

TEMPORAL RESOLUTION AND EVENT VISIBILITY IN SMARTPHONE ASSESSMENT OF DROP-JUMP REACTIVE STRENGTH

Mubeen Aslam

Department of Mathematics, University of the Punjab, Lahore, Pakistan

Received: 27/5/2024 Revised: 12/9/2024 Accepted: 28/10/2024 Published: 20/12/2024

Correspondence: mubeenaslam@pu.edu.pk

ABSTRACT

To determine how frame timing and shoe–floor event visibility constrain flight-time-based reactive strength index (RSI) in smartphone drop-jump assessment. The index $R = gF^2/(8C)$ was evaluated for contact durations $C = 120, 150, 180$ and 240 ms; flight durations $F = 400, 470$ and 600 ms; and capture rates of $30, 60, 120$ and 240 frames/s. First-frame assignment was examined by exact enumeration of camera phase. Separate time brackets for initial landing, rebound take-off and subsequent landing yielded score extrema through monotonicity. All results are analytical calculations; no participant measurements were collected. For $C = 150$ ms and $F = 470$ ms at 120 frames/s, the conservative sampling envelope was -8.59% to $+9.67\%$, while exact phase enumeration gave -1.41% to $+2.14\%$. Conservative 5% sufficient rates at the same contact duration were $241, 226$ and 207 frames/s for 400 -, 470 - and 600 -ms flights, respectively. Two calculated scores, 1.844 and 1.659 m/s, had overlapping one-frame event intervals at 120 frames/s. At 240 frames/s, their intervals separated by 0.031 m/s. Increasing only the second attempt's take-off bracket from 4.167 to 8.333 ms restored overlap. The shared take-off event couples contact and flight errors. A capture-rate threshold bounds quantization, whereas event-time brackets determine whether the timing evidence establishes score ordering. Both calculations require a consistent event definition and an accurate capture time base.

Keywords: smartphone video; drop jump; reactive strength index; temporal quantization; contact time; event visibility.

INTRODUCTION

Drop-jump assessment places a short ground contact between two aerial phases. The rebound score depends on three events: initial landing, rebound take-off and subsequent landing. When jump height is calculated from flight duration, reactive strength index (RSI) divides that height by contact duration. Take-off terminates contact and starts flight; its timing error therefore enters both parts of the ratio with opposing effects on the durations.

Smartphone applications make these measurements accessible outside a biomechanics laboratory. Balsalobre-Fernández et al. validated an iPhone application for countermovement-jump height (Balsalobre-Fernández et al., 2015), and Haynes et al. evaluated My Jump 2 during drop jumps (Haynes et al., 2019). However, two-event flight timing and three-event rebound timing impose different acquisition requirements. Pueo et al. assessed countermovement-jump videos at $120, 240, 480$ and 1000 Hz; technical flight-time errors were $3.4, 1.8, 1.2$ and 0.8 ms, respectively (Pueo et al., 2023). These values describe their flight-time measurements. They do not give the joint error of a height/contact-time ratio.

Automated video analysis also separates several physical quantities that require distinct checks. Aderinola et al. estimated countermovement-jump height from one smartphone (Aderinola et al., 2023). Drazan et al. assessed sagittal joint kinematics during vertical jumping (Drazan et al., 2021), while OpenCap estimates movement kinematics and dynamics from smartphone videos (Uhlrich et al., 2023). Joint positions, vertical displacement and the instant of shoe–floor contact

cannot be validated interchangeably. In walking and running, Mundt et al. demonstrated the importance of sampling and event detection for derived movement parameters (Mundt et al., 2024).

Relative reliability alone does not determine the precision of an individual rebound score. Montalvo et al. found excellent relative RSI reliability across field devices, while absolute reliability failed their stated criterion (Montalvo et al., 2021). The calculation of the index itself also requires care: height/contact-time RSI has units of metres per second, whereas flight-time/contact-time reactive strength ratio is dimensionless (Healy et al., 2018). The accepted manuscript of Haynes et al. uses F/C in its methods although its introduction discusses height/contact time (Haynes et al., 2019). Its ratio-validation coefficients therefore cannot be assigned directly to the height/contact-time index examined here.

