J. Hum. Ecol., 8(1): 61-67 (1997)
DOI: 10.31901/24566608.1997/08.01.08

# Cognitive and Somatic Development of 4 to 6 Year Old Children

S.P.Singh and Ranju Bala

*Department of Human Biology, Punjabi University, Patiala 147 002, Punjab, India*

**KEY WORDS** Cognitive Development. Physical Growth. Weight. Height. Skinfolds.

**ABSTRACT** Cognitive development and physical growth of 4 to 6 year old children of Gharuan village in Ropar District of Punjab was evaluated. The purpose has been to depict sex differences in somatic and cognitive abilities and also to provide basic data for future comparisons. Data on 120 children (60 boys and 60 girls) were collected during 1994-95 who were between 4 to 6 years of age, the time when their formal education begins, forms the basis of this study. Anthropometric measurements which included stature, body mass, circumferences, skinfolds and skeletal diameters (Tanner et al., 1969) and the cognitive abilities (Jaswal et al., 1988) were studied. Evaluation of somatic development has revealed non-existent sexual dimorphism in stature and other body measurements. The boys and girls perform equally well in identification, comparison and achievement abilities, however, the boys exhibit better memory power, thinking, olfactory, recognition and verbal abilities than the girls. The social and parental behaviour favours the male child. The absence of sex dimorphism in somatic development is because of the natural buffering of the human female to environmental insults.

## INTRODUCTION

The status of growth and development of children is a mirror of the overall development of a nation. Developing countries like India are faced with the problem of deprivation of a large proportion of its population which is marginalised. The state of socio-economic situation obtaining in India is really dismal. Under the condition of social and economic deprivation, the full genetic potential for growth cannot be achieved. This results in a truncated growth whose logical consequences may be, (i) a handicap in mental and cognitive development and (ii) a diminished working capacity. Our national priorities need to revolve around these issues uplifting the underprivileged ones so that the growth performance of deprived children be improved. This would reflect the advances made by the nation in a really functional sense rather than projecting rhetorically the economic figures.

The significance of studying growth and development becomes explicit considering the priority given to the national growth surveys and to large studies by many countries (Hamill et al., 1979; Roede and Van Wieringen, 1985; Eiben et al., 1991; ICMR 1972; Prokopec, 1995). Compilation of growth studies by Eveleth and Tanner (1990) has made it possible to define growth specificity to different populations and to disengage the effects of heredity and environment. Coupling of somatic and behavioural development in research studies would go a long way in deciphering the mechanisms of growth. Ghai and Sandhu (1968) provided the standards of growth and behavioural development in urban children. Children with very low birth weight in Europe had marked visual and hearing impairment besides a significant disability in cognitive development (Eiben et al., 1995).

The cognitive and environmental factors related to language development studied by Siegel (1982) on preterm and full term babies suggested significant and emphatic role of cognitive factors in language development. Cognitive development of rural children was also investigated by Jaswal et al. (1988). A comment on the cultural influences on cognitive tests sounds reasonable here. Cultural differences in test performance have been noticeable every where (Anastasi, 1960). Culture-free tests have tried to concentrate on common experiences to different cultures but such tests generally fall short of their objectives (Mussen, 1970). Tests for different cultures be established and administered.

The information on somatic and cognitive development is, however, scanty in India. Recognising this gap in knowledge an attempt is hereby made to put to scrutiny the rural deprived

children of Gharuan village from this angle, who are primary school entrants in the age range of 4 to 6 years. This is roughly the age when formal education begins and is hence of great concern to pedagogists. The objectives of the present study are to present sex differences in somatic and cognitive development and to provide baseline data for comparative studies and for elaborating secular shifts.

## MATERIAL AND METHODS

The present investigation on physical and cognitive development has been undertaken on 120 children (60 girls and 60 boys) ranging in age from 4 to 6 years, of Gharuan village of Ropar District of Punjab during 1994-95. This is a very big village which has a Primary Health Centre apart from having high schools, a nationalised bank and a co-operative society. In spite of these facilities, the educational standards are low and a majority of the adults are illiterates. Addiction to opium and liquor is prevalent. Generally the living standards are poor, the personal hygiene is a distant dream, disposal of garbage and effluence not properly attended to but directed towards the streets. Social and parental attitudes towards children, their problems and activities are casual and a traditional outlook of neglect of the girl child still persists.

