

Research Article

## Comparative performance assessment of composite indicators for DMFT, DMFS, FS-T and T-Health indices among a 35-44 year old urban population: A cross-sectional study

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### ABSTRACT

**Introduction:** Several limitations of decayed, missing, and filled teeth (DMFT) (DMF surfaces [DMFS]) have been addressed with the introduction of new composite indicators such as filled and sound teeth (FS-T) and T-health. These indices not only reflect the determinants of oral health but also reveal the utilization of health services and help in planning health programs.

**Objectives:** The objectives of this study were to assess the dentition status and extract DMFT, DMFS, FS-T, and T-health scores and to determine which of the four would represent the dentition status of a population.

**Basic Research Design:** A cross-sectional study was planned to collect data through probability proportionate sampling. Participants: Two hundred and forty-one individuals aged between 35–44 years old residing in Bangalore city. Sociodemographic data were collected and oral examination of subjects was done to obtain the scores for DMFT, DMFS, FS-T, and T-health indices. Data obtained were analyzed using the SPSS version 19.

**Results:** DMFS index showed maximum variance of 8.5% followed by T-health index which was 7.7%. FS-T showed the variance of 7.2%. Among the individual components, missing teeth component and sound functional teeth showed the maximum variance of 7.6% and 7.1%, respectively.

**Conclusion:** DMFS as an indicator of dentition status is more sensitive than the other three compared indices in identifying sociodemographic factors, utilization of health services by a population, and perceptions about oral health as determinants of oral health.

**Keywords:** Caries, Coronal, Epidemiology, Dental health, Public health

### INTRODUCTION

Dental caries is an irreversible microbial disease affecting the human race irrespective of gender, age groups, and socioeconomic strata.<sup>[1,2]</sup> Decayed, missing, and filled teeth (DMFT) has been traditionally used to measure the dental caries experience and the monitored reports not only serve to present the disease pattern but also reflect the availability and utilization of the oral health services.<sup>[3]</sup> The index scores depreciate the value of restorative dentistry and provide a cumulative score making the individual component assessment difficult.<sup>[4]</sup> DMFT values further make the comparison difficult between communities, consequent on the introduction of a particular oral health program as, regular use of dental services is positively associated with filled

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teeth and negatively with missing teeth.<sup>[3,5]</sup> The limitations appreciated by Sheiham *et al.* for DMFT as a dentition status indicator led to the development of new indices. These indicators of dentition status include filled and sound teeth (FS-T) (number of functioning teeth) which takes into consideration, the sound and filled functional teeth (1:1), and T-health (tissue health index) which gives different weightages to healthy, filled, and decayed teeth (4:2:1).<sup>[3,5]</sup> Rarely, literature from India is reported in relation to the representativeness of indicators of oral health. Hence, this study was conducted to compare the composite indicators of oral health and their individual components, to identify or arrive at an index or an individual component which is more representative of the dentition status. The aim of the study was a comparative performance assessment of composite indicators and their individual components for DMFT, DMF surfaces (DMFS), FS-T, and T-health indices among 35–44 years old population of Bengaluru city.

## OBJECTIVES OF THE STUDY

The objectives of this study were as follows:

1. To assess the dentition status of 35–44 years old population and extract DMFT, DMFS, FS-T, and T-health scores.
2. To determine an individual component or composite indicator of 35–44 years old population that would represent the oral health of a population.

### Sub-objectives

The sub-objectives of this study were as follows:

- To describe the different consequences of dental caries
- To distinguish people with various oral health statuses on the basis of composite indicators
- To reveal sociodemographic and behavioral characteristics associated with oral health.

## METHODOLOGY

Based on a pilot study, with a value fixed at 5% and the power of the study as 80%, the sample size was estimated to be 237 for this cross-sectional study. A prior ethical clearance was obtained from the Institutional Ethics Review Committee for the study. A study tool was developed which included, sociodemographic details and information on perception and utilization of dental services as the first part and dentition status to extract DMFT, DMFS, FS-T, and T-health indices as the second part according to the criteria's given.<sup>[4,6-9]</sup> This study tool was developed based on the Kuppuswamy scale, DMFT, DMFS, FS-T, and T-health indices and the feasibility was tested during the pilot study. The principal investigator identified, underwent training under the guidance of a subject expert for recording the dentition status using

DMFT, DMFS, FS-T, and T-health indices, a week before commencing the on-field visits. The interexaminer agreement was found to be good for the individual components of decayed teeth ( $K = 0.83$ ), missing teeth ( $K = 1.00$ ), filled teeth ( $K = 1.00$ ), decayed surfaces ( $K = 0.97$ ), missing surfaces ( $K = 1.00$ ), filled surfaces ( $K = 1.00$ ), sound functional teeth ( $K = 1.00$ ), and filled functional teeth ( $K = 0.98$ ) between the two examiners.

