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Determining the Effect of Core Strength Training on Dynamic Balance, Flexibility and Footwork Skill of Badminton Players

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Abstract

Background. Badminton is a technical racket sport that requires intense and explosive movements, with performance dependent on factors such as balance, agility, and core strength. Previous research has emphasized the significance of core fitness in fostering stability and dynamic balance for performance and injury prevention. However, its effects on badminton-specific skills remain relatively underexplored.

Objectives. This study aimed to investigate the impact of core strength training on dynamic balance, flexibility, and footwork skills among badminton players.

Materials and methods. Thirty male intercollegiate badminton players, aged 20-25, were randomly divided into experimental (n = 15) and control (n = 15) groups. Over 12 weeks, the experimental group underwent core strength training, while the control group maintained their regular routine. Pre- and post-test data were collected using the Y-balance test for dynamic balance, sit and reach test for flexibility, and Hick's footwork skill test for proficiency.

Results. Statistical analysis using paired t-tests and ANCOVA revealed significant improvements in the experimental group across all measured parameters, including dynamic balance (anterior, posteromedial, and posterolateral reaches), flexibility, and footwork skills. Conversely, the control group exhibited no substantial changes.

Conclusions. These findings underscore the efficacy of core strength training in enhancing essential physical attributes that are critical for badminton performance.

Keywords: dynamic balance, flexibility, footwork skills, badminton players, sports performance, physical fitness, athletic training, injury prevention.

Introduction

Badminton is one of the most popular racket sports all over the world. It is a technical racket sport characterised by intense and explosive short movements around the court (Ahmed, Saraswat, & Esht, 2022). The popularity and participation have grown ever since its inclusion to 1992 Olympic Games. It is a complex sport whose performance depends on different factors such as anthropometry, physiology, motor fitness, etc. (Phomsoupha & Laffaye, 2015). Badminton requires good balance and agility; better balance and agility enables a player to move well and quicker around the court and enables a player to give best performance during a match, (Singh, Raza, & Mohammad, 2011). Mohammadi & Fathi (2018) explained better core fitness level improves the stability and dynamic balance of the body. Which indicates that to enhance badminton performance, there is need to improve motor fitness and core strength improvement will enhance stability.

Previous investigations highlighted the importance of different training methods for the improvement of fitness and badminton performance (Kuo, Liao, & Kao, 2022; Malwanage, Senadheera, & Dassanayake, 2022; Panda et al., 2022). Different form of training shows different level and aspects of improvement in motor fitness as well as performance of badminton players. It is important for coaches and players to adopt appropriate form of training understanding their strength and weakness of the game. As competitive badminton matches last from 40 minutes to 1 hour, players need to maintain higher intensity and execute perfect rallies for longer period of time to have desirable outcome of the game (Phomsoupha & Laffaye, 2015). Ozmen & Aydogmus (2016) explained that core improvement can enhance dynamic balance of adolescent badminton players.

In last few decades, people are getting to understand the importance of core fitness in sport training, performance and injury prevention (Mohammadi & Fathi, 2018). The core muscles of the body stabilize the movement of the upper and lower extremities. Strong core muscles create movement in both the upper and lower bodies efficiently. Core strength in badminton is one of the most fundamental attributes any players should have. It acts to stabilize the body and generate force and act as a kinetic chain for energy transference. A core muscle is used during dynamic activity to support the thorax and pelvis and to create internal pressure for material excretion. Engaging in core strength training can help to decrease and avoid lower and knee joint issues (Churi & Varadharajulu, 2020, Beniwal & Dhauta, 2021). It is very important to train or strengthen the core much as strong core muscle could improve balance and stability, make movement easier and controlled, prevent injury, maintenance of energy system, or controls of movements and also to increase core strength and endurance to improve sports performance and to reduce injury risk (Beniwal & Dhauta, 2021; Shukla, 2022; Behm, Leonard, Young, Bonsey, & MacKinnon, 2005).

While several studies have highlighted the benefits of core training on various physical aspects (Wang & Cheng, 2017). There is a need for targeted research on how core strength training specifically affects dynamic balance, flexibility, and footwork skills in badminton players. This study aims to fill this gap by examining the impact of a structured core strength training program on these critical performance parameters in male badminton players.

