BLOOD PRESSURE OF BAKA PYGMIES LIVING IN SOUTHEASTERN CAMEROON

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ABSTRACT African hunter-gatherers, Baka Pygmies (N = 276, ≥ 17 years of age) from the southeastern part of Cameroon participated in an assessment study of their blood pressure (BP) measurements. For comparison, data from 2 different Japanese populations (H with n = 632, and Y with n = 131 groups) were used.

There were no differences in systolic/diastolic BP in the Baka Pygmies with respect to the sex. A comparison of BP showed that neither systolic nor diastolic BP increased with age in Baka Pygmies, but it increased in the Y group (from 20 to 60 years).

The average systolic/diastolic BP in Baka Pygmies (122.8 ± 10.9/71.2 ± 8.6 mmHg) was significantly lower than that of the H and the Y groups (126.1 ± 17.5/80.3 ± 11.3 and 131.6 ± 15.4/78.8 ± 9.9 mmHg, respectively). Most of the systolic and diastolic BP measurements in the H and the Y groups were classified high-normal or Grade 1 hypertension, whereas BP of most Baka Pygmies were classified as normal or optimal. These results revealed that an average BP of approximately 120/70 mmHg did not increase with age in Baka Pygmies living in the rainforest hunting and gathering for their living.

Key Words: Hunter-gatherers; Baka Pygmies; Blood pressure; Tropical rainforest.

INTRODUCTION

Historically, humans used to move around hunting for their food and a place to sleep, providing sufficient exercise to compensate for any food ingested as well as time spent sleeping. It is difficult to maintain physical health without appropriate amounts of exercise. In addition, lack of physical activity throws circulatory organs off balance, resulting in poor blood circulation, followed by high blood pressure (BP).

Many studies support this hypothesis, and researchers have suggested that BP in people living in hunting and gathering societies does not increase with age but rises as they live in civilized nations (Donnison, 1929; Kaminer & Lutz, 1960; Lowenstein, 1961; Cruz-Coke et al., 1964; Prior et al., 1968; Barnicot et al., 1972; Truswell et al., 1972). Furthermore, in times of war, high BP rates dropped drastically (Lups & Franke, 1947; Watanabe, 1947a), and stroke mortality rates

also decreased (Watanabe, 1947b). Some previous studies found a decrease in high BP through physical training (Kataoka et al., 1977; 1982; 1983). Positive effects of physical training and reduced food intake on blood circulation (Sano et al., 1988) and BP (Kataoka et al., 1983) have been reported.

Recently, many researchers have examined the effects of the natural environment on the mind and body (Kamiyama, 1983). One such research group, of which the primary investigator was a part of had organized camp programs for middle-aged people for over 20 years.

The purpose of the camp programs was to improve health using the natural environment with the aim of minimizing modern life factors such as binge eating, lack of exercise, and stress from modern society. Each camp program lasted for 3 days and 2 nights, and participants ingested reduced amounts of food (1100–1400 kcal/day) and exercised more (walking for 10–14 km in the morning). Each day started with slow-pace running before breakfast, and after lunch and rest, outdoor sports and recreations were provided. Campfires were made after dinner. On the second day, both systolic and diastolic BP decreased after the morning walk and continued to decrease throughout the afternoon. At the end of the program, overall BP had decreased (Wada et al., 1993).

Kawamura (1994) organized a camp program for 21 elderly people (average age 70 years) in Oregon in the United States and found a positive effect of camp life within a natural environment. BP and pulse wave acceleration to assess blood circulation dynamics were measured in each participant before each meal (breakfast, lunch, and dinner) for 14 times in 6 days. The first measurement took place before dinner on the first day, and the last measurement happened before breakfast on the 6th day.

Seven participants had high BP at the beginning of the camp program (153.4 ± 12.5/82.6 ± 8.5 mmHg), with an average of 156.6 ± 16.3/81.1 ± 8.9 mmHg on the second day's morning. However, on the 6th day, average BP began to decrease and eventually decreased substantially to 135.7 ± 8.4/70.3 ± 4.2 mmHg. Furthermore, blood circulation had increased. The program required the participants to walk more, eat less, and enjoy their time during the camp. The results suggest that a balanced life of mind and body living in a natural environment had a positive effect on their health.

