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Keywords

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Medicine ball training in the sequence of complex handball training versus only handball training: effects on physical fitness in pre-adolescence female handball players

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1. Introduction

Increasing competition in elite sports, dynamic confrontations, diversity, and arrhythmia of game techniques are the actual characteristics of modern women's handball [1,2]. The intensification of game actions is expressed in the continuous activity of athletes in the game, an increase in the volume of attacking and defensive moves, increasing the speed of movement and performing tricks with the ball, and the more intense struggle of each athlete in any game episode [3]. Elite players must have a high level of development of motor abilities, technical and tactical skills, and must perform effective play activities at a fast and jagged pace [4].

Running with all strength, long or intermittent, a variety of highly coordinated movements, often performed in unsupported positions, a sudden change in activity, and situations of "power" confrontation require a high level of development of speed, strength, endurance, agility, flexibility, the elasticity of the ligaments [5]. A highly productive technique manifested in starting jerks and performing jump techniques at high speed requires a high level of special physical training.

The probability of a young athlete achieving success in the future depends both on the level of development of his physical qualities at the time of the start of training and on the preservation of the pace of their improvement throughout the entire sports career,

which necessitates a constant search for new and effective means and methods of training young athletes. Researchers focus on determination of the optimal ratio of training means, effective distribution of time and applied training methods, and a search for strategies for effective teaching of game techniques to beginner athletes. Moreover, previous publications have shown the importance of developing essential physical qualities and forming the foundations of basic technical training already at the initial stage, emphasizing the need to modernize the training process to optimize training effects and minimize ineffective loads [6–9].

It has been shown that the purposeful development of sport-specific skills with the help of both dynamic and small games for beginner handball players can become the main success factor in game situations and predetermine competitive efficiency [10, 11]. Evidence shows that the age of 10–12 is sensitive to the development of moderate strength, and the jumping and speed-strength capabilities of children involved in sports significantly increase [7, 12]. Some aspects of the influence of training of various specifics on speed-strength and coordination qualities of handball players of different skill levels have been studied. Plyometric training programs have been reported to improve essential components of physical performance [13–16]. The influence of resistance training, contrast strength training programs using elastic bands on the physical performance of 15–18-year-old handball players was studied [17, 18]. The presented comparison of the effectiveness of explosive strength training and plyometric training on adolescent handball players shows that both programs can be successful regardless of the training order [19].

In addition, studies of recent decades have provided evidence that training with medicine balls (MB) can also be an effective means of physical training for children and beginner athletes to improve strength, speed-strength and coordination abilities, balance, correct posture formation, and injury prevention [20–22]. As some of the advantages of using MB in the training process of young athletes, including handball players, researchers and practitioners consider the ability to vary the complexity of exercises by combining different movements to imitate specific actions that require a complex manifestation of speed-strength and coordination abilities [23]. According to Earp and Kraemer [24], MB throwing exercises are performed with as much amplitude as possible and with minimal deceleration at the end of the movement, which distinguishes them from many traditional strength training exercises.

The productiveness of 6–12-week training programs with MB for developing the speed-strength qualities of young handball players is confirmed by the progress of performance in throwing and strength tests [20, 23]. Several studies on the effects of MB training have shown their advantage in improving speed, agility, endurance, explosive power, arm strength, and abdominal strength in young handball and soccer players [25, 26].

However, these and other studies have focused on the effect of various regimens of strength-oriented training programs on 15–16-year-old and older athletes. The legitimacy of transferring these results to younger athletes remains unclear since there is a high degree of individual differences in the development of motor competence in 10–11-year-old girls. Published research on the effect of MB exercises on physical and fitness performance in novice female handball players seems to be lacking.

We hypothesized that (a) after the introduction of training with medical balls in the sequence of complex handball training (MBTP), there will be an improvement in physical and special fitness, and (b) that this training will demonstrate higher efficiency in comparison to the complex only handball training group. Thus, the study aimed to evaluate the impact of the 16-week MBTP program compared to the only complex handball training (HT) program on physical and special fitness indicators for beginner female handball players.