Materials and Methods

Participants

After obtaining consent, 30 male badminton players, aged between 20 to 25 years, were selected for this study using purposive sampling from colleges affiliated with Manipur University. All participants had previously competed in inter-collegiate badminton tournaments and represent national level tournament. They were divided into two groups: an Experimental Group (15 subjects) and a Control Group (15 subjects). None of the subjects had undergone any formal training in the past five months, although they continued to play badminton regularly. Pre-test data were collected for both groups using specified assessment tests before the commencement of the training program. The Experimental Group then underwent a core strength training regimen for 12 weeks, while the Control Group did not receive any specialized training. After the 12-week period, post-test data were collected from both groups to assess the impact of the core strength training on dynamic balance, flexibility, and footwork skills.

Core Training

The core training was given to the experimental group and they were also allowed to play badminton after or later training. The control group was not implemented with any form of training, they continue playing their regular badminton. The training of core strength was given at Manipur University campus and was conducted in morning for 3 days per week for 12 weeks. The core training exercises include; isometric v-up, Bird Dog, Front plank, Side Plank, Superman, Sit ups Russian Twist, Leg Raise, Reverse Crunches and Kneeling Wheel Roll-Out. The training was conducted in three phases 1-4 weeks (10reps /3sets), 5-8 weeks (12reps/3sets) and 9-12 weeks (15reps/3sets).

Statistical Analysis

The data pertaining the study was examined statistically by using IBM SPSS 21 version software. Shapiro-Wilk normality test was used to check the data normality of the selected parameters. The descriptive analysis of the data was conducted and to compare means, pair sample t-test and Analysis of Covariance (ANCOVA) was used. The level of significance is set at 0.05.

Results

The age of the subjects was 22.60 ± 1.76 for experimental group and 22.06 ± 1.53 for control group. Likewise, 68 ± 10.63 and 66 ± 7.44 were the weight of experimental and control group respectively. The height and BMI of experimental and control group were 5.12 ± 0.24, 23.65 ± 2.03 and 22 ± 1.53, 23.63 ± 2.96 respectively as shown in Table1. There was not much difference in the demographic characteristics of the subjects of both the groups.

From Table 2, we can see that there was normal distribution in most parameters of both control and experimental group excluding, RPM (Dynamic balance) of Experimental group and footwork skill of control group.

The mean and standard deviation, as shown in Table 3, of the dynamic balance; LA, LPL, LPM, RA, RPL, RPM, Footwork and Flexibility of pre-test are 68.20 ± 3.48, 75.93 ± 7.41, 81.46 ± 5.18, 67.46 ± 4.56, 75.53 ± 8.03, 80.40 ± 7.50, 9.13 ± 0.74 and 30.40 ± 4.71. The mean and standard deviation of dynamic balance; LA, LPL, LPM, RA, RPL, RPM, Footwork and Flexibility of post-test are 72.13 ± 3.15, 79.60 ± 7.61, 84.60 ± 4.33, 72.13 ± 3.15, 80.40 ± 7.39, 83.26 ± 7.07, 9.66 ± 0.61 and 33.53 ± 4.45 respectively. There was significant difference found in

Table 1. Demographic characteristics of the participants

GROUP	AGE (Year)	WEIGHT (Kg)	HEIGHT (Feet)	BMI (Kg/m^2)
Experimental	22.60 ± 1.76	68 ± 10.63	5.12 ± 0.24	23.65 ± 2.03
Control	22.06 ± 1.53	66 ± 7.44	5.06 ± 0.01	23.63 ± 2.96

dynamic balance as t value of LA, LPL, LPM, RA, RPL and RPM are respectively 12.458, 9.811, 7.596, 4.167, 7.999and 5.776 which are higher than table t = 2.045. There was significant difference found for footwork and flexibility also as calculated t are respectively 4.000 and 13.256 which are much higher than table t = 2.045. Therefore, there significant improvement found in experimental group. The graphical presentation of pre-test and post-test dynamic balance, flexibility and footwork skill are given in figure1 below.

Table 2. Normality test of the selected variables

Variable	Group	Mean	SD	Shapiro-Wilk	
				W	sig
LPL	CG	76.66	5.74	0.904	0.110
	EG	75.93	7.41	0.926	0.235
LPM	CG	79.06	5.67	0.882	0.051
	EG	81.46	5.18	0.991	1.00
LA	CG	64.46	3.02	0.906	0.120
	EG	68.20	3.48	0.926	0.236
RA	CG	65.26	4.11	0.913	0.153
	EG	67.46	4.56	0.941	0.395
RPL	CG	78.13	6.08	0.914	0.155
	EG	75.53	8.03	0.950	0.523
RPM	CG	80.20	4.72	0.940	0.377
	EG	80.40	7.50	0.843	0.014
Foot-work	CG	8.80	0.77	0.806	0.004
	EG	9.26	0.73	0.894	0.076
Flexibility	CG	32.80	3.66	0.936	0.338
	EG	30.40	4.71	0.947	0.482

