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Various Bodyweight Training Effect on the Explosive Leg Strength of Badminton Players

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Abstract

This study looked at how a six-week training program affected the leg strength of university badminton players in India. The program was done with thirty badminton players from Central University of Punjab who were between 18 and 24 years old. These badminton players did a training program that had them exercise three times a week. The training program had two types of exercises: exercises where the players held a position like wall sits and squat holds, and dynamic exercises where the players moved, like jump squats and lunges. The players' leg strength was tested before and after the training program using the Standing Broad Jump and Vertical Jump tests. The tests were done with a force plate, a measuring tape and the Eze Jump mobile application. The results of the tests were analyzed with a test to make sure the data were normal. Then the results were compared using a statistical test. The results showed that the players' leg strength improved after the training program. The players were able to jump a bit farther in the Standing Broad Jump test from an average of 1.94 meters to 1.99 meters. The players were also able to jump a bit higher in the Vertical Jump test from an average of 30.69 centimeters to 32.73 centimeters. These results show that this type of training program can help badminton players improve their leg strength and get better at movements like lunges and jump smashes. This training program is also good because it does not need any equipment, so it is accessible and cost-effective for athletes and coaches who do not have a lot of resources. The badminton players and coaches can use this training program to improve their strength and get better at badminton. The recommendations can provide easily accessible and effective training guidelines for athletes and coaches in India.

Keywords: Bodyweight training, explosive leg strength, badminton, standing broad jump, vertical jump, SBJ, isotonic, isometric, jump.

INTRODUCTION

Badminton, a fast-paced and high-intensity racket game, requires exceptional physical attributes of an athlete, especially speed, agility, endurance, and explosive strength [1]. The most important of these qualities is explosive leg strength as it helps in faster movements like acceleration, lunges, vertical jumps, and quicker multilateral movements in badminton article. The explosive actions are not just an add-on, but the building blocks for effective footwork, short sprints, recoveries and strokes that will win you matches at all levels of play. The concept of explosive leg strength refers specifically to the ability of the lower limb musculature to generate a maximum force in the shortest time possible. This ability is very closely related to the vertical and horizontal jumping ability of an athlete as well as their ability to accelerate and decelerate in quick succession explaining the need for a strength coach to ensure the best design as well as implementation of a strength and conditioning programme that suits one's athlete need best without failing (Cormie et

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al.,[2] 2011) For badminton players, this type of muscle power is fundamental to outplaying rivals both offensively and defensively. Many important badminton skills, such as jump smash, net kill and dive reach, rely on a player's ability to generate and control explosive force through their legs. Due to the importance of lower body explosiveness, badminton strength and conditioning programs have focused on producing muscle power through resistance training methods. In the recent times, bodyweight-based training regimes which focus mainly on two types of muscular contraction, isometric and isotonic, have started to gain a lot of recognition for their distinct worth and practicality. Both are known to help with overall strength and functionality, but the roles they play, the extent they complement each other and the effect they have on explosive strength (in badminton) is not studied much. And especially not in India, where we seldom have the resources. Isometric exercise means exerting the muscle to a resistance that cannot move. Meaning that the muscle does not change length. Example is wall sit or squat hold. This helps to strengthen the joint at that angle and increase stability. In contrast, isotonic exercises make use of dynamic contractions of muscle through which the muscle lengthens or shortens against a fixed weight or load, as in squats, lunges or jumps. According to Markovic and Mikulic [3] (2010), isotonic training is likely to replicate actual sports or daily activities, thus promoting development of dynamic strength, muscular co-ordination, and functional power through a variety of movement ranges. Though there is plenty of research on isometric and isotonic training from all over the world proving them effective, the impact of the training in isolation and in combination in the case of bodyweight training for badminton players has not been adequately put to the test. This calls for empirical testing and this also applies to the Indian university-going population. This gap is particularly acute in economically deprived and rural areas where the lack of access to commercial gym gears and training resources makes sophisticated resistance training programmes infeasible. Consequently, numerous athletes and coaches encounter considerable difficulties in sourcing quality strength training. In view of these limitations, it is desirable that bodyweight exercises not requiring specialized equipment should be made mandatory for equitable athlete preparation in varied contexts. Studies on related topics have been conducted with positive results. According to Behm and Sale [1] (1993), the important muscle contraction which constitutes rate of force development (RFD) has explosive contraction after performing an isometric contraction. Therefore, it is essential for performance. It has likewise been shown that plyometric and isotonic bodyweight exercises can improve jumping ability and overall leg power (Markovic and Mikulic, [3]2010; Stojanovic et al., [4]2017). Nonetheless, the majority of literature has only examined either isometric or isotonic methods, with the synergistic effects of their combinations insufficiently characterized for badminton populations [5]. This study attempts to fill the gap by scrutinising the effect of a combined isometric and isotonic bodyweight training intervention on the explosive leg strength among the badminton players of the Central University of Punjab, Bathinda [6]. The objective of the study is to evaluate the changes in explosive performance of Junior Australian Football League (JAFL) players using the measures of Standing Broad Jump (SBJ) and Vertical Jump (VJ) tests which are both objective and field friendly. This is done through a structured six-week program. The exercises consist of squat holds, wall sits, jump squats, lunges, and lateral jumps three times a week. The use of low-cost and simple-to-use technology (force plates and mobile applications) allows a broad assessment while reflecting the reality of training in low-resource settings [7]. There are two reasons to go down this path. To begin with, it seeks to give practical suggestions that can be used by anybody like coaches or otherwise athletes with or without resources. Since the world is experiencing a boom in sports science, the second objective of the research attempts to create culturally and contextually relevant knowledge, which can connect the increasing sports science developments globally to solve the problems and exploit opportunities in Indian sport. This research seeks to promote greater inclusion in athlete development, advocating for practical and effective training that is universally accessible. Ultimately, this study addresses an important gap in the literature related to the effect of hybrid (isometric + isotonic) bodyweight training on explosive leg strength in Indian badminton players, which has gained practical importance [8].

