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Physical comparison between Rampasasa Pygmy and Yogyakarta children of Indonesia

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ABSTRACT

In growth studies, somatotyping allows one to characterize changes in physique during growth in order to monitor growth patterns and to better understand variations in adult physique. Information on the physique of children with short stature is limited In Indonesia the study of somatotype for Pygmy children had never been done. The aims of this study were to compare the physiques of Rampasasa Pygmy and Yogyakarta children and to evaluate factors that might lead to variability in physiques. The sample consisted of 61 Rampasasa Pygmy (32 boys and 29 girls) and 319 Javanese children in Yogyakarta (173 boys and 146 girls) aged 8–13 years. Height, weight, biepicondylar breadths of the humerus and femur, calf and upper arm circumferences, and skinfolds (at triceps, subscapula, calf, and supraspine) were measured on each subject. We used somatotyped by the Heath-Carter method. The results showed that the Pygmy children were shorter, lighter, and less endomorphic than the Yogyakarta children. Our findings suggest that the observed differences between Rampasasa Pygmy and Yogyakarta children could be related mainly to environment background in the two areas.

ABSTRAK

Dalam studi pertumbuhan, somatotipe dipakai untuk mencirikan perubahan fisik selama pertumbuhan serta dapat memantau pola pertumbuhan dalam memberikan variasi fisik pada saat dewasa. Penelitian tentang anak-anak dengan tinggi badan pendek masih sangat terbatas. Di Indonesia studi somatotipe untuk anak-anak Pygmi belum pernah dilakukan. Tujuan penelitian ini adalah untuk membandingkan fisik anak-anak Pygmi di Rampasasa dengan anak-anak di Yogyakarta, serta untuk mengevaluasi faktor-faktor yang mungkin berperan dalam perbedaan fisik diantara kedua populasi tersebut. Subjek terdiri dari 61 anak-anak Pygmi dan 319 anak-anak Yogyakarta, usia antara 8-13 tahun. Setiap subjek dilakukan pengukuran meliputi tinggi dan berat badan, diameter biepicondilus humerus dan femur, lingkaran lengan atas dan betis, tebal lipatan trisep, subscapula, supraspinale dan betis. Penentuan somatotipe menggunakan metode Heath Carter. Hasil menunjukkan bahwa anak-anak Pygmi mempunyai ukuran lebih pendek, lebih kurus, dan kurang endomorf dibanding anak-anak Yogyakarta. Pengamatan menunjukkan bahwa adanya perbedaan somatotipe anak-anak di antara kedua populasi tersebut kemungkinan disebabkan oleh faktor lingkungan.

Keywords : height – weight – somatotype - Rampasasa Pygmy children - Yogyakarta children

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INTRODUCTION

Physique refers to an individual's body form. Between birth and maturity the human body does not only increases in size, but also changes substantially in shape. Malina *et al*.[1] suggested that the study of physique is an area of study which sometimes labeled as human constitution. Rating and classification of physique or body form as a whole have a long history. Sheldon *et al*.[2] gave a conceptual approach to the assessment of physique which is the most commonly used method today. They used a term of somatotype for studying physique by focusing on the variable contribution of the three components namely to an individual's body build (endomorphy, mesomorphy, ectomorphy). Originally, the method of somatotyping was developed on adult males by Sheldon *et al*.[2] Heath and Carter[3] modified Sheldon's original method for somatotype assessment in children. The physique study during growth permits a better understanding of variation in adult physique. Moreover, with a minor limitation, the method of Heath and Carter can be applied to both sexes at all ages.[4]

The somatotype during childhood is characterized as part of changing of the body according growth and development. On the average, from preschool ages through young adulthood, boys are more mesomorphic, slightly more ectomorphic, and less endomorphic than girls; these differences increase after adolescence.[1,4] Although there are some changes in somatotype between ages 6 to 12, changes during adolescence into adulthood are greater.[4]

In growth studies, somatotyping allows one to characterize changes in physique during growth in order to monitor growth patterns and to better understand variations in adult physique.[1,5] Changes in somatotype components during growth period can also provide useful information about growth status as well as timing and rate of sexual maturation.[6] Somatotype research in children is important, because they exhibit different somatotype patterns from adults. In normal growth, Rahmawati *et al*.[7,8] reported that the well-off children of Yogyakarta were more endomorphic, and the low-income children were more ectomorphic. During puberty, urban girls were lighter than the urban boys, whereas rural girls had greater stature and weight than rural boys. In the somatochart, before puberty urban children were distributed halfway between endomorphy and mesomorphy in both sexes, and thereafter the boys tended toward ectomorphy and the girls toward endomorphy. The somatotype of rural children remained ectomorphic, but differently by sex with a greater mesomorphic element in the boys and a greater endomorphic element in the girls.

