Journal of Positive School Psychology http://journalppw.com
2022, Vol. 6, No. 5, 1307 – 1319

Effects of 8-week medicine ball training on physical performance among basketball players

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Abstract

Background: In this context, Medicine ball training has been studied to see if it might help basketball players' physical performance and skills. Objectives: Investigated the effects of eight weeks of medicine ball training on physical performance and basketball skill performance among male basketball players aged 18 to 24 years. Materials and Methods: 28 Subjects were recruited into two groups, the experimental group (EG) and the control group (CG), EG=14 (Mean age 21.25 ±1.34) and CG=14 (Mean age 20.52 ±1.77). To detect differences within-between the study groups, repeated-measures ANOVA was used. Results: The analyses demonstrated significant pre-, mid-, and post-test effects on physical performance; all the physical fitness variables examined p<0. 01 and skill performance analyses looked at all variables p<0.01. The medicine ball training EG improves a player's physical performance, which is markable in percentage. The variables such as Overhead Medicine Ball Throw (OHMBT), Standing Long Jump (SLJ), Sprinting 20 m (SPRINT), Agility T-Test (AGILITY), Vertical Jump (VJ), Back and Leg Dynamometer (BLD); 5.11%, 4.52%, 1.34%, 3.49%, 6.45% and 16.40% respectively. Moreover, the study emphasizes that the medicine ball improves basketball skills performance percentage measures in EG, which comprise Control Dribble (CD), Defensive Movement (DM, Passing (PASS) and Speed Spot Shooting (SSS); 2.14%, 3.22%, 6.83% and 13.29% respectively. Conclusion: This research indicates that medicine ball training in conjunction with regular exercise can significantly increase physical performance and basketball skills. It is advised that coaches add medicine balls into players' daily training regimes. The execution of medicine ball workouts free in the direction of skill work improves basketball skill performance. The recommended program for medicine ball workouts is ideal for evaluating improvement in basketball players' physical performance and basketball skill performance.

Keywords: Medicine ball, physical performance, strength training, plyometric training, basketball conditioning.

INTRODUCTION

Basketball requires running, jumping, speed, and agility, which are critical elements of athletic performance. Basketball games require subjects to make intermittent motions other than sprinting and jumping, which requires both strength and endurance (Maulder & Cronin, 2005). Additionally, the game is defined by frequent starts, direction changes, and stops within a specified time frame (Ransone, 2016). Unlike a quarter of gameplay, which lasts eight minutes for high school subjects, the average basketball play segment lasts no more than 20 seconds, covering approximately 5000 meters in 48 minutes (Delextrat & Cohen, 2008; Ransone, 2016). In this context, focusing on physical performance, particularly medicine ball training, to enhance physical performance and basketball skills performance is an area that has received little scholarly attention. According to others, intensity is the most important factor in determining improvements in strength level, which is why most of the existing literature focuses on resistance training when evaluating basketball subjects' performance (Burgess & Naughton, 2010; Giroux et al., 2016). It also gains significance because research indicates that explosive strength alone is insufficient to improve basketball performance (Montgomery et al., 2010), implying the need for power endurance training in general and medicine ball training. The current study was examined medicine ball exercises that improve physical performance such as agility, balance, coordination, muscle endurance, speed, strength, and explosive power. Physical strength is required for most sports. On the other hand, Basketball subjects must maximize their performance through a combination of strength and endurance (Aoki et al., 2015).

