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Independent contributions of nuclear and extended families to risk of early childhood caries among children from low socio-economic status in India

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Objective: The family is a fundamental unit of society and provides care to the needs of its members. This study aims to assess the independent contributions of nuclear and extended families through direct and indirect pathways towards the risk of early childhood caries among 5-year-old children from low socio-economic status families in Central India. ***Methods***: Cross-sectional study with two-stage sampling of 313 randomly selected school children. The American Association of Pediatric Dentistry criteria were used for diagnosing early childhood caries (ECC) and severe early childhood caries (S-ECC). It was hypothesised that the type of family would impact ECC and S-ECC by acting on individual-level variables such as frequency of cleaning teeth, dietary patterns, and utilisation of dental services. Examiner-administered interviews collected information about demographic details and oral hygiene practices. Generalized structural equation modelling (GSEM) examined the relationship between exogenous variables, including nuclear and extended families with ECC and SECC. Path coefficients and the standard error with a 95% confidence interval were reported. ***Results***: ECC and SECC were present among 186 (59.4%) and 47 (15%) children. Nuclear families, more frequent between meal sugar consumption and lower utilization of dental care were associated with ECC (odds ratios of 2.43, 2.78, and 8.65, respectively ($p< 0.001$)). Nuclear families were also associated with SECC. Type of family directly ($p< 0.001$) and indirectly ($p< 0.05$) predicted ECC via three or more times sugar consumption and lower utilization of dental services. ***Conclusions***: Nuclear families were associated with ECC and SECC among children. Health professionals need to understand the influence of the type of family and the associated pathway to tackle and reduce the burden of ECC.

Keywords*: risk factors, dental caries, oral health promotion, access to health care*

Introduction

Early childhood caries (ECC) is a pandemic disease of public health importance affecting preschool children in developing and developed countries. The Global Burden of Disease study (2019) reported about 530 million children with untreated dental caries in primary teeth. ECC is the most common childhood disease, with 1.8 billion new cases every year worldwide, even though it is easily preventable. The condition is rapidly increasing in low- and middle-income countries, where sugar exposures have increased following the change from traditional diets (Phantumvanit *et al*., 2018). ECC is most prevalent among the indigenous, disadvantaged, and marginalised populations, where up to 85% of children are affected (Uribe *et al*., 2021; Pierce *et al*., 2019).

Access to dental treatment is inequitable in many nations, leaving poorer children and families underserved (Northridge *et al*., 2020; Singh and Purohit, 2013). The services required for ECC exceed the capacity of available healthcare resources in most low and middle-income countries due to high prevalence and expensive treatment, especially if general anaesthesia is required (Moynihan *et al*., 2019). ECC differs from caries in older adults by its rapid progression and diverse risk factors. The primary risk factor is exposure to sugars through the diet (Phantumvanit *et al*., 2018). Other environmental risk factors include parental literacy, use of fluoride, and utilisation of dental services (Soares *et al*., 2021; Vandana *et al*., 2018; Singh and Purohit, 2013). Additionally, ECC often manifests in children living in poor families and in poor environmental settings (Phantumvanit *et al*., 2018).

The family is a fundamental unit of society and provides care for the needs of its members. Families teach us customs, traditions, values and culture, passed on from one generation to the next. They may be classified as joint/extended or nuclear family systems (Lodhi et al., 2021). A nuclear family has two-generations with a father, mother and children, whereas a joint or extended family contains three or more generations living together. Advantages and disadvantages have been identified for each type, including social support, protection during crisis, physical space, autonomy, and decision-making flexibility (Wäsche *et al*., 2021). The prevalence of nuclear and joint family systems varies between and within countries. In Western Europe and North America, joint

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families are uncommon. Traditionally, Asian, African and Middle Eastern countries had a joint family system. However, the balance is shifting towards nuclear families (Raymo *et al*., 2015).

