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Plyometric exercise and motor fitness development in school boys: A randomized control trial

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ABSTRACT
Plyometric exercise, known for its rapid muscle stretching and contraction, has been acknowledged for its capacity to improve diverse facets of physical performance. The aim of the study is to examine the impact of structured plyometric training on selected motor fitness parameters among school boys. The research was carried out on 36 participants of age 15.45± 0.52 years were selected and after baseline measurement uniformly allocated into 2 groups i.e., experimental group (n=18) and control group (n=18). The experimental group participated in 6-week plyometric training (3 days/week) and control group maintained their regular physical activity routine. The indicators of motor fitness variables were Speed, Agility, and Leg explosive strength, measured by 20m sprint, 4*10 m shuttle run and standing broad jump respectively. The results of the study revealed a significant effect of plyometric training on agility, speed and leg explosive strength ($p>0.05$). In conclusion, the study demonstrates that plyometric training is valuable intervention and able to yielding significant improvements in motor fitness parameters among school boys. Further research with larger participant group and extended training period is recommended to validate and extend the current findings.

Keywords –speed, health, training, sedentary, agility, strength

INTRODUCTION

Physical fitness is a fundamental aspect of a student's holistic development, and motor fitness, in particular, plays a pivotal role in their overall well-being (Haga, 2008, Kaur et al. 2022). Motor fitness encompasses a spectrum of skills such as agility, balance, coordination, and speed, which are essential for daily activities and active involvement in various athletic and physical events (Bardid et al., 2021). Sports has become more competitive nowadays and to achieve success one must have adequate motor fitness which not only supports physical well-being but it also influences cognitive and social aspects of an athlete's life (Milne et al., 2016, Kumar et al., 2023).

Recently, concerns have emerged regarding the declining levels of physical fitness among school-age boys, largely attributed to a sedentary lifestyle, increased screen time, and reduced opportunities for physical activity (Sagre et al., 2023, Subramaniam, 2011). These trends have raised alarms among educators, parents, and health professionals, prompting a call for interventions aimed at enhancing children's motor fitness (Khudolii, et al. 2015).

Strength exercise is an effective method for athletes engaged in various sports (Burnie et al., 2018, Kumar et al., 2023). A study conducted by Booth and Orr (2016) suggested that the addition of plyometric exercises within a strength training routine can result in enhanced sports performance and enable athletes to advance to a higher skill level (Booth & Orr, 2016). Plyometric exercises encompass dynamic movements characterized by rapid muscle stretching followed by immediate powerful contractions, typically transitioning from concentric to eccentric contractions, which promotes explosive power and strength (Ramírez-Campillo et al., 2013; Kumar et al., 2023). Typically, this approach entails the incorporation of workout that use the stretch-shortening cycle (SSC), wherein a lengthening movement (eccentric) is promptly trailed with a shortening movement (concentric) (Deng et al., 2023). The stretch-shortening cycle can be succinctly described as an improvement in the capacity of the neural and musculotendinous systems to generate the maximum force in minimal time (Beato et al., 2018). Plyometric exercises replicate the dynamic movements observed in different sports, are particularly beneficial for teenagers involved in physical pursuits (Chaudhary & Jhajharia, 2010). Utilizing plyometric exercises in strength training increases a player's start and direction change explosiveness and contraction efficiency (Hammami et al., 2019). Initially, plyometric training was considered risky for young individuals, and it was believed that a certain level of strength was necessary before engaging in such a program (Barbieri & Zaccagni, 2013). Plyometric training has been extensively studied in the context of athletic performance; its potential impact on motor fitness in non-athletic populations, particularly sedentary school boys who have never actively participated in sports, remains a relatively underexplored area. Understanding the potential benefits of plyometric training is not only relevant for physical educators, but also has broader involvements in promotion of physical activity and health. Thus, the main purpose of this study was to investigate the influence of plyometric training on running performance and jumping ability in a preadolescent population.

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METHODOLOGY

Inclusion and Exclusion Criteria

The participants for the research were selected from a cohort of male high school students aged 15 to 17, all of whom were in good health and engaged in regular physical fitness or recreational activities. These students were eager to participate in 6-week plyometric training, with daily sessions lasting one hour. The study's criteria for exclusion encompassed individuals with physical disabilities, those with severe medical conditions, and those who had previously undergone any type of physical training.

