

THE EFFECT OF HAND GRIP STRENGTH AND TRUNK ROTATION STRENGTH ON THROWING BALL VELOCITY

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Abstract

Throwing ball velocity is one of the indicators that determine softball performance. However, most of the training on throwing only focused on the major muscles and they neglected the assisted muscles such as hand grip and trunk rotation muscles that also crucial in improving the throwing performance. Therefore, the purpose of this study is to identify the effect of hand grip strength training, and trunk rotation strength training towards the throwing ball velocity among female collegiate softball players. 54 female collegiate softball players were equally divided into three training groups which are hand grip strength training group (HG), trunk rotation strength training group (TR), and basic strength training group (CG). All the groups performed the same basic strength training program with different additional strength training according to the group's treatment. Each group trained 3 days per week for 6 weeks. Throwing ball velocity was assessed before (pretest) and after (posttest) the 6 weeks training program via one-way between groups analysis of variance (ANOVA) to compare the mean gained score in throwing ball velocity between each group. The result shows that all group significantly differences in throwing ball velocity ($p < .05$). The post-hoc test indicates that all training group significantly differences to each other except for HG and TR group. This study demonstrates that additional training of HG and TR are able to increase the throwing ball velocity rather than performing the basic strength training only. However, both strength training provides a similar impact on throwing ball velocity, therefore, both of the training are considered important to improve the throwing performance.

Keywords: Hand grip, softball, throwing, trunk rotation

Introduction

Softball is a dynamic sport that consists of throwing, catching, batting, running and pitching. Based on the skill, throwing (overhead throw) is one of the important skills that requires due attention in order to improve the softball performance since all softball players would have to use this skill no matter what is their positions during fielding. Basically, one of the components that enhances throwing performance is throwing ball velocity (Escamilla et al., 2012). In softball, throwing ball velocity is crucial to stop the runner from getting more score (Potter & Johnson, 2007).

In order to establish a high velocity during throwing, it is important to develop the selective muscles group that involved explicitly in the throwing execution (Zawrotny, 2005). The effectiveness of selective muscle group to execute the overhead throw will maximize the efficiency of the kinetic chain (McDaniel, 2009; Moynes, Perry, Antonelli, & Jobe, 1986). A complete throwing process beginning with immersion from the lower extremities and continuing up to the trunk, shoulder, elbow, wrist, and fingers (McDaniel, 2009; Moynes et al., 1986). Each of these body parts plays an important role in throwing execution. Szymanski (2012) reviewed 39 journal article regarding the effect of various resistance training methods on overhand throwing and based on the review, there are limited studies that emphasize the importance of hand grip strength and trunk rotation strength training.

Hand grip strength and throwing ball velocity

Throwing ball velocity required the ability to grip the ball in order to create control over the ball and increase the ball spin that leads to improvement in throwing velocity (Ferragut et al., 2010). In addition, Shea (2007) has shown that the maximal hand grip strength is related to throwing ball velocity ($r=.79$). Furthermore, according to McDaniel (2009), an increment in handgrip strength not only improving the skills related to grasping the object, but also can increase the amount of force generated in the throw.

Basically, the amount of force generated depends on the number of muscle group involved in that particular movement. Shea (2007) emphasized that there are 35 muscles involve in forearm and hand, with most of this muscle are related to gripping activities. Other than that, the anatomy of gripping movement consists of flexion and extension. The study highlighted that, flexor mechanism of the finger 62% stronger than extensor mechanism.

Trunk rotation strength and throwing ball velocity

Apart from the hand grip strength, throwing process also required the trunk rotation strength in order to transfer the energy and also generate force to increase the throwing ball velocity. To maximize throwing velocity, Aragon (2010) stated that the player should execute the skill with a proper technique. The trunk rotation can be considered as a mediator to complete the transfer of energy from lower to upper extremities. A proper throwing technique with the appearance of throwing velocity which determines the performance, it results from the effective transfer of energy from lower extremity, mediated by the trunk and forward to the upper extremity (Aragon, 2010). Study of the overhand throw indicated that 46.9% of throwing velocity could be attributed to the stride

and trunk rotation, with 53.1% due to arm action (Zawrotny, 2005). In other words, the legs included hip rotation and trunk contributes almost as much to throwing velocity as the arm itself.

