DOCUMENT RESUME

ED 201 625 SP 018 044

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TITLE Relationship Between Body Fatness and Performance in Proadolescent Children.
PUB DATE Apr 81
NOTE 16p.; Paper presented at the Annual Meeting of the American Alliance for Health, Physical Education, Recreation and Dance (Boston, MA, April, 1981).

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Age Differences; *Body Weight; *Children; Elementary Education; *Performance Factors; *Physical Characteristics; Physical Development; Physical Education; *Sex Differences
IDENTIFIERS *Preadolescents

ABSTRACT

This study investigated the relationship between physical performance tests and body fatness in young children, and the extent to which differences in performance between the sexes could be explained by differences in body fatness. Measurements of age, height, weight, skinfold thicknesses, and performance scores on the vertical jump, standing broad jump, modified pull-up, 40-yard dash, and 400-yard run were obtained on 564 elementary school children in grades one through four. Although males scored significantly higher on tests requiring the ability to move body weight around, sex differences in body fatness were insignificant and did little to explain performance differences between boys and girls. The fact that body fatness accounted for such a small proportion of performance variance from children of this age emphasizes that other underlying biological and cultural factors are more important in explaining performance. (JD)

Relationship Between Body Fatness and Performance in Preadolescent Children

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Presented at the AAHPERD National Convention
Boston, Massachusetts
April 1981

Performance differences between men and women have long been a subject of interest to coaches, physical educators, and exercise scientists. The dramatic increase in women's participation in vigorous physical activities and sports during the 1970's has created a need to know more about the sex differences in physical performance capabilities. Performance differences between males and females have been attributed to both biological and cultural factors, although the relative significance of each is not easily ascertained. Differences in body fatness between males and females has been frequently mentioned as one of the biological factors responsible for variations in physical performance. This is particularly true for those activities which require movement of the total body weight (e.g., running, jumping, and lifting the body weight). Numerous studies have shown body fatness to be inversely related to the ability to move the total body weight. In a previous study with Cureton and Tiburzi (1979), we found that differences in percent body fat accounted for an average of 30% of the mean difference in performance between college age men and women on selected physical performance tests. The fact that young adult women, on the average, possess approximately 8% - 10% more body fat than their male counterparts, can logically explain the importance that body composition plays in the performance differences between college age men and women. However, sex differences in body physique and body composition are generally minor during the preadolescent years (Malina & Rarick, 1973). Thus, it is logical to assume that the variance in weight-bearing physical performance tasks attributable to differences in body fatness of preadolescent boys and girls should be markedly less. But at the same time, performance differences are also generally less, thus leading to speculation that body fatness may have relatively the same effect on explaining differences in performance between young boys and girls as we found for young adult males and females. Therefore, the purposes of this study were (1) to investigate the relationship between selected physical performance tests and body fatness in preadolescent children and (2) to determine the extent to which differences in performance between the sexes could be explained by differences in body fatness.

Measurements of age, height, weight, skinfold thicknesses at two sites (triceps and subscapular), and performance scores on the vertical jump, standing broad jump, modified pull-up, 40-yard dash, and 400-yard run were obtained on 564 elementary school children in grades one through four. Each of these tests were selected to represent tasks involving the ability to move the total body weight; which theoretically, should be most influenced by relative body fatness.

Figure 1 shows the descriptive information regarding the subjects' physical characteristics. The results of the various motor performance tests are shown in Figure 2. It was found that although the boys were slightly taller and heavier, and scored significantly better on the performance tests than the girls, there was no significant difference between the sexes in body fatness, as indicated by the sum of two skinfolds. In general, only low or moderate correlations were found between the biological factors and scores on the motor performance tests. As shown in Figure 3, when considered alone, none of the biological variables accounted for any more than 25% of the variance in any of the performance tests. In fact, if all four of the biological variables were used in regression equations predicting performance, an average of only 30% of the performance variance would be explained. The standing broad jump had the highest proportion of variance explained, 37%, whereas the modified pull-up test had the lowest, 27%. This finding clearly emphasizes the plausibility of other factors contributing to the performance of prepubescent children.