2. Materials and Methods

2.1. Participant eligibility

Young handball healthy female athletes aged 10–11 years old of the initial training groups of the second year of training at the age of 10–11 years (n = 62) took part in the study (Table 1): experimental group (EG), n = 30; control group (CG), n = 32, both groups had no statistically significant differences in the studied parameters ($p > 0.05$). Handball players of both groups were trained according to the handball curriculum for children and youth sports schools 4 times a week [27]. To increase the level of physical and special physical fitness and increase the speed-strength and coordination potential of young athletes from the EG, a training program was proposed using medicine balls. The CG did not conduct any special training with MB. Training sessions of female athletes of this group were carried out according to traditional methods, components of which were means and methods of general and special physical training of handball players, presented in the curriculum for children's and youth handball sports schools. Written informed consent from parents/legal guardians and consent from participants was obtained before the start of the study, and all were fully informed about the experimental protocol and its potential risks and benefits. The study was approved by the proper Ethics Committee, and the described experiments were performed following the principles of the Declaration of Helsinki.

Table 1. Baseline characteristics of subjects from the experimental and control group.

Group	Age (ears) $\bar{x} \pm SD$	Body mass (kg) $\bar{x} \pm SD$	Body height (cm) $\bar{x} \pm SD$	BMI (kg/m^2) $\bar{x} \pm SD$
Experimental (n = 30)	11.23 ±0.41	42.70 ±1.41	153.81 ±10.24	18.25 ±2.59
Control (n = 32)	10.99 ±0.40	42.77 ±1.34	152.51 ±10.01	18.37 ±2.28

2.2. Assessment of anthropometry and physical fitness

To assess the physical development of handball players, the following anthropometric measurements were taken: the body mass was weighed using SECA 869 scale (SECA, Hamburg, Germany), with an accuracy of 100 g; body height was measured using a SECA 217 (SECA, Hamburg, Germany) measuring rod with a 0,1 cm. Based on these measurements, the body mass index (BMI) (kg/m^2) was calculated [28]. All applied types of tests comprehensively characterized the variety of manifestations of general motor abilities concerning the game of handball.

The Stork Balance Stand Test (SBT), described in detail in other studies, was used to assess whole-body balance ability [29]. The test subject had to stand on one foot on the pad of the foot for as long as possible; the time was measured to the nearest 0.01 sec.

Flexibility test. A "Sit-and-Reach" test determined the flexibility of the trunk according to the previously described procedure [30]. The average result (in cm) from the two tests was recorded. The sit-and-reach test was used to assess children's hamstring and lower back flexibility, with an accuracy of 0.5 cm [30].

The Standing Broad Jump Test (SBJ) was used for measurement of the leg strength. The athletes jumped forward twice from the starting point on two feet, and the longer distance after the jump was recorded (in cm). The test was performed as previously described [30].

Hand grip strength. Lead arm dynamometry (static force assessment) was assessed using a Baseline® Electronic Hand Dynamometer (Fabrication Enterprises, Inc., USA) with the subject seated and the elbow at a 90° angle. The detailed testing procedure was described previously [19].

Sit-Ups test in 30 seconds, following the protocol of Eurofit, was used to check the local muscular (abdominal and psoas muscle) endurance strength, where the players had to do as many sit-ups as possible in 30 s [30, 31].

The Shuttle Runs 10 x 5-meter test was used to check agility. Shuttle Run on an indoor running track followed the Eurofit protocol; the time was measured to the nearest 0.01 sec [30].

Tests of special physical fitness which were selected following the handball players' age characteristics are generally accepted, and they are also proposed and described in the current handball curriculum for youth schools approved by the Ministry of Youth and Sports of Ukraine [27].

Dribbling the ball for 30 m in a straight line (s) was used to assess the speed of movement of the player with the ball, the ability to differentiate efforts, and the level of possession of the technique of handling the ball; a detailed description of the test procedure is presented in the literature [27, 32].

The standing triple jump test (cm) was used to assess explosive leg power. The jump was performed with a leap of two legs. Landing was made on any one leg, followed by leap and landing on the other leg, then another leap and landing on two legs. The measurement was made with an accuracy of 1 cm [27].

Throwing a handball ball 50 to 52 cm in circumference and 290 to 330 g in weight (IHF size 1) with one hand from a place at a distance (m) was made with a dominant hand from behind the head, from a standing position to assess the ability of the subject to demonstrate complex coordination of movements of the legs, torso, arms. In the starting position, the athlete's legs should be behind the start line. 2 attempts were given, and the better result was taken into account. The measurement was made with an accuracy of 5 cm [27].