Family effects have been recognised for health outcomes in children. An Indian study reported better mental health among children from joint than nuclear families (Panchal *et al*., 2013). The elderly living in joint families had better social support and quality of life than those in nuclear families in Pakistan (Naz, 2014). Family contribution to individual health status is also measurable and substantial at a population level (Robert *et al*., 2015).

Fisher-Owens et al. (2007) devised a multilevel conceptual model to explain how risk factors can apply at the child and the family level. Individual level factors include genetics, health behaviours, and practices. Socioeconomic status, health behaviour practices and their association with ECC have been well documented (Phantumvanit *et al*., 2018; Uribe *et al*., 2021; Pierce *et al*., 2019). However, fewer studies have assessed family level risk factors for ECC. The type of family may influence a child's behaviours, including oral hygiene practices, sugar consumption practices, and utilization of dental health care services. Risk factors at the family level include family composition. No information exists about early childhood caries and its association with family composition. Therefore, the aim of this study was to assess the independent contributions of nuclear and extended families to the risk of early childhood caries among 5-year-old children from low socio-economic status in the Bhopal district, Central India.

Methods

The target population for the cross-sectional study was 5-year-old school children of Bhopal district, Central India. Thirty-two public schools in the Bhopal district offer primary education, with 5500 primary class students enrolled. Two-stage sampling was used to select the sample. The first stage selected 16 schools, four from each of the four blocks in the district. The second stage selected all target-aged children from those schools. A sample size of 289 children was determined in the pilot study as per ECC prevalence of 75% and precision level of 5%. A total of 313 schoolchildren participated in the study from all the invited 328 schoolchildren in the selected age group between October 2019 to February 2020; the response rate being 95.4%.

Information on nuclear and joint families, maternal and paternal literacy levels, oral health behaviours, including frequency of brushing, the material used for cleaning teeth, utilisation of dental care services, and pain/discomfort from mouth or teeth in the past year were collected by examiner-administered interviews in the presence of a class teacher. The dental team comprised two trained examiners, assisted by two recording clerks.

Children were examined under adequate illumination within the classrooms to collect clinical data on early childhood caries according to WHO (1997) guidelines. The American Academy of Pediatric Dentistry (AAPD, 2019) defines ECC as: "the presence of one or more decayed (non-cavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in a child under the age of six. The definition of severe early childhood caries (S-ECC) is any sign of smooth-surface caries in a child younger than three years of age and from ages three through five, one or more cavitated, missing (due to caries), or filled smooth surfaces in primary maxillary anterior teeth or a decayed, missing, or filled score of greater than or equal to four (age 3), greater than or equal to five (age 4), or greater than or equal to six (age 5)." CPI probes were occasionally used to confirm the cavitated status of carious lesions or to determine whether a sealant was present. ECC was recorded using the decayed missing and filled teeth (dmft) index.

Training and calibration of the study examiners were conducted per WHO (1997) recommendations. Two-day training sessions for standardisation and calibration of data collection methods were conducted for both examiners within the Department of Dentistry, All India Institute of Medical Sciences, Bhopal. An experienced epidemiologist with training in the basic oral health survey methodology acted as trainer and calibrator. The kappa statistics for inter and intra-examiner agreements were in the range of 0.92–0.94.

Ethical clearance was granted by the Institutional Ethics Committee, All India Institute of Medical Sciences, Bhopal. This work is reported in adherence to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines (von Elm *et al*., 2007). Informed written consent was obtained from the school authorities and the parents, and assent was obtained from the children before their inclusion. The examiners duplicated examinations on 10% of the schoolchildren throughout the study.

