

Caries Risk Assessment of 12–13-year-old Government and Private School Going Children of Mysore City Using Cariogram: A Comparative Study

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Received: 06-12-17.
Accepted: 30-12-17.
Published: 24-04-18.

INTRODUCTION

Dental caries is a reversible, dynamic biochemical event at a micron level that has changed perspective of recognizing the caries disease and the caries lesion.^[1] Dental caries remains public health problem due to its widespread characteristic, cost of treatment, and effects on the quality of life.^[2]

To date, various cross-sectional and longitudinal studies regarding caries risk assessment have been reported.^[3-6] In those studies,^[3-6] the accuracy of many different caries

ABSTRACT

Aim: The aim of this study is to assess the caries risk assessment of 12–13-year-old government and private school going children of Mysore city using Cariogram.

Materials and Methods: A cross-sectional examination was carried out on a total of 104 government and private schoolchildren aged 12–13 years. Ten factors from the Cariogram software (D Bratthall, Computer software, Malmo, Sweden) were included from study participant's records to complete the Cariogram. The percentage of "chances of avoiding new lesions" (caries risk) among government and private school study participants were obtained from Cariogram, and the participants were classified into five risk groups. Statistical analysis was performed using the software program Statistical Package of Social Science (version 17.0, SPSS Inc., Chicago IL, USA).

Results: Findings revealed that there is slight difference in caries risk among government and private schoolchildren, where 48% caries risk development and 52% chance to avoid dental caries were showed in government schoolchildren, and 51% caries risk development and 49% chance to avoid dental caries were showed in private schoolchildren, according to Cariogram. Decayed, missing, and filled teeth component, mutans streptococci, and *Lactobacillus* counts were slightly higher in private schoolchildren compared with government schoolchildren.

Conclusion: The private schoolchildren had less favorable values than government schoolchildren for most of the caries-related factors. Cariogram can be the most modest and reliable tool for caries prediction, thus aiding in identifying different risk groups in a community so that appropriate preventive strategies can be provided to overcome new carious lesion formation.

KEYWORDS: Caries risk, Cariogram, government schoolchildren, private schoolchildren

activity tests was evaluated. However, no single variable was proven to be successful in predicting caries development.^[4,5]

The multifactorial etiology of dental caries points to the necessity of developing new caries risk assessment

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How to cite this article: Naik SP, Moyin S, Patel B, Warad LP, Punathil S, Sudeep CB. Caries risk assessment of 12–13-year-old government and private school going children of Mysore city using cariogram: A comparative study. J Int Soc Prevent Communit Dent 2018;8:160-7.

Access this article online	
Quick Response Code: 	Website: www.jispcd.org
	DOI: 10.4103/jispcd.JISPCD_437_17

models that would include the different factors or parameters which influence formation of new carious lesions. Two different approaches were described for caries risk assessment models: the risk model that describes risk factors but does not predict caries outcome and prediction model that estimates the risk of caries progression in future.^[7]

In trying to make a comprehensive caries risk assessment for an individual, one faces a situation that several factors need to be considered and weighted together. Summarizing these factors could be a complex process and to facilitate the practical application, a computer-based risk assessment model for caries, the Cariogram, was developed in 1996 by Bratthall.^[8]

The Cariogram program operates basically in such a way that information on a number of factors are collected about the patient, transferred to “scores,” and these scores then entered into the program. According to its built-in algorithm, the program evaluates the data and presents the summarized result expressed as one figure, a pie diagram, illustrating the “chance of avoiding cavities” in the future.

Caries risk assessment with identification of leading risk factors provides the basis for possibility of developing effective preventive programs that can be implemented at different levels (inside families, schools, institutions, local communities, etc.). For these reasons, it is important to assess caries risk development in children, especially to identify those at high risk.^[9]

Exploration of the available literature related to Cariogram revealed that limited studies have been conducted in India;^[10,11] also in country like India, evaluating the caries risk profiles helps develop preventive measures that can be directed to that group, thereby attempting to eliminate the need for restorative care and refining the quality of life; therefore, the present study had been attempted to test the null hypothesis that there is no difference in caries risk profiles among government and private schoolchildren as assessed by Cariogram computer model, with the dependent variable to be caries risk profiles and independent variable to be caries-related factors illustrated by Cariogram.