2.3. Exercise protocol

The training sessions of both groups were conducted following the current youth sports schools handball curriculum [27]. The total training load was comparable between both groups, with similar training programs consisting of 4 sessions per week of 90 minutes each, consisting of a warm-up period (12–15 minutes) and a cool-down period (10–12 minutes).

The CGs followed only complex HT in the current training program. In particular, physical training was aimed at versatile development and strengthening of the musculoskeletal apparatus and joints, which are under pressure while performing technical and tactical tricks of the game. Athletes performed running, jumping, and gymnastic exercises with dumbbells, and exercises developing special flexibility and coordination of movements. Technical and tactical training was aimed at mastering and improving skills in player movement, passing, leading, throwing the ball, feints, technique, and tactics of the game in defense, in attack, and attacks from the move. Game training included one-sided and two-sided games (by simplified rules with the coach's correction of motor actions). The main methods of development of physical qualities in handball players were a uniform method of increasing the load, a repetitive method of development of individual physical properties, a game method of complex development of physical qualities.

For the female athletes of the EG, part of the normal training regime was replaced with MB once a week. The MBTP was applied for 16 weeks (1 of 4 training sessions per week, a total of 16 sessions). 1 and 2 kg medicine balls were used in training at the beginning of the main part, after warm-up, and including 6–8 exercises (6–10 repetitions each) in 2–3 sets, with rest intervals of up to 2 minutes. Exercises with MB varied by initial positions (standing, sitting, lying) and by a static or dynamic position (jumping, running, or on the spot). When throwing MB balls in pairs, they threw to the following conditional zones: partner's chest zone, the right/left-hand zone, the overhead zone, the zone over the right/left shoulder, the zone under the right/left shoulder, the abdominal level zone. The methods of throwing MB also varied: one or two hands, from the chest, from behind the head, from the side, from below, over yourself, holding the ball with your feet in pairs. The exercises became more difficult gradually, with increasing level of

fitness. In the first four weeks, handball players performed arm, shoulder girdle, and core strengthening exercises, such as MB transfers in pairs on the spot throws from different starting positions [24, 33].

Each successive week the training with MB changed. More technically challenging exercises were added, e.g., MB passes and throws in motion, jumping exercises using elevated support, and a vertical obstacle (height 20–30 cm). After 8 weeks of training, the athletes performed exercises with an emphasis on technical conjugation: MB throws with one hand from the shoulder to the target, ball passes in a jump, ball throws with feet, jumping on two feet (one foot, from foot to foot) through 8–10 MB, located on one line at a distance of 80–100 cm one from another. By the end of the study, young handball players were already performing complex exercises with MB in jumps and with movement, passes in jumping, and motion. The intensity of performance increased proportionally after every two weeks of training and was regulated by modifying the mode of operation (dynamic overcoming or striking), such as throwing the ball only or catching and throwing the ball, respectively, and the length of rest periods between sets. A sample set of exercises with MB is presented in Table 2.

Table 2. Medicine ball training program between training session 1 and training session 16.

1–4 training session	5–8 training session	9–12 training session	13–16 training session
2 sets /6–8 reps (90 s rest)	3 sets /6–8 reps (90 s rest)	2–3 sets x 8–10 reps (75 s rest)	2–3 sets x 8–10 reps (60 s rest)
Exercises			
Throws up and out, catching the ball	Two-handed/one-handed throw from behind the head with a maximum deflection in the swing	Throwing a stuffed ball from the chest with both hands into the wall up with moving sideways forward	Throwing the ball with one / two hands at a distance in the support position and jumping from a place / from a running start
Throws with two/one arm (with/without rotation)	Throwing two balls simultaneously*, on the move – one throwing the ball at a high trajectory, the other at a low trajectory	Throws with two/one arm from shoulder to goal	Taking turns catching and throwing stuffed balls that are thrown from all sides by partners
Throwing the ball from chest to front with both hands*	Throwing two balls: a) standing; b) sitting*	Throw the ball from standing with a ball on top, hands down, back and forth overhead*	Standing, ball up. Torso tilted forward, arms down (swinging). Flex the torso and arms, and pass the ball up and back over the head*
Lying back (or a) sitting; b) squatting; c) standing) throwing the ball up from the chest and catching it with both hands	Lying on stomachs, facing each other. Serve ball a) from the chest with both hands, b) from behind the head with both hands	With the ball between legs, bounce up with feet together over the ball and return to the starting position	Jump off an elevated support and propel yourself by hopping forward on two feet through MB
Facing each other, both partners hold the ball in front of them. Take turns pushing the ball forward, overcoming your partner's resistance	Sitting facing each other at 4–5 m, ball behind the head. Throw a ball up and forward with both hands from behind the head	Crouch with a ball in front of the chest. Flex legs and arms and toss the ball upwards	Throw a ball up, quickly land on the floor, stand, and catch a ball with both hands

