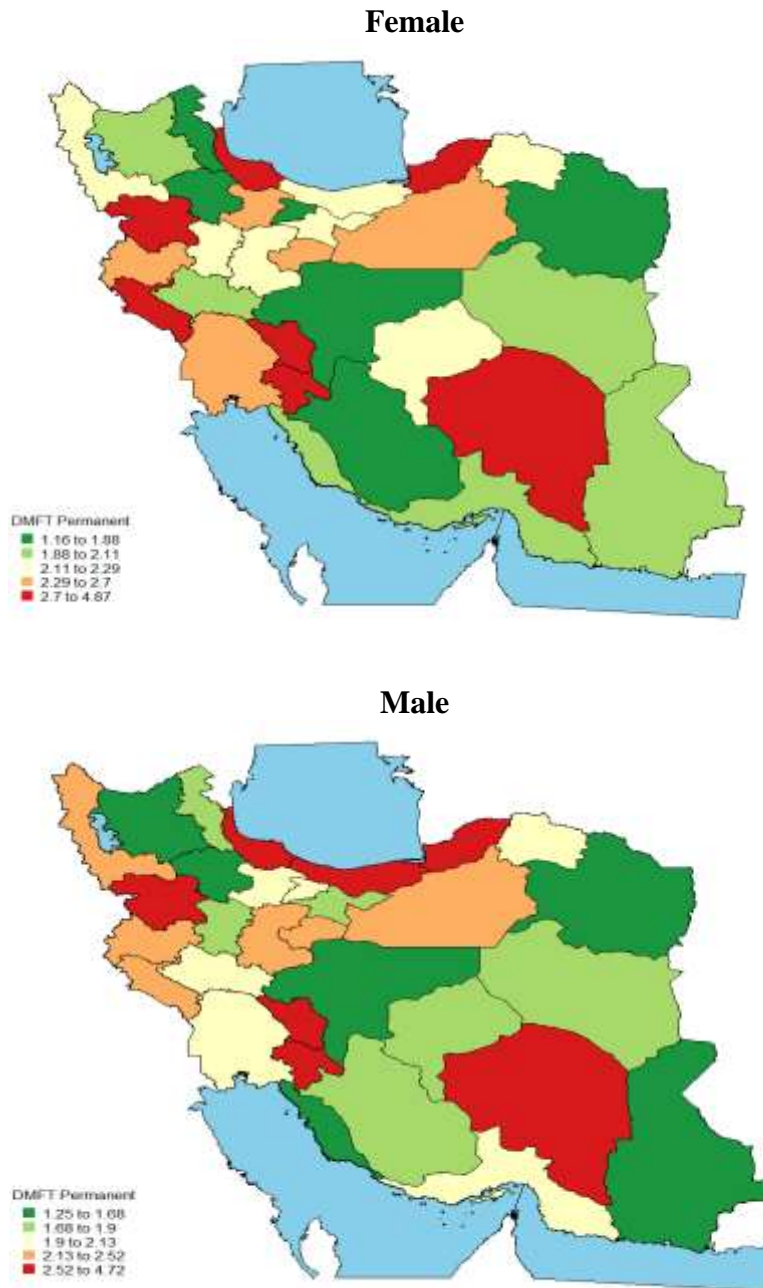


Figure1. The mean of DMFT of females and males in 31 provinces of Iran

Table 3 shows the results of fitting zero-inflated Poisson Regression.

Table 3. Estimated regression coefficient of mixed effect ZIP model for dental data

variable	Part zero of model			Poisson part of model		
	α	SE	P-value	β	SE	P-value
Intercept	-1.130	0.531	0.034	-0.512	0.108	<0.001
Sex	0.149	0.324	0.646	0.078	0.058	0.164
SES ¹ Score	0.680	0.171	<0.001	0.019	0.032	0.554
Sugar Score ²	-	-	-	0.070	0.055	0.203
σ^2	17.11	2.19	<0.001	-	-	-

¹Socio-Economic Status

²The coefficient was omitted from part zero due to converge problem.

The SES score had a significant effect on part zero of the model which means odds of carries free (DMFT=0) is decreased 1.97 times ($\exp(0.680)=1.97$) if SES score increases one unit.

4. Discussion

In this study, a score test was used to evaluate if zero-inflation existed in the data or not. Then, since the zero-inflation existed in the data, the ZIP regression model with a random effect term in zero part of the model was fitted to the dental data obtained from a cross-sectional national survey study.

A nature effect on caries distribution gave rise to the increase of the frequency of count zeros leading to over-dispersion [15, 16]. The over-dispersion problem causes contravene of some essential assumptions of using common parametric distributions [17]. Consequently, a proper regression model was used to address this problem. In the present study, the oral area of each participant was divided into four areas, in a way that maxilla and mandible are divided into right and left sides and DMFT was examined on each side. According to the correlation between DMFT in different jaw sides, a mixed-effects model was used to address this correlation. Mixed-effect zero-inflated Poisson Regression used in this study has two parts: degeneration in zero and Poisson distribution. Part zero of the model represents the probability of caries-

free (zero frequency of DMFT) due to some personal and environmental characteristics and the Poisson part of the model represents a log-linear model that describes the rate of DMFT based on the Poisson probability distribution[8, 18, 19].

It was found that socioeconomic status had a valuable effect on the probability of caries-free (zero frequency of DMFT). Odds of caries-free increased 1.97 times by one unit increase in SES score. Similar to these results, Bedos et al. presented the existence of a relationship between having any caries experience (DMFT ≥ 1) and socioeconomic since odds ratio (OR) of having any caries experience is 1.84 in compared low income with high income in Canada [20]. Also, some other studies mentioned the same results with OR=1.22 in Brazil, OR=2.08 in the US and OR=2.86 in India comparing low income with high-income populations [21-24].

The present results showed that children with lower socioeconomic status were more likely to have decayed, missed, or filled teeth. There is adequate accessibility of dentists in Iran though there are often economic hindrances. Since the dental care system is reigned by the private part, the high costs of dental services and prevention of teeth decay in Iran may be those factors that lead poorer people to have higher dental caries rates [25].

Sex had no significant effect on DMFT. Documents also suggest that sex is neither related nor a causal variable for specifying reported teeth loss or to consider oral health [12, 26].

This study has its own limitations; for instance, regardless of using trained dental experts for collecting the data, some aberrations from the calibration target might have occurred. Another limitation of this study is the cross-sectional design which restricts the ability to recognize causative effects.

In conclusion, using the zero-inflated regression in studies with count data of a high proportion of zeros are required due to over-dispersion that happens in these datasets. The odds of caries-free due to personal and environmental characteristics are greater among rich children in comparison to poor children.

Conflict of interest

The authors declare no conflict of interest.

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