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ORIGINAL ARTICLE

Intra-oral carcinomas in Maiduguri, north-eastern Nigeria

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OBJECTIVE: To document the pattern of intra-oral carcinomas diagnosed in north-eastern Nigeria.
DESIGN AND SETTING: A retrospective clinical and histopathological review seen in a tertiary care hospital (January 1987–December 2002).
MATERIALS AND METHODS: Information on socio-demographic characteristics of patients and details of cancer management were retrieved from the files and histopathology records of cases diagnosed at the hospital.
RESULTS: A total of 378 biopsies, 317 primary cancers including 279 carcinomas of the head and neck were diagnosed during the study period. Intra-oral carcinomas constitute 43 (15.4%) of all head and neck carcinomas reported, with no occurrence in children. The overall mean age of occurrence was 51.2 ± 15.6 years (male = 56.2 ± 13.7 years; females = 47.5 ± 16.2 years) and an overall male–female ratio of 3:4. Carcinomas were commonly reported in the palate 19 (44.2%) and lip six (13.9%) and floor of mouth four (9.3%). Squamous cell carcinoma 28 (65.1%), adenoidcystic carcinoma seven (16.3%) and mucoepidermoid carcinoma five (11.6%) were the commonly reported carcinomas. Squamous cell carcinoma was the most common carcinoma in all sites, in the sixth decade of life, of equal gender distribution and commonly reported in users of kola nuts and tobacco.The occupation of patients diagnosed with oral carcinoma and squamous cell carcinoma was farming (50%, 61.5%). All the staged cancers patients ($n = 7$) reported in the late stages (III/IV) of the disease. The mean interval between symptoms and presentation for the different carcinomas ranged between 9 and 25 months, with the least interval reported for mucoepidermoid carcinoma.
CONCLUSIONS: Squamous cell carcinoma was the most common oral carcinoma, commonly reported in the palate, among farmers and in the sixth decade of life. Its occurrence in under 40 year olds is three to six times greater than reported for the USA and Europe and may be associated with poor diet and the habitual use of kola nuts and tobacco. The survival rates of patients diagnosed with intra-oral carcinomas, although not available, would be expectedly low in view of the prognostic indicators recorded in this series. The routine oral cancer screening of each patient, and counselling of patients with high-risk habits, by dentists is recommended to improve the prognosis of the disease.
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Introduction

A recent International Agency for Research of Cancers (IARC) report showed that malignant neoplasms of the oral cavity, pharynx and salivary glands are responsible for an estimated 390 000 (3.9% of total) new cases of cancer worldwide in 2000 (Parkin *et al*, 2003). In Africa, the frequency of these cancers is lower, with an estimated 19 500 new cases in 2000, representing 3.1% of new cancers.

The report also showed a great deal of geographical variation in the incidence of oral cancers. High incidences were reported in regions where it is related to factors like tobacco (in the Indian subcontinent, Papua New Guinea, Sudan) and alcohol (in France, Switzerland and Eastern Europe) (Parkin *et al*, 2003). The likelihood of the existence of regional and ethnic differences in the incidence of oral carcinomas in Nigeria has also been postulated (Onuigbo, 1977; Adekeye *et al*, 1985).

The relative distribution of sites within the oral cavity also showed considerable differences. Lip carcinoma were associated with whites in areas of high UV radiation; carcinoma of the gums, floor of the mouth and vestibule in tobacco chewers, snuff dippers and toomback users (Elbeshir *et al*, 1989; Johnson, 1991; Idris *et al*, 1994, 1995; Batsakis, 2003, Parkin *et al*, 2003). Odukoya *et al* (1990), in a study on kola nuts as a possible aetiological factor for oral cancers among

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Nigerians, demonstrated its role in promoting the cigarette smoking-induced keratinization of human palatal mucosa.

Different studies on intra-oral carcinomas in Nigeria have reported a relatively low incidence of the condition. This observation has been variously attributed to the low dentist:population ratio, poor and inadequate hospital services and poor (and almost non-existent) cancer registry records obtainable in Nigeria (Daramola *et al*, 1979; Adekeye and Robertson, 1979). The University of Maiduguri Teaching Hospital (UMTH), Maiduguri, Borno State is the only referral centre for histopathology in north-eastern Nigeria (serving Borno, Adamawa, Yobe, Gombe, Bauchi and Taraba States with a population of about 11.9 million people) and receives biopsies from government, private and mission hospitals in the region.

