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Original Article

Training Volume and Performance Indicators in a Paralympic Long Jumper: A Longitudinal Study

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Abstract

This longitudinal single-case study examined the relationship between training volume and performance indicators in an elite Paralympic long jumper during three competitive seasons from 2010 to 2012. Actual volumes of sprint running, speed endurance, specific jumps, plyometric exercises, strength training, and mobility work were analyzed alongside control tests assessing acceleration, horizontal explosive strength, repeated jumping ability, and long-jump performance. Pearson correlation coefficients were interpreted descriptively as intra-individual associations rather than causal effects. The strongest and most consistent relationships were observed for strength training, speed-endurance running, plyometric exercises, and specific jumping work. In the final analyzed season, training completion rates were generally close to 93%, while the athlete achieved his best performance of 6.30 m. The findings support integrated monitoring of training content and control-test results for individualized preparation in elite Paralympic long jump.

1. Introduction

Paralympic athletics has developed substantially in competitive, methodological, and scientific terms. As international performance levels rise and competitive margins narrow, training increasingly depends on individualized planning, monitoring, and evaluation. Performance cannot be explained by total training volume alone, but reflects the interaction between training content, its organization across the annual cycle, and the athlete's individual response (Bompa & Haff, 2009; Issurin, 2010; Vanlandewijck & Thompson, 2011).

In Paralympic sport, individualization is influenced by both event demands and the functional characteristics associated with sport classification. Classification aims to minimize the impact of impairment on competitive outcome so that sporting excellence is determined primarily by training, skill, and execution

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(Tweedy & Vanlandewijck, 2011; Tweedy, Beckman, & Connick, 2014). Nevertheless, athletes within the same sport class may present different functional profiles and individual responses to training. The long jump is a speed-strength event requiring the integration of approach velocity, explosive strength, reactive ability, take-off effectiveness, neuromuscular coordination, and technical execution. Biomechanical research has demonstrated the importance of the interaction between approach speed and take-off mechanics (Bridgett & Linthorne, 2006; Lees, Graham-Smith, & Fowler, 1994; Linthorne, Guzman, & Bridgett, 2005). Consequently, long-jump preparation combines sprint and speed-endurance running, strength training, plyometric exercises, multiple jumps, and event-specific jumping. The effectiveness of these training means depends on their organization within the annual cycle. Periodization requires the systematic adjustment of volume, intensity, and specificity according to training phases, adaptation, fatigue, recovery, and competition objectives (Bompa & Haff, 2009; Issurin, 2010). Explosive-strength and plyometric preparation may contribute to sprint and jumping performance, but transfer to the competitive event depends on their integration with sprint ability and technical execution (Chelly, Hermassi, & Shephard, 2015).

Longitudinal monitoring is particularly relevant in elite para-sport, where the limited number of internationally competitive athletes within homogeneous functional classes can restrict conventional group research designs. Carefully interpreted single-case longitudinal studies can provide useful applied information about individual adaptation, training organization, and performance development without implying population-level generalization (Dehghansai, Lemez, Wattie, & Baker, 2017; Rodríguez Macías, Giménez Fuentes-Guerra, & Abad Robles, 2022).

The present study was based on the premise that control-test results should be interpreted in relation to the training content actually completed by the athlete. Therefore, the purpose of the research was to analyze the longitudinal relationship between the volume of the main training means and the development of selected motor and event-specific performance indicators in a T47 Paralympic long jumper during the 2010-2012 competitive seasons.

2. Material and methods

Purpose of the Research

The purpose of the research was to analyze the longitudinal relationship between the actual volume of the main training means and the development of speed, horizontal explosive strength, repeated jumping ability, and specific long-jump performance in an elite Paralympic athlete classified in the T47 sport class, during three consecutive competitive seasons (2010-2012).

