

NUTRITION AND PHYSICAL FITNESS OF WHITE, COLOURED, AND BANTU HIGH-SCHOOL CHILDREN*

A. W. SLOAN, B.Sc., M.D. (GLASG.), PH.D. (CAPE TOWN), F.R.C.P. (GLASG.), M.R.C.P., F.R.S.S.A.F. AND J. D. L. HANSEN, M.D. (CAPE TOWN), F.R.C.P., D.C.H. (ENG.), *Departments of Physiology and Child Health, University of Cape Town*

In an investigation of the physical fitness of 5,962 Cape Town high-school children¹ the height and weight of each child were measured and the children performed 7 tests of athletic fitness. The children's ages were from 12 to 18 years and they were attending White, Coloured, and Bantu high schools; the Coloured group included a small proportion of Asians. Height was measured (barefoot) to the nearest $\frac{1}{2}$ inch and weight (barefoot and wearing light gymnastic costume) to the nearest 1 lb. The physical fitness tests performed were those recommended by the American Association for Health, Physical Education and Recreation.² The test battery comprises: pull-ups (modified pull-ups for girls), sit-ups, shuttle run, standing broad jump, 50-yard run, softball throw for distance, and 600-yard run-walk. Full details of each test are given in a previous paper.¹

In each age-group White boys were taller and heavier than Coloured and Bantu boys and were superior at 6 of the 7 tests. There was no consistent difference in height or in weight between Coloured and Bantu boys but the Coloured were superior at 5 of the tests. White girls were taller than Coloured and Bantu girls and heavier than Coloured. Bantu girls gained weight rapidly from the age of 14 years to become the heaviest in the older age-groups. There was no consistent difference in fitness between White and Coloured girls but the Bantu were the poorest at 5 of the tests.

The differences in height and weight between White and non-White children, already noted by other investigators,^{3,4} could be due to a number of factors, of which nutritional and economic status are probably the most important.^{5,6} Since poor athletic performance may be due to poor nutrition even before clinical signs of malnutrition are manifest,⁷ it was decided to analyse the data further in order to ascertain whether the poorer performance of this sample of non-White children could be attributed to undernutrition as suggested by their lower heights and weights.

PRESENT INVESTIGATION

In the original investigation every pupil at 15 high schools, who had not been excused from physical activity on medical grounds, was subjected to the tests. For the present analysis racial groups of comparable size of boys and of girls were selected in each age-group (a total of 1,050 children). Since the selection was random they may be regarded as a representative sample of the population originally investigated.

In order to obtain a single index of physical fitness for each child the raw scores for each test were converted to

standard scores⁸ (T-scores,⁹ sigma scores¹⁰). For all the boys and for all the girls the mean (\bar{x}) and the standard deviation (σ) were calculated for the results of each test. For each test for boys and for girls the range $\bar{x} \pm 3\sigma$ was equated to the range 0-100 of the corresponding standard score. The scores for the runs were 'inverted', since the shortest time corresponds to the best performance. Each individual raw score was then converted to the corresponding standard score. The 7 standard scores for each individual were added and the total divided by 7 to give a 'fitness index', which was taken as the measure of physical fitness.

In each age-group of boys and of girls the heights, weights, and fitness indexes of the 3 racial groups were compared. The heights and weights were compared also with standards of height and weight for British children.¹¹ By analysis of covariance the effects of eliminating the height factor or the weight factor on the differences in physical fitness were determined. The analysis was performed on an ICT 1301 computer.

