

# PHYSICAL CAPACITY IN TWINS

LARS-MAGNUS ENGSTRÖM, SIV FISCHBEIN

Department of Educational Research, School of Education, Stockholm, Sweden

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*A comparison of physical capacity, (measured by vital capacity, muscular strength and physical work capacity) in twin boys and controls failed to indicate significant differences. Intrapair correlations showed the MZ twins to be much more similar than the DZ twins in all the capacity measures. The correlations were lower, however, for both MZ and DZ twins for physical work capacity than for the other two capacity variables. When amount of physical exercise during leisure time is kept under control, the DZ twins tend to be more similar for physical work capacity or muscular strength, and the correlations tend to be of the same magnitude for MZ twins. Physical work capacity therefore appears, in this study, to be a more environmentally influenced variable than either vital capacity or muscular strength.*

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## INTRODUCTION

It is a well-known fact that twins tend to have a shorter gestation period and a lower birth weight in comparison to singletons. About 55% of twin births are classified as premature by weight (Mittler 1971).

Wilson (1974a) has studied measures of birth size in twins at different gestational ages. He found a relative growth suppression for twins in birth weight, length, and head circumference. In a follow-up of these twins to four years of age, Wilson (1974b) reported that the deficit was greatest at birth, but there was a marked recovery during the first six months, followed by only gradual changes thereafter. Weight was somewhat more affected than height by growth suppression.

Both Drillien (1964) and Koch (1966) found that twins at the age of five years were, as a group, well below the national norms in both height and weight and in other physical measurements.

Swedish data for grown-up men (19 years of age) have been reported by Husén (1959). Twins showed significant retardation in height and weight in comparison to singletons. The MZ twins were found to be below the DZ twins in height and weight.

In 1964, a longitudinal study of physical and mental growth in twins and controls of matched age (the SLU project) started at the Department of Educational Research at the Stockholm School of Education. A description of this project has been given by Ljung et al. (1974).

A total of 323 twin pairs and a control group of 1194 singletons were followed from age 10 to 18 years. A comparison of physical growth in twins and controls has been made by Ljung et al. (1977).

There were very small differences in physical growth between the twin boys and their controls. For the twin girls, however, there seems to have been a height and weight deficit at all ages,

and they also matured a little later than their controls. (For a discussion of this sex difference, see Fischbein and Lindgren 1975, and Ljung et al. 1977.)

Studies on physical capacity, measured as maximal oxygen uptake, have shown within-pair differences to be smaller in MZ than DZ twins (Klissouras 1975). Vital capacity and muscular strength have also been investigated in MZ and DZ twins by Venerando and Milani-Compartti (1970). They found that the within-pair concordance was higher in MZ than DZ twins. The twins had previously practiced no sports, so the differences could not be said to reflect systematic differences in training.

The aim of the present investigation is to compare physical capacity between male twins and singletons and to compare intrapair correlations between MZ and DZ twins.

## MATERIAL AND METHODS

The twins were randomly selected from different parts of Sweden and their controls were matched according to age and were classmates to the twins. The present results are based on 39 pairs of MZ and 55 of DZ twins, and on 508 controls. The capacity measures (taken in connection with enlistment in military service, when the participants in the study were approximately 18-19 years old) were vital capacity, muscular strength, and physical work capacity.

*Vital capacity* is a measure (in dl) of the maximal volume of gas that can be expelled from the lungs following a maximal inhalation.

*Muscular strength* is a combination of measurements of handgrip, knee stretch, and arm bent. These measurements are given differential weights according to the following:

$1.7 \times \text{hand grip} + 1.3 \times \text{knee stretch} + 3.8 \times \text{arm bent}$ .

The estimated coefficient is transformed to a 9-grade scale:

9 = >250 kilopond	6 = 215-229 kp	3 = 135-174 kp
8 = 240-249 kp	5 = 200-214 kp	2 = 101-134 kp
7 = 230-239 kp	4 = 175-199 kp	1 = <100 kp

*Physical work capacity* is measured on a bicycle ergometer. It is measured as the highest load (watt) the subjects could tolerate for 6 min.