The importance of trunk rotation strength in throwing velocity have been supported by Stodden, Campbell, and Moyer (2008) where this study stated that increase in throwing ball velocity associated with improvement of pelvis and trunk rotation velocity. This is because the increment in pelvis and trunk rotation velocity allows greater force generation to the throwing arm that leads to an increase in the throwing ball velocity. Moreover, Stodden et al. (2008) also stated that muscular strength in trunk rotation could create dynamic stabilization during throwing. In addition, lack of training on trunk rotation may lead to muscle imbalance and caused injury to the athletes.

In general, training should be emphasized on every muscle that involved in overall training movement. However, most of the training programs only focused on the primary muscle which generates energy in overhead throws such as shoulder and lower extremities (McDaniel, 2009; Park, Lee, & Lee, 2014; Pedegana, Elsner, Roberts, Lang, & Farewell, 1982; Zawrotny, 2006). Apparently, they neglected the importance of mediator part which also plays an important role in order to improve throwing performance. Trunk rotation and handgrip strength were classified as the mediator to complete a throwing motion, and these muscles have not been given enough emphasized in training towards improving throwing ball velocity in softball. In response to the existing gap in knowledge, this study aims at identifying the effect of hand grip strength training and trunk rotation strength training towards the throwing ball velocity among female collegiate softball players.

Methods

Subject

The study was conducted on a sample of 54 healthy female softball players. All of the participants were right-handed collegiate female from Universiti Teknologi Mara Malaysia. The participant was divided equally into three groups with 18 participants in each group. Participants with current or prior injuries and illnesses that would place them at risk in performing resistance training and throwing were excluded. Written informed consent was obtained from all the subjects before participation.

Instrumentation

Ball velocity was measured using a radar gun (Bushnell Speedster Speed Gun; Bushnell Inc, Lenexa, KS) with accuracy 1.61 kph (1 mph) (Bowman, Hart, McGuire, Palmieri, & Ingersoll, 2006). A pre-investigation identified the intraclass correlation coefficient (ICC) of the radar gun was reported at .95 which is high reliability.

Procedure

Throwing velocity assessment

Throwing ball velocity was measured using a radar gun (Bushnell Speedster Speed Gun). Based on the procedure done in the study by Tilaar and Marques (2013), the radar gun was placed approximately 1 meter behind the target, perpendicular to the ball direction. A target was provided to control the projectile of the traveling ball. The participants were invited to perform three maximum throwing trials, and each trial has been recorded. Approximately 30 seconds of rest was provided between all throwing trials to prevent muscular fatigue from occurring. The ball velocity was measured with a distance of 10 meters from a standing position of the subject to the throwing target. The researcher considers taking 10 meter length as the pre-investigation identified the ball projectile is minimum within this 10 meter distance and has been proved in the study by Escamilla et al. (2010) which the middle distance between bases is the critical peak velocity in the overhead throw. The throwing ball velocity was assessed before (pretest) and after (posttest) the 6 weeks training program.

Training description

All the experimental training group participated in 3 sessions of resistance training for 6 weeks. Training was performed on three different days in a week with at least one day of rest between sessions. The training conducted in an indoor environment (gymnasium). The exercise program consists of stretching and warm-up exercise (10 min), strength training (50 min), and cool-down or muscular relaxation exercise (10 min). Each exercise session began with a warm-up of slow stretching and movement exercise. Following the warm-up, the participant starts the basic strength training that provided for all groups. The basic strength training program was divided into two categories of exercise which are core exercise and assistance exercise. For core exercise (Bench press, squat, stiff-leg deadlift, and abdominal crunch) the training sets were increased from 2 to 3 at the second weeks, and the repetition is 1-6, meanwhile, the intensity gradually increases from 80 to 90% of the estimated 1RM obtained during 3RM pre-testing. The training repetition was increased first followed by a set and lastly the intensity. In the assistance exercise (biceps curl, seated row, dumbbell press, and triceps extension) the training sets also increase from 2 to 3 sets at the second week with the repetition of 6-10. The intensity was increased from 65 to 75% of estimated 1RM.

