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Pilot pathfinder survey of oral hygiene and periodontal conditions in the rural population of The Gambia (West Africa)

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Jordan RA, Lucaciu A, Fotouhi K, Markovic L, Gaengler P, Zimmer S. Pilot pathfinder survey of oral hygiene and periodontal conditions in the rural population of The Gambia (West Africa).

Abstract: *Objective:* To document oral hygiene and periodontal conditions in the rural population of The Gambia. *Basic research design:* Cross-sectional study according to the recommendations of the WHO for oral health surveys. *Clinical setting:* Examination by two calibrated investigators in the health centres of rural communities after a public radio call. Patients were randomly allocated to the investigators. *Participants:* 162 patients (20–54 years old; 52.5% female, 47.5% male). *Interventions:* Patients were interviewed for personal information and examined in a full-mouth recording. *Main outcome measures:* Oral Hygiene Index (OHI), Gingival Index (GI), Community Periodontal Index (CPI), and the Gingivitis-Periodontitis-Missing/Teeth Index (GPM/T). Statistical analysis was performed using the Wilcoxon-rank-sum test and Kruskal–Wallis test with statistical significance at $P < 0.05$. *Results:* OHI increased by age from 6.9 to 9.2 ($P < 0.05$) and showed in tendency higher levels in men ($P = 0.07$), while the GI remained stable at 1.2. Community Periodontal Index codes increased by age ($P < 0.05$) and showed a fourfold higher prevalence for severe periodontitis in males ($P < 0.05$). Likewise, an age-related increase in GPM/T was evident (20.5 versus 25.4), significantly in the number of moderate periodontitis and missing teeth ($P < 0.05$). In GPM/T, males again demonstrated significantly more teeth affected by periodontitis than women. No statistical associations were found between ethnic groups or for different oral hygiene methods concerning CPI or GPM/T. *Conclusions:* Prevalence of predominantly mild to moderate periodontal disease indicates treatment needs that should be

considered when developing a national oral health care plan in The Gambia (West Africa).

Key words: calculus; campaigns; care; dental hygiene; gingival; gingivitis; index; knowledge; methods/techniques; oral health status; periodontal; problems; toothbrushing

Introduction

The colonial heritage of African countries regarding the public health care system shows uniform key characteristics: general treatment on a more than emergency basis is predominantly provided in few well equipped hospitals in urban areas and is not available and/or not affordable for the vast majority of the rural population (1). Primary oral health care is not of major interest in non-established marked economy (non-EME) countries due to lack of infrastructure and professional manpower, and the most common dental treatment is tooth extraction if at all (2). In The Republic of The Gambia, public dental clinics are located in the urban surroundings of the capital Banjul, thus not accessible for the rural population upcountry where about 43% of the total 1.8 million inhabitants reside according to the last national census in 2003 (3). Geographically, The Gambia is almost an enclave of Senegal and the smallest country on the continent of Africa with 11 300 sq. km. Several ethnic groups (tribes) cooperate with a minimum of inter-tribal friction: Mandinka 42%, Fula 18%, Wolof 16%, Jola 10%, Serahuli 9%, other 4%, non-African 1%. Mean age of the population is 17.9 years and the average life expectancy was calculated with 55.4 years. Illiteracy remains comparatively high with 60%; Gross domestic product per capita was determined with 1300 US$ (position 167 out of a list of 194 countries) (4).

Introducing the Atraumatic Restorative Treatment (ART) for dental caries in the 1990s (5), primary oral health care became manageable in many non-EME countries by training dental auxiliaries (6–8). The ART treatment concept is characterized by independence of electricity, a biological cavity preparation technique using hand excavation, and glass-ionomer cement as an adhesive and fluoride releasing restorative material. Recently, it has been surrounded by other treatment procedures to create a comprehensive primary oral health care concept for under-served communities (9).

To prepare the elaboration of national health care plans, the most prevalent diseases should be screened epidemiologically. In oral health care worldwide, this is supposed to be dental caries and periodontal disease. Individual progression of infectious diseases, like periodontitis, however, is highly different as a consequence of the pathogenicity and virulence factors of the biofilm microorganisms and the immunological host reaction pattern (10). In periodontitis, the latter is supposed to have a stake in genetically determined disease susceptibility of about 50% (11). It is also shown that ethnical variables can modify the susceptibility to periodontal disease (12, 13). In The Gambia, there is a wide variety of ethnic groups and epidemiological data of the populations periodontal status are incomprehensive as yet (14). To give new insights in oral hygiene conditions and periodontal diseases in the rural population of The Republic of The Gambia, it was the aim of this study to describe the epidemiological profile in a cross-sectional study.