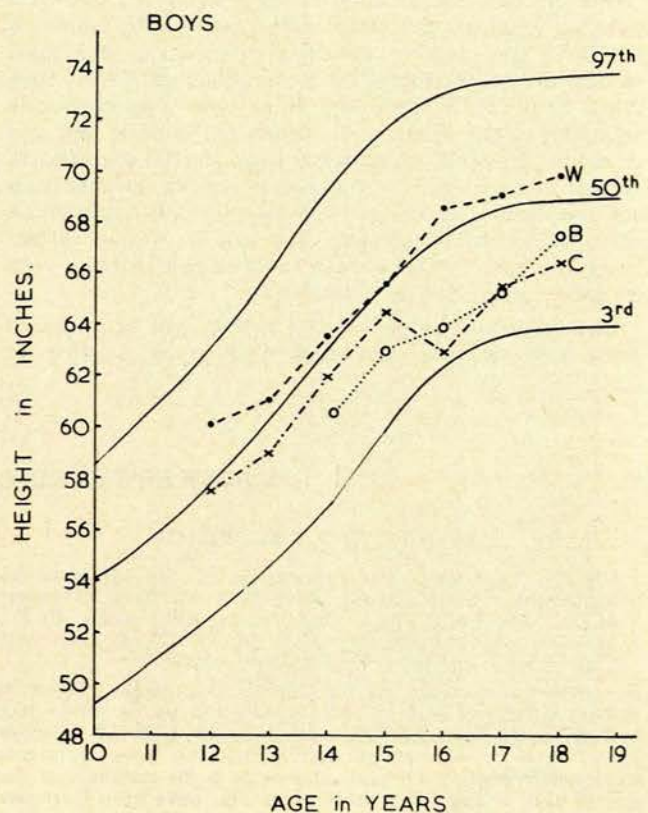


Fig. 1. Height of boys. Continuous lines on Figs. 1-4 are corresponding percentiles for British children. W = White; C = Coloured; B = Bantu.

*Paper presented at the 66th Annual Congress of the South African Association for the Advancement of Science, Lourenço Marques, July 1968.

RESULTS

Figs. 1-6 give the mean values for height, weight, and fitness index in each sex and age-group for White, Coloured, and Bantu children, and relate the heights and weights to those of British children. The inter-racial differences in height, weight, and physical fitness correspond to what might be expected from the data of the original investigation. All the heights and weights fell within the normal range (above the 10th percentile) for British children.

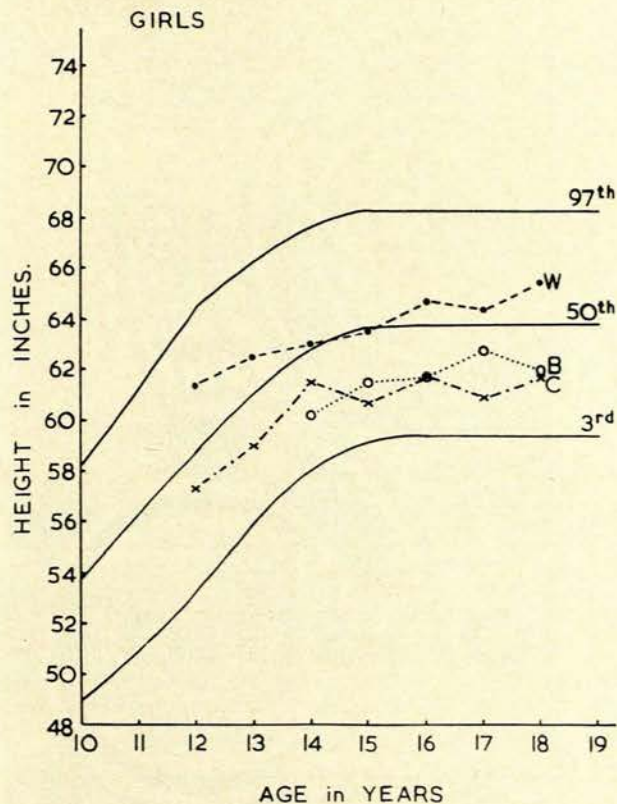


Fig. 2. Height of girls.

By analysis of covariance it was found that elimination of the height factor or the weight factor resulted in no major change in the inter-racial differences of fitness in boys. It is permissible to eliminate the height factor or the

TABLE I. INTER-RACIAL DIFFERENCES IN PHYSICAL FITNESS — BOYS

Age (years)	True difference	Height factor excluded	Weight factor excluded
12	W≈C	W≈C	W≈C
13	W>C	W≈C	W≈C*
14	W>C>B	W>C>B	W>C>B
15	(W≈C)>B	(W≈C)>B	(W≈C)>B
16	(W≈C)>B	(C≈W) (C≈A) W>B	W>B*
17	W>C>B	W>C>B	W>C>B
18	W>C>B	W>C>B	W>C*

W = White; C = Coloured; B = Bantu.
 > greater than (5% level of significance).
 ≈ not significantly different (5% level of significance).
 * influence of weight on criterion is not similar in all groups.

