

## PHYSICAL FITNESS OF CAPE TOWN HIGH SCHOOL CHILDREN\*

A. W. SLOAN, M.D., B.Sc., F.R.C.P. (GLASG.), M.R.C.P. (LOND.), *Professor of Physiology, University of Cape Town*

'Physical fitness' implies not only the absence of overt disease or deformity but also the capacity to perform one's daily tasks without limitations imposed by poor function of any of the systems of the body.<sup>1</sup> Physical educationalists would set a higher standard and claim that physical fitness is a state of health in which active exercise can be undertaken efficiently, without undue fatigue and with a sense of well-being.<sup>2,3</sup> To assess physical fitness various factors such as strength, speed, agility, flexibility, coordination, and endurance may be measured by appropriate tests. Such tests were performed on more than 6,000 boys and girls at high schools in the region of the Cape Peninsula in an attempt to determine the influence of sex, age, and race on physical fitness. Racial segregation in the schools facilitated the interracial comparison.

## SUBJECTS

The subjects of this investigation were pupils of 15 high schools in or near Cape Town. The schools were selected to include those serving upper, middle, and lower-income groups of the White and of the Coloured communities and also the only high school for Africans in Cape Town. Since the 'Coloured' schools cater not only for children of mixed European and African stock but also for a small proportion of Asiatics (mostly Malay or Indian), for the purpose of this investigation these children are all classed as Coloured. The African pupils are mostly pure Bantu. At each school every pupil, who was not exempted on medical grounds from physical activity, was subjected to the tests. Analysis was limited to the age-groups 12-18 and any incomplete records were rejected, leaving 5,962 subjects for analysis.

## TESTS

The test battery employed was that of the American Association for Health, Physical Education and Recreation (AAHPER).<sup>4</sup> This battery of 7 tests has been used extensively in the USA and in Great Britain<sup>5</sup> and all the tests have proved reliable, as indicated by a highly significant test-retest correlation.<sup>6</sup> The first 4 tests are normally performed in the gymnasium by a class during 1 school period and the remaining 3 out of doors in 1 school period.

The AAHPER gives detailed instructions for the performance and scoring of each test, as follows:

*Pull-up*

The pull-up for boys is performed hanging from a bar high enough for the feet to be clear of the floor when the arms are fully extended. The overhand grasp is used (Fig. A). The subject raises his body by his arms until his chin is above the bar and then lowers himself to the starting position. No swinging of the body or kicking of the legs is permitted. The exercise is repeated as often as possible

without resting and the score is the number of complete pull-ups achieved.



Fig. A. Pull-up (boys).

*Modified Pull-up*

In the modified pull-up for girls a horizontal bar, set at about nipple level, is grasped with both hands, using an overhand grasp. The subject extends her legs under the bar and extends her arms fully (Fig. B). The arms should

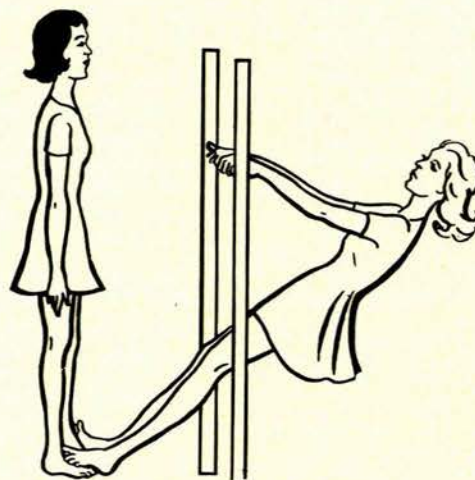


Fig. B. Modified pull-up (girls).

\*The work on which this paper is based forms part of a thesis submitted for the degree of Ph.D. of the University of Cape Town.

form an angle of 90° with the straight trunk and legs, which should form an angle of 45° with the floor. The heels should be braced (for instance against the scorer's

feet) to prevent slipping. From this position, keeping her body straight, the subject raises herself by the arms until the chest touches the bar and then returns to the starting position. No resting is permitted. The score is the number of completed pull-ups to a maximum of 40.