LA: Left Anterior (Dynamic balance for the left leg in the anterior direction), LPL: Left Posterolateral (Dynamic balance for the left leg in the posterolateral direction), LPM: Left Posteromedial (Dynamic balance for the left leg in the posteromedial direction), RA: Right Anterior (Dynamic balance for the right leg in the anterior direction), RPL: Right Posterolateral (Dynamic balance for the right leg in the posterolateral direction), RPM: Right Posteromedial (Dynamic balance for the right leg in the posteromedial direction)

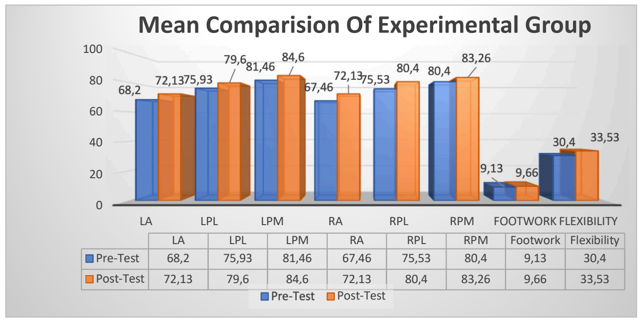

Fig. 1. Pre and post-test mean comparison of experimental group

From Table 4 we can see that the pre-test means and standard deviation of the dynamic balance; LA, LPL, LPM, RA, RPL, RPM, Footwork and Flexibility of pre-test are 64.46 ± 3.02, 76.66 ± 5.74, 79.06 ± 5.67, 65.26 ± 4.11, 78.13 ± 6.08, 80.20 ± 4.72, 8.80 ± 0.77 and 32.73 ± 3.69. The

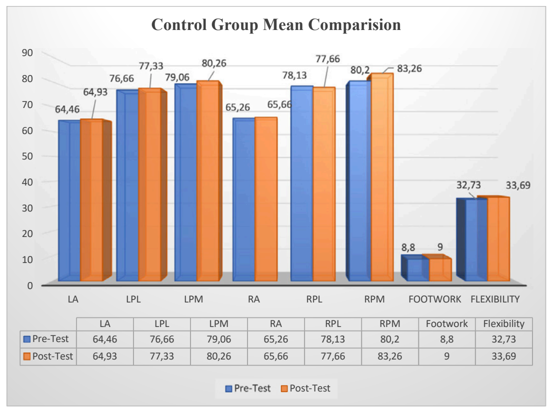

Fig. 2. Pre and post-test mean comparison of control group

Table 3. Descriptive statistics and t-test of experimental group

Variables		n	Mean		SD		Std. Error Mean	t
			Pre	Post	Pre	Post		
Dynamic Balance	LA	15	68.20	72.13	3.48	3.15	0.31	12.458
	LPL	15	75.93	79.60	7.41	7.61	0.37	9.811
	LPM	15	81.46	84.60	5.18	4.33	0.41	7.596
	RA	15	67.46	72.13	4.56	3.15	1.11	4.167
	RPL	15	75.53	80.40	8.03	7.39	0.60	7.999
	RPM	15	80.40	83.26	7.50	7.07	0.49	5.776
Footwork		15	9.13	9.66	0.74	0.61	0.13	4.000
Flexibility		15	30.40	33.53	4.71	4.45	0.23	13.256

*Significant at 0.05, t=2.045 LA: Left Anterior (Dynamic balance for the left leg in the anterior direction), LPL: Left Posterolateral (Dynamic balance for the left leg in the posterolateral direction), LPM: Left Posteromedial (Dynamic balance for the left leg in the posteromedial direction), RA: Right Anterior (Dynamic balance for the right leg in the anterior direction), RPL: Right Posterolateral (Dynamic balance for the right leg in the posterolateral direction), RPM: Right Posteromedial (Dynamic balance for the right leg in the posteromedial direction)