In this regard, medicine ball training was evaluated, which efficiently improves basketball subjects' physical performance. Today, the medicine ball is utilized to increase subjects' explosive muscular power (Ebben, 2002) and to expedite recovery following injury (Ferguson, 2009), which is critical for basketball subjects. Coaches and physical education teachers, on the other hand, are not as involved in medicine ball exercises as they should be. Alternatively, one could argue that they do not adapt to these exercises well during their training session and curriculum. It demonstrates that which may result from their lack of understanding regarding medicine ball training. Thus, this study seeks to close a research gap by determining and clarifying the effects of medicine ball exercises on physical performance among basketball subjects during performance enhancement (Thomasian, 2015). Historically, most of the scholarship on basketball subjects has concentrated exclusively on the subjects' perspective, whether it is about nutrition, training regimens, the mental side of the game, or other aspects that affect performance directly or indirectly. There has been little to no research on the effect of medicine ball training on basketball subjects' physical performance and how it affects them. How do instructors guide their charges? With this backdrop in mind, this research aims to assist coaches in incorporating medicine balls into their coaching tactics. Conditioning exercise increases a broader range of fitness variables to determine the relationship between medicine ball throws and the physical ability of athletes (Ikeda et al., 2007). During the six-week training intervention, resistance training improved speed (Nur Iman Bin Md Rahim & Oleksandr Krasilshchikov, 2015). More precisely, this study would shed light on a previously unknown aspect of medicine ball training: increasing the efficiency of coaching and subjects' performance over a specified period. The purpose of this study was to ascertain the precise effect of medicine ball training, also known as strength and explosive training, on adult basketball subjects and focus on the importance of medicine ball training in improving the quality of physical performance (Wang & Zhang, 2016), which can go a long way in enhancing basketball performance (Dobbs et al., 2015). The hypothesis was that there would be a substantial difference in physical and skill performance between male ball subjects who trained with the medicine ball experimental group (EG) and those who trained with the routine basketball playing control group (CG).

Material & methods

Participants: In this randomised control study, the samples of twenty-eight male subjects volunteered to participate in this study. Male adult basketball players were used as subjects. Subjects ranged in age from 18 to 24 years. 28 Subjects were recruited into two groups, each 14 subjects EG (Mean age 21.25 ±1.34) and CG (Mean age 20.52 ±1.77). The randomisation sequence was created using a computer program (https://www.randomizer.org) and kept secret until the treatments were allocated. Subjects were written verbally and written about the testing processes. Before participating in the trial, everyone signed a written informed consent form. Basketball coaches allowed the investigator to approach potential subjects and solicit their participation in this study.

Study procedures: All of the research procedures were carried out in a basketball facility. Even though all participants had a prior minimum of two years of experience with the fitness tests utilised in this study, all participants attended a one-week familiarisation session before data collection. Correct techniques for each fitness test were tested and performed. Research assistants showed correct testing techniques throughout the intervention, and participants took practice versions of every test. Participants were instructed to refrain from engaging in strenuous physical activity for the trial. The same researchers who evaluated and trained the same volunteers administered the fitness tests in the same location, in the same sequence, using the same equipment and approach. A week before the training period, pre-testing was done; after four weeks, a mid-test was done, and the week after the training period, post-testing was done.

Testing procedure: This section describes the performance test used for Anthropometric Test, Fitness Performance Test, and AAHPERD Basketball Skill Performance Tests.

Anthropometric Test: The anthropometrics of the subjects were measured using a high standard blue tooth electronic digital height measurement and weight measuring scale. The height of the subjects and weight were entered into the readings of body weight, and body mass index was recorded (BMI).

Weight (kg): The Weight Scale Digital Blue tooth machine Brand Name: kangnuo, Model Number: H1H from Guangdong, China. The subjects were stand on the measuring scale. Scoring: Look at the results of the measuring scale. (r =0.967) Mean SD - EG 64.05±10.38 and CG 65.63±9.11.

Height (m): The Height Scale Machine Brand Name: kangnuo, Model Number: H1H from Guangdong, China. The subjects stood straight on the scale and measured their height. Scoring: Mark the height of the measuring scale. (r =1.0) Mean SD - EG 1.73±0.07 and CG 1.76±0.05

Physical Performance Test: The test variables include Overhead Medicine Ball Throw (OHMBT), Standing Long Jump (SLJ), Sprinting 20 m (SPRINT), Agility T-Test (AGILITY), Vertical Jump (VJ), Back and Leg Dynamometer (BLD).

OHMBT: The overhead medicine ball throw test was done with a 3kg STAG model medicine ball, India and measured by using LOMVUM Bluetooth laser rangefinder digital distance meter, Brand Name: LOMVUM, Model: LP series, China. Procedure: The participant maintained behind a straight line while standing in a straight line with feet slightly apart. Like a soccer or football throw-in, the throwing motion is analogous to that of a throw-in. The ball is launched as far as possible after being returned behind the head. Following the throw, the subject is permitted to cross the line and is even encouraged to do so to increase the distance of the throw. Three attempts are permitted in total. The distance from the starting point to where the ball landing is recorded for scoring purposes. The distance is recorded to the closest 5 centimetres. The best result of three throws is used (Wood, 2010). The test-retest reliability for the overhead medicine ball throw test was r = 0.965.

