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The Effects of Medicine Ball Training on Batting Velocity in Female Collegiate Softball Players

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ABSTRACT

Softball batting performance, characterised by bat velocity and rotational strength, is crucial for competitive success. This study explores the effect of medicine ball training, a widely used yet understudied method, on these key performance metrics. This study examines the impact of an 8-week medicine ball training program on torso rotation strength and batting velocity in female collegiate softball players. Forty participants were divided into a control group and a medicine ball group, performing 100 bat swings thrice weekly. Additionally, the medicine ball group undertook full-body medicine ball exercises thrice weekly. Results showed a significant main effect, $F(1, 38) = 5.00$, $p = 0.03$, partial eta squared = 0.12 for torso rotation strength test and $F(1, 38) = 4.01$, $p = 0.05$, partial eta squared = 0.10 for batting velocity, signifying there is a difference in the effectiveness of the two training approaches. Pre- and post-intervention tests showed significant improvements in

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both groups, with the medicine ball group exhibiting notably greater enhancements. Torso rotation strength and batting velocity increased significantly in the medicine ball group, demonstrating large effect sizes (Cohen's d=1.15 and Cohen's d=1.17, respectively). In contrast, the control group showed a substantial improvement in torso rotation strength (Cohen's d=0.86) but a minor increase in batting velocity (Cohen's d=0.22). These results suggest that medicine ball training effectively boosts key performance metrics in female softball players, offering valuable insights for designing more effective athletic training programmes.

Keywords: Batting velocity, collegiate female, medicine ball, softball, torso rotation strength

INTRODUCTION

Softball is a sport that demands a high level of competence in a range of skill sets, including throwing, batting, and fielding. These skills necessitate focused attention to optimise performance. Within the context of player skills, batting stands out as an area that demands considerable attention, focusing on enhancing bat velocity (Hussain, Mea, et al., 2019; Hussain & Shari, 2021). Various elements must be considered. These include swift awareness, reactive reflexes, proper swing technique, and bat velocity to excel in softball batting (Rivera et al., 2018). Batting in softball is characterised by a complex kinetic link, as discussed in previous research (Hussain, Mea, et al., 2019; Larson, 2021). To excel in batting, one must possess physical strength and a deep understanding of the intricate mechanics involved in the swinging technique. Enhancing rotational strength via targeted training can improve bat speed, directly influencing overall batting performance.

Extensive research has been conducted on using medicine balls in baseball and other swing- and throw-related sports. Research has shown that using weighted baseball training programmes can improve pitch velocity, arm biomechanics, and passive range of motion while decreasing the likelihood of injuries (Reinold et al., 2018). Furthermore, research has shown that implementing acute weighted baseball throwing programmes can substantially affect shoulder range of motion and elbow varus torque, suggesting their profound impact on the biomechanics of the throwing motion (Reinold et al., 2020). Moreover, research has shown that incorporating medicine ball training into tennis players' workout regimens can significantly improve their upper-body explosive strength. This finding underscores the efficacy of this training method in enhancing athletic performance, particularly in sports that involve swinging or throwing motions (Kong & Xu, 2023).

In baseball, research has shown that training with weighted baseballs can increase arm speed without significantly increasing elbow and shoulder joint kinetics, implying a potential for performance improvement without putting undue strain on the throwing arm (O'Connell et al., 2022). In addition, research has demonstrated the beneficial impact of medicine ball throws on ball velocity and accuracy among young competitive tennis players. It further reinforces the effectiveness of medicine ball training in improving sports performance, as highlighted by Terraza-Rebollo and Baiget (2021). The necessity of conducting a new study on medicine ball training in softball arises from the sport's distinct biomechanics and skill demands, despite the extensive documentation of its benefits in baseball and other sports. Softball players exhibit unique hitting and throwing techniques, potentially resulting in different effects of medicine ball training on their overall performance. Conducting studies with softball presents an opportunity to develop training programmes specifically designed to meet the biomechanics and skill demands of the sport. It ensures that the training methods are tailored to the unique requirements of softball, optimising their effectiveness. Furthermore, exploring the impact of medicine ball training on softball players can greatly contribute to advancing sport-specific training protocols, thereby enriching the collective knowledge of training methodologies in softball.