#### Sit-up

The sit-up is performed with the subject supine on the floor with the legs extended and feet about 2 ft. apart. The hands are placed on the back of the neck with the fingers interlaced and the elbows against the floor. A partner holds the ankles down and acts as scorer (Fig. C). To perform the test the subject sits up turning the trunk to the left and touching the right elbow to the left knee, returns to the starting position, and then sits up turning the trunk to the



Fig. C. Sit-up.

right and touching the left elbow to the right knee. The exercise is repeated, alternating sides. In scoring, one point is given for each complete movement of touching elbow to knee. No score is counted if the fingertips do not maintain contact behind the head, if knees are bent when the subject lies on his back, or when he begins to sit up, or if he pushes up off the floor with an elbow. The maximum score in number of sit-ups is restricted to 50 for girls and 100 for boys.

#### Shuttle Run

For the shuttle run, two parallel lines are marked on the floor 30 ft. apart and 2 small blocks of wood (2 in. x 2 in.

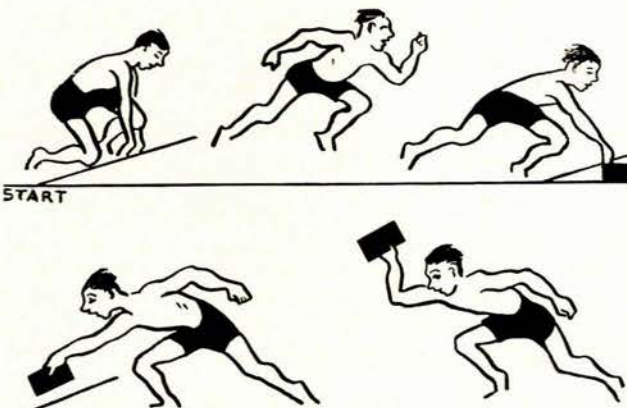


Fig. D. Shuttle run.

x 4 in.) are placed beyond one of the lines. Starting from behind the other line the boy or girl runs to the blocks, picks one up, runs back to the starting line, and places the block behind the line, runs back and picks up the second block, and runs back with it across the starting line (Fig. D). At least 2 scorers should be available with stop-watches so that at least 2 subjects can run at the same time. Two trials are allowed with a rest between. The score is the shorter of the 2 times to the nearest tenth of a second.

#### Standing Broad Jump

For the standing broad jump the boy or girl stands with feet apart and toes just behind the take-off line. Preparatory to jumping the subject swings the arms backwards and bends the knees (Fig. E). The jump is accomplished by

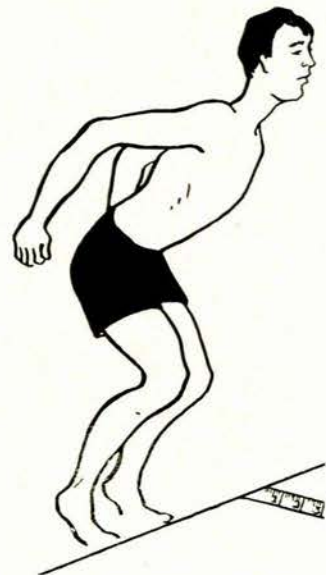


Fig. E. Standing broad jump.

simultaneously extending the knees and swinging forward the arms. The jump is measured to the heel or other part of the body that touches the floor nearest the take-off line. Three trials are allowed and the score is the longest of the 3 jumps measured to the nearest inch.

#### 50-yard Dash

This test is performed by 2 or more subjects at a time, depending on the number of timers with stop-watches available. The starter drops his arm on the command 'go', to give the timer a visual signal. This test is performed once only and the score is the time taken to run 50 yards, measured to the nearest tenth of a second.