SLJ: The Long jump test was measured using a standing long jump testing mat with a non-slip indoor home surface, Brand: Xinorui, Model no: 653082830750, China. The subjects were instructed to stand slightly apart behind a ground-marked line. Start, takeoff, and landing are performed on two feet, with forwarding momentum provided by arm swings and knee bending. Scoring: The participant attempts to leap as high as possible while landing on both feet without falling backwards. Three attempts are at your option (Wood, 2010). The test-retest reliability for the Long jump test was r = 0.991.

SPRINT: The sprinting 20 m test was used with our timing gate using FREEELAP SA PRO, Model: BT 111 with Bluetooth function; SWITZERLAND Procedure: A full warm-up should be followed by practice starts and accelerations. Begin one foot in front of the other and work your way forward. On the starting line, the forward foot must be placed. Before beginning, this runner must be completely still. The tester should begin the timing gate by software; the subject pushes the button, starts running the timing gate, and stops it when the subject reaches the finish line. Scoring: Three tries are permitted, with the best time to the nearest two decimal points recorded on each occasion (Wood, 2010).The test-retest reliability for sprinting the 20 m test was r= 0.996.

AGILITY: The agility t-test was used with our timing gate using FREELAP SA PRO, Model: BT-111 with SWITZERLAND's Bluetooth function. Procedure: When the subject starts the test from cone A, the time gate begins automatically. The subject runs to cone B and places a hand on the base of the cone. The participant must then turn and shuffle sideways to cone C while touching the base with their hand. Then, with the hand touching the base, slide laterally to the right to cone D. Participants return to the cone in sideway B and contact it with their hand before returning backwards to cone A. The timing gate paused when the runners crossed cone A. Take the best time of three successful trials to the nearest 0.01 seconds. The table below shows some scores for adult team sports subjects (Wood, 2010). The test-retest reliability for the agility t-test was r = 0.965.

VJ: The vertical jump was assessed using a Vertical jump machine. Brand Name: BELIEF, Model Number: CR001, Type: vertical jump measurement Rizhao Belief Fitness Equipment Co., Ltd, China. The participant then stands at the right distance from the apparatus' base (about 15 feet), takes three or four steps forward, and leaps as high as possible on both legs, using the arms to assist with acceleration. The participant must fall just short of the apparatus to remain exactly beneath it for the length of the jump. Scoring: The scores were calculated as the difference between the height of the standing reach and the height obtained during the jump. Furthermore, jump height can be translated to a score in centimeter (Wood, 2010). The test-retest reliability for the vertical jump test was r = 0.991.

BLD: The Back-leg Dynamometer was used to measure back and leg strength from Changzhou Kondak Medical Rehabilitation Equipment Co., Ltd, China. Procedure: Ensure that the meter is reading zero before proceeding. Position your feet shoulder-width apart on the dynamometer's base and maintain a straight stance. If your arms are hanging straight down, you must be able to fully understand the centre bar with both hands, palms facing your body. Adjust the chain, so the knees are bowed to approximately 110 degrees. When it starts, your back is just slightly arched. Your head should be held high at the hips, and you should be facing forward. Pull as hard as you can on the chain without bending your back to straighten your legs while keeping a straight arm position. Best results are achieved when the legs are virtually straight at the top of the lift. Scoring: Take a look at the dynamometer results (Wood, 2010). The test-retest reliability for the Back-leg Dynamometer test was r = 0.951.

Basketball Skill Tests (AAHPERD). The AAHPERD basketball skill test applied such as Control Dribble (CD), Defensive Movement (DM, Passing (PASS) and Speed Spot Shooting (SSS).

CD: The participants dribbled the ball as they traversed an obstacle course with six cones placed within the restricted basketball area. The timing of the test was recoded. Each participant had three trials, one of which was a practice run. The points were calculated by adding the second and third attempts as a test (David R Hopkins; Jacqueline Shick; Jeralyn J Plack, 1984; Lacy & Williams, 2018). The control dribbling skill test had test-retest reliability of r = 0.9703.

DM: The participants maintained their absolute defensive position while making seven direction changes without crossing their feet, as indicated by six cones placed along the perimeter lines of the restricted basketball area. The duration of the examination was recorded. Each participant conducted three trials, one of which was a practice run. The sum of the second and third trials was utilized as a test answer (David R Hopkins; Jacqueline Shick; Jeralyn J Plack, 1984; Lacy & Williams, 2018). The test for defensive movement skills had test-retest reliability of r = 0.949.