Even though various causes can be considered responsible for the rise in resting BP, excessive stress from modern life is one of the major indicators that cannot be neglected. Therefore, in the current study, we examined BP in African hunter-gatherers, Baka Pygmies, who still live in the forest where they have little or no stress from modern society.

METHODS

Participants

The participants were Baka Pygmies living in the rainforest close to the border of the Congo in southeastern Cameroon. This study lasted for a month from the

middle of August through the middle of September for 2 consecutive years (2002 and 2003). A total of 430 Baka Pygmies in 23 different settlements on the road between the town of Moloundou, the sub-prefectural capital in Boumba-Ngoko Department, and the village of Ndongo, about 40 km west from Moloundou, participated in this study. Five investigators visited each settlement to explain the purpose, methodology, and dates of the study to each settlement's representative. Some settlements were close to the lodges of the investigators, but the other settlements were so remote that they required the investigators to backpack for 5–10 km carrying their research material, sufficient water, and the food that they acquired from Moloundou (Fig. 1). Among 23 settlements, the villages of Tembe III and Abondo II were absent, therefore these villages were eliminated from the list. Although people in the Ajala settlement do not have a foraging lifestyle and rely upon only agriculture, the investigators measured 2 of the Baka Pygmies from this settlement.

One young Baka Pygmy accompanied the investigators as an interpreter throughout the 21 settlements. He was deeply trusted by the inhabitants of each village, which helped the study to be performed without difficulty. Some Pygmies from each settlement also volunteered to help collect data.

Materials and Procedures

As the actual ages of the participants were unknown, ages were carefully estimated. Of the 430 participants from the 21 settlements, we analyzed in detail 276 individuals whose estimated age was ≥17 years. Measurements included height, weight, and BP. Height was measured in an assembly place called *mbanjo* by using a plastic tape measure with 1-cm increments.

Weight was measured by using a digital scale with an accuracy of 0.1 kg. With a digital OMRON HEM-759P BP monitor, BP was measured 2–3 times with the subject in a seated positions after 5–10 minutes of resting, and the lowest BP was used in our analysis.

We compared the average BP of 276 Baka Pygmies with the average BP of 2 different groups of people in Japan, designated Y and H groups. The Y group included 131 faculty members of the University of Yamanashi whose BP was measured at an annual check-up. The H group included 632 people from a city with the smallest coherent population (55,000 people) in the northwest of Metropolis of Tokyo. These 632 city-dwellers participated in physical fitness courses that were held twice a year in the city. 30–40 people were recruited for each course, which took place once a month for 3 months. The participants in the course filled out a health checklist while their BP and pulse wave acceleration (to assess blood circulation) were measured. Furthermore, before every fitness class started, the healthcare specialist analyzed the participants' health (medical interviews, BP, pulse wave acceleration, etc.). One of the current investigators was able to collect these data to use for the current study after having been a healthcare specialist in this field for 20 years.

Fig. 1. The location of settlements and 40 km travel from Moloundou.

Table 1. Average blood pressure, height, and weight of Baka Pygmies according to the sex

Subject	Age	Stature (cm)	Weight (kg)	Systolic BP (mmHg)	Diastolic BP (mmHg)
Male (n=144)	32.8 (±12.6)[a]	153.8 (±6.6)	50.7 (±7.2)	123.4 (±10.3)	70.8 (±8.5)
Female (n=132)	31.2 (±10.0)	146.4 (±5.4)	45.5 (±5.7)	122.3 (±11.6)	71.6 (±8.7)

[a] X ± SD.

RESULTS AND DISCUSSION

Height, Weight, and BP of the Baka Pygmy Participants

The height, weight, and BP of all 276 Baka Pygmies (estimated 17–65 years of age) are shown in Table 1. There were 144 men and 132 women with an average age of 32.8 ± 12.6 years and 31.2 ± 10.0 years, respectively. The average heights and weights for men and for women were 153.8 ± 6.6 cm and 50.7 ± 7.2 kg, and 146.4 ± 5.4 cm and 45.5 ± 5.7 kg respectively. These averages for height and weight were similar to those found in another study of Baka Pygmies: 154.4 ± 6.0 cm and 49.6 ± 6.2 kg for men and 146.6 ± 4.8 cm and 44.4 ± 5.7 kg for women, respectively (Yamauchi et al., 2000).