#### Softball Throw for Distance

A standard (12-inch circumference) softball is used. Starting from in front of a line 6 ft. behind the take-off line, the boy or girl throws the softball overhand from behind the take-off line as far as possible. The throw is measured from the point of landing to the nearest point on the take-off line. Three throws are allowed and the score is the longest of the 3 throws, measured to the nearest foot.

### 600-yard Run-Walk

From a standing start the boy or girl runs 600 yards. If unable to run the whole distance he intersperses running with walking, but the object is to cover the distance in the shortest possible time. It is convenient to have from 6 to 12 subjects running together; each runner has a partner who notes the time called out by the timer as that runner crosses the finishing line. The test is performed once only and the score is the time taken to cover 600 yards, measured to the nearest second.

At each school I explained the tests to the physical education staff and to the pupils and personally supervised many of the tests to ensure uniformity of scoring. Sex, age, height, and weight were recorded for each pupil as well as the score for each of the tests. Age was taken as age in years at last birthday; height was measured to the nearest half-inch, and weight to the nearest pound. The statistical significance of the interracial differences was calculated with the aid of an ICT computer (Model 1301).

## RESULTS

### Height

White and African boys showed a progressive increase in height up to the age of 18 and Coloured boys up to the age of 17. Coloured girls ceased to gain height at 16 and White and African girls at 17 (Fig. 1). In each age-group and each sex, White children were the tallest. There was no consistent difference in height between African and Coloured children.

### Weight

Boys and girls of all races gained weight up to the age of 18 (Fig. 2). White boys were heavier than Coloured or African boys and there was little difference between Coloureds and Africans. White girls were heavier than Coloureds at every age but African girls, gaining weight rapidly from the age of 14, were the heaviest in the older age-groups.

### Pull-up

At pull-ups (Fig. 3) White and Coloured boys improved progressively up to the age of 17 whereas African boys deteriorated after 16. From 15 years of age the Africans were the poorest at this test. The modified pull-up for girls (with an arbitrary maximum score of 40) showed no significant age trend in any racial group and no significant difference between the races.

### Sit-up

At sit-ups (Fig. 4) a tendency to improve with age was obvious only for White boys, who were better than Coloured boys, who in turn were better than African. White and African girls tended to deteriorate at this test in the older age-groups but Coloured girls showed some improvement after the age of 16. At most ages White girls were superior to Coloureds, and Coloureds were superior to Africans.

### Shuttle Run

White and Coloured boys improved progressively and Africans irregularly with age at the shuttle run (Fig. 5). White boys were better than Coloureds and Africans at most ages and there was no significant difference between Coloureds and Africans. The girls' performance tended to deteriorate with age. Coloured girls were superior to Whites in most age-groups and White girls were superior to Africans.

### Standing Broad Jump

The performance of boys at the standing broad jump showed progressive improvement with age, except for the highest age-group of Coloured boys (Fig. 6). White boys were superior to Coloureds, and Coloured boys to Africans. Girls showed no

consistent age trend at this test. Coloured girls had the highest scores and White girls were better than Africans.

### 50-yard Dash

At the 50-yard dash White and Coloured boys improved progressively with age, but African boys deteriorated after the age of 16 (Fig. 7). White boys were superior to Coloureds and Coloureds were superior to Africans. The performance of White girls was not related to age but Coloured and African girls deteriorated from the age of 14. White girls were superior to Coloureds and Coloureds to Africans at this test.

### Softball Throw

Boys improved with age at the softball throw (Fig. 8). White boys were superior to both other racial groups and there was no significant difference between Coloureds and Africans. Girls showed less obvious improvement with age. Coloured and African girls were better than Whites at this test and, in the younger age-groups, Coloureds were significantly better than Africans.

### 600-yard Run-Walk

At the 600-yard run-walk there was progressive improvement with age in White and Coloured boys but very poor performance by African boys aged 15-17 (Fig. 9). White boys were superior at most ages and African boys were much worse than either of the other racial groups. There was no obvious age trend in White or Coloured girls, but African girls deteriorated from the age of 14. In some age-groups White girls were significantly better than Coloureds and, from the age of 15, White and Coloured girls were significantly better than Africans.

