Original Article
http://mjiri.iums.ac.ir
Medical Journal of the Islamic Republic of Iran (MJIRI)

Med J Islam Repub Iran. 2024 (24 Apr);38.46. https://doi.org/10.47176/mjiri.38.46

Correlation of the Apgar Score with Dental Caries in 3- to 5-year-old Iranian Children

Amin Keykhaie afusi[1], Marzieh Salehi Shahrabi[2], Mehrsa Paryab[2]*, Mohammad Javad Kharrazi Fard[3]

Received: 2 Jul 2023 Published: 24 Apr 2024

Abstract

Background: Dental caries is a serious health condition in children. Poor diet, poor oral hygiene, and unique anatomy of the primary teeth can all contribute to the development of caries in primary teeth. Developmental structural defects in teeth during the fetal period and the first year after birth are believed to increase caries susceptibility. This study aimed to assess the correlation of the Apgar score with dental caries in 3- to 5-year-old Iranian children.

Methods: This retrospective, descriptive, cross-sectional study was conducted at the Pediatric Dental Clinic of Tehran Dental School in 2022. A total of 123 eligible children between 3-5 years were enrolled. The parents were requested to fill out a checklist regarding the information of demographics, birth and infancy condition and Apgar score of children. The children underwent clinical dental examination, and their dmft was recorded. Data were analyzed by the Pearson and regression tests. *P* values < 0.1 were considered statistically significant.

Results: The Pearson test showed that the 1-minute ($P = 0.000$) and 5-minute ($P = 0.000$) Apgar scores had a significant correlation with dmft. The regression analysis of demographic and birth factors revealed significant correlations between duration of breastfeeding ($P = 0.066$) and age of initiation of toothbrushing ($P = 0.019$) with dmft. Also, birth weight ($P = 0.026$) and mother's educational level ($P = 0.090$) had significant correlations with the Apgar score.

Conclusion: The results indicated a significant correlation between the Apgar score and dental caries. Thus, newborns with lower Apgar scores are recommended to receive more regular oral and dental care services.

Keywords: Apgar Score, Dental Caries, Children, Pediatric Patients

Conflicts of Interest: None declared
Funding: None

Cite this article as: Keykhaie afusi A, Salehi Shahrabi M, Paryab M, Kharrazi Fard MJ. Correlation of the Apgar Score with Dental Caries in 3- to 5-year-old Iranian Children. *Med J Islam Repub Iran.* 2024 (24 Apr);38:46. https://doi.org/10.47176/mjiri.38.46

Introduction

Dental caries is a serious health problem for children. It is five times more common than asthma (1, 2). Poor diet and oral hygiene, increased load of cariogenic bacteria, and unique anatomy of the primary teeth can all contribute to the development of caries in primary teeth (1).

Diet and oral health of children after birth are among the responsibilities of parents and healthcare workers. Nonetheless, perinatal conditions (before and after the birth) of infants can also affect the anatomy and structure of enamel and dentin in developing teeth and affect their caries susceptibility (3, 4).

Tooth development is initiated during the fetal period. Impairment of the function of ameloblasts under any condition would result in structural defects in developing teeth. Enamel defects and reduction of enamel thickness have

Corresponding author: Dr Mehrsa Paryab, drmparyab@yahool.com

1. School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran
2. Department of Paediatric Dentistry, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran
3. Dental Research Center, Dentistry Research Institute, Tehran University of Medical Sciences, Tehran, Iran

↑What is "already known" in this topic:
Perinatal conditions of infants, such as nutrition and birth conditions, affect the developing tooth. Apgar score as an index for conditions, has been identified as a correlate of enamel defects of primary dentition.

→What this article adds:
Through this cross-sectional study, we tried to find any relevant evidence about the relation of Apgar score with dental caries in the early childhood years. Our results confirmed this issue. So, it is recommended that more preventive services should be provided for these children.

[DOI: 10.47176/mjiri.38.46]

been observed in children with chromosomal defects, preterm birth, low birth weight, Rh hemolytic disease, respiratory distress at birth, neurological disorders, rickets, metabolic disorders, infectious diseases, hepatic and renal diseases, severe nutritional deficiencies, and toxicities (5, 6).