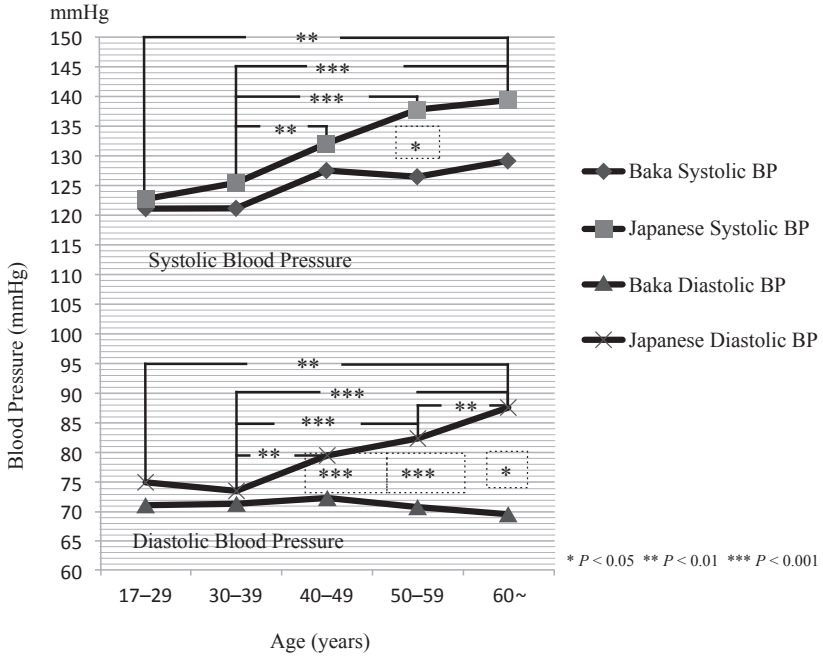
The average systolic BP was 123.4 ± 10.3 mmHg for men and 122.3 ± 11.6 mmHg for women. The average diastolic BP was 70.8 ± 8.5 mmHg for men and 71.6 ± 8.7 mmHg for women. As there was not much difference in the systolic and diastolic BP according to the sex, we eliminated the sex variable and combined the groups of men and women to analyze the effect of age on BP.

Baka Pygmies' Blood Pressure by Age

Figure 2 shows the BP data of the Baka Pygmy participants and the Japanese Y group by age group. Figure 2 shows that there was no significant increase in systolic BP of Baka Pygmies aged in their 20s (17–29 years old), through 30s (31–39 years old). There was a tendency of an increase in the average systolic BP of Baka Pygmies aged in their 40s through 60s. There was no significant difference between the average systolic and diastolic BP. Furthermore, there was no increase in diastolic BP in any age group (20s through 60s).

Y Group Blood Pressure by Age

In contrast to the Baka Pygmies, the Y group participants in their 20s through 30s did not show significant differences in systolic BP, whereas comparisons in the Y group between those in their 20s and 60s showed a significant difference in systolic BP ($P < 0.01$). Furthermore, comparisons in the Y group between age



Age	n	n	Systolic BP X ± SD (mmHg)		Diastolic BP X ± SD (mmHg)	
	Baka	Japanese	Baka	Japanese	Baka	Japanese
17–29	156	7	121.1 ± 10.4	122.6 ± 13.1	71.0 ± 8.1	74.9 ± 8.4
30–39	43	34	121.1 ± 10.4	125.4 ± 9.2	71.3 ± 10.4	73.4 ± 9.2
40–49	49	50	127.4 ± 13.8	132.0 ± 13.2	72.4 ± 9.7	79.4 ± 9.3
50–59	23	32	126.4 ± 12.6	137.8 ± 19.29	70.8 ± 9.9	82.3 ± 11.7
60~	5	8	129.0 ± 15.2	139.3 ± 5.9	69.9 ± 14.6	87.5 ± 8.4

Fig. 2. Blood pressure of Baka Pygmies and Y group (Japan) by age.

groups 30s and 40s, 30s and 50s, and 30s and 60s showed significant differences in the systolic BP ($P < 0.01$, $P < 0.001$, and $P < 0.001$, respectively).