This study determines the error bounds of $gF^2/(8C)$ under uniform frame sampling and the score intervals permitted by three independently bounded event times. Exact camera-phase enumeration retains the common take-off event. Comparisons at 120 and 240 frames/s then quantify the effect of a wider take-off bracket on score ordering.

MATERIALS AND METHODS

ANALYTICAL DESIGN AND INPUT VALUES

The calculations used the contact durations, flight durations and capture rates in Table 1. The three flight durations correspond to flight-time-derived heights of 0.196, 0.271 and 0.441 m. The contact grid emphasizes short rebounds, where division by contact duration amplifies timing error. The 120- and 240-frames/s settings permit comparison with smartphone jump studies (Haynes et al., 2019; Pueo et al., 2023); 30 and 60 frames/s quantify coarser sampling. Figure 1 evaluates contacts continuously from 100 to 300 ms. The 5% and 10% tolerances specify limits on calculated sampling error, rather than thresholds for a training response.

TABLE 1. INPUT VALUES FOR THE SAMPLING CALCULATIONS. EACH CONTACT DURATION WAS COMBINED WITH EACH FLIGHT DURATION AND CAPTURE RATE, GIVING 48 COMBINATIONS.

Quantity	Values
Contact duration, C	120, 150, 180, 240 ms
Flight duration, F	400, 470, 600 ms
Capture rate, f	30, 60, 120, 240 frames/s
Relative error tolerance, ε	0.05, 0.10
Gravitational acceleration, g	9.80665 m/s ²

EVENT DEFINITIONS AND REACTIVE STRENGTH INDEX

Let t_0 denote initial landing, t_1 rebound take-off and t_2 subsequent landing. For a bilateral jump, landing begins when the first shoe contacts the surface; take-off occurs when the final shoe leaves it. A force-threshold event requires its own definition because visible contact and threshold crossing need not coincide. With $t_0 < t_1 < t_2$,

$$C = t_1 - t_0, \quad F = t_2 - t_1. \quad (1)$$

Flight-time-derived height and RSI are

$$h_{FT} = \frac{gF^2}{8}, \quad R = \frac{h_{FT}}{C} = \frac{gF^2}{8C}. \quad (2)$$

Durations are in seconds, height is in metres and R is in metres per second. Eq. (2) differs from F/C and from modified RSI using counter-movement time to take-off. It expresses rebound height per unit contact time; it does not directly measure tendon stiffness, muscle force or elastic energy return.

UNIFORM SAMPLING AND EXACT CAMERA PHASE

For capture rate f , the frame interval is $\Delta = 1/f$. Assigning the first frame at or after an event gives

$$\tilde{t}_j = \Delta \lceil t_j / \Delta \rceil = t_j + e_j, \quad 0 \leq e_j < \Delta. \quad (3)$$

This calculation assumes instantaneous sampling, correct event classification, uniform timestamps and no missing frames. It isolates quantization from recognition error. Consistent nearest-frame assignment also bounds each duration error by one frame interval, but the phase enumeration below uses the first-frame convention exclusively.

For fixed durations, let $u \in [0, 1)$ be the initial event's camera phase in frame units. With $(t_0, t_1, t_2) = (0, C, C + F)$, the assigned frame numbers are

$$n_j(u) = \lceil u + ft_j \rceil. \quad (4)$$

The estimated durations are $(n_1 - n_0)/f$ and $(n_2 - n_1)/f$. Frame assignments change only at $(-ft_j) \bmod 1$. These breakpoints, together with 0 and 1, partition the phase interval. The calculation evaluates each open interval at its midpoint and checks zero and every internal breakpoint separately. Rational arithmetic retains exact input durations and breakpoint positions. Interval lengths sum to one and provide weights for the mean when phase is uniform; extrema require no probability assumption. Eight contact/rate combinations were evaluated for $C = 150$ and 180 ms with $F = 470$ ms.