Apgar is a clinical assessment test for newborns that is performed at 1 and 5 minutes after birth. It was first introduced by Dr. Apgar in 1953 and is a basis for the primary care for newborns. It includes assessment of the skin color, heart rate, muscular tone, reflex irritability, and respiratory efforts of the neonate in the first 1 and 5 minutes after birth. Each physiological parameter is scored 0 to 2, and the sum of scores is calculated and reported as the Apgar score. An Apgar score equal to 10 is optimal. The scores between 7-10 are normal. Scores equal to or smaller than 6 at 1 minute and 8 at 5 minutes indicate that the neonate should receive intensive care (7, 8).

The Apgar score has not been designed for long-term prediction of the condition of newborns. Instead, it provides primary evidence regarding the general and neurological development of newborns. It is mainly used for a clinical assessment right after birth and needs assessment for intensive care for neonates who show low scores. Although it is not an exact indicator of developmental disorders in the future, some limited evidence shows that infants with low Apgar scores, especially at 5 minutes after birth, have a higher risk of disorders such as cerebral palsy, autism, and seizures during childhood, and more frequently develop asthma at 3 years of age, leukemia at 14 years of age, psychosis at 12 years of age, and cardiac diseases (9-16).

From the point of view of dental development, its correlation with the Apgar score has been the topic of several investigations. Animal studies indicated decreased activity of ameloblasts and enamel defects due to hypoxia (17, 18). A higher number of enamel defects has also been reported in children with a low Apgar score at 1 minute (19-21).

On the other hand, a study on permanent molar-incisor hypomineralization found no significant difference in this regard between children with Apgar scores < 5 and those with normal scores (16). The reason is believed to be the compensatory mechanism to preserve cellular activity at the minimum level by secretion of hypoxia-inducible factor-1A (22). It appears that this effect is observed when a low Apgar score is associated with acidosis.

Delayed eruption of primary teeth in children with Apgar scores < 7 at 1 minute (23), and a significant increase in the incidence of dental caries in children with Apgar scores < 8 at 5 minutes have been reported as well (24).

Considering all the above, this study aimed to assess the correlation between clinical conditions at birth based on the Apgar score and dental caries in 3-5-year-old Iranian children.

Methods

In this retrospective, descriptive, cross-sectional study, the sample size was calculated to be 123 children according to a study by Aminabadi et al, (20), assuming $\alpha = 0.05$, $\beta = 0.2$, number of independent variables to be 6, and $R2 = 0.1$, with 95% confidence interval using multiple regression power analysis.

Inclusion and Exclusion Criteria

Three- to five-year-old children with no syndromes, systemic or metabolic diseases, or developmental or mental disorders were selected using simple random sampling.

The study objectives were explained to the parents, and their written informed consent was obtained. The parents were assured of the confidentiality of their information and informed that participation in the study was voluntary.

Children whose parents did not consent to their participation in the study, those whose birth records were not available, and those who had dental developmental defects at the phase of examination were excluded.

Questionnaire completion and dental examination

The parents were then requested to fill out a checklist that asked for 1) demographic information (age, gender, and birth order of child in the family, maternal age at the time of child birth, level of education of the parents, mother's occupation, and family income), and 2) birth and infancy information (birth weight, preterm birth, duration of breastfeeding, and age of initiation of toothbrushing).

Clinical Examinations

The children then underwent clinical dental examination, and their dmft (decayed, missed, and filled teeth) index was calculated according to the World Health Organization criteria (25) to assess their oral health status. A trained, calibrated dental student performed the clinical oral examinations. To assess the intra-examiner agreement, clinical oral examination was randomly repeated for 30 children, and the reproducibility of the results was calculated to be 100%. Dental examinations were performed after cleaning and drying of the teeth with sterile gauze by using a dental mirror and a dental explorer under adequate lighting on the dental chair. For each child, a clinical examination was started by assessing the buccal, lingual, palatal, and occlusal surfaces of the teeth in the maxillary right quadrant, followed by the maxillary left quadrant, mandibular left quadrant, and mandibular right quadrant, and the dmft of each child was recorded.

Finally, the parents were asked to find the 1-minute and 5-minute Apgar scores of their children in their children's birth records and report it over the phone.