Human height is determined by various factors such as genetic, hormones, as well as environmental factors, such as nutrition. Pygmy is a term used for various ethnic groups worldwide whose average height is unusually low; pygmies are short populations with normal body proportions. Anthropologist defines Pygmy as any group whose adult men grow to less than 150 cm (4 feet 11 inches) in average height, and a member of a slightly taller group is termed Pygmoid.[9] The small body size of human Pygmies has been interpreted as an adaptation in itself, whether to live in dense tropical forests, thermoregulation, or endurance againts starvation in low productivity environments.[10]

Merimee *et al*.[11] suggested that short adult stature in Pygmies, for example in African Pygmies is due "primarily", if not solely, to the absence of accelerated growth at puberty, and Merimee also claimed that African pygmies

grow at the same rate as other Africans until puberty, when their growth rate declines and that of the other population increased. Moreover, Merimee *et al*.[11] reported that the testosterone values were normal at all ages, while IGF-levels failed to raise to the same extent in Pygmies at adolescence (250 U/mL) vs 500 U/mL in American adolescents.

Several large cross-sectional growth and somatotype studies in children have been done.[12-21] Information on the physique of children with short stature is limited and in Indonesia the study of somatotype for Pygmy children had never been done. The aims of this study were to compare the physiques of Pygmy children inhabited in Rampasasa Hamlet, Waemulu village, District of Waerii, Manggarai Regency in Flores Island (East Nusa Tenggara) and Yogyakarta children; and to evaluate some factors that might lead to the variability in the physiques.

MATERIALS AND METHODS

Subjects

Cross-sectional data based on a sample of Rampasasa Pygmy children aged 8 to 13 years old, consisted of 32 boys and 29 girls were collected during April 2007. The Pygmy children were inhabited in Rampasasa Hamlet, District of Waerii, Waemulu village, Manggarai Regency in Flores Island. The Rampasasa area is situated at 8°32' 113"South and 120°27'10" East. Suriyanto reported that Rampasasa kampong where the Pygmies live in was inhabited by approximately 207 people (77 males and 103 females).[22] Among them, 61 children were included in this study due to the specified condition being an isolated population. Rampasasa kampong lies approximately 17.36 miles from the city of Ruteng, the capital of Manggarai in Flores Island (East Nusa Tenggara). The main occupation of Rampasasa Pygmy is agriculture which uses plant cultivation systems, such as maize (*Zea mays*), cassava (*Manihot utilissima*), sweet potato (*Ipomoea batatas*), anchoring (*Curcubita pepo*) and kidney beans (*Phaseolus vulgaris*). These people eat meat only at traditional ceremonies, festivals and weddings and also at the time of bereavement.

For comparison, the second subject of Yogyakarta children was measured in 2004, consisted of 157 boys and 145 girls aged 8-13-yearold. Yogyakarta is a city located about 950 miles west of Ruteng city,in the south of central Java and is surrounded by the Indian Ocean in the south. The latitudinal and longitudinal location of Yogyakarta are 7 47 S and 110 22 E. Most of people in Yogyakarta are civil servants and employees. Ethics approval for this study was obtained from the Medical and Health Research Ethics Committee, Faculty of Medicine, Universitas Gadjah Mada, Yogyakarta.

Anthropometric measurements

Ten body measurements were taken in the morning include height, weight, bicondylar humerus, bicondylar femur, upper arm circumference, calf circumference, skinfold at triceps, -subscapula, -suprailiaca, and -calf. The somatotype components of the individual subjects were calculated according to the Heath-Carter anthropometric method using the following equations:[4,23]

Endomorphy = - 0.7182 + 0.1451 (X) – 0.00068 (X^2) + 0.0000014 (X^3)

where X = sum of triceps, subscapular and supraspinale skinfold. For stature-corrected endomorphy, multiply X by 170.18/stature in cm.

