



## Establishing Validity and Reliability of Video Based Motion Analysis – Alternative to Force Platform

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### Article History

Received: 02.04.2026

Accepted: 07.05.2026

Published: 16.05.2026

### Citation

Choudhury. B. P., Tiwari, R., & Guha, A. (2026). Establishing Validity and Reliability of Video Based Motion Analysis – Alternative to Force Platform. *Indiana Journal of Humanities and Social Sciences*, 7(5):15-20.

**Abstract: Purpose:** The study aimed to evaluate the validity and reliability of video-based motion analysis using Kinovea software in comparison with a force platform for assessing the Reactive Strength Index (RSI) and related performance variables during countermovement jump (CMJ) and drop jump (DJ) tests. **Methods:** Fifty-two sports diploma students from the Sports Authority of India participated in the study. Both video and force platform methods measured contact time (CT), flight time (FT), jump height (JH), and RSI simultaneously. **Results:** The results indicated no significant differences between methods across all variables ( $p > 0.05$ ), with small effect sizes and strong agreement in mean values. Minor deviations in CMJ contact time were attributed to frame rate and manual timing limitations. **Conclusion:** The findings support the use of Kinovea as a valid, low-cost, and practical alternative to laboratory-based force platforms for assessing explosive and reactive strength. The portability and affordability of video-based tools enhance their applicability in field environments, promoting broader accessibility to evidence-based athlete monitoring and performance evaluation. Future research should focus on automation and cross-sport validation to further increase accuracy and efficiency in real-world settings.

**Keywords:** Reactive Strength Index, Kinovea, Force Platform, Countermovement Jump, Drop Jump

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## INTRODUCTION

Athletes in explosive sports such as track and field need to enhance their neuromuscular systems to attain peak performance, as explosive strength hinges on rapid force generation and efficient utilization of elastic energy rather than just muscle mass (Nimphius, 2014; McGuigan & Winchester, 2008). The reactive strength index (RSI) is a key metric in this context, calculated by dividing jump height by ground contact time during plyometric movements. RSI provides valuable insights into an athlete's ability to absorb and use muscle and tendon energy, with higher RSI values indicating superior neuromuscular coordination and elasticity that contribute to faster, more precise movements (Young, 1995; Ebben & Petushek, 2010). Conversely, lower RSI scores point to areas requiring focused training and refinement (Komi, 2000).

The reliability and significance of RSI as both a diagnostic and performance enhancement tool have been substantiated by multiple studies and practical applications in sports science. RSI is fundamentally linked to the stretch-shortening cycle (SSC), which describes the rapid transition between eccentric and concentric muscle phases (Komi, 1992). Efficient SSC function enhances elastic energy storage and utilization, supporting increased jump height and speed during athletic activities (Jarvis, 2022; Komi, 2000). Influential factors include muscle-tendon stiffness, neuromuscular synchrony, and the rate of force development, all of

which contribute to higher RSI and improved explosive performance (Wilson, Murphy, & Giorgi, 1996). SSC efficiency is cultivated through ballistic and plyometric training, which replicate the rapid eccentric-concentric transitions critical to sport-specific movement patterns (Aagaard, Simonsen, Andersen, Magnusson, & Dyhre-Poulsen, 2002).

Emphasis is placed on both traditional force platforms and emerging, accessible technologies such as smartphone apps (My Jump, Kinovea) and wearable devices (PUSH Band 2.0, Optojump). These alternative tools are increasingly validated against reference-standard measures, offering reliable and portable solutions for field-based performance diagnostics. Scientific evidence demonstrates that smartphone-based video analysis applications, such as My Jump, have near-perfect correlations with measurements obtained from force platforms for jump height, ground contact time, and RSI. Haynes *et al.* (2019) and Balsalobre-Fernández *et al.* (2015) showed that My Jump provides highly valid and reliable measurements for both research and practical sports science applications. Similarly, PUSH Band 2.0 and Optojump photoelectric cell devices are shown to have strong reliability when compared with force platforms, although small systematic biases may exist (Comyns *et al.*, 2023). Correction equations have been suggested to enhance the accuracy of these alternative instruments, which expands their usability across athlete demographics and test contexts.

