Original Article

Inheritance and Susceptibility to Dental Caries: A Community-based Study

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Background: Effects of consanguineous marriage on human population are known. However, the inherited susceptibility to dental caries is unfortunately quite limited. **Aim:** This study aimed to assess the dental caries status (DMFT/deft [decayed-missed-filling teeth/decayed-extracted-filled teeth] index) in children born out of consanguineous and non-consanguineous marriages. **Design:** Household survey using a cross-sectional study design was planned, with a sample size of 2000 comprising (1600 non-consanguineous and 400 consanguineous) children, aged 6–9 years. Household survey was also planned using a systematic random sampling. Researcher conducted the study by visiting every 10th household of every 10th ward of Aligarh city, Uttar Pradesh, India. Information of risk factors for dental caries (sociodemographic, birth order, oral hygiene, feeding practices) was recorded on a pretested questionnaire with clinical examination of DMFT/deft index. **Analysis:** Student *t* test for equality of means and multivariate logistic regression were used. **Results:** By Student *t* test for equality of means, D component ($P = 0.003$), d component ($P < 0.001$), and deft score ($P < 0.001$) were statistically significant in the consanguineous group. Multivariate logistic regression did not deduce any association of either of the study groups, but a significant association of risk factors with dental caries was observed. **Conclusion:** Dental caries that has multifactorial etiology, both environment and genetic factors, had an influence on the causation of dental caries in this study.

Keywords: *Community education, consanguinity, dental caries, inbreeding, risk factor*

Received : 19-09-19.
Revised : 05-11-19.
Accepted : 05-01-20.
Published : 02-04-20.

Introduction

In clinical genetics, a "Consanguineous Marriage" is defined as a union between two individuals who are related as second cousins or closer,[1] where a second cousin consanguineous marriage goes as a marriage between children of first cousins. They share great-grandparents. The first comprehensive study about effects of consanguineous marriage/inbreeding on human population started in the late 1940s with the historical work of Neel and Schull in Hiroshima and Nagasaki, Japan.[2-4] There is evidence of an inherited susceptibility to dental caries,[5] but unfortunately it is quite limited. However, from a preventive aspect, the relative influence of genetics and environment should be known as that would help in modifying and recommending the preventive measures. Therefore, this issue becomes very important and that is why this study was planned with a hypothesis that there is no difference in the occurrence of dental caries in either of the study groups—consanguineous and non-consanguineous.

Material and Methods

A household survey using a cross-sectional study design was planned. Multilayered sampling method

Access this article online

Quick Response Code:

Website: www.jispcd.org

DOI: 10.4103/jispcd.JISPCD_384_19

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How to cite this article: Khan SY. Inheritance and susceptibility to dental caries: A community-based study. J Int Soc Prevent Communit Dent 2020;10:148-55.

(stratified random sampling) was used. In the first layer, it was assumed that the prevalence of consanguinity itself is around 20% in the study population. At 95% confidence interval (CI) and 80% power and adding for contingency, we went with a sample of 2000 (1600 non-consanguineous and 400 consanguineous). In order to obtain the above calculated sample size in Aligarh city, Uttar Pradesh, India (municipal corporation), which has 70 wards, and to ensure that each ward in the sampling frame has the chance of being selected, the wards were numbered; then a number was selected at random between 1 and 10. For this sampling, ward 4 was picked up and then every 10th ward was selected such as 4, 14, 24, 34, 44, 54, 64, which ended as 7 wards in total by systematic random sampling. The same procedure was adopted for the selection of households by systematic random sampling. The selected ward 4 had 1505 households. Of these households, every 10th household was picked up, which came out to be 150 households in ward 4. The same procedure was adopted in the selection of households in the remaining selected 6 wards (156 + 481 + 148 + 247 + 306 + 114), which came out to a total of 1597 households in 7 wards. So, we had a sample size of 2000 (1600 non-consanguineous and 400 consanguineous couples) living in 1597 households in 7 wards of Aligarh city [Figure 1]. The study population included the children aged 6–9 years (1600 non-consanguineous and 400 consanguineous) living in 1597 households in 7 selected wards of Aligarh city. The sampling frame was bound by the following inclusion and exclusion criteria.

Inclusion criteria

1. Children aged 6–9 years.
2. Permanent residents of Aligarh city; living permanently in Aligarh since birth.
3. Healthy children.

Exclusion criteria

1. Children living continuously outside Aligarh for a duration exceeding 6 months ever since their birth.
2. Non-healthy children.
3. Premature births.
4. All those not willing to participate in the study.

