Decayed/Missing/Filled Teeth and Shortened Dental Arches in Tanzanian Adults

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Purpose: This study assessed decayed/missing/filled teeth (DMFT), presence of occlusal units, and prevalence of shortened dental arches in a Tanzanian adult population. ***Materials and Methods:*** The dental state of samples of the Tanzanian population was studied. Oral examinations were conducted on 5,532 adults from rural and urban cluster samples. DMFT was related to age, gender, and residence. The pattern of tooth loss within dental arches was mapped, and the prevalence of shortened dental arches was estimated. ***Results:*** Mean DMFT scores increased gradually from 1.8 (20- to 29-year-olds) to 3.8 (50- to 59-year-olds). A steep increase was observed in the ⩾ 60-year-olds (DMFT 8.1). "Missing" was the dominant component of DMFT. The mean number of present teeth ranged from 27 in the youngest to 20 in the oldest age group. Under 60 years of age, DMFT was significantly higher for women than for men. No differences were found between residence categories. Molars were more frequently decayed, missing, and mobile than premolars. Of all subjects, 41% had complete dental arches, 44% had interruptions (of these, 73% were in posterior regions only), and 15% had shortened dental arches; 0.5% were edentulous. Of the subjects with shortened dental arches, about 65% had at minimum three pairs of occluding premolars. ***Conclusion:*** An initial low DMFT rate increased after the age of 60 years. Molars had the highest risk of dental decay and were most frequently absent. Shortened dental arches develop as a consequence of the pattern of tooth decay and tooth loss, although interruptions were frequently seen in the posterior regions. *Int J Prosthodont 2004;17:224–230.*

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Generally, operative dentistry aims to restore all decayed teeth to maintain occlusion of complete dental arches (CDA). This aim to preserve dental arches of at least 28 teeth might not be attainable for dental or financial reasons. In this respect, a World Health Organization workshop described as a goal for oral health "the retention throughout life of a functional, aesthetic, natural dentition of not less than 20 natural teeth and not requiring recourse to a prosthesis."[1] Especially in developing countries, extraction is the most common treatment for decayed teeth and pain relief. This may lead to interrupted dental arches, but shortened dental arches (SDA) may also result after extractions.

An SDA is a dentition with intact anterior regions and a reduction of occlusal units posteriorly. An occlusal unit is defined as a pair of opposing posterior teeth that supports the occlusion. The occlusal units in SDAs consist of occluding first molars and premolars or premolars only. In extreme SDA, posterior

support is completely absent. In both SDA and interrupted dental arches, a certain number of occlusal units are required to meet oral functional demands expressed by occlusal stability, chewing function, and esthetics.[2–5] In a first step to estimate decline in oral function of a population with reduced dentitions, interruptions and shortening of the dental arches have to be categorized and their prevalence recorded. Since it is anticipated that molars are affected most frequently and most seriously by caries and periodontal disease,[4–9] interrupted arches in the molar area and SDAs resulting in reduced molar support are of interest.

Epidemiologic studies on dental state among adults generally report on the number of decayed/missing/filled teeth (DMFT), sometimes indicating tooth type and (mean) number of present teeth.[10–14] They give little or no information about the number and location of occlusal units. Most of these studies have been conducted in industrialized countries. While in developing countries it can be expected that a high percentage of the adult population will have reduced dentitions, epidemiologic studies there have primarily aimed at children and adolescents.[15–17] To the authors' knowledge, the extent of occlusal units remaining in reduced dentitions in adults in Africa is not known.

The present cross-sectional study was designed to assess DMFT in a Tanzanian adult population. Specifically, the prevalence of SDA was estimated in relation to the preservation of occlusal units and age of the subjects. It was hypothesized that molars are high-risk teeth for decay compared to anterior and premolar teeth, and therefore interruptions in the molar area or SDAs without molar support would be observed frequently.