The findings can help inform future training programmes and increase involvement in strength and conditioning work. Most importantly, they can enhance the on-court performance and resilience to injury of badminton players from various socio-economic backgrounds [9].

METHODOLOGY

Research Design

To assess the effectiveness of the combined isometric and isotonic training of bodyweight training on explosive strength in the legs, a single-group pre-test–post-test experimental design was adopted. The outcome was the difference in SBJ and VJ performance before the intervention and after [10] (Table-1).

Participants

In total, thirty male badminton players, aged between 18 and 24, participated in the study. Each participant had at least one year of competitive experience and none had experienced a lower-limb injury for the previous six months. All participants provided their written informed consent. The study was approved by the ethics committee of the university [11].

Intervention

This training programme was administered over a period of six weeks, at the rate of three trainings each week (Monday, Wednesday and Friday). Every session was qualified supervised trainer time of 45-60 minutes. Exercises incorporating both isometric (static holds) and isotonic (dynamic movement) features of major lower-body muscles [12].

DETAILED WEEKLY PROGRAM

Monday (Day 1)

- Isometric squat hold (4 sets × 30–45 sec)
- Jump squats (4 × 12–15 reps)
- Wall sit (3 × 45 sec)
- Bodyweight lunges (3 × 20 reps)
- Lateral skater jumps (4 × 10–12 reps)

Wednesday (Day 2)

- Bulgarian split squats (3 × 12 reps/leg)
- Step-ups (4 × 10 reps/leg)
- Pistol squats (3 × 15–20 reps)
- Isometric single-leg holds (3 × 10–15 sec/leg)

Friday (Day 3)

- Jump squats (3 × 12 reps)
- Lateral skater jumps (3 × 15 reps/side)
- Isometric lunge hold (3 × 10 reps/leg)
- Donkey kicks (3 × 15 reps/leg)
- Step-ups with knee drive (3 × 12 reps/leg)

Each set was separated by a two-minute rest; intensity was self-monitored at approximately 60% maximal effort. Every exercise was only body weight so you could do it anywhere that is not the gym [13].

DATA COLLECTION INSTRUMENTS

- *Force Plate:* For objective quantification of jump distance and ground reaction force.
- *Eze Jump App:* To digitally capture vertical jump height, power, and related kinetic variables [14].
- *Measuring Tape:* For direct measurement of horizontal jump distance.

All instruments were calibrated before use according to manufacturer specifications.

OUTCOME MEASURES

Standing Broad Jump (SBJ)

Participants made three maximal-effort horizontal jumps whilst starting stationary. Distance measurement (in meters) was done through a force plate and measured tape (Figure-1).

Vertical Jump (VJ)

Subjects conducted five vertical jumps at maximum height. The power output in watts and heights in cm was recorded through the force plate and the Eze Jump mobile app, which calculated the Reactive Strength Index (RSI). (Figure-2)

To minimize variables, the same warm-up routine was enforced and shoes were kept the same in both tests.