The diastolic BP data showed a similar trend. A comparison between the participants of the Y group in their 20s and 30s showed no difference, whereas comparisons between the participants in their 20s and 60s, 30s and 40s, 30s and 50s, 30s and 60s, and 50s and 60s showed statistical differences ($P < 0.01$, $P < 0.01$, $P < 0.001$, $P < 0.001$, and $P < 0.01$, respectively). Therefore, although Baka Pygmies did not show any statistically significant difference in BP with aging, the BP of the Y group from Japan increased remarkably with age.

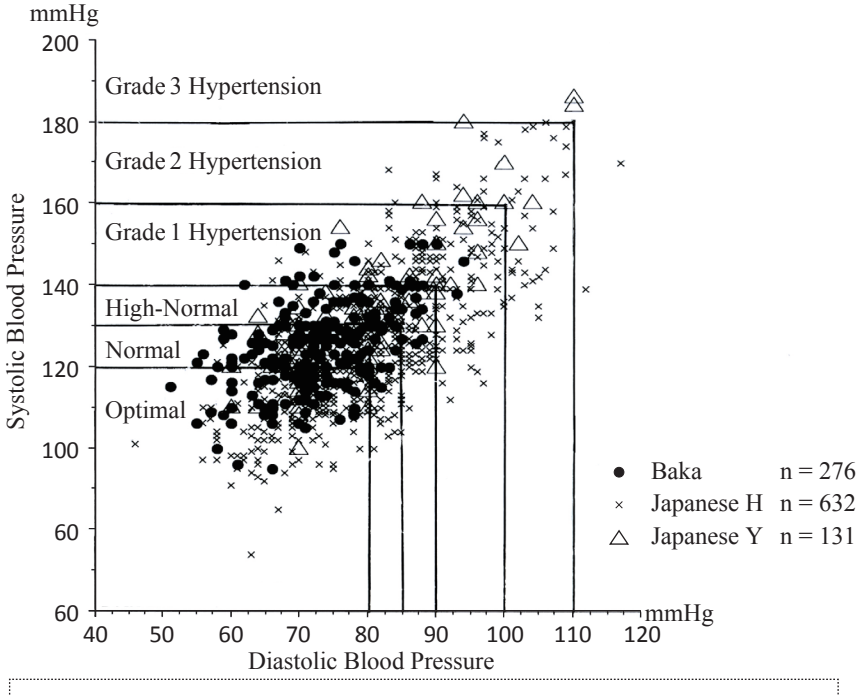
Comparisons of Baka Pygmies and Y Group

When comparing the data of Baka Pygmies and participants from the Y group, the systolic BP and the diastolic BP in their 20s to 30s did not show a significant

differences in both groups. Statistically, in the group who were in their 40s, Baka Pygmies had much lower diastolic BP (72.4 ± 9.7 mmHg) than the Y group (79.4 ± 9.3 mmHg) ($P < 0.001$). In the 50s age group, both the systolic and diastolic BP showed significant differences between Baka Pygmies and the Y group ($P < 0.05$ and $P < 0.001$, respectively). The Baka Pygmies in their 60s showed significantly lower diastolic BP compared with the Y group ($P < 0.05$). Overall, when comparing both the systolic and diastolic BP in any age group (20s through 60s), Baka Pygmies showed much lower average BP than the Y group.

Comparison of Baka Pygmies, Y group, and H group

We compared the BP of Baka Pygmies (n = 276), the Y group (n = 131), and the H group (n = 632). Figure 3 shows the average systolic and diastolic BP of all the groups and a graph of all of the participants' systolic and diastolic BP measurements. The average systolic/diastolic BP of Baka Pygmies was 122.8 ±



Group	n	Systolic BP		Diastolic BP	
		X ± SD mmHg		X ± SD mmHg	
Baka	276	122.8 ± 10.9	(t = 2.9**)	71.2 ± 8.6	(t = 11.95***)
Japanese H	632	126.1 ± 17.5	(t = 5.4***)	80.3 ± 11.3	(t = 7.9***)
		(t = 3.3***)		N	
Japanese Y	131	131.6 ± 15.4		78.8 ± 9.9	

** $P < 0.01$ *** $P < 0.001$

Fig. 3. Correlation between systolic and diastolic blood pressure.

