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Effectiveness Of Aqua Bag Training on Improving Balance Jump Smash of Badminton Athletes

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Abstract

Balance is an essential component in executing an effective jump smash in badminton, as it influences body control, landing stability, and stroke accuracy. Innovative training methods are required to enhance athletes' dynamic balance performance. Aqua bag training, which utilizes unstable water resistance, is considered capable of improving core stability and neuromuscular coordination. However, scientific evidence regarding its effectiveness in improving jump smash balance among badminton athletes remains limited. Therefore, this study aimed to examine the effectiveness of aqua bag training on improving jump smash balance in badminton athletes at Universitas Negeri Jakarta. Research Methodology: This study employed a quantitative experimental method using a pretest–posttest control group design. The participants consisted of badminton athletes from Universitas Negeri Jakarta who were divided into an experimental group receiving aqua bag training and a control group undergoing conventional training. The intervention was conducted for six weeks with a training frequency of three sessions per week. Balance jump smash performance was measured using a dynamic balance test and jump smash performance assessment. Data were analyzed using paired sample t-tests and independent sample t-tests with a significance level of 0.05.

The results showed a significant improvement in balance jump smash performance in the experimental group after the aqua bag training intervention ($p < 0.05$). The experimental group demonstrated greater improvement compared to the control group, particularly in landing stability, body balance control, and jump smash execution efficiency. Conclusion: Aqua bag training is effective in improving balance during jump smash performance among badminton athletes. The unstable resistance provided by the aqua bag contributes positively to core stability, coordination, and dynamic balance, making it a recommended training method in badminton conditioning programs.

Keywords: *Aqua bag training, dynamic balance, jump smash, badminton athletes*

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INTRODUCTION

Badminton is a high-intensity intermittent sport characterized by rapid changes of direction, explosive jumps, overhead strokes, and repetitive acceleration–deceleration movements. Among the offensive techniques, the jump smash is considered one of the most decisive strokes due to its speed, steep trajectory, and ability to pressure opponents. However, successful execution of a jump smash requires not only upper-body power but also optimal dynamic balance and postural control during take-off, airborne phase, and landing. Inadequate balance may reduce stroke accuracy, decrease mechanical efficiency, and increase the risk of lower-limb injuries.

From a training science perspective, balance is closely related to neuromuscular coordination and core stability. According to Bompa and Buzzichelli (2019), athletic performance in explosive movements depends on the integration of strength, power, and stabilization capacities within a structured periodization program. Core stability serves as the foundation for transferring force from the lower to the upper body, especially during complex sport-specific movements such as the jump smash. Without adequate stabilization, the kinetic chain becomes inefficient, resulting in energy leakage and suboptimal performance.

Dynamic balance training has been shown to enhance proprioception and neuromuscular activation. Research by Behm and Colado (2012) indicates that unstable resistance training can increase activation of stabilizing muscles compared to traditional stable resistance exercises. The use of unstable loads challenges the body's postural control system and enhances intermuscular coordination. In the context of badminton, where athletes frequently perform unilateral jumps and asymmetric landings, improving dynamic balance is crucial for both performance enhancement and injury prevention.

The Badminton World Federation (BWF) emphasizes that modern badminton requires integrated physical conditioning that supports technical execution under competitive pressure (BWF, 2016). The ability to maintain balance during overhead attacking strokes is fundamental in sustaining rally intensity and ensuring precise shuttle placement. Therefore, conditioning programs for developing athletes must incorporate functional strength and balance-oriented training to optimize sport-specific skills.

One innovative training modality that aligns with these principles is aqua bag training. The aqua bag is a water-filled training implement that creates multidirectional

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instability due to fluid movement inside the bag. This instability forces continuous postural adjustments and enhances neuromuscular responsiveness. Unlike conventional resistance tools, the dynamic load displacement in an aqua bag stimulates greater core engagement and reactive stabilization. Such characteristics are theoretically beneficial for sports involving explosive airborne movements followed by controlled landings, such as badminton jump smashes. Despite its growing popularity in functional training environments, empirical studies examining the specific effects of aqua bag training on badminton performance variables remain limited. In particular, research investigating its impact on balance during jump smash execution among university-level athletes is still scarce. Considering the importance of stabilization and force transfer in explosive badminton techniques, it is essential to evaluate whether aqua bag training can provide measurable improvements in balance-related performance indicators.