EVENT-TIME BRACKETS

An event bracket $[a_j, b_j]$ contains the times compatible with the corresponding images. Landing is bracketed between the last image clearly showing both shoes airborne and the first clearly showing at least one shoe in contact. Take-off is bracketed between the last image with any shoe contact and the first with both shoes airborne. Both shoe-floor interfaces must be inspected. Ambiguous intervening images remain inside the bracket.

Endpoint times must include the exposure support and, where relevant, row-dependent readout and relative camera synchronization uncertainty. Native capture timestamps determine the time base. Playback speed and interpolated images cannot establish it. A common additive offset cancels in durations; event-dependent offsets and clock drift do not.

Two observers identify endpoints independently. If their justified brackets differ, the smallest interval enclosing both is retained; averaging endpoints would narrow the interval without additional timing evidence. A bracket with unknown exposure support or an invisible transition cannot establish guaranteed event coverage. The finite score bounds require

$$a_1 > b_0, \quad a_2 > b_1. \quad (5)$$

These inequalities ensure chronological order throughout the product of the three intervals. Bounds are conditional on all three true events lying within their brackets. The annotation rule specifies a measurement procedure; it was not applied to participant recordings in this study.

SCORE COMPARISONS AND CALCULATION CHECKS

The first comparison used $C_A = 0.150$ s, $C_B = 1/6$ s and $F_A = F_B = 0.475$ s. At 120 frames/s these durations span 18 and 20 contact frames and 57 flight frames; at 240 frames/s they span 36 and 40 contact frames and 114 flight frames. Each event bracket initially had width $1/f$ centred on its event time. A further calculation doubled only B's take-off bracket at 240 frames/s.

The second comparison used $C_B = C_A(1 + q)$ with $q = 0.05, 1/9$ and 0.20 , keeping $C_A = 150$ ms and both flights at 475 ms. Each event bracket had width $w = 4, 8$ or 12 ms. These widths specify bounded timing information independently of a uniform frame grid. The separation margin was $M = R_{A,\min} - R_{B,\max}$.

Calculations used Python 3.12.14, NumPy 2.3.5 and Matplotlib 3.10.8. The standard-library fraction class provided rational phase enumeration. Independent root finding with SciPy 1.17.0 checked capture-rate boundaries. Direct substitution of all eight endpoint combinations checked each event-bracket extremum. No population estimates or significance tests were calculated.

RESULTS

COUPLED CONTACT AND FLIGHT ERRORS

Eqs. (1) and (3) give

$$\tilde{C} - C = e_1 - e_0, \quad \tilde{F} - F = e_2 - e_1. \quad (6)$$

Each error has magnitude less than Δ , because both offsets lie in the same interval of width Δ . A duration spanning two events therefore has a one-frame quantization bound under consistent assignment. This bound does not include annotation mistakes.

Increasing the assigned take-off time increases contact duration and decreases flight duration. For a take-off displacement δ with both landing times fixed,

$$\frac{R(\delta)}{R(0)} = \frac{(1 - \delta/F)^2}{1 + \delta/C}. \quad (7)$$

For $C = 150$ ms and $F = 470$ ms, a 10-ms delay in take-off reduces RSI by 10.20%. The local sensitivity is

$$\frac{dR}{R} \approx \frac{2dF}{F} - \frac{dC}{C}. \quad (8)$$

Here $1/C = 6.67 \text{ s}^{-1}$ and $2/F = 4.26 \text{ s}^{-1}$. A take-off error combines these sensitivities; an error in either landing affects only one duration.

CONSERVATIVE SAMPLING ENVELOPE

The duration bounds and monotonicity of Eq. (2) yield

$$\frac{(1 - \Delta/F)^2}{1 + \Delta/C} \leq \frac{\tilde{R}}{R} \leq \frac{(1 + \Delta/F)^2}{1 - \Delta/C}, \quad C > \Delta, F > \Delta. \quad (9)$$

The common clock can exclude some combinations of duration errors for fixed C and F . Eq. (9) consequently gives a conservative envelope rather than the exact phase range.

