Is Low Birth Weight a Risk Factor for Early Childhood Caries? : A Nationwide Retrospective Cohort

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Abstract

Objectives: We investigated the impact of birth weight on early childhood caries (ECC) to identify the association between birth-related factors and oral health using Korea' national health screening database.

Methods: Children born between 2008 and 2012 who had undergone the first and second health screening at least once and had been confirmed ECC through ECC examination in the first to third oral health screening were included. They were classified according to the presence of dental caries (ECC or non-ECC group) and their birth weight (low [LBW; <2,500 g] or normal birth weight [NBW; 2,500–4,000 g]). We analyzed the association of multiple variables with ECC and examined the impact of birth weight on ECC by logistic regression and log binomial modeling to determine the odds ratio (OR) and relative risk (RR).

Findings: ECC prevalence among the 47,633 included infants and children was approximately 29%. Logistic regression and log binomial modeling showed that the OR and RR for ECC were 0.82 (95% CI, 0.73-0.91) and 0.86 (95% CI, 0.79-0.94), respectively, for children with LBW against those with NBW.

Conclusions: Our results indicated that LBW is not a risk factor for ECC. ECC is a preventable disease for which early detection is crucial. Therefore, oral health screening programs for infants and children should be further promoted to prevent oral diseases and improve oral health.

Keywords**:** *Early childhood caries, Low birth weight, Oral health*

Introduction

Birth weight is a vital indicator of children's health. Low birth weight (LBW) of less than 2,500 g and preterm birth are associated with increased morbidity and mortality.[1] In addition, LBW also impacts the oral structures, leading to enamel defects, crown dilacerations, palatal distortion, and delayed eruption.[2] As infants are valuable human resources for the future society, their health is a critical issue; thus, countries worldwide are paying attention to birth weight in order to optimize infants' health.[3]

Another indicator of children's health is the prevalence of dental caries.[4] The World Health Organization (WHO) reported that primary teeth caries is the twelfth most prevalent disease and that early childhood caries (ECC) poses a global burden, medically, socially, and economically.[5] ECC refers to severe carious lesions or one or more teeth with filled tooth surfaces due to a white spot or caries in the anterior and posterior primary teeth in children under the age of six.[5] After a tooth is erupted, ECC occurs through various pathways, such as bacteria, diet, oral hygiene management, host factors, and maternal bacterial transmission.[6] ECC has an array of negative effects, including pain, discomfort, abscess formation, caries lesions in primary and permanent dentition, risk of delayed physical growth and development, limitation of activity, and deterioration of oral health-related quality of life.[5] Untreated caries in primary dentition is the tenth most prevalent condition affecting 621 million children worldwide.[7] The 2018 Korean Oral Health Survey in Children reported that the prevalence of caries in primary teeth among Korean 5-year-olds increased from 62.2%

in 2012 to 68.5% in 2018. Moreover, the prevalence of caries in primary teeth was 33.9% in 2018, showing that an approximately 34 out of 100 children have untreated caries.[8] With this background, Korea is not an exception to the global trend of endeavors to prevent and manage ECC as a predictor of poor oral health into adulthood and older adulthood.[6,9]

While ECC is multifactorial, there are contradictory results on the association between birth weight and oral health. One study found that LBW is associated with a lower risk of ECC compared to normal birth weight (NBW),[10] while other studies demonstrated that LBW is associated with a higher risk of ECC.[11,12] Systematic reviews pertinent to LBW and ECC [13] reported that the association between LBW and ECC is yet unclear and emphasized the need for further studies. Most of these studies were cross-sectional studies or utilized self-reported questionnaires and had varying participant inclusion criteria and study periods, which limits the examination of the causal relationship between the two variables. Therefore, a large-scale cohort study is needed to present empirical evidence for the association between LBW and ECC.

In this study, we utilized data from Korea's Oral Health Screening Program for Infants and Children to examine the association between birth-related factors and oral health, aiming to investigate the impact of birth weight on ECC in order to present evidence that would contribute to improvement of the measures for prevention and management of ECC and consequently, lower the social burden.

Materials and Methods

Ethical considerations: In accordance with the Declaration of Helsinki, the Institutional Review Board of Korea University reviewed and approved the study protocol (KU-IRB16-EX-249-A-1).

