

To Develop Training Program for Improvement of Libero Volleyball Players of Rajasthan

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Abstract— The libero position was introduced in volleyball in the year 1998. It is essential for the organization of defense and efficiency in serve reception. However, systematic, evidence-based, position-specific training programs for libero players are not available at regional levels in India, particularly in the state of Rajasthan. The present study aimed to develop and evaluate the efficacy of 4-week libero specific training program on biomotor abilities and position-specific technical skills of Rajasthan state-level and district-level libero volleyball players. They used a single-group experimental design. The study involved thirty male libero volleyball players ($n = 30$; mean age: 21.47 ± 2.13 years; mean height: 173.2 ± 5.4 cm; mean body mass: 68.5 ± 6.8 kg; mean playing experience: 4.8 ± 1.9 years), who were purposively selected from Rajasthan. The programming for the libero-specific training that was applied in the study utilized periodization principles (Bompa & Haff, 2009) and also drew on the force-velocity spectrum concept which governs human movement (Haff & Nimphius, 2012). It consisted of five sessions a week for four weeks each and was divided into Foundation, Development and Peaking phases. The main aims of the training were to improve the reactive strength, explosive power, agility, forearm passing accuracy and reactive digging efficacy of the athletes.

Normality of the data was tested using Kolmogorov-Smirnov tests, while homogeneity of variance was assessed via Levine's test. The analysis of the results indicated statistically significant improvements in

all five dependent variables. The countermovement jump (CMJ) improved by 3.87 cm (10.2%), $t = 12.45$, $p < 0.001$, $d = 2.27$. The reactive strength index (RSI) improved by 0.27 (14.8%), $t = 10.82$, $p < 0.001$, $d = 1.98$. The pro-agility shuttle time improved by -0.35 seconds (6.4%), $t = -11.24$, $p < 0.001$, $d = 2.05$. The forearm passing accuracy improved by 10.40% (15.3%), $t = 14.82$, $p < 0.001$, $d = 2.71$. Finally, the reactive digging efficacy improved by 11.47% (18.2%), $t = 13.56$, $p < 0.001$, $d = 2.48$. All Cohen's d values were greater than 1.98, indicating very large practical effects. All five proposed research hypotheses were accepted. Backed by scientific proof, the research introduces a values-driven training program for position-specific libero, which through short-duration training, can induce superior performance changes in physical and technical skills of an inter-school libero. The results have significant coach education and libero development implications in the state of Rajasthan.

Keywords— Libero, Volleyball, Position-Specific Training, Rajasthan, Reactive Strength Index, Countermovement Jump, Passing Accuracy, Digging Efficacy, Periodization.

I. INTRODUCTION

Volleyball is one of the most played team sports worldwide (estimated 800 million participants in 220 countries) which was created in 1895 (FIVB, 2021). The libero player introduced in 1998 has probably been the most transformational rule change of the modern era in the game of volleyball. The original text states that this player was introduced to

prolong rallies and improve defensive quality, as well as to counterbalance the overwhelming competitive advantage that offensive spikers had gotten (FIVB, 1999). Which basically means that these players were introduced to balance the growing dominance that attacking spikers have acquired. In modern volleyball, the libero touches the ball on more than 45% of the contacts per set, working as the key for serve reception efficiency, defence organisation and transition offence (Altavilla & Raiola, 2019).

The physiological and technical requirements of the libero position are different from those of all the volleyball positions. According to Match analysis of positional play (Sheppard et al. (2009), liberos perform 42% more defensive actions in each set than front row players, cover a significantly greater total distance on the court, while there is considerably shorter mean break between efforts (12.4 ± 3.1 seconds) than an outside hitter (18.7 ± 4.2 seconds).

Bobula et al. (2024) conducted a cross-sectional study of 96 competitive players. It was found that a libero's effectiveness was most strongly associated with their eccentric hamstring strength ($r = 0.69$, $p < 0.001$) and ability to maintain low postural positions while lateral shuffling. Liberos had 31% greater eccentric hamstring strength than outside hitters, and 22% faster rate of force development than middle blockers. The physiological demands created by the specific performance requirements of back row players need a highly specialized training stimulus to develop, which conventional back row training programs do not provide.

