Caries Status of Children in Eastern Trinidad, West Indies

Adenike A. Adewakun[a]/Tricia M. Percival[b]/Sally R. Barclay[b]/
Bennett T. Amaechi[c]

Purpose: To determine the prevalence, severity and caries burden among children residing in eastern Trinidad.

Materials and Methods: This is a cross-sectional study comprising probability, stratified, and proportionate-to-size sampling. Seven hundred and eleven school children aged six, 12 and 15 years were examined between November 1999 and January 2000 by two calibrated dentists using World Health Organization (WHO) assessment criteria.

Results: Overall mean DMFT and dft scores were 1.29 ± 2.3 and 1.78 ± 3.1 while 30.4% were caries-free. At ages six, 12 and 15 years, mean DMFT scores were 0.08 ± 0.38; 2.18 ± 2.49; 2.66 ± 3.0 while dft scores were 3.74 ± 3.63; 0.14 ± 2.65; 0. Significant Caries Indices (SiC) for permanent and primary teeth were 3.75 and 5.28. Children of parents/carers with university education had the lowest DMFT/dft scores (1.0 ± 2.47/0.83 ± 1.58), treatment need (23.8%), and comprised the highest proportion of caries-free (76.2%) population. The values for father/male carer were statistically significant ($p < 0.005$). All four first permanent molars were decayed in 8.76%. First permanent molars were most frequently decayed in 12-year-olds (55.4%) and 15-year-olds (50.0%). Untreated caries and first permanent molar decay among six-year-olds were 84% and 8.3% respectively. Tooth mortality was 0.978 and 0.964 in permanent and primary teeth. The Restorative Indices for permanent and primary teeth were 0.02134 and 0.0213.

Conclusion: Based on WHO severity criteria for the respective ages, caries experience is low in Eastern Trinidad. The mean DMFT is much lower than recently reported country data for 12-year-olds. However, the incidence is increasing. The SiC suggests that a small proportion of the population accounts for most of the decayed teeth.

Key words: caries prevalence, caries experience, Significant Caries Index, caries burden

Oral Health Prev Dent 2005; 3: 249–261. Submitted for publication: 28.12.04; accepted for publication: 15.11.05.

[a] *Oral HealthCare Solutions, Tunapuna, Trinidad, West Indies*

[b] *The University of the West Indies Dental School, Trinidad*

[c] *Caries Research Unit, Department of Community Dentistry, University of Texas Health Science Center at San Antonio, Texas, USA*

Reprint requests: *Bennett T. Amaechi, BSc, BDS, MSc, PhD, Assistant Professor, Caries Research Unit, Department of Community Dentistry, University of Texas Health Science Center at San Antonio, 7703 Floyd Curl Drive, San Antonio, Texas 78229-3900, USA. Tel: +1 210 567 3200/3185. Fax: +1 210 567 4587. E-mail: amaechi@uthscsa.edu*

A decline in caries prevalence and severity with a concomitant decreasing incidence has been confirmed in industrialised countries (Marthaler, 2004; Reich, 2001; Petersson and Bratthall, 1996; Heloe and Haugejorden, 1981). Similar trends have been reported in the Caribbean region. However, the magnitudes are comparatively low and the reductions less consistent (Topping and Furlinetto, 2004; Beltran-Aguilar, 1998; Beltran-Aguilar et al, 1999; Bonecker and Cleaton-Jones, 2003; Warpeha et al, 2001). An increase in caries severity in Grenada and Trinidad has been documented (Adewakun, 1997). The WHO classification stipulates that the caries

prevalence level is low if more than 20% of 12-year-olds in a specified population have any decayed, missing or filled permanent teeth (DMFT ≥ 0) (LeClerq et al, 1987). Using this standard, the prevalence is moderate to high (14% caries-free), while severity remains high and increasing among 12-year-olds in Trinidad (DMFT 4.9 in 1989 and 5.2 in 1998) (WHO 'AMRO', 2004a).

The caries decline has been largely attributed to the widespread availability of fluorides particularly dentifrices (Bratthall et al, 1996). Increases in prevalence and severity in less industrialised countries were ascribed to the consumption of refined sugar and cariogenic foods as well as the adoption of Western and Western-type diets especially in urban areas (Renson, 1989; Ismail et al, 1997). A significant and direct association between sugar and dental caries prevalence has been documented (Zero, 2004; Sreebny, 1982; Touger-Decker and van Loveren, 2003). An accelerated rate of increase in caries incidence has been associated with both per capita and population consumption of free sugars in excess of 15 kg (Moynihan and Petersen, 2004; Sheiham, 1991). The WHO data bank indicates that countries with the highest DMFT are located in the sugar belt. Between 1991 and 1997, the annual per capita sugar consumption in Trinidad and Tobago increased from 49.0 to 68.2 kg (28.2%). Although a decrease of 14.8% (from 68.2 to 59.4 kg) was recorded between 1997 and 2000, annual per capita consumption in Trinidad and Tobago was almost four times the limit recommended for industrialised countries. Consumption of free sugars in Trinidad ranks fourth in the Americas and third in the English-speaking Caribbean (WHO 'AMRO', 2004b). With sugar cane occupying at least one-third of the arable land, sugar is the main agricultural export (SICE, 1998). Produced mostly for direct domestic consumption, it is suggested that the trend reflects the socio-cultural role of sugar in Trinidad (Country Studies, 2003).

