SOCIOECONOMIC AND GENETIC FACTORS INFLUENCING THE STRENGTH, WEIGHT, LENGTH AND WIDTH MEASUREMENTS OF CHILDREN

Myrtati D Artaria
Department of Anthropology
and Department of Anatomy and Histology
Airlangga University, Surabaya.

ABSTRACT

Child growth has been the interest of scientists for a long time. Most children in Africa and Asia still live in conditions that are not considered "optimal" by comparison with those prevailing in Europe and North America. There are, however, socioeconomic status (SES) improvements on those continents that create, in circumscribed populations, living conditions on a par with those of the "first world". The Javanese sample came from good socioeconomic status (SES) children in Malang (East Java). A total of 1913 Javanese children (822 boys and 1091 girls) were measured. The samples from South Africa were from high (urban) and low (rural) SES. As many as 1109 children (274 rural females, 297 urban females, 263 rural males, and 275 urban males) were measured. Analysis of variance was used to find significant differences, and probit analysis was used to calculate the age of menarche (12.15 years, s=1.10). The results showed that Javanese girls had significantly younger age of menarche. Socioeconomic and genetic factors both affect the growth and development of children, but differently, depended on the variables, the sex, and the age of the growing children. Grip strength development was affected by socioeconomic factor in male children. However, during later period of growth and development, the low socioeconomic children showed an indicator of catch up growth. On the other hand, female Cape Coloured children did not show significant differences between urban and rural, in the averages of grip strength. Males seem to be more affected by adverse environment. Although SES seemed to affect the averages of elbow breadth, the rural children of both sexes managed to catch-up at the last period of their growth and development. The differences between Javanese and Cape Coloured children were an example of the adaptation to specific environment, manifested in the different regulation in attaining adult height. This may be a result of the population history of Cape Coloured people who received substantial admixtures from European gene pool, while Javanese are descendants of people who for a very large number of generations resided in South East Asian environmental conditions. Thus the small final body size of Javanese people, determined by early puberty, is an adaptation to the life in climate that being warm and humid, it would be better to have low body mass/body surface ratio for efficient passive radiation of heat.

Keywords: *anthropometry, grip strength, height, biepycondylar breadth, adaptation*

Correspondence: MD Artaria, Department of Anthropology, Airlangga University, Jl. Airlangga 4-6 Surabaya 60286. Phone: 031-5011 744. E-mail: myrtati@gmail.com

INTRODUCTION

The growth of children is important for the health of the new generation. Currently, a common WHO reference (de Onis et al 2007) is recommended for use in population assessments. Child growth has been the interest of scientists for a long time (Bogin 1999). Most children in Africa and Asia still live in conditions that are not considered "optimal" by comparison with those prevailing in Europe and North America. There are, however, socioeconomic status (SES) improvements on those continents that create, in circumscribed populations, living conditions on a par with those of the "first world". It is of interest to examine children of non-European origin growing in such conditions in environments of their own countries, rather than as immigrants to the "First World". Such examinations may indicate whether some differences in growth in comparison to the single reference derived primarily from the USA studies (de Onis et al 2007) exist, indicating different heritable growth programming.

Height and weight are often used in populational studies assessing nutritional status. Although nutrition influences these anthropometric measures to a certain degree, both are also subject to genetic and psychosocial control. Since direct measurement of nutrition is logistically very difficult, such conceptual oversimplification – use of anthropometry as an indicator of "nutrition", is common. It has been questioned whether the reference curves from US or Britain were adequate to use for children from other

populations (Abolfotouh et al 1993, de Onis et al 1997, 2007, Liang and Dai 1989).

In Indonesia, child growth studies that have been done in children above five years old are rare. In South Africa, a specific population of "Cape Coloured" people derived primarily from the Khoi-San population of what is now Western Cape Province had its children growing in both typical Western middle-class conditions and in very poor rural environments. Research into the role of SES in child growth has not shown consistent results. Some researchers found that SES mattered and influenced the way children grow (e.g.: Nath 1980). Research on Cape Coloured children found significantly lower mean growth among rural (low SES) children than among urban (high SES) children (Henneberg and Louw 1998). Furthermore, small-stature Cape Coloured children from rural communities differed significantly from their urban counterparts (Henneberg et al 1998).