Rajasthan is a state that represents an active volleyball culture and competitive structures organized through the Rajasthan Volleyball Association (RVA, 2020). Like most states, Rajasthan has many capable attackers and blockers and has consistently produced these kinds of players. However, the lack of any elite-level liberos who can consistently compete at the national level is a worrying thought (Sharma & Gupta, 2018).

According to Choudhary & Meena (2021), typical liberos representing Rajasthan at the state level are found to be deficient in a few areas. These include consistency of forearm passing under float serve. Moreover, they will have a delayed response to cross-court spikes. Furthermore, there will be improper block-defender coordination. Lastly, there will also be a deficiency with composure under competition stress. Coaches in Rajasthan have historically trained liberos with back-row drills meant for all-round or front-row players. Such an approach regularly fails to address the unique biomechanical, perceptual-cognitive, and physiological demands of the position (Krishna & Bhatt, 2019).

This highlights a research gap that warrants attention from scholars and practitioners. Although studies in other countries have profiled elite libero physiology (Sheppard et al., 2009; Bobula et al., 2024), proposed performance evaluation frameworks (Palao et al., 2015; Marra et al., 2019) and examined position-specific training principles (Yılmaz & Ozkan, 2025), almost no study has converted these findings into a complete, periodized training intervention that is validated in a regional, resource-constrained, Indian context. In addition, there is no published study that has systematically assessed the performance deficiencies of the liberos in the state of Rajasthan and developed an evidence-based, context-specific training program to address them. In light of the aforementioned, the present investigation was undertaken to fill this major gap in the literature by developing, implementing, and assessing an empirical position-specific libero training program for the context of Rajasthan's volleyball.

II. REVIEW OF RELATED LITERATURE

A. Physiological Profile and Position-Specific Demands of the Libero

Sheppard et al. (2009) have the first analysis of competition demands and physiological

characteristics of elite male volleyball players in Australia of all positions. According to the study, liberos exhibited better jump ability (reactive strength index, RSI) than middle blockers in volleyball, as well as faster sprint times. This means that the liberos who are essentially defence specialists demonstrated superior performance in terms of explosive strength and speed relative to the middle blockers. These findings lead to the overarching suggestion that the conditioning of a libero should focus on rate of force development (RFD), reactive strength, and repeated-effort capacity rather than maximal strength and this was incorporated into the training programme formulated in the present study.

An understanding of this was expanded by Bobula et al. (2024) through a biomechanical cross-sectional study of 96 competitive volleyball players. Using isokinetic dynamometry, force plate analysis, and three-dimensional motion capture, the authors found that a libero's effectiveness in digging and passing was most strongly correlated with the libero having greater eccentric hamstring strength ($r = 0.69$, $p < 0.001$), rapid rate of force development (22% faster than middle blockers), and ability to maintain low postural positions during lateral shuffling. It is worth noting that liberos had lower concentric quadriceps peak torque compared with front-row attackers, supporting the notion that training for this position should prioritize eccentric strength and sport-specific movement patterns over generalized lower-extremity strengthening. Yilmaz and Ozkan, in 2025, used micro-sensor-LFS technology in 42 elite female players to show that liberos performed 34% more high-intensity directional changes during pre-match warm-ups than the average across all front-row positions, providing evidence to support position-specific warm-up and choice-making.

B. Technical Performance Evaluation of Libero Players

Marra et al. (2019) conducted a longitudinal case study following an elite libero over an 8-month competitive season, documenting improvements in passing efficacy from 68.4% positive passes at season start to 82.1% at peak competition ($p < 0.01$). Crucially, the largest improvements occurred during a six-week mid-season block emphasizing reactive drills and decision-making training, and the strongest predictor of match performance was passing technique maintenance under fatigue — demonstrated by an 11% decline in passing accuracy during third-set versus first-set action. This study provided both the performance benchmarks and the progressive testing protocols (Progressive Bagher Test and Reactive Dig Score) adapted in the present study.

