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A novel protocol to measure short sprint performance

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Abstract

This study assessed the validity of a novel protocol in the measurement of 5 and 10 m sprint time from standing and block starts. Sprint time was assessed using high speed video timing and a novel method which incorporated dual beam photocells synchronized with an optical measuring system. Team sport athletes and sprinters completed 10 m sprints from standing and block starts with both methods measuring sprint time concurrently. No significant differences were found between methods ($p > 0.05$) with a negligible mean bias (< 0.01 s). These results suggest that the novel method can accurately measure short sprint performance.

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1. Introduction

Sprint performance is an important skill in many team and individual sports such as track sprinting, with the ability to accelerate rapidly critical to success. A key factor in any speed testing protocol is the ability to accurately measure performance so that changes that may come as a result of training or decrements in performance due to injury can be identified.

The development of infrared photocell systems has enabled sprint times to be measured to within 0.01 s, with sprint acceleration ability frequently assessed over a five or ten meter distance. When photocell systems are used, the athlete is required to start at a set distance, typically 0.3 – 1.0 m behind the initial timing gate with timing triggered only when the infrared beams are disrupted, ideally by the athlete's hips. In this way, all sprints assessed with this protocol can be considered as "flying" i.e. the athlete has developed momentum prior to the initiation of timing and therefore changes in performance over the initial distance cannot be detected. Additionally, timing gate errors can arise if the athlete's arms prematurely trigger the photocell system. These errors can be minimized but not removed entirely with the use of dual or triple beam photocell systems. If the true sprint time is desired, high speed video cameras can be used to identify the initiation of movement of an athlete with the level of accuracy depending on the sampling rate of the camera. Although this method is accurate, it is time consuming and requires careful camera placement along with appropriate lighting. Therefore, alternative methods utilizing contact mats, floor plates or pressure pods to initiate timing have been proposed [1, 2].

Infra-red photoelectric measurement systems such as the Optojump™ have been used to assess sprint parameters including ground contact time (the duration an athlete's foot is in contact with the ground) and step length in real time. Advantages of these infra-red photoelectric systems over contact mats or pressure pads include the ability to connect multiple segments together (up to a maximum distance of 100 m) and their ability to operate on any flat sport specific surface thus increasing their ecological validity. In addition to this hand release pressure pods and floor plates rely on the correct calibration of pressure thresholds which may vary between instruments [2] whereas photoelectric measurement systems operate through the disruption of infra-red light only.

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This paper outlines a novel method to assess five and ten meter sprint performance where timing is triggered by the initial movement of the athlete through the synchronization of dual beam timing gates and the OptojumpTM optical measuring system (Microgate, Bolzano, Italy). The aim of this study is to establish the validity of this novel protocol compared to a traditional high speed video timing method.

2. Methods

2.1 Participants

Following ethical approval by the local University Research Ethics Committee, three track sprint athletes ($n = 3$) and three team sport athletes ($n = 3$) were recruited for this study. Participant characteristics are given in Table 1. All participants completed a physical activity readiness questionnaire, provided written informed consent before participation and were free from injury at the time of testing. The track sprint athletes were required to begin all sprint trials from a block start whereas the team sport athletes were required to begin all sprint trials from a standing start. All participants were well accustomed to their respective starting techniques.

Table 1: Participant Characteristics

	Track Sprinters	Team Sports
Age (years)	22 ± 1.5	26 ± 2.0
Mass (kg)	76.7 ± 4.8	96.2 ± 5.4
Height (m)	1.81 ± 0.06	1.80 ± 0.03

2.2 Instrumentation

The OptojumpTM photoelectric cells (Microgate, Bolzano, Italy) consist of two parallel bars that are connected to a personal computer. One bar acts as a transmitter unit containing 96 infra-red light emitting diodes whereas the other acts as the receiver unit. When the light is disrupted by an individual's foot or hand, the timer in the unit is triggered and records with a precision of 0.001 s which allows the measurement of contact time (the total time that the light is interrupted) and flight time (the total time between interruptions). Data is automatically calculated and output by the OptojumpTM proprietary software (OptojumpTM Next software, version 1.9.9.0). The OptojumpTM was set up ~ 0.2 m behind the start line for the standing start and on the start line for the block start (Figure 1).

The Racetime 2, dual-beam timing gates (Microgate, Bolzano, Italy) consist of two units which transmit and receive infra-red light. The units must be aligned to corresponding reflectors. A gate is only triggered when both infra-red light receivers are disrupted simultaneously. When this occurs a signal is immediately transmitted to a handheld timer which displays timing information in real time with an accuracy of 0.01 s. Based on the recommendation of Yeadon et al. [3] timing gates were positioned at hip height and placed at the 5 and 10 m mark. A triggering box was used to supply a signal which initiated both the OptojumpTM and the timing gates concurrently.

High speed video footage was recorded via a high speed Casio EX-F1 camera operating at 300 frames per second with a shutter speed of 1/320 s. The camera was positioned perpendicular to the direction of the sprint, 15 m from the 5 m mark. To control for parallax error a calibration pole was set up 0.15 m before the 10 m mark.

