

DENTAL SURVEY IN NIGERIA  
PART 2 BITING FORCE OF NIGERIAN

BY

Yoshiaki ONO\*<sup>1</sup>, Kinziro KUBOTA\*<sup>2</sup>, Shogoro OKADA\*<sup>3</sup>, Minoru NAKATA\*\*<sup>1</sup>,  
Masatoshi OHNISHI\*\*<sup>2</sup>, Yasuhisa KAMEDA\*\*\*<sup>3</sup>, T. Adesanya Ige GRILLO\*\*\*<sup>1</sup>,  
N. O. HOLLIST\*\*\*<sup>2</sup>, and S. O. JOHNSON\*\*\*<sup>3</sup>

ABSTRACT

The biting force of 855 Nigerian children and adults from the age of 3 to 60 was recorded in the Joint Dental Epidemiological Survey in Nigeria in 1981. The biting force of the Nigerian rural group (245 males and 178 females) was significantly greater than those of the Nigerian urban group (227 males and 203 females) and the Japanese males and females.

Key words: Biting force, dental epidemiological survey, Nigerian and Japanese

INTRODUCTION

Measurements of the biting force were one of the fruitful results obtained from the Joint Dental Epidemiological Survey in Nigeria in 1981, which was funded by the grant from the Japanese Ministry of Education, Science and Culture, and conducted by the University of Ife, Ile-Ife, Nigeria. The general description of this survey are summarized in PART I of the previous report (Kubota *et al.* [1]).

According to one of the unpublished results of this survey, severe tooth attri-

tion was observed on the dentition of the Nigerian. Therefore, the measurements of the biting force were performed as one of the examination items of the survey to evaluate the functional aspects of the dentition.

There have been no documented reports concerning the biting force of the Nigerian and this paper presents the results of the measurement of the maximum biting force of the Nigerian. The results obtained are also compared with the biting force of the Japanese. (One *et al.* [2] and Kubota *et al.* [3]).

\*<sup>1</sup> 小野芳明: Department of Pedodontics (Chief: Prof. H. ONO), Faculty of Dentistry, Tokyo Medical and Dental University (Tokyo Ika Shika Daigaku); \*\*<sup>2</sup> 窪田金次郎: Institute of Stomatognathic Science (Director and Chief: Prof. K. KUBOTA), Faculty of Dentistry, Tokyo Medical and Dental University (Tokyo Ika Shika Daigaku); \*\*\*<sup>3</sup> 岡田昭五郎: Department of Preventive Dentistry and Public Health (Chief: Prof. S. OKADA), Faculty of Dentistry, Tokyo Medical and Dental University (Tokyo Ika Shika Daigaku); \*\*<sup>1</sup> 中田 稔: Department of Pedodontics (Chief: Prof. M. NAKATA), Faculty of Dentistry, Kyushu University; \*\*<sup>2</sup> 大西正俊: Department of Oral Surgery (Chief: Prof. M. OHNISHI), Yamashiro Medical College; \*\*\*<sup>3</sup> 亀田寧久: Department of Conservative Dentistry (Chief: Prof. S. KATSUYAMA), Nippon Dental University, Tokyo; \*\*\*<sup>1</sup> T.A.I. グリロ: Department of Anatomy and Cell Biology, Faculty of Health Sciences, University of Ife, Nigeria; \*\*\*<sup>2</sup> N.O. ホリスト: Department of Conservative Dentistry (Chief: N. O. HOLLIST), Faculty of Dentistry, University of Ife, Nigeria; \*\*\*<sup>3</sup> S.O. ジョンソン: Federal Ministry of Health in Nigeria.