The most southerly island in the Caribbean archipelago with an estimated 1.23 million people, the main ethnic groups are East Indian (40.3%), African (39.5%) and Mixed (18.4%). Caucasians and Chinese and others comprise 0.6% and 1.2% respectively. Of the eight counties in Trinidad, the four located in the eastern region (St. Andrew, St. David, Nariva and Mayaro) are the most sparsely populated. The population distribution, however, reflects that of the entire country, with East Indian (43.1%), African (32.5%) and Mixed (23.5%) predominating, while Caucasian and Chinese comprise 0.13%.

The northern and southern two-thirds of Eastern Trinidad are considered to be rural, while the middle third is peri-urban. The three cities (Arima, Port of Spain and San Fernando) are located outside of the Eastern Health Region. The respective proportions of persons with primary, secondary and tertiary education in Eastern Trinidad at the time of the study were 54.3%, 27.4% and 0.57% (MPD, Trinidad and Tobago, 2000).

Approximately 35,157 persons aged 15 years and under reside in Eastern Trinidad. A total of 26,400 children were enrolled in the 65 primary (n = 18367) and 10 secondary (n = 8033) schools in 1999/2000 of which 6,151 (23.3%) were aged six, 12 and 15 years (MED, Trinidad and Tobago, 1999). Natural fluoride levels in water sources in Trinidad range from 0.004 to 1.65 ppm. Three of the four geographic locations with the highest fluoride levels are located in eastern Trinidad (Adewakun et al, 2003).

Free oral health care is available for children until the age of 12 years. Services are provided by dental nurses operating either unsupervised or under remote supervision in government health centres. Above this age, limited services comprising tooth removal and simple fillings are provided by dentists. Dental nurses also provide health education in primary schools. The nature, extent and coverage vary and the programmes are yet to be evaluated. A recent amendment to the Dental Act has enabled dental nurses to operate under supervision in private dental practices (Steele, 1988; Naidu et al, 2002).

The Health Sector Reform Programme in 1995 resulted in the establishment of five Regional Health Authorities (RHAs) as autonomous statutory bodies. Mandated to provide ensure healthcare services to residents of their respective counties, the Ministry of Health purchases health from the RHAs on behalf of the population. Reduced to four in 1999, each RHA owns and operates the health facilities within its boundaries.

The Eastern Regional Health Authority (ERHA) is widely acclaimed as the flagship RHA based on the nature, scope and coverage of its services. Ten of its sixteen health facilities in Eastern Trinidad have dental chairs and five of these were fully operational at the time of the study. Four of the 56 dental nurses in Trinidad and Tobago were employed by the ERHA, while four of the 176 registered dentists

practised in Eastern Trinidad (three in government and four in private practice) at the time.

Three oral health surveys were conducted between 1961 and 1989, the results of which remain unpublished. Children residing in Eastern Trinidad were excluded from the 1989 national oral survey for reasons related to accessibility. With the exception of the limited prevalence survey of five- and six-year-olds conducted in 1983, the present study is the first evaluation of caries status among children in eastern Trinidad.

The earliest available report of caries status is a regional survey conducted by the West Indian Interdepartmental Committee on Nutrition for National Defence in 1961. A sample of 3,147 persons in Trinidad and Tobago was examined with individual DMFT scores ranging from 0.9 (ages five to nine years) to 17.3 (ages 45–49 years). Mean DMFT scores of 6.9 and 3.9 were reported for seven and 12-year-old children respectively. At ages three, seven and 12 years, mean dmft scores were 1.8, 6.1 and 3.9. The ratio of filled to decayed teeth was 1:9. Very low proportions of the children examined in Eastern Trinidad (2.3% in Nariva/Mayaro and 5.2% in St. Andrew/St. David) were caries-free (Ashraph, 1989).

A national caries prevalence survey involving five- and six-year-old children was conducted in 1983. The distribution of the caries-free population is shown in Table 1. When disaggregated by county, the highest proportion of caries-free children (56.0%) was recorded for St. Andrew/St. David.

The 1989 national survey involved 831 children aged six, nine, 12 and 15 years from four counties, excluding those in the ERHA. The examiners were trained by the Pan American Health Organisation (PAHO). At age 12 years, a mean DMFT score of 4.9 and 14% caries-free population were reported. At ages six, nine and 15 years, 45.7%, 9.0% and 7.0% were caries-free while the respective DMFT scores were 0.13, 0.09 and 5.14 (Ashraph, 1989).

The present study was conducted 10 years after the first national oral health survey as part of a needs assessment to consider the feasibility of introducing mobile dental services in Eastern Trinidad. The aim was to evaluate the caries status of the children in Eastern Trinidad and compare the results with those obtained for the other counties in 1989.

Table 1 Caries-free 5-6 year-old children in Trinidad and Tobago in 1983 survey

County	No. of children	Caries-free population	
		No.	(%)
All	11292	4968	43.99
Others*	9194	3975	43.23
Tobago	380	135	35.52
Eastern Trinidad	1718	858	49.94

* (Trinidad – Caroni, St. George, St. Patrick, and Victoria)

MATERIALS AND METHODS

Study Design

This study was commissioned by the Eastern Regional Health Authority, which was also responsible for obtaining the necessary approvals from the Ministries of Education and Health. Letters of Intent explaining the objective and examination procedure were sent to the education supervisor in each of the three school districts. Awareness of the survey was raised through the respective school principals, a newspaper article and radio announcements. The completion of consent forms by parents and guardians and assent by children were prerequisites for participation. Children in the selected schools were unaware of the specific examination dates. Two calibrated dentists conducted the examinations, using WHO methodology and caries assessment criteria. At calibration, inter-examiner agreement (Kappa Statistic) was 0.948, and increased to 0.966 and 0.977 respectively for duplicate examinations conducted on 10% of children randomly selected mid-way and at the end of the survey.