The aim of this current study were (1) to assess the caries risk profiles among 12–13-year-old government and private 104 school going children of Mysore city using Cariogram program and (2) to compare the differences in caries risk profiles among 12–13-year-old government and private school going children of Mysore city as illustrated by Cariogram program.

MATERIALS AND METHODS

STUDY POPULATION AND DESIGN

A cross-sectional study was conducted to assess caries risk among 12–13-year-old school going children of government and private schools of Mysore city using Cariogram computer model. Mysore city is situated in the southern part of India. Study population was selected on the basis of stratified cluster random sampling. The nature and purpose of the study were explained to institutional review board (JSSDH/PG/2011/126), and ethical clearance was obtained. Written informed consent and verbal assent were obtained from parents and children, respectively, after explaining about the purpose and study procedure at the beginning of study.

The inclusion and exclusion criteria were as follows:

INCLUSION CRITERIA

1. Schoolchildren of 12–13 years of age as per school records
2. Schoolchildren willing to participate
3. Schoolchildren with permanent teeth.

EXCLUSION CRITERIA

1. Schoolchildren who were not present on the day of examination
2. Schoolchildren having primary teeth.

SAMPLE

The sample size was calculated by conducting a pilot study. Based on this study, it was found the average caries risk using reduced Cariogram computer model.^[12]

To estimate the final sample size with 95% confidence interval and 80% power, the comparison of two mean% was done using the statistical formula.

$$n = \frac{2\bar{P}(1-\bar{P})(Z_{\alpha/2} + Z_{\beta})^2}{(P_1 - P_2)^2}$$

$$n = 50$$

$$Z_{\alpha/2} = 1.96$$

$$Z_{\beta} = 0.84$$

$$P_1 = 60$$

$$P_2 = 32$$

$$P_1 - P_2 = 28$$

The minimum sample size was estimated to be 50 in each group. To compensate for dropouts up to 10% if any, a total sample size of 104 was set.

It followed the study method to assess the caries-related factors as illustrated by Cariogram model with some

modifications accordingly which was applicable with respect field study among schoolchildren.

Study methodology consisted of the following steps:

PREPARATION OF A QUESTIONNAIRE AND AN INTERVIEW WITH THE PARTICIPANTS

A specially prepared and pretested questionnaire in English language, exclusively designed for recording all the relevant caries-related data as illustrated by Cariogram, was used. The questionnaire focused on questions about demographic and socioeconomic information (based on modified Kuppuswamy's socioeconomic status scale).^[13]

In addition, the 3-day diet diary (including Sunday) to be filled by the children with the assistance of parents was employed to collect data pertaining to diet and frequency of eating snacks/meals per day.

INTRAORAL EXAMINATION

All the examination was performed by the same examiner (SPN) under standardized conditions in the classroom setup. Study participants were examined for plaque and dental caries. The oral hygiene and plaque amount were estimated using a mirror and periodontal probe in accordance with the Silness and Løe plaque index^[14] (1964). The participants were classified into one of four groups: excellent, good, fair, and poor plaque amount according to the Cariogram Manual.^[15]

The level of caries was scored by decayed, missing, and filled teeth (DMFT) index^[16] (1938) and was obtained by calculating the number of Decayed (D), Missing (M), and Filled (F) teeth (T). The scoring of DMFT index was done under favorable lighting conditions using a No. 3 plain mirror and WHO probe. A single trained and calibrated examiner recorded both the index. The degree of intra-examiner reliability was established through an examination of 20 children by the examiner, and the procedure was repeated after 4 weeks. The mean intra-examiner kappa values for plaque and caries index were $k = 0.84$ and $k = 0.86$, respectively.

SALIVA SAMPLING

All participants undergoing saliva sampling were given clear instructions to refrain from oral hygiene measures and eating, before 1 h. To avoid contamination with food debris, participants were asked to rinse their mouth thoroughly with water. To control circadian variation, samples were collected between 8 and 9 AM to control the circadian variation. Due to nonavailability of chewable paraffin wax, sterilized rubber bands^[17] were used in this study for stimulation of saliva. The study participants were instructed to place the sterilized rubber band in the mouth and start chewing it for 30 s

and swallow the accumulated saliva; this was followed by continuously chewing for 5 min without swallowing the saliva to ensure that the stimulated saliva produced properly washes all the areas of the oral cavity.