Permission to carry out the study was obtained from the Institutional Ethics and Research Advisory Committee (D. No. 41/FM/04/08/15). Informed consent was obtained from all the parents of the respondents and they were assured of the confidentiality of the information given by them. All the procedures have been performed as per the ethical guidelines laid down by the Declaration of Helsinki (2008).

To conduct a pilot study and to remove intra-observer bias, the information was recorded on a predesigned questionnaire, which was administered to 20 children. These 20 children were not included in the study sample. The study was conducted by a single examiner. Standardization and validity of the observer was carried out before the conduct of the study. The mean κ value was found to be 0.86. The overall internal reliability of the questionnaire was 0.74 according to Cronbach α. After testing and making necessary corrections in the questionnaire used in the pilot study, the responses were recorded on a self prepared and now a pretested questionnaire. History of risk factors for dental caries was taken (World Health Organization [WHO] Oral health questionnaire for children).[6] Decayed-missed-filling teeth/decayed-extracted-filled teeth (DMFT/deft) index was recorded in accordance with the WHO criteria for epidemiological studies.[7] Oral examination was performed in natural light with children in supine position.[8]

Data were analyzed using IBM, Statistical Package for the Social Sciences (SPSS) (Statistics for Windows software, version 16.0). Descriptive statistics, Student *t* test, chi-square test, and multivariate logistic regression were used, with a *P* value of < 0.05 as significant.

Results

Table 1 shows the highest number of respondents in non-consanguineous group and consanguineous group as 506 (31.6%) 8-year olds and 136 (34%) 7-year olds, respectively. The difference was statistically highly significant ($P < 0.001$). Males outnumbered females in both the study groups, that is, 992 males (62%) in non-consanguineous and 276 males (69%) in consanguineous group. Difference was statistically significant ($P = 0.009$). By religion, majority of respondents in non-consanguineous were Hindus, 1152 (72%), whereas 386 (96.5%) Muslims were in majority in consanguineous group. The difference was statistically highly significant ($P < 0.001$). Table 2 presents the DMFT score for the non-consanguineous group and the consanguineous group as 2.02 ± 1.42 and 1.82 ± 0.90, respectively, and the deft score for the non-consanguineous group and the consanguineous group as 3.02 ± 2.13 and 4.06 ± 2.32, respectively. Table 3 shows the comparison of mean values of DMFT and deft score in consanguineous and non-consanguineous group by Student *t* test for equality of means; D component ($P = 0.003$), d component ($P < 0.001$), and def score ($P < 0.001$) were statistically significant in the consanguineous group. For multivariate logistic regression analysis, dental caries was the dependent