Palao et al. (2015) proposed a comprehensive multi-dimensional evaluation framework for libero performance comprising technical efficiency (passing accuracy, digging success), tactical decision quality, physical performance (court coverage, reactive movement time), and psychological indicators. The framework provided normative data from 120 elite matches and recommended integrated quantitative and qualitative assessment. Gabbett et al. (2010) established in a study of 52 sub-elite female volleyball players that passing and digging skills correlated most strongly with countermovement jump height ($r = 0.61$, $p < 0.01$) and pro-agility shuttle time ($r = 0.58$, $p < 0.01$), and that a combination of these two variables explained 47% of the variance in defensive skill performance — empirical evidence directly informing the selection of CMJ and pro-agility shuttle as primary biomotor outcome measures in the present study.

C. Training Program Design Principles for Libero Development

Bompa and Haff (2009) established the theoretical foundation for the present study's periodized structure through their seminal text on periodization theory. The block periodization model — wherein

each mesocycle emphasizes a limited number of complementary training qualities — was operationalized in the present study as a Foundation Phase (movement efficiency and basic technique), Development Phase (reactive strength and advanced technical skills), and Peaking Phase (competition transfer and maintenance). The force-velocity spectrum framework articulated by Haff and Nimphius (2012), defining a tiered approach from foundational maximal strength through strength-power, power-speed, and speed-strength exercises, was applied to the plyometric and reactive training progressions in the libero program — specifically to develop the lower body reactive power essential for digs and lateral shuffles.

Cormie et al. (2011) provided evidence-based training load guidelines supporting the program design: peak power during ballistic lower body exercises occurs at 30–40% of 1RM; complex training pairing heavy resistance with biomechanically similar ballistic or plyometric movements enhances acute and chronic power adaptations. For the present libero program, these principles translated to complex pairings such as squat jumps followed by reactive lateral bounds in the Development Phase. Altavilla and Raiola (2019), through video analysis of 30 elite FIVB matches, proposed a position-specific training framework comprising five technical pillars (forearm passing, overhead passing, defensive digging, covering, and transition positioning) and three tactical pillars, concluding that libero training must shift from general back-row drills to highly specialized scenario-based training that replicates competitive decision-making demands — a conclusion directly operationalized in the present study's technical training progressions.

III. METHOD & MATERIAL

A. Study Design

The present study employed a pre-test/post-test single-group experimental research design to evaluate the effectiveness of a newly developed

libero-specific training program. All 30 subjects received the experimental training intervention, with standardized assessments administered at baseline (pre-test) and immediately following the 4-week training program (post-test). This design was appropriate for the primary objective of evaluating whether the training program produced significant improvements and is consistent with similar training program development studies in sports science contexts where ethical considerations and practical constraints preclude withholding treatment from a control group.

B. Subjects

Thirty male libero volleyball players ($n = 30$) were purposively selected from Rajasthan. Inclusion criteria required: age 18–25 years; currently representing district-level or state-level teams in competitions sanctioned by the Rajasthan Volleyball Association; minimum of two years of competitive volleyball experience playing exclusively as libero; free from acute or chronic injury at time of testing; available for the entire 4-week training period; and provision of written informed consent. Mean participant characteristics: age 21.47 ± 2.13 years; height 173.2 ± 5.4 cm; body mass 68.5 ± 6.8 kg; playing experience 4.8 ± 1.9 years.

C. Dependent Variables and Assessment Tools

Five dependent variables were assessed at pre-test and post-test: (i) Countermovement Jump height (CMJ, cm) — measured using force plate or validated smartphone jump app; three trials, best recorded; assesses lower body explosive power and stretch-shortening cycle efficiency. (ii) Reactive Strength Index (RSI) — calculated as jump height (cm) $\div$ ground contact time (sec) during a 30-cm drop jump; three trials, mean recorded; assesses neuromuscular efficiency for rapid eccentric-to-concentric transitions. (iii) Pro-Agility Shuttle time (5-10-5, sec) — from three-point stance, sprint 5 yards left, touch, sprint 10 yards right, touch, sprint 5 yards through finish; best of two trials; assesses change-of-direction speed. (iv) Forearm Passing

Accuracy (%) — server delivers 20 standardized serves (float, topspin, underhand mix); libero passes to 50-cm target zone at net; passes rated 0–3; outcome = percentage of perfect passes; adapted from Marra et al. (2019) Progressive Bagher Test.

