

The impact of mother's literacy on child dental caries: Individual data or aggregate data analysis?

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ABSTRACT

Introduction: To evaluate the impact of mother's literacy on child dental caries based on a national oral health survey in Iran and to investigate the possibility of ecological fallacy in aggregate data analysis. **Materials and Methods:** Existing data were from second national oral health survey that was carried out in 2004, which including 8725 6 years old participants. The association of mother's literacy with caries occurrence (DMF (Decayed, Missing, Filling) total score >0) of her child was assessed using individual data by logistic regression model. Then the association of the percentages of mother's literacy and the percentages of decayed teeth in each 30 provinces of Iran was assessed using aggregated data retrieved from the data of second national oral health survey of Iran and alternatively from census of "Statistical Center of Iran" using linear regression model. The significance level was set at 0.05 for all analysis. **Results:** Individual data analysis showed a statistically significant association between mother's literacy and decayed teeth of children ($P = 0.02$, odds ratio = 0.83). There were not statistical significant association between mother's literacy and child dental caries in aggregate data analysis of oral health survey ($P = 0.79$, $B = 0.03$) and census of "Statistical Center of Statistics" ($P = 0.60$, $B = 0.14$). **Conclusion:** Literate mothers have a preventive effect on occurring dental caries of children. According to the high percentage of illiterate parents in Iran, it's logical to consider suitable methods of oral health education which do not need reading or writing. Aggregate data analysis and individual data analysis had completely different results in this study.

Key words: Aggregate data, dental caries, literacy

INTRODUCTION

Literacy means the ability to read and write and enabling individuals to achieve their goals, to develop their knowledge and potential, and to participate fully in their community and wider society. Literacy rate in 10–49-year-old people in 2006 in Iran was 91.7% and in 2011 was 92.4%.^[1]

Data available in the medical literature indicating a relationship between higher levels of health literacy and a positive impact on an individual's health and their health care. Parents make decisions, take actions, and consider issues that influence not only their own health, but also that of their children.^[2]

Zero *et al.*, in a systematic review of the literature concerning caries risk indicators, concluded that parent education level was one of the primary factors for caries prediction in primary teeth.^[3] Sharma *et al.*, in a study which evaluated

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the oral health of children aged 9–12 years in urban Meerut found that there was a strong relationship between mother's educational level and children oral health.^[4] A defined and clear association between mother's literacy and children's dental caries cannot be illustrated if the proper statistical analysis is not used. There could be many mistakes in analysis and interpretation of the results. One of the most important mistakes is "ecological fallacy."

Indices which summarize groups of individuals, rather than the individuals themselves, are named "ecological" and are usually used when the analysis of individuals' data are not possible. Serious errors can result when an investigator makes the seemingly natural assumption that the inferences from an ecological analysis must pertain either to the individuals. This mistake is called an ecological fallacy.^[5] There are some studies in oral health field which show the possibility of ecological fallacy in the findings.^[6,7] There is a gap in oral health researches about the importance of ecological fallacy and the possibility of bias in using aggregate data instead of individual data.

The purpose of the current study was to evaluate the impact of mother's literacy on child dental caries according to a second national oral health survey in Iran in 2004. To investigate a possible trace of ecological fallacy, three different analyses were done on individual and aggregate data.

MATERIALS AND METHODS

Study population and methodology

The second national oral health survey was carried out in 2004 which including 8725 6 years old Iranian participants.^[8] This cross-sectional study was done according to WHO criteria of national surveys. Thus, it was roughly valid and reliable.^[9] A cluster multistage sampling was performed to provide nationally representative data. The sampling area consisted of all provinces. A team of dentists trained and calibrated to WHO standards performed all dental examinations. The examiners used dental mirrors, number 23 explorers, and high-intensity artificial lighting. Data on decayed, missing and filled teeth (primary and permanent) were recorded. Furthermore, some information related to the socio-economic and demographic situation of the participants were gathered.

The survey protocol was reviewed and approved by Ethical Committee of the Ministry of Health and Medical Education and the parents of all survey participants signed informed consent forms.

At first, the association of mother's literacy (literate, illiterate) with caries occurrence (decayed that was DMF score >0 vs. sound dentin) of the teeth of her child was assessed using individual data by logistic regression model. Then the association of the percentages of mother's literacy and the percentages of decayed teeth in each 30 provinces was assessed using aggregated data retrieved from the data

of second national oral health survey of Iran using linear regression model.

Furthermore, as an alternative approach, the aggregated data for the percentages of mother's literacy of each province were gained from census of "Statistical Center of Iran" in 2005, instead of the second national oral health survey. This part of analysis was carried out because we thought the reliability of data of "Statistical Center of Iran" may be higher for mother's literacy percentage than aggregated data gained from the national oral health survey.

The significance level was set at 0.05 for all analysis. SPSS version 16 (SPSS, Chicago, IL, USA) was used for data analysis.