TABLE 2. LOWER AND UPPER RSI ERRORS (%) FROM EQ. (9) FOR $F = 470$ MS.

Capture rate (frames/s)	Contact duration			
	120 ms	150 ms	180 ms	240 ms
30	−32.45 to 58.80	−29.38 to 47.46	−27.17 to 40.75	−24.21 to 33.19
60	−18.31 to 24.51	−16.27 to 20.62	−14.85 to 18.16	−13.01 to 15.22
120	−9.78 to 11.31	−8.59 to 9.67	−7.78 to 8.61	−6.75 to 7.30
240	−5.06 to 5.44	−4.42 to 4.69	−3.99 to 4.19	−3.44 to 3.58

At $C = 150$ ms, the upper envelope decreases from 47.46% at 30 frames/s to 9.67% at 120 frames/s and 4.69% at 240 frames/s. At $C = 120$ ms, the 240-frames/s upper envelope is 5.44%. Shorter contact increases the effect of the same frame interval.

CAPTURE RATES SATISFYING 5% AND 10% ENVELOPES

For an upper relative-error tolerance ε ,

$$\frac{(1 + \Delta/F)^2}{1 - \Delta/C} \leq 1 + \varepsilon. \quad (10)$$

The upper error exceeds the absolute lower error for $0 < \Delta < \min(C, F)$, this inequality therefore contains both error directions. Defining $B = 2/F + (1 + \varepsilon)/C$ gives

$$\Delta_{\text{env}} = \frac{2\varepsilon}{B + \sqrt{B^2 + 4\varepsilon/F^2}}, \quad f_{\text{env}} = 1/\Delta_{\text{env}}. \quad (11)$$

Table 3 rounds f_{env} upward. These integer rates satisfy the conservative envelope; they are sufficient without being necessary under exact camera-phase alignment.

At $C = 150$ ms, shortening flight from 600 to 400 ms raises the 5% sufficient rate from 207 to 241 frames/s. Across $120 \leq C \leq 240$ ms and $400 \leq F \leq 600$ ms, 276 frames/s satisfies the conservative 5% tolerance. The largest envelope occurs at the shortest contact and flight. These rates allocate the tolerance to quantization alone.

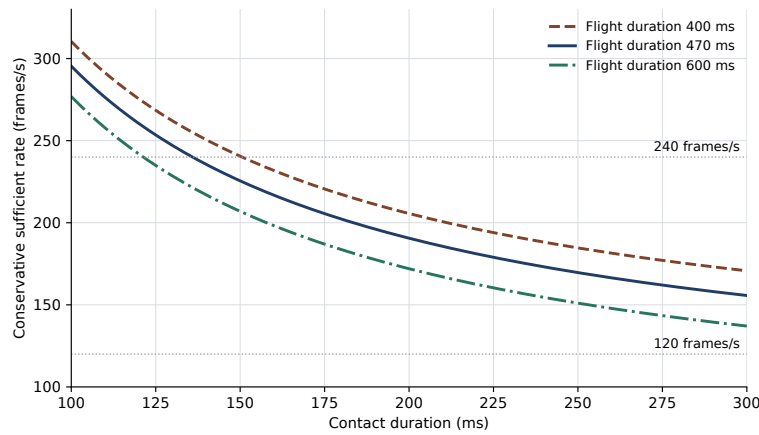
EXACT FRAME COUNTS AND PHASE-DEPENDENT ERRORS

Table 4 gives the extrema over all camera phases. Means use interval-length weights under uniform phase. The exact ranges remain inside Eq. (9).

For $C = 150$ ms at 120 frames/s, contact spans exactly 18 frames at every phase. The 470-ms flight is assigned either 56 or 57 frames. RSI errors are therefore -1.41% and $+2.14\%$, within 5% despite the conservative sufficient rate of 226

TABLE 3. SMALLEST INTEGER CAPTURE RATES SATISFYING THE CONSERVATIVE 5% AND 10% SAMPLING ENVELOPES.