Hypothesis of the Research

It was hypothesized that the progressive and individualized organization of the main training means, together with systematic monitoring through specific control tests, would be associated with improvements in speed, horizontal explosive strength, repeated jumping ability, and specific long-jump performance throughout the investigated period.

Procedures and Methods of Research

The research was conducted as a longitudinal single-case study over three consecutive competitive seasons, from 2010 to 2012. The following research methods were used: bibliographical study, pedagogical observation, analysis of training plans and records, motor and specific control testing, longitudinal monitoring, and statistical analysis.

The research procedure consisted of recording and analyzing the planned and completed volumes of the main training means for each season, periodically monitoring the athlete’s motor and specific performance, and examining the relationships between completed training volumes and control-test results.

Research Subject

The participant was a male elite Paralympic athlete specializing in the long jump and classified in sport class T47. He had a unilateral upper-limb impairment without functional impairment of the lower limbs. During the analyzed period, the athlete competed at national and international level, including major championships and the London 2012 Paralympic Games.

Applied Tests

The monitoring battery included the 30 m acceleration test, 50 m acceleration test, standing long jump, five-bound jump, and long jump with approach. These tests were used to assess acceleration ability, sprint performance, horizontal explosive strength, repeated jumping ability, and event-specific performance. The same testing battery was maintained throughout the investigated period to ensure longitudinal comparability.

Description of the Experimental Process

The training process was organized according to periodization principles and included general preparation, specific preparation, pre-competition, competition, and recovery phases. The analyzed training means were 30-60 m running, 60-80 m running, 120-200 m running, specific jumps and multiple jumps, plyometric exercises, strength training, and mobility work.

Running volume was expressed in kilometres, jumping and plyometric work in repetitions, strength work in training sessions, and mobility work in hours. Training volumes and control-test results were recorded throughout each season and subsequently analyzed to identify intra-individual relationships between completed training content and performance indicators.

Statistical Analysis

Descriptive statistical analysis was used to examine the planned and completed training volumes and the results of the control tests. Training completion rates were calculated as percentages.

Correlation coefficients were calculated from repeated within-season observations of completed training volumes and the corresponding control-test results. Therefore, the correlation analysis was based on periodic monitoring data rather than solely on the annual totals presented in Table 1.

Pearson’s correlation coefficient (r) was used to describe the relationships between completed training volumes and control-test results. For sprint tests expressed in seconds, negative coefficients indicated that higher training volumes were associated with lower running times. For tests expressed in metres, positive coefficients indicated parallel development between training volume and performance.

Because the study used a longitudinal single-case design, correlation coefficients were interpreted descriptively and intra-individually. They were used to identify patterns of association within the athlete's development and were not interpreted as evidence of causality or generalized to the wider population of T47 athletes.

3. Results and Discussions

Across the three analyzed seasons, total training time increased progressively, while the relationship between general and specific training means was gradually reorganized. The athlete completed 290 training days and 620 training hours in 2010, 300 days and 660 hours in 2011, and 305 days and 690 hours in 2012. Planned and completed volumes for the principal training means are presented in Table 1**.**

Table 1. *Planned and completed training volumes across the analyzed seasons*

Training means	2010 P/C	%	2011 P/C	%	2012 P/C	%
30-60 m running (km)	9.10/8.55	93.9	9.90/8.10	81.8	-	-
60-80 m running (km)	18.80/16.95	90.2	19.30/16.90	87.6	20.80/19.41	93.3
120-200 m running (km)	34.60/30.60	88.4	36.60/31.40	85.8	38.00/35.69	93.9
Specific jumps (reps)	2200/1840	83.6	2460/2080	84.6	2720/2535	93.2
Plyometrics (reps)	1480/1270	85.8	1640/1350	82.3	1880/1751	93.1
Strength (sessions)	80/73	91.3	73/60	82.2	77/72	93.5
Mobility (hours)	86/80	93.0	84/70	83.3	96/89	92.7

Note. P = planned volume; C = completed volume. Annual planned and completed totals for 30–60 m running in 2012 were not available in the summarized seasonal dataset; however, repeated within-season monitoring observations were available and were included in the correlation analysis. The global analysis of the main training categories in 2012 indicated a completion rate of approximately 93%.