This study was carried out to document baseline information on the pattern of intra-oral carcinomas (International Classification of Diseases for Oncology, ICD-O; C00–C06) in the north-east, a multiethnic region of Nigeria.

Materials and methods

The ethical clearance required to access data for the study was obtained from the Chief Medical Director of the hospital.

Socio-demographic information and history of patient management (age, sex, occupation, ethnic group, history of habits; history of symptoms, dates of referral and first appointment, pretreatment and histological tumour, node, metastasis (TNM) staging of lesion, clinical and histological diagnoses, dates of biopsy and dates of biopsy report; definitive treatments and date of discharge), according to the pattern developed for the Minimum Cancer Data set (Wight *et al*, 1999) by the British Association of Head and Neck Oncologists (BAHNO), were retrieved from pathology records and medical records of patients diagnosed histologically with malignant neoplasms of intra-oral sites at the UMTH, Maiduguri, for the period between the start of histopathology services in January 1987 and December 2002.

The oral cavity, for the purpose of this study, includes the lip (excluding the skin), tongue, gingiva, floor of the mouth, buccal mucosa, alveolus of maxilla and mandible, unspecified 'mouth'/'oral cavity' and the palate, as classified by the ICD-O (C00–C06), 3rd edn (Fritz *et al*, 2000).

The information was analysed statistically using SPSS 8+ and EPI INFO Version 6.0. Relationships between nominal variables were calculated using the chi-square (Yate's corrected and Fischer's exact) test. The Kolmogorov–Smirnov test was used to test association between various habits and intra-oral carcinomas. A *P*-value of 0.05 or less was considered significant.

Results

A total of 378 biopsies, 317 cases of primary cancers, including 279 carcinomas of the head and neck, were diagnosed during the study period. A total of 43 cases of intra-oral carcinomas, which constitute 15.4% of head and neck carcinomas, were reported. There was no childhood carcinoma reported in this series.

The overall mean age of occurrence was 51.2 ± 15.6 years (male = 56.2 ± 13.7 years; females = 47.5 ± 16.2 years) and an overall male–female ratio of 3:4.

Type, site, age and gender distribution

The carcinomas reported include squamous cell carcinoma (M-8070/3), adenoidcystic carcinoma (M-8200/3), mucoepidermoid carcinomas (M-8430/3), terminal duct (adeno)carcinoma (M-8525/3) and anaplastic carcinoma (M-8021/3).

The predominant carcinomas were squamous cell carcinoma, adenoidcystic carcinoma and mucoepidermoid carcinoma (Tables 2 and 3). *Squamous cell carcinoma* was reported commonly in the palate eight (28.6%), lip five (17.8%), floor of the mouth four (14.3%) and tongue three (10.7%). The buccal mucosa and alveolus two (7.1%) each and gingiva one (3.6%) were the least affected sites. Three cases (10.7%) were reported in unspecified 'oral cavity' (Table 1). It was commonly reported in the sixth decade of life, with a mean age of occurrence of 56.5 ± 14.8 years (males = 61 ± 9.9 years; females = 52.6 ± 17.3 years), and a M–F ratio of 6:7 (Tables 2 and 3).

Adenoidcystic carcinoma was reported in the minor salivary glands of the palate and in unspecified oral cavity. It was commonly reported in the fifth decade of

Table 1 Primary intra-oral carcinomas by age group and International Classification of Diseases for Oncology (ICD-O) sites ($n = 43$)

Sites	*ICD-O number*	*Age groups (years)*			*Total*	*Percentage of intra-oral carcinoma*
		0–14	*15–75+*	*Unspecified*		
Lip	C00	–	5	1	6	13.9
Tongue	C01–02	–	3	–	3	7.0
Alveolar mucosa	C03	–	2	–	2	4.7
Gingiva	C03	–	1	–	1	2.3
Floor of mouth	C04	–	3	1	4	9.3
Palate	C05	–	19		19	44.2
Unspecified site	C06	–	6	–	6	13.9
Buccal mucosa	C06	–	2	–	2	4.7
Total (%)		–	41	2	43 (100)	