RESULTS

Individual data analysis

The dataset consists of information of 8725 6-year-old-children. The descriptive result of the percentage of literate mothers relating to the percentage of decayed teeth of their child can be found in Table 1.

Logistic regression model showed a statistically significant association between mother's literacy and decayed teeth of children ($P = 0.02$, odds ratio [OR] = 0.83). It means that, the probabilities of decayed teeth in children whose mothers are literate are 17% lower than children whose mothers are illiterate.

Analysis based on aggregated data of oral health survey

A linear regression model used to correlate the percentages of illiterate mothers of 30 provinces and the percentages of decayed teeth in same provinces. There was not any statistically significant association between mother's literacy and the occurrence of decayed teeth of their children ($P = 0.79$, $B = 0.03$). By increasing 1% to the percentage of literate mothers, the percentage of children who were caries free decreased 3%.

Analysis based on aggregated data of statistical center of Iran

A linear regression model fitted to correlate the percentages of children with decayed teeth based of 30 provinces of Iran and the percentage of illiterate mothers based on a census of "Statistical Center of Iran."

Table 1: 2×2 which shows the percentages of mother's literacy related to the percentage of caries occurrence in children

Mother education	Dental caries of child		Total (%)
	Caries free (%)	Decayed teeth (%)	
Illiterate	222 (20.9)	1856 (24.2)	2078 (23.8)
Literate	839 (79.1)	5808 (75.8)	6647 (76.2)
Total	1061 (100.0)	7664 (100.0)	8725 (100.0)

There was not any statistically significant association between mother's literacy and the occurrence of decayed teeth of their children ($P = 0.60$, $B = 0.14$).

DISCUSSION

The association between mother's literacy and dental caries of children were analyzed using three different statistical approaches. At first, a dataset of second oral health national survey of Iran was used to analyze the association by individual data. Furthermore, the statistical analysis was done as aggregated data by information gathered from each province of the survey or data got from "Statistical Center of Iran."

It was shown that in the two statistical analyses using aggregated data; there was not any significant association between mother's literacy and dental caries in children. On the other hand, by using individual data, it was found that literate mothers have a preventive effect on occurring dental caries of children. Surprisingly, the direction of association was opposite in individual data analysis compared to two aggregated data analysis. Thus, if we misuse the aggregated data results to discuss about individuals, we may claim that "there is no association between mother's literacy and dental caries occurrence of children" which is not right and it's an example of ecological fallacy. It was better we could use similar statistical models to compare different analysis, but according to the variables we could not. However, as the direction of association was different in 3 analyses, it was not a great problem. Furthermore, it must be considered that normally the association among aggregated data is calculated by lower sample size than the association between individual data. Thus, the possibility of finding a significant association is lower according to decreased power of statistical tests in aggregated data.

Ecological fallacy which was first explained by Finney *et al.* from Robinson means that the association between two variables when the group is used as the unit of analysis may be quite different from the association between those two variables when individual people are used as the unit of analysis^[10].

In our study, it was shown that the association between mother's literacy and children dental caries was different when the unit of analysis was changed.

Parent's literacy has a major impact on the successful implementation of many health programs. Every day, parents make decisions, take actions, and consider issues that influence not only their own health, but also that of their children.

Miller *et al.* showed Caregiver literacy is significantly associated with children's dental disease status ($OR = 1.14$).^[11] Sharma *et al.* showed similar results. They found that mother's educational status had a significant impact on the oral health

of children.^[4] Our findings were similar to these studies, and when we used individual data, we found a relationship between mother's literacy and children's oral health.

Unfortunately, according to the results of a second oral health national survey in 2004, 23.8% of Iranian mothers were illiterate. In data from "Statistical Center of Iran," the percentage of illiterate females was similar (20%) in 2005. As some of the females in the report of "Statistical Center of Iran" were young girl which the probability to be illiterate is lower among them, the lower percentage of illiterate female in the report of "Statistical Center of Iran" is accepted. The findings mean, in some Iranian women, health education methods like pamphlets which need reading would be useless. Without the ability to read these materials, parents lack the possibility of understanding the materials and implementing any recommendations to prevent or treat oral diseases. Chairside oral health education has been shown to be effective more consistently than other methods of health promotion and can be used for illiterate persons.^[12]

CONCLUSION

The probability of occurrence of dental caries in a child will be lower when his mother was literate in Iran in 2004. According to the high percentage of illiterate parents in Iran, it's logical to consider suitable methods of oral health education which do not need reading or writing.

Aggregate data analysis in national health surveys needs caution. Because the association between two variables, when the group is used as the unit of analysis may be quite different from the association between those two variables when individual people are used as the unit of analysis, and this means ecological fallacy.

Aggregate data analysis and individual data analysis had completely different results in this study.

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Conflicts of interest

There are no conflicts of interest.

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