THE DEMOGRAPHIC CHARACTERISTICS AND NUTRITIONAL STATUS FOR A HUNTER-GATHERER SOCIETY WITH SOCIAL TRANSITIONS IN SOUTHEASTERN CAMEROON

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ABSTRACT Economic development and social transition often influence the health status of local populations. Pygmy hunter-gatherers in central African rainforest had lived in nomadic life, however, their surrounding environment have been changing. This study aimed to assess the transition of nutritional status for local hunter-gatherers societies which faced social transition. Cross-sectional surveys were conducted in 1996 and 2010–2011 for a village of Baka Pygmy in southeastern Cameroon. The census and anthropometric data were collected from all inhabitants. The nutritional statuses were assessed by following ways; (1) BMI classification, (2) Z-score converting for children using CDC/NHANES reference, and (3) Deriving biological parameters for child growth from Preece-Baines model. During 15 years, despite the migrants greatly increased, the number of Baka was decreased and their living areas were become dispersed. However, the mean values of BMI and %fat for adults were proper and unchanged. Children's Z-scores indicated that although their body sizes were smaller than reference population, they had much amount of body weight and muscle for their height. In addition, the onset of growth spurt for children was occurred in moderate ages. These indices indicated that the nutritional status for Baka people was generally good, and that statuses were not changed.

Key Words: Baka Pygmy; Demographic characteristics; Nutritional status; Child growth; Social transition.

INTRODUCTION

Economic and regional developments often influence the nutritional status of neighborhood residents (Bradley & Corwyn, 2002; Heltberg, 2009). Children, in terms of their physical and psychological development, have higher risks from, and vulnerability to, environmental or social hazards than do adults (Engle et al., 1996); thus, changes in nutrient intake, disease infection, or socioeconomic status may produce variations of growth in children (Cole, 2003; Steckel, 1995). These influences cause both positive and negative effects, considering the increasing growth tempo in developed countries or the growth retardation in developing countries. For these reasons, nutritional status and growth patterns in children have been widely used as indicators to reflect the nutritional status of an entire population (WHO, 1986).

The demographic properties of a population are summations and averages of the characteristics and behavior of their daily lives (Chamberlain, 2006). Especially for the population to maintain their traditional lifestyles, population structure and dynamics are considered basic aspects related to the process of adaption to the environment (Ohtsuka & Suzuki, 1990). Therefore, for assessing the nutritional status of the entire population, it is important to use demographic methods based on the whole population, as well as individual survey methods.

The Baka are one of the groups of Pygmy hunter-gatherers living in the northwestern Congo Basin (Joiris, 1998). Yamauchi et al. (2000) revealed that Baka adults have middle-ranged height and weight compared to some groups of Pygmy hunter-gatherers, and their nutritional status were considered generally good. Settlement policy and agriculture development for the Baka have been promoted in the Republic of Cameroon for some decades. In addition, logging companies and the influx of a large-scale cash economy influenced the local community of the Baka in southeastern Cameroon (Oishi, 2012). Travaglino et al. (2011) described the presence of a secular trend for improving the average heights among Cameroonian Bantu adults by increasing their socioeconomic status and health conditions. They also suggested the initiation of a secular variation in height for West Pygmy females; however, they concluded that the presence of a secular trend among the Pygmies living during this century is still controversial.

Although many previous studies have described the social and anthropometric characteristics of the Baka, the influence of social factors on their nutritional status is not clear. Moreover, no study has geographically followed the same village of Baka for more than a decade to assess the secular variations in nutritional status of both children and adults. Therefore, we aimed to clarify the following two topics in our research: (1) the secular trend of nutritional status and growth patterns of the Baka population, and (2) the variation of demographic characteristics and residential patterns in the village.

SUBJECTS AND METHODS

The field surveys were conducted three times—September 1996, August 2010, and August–September 2011—at the same village located in the southeast of the Republic of Cameroon. The study was conducted in the village over 13 days, 14 days, and 9 days, respectively. Participation in the study was voluntary, and the study was explained to the participants and their caregivers in their local languages.

