# FURTHER ANALYSIS OF VITAL CAPACITY, ANTHROPOMETRIC MEASUREMENTS, AND ENDURANCE PERFORMANCE.

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## Introduction

A previous article (McKethan and Mayhew, 1972) confirmed earlier observations that the zero order correlation between vital capacity and endurance performance was essentially nil. The associations between vital capacity and height, weight, and body surface area (BSA) were similar to previous findings, which confirmed our speculation that the data were accurate and representative measurements of college males.

Even though vital capacity was highly related to anthropometric measurements and insignificantly related to endurance performance, further analysis revealed than an association between lung volume and endurance performance may be present if other variables were controlled statistically.

## Procedure

The methodology for this study has been reported earlier (McKethan and Mayhew, 1972). Briefly, 24 male volunteers were tested for vital capacity and two-mile run performance. In addition, essential anthropometric measurements were taken.

Zero order correlations were calculated using the Pearson product-moment technique. First and second order partial correlations, multiple correlations, and multiple regression equations were calculated according to Garrett (1966).

## Results and Discussion.

*TABLE 1*

*SUBJECT DATA (N = 24)*

| Variable | Units | Mean | S. D. |
|---|---|---|---|
| Age | yrs. | 21.41 | 2.02 |
| Height | ins. | 68.94 | 1.92 |
| Weight | lbs. | 155.19 | 16.63 |
| BSA | $m^2$ | 1.85 | 0.11 |
| Vital Capacity | ml | 5399.80 | 598.80 |
| Two-Mile Run | mins. | 13.30 | 2.00 |

Essential data are given in Table 1. Generally, the anthropometric data were slightly greater than earlier studies (Hewlett and Jackson, 1922; Cripps, Greenwood, and Newbold, 1923; Jackson and Lees, 1929) but in agreement with present investigations (Bachman and Horvath, 1968; Vrijens and Becue, 1972). This may serve to indicate that the human physique has continually grown larger over the last several generations.

*TABLE 2*

*ZERO ORDER CORRELATION MATRIX*

| | Ht. | Wt. | BSA | VC | Two-Mile Run |
|---|---|---|---|---|---|
| Age | .401 | .416 | .452 | .546 | -.142 |
| Height | | .579 | .781 | .631 | -.009 |
| Weight | | | .956 | .669 | .512 |
| BSA | | | | .742 | .394 |
| Vital Capacity | | | | | .029 |

**Correlations of .404 ($p < .05$) and .515 ($p < .01$) were significantly different from zero.*

Zero order correlations (Table 2) for all data agreed closely with earlier works (Schuster, 1912; Cripps, Greenwood, and Newbold, 1923; Jackson and Lees, 1929), as well as more recent ones (Vrijens and Becue, 1972). This indicated that the relationship between various anthropometric variables (including vital capacity) may be relatively constant.

Partial correlations are shown in Table 3. Generally, the statistical removal of one anthropometric variable caused a reduction in the correlation between vital capacity and other anthropometric measurements. First order partial correlations demonstrated that vital capacity was approximately equally related to height and weight (r = .479 and .481, respectively). The relationship between endurance performance and vital capacity was not enhanced by statistically holding height constant (Table 3). However, when weight was held constant, the relationship rose to significance ($p < 0.05$). This was also the case when BSA and both height and weight were held constant (Figure 1). These points have not been demonstrated previously to our knowledge and hold some interesting speculations concerning performance.