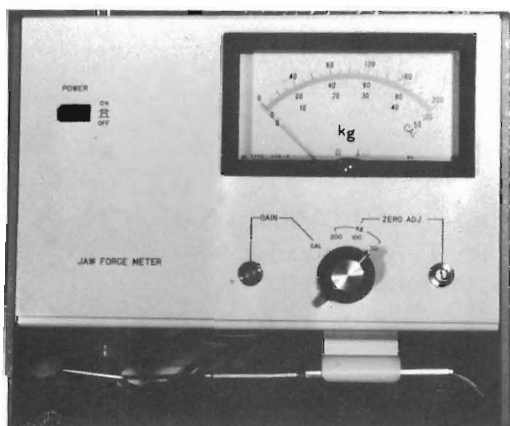


Fig. 1. General view of Jaw Force Meter (MPM-2410 Nihon Kohden Co., Ltd.)

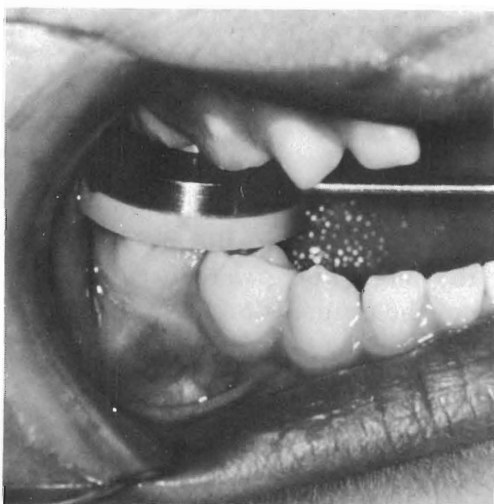


Fig. 3. Placement of Strain Gauge Between the Posterior Molar Teeth

#### MATERIAL AND METHOD

The maximum biting force was measured on a total of 945 males and females, ranged from 3 to 60 years of age. All the subjects were selected randomly from the roster of the nurseries, schools and communities of the Yoruban tribes living mainly in Ile-Ife in the southwestern part of Nigeria (The Federal Republic of Nigeria). Out of the 945 subjects, 90 subjects were excluded from the analysis of biting force due to their severe carious



Fig. 2. Strain gauge (Pressure Sensor)

experience which is rare (Kubota, *et al.* [1]), or the lack of cooperation in the test. Thus, the biting force measured on the 855 Nigerian subjects are available for the present analysis.

The subjects consisted of two different community groups. One is the urban group (227 males and 203 females) living in the town of Ile-Ife, Oyo State, Nigeria. The other is the rural group (245 males and 178 females) living in the rural area (Ipetumodu and Ashipa) of Ile-Ife.

The maximum biting force was measured with Jaw Force Meter MPM-2410 (Nihon Kohden Co., Ltd.), as shown in Figure 1. This instrument is designed specially to convert the strength of the force exerted on the strain gauge (pressure sensor) to the intensity of electric currency, and through the filter circuits, it gives the biting force in kilograms.

On each subject, the maximum biting force was measured on the posterior molar teeth (first and second deciduous molars in the deciduous dentition, second deciduous and first permanent molars in the mixed dentition and first permanent molars in the permanent dentition). The strain gauge (Figure 2), 16 mm in diameter and 5 mm in thickness, was placed between the posterior molar teeth (Figure 3) and the subject was asked to bite as hard as possible. The series of registra-

Table 1. Maximum Biting Force of Nigerian Urban Male (kgf)

| Age   | N   | Mean  | S.D.  | Max.  | Min. |
|-------|-----|-------|-------|-------|------|
| 4     | 8   | 16.25 | 6.96  | 30.0  | 10.0 |
| 5     | 13  | 26.54 | 9.96  | 48.0  | 15.0 |
| 6     | 16  | 27.06 | 10.80 | 49.0  | 12.0 |
| 7     | 17  | 21.53 | 6.73  | 37.0  | 10.0 |
| 8     | 19  | 25.84 | 9.67  | 52.0  | 12.0 |
| 9     | 13  | 28.62 | 12.12 | 50.0  | 13.0 |
| 10    | 15  | 28.67 | 10.90 | 49.0  | 13.0 |
| 11    | 6   | 26.67 | 11.13 | 40.0  | 11.0 |
| 12    | 24  | 33.83 | 11.37 | 59.0  | 13.0 |
| 13    | 27  | 29.89 | 11.31 | 52.0  | 14.0 |
| 14    | 25  | 34.28 | 13.79 | 64.0  | 16.0 |
| 15    | 12  | 41.33 | 16.60 | 78.0  | 11.0 |
| 16    | 10  | 42.50 | 20.26 | 86.0  | 18.0 |
| 17    | 9   | 38.11 | 17.16 | 72.0  | 10.0 |
| 18    | 4   | 39.00 | 9.13  | 52.0  | 31.0 |
| 19-21 | 9   | 55.11 | 28.18 | 102.0 | 27.0 |
| Total | 227 |       |       |       |      |