Materials and Methods

A stratified cluster sample of 5,984 subjects was obtained from urban (two cities) and rural (two regions) adult populations of the Coastal zone in Tanzania from 1998 to 2000. The selection of subjects has been described earlier.[18] The clusters in the urban region consisted of seven institutions and factories; the rural clusters consisted of two districts. Per urban cluster, a random sample from both male and female employees was taken. In the rural clusters, all inhabitants of six randomly selected villages were included. Finally, stratification included residence (urban/rural), gender, and age (younger: $\geqslant$ 20 and $<$ 40 years; older: $\geqslant$ 40 years).

All selected subjects were invited for an examination of the state of the dentition. After obtaining verbal consent, the dental examination was performed in natural light by one examiner using a mouth mirror and a dental probe, with the subject seated on an ordinary chair. Altogether, 5,532 subjects completed the examination. A total of 452 (7.5%) subjects did not participate for reasons including travel (331), refusal (48), leave (29), retirement/dismissal from work (23), and illness (21).

First, the status of each tooth was recorded as: *(1)* present; *(2)* absent; *(3)* replaced by removable partial denture (used by the subject); *(4)* as 3, but removable partial denture not used; *(5)* replaced by complete denture (used); or *(6)* as 5, but complete denture not used. States 2 to 6 formed the "missing" component in DMFT.

Second, the "decayed" and "filled" components of DMFT were scored as: *(1)* sound (no caries, no restoration); *(2)* primary caries, considered repairable by direct restorative materials; *(3)* primary caries, not repairable; *(4)* restored (otherwise sound); *(5)* restored, needing repair (defective restoration); *(6)* secondary caries, repairable; *(7)* secondary caries, not repairable; or *(8)* root. Caries was assessed by visual inspection, with tactile inspection with the dental probe added if required. Only cavitated lesions with softened surfaces were recorded as caries. In doubtful cases, no caries was recorded. Visible remnants of teeth were recorded as roots.

Third, tooth mobility was estimated for all teeth and scored as: *(1)* physiologic mobility; *(2)* slightly more than physiologic mobility; *(3)* moderately more than physiologic mobility; or *(4)* severe horizontal mobility combined with vertical displacement.[19]

Fourth, characteristics of the dental arches were recorded. Besides CDAs (with or without third molars), SDAs were categorized according to their length and symmetry based on the most posterior occluding teeth.[18] Interrupted dental arches were classified as: *(1)* interrupted arches in the anterior regions that might include interruptions in the posterior regions; or *(2)* interrupted arches in the posterior regions only.

The examiner was calibrated against two experienced researchers familiar with the SDA concept.[5] Interobserver agreements between the examiner and each of the two researchers were checked by examining 15 subjects in an urban area at the beginning of the study and 16 subjects in a rural district 2 years afterward. Cohen's kappa coefficients for presence of teeth were both 1.0 at baseline and both 0.99 after 2 years. For caries, kappa was .69 and .74 at baseline and .69 and .81 after 2 years, respectively. For tooth mobility, the coefficients were both .80 at baseline and .37 and 1.0, respectively, after 2 years.

Five age groups were distinguished: 20 to 29 years (mean 24.6 years, standard deviation [SD] 3.0), 30 to 39 years (mean 34.2 years, SD 3.0), 40 to 49 years (mean 44.5 years, SD 2.9), 50 to 59 years (mean age 52.8 years, SD 2.6), and $\geqslant$ 60 years (mean 68.7 years, SD 7.3). Data were analyzed by using descriptive statistics.

Table 1 Distribution of Subjects According to Type of Dental Arch and Age

Type of dental arch	20–29 y		30–39 y		40–49 y		50–59 y		⩾ 60 y	
	n	%	n	%	n	%	n	%	n	%
Complete	738	60	719	46	466	34	264	30	67	13
Shortened	119	10	221	14	213	16	152	17	104	21
Interrupted										
In anterior regions	36	3	96	6	185	14	153	17	185	36
In posterior regions only	323	27	529	34	484	36	326	36	122	24
Edentulous	0	0	0	0	0	0	2	0	28	6
Total	1,216	100	1,565	100	1,348	100	897	99	506	100