In general, age had the highest relationship with the motor performance tests, being positively related to all types of performance. As expected, the sum of two skinfolds, as an indicator of body fatness, was found to be associated with poorer performance on each of the motor performance tests. For the combined group of boys and girls, the performance variance accounted for by body fatness was 2% for the vertical jump, 5% for the 400-yard run, 1% for the standing broad jump, 2% for the 40-yard dash, and 16% for the modified pull-up (Figure 4). Although the mechanism by which body fat influences performance is apparently consistent from one test to another, the extent of this relationship may vary considerably due to the specificity requirements of the task, as seen in the modified pull-up test. For the separate groups of boys and girls, similar relationships between body fatness and performance were observed. As shown in Figure 4, the magnitude of this relationship for the group of boys was somewhat greater than that for the girls, although still not sufficiently large enough to indicate that body fatness was a practical determinant of performance. Thus, with the possible exception of the modified pull-up test, the effect of body fatness on performance of preadolescent children was slight, clearly suggesting that other factors contributed to individual performance differences.

The correlation between age and body fatness for the children in this study was only a modest .20. The sum of the two skinfolds increased with age, but analysis across the various age groups indicated that the differences were not significant until age 10. Figure 5 shows the mean skinfold sum for each age group, revealing a noticeable increase between ages 9 and 10. This finding suggests that until about age 10, near the onset of puberty, body fatness levels remain approximately the same, although consistent increases in skinfold sums were observed.

From the numerous studies that have investigated the relationship between body fatness and performance, and the more recent findings which point to body fatness as one factor which partially explains sex differences in many physical performance tasks, a theoretical model of this relationship can be postulated (Figure 6). Path analysis was used to investigate the functional relationship between the variables in this model in an effort to evaluate the "direct effects" of certain variables on others. For the data in this study, this rather simple path analysis can best be summarized by the path diagram shown in Figure 7. Although these illustrations only represent two of the five motor performance tests investigated, similar associations were observed for the others. The magnitude of the direct path of body fatness reinforces the suggestion that for preadolescent children, the direct effect of body fatness on performance, with the possible exception of the modified pull-up, was only slight. A similar path analysis was performed on data for college age students. Utilizing the same path model, it can be seen that the direct effect of body fatness on performance of young adults is substantially higher (Figure 8). Although this path model is relatively simple, we are presently working on another path model that involves more variables and is considerably more complex.

In summary, although preadolescent males scored significantly higher on motor performance tests requiring the ability to move the body weight around, sex differences in body fatness were insignificant and, consequently, did little to explain the performance differences between boys and girls. The fact that body fatness accounted for such a small proportion of performance variance of these age children clearly emphasizes that other underlying biological and cultural factors are more important in explaining performance differences.

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FIGURE 1

DESCRIPTIVE INFORMATION ON SUBJECTS

VARIABLE	BOYS $\overline{X}$	BOYS SD	GIRLS $\overline{X}$	GIRLS SD
AGE (mos)	101.0	13.1	99.9	12.3
HEIGHT (cm)	130.3	7.9	127.8	8.4
WEIGHT (kg)	29.5	6.5	27.4	6.0
SKINFOLD SUM (mm)	17.0	8.1	17.7	7.3

FIGURE 2

PERFORMANCE TEST RESULTS

VARIABLE	BOYS $\overline{X}$	BOYS SD	GIRLS $\overline{X}$	GIRLS SD
VERTICAL JUMP (cm)	14.5	5.1	13.7	4.6
STANDING BROAD JUMP (cm)	124.0	21.3	113.3	21.6
PULL-UPS (no)	21.1	11.4	18.4	9.1
40-YD DASH (sec)	8.1	1.0	8.3	0.9
400-YD RUN (sec)	114.6	21.2	121.0	19.9