Data Collection and Analysis

- Normality of data was assessed by the Shapiro-Wilk test (Table-2).
- Statistical significance between pre- and post-test scores for SBJ and VJ was determined using paired T-tests ($p < 0.05$) (Table-3).
- Descriptive statistics summarized means, standard deviations, skewness, and kurtosis.

All statistical analyses were performed using SPSS (version 27).

RESULTS

Table 1. Comparison of mean SD (in meter) pre and post data.

Variable	Pre-test mean	Pre-test SD	Post-test mean	Post-test SD
SBJ (m)	1.94	0.196	1.99	0.181
VJ (cm)	30.69	4.70	32.73	3.36

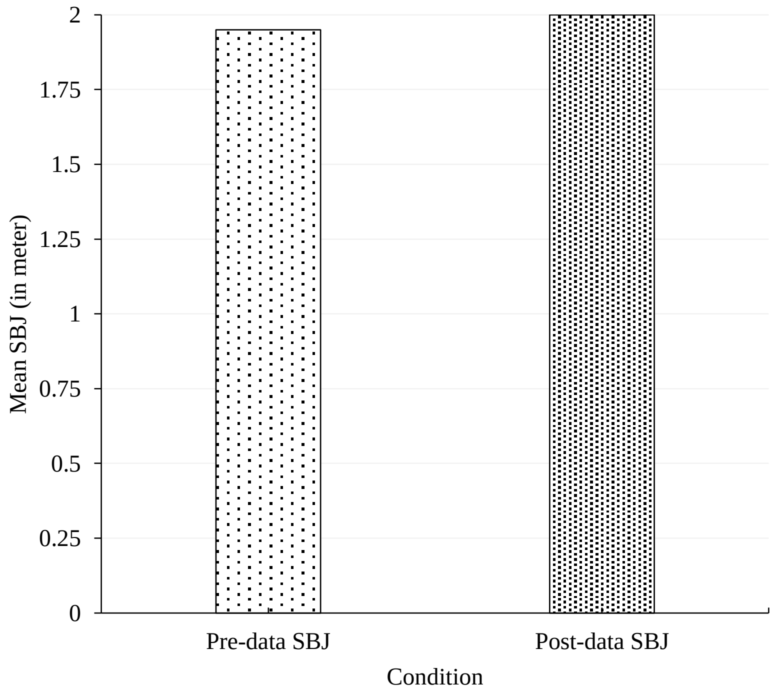

Figure 1. Comparison of mean SBJ (in meter) pre and post data.

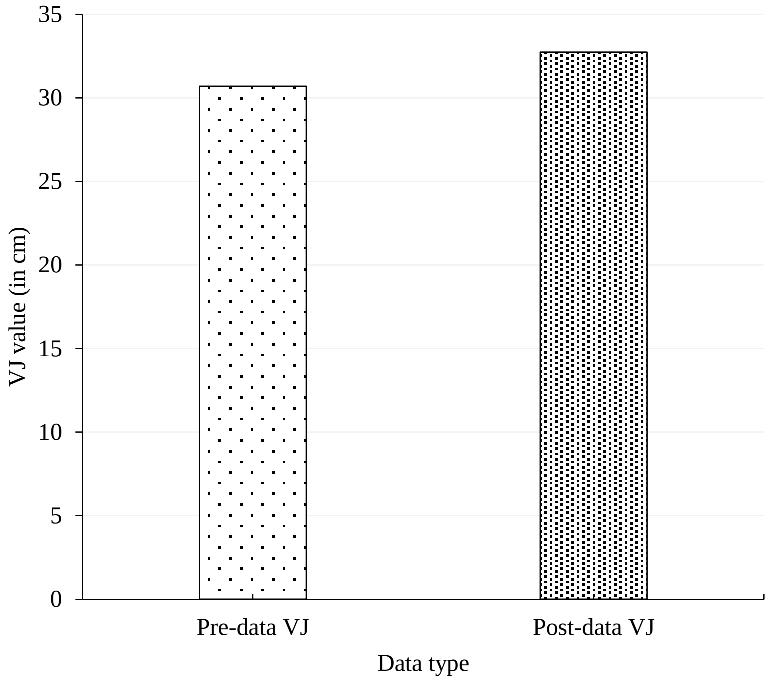

Figure 2. Comparison of pre-data VJ and post-data VJ.

