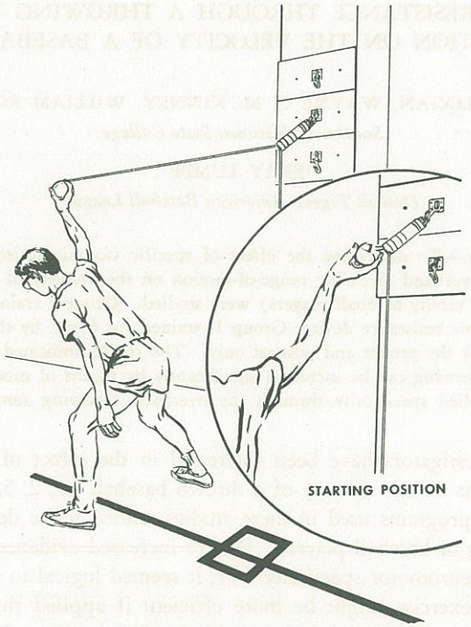

FIG. 1. Exercise position performance

days per week (Fig. 1). The Exer-genie was set arbitrarily at 2.5 lb. for all *Ss* in Group I throughout the study. Group II ($N = 13$) trained by throwing 30 times per day, 5 days per week. The overhand throw was used and each *S* was supervised while throwing. Group III ($N = 13$) was a control group, i.e., they took the pre- and posttests only. *Ss* in Group III were instructed not to throw or do any form of resistance training during the 6-wk. training phase of the study.

The posttest was an exact duplication of the pretest.

RESULTS

Due to irregular participation by 6 *Ss* in Group II during the training phase of the study, the *N* of Group II was reduced to 7. It was necessary to reduce Groups I and III by the same number. Therefore, each group had an *N* of 7 for the final statistical analyses. This procedure was possible because of an initial matching of *Ss* into groups on the basis of throwing velocity.

The pretest means were: (1) Group I, 75.895 mph; (2) Group II, 75.895 mph and (3) Group III, 75.159 mph. The .05 level of significance was chosen to determine statistical significance. The differences at pretest between pairs of groups were not statistically significant as determined by the Wilcoxon matched-pairs signed-ranks test [*N* equals the number of pairs whose difference was absolute zero (Group I vs II, $T = 4, p > .05, N = 7$; Group I vs III, $T = 1, p > .05, N = 6$; Group II vs III, $T = 3, p > .05, N = 7$)].

The posttest means were: (1) Group I, 84.001 mph; (2) Group II, 78.842 mph and (3) Group III, 75.306 mph. These results are shown graphically in Fig. 2. The difference between Groups I and II was statistically significant ($T = 1, p < .05, N = 7$) as was the difference between Groups I and III ($T = 0, p < .05, N = 6$). The difference between Groups II and III did not reach the .05 level ($T = 3, p > .05, N = 7$).

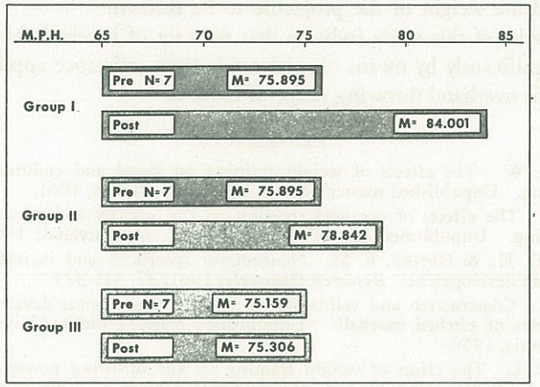

FIG. 2. Mean performance for Groups I, II, and III

Pre- and posttest comparisons were made within groups. The velocity gain made by Group I was significant at the .05 level ($T = 1, p < .05, N = 7$). However, gains made by Group II ($T = 6, p > .05, N = 7$) and Group III ($T = 6, p > .05, N = 6$) during the same period were not statistically significant.