Study design and participants: Korea launched the National Health Screening Program for Infants and Children, led by the Ministry of Health and Welfare, in 2007, as an effort to provide age-appropriate health management. The Oral Health Screening Program for Infants and Children is conducted in three rounds, with the oral examinations performed at 18–24, 42–48, and 54–60 months of age. Each examination consists of a questionnaire pertaining to the current oral state, oral health behaviors, and diet, and an oral examination. The examinations are performed at a dental clinic, and all 20 primary teeth are examined. Dentists examine the teeth for eruption, non-eruption, demineralization, caries, treated teeth, and sealants, evaluate the overall oral state, and provide examination results.[14]

For the present study, we used data from the NHIS-established database for the National Health Screening Program for Infants and Children, which is integrated with the health insurance claims database. The database was developed by sampling 5% of children born between 2008 and 2012 by year. The study population comprised children who had undergone the first and second screening examinations of the National Health Screening Program for Infants and Children at least once and who had been confirmed ECC through ECC examination in the first to third oral screening examinations for infants and children.

Variables: The dependent variable was ECC. We reviewed the results of the three oral screening examinations for all participants. The state of all 20 primary teeth was classified as follows: erupted, non-erupted, erupting, demineralized, caries, treated, or sealant. Therefore, we used the following operational definitions. Children were classified in the ECC group if there was at least one primary tooth with caries in the first oral examination or in the non-ECC group if there were no teeth with caries. For the latter group, the presence of caries in primary teeth was examined in the second and third oral examination.

The independent variable was birth weight. This was the weight reported in the "birth weight" item in the first health screening examination. Birth weight ranged from 500–5000 g. Children were classified into those with a LBW (< 2,500 g) and those with a NBW (2,500–4,000 g). Children with missing values and extreme values were excluded.

Statistical Analysis

The participants' demographic characteristics and variables were analyzed using frequency and chi-square analyses. The impact of birth weight on ECC was analyzed by logistic regression and log binomial modeling to determine the odds ratio (OR), relative risk

(RR), and 95% confidence intervals (95% CI).

Although the RR/prevalence ratio and OR are widely used in medical research or epidemiological studies, the OR through logistic regression is actually excessively used due to direct relations; thus, the interpretation of the OR in terms of RR may lead to an incorrect inference on the prevalence of a particular event.[15] Therefore, in this study, we used log binomial models to reconfirm the impact of birth weight on ECC from the perspective of RR. Statistical significance was set to 0.05. All statistical analyses were performed using SAS Enterprise Guide version 7.13 (SAS Institute, Cary, NC, USA)

REsults

Impact of birth weight on ECC: The OR for ECC in children with LBW against those with NBW was 0.81 (95% CI, 0.73-0.91) and remained significant even after adjusting for the confounders (OR=0.82; 95% CI, 0.73-0.91). In other words, the odds for ECC was approximately 1.22 times higher in children with NBW than in those with LBW (Table 1).

In the log binomial model (Table 2), the RR for ECC in children with LBW against those with NBW was 0.86 in the univariate analysis and after adjusting for confounders. In other words, children with NBW had a significantly greater RR (1.16 times) for ECC than those with LBW.

Table 1. The impact of birth weight on ECC – univariate and multivariate logistic regression models.

Variable	Category	OR	95% CI	Adjusted OR	95% CI
Gender	Male			1.09***	1.04-1.14
	Female			1	
Income	Low level			1.17***	1.09-1.25
	Middle-low level			1.07	1.00-1.14
	Middle level			1.02	0.95-1.10
	Middle-high level			1.07	0.99-1.15
	High level			1	
Medical insurance	Community-based			1.10	0.94-1.28
	Employment-based			1.02	0.88-1.19
	Medical aid			1	
Residence area	Metropolitan			0.94**	0.90-1.00
	Small city			1.0	0.95-1.07
	Rural county			1	
Birth weight	LBW	0.81***	0.73-0.91	0.82***	0.73-0.91
	NBW	1		1	

Dependent variable: ECC (ref. no). ECC, early childhood caries; LBW, low birth weight; NBW, normal birth weight, OR, odds ratio; CI, confidence interval.

**$p<0.01$, ***$p<0.001$

Table 2. The impact of birth weight on ECC – log binomial model.

Variable	Category	RR	95% CI	Adjusted RR	95% CI
Birth weight	LBW	0.86***	0.79-0.93	0.86***	0.79-0.940
	NBW	1		1	

Dependent variable: ECC (ref. no). ECC, early childhood caries; LBW, low birth weight; NBW, normal birth weight, OR, odds ratio; CI, confidence interval.

***$p<0.001$

Discussion

According to the life course approach, LBW, an early life event, is associated with diseases later in life.[16] From this perspective, the impact of birth weight on oral health is an important issue to be considered in order to develop public health strategies and promote efficiency of social cost.