Flight (ms)	Contact (ms)	5% (frames/s)	10% (frames/s)
400	120	276	143
400	150	241	124
400	180	218	112
400	240	189	97
470	120	261	135
470	150	226	117
470	180	203	105
470	240	174	89
600	120	242	126
600	150	207	107
600	180	184	95
600	240	155	80

**FIGURE 1.** CAPTURE-RATE BOUNDARIES FOR A 5% CONSERVATIVE RSI ENVELOPE AT $F = 400, 470$ AND 600 MS. RATES ON OR ABOVE EACH CURVE SATISFY EQ. (10). DOTTED LINES INDICATE 120 AND 240 FRAMES/S.**TABLE 4.** RSI ERRORS FOR $F = 470$ MS UNDER EXACT FIRST-FRAME ASSIGNMENT. THE MEAN ASSUMES UNIFORM INITIAL CAMERA PHASE.

Contact (ms)	Rate (frames/s)	Minimum (%)	Maximum (%)	Mean (%)
150	30	-11.27	+27.32	+1.460
150	60	-1.41	+5.75	+0.020
150	120	-1.41	+2.14	+0.008
150	240	-1.41	+0.35	+0.001
180	30	-11.27	+22.23	+0.951
180	60	-3.21	+14.21	+0.278
180	120	-3.21	+5.06	+0.099
180	240	-3.21	+0.82	+0.016

frames/s. For $C = 180$ ms at the same rate, the exact maximum is +5.06%. Integer contact alignment explains why one fixed-duration case meets the tolerance and the other does not.

Uniform phase makes each estimated duration unbiased, but the nonlinear ratio retains a mean error: +0.008% for the 150/470-ms case at 120 frames/s. The phase means describe this clock model and cannot be interpreted as average error across athletes.

SCORE EXTREMA FROM UNEQUAL EVENT BRACKETS

The index increases with t_0 and t_2 and decreases with t_1 . Under Eq. (5), its exact extrema over the three event brackets are

$$R_{\min} = \frac{g(a_2 - b_1)^2}{8(b_1 - a_0)}, \quad R_{\max} = \frac{g(b_2 - a_1)^2}{8(a_1 - b_0)}. \quad (12)$$

The same take-off endpoint enters both durations, preserving their dependence. Additional joint constraints on event times can reduce the interval; if Eq. (5) fails, these finite bounds cannot be applied.

For the event brackets $[0, 4]$, $[148, 160]$ and $[620, 624]$ ms, midpoint times give $C = 152$ ms, $F = 468$ ms and $R = 1.766$ m/s. Eq. (12) gives 1.621–1.929 m/s. The 12-ms take-off bracket affects contact and flight simultaneously. This interval is calculated from the specified endpoints, without a probability distribution inside them.

ORDERING OF TWO REBOUND SCORES

Strict A-above-B ordering throughout the product of the two event sets requires

$$R_{A,\min} > R_{B,\max} \quad (13)$$

When no further joint constraints link the attempts, this condition is necessary and sufficient for that ordering. Overlap leaves ordering unresolved by the timing bounds.

For $C_A = 150$ ms, $C_B = 166.667$ ms and $F_A = F_B = 475$ ms, midpoint scores are 1.844 and 1.659 m/s: A exceeds B by 11.11% relative to B. At 120 frames/s, one-frame brackets give A an interval of 1.686–2.021 m/s and B an interval of 1.525–1.809 m/s. At 240 frames/s, these intervals become 1.763–1.930 and 1.591–1.732 m/s, separated by 0.031 m/s.

Doubling only B's take-off width at 240 frames/s from 4.167 to 8.333 ms changes its interval to 1.558–1.770 m/s. Overlap with A returns while both midpoint scores remain unchanged (Figure 2). These bounds surround specified event midpoints; they differ from the forward sampling errors in Table 4.