1–4 training session	5–8 training session	9–12 training session	13–16 training session
2 sets /6–8 reps (90 s rest)	3 sets /6–8 reps (90 s rest)	2–3 sets x 8–10 reps (75 s rest)	2–3 sets x 8–10 reps (60 s rest)
Throw the ball up and catch it in front from behind	Standing with feet shoulder-width apart, ball underneath. Bend forward, back arching torso and arms, backhand, and throw upwards to partner	Stand with the ball between legs. Throw a ball up with legs in a jump	Stand with feet shoulder-width apart, ball up. Bend down, then toss the ball between legs behind back up. Stretch out, and turn 180° to catch a ball overhead
Pass two balls at the same time. Options: a) two hands from the chest; b) one hand from the shoulder; c) from below with one hand	Jump with a ball on outstretched arms and pass to partner 10–20 m to a landmark	Jog from side to side and throw one or two balls countermovement) to partner from the chest with both hands	Pass ball in jump action. Receive the ball from partner while standing on the gymnastic bench, and pass the ball while jumping off the bench
Crouch with the ball behind the head. Bending legs and arms, toss a ball up and catch it while standing, hands up	Jumping from an elevated support and advancing on two legs through MB	Hold the ball between legs. Throw a ball up with legs from behind and catch it with both hands in front	Jump off an elevated support on one foot and hop forward (on one foot) over MB

[1] Note: * – exercises are performed in pairs

2.4. Statistical analysis

All statistical analyses were carried out with SPSS version 22.00 software (IBM SPSS, Armonk, NY, USA). All data were presented as mean ± standard deviation of the Mean (SD). The data were checked for normal distribution using the Kolmogorov-Smirnov test; the achieved significance level was more than 0.05. A student's t-test of independent samples was used to compare the average values between the results in separate groups: preliminary testing in the EG and CG and post-testing results in the EG and CG. A student's t-test of dependent samples was performed to compare the average values in dependent samples, i.e., between the results in the EG (pre- and post-training) and the comparison of the average values between the results in the CG (pre- and post-training). Measures of the effect size (ES) for differences were calculated by dividing the mean difference by the pre-training measurement's standard deviation (SD). The magnitude of the ES was classified according to the following criteria: $0.2 < d < 0.5$ was considered "small", $0.5 < d < 0.8$ represented "medium," and $d > 0.8$ constituted "large" [34]. Differences were considered reliable at a significance level of $p < 0.05$.

3. Results

There were no statistically significant intergroup differences in anthropometric parameters ($p > 0.05$) at baseline (Table 1). Comparison of the results of young handball players of the experimental and control groups in performance tests at the beginning of the study also indicates that there were no significant differences between them ($p > 0.05$) (Table 3).

Table 3. Indicators test scores of general and special physical fitness concerning handball female athletes aged 10–11 years old before (pre-test) and after 16 weeks (post-test) of training in experimental (EG; n = 30) and control (CG; n = 32) groups.

Measurable indicators	Groups	Pre-test	Post-test	Difference Absolute (ES)	Δ %
Stork balance stand test, (s)	EG	15.72(3.17)	16.02(3.19)*	0.30(0.95)	1.91
	CG	15.89(4.08)	16.25(4.15)*	0.36(0.88)	2.27
Flexibility test, (cm)	EG	19.20(5.20)	20.42(5.60)*	1.22(0.23)	6.35
	CG	18.68(6.17)	19.98(6.70)*	1.3(0.20)	6.96
Standing broad jump, (cm)	EG	134.42(14.34)	144.81(14.93)*†	9.09(0.67)	7.73
	CG	133.77(15.43)	136.98(15.11)*	3.21(0.21)	2.4
Handgrip, (kg)	EG	14.66(1.94)	16.72(2.50)*	2.06(1.07)	14.05
	CG	15.37(2.83)	16.05(2.64)*	0.68(0.25)	4.24
Sit-ups in 30 seconds, (total number)	EG	17.90(3.03)	20.87(3.10)*†	2.97(0.88)	16.59
	CG	17.97(2.97)	19.13(2.84)*	1.16 (0.39)	6.46
10 × 5 meter shuttle run, (s)	EG	20.38(2.03)	18.80(1.83)*	1.58(0.76)	-7.75
	CG	20.24(1.31)	19.36(1.17)*	0.85(0.65)	-4.15
Dribbling the ball for 30 m in a straight line (s)	EG	6.04(0.74)	5.23(0.54)*†	0.82(1.07)	-13.41
	CG	5.72(0.66)	5.54(0.66)*	0.18(0.26)	-3.14
Triple jump test (cm)	EG	496.70(51.00)	519.63(50.11)*	22.93(0.45)	4.62
	CG	498.44(55.51)	502.60(54.88)*	4.16(0.76)	0.83
Throwing the handball ball with one hand (m)	EG	14.58(1.28)	18.75(1.76)*†	4.17(1.6)	28.6
	CG	15.10(1.80)	17.45(2.20)*	2.35(1.01)	15.56

