

East African Medical Journal Vol. 78 No. 6 June 2001

ANTHROPOMETRIC ASSESSMENTS IN NIGERIAN CHILDREN

O. F. Aina, MBBS, FWACP, Department of Psychiatry, College of Medicine, University of Lagos, Lagos, Nigeria, O. Morakinyo, MBBS, DPM, FWACP, FMC Psy, FICP, Professor and Head, Department of Mental Health, College of Health Sciences, Obafemi Awolowo University, Ile-Ife, Nigeria.

Request for reprints to: Dr. O. F. Aina, Department of Psychiatry, College of Medicine, University of Lagos, P.M.B. 12003, Lagos, Nigeria.

ANTHROPOMETRIC ASSESSMENTS IN NIGERIAN CHILDREN

O. F. AINA and O. MORAKINYO

ABSTRACT

Objective: To determine the relationship between psychomotor development and the anthropometric indices in a sample of Nigerian children.

Design: A cross-sectional study.

Setting: Anthropometric and developmental assessments were carried out on the subjects in research rooms or semi-opened spaces that were generally conducive for the display of developmental skills by children in the various study centres as follows: well baby/immunisation clinic, nursery schools and religious centres.

Subjects: Ninety six apparently healthy children aged 7.5, 10, 12, 18, 24 and 30 months (sixteen subjects in each age group) were assessed in the various study centres.

Main outcome measures: The anthropometric indices of weight, height and mid upper arm circumference (MUAC) were measured on each subject; who was in turn subsequently assessed with the Bayley Scales of Infant Development (BSID): a performance developmental inventory.

Results: The anthropometric indices of the subjects were found to steadily rise with age but below normal standard values for each corresponding age group. However, all the subjects scored above the normal minimal developmental index of 50 when assessed with the BSID.

Conclusion: The finding in this study is in line with the submission of earlier authors that malnutrition (as indicated by the anthropometric indices) on its own alone may not necessarily cause poor psychomotor development but perhaps in synergy with some other environmental factors linked with retarded development. Based on the anthropometric findings in this study, it is suggested by the authors that concerted efforts should be made to improve the nutritional states of the Nigerian children so as to, among other things, enhance their maximal developmental potential.

INTRODUCTION

A number of factors are known to affect childhood development; and these include physical, family, socio-cultural and especially adequate nutrition of the child (1-3). Several studies in the past have shown that adequate nutrition is essential for smooth psychomotor development in children(4-7). Furthermore, deficiency in groups of nutrients predict developmental outcome and severe deficit in a single critical nutrient such as iron can result in behavioural deficit(8). For example, computed tomography scans of the brains of severely malnourished children showed cerebral atrophy(9). In addition to cerebral atrophy, Stoch *et al*(10) earlier demonstrated deficits in visuo-motor integration in the severely malnourished infants. In developing countries including Nigeria where this study was carried out, there is a high prevalence of malnutrition due mainly to poor socio-economic status and ignorance of the larger populace. Anthropometric indices such as weight, height and mid upper arm circumference (MUAC) are used in the assessment of the nutritional status of children especially the under five years old(11). Generally,

abnormal anthropometry is statistically defined as anthropometric value above +2 standard deviation (SD) or below -2 SD relative to the reference mean; and poor growth (mostly resulting from poor nutrition) is associated with retarded development(12). However, malnutrition in early childhood usually interact with other environmental factors to cause poor cognitive and motor development(13); and it was previously demonstrated in studies by Grantham-McGregor *et al*(14) that psycho-social stimulation improved development in children that were previously malnourished, though they still lag behind normal controls in psychomotor development.

In this study, the anthropometric indices such as weight, height and MUAC of the subjects were measured to find their relationship with the developmental stature.

MATERIALS AND METHODS

Subjects: Ninety six healthy children aged between six months and 30 months were assessed to determine the relationship between anthropometric indices and developmental scores using a performance developmental instrument. The subjects were sampled from the population of healthy children brought to the

various study centres, for example, immunisation clinic, nursery schools and religious centres. The well-being of each subject was determined through history obtained from the mother or care giver and thorough physical state examination carried out on each subject by one of the researchers (OFA) on the day of assessment. Informed consent of the children's mothers or caregivers was first obtained for their wards to be included in the study. Thereafter, the children seen in such centres were stratified to the different age groups studied: 7.5, 10, 12, 18, 24 and 30 months. These ages are among those recommended by the author of the developmental instrument used, that is, Bayley Scales of Infant Development (BSID) and such ages are said to indicate integrative periods of major shifts in infant development (15). To obtain the sample studied, random sampling by the method of tossing of a coin was done to get the sixteen subjects for each of the six stratified age groups.