After description of the data, Chi Squares and independent sample t-tests were used to distinguish between groups. Logistic regression analysis determined the contribution of variables towards ECC, S-ECC. Generalised structural equation modelling (GSEM) examined the relationship between exogenous variables with ECC and SECC. It was hypothesised that the type of family would impact ECC and S-ECC directly and indirectly by acting on individual-level variables like frequency of cleaning teeth, dietary patterns, and utilisation of dental services (Figure 1). The dotted lines in the conceptual framework represent indirect effects, and solid lines represent the direct effect. Number of teeth affected by ECC and SECC were treated as continuous variables in SEM. All other variables were dichotomized as for logistic regression analysis. Several features of SEM are not available with GSEM, including the goodness of fit test (STATA, 2107). Two conceptual frameworks were initially considered and evaluated for a better fit. The Akaike Information Criteria (AIC) value was reported for comparison between two different frameworks, and the framework with a lower AIC is presented in Figure 1. Lower the AIC scores indicate better model fit. Analysis was performed using Stata v.15 (College Station, TX, USA) and SPSS version 21.0 (IBM SPSS Statistics for Windows, IBM Corp., Armonk, N.Y., USA). Odds ratios and path coefficients were calculated for all variables with 95% confidence intervals. $p<0.05$ was considered significant.

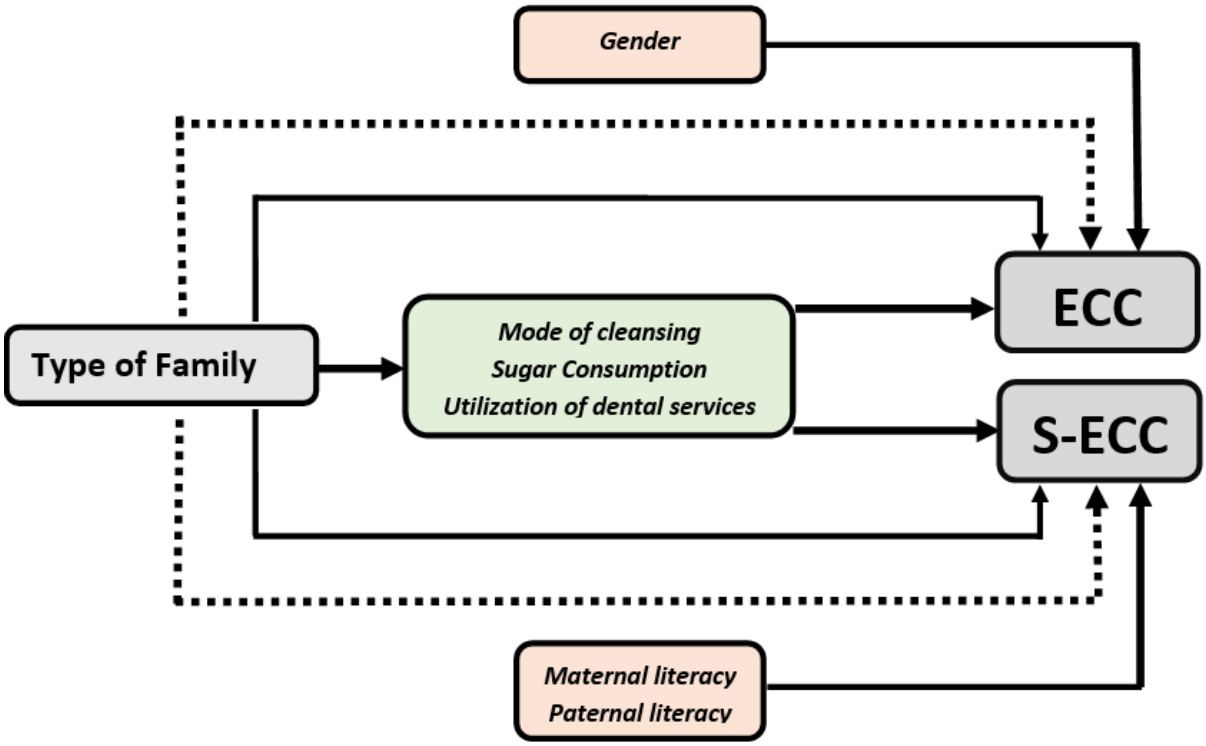

Figure 1. *Conceptualised framework to assess the impact of type of family on ECC and S-ECC.*

Results

Three hundred and thirteen school children from lower socio-economic status families participated, 70.6% of whom were female and 29.4% male. Low literacy levels were noted among the parents. No significant gender differences were noted between the literacy status of parents and residential status based on the type of family (Table 1). A toothbrush was used to clean teeth by 76.8% and 86.9% of children from nuclear and extended families, respectively. Differences between groups were noted for the mode of cleaning teeth, frequency of cleaning teeth, and frequency of meal sugar consumption (Table 2).