Studies showing improved athletic performance have supported using medicine balls in baseball and other swing- and throw-related sports. The effectiveness of medicine ball training has been well-documented in different sports. However, conducting a specific study on softball is crucial due to its distinct biomechanics and skill requirements. It emphasises the significance of designing training programmes catering to softball's demands. Despite their frequent incorporation into training regimens, more research needs to be conducted on the impact of medicine ball exercises, particularly in the context of female softball players. Our study seeks to fill a void in existing research by examining the effects of medicine ball training on bat swing velocity in female collegiate softball players. By doing so, we aim to enhance our knowledge of effective training techniques in this sport.

MATERIALS AND METHODS

Research Area and Duration

This research was conducted to determine the effect of eight-week medicine ball training on improving female collegiate softball players' torso strength and batting velocity. The research area occurred at the Universiti of Teknologi MARA Selangor, Shah Alam campus, Malaysia.

Research Design

The study employed an experimental design, incorporating a pre-test and post-test randomised design.

Participants

The sample size for this study was determined through a thorough calculation of the effect size, utilising the formula proposed by Cohen (1992). According to the findings of a previous study by Higuchi et al. (2013), this method has a large effect size (0.75) on batting velocity, as seen in 12 participants. In a study conducted by Schoenfeld et al. (2014), a group of 10 participants was examined, revealing a moderate effect size (0.56) in batting velocity. Twenty of the sixty female softball players who initially volunteered for the study were excluded because of predetermined inclusion requirements. Forty healthy female athletes were left in the final cohort. The participants in the study had an average age of 23.32 years (±1.87), a height of 156.42 cm (±1.69), and a weight of 53.49 kg (±3.06). The following were the requirements for inclusion in the study: (1) having a valid collegiate softball team roster, (2) having prior experience with resistance training, and (3) not having any self-reported medical conditions, neurological disorders, mental illnesses, or significant past or present injuries that could put participants at risk during training or exercises. A bat speed measurement was performed on each participant to guarantee baseline comparability. Participants were randomly assigned to the Medicine Ball (MB) or Control (CT) group by fish-bowl drawing, with no initial batting velocity differences. The methodological approach utilised in this study received approval from the Research Ethics Committee of Universiti Teknologi MARA (600-RMI 5/1/6), underscoring the study's commitment to upholding ethical research standards.

Instrument

Torso Rotation Strength Test

The Cybex Torso Rotation Machine™ has been widely utilised for conducting 3RM torso rotation strength tests, as demonstrated in the study by Szymanski et al. in 2010. Before the 3RM rotational strength test, participants were instructed to engage in standing torso exercises with a lightweight medicine ball as a warm-up. After the warm-up, participants were provided with a brief one-minute rest period. The participants assumed a seated position on the machine and gently positioned their feet on the footplates. They applied pressure to the machine's adductor pads to ensure their knees were at a 90° angle. The post-test involved recording the number of seat adjustments made by each participant. Participants assumed an upright position, firmly grasping the handles with both hands and applying pressure to their chests against the machine's chest pad. The study aimed to evaluate the participants' strength on the dominant side of their torso, specifically focusing on the direction of their bat swing. Before the test, each participant performed a single bat swing. Participants were instructed to execute rotations within a range of motion that closely mimicked the movements involved in a softball swing to assess the strength of their torso rotation. This range spanned from -30º to +75º, resulting in a total range of 105º. This range was established utilising the Cybex Torso Rotation Machine™ and has been used in softball and baseball batting experiments (Szymanski et al., 2010). Each participant's movement during the test was carefully monitored and guided by a qualified strength and conditioning instructor. Participants were given a 2-minute rest after failing to complete the full range of motion (105°) or perform the test properly before trying again with a 2.3-kg load. The test-retest reliability for these variables was statistically significant, with a correlation coefficient greater than 0.90 ($p \leq 0.05$).