Table 4. Descriptive statistics and t-test of control group

Variables		n	Mean		SD		Std. Error Mean	t
			Pre	Post	Pre	Post		
Dynamic Balance	LA	15	64.46	64.93	3.02	3.39	1.28	0.363
	LPL	15	76.66	77.33	5.74	5.40	0.28	2.320
	LPM	15	79.06	80.26	5.67	5.04	1.94	0.619
	RA	15	65.26	65.66	4.11	3.65	1.21	0.328
	RPL	15	78.13	77.66	6.08	6.37	1.94	0.240
	RPM	15	80.20	83.26	4.72	7.07	1.50	2.035
Footwork		15	8.80	9.00	0.77	0.75	0.10	1.871
Flexibility		15	32.73	33.06	3.69	2.86	0.98	0.337

LA: Left Anterior (Dynamic balance for the left leg in the anterior direction), LPL: Left Posterolateral (Dynamic balance for the left leg in the posterolateral direction), LPM: Left Posteromedial (Dynamic balance for the left leg in the posteromedial direction), RA: Right Anterior (Dynamic balance for the right leg in the anterior direction), RPL: Right Posterolateral (Dynamic balance for the right leg in the posterolateral direction), RPM: Right Posteromedial (Dynamic balance for the right leg in the posteromedial direction)

Table 5. Pre and post mean comparison of experimental and control groups (ANCOVA)

Variables		Sources	Type III sum of squares	df	Mean Square	F	Sig. (P)
Dynamic Balance	LA	Group	78.31	1	78.32	45.10	0.000
		Error	46.88	27	1.73		
		Total	141594.00	30			
	LPL	Group	66.53	1	66.53	39.02	0.000
		Error	46.02	27	1.70		
		Total	185970.00	30			
	LPM	Group	42.28	1	42.28	18.95	0.000
		Error	60.22	27	2.23		
		Total	204452.00	30			
	RA	Group	194.96	1	194.96	30.81	0.000
		Error	170.82	27	6.32		
		Total	143057.00	30			
	RPL	Group	145.50	1	145.50	51.53	0.000
		Error	76.22	27	2.82		
		Total	190084.00	30			
	RPM	Group	36.96	1	36.96	14.71	0.001
		Error	67.82	27	2.51		
		Total	203048.00	30			
Footwork		Group	1.30	1	1.30	7.12	0.013
		Error	4.90	27	0.18		
		Total	2630.00	30			
Flexibility		Group	35.31	1	35.31	8.44	0.007
		Error	112.91	27	4.18		
		Total	33661.00	30			

*Significant at 0.05 level of confidence, where tabulated F (0.05) (1, 27) =4.21

post-test means and standard deviation of dynamic balance; LA, LPL, LPM, RA, RPL, RPM, Footwork and Flexibility of post-test are 64.93 ± 3.39, 77.33 ± 5.40, 80.26 ± 5.04, 65.66 ± 3.65, 77.66 ± 6.37, 83.26 ± 7.07, 9.00 ± 0.75 and 33.06 ± 2.86 respectively. For dynamic balance, there was insignificant difference found for LA, LPM, RA, RPL and RPM as calculated t value are respectively 0.363, 0.619, 0.328, 0.240 and 2.035 which are lower than table t = 2.045 whereas there was significant difference found for LPL as calculated t = 2.320 was higher than table t = 2.045. There was insignificant difference found for footwork skill and flexibility as calculated t are respectively 1.871 and 0.337 are lower than table t = 2.045. The graphical presentation of pre-test and post-test dynamic balance, flexibility and footwork skill are given in figure 2.

It is evident from the findings of Table-V that there is significant improvement observed in dynamic balance; LA, LPL, LPM, RA, RPL and RPM between pre and post mean comparison between experimental and control groups as the observed F value; 45.10, 39.02, 18.95, 30.81, 51.53 and

14.71 respectively are much higher than table F value = 4.21 at 0.05 level of confidence and (1, 27) degree of freedom. There is significant difference found in footwork skill and flexibility of badminton players as calculated F value; 7.12 & 8.44 respectively are much higher than table F value = 4.21 at 0.05 level of confidence and (1, 27) degree of freedom.

Discussion

As per the findings of the study, it is understood that the selected dependent variables: dynamic balance, flexibility and footwork skill, showed significant improvement after 12 weeks of core strength training. The core muscles like any other muscle develops after conditioning and training. After 12 weeks of core strength training, it develops its strength, neural control of the muscles and enhance the neuromuscular efficiency.