DISCUSSION

Throwing is dependent upon a summation of forces. The throwing limb is the receptor of all preceding forces; consequently, its speed of movement is a key factor. When considering specificity of training for subsequent throwing performances, it may be necessary to keep isotonic resistance relatively light and have it applied through the specific throwing range-of-motion which will be used during the athletic contest.

Ss in Group I were instructed to pull on the Exer-genie as fast as the device would allow with a resistance of 2.5 lb. The attempt by *S* to pull as hard as possible on each successive "throw" constituted a form of overload. Overload in this case was a progressively increased effort against a fixed resistance.

The 2.5-lb. resistance was established arbitrarily by trial and error. The basic objective was to allow *S* to retain a near normal limb speed while perform-

ing against a constant resistance. The basic logic for this procedure was related to neuromotor specificity involved for development of skill. Several factors appear to be involved in throwing, i.e., speed of movement, strength, flexibility, muscular endurance, and neuromuscular adaptation of specific body areas to perform a skilled act such as throwing.

The question arises: would the increase in velocity seen in the present study have occurred under conditions involving progressively greater resistance and slower limb speed during exercise? This remains to be studied. Perhaps there is a relationship between the amount of resistance to be applied in an exercise program and the weight of the projectile to be thrown?

The results of this study indicate that velocity of baseball throwing can be increased significantly by means of moderately light resistance applied specifically through the overhand throwing range-of-motion.

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Accepted April 27, 1966.

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Perceptual and Motor Skills, 1966, 23, 55-58. © Southern Universities Press 1966

EFFECT OF RESISTANCE THROUGH A THROWING RANGE-OF-MOTION ON THE VELOCITY OF A BASEBALL

GENE A. LOGAN, WAYNE C. MC KINNEY, WILLIAM ROWE, JR.
Southwest Missouri State College

JERRY LUMPE
Detroit Tigers, American Baseball League

Summary.—To determine the effect of specific isotonic resistance applied through the overhand throwing range-of-motion on the velocity of a baseball 3 groups of *S*s (varsity baseball players) were studied. Group I trained for 6 wk. with an isotonic resistance device; Group II trained for 6 wk. by throwing, and Group III took the pretest and posttest only. The results indicated that velocity of baseball throwing can be increased significantly by means of moderately light resistance applied specifically through the overhand throwing range-of-motion.

Several investigators have been interested in the effect of various weight training programs on the velocity of a thrown baseball (1, 2, 5, 6, 7, 8). The weight training programs used in these studies tended to be designed for general conditioning of baseball players. Due to increased evidence supporting the theory of high neuromotor specificity (3), it seemed logical to assume that isotonic resistance exercise might be more efficient if applied through the exact range-of-motion(s) of the subsequent athletic performance. This would condition muscles at the specific joint angles and through the planes which would be used during the performance. This hypothesis was tested. The specific purpose of this study, therefore, was to determine the effect of specific isotonic resistance applied through the overhand throwing range-of-motion on the velocity of a baseball.

METHOD

Thirty-nine *S*s, candidates for the varsity baseball team at Southwest Missouri State College, were given a pretest to determine their initial throwing velocities in miles per hour. Velocity was determined by use of the Velocitimer (4). Each *S* was instructed to warm-up by throwing 20 times against a padded wall. Following the warm-up, each *S* threw 10 times through the Velocitimer. The mean velocity (stated in mph) for 10 trials constituted the pretest score for each *S*. The measured throwing distance was 15 ft. 1½ in. or the first one-fourth of the regulation baseball pitching distance.

Following the pretest, *S*s were divided into 3 equal-sized and statistically equal groups (matched triplets) for the 6-wk. training phase of the study. Group I ($N = 13$) trained with an isotonic resistance device (the Exer-genie). Each *S* was supervised while he pulled a baseball attached to the Exer-genie through his normal overhand throwing range-of-motion 30 times per day, 5

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