Dental caries (ECC), missing teeth and filled teeth were noted among 75.4%, 13.8% and 1.4% of children from nuclear families, compared to 49.7%, 3.4% and 2.9% in children from extended families. Children from nuclear families were more likely to have ECC and S-ECC, although no fillings were observed among children with SECC (Table 3).

Logistic regression analysis determined the contribution of family type towards ECC and S-ECC. Living in nuclear families was associated with paternal literacy, frequency of between meal sugar consumption, pain/discomfort from teeth in the past year, and utilisation of dental services with ECC and S-ECC.

In GSEM, living in a nuclear family was associated with ECC (PC= -1.17, $p< 0.001$) and SECC (-1.81, $p< 0.001$) (Table 4). An indirect association was noted between ECC and nuclear families through higher sugar consumption and utilisation of dental services. Path coefficients and the standard error with a 95% confidence interval from the conceptualised framework for direct, indirect and total effects are reported in Figure 2 and Figure 3.

Discussion

Early childhood caries has a major impact on children's health and carries costs to society. Effective management of ECC should be based on an understanding its complex aetiology. The condition was common and there was low utilisation of dental care among these children from low-income families. Living as part of a nuclear families was associated with ECC and SECC, mediated by higher sugar consumption and lower utilisation of dental care services.

Table 1. Demographic characteristics of 313 children.

	Males n = 92 (%)	Females n =221 (%)	p (Chi-sq)
Mother's educational status			
Illiterate	35.9	40.3	0.63
Junior to middle school (1st to 7th Grade)	20.7	20.4	
Completed high school (10th Grade)	34.8	28	
Graduation and higher	8.6	11.3	
Father's educational status			
Illiterate	46.9	42	0.29
Junior to middle school (1st to7th Grade)	16.5	16.2	
Completed high school (10th Grade)	30	37.9	
Graduation and higher	6.6	3.9	
Type of Family			
Nuclear	48.9	42.1	0.32
Joint	51.1	57.9	

Table 2. Oral health behaviours of 313 children.

Oral health behavior-related variables		*Total*	*Nuclear Families n = 138 (%)*	*Joint Families n = 175 (%)*	*p (Chi-sq)*
Mode of cleaning teeth	Finger	37	56.8	43.2	
	Toothbrush	258	41.1	58.9	0.04
	Datun	18	61.1	38.9	
Frequency of cleaning teeth	Once daily	237	47.7	52.3	
	≥ 2 times a day	76	32.9	67.1	0.01
Material used for cleaning teeth	Toothpaste	270	41.1	58.9	
	Toothpowder	20	65.0	35.0	0.03
	Others	23	60.9	39.1	
Frequency of sugar between meals	Never	32	31.2	68.8	
	Once a day	112	45.5	54.5	0.001
	Two times a day	75	41.3	58.7	
	≥ 3 times a day	94	48.9	51.1	
Utilization of dental care	Never visited	247	45.7	54.3	
	Previous visit (within 1 year)	52	40.4	59.6	0.05
	Previous visit (beyond 1 year)	14	28.6	71.4	
Pain/discomfort from mouth or teeth in past one year	Yes	127	57.5	42.5	
	No	186	34.9	65.1	0.001

Table 3. Dental status of 313 children.