Mengyao Xie (2016) stated that a more stable core muscles coordinate the upper extremities and lower extremities and regulates the energy system in various actions during the badminton game. Palekar, Nitin Savla, & Sangaonkar (2020) stated that there is positive correlation between core stability and agility in badminton players. As the training included exercises which aim in the development of core muscles and the training volume and intensity during the training, the core muscles develop its strength and therefore enhance its ability of the motor control of the upper and lower extremities. Body balance and stability depends mostly of the coordination of the upper and lower extremities, and after going through the full session of training the core muscles develops its strength. Hence, there was significant improvement found in dynamic balance which is an important fitness aspect for badminton players. Core fitness training is a form of training which helps in the development of core muscle efficiency which brings harmony in the functioning of the body increasing body stability which is important for any form of sports and activities. Many previous studies have showed the importance of proper core strength training for the improvement of balance (Jo et al., 2022; Salar et al., 2023; Bora & Dağlıoğlu, 2022). Simão et al. (2011) indicated that participation in strength training enhances the flexibility of the individuals. As the core muscles developed through core muscle training, the flexibility of badminton players increases. Malwanage et al. (2022) stated that improved stability enhances the footwork of badminton players. The improvement in core muscles enhance the performance of foot-work skill and as the muscle tone improved, the flexibility increases.

These findings are supported by another study of Hariprasad, Author, & Suthakar (2020). He studied the effects of core circuit stability training and periodised resistance circuit training on flexibility of collegiate male badminton players and found that the core stability circuit preparing enhanced Flexibility of inter collegiate male badminton players. Sighamoney, Kad, & Yeole (2018) studied the effect of core strengthening on dynamic balance and agility in badminton players and found that core strengthening significantly improves dynamic balance and ability of badminton players. In another study of Solanki & Gill (2021), it was found that core stability training improves smash stoke performance of various racket sports.

Conclusion

The study concludes that core strength training significantly enhances dynamic balance, flexibility, and footwork skills in badminton players. The experimental group's marked improvements in these areas compared to the control group emphasize the critical role of core strength in sports performance. These findings promote the integration of core strength exercises into regular training programs to boost athletic performance and minimize the risk of injuries among badminton players.

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Conflict of Interest

The authors declared no conflict of interest.

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Визначення впливу силових тренувань м'язів кору на показники динамічної

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 5 табл., 2 рис., 22 джерела.

Історія питання. Бадмінтон — це технічний вид спорту з використанням ракетки, який потребує інтенсивних і вибухових рухів, а результативність гри залежить від певних факторів, як-от рівновага, спритність і сила м'язів кору. У попередніх дослідженнях наголошувалося на важливості тренованості м'язів корпусу у розвитку стійкості та динамічної рівноваги для досягнення результативності та профілактики травматизму. Однак питання щодо впливу тренованості м'язів кору на формування специфічних для бадмінтону навичок залишається відносно недостатньо вивченим.

Мета дослідження. Це дослідження мало на меті вивчити вплив силових тренувань м'язів кору на показники динамічної рівноваги, гнучкості та розвитку навичок роботи ніг серед гравців у бадмінтон.

Матеріали та методи. Тридцять чоловіків-бадмінтоністів міжвузівського рівня віком 20-25 років було розподілено за методом рандомізації на експериментальну (n=15) та контрольну (n=15) групи. Впродовж 12 тижнів експериментальна група проходила силові тренування м'язів кору, в той час як контрольна група дотримувалася свого звичайного режиму тренувань. Збір даних перед початком та після завершення тестування проводився за допомогою тесту на динамічну рівновагу ("Y-balance test"), тесту на гнучкість, що передбачає вимірювання загальної гнучкості тіла при згинанні тулуба вперед, сидячи на підлозі з витягнутими вперед руками ("Sit and reach test") та тесту Гіка з метою визначення рівня володіння навичками роботи ніг ("Hick's footwork skill test").

Результати. За результатами статистичного аналізу із застосуванням парних t-критеріїв та коваріаційного аналізу (ANCOVA) в експериментальній групі встановлено значне покращення за всіма вимірюваними параметрами, включаючи динамічну рівновагу (передній, задньомедіальний та задньолатеральний розмахи рухів), гнучкість та розвиток навичок роботи ніг. Натомість у контрольній групі суттєвих змін не спостерігалося.

Висновки. Отримані дані підкреслюють ефективність виконання силових тренувань м'язів кору щодо поліпшення основних фізичних якостей, що мають вирішальне значення для досягнення результативності в бадмінтоні.

Ключові слова: динамічна рівновага, гнучкість, навички роботи ніг, бадмінтоністи, спортивна результативність, фізична підготовленість, спортивне тренування, профілактика травматизму.

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