Video analysis tools and high-speed camera apps (Kinovea, My Jump) have proven utility for testing athletes in a variety of environments, broadening the accessibility of advanced RSI and jump assessments outside the laboratory. Studies involving older adults (Cruvinel-Cabral *et al.*, 2018) reinforce the consistency of video-based methods, while wearable accelerometers and optical sensors facilitate continuous performance monitoring. These technologies empower coaches and practitioners to efficiently track athlete progress, manage training loads, and identify injury risks in real time without the logistical and financial limitations of traditional force plates. Despite technological advancements, accessibility and affordability remain key challenges for RSI measurement. Force platforms, while reliable, are expensive and not broadly available to most practitioners. Emerging alternatives warrant rigorous scientific validation to ensure they provide equivalent accuracy and practicality. This thesis investigates the correlation between measurements obtained via force platforms and those derived from video-based analysis using Kinovea software, seeking to determine whether affordable methods can serve as reliable substitutes.

The study compares RSI measurements during countermovement and drop jumps using force platforms and video analysis. To evaluate the feasibility of video analysis methods and develop recommendations for best practices in RSI measurement. The significance of this research is manifold. Validating cost-efficient video-based methods will democratize RSI assessment, enabling widespread, evidence-based athlete monitoring in both elite and grassroots sports environments. This can lead to enhanced athlete development, safer training interventions, and more targeted injury prevention strategies, ultimately improving overall sports performance. The undertaken study aims to advance this field by providing data-driven confirmation of the reliability and practicality of affordable alternatives, strengthening their position in the toolkit for modern sports diagnostics.

## METHODS AND MATERIALS

### Participants

The study was conducted on 52 Sports Diploma students ( $N = 52$ ) from the Sports Authority of India (SAI), Netaji Subhash National Institute of Sports, Patiala, Punjab. Participants were briefed about the research objectives and potential benefits before testing, and consent was obtained. All participants performed a self-selected warm-up prior to the assessments.

### Study Design

A cross-sectional study design was applied to evaluate reactive strength and jump performance among athletes from various sports disciplines. The design allowed for comparison of biomechanical variables across groups at a single measurement point. Participants represented sports including athletics, football, swimming, wushu, boxing, weightlifting, and hockey.

### Testing Protocol

Anthropometric data was obtained using electronic stadiometer with weighing machine (Inbody BSM 370). The RSI was computed from force platform (KISTLER 9281-BA) integrated with BioWare software. The participants were instructed to perform countermovement jump (CMJ) and drop jump (DJ) from a box height of 30 cm. A camera (SONY- RX10-MIV) was placed according to the sagittal plane of the participant to simultaneously record the movement for video analysis using movement analysis software (Kinovea Ver 2023.1.2). During the testing, the CMJ required athletes to start from an upright standing position, quickly squat down, and then immediately jump vertically as fast and high as possible. This jump type is widely used to evaluate an athlete's lower body explosive power, as it engages both the stretch-shortening cycle and the elastic properties of muscles and tendons (Markovic *et al.*, 2004; Komi & Bosco, 1978). The DJ on the other hand, involved athletes stepping off an elevated platform (30 cm box) and, upon landing, immediately performing a vertical jump. This movement is designed to assess reactive strength, which reflects the ability to utilize the stretch-shortening cycle under high-impact conditions (Bobbert *et al.*, 1996; Schmidtbleicher, 1992). Each participant executed three repetitions of each jump type, with a one-minute inter-trials and a 4–5-minute inter-type jumps to avoid onset of fatigue. Both the force platform and high-speed camera recorded data simultaneously.

### Statistical Analysis

Data were tabulated, and mean values with standard deviations were computed for all variables. Statistical analysis was performed using IBM SPSS Statistics Version 26 software. An independent sample t-test was used to compare mean values obtained from the two measurement techniques, with significance set at  $p < 0.05$ .

## RESULTS

The participants had an average age of  $26 \pm 5.71$  years, a mean body weight of  $68.25 \pm 13.98$  kg, and a mean height of  $168.58 \pm 9.44$  cm, indicating moderate variability in physical characteristics.