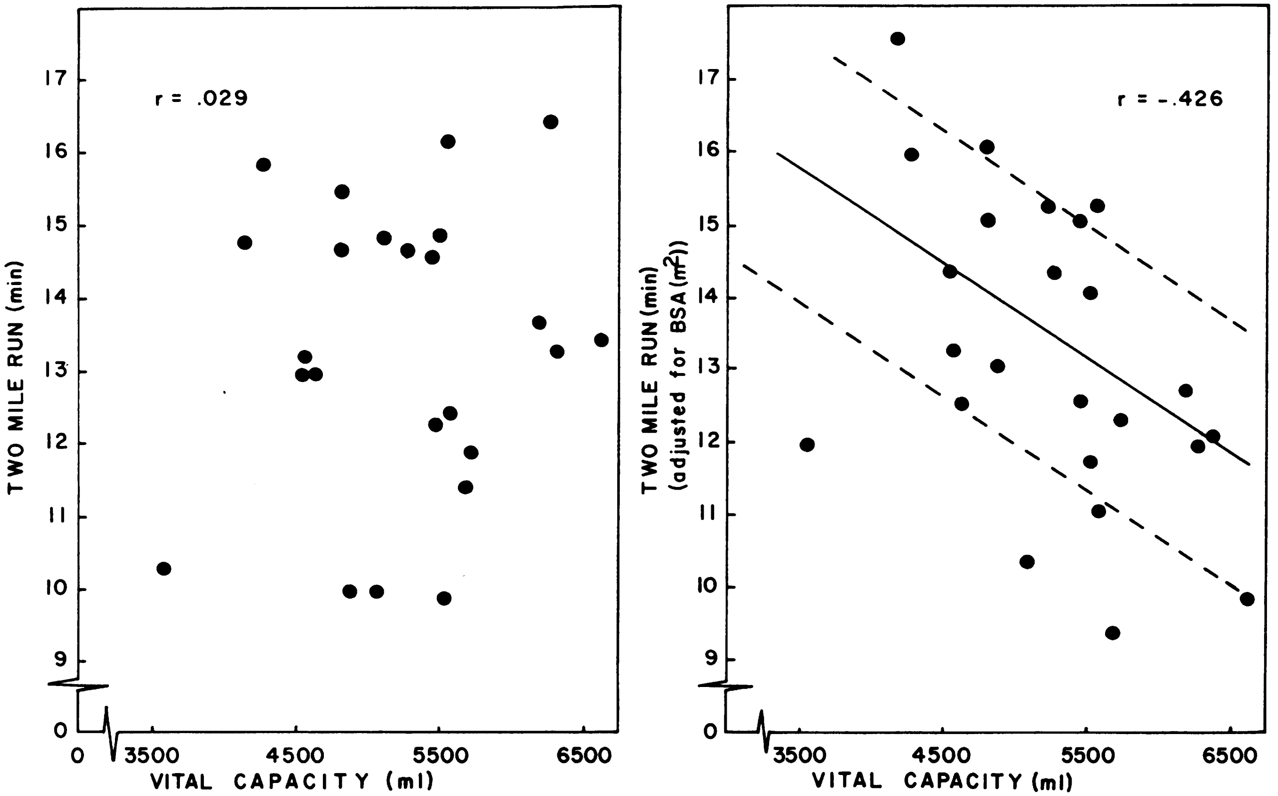
*TABLE 3 PARTIAL CORRELATIONS*

| Correlate | Variable(s) Partialled out | r |
|---|---|---|
| Vital Capacity with: | | |
| Age | Height | .412 |
| Age | Weight | .397 |
| Age | BSA | .663 |
| Age | Height & Weight | .346 |
| Height | Weight | .479 |
| Height | Age | .536 |
| Height | Age & Weight | .438 |
| Weight | Height | .481 |
| Weight | Age | .581 |
| Weight | Age & Height | .295 |
| Two-Mile Run with: | | |
| Vital Capacity | Height | -.034 |
| Vital Capacity | Weight | -.491 |
| Vital Capacity | BSA | -.426 |
| Vital Capacity | Height & Weight | -.438 |
| Height | Weight | -.436 |
| Weight | Height | .481 |

Multiple regression equations (Table 4) for estimating vital capacity coincided with previous studies (Hewlett and Jackson, 1922; Cripps, Greenwood, and Newbold, 1923; Jackson and Lees, 1929; Cureton, 1936; Kory *et al.,* 1961). Note that the use of height or weight separately or in combination was no more effective in predicting vital capacity than BSA calculated by the DuBois technique (DuBois and DuBoise, 1916). The most effective method was a combination of BSA and age (eq. 6).

When corrected for inflation (Garrett, 1966), the multiple $\bar{R}_c$ for equations (3), (5), and (6) became 0.701, 0.729, and 0.766, respectively, all of which are significant ($p < .05$). Upon converting beta coefficients to standard score beta weights, it was revealed that weight contributed 97.6% to equation (3), while height contributed only 2.4%. In equation (5) the contribution of each variable to the prediction was approximately equal: weight = 38.2%, height = 36.2%, age = 25.6%. In equation (6) BSA made the largest contribution (81.1%). While having a coefficient of determination of only 58.7%, equation (6) had a very small standard error of estimate compared to other prediction equations (Cripps, Greenwood, and Newbold, 1923; Cureton, 1936).