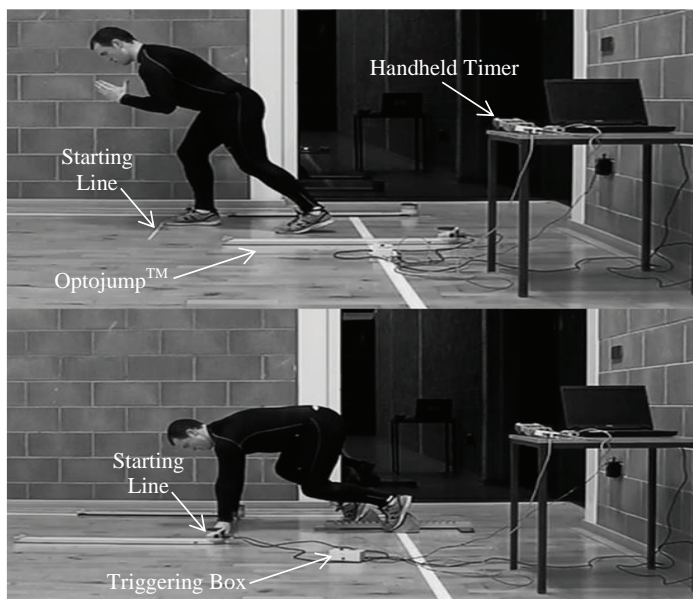


Figure. 1. (Top) Athlete in standing start position; (Bottom) Athlete in block start position

2.3 Testing procedure

Participants completed a 15 minute standardised warm-up which included light jogging, dynamic stretching exercises, and 10 m accelerations at 70, 80 and 90% of self-reported maximal effort. Participants wore black lycra leggings and top. Reflective tape was placed on the participant's left hip at the approximate height of the timing gates. After timing was initiated participants were asked to adopt the appropriate starting position. Participants then completed ten 10 m sprints with ~ 2 minutes of recovery given between sprints to mitigate any effect of fatigue. For each trial, participants were asked to sprint past a cone placed at 1.5 m beyond the second timing gate to avoid early deceleration.

2.4 Data analysis

Sprint times were recorded for the novel method as follows; the time elapsed prior to the athlete's initial movement (time to adopt the starting position) was deducted from the 5 and 10 m split times as recorded by the dual-beam timing gates. The time taken to adopt the starting position was output by the Optojump™ in real time. The initial movement was considered as the instant the back foot (standing start) or the left hand (block start) left the ground. The high speed video footage was exported into the open-license Kinovea 0.8.15 software where sprints times were calculated as time taken from the initial athlete's movement to the 5 and 10 m mark. The athlete was considered to have reached the 5 m mark when their hip as identified by the reflective tape, passed the first timing gate, and the 10 m mark when their hip passed the calibration pole.

2.5 Statistical analysis

Differences in sprint times between methods were assessed using paired t-tests with the alpha level set at $p < 0.05$. Concurrent (criterion related) validity of the novel method was examined using Bland-Altman 95% limits of agreement (LOA) [4] and intraclass correlation coefficients (ICCs) with 95% confidence intervals (CI) [5]. Sprint times for the novel method were also plotted against the criterion method in order to check for proportional bias i.e. increasing error as the magnitude of the measure increases.

3. Results

Mean sprint times \pm SD, mean difference \pm SD, mean bias \pm 95% LOA and ICCs for the block start and the standing start using both methods are given in Table 2. No significant differences were found between methods for 5 and 10 m times in either starting condition. Associations between methods for 5 and 10 m times for standing and block start positions are illustrated in Figure 2 and Figure 3 respectively with no evidence of proportional bias being found.

Table 2: 5 and 10 m sprint times from a block start and a standing start measured with the novel method and the video method. Data are presented as mean (SD).

	Block Start		Standing Start	
	5 m	10 m	5 m	10 m
Novel Method	1.41 (0.03)	2.25 (0.04)	1.18 (0.03)	2.01 (0.05)
High Speed Video Timing	1.41 (0.03)	2.25 (0.04)	1.18 (0.03)	2.01 (0.05)
Difference between Methods	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)
Bias \pm 95% LOA	0.00 \pm 0.01	0.00 \pm 0.01	0.00 \pm 0.02	0.00 \pm 0.02
ICC (95% CI)	0.985 (0.969 – 0.993)	0.994 (0.986 – 0.997)	0.979 (0.954 – 0.990)	0.987 (0.972 – 0.994)

LOA: 95% Limits of agreement

None of the differences were statistically significant.