Statistical analysis

Data were analyzed using SPSS version 25. Pearson's correlation test was used to analyze the correlation of the Apgar score with the dmft score. Also, the correlation of demographic variables with the Apgar score and dmft, and the effect of demographic factors on the Apgar score and dmft were analyzed by the multiple linear regression test. *P* values < 0.1 were considered statistically significant.

Results

A total of 156 children between 3 and 5 years were initially selected according to the inclusion criteria. After applying the exclusion criteria, 123 children (43 girls and 80 boys) remained in the study. The children had a mean age of 4.18±0.78 years. With respect to age distribution, there were 26 three-year-olds, 44 four-year-olds, and 53 fifth-

[DOI: 10.47176/mjiri.38.46]

year-olds children. Table 1 presents the demographic information of the participants, and Table 2 shows the information regarding the infancy period of children.

Dental clinical examination as the minimum, maximum, and mean number of decayed teeth (d), missed teeth due to caries (m), filled teeth (f), dmft, 1-minute Apgar score, and 5-minute Apgar score are presented in Table 3.

The Pearson test showed that the 1-minute and 5-minute Apgar scores had a significant correlation (low to moderate) with the number of decayed teeth (d), missed teeth due to caries (m), and also with dmft. However, the 1-minute and 5-minute Apgar scores had no significant correlation with the number of filled teeth (f). the amount of P values and correlation Coefficient are presented in Table 4.

The regression analysis of demographic and birth factors revealed significant correlations between duration of breastfeeding (P = 0.066, standardized coefficient beta: 0.188) and age of initiation of toothbrushing (P = 0.019, standardized coefficient beta: 0.241) with dmft. Birth weight (P = 0.026, standardized coefficient beta: 0.209) and educational level of the mother (P = 0.090, standardized coefficient beta: 0.159) had significant correlations with the Apgar score. Other variables had no significant correlation with the dmft or Apgar score of children (P > 0.1).

Discussion

Early Dental caries in children causes several complications and may necessitate emergency visits or treatments under sedation or general anesthesia (26, 27). Also, it has been reported that severe childhood caries increase the susceptibility to caries in adulthood (28). Pediatricians do not

Table 1. Demographic information of children

variable	Category	Number (percentage)
Child's Birth order	First	65 (52.8%)
	Second	39 (31.7%)
	Third or more	17 (13.8%)
Mother's educational level	High-school diploma or lower	59 (48%)
	Bachelor or Master's degree	59 (48%)
	Doctorate degree	5 (4.16%)
Mother's occupational status	Housewife	86 (69.9%)
	Working	37 (30.1)
Father's educational level	High-school diploma or lower	63 (51.2%)
	Bachelor or Master's degree	56 (45.5%)
	Doctorate degree	4 (3.3%)
Family income	< 6 Million Toomans	28 (22.8%)
	6-12 Million Toomans	50 (40.7%)
	>12 Million Toomans	41 (33%)

Table 2. Birth and infancy information of children

variable	Category	Number (percentage)
Birth weight	< 2 kg	9 (7.3%)
	>2 kg	113 (91.9%)
Preterm/full-term birth	< 28 weeks	6 (4.9%)
	>28 weeks	112 (91.1%)
Maternal age	20-30 years	67 (54.5%)
	30-40 years	52 (42.3%)
	>40 years	4 (3.2%)
Duration of breastfeeding	No breastfeeding	15 (12.2%)
	< 6 months	12 (9.8%)
	> 6 months	96 (78%)
Toothbrushing	Yes	92 (74.8%)
	No	31 (25.2%)
Initiation of toothbrushing	< 2 years of age	37 (30.1%)
	>3 years of age	68 (55.3%)
Consumption of sweet drinks with a nursing bottle	Yes	49 (39.8%)
	No	74 (60.2%)

Table 3. Measures for the dmft and its components and the Apgar score of children

Variable	Minimum	Maximum	Mean (std. deviation)
d	0	16	5.12 (±4.29)
m	0	3	0.25 (±0.62)
f	0	8	0.49 (±1.51)
dmft	0	16	5.88 (±4.40)
1-minute Apgar score	5	10	8.67 (±1.06)
5-minute Apgar score	6	10	9.07 (±0.97)

Table 4. The amount of P values (Correlation Coefficient) in the relation of Apgar score and dmft index using the Pearson test

	dmf index		
Apgar indices	Decayed teeth	Missing teeth due to caries	Filled teeth
1- minute Apgar score	<0.001 (-0.363)	0.002 (-0.271)	0.676 (-0.038)
5- minute Apgar score	<0.001 (-0.352)	0.001 (-0.287)	0.191 (-0.119)

[DOI: 10.47176/mjiri.38.46]

have sufficient knowledge about preventive dentistry. Thus, many children present to a dentist for the first time only when there is a problem (28, 29).