With anthropometric measurements held constant, vital capacity became significantly related to endurance



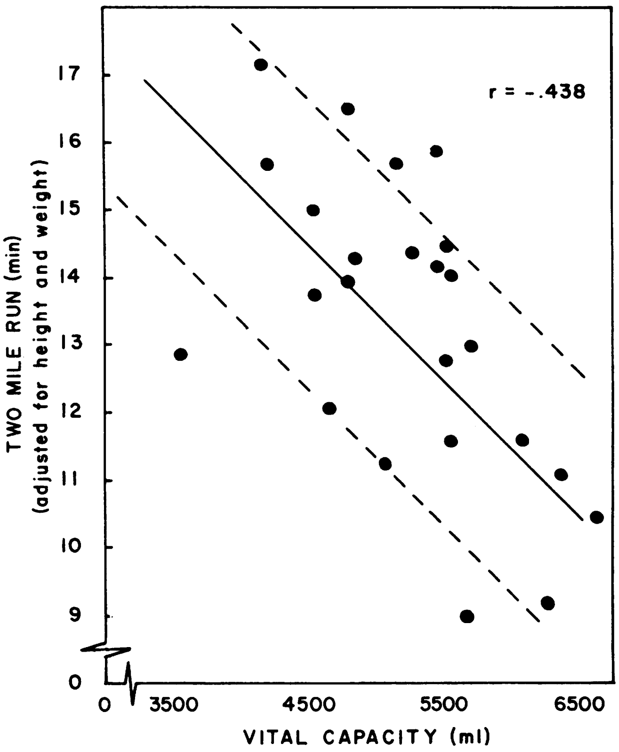



***Figure 1.*** ***Effect of statistical removal of anthropometric variables on relationship between vital capacity and two-mile run.***

performance (Table 3). Substantial increases in the accuracy of predicting endurance performance were shown when anthropometric variables were combined with vital capacity (Table 5). Moreover, it should be noted that in both cases anthropometric variables contributed more than vital capacity to each equation. In equation (7), BSA contributed 66.6% and vital capacity accounted for 33.4%. In equation (8), weight contributed 78.3%, height 4.6%, and vital capacity 17.1%.

*TABLE 4*

*REGRESSION EQUATIONS FOR DETERMINING VITAL CAPACITY*

| Regression equation | $SE_{est}$ (ml) | R | $\bar{R}_c$ | Coefficient of Determination |
|---|---|---|---|---|
| [1] VC (ml) = 196.777 Ht. (ins) – 8165.98 | 465 | .631 | —— | 39.8% |
| [2] VC (ml) = 24.0868 Wt. (lbs) + 1661.80 | 447 | .669 | —— | 44.8% |
| [3] VC (ml) = 3.1959 Ht. (ins) + 14.8676 Wt. (lbs) + 2872.2 | 408 | .732 | .701 | 49.1% |
| [4] VC (ml) = 4038.84 BSA ($m^2$) – 2072.02 | 401 | .742 | —— | 55.0% |
| [5] VC (ml) = 117.127 Ht. (ins) + 14.249 Wt. (lbs) + 78.756 Age (yrs) – 6572.325 | 382 | .770 | .729 | 53.1% |
| [6] VC (ml) = 3344.97 BSA ($m^2$) + 88.178 Age (yrs) – 2676.255 | 368 | .789 | .766 | 58.7% |

*TABLE 5*

*REGRESSION EQUATIONS FOR PREDICTING TWO-MILE RUN*

| Regression equation | $SE_{est}$ (mins) | R | $\bar{R}_c$ | Coefficient of Determination |
|---|---|---|---|---|
| [7] Two-Mile Run (mins) = –.002 VC (ml) + 15.380 BSA ($m^2$) – 4.350 | 1.66 | .558 | .496 | 31.1% |
| [8] Two-Mile Run (mins) = –.0016 VC (ml) – .2592 Ht. (ins) + .1228 Wt. (lbs) + 20.75 | 1.35 | .738 | .680 | 54.5% |

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