Assessment of salivary flow rate

Saliva from the oral cavity was sucked using a sterile disposable syringe and was transferred in a measurable labeled sterilized polypropylene centrifuge tubes, and the quantity of saliva secreted per minute was estimated.

Estimation of salivary-buffering capacity

0.5 ml of saliva was added to 1.5 ml of 0.005 molarity of hydrochloric acid (HCl). Buffering capacity of saliva was assessed by electronic pH meter and categorized accordingly.

EVALUATION AND ENUMERATION OF STREPTOCOCCUS MUTANS AND LACTOBACILLUS

The saliva samples were processed within 3 h on the same day. For the evaluation and enumeration of *Streptococcus mutans* and *Lactobacillus*, serial dilution and plating^[18] was performed. One milliliter of saliva sample was diluted with 9 ml of sterile phosphate-buffered solution (diluent) and homogenized in a vortex mixer and serially diluted till 10^{-7} dilutions in sterile phosphate-buffered solution. One hundred microliters of pipette sample was then inoculated by spread plate technique on mitis-salivarius-bacitracin^[19] agar medium plate selective for *S. mutans* and on Rogosa agar medium plate for *Lactobacillus*,^[20] with the help of sterile inoculating glass rod.

The mitis-salivarius agar plates were incubated in an anaerobic jar for about 48 h at 37°C in an incubator, and similar procedure was followed for Rogosa agar plates, which were incubated for nearly 96 h.

CREATING A RISK PROFILE USING THE CARIGRAM

When all the information regarding the caries-related factors was collected, scoring was given according to predetermined scale as 0–2 or 0–3 [Table 1].

For all the individuals in the present study, the “clinical judgment factor” was given a score of 1, which means that the risk is evaluated according to other values entered.

In Cariogram, the settings for country/area was set to standard since standard set is suitable to those countries without water fluoridation and the country like India falls under this category.

The scores were included into the Cariogram computer software program; a pie diagram is automatically generated five different sectors expressed as percentages, i.e. (1) “diet,” based on a combination of sugar intake

Table 1: Caries related factors and scores used to create the Cariogram

Sector	Factor	Information and data collected	Cariogram scores
Circumstances	Caries experience	Past caries experience, including cavities, fillings, and missing teeth because of caries	No caries lesion=DMFT of 0 DMFT of 1 DMFT of 2 (2 in 12 years old in Karnataka state considered normal) ^[21] DMFT of 3
	Related general disease	General diseases or conditions associated to dental caries; medical history, medications; data from interviews	0: No disease, healthy 1: A general disease which can directly influence the caries process to a mild degree 2: A general disease which can indirectly influence the caries process to a high degree
Diet	Diet, contents	Estimation of the cariogenicity of the food, in particular, sugar contents <i>Lactobacillus</i> counts were used as a measure of cariogenic diet	0: <10 ³ CFU/ml 1: >10 ³ -10 ⁴ CFU/ml 2: 10 ⁴ -10 ⁵ CFU/ml 3: >10 ⁵ -10 ⁶ CFU/ml
	Diet frequency	Estimation of number of meals and snacks per day, mean for “normal days” Data were obtained from average of 3-day diet diary	0: 3 meals/day 1: 4-5 meals/day 2: 6-7 meals/day 3: >7 meals/day
Bacteria	Plaque amount	Estimation of hygiene Silness-Loe PI was used	0: 0 (excellent) 1: 0.1-0.9 (good) 2: 1.0-1.9 (fair) 3: 2.0-3.0 (poor)
	<i>S. mutans</i>	Estimation of levels of <i>S. mutans</i> Salivary <i>S. mutans</i> was assessed using microbial analysis and expressed as CFU/ml of saliva	0: <10 ³ CFU/ml (negligible) 1: >10 ⁴ CFU/ml 2: 10 ⁴ -10 ⁵ CFU/ml 3: >10 ⁵ -10 ⁶ CFU/ml
Susceptibility	Fluoride program	Estimation of to what extent fluoride is available in the oral cavity over the coming period of time Obtained through interview	0: Maximum fluoride program 1: Fluoride supplements 2: Only fluoride toothpaste 3: No fluoride
	Saliva secretion	Estimation of amount of saliva Sterile rubber band-stimulated secretion assessed as mm saliva per ml	0: 0.7 ml/min 1: 0.3-0.7 ml/min 2: <0.3 ml/min
	Buffering capacity	Estimation of buffering capacity assessed using pH meter	0: pH>6.0 1: pH 4.5-5.5 2: pH<4.0