The data were collected from the primary school, from the household and from the primary health centre by RB where her father is a health official. The anthropometric measurements were taken according to standard IBP/HA growth committee recommendations (Tanner et al., 1969) which included stature, body mass, circumferences of the head, chest, calf and upper arm, skinfolds at the biceps, triceps, subscapular, suprailiac and calf and diameters of the humerus and femur bicondylar. Body mass of the children was taken with a standardised weighing machine upto the nearest 0.5 kg. Skin and subcutaneous tissue fold thicknesses were measured with a Harpenden Caliper up to the nearest 0.2 mm whereas all other measurements were taken to the nearest millimetre. Test retest was performed on 10 subjects of the same age groups on two different days in order to report on the level of accuracy of the investigator. The percentage of difference on two occasions was 0.46 for height, 0.81 for head circumference. Chest, upper arm and calf circumferences and femur bicondylar diameter have less than 2% of differences on two occasions. The skinfolds have shown higher differences on two occasions which were up to 5%.

Authenticity and precision in growth studies is linked to the age of the participants. The investigator and her father had excellent rapports with the parents of the children as they were in a position to help them in case of illness. The dates of birth were recorded with lots of accuracy. The technique of age grouping is such where the mean age would be depicted as a whole year figure, *e.g.*, age group of 4 includes subjects of ages 3.500 to 4.499 years. Skinfolds were log transformed using Edwards et al. (1955) method in order to make their distribution Gaussian.

A scale developed by Jaswal et al. (1988) has been used to assess the cognitive abilities of the present children. According to Jaswal et al. (1988) "This scale assesses cognition by evaluating individual performance in nine cognitive abilities; *viz.*, verbal, identification, recognition, comparison, achievement/performance, thinking, memory, olfactory and auditory discrimination." The test has to be presented as a game to the child and his performance is to be judged only after he is sufficiently motivated. The administration of this test has been a very difficult task which required a long time and involved repetitions. To collect data on 120 subjects has been a huge job.

## RESULTS

### *Somatic Development*

Tables 1 to 3 depict the means and SD of various body measurements of children of the present study. All the measurements except for skinfolds increase with age in boys and girls.

**Table 1: The mean, SD and t-value of stature, body mass, humerus and femur bicondylar diameter of children of Gharuan village from 4 years to 6 years of age**

| Age (in years) | Boys | | | Girls | | | t-value |
|---|---|---|---|---|---|---|---|
| | N | Mean | SD | N | Mean | SD | |
| | | | *Stature (cm)* | | | | |
| 4 | 20 | 99.06 | 5.44 | 20 | 97.92 | 4.03 | 0.75 |
| 5 | 20 | 103.20 | 6.26 | 20 | 104.59 | 5.86 | 0.72 |
| 6 | 20 | 107.43 | 4.96 | 20 | 109.32 | 4.69 | 1.23 |
| | | | *Body mass (kg)* | | | | |
| 4 | 20 | 14.375 | 1.54 | 20 | 13.50 | 1.23 | 2.02* |
| 5 | 20 | 15.500 | 1.80 | 20 | 15.25 | 2.22 | 0.39 |
| 6 | 20 | 16.150 | 2.07 | 20 | 15.70 | 1.92 | 0.71 |
| | | | *Humerus bicondylar diameter (cm)* | | | | |
| 4 | 20 | 3.91 | 0.39 | 20 | 3.75 | 0.42 | 1.19 |
| 5 | 20 | 4.15 | 0.36 | 20 | 4.06 | 0.54 | 0.64 |
| 6 | 20 | 4.27 | 0.28 | 20 | 4.11 | 0.48 | 1.28 |
| | | | *Femur bicondylar diameter (cm)* | | | | |
| 4 | 20 | 6.28 | 0.15 | 20 | 6.02 | 0.27 | 3.71* |
| 5 | 20 | 6.62 | 0.44 | 20 | 6.30 | 0.33 | 2.58* |
| 6 | 20 | 6.69 | 0.47 | 20 | 6.32 | 0.37 | 2.76* |