Batting Velocity

After conducting the 3RM Torso rotation strength test, a 30-minute break was provided before proceeding with the batting velocity test. Before assessing the bat swing, a comprehensive warm-up routine lasting 5 minutes was implemented, consisting of intense full-body exercises. Five dry swings were conducted using the designated softball bat for the upcoming testing as part of the warm-up routine. The bat utilised during the testing phase was constructed from aluminium, with a length of 84 cm and a weight of 0.68 kg. The bat swing velocity was measured using a portable swing analyser (ZEP-BT-000002; Zepp Company, Cupertino, California, USA). According to a study conducted by Hussain, Kee, et al. (2019), this swing analyser has been found to have reliability ranging from $r = 0.822$ to 0.988. The participants performed a series of five swings, with a brief 30-second rest period between each swing. The participants were instructed to execute rapid swings while ensuring a consistent stance and technique. Participants were asked to focus on the external environment rather than their bodily movements to optimise performance (Gray, 2018). The velocities of each of the five swings were meticulously recorded for analysis.

Procedure

Participants were required to attend a one-day session for assessment. The initial evaluation involved measuring body composition, including height, weight, and body mass index, as well as conducting a 3-Repetition Maximum (3RM) torso rotation strength test. The pre-test for batting velocity was conducted at the same location, with a 30-minute rest period following the 3RM torso rotation strength test. Participants were instructed to abstain from high-intensity physical activity before the test session. All the tests were recorded for each participant—the MB group was involved in regular practice, performing 100 dry swings three times a week. Nevertheless, the group engaged in medicine ball training in the gymnasium following the completion of swing training. The training was structured using the stepwise periodised method, as seen in previous studies on resistance training for enhancing strength and batting velocity (Szymanski et al., 2007). The training regimen began with a high volume of training at a low intensity (300 kg), gradually transitioning to a lower volume of training at a higher intensity (320 kg), as illustrated in Table 1.

During each training session, participants engaged in a sequence of exercises, completing a predetermined number of repetitions. The exercises mentioned encompassed various throwing techniques, such as the hitter's throw, figure-of-eight throw, speed rotation, standing side throw, and squat and hurl. The throw executed by the hitter follows a conventional

Table 1
Medicine ball training program

Variables	Week 1 to Week 4			Week 5 to Week 8		
	Sets		Reps	Sets		Reps
Warm-up	2		10	2		10
Swing practice	5		20	5		20
Medicine Ball Exercise	Sets	Reps	Load (kg)	Sets	Reps	Load (kg)
Hitters throw	2	6	5	2	8	4
Standing figure of eight	2	6	5	2	8	4
Speed rotation	2	6	5	2	8	4
Standing side throw	2	6	5	2	8	4
Squat and hurl	2	6	5	2	8	4

Source: Szymanski et al. (2007)

batting stance, resembling the motion of swinging a softball bat while incorporating a medicine ball. The figure-of-eight throw involves a dynamic exchange of medicine balls between two participants positioned back-to-back, requiring them to rotate swiftly. The partner pass entails swiftly rotating the torso and throwing a medicine ball to a designated partner. A notable exercise is the standing side throw, in which individuals vigorously propel a medicine ball following a swift rotation, emulating a batter's stance. The rotational exercises involving the medicine ball were executed in both directions to promote equilibrium and enhance the development of the muscles in the torso. The squat and hurl exercise involves participants squatting down and rapidly extending their arms to throw the ball forcefully. In week five, modifications were implemented to replicate the conditions of a game by adjusting the weight and repetitions of the medicine ball by transitioning from heavier to lighter balls and increasing the number of repetitions. The CT group utilised the training programme Szymanski et al. (2009) developed for the baseball swing. The batting velocity of baseball players experienced a notable increase due to the implementation of this programme.

Furthermore, the instructors utilise this programme during their regular softball practice sessions. Participants performed several sets of swing training, with each exercise session commencing with a warm-up consisting of two sets of ten swings using a standard bat. Next, the participants are required to complete five sets of 20 swings. During the eight-week training period, participants consistently stuck with the bat they had chosen.

Statistical Analysis

Before proceeding with the analysis, a Kolmogorov-Smirnov test was conducted to evaluate the normality of the data distribution. The findings revealed that all parameters exhibited a normal distribution. This study used a mixed within-group analysis to examine the changes in the 3RM torso rotational strength test and batting velocity before and after an eight-week intervention. A pairwise comparison analysis was used to compare the pre-and post-test results for each variable. A test was conducted to validate the assumption of homogenous variances. The data was analysed using SPSS 23 software (IBM®, Armonk, NY, USA), with an alpha level of $p \leq 0.05$ to determine statistical significance.