For classifying the pairs of twins, a morphological diagnosis was applied according to a special schedule. This schedule is based on earlier investigations of similarity diagnosis of twins (Essen-Möller 1941, Norinder 1946, Husén 1959). A full description of the zygoty classification of the SLU twins has been given by Ljung et al. (1977).

## RESULTS

### 1. Comparison Between Twins and Controls

Since we have found no significant differences in the physical growth of male twins and controls, our hypothesis will be that there are no differences in the physical capacity measures described. Since these measurements are correlated for the twins in a pair, we have used the means for the twin pairs to test the significance of the differences between MZ and DZ twins and their controls.

In fact, as can be seen from Table 1, no significant differences have been found between twins and controls in vital capacity, muscular strength, or physical work capacity.

Table 1. *Vital capacity, muscular strength and physical work capacity in twins and controls*

	MZ pairs			DZ pairs			Controls			F	DF
	Mean <sup>a</sup>	SD	N	Mean <sup>a</sup>	SD	N	Mean <sup>a</sup>	SD	N		
Vital capacity (dl)	48.46	6.28	39	49.18	5.53	55	49.41	6.47	518	0.42	2,611
Muscular strength (9-grade scale)	4.77	1.53	39	5.00	1.45	55	5.30	1.75	518	2.36	2,611
Physical work capacity (watt)	245.28	27.99	39	247.40	36.85	55	239.10	36.20	518	1.74	2,611

<sup>a</sup> The mean for each twin pair is used as an observation.

2. *Intrapair Correlations in MZ and DZ Twins*

Previous results (Venerando and Milani-Comparetti 1970, Klissouras 1975) point to a genetic factor in the types of functional parameters used in this study. An interesting question, however, is whether this genetic influence tends to be of the same magnitude in the different kinds of measurements.

Fig. 1 shows the intrapair correlations for vital capacity, muscular strength, and physical work capacity in our sample of twins. Since measures of physical capacity can be assumed to be related to stature (Astrand and Rodahl 1970, Mc Miken 1976) and MZ twins presumably have a more similar stature than DZ twins, the capacity measures in this study have been related to stature as follows: *vital capacity* divided by body weight; *muscular strength* divided by the square of height, since the maximal force a muscle can develop is proportional to its cross-sectional area (Hill 1950); *physical capacity* divided by body weight.

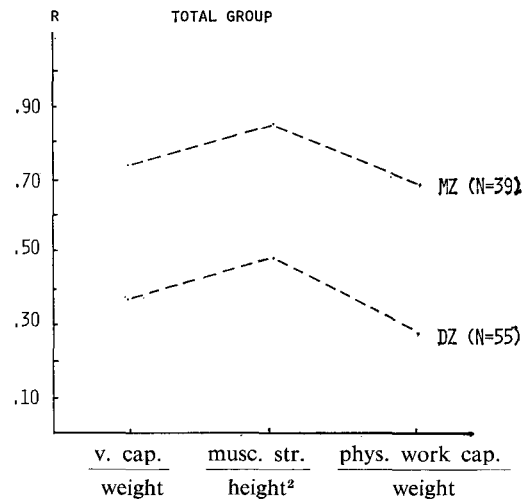


Fig. 1. Intrapair correlations for MZ and DZ twins for vital capacity, muscular strength and physical work capacity.  $[R = (V_{bp} - V_{wp}) / (V_{bp} + V_{wp})]$ , where  $V_{bp}$  = variance between pairs, and  $V_{wp}$  = variance within pairs. For a detailed discussion of this method, see Ljung 1966].