PASS: Six 60x60 centimetre targets were mounted on a wall at varying heights between 150 and 90 centimetres from the floor. The participants completed chest passes against this wall for 30 seconds and recovered the ball while moving behind a line 2.45 m away from the wall. Each pass that made contact with the target or the boundary was scored two points, but those that made contact with the wall's gaps were worth only one point. It operated as follows: Each participant conducted three trials, one of which was a practice run. The answer was calculated by the sum of the second and third attempts as a check (David R Hopkins; Jacqueline Shick; Jeralyn J Plack, 1984; Lacy & Williams, 2018). Passing skill test-retest reliability was r = 0.947.

SSS: Marked five shooting points in the basketball area, and participants were taken shots at 4.57 meters away from the basket and at five different angles (0, 45, and 90 degrees to the basket backboard). Each participant retrieved their rebound and relocated to a newly specified location within 60 seconds. In each trial, a total of four non-consecutive layups were permitted. When a shot missed the rim, one point was awarded, and two points were awarded when it made the basket. Each participant conducted three trials, one of which was a practice run. Adding the second and third attempts points as a test result (David R Hopkins; Jacqueline Shick; Jeralyn J Plack, 1984; Lacy & Williams, 2018). The Speed spot shooting test's test-retest reliability was r = 0.708.

Training Procedures: Most of the exercises are done alone; however, some are done with a partner. Two sessions each week on non-consecutive days. Exercise order is an important variable in resistance training prescription, just as load, volume, and rest intervals between sets and exercises (Ratamess, 2011). In addition, the workout uses a large or small muscle group. A familiarisation event scheduled before the intervention for one week (2 sessions) for the experimental group (Bompa & Haff, 2009; Ferguson, 2009). The medicine ball training is done twice a week on non-consecutive days (Monday and Thursday) for eight weeks under strict supervision and management by the coaches. Before each training session, all subjects were encouraged to do a 10-minute warm-up that included stretching and jogging at a moderate pace. Succeeding the warm-up, EG completed medicine ball exercises (40 min). The subjects participated in 10-minute cool-down activities at the end of the training session. The workout exclusively based on using medicine balls of various weights ranging from 1 to 6 kilogrammes for eight weeks. These exercises are done in two sessions each week on non-consecutive days for 60 minutes per session, including the warm-up and cool-down. The number of repetitions for each exercise ranged from 8 to 12, with a rest period of 1-3 minutes in between sets (De Salles et al., 2009).

Professional basketball, strength and conditioning coaches discussed and showed effective exercise techniques (Robergs, 2004). The subjects are constantly encouraged by the coaches to maintain good technique. It took eight weeks to complete the intervention, plus time for the familiarisation week, testing procedure, and ten days. During the medicine ball conditioning phase, EG subjects practice a range of medicine ball exercises that progress from easy to difficult as their skill and confidence improve (Faigenbaum & Mediate, 2008). The exercises become more challenging as they proceed from the least to the most difficult. Table 1 provides an overview of the medicine ball training regime (Mediate, 2006). For CG, each training session began with warm-up drills, stretching, and basketball play. All subjects were instructed not to perform medicine ball strength training during the study. All subjects continued to participate in their basketball training. Both groups and all subjects participated in all three-time tests. All the subjects participated in more than 82.5% of the training sessions; therefore, no one eliminates from this study.

Table 1: *Summary of medicine ball training program.*

Week	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**
MB Exercise Level*	**I**	**I**	**II**	**II**	**III**	**III**	**IV**	**IV**
Medicine Ball (kg)	**1-3**	**1-3**	**2-4**	**2-4**	**3-5**	**3-5**	**4-6**	**4-6**
Sets	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
Repetitions (n)	**8-10**	**8-10**	**10-12**	**10-12**	**10-12**	**10-12**	**8-12**	**8-12**
Rest (min)	**1-3**	**1-3**	**1-3**	**1-3**	**1-3**	**1-3**	**1-3**	**1-3**
Exercises (n)	**6**	**6**	**8**	**8**	**10**	**10**	**12**	**10**
OHMBT	x		x		x	x		x
BOHMBT	x		x		x		x	x
SUT		x		x		x		x
TT	x	x		x		x	x	
SFCPT	x	x		x		x	x	
BJP	x	x		x		x	x	
SP		x	x		x		x	x
SBT		x	x		x	x	x	
OHTK			x		x	x	x	
ST			x		x		x	x
FUHT	x		x		x	x	x	
VT			x		x		x	x
PSUOHT				x		x		x
MBSP				x		x		x
JSMBCP				x	x		x	x
OHS				x	x		x	x