Previous study of the Javanese and Cape Coloured yield interesting results (Artaria and Henneberg, in print; Artaria, 2009). The pattern of growth showed that the Javanese children tend to have similar pattern to the high SES Cape Coloured during the early years, but similar to the low SES Cape Coloured during the later years of development. The studies indicated that the different pattern of growth were not caused by simple differences in SES, but more to the differences in the environmental background, hence the difference in body size and shape (Artaria and Henneberg, in print). Based of the facts stated above, it would be interesting to know the differences between Javanese and Cape Coloured in the strength of their grips; by comparing the grip strength of high and low SES Cape Coloured children, to those of Javanese children. This research will be useful to, first, shed a light of the long-lasting consequences of socioeconomic discrepancies to developing children. Second, to find possibilities of the cause of various patterns of growth found in non-western mid- to high SES populations.

MATERIALS AND METHOD

The Javanese sample came from good socioeconomic status (SES) children in Malang (East Java). A total of 1913 children (822 boys and 1091 girls) were measured. Age was determined to a day by subtracting the date of birth that was reported during the measurement from the date of examination, and was cross-checked via using questionnaires. The samples from South Africa were from high and low SES. The high SES lived in the urban area, while the low SES lived in the rural area of Capetown. As many as 1109 children (274 rural females, 297 urban females, 263 rural males, and 275 urban males) were measured. The measurements were conducted according to the standard protocol defined by Martin and Saller (1957). Height was measured using an anthropometer. Sliding and spreading calipers were used to measure elbow breadth. A dynamometer was used to measure grip strength. Weight was measured using a bathroom scale to the nearest 0.5 kg, which was calibrated regularly to ensure correct weight measurement. All participants were measured while wearing light clothing and without footwear. Differences between SES were analyzed using ANOVA. Probit analysis was used for calculating the age of menarche of the Javanese females. When data from international growth reference (NHANES) was available, the averages of NHANES were plotted together with the Javanese and Cape Coloured data. This was for giving the idea how much far apart the averages of the samples deviated from the WHO reference.

RESULTS

The average menarcheal age of the Javanese girls based on probit analysis was 12.15 years (s=1.10). This average differed significantly (to ? 9.2) from the age of menarche of urban Cape Coloured girls (12.61, s=1.25) (Henneberg and Louw 1995). Grip strengths for Javanese children were compared to those for the Cape Coloured children from South Africa (Figures 1 and 2). The Javanese children were generally stronger than the South African children. In males, grip strength averages were significantly greater in individuals from high socioeconomic status in all age groups even when matched for stature. The differences in the neuromuscular control of strength were responsible for these findings. The averages of grip strength of Javanese males were comparable to those of urban males. On the contrary, rural males' averages were lower than the other two groups, from 5 to 15 years. At age 16 the number of sample was very small so that it did not reflect the real condition of the population. The averages of grip strength of urban did not differ much from the rural females' grip strength averages. This of course was a different case from the males. This means that the effect of unfavorable environmental condition was more evident in the grip strength of males. Comparison of Javanese and Cape Coloured females showed that the Javanese females generally were stronger than urban and rural Cape Coloured females. The differences in the trend of grip strength patterns between the males and females may also reflect differences in culture, such as the kind of work and activities that have been conducted by the children in these two different settings of culture. Further study should be conducted in this area.

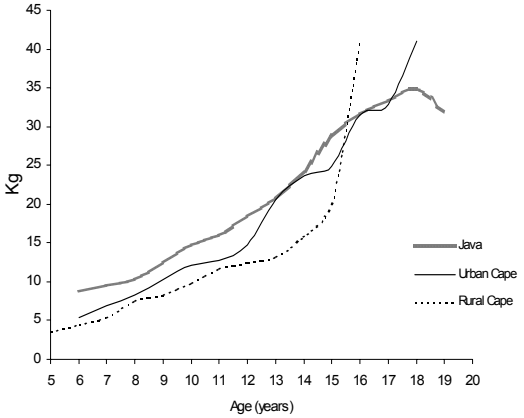

Figure 1. Grip strength averages of Javanese males compared to South African Cape Coloured males