Study population and methodology

The study design protocol of this oral hygiene and periodontal pilot pathfinder survey was designed according to the recommendations of the WHO for oral health surveys (15). Modifications of the study design were required concerning a standard informed consent and the index age groups: Because of widespread illiteracy in rural areas of the country, an informed consent with signature could not be achieved and was therefore assented by a mark after oral explanation in the tribal language; an exact stratification by age was not feasible as people living in rural areas of The Gambia have no access to central registers to obtain exact birth dates. For this reason, the subjects were allocated into two age groups after patients' self-assessment: young adults (aged between 20 and 34 years) and senior adults (aged between 35 and 54 years). As standardized general health care is not accessible for the rural population of The Gambia, people have no knowledge about their general health status or chronic diseases, which could interfere with periodontitis. Therefore, all patients presenting a permanent dentition were included in the study after providing their consent. To draw a representative picture of the oral hygiene and periodontal status, two rural towns (Bansang, Central River Region, and Basse St. Su, Upper River Region) and four rural villages (Brikama Ba, Jahali, Janjangbureh and Madina, each in Central River Region) were selected. Clinical examination was performed by two calibrated investigators in the health centres

of the villages/towns after a public radio call. Patients were randomly allocated to the investigators using an open-source software (http://www.randomizer.org). Ethical approval was obtained from the Gambian Department of State for Health, Social Welfare and Women's Affairs (Banjul, The Gambia), and the study was conducted according to the rules of the Declaration of Helsinki.

One hundred and sixty-two subjects were examined in August 2006. Parameters of personal information were: ethnic group (tribe), gender, self-assessed age, and self-reported mode of oral hygiene measures. All findings were recorded in standardized sheets. Patients were seated on mobile dental chairs and examined with a periodontal probe (PCP 12 periodontometer, Hu Fridey, Chicago) under daylight conditions for lack of electricity. Periodontal pocket depth probing was carried out at six sites per tooth (mesial-buccal, central-buccal, distal-buccal, distal-oral, central-oral, mesial-oral; in mm) with a sensing force not more than 0.2 N. Gingival inflammation was measured using a 3-value scale according to Löe and Sillness (16). Plaque and calculus were quantified in three values each according to Greene and Vermillion without dying (17). After a full-mouth recording, the periodontal condition was determined by calculating the Community Periodontal Index (CPI). The Gingivitis-Periodontitis-Missing/Teeth Index (GPM/T) was calculated to obtain more detailed information concerning extent and severity of the disease distribution (18). Periodontal disease progression by GPM/T was classified according to the following definitions: P_1 = periodontal pocket probing depth between 3.5 and 5.5 mm (shallow pockets/slight periodontitis progression), P_2 = periodontal pocket probing depth between 5.5 and 7.5 mm (moderate pockets/moderate periodontitis progression), P_3 = periodontal pocket probing depth > 7.5 mm (deep pockets/advanced periodontitis progression). Since non-parametric distribution was given, statistical analysis of two groups was performed by Wilcoxon-rank-sum test; for comparison of more than two groups, the Kruskal–Wallis test with Bonferroni adjustment was used. The confidence interval was set by 95% assuming statistical significance at $P < 0.05$. Absolute and percental proportions or mean and standard deviations (SD) were calculated. Statistical analysis was performed with SAS 8.2 (SAS Institute Inc., Cary, NC, USA).

Results

With respect to ethnic groups, distribution of subjects was semi-representative for the population of The Gambia. The Serahuli tribe was over-represented in the current survey whereas the Jola tribe was under-represented: Mandinka 43%, Fula 21%, Wolof 12%, Jola 2%, and Serahuli 22%. Females were represented by 52.5% and males by 47.5%. The age index groups of 20- to 34-year and 35- to 54-year olds represented about 54% of the Gambian population due to the low average age and life expectancy.

Oral hygiene measures were performed by most female and male subjects, and they exhibited no statistical significant differences in the preferred method. According to the interview results, tooth brushes were generally used once daily, and chewing sticks were used several times a day in line with Muslim calls for prayer. Oral hygiene techniques were consistent with the cultural understanding of the different ethnic groups: while subjects of animist tribe origin, like Fulla or Wolof, used the traditional chewing sticks typically, western oriented ethnic groups, like Jolla and Serahuli, tended to buy commercially available tooth brushes. Effectiveness of various tooth cleaning techniques as measured by the Oral Hygiene Index (OHI), however, was not statistically significantly different (Table 1). Plaque (DI) and calculus (CI) accumulation – as single parameters of the Oral Hygiene Index – increased by age (Fig. 1) leading to statistical high significance in the OHI, and it remained statistically significantly lower in females than in males. No statistical significant differences were observed when comparing different ethnic groups (Table 1).