OHMBT=Overhead MB throw; BOHMBT=Backward overhead MB throw; SUT=Sit up throws; TT=Twisting throws; SFCPT=Step forward chest pass throws; BJP=Broad Jump Pass; SP=Squat Press; SBT=Seated backward throw; OHTK=Overhead throw kneeling lunge; ST=Side throws to wall; FUHT=Forwards Underhand throw; VT=Vertical toss for height; PSUOHT=Plyometric sit-up overhead throw; MBSP=Medicine ball shoulder press throw; JSMBCP=Jump squats to MB chest pass; OHS=Overhead slam to vertical jump; MB=Medicine ball. Details of the training programme are discussed in the text.

Data Collection: Before the eight-week study period, subjects were pretested for their test, which was also conducted after four weeks (mid-test) and after eight weeks of training (post-test). Data collection in Sri Lanka. The Research and Ethics Committee approved the research protocol of the Universiti Sains Malaysia.

Statistical Analysis: For each variable, descriptive variables were computed. Independent sample t-tests were used to determine group differences at baseline. A two-way repeated measures ANOVA (2x3) was used to assess for interactions and main effects of time (initial vs. final) and group (experimental vs. control) on the dependent physical and skill performance variables. Version 27 of SPSS statistics was utilized for the analysis. For each variable, descriptive data were made. Independent sample t-tests were used to look at group differences at the pretest. OHMBT, SLJ, SPRINT, AGILITY, VJ, BLD, and CD, DM, PASS, SSS were the physical and skill variables of interest. A two-way within-between (group x time) repeated measures ANOVA was used to look for group differences in these physical and skill variables. Subjects used Bonferroni corrections when there were significant main effects and interactions. They used paired t-tests to find out about the specific differences. An analysis confidence level of 95% and the significance was set at $p<0.05$.

Results

Table 2: *Basic anthropometric characteristics of the study participants; Values and means (±SD)*

Group	Age (y)	Body height (m)	Body weight (kg)	BMI (kg/m2)
EG (14)	21.25 ±1.34	1.73±0.07	64.05±10.38	21.03±2.43
CG (14)	20.52 ±1.77	1.76±0.05	65.63±9.11	21.05±2.35

Table 3: *Physical performance measures from Pre-test, Mid Test and Post-test training for the CG & EG*

GROUP	Pre-Test Mean(±SD)	Mid Test Mean(±SD)	Post Test Mean(±SD)	Group F (1,26), p-value (ES)	Time F (1,27), p-value (ES)	Time x Group F (2,52) p-value (ES)	Δ%
Overhead medicine ball throw – m - (OHMBT)							
CG	8.80±1.61	8.84±1.63	8.90±1.65*	F=0.196	F=18.63	F=11.263	1.13
EG	8.81±1.33	9.11±1.25	9.36±1.26*#	p=0.662	p=0.001 (1.453)	p<0.001 (0.759)	6.24
Standing long jump – m - (SLJ)							
CG	2.33±0.27	2.35±0.28	2.38±0.28*	F=1.080	F=30.65	F=27.804	2.14
EG	2.40±0.23	2.47±0.22	2.56±0.22*#	p=0.206	p<0.001 (0.284)	p<0.01 (0.143)	6.66
Sprint 20 m – sec - (SPRINT)							
CG	3.53±0.37	3.51±0.37	3.46±0.39*	F=4.355	F=59.09	F=2.122	-
EG	3.31±0.22	3.26±0.22	3.20±0.24*#	p=0.047	p<0.001 (0.117)	p=0.130 (0.005)	-
Agility T – Test – sec - (AGILITY)							
CG	10.92±0.55	11.06±0.60	10.98±0.71	F=22.687	F=2.29	F=5.727	0.54
EG	10.19±0.50	10.05±0.46	9.89±0.43*#	p<0.001(18.65	p=0.142 (0.199)	p=0.006 (0.500)	-
Vertical jump – cm - (VJ)							
CG	57.21±17.69	57.71±17.50	58.86±17.12*	F=16.510	F=28.27	F=14.253	2.88
EG	78.07±13.41	80.57±13.28	85.36±11.84*	p<0.001	p<0.001 (279.01)	p<0.001	9.33
Back and leg dynamometer – kg - (BLD)							
CG	132.71±25.6	134.86±26.3	138.79±27.05	F=0.36	F=31.330	F=19.934	4.58
EG	123.93±14.5	136.93±12.5	149.93±14.38	p=0.850(45.76	p<0.001(3600.01	p<0.001(1393.73	20.9

* denotes a significant improvement between the pre-intervention and post-intervention periods.