Demographic and lifestyle questionnaire

Before the commencement, participants were requested to complete a modified demographic questionnaire. This questionnaire included inquiries regarding their age, height, weight, medical history, and prior engagement in physical activities (training age).

Participants and Study Design

A within-group design was employed to examine the effect of plyometric training program on school boys.40 participants willingly participated. Among the 40 participants, 3 participants didn't meet the inclusion criteria and 1 participant have respiratory disorder, leading to inclusion of total 36 participants only. After baseline measurement, by using Microsoft Excel randomization routine the participants were uniformly divide into two equal groups: with one group receiving the plyometric training for 6 weeks (2 days/week), while the other served as the control. The demographic profile and participants flow during the study is shown in Table1 and Figure1 respectively.

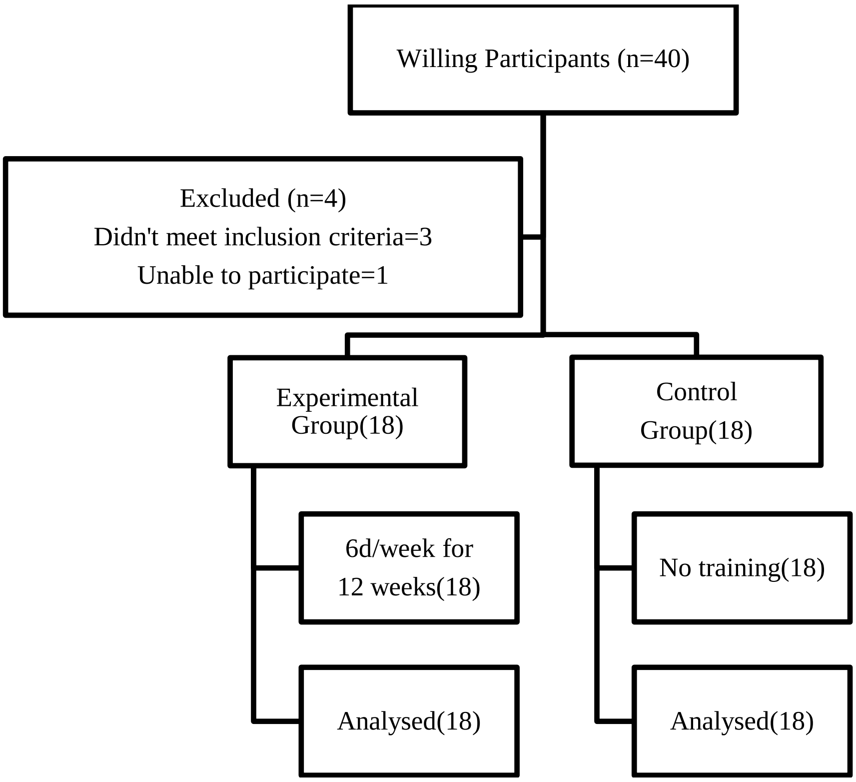

Figure 1. Flow chart showing participant's flow during the study.

Table 1. Demographic profile of the participants. Values are expressed as Mean (Standard deviation).

Variables	Experimental Group (n=18)	Control Group (n=18)
Age (year)	15.45 (0.52)	15.49 (0.49)
Height (cm)	161.73 (6.07)	160.58 (7.82)
Weight (kg)	47.67(8.01)	48.50 (7.96)
Body Mass Index (kg/m^2)	18.18 (2.51)	18.26 (2.66)

Plyometric Training

To achieve out the objectives of the study, we employed a 6-week (3 days/week) plyometric training regimen inspired by the successful approach used by Luebbers et al. in 2003, to enhance lower limb anaerobic power (Table 2). Recent study suggested plyometric training to improve jumping ability in school players participating in football and basketball respectively (Impellizzeri et al., 2008; Ziv & Lidor, 2010). This regimen includes different jumping exercises, resulting in accelerating vertical (vertical jump) and horizontal (i.e., short sprint and broad jumps) explosive strength. Participants were instructed to give their highest level of effort during every training session. Recovery periods between repetitions and sets adhered to the guidelines established by Luebbers et al. in 2003, with 15–30 seconds and 1–2 minutes allotted, respectively.

Table 2 Plyometric Training Program.