Gingival inflammation, measured by the Gingival Index (GI), showed no statistical significant differences neither according to specific oral hygiene methods nor to ethnic, age groups or gender. The mean GI index score was almost 1.2 throughout all subgroups (Table 1).

The CPI showed the following results: almost no occurrence of CPI codes 0 and 1; CPI code 2 remained below 10%. More than three-fourths of the subjects demonstrated CPI codes of 3 and 4.

There was a statistical significant difference in the CPI between the index age groups in favour of young adults (Table 1). Men demonstrated a significantly elevated severe disease progression with almost 25% prevalence in the CPI code 4 as compared to women with 6% ($P < 0.05$). No statistical significant differences were found with respect to ethnic groups or oral hygiene measures (Table 2). More detailed information of the distribution of periodontal disease progression and treatment needs were evident according to the GPM/T index. Gingivitis units, represented by G/T, increased slightly by age from 5.3 to 5.6. The mean number of teeth exhibiting periodontitis, represented by P/T, increased from 12.2 teeth in young adults to 15.2 in the senior age group just as missing teeth increased from 3.0 to 4.6. Although, the number of missing teeth (*M*) and teeth with moderate

Table 1. **Oral Hygiene Index (OHI) and Gingival Index (GI) according to oral hygiene measures**

		Oral Hygiene Index (OHI)		Gingival Index (GI)	
Subjects	*n* (%)	Mean (SD)	*P*-value	Mean (SD)	*P*-value
Age groups					
20–34 years	112 (69.1)	6.9 (3.0)	<0.05	1.2 (0.2)	0.4
35–54 years	50 (30.9)	9.2 (2.6)		1.2 (0.2)	
Gender					
Female	85 (52.5)	7.0 (2.8)	0.07	1.2 (0.2)	0.8
Male	77 (47.5)	8.4 (3.0)		1.2 (0.2)	
Ethnic group					
Mandinka	70 (43.2)	7.9 (3.0)	0.7	1.3 (0.2)	0.4
Fula	34 (21.0)	7.4 (3.3)		1.2 (0.2)	
Wolof	20 (12.3)	7.0 (2.4)		1.2 (0.1)	
Jola	3 (1.9)	5.3 (4.4)		1.1 (0.0)	
Serahuli	35 (21.6)	7.7 (2.5)		1.2 (0.2)	
Oral hygiene measure					
Tooth brush	56 (34.6)	3.4 (1.5)	0.3	1.2 (0.2)	0.6
Chewing stick	82 (50.6)	3.9 (1.6)		1.3 (0.2)	
Non-brushing	15 (9.3)	4.7 (0.9)		1.2 (0.3)	
Brush and stick	9 (5.5)	3.5 (1.8)		1.2 (0.2)	

SD, standard deviation; *n*, number of subjects.

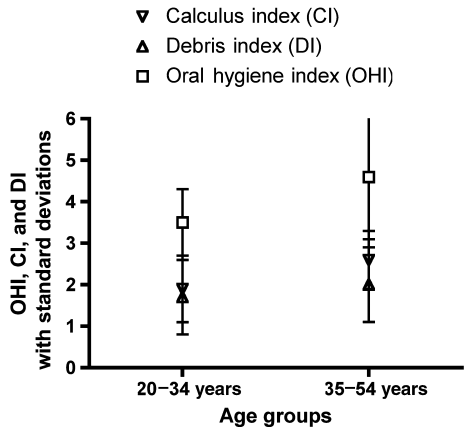

Fig. 1. Mean Oral Hygiene Index (OHI) in the different age groups and its single parameters of the Calculus Index (CI) and Debris Index (DI) with standard deviations.

periodontitis (P_2) significantly increased by age, the development of the entire GPM/T sum score did not (Table 3). Analyzed by gender, a significant increment of all periodontitis teeth ($P_{1–3}$), however, was evident with mean 11.3 teeth in women and 15.2 teeth in men, respectively. Again, there were no associations when taking ethnic groups or the diverse oral hygiene methods into statistical account (Table 3).