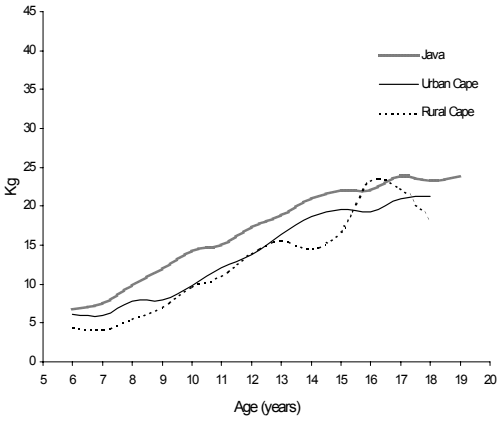

Figure 2. Grip strength averages of Javanese females compared to South African Cape Coloured females

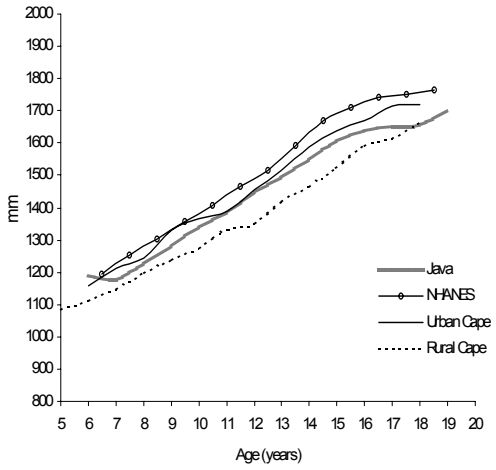

Figure 3. Height averages of Javanese males compared to South African Cape Coloured males

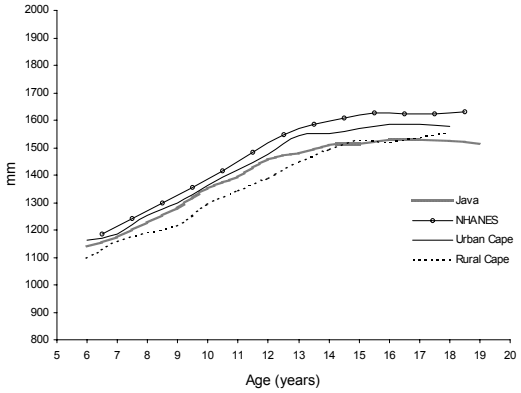

Figure 4. Height averages of Javanese females compared to South African Cape Coloured females

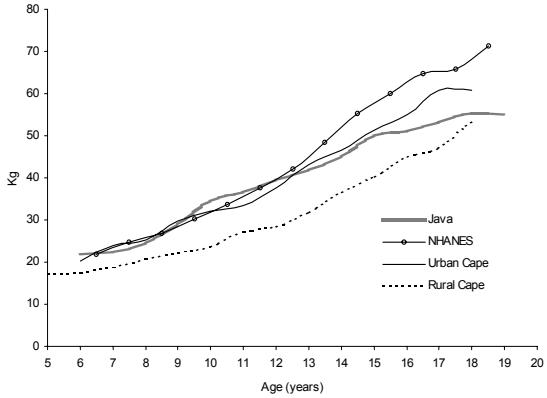

Figure 5. Weight averages of Javanese males compared to South African Cape Coloured males

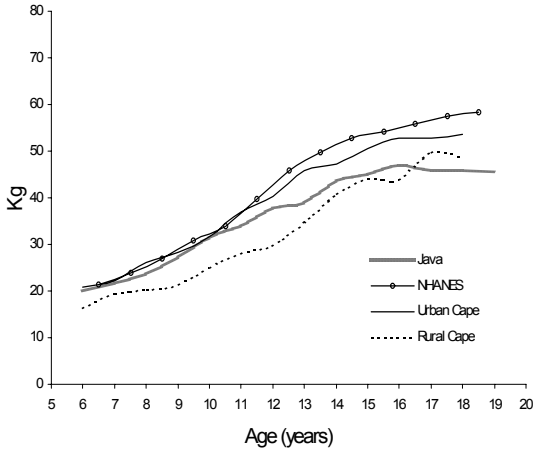

Figure 6. Weight averages of Javanese females compared to South African Cape Coloured females