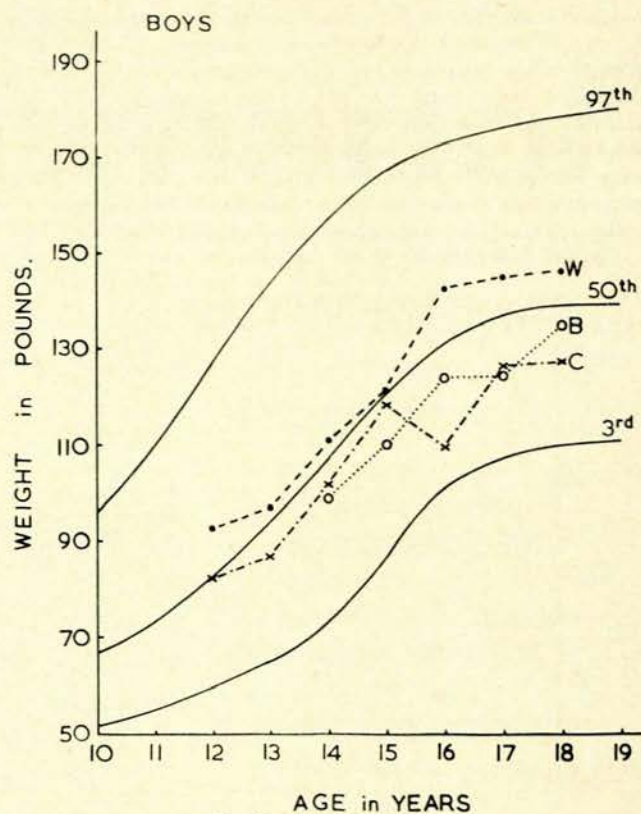


Fig. 3. Weight of boys.

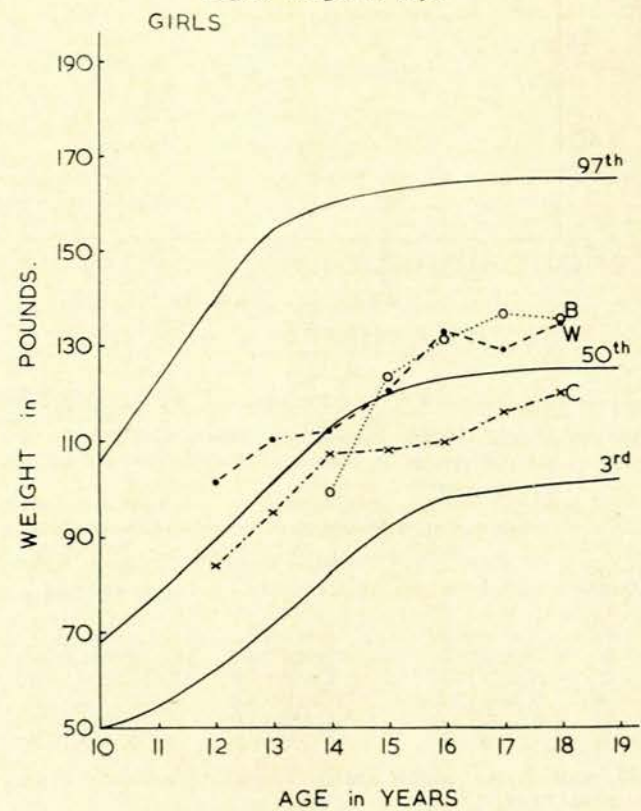


Fig. 4. Weight of girls.

weight factor only if the relation of performance to height or of performance to weight is similar in each of the groups being compared. In the comparison of White and Coloured boys aged 13 years, this condition was not satisfied for exclusion of the weight factor; the heavier White boys were fitter, whereas the heavier Coloured boys were less fit. The relation of weight to fitness in 16-year-old boys was similar in White and Bantu but different in Coloured; at 18 years of age it was similar in White and Coloured but different in Bantu subjects.