Mesomorphy = [(0.858 x humerus breadth) + (0.601x femur breadth) + (0.188 + corrected arm girth) + (0.161 x

corrected calf girth)] – (height x 0.131) + 4.5
Ectomorphy = HWR x 0.732 – 28.58
If HWR is less than 40.75 but more than 38.25, Ectomorphy = HWR x 0.463 – 17.63.
If HWR is equal to or less than 38.25 give a rating of 0.1
HWR = stature/cube root of weight

Statistical analysis

Data were computerized using Statistical Package for Social Sciences (SPSS) version 17.0. The mean somatotype values of the groups were put in a two-dimensional somatochart.

RESULTS

TABLE 1 and 2 show the mean of body height, weight, and somatotype components of Rampasasa Pygmy and Yogyakarta children (boys and girls) aged 8-13-year-old. Cross sectional growth curves of body height and weight of the children presented in FIGURE 1, while FIGURE 2 show the mean somatotype on the Carter's somatochart. Because of the data amount is not balanced between the two populations, therefore the statistical analysis is only used to find the mean and standard deviation. The mean total of body height and weight in children, aged 8-13 years, Yogyakarta children were 136.6 ± 12.79 cm and 32.5 ± 12.69 kg in boys, and 136.9 ± 12.32 cm and 32.2 ± 10.83 kg in girls, respectively; meanwhile, Pygmy children were 120.1 ± 12.89 cm and 20.8 ± 5.47 kg in boys, and 120.2 ± 11.28 cm and 22.2 ± 5.25 kg in girls, respectively.

TABLE 1. Mean and standard deviation (SD) of height (cm), weight (kg), and somatotype components of Pygmy and Yogyakarta boys, aged 8-13 years old in Indonesia

Variable	Years	N	Weight		Height		Somatotype					
Sex					K1		K2		K3			
			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Boys												
Pygmy	± 8	5	13.7	1.56	99.6	3.92	3.0	0.37	4.2	0.52	2.0	0.55
Yogyakarta	± 8	16	23.2	4.74	123.8	4.74	3.7	1.02	2.6	0.99	3.5	1.33
Pygmy	± 9	3	17.8	0.76	113.8	4.82	2.3	0.04	2.9	0.80	3.3	1.12
Yogyakarta	± 9	17	27.7	9.53	128.4	5.65	4.0	1.86	2.9	1.43	3.2	1.54
Pygmy	± 10	8	21.1	3.48	120.8	7.75	2.1	0.47	2.5	0.93	3.6	1.07
Yogyakarta	± 10	24	28.1	6.57	132.1	4.48	3.5	1.24	2.5	0.89	3.6	1.35
Pygmy	± 11	5	21.1	2.56	123.9	7.52	1.8	0.31	2.5	1.08	4.3	0.85
Yogyakarta	± 11	31	33.7	10.85	137.1	7.21	4.0	1.67	2.8	1.17	3.1	1.37
Pygmy	± 12	4	22.6	0.75	127.4	3.50	1.8	0.17	2.1	1.02	4.4	0.86
Yogyakarta	± 12	25	38.0	9.37	143.6	8.77	3.9	1.68	2.7	1.43	3.1	1.57
Pygmy	± 13	7	28.5	4.25	134.1	9.22	2.0	0.36	2.5	0.83	3.6	1.16
Yogyakarta	± 13	44	44.2	13.96	154.9	7.64	3.4	1.54	1.9	1.39	4.0	1.73

TABLE 2. Mean and standard deviation (SD) of height (cm), weight (kg), and somatotype components of Pygmy and Yogyakarta girls, aged 8-13 years old in Indonesia