RESULTS AND DISCUSSION

An analysis of variance was conducted to evaluate the effects of two interventions (medicine ball and bat swing) on participants' scores on the torso rotation strength test and batting velocity test over two periods (pre-intervention and post-intervention). The analysis revealed no significant interaction between training and time for the torso rotation strength test and batting velocity (Wilks' Lambda =0.59, F (1, 38) = 26.43, p =0.15, partial eta squared =0.42). Similarly, no significant effect was found for the same variables when considering Wilks' Lambda = 1.05, F(1, 38) = 322.47, p =0.16, and partial eta squared =0.89. The results revealed a significant main effect for time, indicating a substantial increase in torso rotation strength test and batting velocity scores across the two periods (Table 2). The statistical analysis showed a strong effect size, with Wilks' Lambda =0.16, F (1, 38) = 199.91, p <0.001, partial eta squared =0.84 for the torso rotation strength test, and Wilks' Lambda =0.06, F(1, 38) = 642.79, p <0.001, partial eta squared =0.94 for batting velocity scores. The study's results revealed a significant main effect when comparing the two types of interventions. For the torso rotation strength test, the F-value was 5.00 (p =0.03, partial eta squared =0.12), while for the other test, the F-value was 4.01 (p =0.05, partial eta squared =0.10). These findings suggest a notable difference in the effectiveness of the two training approaches. Statistical analyses through pairwise comparisons indicated a significant enhancement in torso rotation strength for the Medicine Ball (MB) group when contrasted with pre-intervention values (p <0.001), exhibiting a large effect size (Cohen's d=1.15). A parallel increase was

Table 2
3RM Torso rotation strength test and batting velocity test scores for the medicine ball and control groups across two time periods

Parameters	Group		Mean	Std. deviation	N
Torso Rotation Strength Test	MB	Pre	30.36	7.16	20
		Post	39.21	8.23	20
	CT	Pre	28.29	5.16	20
		Post	32.42	4.39	20
Batting Velocity	MB	Pre	87.95	6.47	20
		Post	95.48	6.40	20
	CT	Pre	87.22	5.87	20
		Post	88.51	5.58	20

Source: Authors' work

observed in batting velocity, displaying a large effect size (Cohen's d=1.17). In the Control (CT) group, pairwise comparisons denoted a notable improvement in torso rotation strength compared to baseline measurements ($p < 0.001$), with a large effect size (Cohen's d=0.86). Conversely, the alterations in batting velocity from pre- to post-intervention for the CT group were associated with a small effect size (Cohen's d=0.22).

The present study utilised a between-subjects design to examine and compare the bat swing velocity of the medicine ball (MB) and the control (CT) groups by investigating the impact of medicine ball training, a specialised form of resistance training, on the bat speed of collegiate softball players. The experimental design employed in this research allowed for a thorough examination of this relationship. Previous studies have predominantly centred around training programmes to enhance the bat speed of high school and collegiate baseball players. The training programmes discussed in the literature incorporate various sport-specific resistance training methods, including weighted implement warm-ups, weighted bat training, and total-body resistance training. These programmes have yielded favourable outcomes in enhancing batting velocity (Kobak et al., 2018; Rivera et al., 2018). The current study found that the MB group demonstrated significantly greater improvements in the 3RM torso rotation strength test (%) and batting velocity (%) compared to the CT group. The results of this study were anticipated, as the MB group incorporated a structured medicine ball programme consisting of periodic rotations thrice a week for eight weeks. It is worth noting that the MB group also maintained the same number of total bat swings as the CT group.

In contrast to not incorporating medicine ball exercises, the CT group demonstrated a modest improvement in the 3RM torso rotation strength test and batting velocity. Felion and DeBeliso (2020) discovered that engaging in a daily routine of swinging a bat 100 times three days a week for six weeks significantly improved bat swing velocity. According to Szymanski et al. (2009), the relationship between strength and power and its impact on the batting velocity of adolescent, high school, and collegiate baseball players has been explored in 11 different studies. Based on the analysis, it is evident that enhancing strength and power directly correlates with increased batting velocity. Power is the result of combining strength and velocity. Power can be defined as multiplying the applied force by the applied velocity. The correlation between force and velocity is crucial in determining muscular power output. An inverse relationship exists between the force-generated quantity and application velocity.