* $p < 0.05$

**Table 2: Head circumference, chest circumference, upper arm circumference and calf circumference in the children of Gharuan village from 4 years to 6 years of age**

| Age (in years) | Boys | | | Girls | | | t-value |
|---|---|---|---|---|---|---|---|
| | N | Mean | SD | N | Mean | SD | |
| | | | *Head circumference (cm)* | | | | |
| 4 | 20 | 49.95 | 1.26 | 20 | 48.27 | 1.25 | 4.24* |
| 5. | 20 | 49.72 | 1.35 | 20 | 49.18 | 1.34 | 1.28 |
| 6 | 20 | 50.18 | 1.70 | 20 | 49.16 | 1.60 | 1.95 |
| | | | *Chest circumference (cm)* | | | | |
| 4 | 20 | 50.89 | 2.50 | 20 | 48.49 | 2.35 | 3.16* |
| 5 | 20 | 52.53 | 2.27 | 20 | 51.46 | 2.47 | 1.43 |
| 6 | 20 | 51.95 | 1.98 | 20 | 50.96 | 2.45 | 1.41 |
| | | | *Upper arm circumference (cm)* | | | | |
| 4 | 20 | 15.28 | 1.03 | 20 | 15.16 | 0.92 | 0.39 |
| 5 | 20 | 15.42 | 0.99 | 20 | 15.46 | 1.32 | 0.12 |
| 6 | 20 | 15.40 | 1.29 | 2- | 14.85 | 0.77 | 1.64 |
| | | | *Calf circumference (cm)* | | | | |
| 4 | 20 | 19.79 | 1.09 | 20 | ,9.64 | 1.04 | 0.45 |
| 5 | 20 | 20.17 | 1.02 | 20 | 20.50 | 1.63 | 0.77 |
| 6 | 20 | 20.31 | 1.36 | 20 | 19.83 | 0.96 | 1.29 |

*$p < 0.05$

Significant sexual differences emerge in body mass, head and chest circumferences in the age group of 4 years only, which are in favour of boys. Femur bicondylar diameter is significantly larger in boys at all the ages.

The thickness of skin and subcutaneous tissue folds at biceps, triceps, subscapular, suprailiac and calf has shown a typical trend of reduction with advancing age, in boys and girls equally. Except for triceps and subscapular at age 5, which are significantly greater in girls, all other fatfolds are almost similar in the two sexes.

### *Cognitive Development*

The cognitive abilities have been presented in table 4 and 5 which are in percentage of the ulti-

**Table 3: Log transformation of triceps skinfold, biceps skinfold, calf skinfold, subscapular skinfold and suprailiac skinfold**

| *Age (in years)* | *Boys* | | | *Girls* | | | *t-value* |
|---|---|---|---|---|---|---|---|
| | *N* | *Mean* | *SD* | *N* | *Mean* | *SD* | |
| | | | *Triceps skinfold* | | | | |
| 4 | 20 | 190.80 | 12.32 | 20 | 193.80 | 8.87 | 0.88 |
| 5 | 20 | 183.70 | 15.50 | 20 | 193.90 | 13.63 | 2.21* |
| 6 | 20 | 181.60 | 11.95 | 20 | 184.40 | 12.53 | 0.72 |
| | | | *Biceps skinfold* | | | | |
| 4 | 20 | 178.10 | 16.56 | 20 | 179.00 | 16.92 | 0.17 |
| 5 | 20 | 174.90 | 13.09 | 20 | 177.60 | 16.18 | 0.58 |
| 6 | 20 | 169.55 | 13.66 | 20 | 161.70 | 22.44 | 1.34 |
| | | | *Calf skinfold* | | | | |
| 4 | 20 | 188.10 | 13.09 | 20 | 188.80 | 14.97 | 0.16 |
| 5 | 20 | 181.10 | 12.42 | 20 | 187.80 | 15.80 | 1.49 |
| 6 | 20 | 178.30 | 15.69 | 20 | 177.10 | 12.00 | 0.27 |
| | | | *Subscapular skinfold* | | | | |
| 4 | 20 | 156.90 | 13.07 | 20 | 153.30 | 12.86 | 0.88 |
| 5 | 20 | 150.15 | 16.15 | 20 | 160.70 | 13.56 | 2.24* |
| 6 | 20 | 146.60 | 11.01 | 20 | 150.30 | 13.45 | 0.95 |
| | | | *Suprailiac skinfold* | | | | |
| 4 | 20 | 149.80 | 26.06 | 20 | 150.80 | 16.44 | 0.15 |
| 5 | 20 | 136.70 | 23.58 | 20 | 143.30 | 20.74 | 0.94 |
| 6 | 20 | 135.25 | 19.78 | 20 | 127.55 | 27.25 | 1.02 |