Anthropometric Measurements and Age Estimations

Anthropometric dimensions, including height, weight, upper arm circumference and two sites of skinfold-thickness were measured using standard protocol (Weiner & Lourie, 1981). Height was measured to the nearest 1 mm using a field anthropometer, and weight was measured to the nearest 0.1 kg using a portable digital scale. Upper arm circumference (UAC) was measured with a glass measuring tape. Skinfold-thickness was measured at the triceps and subscapular sites to the nearest 0.2 mm using a skinfold caliper (Holtain, Briberian, UK). Anthropometric measurements were performed for all inhabitants who stayed in the village during each study period.

Because most participants did not know their exact ages, their ages were estimated at 1-year and 10-year rates for children and adults using the following methods: (1) Sorting in order of birth; (2) matching their birth dates with local events; and (3) interviewing a local assistant who was well educated, lived in the nearby villages, and knew the participants well.

Nutritional Status and Growth Patterns

The nutritional status of children was assessed by using Z-scores. Two reference datasets were used to convert the children's anthropometric data to Z-scores. The height-for-age Z-score (HAZ), weight-for-age Z-score (WAZ), weight-for-height Z-score (WHZ), and BMI-for-age Z-score (BMIAZ) were calculated using the Center for Disease Control (CDC) 2000 reference (Kuczmarski et al., 2002). The upper arm circumference-for-age Z-score (UACAZ), triceps skinfold thickness-for-age Z-score (TSFAZ), subscapular skinfold thickness-for-age Z-score (SSFAZ), arm muscle area-for-age Z-score (AMAAZ), arm muscle area-for-height Z-score (AMAHZ), arm fat area-for-age Z-score (AFAAZ), and sum of skinfold thickness-for-age Z-score (SumSFAZ) were calculated from the United States reference data (NHANES I and II; Frisancho, 1990). A Z-score below -2 was defined as malnutrition (WHO, 1986) and was used to determine the prevalence of malnutrition.

The nutritional status of adults was assessed by measuring BMI and percent body fat. Two equations of Durnin & Womersley (1974) and Siri (1956) were used to estimate the participants' percentage of body fat. Adults' BMI were classified into four categories using three cut-offs, 18.5, 25, and 30 (WHO, 2000).

To evaluate the growth pattern, the Preece-Baines model I (PB-1; Preece & Baines, 1978) was adopted for fitting children's height data into the following formula:

$$h = h_1 - \frac{2(h_1 - h_\theta)}{s_0^{(t - \theta)} + s_1^{(t - \theta)}}$$

H represents height at time t, h_1 is a final height, h_θ is a height at time θ, s_0 and s_1 are rate constants, and θ is a time constant. The Preece-Baines model is a family of curves used to fit the human growth curve. This model is often used to analyze longitudinal datasets on an individual, but it can also apply to cross-sectional datasets (de Onis et al., 2001; Zemel & Johnson, 1994). For performing the curve-fitting, we used the mean age for each age group. The age group was classified into 1-year intervals, in which 2.0–2.9 and 3.0–3.9 years of age, for example, were grouped as 2.5 and 3.5 years old. Some biological parameters were calculated to indicate children's growth patterns (e.g., VTO: height velocity at take-off; APHV: age at peak height velocity).

Census Data Collecting

Demographic datasets were obtained for each *de facto* population and *de jure* population. The *de facto* population is a concept under which individuals were presented and recorded in a certain geographical area during the observation periods. The *de jure* population is a concept under which individuals were recorded as the residents in the geographical area. Because anthropometric measurements were conducted for all people who stayed in the village, the numbers of *de facto* population members for each generation were obtained from anthropometric studies. The numbers of the *de jure* populations for 2010 and 2011 were obtained from a census study. During the census study, the interviewer visited each residence, interviewed the number of residents, and obtained individual data including name, sex, and marriage status. The numbers of *de jure* populations in 1996 were substituted by the numbers of the *de facto* population.

Statistical Analysis

Because of the limited number of participants, the datasets obtained in 2010 and 2011 were united as the 2010–2011 population. As the 1996 population had previously been analyzed in our study (Hagino et al., 2011), the datasets for the 1996 generations were used in these same datasets. The mean value of the Z-scores (1996 vs. 2010 and 2011) were examined by the t-tests. The biological parameters calculated from the PB-1 function were compared between 1996 and 2010–2011, and then these were compared with our previous cross-sectional study with large samples (Hagino et al., 2012). Adults' body characteristics for 2010–2011 were compared with those listed in our previous study (Yamauchi et al., 2000), which used the same datasets as that for 1996.