Aside from the important role of genetic susceptibility of teeth to caries (22), it is believed that if ameloblasts are exposed to an abnormal condition during the fetal period and birth, such as hypoxia and acidosis, impairments and defects in enamel development would occur (18, 22). To prevent dental caries, the detection of the factors that enhance the susceptibility to caries has been a major goal for many researchers.

The Apgar score is a clinical index for general clinical assessment of neonates in the first minutes after birth. The time it takes for the Apgar score to pass 7 indicates the degree of asphyxia and lower maturity of the neonate. The Apgar score < 9 at 5 minutes has a high predictive value for developmental conditions and even death of the neonate (30, 31). Children with lower Apgar scores at birth have shown a significantly higher number of enamel defects in their primary (19, 20) and permanent (21) teeth. Also, a higher rate of dental caries has been reported in children with a low Apgar score at birth, even with no clinical diagnosis of enamel hypoplasia (24). The present results, similar to the study by Sanders et al. (24) (2010) showed that children, both girls and boys, with lower Apgar scores had significantly higher frequency of decayed and missed teeth. It seems that the main cause of the increased prevalence of caries is the reduction in thickness or mineralization quality of the tooth structure (6, 32-34). Another mechanism that can explain the higher frequency of caries in such children is insufficient development of the immune system and colonization of the oral environment by Streptococcus mutans at a lower age. Such children often have a higher frequency of otitis media and airway infections in the first year after birth and are susceptible to developing severe diseases, which indicate a weaker immune system in them (35). Moreover, children with lower Apgar scores at birth often show impairments in their functions, behavioral coping mechanisms, and concentration, which often result in cariogenic diets containing high amounts of sugar and less cooperation of children in oral hygiene practices such as toothbrushing. Thus, such children often experience a higher rate of caries (10).

Some other birth-related factors that can increase the susceptibility to caries include preterm labor, birth weight, and maternal age. Labor earlier than 37th pregnancy week, intrauterine growth retardation, and birth weight < 2000 g, and particularly 1500 g, inadequate breast feeding, and underweight can all adversely affect enamel development, and increase the susceptibility to caries (36-38). In the present study, preterm labor (earlier than the 28th week of pregnancy) was noted in 6 children, and birth weight < 2 kg was reported in 9 children. However, statistical analysis revealed no significant correlation between the above-mentioned parameters and increased rate of caries, which was in agreement with the results of Sanders et al, (24); however, this result may be due to the small number of children with such conditions in the present study and that of Sanders et al, (24).

Other factors evaluated in this study included maternal age, duration of breastfeeding, consumption of sweet drinks with a nursing bottle, and age of initiation of toothbrushing. However, of all the assessed variables, only the duration of breastfeeding and age of initiation of toothbrushing had significant effects on the rate of caries. In other words, longer duration of breastfeeding and initiation of toothbrushing at an older age increased the rate of caries. The same results were reported by Sanders et al. (24), who showed that the age of initiation of toothbrushing was an effective factor; however, maternal age and consumption of sweet drinks had no significant effect on caries.

Demographic factors in different studies such as the birth order of the child, occupation of the parents, particularly the mother, level of education of the parents, particularly the mother, and socioeconomic status of the family can all affect the risk of dental caries (39-41). In the present study, demographic factors had no significant effect on the risk of caries, which was different from the previous findings. In the study by Sanders et al. (24), the first children of the family had a lower Apgar score and a higher rate of caries. Some other studies also showed a lower rate of caries in children with educated or working mothers (42-44). Another study showed a higher risk of caries in children with educated or working mothers (45).

According to the child's gender, the same results were obtained in girls and boys, which was in accordance with the findings of other studies regarding the risk of hypoplasia and caries (19-24), which indicates that the reported difference in this regard between girls and boys at older ages is attributed to their different behaviors, diet, or hormonal changes.