* $p < 0.05$

**Table 4: Percentage scores of verbal test, identification test, recognition test, comparison test and achelvement/ performance ability test in the children of Gharuan village from 4 years to 6 years of age**

| *Age (in years)* | *Boys* | | | *Girls* | | | *t value* |
|---|---|---|---|---|---|---|---|
| | *N* | *Mean* | *SD* | *N* | *Mean* | *SD* | |
| | | | *Verbal test (%)* | | | | |
| 4 | 20 | 87.50 | 12.17 | 20 | 81.87 | 13.74 | 1.37 |
| 5 | 20 | 89.37 | 10.94 | 20 | 91.87 | 10.16 | 0.75 |
| 6 | 20 | 91.87 | 10.94 | 20 | 83.62 | 10.65 | 2.42* |
| | | | *Identification test (%)* | | | | |
| 4 | 20 | 81.63 | 6.89 | 20 | 82.93 | 7.34 | 0.58 |
| 5 | 20 | 89.24 | 7.21 | 20 | 87.82 | 7.83 | 0.60 |
| 6 | 20 | 94.46 | 5.49 | 20 | 91.19 | 5.57 | 1.87 |
| | | | *Recognition test (%)* | | | | |
| 4 | 20 | 89.99 | 9.03 | 20 | 83.07 | 5.91 | 2.87* |
| 5 | 20 | 92.50 | 7.54 | 20 | 90.77 | 10.84 | 0.58 |
| 6 | 20 | 98.08 | 4.23 | 20 | 94.42 | 7.84 | 1.84 |
| | | | *Comparison test (%)* | | | | |
| 4 | 20 | 74.99 | 5.89 | 20 | 78.42 | 6.37 | 1.77 |
| 5 | 20 | 80.79 | 13.47 | 20 | 84.74 | 0.0 | 1.09 |
| 6 | 20 | 88.42 | 10.04 | 20 | 87.10 | 12.83 | 0.36 |
| | | | *Achievement/performance ability test (%)* | | | | |
| 4 | 20 | 55.83 | 18.55 | 20 | 63.75 | 14.87 | 1.49 |
| 5 | 20 | 75.00 | 24.93 | 20 | 73.75 | 18.59 | 0.18 |
| 6 | 20 | 82.08 | 19.73 | 20 | 73.75 | 22.17 | 1.25 |

* $p < 0.05$

mate performance. Generally all the abilities increase with age except for auditory and olfactory discrimination. Boys have scored cent per cent ratings in these two abilities at age 4 and 6

**Table 5: Percentage scores of thinking ability, memory power auditory discrimination. olfactory discrimination and total cognitive ability in the children of Gharuan village from 4 years to 6 years of age**

| Age (in years) | Boys | | | Girls | | | t-value |
|---|---|---|---|---|---|---|---|
| | N | Mean | SD | N | Mean | SD | |
| | | | *Thinking ability (%)* | | | | |
| 4 | 20 | 72.27 | 18.76 | 20 | 64.55 | 16.13 | 1.39 |
| 5 | 20 | 73.54 | 12.13 | 20 | 71.36 | 17.76 | 0.45 |
| 6 | 20 | 91.36 | 13.01 | 20 | 81.36 | 14.29 | 2.32* |
| | | | *Memory power (%)* | | | | |
| 4 | 20 | 80.62 | 19.23 | 20 | 63.75 | 1.09 | 2.85* |
| 5 | 20 | 76.87 | 23.04 | 20 | 82.50 | 20.44 | 0.82 |
| 6 | 20 | 87.50 | 19.87 | 20 | 80.62 | 18.35 | 1.14 |
| | | | *Auditory discrimination (%)* | | | | |
| 4 | 20 | 100.00 | 0.00 | 20 | 95.00 | 22.36 | 1.00 |
| 5 | 20 | 97.50 | 11.18 | 20 | 100.00 | 0.00 | 1.00 |
| 6 | 20 | 100.00 | 0.00 | 20 | 100.00 | 0.00 | 0.00 |
| | | | *Olfactory discrimination (%)* | | | | |
| 4 | 20 | 100.00 | 0.00 | 20 | 80.00 | 41.04 | 2.18* |
| 5 | 20 | 80.00 | 41.04 | 20 | 80.00 | 41.04 | 0.00 |
| 6 | 20 | 100.00 | 0.00 | 20 | 75.00 | 44.43 | 2.51* |
| | | | *Pecentage score of total cognitive ability (%)* | | | | |
| 4 | 20 | 80.07 | 5.74 | 20 | 78.02 | 6.14 | 1.09 |
| 5 | 20 | 86.08 | 7.21 | 20 | 85.41 | 9.17 | 0.26 |
| 6 | 20 | 92.53 | 5.49 | 20 | 87.83 | 6.90 | 2.38* |