(v) Reactive Digging Efficacy (%) — 20 standardized spikes delivered by trained server from attack line (cross-court, line, and tip varied); libero starts in defensive base position; successful dig = controlled pass playable by setter; outcome = dig success percentage; adapted from Palao et al. (2015) Reactive Dig Test.

D. Training Program Design

The libero-specific training program, carried out over a 4-week period, was based on periodization (Bompa & Haff, 2009) and force-velocity spectrum theory (Haff & Nimphius, 2012). The parameters of this program suggest five sessions per week, Monday to Friday, each lasting 75–90 minutes. On Saturday and Sunday, it is active recovery or rest. Each session included a standardized dynamic warm-up (light jogging, dynamic stretching, and movement preparation (lateral shuffles, low-posture holds)) that lasted 15 minutes. The booking coach decided on three different components: Component 1 Biomotor training, 15–20 minutes (plyometric, speed, or reactive strength drills that progressed by week); Component 2 Technical skill drills, 20–25 minutes (passing, digging, overhead passing, covering, transition positioning; Component 3 Perceptual-cognitive training, 10–15 minutes (reactive drills, decision-making scenarios, visual tracking). The session lasted another 10-minutes.

Plyos, very low box jumps, and a couple of pogos. Some forearm passing basics against float serves, simple reaction skills, and visual tracking. During the Development Phase I (Week 2), the plan includes low-intensity plyometrics, including CMJ and squat jumps; passing against topspin serves; reactive digging against line spikes; and choice reaction and anticipation drills. Week three, or development phase two, included activities such as

high-intensity plyometric activities, passing against jump serves, reactive digging against cross-court attacks, block-defender synchronization, and decision-making under time pressure. In Week 4, there will be a taper in volume while intensity is retained. There will also be technical refinement, competition-simulation scenarios, and confidence-building and mental-preparation techniques. Daily monitoring of the Recovery and Stress Scale and collecting the session RPE ensured we managed load correctly.

E. Statistical Analysis

All variables were evaluated with descriptive statistics (mean $\pm$ SD, minimum, maximum, range, SEM). Changes from pre- to post for each variable were assessed using a paired-samples t-test. The effect size was evaluated using Cohen's d, which considers an effect as small for value less than 0.2, medium for 0.5, large for 0.8 in size and very large for > 1.2 . Significance level alpha is 0.05 All tests were performed using IMB SPSS version 26.0.

IV. RESULTS & DISCUSSION

A. Participant Characteristics

TABLE I
DESCRIPTIVE CHARACTERISTICS OF PARTICIPANTS (N = 30)

Variable	Mean	SD	Min	Max	Range
Age (years)	21.47	2.13	18	25	7
Height (cm)	173.2	5.4	162	185	23
Body Mass (kg)	68.5	6.8	55	82	27
Playing Experience (years)	4.8	1.9	2	9	7

B. Biomotor Abilities — Pre-test and Post-test Comparison

TABLE II
DESCRIPTIVE STATISTICS AND PAIRED T – TEST — COUNTERMOVEMENT JUMP (CM)

Test	Pre-test	Post-test	Paired t-test
Mean	37.86	41.73	t = 12.45

Test	Pre-test	Post-test	Paired t-test
SD	2.68	2.75	df = 29
SEM	0.49	0.50	p = 0.0001
Min	33.2	36.5	—
Max	42.5	46.8	—
Range	9.3	10.3	d = 2.27
Change	—	+3.87 cm	Significant

TABLE III
DESCRIPTIVE STATISTICS AND PAIRED T-TEST — REACTIVE STRENGTH INDEX (DROP JUMP)

Test	Pre-test	Post-test	Paired t-test
Mean	1.82	2.09	t = 10.82
SD	0.13	0.14	df = 29
SEM	0.02	0.03	p = 0.0001
Min	1.58	1.82	—
Max	2.05	2.35	—
Range	0.47	0.53	d = 1.98
Change	—	0.27	Significant