[2] Note: CG: control group; EG: experimental group; M = mean; SD = standard deviation; * $p \leq 0.05$ (vs. baseline); † significantly greater improvement than in control group ($p < 0.05$); ES = Cohen's d effect size.

In absolute terms, EG athletes had the best trunk flexibility and strength indicators. All other physical qualities are better developed among female handball players from the CG. The results of retesting, presented in Table 3, show that there have been specific positive changes in almost all tests. However, the EG that participated in the medicine ball training program made significantly greater gains in the SBJ ($t_{(60)} = 2.05$, $p < 0.05$), Sit-Ups in 30 seconds ($t_{(60)} = 2.38$, $p < 0,05$), Dribbling the ball for 30 m in a straight line ($t_{(60)} = –2.08$, $p < 0,05$), Throwing the handball ball with one hand from a place at distance ($t_{(60)} = 2.55$, $p < 0.05$), as compared to the CG.

4. Discussion

To the best of our knowledge, this is the first study to investigate the impact of a training program with medicine balls (MBTP) as part of handball training compared to only handball training (HT) on general and special physical performance in girl handball players aged 10–11 years. We used tests that reflected the handball players' physical and special fitness, consisting of the manifestation of the qualities of strength and speed-force abilities, as well as flexibility and balance of the studied athletes in the available coordination of the performed movements in a complex way.

The results showed that both methods of training for 16 weeks led to an improvement in all the studied indicators in handball players ($p < 0.05$–0.0001), but the athletes of

EG, practicing MBTP achieved greater improvement than the athletes of CG. In particular, the EG handball players showed a significant improvement in the tests of general physical fitness. Their power qualities, according to the results in the SBJ and Sit-ups tests, have become significantly better than their CG counterparts. In addition, the combination of MBTP and complex handball training during the intervention contributed to an improvement in special fitness and better results in the tests Dribbling the ball for 30 m in a straight line and Throwing the handball ball with one hand from a place at a distance compared to HT.

In the present study, the results of some fitness tests suggest that both training methods are effective in improving balance, flexibility, agility, and strength in female athletes, as no significant differences in post-test results were observed between the EG and CG athletes. This may be due to the similar content and volume of training for girls in both groups. Balance and flexibility gains of 2.27% and 6.96%, respectively, were higher in the cohort, while gains in arm strength, explosive power, and agility were more pronounced in the EG with 14.05%, 4.62%, and 7.75%, respectively, indicating a greater potential benefit of MB exercises. Although direct comparisons are difficult due to a lack of available studies, an indirect comparison shows that the data differ from the results of studies in which an intervention program combining strength training and only handball training has been studied. For example, Hammami et al. [35] found a significant effect of a combined plyometric training program on high-intensity actions, particularly vertical and horizontal jumps, hand strength performance and balance in young female handball players. More recently, Hammami et al. [13] investigated the effects of contrast strength training with an elastic band program in combination with conventional handball training on jump, strength, balance, and agility in young female handball players and determined its effectiveness in improving agility and arm strength, which can probably be explained by the fact that 15–16-year-old female handball players already have some basic strength, compared to which our participants were initially much weaker. At the same time, they showed no significant advantage in terms of balance after the intervention [13]. In contrast, Labib H. [36] found a significant improvement in balance after the introduction of functional strength training but no significant change in arm strength. Savithiri and Kumaresan [25] found that applying five days per week for a 12-week low-intensity medicine ball training program improved agility and arm strength in adolescent boys by 14.59% and 16.87%, respectively. These discrepancies may be due to age differences (older), training experience (more than 2 years) of female athletes or the amount and type of training exercises performed.