* $p < 0.05$

but in the intervening period at 5 years, they fall short of the ultimate target. Sexual differences exist in verbal test (age 6), in recognition (age 4), in thinking (age 6), in memory power (age 4) and in olfactory discrimination (ages 4,6) where the boys outperform the girls. Collective cognitive ability which combines the individual scores depicts a situation firmly in favour of boys especially at age 6 where they have significantly higher performance scores than that of the girls. This total cognitive ability increases from 80.07% to 92.53% during 4 to 6 years in boys but the girls improve it from 78.02% to 87.83% only, during the same period. At age 4, both the sexes have already accomplished more than three fourth of these specific cognitive abilities but have yet to accomplish them totally by the age of 6 years. It may be remembered that these abilities represent nominal variables and are not comparable amongst themselves. Each may be having its own scale of development and time of full achievement. It is not reasonable, therefore, to comment on the comparative development or achievement in these cognitive abilities.

## DISCUSSION

Evaluation of somatic development has revealed a non-existent sexual dimorphism in stature and other body measurements. The only exception to this are body mass, head and chest circumference at age 4 and femur bicondylar at all ages. The lack of sexual dimorphism is quite contrary to the general findings obtained on boys and girls in other populations (Roede and Van Wieringen, 1985; Ghai and Sandhu, 1968; Tanner, 1978; Eiben et al., 1991; Hamill et al., 1979). According to Eveleth and Tanner (1990), "the sex differences in all countries are much larger after puberty than before it, since the boys' adolescent spurt is greater than the girls'. Sex dimorphism, however, differs from one population to another, both before and more strikingly, after puberty."

The reason for the absence or narrowing down of sex differences may be sought on the basis of differential responses to the growth processes followed by the two sexes. It may be due to the fact that the boys and girls follow differ-

ent strategies to achieve their growth potentials under conditions of environmental stress. It may be noted that the children have been living under conditions of nutritional stress, poor personal hygiene and greater susceptibility to disease. These conditions are likely to result in growth depression. The two fold consequences of underprivileged conditions on growth of these children would be (a) an inablity to fulfil genetic potential and (b) a virtual absence of sex dimorphism because of the natural buffering of the human female to environmental insults. A reduced sexual dimorphism as a consequence of nutritional stress has been noticed on may populations (Eveleth, 1975; Stini, 1985; Stinson, 1985; Gaur and Singh, 1994; Gaur et al., 1996; Singh, 1980, 1987; Singh et al., 1987).

The adiposity as reflected by skinfold thickness has shown a trend of decline with age in girls and boys of this study, the former possess significantly greater thickness at triceps and subscapular at the age of 5 years, than the latter. There is a general concensus over this trend of age change in children till 6 to 8 years. The infant accumulates fat which becomes maximum upto about 9 months, roughly the age when it becomes mobile (Tanner, 1978; Eveleth and Tanner, 1990). This reduction in fat from nine months to about 6 to 8 years may be due to the hyperactive nature of children who in playful activities reach their maxima of physiological work capacity many times a day. This ways they shed off extra amounts of adipose tissue accumulated immediately after birth.

The cognitive abilities evaluated with the help of a locally developed scale takes care of various facets of the development of children. The choice of articles has been meticulously made so as to make the children comfortable with it and perform various tasks easily. Olfactory and auditory discrimination judged with these tests have perhaps been already fully achieved by boys. The boys and girls perform equally well in identification, comparison and acheivement/performance abilities. The boys have exhibited better cognitive abilities in memory power, thinking, olfactory, recognition and verbal dexterity than the girls at certain ages. Definitely the social and parental behaviour favours the boys who get better opportunities and interaction.