DISCUSSION

The AAHPER test battery is a satisfactory and widely accepted measure of the physical fitness of adolescents and young adults. Since there is a low correlation between the results of the different tests^{12,13} it is assumed that they measure different aspects of physical fitness (strength, flexibility, agility, power, speed, coordination, and endurance). The fitness index derived from the results of the 7 tests is therefore a fair indication (without loading the results of individual tests) of general fitness for athletic activity.

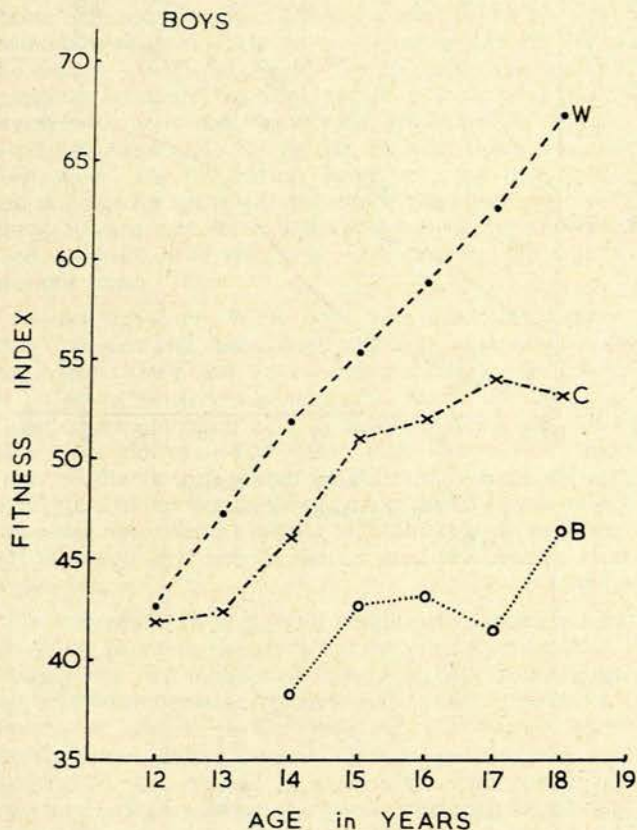


Fig. 5. Fitness index of boys.

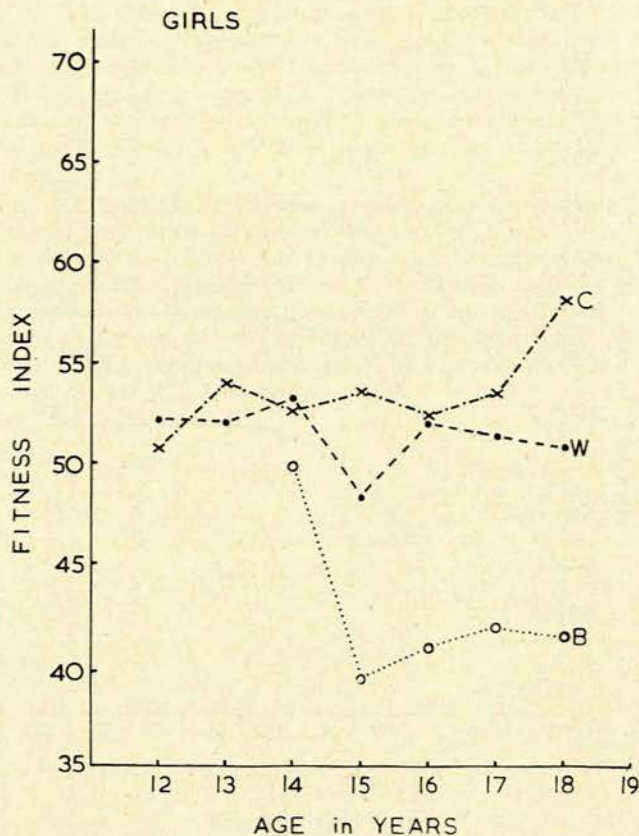


Fig. 6. Fitness index of girls.