## COMMENTS ON RESULTS

### Height

The growth curves of height follow the usual pattern for children and adolescents.<sup>7,8</sup> The apparent loss of height of African girls from 16 to 17 years of age is presumably due to the taller individuals leaving school at a younger age than the others, but no far-reaching conclusions should be drawn from this observation. The greater height of White than of other children in South Africa may be due to better nutrition.<sup>9</sup> The dominant effect of undernutrition in children is retardation of growth.<sup>10</sup> Although growth in weight is usually affected more than growth in height, much smallness of stature attributed to racial factors is really due to malnutrition.<sup>11</sup> A privileged group of Bantu children in South Africa has been shown to achieve the same heights and weights as White South African children.<sup>12</sup>

### Weight

The growth curve for weight of boys follows the same general pattern as the curve for height, and the greater weight of White than of Coloured boys and of Coloureds than Africans may have the same nutritional basis as the differences in height. The lesser weight gain in White and Coloured girls and the considerable increase in weight of African girls during adolescence may have a sociological basis. At this age girls wish to be attractive to boys; in the White and Coloured communities the more slender girl is considered more attractive whereas in the African community the more obese girl is favoured. Consequently White and Coloured adolescent girls tend to restrict their diet, whereas Africans are content to gain weight, which is easily achieved on their high-carbohydrate diet.