Bengaluru has eight zones and 198 wards, and probability proportionate sampling was done to obtain a representative sample.<sup>[10]</sup> Based on the population of each zone, population of each ward was taken into account to determine the proportion of sample to be obtained from the particular area. House-to-house survey was conducted until the proportioned sample for that zone was met. The purpose and procedure of the study were explained in detail and duly signed consent was obtained from each participant. Two hundred and forty-one dentate subjects aged between 35–44 years (the WHO age group representative of functional oral health) and residents of the zones were included in the survey. The study was conducted over a period of 5 months from February 20 to June 20, 2014. Interview administered study tool was used to record the data pertaining to sociodemographic details, utilization of dental services, and perceptions about oral health, and it was followed by the clinical examination to extract the dentition status. Sterilized set of instruments was used for intraoral examination of each subject. Duration of data collection for each subject ranged from 10 to 15 min. The subjects diagnosed with oral conditions/diseases were referred appropriately to the nearby satellite centers and the dental institutions.

### Data analysis

The Statistical Package for the Social Sciences version 19 (IBM Corp. Released 2010. IBM SPSS Statistics for Windows, Version 19.0., Armonk, NY: IBM Corp.) was used for the data analysis. Descriptive statistics were obtained for sociodemographic and behavioral characteristics, score of Kuppuswamy scale, individual components of D, M and F teeth/surfaces, and composite indicators of DMFT, DMFS, FS-T, and T-health. The independent factors of perceptions and utilization of health services were recorded using nominal and ordinal scales. As the data were found to be non-parametric through Shapiro–Wilk test, a bivariate analysis using Spearman's rho was indicated for correlation. Backward stepwise method of multiple linear regression was used to assess the strength of independent variables correlating with the oral health indicators.  $P < 0.05$  was considered as statistically significant for the above-mentioned inferential statistics. Hierarchical cluster analysis (multivariate analysis) was done to distinguish people with various states of oral health for the common factors of DMFS (as no risk or at risk) for each index of DMFT, DMFS, FS-T, and T-health. Clear

demarcation point was identified in the reagglomerating data, which showed the number of clusters as two. Ward's method was used to determine the distance between the clusters using the algorithm of squared Euclidean distance. Independent sample *t*-test was used to compare the means of the risk and the non-risk groups for the different dependent variables for different composite indicators. Since the study defined the sensitivity of dental health indicators, further these clusters for various composite indicators were subjected to multiple logistic regression with independent variables proposed as a model in linear regression affecting the oral health of this adult population. Hosmer–Lemeshow test was used as a statistical test for goodness of fit for logistic regression models. Significance larger than 0.05 was accepted for the goodness of fit for the model.

## RESULTS

Comparative assessment was done for DMFT, sound functional teeth, and filled functional teeth components and DMFT, DMFS, FS-T, and T-health indices recorded. The following results were obtained for the study conducted.

### Sociodemographic characteristics of the study subjects

The target age group of 35–44 years had a mean age of  $39.5 \pm 2.71$  years (241 subjects) including 50.6% of males and 49.4% of females. About 0.8% belonged to the lower socioeconomic status, 26.1% belonged to upper-lower class, 42.7% belonged to the lower-middle class, 27.8% belonged to the upper-middle status, and 2.5% belonged to the upper socioeconomic status.

### Dentition status among the study subjects

Mean of the D component was  $1.66 \pm 2.07$ , M component was  $2.53 \pm 3.67$ , and the F component was  $0.84 \pm 1.76$ . Total DMFT reported a mean  $5.02 \pm 4.75$  for the study subjects. The mean of D(s) was  $2.53 \pm 3.47$ , M(s) was  $10.86 \pm 15.90$ , and F(s) was  $2.23 \pm 5.26$ . The mean DMF(s) was found to be  $15.61 \pm 17.65$  for the study subjects. Mean of the sound teeth was  $25.69 \pm 5.91$  and for the restored functional teeth was  $0.88 \pm 2.13$  with the total FS-T index giving a mean of  $26.51 \pm 5.84$ . T-health index showed a mean of  $106.26 \pm 22.07$  for the study subjects.