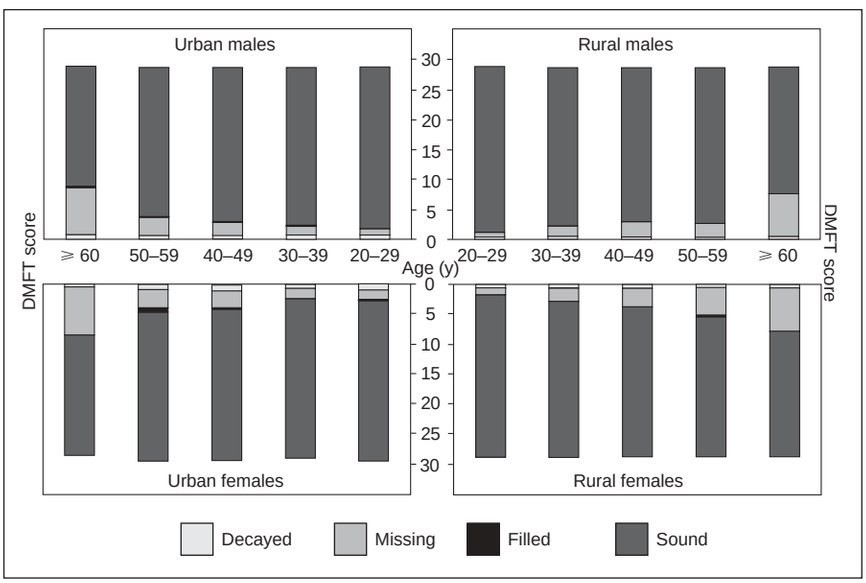

Fig 1 Decayed, missing, and filled teeth *(DMFT)* based on 28 teeth, according to residence and gender for the five age categories.

One-way analysis of variance (ANOVA) was performed, and in case of a skewed data distribution, squared root transformation was applied. Level of statistical significance was .05.

Results

Overall, 2,254 subjects (41%) had CDAs comprising 28 to 32 teeth, whereas 2,439 (44%) had interrupted dental arches and 809 (15%) had SDAs (Table 1). Thirty subjects (0.5%) were edentulous; they were older than 50 years, and none of them had complete dentures. The proportion of subjects with CDAs decreased from 60% in the 20- to 29-year-olds to 13% in those aged 60 years and over. Of the subjects with interrupted dental arches, 73% had intact anterior regions. Under 60 years of age, about 80% had interruptions in the posterior region only. In contrast, subjects above 60 years of age had more interruptions in the anterior regions than in "posterior regions only."

Overall, 37 subjects had an acrylic resin removable partial denture in the maxilla, three had one in the mandible, and seven had one in both jaws.

The mean numbers of present teeth ranged from 27.0 (SD 1.7) in the 20- to 29-year-olds to 19.9 (SD 7.5) in elderly subjects (Fig 1). Mean DMFT scores increased gradually from the youngest age group (DMFT 1.8, SD 2.9) to the age group of 50 to 59 years (DMFT 3.8, SD 4.2). A steep increase was seen from the latter age group to the age group 60 years and over (DMFT 8.1, SD 7.2). For all age groups, the missing component formed the main part of the DMFT score, being 58% in the youngest and 95% in the elderly subjects. No difference was observed between the mean DMFT score in urban and rural areas (both 3.3, SD 4.4; $P = .6$). Under the age of 60, women had a significantly higher mean DMFT score (3.1, SD 4.0) than did men (2.6, SD 3.5; $P < .001$). Above 60 years of age, there were no significant gender differences in mean DMFT scores.