Discussion

Starting in the 11th century, the time of Islamization of the West African region, the natural chewing stick became integrated into the culture as miswak. Oral hygiene measures in our study, with more than half of the population using the miswak, appeared to be quite effective as compared to subjects using tooth brushes and as compared to other under-served populations (19–21). The effectiveness of chewing sticks in comparison to conventional tooth brushes makes the widespread and regular use understandable and conclusive. In The Gambia, conventional tooth brushes are exclusively available on markets in major cities and the common use of the chewing stick may further be attractive as appropriate trees for this technique (Azadirachta indica, Nimtree) prosper all over the country offering antimicrobial qualities and biologically active compounds in addition to their mechanical effect, when prepared freshly as a natural tooth brush (22). Based on our results, there is no dispute concerning miswak versus tooth brush: Oral hygiene conditions in The Gambia emphasized the recommendations of the World Health Organization stressing the natural tooth brush in case modern devices are unavailable for economical, social or traditional reasons (23).

Gingival inflammation in the Gambian population exhibited a similar prevalence as compared to clinical controlled trial conditions in other Muslim communities with comparable oral hygiene habits (24). The results also correspond to outcomes of well-served communities (18). In our study, the use of both tooth cleaning instruments, chewing stick and tooth brush, resulted in a comparable ginvigitis prevalence independently from an age related increase in the Oral Hygiene Index. However, early oral hygiene promotion within the families and professional instructions during school education may improve oral hygiene efficacy in The Gambia.

Table 2. **Distribution of the Community Periodontal Index (CPI) in age groups, per gender and ethnic groups**

	Absolute number (in per cent)					
Subjects	*n* (%)	CPI 1	CPI 2 (%)	CPI 3 (%)	CPI 4 (%)	*P*-value
Age groups						
20–34 years	112 (69.1)	0	8 (7.1)	91 (81.3)	13 (11.6)	<0.05
35–54 years	50 (30.9)	0	0 (0)	39 (78.0)	11 (22.0)	
Gender						
Female	85 (52.5)	0	6 (7.1)	74 (87.1)	5 (5.8)	<0.05
Male	77 (47.5)	0	2 (2.6)	56 (72.7)	19 (24.7)	
Ethnic groups						
Mandinka	70 (43.2)	0	3 (4.3)	53 (75.7)	14 (20.0)	0.3
Fula	34 (21.0)	0	2 (5.9)	27 (79.4)	5 (14.7)	
Wolof	20 (12.3)	0	2 (10.0)	16 (80.0)	2 (10.0)	
Jola	3 (1.9)	0	0 (0)	2 (66.7)	1 (33.3)	
Serahuli	35 (21.6)	0	1 (2.9)	32 (91.4)	2 (5.7)	
Oral hygiene measures						
Tooth brush	56 (34.6)	0	3 (5.4)	46 (82.1)	7 (12.5)	0.4
Chewing stick	82 (50.6)	0	5 (6.1)	65 (79.3)	12 (14.6)	
Non-brushing	15 (9.3)	0	0	11 (73.3)	4 (26.7)	
Brush and stick	9 (5.5)	0	0	8 (88.9)	1 (11.1)	

n, number of subjects.

Table 3. **Average number of teeth with gingivitis (G), periodontitis teeth (P), missing teeth (M) according to GPM/T index in age groups, per gender and ethnic groups**

	Mean (SD)								
Subjects	*n* (%)	G	P_1	P_2	P_3	P_{1-3}	*M*	GPM	*P*-value
Age groups									
20–34 years	112 (69.1)	5.3 (5.2)	11.9 (7.2)	0.3 (0.9)	0.0 (0.2)	12.2 (7.0)	3.0 (3.9)	20.5 (6.1)	0.2
35–54 years	50 (30.9)	5.6 (5.1)	13.8 (6.4)	1.3 (2.5)*	0.1 (0.6)	15.2 (6.0)	4.6 (3.7)*	25.4 (5.4)	
Gender									
Female	85 (52.5)	5.6 (5.1)	11.1 (6.8)	0.2 (0.6)	0.0 (0.1)	11.3 (6.7)	3.7 (4.2)	20.6 (5.8)	0.4
Male	77 (47.5)	5.2 (5.2)	14.1 (6.9)	1.0 (1.9)	0.1 (0.5)	15.2 (6.5)*	3.4 (3.3)	23.8 (5.8)	
Ethnic group									
Mandinka	70 (43.2)	6.4 (6.0)	13.1 (7.4)	0.9 (1.9)	0.1 (0.3)	14.1 (7.4)	3.3 (3.3)	23.8 (6.5)	0.3
Fula	34 (21.0)	4.7 (4.8)	13.3 (6.7)	0.5 (0.8)	0.1 (0.3)	13.9 (6.9)	4.1 (2.6)	22.7 (5.7)	
Wolof	20 (12.3)	5.1 (4.1)	10.8 (6.7)	0.4 (1.1)	0	11.2 (6.5)	2.1 (2.9)	18.4 (5.4)	
Jola	3 (1.9)	2.3 (0.9)	6.3 (0.5)	0.3 (0.0)	0	6.6 (0.5)	1.3 (0.5)	10.2 (0.6)	
Serahuli	35 (21.6)	4.3 (3.2)	12.0 (5.8)	0.1 (0.5)	0	12.1 (5.8)	4.3 (5.6)	20.7 (5.2)	
Oral hygiene measures									
Tooth brush	56 (34.6)	5.0 (4.9)	11.5 (6.7)	0.7 (1.5)	0	12.2 (6.4)	2.7 (2.9)	19.9 (5.5)	0.5
Chewing stick	82 (50.6)	5.7 (5.5)	13.0 (7.2)	0.5 (1.2)	0.1 (0.5)	13.6 (6.9)	3.8 (3.4)	23.1 (6.0)	
Non-brushing	15 (9.3)	5.5 (5.2)	15.1 (5.8)	1.0 (1.4)	0.1 (0.2)	16.2 (5.5)	5.5 (7.3)	27.2 (5.8)	
Brush and stick	9 (5.5)	5.6 (5.7)	9.8 (3.1)	0.3 (0.5)	0	10.1 (3.0)	2.6 (1.4)	18.3 (3.6)	