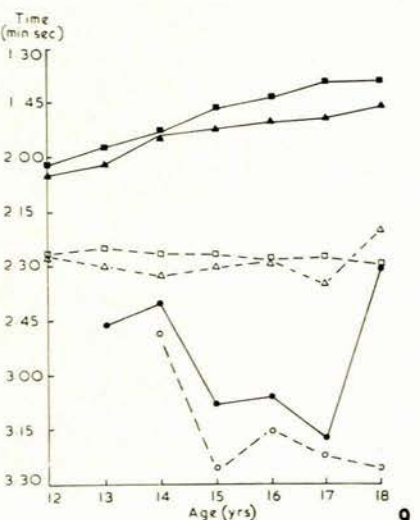
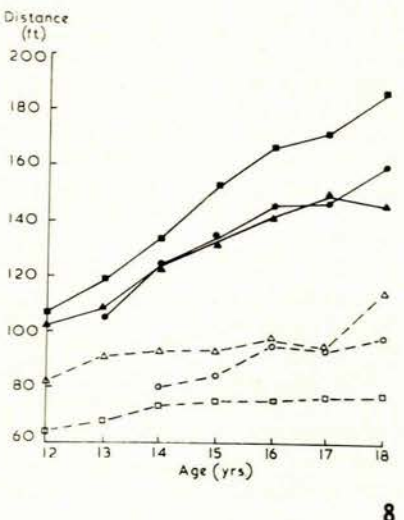
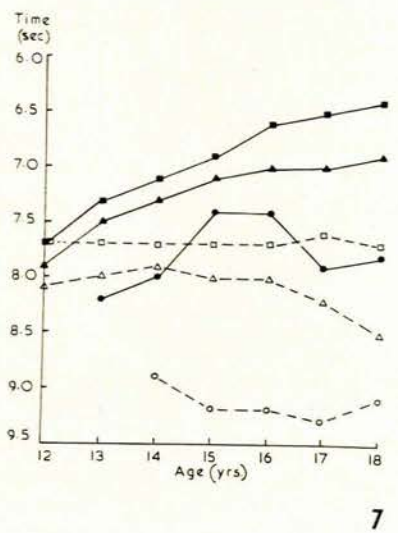
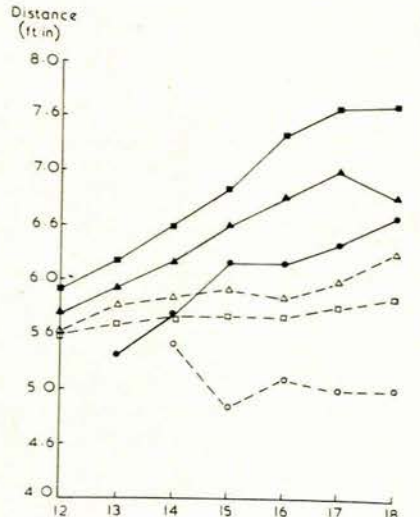
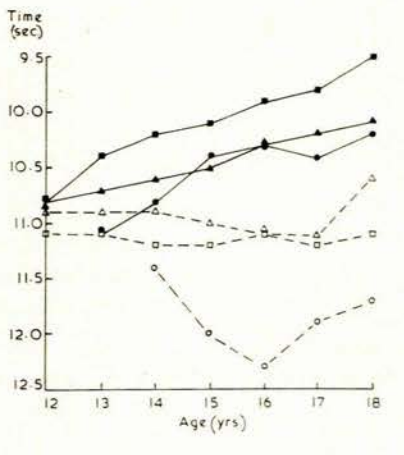
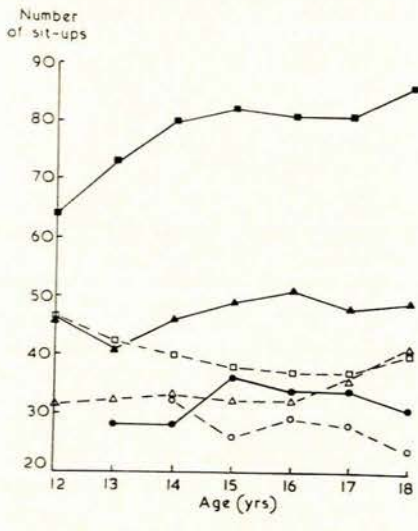
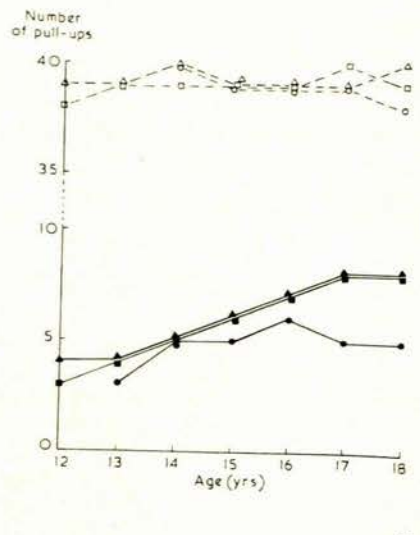
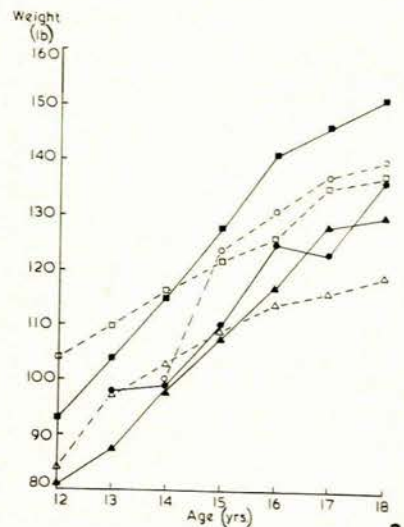
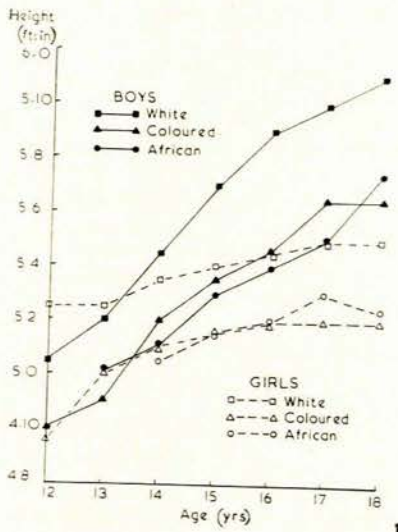


Fig. 1. Height. Fig. 2. Weight. Fig. 3. Pull-up and modified pull-up. Fig. 4. Sit-up. Fig. 5. Shuttle run. Fig. 6. Standing broad jump. Fig. 7. 50-yard dash. Fig. 8. Softball throw. Fig. 9. 600-yard run-walk.