Variable / Sex	Years	N	Weight		Height		Somatotype					
					K1		K2		K3			
			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Girls												
Pygmy	± 8	5	15.7	2.11	104.8	5.80	2.6	0.33	3.3	1.04	2.2	1.16
Yogyakarta	± 8	32	24.5	5.75	124.5	6.64	4.0	1.47	2.7	0.94	3.2	1.43
Pygmy	± 9	5	18.8	3.56	111.6	6.28	2.7	0.61	3.1	0.37	2.3	0.97
Yogyakarta	± 9	34	26.4	6.57	127.6	6.40	4.0	1.46	2.6	1.00	3.2	1.61
Pygmy	± 10	4	21.8	3.95	120.7	9.28	2.3	0.04	3.0	0.88	3.2	0.94
Yogyakarta	± 10	13	31.7	6.97	136.5	6.63	4.3	1.54	2.4	1.40	3.0	1.51
Pygmy	± 11	6	22.9	3.01	122.8	2.37	2.5	0.57	2.4	0.61	3.2	0.80
Yogyakarta	± 11	18	30.9	6.57	137.7	6.86	4.0	1.23	2.2	1.00	3.8	1.58
Pygmy	± 12	5	25.8	5.02	127.5	9.49	2.9	0.29	2.2	0.48	3.2	1.37
Yogyakarta	± 12	15	34.8	8.30	144.4	10.31	4.2	1.32	2.3	1.05	3.5	1.52
Pygmy	± 13	4	28.5	1.96	133.9	2.95	2.6	0.92	2.0	0.50	3.6	0.37
Yogyakarta	± 13	33	43.2	11.95	150.9	6.05	4.3	1.17	1.9	1.41	3.4	1.59

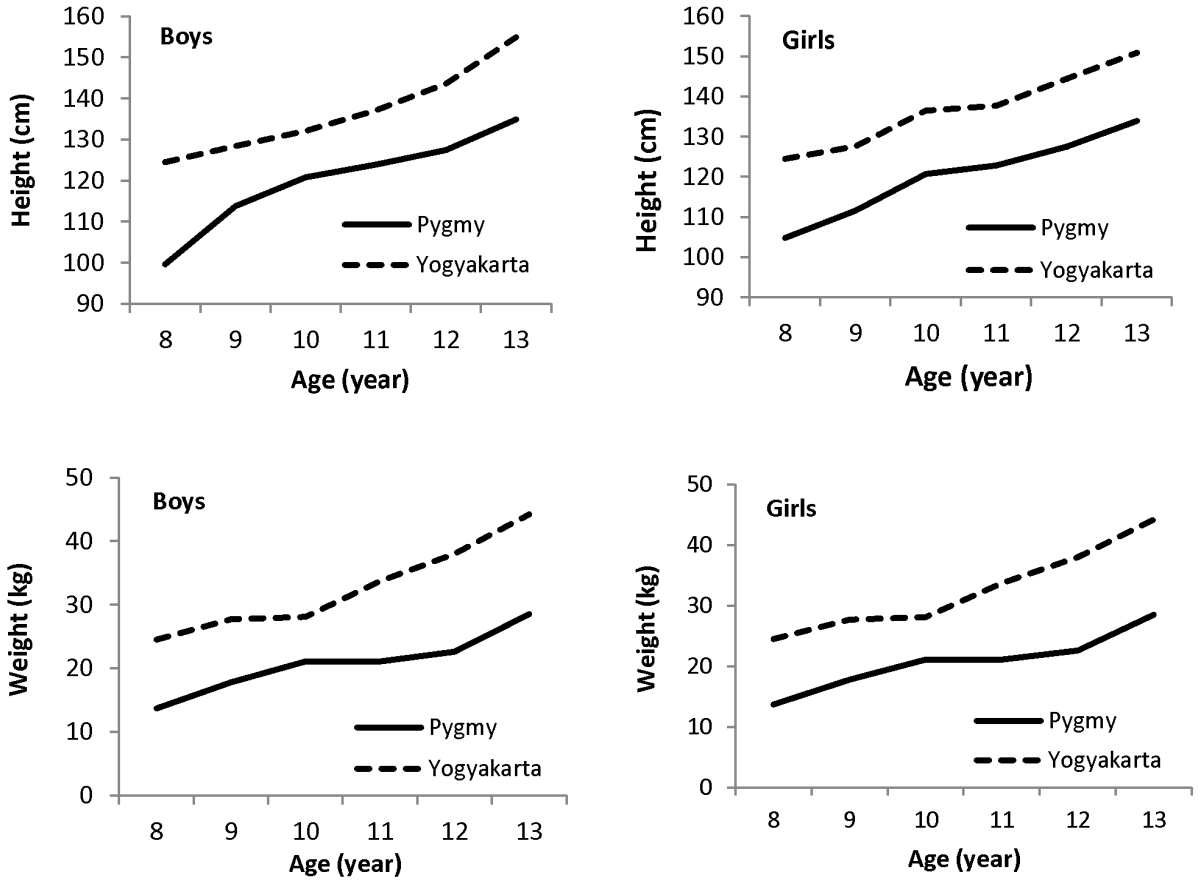

FIGURE 1. Comparison of height and weight between boys and girls of Pygmy Rampasasa and Yogyakarta