All values were shown as Mean ± SD. All statistical analyses were performed with the JMP 10.0.2 software package (SAS Institute Inc.) The level of significance was set at $P < 0.05$.

RESULTS

Table 1 shows the mean values and the standard deviations of Z-scores for boys with percentages of malnutrition ($Z < -2$). Significant generational differences were found in three indices, the TSFAZ, AMAAZ, and AMAHZ ($P < 0.05$). The 1996 generation had a significantly greater amount of upper arm muscle for their age or height than did the 2010–2011 generation. The percentage of "stunting (HAZ < -2)" for each generations was more than 95%, and that of the "underweight (WAZ < -2)" was about 80%. On the other hand, less than 20% of the participants were classified into "wasting (WHZ < -2)," and the percentage of "thinness (BMIAZ < -2)" were less.

As for boys, mean values, standard deviations and percentages of malnutrition for girls are shown in Table 2. There was no significant generational difference found among 11 Z-scores. Although there were fewer participants who were

Table 1. Z-scores for Baka boys

	1996[1]			2010–2011			
	N	Mean ± SD	% Z < -2	N	Mean ± SD	% Z < -2	*P* [2]
HAZ	85	-3.05 ± 0.55	98.1	54	-3.39 ± 0.72	95.3	ns
WAZ	87	-2.60 ± 0.92	75.9	54	-3.07 ± 1.14	80.5	ns
WHZ	38	-0.24 ± 0.80	0.0	23	-0.92 ± 1.53	18.4	ns
BMIAZ	85	-0.60 ± 1.10	9.4	53	-0.71 ± 1.05	7.1	ns
UACAZ	88	-0.77 ± 0.54	5.6	54	-0.93 ± 0.68	11.4	ns
TSFAZ	88	-0.80 ± 0.41	0.0	54	-0.60 ± 0.44	0.0	< 0.05
SSFAZ	88	-0.10 ± 0.60	0.0	54	0.00 ± 0.70	0.0	ns
AMAAZ	88	-0.25 ± 0.87	0.0	54	-1.36 ± 0.72	19.3	< 0.0001
AMAHZ	49	2.26 ± 1.68	0.0	36	0.24 ± 1.46	4.1	< 0.0001
AFAAZ	88	-0.86 ± 0.31	0.0	54	-0.77 ± 0.35	0.0	ns
SumSKAZ	88	-0.50 ± 0.47	0.0	54	-0.35 ± 0.52	0.0	ns

1: from Hagino et al. (2011).
2: t-test.

Table 2. Z-scores for Baka girls

	1996[1]			2010–2011			
	N	Mean ± SD	% Z < -2	N	Mean ± SD	% Z < -2	*P* [2]
HAZ	64	-3.25 ± 0.69	94.0	50	-3.05 ± 0.93	89.1	ns
WAZ	65	-2.42 ± 1.04	72.0	50	-2.40 ± 1.18	61.5	ns
WHZ	21	-0.03 ± 1.05	0.0	25	-0.32 ± 0.88	9.5	ns
BMIAZ	64	-0.33 ± 0.87	2.1	48	-0.41 ± 0.81	3.1	ns
UACAZ	66	-1.04 ± 0.72	6.0	50	-0.92 ± 0.62	3.0	ns
TSFAZ	66	-0.91 ± 0.64	0.0	50	-0.92 ± 0.50	0.0	ns
SSFAZ	66	-0.13 ± 0.63	0.0	50	0.00 ± 0.49	0.0	ns
AMAAZ	66	-0.57 ± 0.88	6.0	50	-0.28 ± 0.89	1.5	ns
AMAHZ	39	1.34 ± 1.40	0.0	32	1.31 ± 1.25	0.0	ns
AFAAZ	66	-0.88 ± 0.51	0.0	50	-0.86 ± 0.42	0.0	ns
SumSKAZ	66	-0.54 ± 0.60	0.0	50	-0.47 ± 0.49	0.0	ns

1: from Hagino et al. (2011).
2: t-test.