Table 2 (A) Demographic characteristics of the different types of intra-oral carcinoma; (B) association between habits and intra-oral carcinomas (one sample K-S test)

	Carcinoma	*Squamous cell carcinoma*	*Adenoidcystic carcinoma*	*Mucoepidermoid carcinoma*	*Terminal duct carcinoma*	*Anaplastic carcinoma*
(A)						
Age group						
< 20		–	–	2	–	–
21–40		4	1	2	1	1
41–60		12	5	–	1	–
61 +		10	–	–	–	–
Unspecified		2	1	1	–	–
Missing		–	–	–	–	–
Gender						
Males		12	4	1	–	–
Females		14	3	4	2	1
Missing		2	–	–	–	–
Occupation						
Farming		8	2	–	–	–
Housewife		3	1	1	–	–
Student		1	–	–	–	–
Teacher		1	1	–	–	–
Unspecified		1	–	–	–	–
Missing		14	3	3	2	1
Tribe						
Kanuri	7	5				
Fulani	6	3				
Kilba	3	3				
Shuwa	1	1				
Marghi	1	1				
Guduma	1	–				
Unspecified	1	1				
Missing	23	14				
Habits						
T/smoking						
Users	2					
Non-users	10					
Missing	31					
Snuff						
Users	–					
Non-users	3					
Missing	40					
T/chewing						
Users	1					
Non-users	–					
Missing	42					
Kola nut						
Users	4					
Non-users	1					
Missing	38					
Alcohol						
Users	1					
Non-users	12					
Missing	30					
Fuel sucking						
Users	–					
Non-users	–					
Missing	43					

(B)

K-S test scores	*Habits*		
	Tobacco use	*Kola nut use*	*Alcohol use*
K-S z-score	1.694	1.057	1.919
Asymptotic significance (two-tailed)	0.006	0.214	0.001

life, with an overall mean age of occurrence of 49.5 ± 5.0 years (males = 52.3 ± 2.5 years; females = 46.7 ± 5.8 years) and a M–F ratio of 4:3 (Table 2).

Mucoepidermoid carcinoma was reported in the minor salivary glands of the palate two (40%), unspecified mouth/oral cavity two (40%) and the lip one (20%).

Table 3 Distribution of intra-oral carcinoma cases by site and stage at presentation

	Lip	*Tongue*	*Gingiva*	*Floor of mouth*	*Palate*	*Buccal mucosa*	*Alveolus*	*Unspecified mouth*
Age group								
< 20	–	–	–	–	2	–	–	–
21–40	1	–	–	–	6	–	–	2
41–60	3	2	1	1	8	–	1	2
61+	–	1	–	2	2	2	1	2
Unspecified	2	–	–	1	1	–	–	–
Missing	–	–	–	–	–	–	–	–
Stage								
I	–	–	–	–	–	–	–	–
II	–	–	–	–	–	–	–	–
III	–	–	–	1	–	1	–	–
IV	–	2	–	–	1	–	1	–
Missing	6	1	1	3	18	1	1	–
Carcinoma								
Squamous cell carcinoma	5	3	1	4	8	2	2	3
Adenoidcystic carcinoma	–	–	–	–	6	–	–	1
Mucoepidermoid carcinoma	1	–	–	–	2	–	–	2
Terminal duct carcinoma	–	–	–	–	2	–	–	–
Anaplastic carcinoma	–	–	–	–	1	–	–	–
Missing	–	–	–	–	–	–	–	–

It was most commonly reported in the second decade of life, with an overall mean age of occurrence of 26.3 ± 10.9 years (males = 17 ± s.d. years; females = 29.3 ± 11.0 years) and a M–F ratio of 1:2 (Table 2).

Habits, occupation and ethnic groups of patients

A total of 20 patients (45.4%) were asked questions relating to the use of tobacco, kola nuts, alcohol and fuel sucking, of which eight patients admitted involvement in some of these habits. Of the six habits enquired into, those reported in patients with various intra-oral carcinomas were kola nut chewing four (50%), tobacco use (smoking and chewing) three (37.5%) and alcohol use one (12.5%). Alcohol use ($P = 0.001$) and tobacco use ($P = 0.006$) were associated with intra-oral carcinomas (Table 2).