Table 2. Maximum Biting Force of Nigerian Urban Female (kgf)

| Age   | N   | Mean  | S.D.  | Max. | Min. |
|-------|-----|-------|-------|------|------|
| 3     | 2   | 13.00 | 2.83  | 15.0 | 11.0 |
| 4     | 6   | 13.67 | 4.23  | 19.0 | 10.0 |
| 5     | 7   | 19.57 | 7.14  | 30.0 | 10.0 |
| 6     | 23  | 23.35 | 10.09 | 50.0 | 10.0 |
| 7     | 15  | 26.47 | 11.67 | 50.0 | 12.0 |
| 8     | 18  | 22.06 | 10.21 | 51.0 | 10.0 |
| 9     | 7   | 32.43 | 12.01 | 52.0 | 22.0 |
| 10    | 11  | 21.91 | 7.31  | 30.0 | 10.0 |
| 11    | 13  | 22.31 | 8.77  | 37.0 | 10.0 |
| 12    | 20  | 24.90 | 10.87 | 53.0 | 11.0 |
| 13    | 13  | 28.69 | 11.60 | 59.0 | 12.0 |
| 14    | 14  | 31.50 | 10.80 | 50.0 | 10.0 |
| 15    | 18  | 30.50 | 16.18 | 74.0 | 10.0 |
| 16    | 15  | 32.87 | 13.31 | 59.0 | 14.0 |
| 17    | 9   | 34.89 | 13.38 | 53.0 | 12.0 |
| 18    | 5   | 51.40 | 14.52 | 69.0 | 33.0 |
| 19-20 | 7   | 40.14 | 14.62 | 64.0 | 26.0 |
| Total | 203 |       |       |      |      |

Table 3. Maximum Biting Force of Nigerian Rural Male (kgf)

| Age   | N   | Mean  | S.D.  | Max.  | Min. |
|-------|-----|-------|-------|-------|------|
| 3     | 7   | 12.50 | 3.05  | 18.5  | 10.0 |
| 4     | 3   | 16.83 | 2.08  | 18.5  | 14.5 |
| 5     | 12  | 19.38 | 5.16  | 30.0  | 12.5 |
| 6     | 10  | 22.20 | 8.24  | 36.0  | 12.0 |
| 7     | 8   | 26.88 | 14.15 | 50.0  | 10.0 |
| 8     | 11  | 30.27 | 10.53 | 50.0  | 11.0 |
| 9     | 17  | 31.59 | 14.50 | 69.0  | 12.0 |
| 10    | 11  | 30.82 | 13.88 | 58.0  | 13.0 |
| 11    | 12  | 36.92 | 12.99 | 56.0  | 16.0 |
| 12    | 11  | 39.36 | 11.99 | 60.0  | 23.0 |
| 13    | 15  | 43.00 | 13.11 | 78.0  | 22.0 |
| 14    | 20  | 37.55 | 9.04  | 52.0  | 22.0 |
| 15    | 21  | 51.71 | 18.38 | 88.0  | 17.0 |
| 16    | 15  | 52.73 | 10.97 | 69.0  | 20.0 |
| 17    | 9   | 57.22 | 13.13 | 76.0  | 39.0 |
| 18    | 8   | 61.38 | 25.94 | 94.0  | 17.0 |
| 19-60 | 55  | 55.20 | 24.17 | 118.0 | 20.0 |
| Total | 245 |       |       |       |      |