On the other hand, the girls get limited opportunities for learning. There are no proper stimuli for girls to explore their surroundings fully and to respond accordingly. The reasons for this are embedded in this prejudiced social mileau. The findings on cognitive development in these children would form a basis for future comparisons on the role of various factors affecting this development.

## REFERENCES


Anastasi, A. :-Cultural differences. *Encyl. Edu. Res.*, 350-358 (1960).

Edwards, D.A.W., Hammond, W.H., Healy, M.J.R., Tanner, J.M., Whitehouse, R.H. : Design and accuracy of calipers for measuring subcutaneous tissue thickness. *Brit. J. Nutr.*, **9** : 133-143 (1955).

Eiben, O.G., Barabas, A. and Panto, E. : *The Hungarian National Growth Study.* Humanbiologia Budapestinensis, Budapest (1991).

Eiben, R.M., Hack, M., Taylor, G. and Klein, M. : Neurological and cognitive outcome of extremely low birth weight (750 g) children at school age. *Auxology*, **94** : 63-68 (1995).

Eveleth, P.B. : Difference between ethnic groups in sex dimorphism of adult height. *Ann. Hum. Biol.*, **2** : 35-39 (1975).

Eveleth, P.B. and Tanner, J.M. : *Worldwide Variations in Human Growth.* Cambridge Univ. Press, Cambridge (1990).

Gaur, R. and Singh, N.Y. : Nutritional status among rural Meitei Children of Manipur, India. *Am. J., Hum. Biol.*, **6** : 731-740 (1994).

Gaur, R., Vasishat, R.N., Vermani, V. and Manku, R. : Growth and nutritional status of Himachali Children. In : *Human Biology, Global Developments.* L.S. Sidhu and S.P. Singh (Eds.) (1996).

Ghai, O.P. and Sandhu, R.K. : Study of Physical growth of Indian Children in Delhi. *Ind. J. Pediatrics*, **35** : 92-98 (1968).

Hamill, P.V., Drizd, T.A., Johnson, C.L., Reed, R.B. and Moore, W.M. : Physical growth : National Centre for Health Statistics Percentiles. *Am. J. Clin. Nutr.*, **32** : 607-629 (1979).

ICMR : Growth and physical development of Indian infants and children. *Technical Report Series No.* 18, New Delhi (1972).

Jaswal, S., Gulati, J., Grewal, H.P. and Deb, M. : Cognitive development of rural children. *Ind. J. Behaviour*, **12** : (1988).

Mussen, P.H. : *Handbook of Research Methods in Child Development*. Wiley Eastern Priv. Ltd. New Delhi (1970).

Prokopec, M., Vignerova, J. and Tomasek, L. : Somatic development in later life of low and high birth weight babies. In : *Human Biology : Global Development*, L.S. Sidhu and S.P. Singh (Eds.) (1996).

Roede, M.J. and van Wieringen, J.C. : Growth diagrams 1980. *Jaargang*, **63** : 1-34 (1985).

Siegel, L.S. : Early cognitive and environmental correlates of language development at 4 years. *Int. J. Behav. Develop.*, **5** : 433-444 (1982).

Singh, S.P. : Physical growth of Gaddi Rajputs of Dhaula Dhar range of the Himalayas. *Z. Morph. Anthrop.*, **54** : 272-292 (1980).

Singh, S.P. : Variations in adult anthropometry, Child Growth and Development in the Western Himalayas - A review. *J. Ind. Anthrop. Soc.*, **22** : 181-204 (1987).

Singh, S.P., Sidhu. L.S. and Malhotra, P. : Growth performance of Punjabi children aged 6-12 years. *Ann. Hum. Biol.*, **14** : 169-179 (1987).

Stini, W.A. : Growth rate and sexual dimorphism in evolutionary perspective. In : *Analysis of Prehistoric Diets*, R.I. Gilbert and J.H. Mielke (Eds.). Academic Press, New York (1985).

Stinson, S. : Sex differences in environmental sensitivity during growth and development. *Yearbook Phys. Anthrop.*, **28** : 123-147 (1985).

Tanner, J.M. : *Foetus into Man*. Blackwell Scientific Publications, Oxford (1978).

Tanner, J.M., Hiernaux, J. and Jarman S. : Growth and physique studies. In : *Human Biology - A Guide to Field Methods*. J.S. Weiner and J.A. Lourie (Eds.). Blackwell Scientific Publication, Oxford (1969).