Farming is the most common occupation among patients diagnosed of intra-oral carcinomas and squamous cell carcinoma (Table 2).

Squamous cell carcinoma was reported more commonly among the Kanuris, Fulanis and Kilbas (Table 2).

Interval before presentation and stage at presentation

The mean interval before presentation is between 9 and 25 months, with the least interval recorded for mucoepidermoid carcinoma while the longest interval was recorded for adenoidcystic carcinoma. The mean interval for squamous cell carcinoma is 16.2 ± 22.9 months. The earliest presentation of the patients was in the stage III of the disease (28.6%), with the majority (71.4%) of cases presenting during the stage IV of the disease (Table 3).

Survival analysis

Information relevant for the estimation of survival rates were not documented as the majority of the patients treated at the hospital were 'lost to follow-up' following the initial treatments.

Discussion

Type, site, age and gender distribution

The findings of Mashberg and Meyers (1976) study of early/asymptomatic squamous cell carcinoma of the oral cavity showed the carcinoma in the floor of the mouth and tongue as the two commonest sites in a United States population. This agrees with the findings in different studies in America and Europe (Pinholt *et al*, 1997; Batsakis, 2003; Zavras *et al*, 2003). The prevalence of malignancy in the palate in the present study is fairly similar to the findings of Daramola *et al* (1979) and Odukoya *et al* (1986) for Nigeria, but contrasts with the reported findings in parts of the USA and Europe. This suggests an association between the different prevalent sites of oral squamous cell carcinoma and certain high-risk habits.

The occurrence of a predominant squamous cell carcinoma and in the sixth decade of life is in agreement with previously reported studies around the world (Daramola *et al*, 1979; Odukoya *et al*, 1986; Silverman and Gorsky, 1990; Abiose *et al*, 1991; Rafindadi and Ayuba, 2000). The 15.4% occurrence in the under 40 years age group approximates the findings in studies in East Africa, but is less than the 17.3–29.2% ($P > 0.05$) reported in previous African studies (Daramola *et al*, 1979; Odukoya *et al*, 1986; Abiose *et al*, 1991; Idris *et al*, 1995; Onyango *et al*, 1995; Rafindadi and Ayuba, 2000; Ojulu, 2002). These values are about three to six times greater than the 0–5% reported in developed countries in Europe and North America ($P < 0.05$) (Amsterdam and Strawitz, 1982; Silverman and Gorsky, 1990; Pinholt *et al*, 1997; Howell *et al*, 2003) (Table 4). This could be attributed to the advanced network of cancer reporting, early diagnosis and elaborate preventive practices that have been established in developed countries.

The slightly higher preponderance of females in this study (observed with the lips and floor of mouth)

Table 4 (A) Comparison of age of occurrence of squamous cell carcinoma with studies in other countries (B) Comparison of age of occurrence of oral squamous cell carcinoma with other studies in Nigeria

Study locations	*Age groups (years)*		P-*values (Fischer's exact test)*
	0–40	*Over 40*	
(A)			
Maiduguri (this study)	4	24	1-tail = 0.0026
USA (Amsterdam and Strawitz JG, 1982)	12	664	2-tail = 0.0026
Maiduguri (this study)	4	24	1-tail = 0.0019
Denmark (Pinholt *et al*, 1997)	0	100	2-tail = 0.0019
Maiduguri (this study)	4	24	1-tail = 0.05
Canada (Howell *et al*, 2003)	58	1097	2-tail = 0.05
Maiduguri (this study)	4	24	1-tail = 0.438
Sudan (Idris *et al*, 1995)	103	480	2-tail = 0.803
Maiduguri (this study)	4	24	1-tail = 0.548
Kenya (Onyango *et al*, 1995)	86	544	2-tail = 0.785
(B)			
Maiduguri (this study)	4	24	YC = 0.058
Jos (Otoh *et al*, 2004)	14	22	
Maiduguri	4	24	YC = 0.60
Zaria (Rafindadi and Ayuba, 2000)	24	91	
Maiduguri	4	24	YC = 0.17
Lagos (Odukoya *et al*, 1986)	31	75	

contrasts with most reported studies in Nigeria, and could be attributed to the increasing exposure to carcinogenic agents associated with squamous cell carcinomas at these sites (Nwawolo *et al*, 2001; Batsakis, 2003).