Sampling Method

The sampling frame consisted of the 65 primary and 10 secondary schools in Eastern Trinidad with a combined total enrolment of 26400. Enrolment lists were obtained from the school district supervisors and principals. The enrolment lists obtained from the education district supervisors were compared with those obtained from the school princi-

pals. Those schools with six-, 12- and 15-year-old children were selected from the lists provided, and identical letters of intent were sent to the respective Principals. Where discrepancies existed, enrolment lists provided by Principals were used as they were deemed to be more reliable resulting in a total enrolment of 6,151 children aged six, 12 and 15.

Schools were stratified according to (a) *education district* (to determine the number of schools in each district); (b) *type* (primary, junior secondary only, senior secondary only, composite, seven-year schools – to determine the index ages available in each school); (c) *gender* (coeducational, boys only and girls only – to obtain proportionate samples); (d) *location* (rural, peri-urban – to obtain a representative distribution); and (e) *enrolment size* (for proportionate inclusion of subjects). Probability (using the formulae $n = n_0/(1+n^0/n)$ and $(n_0 = pqt^2/d^2)$ was used to determine the overall sample size based on an estimated caries prevalence *(p)* of 80%; precision level *(d)* set at 2%; q = (1 – p); Type I error *(t)* = 0.05 at a 95% confidence interval.

The number and type of schools included in the study by education district, type, class size, gender and geographic location were determined by probability, stratified multistage and proportionate-to-size sampling. Following stratification, the schools were arrayed according to enrolment sizes of the respective index ages and a table of random numbers was used to systematically select six secondary and 11 primary schools (22.67%). A total of 739 children representing 12.01% of the six-, 12- and 15-year-olds enrolled in eastern Trinidad were selected. Some 15-year-olds in one school could not be examined because of water shortage on the scheduled day, while three six-year-olds were unwilling to be examined, resulting in a final sample population of 711 (96.2% of eligible population).

Organisation

Children lay supine on long tables covered with crepe paper sheeting, and examinations were conducted in adequately illuminated and well-ventilated halls. Children entered and went out through separate doors. A participant-observer collected the consent forms and stapled them to the survey form prior to the examination, while a non-participant observer randomly selected children for duplicate examinations on exit.

Oral Examination

A tooth was deemed to be present when part of it was visible on the occlusal plane without the need for gingival displacement. A pre-packed sterile examination set containing a mouth mirror, explorer, probe, wooden tongue depressor and two gauze squares was used for each child. Disposable gloves were changed after each examination and face masks were used throughout the procedure. Teeth were examined under natural light without drying. A standard sequence was adopted, beginning in the upper right quadrant, moving across the midline to the upper left, down to the lower left and ending in the lower right quadrant. The tooth surface examination sequence was mesial, occlusal distal, buccal and lingual. Tooth-based caries status and person-based treatment urgency were determined for each child using WHO criteria (WHO, 1997). After the examinations, Treatment Need Notification slips addressed to parents/guardians were given to each child requiring routine or urgent care. Data were analysed using SPSS software package.

RESULTS

Sample Population Characteristics

The distribution of the sampled population is shown in Table 2. The results for children of Caucasian (n = 1) and Chinese (n = 3) ethnic origins are excluded from the discussion because of their respective sample sizes.

Caries Prevalence

Caries prevalence in this study is depicted using the caries-free population (i.e. DMFT/dmft = 0) as described by WHO. Less than one-third (30.42%) of the population was caries-free, the majority (36.3%) being 12-year-olds. Although an almost equal proportion of boys and girls were caries-free overall, the difference was statistically significant at ages 12 and 15 years. The marginally higher caries-free population of African (31.9%) compared with East Indian children (30.4%) was also statistically significant at the 95% confidence level. The highest proportion of caries-free children had mothers and fathers with university education while the lowest proportions were children of mothers with

Table 2 Sample population distribution by age, gender, ethnic origin and educational level of parents/carers

		% of children (N = 711)	
Age (years)	6	46.5	
	12	35.3	
	15	18.1	
Gender	Male	47.9	
	Female	52.1	
Ethnic origin	African	29.53	
	Caucasian	0.42	
	Chinese	0.84	
	East Indian	44.02	
	Mixed	25.17	
Parents' educational level		Father/primary male carer	Mother/primary female carer
	Primary school	27.98	27.71
	Part secondary	25.17	30.24
	Complete secondary	10.41	13.64
	Vocational/technical	4.22	2.25
	University	2.95	2.53
	Non-respondents	29.25	26.63

primary education and whose fathers had vocational/technical training (Table 3).

The probability of being caries-free was highest for children of African descent, followed by East Indian and Mixed origin respectively. Children of parents and carers with university education had the highest probability of being caries-free (0.76 [male carers] and 0.56 [female carers]).

Caries Experience

The combined mean DMFT and dft scores were 1.29 ± 2.3 and 1.78 ± 3.1 respectively (Table 4). The mean DMFT increased with age while dft decreased reflecting the number of teeth at risk. The mean DMFT scores for girls and boys were 1.5 and 1.1 respectively (Table 5). It was also higher for girls for all ages with the greatest difference occurring among 15-year-olds. Mean DMFT scores for African, East Indian and Mixed children were 1.65, 1.12 and 1.23 respectively, the differences being statistically significant. Mean dft scores for the respective ethnic groups were 1.0, 2.3 and 1.9. Children of parents or guardians with university education level had the lowest mean DMFT/dft scores (mothers-1.0 ± 2.47 and fathers-0.38 ± 1.36) while it was highest among children of parents with primary school education. Although this distribution was maintained when scores were disaggregated by parents' gender, the values for father/male guardian were generally lower than that for mothers, the differences being statistically significant. The mandibular first permanent molars were the most commonly decayed teeth with all four first molars affected in 8.3%, 55.4% and 50.4% at ages 6, 12 and 15 years respectively.