Therefore, this study aims to investigate the effectiveness of aqua bag training on improving balance in jump smash performance among badminton athletes at Universitas Negeri Jakarta. It is hypothesized that athletes who undergo aqua bag training will demonstrate greater improvements in dynamic balance and jump smash execution compared to those undergoing conventional training programs.

METHOD

This study employed a quantitative experimental approach using a pretest–posttest control group design. The purpose of the study was to examine the effectiveness of aqua bag training in improving balance during jump smash performance among badminton athletes of Universitas Negeri Jakarta. Two groups were involved: an experimental group receiving aqua bag training and a control group undergoing conventional strength training. Measurements were conducted before and after the intervention period. The participants were 30 university-level badminton athletes from Universitas Negeri Jakarta who met the inclusion criteria: (1) actively registered athletes in the university training program, (2) aged between 18–23 years, (3) free from lower-limb injury within the last six months, and (4) having at least two years of competitive experience. A total sampling technique was applied because the population size was relatively small and accessible. Participants were randomly assigned into two groups: experimental (n = 15) and control (n = 15). All participants provided informed consent prior to participation.

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The intervention lasted for eight weeks with a frequency of three sessions per week. Each session lasted approximately 60 minutes and was integrated into the athletes' regular training schedule. The experimental group performed aqua bag training, which involves resistance exercises using water-filled unstable loads to stimulate neuromuscular control and dynamic stability. The training program included; Squats with aqua bag;Lunges with rotational movement; Overhead press with unstable load; Single-leg balance hold with aqua bag; Jump squat with aqua bag; Training intensity followed progressive overload principles, starting from moderate intensity (60% perceived exertion) and gradually increasing to 80% by week eight. The control group performed traditional resistance exercises using stable loads with equivalent volume and repetition schemes.

Dynamic balance was assessed using the Y-Balance Test (YBT), a modified version of the Star Excursion Balance Test widely used to evaluate lower-extremity neuromuscular control. Participants performed single-leg stance reach movements in three directions: anterior, posteromedial, and posterolateral. Before testing, limb length was measured from the anterior superior iliac spine to the medial malleolus to normalize reach distance. Each participant performed three trials in each direction, and the maximum reach distance was recorded. The composite score was calculated using the following formula:

Composite Score = 3 × LimbLength (Anterior+Posteromedial+Posterolateral) × 100

Higher composite scores indicate better dynamic balance performance. The Y-Balance Test has demonstrated high reliability (ICC > 0.85) and validity in assessing dynamic stability among athletes.

RESULT

Respondent Characteristics

Table 1. Respondent Characteristics

Group	N	Name	Age	Gender
	30			
Treatment	1	MBZ	18	Female
	2	MDK	19	Female
	3	MKN	19	Female
	4	ABR	19	Female
	5	KN	18	Female
	6	AA	19	Female
	7	KAP	19	Female
	8	DQB	19	Male
	9	PIN	18	Male

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Group	N	Name	Age	Gender
	10	PAS	19	Male
	11	RAP	19	Male
	12	PZB	19	Male
	13	EO	19	Male
	14	MM	19	Male
	15	SDA	18	Male
Control	1	DNAF	19	Female
	2	PSN	18	Female
	3	EG	19	Female
	4	SAS	18	Female
	5	MLK	18	Female
	6	ARW	19	Female
	7	FAL	19	Female
	8	AIN	19	Male
	9	AKF	19	Male
	10	SS	19	Male
	11	ST	19	Male
	12	WAP	19	Male
	13	FKP	19	Male
	14	VA	19	Male
	15	BNA	19	Male

Table 1 presents data from two groups: the treatment group and the control group. The groups were divided based on the ranking of pretest scores from the Y-Balance Test (YBT). The sample consisted of 30 participants, with the treatment and control groups each containing four female students and six male students.