Table 4. Maximum Biting Force of Nigerian Rural Female (kgf)

| Age   | N   | Mean  | S.D.  | Max. | Min. |
|-------|-----|-------|-------|------|------|
| 3     | 2   | 13.75 | 5.30  | 17.5 | 10.0 |
| 4     | 4   | 12.88 | 0.62  | 13.5 | 12.0 |
| 5     | 8   | 14.44 | 3.74  | 22.0 | 10.0 |
| 6     | 9   | 23.89 | 8.42  | 42.0 | 13.0 |
| 7     | 10  | 27.50 | 8.81  | 32.0 | 10.0 |
| 8     | 7   | 28.57 | 11.49 | 42.0 | 10.0 |
| 9     | 15  | 30.00 | 15.71 | 62.0 | 12.0 |
| 10    | 25  | 27.36 | 12.57 | 56.0 | 10.0 |
| 11    | 9   | 28.33 | 11.92 | 47.0 | 13.0 |
| 12    | 16  | 32.94 | 12.83 | 60.0 | 15.0 |
| 13    | 8   | 38.63 | 16.61 | 63.0 | 12.0 |
| 14    | 10  | 36.30 | 10.50 | 53.0 | 20.0 |
| 15    | 12  | 43.50 | 12.22 | 65.0 | 18.0 |
| 16    | 20  | 45.40 | 21.00 | 92.0 | 11.0 |
| 17    | 12  | 37.42 | 17.79 | 72.0 | 14.0 |
| 18    | 3   | 46.67 | 10.79 | 59.0 | 39.0 |
| 19-45 | 8   | 48.00 | 19.4  | 77.0 | 24.0 |
| Total | 178 |       |       |      |      |

tion of the biting force was started from the right side, repeating three times after each pause of about five seconds, and then the measurement was continued on the left side in the same fashion.

The examination of the biting force

was performed by two examiners only, one acting as an operator and the other as a recorder. There were no statistically significant inter-examiner differences in the biting force measurements. Care was taken not to shift the jaw laterally during

Table 5. Maximum Biting Force  
Japanese Male (kgf)

| Age    | N   | Mean  | S.D.  | Max. | Min. |
|--------|-----|-------|-------|------|------|
| 3      | 51  | 16.59 | 4.94  | 30.0 | 10.0 |
| 4      | 91  | 19.79 | 6.32  | 43.0 | 10.0 |
| 5      | 46  | 19.07 | 6.07  | 43.0 | 10.0 |
| 6      | 18  | 20.83 | 9.57  | 38.0 | 10.0 |
| 7      |     |       |       |      |      |
| 8      | 12  | 14.50 | 5.85  | 30.0 | 10.0 |
| 9      | 30  | 25.86 | 10.12 | 49.0 | 12.0 |
| 10     | 51  | 26.33 | 11.56 | 56.0 | 10.0 |
| 11     | 50  | 28.46 | 12.51 | 74.0 | 10.0 |
| 12     | 7   | 34.00 | 17.63 | 68.0 | 17.0 |
| 13     | 9   | 28.56 | 11.85 | 48.0 | 14.0 |
| * 14   | 8   | 35.88 | 13.23 | 61.0 | 21.0 |
| * 15   |     |       |       |      |      |
| * 16   | 4   | 38.50 | 16.60 | 57.0 | 17.0 |
| * 17   | 3   | 30.33 | 14.05 | 45.0 | 17.0 |
| * 18   | 4   | 45.75 | 22.91 | 79.0 | 27.0 |
| *19-23 | 12  | 51.25 | 16.38 | 75.0 | 25.0 |
| Total  | 396 |       |       |      |      |

(From Ono *et al.* [2], \*From Kubota *et al.* [3]).

the biting.