Habits, occupation and ethnic groups

The observation of the use of alcohol and tobacco among patients diagnosed of squamous cell carcinoma agrees with previously reported findings (Johnson, 1991; Nwawolo *et al*, 2001; Ojulu, 2002, Parkin *et al*, 2003). Tobacco and alcohol have been shown to reduce the antioxidant capacity of abusers by (i) the generation of free radicals; (ii) reducing food consumption; (iii) increasing the urinary loss of ascorbic acid and (iv) causing a marked depletion of vitamin E (α-tocopherol), a key scavenger of free radicals in the lipid domain and encouraging the production of free radicals (Enwonwu and Meeks, 1995). Although the numbers are small, the kola nut-chewing habit observed commonly among Nigerian patients diagnosed with intra-oral squamous cell carcinoma, as presented in this study, has not been previously reported. This finding, coupled with the high occurrence of squamous cell carcinoma in the palate, agrees with the findings of Odukoya *et al* (1990) who demonstrated the role of kola nuts in promoting the cigarette smoking-induced keratinization of human palatal mucosa. The strength of association of this habit with intra-oral carcinoma could not be determined because of the inadequate data obtained from the patient and cancer registry records. There is a need for proper clerking, with a detailed history of commonly observed habits/practices (tobacco, kola nut and alcohol use). There is also a need for further research into the potentially harmful practice of fuel sucking which is gaining prominence in the wake of the recurrent fuel crises in the country.

The commonly observed occupation among patients diagnosed with intra-oral carcinoma and squamous cell carcinoma is farming. The predominant occupation in the region is farming for all the family members, including the women. This occupation exposes the people to the adverse effects of sunlight for a greater part of the year.

The diet among the people is mainly millet, guinea corn, wheat, rice and maize. These have trace amounts of essential anticarcinogenic nutrients. The processing of the millet/corn-based alcoholic beverage has been reported to involve substantial losses of these essential nutrients like β-carotene, vitamins A, C and E which, reportedly, have protective roles in carcinogenesis (Odunfa, 1999, Enwonwu and Meeks, 1995; Key *et al*, 2002).

The prevalence of carcinomas and squamous cell carcinomas among the Kanuri and Fulani ethnic groups may be related to their diet. Studies among Fulani and Kanuri women have reported a significantly lower antioxidant capacity of Fulani women (Okolo *et al*, 2000; VanderJagt *et al*, 2001). The presence of a heat-stable inhibitor of bile salt-stimulated lipase (BSSL) in cow's milk, a staple diet among Fulanis and related ethnic groups in northern Nigeria would deplete the absorption of the critical fatty acids and lipid soluble antioxidants (Schmeits *et al*, 1999; Torres *et al*, 2001). These findings suggest a lowered anticarcinogenic capacity among Fulanis. There are no reported studies done among the Kilbas of Adamawa State.

The Fulanis are migrant pasturalists spread over the entire zone and show a prevalence of squamous cell carcinoma in five of the six states in the north-east. The high observation of carcinomas among Kanuris (who are localized primarily in Borno State) could be attributed to the location of the hospital, which encouraged hospital attendance.

Interval before presentation and stage at presentation

Information on the cancer stage at presentation was available in only five (17.9%) of the cases of squamous cell carcinoma biopsied. This is significantly low

($P < 0.05$), and shows the need for more detailed clerking of patients by the management team.

The delayed reporting and advanced cancer stage at presentation, as observed in this study, has been previously reported among patients in Nigeria and the African subcontinent (Oji, 1999). This observation contrasts with the 10–15% or less of patients with cervical metastasis (of carcinoma of the lip) at presentation reported in the USA (Batsakis, 2003).

The late presentation has been variously attributed to societal beliefs, the initial recourse to traditional healers, with the existing health facilities (where available) as a last resort; and tumour characteristics (Oji, 1999; Solanke, 2000; Batsakis, 2003). The late reporting of cancer cases among Fulanis may be influenced by the postulated high pain tolerance among them, especially when considered in the light of the mean interval of 10 days between the referral and first appointment.