Completion rates varied across the three seasons (Table 1). In 2010, the highest rates were recorded for 30-60 m running (93.9%), mobility work (93.0%), and strength training (91.3%), whereas specific jumps and plyometric exercises showed lower completion rates. Greater differences between planned and completed volumes were observed in 2011, particularly for short sprint work, strength training, plyometrics, and mobility. In 2012, the principal training categories showed completion rates close to 93%, indicating greater stability between planned and completed work. During the same season, the athlete achieved the best performance of the analyzed period, with a long jump of 6.30 m.

The associations between completed training volumes and the control-test results recorded during the 2010 season are presented in Table 2.

Table 2. *Associations between completed training volume and control tests in 2010*

Training means	30 m	50 m	SLJ	5-bound	LJ
30-60 m running	-0.68	-0.70	0.64	0.66	0.62
60-80 m running	-0.74	-0.76	0.69	0.71	0.66
120-200 m running	-0.84	-0.86	0.79	0.81	0.76
Specific jumps	-0.72	-0.74	0.76	0.78	0.74
Plyometrics	-0.79	-0.80	0.78	0.80	0.76
Strength	-0.87	-0.88	0.83	0.85	0.81
Mobility	-0.75	-0.77	0.74	0.76	0.72

Note. SLJ = standing long jump; 5-bound = five-bound jump; LJ = long jump with approach.

In 2010, absolute correlation coefficients ranged from 0.62 to 0.88 (Table 2). Strength training showed the strongest overall associations, particularly with the 30 m ($r = -0.87$), 50 m ($r = -0.88$), standing long jump ($r = 0.83$), five-bound jump ($r = 0.85$), and approach long jump ($r = 0.81$). The 120-200 m running volume also showed consistently strong associations with both sprint and jumping indicators.

The associations recorded during the 2011 season are presented in Table 3.

Table 3. *Associations between completed training volume and control tests in 2011*

Training means	30 m	50 m	SLJ	5-bound	LJ
30-60 m running	-0.70	-0.72	0.66	0.68	0.64
60-80 m running	-0.76	-0.78	0.71	0.73	0.68
120-200 m running	-0.85	-0.87	0.81	0.83	0.78
Specific jumps	-0.74	-0.76	0.79	0.81	0.77
Plyometrics	-0.80	-0.82	0.80	0.82	0.78
Strength	-0.84	-0.86	0.83	0.85	0.81
Mobility	-0.73	-0.75	0.77	0.79	0.75

Note. SLJ = standing long jump; 5-bound = five-bound jump; LJ = long jump with approach.

In 2011, absolute correlation coefficients ranged from 0.64 to 0.87 (Table 3). The 120-200 m running volume showed the strongest associations with the sprint tests ($r = -0.85$ for 30 m and $r = -0.87$ for 50 m), while strength training remained strongly associated with the standing long jump ($r = 0.83$), five-bound jump ($r = 0.85$), and approach long jump ($r = 0.81$). Specific jumps and plyometric work also showed strong associations with the horizontal jumping indicators.

The associations recorded during the 2012 season are presented in Table 4.

Table 4. *Associations between completed training volume and control tests in 2012*

Training means	30 m	50 m	SLJ	5-bound	LJ
30-60 m running	-0.72	-0.74	0.62	0.65	0.56
60-80 m running	-0.78	-0.80	0.66	0.69	0.60
120-200 m running	-0.87	-0.89	0.76	0.79	0.70
Specific jumps	-0.76	-0.78	0.81	0.83	0.74
Plyometrics	-0.82	-0.84	0.82	0.84	0.75
Strength	-0.85	-0.87	0.85	0.87	0.78
Mobility	-0.77	-0.79	0.79	0.81	0.72

Note. SLJ = standing long jump; 5-bound = five-bound jump; LJ = long jump with approach.