*Pull-up*

The improvement in pull-ups with age is presumably related to progressive increase in muscular strength, and the poorer performance of African boys may be due to poorer muscular development, resulting from a less adequate diet. The modified pull-ups proved useless as a fitness test for South African girls since nearly all of them could achieve without effort the arbitrary maximum score of 40.

*Sit-up*

Sit-ups, a test of strength and flexibility, showed less obvious age trends, possibly because increasing strength is accompanied by diminishing flexibility. White boys, presumably the strongest group from their greater weight and superior performance at pull-ups, were the best at this test. In girls, whose strength does not increase much after puberty, reduced flexibility led to deterioration, especially in White and African girls. The Coloured girls, not apparently stronger than the White, retained more flexibility. An unsatisfactory feature of this test is the arbitrary maximum score of 100 for boys and 50 for girls. Many children can exceed this maximum; indeed one boy performed 468 sit-ups.

*Shuttle Run*

As shown by the shuttle run, speed and agility improve with age in boys and deteriorate in girls. The superiority of White boys and of Coloured girls has no obvious explanation but the very poor performance of African girls may be related to obesity.

*Standing Broad Jump*

The increase of strength with age in boys and the greater strength of White boys explains the progressive improvement with age and the superiority of White boys at the standing broad jump. The absence of any age trend in girls at this test is not surprising but the superiority of Coloured girls is unexpected; from their slighter build one would expect them to be less strong than White girls but it seems that they can mobilize their strength more efficiently.

*50-yard Dash*

At a test of speed (50-yard dash) White and Coloured boys showed the expected improvement with age, whereas African boys did not. Unlike Botha, Clarke and Jokl<sup>13</sup> I found African boys worse than others at this test, possibly because my subjects were urban, whereas many of theirs were rural. The deterioration of Coloured and African girls at this test after puberty follows the usual pattern (see below) but White girls, although not improving, did not deteriorate.

*Softball Throw*

The better performance at the softball throw by older boys is associated with greater strength and probably better neuromuscular coordination. The greater muscular development of the White boys explains their superiority at this test. Since girls do not gain strength appreciably after puberty, they show no consistent improvement. As in the other test of explosive strength (standing broad jump) the Coloured girls were superior in most age-groups. The

very poor performance of this test by White girls is unexplained.

*600-yard Run-Walk*

Finally, in the test of endurance (600-yard run-walk) White and Coloured boys showed the expected improvement with age. African boys were much slower than White or Coloured boys and, in most age-groups, than White or Coloured girls. This observation conflicts with that of Botha and his colleagues<sup>13</sup> who found African boys superior at the 600-yard run. As I am assured by an eminent social anthropologist<sup>14</sup> that there is no sociological reason why African boys of this age should not exert themselves (it is not considered undignified to run) I am at a loss to explain this observation. If it were due to dietary deficiency one would expect to observe signs of this, but such signs were absent. African girls, but not Whites or Coloureds, showed the expected reduction in endurance after puberty (see below) and, like African boys, were much worse than the other racial groups. In the girls' case the difference in body build (obesity in the Africans) may be at least a partial explanation.