Instruments: (a) Bayley Scales of Infant Development (BSID) was the performance developmental instrument used in this study. BSID was designed by Nancy Bayley in 1969. The instrument (BSID) came in to use following Nancy Bayley's extensive researches and modifications of scales already in existence such as Gesell Schedules, the California Infant Scale of Motor Development, and California First Year Mental Scale (16).

BSID consists of colourful, attractive and durable toys and manipulatory items packed neatly into a test box with an appropriate 180 page test manual included. Additionally, two components of the BSID were constructed locally in accordance with the author's specifications in the test manual and these include a 3-step twin stair case and a walking board. BSID provides three complimentary tools for the assessment of children aged between 2 months to 30 months. The three complimentary tools are: (i) The Mental Scale: This contains one hundred and sixty three items arranged in chronological order according to the different ages in months. This scale is designed to assess sensory-perceptual acquities, memory, learning, problem solving ability and the beginning of verbal communication; (ii) The Motor Scale: measures a child's gross and fine motor skills. There are eighty one items and; (iii) The Infant Behaviour Recording (IBR): this is a rating scale designed to be completed by the examiner on the child's social behaviour during the developmental assessment. It is usually completed following the administration of the mental and motor scales.

The BSID is a performance instrument that tests the innate psychobiologic manipulatory skills of a child and requires no complex verbal instruction; hence its validity for cross-cultural applicability in developmental assessment. Wener strongly supported this submission of the validity of the performance types of developmental scales across various cultures. He stated thus: "in the age-range reviewed i.e. birth to three years, infant tests of psychomotor development (using performance instruments) satisfy the following criteria: (i) test administration does not require verbal instructions and; (ii) the psychobiologic actions displayed in the course of manipulating test items are the ones being measured. These criteria justify the assumption of 'cultural equivalence' of the test measures" (17). Furthermore Anastasi also argued in support of the cross-cultural validity of these performance developmental instruments for cross-cultural testing (18). Thus, BSID has been used as a valid inventory in past works across various cultures (16,17,19,20).

(b) Other Instruments: (i) One hundred and fifty two centimetres i.e. 1.52 metres length tape rule; (ii) Weighing Scales: Ten kilogram capacity "DETECTO" weighing scale used to take the weights of the subjects aged 7.5 months. It has

a container on which the child can sit while being weighed. The other weighing scale used for the subjects aged 10 months to 30 months was the 140kg capacity weight scale on which the subject stands while being weighed. However, four of the subjects; three aged 10 months who could not stand well enough on the scale and one aged 12 months who was afraid to stand alone on it had their weights taken in a modified way. Each of such subjects was in turn carried by the mother and the weight of the two were taken with the mother standing on the weighing scale; thereafter, the mother was immediately weighed alone on the same scale and the net difference was recorded as the weight of the subject.

Study design: In each of the study centres, appropriate room or semi-open space free from unnecessary interference and conducive enough as well to enhance unrestricted display of developmental skills was chosen for the assessment of the sampled subjects. The appropriate instruments and play items were displayed in such designated rooms or spaces. The subjects' mothers or care givers were present; and in most cases tokens were given during the assessment to further enhance their co-operation.

Each subject to be assessed in a day was weighed and the height as well as mid upper arm circumference (MUAC) were measured by a research assistant (final year medical student). The weight was taken in kilograms (kg) while the height and MUAC were measured in centimetres (cm). These values were made blind to the researcher. Thereafter, the subject was now assessed with the performance developmental instrument (BSID) by the researcher (OFA).

Test administration using the Bayley's Scales of Infant Development (BSID): As earlier mentioned, BSID consists of play materials and manipulatory items. A child (subject) manipulates these items to display innate psychobiologic skills which can be measured according to the directive in the BSID test manual.