From Table 1, the CMJ assessed through video analysis, the mean CT was  $0.74 \pm 0.16$  s, while the mean FT and JH were  $0.50 \pm 0.07$  s and  $0.32 \pm 0.09$  m, respectively. The corresponding RSI had a mean value of  $0.44 \pm 0.13$ . Similar values were obtained from the force platform: CT  $0.80 \pm 0.15$  s, FT  $0.50 \pm 0.06$  s, JH  $0.31 \pm 0.08$  m, and RSI  $0.40 \pm 0.12$ . During the DJ, athletes exhibited faster ground contact and higher RSI values. The mean CT measured via video was  $0.35 \pm 0.11$  s, with a FT of  $0.53 \pm 0.08$  s and a JH of  $0.35 \pm 0.11$  m. The corresponding RSI averaged  $1.12 \pm 0.56$ . Force platform data reflected similar trends with mean values of CT  $0.35 \pm 0.11$  s, FT  $0.53 \pm 0.08$  s, JH  $0.35 \pm 0.11$  m, and RSI  $1.12 \pm 0.57$ . Overall, the data indicate consistency

between video and force platform analyses, with all variables exhibiting low to moderate dispersion (standard deviation). Skewness and kurtosis values for these variables were within the acceptable range ( $\pm 2$ ),

suggesting a normal distribution, supporting the reliability of the dataset for subsequent inferential analysis.

**Table 1: Descriptive statistics**

Methods	Countermovement Jump metrics				Drop Jump metrics			
	CT	FT	JH	RSI	CT	FT	JH	RSI
Video analysis	0.74 $\pm$ 0.16	0.50 $\pm$ 0.07	0.32 $\pm$ 0.09	0.44 $\pm$ 0.13	0.35 $\pm$ 0.11	0.53 $\pm$ 0.08	0.35 $\pm$ 0.11	1.12 $\pm$ 0.56
Force Platform	0.80 $\pm$ 0.15	0.50 $\pm$ 0.06	0.31 $\pm$ 0.08	0.40 $\pm$ 0.12	0.35 $\pm$ 0.11	0.53 $\pm$ 0.08	0.35 $\pm$ 0.11	1.12 $\pm$ 0.57

*Note.* CT – Contact Time, FT – Flight Time, JH – Jump Height, RSI – Reactive Strength Index

The present study aimed to compare the values obtained from the video-based analysis method and the force platform method for assessing various jump parameters during countermovement jumps (CMJ) and drop jumps (DJ). Table 2 presented the independent samples t-test results indicated no significant differences between the two measurement methods across all analyzed variables, including contact time (CT), flight time (FT), jump height (JH), and reactive strength index (RSI).

For the CMJ variables, none of the comparisons reached statistical significance ( $p > 0.05$ ). The closest to significance was observed in CMJ contact time ( $p = 0.052$ ), suggesting a possible trend toward slightly lower contact times recorded via video analysis compared to the force platform. However, as the p-value did not meet the conventional threshold for significance ( $p < 0.05$ ), this difference is not considered meaningful. The results for flight time, jump height, and RSI ( $p = 0.753$ ,  $0.716$ , and  $0.121$ , respectively) further reinforce the consistency between both measurement techniques. However, a possible explanation for the marginal difference observed in CMJ contact time could be due to frame rate limitations or manual triggering delays inherent in 2D video analysis. Such systematic discrepancies, though minimal, should be considered when extremely high precision is required, as suggested by Linthorne (2001) and Challis (2001), who highlighted potential sources of error in time-based motion capture.

Similarly, for the DJ parameters, no significant differences were found for any variable, including contact time ( $p = 0.966$ ), flight time ( $p = 0.943$ ), jump height ( $p = 0.922$ ), and RSI ( $p = 0.938$ ). These findings

suggest that both video analysis using Kinovea software and the force platform provide comparable outcomes in measuring reactive and explosive jump performance. The negligible differences in mean values and small standard errors support the validity of low-cost, camera-based methods as viable alternatives to laboratory-grade force measurement systems.

The small, calculated Cohen's d effect sizes, combined with non-significant t-test results from the independent samples test, demonstrate the interchangeable use of these methods in both research and applied sport science settings. However, potential small systematic biases in contact time measurements from video analysis, possibly due to frame rate and manual timing limitations should be considered. Overall, Cohen's d calculations affirm that the two methods produce highly similar results, making video analysis a reliable option for field assessments of explosive lower-body performance, particularly when force platforms are unavailable.

The results align with previous research validating the accuracy and reliability of video-based motion analysis systems for jump assessment. Studies by Balsalobre-Fernández *et al.* (2014, 2015) and Glatthorn *et al.* (2011) demonstrated strong correlations between high-speed camera or mobile-based systems and force platforms for measuring flight time and jump height. Similarly, Moir (2008) and Cruvinel-Cabral *et al.* (2018) reported that portable or app-based tools could yield valid estimations of jump performance with minimal error margins when tested against gold-standard force plates.