Exercise	**Number of sets (number of repetitions)**			
	Week 1	Week 2	Week 3	Week 4-6
Vertical jump	15 (10)	20 (10)	25 (10)	25 (10)
Bounding	3 (30 m)	5 (30 m)	5(30 m)	6 (30 m)
SBJ	5 (15 m)	5 (30 m)	7 (30 m)	8 (30 m)
Drop jump	3 (5)	5 (9)	6 (15)	6 (15)

SBJ- Standing Broad Jump; m- meter

Measurement

The pre and post intervention measurement were taken 2 days prior and after the training intervention respectively. The data was collected on selected motor fitness variables such as speed, agility and explosive strength measured by 20-meter sprint, 4*10-meter shuttle run and standing broad jump respectively. Before commencement of the tests, all the participants were advised to refrain from engaging in vigorous physical activities, the day before data assessment and to abstains of consuming caffeine 8-9 hours before data collection. Participants were prior familiarized to the test battery to optimize their performance and ensure their comfort during the testing process.

Statistical analysis

All the statistical study was accomplished using the GraphPad Prism (Version 8). Independent t-test was applied to examine the significant changes in the baseline measurement between the groups and paired t-test was applied to determine the significant changes among baseline measurement and after training measurements. The level of signification was set to the conventional value $\alpha = 0.05$ for all the analysis.

RESULTS

Table 1 presented the baseline characteristics of the participants. During the study, none of the participants reported any serious adverse injuries and no dropouts occurred till the completion of the study. All 36 participants effectively completed the exercise program and underwent the required assessments without encountering any complications. The average age of the experimental group and control group was 15.45 (0.52) and 15.49 (0.49) years respectively. There was no significant difference were found in the demographic characteristics of the participants. There were no significant differences in the baseline measurement($p<0.05$). The table 3 displays the motor fitness parameters measured before and after the experimental intervention.

The findings reported the timing for experimental group in 20 m sprint, decreased from pretest [4.17 (0.220)] to post-test [3.80 (0.184)] by 0.36 sec., while in control group it decreased from pretest [4.23 (0.359) to post-test [4.14 (0.244)] by 0.09 sec.

Table 3: Effect of plyometric training on motor fitness parameters.

Variable	Exp. Group			Cont. Group		
	Pre	Post	Sig.	Pre	Post	Sig.
Speed (sec)	4.15(0.28)	3.95(0.21)	0.035*	4.19(0.39)	4.01(0.35)	0.20
Agility (sec)	11.65(0.74)	11.03(0.56)	0.015*	11.42(0.84)	11.02(0.96)	0.23
Strength (sec)	195.58(21.04)	212.44(23.05)	0.046*	192.33(22.65)	201.69(27.56)	0.31

All values are expressed in Mean (standard deviation); *- Significant

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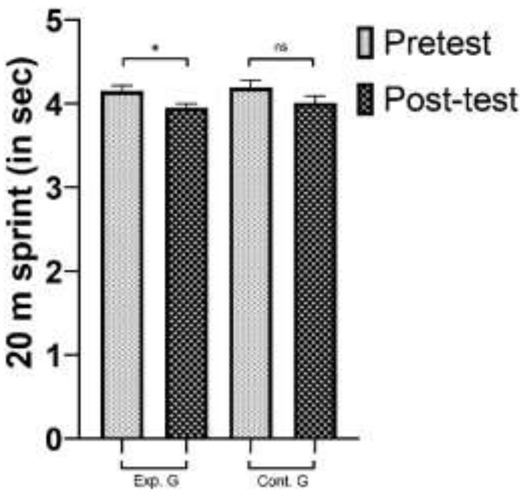
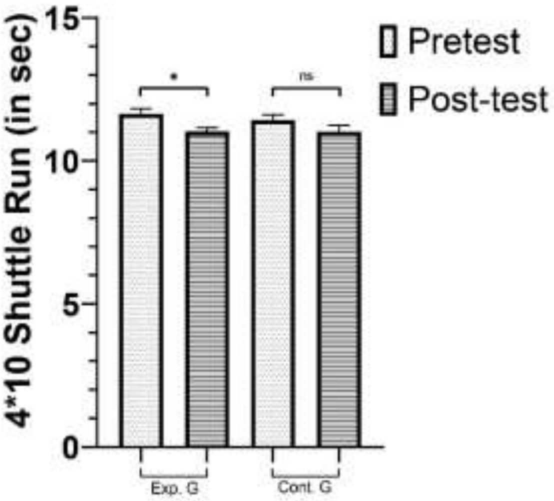
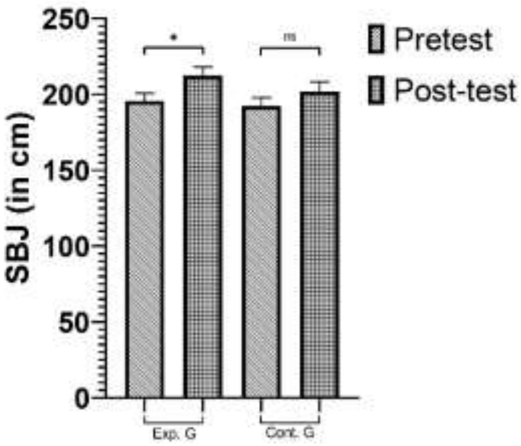