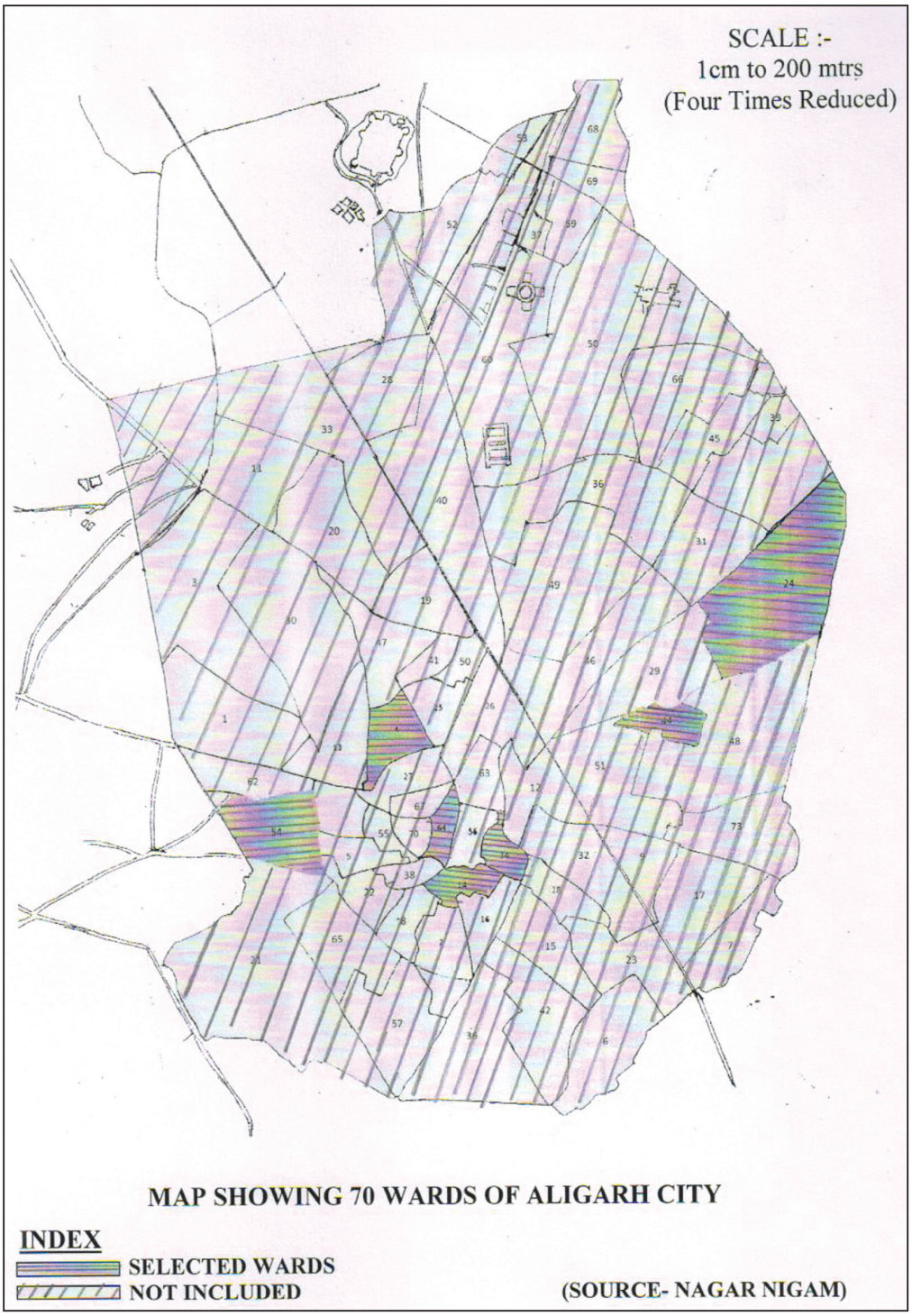

Figure 1: Map showing 70 wards of Aligarh city (Source: Nagar Nigam)

variable, and consanguinity and associated risk factors (demographic, feeding practices, oral hygiene practices) were the independent variables [Table 4]. In this study by multivariate logistic regression, no significant association was deduced between either of the study groups and dental caries. The association of dental caries with risk factors showed the following the results. Under demographic factors, Unemployment ($p < 0.001$, odd's ratio (OR) -4.504, CI = 2.512- 8.075), with regard to oral hygiene practices: frequency of teeth cleaning (never, once a day), mode of cleaning (wooden toothpick = 0.051, OR = 0.283, CI= 0.079-1.007), use of tooth paste ($p < 0.001$, OR = 1.531E7, CI = 1.00E7-2.130E7) and no knowledge of respondents

Table 1: Frequency distribution of personal characteristics between consanguineous and non-consanguineous group

Personal characteristics	Non-consanguineous, (n = 1600)		Consanguineous, (n = 400)		Fisher exact test/Pearson chi-square test	*df*	*P* value
	No.	%	No.	%			
Age of respondents (years)							
6	450	28.1	68	17.0	29.76	3	**0.000***
7	380	23.8	136	34.0			
8	506	31.6	120	30.0			
9	264	16.5	76	19.0			
Gender of respondents							
Female	608	38	124	31	67.57	1	**0.009***
Male	992	62	276	69			
Religion of respondents							
Hindu	1152	72	0	0	694.2	4	**0.000***
Islam	420	26.20	386	96.5			
Christian	16	1	6	1.50			
Buddhist	6	0.40	8	2			
Sikh	6	0.40	0	0			

P = value of probability

*Figures in bold depict statistically significant values

Table 2: Decayed-missed-filling teeth and decayed-extracted-filled teeth index of respondents