S. mutans=*Streptococcus mutans*, PI=Plaque index, DMFT=Decayed, missing, and filled teeth

and the number of lactobacilli (dark blue sector); (2) “bacteria,” which is a combination of plaque score and the number of mutans streptococci (red sector); (3) “susceptibility,” including the fluoride program, the salivary secretion, and the buffer capacity (light blue sector); (4) “circumstances,” the past caries experience and related general disease (yellow sector); and (5) “chance of avoiding caries”(green sector).

The participants were also classified into five caries risk groups according to the percentage shown by the Cariogram:

- Very low risk: 81%–100%
- Low risk: 61%–80%
- Moderate risk: 41%–60%
- High risk: 21%–40%
- Very high risk: 0%–20%.

STATISTICAL METHODS

Data were analyzed using SPSS statistical package (version 17.0, SPSS Inc., Chicago IL, USA). Descriptive statistics, including Pearson’s Chi-squared test, was used to find statistical significant difference in the frequency distribution of the various caries-related

factors illustrated by Cariogram between government and private school study participant. The differences in government and private schoolchildren were compared using Mann–Whitney U-test. Spearman’s correlation coefficients were used to explore associations among Cariogram sectors and caries risk. The probability level for statistical significance was at $\alpha = 0.05$.

RESULTS

Petersson *et al.*^[21] expressed the results of their studies with the Cariogram® as chance to avoid caries. For obtaining greater scope for statistical analysis, the present study results were expressed as caries risk [Table 2], which is believed to be a more comprehensible and useful value; obtained by adding up the partial caries risks of susceptibility, circumstances, bacteria, and diet, it allows correlations to be established.^[22]

Table 3 shows distribution of government and private schoolchildren according to Kuppaswamy’s socioeconomic status 2012.^[13] The results show that majority 84.6% of government schoolchildren belong to low socioeconomic status (upper lower-IV) and majority 63.5% of private schoolchildren belong to high socioeconomic status (upper middle-II).

Table 4 represents comparison of caries-related factors between government and private schoolchildren. Differences in DMFT were statistically significant among government and private school study participants ($P < 0.05$).

Table 4 represents the average caries risk profiles of 12–13-year-old study participants among government and private schools. Findings revealed that there is slight difference in caries risk among government and private schoolchildren, where government schoolchildren showed 48% risk for caries development, with 52% chance of avoiding caries in future, and private schoolchildren showed 51% risk for caries development, with 49% chance of avoiding caries in future, according to Cariogram.

Table 5 shows that when government and private schoolchildren were classified according to chance

to avoid caries, it was found that majority of the private schoolchildren (70.5%) and government schoolchildren (64.1%) belonged to medium risk category.

Spearman’s correlation coefficient was used to find the correlation between caries risk and Cariogram sectors among government and private schoolchildren [Table 6].

Caries risk of the participants was significantly highly correlated with all the sectors except circumstance sector which obtained significantly low correlation with caries risk.

DISCUSSION

In India, the type of school a child attends depends on the environment where the child lives and the parent’s socioeconomic status. Most children from high and middle socioeconomic family status attend government schools while children from low-income family status attend private schools. The major reason for this difference in the choice of school is finance.

The present study sample consisted of schoolchildren from both government and private schools to have representative of children from all the social, economic, and cultural communities. This will provide a realistic picture of the caries risk profiles of the target group in the studied population.