In 2012, absolute correlation coefficients ranged from 0.56 to 0.89 (Table 4). The 120-200 m running volume showed the strongest associations with sprint performance (r = −0.87 for 30 m and r = −0.89 for 50 m). Strength training remained strongly associated with the standing long jump (r = 0.85), five-bound jump (r = 0.87), and approach long jump (r = 0.78), while specific jumps and plyometric work showed strong associations with the horizontal explosive-strength and repeated-jumping indicators.

Across the three seasons, strength training showed consistently strong relationships with the horizontal jumping tests, whereas 120-200 m running was particularly associated with sprint performance. Associations with approach long-jump performance were generally lower than several of those observed for the analytical motor tests. These longitudinal patterns are discussed in relation to previous research in the following section.

Discussions

The present findings indicate that the athlete’s development across the three competitive seasons was associated with the combined organization of sprint training, speed-endurance running, strength development, plyometric exercises, and specific jumping work. The strongest associations were observed for strength training, 120-200 m running, plyometric exercises, and specific jumps, while the relationships with approach long-jump performance were generally lower than those observed for the analytical motor tests.

The progressive reorganization of training content between 2010 and 2012 is consistent with established principles of periodization. Bompa and Haff (2009) emphasized that performance development depends on the planned manipulation of training volume, intensity, and specificity, while Issurin (2010) highlighted the need to organize training effects according to the objectives and adaptive demands of successive preparation phases. In the present study, differences between planned and completed volumes should therefore not be interpreted only as deviations from the programme, but also as possible adjustments related to fatigue, adaptation, recovery, and competition demands. The greater stability observed in 2012 coincided with the athlete’s best performance of 6.30 m, although this temporal correspondence does not demonstrate causality.

The consistently strong associations between strength training and the standing long jump and five-bound jump support the importance of force-production capacity in horizontal jumping performance. Zatsiorsky and Kraemer (2006) emphasized the role of maximal strength and rapid force production in explosive athletic tasks. However, competitive long jumping requires these capacities to be expressed during a short take-off contact while maintaining an effective interaction between horizontal velocity and vertical impulse. Therefore, the present results support the importance of strength development without suggesting that strength alone determines competitive performance.

The relationships observed between plyometric training, specific jumping work, and the jumping tests are consistent with previous research on speed-strength development. Chelly et al. (2015) reported improvements in sprint and jump performance following plyometric training. Markovic (2007), through a meta-analysis, also reported positive effects of plyometric training on jumping performance, while Markovic and Mikulic (2010) described neuromuscular and performance adaptations associated with this type of training. The present findings are compatible with these observations, as plyometric and specific jumping volumes showed strong intra-individual associations with the standing long jump and five-bound jump, particularly during the 2011 and 2012 seasons. Nevertheless, training volume should not be interpreted independently of exercise intensity, technical quality, fatigue, and recovery.

The strong relationships between 120-200 m running volume and sprint performance, particularly in 2011 and 2012, suggest that the athlete’s sprint development was associated not only with short acceleration work but also with training supporting the maintenance of high running velocity. This is relevant to long-jump preparation because the approach run must combine velocity, rhythm, and control to create favourable conditions for take-off. Bridgett and Linthorne (2006) showed that changes in run-up speed are accompanied by modifications in take-off technique, indicating that greater approach velocity is effective only when integrated with appropriate technical execution.

This interpretation is supported by biomechanical research. Lees et al. (1994) emphasized the interdependence of the final approach stride, touchdown, and take-off, while Linthorne et al. (2005) showed that long-jump performance depends on the interaction between horizontal velocity and the generation of vertical velocity at take-off. Seyfarth, Friedrichs, Wank, and Blickhan (1999) also emphasized the mechanical interaction between approach conditions and take-off organization. These findings help explain why the associations with approach long-jump performance in the present study were generally lower than those observed for analytical tests: the competitive event integrates sprinting, approach rhythm, accuracy at the board, force production, take-off mechanics, flight, and landing.