	Study group	*N* (no. of subjects)	Total score	Mean	Std. deviation	Std. error mean
D	Non-consanguineous	624	1236	1.98	1.374	0.055
	Consanguineous	172	286	1.66	0.694	0.053
M	Non-consanguineous	4	4	1.00	0.000	0.000
	Consanguineous	0	0			
F	Non-consanguineous	14	32	2.29	1.204	0.322
	Consanguineous	16	34	2.12	1.204	0.301
DMF	Non-consanguineous	630	1272	2.02	1.424	0.057
	Consanguineous	176	320	1.82	0.901	0.068
d	Non-consanguineous	620	1904	3.07	2.148	0.086
	Consanguineous	181	729	4.03	2.325	0.173
e	Non-consanguineous	4	5	1.25	0.500	0.250
	Consanguineous	40	78	1.95	0.815	0.129
f	Non-consanguineous	42	68	1.62	0.731	0.113
	Consanguineous	56	106	1.89	0.779	0.104
def	Non-consanguineous	654	1977	3.02	2.139	0.084
	Consanguineous	225	913	4.06	2.326	0.155

DMF = decayed-missed-filling, def = decayed-extracted-filled, *P* = value of probability

Table 3: Comparison of means of scores of D, M, F, and DMF, d, e, f and def in two groups by Student *t* test

	t test for equality of means						
	t	*df*	*P* value	Mean difference	Std. error difference	95% confidence interval of the difference	
						Lower	Upper
D	2.933	794	**0.003***	0.318	0.108	0.105	0.531
F	0.365	28	0.718	0.161	0.441	−0.742	1.063
DMF	1.774	804	0.076	0.201	0.113	−0.021	0.423
d	−5.172	799	**0.000***	−0.957	0.185	−1.320	−0.594
e	−1.676	42	0.101	−0.700	0.418	−1.543	0.143
f	−1.768	96	0.080	−0.274	0.155	−0.581	0.034
def	−6.119	877	**0.000***	−1.035	0.169	−1.367	−0.703

DMF = decayed-missed-filling, def = decayed-extracted-missed, *P* = value of probability

*Figures in bold depict statistically significant values

Table 4: Multivariate logistic regression—parameter estimates

Dental caries[a]		B	Std. error	Wald	*df*	Sig.	Exp(B)	95% confidence interval for Exp(B)	
								Lower bound	Upper bound
Intercept		−32.553	517.191	0.004	1	0.950			
Yes	Non-consanguineous	0.095	0.170	0.316	1	0.574	1.100	0.789	1.534
	Consanguineous	0[b]			0				
	Paternal education;								
	Illiterate	0.533	0.724	0.541	1	0.462	1.704	0.412	7.043
	Just literate	0.769	0.771	0.994	1	0.319	2.158	0.476	9.781
	Primary school	0.600	0.719	0.695	1	0.404	1.821	0.445	7.456
	Middle school	0.356	0.706	0.254	1	0.614	1.427	0.358	5.689
	High school	0.556	0.704	0.625	1	0.429	1.744	0.439	6.931
	Intermediate	0.977	0.698	1.960	1	0.162	2.657	0.676	10.436
	Graduate	0.347	0.708	0.240	1	0.624	1.415	0.353	5.669
	Postgraduate	0[b]			0				
	Maternal education;								
	lliterate	14.638	517.188	0.001	1	0.977	2.276E6	0.000	[c]
	Just literate	15.379	517.188	0.001	1	0.976	4.776E6	0.000	[c]
	Primary school	15.621	517.188	0.001	1	0.976	6.080E6	0.000	[c]
	Middle School	15.095	517.188	0.001	1	0.977	3.594E6	0.000	[c]
	High school	15.009	517.188	0.001	1	0.977	3.299E6	0.000	[c]
	Intermediate	15.629	517.188	0.001	1	0.976	6.135E6	0.000	[c]
	Graduate	15.781	517.188	0.001	1	0.976	7.137E6	0.000	[c]
	Postgraduate	0[b]			0				
	Birth order;								
	First child	−0.302	0.162	3.496	1	0.062	0.739	0.538	1.015
	Second child	−0.215	0.141	2.332	1	0.127	0.806	0.612	1.063
	Others	0[b]			0				
	Parental occupation;								
	Unemployed	1.505	0.298	25.512	1	**0.000**	4.504	2.512	8.075
	Private	0.063	0.205	0.095	1	0.758	1.065	0.712	1.593
	Self-employed	0.096	0.199	0.235	1	0.628	1.101	0.746	1.626
	Government employed	0[b]			0				
	Frequency of cleaning;								
	Never	1.910	0.480	15.833	1	**0.000**	6.754	2.636	17.304
	Several times a week	0.830	0.439	3.569	1	0.059	2.294	0.969	5.429
	Once a day	1.475	0.425	12.05	1	**0.001**	4.369	1.900	10.046
	2 or > times/day	0[b]			0				
	Mode of cleaning;								
	Toothbrush	−0.170	0.219	0.601	1	0.438	0.844	0.550	1.296
	Wooden toothpicks	−1.264	0.648	3.797	1	**0.051**	0.283	0.079	1.007
	Plastic toothpick	15.744	538.641	0.001	1	0.977	6.882E6	0.000	[c]
	Thread (floss)	−0.738	0.813	0.824	1	0.364	0.478	0.097	2.353
	Charcoal	−.108	.252	.183	1	.668	.898	.548	1.471
	Chew stick/Miswak	−0.359	0.295	1.481	1	0.224	0.699	0.392	1.245
	Any other (finger)	0.177	0.307	0.333	1	0.564	1.194	0.654	2.178
	No brushing	0[b]			0				
	Use of paste;								
	Yes	16.544	00.169	9.630E	1	**0.000**	1.531E7	1.100E7	2.130E7
	No	16.738	0.000		1		1.859E7	1.859E7	1.859E7
	Paste with fluoride;								
	Yes	0.764	0.212	13.051	1	**0.000**	2.148	1.419	3.251
	No	−0.589	0.157	14.123	1	**0.000**	0.555	0.408	0.754
	Don't know	0[b]			0				