The significant difference in trunk strength between the two groups that we observed in the post-test suggests that dynamic MBTP exercises of a complex nature, with predominant involvement of the abdominals and back (for example, a two-handed throw from the chest with an upward leap), was the main factor in the improvements. Similar results were obtained in a recent study by Pramod [26], who reported significant improvements in abdominal strength and endurance after 6 weeks of medicine ball training in school football players. Pržulj et al. [37] also noted that the improved performance in sit-ups associated with training with MB is consistent with the perceived role of this training as an effective training strategy for increasing strength in children, adolescents and novice athletes.

A 7.73% greater improvement in the Standing Broad Jump test for the EG compared to the CG is probably due to repeated high-intensity performance of the proposed combined jumping exercises with MB, and well-developed jumping ability, the optimal level of explosive strength, speed and power qualities provided an opportunity for the successful formation of special technical preparedness. These results are consistent with those of Trajković et al. [38], who found the effectiveness of MB exercises in improving speed and strength in the long jump and vertical jump in schoolgirls of the same age. Furthermore, our results are consistent with the findings of studies in which additional

functional training within traditional programs was more effective for young female handball players [35,36].

A significant difference in post-test results between the groups was found in dribbling the ball for 30 m in a straight line; the EG athletes increased their performance by 13.41%. We suppose that such a successful performance of a specific test can be explained by well-coordinated speed-force abilities of all parts of the body, ensured by performing exercises with MB movement in different directions, and combined jumping exercises, which simultaneously engage different muscle groups. Thus, the increase in performance in dribbling the ball corresponded to a similar improvement in dribbling the ball under the influence of three repetitive bodyweight exercises along with handball training for 8 weeks in 9–10-year-old boy handball players [39].

The proposed complex movements, which mimicked the athletes' body position and the nature of movements arising in game situations, improved the specialized coordination ability according to the results in Throwing the handball ball with one hand. The throwing distance of the ball in the female athletes of the EG increased by 28.6%, which can be explained by the use of exercises with variations of throwing two MB simultaneously in pairs, in motion, throwing the ball at a target, thereby adjusting the locomotor apparatus to perform technical elements. The present findings seem to be consistent with other research, which found that the results in throwing depend not only on the level of display of speed and power qualities but also on the mastery of movement technique [8,15,35]. Furthermore, these results support the opinion of Ignjatovic, Markovic and Radovanovic [20], who suggested that the training adaptation in young female athletes is specific to movement pattern, movement speed and contraction force, so the greatest increase is observed in the tests most specific to the training program. Moreover, like the named study, our results show an increase in muscle strength of about 30% more than expected as a result of growth and maturation [31].

Comparing the results of the tests related to the evaluation of the upper limb speed and power qualities, namely arm strength and throwing the ball at a distance, it can be stated that these qualities are better developed in the girls of the EG. This is probably due to the combined effect of different training work regimes in a weekly training cycle, involving an alternation between a medicine ball and a handball with varying duration and intensity of load, pauses for rest, as well as the distance between partners. Similar evidence for the effect of training with MB is demonstrated in a study by Pržulj et al. [37], who observed significant improvements in strength on tests of throwing with a ball from different resting positions in 10–11-year-old female pupils and concluded that exercising with a ball at least once a week leads to better fitness results than standard physical education classes for children

5. Conclusions

The most obvious finding to emerge from this study is that medicine ball training in the sequence of handball training and only handball training for 16 weeks had a positive effect on all studied general and special fitness indices in prepubescent female handball players. Although the MBTP was characterized by large improvements, significant improvements compared with merely the traditional training program were found only for the strength parameters of the trunk and legs and handball-related fitness indicators, such as ball handling and throwing distance. Execution of age-appropriate handball-specific exercises with the MB in girls 10–11 years of age entails the exercise of physical qualities, comprehensively engages muscle groups to perform a variety of sport-specific movements, and contributes to the development of speed, strength, coordination, and throwing ability of female athletes without additional time and complex equipment. Thus, coaches can be encouraged to incorporate elements of the MBT program into regular handball and other team sports training as a preliminary strength training program for girls in this age group to rationalize the training process.

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