10.9/71.2 ± 8.6 mmHg, which was much lower than the respective values of the H group (126.1 ± 17.5/80.3 ± 11.3 mmHg) and the Y group (131.6 ± 15.4/78.8 ± 9.9 mmHg). The Baka Pygmies' systolic BP was significantly lower than that of the H group ($P < 0.01$) and the Y group ($P < 0.001$). Furthermore, the H group had significantly lower systolic BP ($P < 0.001$) than the Y group. The Baka Pygmies' diastolic BP was also significantly lower than the H and the Y groups ($P < 0.001$), whereas there was no statistically significant difference in diastolic BP between the H and the Y groups.

Figure 3 shows systolic and diastolic BP based on the 1999 World Health Organization, International Society of Hypertension guidelines (Guidelines Subcommittee, 1999). Many of the Baka Pygmies's BP values were the range of 120/70 mmHg, which were classified as either optimal (120/80 mmHg) or normal (130/85 mmHg).

The distribution of Grade 1 hypertension (or high BP) (140–159/90–99 mmHg) was very small for the Baka Pygmies.The H and the Y groups showed wide BP distributions. Although some BP values were classified as optimal or normal, many others were classified as Grade 1 hypertension (140–159/90–99 mmHg) or Grade 2 hypertension (160–179/100–109 mmHg).

Lifestyle and Blood Pressure

Individual health and blood circulation are strongly related. Generally, aerobic exercise is effective for ameliorating circulatory function and metabolism and prevents adult disease. Aerobic exercise improves blood circulation and efficient transport of oxygen and nutrients. In a non-sedentary person, blood circulates through the heart with well-balanced function not only because of the heart's pumping action and muscle contraction-relaxation but also because of the increased pumping action of intrapleural pressure occurring from increased respiration. Being active also stimulates better and balanced venous and arteriovenous flow. Therefore, it is difficult to maintain a healthy blood circulation system without regular physical activity. Furthermore, the lifestyles of people living in modern civilization contradict fundamental schemes of how human bodies should move, possibly resulting in many health problems including high BP and early-onset adult diseases. Excessive nutrient intake, lack of physical activity, increased activity at night, and less time sleep are major factors in causing unbalanced functions of circulatory organs, which aggravates blood circulation systems while consequently increasing BP.

Some studies showed a relationship between lifestyles and blood circulatory systems. Although there is a tendency in developed countries for BP to increase with age, this tendency is not seen in developing countries (Barnicot et al., 1972; Cruz-Coke et al., 1964; Kaminer & Lutz, 1960). One researcher reported that as societies became modernized and people shifted their lifestyle from hunting and gathering to agriculture, BP increased as aging occurred (Truswell et al., 1972). Furthermore, during times of war, many reports showed drastically lower BP, and cerebral strokes and heart attack mortality rates also decreased (Lups & Franke, 1947; Watanabe, 1947a).

The current study focused on hunter-gatherers living with nature in the African rainforests and examined their lifestyle and its effects on their health. It is believed that they have a much lower chance of getting adult diseases including heart diseases, vascular brain diseases, and malignant growths.

Baka Pygmies, especially the men, have very little body fat and much more muscle. There was no obesity in either the men or women. Consistent with the well-known strong relationship of obesity and high BP, the Baka Pygmies had significantly lower BP (120/70 mmHg) than the H and the Y groups. It seems that people living a rich life, with easy access to basic needs (e.g., food) have weakened their natural ability to endure harshness in nature. This loss of endurance can be stressful and contribute to problems of the mind and body. Today, Baka Pygmies in Africa rely not only on animals and plants in the wild but also on agricultural crops. They have high adaptability to live well in differing conditions in nature. Although their exact ages are unknown, we do know that Baka Pygmies do not usually live long. However, it seems that they are happily living and cherishing the nature around them.

Baka Pygmies who live in hunting, gathering, and farming societies in the African rainforest do not necessarily consume large amounts of high nutritious food. These Baka Pygmies are required to exercise in order to obtain their food on a day to day basis, and their BP show healthy values. The purpose of this study is to corroborate the hypothesis that exercise and diet control have positive effects on BP. In the modern lifestyles, moderate exercise and restricted diets are important and effective in order for people to maintain healthy BP rates.