Table 4: Multivariate logistic regression—parameter estimates

Dental caries[a]	B	Std. error	Wald	*df*	Sig.	Exp(B)	95% confidence interval for Exp(B)	
							Lower bound	Upper bound
Frequency of consumption of fruits;								
Never	1.671	1.359	1.513	1	0.219	0.188	0.013	2.696
Several times a month	−1.682	1.353	1.547	1	0.214	0.186	0.013	2.635
Once a week	−1.372	1.352	1.029	1	0.310	0.254	0.018	3.591
Several times a week	−1.253	1.361	0.848	1	0.357	0.286	0.020	4.116
Every day	−2.222	1.358	2.677	1	0.102	0.108	0.008	1.552
Several times a day	0[b]			0				
Frequency of consumption of biscuits;								
Never	−0.507	0.343	2.188	1	0.139	0.602	0.308	1.179
Several times a month	−0.406	0.376	1.164	1	0.281	0.666	0.319	1.393
Once a week	−0.459	0.266	2.985	1	0.084	0.632	0.375	1.064
Several times a week	−0.439	0.296	2.199	1	0.138	0.645	0.361	1.152
Every day	0.312	0.264	1.403	1	0.236	1.367	0.815	2.292
Several times a day	0[b]			0				
Frequency of consumption of soft drinks;								
Never	−0.204	0.382	0.285	1	0.594	0.816	0.386	1.724
Several times a month	−0.521	0.452	1.329	1	0.249	0.594	0.245	1.440
Once a week	−0.456	0.352	1.677	1	0.195	0.634	0.318	1.264
Several times a week	0.458	0.372	1.515	1	0.218	1.581	0.762	3.281
Every day	0.414	0.305	1.839	1	0.175	1.512	0.832	2.749
Several times a day	0[b]			0				
Frequency of consumption of sweets;								
Never	−0.468	0.335	1.948	1	0.163	0.626	0.324	1.208
Several times a month	−0.201	0.351	0.328	1	0.567	0.818	0.411	1.628
Once a week	−0.552	0.204	7.329	1	**0.007**	0.576	0.386	0.859
Several times a week	0.352	0.256	1.900	1	0.168	1.422	0.862	2.347
Every day	0.717	0.173	17.198	1	**0.000**	0.488	0.348	0.685
Several times a day	0[b]			0				
Milk with sugar intake;								
Never	0.825	0.313	6.946	1	**0.008**	2.283	1.236	4.217
Several times a month	0.784	0.334	5.501	1	**0.019**	2.189	1.137	4.214
Once a week	1.046	0.309	11.491	1	**0.001**	2.848	1.555	5.215
Several times a week	1.188	0.342	12.077	1	**0.001**	3.281	1.679	6.413
Every day	0.740	0.312	5.644	1	**0.018**	2.096	1.138	3.861
Several times a day	0[b]			0				
Tea with sugar;								
Never	−1.476	0.314	22.076	1	**0.000**	0.228	0.123	0.423
Several times a month	0.561	0.243	5.340	1	**0.021**	1.753	1.089	2.822
Once a week	0.563	0.294	3.684	1	0.055	1.757	0.988	3.123
Several times a day	0[b]			0				
Nocturnal bottle feed;								
Yes	0.667	0.204	10.707	1	**0.001**	1.949	1.307	2.907
No	0[b]			0				

[a]The reference category is: No dental caries

[b]This parameter is set to zero because it is redundant

[c]Floating point overflow occurred while computing this statistics. Its value is therefore set to system missing

All those entries in bold depict significant association of the variable with dental caries

regarding the use of fluoridated tooth paste showed an association with dental caries. In relation to feeding practices, frequency of sweets consumption (every day), milk with sugar (never, several times a month, once a week, every day), tea with sugar (several times a month, several times a week), and nocturnal bottle feeding with milk ($P < 0.001$; OR = 1.949, CI = 1.307–2.907) had a significant association with dental caries.