It can be seen from Fig. 1 that MZ twins are more similar than DZ twins in all capacity measures, which is in accordance with earlier investigations. The lowest within-pair correlations for both MZ and DZ are found for physical work capacity. This would indicate that this variable is the most environmentally influenced of the capacity measures used in this study,

and it might therefore also be influenced by physical exercise. This hypothesis is supported by experimental studies on the effect of physical exercise on physical work capacity (Saltin et al. 1968, Ekblom 1969, 1970, Astrand and Rodahl 1970, Eriksson 1972).

### 3. The Effect of Physical Exercise During Leisure Time

To investigate the possible effect of physical exercise on the above-mentioned capacity variables, we selected a group of MZ and DZ twins, where both twins in each pair were concordant for amount of exercise during their leisure time.

The selection was based on the following scale used in a questionnaire by the Swedish twin registry (Medlund et al. 1976):

(1) Practically no physical exercise; (2) Very little physical exercise; (3) Rather little physical exercise; (4) Not very much physical exercise; (5) Rather much physical exercise; (6) Much physical exercise; (7) Very much physical exercise.

The selected group consisted of pairs of twins where both twins had given the same or practically the same estimation ( $\leq 1$  step on the scale).

If the reported amount of physical exercise has a substantial effect on the capacity variables, it would tend to increase the concordance for DZ and possibly not affect the correlation for MZ twins (Engström 1976).

The results for the MZ and DZ twins who have reported a similar amount of physical exercise during leisure time, are presented in Fig. 2. DZ twins are more alike for the physical work capacity measure than for vital capacity or muscular strength. This trend cannot be seen for the MZ twins, where the correlations tend to be the same as before.

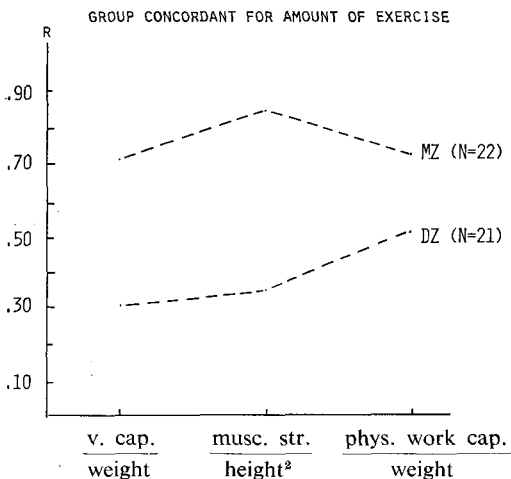


Fig. 2. Intrapair correlations for MZ and DZ twins concordant for amount of exercise.

To evaluate the statistical significance of the difference between the DZ and MZ within-pair variance for vital capacity, muscular strength, and physical work capacity, F-ratios ( $V_{DZ}/V_{MZ}$ , Vandenberg 1965) have been estimated and are presented in Table 2.

For the total group, there is a significant difference between MZ and DZ twins in all capacity measures. When physical exercise is kept under control, the difference persists for vital capacity and muscular strength, but not for physical work capacity.

Table 2. *F-ratios ( $V_{DZ}/V_{MZ}$ ) between DZ and MZ within-pair variance in different physical capacity measures*

Physical capacity measures	Total group		Group concordant for amount of exercise	
	F	DF	F	DF
Vital capacity/weight	2.21**	55/39	2.64*	21/22
Muscular strength/height <sup>2</sup>	4.28**	55/39	4.48**	21/22
Physical work capacity/weight	2.10**	55/39	0.96	21/22

\* =  $p < 0.05$ ; \*\* =  $p < 0.01$

## DISCUSSION

To study genetic factors in physical capacity variables, a comparison was made of intrapair correlations for MZ and DZ twin boys. MZ were more alike than DZ twins in all the capacity measures. The correlations in both MZ and DZ twins, were found to be lower for physical work capacity than for muscular strength and vital capacity.