SD, standard deviation.
* indicates a statistical significant difference compared to other group.

For classification of a community periodontal profile, several simplified indices have been developed (15, 25, 26), but they usually ignore a substantial amount of the information ordinarily available in epidemiological research by using few index teeth for full-mouth extrapolation. This may lead to over-estimation of disease progression (27). The GPM/T index was proposed as a periodontal equivalent to the DMF/T index including each tooth of the dentition. Therefore, and to give more information about extent and severity of periodontal diseases, both indices were used in this survey. On the contrary, it must be considered that community periodontal indices usually do not provide for the attachment level thus ignoring recessions. The results of this survey have to be interpreted on basis of these limitations.

In 1995, Adegbembo *et al.* collected periodontal data in a national pathfinder survey in The Republic of The Gambia (14). The age group between 20- and 34-year olds demonstrated a distribution of CPITN codes as follows: CPITN 0–6%, CPITN 1–4%, CPITN 2–40%, CPITN 3–20%, CPITN 4–30%. Between 35 and 54 years of age, CPITN distribution

was: CPITN 0–1%, CPITN 1–0%, CPITN 2–20%, CPITN 3–26%, CPITN 4–53%. These data suggest that already one-third of young adults exhibited severe periodontitis which was increasing with age to over 50%. Comparable high prevalence of periodontal diseases in African countries were hardly documented (19). In the north-western African region, prevalence of severe periodontitis (CPITN code 4) in 35- to 44-year-old adults ranged from 5% in Ghana (28) and Niger (29) to 13% in Algeria (28) and 18% in Marocco (30). Only in Nigeria (31) and in Sierra Leone (32), comparable data of severe periodontitis with 40% and 53%, respectively, of subjects between 35 and 44 years of age were documented. However, our data showed some different outcomes as the most prevalent CPI scores were found for moderate periodontitis progression (CPI 3). Only 11% and 22% of the subjects exhibited severe periodontitis in young and senior adults, respectively. The differences in periodontal disease progression in The Gambia between 1995 and 2006 might have their reason in the incipient development of primary oral health care facilities in rural areas since then: By implementing public dental clinics in some rural health centres, teeth with progressive periodontal disease may be extracted to avoid further complications like discomfort in chewing ability or periodontal abscesses. Missing teeth, though, do not rank among the CPI anymore. Within the limits of this hypothesis, the differences between these pathfinder survey outcomes could be explained. Under closer scrutiny of the GPM/T index, a fairly high occurrence of shallow pockets was obvious in our study, whereas deep pockets were infrequent. Beside some incidence in the senior adult age group, tooth retention was generally high as compared to industrialized countries. The findings underline the considerations of over-estimation of periodontal disease progression and of treatment needs by using the CPI alone.

Conclusions

The standard treatment option for progressive dental caries and periodontal disease in many African countries is so far tooth extraction. This is with no doubt an inadequate echo of the historic dental care situation in almost all industrialized countries a century ago, where tooth extractions have been the predominant treatment approach for the majority of these populations. Therefore, public health challenges rise worldwide and the assessment of national oral health scenarios should be based on epidemiological data. Taking these periodontal disease data into account, the rural population of The Gambia demonstrated moderate treatment needs at present, probably raising with increasing life expectancy in the future.

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