Clinical variables		*Total*	*Nuclear Families n = 138 (%)*	*Joint Families n = 175 (%)*	*p (Chi-square test; t test*)*
Decayed teeth (DT)	Present ECC	186	5.4	49.7	0.001
N (%)	SECC	47	78.7	21.3	0.001
Missing teeth (MT)	Present ECC	25	76.0	24.0	0.001
N (%)	SECC	24	79.2	20.8	0.001
Filled teeth (FT)	Present ECC	7	28.6	71.4	0.25
N (%)	SECC	- (-)	- (-)	- (-)	
Mean DMFT	ECC	2.0 ± 2.12	2.74 ± 2.46	1.25 ± 1.79	0.001
	SECC	6.4 ± 0.58	6.50±0.70	6.21 ± 0.47	0.03*
Range DMFT	0	127	29.1	70.9	
N (%)	1-2	92	41.3	58.7	0.001
	≥ 3	94	67	33	

These findings might be explained by extended families having more caregivers, such as grandparents for the children. Members of extended families might ensure that children are safe and healthy and equip them with behavioural habits and cultural values. They may provide an intimate setting for nurturing children and protecting them as they develop their personalities and identities and mature physically, cognitively emotionally and socially (American Psychological Association Task Force, 2008).

Children in extended families may form close relationships with not just their immediate family members, but also their grandparents, aunts, uncles, cousins, etc. These relationships provide children with emotional benefits, a sense of security, belonging, and identity, which help them to develop essential behavioural and communication skills. This additional sense of security and emotional benefits could support the direct association between ECC and type of families. Parents can also rely on other family members for support with childcare, household chores, and financial needs, which can alleviate some of the stress and pressure of parenting. The role of grandparents in raising healthy and happy children should not be overlooked. Schwartz et al. (2009) linked spending time with a grandparent with better social and behavioural skills, particularly among children living in single-parent or stepfamily homes. Supportive interactions with family members outside of the immediate family may also lead to better behavioural skills and the child's adjustment to the surrounding environment. (Chen *et al*., 2013).

Family structure has been associated with oral health literacy among school children in Brazil. Children with separated and disengaged families had lower oral health literacy than connected families. The influence of the family environment remained significant throughout childhood and early adolescence, including maintaining preventive care and healthy habits and to influence the oral health of the children (Bauldry *et al.*, 2016). Also, changes in family structure and functioning can undermine learning processes in children and adolescents (Calderón *et al*., 2017). Poor oral health literacy and low levels of

Table 4. GSEM for direct and indirect effects of risk factors for ECC and SECC.

		PC (95% CI)	*p*
ECC	Direct Effects		
	Gender	-0.59 (-1.09, -.08)	0.020
	Type of family	-1.17 (-1.61, -073)	0.001
	Maternal health education	-1.11 (-1.58, -0.63)	0.001
	Paternal health education	-0.74 (-1.25, -0.23)	0.004
	Mode of cleaning	1.06 (0.31, 1.81)	0.005
	Sugar consumption (≥ 3 times a day)	1.34 (0.52, 2.16)	0.001
	Utilization of dental services (Never utilised)	-1.03 (-1.78, -0.28)	0.007
	Indirect Effects		
	Type of Family (Effect of nuclear families via three or more than three times sugar consumption and lower utilization of dental services)	-1.78 (-3.58, 0.01)	0.050
	Total Effects		
	Type of Family	-2.67 (-4.26, -1.07)	0.001
SECC	Direct Effects		
	Gender	0.82 (0.02, 1.61)	0.040
	Type of family	-1.81 (-2.68, -0.95)	0.001
	Utilization of dental services (Never utilised)	2.0 (0.99, 3.0)	0.001
	Mode of cleaning	2.65 (0.32, 4.97)	0.020
	Indirect Effects		
	Type of Family (Effect of nuclear families via three or more than three times sugar consumption and lower utilization of dental services)	-2.22 (-4.96, 0.51)	
	Total Effects (Direct and Indirect)		
	Type of Family	-4.04 (-6.91, -1.16) 0.006	0.110