The relationship between force and velocity presents a trade-off. Muscle strength and speed have a positive correlation, although this relationship has limits. As a result, the highest level of muscle strength is achieved by effectively combining force and velocity. The findings indicate that the robust and fluid movements of the kinetic link components, namely the hips and thorax, significantly impact increasing bat speed. The findings of this study align with the research discussed in a previous review article (Szymanski et al., 2009). The results of this study demonstrate a significant improvement in both the torso rotation strength test and batting velocity following strength-power (medicine ball) training. The post-test results of torso rotation strength considerably impact the batting velocity, with a substantial effect size exceeding 1.0. The study highlights two key factors contributing to the increased torso rotation strength test. Firstly, the use of a standard softball bat as a resistance tool proves to be effective.

Additionally, engaging in medicine ball training also plays a significant role in enhancing strength. The study participants performed 100 swings with a standard softball bat daily, thrice a week, over eight weeks. In addition, a stepwise medicine ball training programme was implemented three days a week for eight weeks. The study's findings suggest a significant enhancement in torso rotation strength among female collegiate softball players due to engaging in this combination of activities. Medicine ball training has been widely utilised in the athletic community for its effectiveness as a targeted power training technique (Kobak et al., 2018). The current study suggests that the movements performed with a medicine ball resemble those utilised in rotational power sports. The primary goal of these sports is to efficiently transfer the highest possible rotational speed to an external object through a combination of large and precise body movements. Medicine ball throws have been recognised in previous research as an effective method of resistance training due to their capacity to enhance speed and power compared to conventional athletic activities (Bragazzi et al., 2020).

This study explored the effects of increased force on power generation at a particular point on the force-velocity curve. The findings of this research could be valuable for athletes, as they shed light on the significance of powerful high-velocity movements that are often neglected in sports and resistance training programmes. The medicine ball training programme was conducted in a manner that closely replicated explosive, rotating softball-specific batting actions. The programme followed a ballistic and sequential approach to achieve this simulation. While striking a ball, the trunk flexors exert significant effort to rotate and stabilise the spine. Consequently, throughout swing practice and medicine ball training, the trunk flexors of softball players may undergo numerous contractions. The softball swing encompasses a circular kinetic link motion, engaging various body components such as the legs, trunk, shoulders, and arms. Therefore, it is imperative to implement sport-specific routines to replicate the swing accurately. To optimise bat swing velocity, it may be beneficial to incorporate methods such as adding resistance to the bat or engaging in explosive medicine ball throws.

The current study investigated the impact of an 8-week progressive medicine ball training regimen on the strength of torso rotation and batting velocity in female collegiate softball athletes. The study's results indicated a notable enhancement in torso rotation strength and batting velocity due to this training method. These findings underscore the advantages of integrating medicine ball exercises into softball training programmes. The findings of this study provide valuable insights into the effects of movement-specific resistance training on softball performance, enhancing our understanding of this training approach. The swift rotation of the hips and torso greatly influences the effectiveness of softball actions. The body's role as a kinetic link is paramount in enhancing both batting and throwing skills. Incorporating medicine ball exercises into training regimens can greatly improve softball players' explosive rotational power while fortifying their core muscles through various movement patterns. The training method presented in this study provides a practical and adaptable strategy for improving performance in sports that require rotational power. This approach offers a cost-effective solution that benefits athletes in these specific sports.

Nevertheless, it is important to acknowledge that the study did not fully consider all potential confounding factors that could have influenced the results, potentially impacting the outcome. Further investigation is necessary to overcome these limitations and enhance the validity and dependability of the findings. It is recommended that forthcoming studies incorporate control groups with varying training interventions to strengthen the comprehension of medicine ball training and its utilisation in softball and other rotational power sports. Direct comparisons could be facilitated, and the specific effects of medicine ball training could be better isolated. In addition, thoroughly examining the lasting impacts of these training programmes and their applicability to competitive performance could provide valuable insights for athletes and coaches.

CONCLUSION

Based on the findings, incorporating medicine ball training into the preparation of softball athletes yields noteworthy enhancements in torso rotation strength and batting velocity. Coaches and trainers can effectively utilise this training method to improve female collegiate softball players' performance and potentially positively affect athletes in other rotational power sports. However, it is essential to consider the study's limitations. Further studies should expand on these findings to enhance our comprehension of movement-specific resistance training and its practical applications for athletes.

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