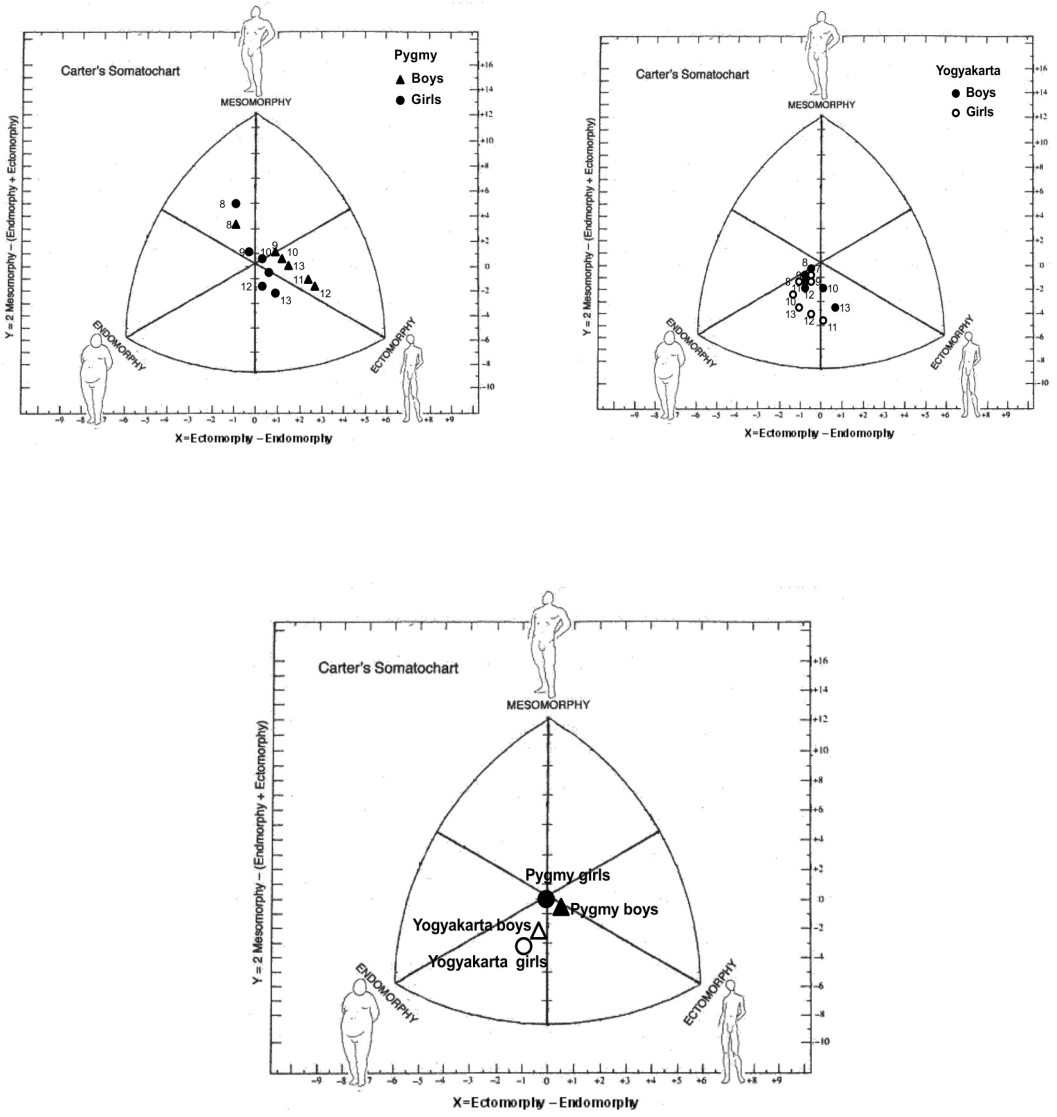

FIGURE 2. Mean somatotypes of Pygmy and Yogyakarta children.