The three scales of the BSID, that is, mental, motor and IBR were administered one after the other to a subject being assessed. For the subject being assessed with the mental scale; of the 163 items in the scale, those corresponding to his or her age are administered. If the child performed well on this, he or she was thereafter assessed with items progressively higher up on the scale until successive points that he/she could no longer perform the tasks. However, for a subject not competent enough to perform tasks in the scale corresponding to his age, he/she was administered and assessed on items corresponding to ages below his own until he/she could perform the task. The child (subject) was then given a "raw-score" corresponding to his/her performance and in line with the instruction in the test manual.

Similar testing procedure was carried out on the subject in the motor scale to obtain the motor "raw score".

The mental and motor "raw scores" were thereafter converted to standard scores, namely, Mental Developmental Index (MDI) and Psychomotor Developmental Index (PDI) respectively using the conversion tables in the test manual. Lastly, the Infant Behavioural Recording (IBR) was filled for the subject to indicate his/her social behaviour and co-operativeness during the assessment.

Inter-relationship between the anthropometric measures and the developmental scores: The independent variables are the anthropometric measures, such as weight, height and MUAC while the dependent variables are the standardised developmental scores, i.e. MDI and PDI from the BSID assessment of the subjects.

To find the inter-relationship between the dependent and independent variables, a multiple regression analysis was carried out as follows:

$$D_s = \alpha_1 + w\beta_{1.1} + h\beta_{2.1} + m\beta_{3.1} + e_1$$

where: D_s = dependent variable i.e. the developmental score with BSID

α_1 = a constant

w, h, m = independent variables i.e. weight, height and MUAC respectively.

e_1 = error.

The formula as stated above is when variable 1, in this case weight is held constant and variables 2 (height) and 3 (MUAC) vary. The variables 2 or 3 can also be held constant in turn while the others vary respectively.

In this study, when the derived statistical values were substituted in the multiple regression equation, we obtained the following:

$$\begin{aligned} D_s &= -102.01 + 4.86w + 2.86h + 2.08m + 15.04 \\ &= 4.86w + 2.86h + 2.08m + 15.04 - 102.01 \\ &= 4.86w + 2.86h + 2.08m - 86.97 \end{aligned}$$

For the sample of Nigerian children evaluated with the BSID on their psychomotor development; the interrelationship between their developmental scores and anthropometric indices of weight, height and MUAC is: $D_s = 4.86w + 2.86h + 2.08m - 86.97$.

RESULTS

Of the ninety six subjects studied, fifty of them were males (52.1%) while forty six (47.9%) were females (Table 1).

Anthropometric findings: Tables 2-4 show the mean values of weight, mid upper arm circumference (MUAC) and height of the subject in each different age group studied.

Table 1

Sex distribution of subjects

Age (months)	No of males (%)	No of females (%)	Total
7.5	12 (75)	4 (25)	16
10	6 (37.5)	10 (62.5)	16
12	7 (43.5)	9 (56.2)	16
18	5 (31.2)	11 (68.8)	16
24	8 (50)	8 (50)	16
30	12 (75)	4 (25)	16
	50 (52)	46 (48)	96 (100)

Table 2

Weight-for-age

Age	Mean weight(kg)			SD (Z-scores)			Percentage below-2 Z-scores		
	Male	Female	Both	Male	Female	Both	Male	Female	Both
32 weeks	7.3	7.0	7.2	1.41	0.10	1.3	0.0	20.0	0.0
10 months	8.1	8.0	8.1	0.96	0.78	0.85	0.0	10.0	12.5
12 months	9.4	8.1	8.6	1.16	0.73	1.14	0.0	11.1	0.0
18 months	11.9	10.5	10.9	1.50	1.98	1.96	0.0	0.0	0.0
24 months	11.4	9.5	10.2	1.30	1.66	1.79	0.0	0.0	6.3
30 months	10.4	10.2	10.3	1.70	1.29	1.58	0.0	0.0	6.3

Table 3

Mid-upper-arm circumference (MUAC) for age

Age	MUAC (cm)			SD(Z- scores)			Scores Percentage below-2 Z-scores		
	Male	Female	Both	Male	Female	Both	Male	Female	Both
32 weeks	14.2	13.9	14.1	1.81	0.84	1.58	0.0	0.0	0.0
10 months	13.7	14.3	14.0	1.14	0.72	0.95	16.7	10.0	6.3
12 months	15.3	14.5	14.9	1.22	1.34	1.22	0.0	11.1	6.3
18 months	14.4	14.6	14.5	1.15	1.18	1.18	0.0	0.0	0.0
24 months	14.5	14.6	14.6	1.63	0.91	1.24	0.0	0.0	6.3
30 months	15.0	13.9	14.7	1.45	1.15	1.50	0.0	0.0	6.3

Note: The columns headed 'Both' in the tables indicate when male and female are combined.