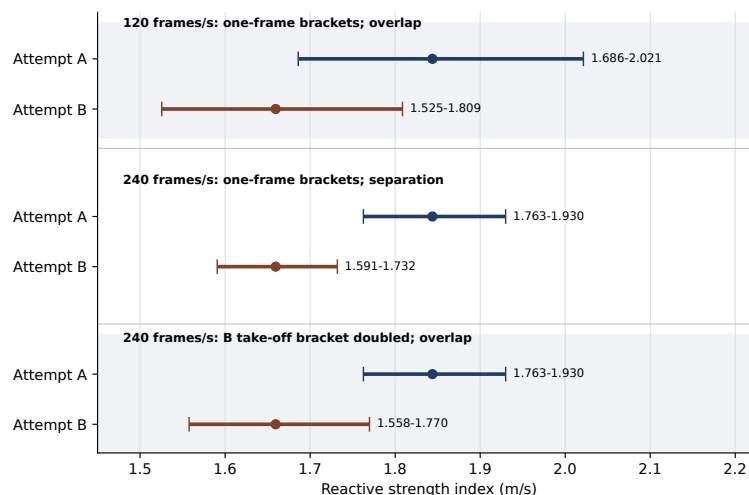


FIGURE 2. RSI INTERVALS FOR $C_A = 150$ MS, $C_B = 166.667$ MS AND EQUAL 475-MS FLIGHTS. ONE-FRAME EVENT WIDTHS ARE 8.333 MS AT 120 FRAMES/S AND 4.167 MS AT 240 FRAMES/S. IN THE LOWEST COMPARISON, ONLY B'S TAKE-OFF WIDTH INCREASES TO 8.333 MS. POINTS MARK MIDPOINT SCORES; HORIZONTAL BARS GIVE THE EXTREMA OF EQ. (12).

Table 5 isolates the effect of bracket width at three score differences. A 5% difference remains unresolved with 4-ms brackets ($M = -0.066$ m/s). An 11.1% difference is resolved at 4 ms ($M = +0.037$ m/s) but not at 8 ms ($M = -0.110$ m/s). A 20% difference is resolved at 8 ms ($M = +0.029$ m/s) and unresolved at 12 ms ($M = -0.108$ m/s).

TABLE 5. SCORE-SEPARATION MARGIN $M = R_{A,\min} - R_{B,\max}$ (M/S) FOR EQUAL EVENT-BRACKET WIDTHS. INPUTS ARE $C_A = 150$ MS, $C_B = C_A(1 + q)$ AND $F_A = F_B = 475$ MS. POSITIVE MARGINS ESTABLISH A-ABOVE-B ORDERING.

A advantage, 100q (%)	w = 4 ms	w = 8 ms	w = 12 ms
5.00	−0.066	−0.221	−0.376
11.11	+0.037	−0.110	−0.258
20.00	+0.168	+0.029	−0.108

DISCUSSION

CONTACT DURATION DETERMINES THE SAMPLING REQUIREMENT

A 150-ms contact with a 470-ms flight satisfies the conservative 5% envelope at 240 frames/s; shortening flight to 400 ms raises the sufficient rate to 241 frames/s. Exact alignment can lower the rate needed for a particular fixed contact,

as the 18-frame contact at 120 frames/s demonstrates. Variable attempts cannot be assumed to retain this alignment. Eq. (11) provides a duration-dependent sufficient bound when phase is unknown.

Pueo et al. found no material improvement in countermovement-jump height accuracy above 240 Hz under their acquisition conditions (Pueo et al., 2023). Their two-event height outcome and empirical technical error differ from the three-event ratio and conservative tolerance used here. A height-validation result therefore does not specify the capture rate needed for a short-contact RSI bound.

Frame rate also acts independently of exposure duration, illumination and shutter readout (Pueo, 2016). A short timestamp interval can coexist with motion blur at the shoe-floor boundary. Rolling-shutter capture gives different image rows different effective times. Irregular capture intervals require actual frame timestamps in the event brackets. Duplicate or interpolated images do not add observed instants.