Table 3. Biological parameters about child growth from PB-1

		Boys			Girls		
		2010–2011	1996[6]	2010[7]	2010–2011	1996[6]	2010[7]
ATO[1]	(yrs old)	10.70	11.31	10.67	9.75	9.23	9.30
APHV[2]	(yrs old)	14.47	15.19	14.98	12.82	12.17	12.24
AD[3]	(years)	3.77	3.88	4.31	3.07	2.94	2.94
VTO[4]	(cm/yr)	4.04	3.54	3.80	4.24	4.61	4.46
PHV[5]	(cm/yr)	4.56	6.98	4.88	5.47	4.98	4.71

1: Age at take-off.
2: Age at peak height velocity.
3: Adolescence duration.
4: Velocity at take-off.
5: Peak height velocity.
6: from Hagino et al. (2011).
7: from Hagino et al. (2012), large sample study.

Table 4. Anthropometric characteristics of Baka adults

	Male			Female		
	1996[4]	2010–2011	P[5]	1996[4]	2010–2011	P[5]
N	75	60		73	66	
Height (cm)	154.4 ± 6.0	152.7 ± 5.7	ns	146.8 ± 5.7	146.8 ± 5.1	ns
Weight (kg)	49.6 ± 6.2	48.3 ± 7.3	ns	45.1 ± 7.3	45.1 ± 6.6	ns
UAC[1] (cm)	25.9 ± 1.9	25.6 ± 2.3	ns	24.5 ± 2.3	24.5 ± 2.2	ns
BMI[2] (kg/m^2)	20.8 ± 1.9	20.6 ± 2.2	ns	20.9 ± 2.2	20.9 ± 2.4	ns
%fat[3] (%)	13.6 ± 2.9	13.9 ± 2.9	ns	24.3 ± 5.2	25.2 ± 7.8	ns

1: Upper arm circumference.
2: Body mass index.
3: Percent body fat.
4: from Yamauchi et al. (2000).
5: t-test.

Table 5. The number and proportion of BMI classifications for Baka adults

	Male				Female			
	1996[1]		2010–2011		1996[1]		2010–2011	
Normal	66	88.0%	48	80.0%	59	80.8%	52	78.8%
Thin	7	9.3%	9	15.0%	11	15.1%	11	16.7%
Overweight	2	2.7%	3	5.0%	3	4.1%	3	4.5%
Obesity	0	0.0%	0	0.0%	0	0.0%	0	0.0%

Classified by WHO (2000).
1: from Yamauchi et al. (2000).

Table 6. The number of de facto & de jure population in this village

Survey year	Research periods (days)	Num. *de facto*[1]	Num. *de jure*[2]	Ratio[3]
1996	14	238	≈ 238	95.0% <
2010	13	175	214	81.8%
2011	9	128	221	57.4%

1: Number of *de facto* population.
2: Number of *de jure* population.
3: Num. *de facto* / Num. *de jure* (%).

classified as stunting or underweight than as boys, the percentages in each of those categories were extremely high in both generations. However, there were only a few girls who were defined as wasting or thinness.

Table 3 contains some biological parameters for child growth, which were calculated from the PB-1 mathematical parameters. Each parameter was compared between generations 1996 and 2010–2011, and the population of the largely sampled cross-sectional study. Ages at take-off (ATO, in years old) were similar among the three populations, both for boys (11.31, 10.70, and 10.67) and for girls (9.23, 9.75, and 9.30). Adolescence duration (AD, in years) was almost equivalent between the two generations for both boys (3.88 vs. 3.77 years) and girls (2.94 vs. 3.07 years). For both sexes, there was no great difference in velocity at take-off (VTO, cm/yr); however, peak height velocity (PHV, cm/yr) showed a slightly different trend between the two populations. The PHV for the 1996 boys (6.98) was greater than those of the other two boys' populations (4.56 and 4.88). In addition, the PHV of the 2010–2011 girls (5.47) was slightly greater than those of the others (4.98 and 4.71).