DISCUSSIONS

Growth

Human height is determined by various factors such as genetic predisposition, hormones, as well as environmental factors such as nutrition.[24] In the present study, we observed that Rampasasa Pygmy children were significantly smaller in both stature and weight than Yogyakarta children, except for stature in boys age 9 (FIGURE 1); these results supported the subjective impression that the Pygmy children in rural area were short and thin than the Yogyakarta children. In Rampasasa Pygmies, there was a close relationship between economic opportunities in Pygmy communities, which may have an important impact on food availability and childhood growth. Eveleth & Tanner[25] suggested that in most human populations, a large portion of variance in stature can be accounted for by nutritional status; the growth response to stress-societies with very high

caloric budgets show significant secular trends toward faster body growth and increased size, whereas populations under nutritional stress normally reduce growth rates and show smaller adult body sizes.

Suriyanto reported that Flores Pygmy people rely on agriculture for food provision and encountered outsiders that may also influence their way of living.[22] The short statures of Pygmy children were inherited by their parent who's their average male adult stature (less than 150 cm) may gently be affected by mating with Pygmy people. Consequently, there will be a very strong association between the heights of offspring and the average height of the two parents. The differences between Rampasasa Pygmy and Yogyakarta children can also be influenced by different of growth patterns, Malina *et al*.[1] suggested that some genetically short children may be labeled as stunted, but in lesser developed areas of the world, the majority of short children are stunted in growth, reflected the generally impoverished nutritional and health circumstances under which they live. Merimee *et al*.[11] reported that the short stature of African Pygmies could be attributed to the absence of a growth spurt during puberty; and they found that adolescent Pygmies had subnormal serum levels of insulin-like GF1 which was a principal factor responsible for normal pubertal growth. It is believed that IGF can be found in meat and milk, so there are plausible dietary reasons that may account for these differences. Moreover Bogin wrote that the short stature of Pygmy is indeed genetic, some evidently lack of genes for producing the growth promoting hormones that course through other people's bodies, while others are genetically incapable of using these hormones to trigger the cascade of reactions that lead to growth.[26] However, this research did not investigate the genetic and physiological characteristics.

Another possibility that may account for the difference between Rampasasa Pygmy and Yogyakarta children is environmental background; Hastuti *et al*.[27] showed that a complex ecological stress of low barometric pressure resulting in hypoxia, and combined with low moisture and cold air, were any environmental factors which may affect human growth in the Rampasasa Pygmy children. Travaglino *et al*.[24] suggested that the small body size of Pygmy could favor their life in the hot, humid climate of tropical forest by minimizing the body's heat production during exercise. The mean of Pygmy children from Rampasasa in our study were substantially lower (16.5 cm for boys and 16.7 cm for girls) and lighter (11.7 kg for boys and 10.0 kg for girls) than Yogyakarta children.

Concerning sex differences, we noted that Rampasasa Pygmy boys were taller and heavier than Rampasasa Pygmy girls (FIGURE 2). In general, in all human populations, boys are slightly taller than girls until the girls' adolescent growth spurt begins. At that time girls become taller for the period during their spurt continues, while the boys' spurt is yet to occur.[25] Singh[28] eported that girls from various schools in India were taller than boys at ages 10 to 12 years and heavier at 10 to 13 years. In the present study, we noted that the Pygmy girls in Rampasasa were not taller and heavier than the boys during puberty. This was likely due to the age of subjects who have not reached puberty; consequently there was no marked difference in size between boys and girls at the end of the children period.

Somatotype

Regarding somatotype components, the Rampasasa Pygmy boys were less endomorphic than the Yogyakarta boys, except at age 8 and 9, whereas the Rampasasa Pygmy

girls were smaller in the first component than Yogyakarta girls at ages 8 to 13 years. These values indicate that the Pygmy children were less endomorphic than Yogyakarta children. Concerning the second component, the Pygmy children boys were more mesomorphic than the Yogyakarta boys only at age 8, whereas the Pygmy girls were not different from Yogyakarta girls. In the third component, the Pygmy children were more ectomorphic from age 11 to 12 only in boys than the Yogyakarta children.