In the present study, the mother's level of education and birth weight had significant correlations with the Apgar score ($P < 0.1$) such that children whose mothers had higher levels of education had a higher Apgar score, which highlights the importance of the mother's knowledge about pregnancy care. Also, children with lower birth weight had a lower Apgar score, which has been previously confirmed as well (10).

Some previous studies assessed the correlation of different Apgar criteria with enamel defects. Nirmara et al. (19) reported a significant correlation of reflex irritability and heart rate with enamel defects. Hegyi et al. (46) showed a significant correlation of respiratory efforts, muscle tone, and reflex irritability with enamel defects while heart rate and skin color had no significant correlation with enamel defects. In the present study, information regarding different Apgar criteria of children was not available. Therefore, their correlation with dental caries could not be independently analyzed.

This study had a cross-sectional design and a relatively small sample size. Future studies with a larger sample size are required to assess the independent effects of different demographic factors. Also, children with Apgar scores < 6 should be assessed in a separate study to evaluate the diagnostic value of this index. Moreover, the correlation of each Apgar criterion with early childhood caries should be analyzed in future studies.

[DOI: 10.47176/mjiri.38.46]

Conclusion

The present results showed a significant correlation between the Apgar score and dental caries in 3-5-year-old Iranian children. Thus, newborns with lower Apgar scores are recommended to receive more regular oral and dental care services through periodic follow-ups with short intervals.

Ethical approval

This retrospective, descriptive, cross-sectional study was approved by the ethics committee of Tehran University of Medical Sciences (IR.TUMS.Dentistry.REC.1401.117) and conducted at the Pediatric Dental Clinic of the School of Dentistry in 2022.

Acknowledgments

None

Authors contributions

Amin Keykhaie afusi was involved in data collection. Marzieh Salehi Shahrabi contributed to the design considerations. Mehrsa Paryab was involved in the overall supervision of the project and was responsible for preparing the manuscript. Mohammad Javad Kharrazi Fard was involved in data analysis.

Conflict of Interests

The authors declare that they have no competing interests.