# denotes a considerably better improvement between the pre-intervention and post-intervention periods in EG than CG.

ES: effect size. Δ%: relative pre-post intervention changes.

Table 4: *Basketball skill measures from Pre-test, Mid Test and Post-test training for the CG & EG*

GROUP	Pre-Test Mean(±SD)	Mid Test Mean(±SD)	Post Test Mean(±SD)	Group F (1,26), p-value (ES)	Time F (1,27), p-value (ES)	Group x Time F (2,52), p-value (ES)	Δ%
Control dribble – sec - (CD)							
CG	21.83±0.93	21.97±0.98	21.71±1.15*	F=49.049	F=9.487	F=3.143	-0.54
EG	20.07±0.48	19.82±0.51	19.53±0.64*#	p<0.001 (86.701)	p<0.005 (1.528)	p=0.51 (0.786)	-2.69
Defence movement – sec - (DM)							
CG	21.83±1.11	21.81±0.97	21.86±1.02	F=3.606	F=5.948	F=5.638	0.13
EG	21.44±1.06	21.15±0.91	20.78±1.14*#	p=0.069 (10.650)	p<0.022 (1.364)	p=0.005 (1.651)	-3.07
Passing – points - (PASS)							
CG	31.86±3.28	31.93±3.54	32.86±3.28*	F=5.187	F=30.903	F=7.032	3.13
EG	33.71±3.58	35.07±4.36	37.07±4.01*#	p=0.031 (198.107)	p<0.001 (66.446)	p=0.002 (19.550)	9.96
Speed spot shooting – points - (SSS)							
CG	11.29±1.82	11.29±2.09	12.07±1.98*	F=1.128	F=29.246	F=4.963	6.90
EG	11.29±1.68	12.00±2.11	13.57±2.14*#	p=0.298 (11.440)	p<0.001 (33.018)	p<0.011 (7.881)	20.19

* denotes a significant improvement between the pre-intervention and post-intervention periods.

# denotes a considerably better improvement between the pre-intervention and post-intervention periods in EG than CG.

ES: effect size. Δ%: relative pre-post intervention changes.

Almost all the people who took part in both groups showed up for more than 82.5% of EG subjects participated in the sessions. There were no injuries from the training. At the start, there were no significant differences between groups regarding physical and skill performance measures.

Anthropometric Test: This Shows Table (1) that the CG and EG groups did not have different physical characteristics at the pre-test of the intervention.

Physical Test: Physical performance was found to have significant differences between groups on SPRINT, AGILITY, VJ, $F (1,26) = 4.3, 22.6$, and 16.5, respectively, with p values less than 0.05 for each one. There were no significant interactions in the pre-test between the group for the OHMBT, SLJ, and BLD. The main effects found on the "time interval" within the analysis were that EG got better on most variables except for Agility. Subjects in the EG group made much more progress than those in the CG group made OHMBT, SLJ, SPRINT, VJ, and BLD. $F (1,27) =18.6, 30.6, 59.0, 28.2$ and 31.3 respectively. Main effects were found on the "Time x group" in OHMBT, SLJ, AGILITY, VJ and BLD, but not SPRINT. $F (2,52) =11.2, 27.8, 5.7, 14.2$ and 19.9 respectively, $p < 0.01$.

Basketball Skill Test: In table (2), you can see baseline and post-test physical performance data. CD, PASS, $F (1,26) = 49.4, 5.1$ respectively, with a p-value lesser than to 0.05 except DM, SSS. EG made a lot more progress than the subject in the CG did. Skills performance $F (1,27) = 9.4, 5.9, 3.0$, and 2.9 were significant differences in CD, DM, Pass, and SSS. Skill performance showed significant differences in CD, DM, Pass, and SSS, as $F (2,52) = 3.1, 5.6, 7.0$ and 4.9, respectively.