The additional training program given in each group is different according to the group. Participants underwent basic resistance training with additional of hand grip strength training for HG group, trunk rotation strength training for TR group and CG group only performing the basic strength training. Type of exercise for HG is barbell reverse wrist curl, barbell wrist curl, hammer cable wrist curl, hammer cable reverse wrist curl, cable wrist curl, and cable reverse wrist curl. Meanwhile, exercise for TR was kneeling cable lift, kneeling cable chop, wood chop cable, seated cable core rotation, standing cable core rotation, and torso rotation. All the additional training program intensities were followed the assisted exercise program since this strength considered as assisted muscle in throwing execution. Exercise order was random with alternating agonist and antagonist, and upper

and lower body exercise. The guideline for the training is according to the Beachle and Earle (2008), and the exercise of training was proposed based on Zawrotny (2005).

Data Analysis

All the data were analyzed using Statistical Package of Social Sciences (SPSS) program software version 20.0. In order to identify the significant difference between the three groups, One-way ANOVA on mean gained score was conducted. First, the result score was converted from mph to m/s and then mean gained was calculate prior to the analysis to analyze the treatment effect. Next, One-way ANOVA was performed to compare the significant difference between groups on the main variables of this study (throwing ball velocity). The analysis was suggested by Huck and McLean (1975).

Results

Table 1 below shows the mean score and mean gained score in pretest and post-test result according to the group.

Table 1: Mean score and mean gained score for throwing ball velocity

Group	N	PRE-TEST	POST-TEST	Mean gained (<i>SD</i>) m/s
		Mean (<i>SD</i>) m/s	Mean (<i>SD</i>) m/s	
HG	18	17.71 (2.37)	19.18 (2.40)	1.47 (.38)
TR	18	17.78 (2.09)	19.45 (1.96)	1.67 (.48)
CG	18	17.81 (2.06)	18.78 (2.05)	.97 (.32)

HG = Hand grip strength training group

TR = Trunk rotation strength training group

CG = Basic strength training group

As presented in table 1, TR group showed the greatest changes with the mean difference of 1.67 m/s, followed by HG group with a mean difference score of 1.47m/s. Meanwhile, CG group showed the lowest score with the mean difference of .97 m/s.

In order to identify the significant difference between the three groups, one-way ANOVA on mean gained score was conducted. The result shows that there is a statistically significant difference at the $p < .05$ level in throwing ball velocity for the three groups: $F(2, 51) = 14.93$, $p = .000$. Multiple comparisons with confidence interval adjustment using the Tukey HSD test were used in post-hoc analysis to compare the entire three groups (HG, TR, and CG). The result of this analysis showed that there was no significant difference between HG and TR with $p=.30$. Meanwhile, the mean gained score for HG and CG showed a significant difference where $p=.001$. It was also revealed significant differences between TR and CG with $p=.000$. In conclusion, all the three groups were significant to each other except for the HG and TR groups.

Discussion

Based on the result, there is no significant difference between HG group and TR group after 6 weeks of intervention training on throwing ball velocity. This indicates that the increment of throwing ball velocity mean score between these two groups is approximately equivalent. HG group improves about 1.47 m/s while TR group increases to 1.67 m/s and both of the group's throwing ball velocity mean score only showed a difference of .20 m/s. Hand grip strength and trunk rotation strength can be classified as element or factor in throwing ball velocity since both of these strength have their own function that can contribute to generate a greater force to increase the velocity (Ferragut et al., 2010; Fleisig, Hsu, Fortenbaugh, Cordover, & Press, 2013; Myers, Sciascia, Westgate, Kibler, & Uhl, 2015; Oyama, Yu, Blackburn, Padua, Li, & Myers, 2014; Shea, 2007; Takahashi, Ae, & Fujii, 2001; Talukdar, Cronin, Zois, & Sharp, 2015).