The age group of 12–13-year-old was chosen to evaluate the caries risk profile as this is a WHO global monitoring age for dental caries since all deciduous teeth are said to have exfoliated and the second molars would have just erupted or erupting in any child at this age,^[23] to avoid discrepancies between mixed and permanent dentition only children with permanent dentition were selected regard to microbial counts as described by Martins MT *et al.*^[24] Excellent positive predictive values for *S. mutans* were found for young children aged 2–4 years and for children aged 12–13 years as stated by Krasse.^[25]

The average risk profile among government schoolchildren showed that the study participants have 48% risk for caries development, with 52% chance

Table 2: Caries risk (percentage chance of avoiding caries) among government and private schoolchildren made by Cariogram

Schools	High risk	Medium risk category			Low risk	Total, n (%)	Significant
	(0%-20%), n (%)	21%-40%, n (%)	41%-60%, n (%)	61%-80%, n (%)	(81%-100%), n (%)		
Government school	5 (9.8)	12 (23.1)	13 (25.0)	16 (30.8)	6 (11.5)	52 (100)	NS
Private school	6 (11.5)	23 (21.2)	22 (42.3)	7 (13.5)	6 (11.5)	52 (100)	
Total	11 (10.6)	23 (22.1)	35 (33.7)	23 (22.1)	12 (11.5)	104 (100)	
χ^2			df			P	
5.970			4			0.201	

of avoiding new caries in future, whereas the average risk profile among private schoolchildren showed that the study participants have a 51% risk for caries

development, with 49% chance of avoiding new caries in future. Although this difference was not statistically significant [Table 5]. This can be attributed to the fact that social factors such as economic status and education levels are related to caries experience and increment.^[26]

Table 3: Distribution of government and private school study participants according to socioeconomic status

Socioeconomic status	Government school, n (%)	Private school, n (%)
Upper (I)	0	1 (1.9)
Upper middle (II)	0	33 (63.5)
Lower middle (III)	8 (15.4)	18 (34.6)
Upper lower (IV)	44 (84.6)	0
Lower (V)	40 (77.3)	0
Total	52 (100)	52 (100)

The impact of the “economic status,” however, is different in different countries. In developing countries, low-income persons often belong to the high caries risk group. This depends, of course, on caries-related behavior and lifestyle the social factors will result in. Most often, this concerns oral hygiene measures, choice of diet and whether or not fluoride is used factors already concerned in the Cariogram.^[27]

Table 4: Comparison of caries-related factors between government and private schoolchildren

Caries related factors	Government schoolchildren, n (%)	Private schoolchildren, n (%)	Total, n (%)	P
Plaque amount				
0: 0 (excellent)	0	0	0	1.000
1: 0.1-0.9 (good)	0	0	0	
2: 1.0-1.9 (fair)	43 (82.7)	43 (82.7)	86 (82.7)	
3: 2.0-3.0 (poor)	9 (17.3)	9 (17.3)	18 (17.3)	
Mutans streptococci				
0: Negligible	0	0	0	0.202
1: <10 ⁴ CFU/ml	12 (23.1)	11 (21.2)	23 (22.1)	
2: 10 ⁴ -10 ⁵ CFU/ml	34 (65.4)	28 (53.8)	62 (59.6)	
3: >10 ⁵ CFU/ml	6 (11.5)	13 (25)	16 (18.3)	
Caries experience				
0: DMFT 0	10 (19.2)	17 (32.7)	27 (26.0)	0.02
1: DMFT 1	12 (23.07)	14 (26.9)	26 (25)	
2: DMFT 2	25 (48.07)	11 (21.15)	36 (34.6)	
3: DMFT ≥3	5 (26.9)	10 (36.5)	15 (14.44)	
Diet, content				
0: <10 ³ CFU/ml	0	0	0	0.563
1: >10 ³ -10 ⁴ CFU/ml	16 (30.8)	14 (26.9)	30 (28.8)	
2: 10 ⁴ -10 ⁵ CFU/ml	33 (63.5)	32 (61.5)	65 (62.5)	
3: >10 ⁵ -10 ⁶ CFU/ml	3 (5.8)	6 (11.5)	9 (8.7)	
Diet frequency				
0: 3 meals/day	0	0	0	0.05
1: 4-5 meals/day	16 (30.8)	17 (32.7)	33 (31.7)	
2: 6-7 meals/day	18 (34.6)	27 (51.9)	45 (43.3)	
3: >7 meals/day	18 (34.6)	8 (15.4)	26 (25)	
Fluoride program				
0: Maximum fluoride program	0	0	0	
1: Fluoride supplements	0	0	0	
2: Only fluoride toothpaste	52 (100)	52 (100)	104 (100)	
3: No fluoride	0	0	0	
Saliva secretion				
0: 0.7 ml/min	51 (98.1)	52 (100)	103 (99)	0.315
1: 0.3-0.7 ml/min	1 (1.9)	0	1 (1.9)	
2: <0.3 ml/min	0	0	0	
Saliva-buffering capacity				
0: pH >6.0	47 (90.4)	47 (90.4)	94 (90.4)	0.574
1: pH 4.5-5.5	49 (7.7)	5 (9.6)	9 (8.7)	
2: pH <4.0	1 (1.90)	0	1 (1)	