**Table 2: Independent t test for the jump metrics grouped by methods**

Jump metrics	Video Analysis		Force Platform		t (102)	Sig. (2-tailed)	Cohen's d	
	Mean	Sd	Mean	Sd				
CMJ	CT	0.74	0.16	0.80	0.15	-1.963	0.052	-0.39
	FT	0.50	0.07	0.50	0.06	0.315	0.753	0.06
	JH	0.32	0.09	0.31	0.08	0.364	0.716	0.07
	RSI	0.44	0.13	0.40	0.12	1.562	0.121	0.31
DJ	CT	0.35	0.11	0.35	0.11	0.043	0.966	0.00
	FT	0.53	0.08	0.53	0.08	0.072	0.943	0.02
	JH	0.35	0.11	0.35	0.11	0.098	0.922	0.02
	RSI	1.12	0.56	1.12	0.56	-0.077	0.938	-0.02

Note. CMJ – Countermovement jump, DJ – Drop jump, CT – Contact Time, FT – Flight Time, JH – Jump Height, RSI – Reactive Strength Index

The absence of significant differences across all parameters in the present study supports the growing body of evidence that video analysis tools can effectively be utilized for field-based performance assessment. This has practical implications, as such tools are cost-effective, portable, and accessible to coaches and practitioners who may not have regular access to advanced biomechanics laboratories.

Overall, the findings reaffirm that both methods are suitable for assessing lower-body explosive and reactive strength characteristics. The close agreement between the results from video analysis and the force platform suggests that coaches and sports scientists can confidently use video-based systems for evaluating jump performance in applied settings where high-cost or stationary equipment may not be feasible.

## DISCUSSIONS

The current study compared key variables of countermovement jump (CMJ) and drop jump (DJ) performance using video analysis and force platform measurements. The results demonstrate notable consistency and reliability between the two methods across almost all variables, with minor differences in a few parameters.

For CMJ variables, video analysis and force platform measurements revealed similar trends. Contact time (CT) was slightly lower in video analysis ( $0.74 \pm 0.16$  s) compared to force platform ( $0.80 \pm 0.15$  s), with a t-value of -1.963 and borderline significance ( $p = 0.052$ ), and a small effect size (Cohen's  $d = -0.39$ ). These findings echo Markovic *et al.* (2004), who highlighted that although both methods are reliable, small differences may exist in CT measurement, potentially due to frame rate limitations inherent in video capture (Markovic *et al.*, 2004). Flight time (FT) was highly consistent between methods ( $\sim 0.50$  s), confirming findings from Glatthorn *et al.* (2011) who reported high agreement in FT measurements using video and force plates (Glatthorn *et al.*, 2011).

Jump height (JH) showed minimal differences between methods, with video analysis at  $0.32 \pm 0.09$  m

and force platform at  $0.31 \pm 0.08$  m ( $p = 0.716$ ,  $d = 0.07$ ), supporting the high reliability of both methodologies for measuring vertical displacement (Challis, 2001). The reactive strength index (RSI) in CMJ had a small but not statistically significant difference (video:  $0.44 \pm 0.13$ ; force platform:  $0.40 \pm 0.12$ ;  $p = 0.121$ ;  $d = 0.31$ ). Previous research by Flanagan and Comyns (2008) emphasizes that RSI is sensitive to measurement methods and small differences can arise when synchronizing temporal and spatial data (Flanagan & Comyns, 2008).

Regarding DJ performance, the study confirmed an excellent agreement between video and force platform across all measured variables. Contact time, flight time, jump height, and RSI were nearly identical across methods (all  $p > 0.9$ ; Cohen's  $d$  approximately 0), consistent with the findings of McMahon *et al.* (2017), who reported the reliability of video analysis as an alternative to force platforms in plyometric assessments (McMahon *et al.*, 2017). The negligible differences reinforce both methodologies as valid tools to assess DJ performance, crucial for training and athlete monitoring (Bobbert, 1990).

The close alignment in flight time, combined with similar metrics in contact time, jump height, and RSI between video analysis and force platform measurements underlines the practical interchangeability of these tools in CMJ and DJ assessments. Minor discrepancies are likely attributable to inherent limitations in video frame rate and manual timing precision, rather than methodological flaws (Markovic *et al.*, 2004; Linthorne, 2001).