The results therefore support the use of a multidimensional monitoring battery. Improvements in 30 m or 50 m sprint performance should be interpreted together with changes in horizontal explosive strength, repeated jumping ability, and event-specific performance. Halson (2014) emphasized that monitoring training load can provide relevant information about adaptation, fatigue, and recovery. In the present study, completed external training volume was examined together with repeated control-test results, allowing training content to be interpreted in relation to performance development. However, similar external workloads may produce different individual responses; therefore, the observed associations should not be interpreted as simple dose-response relationships.

Individualized monitoring is particularly relevant in Paralympic sport. Dehghansai et al. (2017) emphasized that the development of athletes with disabilities is influenced by multiple interacting factors and individual pathways, while Rodríguez Macías et al. (2022) highlighted the importance of individualized training organization and systematic monitoring in para-athletes. The present findings are consistent with these perspectives because the relationships between training means and performance indicators varied across seasons and should be interpreted in relation to the athlete's individual functional characteristics and training history.

The classification context must also be considered. Tweedy and Vanlandewijck (2011) explained that Paralympic classification aims to minimize the impact of impairment on competitive outcome, while Tweedy et al. (2014) described the scientific principles underlying classification systems. Nevertheless, athletes within the same sport class may differ in functional profile, sporting experience, and training response. Consequently, the present findings cannot be generalized to all T47 athletes; their value lies in the longitudinal examination of intra-individual adaptation across three successive competitive seasons.

Overall, the transition from foundation development in 2010 to greater competition-specific organization in 2011 and performance stabilization in 2012 was reflected in both training completion patterns and the relationships between training means and control-test results. The findings support an integrated model of preparation in which sprint training, strength development, plyometric exercises, specific jumps, technical preparation, and recovery are monitored together. This interpretation is consistent with periodization approaches that view adaptation as the cumulative result of interacting training stimuli rather than the consequence of a single isolated variable (Bompa & Haff, 2009; Issurin, 2010).

Practical Applications

The results of the study suggest that coaches working with elite Paralympic long jumpers should combine systematic recording of completed training volume with repeated motor and event-specific control testing.

Sprint results should be interpreted together with indicators of horizontal explosive strength, repeated impulse ability, and specific long-jump performance. Strength and plyometric training should be carefully monitored because of their high neuromuscular demands, particularly during phases preceding major competitions.

Differences between planned and completed training volumes should not automatically be interpreted as programming errors. Adjustments based on fatigue, adaptation, recovery, and competition requirements represent an essential component of individualized training.

The approach long jump should be considered an integrative performance indicator because it reflects the combined influence of physical capacity, approach speed, take-off effectiveness, and technical execution.

Limitations of the Study

The main limitation of the research is the longitudinal single-case design. The findings describe the intra-individual development of one elite Paralympic athlete and cannot be statistically generalized to all athletes classified in the T47 sport class.

Pearson's correlation coefficients were used as descriptive indicators of association between training volumes and control-test results. The coefficients do not establish causal relationships and may be influenced by common temporal trends in periodization, delayed training effects, fatigue, recovery status, technical development, and competition-related factors.

Another limitation is the use of training volume as the principal indicator of external training load. Future research should integrate volume with training intensity, internal load indicators, fatigue and recovery measures, and neuromuscular response variables.

4. Conclusions

The longitudinal analysis showed a coherent relationship between the organization of training and the development of motor and event-specific indicators in the athlete studied.

Strength training showed consistently strong associations with both sprint indicators and horizontal explosive-strength indicators, while 120–200 m running showed the strongest associations with sprint performance during the 2011 and 2012 seasons.