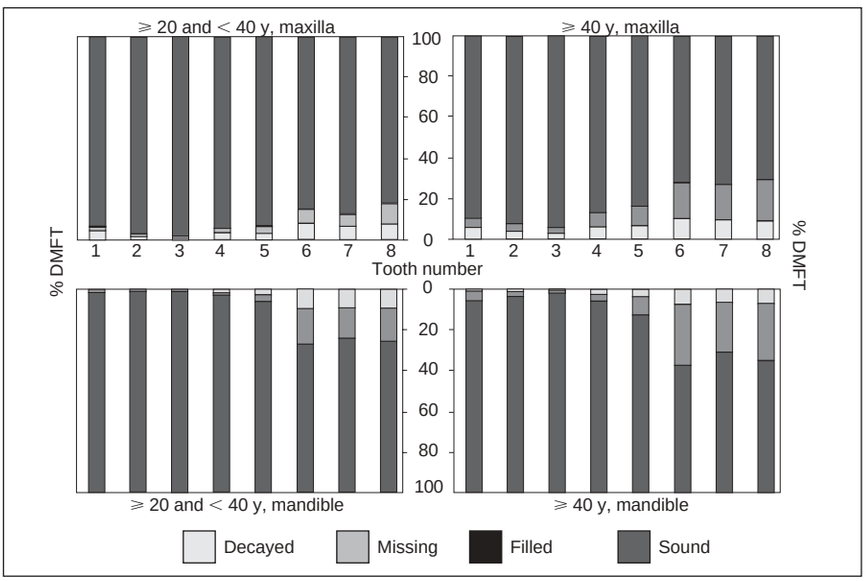

Fig 2 Percentage distribution of decayed, missing, and filled per tooth *(DMFT)*, according to jaw and age group. The original two-group division of age is used for convenience.

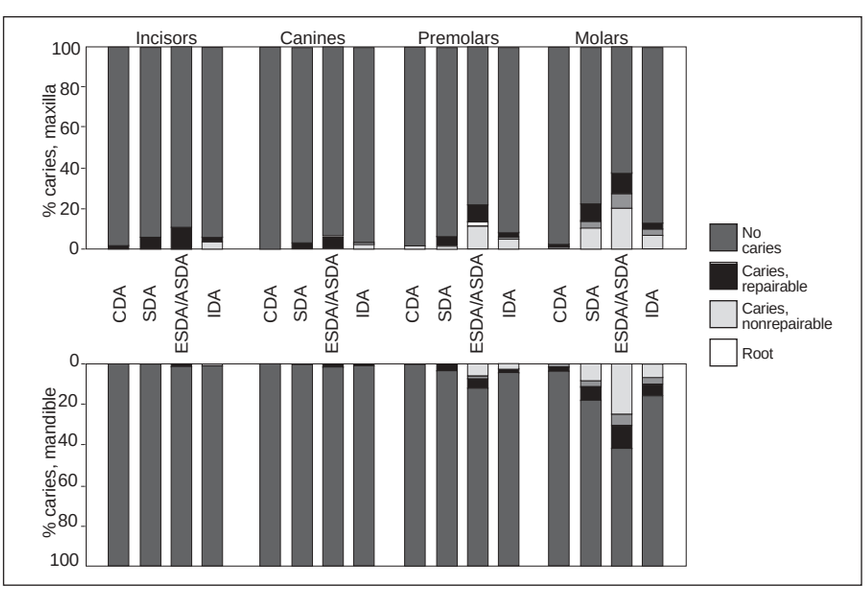

Fig 3 Percentage distribution of cariologic state of the teeth by tooth type and dental arch category for the maxilla and mandible. *CDA* = complete dental arch; *SDA* = slightly SDA and SDA I and II; *ESDA/ASDA* = extreme SDA I and II and asymmetric SDA I to III; *IDA* = interrupted dental arch.

In all five age groups, posterior teeth were more often missing than anterior teeth (Fig 2). Molars were more frequently absent than premolars. Mandibular molars were more frequently absent than their maxillary counterparts. In contrast, anterior teeth and premolars were more often absent in the maxilla than in the mandible. A closer look at decayed teeth revealed that a low percentage of the anterior teeth had caries and that they were considered repairable for all arch categories (Fig 3). This also applied to premolars in the CDA and SDA categories (which comprise the moderate types of SDA). In molars, nonrepairable lesions and roots were prevalent. Most of the carious lesions and retained roots were found in molars and premolars in subjects who were already missing teeth (SDA and interrupted arches, but most certainly extreme SDA/asymmetric