Survival analysis

Information on survival and prognosis of treatment were not recorded for the majority of the patients, as these were lost to follow up. The prevalence of carcinomas in the palate, exclusively in the late stage and large tumour size at presentation; and the extensive lymph node invasion observed in this study are predictors of a low survival rate for the patients (Gonzalez-Moles *et al*, 2001). The routine oral cancer screening of each patient and counselling of patients with high-risk habits, by dentists is recommended to improve the prognosis of the disease (Weinberg and Estefan, 2002; Gellrich *et al*, 2003).

Conclusions

Intra-oral squamous cell carcinoma was the most common and commonly reported in the palate, among farmers and in the sixth decade of life.

Its occurrence in under 40 year olds is three to six times greater than reported for the USA and Europe and its associated with the use of kola nuts and tobacco. The majority of patients reported in stage IV of the disease, requiring primary radiotherapy with an adjunctive surgery or chemotherapy; in view of which the survival rate of patients would be expectedly low. The routine oral cancer screening of each patient and counselling of patients with high-risk habits, by dentists is recommended to improve the prognosis of the disease.

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References

Abiose BO, Ogunniyi J, Oyejide O (1991). Oral soft tissue malignancies in Ibadan, Nigeria. *Afr J Med Med Sci* **20:** 107–113.

Adekeye EO, Robertson JM (1979). Salivary gland tumours in northern Nigeria. *Trop Doct* **9:** 168–174.

Adekeye EO, Asamoa E, Cohen B (1985). Intra-oral carcinoma in Nigeria: a review of 137 cases. *Ann R Coll Surg Engl* **76:** 180–182.

Amsterdam JT, Strawitz JG (1982). Squamous cell carcinoma of the oral cavity in young adults. *J Surg Oncol* **19:** 65–68.

Batsakis JG (2003). Clinical pathology of oral cancer. In: Shah JP, Johnson NW, Batsakis JG, eds. *Oral cancer*. Martin Dunitz Publication: London, UK, pp. 77–129.

Daramola JO, Ajagbe HA, Oluwasanmi JO (1979). Pattern of oral cancer in a Nigerian population. *Br J Oral Surg* **17:** 123–128.

Enwonwu CO, Meeks VI (1995). Bionutrition and oral cancer in humans. *Crit Rev Oral Biol Med* **6:** 5–17.

Elbeshir EI, Abeen HA, Idris AM, Abbas K (1989). Snuff dipping and oral cancer in Sudan. *Br J Oral Maxfac Surg* **27:** 243–248.

Fritz A, Percy C, Jack A *et al* (eds) (2000). *International Classification of Diseases for Oncology*, 3rd edn. WHO, Geneva, Switzerland.

Gellrich NC, Suarez-Conqueiro MM, Bremerich A, Schramm A (2003). Characteristics of oral cancer in a central European population: defining the dentist's role. *J Am Dent Assoc* **134:** 307–314.

Gonzalez-Moles MA, Galindo P, Gitierrez-Fernandez J *et al* (2001). P53 protein expression in oral squamous cell carcinoma. Survival analysis. *Anticancer Res* **21:** 2889–2894.

Howell RE, Wright BA, Dewar R (2003). Trends in the incidence of oral cancer in Nova Scotia from 1983 to 1997. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* **95:** 205–212.

Idris AM, Prokopczyk B, Hoffman D (1994). Toomback: A major risk factor for cancer of the oral cavity in Sudan. *Prev Med* **22:** 832–839.

Idris AM, Ahmed HM, Mukhtar BI, Gadir AF, El-Beshir EI (1995). Descriptive epidemiology of oral neoplasms in Sudan 1970–1985 and the role of toomback. *Int J Cancer* **61:** 155–158.

Johnson NW (1991). Orofacial neoplasms: global epidemiology, risk factors and recommendations for research. *Int Dent J* **41:** 365–375.

Key TJ, Allen NE, Spencer EA, Travis RC (2002). The effect of diet on risk of cancer. *Lancet* **360:** 861–868.

Mashberg A, Myers H (1976). Anatomic site and size of 222 early asymptomatic oral squamous cell carcinomas. *Cancer* **37:** 2146–2153.