Table 4
Height-for-age

Age	Mean height(cm)			SD(Z score)			Percentage below -2 Z-scores		
	Male	Female	Both	Male	Female	Both	Male	Female	Both
32 weeks	64.2	62.3	63.6	2.72	3.76	3.21	0.0	0.0	0.0
10 months	66.7	67.9	67.4	4.00	6.49	4.35	0.0	10.0	6.3
12 months	70.4	68.1	69.1	3.69	4.38	4.26	0.0	0.0	6.3
18 months	78.0	75.6	76.3	4.82	4.45	4.70	0.0	0.0	0.0
24 months	81.9	82.6	82.3	5.58	5.05	5.27	0.0	0.0	0.0
30 months	85.8	83.3	85.0	4.81	8.12	6.16	9.0	0.0	6.3

Note: The columns headed 'Both' in the tables indicate when male and female are combined.

Other statistical derivatives (standard deviation +2SD, 2SD etc are shown in the tables).

Weight: According to the finding, the mean weight increases steadily with age; however, this falls below the standard expected for each age group. For instance, the mean weight for subjects aged 12 months i.e. one year was found to be 8.6 kg; whereas the expected standard weight at one year to age is 10kg. The results also shows the male subjects in each age group have greater mean weight than their corresponding female counterparts. Of the ten month old subjects, 12.5% are of weights less than 2SD, those aged 24 and 30 months have 6.3% below 2SD for each of the age groups (Table 2).

Mid upper arm circumference (MUAC): The mean value of MUAC was found to rise steadily with age and with a peak at age 12 months, i.e. 14.9cm. However, beyond this age the value dropped to 14.5cm for age 18 months and thereafter steadily rising again for subsequent ages. Subjects in the age groups 10 and 12 months had 6.3% MUAC below 2SD respectively (Table 3).

Height: The mean height was found to rise steadily with age. The 7.5 month-aged subjects had mean height of 63.6cm while the 30 month- old subjects had mean height of 85.0cm (the highest mean value). As it was found with the mean weight values, males were found to be taller than their corresponding female counterparts of the same age groups. Similar to MUAC, subjects in each of the groups 10 and 12 months had 6.3% of their members having heights <2SD (Table 4).

Developmental scores: Employing the BSID, all the subjects were found to score above the normal minimal developmental index of 50.

DISCUSSION

Anthropometric indices such as weight, height and mid upper arm circumference (MUAC) are used as the important criteria in growth and nutritional assessment of children; especially the under five years of age(12) and adequate nutrition is an important factor of development.

The results from this study using the weight-for-age index shows mild to moderate malnutrition of the subjects. For instance, the ideal weight for a 12-month old child

according to WHO standard is expected to be 10kg; however, the mean weight for the 12-month old subjects in this study was 8.6kg. Of the six different age groups, none of the mean weights is up to the ideal for the respective ages. Additionally, for each age group, girls weighed much less than their male counterparts. These findings could reflect the common state of under-nourishment of children in developing countries at these age groups due to earlier weaning and introduction of poor calorie and protein deficient adult diets. In addition to this, the culture in some developing nations including Nigeria shows preferential care or treatment for male children over their female counterparts. Hence, this could be a possible reason for the apparent higher weights for the males who might have been fed better than their female colleagues.

Despite the finding of the subjects being underweight, only 12.5% of the subjects aged ten months; 6.3% for the subjects aged 24 and 30 months respectively have their weights below '2 Z-scores'. These percentages are far less than those found for children in Ondo state of Nigeria where 26.9% of the children studied were below 2 Z-scores in a transcultural study involving many countries (12). Similarly for the other anthropometric measures of height and MUAC only a small percentage of the subjects were found to fall below 2 Z-scores (Tables 3 and 4).

Despite the finding of general underweight of the subjects in this study, all of them scored above the minimum normal developmental index of 50 when assessed with the BSID instrument. Perhaps, this is in line with the previous findings by earlier authors that malnutrition in early life is clearly linked with poorer behavioural and cognitive development but this causative link is in synergy with some other environmental factors(3,21). It is, however, curious to note that despite the unfavourable nutritional status of a number of children in Africa; investigations carried out on Kenyan children using BSID in the mid 70's revealed the finding of 'motor precocity' in psychomotor development of the African children when compared with their caucasian counterparts(19). This finding was attributed to the regular muscular stimulation of the babies during 'rocky' and 'backing' play with the child, a common practice among the African mothers or caregivers(19).