(A)



(B)



(C)

Figure 2 shows significant changes in experimental group and insignificant changes in control group in speed (A), agility (B) and explosive strength (C); sec- second; m- meter; Exp- Experimental; Cont.- Control; G- Group; ns- not significant; *- Significant; SBJ- Standing Broad Jump

Similarly, the timing for experimental group in 4*10 m shuttle run, decreased from pretest (11.40 (0.444)) to post-test (11.17 (0.378)) by 0.23 sec, while in control group it decreased from pretest [11.46 (0.532)] to post-test [11.34 (0.427)] by 0.12 sec. Standing broad jump improved in experimental group from [195.58 (21.049)] to [212.44 (23.05)] by 31 cm, while in the control group it increased from [192.33 (22.65)] to [201.69 (27.56)] by 8 cm.

DISCUSSION

The finding of the current study is 20m sprint and 4*10m shuttle run timing decreases in experimental group from pre to post intervention measurement. This decrease in timing shows that the volunteers after training intervention covers the same distance in lesser time as compare to the pretest measurement. A study conducted by Michailidis et al. on preadolescent boys, reported significant changes in speed following a plyometric training (Michailidis et al., 2013). Similar study conducted by Shamshuddin et al. on recreational football players reported significant changes in speed and agility following a 6-week plyometric training (Shamshuddin et al., 2020). Concerning plyometrics, Özmen & aydoğmuş have observed the most significant improvements after plyometrics in agility, which are in accordance with our findings. The mechanisms behind this enhancement may include increased rate of force development and enhanced muscle fiber recruitment, which are beneficial for sprinting. The current study also reported the positive changes in standing broad jump in experimental group i.e., the participants after training intervention covers more distance as compared to the pretest measurement. A study conducted by Silva et al. (2019) on volleyball players described that plyometric activity enhances vertical jump as well as horizontal jump performance, strength, flexibility and agility/speed in volleyball players. Similar study conducted by Franchi et al. (2019) found a quick increase in mass and strength of muscle in both young and aged individuals because of plyometric activity. Turner et al. (2015) conducted a study during pre-competition practices and found significant increase in sprint acceleration in athletes following plyometric exercise intervention. A study conducted by Chelly et al. (2015) stated that adding plyometric training to standard in-season training improves important components of athletic performance in young runners. Witzke & snow. (2000) conducted a study on adolescent girls and found plyometric jump training for a longer period of time can leads to increase peak bone mass. A study conducted by Huang et al. revealed significant changes were observed in strength, speed and agility after plyometric training in school students (Huang et al., 2023). The improvement in jump performance may be due to enhanced muscle stiffness and improved stretch-shortening cycle efficiency, which are crucial for maximizing jump distance. The current research demonstrates that a 6-week plyometric training program can significantly improve motor fitness parameters in school children. These findings highlight the potential of plyometric training as an effective tool in physical education programs aimed at enhancing the overall well-being of children.

Limitations

While this study provides compelling evidence for the benefits of plyometric training, it is not without limitations. The sample size was relatively small, and the duration of the intervention was limited. Future research should explore the long-term effects of plyometric training and its impact on different populations, including female athletes and older adults. Additionally, investigating the optimal frequency and intensity of plyometric exercises for maximizing performance gains would be valuable.

CONCLUSION

In accordance with the results, it is concluded that the training has significantly improve the selected motor fitness parameters. Therefore, it is advised to implement the training with players in order to enhance the motor fitness components during their sensitive growth phases as this is the key to their development and reaching the peak level, demonstrating the influence of its efficacy on the growth of athletic abilities. Further this study can also be done on younger age group so that the importance of plyometric training can be identified at the base level of the players.

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DISCLOSURE OF INTEREST

No conflict of interest.

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