DATA NORMALITY

Table 2. Shapiro-wilk test values confirmed normal distribution for all variables.

Variables	Shapiro-wilk test statistic	p-value
SBJ pre	0.97985	0.8216
SBJ post	0.95782	0.2722
VJ pre	0.91452	0.11938
VJ post	0.95585	0.2418

Paired T-Test

Table 3. Both SBJ and VJ saw statistically significant improvements in post-intervention ($p < 0.05$).

Variable	t	df	p-value	Significance
SBJ	-3.64	29	0.00104	Significant
VJ	-4.15	29	0.00026	Significant

Distribution Analysis

Using pre- and post-intervention data analysis, it was found that skewness only had minor degrees of skewness and the platykurtic and leptokurtic nature shows data mostly clustering on a middle performance level with occasional outlier data at the low and high ends.

DISCUSSION

The current research was designed to analyze the effect of six weeks of combined isometric and isotonic bodyweight training on the explosive leg strength of university badminton players. A clear improvement was shown in both SBJ and VJ performance following the application of the selected intervention, indicating that statistically significant ($p < 0.05$) enhancements occurred. The results indicate that incorporating isometric and isotonic bodyweight exercises enhances lower body neuromuscular performance of badminton players. This is particularly beneficial for places where equipment and weights are unavailable or limited (Table-3).

INTERPRETATION OF KEY FINDINGS

The sharp rise in SBJ and VJ scores after the intervention indicates that the combined isometric and isotonic protocol had a significant effect on the horizontal and vertical explosive power [15]. The greater improvement in SBJ indicates that the players were able to produce a greater horizontal force and coordinate better. The height increased in the VJ shows that the players managed to develop a greater vertical leg power and RFD. All these components are crucial for badminton, enabling players to execute effective lunge, jump smash, change direction quickly and accelerate quickly [16]. The aforementioned results show consistency with earlier studies which separately supported isometric and isotonic training benefits for power. For instance, it was demonstrated by Behm and Sale [1] (1993) that performing isometric contractions with explosive intent could significantly increase RFD in trained individuals, which, in turn, facilitates rapid force output for actions of short burst that are common in badminton. Isotonic (especially plyometric) training enhances muscle-tendon stiffness and neuromuscular coordination, which results in higher jump heights and better power endurance (Marković and Mikulić, [3]2010; Stojanović et al., [4]2017). Through the integration of these two modalities, the present study capitalised on the complementary physiological mechanisms underlining each contraction type, yielding superior enhancements compared to isolated training modes [17].

PHYSIOLOGICAL MECHANISMS AND TRAINING SPECIFICITY

Isometric training involves maintaining constant tension in a muscle without visible joint movement [18]. Although strength increases are restricted to the trained joint angles, the method also develops muscular endurance and stabilization (Andersen et al.,[6] 2010). Increased motor unit recruitment and neural drive, important for the rapid generation of force, takes place. On the other hand, isotonic exercises involve concentric and eccentric muscle actions, which mimic the dynamic pattern sports activity closely [19]. This condition not only muscle fibers for the respective sports activity but also improves the efficiency of the stretch-shortening cycle (Marković & Mikulić,[3] 2010). The hybrid training program illustrated in this study consisted of static holds like wall sits and squat holds, performed alongside dynamic movements like jump squats, lunges, and lateral skater jumps [20]. This technique also probably improves muscle control at the joint level, joint stability and the abilities for dynamic force, by developing muscles over their full function range and their explosive contractile demands at the same time [21]. This level of specificity is essential in interpreting gains as functional improvements on the court where athletes must switch quickly between stable postures and explosive movements [22].

PRACTICAL IMPLICATIONS FOR BADMINTON TRAINING

The enhancements in explosive leg strength observed in this study will certainly enhance performance, given the demands of badminton such as quick acceleration, strong lunges, fast recovery, and high vertical reach. Improved SBJ and VJ scores indicate better force production and neuromuscular efficiency which can enhances movement efficiency, shot power as well as reaction time at competition situation [23].

By focusing on joint stability and muscular endurance, fatigue and risk of injury may be reduced. Crucially, the training program me of the study relied only on bodyweight exercises meaning that players and coaches operating in India’s rural and under-equipped settings can easily implement it. The freedom from reliance on additional weights and gym equipment eliminates the limitations imposed by accessibility and cost. Similar protocols are simple for all coaches to implement as they require little space and no cost [24].