In our study, the prevalence of ECC was approximately 29%. ECC prevalence among infants and children has been reported to range from 25–95%, with great disparities between developed and developing countries. While the prevalence is high at about 85% in the Philippines, Laos, and Cambodia,[17] it is only about 23% in the US [18] and 27.9% in the UK.[19] The prevalence of ECC among infants and children in our study was similar to that in developed countries, indicating that the National Oral Examination Program for Infants and Children has practical benefits.

In this study, we confirmed that LBW does not increase the risk for ECC. In Korea, children under the age of six are provided care in care facilities for young children upon need. As LBW infants show different growth patterns, care may be focused on these children, which may result in a different rate of exposure to institutional care. That is, children with NBW are likely to be exposed to institutional care earlier, thereby being placed in an educational environment that lacks meticulous nutritional intake and oral hygiene. Hence, this may have had an impact on our findings.[20] A US longitudinal study reported that at 8 months of age, streptococcus mutans was more prevalent among children born with NBW than among those born with LBW (28.2% vs. 16.8%; $p=0.007$).[10] The authors of the said study attributed the result to the fact that medically compromised infants are routinely given antibiotics or are medically well-monitored during their hospital stay. A Brazilian cross-sectional study that investigated the association between LBW and delayed deciduous teething found that these two variables were positively associated in children under the age of 24 months (PR=2.27; 95% CI, 1.02-5.07). The authors presumed that LBW may contribute to delayed teething because nutritional factors influence odontogenesis and teeth eruption.[21] Our results that infants with NBW were at a greater risk for ECC than those with LBW may be attributable to the delayed teething caused by LBW and the consequent delay in intraoral exposure. Moreover, a systematic review of studies on the relation of ECC and body mass index as an indicator of the body weight status reported that overweight children were at a higher risk for ECC than normal weight/underweight children, which supports our results that ECC is less likely to occur among LBW infants than among NBW infants.[22] These findings suggest that increased body weight, and not LBW, is a risk factor for ECC. Moreover, personal factors, such as diet and oral hygiene, seem to have a greater impact on ECC.

ECC is a preventable disease for which early detection is crucial. Its outcome may be altered with interventions following tooth eruption. The WHO declared that countries need to develop strategies and interventions aiming to prevent and control ECC and that group-oriented oral health education for families

and community involvement for fluoride management are essential for such purpose.[5,9] It also underlined the need to perform cost-effectiveness evaluation of ECC prevention interventions in addition to relevant research so as to adequately consider both cost problems and social impact. Moreover, as effective preventive measures to lower the prevalence of ECC, the FDI World Dental Federation also recommends dental care education for pregnant women, education pertaining to preventive dental care for healthcare and dental providers, easily accessible oral services for pregnant women, infants and children, interprofessional education and collaboration to enhance the quality of and access to dental care in developing countries, and government surveillance systems focused on the prevention of dental caries in infants and preschoolers (0-5 years).[23] Therefore, promotion of early oral health examination programs for infants and children as a national policy may reduce the adverse impacts of oral diseases such as ECC, including pain and discomfort, risk of delayed physical growth and development, deterioration of oral health-related quality of life, and burden of cost of care. Measures such as professional management of dental plaques, oral health education, primary care dentist system for children, and expansion of insurance coverage of preventive care may be some specific options for this purpose.

The limitations of this study pertain to the limitation of the NHIS cohort data. First, infants and children who did not undergo the first or second National Health Screening for Infants and Children were not included in the sample, and of the initially screened children, those who completed an oral examination were specifically screened. Thus, the sample is not representative of Korea's entire infant and children population and the results must be interpreted with caution. Second, we could not consider socioeconomic variables that may affect ECC, such as parents' characteristics, or the biological pathway of biological factors, such as mutans streptococci, in our study model. Nevertheless, this study is significant in that it conducted a retrospective follow-up using NHIS cohort data, which is large enough to be nationally representative, to provide evidence for the association between birth weight and ECC and highlighted the importance of birth group as an early intervention strategy to promote oral health of infants and children.

Conclusion

We examined the association between birth weight and ECC using Korea's national database for oral examinations for infants and children and found that LBW is not a risk factor for ECC. Further large-scale cohort studies on the association between these two factors conducted worldwide would be conducive to gaining more robust evidence on the risk factors of ECC. As ECC is a preventable disease for which early detection is crucial, oral health screening programs for infants and children should be further promoted to prevent oral diseases and improve oral health.

Ethical Clearance: Not required

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Conflict of Interest: None declared.

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