TABLE IV
DESCRIPTIVE STATISTICS AND PAIRED T-TEST — PRO-AGILITY SHUTTLE TIME (SECONDS)

Test	Pre-test	Post-test	Paired t-test
Mean	5.48 s	5.13 s	t = -11.24
SD	0.21	0.2	df = 29
SEM	0.04	0.04	p = 0.0001
Min	5.12	4.78	—
Max	5.85	5.52	—
Range	0.73	0.74	d = 2.05
Change	—	-0.35 s	Significant

Note: For Pro-Agility Shuttle, lower time = better performance; negative mean difference indicates improvement

A 4-week libero-specific training program showed statistically significant improvements in CMJ (+3.87 cm, 10.2%), RSI (+0.27, 14.8%) and Pro-Agility time (-0.35 sec, 6.4%) with the respective Cohen's d values > 1.98 (very large). These values indicate a significant improvement in three physiological qualities most important for defense. According to Sheppard et al. (2009), 2.1 ± 0.3 elite

libero RSI values are the position-specific profile established by Sheppard and colleagues (2009). These results are also consistent with those of Gabbett et al. (2010), whose CMJ and pro-agility performance explained 47% of the variance in defensive skill.

The 14.8% improvement in RSI is quite remarkable for a libero position. RSI reveals stretch-shortening cycle efficiency, the ability to rapidly switch from eccentric to concentric contraction, a neurophysiological quality liberos deploy constantly through low positions in defense, rapid lateral movements, and from diving back to standing. The enhancements mirror the gradually increasing plyometric loading used in the training program (low box pogoes and CMJ in Week 1 through to Depth Jumps and Reactive Lateral Bounds in Week 3), which coincide with the Cormie et al. (2011) power development guidelines. The improvement of 6.4% in the pro-agility shuttle time has a direct translational value since liberos cover more court distance and make more directional changes than any other volleyball position (Yılmaz & Ozkan, 2025).

C. Position-Specific Technical Skills

TABLE V
DESCRIPTIVE STATISTICS AND PAIRED T-TEST, FOREARM PASSING ACCURACY (%)

Test	Pre-test	Post-test	Paired t-test
Mean	67.83%	78.23%	t = 14.82
SD	4.52	4.68	df = 29
SEM	0.83	0.85	p = 0.0001
Min	60	70	—
Max	75	86	—
Range	15	16	d = 2.71
Change	—	10.40%	Significant

TABLE VI
DESCRIPTIVE STATISTICS AND PAIRED T-TEST, REACTIVE DIGGING EFFICACY (%)

Test	Pre-test	Post-test	Paired t-test
Mean	63.10%	74.57%	t = 13.56

Test	Pre-test	Post-test	Paired t-test
SD	4.81	4.95	df = 29
SEM	0.88	0.9	p = 0.0001
Min	55	65	—
Max	72	84	—
Range	17	19	d = 2.48
Change	—	11.47%	Significant

The most practically significant findings of the study concerned improvements in forearm passing accuracy (+10.40 percentage points, 15.3%; $d = 2.71$) and reactive digging efficacy (+11.47 percentage points, 18.2%; $d = 2.48$), as these represent the libero's main competitive contributions. The increase in passing accuracy from 67.83% to 78.23% resembles the increases documented by Marra et al. (2019) for an elite libero over the course of an 8-month competitive season (68.4% to 82.1%). The improvements reported here were achieved in only 4 weeks of position-specific training. The comparison indicates that if the player undertook systematic, progressive technical training (float, topspin, random sequences, and increasing difficulty) targeting the respective serve type, the entire process traditionally covered over a competitive season could be compressed into a focused training block.

The effectiveness of digging improved from 63.10% to 74.57%, which means that after the intervention, the liberos were able to successfully defend around 12 more spikes per 100 attempts. In competitive volleyball, the successful dig that sweeps the setting can have a large practical impact. Progressive reactive digging protocol from coach-directed spikes to predictable zones (Week 1), through live hitters with blockers and randomized attack selection (Weeks 2–3), to full defensive scrimmage scenarios (Week 4) mirrors the scenario-based training framework promoted by Altavilla and Raiola (2019), where libero training progressively simulates competitive decision-making demands. The very strong positive correlation between passing accuracy and digging efficacy ($r = 0.82$) confirms

the effective transfer of the core technical principles of platform angle, weight transfer, and body positioning from serve reception to spike defense. This finding advocates for an integrated approach to libero technical training.

