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Relationships between Muscular Strength of Upper Arm Muscle Group and Physical Measurements (Report 1)

—Relationships between Pull-up Scores/Push-up Scores and Weight Deviation/Weight-corrected Upper Arm Circumference—

By *Sadayoshi Imae**

As a method for evaluating total strength of the upper arm muscle group, a method to measure pull-up scores and push-up scores was used for many years. Even today, this method is being used widely as one of the sports test, physical training at schools, and muscular training for various kinds of sports. And many studies on these exercises have been made from various angles.

Pull-up or push-up exercise, which pulls up or pushes up one's body weight a certain distance, will significantly vary according to one's degree of obesity and difference in muscle mass as well as other physical factors.

The author has recently completed measurements of the stature, weight and circumference of the right upper arm, as well as pull-up scores and push-up scores, on 205 male high-school students aged 16 and 17. Based on the values obtained in the measurements, studies were made as follows.

- a) From individual stature and body weight, a weight deviation was obtained by using the standard body weight table by Matsuki. The relationships between the deviation thus obtained and pull-up and push-up scores were studied.
- b) A regression line of the upper arm circumference for the weight deviation was obtained, and an upper arm circumference at the point where the regression line crossed with standard body weight was obtained; the upper arm circumference thus obtained was called weight-corrected upper arm circumference. Then, relationships between the weight-corrected upper arm circumference and pull-up and push-up scores were studied and discussed.

(1) Weight Deviation

The average weight deviation was $-4.2 \pm 0.7\%$; 68.8% of the students were in

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the range of -10 to $+10$; 6.3% of them in the range of $+10$ and above; and 24.9% of them in the range of -10 and under.

It was as expected that about 69% of all the students fell in the range of -10 to $+10$; the percentage of 25 (-10 and under) seemed too high. This high percentage may be due to the fact that the standard body weight table used was for adults, and the students subjected to the study were still in the stage of continuing their growth.

While in the case of the students who were in the range of $+10$ and above may be said they were in a state of obesity.

(2) Weight-corrected Upper Arm Circumference

The average weight-corrected upper arm circumference was 26.9 cm. Comparison was made between those who were members of sports clubs and those who were not; the weight-corrected upper arm circumference of the members was significantly larger ($p < 0.01$). It is supposed that this result tells that their muscle masses were increased by training.

(3) Pull-up Scores and Push-up Scores

The average of pull-up scores was 7.1 ± 0.2 , and the average of push-up scores was 12.9 ± 0.4 . As to pull-up scores, comparison was made between the students who belonged to sports clubs and those who did not belong, with the result that the value was larger with the former students ($p < 0.10$). However, in the case of push-up scores, no significant difference was obtained. This result may be due to the fact that even in the case of the sports club member students, they took training only about 1.5 hours per day and 2 or 3 days per week; and in the case of non-member students, they, together with the member students, received physical training as a regular curriculum: four days per week and each day they were given push-up exercises as part of reinforcing exercises, they making 30 to 50 scores.

(4) Relationships between Pull-up Scores/Push-up Scores and Weight Deviation

A significant negative correlation was seen between pull-up scores and weight deviation ($p < 0.01$). Also, a significant negative correlation was seen between push-up scores and weight deviation ($p < 0.01$).

When comparison was made for the pull-up scores on a by-weight deviation classification basis. The result was that the number of the students in the range of -10 to $+10\%$ and that of those in the range of -10% and under was almost the same.

And a significant difference ($p < 0.01$) was seen between the students in these two ranges and the students who were in the range of +10% and above.

As the number of the students in the range of +10% and above was small, it may be dangerous to seek a conclusion simply, however, it seems certain that the state of obesity will act as a minus factor upon pull-up exercises.

(5) Relationships between Pull-up Scores/Push-up Scores and Weight-corrected Upper Arm Circumference

A significant positive correlation was seen between pull-up scores and weight-corrected upper arm circumference ($p < 0.01$). Also, a significant positive correlation was seen between push-up scores and weight-corrected upper arm circumference ($p < 0.01$).

Meantime, a non-correlation was found between pull-up scores and push-up scores and the upper arm circumference.

Pull-ups and Push-ups are exercises which require to pull up and push up one's considerably heavy body weight a certain distance. For these exercises, the total strength of the upper arm muscle group, chiefly the strength of the upper arm biceps or triceps, is required. In actual measurements, these exercises has no correlation with the upper arm circumference, however, in the case of the weight-corrected upper arm circumference, positive correlation was seen. This fact indicates the significance which the weight-corrected upper arm circumference demonstrates in exercises requiring muscular strength. As studied and reported by Matsuki et al., a weight-corrected upper arm circumference may certainly be a simple and convenient index for estimating muscular strength.