Plyometric and specific jumping work showed strong associations with horizontal explosive strength and repeated impulse ability, supporting their systematic role within long-jump preparation.

Associations with approach long-jump performance were lower than several associations observed for analytical motor tests, reinforcing the multifactorial character of event performance.

The 2012 season showed the closest overall correspondence between planned and completed training volumes, at approximately 93% for the principal means, and coincided with the best performance of the analyzed period, 6.30 m.

Integrated monitoring of actual training content and a multidimensional battery of control tests can support individualized decision-making in elite Paralympic long-jump preparation.

References

1. BOMPA, T.O., & HAFF, G.G. (2009). *Periodization: Theory and methodology of training* (5th ed.), Champaign: Human Kinetics, USA;
2. BRIDGETT, L.A., & LINTHORNE, N.P. (2006). Changes in long jump take-off technique with increasing run-up speed, *Journal of Sports Sciences, 24* (8), 889-897;

3. CHELLY, M.S., HERMASSI, S., & SHEPHARD, R.J. (2015). Effects of in-season short-term plyometric training program on sprint and jump performance of young male track athletes, *Journal of Strength and Conditioning Research, 29* (8), 2128-2136;
4. DEHGHANSAI, N., LEMEZ, S., WATTIE, N., & BAKER, J. (2017). A systematic review of influences on development of athletes with disabilities, *Adapted Physical Activity Quarterly, 34* (1), 72-90;
5. HALSON, S.L. (2014). Monitoring training load to understand fatigue in athletes, *Sports Medicine, 44* (Suppl. 2), S139-S147;
6. ISSURIN, V.B. (2010). New horizons for the methodology and physiology of training periodization, *Sports Medicine, 40* (3), 189-206;
7. LEES, A., GRAHAM-SMITH, P., & FOWLER, N.E. (1994). A biomechanical analysis of the last stride, touchdown, and takeoff characteristics of the men's long jump, *Journal of Applied Biomechanics, 10* (1), 61-78;
8. LINTHORNE, N.P., GUZMAN, M.S., & BRIDGETT, L.A. (2005). Optimum take-off angle in the long jump, *Journal of Sports Sciences, 23* (7), 703-712;
9. MARKOVIC, G. (2007). Does plyometric training improve vertical jump height? A meta-analytical review, *British Journal of Sports Medicine, 41* (6), 349-355;
10. MARKOVIC, G., & MIKULIC, P. (2010). Neuro-musculoskeletal and performance adaptations to lower-extremity plyometric training, *Sports Medicine, 40* (10), 859-895;
11. RODRÍGUEZ MACÍAS, M., GIMÉNEZ FUENTES-GUERRA, F.J., & ABAD ROBLES, M.T. (2022). The sport training process of para-athletes: A systematic review, *International Journal of Environmental Research and Public Health, 19* (12), 7242;
12. SEYFARTH, A., FRIEDRICHS, A., WANK, V., & BLICKHAN, R. (1999). Dynamics of the long jump, *Journal of Biomechanics, 32* (12), 1259-1267;
13. TWEEDY, S.M., BECKMAN, E.M., & CONNICK, M.J. (2014). Paralympic classification: Conceptual basis, current methods, and research update, *PM&R, 6* (8 Suppl.), S11-S17;
14. TWEEDY, S.M., & VANLANDEWIJCK, Y.C. (2011). International Paralympic Committee position stand—Background and scientific principles of classification in Paralympic sport, *British Journal of Sports Medicine, 45* (4), 259-269;
15. VANLANDEWIJCK, Y.C., & THOMPSON, W.R. (Eds.). (2011). *Training and coaching the Paralympic athlete*, Chichester: Wiley-Blackwell, UK;
16. ZATSIORSKY, V.M., & KRAEMER, W.J. (2006). *Science and practice of strength training* (2nd ed.), Champaign: Human Kinetics, USA.