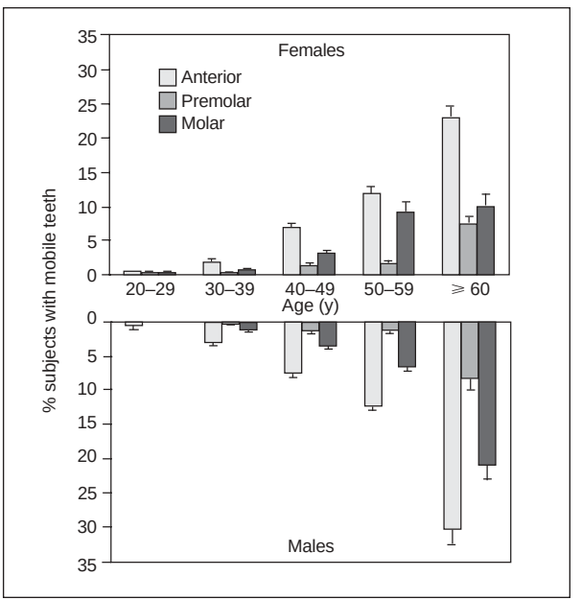

Fig 4 Percentage distribution of subjects with one or more mobile teeth, according to gender and dental region for the five age categories.

Table 2 Distribution of Subjects According to Shortened Dental Arch (SDA) Category and Age

Category	20–29 y		30–39 y		40–49 y		50–59 y		⩾ 60 y	
	n	%	n	%	n	%	n	%	n	%
Slightly SDA: M_1–$M_1/M_2/M_3$	34	28	48	22	53	25	33	22	7	7
SDA I: P_2–$M_1/M_2/M_3$	28	23	44	20	42	20	23	15	8	8
SDA II: P_2–P_1/P_2	27	23	42	19	34	16	16	11	23	22
Extreme SDA I: P_1–P_1	8	7	16	7	15	7	17	11	9	8
Extreme SDA II: C–C/P_1	7	6	31	14	28	13	22	14	21	20
Asymmetric SDA I: P_1–$M_1/M_2/M_3$	11	9	15	7	18	8	17	11	8	8
Asymmetric SDA II: C–$M_1/M_2/M_3$	1	1	11	5	9	4	14	9	4	4
Asymmetric SDA III: C–P_2	3	3	14	6	14	7	10	7	24	23
Total	119	100	221	100	213	100	152	100	104	100

M = molar; P = premolar; C = canine.

SDA, the latter two being the categories of advanced SDA). A large portion of these lesions were considered nonrepairable.

The percentage of subjects with one or more mobile teeth increased with age ($P < .001$; Fig 4). Mobility in the premolar region was less frequent than in the anterior or molar region. Significantly more men had mobile teeth than women for anterior teeth ($P = .01$) and for molars ($P = .01$), yet the difference was not significant for premolars ($P = .6$). Gender differences were greatest for subjects aged 60 years and over.

The frequency distribution of subjects according to SDA category is shown in Table 2. Most frequently, slightly SDAs (22%) were seen, followed by SDAs I (18%) and SDAs II (18%). These three SDA categories, added to asymmetric SDAs I (9%), formed 65% of the subjects with SDAs who had at minimum three pairs of occluding premolars. With increasing age, SDAs got more extreme, leaving fewer occluding premolars. Prevalence of the categories extreme SDA I and II, together with asymmetric SDA III, increased from 15% in the young age group to 52% in the oldest age group. These categories had zero to two pairs of occluding premolars. Of the subjects with interruptions in the posterior region only, about 80% of subjects aged 20 to 29 years and about 60% of the three middle age groups had one or more interruptions located distal of the second premolar(s) (Table 3).