References

1. Chin JR, Kowolik JE, Martinez-Mier A, Cirett JLU. Dental caries in the child and adolescent. In : Dean JA, Jones JE, Sanders BJ, Walke Vinson LA, Yepes JF. Dentistry for the child and adolescent. 11 ed, Elsevier, Inc; 2022. P. 199.
2. Kotha SB. Prevalence and risk factors of early childhood caries in the middle east region: A Systematic Review. J Popl Ther Clin Pharmacol. 2022; 29(03): e43-57.
3. Vargas-Ferreira F, Salas MM, Nascimento GG, Tarquinio SB, Faggion CM Jr, Peres MA, Thomson WM, Demarco FF. Association between developmental defects of enamel and dental caries: A systematic review and meta-analysis. J Dent. 2015 Jun;43(6):619-28.
4. Hong L, Levy SM, Warren JJ, Broffitt B. Association between enamel hypoplasia and dental caries in primary second molars: a cohort study. Caries Res. 2009;43(5):345-53.
5. Lacruz RS, Habelitz S, Wright JT, Paine ML. Dental Enamel Formation and Implications for Oral Health and Disease. Physiol Rev. 2017 Jul 1;97(3):939-993
6. Seow WK, Young WG, Tsang AK, Daley T. A study of primarydental enamel from preterm and full-term children using light and scanning electron microscopy. Pediatr Dent 2005; 27:374–379.
7. Apgar V. Proposal for a new method of evaluation of the new born infant. Curr Res Anesth Analg 1953; 32: 260-7.
8. American Academy of Pediatrics, Committee on Fetus and Newborn; American College of Obstetricians and Gynecologists and Committee on Obstetric Practice. The Apgar score. Pediatrics 2006; 117;1444-7.
9. Wainstock T, Sheiner E. Low Five-Minute Apgar Score and Neurological Morbidities: Does Prematurity Modify the Association? J Clin Med. 2022; 11(7):1922.
10. Bagheri M, Javadi H, Hossini SE, Sohrabi N. Examining the correlation of Apgar with cognitive development and symptoms of behavioral disorders among children and adolescents aged 5, 8, and 12 years old. J Bas Res Med Sci 2021; 8(3): 49-54.
11. Lie KK, Grøholt EK, Eskild A. Association of cerebral palsy with Apgar score in low and normal birthweight infants: Population based cohort study. BMJ. 2010;341:c4990
12. Larsson HJ, Eaton WW, Madsen KM, Vestergaard M, Olesen AV, Agerbo E, et al Risk factors for autism: Perinatal factors, parental psychiatric history, and socioeconomic status Am J Epidemiol. 2005;161:916–25
13. Ehrenstein V, Sørensen HT, Pedersen L, Larsen H, Holsteen V, Rothman KJ. Apgar score and hospitalization for epilepsy in childhood: A registry-based cohort study. BMC Public Health. 2006;6:23
14. Mahon BE, Ehrenstein V, Nørgaard M, Pedersen L, Rothman KJ, Sørensen HT. Perinatal risk factors for hospitalization for pneumococcal disease in childhood: A population-based cohort study. Pediatrics. 2007;119:e804–12.
15. Metsälä J, Kilkkinen A, Kaila M, Tapanainen H, Klaukka T, Gissler M, et al Perinatal factors and the risk of asthma in childhood - a population-based register study in Finland. Am J Epidemiol. 2008;168:170–8.
16. johnson KJ, Soler JT, Puumala SE, Ross JA, Spector LG. Parentaland infant characteristics and childhood leukemia in Minnesota. BMC Pediatr. 2008;8:7.
17. Sidaly R, Landin MA, Suo Z, Snead ML, Lyngstadaas SP, Reseland JE. Hypoxia increases the expression of enamel genes and cytokines in an ameloblastderived cell line. Eur J Oral Sci. 2015;123(5):335–40
18. Sidaly R, Risnes S, Khan QE, Stiris T, Sehic A. The effect of hypoxia on the formation of mouse incisor enamel. Arch Oral Biol. 2015;60(11):1601–12.
19. Nirmala SV, Quadar MA, Veluru S, Tharay N, Kolli NK, Minor Babu MS. Apgar index as a probable risk indicator for enamel defects in primary dentition: a cross sectional study. J Indian Soc Pedod Prev Dent. 2015 Jul-Sep;33(3):229-33.
20. Aminabadi NA, Farahani RM, Gajan EB. Apgar index as a correlate of enamel defects of primary dentition. Oral Health Prev Dent. 2008;6(4):331-5.
21. Memarpour M, Golkari A, Ahmadian R. Association of characteristics of delivery and medical conditions during the first month of life with developmental defects of enamel. BMC Oral Health. 2014 Oct 1;14:122.
22. Sidaly R, Schmalfuss A, Skaare AB, Sehic A, Stiris T, Espelid I. Five-minute Apgar score ≤ 5 and Molar Incisor Hypomineralisation (MIH) - a case control study. BMC Oral Health. 2016 Jul 22;17(1):25.
23. Agarwal M, Vegesana D, Konde Sapna. Correlation of Apgar Score to the eruption status of primary dentition: A cross sectional study. Int J Curr Res Aca Rev 2017; 5(11): 7-11.
24.Sanders AE, Slade GD. Apgar score and dental caries risk in the primary dentition of five year olds. Austr Dent J 2010; 55: 260-267.
25. Broadbent JM, Thomson WM. For debate: problems with the DMF index pertinent to dental caries data analysis. Community Dent Oral Epidemiol. 2005 Dec;33(6):400-9.
26. Corrêa-Faria P, Paixão-Gonçalves S, Paiva SM, Martins- Júnior PA, Vieira-Andrade RG, Marques LS, et al. Dental caries, but not malocclusion or developmental defects, negatively impacts preschoolers' quality of life. Int J Paediatr Dent. 2016;26(3):211-9.
27. Abanto J, Carvalho TS, Mendes FM, Wanderley MT, Bönecker M, Raggio DP. Impact of oral diseases and disorders on oral health-related quality of life of preschool children. Community Dent Oral Epidemiol. 2011;39(2):105-14.
28. American Academi of pediatric Dentistry. Guideline on perinatal and infant oral health care. Pediatr Dent. 2016; 38(special issue):150-154.
29. Nowak AJ, Christensen JR, Townsed JA, Marby TR, Wells MH. Pediatric dentistry: infancy through adolescence. 6 ed. Philadelphia, PA; 2019: Chapter 14.
30. Iliodromiti S, Mackay DF, Smith GC, Pell JP, Nelson SM. Apgar score and the risk of cause-specific infant mortality: a population-based cohort study. Lancet. 2014;384(9956):1749–55.
31. Chong DS, Karlberg J. Refining the Apgar score cut-off point for newborns at risk. Acta Pediatr. 2004;93:53-59.
32. Castañeda-Sarmiento S, Uchima Koecklin KH, Barahona Hernandez MB, Santos GP, Bruno Luyo JC, Sánchez Sotomayor JC, Ruiz-Yasuda C, Apaza ZR, Adasme DP, Torres Ricse DA, Mendoza Ballena ME, Salcedo A, Ramirez-Sotelo LR, Blanco-Victorio DJ, Arieta-Miranda J, Torres-Ramos G. Association between developmental defects of enamel and early childhood caries in children under 6 years old: A systematic review and meta-analysis. Heliyon. 2022 30;8(9):e10479.
33. Thang Le VN, Kim JG, Yang YM, Lee DW. Risk Factors for Early Childhood Caries: An Umbrella Review. Pediatr Dent. 2021 May 15;43(3):176-194.
34. Oliveira AF, Chaves AM, Rosenblatt A. The influence of enamel defects on the development of early childhood caries in a population