The anthropometric characteristics of the adult participants are shown in Table 4. Significant generational differences were not found in all the indices. The mean values of BMI for each four generation-sex group were within the normal range (18.5 <, ≤ 25). Similarly, for percent body fat, they had normally ranged mean values (< 20% for males, < 30% for females). Table 5 shows the proportions for the adults' BMI classifications. For each sex-generation group, over 70% of the participants had normally ranged BMI values. There was no significant generational difference between the proportions for both sexes (P = 0.82 for male, and 0.66 for female).

The research duration (days), numbers of the population *de facto*, and the population *de jure* were shown in Table 6. The numbers of population *de jure* were almost similar among the three generations and were estimated to be about 220. On the contrary, the numbers of population *de facto* were greatly decreased. In addition, the percentage of people who stayed in that village during the study periods is also shown in that same table. As the population *de facto* decreased, these percentages greatly decreased.

DISCUSSION

Socioeconomic and environmental variations often influence the physical characteristics of a community's inhabitants (WHO, 1986). It is known that these effects appeared as a secular trend in terms of adult height, children's height, weight, and tempo of growth, among other measurable factors (Cole, 2003). This study is one of the few studies that followed up with the inhabitants of the same village of Baka Pygmy and examined the relation between the sociological factors and the nutritional statuses of its inhabitants.

Two Z-scores (WHZ and BMIAZ), which were standardized by height, indicated the sufficient weight gain among Baka children. A WHZ score of less than -2 is a sign of acute malnutrition and indicates wasting. WHZ detects child growth for the short term, and often marks decline due to a short-term food shortage or an acute illness. The mean WHZ values of Baka children ranged between -1 and 0. Additionally, the proportions of wasting were much lower than those of stunting or underweight for both sexes (Table 1). The ratio of participants who were classified as wasting (8.4%) was higher than the ratio represented by Cameroonian statistics (5.8%); however, it was lower than the mean value as measured in all African countries (10.4%; United Nations Secretariat, 2011). Moreover, the mean values of BMIAZ for all groups were above -1, and less than 10% of children were classified into thinness category. These results should be considered in relation to the fact that Baka children have proportional body weight for their height, which is equivalent to what is found in the case of the US reference children.

Although the mean values of HAZ and WAZ were extremely low, the tempo of child growth was not considered adversely affected. WAZ is known as a brief indicator that reflects children's nutritional status, and HAZ is strongly related to skeletal growth; thus, low HAZ is often accompanied by long-term malnutrition or growth faltering (WHO, 1986). The mean values of HAZ and WAZ were very low for both sexes, and for both the generational groups of 1996 and 2010–2011 (Tables 2, 3). Furthermore, almost all the participants were defined as stunting or underweight (90% and 70%, respectively). However, biological parameters did not indicate growth retardation in our participants. ATO is the parameter for timing the start of the adolescent growth spurt, and it is known to be influenced by nutritional status during early childhood (Kulin et al., 1982). Similarly to the findings of our previous study (Hagino et al., 2011), ATOs for Baka children in each generation appear earlier than for the Gambian children (Boys: 12.2; Girls: 10.19, in years old; Billewicz & McGregor, 1982), and they are comparable to the rates found in developed countries. The final body size of Baka adults as measure in the present study (Male: 152.7 cm, 48.3 kg; Female: 146.8 cm, 45.1 kg) was found to be much smaller than the CDC 2000 reference population (Male: 176.7 cm, 70 kg; Female: 163.5 cm, 57 kg; Kuczmarski et al., 2002); thus, the HAZ and WAZ of Baka children were considered to be greatly underestimated.

The secular body size trend was not observed in either children or adults. There was no significant generational difference among the height, weight, arm circumference, BMI, and percentage of body fat for adults for both sexes (Tables 4, 5). Mean BMI values and adult percent body fat were normally ranged, and 70% of adults had BMIs within a normal range. As we previously showed, four Z-scores (HAZ, WAZ, WHZ, and BMIAZ) were almost the same between the generations. In addition, the timing and duration of the adolescent growth spurt did not changed drastically. These indices about growth tempo, childhood nutritional status, and adult body size suggested that the nutritional statuses of inhabitants in this village were considered generally good, and this had not changed for 15 years.