DMFT components

Overall, high and similar proportions of primary and permanent teeth were untreated. Tooth mortality (D:DMFT) was high in both permanent (0.978) and

Table 3 Percentage of caries-free children by age, ethnic origin and educational level of parents/guardians

		% Caries-free		
		Overall	Male	female
Age (years)	6	26.3	24.0	28.6
	12	36.3	37.4	35.3
	15	29.7	36.4	24.7
Ethnic origin	African	31.9		
	Caucasian	33.3		
	Chinese	50.0		
	East Indian	30.4		
	Mixed	28.2		
Parents' educational level Mother/female carers	Primary	27.4		
	Part secondary	30.7		
	Complete secondary	36.5		
	Vocational/technical	43.8		
	University	55.6		
	Non-respondents	26.2		
Parents' educational level Father/male carers	Primary	29.1		
	Part secondary	30.7		
	Complete secondary	35.2		
	Vocational/technical	23.3		
	University	76.2		
	Non-respondents	26.8		

primary (0.964) teeth. Untreated caries was highest among 12 year-olds (99.5%) and higher in girls (99.8%). Among the 6-year-olds, untreated caries was 84% and first permanent molars comprised 8.3% of all decayed teeth. The Restorative (Care) Index (F:DMFT) was similarly low for both primary (0.02134) and permanent (0.0213) teeth.

Significant Caries Index (SiC)

The SiC distribution mirrored that for mean DMFT scores by age, gender, ethnic origin and educational level attained by parents/guardians with the magnitude being three times as high in each instance. The overall SiC was 5.28 while that for permanent and primary teeth were 3.8 and 5.3 respectively. The SiC increased with age for permanent teeth and decreased with age for primary teeth (Table 5).

Treatment Need and Treatment Urgency

The highest proportion of children requiring no treatment were 12-year-olds and those whose parents or carers had university education (Table 6). Similar proportions of African (30.5%) and East Indian (30.7%) children required no treatment, however majority of children requiring urgent treatment were of East Indian descent.

DISCUSSION

The mean DMFT of 5.2 reported for Trinidad by the WHO Global Oral Health Data Bank (1998 data) is more than twice that reported for 12 year-olds in this study. Although the prevalence and severity are low for all index ages in this study based on WHO criteria, the 6-year-old DMFT suggests an increasing incidence as well as an emerging high-risk sub-

Table 4 Mean DMFT/dft by age, ethnic origin and educational level of parents/carers

		DMFT (Permanent teeth) Mean (standard deviation)	dft (Primary teeth) Mean (standard deviation)
Age (years)	Overall	1.29 (2.3)	1.78 (3.1)
	6	0.08 (0.38)	3.74 (3.63)
	12	2.18 (2.49)	0.14 (0.65)
	15	2.66 (3.0)	0
Ethnic origin	African	1.65 (2.57)	1.0 (2.35)
	Caucasian	0.67 (0.58)	0
	Chinese	0.17 (0.41)	1.17 (1.83)
	East Indian	1.12 (2.10)	2.33 (3.44)
	Mixed	1.23 (2.22)	1.9 (3.00)
Parents' educational level Mother/female carers	Primary	1.34 (2.09)	1.77 (3.33)
	Part secondary	1.08 (2.09)	1.83 (2.95)
	Complete secondary	1.39 (2.49)	1.71 (3.03)
	Vocational/technical	2.0 (3.42)	1.0 (2.39)
	University	1.0 (2.47)	0.83 (1.58)
	Non-respondents	1.41 (2.42)	1.99 (3.21)
Parents' educational level Father/male carers	Primary	1.46 (2.28)	1.41 (2.81)
	Part secondary	1.11 (2.25)	2.13 (3.36)
	Complete secondary	1.21 (2.06)	1.70 (3.10)
	Vocational/technical	1.2 (2.06)	1.87 (3.08)
	University	0.38 (1.36)	0.67 (1.9)
	Non-respondents	1.4 (2.46)	2.0 (3.12)

population in eastern Trinidad. Previous assessments suggest a moderate prevalence and high severity among 12-year-olds with an increasing incidence (Table 7).

The 12-year-olds comprised the highest proportion of children with untreated caries and accounted for the majority of those not requiring treatment. This distribution suggests that a small proportion of children account for a considerable amount of decayed teeth. This finding has significant dental public health implications as free and comprehensive dental services are not accessible beyond the age of 12 years. Given the number of private dentists in eastern Trinidad, it is unlikely that this high-risk population will benefit from oral health care. It is also suggested that this pattern is certain to endure given the age ceiling for accessing free oral health care.

In 1989, 6-year-olds comprised the highest proportion of children needing no treatment (Ashraph, 1989); however they comprised the lowest proportion of children requiring no treatment in this study (Table 6). This trend reversal supported by the 5.77% increase in DMFT between 1989 and 1999 (Table 8) suggests an increasing incidence in spite of the relatively lower prevalence and severity in Eastern Trinidad.