SHOE-FLOOR VISIBILITY DETERMINES BRACKET WIDTH

The first contacting shoe and final departing shoe define bilateral contact duration. A clear image of the nearer foot can conceal the relevant event at the farther foot. Camera placement must preserve both shoe-floor interfaces; a second view contributes timing evidence only when relative synchronization uncertainty is included.

Jimenez-Olmedo et al. found high reliability for countermovement-jump height at crouching and standing observation heights (Jimenez-Olmedo et al., 2022). That result does not establish a universal camera height for rebound contact detection. Nakano et al. identified larger markerless position errors associated with tracking failures, including incorrect body-segment assignment (Nakano et al., 2020). A complete pose overlay or a smooth trajectory cannot establish a contact instant that the images conceal. A keypoint confidence value requires calibration against event-time error before it can determine a timing bracket.

The comparison in Figure 2 quantifies this distinction: 240 frames/s separates the two scores with 4.167-ms event widths, but an 8.333-ms take-off width for B removes that separation. An assessment record should therefore retain event endpoints and the reason for each width alongside contact time, flight time and RSI. The number of attempts excluded because an event cannot be bracketed is also needed to assess selection of clearly visible jumps.

HEIGHT DEFINITION REMAINS INDEPENDENT OF TIMING PRECISION

Eq. (2) assumes equal centre-of-mass heights at take-off and landing. Let $\delta y = y_{\text{landing}} - y_{\text{takeoff}}$. Ballistic motion gives

$$v_{\text{takeoff}} = \frac{gF}{2} + \frac{\delta y}{F}, \quad h_{\text{apex}} = \frac{v_{\text{takeoff}}^2}{2g}. \quad (14)$$

A changed landing configuration can alter the height inferred from flight time without an equivalent change in take-off velocity. The intervals calculated here bound flight-time-based RSI; they do not include uncertainty in δy .

Wade et al. compared laboratory height calculations with flight-time estimates (Wade et al., 2020). Xu et al. distinguished height measured from initial standing from height measured at take-off (Xu et al., 2023), and Attia et al. demonstrated systematic differences between flight-time and force-based height calculations despite strong association (Attia et al., 2017). Device comparisons must retain the same physical height definition. Contact time, flight time and height also require separate checks because numerator and denominator errors can compensate in their ratio.

CONDITIONS FOR FIELD VALIDATION

Event-bracket coverage requires comparison with independently established event times. Synchronized high-speed video and a force platform can evaluate the three transitions, provided the force threshold and the visible-contact convention are both specified. Errors should be examined separately for initial landing, take-off and subsequent landing, including their dependence on occlusion and movement speed. Contact-duration, flight-duration and RSI differences need absolute units as well as percentages.

Under uniform sampling and correct classification, exact phase errors must remain inside Eq. (9). When independently established events fall outside their image-based brackets, Eq. (12) loses its coverage guarantee. Such failures identify a timing, visibility or event-definition problem rather than a change in the analytical bound.

Interval separation establishes ordering within specified timing limits, not a training effect. Jump-to-jump variation, effort, familiarization and surface conditions require repeated athlete measurements. Comyns et al. found that reliable rebound-jump indices did not consistently detect the smallest worthwhile performance change across their tested

groups and protocols (Comyns et al., 2019). The 5% sampling tolerance used here consequently cannot substitute for an athlete-specific threshold for meaningful change.

CONCLUSIONS

The shared take-off event couples contact and flight errors in smartphone drop-jump RSI. At a 150-ms contact and 470-ms flight, exact first-frame errors at 120 frames/s are -1.41% to $+2.14\%$, compared with a conservative envelope of -8.59% to $+9.67\%$. Conservative rate thresholds are sufficient rather than necessary under exact alignment. Event brackets determine whether score ordering survives unequal visibility: an 11.11% midpoint difference separates at 240 frames/s with one-frame brackets, but doubling one take-off width restores overlap. Field interpretation requires verified event coverage, calibrated timestamps and a consistent jump-height definition.