## GENERAL DISCUSSION

With children, as with adults, different standards must be set for male and for female. Before puberty there is little or no sex difference in work capacity<sup>17,18</sup> or athletic performance<sup>17,18</sup> but girls are superior at tests of flexibility.<sup>19</sup> At all ages, boys are better at jumping and at throwing.<sup>17,18</sup> After puberty boys are superior in work capacity<sup>20-22</sup> and at most athletic tests,<sup>23,24</sup> although trained girls may equal or surpass untrained boys of the same age.<sup>25-27</sup>

Age is an important factor in the athletic performance of children. The physical fitness of boys, estimated by tests of speed, strength, and endurance, increases progressively up to 18 or 19 years of age<sup>17,18,28-33</sup> and the athletic performance of girls improves with age up to puberty, after which there is either no further improvement<sup>18,29-31</sup> or deterioration, especially in endurance.<sup>17,26,28,32,34-36</sup> Strength, as estimated by shot-put<sup>28</sup> or standing broad jump<sup>37</sup> shows progressive improvement with age in boys, and highly trained girl athletes do not suffer the deterioration in strength customary to their sex.<sup>38</sup> The deterioration in physical performance of girls after puberty may be due to lack of interest and motivation rather than to physical disability.<sup>17,18</sup>

Interracial studies of the physical fitness of children have been reported from South Africa, the U.S.A. and Ceylon. Cluver, De Jongh and Jokl<sup>13</sup> applied 3 tests (100-yard run, 600-yard run, and 12-lb. shot-put) to 9,214 South African children, classified as White, Bantu, and Asiatic. Up to puberty the Bantu boys and girls were superior to the other groups, except at the shot-put, where White boys were better than Bantu boys. After puberty the White boys led in all the tests and White girls were better than other girls at the 100-yard run. Asiatic children (Chinese and Indian) were the most inferior at all the tests.

Botha, Clarke and Jokl<sup>13</sup> applied the same tests to 1,542 White and Bantu children. They found that Bantu children performed better at the runs, in spite of a high incidence of

malnutrition and parasitic infestation, but White children were better at the shot-put, performance of which was related to body-weight. Applying the Kraus-Weber tests to 2,626 White and Bantu children, Smit<sup>30</sup> found greater flexibility in the Bantu. In Philadelphia no significant difference in work capacity was found between White and non-White children.<sup>40</sup> In Ceylon, racial differences in performance of fitness tests could be attributed to different economic and nutritional circumstances.<sup>41</sup>

Although the subjects of the present investigation showed the expected relationship of physical performance to age and sex, the interracial comparison differs from what has been observed elsewhere and even from what has been observed previously in South Africa. The very poor performance of African children in my investigation may have some nutritional basis, although they showed no overt signs of malnutrition. Athletic performance can be impaired by malnutrition before clinical signs of dietary deficiency are manifest.<sup>42</sup>

It would be enlightening and useful to carry out tests such as these in other parts of the country, including urban and rural communities, and to correlate the results with nutritional surveys.

## SUMMARY

The influence of age and of race on physical fitness was studied in a series of 5,962 South African children who performed the AAHPER battery of tests. Boys showed the anticipated gains in height and weight with increasing age and girls showed the anticipated gain in height with advancing age and in weight up to puberty. From the age of 14 years African girls increased markedly in weight, which may be attributable to sociological and dietary factors. In each age-group and each sex, White children were the tallest. There was no consistent difference in height between Coloured and African children. At all ages White boys were heavier than Coloureds and at most ages heavier than Africans, there being no consistent difference in weight between Coloured and African boys. White girls were the heaviest in the younger age-groups but in the older age-groups African girls were the heaviest.

Boys showed progressive improvement with age at most of the AAHPER tests. At most of the tests White boys were superior to Coloureds and Coloureds were superior to Africans, but the difference between Whites and Coloureds was small at pull-ups and at the 600-yard run-walk. At the shuttle run and softball throw the differences between Coloured and African boys were significant only in some age-groups.

The modified pull-ups for girls proved an unsatisfactory test of fitness. Girls showed no consistent age trend in the AAHPER tests. The differences between White, Coloured, and African girls at the several tests were less marked than the corresponding difference in boys, the Whites being superior at some tests and the Coloureds at others. The African girls were inferior at most tests, with the exception of the softball throw, at which White girls were the worst.

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