For girls, as for boys, elimination of the height factor or the weight factor caused no major change in the inter-racial differences in fitness (Table II).

TABLE II. INTER-RACIAL DIFFERENCES IN PHYSICAL FITNESS — GIRLS

Age (years)	True difference	Height factor excluded	Weight factor excluded
12	W ≈ C	W ≈ C	W ≈ C
13	C ≈ W	W ≈ C	W ≈ C
14	W ≈ C ≈ B	W ≈ C ≈ B	W ≈ C ≈ B
15	(C ≈ W) > B	(C ≈ W) > B	(C ≈ W) > B
16	(C ≈ W) > B	(C ≈ W) > B	(W ≈ C) > B
17	(C ≈ W) > B	(C ≈ W) > B	(C ≈ W) > B
18	C > W > B	(C ≈ W) > B	(C ≈ W) > B

W = White; C = Coloured; B = Bantu.
 > greater than (5% level of significance).
 ≈ not significantly different (5% level of significance).

Close agreement of the mean values for height and weight in each group of the sample with the mean values in the original investigation shows that the sample fairly represents all the children tested.

The non-White high-school children are presumably from the higher-income families since school attendance declines with age in the lower income groups. Although most of the inter-racial differences in height and weight are statistically significant they may not be biologically significant, since all the mean values fall within the normal range for British children; this excludes any gross nutritional deficiency. It does not however exclude minor degrees of mal- or undernutrition as the cause of the observed inter-racial differences in physical fitness of the present series. However, if this were the explanation of the poorer performance of some non-White children, we

should expect the taller and heavier of the non-White children to have the same performance as White children of the same height and weight. Elimination of the factors of height and weight by analysis of covariance showed that this was not so; the inter-racial differences in physical fitness remained even when the factors of height and weight were excluded. Consequently we are led to the conclusion that the inter-racial differences in physical fitness are not due to undernutrition of the children with the poorer athletic performance. The explanation must be sought in terms of other factors which influence the performance of athletic tests, such as genetically determined patterns of body structure, skill, training, and motivation.

In Texas, Ponthieux and Barker¹⁴ found Negro children significantly better than White at most of the AAHPER tests; the heights and weights of the children were not recorded. With a similar test battery, Ikeda¹⁵ found Japanese children superior to American at 6 of 7 tests, although the Japanese were shorter and lighter. Asmussen¹⁶ has shown how particular body shapes favour performance of particular athletic events; for instance, greater stature favours jumping and throwing, whereas a more compact build favours the weight-lifter and would be of advantage in the pull-up test. A detailed anthropometric study of South African school-children has shown significant inter-racial differences in other parameters as well as in height and weight.¹⁷

Although some skill, and the coordination on which it depends, may be inherited, skill is improved by training, as are speed, strength, and endurance.^{18,19} The degree of habitual physical activity of different groups of children may be a major factor in determining their relative physical fitness. Kammeyer,²⁰ in Washington State, found that the physical fitness of high-school girls was related to the degree of extracurricular physical activity. Rosenstein and Frost,²¹ in New York State, found little correlation between physical fitness and extracurricular physical activity in high-school children, but Rosenstein²² found that the physical fitness of the children was related to the quality of the physical education programme at the different schools. Although physical education formed part of the weekly curriculum of all the schools included in the present survey, every White school had a gymnasium and a trained physical education teacher, whereas most of the non-White schools had neither.

Although motivation is a major factor in the performance of strenuous tests of fitness,^{23,24} it is very difficult to assess. In the present investigation motivation was encouraged by making the tests competitive between schools. At each school the pupils were told which rival schools were performing the tests and that the results would be compared. Since degrees of motivation cannot be measured an attempt must be made to attain the maximum motivation in every case.

The full explanation of the inter-racial differences in physical fitness which we have observed in Cape Town high-school children is still to be found.