Discussion

As a consequence of the cluster sampling used in this study, in urban regions people older than working age were not taken into consideration. Hence, mean ages in the oldest groups might differ between urban and rural regions. This appeared not to be the case (mean age 68 vs 69 years). By choosing the clusters, a true random representative sample is not obtained,[20] which might restrict the inference of the findings. However, the selection of subjects from the participating insti-

Table 3 Subjects with Interrupted Dental Arches only in Posterior Regions According to Shortened Dental Arch (SDA) that Remains if Teeth Distal of Interruption Are Not Considered, and Age

Remaining SDA length	20–29 y		30–39 y		40–49 y		50–59 y		⩾ 60 y	
	n	%	n	%	n	%	n	%	n	%
Extreme SDA I: P_1–P_1	25	8	78	15	97	20	78	24	35	29
Extreme SDA II: C–C/P_1	32	10	91	17	102	21	58	18	25	21
SDA I: P_2–M_1/M_2/M_3	224	69	282	53	230	48	162	49	53	43
Slightly SDA: M_1–M_1/M_2/M_3	42	13	78	15	55	11	28	9	9	7
Total	323	100	529	100	484	100	326	100	122	100

M = molar; P = premolar; C = canine.

tutions as well as in the villages was randomized. The large sample was taken from diverse areas and is considered to provide a realistic profile of the population of the Northern Coastal area of Tanzania.

The caries prevalence seen in this study confirms findings reported earlier in Tanzania[21,22] and in other developing countries.[23–26] Although lower caries prevalence in rural compared to urban populations has been reported in Africa,[26,27] this difference was not found in the present populations. The reason for this is obscure. The earlier observations were attributed to a shift from indigenous to modern dietary habits by urban residents. Possibly the higher mobility of the rural population contributes to a leveling of the dietary patterns. The higher DMFT scores seen with increasing age were expected. Decayed teeth (including retained roots) followed the same pattern as missing teeth, although subjects ⩾ 40 years seemed to have more maxillary than mandibular molars decayed. The rarity of filled teeth reflects the limited resources and the few health care professionals available for the Tanzanian population at this moment.

Like other studies,[26,28–31] higher DMFT was found in women than in men, although this difference was not observed in the oldest group. For tooth mobility, on the contrary, particularly in the oldest age group, men showed higher frequencies than women. This suggests that men lose relatively more teeth because of periodontal disease than do women. A swift increased prevalence of mobile teeth and interruptions in the anterior regions was seen in subjects aged 60 years and over. It is not clear whether these are reliable observations, since the mean age of the oldest group was 15 years higher than that of the precursor group, while the difference between the other groups generally was 10 years. Clearly, at increased age not only molars are high-risk teeth.

The low prevalence of edentulous persons might be an underestimation. As stated, the sampling excluded urban people older than working age. Especially in the group older than 65 years, a high prevalence of edentulism can be expected. In rural areas, edentulous people could perceive no benefit from any dental examination and might not show up. However, the prevalence of edentulism in this study was comparable to that reported previously in Tanzania[21] and in other African countries.[24,26,32]

The results support our hypothesis that molars are high-risk teeth for decay (particularly in the mandible). Because of limited treatment possibilities, repairable molars might have been extracted, actually increasing the missing component of DMFT. Yet those repairable molars were decayed anyway, which does not change the overall DMFT figures related to molars. Thus, anterior and premolar teeth seem to be more resistant to dental decay than molars, which makes molars the most frequently missing teeth.[22]

Extraction of molars in uninterrupted dental arches creates SDAs of moderate types. The prevalence of these types of SDAs was 8% to 10% of the population and about 60% for all types of SDA. Those SDA types offer reduced but functional and stable dentitions.[3,33] Extraction of molars in interrupted dental arches with missing premolars results in more extreme SDA categories. These categories are associated with occlusal instability and impaired function.[4,33,34] The data show that these extreme SDAs prevail in the older age groups.

On the basis of the observed pattern of tooth decay and tooth loss, SDAs are a logical consequence of decay in human dentitions,[5] although interruptions in anterior regions increase from middle-aged groups. To prevent pain or for pain relief, extraction of decayed molars is a treatment option that actively introduces the SDA concept to dental care. Given the limited resources in Tanzania, it seems reasonable to extract decayed molars, leading to an SDA, and direct prevention and restorative efforts to the anterior and premolar regions.

Acknowledgments

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