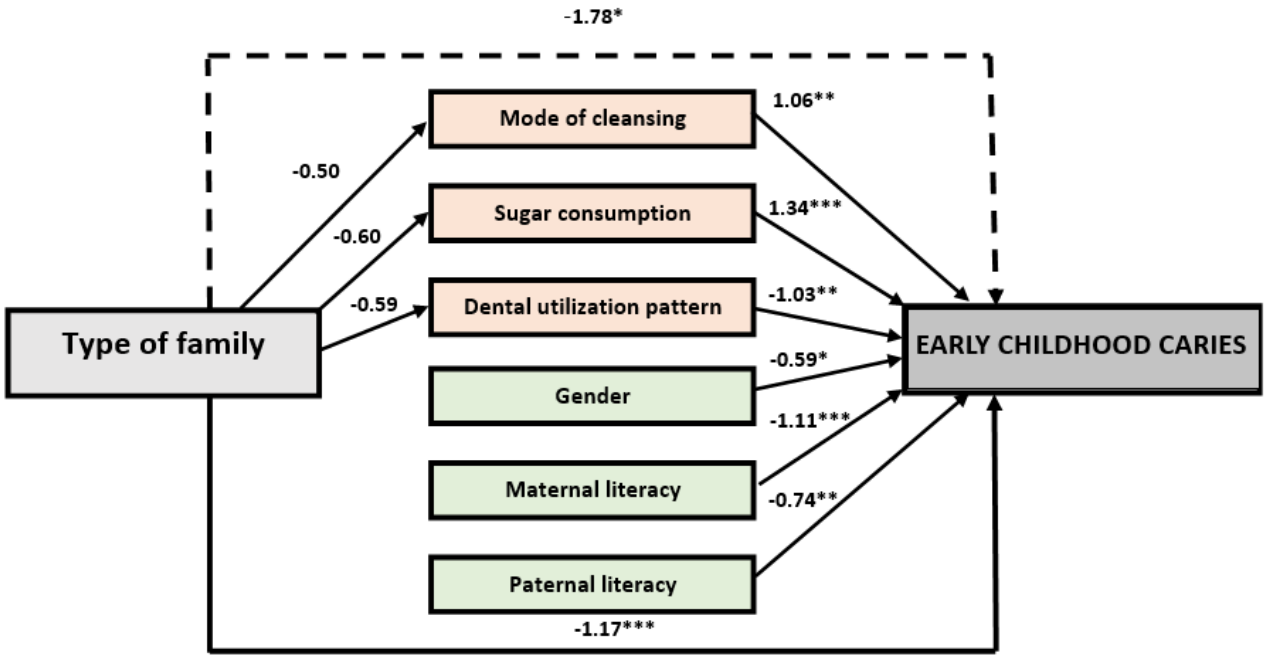

Figure 2. *Structural Equation Model of predictors for early childhood caries (ECC).*

family cohesion are predictors of behavioural problems and dental caries in children and adolescents (Duijster *et al*., 2013; Ferreira *et al*., 2013; Neves *et al*., 2020).

The presence of ECC and SECC was associated with utilisation of dental care services in regression analysis with odds ratios of 8.65 and 2.65, respectively. (Data available on request) The reason for this may be reverse causality, where families had taken their children to the dentist because they had tooth decay. Logistic regression assumes that all variables act independently and simultaneously, whereas disease is often the result of a causal chain, with some variables mediating the effect of others. In this case Structural Equation Modelling is more appropriate and confirmed the lower utilization of dental services to predict caries.

Public health approaches to caries prevention include increasing the availability of fluoride, in drinking water or via toothpaste. WHO also recommends non-milk extrinsic sugar should provide no more than 10% of total energy in the diet (WHO, 2015). Increasing health literacy and