Nwawolo CC, Ajekigbe AT, Oyeneyin JO, Nwankwo KC, Okeowo PA (2001). Pattern of head and neck cancers among Nigerians in Lagos. *West Afr J Med* **9:** 304–310.

Odukoya O, Mosadomi A, Sawyer DR, Orejobi A, Kekere-Ekun A (1986). Squamous cell carcinoma of the oral cavity. A clinico-pathological study of 106 Nigerian cases. *J Maxillofac Surg* **14:** 267–269.

Odukoya O, Roberts T, Arole G (1990). A cytologic study of the effect of kola nut on the keratinization of the palatal mucosa of Nigerian smokers. *Afr Dent J* **4:** 1–5.

Odunfa SA (1999). Cereal fermentation in African countries. In: Haard NF, Odunfa SA, Lee C, Quintero-Ramirez R, Warcher-Radarte C, eds. *Fermented cereals: a global perspective*. FAO Agricultural Services Bulletin No. 138, Chapter 2. FAO, Rome, Italy.

Oji C (1999). Late presentation of orofacial tumours. *J Craniomaxillofac Surg* **27:** 1–6.

Ojulu E (2002). *Tobacco use and oral cancer patients in Uganda*. All Africa Global media (http://www.AllAfrica.com/stories/200203250020.html).

Okolo SN, Onwuanaku C, Okonji M *et al* (2000). Concentration of eight trace minerals in milk and sera of mother-infant pairs in northern Nigeria. *J Trop Paediatr* **46:** 160–162.

Onuigbo WIB (1977). Cancer of the oral cavity in Nigerian Igbos. *ORL Head Neck Nurs* **39:** 247–250.

Onyango JF, Awange DO, Wakiaga JM (1995). Oral tumours and tumour-like conditions in Kenya: II. Age, sex and site distribution. *East Afr Med J* **72:** 568–576.

Otoh EC, Johnson NW, Mandong BM, Danfillo IS (2004). Pattern of oral cancers in north-central Nigeria. *Afr J Oral Health* **1:** 47–53.

Parkin DM, Whelan SL, Ferlay J, Teppo L, Thomas DB (eds) (2003). *Cancers in five continents*, Vol. VIII, IARC Scientific Publication No. 155. IARC: Lyon, France.

Pinholt EM, Rindum J, Pindborg J (1997). Oral cancer: a retrospective study of 100 Danish cases. *Br J Oral Maxillofac Surg* **35:** 77–80.

Rafindadi AH, Ayuba GI (2000). Oral tumours in Zaria. *Niger J Surg Res* **2:** 21–25.

Schmeits BL, Okolo SN, VanderJagt DJ *et al* (1999). Content of lipid nutrients in the milk of Fulani women. *J Hum Lact* **15:** 113–120.

Silverman S Jr, Gorsky M (1990). Epidemiologic and demographic update in oral cancer: California and National data – 1973 to 1985. *J Am Dent Assoc* **120:** 495–499.

Solanke TF (2000). Cancer in the Nigerian setting (with particular reference to Ibadan). *Arch Ibadan Med* **1:** 3–5.

Torres JE, VanderJagt D, Okolo SN, Magnussen M, Bhatta SK, Glew RH (2001). Bile salt-stimulated lipase in the milk of Fulani and Kanuri women in Nigeria and native Nepalese women. *J Natl Med Assoc* **93:** 201–207.

VanderJagt DJ, Okolo SN, Costanza A, Blackwell W, Glew RH (2001). Antioxidant content of the milk of Nigerian women and the sera of their exclusively breast-fed infants. *Nutr Res* **21:** 1–8.

Weinberg MA, Estefan DJ (2002). Assessing oral malignancies. *Am Fam Physician* **65:** 1379–1384.

Wight R, Johnson NW, Giles A (1999). *BAHNO national minimum and advisory head and neck cancer data sets*. Version 1.0. London, UK (http://www.bahno.org.uk).

Zavras AI, Laskaris C, Kittas C, Laskaris G (2003). Leukoplakia and intraoral malignancies: female cases increase in Greece. *J Eur Acad Dermatol Venerol* **17:** 25–27.