Similar to the effect found for body size, the secular trend for the body composition of children was not found to exist. Upper arm circumference and skinfold-thickness strongly reflect energy or protein intakes. As shown in Tables 1 and 2, there was no significant generational difference, except for boys' TSFAZ, AMAAZ, and AMAHZ. Because anthropometric surveys were performed by different researchers (TY for 1996, IH for 2010–2011), an inter-observer bias for triceps skinfold-thickness might be present. However, all of the mean AMAHZ values were above zero, so that should mean that the Baka boys and girls had a greater amount of upper arm muscle than did the US reference children. In addition, only a few children were classified into the malnutrition category ($Z < -2$), and no child whose TSFAZ, SSFAZ, AFAAZ, or SumSKAZ were lower than -2 was included. These results indicated that Baka children had sufficient body muscle and body fat, and that their body composition was unchanged over time.

Three times of census surveys showed that the numbers of *de jure* population was unchanged; however, the numbers in the *de facto* population during research

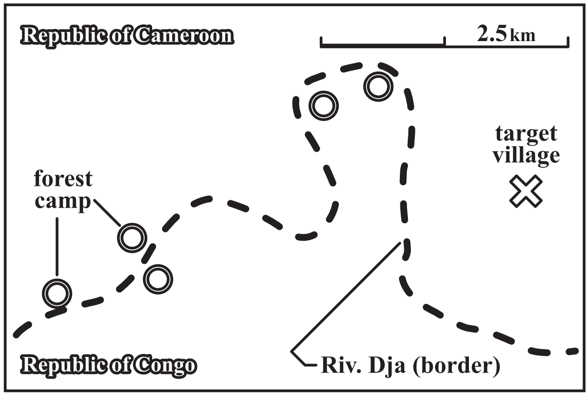

Fig. 1. The locations of five forest camps around the target village.

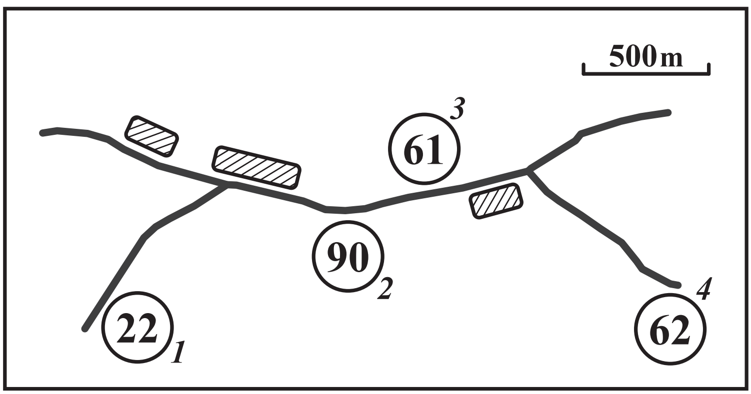

Fig. 2. Distribution pattern of residents in the village (1996).

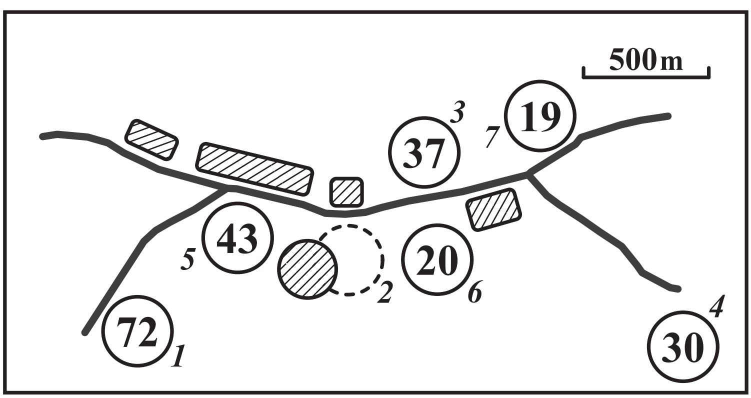

Fig. 3. Distribution pattern of residents in the village (2010).

periods got decrease. Although the research period in 2011 was shorter than in the other two surveys, the proportion of the *de facto* population to the *de jure* population in 2010 was clearly lower than that proportion in 1996 (Table 6). The Baka in this village still remained attached to their semi-nomadic lifestyle in 2010–2011. They often stayed in the forest camp for some days, or even for a few months. Previous studies described various reasons for them staying in the forest: (1) gathering edible wild plants for each season; (2) long-term foraging expeditions (called *molongo*) for acquisition of game or animal protein (Yasuoka, 2006); and (3) avoiding conflicts with other people in their village (Oishi, 2010). Figure 1 shows the locations of the forest camps for the Baka people around the target village in 2010. We obtained five camps' locations by the side of the large river that borders the Republic of Congo; 66 Baka people (30.8% of the *de jure* population) stayed in these forest camps, and all the members returned to the village during the study period. On the other hand, about 18% of village residents did not come back to the village.