In conclusion, despite the general state of malnutrition as reflected in the anthropometric indices of the sample of Nigerian children studied, they obtained normal developmental scores with the BSID in the course of their developmental assessment. However, it is the suggestion of the authors that appropriate interventions should be taken to improve the nutritional status of the Nigerian children so as to further enhance their maximal developmental attainment. In this study, the sample size was noted to be rather small for childhood developmental and anthropometric assessment of this nature, but it is our conviction that the findings are significant enough to justify concerted efforts to improve the nutritional states of the Nigerian children.

REFERENCES

1. Bennett, F.J. Growth and Development: Child health in the tropics, 4th Edition. 1982, ELBS Publishers.
2. Senemaud, B. Diet, Environment and Children's Development. Children in the tropics. 1988; 77.
3. Stanton, W.R. Indices of perinatal complications, family background, child rearing and Health as Predictors of Early Cognition and Motor Development. *Paediatrics*. 1991; 88:5
4. Winick, M. Malnutrition and mental development. In Alfin-Slater, R.B. and Kritchevsky, D. (eds.): Human Nutrition. Plenum Press: New York, 1979.
5. Read, M.S. Malnutrition and Behaviour. Occasional paper series No.9. Chapel Hill, N.C: Institute of Nutrition., 1982.
6. Dobbing, J. Infant Nutrition and later achievement. *Nutr. Rev.* 1984; 42:1-7.
7. Trulson, M.E. Dietary tryptophan does not alter the function of brain serotonin neurons. *Life Sci.* 1985; 37:1067-1072.
8. Wachs, T.D. Nutritional intake and context as predictors of Cognition and Adaptive Behaviour of Egyptian School age Children. *Intern. J. Behav. Dev.* 1995; 3: 425-450.
9. Houscham, K.C; DeVilliers, J.F.K. Computed tomography in severe protein energy malnutrition. *Arch. Dis. Child.* 1987; 62: 589-592.
10. Stoch, M.B., Smythe, P.M., Moodie, A.D. and Bradshaw, D. Psychosocial outcome and CT findings after gross undernourishment during infancy: A 20-year developmental study. *Dev. Med. Child. Neurol.* 1982; 24: 419-436.
11. World Health Organisation. Guidelines for Training Community Health Workers in Nutrition. 2nd edition., 1986 W.H.O., Geneva.
12. Report of a WHO Expert Committee. Physical Status:- The Measurement and Interpretation of Anthropometry; 1995 WHO, Geneva.
13. Galler, J.R., Ramsey, F., and Forde, V. A follow-up study of the influence of early malnutrition on subsequent development: Intellectual performance during adolescence. *Nutr. Behav.* 1986; 3: 211-222
14. Grantham-McGregor, S, Schofield, W, and Harris, L. Effects of Psychosocial Stimulation on Mental Development of Severely Malnourished Children: An interim report. *Paediatrics*. 1983; 72: 239-243.
15. Knobloch, H. and Pesamanick, B. Gesell end Amatruda's Developmental diagnosis, 3rd edition, 1974. Harpar and Row: Hagerstown, M.D.
16. Bayley, N. Bayley Scales of Infant Development. The Psychological Corporation. New York, 1969.
17. Wener, E. E. Infants Around the World: Cross-cultural Studies of Psychomotor Development from Birth to Two years. *J. Cross Cult. Psychol.* 1972; 3:111-134.
18. Anastasi, A. Psychological Testing, 4th edition Macmillan Publishing Co Inc: New York 1976.
19. Super, C. M. Environmental Effects on Motor Development: The Case of South African Precocity. *Dev. Med. Child. Neurol.* 1976; 18: 581-587
20. Solomos, H. C. Cross-cultural Norms for Infant Development Screening. *Int. J. Rehab. Res.* 1981; 4:531.
21. Raiten, D. J. Nutrition and Developmental Disabilities: Issues in Chronic Care. In Schopler, E. and Mesibov, G. B. (eds.): Neurobiological Issues in Autism, Plenum Press: New York. 1987.