DECLARATIONS

CONFLICT OF INTEREST

The author declares that there are no conflicts of interest related to this study.

DATA AVAILABILITY

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

FUNDING

This research received no external funding.

REFERENCES

1. Aderinola TB, Younesian H, Whelan D, Caulfield B, Ifrim G. Quantifying jump height using markerless motion capture with a single smartphone. *IEEE Open J Eng Med Biol.* 2023;4:109–115.
2. Attia A, Dhahbi W, Chaouachi A, Padulo J, Wong DP, Chamari K. Measurement errors when estimating the vertical jump height with flight time using photocell devices: the example of Optojump. *Biol Sport.* 2017;34(1):63–70.
3. Balsalobre-Fernández C, Glaister M, Lockey RA. The validity and reliability of an iPhone app for measuring vertical jump performance. *J Sports Sci.* 2015;33(15):1574–1579.
4. Comyns TM, Flanagan EP, Fleming S, Fitzgerald E, Harper DJ. Interday reliability and usefulness of a reactive strength index derived from 2 maximal rebound jump tests. *Int J Sports Physiol Perform.* 2019;14(9):1200–1204.
5. Drazan JF, Phillips WT, Seethapathi N, Hullfish TJ, Baxter JR. Moving outside the lab: markerless motion capture accurately quantifies sagittal plane kinematics during the vertical jump. *J Biomech.* 2021;125:110547.
6. Haynes T, Bishop C, Antrobus M, Brazier J. The validity and reliability of the My Jump 2 app for measuring the reactive strength index and drop jump performance. *J Sports Med Phys Fitness.* 2019;59(2):253–258.
7. Healy R, Kenny IC, Harrison AJ. Reactive strength index: a poor indicator of reactive strength? *Int J Sports Physiol Perform.* 2018;13(6):802–809.
8. Jimenez-Olmedo JM, Pueo B, Mossi JM, Villalon-Gasch L. Reliability of My Jump 2 derived from crouching and standing observation heights. *Int J Environ Res Public Health.* 2022;19(16):9854.
9. Montalvo S, Gonzalez MP, Dietze-Hermosa MS, Eggleston JD, Dorgo S. Common vertical jump and reactive strength index measuring devices: a validity and reliability analysis. *J Strength Cond Res.* 2021;35(5):1234–1243.
10. Mundt M, Colyer S, Wade L, Needham L, Evans M, Millett E, Alderson J. Automating video-based two-dimensional motion analysis in sport? Implications for gait event detection, pose estimation, and performance parameter analysis. *Scand J Med Sci Sports.* 2024;34(7):e14693.
11. Nakano N, Sakura T, Ueda K, Omura L, Kimura A, Iino Y, et al. Evaluation of 3D markerless motion capture accuracy using OpenPose with multiple video cameras. *Front Sports Act Living.* 2020;2:50.
12. Pueo B. High speed cameras for motion analysis in sports science. *J Hum Sport Exerc.* 2016;11(1):53–73.

13. Pueo B, Hopkins WG, Penichet-Tomas A, Jimenez-Olmedo JM. Accuracy of flight time and countermovement-jump height estimated from videos at different frame rates with MyJump. *Biol Sport*. 2023;40(2):595–601.
14. Uhlich SD, Falisse A, Kidziński Ł, Muccini J, Ko M, Chaudhari AS, et al. OpenCap: human movement dynamics from smartphone videos. *PLoS Comput Biol*. 2023;19(10):e1011462.
15. Wade L, Lichtwark GA, Farris DJ. Comparisons of laboratory-based methods to calculate jump height and improvements to the field-based flight-time method. *Scand J Med Sci Sports*. 2020;30(1):31–37.
16. Xu J, Turner A, Comfort P, Harry JR, McMahon JJ, Chavda S, Bishop C. A systematic review of the different calculation methods for measuring jump height during the countermovement and drop jump tests. *Sports Med*. 2023;53(5):1055–1072.