DMFT=Decayed, missing, and filled teeth

Table 5: The average caries risk profiles of 12-13-year-old study participants among government and private schools

	Government school		Private school		Significance
	Mean	SD	Mean	SD	
Susceptibility	9.8	3.8	10.2	3.6	0.574
Bacteria	19.3	8.3	21.3	8.3	0.221
Diet	13.7	8.6	14.3	8.3	0.691
Circumstance	5.1	4.5	5.8	3.8	0.422
Caries risk	48.0	22.7	51.6	21.4	0.371

In our study, it was found that there was a statistical difference in the frequency distribution of the *Lactobacillus* levels between government and private school study participants. It seems reasonable to suggest an economic explanation indicating that sweet consumption was most common among children who can afford products such as sugar-containing beverages and sweets. Differences are evident when sugar consumption pattern is compared with other study reports. This can be attributed to the variation in sociocultural and geographical factors.^[28]

Caries risk of the participants was significantly highly correlated with all the sectors [Table 6] except circumstance sector which obtained significantly low correlation with caries risk. The low correlation between circumstance sector and caries risk may be attributed to the fact that there was absence of related disease and the participated study individuals are young similar results was obtained from a study conducted by Miravet *et al.*^[22]

Private school study participants are having more caries experience as compared to government school study participants. It is imperative to realize that the past caries is the effect of caries manifestation and not the cause of caries disease. If effective interventions are introduced and risk factors eliminated, then past caries experience loses its predictive role.^[29] The fact that this variable is still so powerful in so many studies rather reflects that caries normally is not controlled adequately or that routine preventive measures are not effective enough.^[10,30] The present study results are contradictory to the study done by Mitha *et al.*^[31] and Taqi *et al.*,^[32] stating that the majority of the study participants from government schools belonged to medium risk category and private school participants belonged to low-risk category which inferred that private school students have high chance to avoid dental caries compared to government study participants.

Therefore, the socioeconomic condition in which a child is raised is an important caries risk determinant but does not predict disease on an individual basis which can be used as serious screening factors that help for the assessment of the dental caries risk.^[33,34]

Our study should be considered in light of some limitations:

Table 6: Correlation between caries risk and Cariogram sectors among study participants belonging to both schools

Sectors	Caries risk
Circumstance sector	0.783**
Susceptibility sector	0.936**
Bacteria sector	0.938**
Diet sector	0.916**

- The Cariogram model is truly comprehensive and illustrates the relative importance of various caries-related factors in an individual risk profile, but the inclusion of salivary tests with microbiological cultivations, such as mutans streptococci and lactobacilli enumeration and usage of chair-side microbial tests which are costly and time-consuming, may delay the process from a patient-motivating point of view and may impart its limited use
- Due to the uncertainty of error during processing and inoculating of the microbiological plates and subjective morphotyping of the bacteriological colonies may prone for underestimation/overestimation of the bacteriological count.

CONCLUSION

Since prevention is still the least costly alternative treatment hence the saying Prevention is better than cure which holds good for dental caries too. Thus, it is pragmatic to use Cariogram with caries. Preventive programs can be formulated based on such profiles. Followings are preventive programs that can be incorporated to minimize/eradicate the risk for caries among the children.

- The diet which includes fermentable carbohydrates is a problem – a reduced intake of such products would be an advantageous
- The bacterial situation with respect to counts of Mutans streptococci is one of the problems. If any caries lesions are developing, local fluoride and chlorhexidine treatments could be considered
- A reinforced fluoride program in addition to the fluoride toothpaste is one possible action to reduce the caries risk.

FINANCIAL SUPPORT AND SPONSORSHIP

Nil.

CONFLICTS OF INTEREST

There are no conflicts of interest.

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