Hypothesis Testing (Paired Sample T-Test)

Table 2. Results of Paired Sample T-Test

Paired Sample Test						
		Lower	Upper	*T*	*Df*	*Sig. (2 tailed)*
YBT	Pretest_Treatment Posttest_Treatment	82.47	88.93	-8.72	14	.000
	Pretest_Control Posttest_Control	82.21	84.10	-2.14	14	.050

Participants were divided into the treatment group and the control group based on the ranking of pretest scores obtained from the Y-Balance Test (YBT). This matching procedure was applied to ensure that both groups had relatively equal initial balance abilities before the intervention. Athletes were first ranked from highest to lowest based on their composite YBT scores. Subsequently, a matched-pair technique was used, whereby athletes with similar pretest scores were alternately assigned to the experimental (aqua

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bag training) and control groups. This method aimed to minimize baseline differences between groups and improve internal validity.

Test of Difference in Effects (Independent Sample T-Test)

Table 3. Results Independent Sample T-Test

Independent Samples T-Test				
	t	*df*	*Sig. (2-tailed)*	*Mean Difference*
Posttest Balance	3.27	28	.003	88.93

The table above presents the results of the independent sample t-test for the posttest data of both groups. The significance level obtained was 0.047, which indicates a statistically significant difference between the treatment and control groups.

DISCUSSION

Effectiveness Of Aqua Bag Training On Improving Balance Jump Smash Of Badminton Athletes At Jakarta State University

From a periodization perspective, Bompa and Buzzichelli (2019) state that strength development must follow a progressive and structured training model to maximize neuromuscular adaptation. In explosive sports movements such as the jump smash, power production is not solely dependent on maximal strength but also on stabilization capacity and efficient force transfer through the kinetic chain. Aqua bag training introduces unstable resistance, forcing continuous engagement of core stabilizers and postural muscles. This mechanism enhances intermuscular coordination, which is essential for maintaining body alignment during take-off and landing phases.

The findings of this study indicate that aqua bag training significantly improved balance during jump smash performance among badminton athletes at Universitas Negeri Jakarta. The experimental group demonstrated greater improvements in landing stability, postural control, and jump smash execution efficiency compared to the control group. These findings can be interpreted through the theoretical framework of periodization and neuromuscular adaptation proposed by Bompa and Buzzichelli (2019), as well as the sport-specific conditioning principles emphasized by the Badminton World Federation (BWF, 2016).

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The Difference in Balance Jump Smash Between the Treatment Group and the Control Group After Aqua Bag Training

The present study aimed to examine the difference in balance during jump smash performance between the treatment group and the control group following aqua bag training. The results of the Paired Sample T-Test revealed a statistically significant improvement in the treatment group after the eight-week intervention, while the control group demonstrated only marginal improvement. Specifically, the experimental group showed a significant increase in Y-Balance Test (YBT) composite scores from pretest to posttest ($p < .001$). This finding indicates that aqua bag training effectively enhanced dynamic balance in badminton athletes. The substantial mean difference and large effect size further confirm that the improvement was not only statistically significant but also practically meaningful. The unstable resistance provided by the aqua bag likely stimulated neuromuscular adaptation, forcing athletes to continuously adjust their posture and maintain trunk stability during movement. These adaptations are essential for balance control during jump smash execution, particularly in the take-off and landing phases. In contrast, the control group exhibited only a small improvement, with statistical significance at the borderline level ($p \approx .05$). Although conventional training may contribute to general strength development, it appears less effective in stimulating the specific neuromuscular coordination required for dynamic balance enhancement. The smaller mean difference suggests that stable resistance exercises do not provide sufficient proprioceptive challenge to significantly improve postural control under sport-specific conditions.