The caries attack rate (8.3%) and proportion (10% of untreated caries) of first permanent molars among 6-year-olds found in this survey is a cause for concern. Contrary to the accepted norm for first permanent molar pattern and sequence of erup-

Table 5 Significant caries index (SiC) by age, gender and ethnic origin

		SiC (DMFT) Permanent teeth	SiC (dft) Primary teeth
Age (years)	Overall	3.8 (1.3)	5.3 (1.8)
	6	0.3 (0.1)	8.1 (3.7)
	12	5.1 (2.2)	0.4 (0.1)
	15	6.0 (2.7)	0 (0)
Male	Overall	3.3 (1.1)	6.1 (2.1)
	6	0.1 (0.03)	8.8 (4.1)
	12	5.0 (2.1)	0.6 (0.2)
	15	5.4 (2.3)	0 (0)
Female	Overall	4.2 (1.5)	4.5 (1.5)
	6	0.4 (0.1)	7.3 (3.4)
	12	5.3 (2.3)	0.3 (0.1)
	15	6.5 (2.9)	0 (0)
Ethnic origin	African	4.5 (1.6)	3.0 (1.0)
	Caucasian	1.0 (0.7)	0 (0)
	Chinese	0.5 (0.2)	3.5 (1.2)
	East Indian	3.4 (1.1)	6.5 (2.3)
	Mixed	3.6 (1.2)	5.4 (1.9)

tion, these teeth have been found in children as early as the age of four years. An unpublished study by these authors showed a 46.4% prevalence of early erupted permanent teeth among school children in Trinidad and Tobago (Adewakun et al, 2006). It is argued that this finding may be explained in part by the premature exposure of newly erupted teeth into a cariogenic environment. The need for a national oral health survey which includes qualitative elements of knowledge, attitudes and practice in order to better understand the relevant and significant factors associated with these prevalence and severity levels is indicated.

Significant ethnic differences in caries prevalence, severity and untreated disease have been reported (Sundby et al, 2003; Reid et al, 2004). The respective overall mean DMFT scores for African and East Indian children were 4.43 and 3.54 in 1989. However, the DMFT of East Indian children (4.33) was twice that of African (2.17) children at age 6 years (Ashraph, 1989). This study shows considerably lower scores for both groups indicating a reduced severity. The trend reversal in which children of African descent have a higher DMFT score, however, needs to be investigated further.

The highest mean DMFT score and highest caries-free population recorded for children of African descent in this study suggest the emergence of a high-risk subgroup. This distribution paradox may be partly explained by the fact that a significant proportion of African children in Trinidad are of mixed ethnicity and may therefore not reflect the relatively low caries prevalence and severity levels generally reported in studies among African children of non-mixed ethnicity (Bruce et al, 2002; Makoni et al, 1997; du Plessis 2000). It is also argued that the confounding effects of diet preferences and feeding patterns may be difficult to isolate; furthermore the extent to which inherent tooth susceptibility in homogeneous ethnic groups may have been modified as a result of multicultural influences in heterogeneous ethnic groups is difficult to quantify.

The high tooth mortality and low restorative index reported among similar populations in the

Table 6 Percentage of children not requiring treatment by educational level of parents/guardians

		% of children not requiring treatment
Age (years)	6	26.0
	12	37.1
	15	29.7
Ethnic origin	African	30.5
	Caucasian	66.7
	East Indian	30.7
	Mixed	29.4
	Chinese	50.0
Parents' educational level Mother/female carers	Primary	27.9
	Part secondary	30.7
	Complete secondary	38.5
	Vocational/technical	37.5
	University	55.6
	Non-respondents	25.6
Parents' educational level Father/male carers	Primary	30.7
	Part secondary	31.3
	Complete secondary	33.8
	Vocational/technical	23.3
	University	76.2
	Non-respondents	25.9

Table 7 Previously reported mean DMFT scores in Trinidad

Year of survey	Age(s) examined (yrs)/Pop	Data source	DMFT-12	WHO standard
1998	12 (unknown)	WHO data bank (2002)	5.2	High
1989	6, 9, 12, 15 (n = 831)	Survey report	4.9	High
1983	5 – 6 (n = 11292)	Ministry of Health	n/a	n/a
1961	3, 7, 12 (unknown) Adults (n = 3060)	Ministry of Health	3.9	Moderate

Caribbean were also found in this study (Vignarajah 1993; Leake et al, 1989; Alonge, 1999; Elias-Boneta et al, 2003). Completely untreated decay has been reported in rural areas of Mexico and Jamaica (Irigoyen et al, 2000; Meyer-Lueckel et al, 2002). A distribution maintained irrespective of the level of caries prevalence and severity, this magnitude of unmet need portends an enduring pattern that characterises many non-industrialised countries and suggests low levels of perceived need for care, low demand and/or deferred presentation for caries management.

Table 8 Comparison of DMFT and caries prevalence with 1989 (other counties) by age

Age (yrs)	% of caries-free children		DMFT	
	1999 (this study)	1989	1999 (this study)	1989
6	26.3	45.7	0.08	2.7
12	36.3	9.0	2.18	4.9
15	29.7	7.9	2.66	5.0

The SiC is designed to unmask high individual DMFT and dft scores in a given population. Derived by sorting the sample population in ascending order of DMFT and dft values, the one-third with the highest scores is selected and their mean DMFT and dft is calculated in the usual manner (Bratthall, 2000). It describes the prevalence among the most severely affected sub-group in the sampled population and may include persons with DMFT = 0 depending on the proportion of caries-free persons (Nishi et al, 2002). A strong linear relationship has been reported between SiC and mean DMFT score and its inclusion in caries assessments has been advocated. This relationship was demonstrated in this study however the magnitude was three times as high as the DMFT compared with twice reported in a study of 15 countries indicating high risk sub-populations within the index ages that accounted for a considerable proportion of decayed teeth (Campus et al, 2003). The SiC for 12-year-old children in eastern Trinidad observed in this study is almost twice as high as that of the only Caribbean country reported by the WHO (WHO 'SiC data' 2004).