### Comparison of the individual components and indices according to sociodemographic and behavioral variables

Spearman's correlation test showed the maximum number of significant values for utilization and perception about oral health when related to the different indicators of oral health. Among the various sociodemographic variables – age, sex, upper-middle class strata, lower-middle class strata,

and upper-lower class strata showed significant relations with DMFS and FS-T, decayed teeth and FS-T, filled teeth, DMFT, respectively ( $P < 0.05$ ). Frequency of dental visits related negatively with the D, M, and F components and positively with the functionality of the dentition. The scores of perceptions about oral health related positively with the D, M, F, DMFT, and DMFS and negatively with FS-T and T-health. Self-reported satisfaction with oral health and need for dental treatment related to the individual components of missing teeth and to all the composite indicators significantly ( $P < 0.05$ ). Variables were further subjected to linear regression analysis with individual components and the composite indicators [Table 1] as dependent variables. Sensitivity of each index was assessed for the model obtained on the basis of variance ( $R^2$  value) [Table 2]. Among the individual variables, missing component showed the maximum variance of 7.6%, followed by sound functional teeth and restored functional teeth resulting in a variance of 7.1% and 6.7%, respectively. Decayed teeth showed the minimum variance of 5.1%. In addition to this, the component of the missing teeth and sound functional teeth ( $P < 0.001$ ) both had significant F change value and  $\beta$  coefficient values ( $P < 0.05$ ). Among the composite indicators, maximum variance of 8.5% was reported by DMFS index followed by the T-health and FS-T index reporting a variance of 7.7% and 7.2%, respectively. The  $\beta$  coefficient was significant for all four composite indicators with a value of 11.159 for DMFT, 40.903 for DMFS, 18.786 for FS-T, and 76.675 for T-health ( $P < 0.01$ ).

### Categorization of population with various states of oral health into risk groups based on composite indicators

Based on the cluster analysis, non-risk group comprised 89.6% of the population and the risk group comprised 10.4% of the population. Independent sample *t*-test was used to assess the difference between the means of non-risk and risk groups for the different composite indicators [Figure 1a-d].

### Reveal sociodemographic and behavioral characteristics associated with oral health

Multiple logistic regression was used for the prediction of risk for oral health among the dentate adults based on the independent variables.  $\beta$  coefficient of lower-middle class was significant and revealed these socioeconomic strata to be a good predictor of FS-T index ( $P < 0.05$ ) [Table 3]. Hosmer–Lemeshow test showed a good fit for the expected values for the indicators of DMFS, FS-T, and T-health [ $P > 0.05$ , Table 3].

## DISCUSSION

This study was conducted to compare the composite indicators of oral health and their individual components,

**Table 1:**  $\beta$  coefficient of independent variables with the individual components of composite indicators.

		D	M	F	Sound functional teeth	Restored functional teeth	DMFT	DMFS	FS-T	T-health
Age	$\beta$ coefficient	-0.055	-0.132**	0.019	0.197	-0.165	-0.711**	0.221**	0.827**	0.024
Sex	$\beta$ coefficient	-0.024	-0.082	0.055	0.062	-0.052	-0.380	0.121	0.320	0.059
Upper-middle class	$\beta$ coefficient	0.535	1.046	-0.068	-2.133	1.656	3.826	-1.849	-7.214	0.285
Lower-middle class	$\beta$ coefficient	1.151	1.028	-0.381	-2.049	1.799	2.716	-2.448	-7.549	-0.399
Upper-lower class	$\beta$ coefficient	0.707	1.768	-0.860	-2.239	1.559	5.936	-3.134	-9.274	-0.894
Last visit to the dentist	$\beta$ coefficient	0.000	-0.002	-0.009	0.002	-0.011	-0.037	-0.006	-0.007	-0.008
Self-reported perception of oral health	$\beta$ coefficient	0.022	-0.026	-0.011	0.028	-0.015	-0.080	0.017	0.108**	-0.012
Satisfaction with oral health	$\beta$ coefficient	-0.219	0.562	0.296	-1.132	0.669	3.939	-0.695	-3.821	0.437
Self-reported need for dental treatment	$\beta$ coefficient	-0.421	-0.871	-0.025	1.600**	-1.328**	-3.761	1.466**	6.213**	-0.134

\* $P < 0.01$  (significant value), \*\* $P < 0.05$  (significant value)