REFERENCES

Barnicot, N.A., F.J. Bennett, J.C. Woodburn, T.R. Pilkington & A. Antonis 1972. Blood pressure and serum cholesterol in the Hadza of Tanzania. *Human Biology*, 44(1): 87–116.

Cruz-Coke, R., R. Etcheverry & R.Nagel 1964. Influence of migration on blood-pressure of Easter islanders. *The Lancet*, 283(7335): 697–699.

Donnison, C.P. 1929. Blood pressure in the African native. *The Lancet*, 213(5497): 6–7.

Guidelines Subcommittee 1999 World Health Organization: International Society of Hypertension. *Guidelines for the Management of Hypertension. J. hypertension, 1999*, 17: 151–183.

Kamiyama, K. 1983. *Wonders of Forests*. (in Japanese). Iwanami Shoten, Tokyo.

Kaminer, B & W.P.W. Lutz 1960. Blood pressure in Bushman of the Kalahari desert. *Circulation*, 22: 289–295.

Kataoka, Y., T. Ikuyama, M. Wada, Y. Sano & H. Osanai 1977. A study of therapeutic effect of physical training on hypertension. (in Japanese with English abstract). *Bulletin of the Physical Fitness Research Institute*, 36: 52–66.

Kataoka, Y., Y. Sano, T. Ikuyama, M. Wada, H. Imano, T. Arao, K. Kawamura & H. Osanai 1982. A study of therapeutic effect of physical training on hypertension (Report 2): The convergence of blood pressure due to physical training. (in Japanese with English abstract). *Bulletin of the Physical Fitness Research Institute*, 51: 1–10.

Kataoka,Y., T. Ikuyama, M. Wada, Y. Sano, H. Imano, K. Kawamura & H. Osanai 1983. A study of therapeutic effect of physical training on hypertension (Report 3): The effective doses of exercise for improving the hypertension. (in Japanese with English abstract). *Bulletin of the Physical Fitness Research Institute*, 55: 41–54.

Kawamura, K. 1994. The effects of camping lifestyle on blood pressure and blood circulation of elderly people. (in Japanese). *Bulletin of the Faculty of Education & Human Sciences Yamanashi University*, 9: 166–180.

Lowenstein, F.W. 1961. Blood-pressure in relation to age and sex in the tropics and subtropics: A review of the literature and an investigation in two tribes of Brazil Indians. *The Lancet*, 277(7173): 389–392.

Lups, S. & C. Franke 1947. On the changes in blood pressure during the period of starvation (September 1944 to May 1945) and after the liberation (May 1945 to September 1945) in Utrecht, Holland. *Acta Medica Scandinavica*, 126(6): 449–458.

Prior, I.A., J.G. Evans, H.P. Harvey, F. Davison & M. Lindsey 1968. Sodium intake and blood pressure in two polynesian population. *New England Journal of Medicine*, 279(10): 515–520.

Sano,Y., Y. Kataoka, T. Ikuyama, M. Wada, H. Imano, K. Kawanura, T. Watanabe, A. Nishida & H. Osanai 1985. Evaluation of peripheral circulation with accelerated plethysmography and its practical application. (in Japanese). *Journal of Science of Labour*, 61(3): 129–143.

Truswell, A.S., B.M. Kennelly, J.D.L. Hansen & R.B. Lee 1972. Blood pressure of !Kung bushman in northern Botswana. *American Heart Journal*, 84(1): 5–12.

Wada, M., Y. Kataoka, M. Ikuyama, Y. Sano, H. Imano, K. Kawamura, A. Watanabe, A. Nishida & H. Osanai 1993. Impacts of camp life on the blood pressure changes in the middle-aged individuals with hypertension. *Chiba Journal of Physical Education*, 16: 55–60.

Watanabe, J. 1947a. The new movements of tuberculosis deaths and stroke deaths. *Journal of the Japan Medical Association*, 21(7), 30–35.

———— 1947b. The transition of stroke deaths. *Welfare Indication*, 1(2): 6–12.

Yamauchi, T., H. Sato & K. Kawamura 2000. Nutritional status, activity pattern and dietary intake among the Baka hunter-gathterers in the village camps in Cameroon. *African Study Monographs*, 21(2): 67–82.

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