These findings corroborate the broader literature, which validates video-based jump analysis as a reliable, cost-effective alternative to force platforms, enabling broader accessibility in field assessments without sacrificing data accuracy (Cormie *et al.*, 2008; González-Badillo & Sánchez-Medina, 2010; Haynes *et al.*, 2019). Use of either method can provide coaches and sports scientists with dependable data to optimize training and athlete performance.

## CONCLUSION

The findings of this study demonstrate that video-based analysis using Kinovea software is a reliable and valid alternative to the traditional force platform method for measuring RSI and its related jump performance metrics, including contact time, flight time, and jump height during CMJ and DJ. While minor differences were observed in CMJ contact time and RSI measurements, these differences were of small effect size and not statistically significant, reinforcing that both methods yield comparable data suitable for applied sports science.

Given the high cost, limited portability, and accessibility challenges associated with force platforms, especially in field settings and grassroots sport environments, the use of affordable video analysis tools can democratize athlete monitoring and performance diagnostics. These tools empower coaches and practitioners to assess neuromuscular function and explosive power effectively without the financial and logistical constraints of laboratory-grade equipment. However, practitioners should ensure proper calibration, consistent testing protocols, and high frame-rate video capture to minimize measurement variability and enhance precision.

Further research should focus on refining automated video capture and analysis techniques, integrating machine learning to optimize measurement reliability, and expanding validation across diverse populations and sports. Validated video analysis methods provide a practical, reliable, and widely accessible option for the assessment of explosive strength and reactive capacity in athletes, facilitating broader implementation of evidence-based training, injury prevention, and performance optimization strategies.

## REFERENCES

1. Aagaard, P., Simonsen, E. B., Andersen, J. L., Magnusson, P., & Dyhre-Poulsen, P. (2002). Increased rate of force development and neural drive of human skeletal muscle following resistance training. *Journal of Applied Physiology*, *93*(4), 1318–1326. <https://doi.org/10.1152/jappphysiol.00283.2002>
2. Balsalobre-Fernández, C., Glaister, M., & Lockey, R. A. (2015). The validity and reliability of an iPhone app for measuring vertical jump performance. *Journal of Sports Sciences*, *33*(15), 1574–1579. <https://doi.org/10.1080/02640414.2014.996184>
3. Balsalobre-Fernández, C., Tejero-González, C. M., del Campo-Vecino, J., & Bavaresco, N. (2014). The concurrent validity and reliability of a low-cost, high-speed camera-based method for measuring the flight time of vertical jumps. *Journal of Strength and Conditioning Research*, *28*(2), 528–533. <https://doi.org/10.1519/JSC.0b013e318299a52e>
4. Bobbert, M. F. (1990). Drop jumping as a training method for jumping ability. *Sports Medicine*, *9*(1), 7–22. <https://doi.org/10.2165/00007256-199009010-00002>
5. Bobbert, M. F., Gerritsen, K. G., Litjens, M. C., & Van Soest, A. J. (1996). Why is countermovement jump height greater than squat jump height? *Medicine and Science in Sports and Exercise*, *28*(11), 1402–1412. <https://doi.org/10.1097/00005768-199611000-00009>
6. Challis, J. H. (2001). The variability in running gait caused by force plate targeting. *Journal of Applied Biomechanics*, *17*(1), 77–83. <https://doi.org/10.1123/jab.17.1.77>
7. Comyns, T. M., Murphy, J., & O'Leary, D. (2023). Reliability, usefulness, and validity of field-based vertical jump measuring devices. *Journal of Strength and Conditioning Research*. Advance online publication. <https://doi.org/10.1519/JSC.0000000000004436>
8. Cormie, P., McBride, J. M., & McCaulley, G. O. (2008). Power-time, force-time, and velocity-time curve analysis during the jump squat: Impact of load. *Journal of Applied Biomechanics*, *24*(2), 112–120. <https://doi.org/10.1123/jab.24.2.112>
9. Cruvinel-Cabral, R. M., Oliveira-Silva, I., Medeiros, A. R., Claudino, J. G., Jiménez-Reyes, P., & Boulosa, D. A. (2018). The validity and reliability of the “My Jump App” for measuring jump height of the elderly. *PeerJ*, *6*, e5804. <https://doi.org/10.7717/peerj.5804>
10. Ebben, W. P., & Petushek, E. J. (2010). Using the reactive strength index modified to evaluate plyometric performance. *Journal of Strength and Conditioning Research*, *24*(8), 1983–1987. <https://doi.org/10.1519/JSC.0b013e3181e72466>
11. Flanagan, E. P., & Comyns, T. M. (2008). The use of contact time and the reactive strength index to optimize fast stretch-shortening cycle training. *Strength and Conditioning Journal*, *30*(5), 32–38. <https://doi.org/10.1519/SSC.0b013e318187e25b>
12. Glatthorn, J. F., Gouge, S., Nussbaumer, S., Stauffacher, S., Impellizzeri, F. M., & Maffiuletti, N. A. (2011). Validity and reliability of Optojump photoelectric cells for estimating vertical jump height. *Journal of Strength and Conditioning Research*, *25*(2), 556–560. <https://doi.org/10.1519/JSC.0b013e3181ccb18d>
13. González-Badillo, J. J., & Sánchez-Medina, L. (2010). Movement velocity as a measure of loading intensity in resistance training. *International Journal of Sports Medicine*, *31*(5), 347–352. <https://doi.org/10.1055/s-0030-1248333>