SUMMARY

For 1,050 healthy Cape Town high-school children (a representative sample of approximately 6,000 investigated) the mean

height and weight of each age-group of each sex of White, Coloured, and Bantu children were compared with the corresponding figures for the other racial groups and with standards for British children. White South African boys were taller and heavier than Coloured and Bantu boys, and White South African girls were taller and heavier than Coloured and taller than Bantu girls, but the heights and weights of all the South African groups fell within the normal range for British children.

A composite fitness index was derived for each South African child from the results of 7 tests of athletic fitness, and inter-racial comparisons were carried out for each age-group of either sex. At most ages White boys were fitter than Coloured, who were fitter than Bantu, and White and Coloured girls were fitter than Bantu. After elimination of the height and weight factors by analysis of covariance the inter-racial differences in fitness were substantially unchanged, which suggests that the poorer performance of some non-White children was not due to undernutrition. The differences may be due to inherent genetic factors, to differences in training or in habitual physical activity, or to different degrees of motivation.

Our thanks are due to the Staff Research Fund of the University of Cape Town and to USPHS Grant AMO 3995 for financial support. We wish to thank Prof. G. G. Troskie and Messrs W. B. de V. Smit and Z. Zaltzman for the statistical analysis.

The statistical data on which Figs. 1-6 are based may be obtained on request.

REFERENCES

- Sloan, A. W. (1966): *S. Afr. Med. J.*, **40**, 682.
- American Association for Health, Physical Education and Recreation (1958): *Youth Fitness Test Manual*. Washington, DC: AAHPER.
- Woodrow, E. P. and Robertson, I. (1950): *S. Afr. Med. J.*, **24**, 761.
- Lurie, G. M. and Ford, F. J. (1958): *Ibid.*, **32**, 1017.
- Hansen, J. D. L. (1962): *Proc. Nutr. Soc. Sth Afr.*, **3**, 126.
- Wittmann, W., Moodie, A. D., Fellingham, S. A. and Hansen, J. D. L. (1967): *S. Afr. Med. J.*, **41**, 664.
- Van Itallie, T. B., Sinisterra, L. and Stare, F. J. (1956): *J. Amer. Med. Assoc.*, **162**, 1120.
- Cureton, T. K. (1947): *Physical Fitness Appraisal and Guidance*. St. Louis: C. V. Mosby.
- Sloan, A. W. and Wiggett, R. (1967): *J. Sport Med. (Torino)*, **7**, 192.
- Campbell, W. R. and Tucker, N. M. (1967): *An Introduction to Tests and Measurements in Physical Education*. London: G. Bell & Sons.
- Tanner, J. M., Whitehouse, R. H. and Takaishi, M. (1966): *Arch. Dis. Childh.*, **41**, 454 and 613.
- Fowler, W. M. and Gardner, G. G. (1963): *Pediatrics*, **32**, 778.
- Hunsicker, P. A. and Reiff, G. G. (1966): *J. Hlth Phys. Educ.*, **37**, 23.
- Ponthieux, N. A. and Barker, D. G. (1965): *Res. Quart. Amer. Assoc. Hlth Phys. Educ.*, **36**, 468.
- Ikeda, N. (1962): *Ibid.*, **33**, 541.
- Asmussen, E. (1964): *Proceedings of the International Congress on Sport Science*, Tokyo, p. 67.
- Smit, P. J., Potgieter, J. F., Neser, M. L. and Fellingham, S. A. (1967): *S. Afr. Med. J.*, **41**, 422.
- Knuttgen, H. G. and Steendahl, K. (1963): *Res. Quart. Amer. Assoc. Hlth Phys. Educ.*, **34**, 34.
- Banister, E. W. (1965): *Ibid.*, **36**, 387.
- Kammeyer, S. J. (1956): *Ibid.*, **27**, 310.
- Rosenstein, I. and Frost, R. B. (1964): *Ibid.*, **35**, 403.
- Rosenstein, I. (1963): *Physical Fitness Achievement in Selected Physical Education Programs*. Albany, NY: University of the State of New York.
- Michael, E. D. jr and Horvath, S. M. (1965): *J. Appl. Physiol.*, **20**, 263.
- Askew, N. R. (1966): *Res. Quart. Amer. Assoc. Hlth Phys. Educ.*, **37**, 451.