COMPARISONS WITH PREVIOUS RESEARCH

The results of this study contribute to the literature by providing evidence for the synergistic benefits of isometric and isotonic bodyweight training in an Indian university badminton player population [25]. Despite previous findings highlighting the efficacy of these training types by themselves (Behm & Sale,[1] 1993; Marković & Mikulić, [3]2010), there has been little investigation into their joint effect in a bodyweight-only format in a resource-limited setting. The present findings confirm and extend the recommendations made by Faigenbaum and Myer [5] (2010) for early inclusion of bodyweight resistance training for neuromuscular coordination and injury prevention in young athletes. Using isometric holds and dynamic isotonic drills could improve training adaptations: the different forms of strength and power are being targeted. This could be particularly relevant for those athletes limited to traditional resistance modalities [26].

LIMITATIONS AND CONSIDERATIONS

Though promising, there are several limitations of this study. To begin with the sample contained only male university players aged between 18 to 24 years from the same university which limited the generalizability on gender, age-group or competitive level [27]. Further research should investigate these results in female players, as well as in younger or elite athletes, to determine the program's broader applicability [28]. Secondly, this study addressed only explosive leg strength, as measured by SBJ and VJ performances, which is only some components of badminton performance [29]. The addition of other performance measures like agility tests, sprint times or on-court skill assessments might provide further insights to enhance understanding of how strength gains impact sport performance. Moreover, a comparison of the combined training program against isometric-only or isotonic-only protocols would have helped to identify the relative contributions of each modality and potentials additive or synergistic effects. The performance results may have been affected by diet, sleep quality, and mental health, as those factors were not controlled [30]. While six weeks is enough to see significant changes, it is a minor duration; longitudinal studies could look at long-term effects…sustainability and injury prevention benefit.

CONCLUSION

As a result of this study, after six weeks of combined isometric and isotonic bodyweight training, university badminton players will notice significant improvements in explosive leg strength. The Standing Broad Jump (SBJ) performance and vertical jump (VJ) performance were significantly improved after the training. This shows that there was an effect of combining static (isometric) and dynamic (isotonic) exercises in a training program. Findings establish that hybrid bodyweight training protocols can effectively elicit neuromuscular adaptations that underline the horizontal and vertical components of explosive leg power that are important in badminton. The enhancement of SBJ indicated a more capable application of horizontal force and optimization of legs coordination to make a powerful lunge and rapid directional change. The enhancements in VJ similarly indicate an increase in vertical force output and rate of force development (RFD). These factors are critical for executing jump smashes, quick recoveries, and achieving reach advantage in play. Notably, the primary finding of this study is that performance can improve substantially without the use of specialized gym equipment or weights. The bodyweight training program's cost-effectiveness and accessibility benefit athletes and coaches working in resource-poor settings most notably, those in the rural and underdeveloped areas of India. By making it more accessible, it ensures the delivery of effective strength and conditioning in a more equitable manner, helping athletes of all shapes and sizes develop who otherwise would not. In addition, isometric exercises helped in the improvement of joint stability and muscular endurance at angles specific to badminton movements whereas isotonic dynamic exercises enhanced muscle coordination, tendon stiffness and functional power across joint range. This synergy probably accounts for the enhanced results when utilized together than with only one of the two methods. This evidence suggests that coaches should use varied training stimuli to help players meet the demands of the sport fully. The focus on explosive strength offers athletes promising benefits by minimizing injuries through improved muscle support whilst accelerating speed and agility which could be further evaluated in the future. The program's design also promoted adherence by ensuring that intensity and volume were balanced with recovery, which is key to long-term conditioning. The study recognizes certain limitations, notably that the sample involved male university players from a single institution and the intervention lasted for a relatively short duration of six weeks. Subsequent studies should include more diverse subjects, such as female athletes and athletes with varying levels of experience, including the effects on strength retention over time and performance transfer in competition contexts. Research into the effectiveness of pure isometric, pure isotonic, and combination training programs will clarify the best programming for training retarded muscle fibers. To conclude, this study offers useful and contextual evidence in favor of the idea that a combined method using isotonic and isometric bodyweight training is an effective and inclusive and practical way to enhance explosive strength of the legs of badminton players. Stakeholders such as coach's physical educator and sports scientist may learn this hybrid training method in their conditioning programs with limited resources to enhance the athletic performance of the players and overall development of the players.

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