The hand grip strength has been identified to involve in overhead throw since the player needs to hold the ball throughout the throwing phase. Since the hand grip strength reported to have a high correlation with throwing ball velocity as stated by Ferragut et al. (2010), where the relationship is .79 indicate moderate to high relationship, therefore it is not surprising that the improvement in hand grip strength group increased the throwing ball velocity. Ferragut et al. (2010) also stated that the grip strength and wrist flexion contributes approximately 8-13% in maximum throwing velocity. This movement has been analyzed and it is well documented that the last phase of the overhead throwing is forearm extension, wrist flexion, and finger flexion in order to maximize the throwing ball velocity and increase throwing accuracy (Ferragut et al., 2010).

For a better understanding on how hand grip strength can increase throwing velocity in biomechanically, Takahashi et al. (2001) explain the relationship between force exerted on the ball by the finger and backspin of the ball during baseball pitching and throwing. In general, fingers are the main joint that generates force to produce hand grip strength. Therefore, increase in hand grip strength can lead to greater force production in fingers motion. A study by Takahashi et al. (2001), found that maximal velocity of all joint in fingers are significantly correlated with backspin rate of the ball. This study revealed that fingers are the important body segment in producing the backspin of the ball, which generates Magnus force that lifts up the ball during throwing.

The trunk rotation strength also provides approximately the same impact as hand grip with a different approach and function. Trunk rotation not only a medium to transfer energy from lower extremities to upper extremities but also can be utilized as one of the elements in generating force to increase the throwing velocity. The trunk rotation strength allows greater force generation to the throwing arm and indirectly can maximize the throwing ball velocity (Stodden et al., 2008). Sakurai (2000) also stated that without stepping and trunk rotation, the ball was accelerated to only 50% of that attained in the normal throwing motion.

A study by Fleisig et al. (2013) describes biomechanically on how trunk axial rotation during throwing movement. Trunk rotation starts to involve during the stride phase or also known as the wind-up phase. The athlete began to rotate the pelvis to face the target while

keeping the upper trunk parallel to the direction of throwing. Maximal trunk rotation occurred near the instant of foot contact to the ground. Trunk axial acceleration also peaked at this point. The pelvis and upper trunk rotated as the throwing arm externally rotated the movement acceleration is maximum according to the force generated by the muscles contraction (Fleisig et al., 2013). This is where the trunk rotation strength plays an important role to produce greater force in order to increase the throwing ball velocity.

Among the three groups (HG, TR, and CG), HG and TR groups have shown a significant difference compared to CG. This study also reveals that throwing ball velocity can be increased about .97 m/s by performing the only the basic strength training program. This statement and finding are in line with the review by Szymanski (2012), where out of 14 studies, 12 studies show that general resistance training performs by handball, softball, baseball and water polo athletes all improved the throwing velocity. In addition, Szymanski (2012) also stated that throwing velocity for high school, collegiate and elite athlete can be increased with a 6-12 week of general resistance training. Since the participant for this current study belongs in the criteria stated above, there is no astonishment that the basic strength training from this study has increased the throwing velocity.

Weight training also was proven to give a significant effect on throwing velocity even the training movement are not specifically similar to throwing movement as medicine ball training (Newton & McEvoy, 1994). Basic strength training or weight training basically develop specific muscles that may involve in throwing movement and contributes to throwing velocity. In addition, Newton and McEvoy (1994) also stated that conventional weight training improves neuromuscular qualities of force output and improve the rate of force development indirectly lead to increase in throwing velocity.

Conclusions

Overall, this study emphasizes that the throwing velocity was influenced by the hand grip strength and trunk rotation strength and later made an impact on softball performance. Since the hand grip and trunk rotation strength had increased the average throw velocity, both training should be included in the training regime of the athletes. It is also important that further studies include the hand grip strength and trunk rotation strength to be tested on other sports specifically sports that involve in similar movement as throwing such as baseball, cricket, handball, javelin throw, tennis or water polo. It is suggested that future research could also use this training method to compare between beginner and expert throwers. This comparison will describe further in term of the difference in skill level and generate a potential reason to utilize this training method. Ultimately, such data could be related to prospective injury data specifically on throwing, and this allows a better explain the cause of throwing-related injury.

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