**Table 2:** Model summary – Linear regression analysis (individual components and composite indicators).

		D	M	F	Sound functional teeth	Restored functional teeth
Age	R square	0.051	0.076	0.065	0.071	0.067
Sex	Fchange	1.369	2.118	1.771	1.947	1.855
Upper-middle class	Fchange/	0.203	0.029	0.075	0.047	0.060
Lower-middle class	*Sig $\leq 0.05$					
Upper-lower class	$\beta$ coefficient	3.955	7.260	0.069	18.955	-0.169
Last visit to the dentist	t= $\beta$ /SE	2.101	2.206	0.044	3.561	-0.088
Self-reported perception of oral health	Significance	0.037**	0.028**	0.965	0.000*	0.930
Satisfaction with oral health	DMFT		DMFS	FS-T	T-health	
Self-reported need for dental treatment	R square	0.066	0.085	0.072	0.077	
	Fchange	1.804	2.375	1.988	2.154	
	Fchange/	0.069	0.014*	0.041*	0.026*	
	*Sig $< 0.05$					
	$\beta$ coefficient	11.159	40.903	18.786	76.675	
	t= $\beta$ /SE	2.606	2.601	3.583	3.884	
	Significance	0.010*	0.010*	0.000*	0.000*	

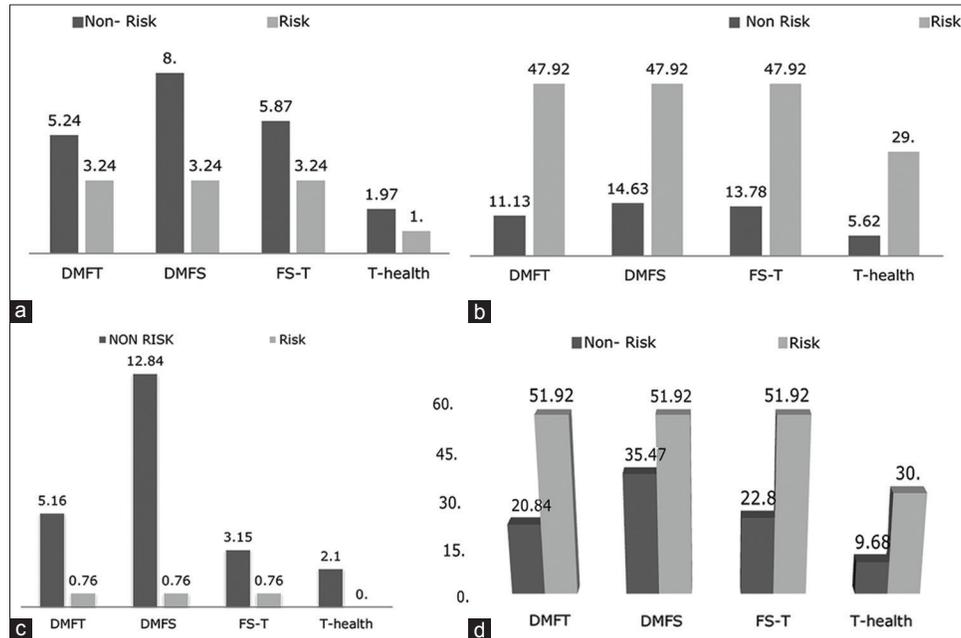
\* $P < 0.01$  (significant value), \*\* $P < 0.05$  (significant value). DMFS: Decayed, missing, and filled surfaces, DMFT: Decayed, missing, and filled surfaces, T-health, FS-T: Filled and sound teeth

to identify indices and components, more representative of the dentition status. The results of this study showed significant Spearman's correlations with the individual components of DMFT for the three socioeconomic classes (upper-middle class, lower-middle class, and upper-lower class). In accordance to the previous literature, decay component was positively correlated; the filled component was negatively correlated with the lower socioeconomic classes.<sup>[11,12]</sup> Non-significant, relations were reported for the individual factors of income, education, and occupation with the dependent variables, but overall cumulative strata's showed significance for

socioeconomic status, unveiling the fact of Kuppuswamy scale as an appropriate measure of socioeconomic status for the studies related to oral epidemiology in urban India.

The linear regression revealed less number of independent variables as the predictors of the dependent variables. The previous studies in contradiction used retrospective data, and the Pearson's correlation coefficient which has less stringent values for significance of  $P < 0.05$ .<sup>[3]</sup>

Individual component of missing teeth in DMFT and sound functional teeth in FS-T showed maximum variance



**Figure 1:** (a) Mean number of decayed surfaces, (b) mean number of missing surfaces, (c) mean number of filled surfaces, (d) mean number of decayed, missing, and filled surfaces. Independent sample t-test \* $P < 0.05$  (significant value).

**Table 3:** Multiple logistic regressions with DMFT, DMFS, T-health, and FS-T as the dependent variables. Prediction of risk among dentate adults based on the model and the goodness of fit of the model.