Considering the mean of all the ages together, the rating of endomorphy, mesomorphy, and ectomorphy among the Pygmy boys were 2.2, 2.7 and 2.5 respectively, while those of the Pygmy girls were 2.6, 2.7, and 3.9 respectively. The average somatotype of the Yogyakarta children was 3.7 – 2.5 – 3.5 (boys) and 4.1 – 2.4 – 3.4 (girls) respectively. The Pygmy boys were mainly endomorphic mesomorph and mesomorphic ectomorph, while the Yogyakarta boys fall within categories ectomorphic endomorph and endomorph ectomorph. The majority of Pygmy girls were endomorphic ectomorph, while Yogyakarta girls were ectomorphic endomorph. As age proceeded, the mean somatotype of Pygmy boys moved from the endomorphic mesomorph region toward the mesomorphic ectomorph area. The mean somatotype of Pygmy girls developed by moving from the endomorphic mesomorph area into the endomorphic ectomorph area. In contrast, the Yogyakarta children were distributed mostly in endomorphy, except the boys of age 13 (FIGURE 2). These cross-sectional observations suggested that the differences between Pygmy and Yogyakarta children may be influenced by different environment/geographical and socio-economic conditions where they were living.

In term of sex differences in somatotype components, in general the values of Pygmy boys were less endomorphic and more ectomorphic than Pygmy girls, but only at age 11 for first and third components were different, and at age 12 for first component. These values indicate that in Pygmy girls, the endomorphy component was higher, and ectomorphy component was lower than Pygmy boys. Sexual differences of the mean somatotype became gradually greater with age; although girls were differ in their somatotype components for the first and the third components. The components of endomorphy and ectomorphy changed opposing directions in the two sexes, analogous to the present results; Bodzsar[17] found that by the end of puberty sexual dimorphism is very near to that observed in adults. In Pygmy children of Rampasasa, the first component of the mean boys' somatotype decreased that lasted until 11 years of age when it becomes constant. Endomorphy increased in the girls except at 10 year. For the second component, Pygmy children decreased until the age of 12 year, and then increased at 13 year in boys. Bodzsar[17] also suggested that mesomorphy changes little during childhood, in prepuberty both sexes display some decrease of it, this is why mesomorphy shows merely a slight increase when habitual physical activity is not sufficiently intense, with the onset of puberty a phase lag develops between the intensity of bone and muscle development. In the third component (ectomorphy), the more essential changes developed during puberty in the both sexes in an opposite way.

The distributions of the subjects on the somatocharts (FIGURE 2) showed that Pygmy children were grouped toward central and endomorphic ectomorph, while the Yogyakarta children were ectomorphic endomorph. Moreover, Bodzsar[17] found that the distribution of individual somatotype in a given age group was more homogenous

before than during puberty. The greatest heterogeneity of Pygmy Rampasasa were in the age interval of 8 through 9 years for boys, and 9 through 12 for girls.

In children, there was a general tendency to an increase in endomorphy, a decrease in mesomorphy, and an increase in ectomorphy during growth,[6] but in the present study showed a tendency to increase in ectomorphy and decrease in mesomorphy and endomorphy. The Pygmy children were less endomorphic than the Yogyakarta children. In summary, the results of the present study clearly indicated a dominance of the endomorphic components in urban Yogyakarta children than rural Rampasasa Pygmy children. Difference in the physique of two groups may be atributed to differences in environment, dietic characteristics, and life style of the both groups. Several studies[7.18.21.28] have analyzed the relationship between environmental factors such as nutrition, and the socio-cultural lifestyle associated with individual's physique and suggested that remarkable differences in body dimensions and physique existed between children when their social background was dissimilar. Moreover, rural Rampasasa Pygmy children have more limited opportunities to receive nutritional requirements and health care services, which adversely affect their quality of life.

CONCLUSIONS

In conclusion, the Rampasasa Pygmy children were shorter, lighter, and less endomorphic than the Yogyakarta children. These results suggested that the observed differences of growth and somatotypes between Rampasasa Pygmy and Yogyakarta children could be related mainly to environment background in the two areas.

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