14. Haynes, T., Bishop, C., Antrobus, M., & Brazier, J. (2019). The validity and reliability of the My Jump 2 app for measuring the reactive strength index and drop jump performance. *The Journal of Sports Medicine and Physical Fitness*, 59(2), 253–258. <https://doi.org/10.23736/S0022-4707.18.08195-1>
15. Jarvis, P., Turner, A., Read, P., & Bishop, C. (2022). Reactive strength index and its associations with measures of physical and sports performance: A systematic review with meta-analysis. *Sports Medicine*, 52(2), 301–330. <https://doi.org/10.1007/s40279-021-01566-y>
16. Komi, P. V. (2000). Stretch-shortening cycle: A powerful model to study normal and fatigued muscle. *Journal of Biomechanics*, 33(10), 1197–1206. [https://doi.org/10.1016/S0021-9290\(00\)00064-6](https://doi.org/10.1016/S0021-9290(00)00064-6)
17. Komi, P. V., & Bosco, C. (1978). Utilization of stored elastic energy in leg extensor muscles by men and women. *Medicine and Science in Sports and Exercise*, 10(4), 261–265.
18. Komi, P. V., Fukashiro, S., & Järvinen, M. (1992). Biomechanical loading of Achilles tendon during normal locomotion. *Clinics in Sports Medicine*, 11(3), 521–531.
19. Linthorne, N. P. (2001). Analysis of standing vertical jumps using a force platform. *American Journal of Physics*, 69(11), 1198–1204. <https://doi.org/10.1119/1.1397460>
20. Markovic, G., Dizdar, D., Jukic, I., & Cardinale, M. (2004). Reliability and factorial validity of squat and countermovement jump tests. *Journal of Strength and Conditioning Research*, 18(3), 551–555. [https://doi.org/10.1519/1533-4287\(2004\)18<551:RAFVOS>2.0.CO;2](https://doi.org/10.1519/1533-4287(2004)18<551:RAFVOS>2.0.CO;2)
21. McGuigan, M. R., & Winchester, J. B. (2008). The relationship between isometric and dynamic strength in college football players. *Journal of Sports Science & Medicine*, 7(1), 101–105.
22. McMahon, J. J., Suchomel, T. J., Lake, J. P., & Comfort, P. (2018). Understanding the key phases of the countermovement jump force-time curve. *Strength and Conditioning Journal*, 40(4). <https://doi.org/10.1519/SSC.0000000000000375>
23. Moir, G. L. (2008). Three different methods of calculating vertical jump height from force platform data in men and women. *Measurement in Physical Education and Exercise Science*, 12(4), 207–218. <https://doi.org/10.1080/10913670802349766>
24. Nimphius, S. (2014). Increasing agility. In D. Joyce & D. Lewindon (Eds.), *High-performance training for sports* (pp. 185–198). Human Kinetics.
25. Schmidtbleicher, D. (1992). Training for power events. In *Strength and power in sport* (Vol. 1, pp. 381–395).
26. Wilson, G. J., Murphy, A. J., & Giorgi, A. (1996). Weight and plyometric training: Effects on eccentric and concentric force production. *Canadian Journal of Applied Physiology*, 21(4), 301–315. <https://doi.org/10.1139/h96-026>
- Young, W. B., Pryor, J. F., & Wilson, G. J. (1995). Effect of instructions on characteristics of countermovement and drop jump performance. *Journal of Strength and Conditioning Research*, 9(4), 232–236.