Additionally, there was some generational variation for the distribution pattern of the settlement in the village. The distribution pattern for 1996 is shown in Figure 2, and that for 2010 is shown in Figure 3. The plain circle signifies a residential area for the Baka, and the slashed shapes represent the living areas of the surrounding ethnic groups (agriculturists, merchants). The numbers in each circle show the number of Baka residents. For 15 years, agriculturists migrated into the center of the village. Moreover, the residential area for the Baka dispersed and became more marginalized. There were fewer than five households of agriculturists in 1996; however, that number grew greatly in 2010 (30–40 households according to our interview and 45 households, according to Oishi (2012). In addition, a logging company established their base in a nearby village, and then a local hotel and some bars were built in the center of the village. Since many residents assemble in the bar until late at night, some Baka families moved to other residential areas to avoid the noises and loud sounds in the night. The migrations of other ethnic groups and the influx of companies in neighboring villages produced changes in the population distribution, and this would serve to increase social stress for the Baka people.

The numbers of new births and deaths indicated a slight trend toward a natural increase in this village. The number of births (5) and deaths (3) during 12 months were obtained from interviews with an agriculturist informant and from census data from 2010 and 2011. The crude birth rate was 23.4, and the crude mortality rate was 14.1. These values indicate equivalent mortality and slightly lower fertility compared to statistics of Cameroonian residents (CBR: 35.7, CMR: 13.2; United Nations Secretariat, 2011). Due to the lack of longitudinal census data from 1996 to 2010, it is not possible to discuss population growth rate during these 15 years; however, the tendency for population growth was observed in a short period (2010–2011), with social stress increasing. These trends suggested that the nutritional status of the residents was secured at a generally good level.

The nomadic lifestyle of the Baka people was thought to contribute to maintaining their nutritional status, despite increasing social stress. Yamauchi et al. (2009) targeted Baka adults living in the same village, and they described their energy intake and expenditure as being well-balanced in both the village camp and the forest camp. On the other hand, their TEI and TEE were lower in the village camp than in the forest camp, thus implying that staying in the forest is more healthful for the Baka people, as they can subsist in a more active manner. Furthermore, it is also revealed that they can acquire adequate energy and protein in the forest throughout the year (Sato et al., 2012; Yasuoka, 2006). As Oishi (2010) described, staying in the forest camp freed them from many of the stresses of the village, and their traditional lifestyle was thought to reduce the stress in their daily lives.

There are some limitations to our study. First, was the difficulty of obtaining longitudinal demographic datasets. As it is very difficult to follow up with drastic residential movements during a short-term field survey, the description of the demographic characteristics of this village was partly dependent on descriptive notes. The second limitation was caused by unstable age estimation. In general, child growth patterns and assessments of physical development required detailed age information (e.g., 0.1–0.5-year range); however, age estimation was performed within a one-year range in this study. In addition, an accuracy difference might exist because different researchers administered the surveys in 1996 (TY) and 2010–2011 (IH); thus, the VTO of boys was thought to be greatly different between the generations. For further study, we would like to reveal detailed population dynamics and child growth patterns with continual census collecting and more accurate age estimation.

CONCLUSION

Some demographic characteristics might indicate increasing social stress for the Baka people in this village. However, indices concerning the physical development of the children, adult body size, and body composition all implied that the nutritional statuses of the Baka residents were generally good. Additionally, negative secular trends in their nutritional statuses were non-existent during the 15-year period between the two survey administrations, even with an increase in social stress. In conclusion, our results suggest that the nomadic forest lifestyle of the Baka people support an ability to avoid stress or conflict within their village, and this helps them to maintain their nutritional status well.

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