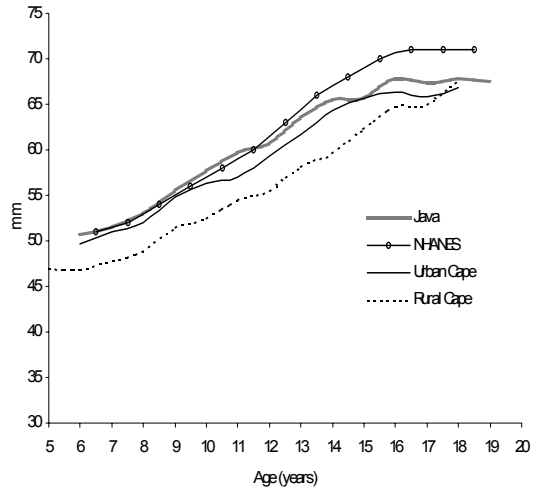

Figure 7. Humerus biepicondylar breadth averages of Javanese males compared to South African Cape Coloured males

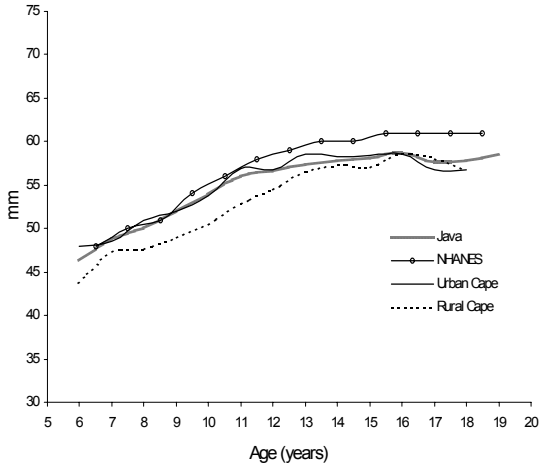

Figure 8. Humerus biepicondylar breadth averages of Javanese females compared to South African Cape Coloured females

The averages for height of Javanese males were closer to those of urban South African Cape Coloured males than to their rural counterparts, until the age of 13 years. After the age of 13 years, the height averages were lower and more similar to the averages for rural South African Cape Coloured males (Figure 3). On the mean time, the height averages for Javanese females were closer to the averages for urban South African Cape Coloured girls until the age of 10 years, when the trend began to move towards the averages for rural South African Cape Coloured girls (Figure 4).

The averages for weight of Javanese males were similar to those of urban South African Cape Coloured, until the age of 15 years. The averages for weight of rural South African Cape Coloured males were substantially below those of urban South African Cape Coloured and Javanese boys (Figure 5). Javanese females' weight averages were similar to those of urban South African Cape Coloured until the age of 10 years. From age 11 the weight averages of the Javanese became lower and approached the averages of rural South African Cape Coloured (Figure 6).

The averages of humerus biepicondylar (elbow) breadth showed interesting patterns for both sexes (Figures 7 and 8). In males, at age 16 years the averages for the three groups (Javanese, and urban and rural Cape Coloured) approached each other, indicating that there was a 'catch up' of rural averages. Finally the averages of the three groups became similar at age 17 years. From age 6 to 15 years, the averages of elbow breadth for Javanese males were similar to those for urban Cape Coloured (Figure 7). The averages of humerus biepicondylar breadth for Javanese females were similar to those for urban females from age 6 to 12 years. The averages for the three groups (Javanese, and urban and rural Cape Coloured) became similar when rural averages caught up at the age of 13 years (Figure 8).

DISCUSSION

Similar to other measurements such as breadth and circumference (Artaria, 2009), the height and weight averages of Javanese were comparable to those of urban Cape Coloured in early years of measurements, but closer to those of rural Cape Coloured in the later years of measurements. This cannot be caused neither by lower socioeconomic status nor poorer nutrition, as indicated by significant younger age of menarche of the Javanese. Socioeconomic and genetic factors both affect the growth and development of children, but differently, depended on the variables, the sex, and the age of the growing children. Grip strength development was affected by socioeconomic factor in male children. However, during later period of growth and development, the low socioeconomic children showed an indicator of catch up growth, although it was a bit difficult to ascertain due to the small number of sample. On the other hand, female Cape Coloured children did not show significant differences between urban and rural, in the averages of grip strength. It supported what has been believed that males are more prone to, therefore more being affected by, adverse environment (Zellner et al 1996). Even in height and weight averages (Figures 4 and 6), rural females seemed to have their

averages approaching those of urban females by the age of 17 or 18 years.