The highest measured value of the registrations on each side was used for the statistical analysis. Since the preliminary analysis showed no significant differences between the maximum biting force of the right and left side, the maximum biting force of the right side was considered to be the representative of the biting force of the subject. The results obtained are compared with the biting force of the Japanese children and adults (Ono *et al.* [2] and Kubota *et al.* [3]).

### RESULTS

The results of the biting force of the Nigerian children and adults are shown in Tables 1, 2, 3 and 4. Those of the Japanese are referred from Ono *et al.* [2] and Kubota *et al.* [3] in Tables 5 and 6. The Nigerian and the Japanese results are displayed graphically in Figure 4 for the males and Figure 5 for the females.

Statistically significant differences

Table 6. Maximum Biting Force  
Japanese Female (kgf)

| Age   | N   | Mean  | S.D.  | Max. | Min. |
|-------|-----|-------|-------|------|------|
| 3     | 51  | 16.24 | 4.64  | 31.0 | 10.0 |
| 4     | 65  | 18.90 | 7.35  | 45.0 | 10.0 |
| 5     | 69  | 20.56 | 7.49  | 45.0 | 10.0 |
| 6     | 16  | 18.94 | 8.04  | 35.0 | 10.0 |
| 7     |     |       |       |      |      |
| 8     | 10  | 18.50 | 4.97  | 26.0 | 10.0 |
| 9     | 41  | 21.24 | 8.98  | 40.0 | 10.0 |
| 10    | 42  | 22.76 | 9.02  | 43.0 | 10.0 |
| 11    | 22  | 23.31 | 8.75  | 42.0 | 12.0 |
| 12    | 4   | 25.00 | 10.92 | 38.0 | 15.0 |
| Total | 320 |       |       |      |      |

(From Ono *et al.* [2]).

were found to exist among the mean values of the Nigerian urban, the Nigerian rural and the Japanese groups (Table 7 for the males and Table 8 for the females). From the present data, it can be emphasized that the biting force of the Nigerian rural males and females is generally greater than those of the other two groups.

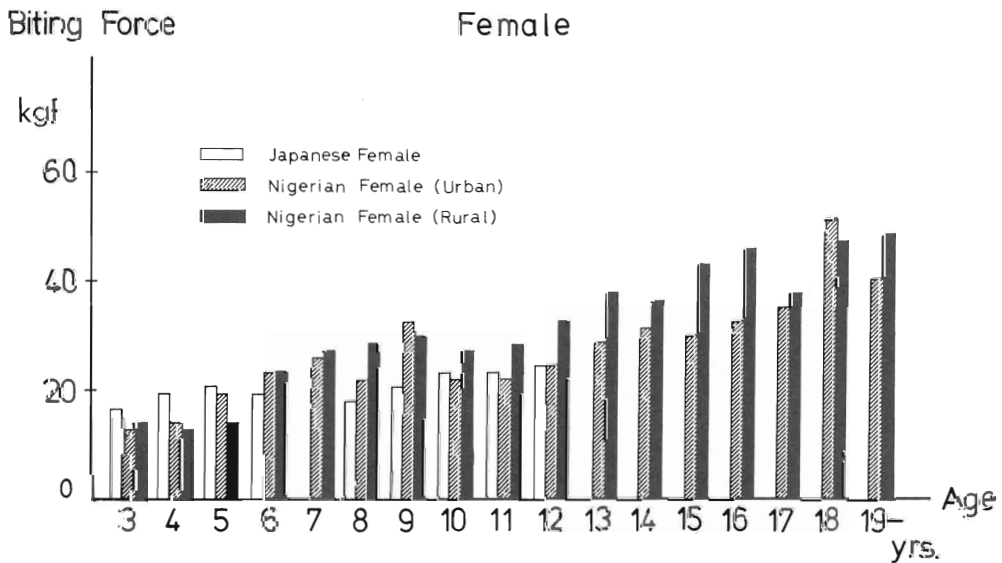
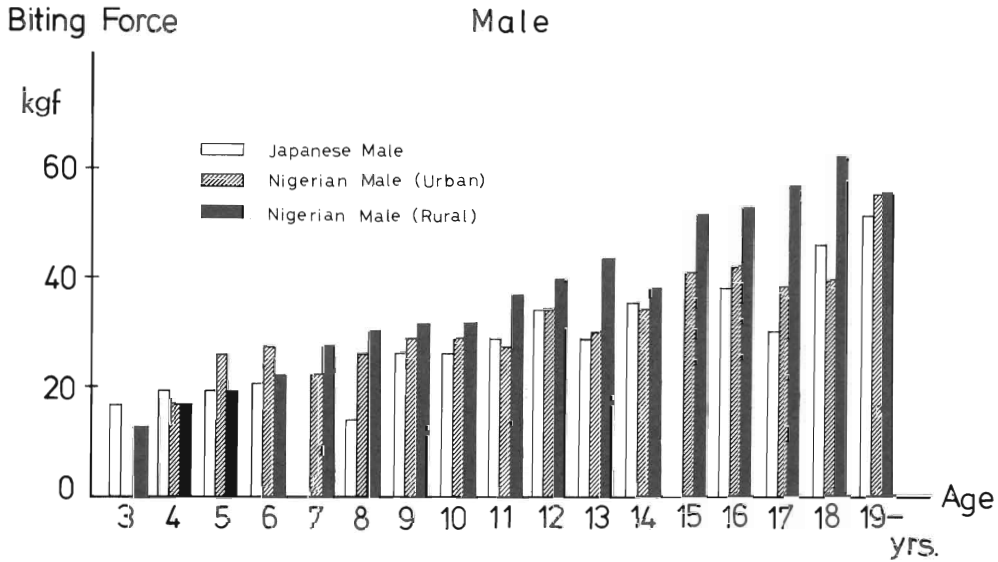
The mean values of the Nigerian preschool children aged 3 to 5 are seen to be somewhat less than those of the Japanese.