In further analyzing the results, the reported amount of physical exercise has been kept under control. Intrapair correlations in physical capacity variables have been studied for MZ and DZ male twin pairs with comparable amount of physical exercise in leisure time. MZ twins with the same amount of exercise tend to be more similar than DZ twins in both vital capacity and muscular strength, while the difference practically disappears for physical work capacity. This is due to the fact that DZ twins with the same amount of exercise are more similar in physical work capacity than in the other capacity variables.

Although it has not been possible, in this study, to manipulate the amount of physical exercise, the results give further support to the experimentally shown relationship between physical exercise and physical work capacity. Vital capacity and muscular strength seem, in this study, to be less environmentally influenced than physical work capacity. On the other hand, the type of reported physical exercise might have contained activities with stronger effects on physical work capacity than on vital capacity and muscular strength. Depending on the kinds of measures used and the type of activities involved, the relationship between capacity measures and amount and kind of exercise might change.

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## RIASSUNTO

### *Capacità Fisica in Gemelli*

Un raffronto della capacità fisica (valutata mediante volume respiratorio, forza muscolare e capacità di lavoro fisico) in gemelli e non gemelli maschi non ha indicato differenze significative. Le correlazioni intracoppia hanno indicato una maggiore somiglianza nei gemelli MZ rispetto ai DZ per tutte le misure. Tuttavia, le correlazioni sono risultate inferiori, in gemelli sia MZ che DZ, per la capacità di lavoro fisico rispetto alle altre due variabili. Una volta che si controlli l'esercizio fisico durante il tempo libero, i gemelli DZ tendono a somigliarsi di più, ed i MZ di meno, per la capacità di lavoro fisico rispetto al volume respiratorio o alla forza muscolare. La capacità di lavoro fisico risulterebbe dunque, in questo studio, come una variabile maggiormente soggetta all'influenza ambientale di quanto non lo siano il volume respiratorio o la forza muscolare.

## RÉSUMÉ

### *Capacité Physique chez les Jumeaux*

Une comparaison de la capacité physique (évaluée moyennant capacité vitale, force musculaire et capacité de travail physique) chez des jumeaux et des non-jumeaux mâles, n'a pas indiqué de différences significatives. Les corrélations entre jumeaux MZ étaient plus élevées par rapport aux corrélations entre jumeaux DZ pour toutes les mensurations. Chez les MZ comme chez les DZ, toutefois, les corrélations étaient moins élevées pour la capacité de travail physique par rapport aux deux autres variables. Si l'exercice physique dans le temps libre est contrôlé, les jumeaux DZ tendent à se ressembler de plus, et les MZ de moins, dans la capacité de travail physique par rapport aux deux autres variables. Cette-ci serait donc plus influencée de la capacité vitale ou de la force musculaire par les facteurs ambiants.

## ZUSAMMENFASSUNG

*Die körperliche Leistungsfähigkeit von Zwillingen*

Ein Vergleich der körperlichen Leistungsfähigkeit (gemessen mit Hilfe des Atemvolumens, der Muskelkraft und der körperlichen Arbeitsleistung) ergab keine wesentlichen Unterschiede zwischen den männlichen Zwillingen und Einlingen. Für alle Masse war die Korrelation zwischen den Paarlingen grösser bei EZ als bei ZZ. Sowohl bei EZ als bei ZZ waren jedoch die Korrelationen für die Leistungen der körperlichen Arbeit geringer als die für die anderen beiden Variablen. Bei einer Kontrolle der Leibesübungen in der Freizeit zeigt sich bei ZZ eine grössere Tendenz zur Ähnlichkeit; bei EZ besteht diese Tendenz hingegen weniger in den Leistungen der körperlichen Arbeit als in den anderen beiden Variablen. Aus dieser Untersuchung würde also hervorgehen, dass die Leistungen der körperlichen Arbeit in grösserem Masse umweltsbedingt sind als Atemvolumen und Muskelkraft.

Siv Fischbein, Ph.D., Department of Educational and Psychological Research, School of Education, S-100 26 Stockholm, Sweden.