A strong and significant association between caries prevalence and severity and socioeconomic status including educational level attained by parents has been reported in several studies using multiple regression and similar analyses (Hobdell et al, 2003; Jimenez, 2004; Khan and Cleaton-Jones, 1998; Lewsey and Thomson, 2004). Educational level attained by parents has been inversely associated with caries prevalence and severity (Chen, 2002). In a study of Haitian immigrants in New York City, multivariate analyses showed that education is a predictor of unmet need (Cruz et al, 2001). The statistically significant finding associating low caries prevalence and severity in children of persons with high educational levels across all ages and ethnic groups in this study is in agreement with studies in several industrialised and non-industrialised countries (Adair et al, 2004).

The clear statistical significance and strong correlation between DMFT/dft scores, proportion of caries-free children and educational levels of male carers reflects the socio- and psycho-cultural roles and significance of males in the home setting. This finding needs to be further investigated and the results optimally utilised in planning, design and dissemination of caries-preventive interventions for children in eastern Trinidad. The approach of targeting customised oral health promotion messages at parents and primary caregivers of different ethnic origins based on dietary patterns and preferences and consistent with their educational level rather than general messages to groups of children may be contextually preferable and more effective based on the findings of this study (Edelstein, 2000). There is a need to conduct further qualitative research into the oral health knowledge, attitudes and practices of parents, guardians and primary caregivers in order to provide effective messages to these children.

Caries Burden

The caries burden is derived from the mean DMFT and dft of children with caries (i.e. DMFT/dft > 0). It combines prevalence and severity to determine the average number of decayed, missing or filled primary or permanent teeth in those children with caries. This survey showed that on average, seven out of ten children in Eastern Trinidad have between one and two decayed missing and/or filled primary or permanent teeth. The caries burden suggests low severity spread across a significant proportion

of the sampled population. This magnitude of disease has considerable resource implications for the ERHA especially in the face of increasing incidence. Being the first oral health survey in this region, it is impossible however, to tell whether this caries status is indicative of an improvement in the intervening years (i.e. between 1989 and 1999).

Differences in individual tooth susceptibility have been attributed to a (a) change to a more cariogenic diet shortly before the eruption of the second molars; (b) colonisation of first molar fissures by non-cariogenic bacteria prior to the dietary change; (c) colonisation of second molar fissures by S. mutans; and (d) eruption after dietary change (Loesche, 1986). These as well as surface morphological factors have resulted in relative tooth susceptibility patterns. An increased caries susceptibility was reported for first permanent molars of African children in urban areas compared with increased DMFT values for second molars among those consuming traditional diets. The hypothesis tested was that DMFT values of second molars will be higher if first molars have reached a high degree of enamel maturation before being exposed to an increased cariogenic challenge (Johnson and Gjermo, 1989; Cirino and Scantlebury, 1998). Consistent with this finding, the first permanent molars comprised the highest proportion of decayed teeth at ages 12 and 15 years and comprised 10% of untreated decayed teeth among 6-year-olds.

Sugar is widely used in the preparation of cooked dishes including soups and stews in Trinidad. A plethora of indigenous cariogenic snacks with a propensity for low intraoral clearance abound in urban, peri-urban and rural areas. The most common are *toolum* (finely grated coconut boiled with molasses), pawpaw balls (papaya pulp boiled in sugar solution and coated with granulated sugar), *guava jelly* (guava pulp similarly prepared), *sugar cake* (grated coconut boiled in syrup), *benne balls* (sesame seeds boiled in sugar solution and glazed with honey), sweetened mango slices and honey roasted nuts all of which are cheaply available and readily accessible at road-side kiosks, street-corner shops and super-markets throughout the country. It is suggested that these snacks are significant contributors to the increasing caries incidence. An enduring challenge is the pervasive subculture of penna-cool (packets of frozen sugar solution with added colouring and flavouring agents) consumption among primary school children. It is in these primary schools that timely and effective preventive intervention and oral health promotion are most critical (Burt, 1998).

In light of the global caries decline and widespread availability and use of fluoride vehicles and supplements, the caries prevalence class intervals and proportions of caries-free 12-year-olds stipulated by the WHO classification of caries prevalence needs to be reviewed. The authors suggest that the base point of 20 per cent bar for '*low*' caries prevalence should be raised to 50 per cent and the range of values for the respective categories of prevalence should be narrower. A meta-analysis of studies reporting reductions in caries incidence over certain time periods and the allocation of weighted averages may be required in order to arrive at appropriate ranges and class intervals. It is advocated that some *'measure of incidence'* should be factored into descriptions of caries burdens since it is possible to have low prevalence with rapidly increasing incidence as reported in this study. The reasons for such increases should be investigated within one year of the reported finding so that contributory factors can be addressed.

It is recommended that dental nurses who are directly responsible for the oral care of children should be given appropriate training such that oral health promotion messages are culturally relevant and customised to suit different sub-groups in the various counties. They should also be exposed to the preventive philosophy and minimal caries intervention methods in oral healthcare delivery.

Two confounding variables in this study are the non-respondents and parents/guardians with technical training or vocational education. This level of education includes middle and supervisory management, skilled and semi-skilled artisans and craftsmen who may be either self-employed or employees among others. Identifying, quantifying and translating the knowledge effects of the broad scope of definitions subsumed in this educational level into health-related and/or preventive health behaviour is complex and beyond the remit of this study.