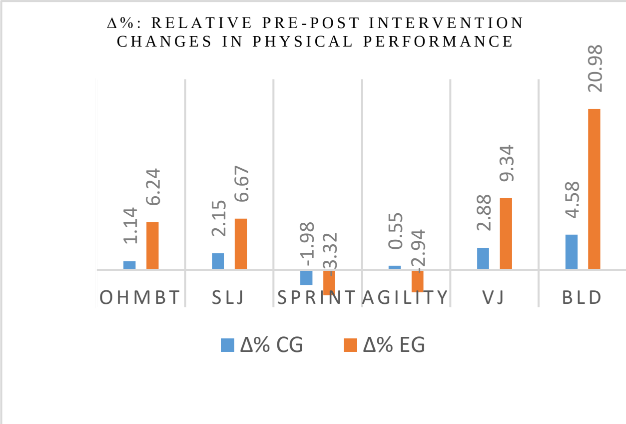

Figure 1: Δ% *Relative pre-post intervention changes in physical performance*

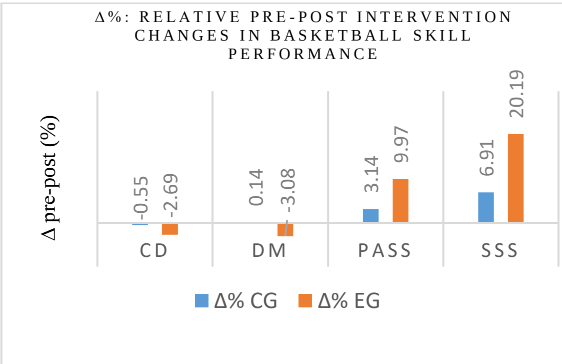

Figure 2: Δ% *Relative pre-post intervention changes in basketball skill performance*

Discussion

Physical Test Performance: In this study, EG participants who participated in the medicine ball training program improved their upper body power, lower body power, strength, speed, and agility much more than CG subjects who did regular basketball training. The study found no significant difference in variables in the pre-test within the two intervention groups. This finding supports initial findings by (Stenevi-Lundgren et al., 2010), who asserted that before subjects are exposed to vigorous exercise that boosts their physical zeal and the ability to play, it may not be easy to observe differences in their muscle strength. However, there was a significant difference in muscle strength between the two intervention groups after the experiment. The finding compares to a prior assertion by (Ignjatovic et al., 2012a) that physical exercise compares muscle strength, especially where there are no other measures variables.

Accordingly, the study concludes that medicine ball training exposes subjects to vigorous physical hardship. Through it, subjects are likely to exhibit a different physical strength than before they are trained. Similarly, the same training improves the basketball subjects' skills in terms of the mean sprint score, but with variations from one player to another. The finding is backed by initial establishments from (Faigenbaum & Mediate, 2008; Falk & Mor, 1996; Mediate, 2006) who also observed through their field study that there is a significant difference in the vertical jump between the control and their experimental groups; that is, basketball subjects are likely to jump higher when exposed to medicine ball training as opposed to when training is not conducted.

CG & EG demonstrate different vertical jump scores during the pre-experiment phase. This finding supports an initial finding by (Meylan et al., 2010), who alluded that medicine ball training improves the vertical jumps of subjects who undergo the same training. As a result, a statistically significant difference was expected, as observed in the current experiment between the control and experimental group. Therefore, the current study concludes that medicine ball procedures improve subjects' physical performance, as hypothesized.

The EG medicine ball treatment increased upper body strength by 6.24%, as evaluated by the OHMBT, but the CG only gained 1.14%. The BLD test found that whole-body EG strength improved by 20.98%, compared to CG by 4.58%, indicating that the medicine ball training outcome improved more. As assessed by the VJ, the lower body vertical power increased by 9.34% in EG compared to 2.88% in CG. In addition to the EG individuals, CG subjects improved their SLJ performance by 6.67% and 2.15%, respectively.

In the AGILITY test, medicine ball training EG substantially increased performance compared to CG by 3.49%. In the sprint 20 m test, the EG showed a 1.34% improvement over the CG. This study highlights the need for a multi-weighted medicine ball training program to improve performance in tasks that require acceleration, deceleration, and direction change. It's possible that a thorough conditioning program that incorporates plyometric training, weight training, and technique-oriented sprinting mechanics coaching may help young basketball players improve their physical performance.