D. Summary of All Hypotheses

TABLE VII
HYPOTHESIS TESTING SUMMARY — 4-WEEK LIBERO-SPECIFIC TRAINING PROGRAM

H	H1	H2	H3	H4	H5
Variable	CMJ (cm)	RSI	Pro-Agility (s)	Passing Accuracy (%)	Digging Efficacy (%)
Pre-test	37.86	1.82	5.48	67.83	63.1
Post-test	41.73	2.09	5.13	78.23	74.57
Change	+3.87 (10.2%)	+0.27 (14.8%)	−0.35 (6.4%)	+10.40 (15.3%)	+11.47 (18.2%)
t-value	12.45	10.82	−11.24	14.82	13.56
p-value / d	p<0.001 / d=2.27	p<0.001 / d=1.98	p<0.001 / d=2.05	p<0.001 / d=2.71	p<0.001 / d=2.48
Decision	Accepted	Accepted	Accepted	Accepted	Accepted

TABLE VIII
PERCENTAGE IMPROVEMENT ACROSS ALL VARIABLES — 4-WEEK PROGRAM

Variable	Pre-test Mean	Post-test Mean	Absolute Change	% Improvement
CMJ (cm)	37.86	41.73	3.87	10.20%
Reactive Strength Index	1.82	2.09	0.27	14.80%
Pro-Agility Shuttle (s)	5.48	5.13	−0.35	6.40%
Forearm Passing Accuracy (%)	67.83	78.23	10.40%	15.30%
Reactive Digging Efficacy (%)	63.1	74.57	11.47%	18.20%

Percentage improvement range: 6.4% (pro-agility) to 18.2% (digging efficacy) across all 5 variables

V. CONCLUSION

The current research study is the first empirical validation of a libero positional training program created for Rajasthan state-level and district-level volleyball players and tested on them. A 4-week, periodized intervention comprising a Foundation, Development, and Peaking phase, and delivered across reactive strength, explosive power, agility, forearm passing accuracy, and reactive digging efficacy within the same session was implemented.

There were statistically significant and practically large improvements in all five measured variables (all $p < 0.001$; Cohen's d : 1.98 to 2.71). All five of the research hypotheses were accepted.

The results clearly indicate that the historical deficiencies of Rajasthan liberos cannot be attributed to lack of effort or athletic potential, but to non-specialized training methods that do not fit the requirements. A well-designed evidence-based position-specific program can lead to performance enhancements comparable to that seen over an entire competitive season within a condensed 4-week training block. The obtained very large effect sizes support the conclusion that the training program was effective not only statistically but also practically for the population under study.

The libero-specific program developed in this study should be included in the official coaching syllabus by the coaches and Rajasthan Volleyball Association. The testing battery consisting of CMJ, RSI, pro-agility, passing accuracy and digging efficacy should be adopted for talent testing and tracking. The pre-test normative data (CMJ: 37.86 cm; RSI: 1.82; pro-agility: 5.48 sec; passing accuracy: 67.83%; digging efficacy: 63.10%) and post-test targets (41.73 cm; 2.09; 5.13 sec; 78.23%; 74.57%) gave the coach a concrete 4-week training block. Notably, the intervention was designed to be feasible in resource-limited settings without specialized equipment. In particular, smartphone jump applications, cones and stopwatches were standard items. In more detail, regulation volleyball equipment was used in the intervention.

The impact of such a program should be studied with a random control group design, retention of training benefits evaluated at a 3–6 month follow up, including female liberos and younger age categories, and finally whether laboratory improvements will have a “real world” effect on performance outcomes (serve reception percentage, dig success percentage, win/loss record). Longitudinal studies of the libero over multiple training cycles would further delineate

optimal periodization parameters at different phases of development.

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