CONCLUSION

Caries prevalence and severity are low among children in eastern Trinidad based on the WHO criteria and much lower than that reported for other counties in the country. The incidence is however in-

creasing with a reduced population of caries-free 6-year-olds (26.3%) compared with 49.94% in 1983 and 45.7% in 1989. The high proportion of children with untreated decayed teeth and low proportion of children with filled teeth have persisted since the 1989 survey.

The emerging high-risk subpopulation of African children in eastern Trinidad needs to be confirmed in other counties. The small proportion of 12-year-olds accounting for considerable disease is of dental public health significance as opportunities for subsequent intervention and management are not available in the ERHA. Although prevalence and severity are lower, the patterns and distribution characteristics are consistent with those reported for other counties in 1989. Future surveys should include qualitative aspects including dietary preferences, knowledge, attitudes and oral health-related behaviours using trained interviewers.

A national oral health survey involving all Health Regions should be conducted in order to find out if the reported trends are widespread or limited to eastern Trinidad. Such surveillance would serve to inform and guide policy decisions and assist in the planning, design and evaluation of appropriate, effective and efficient preventive interventions to reduce caries incidence.

REFERENCES

1. Adair PM, Pine CM, Burnside G, Nicoll AD et al. Familial and cultural perceptions and beliefs of oral hygiene and dietary practices among ethnically and socio-economically diverse groups. Community Dent Health 2004;21:1(Suppl):102-111.
2. Adewakun AA. Oral health. In: Health Conditions in the Caribbean. PAHO Sci Pub 1997;521:221-235.
3. Adewakun AA, Goddard C, McMillan-Haynes A-M et al. Fluoride availability in Trinidad and Tobago: the implications for caries prevention in children. J Dent Res 2003;82(Sp Iss B): Abs152.
4. Adewakun AA, Percival TM, Barclay SR et al. Early erupted permanent teeth among school children in Trinidad and Tobago. J Public Health Dent, 2006 (In press).
5. Alonge OK, Narendran S. Dental caries experience among school children in St.Vincent and the Grenadines: report of the first national oral health survey. Community Dent Health 1999;16:45-49.
6. Ashraph AK. 1989 Oral health survey of 6, 9, 12 and 15-year-old children in Trinidad and Tobago. Written Communication. pp 12-39. Unpublished Oral Health Survey Report – available from Ministry of Health, Dental Department, Republic of Trinidad and Tobago.
7. Beltran-Aguilar ED. Oral health. In: Health in the Americas. Port of Spain: Pan American Health Organisation, 1998.
8. Beltran-Aguilar ED, Estupinan-Day S, Baez R. Analysis of prevalence and trends of dental caries in the Americas between the 1970 s and the 1990 s. Int Dent J 1999;49:6,322-329.
9. Bonecker M, Cleaton-Jones P. Trends in dental caries in Latin American and Caribbean 5-6 and 11-13-year-old children: a systematic review. Community Dent Oral Epidemiol 2003;31: 2,152-157.
10. Bratthall D. Introducing the Significant Caries Index together with a proposal for a new global oral health goal for 12-year-olds. Int Dent J 2000;50:378-384.
11. Bratthall D, Hansel-Petersson G, Sundberg H. Reasons for the caries decline: what do the experts believe? Eur J Oral Sci 1996;104:4(Part 2),416-421.
12. Bruce I, Addo ME, Ndanu T. Oral health status of peri-urban schoolchildren in Accra, Ghana. Int Dent J 2002;52:278-282.
13. Burt BA. Prevention policies in the light of the changed distribution of dental caries. Acta Odontol Scand 1998;56:3, 179-186.
14. Campus G, Solinas G, Maida C, Castiglia P. The Significant Caries Index' (SiC): a critical approach. Oral Hyg Prev Dent 2003;1:173-178.
15. Chen MS. Oral health status and its inequality among education groups: comparing seven international study sites. Int J Health Serv 2002;32:1,139-161.
16. Cirino SM, Scantlebury S. Dental caries in developing countries: preventive and restorative approaches to treatment. N Y State Dent J 1998;64:2,32-39.
17. http://countrystudies.us/caribbean-islands/52.htm. 2003 Country Studies US.
18. Cruz GD, Xue X, LeGeros RZ et al. Dental caries experience, tooth loss and factors associated with unmet needs of Haitian immigrants in New York City. J Public Health Dent 2001;61:4,203-209.
19. Edelstein BL. Public and clinical policy considerations in maximising childrens' oral health. Pediatr Clin North Am 2000;47:5,1177-1189.
20. Elias-Boneta AR, Crespo Kebler K, Gierbolini CC et al. Dental caries prevalence of 12-year- olds in Puerto Rico. Community Dent Health 2003 Sep;20:3,171-176.
21. Enrolment List of Schools in Nariva/Mayaro and St. Andrew/St. David. Education District Supervisor III. Trinidad. Ministry of Education Document. September 1999.
22. Heloe LA, Haugejorden O. The 'rise and fall' of dental caries: some global aspects of dental caries epidemiology. Community Dent Oral Epidemiol 1981;9:6,294-299.
23. Hobdell MH, Oliveira ER, Bautista R et al. Oral diseases and socioeconomic status. Br. Dent J 2003;25;194:2,91-96.
24. Ismail AI, Tanzer JM, Dingle JL. Current trends in sugar consumption in developing societies. Community Dent Oral Epidemiol 1997;25:6,438-443.
25. Irigoyen ME, Luengas IF, Yashine A, Mejia AM. Dental caries experience in Mexican schoolchildren from rural and urban communities. Int Dent J 2000;50:41-45.
26. Jimenez R, Tapias-Ledesma MA, Gallardo-Pino C et al. Influence of sociodemographic variables on use of dental services, oral health and oral hygiene among Spanish children. Int Dent J 2004;54:4,187-192.
27. Johnson AS, Gjermo P. Pattern of caries experience in permanent molars in a 15-year-old African population. Caries Res 1989;23:6,423-426.