Consequently, the proposed adaptations for medicine ball training that increased maximal Achilles tendon elongation as well as the amount of stored elastic energy, as well as better joint proprioception due to increased sensitivity of the muscle spindle, are likely the most important mechanisms for improving overall physical performance while players are performing medicine ball training (Kubo et al., 2017; Swanik et al., n.d., 2015).

Basketball Skill Test Performance: The result reveals that dribbling performance decreases among the experimental group after the experiment. Although previous studies have not established a proper reason to support the current finding, it can be argued in assertions (Ignjatovic et al., 2012b) that medicine ball training tends to improve basketball skills other than dribbling skills. Therefore, the current study concludes that a medicine ball improves the defence movement skills of basketball subjects.

This section showed that EG participants who participated in the medicine ball training program improved their basketball skills such as CD, DM, PASS, and SSS rather than CG subjects who participated in formal basketball training increased their basketball skills. Compared to CG, the EG medicine ball treatment resulted in a modest rise in CD and DM, with 2.14% and 2.94% increases, respectively. In addition, the PASS skill has improved by 6.83% when compared to CG. There was a greater improvement in SSS as EG by 20.19% and CG by 6.91%, respectively.

Results reveal no significant difference in passing skills between control and experimental groups for the pre-experiment. The finding backs initial findings by (Meylan et al., 2010) that through medicine ball training, basketball subjects are exposed to various passing and shooting skills and the challenges to expect, especially when playing against an opponent with the same skills. Therefore, the current study concludes that medicine ball improves passing skills and speed spot shooting among subjects.

Meanwhile, given the minimal correlations among skill variables of change, progress in basketball abilities is most likely due to other adaptations, such as an increased number of activated motor units, increased neuronal firing frequency, or simple cognitive–motor learning effects (Hernández et al., 2018; McLaughlin, 2001). Even though as a result, the changes that happened in medicine ball training are significant findings of this study. In EG, the factors of pre-to-post differences were more significant. Moreover, which leads us to believe that a common underlying mechanism caused the improvements in physical and skill performance generated by medicine ball training.

One limitation of this 8-week trial was that the CG did not participate in medicine ball training. On the other hand, the current study aimed to compare the effects of eight weeks of medicine ball training on CG and EG physical skill performance among basketball subjects. Although there were no baseline differences in physical or skill measurements between groups, participants in each group may have differed in biological maturation. Finally, even though both groups are involved their training and trained for perticular hours per day, the EG who did medicine ball training had higher physical conditioning than the CG that did conventional basketball training. When coaching a group of athletes, coaches must focus on each athlete's performance rather than the group's overall performance. Therefore, Strength and conditioning coaches should choose the most successful model in a periodized manner for their subjects to improve physical performance and avoid overtraining (Sellathurai & Draper, 2022).

Conclusion

In summary, the general conclusion of the current study is that a medicine ball improves a player's physical performance than covers OHMBT, SLJ, SPRINT, AGILITY, VJ and BLD. The findings of this research indicate that medicine ball training in conjunction with regular exercise can significantly increase physical performance and basketball skills in adult male basketball subjects. Moreover, the study emphasizes that the medicine ball improves different basketball skills performance measures that comprise CD, DM, PASS, and SSS. However, the skills may not be consistent, but there is a significant variation from one basket player to another. It is advised that coaches add medicine balls into subjects' daily training regimes. The execution of medicine ball workouts free in the direction of skill work improves basketball skill performance. The recommended program for medicine ball workouts is ideal for evaluating improvement in basketball subjects' physical performance and basketball skill performance.

Recommendations

The recommended training program, which includes medicine ball exercises, should be included in physical preparation for basketball subjects. Since their considerable impact on boosting the physical performance and basketball skill level of basketball subjects, it is vital to improving trainer knowledge of the value of medicine ball workouts.

Acknowledgement

The authors thank the administration Department of Sports, Northern Province, Sri Lanka and the Jaffna District Basketball Association for their support of this research study. The authors also thank T.Kovshikan (Basketball Coach & Sports Officer), S.Jegatheeswaran (Basketball Coach) for assistance with data collection and thank all the subjects who volunteered to participate in this study.

Conflicts of Interest

There are no conflicts of interest to declare by the authors. All experimental techniques for human participants conform to local government regulations.

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