[DOI: 10.47176/mjiri.38.46]

with low socioeconomic status: a longitudinal study. Caries Res. 2006;40(4):296-302.
35. Caufield PW, Cutter GR, Dasanayake AP. Initial acquisition of mutans streptococci by infants: evidence for a discrete window of infectivity. J Dent Res. 1993;72:37–45.
36. Gravina DB, Cruvinel VR, Azevedo TD, Toledo OA, Bezerra AC. Enamel defects in the primary dentition of preterm and full-term children. J Clin Pediatr Dent. 2013 Summer;37(4):391-5.
37. Aine L. et al. Enamel defects in primary and permanent teeth of children born prematurely. J Oral Pathol Med; 29(8): 403-9. 2000.
38. Lai PY, Seow WK, Tudehope DI, Rogers Y. Enamel hypoplasia and dental caries in very-low birthweight children: a case-controlled, longitudinal study. Pediatr Dent. 1997;19(1): 42-9.
39. Kotha SB. Prevalence and risk factors of early childhood caries in the middle east region: A Systematic Review. J Popl Ther Clin Pharmacol. 2022;29(03): e43-57.
40. Ganesh A, Sampath V, Sivanandam BP, H S, Ramesh A. Risk Factors for Early Childhood Caries in Toddlers: An Institution-based Study. Cureus. 2020;12(4):e7516.
41. Devan I, Ramanarayanan V, Janakiram C. Prevalence of early childhood caries in India: A systematic review and meta-analysis. Indian J Public Health. 2022 Nov;66(Supplement):S3-S11.
42. Ghandehari Motlagh M, Zeraati H, Jamshidi Sh. An epidemiologic survey on dmft among 4-5 year old children of kindergartens under the supervision of Behzisti Organization in Tehran, 2003. J Islamic Dent Assoc Iran. 2004;50(16):15-21. (Persian)
43. Makarem A, Khordi Mood M, Talebi M. A study of dental health and some related factors in children of kindergartens in Mashhad. J Mash Dent Sch. 1999;23(3,4):185-92. (Persian)
44. Nematollahi H, Mehrabkhani M, Esmaily H. Dental Caries Experience and its Relationship to Socio-Economic Factors in 2-6 Year Old Kindergarten Children in Birjand – Iran in 2007. J Mash Dent Sch. 2009;32(4):325-32.
45. Nematollahi H, KhordiMood M. A study of relationship between dental caries experience of 6-36 month old children and dental caries experience & socioeconomic status of their mothers in Mashhad. J Mash Dent Sch. 2001;25(1,2):78-88. (Persian)
46. Hegyi T, Carbone T, Anwar M, Ostfeld B, Hiatt M, Koons A, et al The Apgar score and its components in the preterm infant. Pediatrics. 1998.;101(1):77–81.

[DOI: 10.47176/mjiri.38.46]