28. Khan MN, Cleaton-Jones PE. Dental caries in African preschool children: social factors as disease markers. J Public Health Dent 1998;58:1,7-11.
29. Leake JL, Otchere DF, Davey KW et al. The dental health of 12-year-old children in Dominica: A report of a survey using WHO methods. Journal of Canadian Dental Association 1989;56:1025-1028.
30. LeClerq M-H, Barmes DE, Sardo-Infirri J. Oral health: global trends and projections. World Health Statistics Quarterly 1987;40:116-128.
31. Lewsey JD, Thomson WM. The utility of the zero-inflated Poisson and zero-inflated negative binomial models: a case study of cross-sectional and longitudinal DMF data examining the effect of socio-economic status. Community Dent Oral Epidemiol 2004;32:3,183-189.
32. Loesche WJ. Role of streptococcus mutans in human dental decay. Microbiol Reviews 1986;50:353-380.
33. Marthaler TM. Changes in dental caries 1953-2003. Caries Res 2004;38:5,173-181.
34. Makoni F, Frencken JE, Sithole WD. Oral health status among secondary school students in Harare, Zimbabwe. J Dent Assoc S Afr 1997;52:7,491-494.
35. Meyer-Lueckel H, Satzinger T, Kielbassa AM. Caries prevalence among 6- to 16-year-old students in Jamaica 12 years after the introduction of salt fluoridation. Caries Res 2002; 36:3,170-173.
36. Ministry of Planning and Development. Republic of Trinidad and Tobago. Central Statistical Office. Population and Housing Census 2000. 26-27, 48, 56-57, 101.
37. Moynihan PJ, Petersen PE. Diet, nutrition and the prevention of dental disease. Public Health Nutr 2004;7(1A):201-226.
38. Naidu RN, Gobin I, Ashraph A. Working practices and job satisfaction of dental nurses in Trinidad and Tobago: findings of a national survey 2002. Int Dent J 2002;52:321-324.
39. Nishi M, Stjernsward J, Carlsson P, Bratthall D. Caries experience of some countries and areas expressed by the Significant Caries Index. Community Dent Oral Epidemiol 2002;30: 296-301.
40. Petersson GH, Bratthall D. The caries decline: a review of reviews. Eur J Oral Sci 1996;104:4(Pt 2),436-443.
41. du Plessis JB. The oral health status of the Mahonisia community with very low levels of dental caries, SADJ 2000;55:6, 308-312.
42. Reich E. Trends in caries and periodontal health epidemiology in Europe. Int Dent J 2001;51:6(Suppl 1):392-398.
43. Reid BC, Hyman JJ, Macek MD. Race/ethnicity and untreated dental caries: the impact of material and behavioural factors. Community Dent Oral Epidemiol 2004;32:5,329-336.
44. Renson CE. Global changes in caries prevalence and dental manpower requirements: 2. The reasons underlying the changes in prevalence. Dent Update 1989;16:8,345-351.
45. Sheiham A. Why free sugars consumption should be below 15kgper person per year in industrialised countries. Br Dent J 1991;171:2,63-65.
46. Sreebny LM. Sugar availability, sugar consumption and dental caries. Community Dent Oral Epidemiol 1982;10:1,1-7.
47. Steele L. Dental nurses in Trinidad and Tobago. PAHO Bulletin 1988;22:4,364-372.
48. http://www.sice.oas.org/ctyindex/wto/tprtt87.asp. November 1998
49. Sundby A, Petersen PE. Oral health status in relation to ethnicity of children in the municipality of Copenhagen, Denmark. Int J Pediatr Dent 2003;13:3,150-157.
50. Touger-Decker R, van Loveren C. Sugars and dental caries. Am J Clin Nutr 2003;78:4,881-892.
51. Topping G, Furlinetto D. Evidence of downward trends in dental caries in Latin America and the Caribbean. Evid Based Dent 2004;5:3,68.
52. Vignarajah S. Dental caries experience and enamel opacities in children residing in urban and rural areas of Antigua with different levels of natural fluoride in drinking water. Community Dent Health 1993;10:2,159-166.
53. Warpeha R, Beltran-Aguilar E, Baez R. Methodological and biological factors explaining the reduction in dental caries in Jamaican school children between 1984 and 1995. Pan Am J Public Health 2001;10:1,37-44.
54. WHO Oral Health Country/Area Profile Programme. The Americas 'AMRO', November 19, 2004a. http://www.whocollab.od.mah.se/amro.html
55. WHO Oral Health Country/Area Profile Programme. The Americas 'AMRO'. November 19, 2004b. http://www.whocollab.od.mah.se/amro/amrosugar.html
56. World Health Organization. Oral Health Surveys: Basic Methods. 4th Edn. Geneva; WHO, 1997.
57. WHO Oral Health Country/Area Profile Programme. Significant Caries Index. http://www.whocollab.od.mah.se/sicdata.html
58. Zero DT. Sugars – the arch criminal? Caries Res 2004;38:3, 277-285.