Variables		DMFT	DMFS	FS-T	T-health	
Sex	Male	0.097	0.641	0.556	0.541	
	Female	-	-	-	-	
Age	35–39 years	19.033	21.669	30.886	22.281	
	40–44 years	18.553	21.346	31.210	21.490	
Socioeconomic strata	Upper-middle class	22.340	-20.334	-22.083	-20.511	
	Lower-middle class	23.898	-1.882	-3.708*	-20.531	
	Upper-lower class	18.808	1.167	53.900	1.415	
Utilization of oral health services	When did you last visit your dentist?	Within 6 months	-1.341	-0.711	19.003	0.898
		Within 6 months–1 year	1.453	0.625	-17.062	-1.126
		More than a year	-0.551	0.935	-0.103	-0.541
		Never	-0.190	1.725	1.638	0.863
Perceptions about oral health	How do you perceive your oral health as?	Excellent	0.104	1.421	-18.540	1.895
		Good	0.496	-0.366	17.083	0.265
		Poor	-	-	-	-
	Are you satisfied with your oral health?	Yes	2.683	-3.073	1.300	-0.312
		No	3.017	-2.341	-0.783	0.273
Do you think you need a dental treatment?	Yes	0.764	-0.225	19.130	20.161	
	No	-0.262	0.014	19.366	19.695	
	Chi-square value	17.589	14.466	0.998	0.358	
Hosmer–Lemeshow test	Values for goodness of fit	df	8	8	8	8
		Significance ( $P > 0.05$ )	0.025	0.070*	0.998*	1.000*

Significance value for odds ratio,  $P < 0.05$ . Hosmer–Lemeshow test for goodness of fit of the above-proposed model used the Chi-square significance  $> 0.05$ . DMFS: Decayed, missing, and filled surfaces, DMFT: Decayed, missing, and filled surfaces, T-health, FS-T: Filled and sound teeth

of 7.6% and 7.1%, respectively, for regression model. The individual components of missing and sound filled teeth were found to be equivalent or better than some of the

composite indicators such as DMFT and FS-T. This study reveals sound functional teeth as an effective measure of monitoring the improvement in utilization of oral health

services, although the component of decay is an important factor in a developing country in accordance to a previous research.<sup>[13]</sup> Thus, this study also revealed that individual components of DMFT and FS-T may account to more variance in different populations and thus, these composite indicators do not form a complete replacement of DMFT. DMFS was followed by T-health as the next representative index. The results of the variance were found to be maximum for DMFS (8.5%), followed by T-health (7.7%), FS-T (7.2%), and the DMFT (6.6%). Other than FS-T, all indices include the decayed component. The weightage of 4:2:1 given for sound functional teeth, filled functional teeth, and decayed teeth, respectively, explains the different variance of FS-T index when compared DMFT, although both consider the same components. Less reported variance in the study could be attributed to the fact that research is done in a developing country and utilized a cumulative Kuppusswamy scale for the socioeconomic strata, while the previous studies classified the population only on the basis of the income. Lower-middle economy of the country significantly affects the affordability, access, and infrastructure available for oral health services when compared to the developed economies.

Despite the proven advantages, all four indices utilized, fail to differentiate between preventive and therapeutic restorations. The new composite indicators do not overcome all the limitations of DMFT/S indices. According to the WHO, the scientific instrument should measure the entire spectrum of a disease for planning health programs and policies, but none of these indices include the complete spectrum of dental caries and include a transverse assessment of dental caries, limiting the effect of time critical in the development of a carious lesion.<sup>[14]</sup> Thus, the composite indices only represent the effect of preventive health programs or the effect of new oral health services made available for any community. As the global decline of dental caries is attributed to the use of fluorides.<sup>[15]</sup> The study also showed the limitation of not taking oral health awareness or personal oral hygiene measures, and use of fluorides into account that could have improvised on the model suggested by this research for the factors affecting oral health.

DMFS and T-health showed the best performance followed by the missing component, as indicators of oral health. The individual component of sound filled teeth used for the FS-T index showed the next highest variance. Hence, DMFS and T-health indices are more representative of the difference in the dentition status of the population with dissimilar sociodemographic and behavioral factors. The age group of 35–44 years is significant as it indirectly reflects the levels of oral hygiene practices and oral health promotional activities.<sup>[3,16]</sup> Although this age group was found to significantly correlate with the dependent variables, it would

be difficult to explain the variation in dentition status on the basis of this narrow range of age group.

## CONCLUSION

We conclude that DMFS as an indicator is more sensitive than the other three indices and the five individual components, in identifying sociodemographic and behavioral factors influencing the oral health of this adult population. Missing teeth and sound functional teeth are more sensitive indicators of oral health among the individual components. This research recommends to test the performance of these indicators, including the individual components, among the other WHO index age groups, and invites further analytical studies for the determinants presented as independent variables in the model.

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## Conflicts of interest

There are no conflicts of interest.

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