Discussion

Dental caries is an infectious and multifactorial disease caused by interaction between microorganisms, substrate, tooth, and time. The evidence in support of an inherited susceptibility to dental caries is quite limited.[5] From a preventive aspect, the relative influence of genetics and environment should be known as that would help in modifying and recommending the preventive measures. Genes are involved in tooth eruption, tooth morphology, saliva, oral flora, arch shape, dental spacing, and immune response; hence, they are capable of influencing the individual susceptibility to dental caries.[9]

In the clinical examination of this study, DMFT score for non-consanguineous group and consanguineous group was 2.02 ± 1.42 and 1.82 ± 0.90, respectively. The deft score for non-consanguineous group and consanguineous group was 3.02 ± 2.13 and 4.06 ± 2.32, respectively, which was statistically significant ($P < 0.001$). Major contribution was offered by the decayed component, probable explanation being that dental care is still considered to be neglected in developing countries. Furthermore, poor accessibility, availability of dental health services, and cost also play their role. Reddy *et al.*[10] reported a deft and DMFT score of 1.49 and 0.57, respectively, whereas Poornima *et al.*[11] found a deft and DMFT score of 2.77 and 0.26, respectively, in their studies. The DMFT score was lower as compared to deft score in this study, as the majority of respondents in non-consanguineous group were 8-year olds, whereas in consanguineous group, the majority were represented by 7-year-old respondents where only a few permanent teeth had erupted.

Consumption of cream biscuits/cakes once a week, soft drinks every day, sweets/candy several times a week (2–3 times), and tea with sugar are documented risk factors associated with dental caries.[12,13] These refined and additional sugar provides more carbohydrate source to promote acid production, hence favoring a high DMFT/deft score. Using toothbrush and paste as a cleaning aid and having knowledge about fluoride in the same group with aforementioned quoted favorable eating habits for the causation of dental caries can be attributed to the social desirability to provide correct answers, similar views were expressed in studies by Ahamad *et al.*,[14] Al-Darwish,[15] and Al-Samadani *et al.*[16] Another probable possible explanation could be the role of genes in saliva, tooth morphology, immune response, and oral flora, rendering the respondents more susceptible to dental caries in this study, again an interesting area of further research.

Conclusion

After studying the confounding factors and the statistically significant association of deft score with consanguineous group, one can conclude that dental caries that has multifactorial etiology, both environmental and genetic factors, had an influence in the causation of dental caries in this study. Individual, family, and community have to be educated through information education communication programs, and awareness has to be created among them, regarding the consequences of consanguineous marriages. Collaboration between dental professionals and geneticists is needed.

Limitations

For this study, there is a possibility of information bias, especially regarding memory recall. Being a cross sectional study, it gave no idea about the etiology, period prevalence and incidence rate.

Importance to pediatric dentists

1. Dentist should know that dental caries follow an inheritance pattern, and they can play an active role with the geneticist in premarital counseling and patient education.
2. This voluntary action will help to create awareness among patients that not only medical conditions but dental conditions too have an association with consanguinity.

Acknowledgement

I thank all my patients for their immense cooperation.

Financial support and sponsorship

This was a self-financed study.

Conflicts of interest

There are no conflicts of interest.

Author contribution

As per ICJME guidelines, only I was involved in the study design, conception, data collection and acquisition, interpretation and manuscript writing.

Ethical policy and institutional review board

All procedures have been performed a per the ethical guidelines laid down by the Declaration of Helinski (2008). Permission to carry out the study was obtained from the Institutional Ethics and Research Advisory Committee of Faculty of Medicine, Aligarh Muslim University (D.No.41/FM/04/08/15).

Patient declaration of consent

Informed written consent was obtained from all the parents of the respondents for participation in the study and publication of the data for research and educational purposes was sought before the start of the study.

Data availability statement

Not applicable.

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