### DISCUSSION

#### *Measuring instrument*

Several types of instruments have been devised for the measurement of the biting force (Brawley, *et al.* [4], Anderson [5] and Flostrand [6]). In the present study, the Jaw Force Meter was used for the following three reasons: 1) It is of compact size with rechargable batteries and can be carried to the surveying spot; 2) It is easy to examine the biting force of the mass population in a relatively short time. 3) It shows the biting force in kilograms and makes it possible to compare the results with those of other investigators.

#### *Nigerian preschool children*



There was a lack of adequate communication between the Nigerian preschool children and the examiners during the examination. This is because all the instructions were given in English which they could not understand. English is used as the official language in the Nigerian communities. But the teaching of English only begins in the elementary schools. This communication gap be-

tween the examiners and the preschool children adversely affected the measurements (Worner, *et al.* [7]). This factor was deemed to have been responsible for the lower biting force of the Nigerian preschool children compared to their Japanese counterpart.

*Biting force of the rural Nigerian being higher than those of the other two groups*  
 Several factors have been reported to

Table 7. Test of Significance Between the Means of Each Group (Male, kgf)

| Age | Nigerian   |            | Japanese |       | Nigerian   |            |       |
|-----|------------|------------|----------|-------|------------|------------|-------|
|     | Urban Mean | Rural Mean | Mean     | Mean  | Urban Mean | Urban Mean |       |
| 3   |            | 12.50      | <        | 16.59 |            |            |       |
| 4   | 16.25      | <          | 16.83    | <     | 19.79      | 16.25      |       |
| 5   | 26.54      | >          | 19.38    |       | 19.07      | <          | 26.54 |
| 6   | 27.06      |            | 22.20    |       | 20.83      |            | 27.06 |
| 7   | 21.53      | <          | 26.88    |       |            |            | 21.53 |
| 8   | 25.84      |            | 30.27    | >     | 14.50      | <          | 25.84 |
| 9   | 28.62      |            | 31.59    | >     | 25.86      |            | 28.62 |
| 10  | 28.67      |            | 30.82    |       | 26.33      |            | 28.67 |
| 11  | 26.67      |            | 36.92    | >     | 28.46      |            | 26.67 |
| 12  | 33.83      |            | 39.36    |       | 34.00      |            | 33.83 |
| 13  | 29.89      |            | 43.00    | >     | 28.56      |            | 29.89 |
| 14  | 34.28      | <          | 37.55    |       | 35.88      |            | 34.28 |
| 15  | 41.33      |            | 51.71    |       |            |            | 41.33 |
| 16  | 42.50      | <          | 52.73    |       | 38.50      |            | 42.50 |
| 17  | 38.11      | <          | 57.22    | >     | 30.33      |            | 38.11 |
| 18  | 39.00      | <          | 61.38    |       | 45.75      |            | 39.00 |
| 19- | 55.11      |            | 55.20    |       | 51.25      | <          | 55.11 |

<, > Significant at 5% level.

Table 8. Test of Significance Between the Means of Each Group (Female, kgf)