FIGURE 3

CORRELATIONS AMONG VARIABLES

	AGE	HT	WGT	SKINFOLD SUM
VERTICAL JUMP	.44	.29	.06	-.13
STANOING BROAO JUMP	.50	.44	.17	-.12
PULL-UPS	.20	.01	-.22	-.40
40-YO DASH	-.42	-.43	-.16	.13
400-YO RUN	-.39	-.33	-.04	.22

FIGURE 4

PERFORMANCE VARIANCE EXPLAINED

BY BODY FATNESS

	BOYS	GIRLS	TOTAL
VERTICAL JUMP	3%	1%	2%
STANDING BROAD JUMP	5	1	1
PULL-UPS	20	10	16
40-YD DASH	5	1	2
400-YD RUN	9	2	5

FIGURE 5

SKINFOLD SUM BY AGE

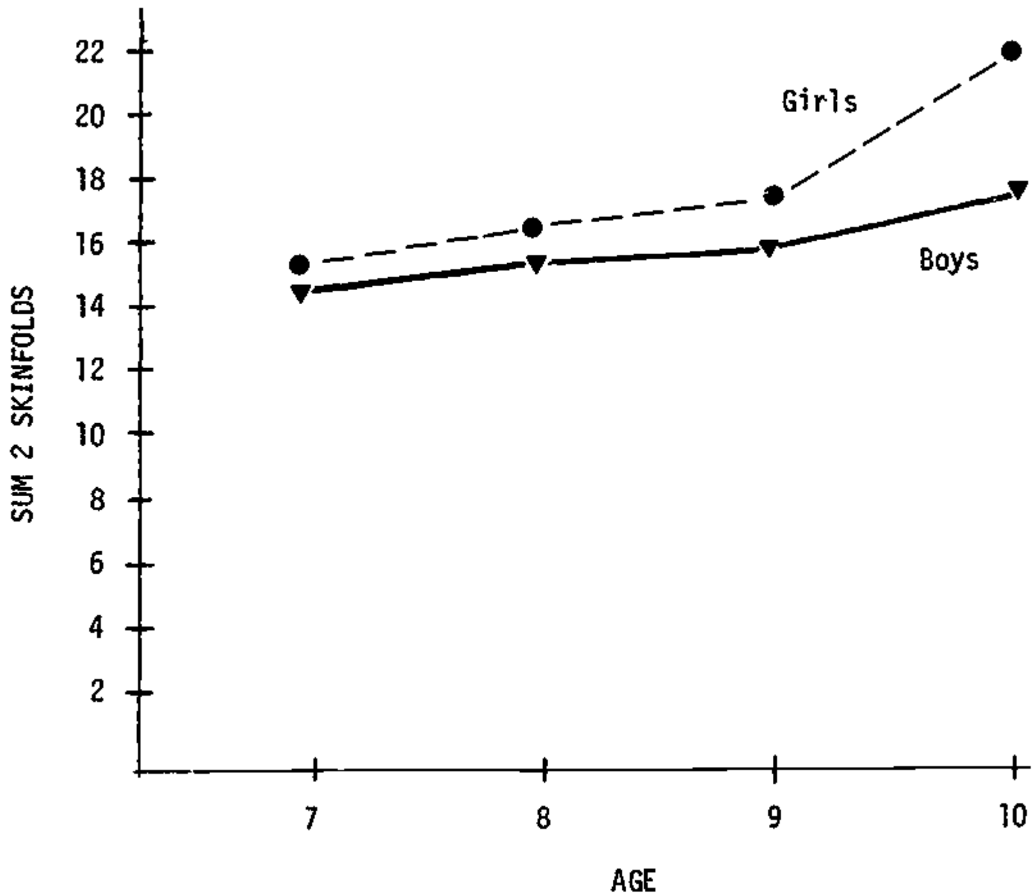


FIGURE 6

PATH MODEL

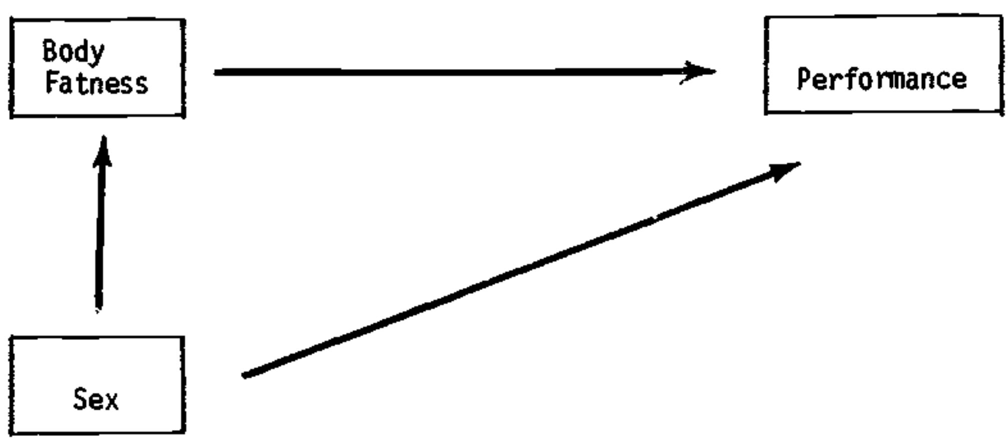
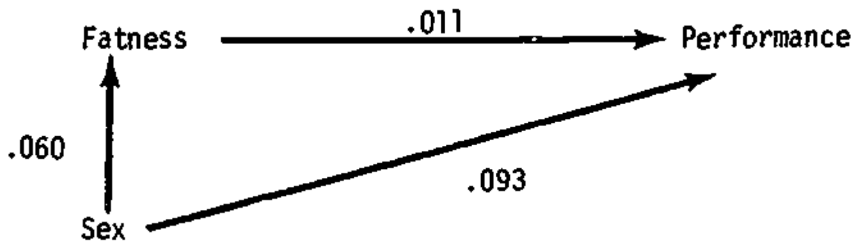


FIGURE 7

PATH DIAGRAM: CHILDREN

40-yard Dash



Standing Broad Jump

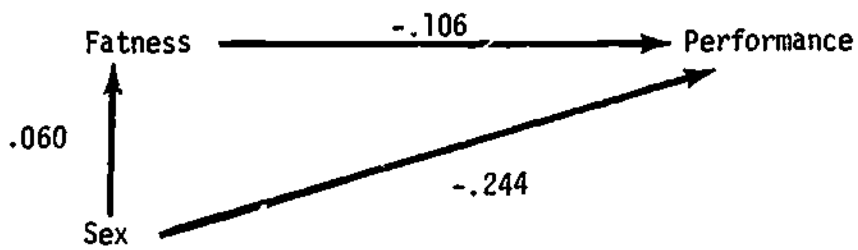
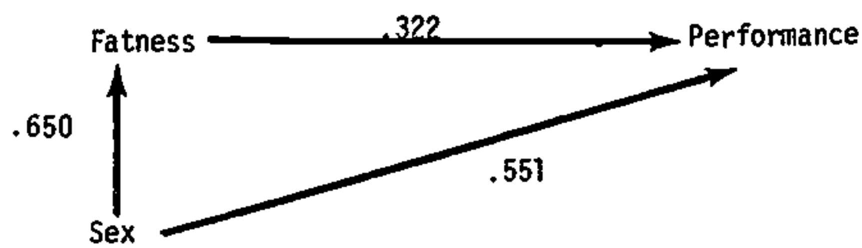


FIGURE 8

PATH DIAGRAM: ADULTS

50-yard Dash



Standing Broad Jump