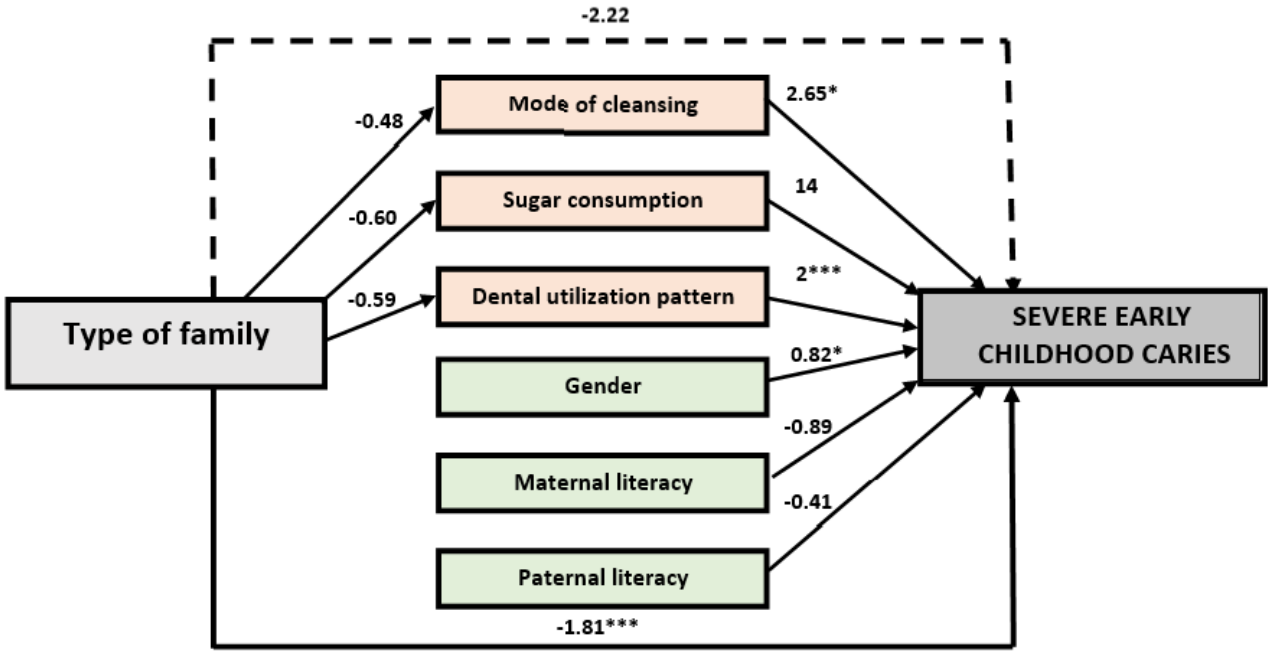

Figure 3. *Structural Equation Model of predictors for severe early childhood caries (SEC).*

awareness levels among the population may mitigate the effects of SES. Family-centered and customised recommendations for preventing ECC have been demonstrated to be more effective than general ones, like cleaning teeth twice a day in engaging parents to change specific parenting practices (Tinanoff *et al*., 2019). Preventive dental examinations should include caries risk assessment, tooth brushing instruction and diet counselling. Partnerships with non-dental primary care providers for early preventive examinations and referrals are essential to integrate oral health promotion into general health. School-based programs that train schoolteachers have also been successful in reducing ECC. Treatment for ECC should be included under universal health coverage (UHC) so that the child receives the health services they need without financial hardship to the individual, family, and community. Targeted interventions may reduce disparities in access to oral health care among disadvantaged populations.

The FDI World Dental Federation has called for measures to alleviate tooth decay's burden by controlling ECC's high global prevalence and encouraging the use of preventive dental medicine (Enzo *et al*., 2020). WHO recommends that national health authorities develop plans and implement strategies aimed at preventing and controlling the disease (Phantumvanit *et al*., 2018). National or regional preventive programs to tackle ECC are not yet prioritised in many countries including India. A global drive to manage and eliminate ECC has been long overdue for a disease with wide-ranging public health effects.

Conclusion

Nuclear families were significantly associated with ECC both directly and indirectly through the hypothesised pathway among children from lower socioeconomic status. Practicing dentists need to understand the influence of the type of family and the associated pathway to tackle and reduce the burden of ECC.

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Data Availability Statement

The data supporting this study's findings is available from the corresponding author on reasonable request.

Conflict of Interest

None of the authors have any conflicts or financial interests related to the article.

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