Although SES seemed to affect the averages of elbow breadth, the rural children of both sexes managed to catch-up at the last period of their growth and development. It was hard to see whether rural children, especially the males, managed to catch-up in their averages of body height and weight by the end of their growth period. Therefore it is suggested that there should be further research within this population that include individuals who already attain adult height. The differences between Javanese and Cape Coloured children were an example of the adaptation to specific environment, manifested in the different regulation in attaining adult height. At puberty, genetic control of growth and development is stronger than during the childhood (Johnston et al 1976, Silventoinen et al 2008). It seems that such a heritable difference may explain the observed pattern of growth of Javanese and Cape Coloured. This may be a result of the population history of Cape Coloured people who received substantial admixtures from European gene pool, while Javanese are descendants of people who for a very large number of generations resided in South East Asian environmental conditions. These conditions are typical for the equatorial islands. High temperatures and high humidity predominate around the year with very little seasonal difference. In the Western Cape of South Africa seasonal differences in temperature and humidity are more pronounced with cold rainy winters and warm dry summers. Thus the small final body size of Javanese people, determined by early puberty, is an adaptation to the life in climate that being warm and humid, it would be better to have low body mass/body surface ratio for efficient passive radiation of heat.

CONCLUSION

It could be concluded from the results of this research that height and weight averages of Javanese were comparable to those of urban Cape Coloured in early years of measurements, but closer to those of rural Cape Coloured in the later years of measurements. This may not be caused neither simply by lower socioeconomic status nor poorer nutrition. Meanwhile, grip strength development was affected by socioeconomic factor so that it showed significant differences in male samples but the lower SES started to catch up later on, near the age of puberty. Females had been known to be less affected by adverse environment, which was proven by this sample—no significant differences in grip strength between female samples.

REFERENCES

1. Abolfotouh MA, Abu-Zeid HA, Badawi IA, & Mahfouz AA (1993). A method for adjusting the international growth curves for local use in the assessment of nutritional status of Saudi pre-school children. J Egypt Public Health Assoc 68, 687-702
2. Artaria MD and Henneberg M, in print. Schoolchildren who do not reach WHO reference despite good socioeconomic status: A mixed-longitudinal study of body height and weight of Javanese and Cape-Coloured Schoolchildren. Bulletin SGA.
3. Artaria MD (2009). Peran Faktor Sosial-Ekonomi dan Gizi pada Tumbuh Kembang Anak. Masyarakat, Kebudayaan dan Politik 22, 51-60
4. Bogin B (1999). Patterns of Human Growth. Cambridge: Cambridge University Press.
5. de Onis M, Garza C, Habicht JP (1997). Time for a new growth reference. Pediatrics 100, E8
6. de Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J (2007). Development of a WHO growth reference for school-aged children and adolescents, Bulletin of the WHO 85, 660-667
7. Henneberg M, and Louw GJ (1998). Cross-sectional survey of growth of urban and rural "Cape Coloured" schoolchildren: Anthropometry and function tests. American Journal of Human Biology 10, 73-85
8. Henneberg M, Brush G, and Harrison GA (2001). Growth of specific muscle strength between 6 and 18 years in contrasting socioeconomic conditions. American Journal of Physical Anthropology 115, 62-70
9. Henneberg M, Harrison GA, Brush G (1998). The small child: Anthropometric and physical performance characteristics of short-for-age children growing in good and in poor socio-economic conditions. European Journal of Clinical Nutrition 52, 286-291
10. Johnston FE, Wainer H, Thissen D, and MacVean R (1976). Hereditary and environmental determinants of growth in height in a longitudinal sample of children and youth of Guatemalan and European ancestry. Am J Phys Anthropol 44, 469-75
11. Liang SF, and Dai WZ (1989). A growth velocity standard for Chinese children in Hong Kong. Chin Med J Engl 102, 233-5
12. Martin R, and Saller K (1957). Lehrbuch der Anthropologie. Stuttgart: G. Fisher Verlag.
13. Nath S (1980). A study of progression of segmental growth and maturational direction among tribal boys of India. Anthropologie 84, 292-299
14. Silventoinen K, Haukka J, Dunkel L, Tynelius P, Rasmussen F (2008). Genetics of Pubertal Timing

and Its Associations with Relative Weight in Childhood and Adult Height: The Swedish Young Male Twins Study Pediatrics 121, 885-891
15. Zellner K, Kromeyer K, Jaeger U (1996). Growth studies in Jena, Germany: Historical background and secular changes in stature and weight in children 7-14 years. American Journal of Human Biology 8, 371-382