| Age | Nigerian   |            | Japanese |      | Nigerian   |            |       |
|-----|------------|------------|----------|------|------------|------------|-------|
|     | Urban Mean | Rural Mean | Mean     | Mean | Urban Mean | Urban Mean |       |
| 3   | 13.00      |            | 13.75    |      | 16.24      |            | 13.00 |
| 4   | 13.67      | >          | 12.88    | <    | 18.90      | >          | 13.67 |
| 5   | 19.57      | >          | 14.44    | <    | 20.56      |            | 19.57 |
| 6   | 23.35      |            | 23.89    |      | 18.94      |            | 23.35 |
| 7   | 26.47      |            | 27.50    |      |            |            | 26.47 |
| 8   | 22.06      |            | 28.57    | >    | 18.50      | <          | 22.06 |
| 9   | 32.43      |            | 30.00    | >    | 21.24      | <          | 32.43 |
| 10  | 21.91      | <          | 27.36    | >    | 22.76      |            | 21.91 |
| 11  | 22.31      |            | 28.33    |      | 23.31      |            | 22.31 |
| 12  | 24.90      | <          | 32.94    |      | 25.00      |            | 24.90 |
| 13  | 28.69      |            | 38.63    |      |            |            | 28.69 |
| 14  | 31.50      |            | 36.30    |      |            |            | 31.50 |
| 15  | 30.50      | <          | 43.50    |      |            |            | 30.50 |
| 16  | 32.87      | <          | 45.40    |      |            |            | 32.87 |
| 17  | 34.89      |            | 37.42    |      |            |            | 34.89 |
| 18  | 51.40      |            | 46.67    |      |            |            | 51.40 |
| 19- | 40.14      |            | 48.00    |      |            |            | 40.14 |

<, > Significant at 5% level.

produce observed differences in the biting forces between the different groups of subjects. One of the factors which influence the maximum biting force is the anatomical differences (Sassouni [8]) between the Nigerian and the Japanese. The anthropological measurements of the cranium revealed that the Nigerians are dolico-cephalic while the Japanese are brachy-cephalic and the gonial angle of the mandible of the Nigerian is less obtuse than that of the Japanese (Ono, *et al.* [9]). This may, in part, explain the observed differences in the biting force between the Nigerian and the Japanese.

Environmental differences such as the texture of food and the biting habits also affect the biting force (Jenkins [10]). The Nigerian diet consisted mostly of unprocessed food and the cooked meat is never sufficiently tender. There are no facilities for pressure cooking—a situation that is occasionally available to the urban Nigerian. The use of the chewing stick has also served to develop the biting force. This is used more in the rural than urban population in the Western part of Nigeria. These two factors, diet and habit, may take important roles in explaining the higher biting force of the rural Nigerian than those of the urban Nigerian and the Japanese. Also, differences in biting forces observed between these three groups seem to be related to a consequence of *urbanization*. These environmental factors should be further studies in the coming survey planned in 1986.

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