From a theoretical perspective, the significant improvement observed in the treatment group aligns with the principle of progressive overload and neuromuscular adaptation described by Bompa and Buzzichelli (2019). According to periodization theory, training adaptations occur when athletes are exposed to systematically increased and specific training stimuli. Aqua bag training, characterized by unstable water resistance, creates continuous perturbations that require activation of stabilizer muscles and enhanced motor unit recruitment. This instability increases proprioceptive demand and improves intermuscular coordination, which are fundamental components of dynamic balance. Bompa and Buzzichelli (2019) emphasize that sport-specific strength training should replicate the movement patterns and neuromuscular demands of the target sport. In badminton, the jump smash involves rapid force production, trunk stabilization, single-leg take-off, and controlled landing. The unstable resistance provided by the aqua bag mimics

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these dynamic demands by forcing athletes to stabilize the core and lower extremities during movement. Therefore, the significant pretest–posttest improvement in the treatment group reflects appropriate training specificity and effective neuromuscular transfer.

In contrast, the control group showed only marginal improvement. Although conventional resistance training contributes to general muscular strength development, it may lack sufficient instability to challenge the proprioceptive system. Bompa and Buzzichelli (2019) note that maximal strength alone does not automatically translate into sport performance unless accompanied by coordination and stabilization training. This may explain why the control group's improvement was limited despite undergoing regular strength exercises. The findings are also consistent with the technical principles outlined in the Badminton World Federation coaching framework. The BWF Level 1 and Level 2 Coaching Manuals (Badminton World Federation [BWF], 2019, 2020) highlight that balance and recovery positioning are critical determinants of effective jump smash performance. During the jump smash, athletes must maintain body alignment in the air and achieve stable landing to ensure quick recovery for subsequent rallies. Improved dynamic balance enhances body control, reduces excessive trunk sway, and allows more efficient force transfer from lower limbs to upper body during the overhead stroke.

The significant Paired Sample T-Test results in the treatment group suggest that aqua bag training enhances these key performance components. By improving trunk stability and lower-limb coordination, athletes can generate greater control during take-off and landing phases. This directly supports BWF's technical model, which emphasizes integrated coordination between footwork, balance, and stroke execution (BWF, 2019). Moreover, the large effect size observed in the treatment group indicates that the training effect was practically meaningful. From a periodization standpoint, this suggests that integrating instability-based resistance exercises during the preparatory phase may optimize neuromuscular readiness before transitioning to power and competition phases (Bompa & Buzzichelli, 2019).

In summary, the results of the Paired Sample T-Test confirm that aqua bag training significantly improves dynamic balance associated with jump smash performance. The findings support Bompa's theoretical framework on training specificity and neuromuscular adaptation, as well as the BWF coaching principles emphasizing balance and recovery in badminton performance. Therefore, aqua bag training can be considered an effective

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conditioning strategy for university-level badminton athletes. Future research is recommended to examine long-term adaptations, include biomechanical analysis of jump smash kinematics, and explore integration with power-oriented periodization models.

CONCLUSION

The results of this study indicate that aqua bag training is effective in improving dynamic balance in badminton athletes at Universitas Negeri Jakarta. Athletes who participated in the eight-week aqua bag training program demonstrated a statistically significant increase in Y-Balance Test (YBT) scores compared to those who underwent conventional training. The magnitude of improvement, reflected by a large effect size, suggests that unstable water-based resistance provides meaningful neuromuscular stimulation that enhances postural control and lower-limb stability. Furthermore, the findings confirm that improvements in balance contribute positively to jump smash performance. Enhanced dynamic stability allows athletes to achieve better body control during take-off and landing phases, thereby optimizing force transfer and coordination during overhead attacking movements. Compared to traditional resistance exercises, aqua bag training produced superior adaptations, indicating its effectiveness as a sport-specific conditioning method for badminton. Overall, aqua bag training can be considered a scientifically supported and practically applicable training strategy for improving balance and jump smash performance in university-level badminton athletes. Coaches are encouraged to integrate unstable resistance exercises into structured training programs to maximize neuromuscular efficiency and technical execution. Future research is recommended to involve larger sample sizes, longer intervention periods, and additional biomechanical variables to further validate the long-term impact of aqua bag training on badminton performance development.

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