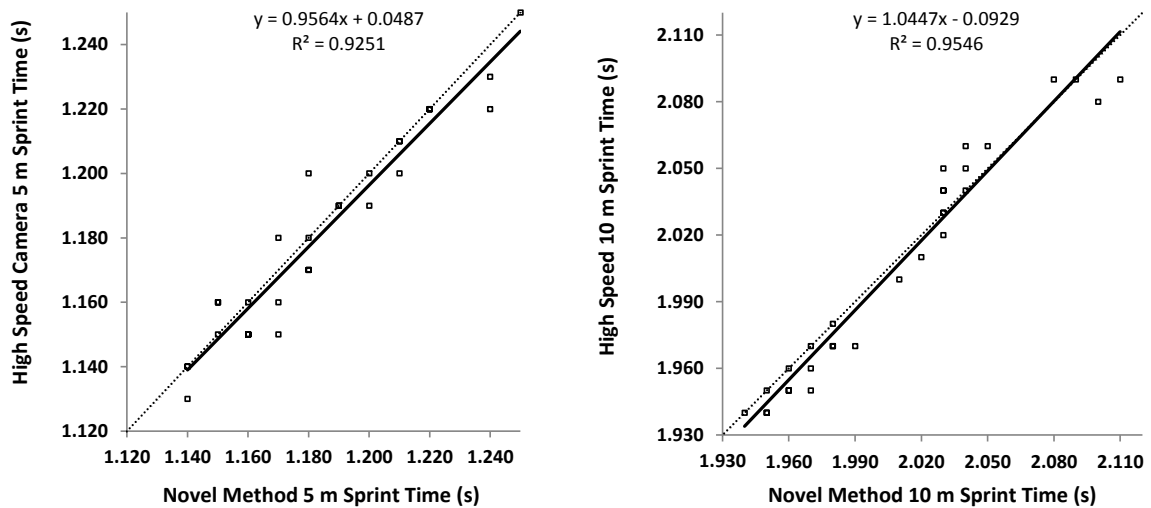


Figure 2. Association between the novel method and high speed camera method for 5 m (Left) and 10 m (Right) sprint time from a standing start position. The dotted line is the line of identity and the black line is the trend line.

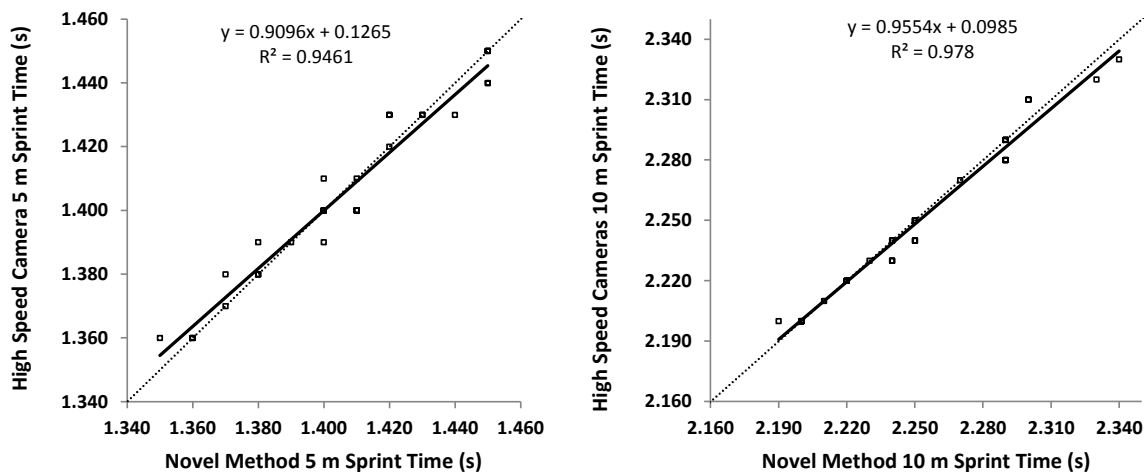


Figure 3. Association between the novel method and high speed camera method for 5 m (Left) and 10 m (Right) sprint time from a block start position. The dotted line is the line of identity and the black line is the trend line.

4. Discussion

The results of this study indicate that the novel method demonstrated excellent validity in the assessment of 5 and 10 m sprint time with no significant differences found and all ICCs greater than 0.97. Previous research by Haugen et al. [2] compared timing procedures including a hand release pressure pod and a floor plate which was triggered by foot release against high speed video timing. A small but significant difference was found between video timing and the pressure pod (0.04 s) and video timing and the floor plate (0.02 s). The authors suggested that differences between methods in detecting initial movement were most likely due to differences in pressure thresholds. The accuracy of the novel method is likely to precisely detect initial movement in both standing start and block start conditions. With this in mind the novel method outlined in this paper can likely be applied to other starting procedures such as three point starts and four point starts as the initial movement will be calculated in an identical manner to a block start. Subsequent dual beam timing gates can also be added as the novel method only requires the accurate detection of the first split i.e. 0 – 5 m, as the remaining splits will be recorded by the timing gates.

The type of starting condition used will affect sprint times. In relation to this investigation, for any given athlete the block start condition will generally yield slower sprint times than the standing start condition. This can be explained by the position of the athlete's center of mass relative to the starting line. In the block start condition, the athlete's center of mass is positioned lower down and further back from the starting line than in the standing position [6]. Consequently, greater work must be carried out against gravity and athletes must cover a greater distance resulting in slower sprint times.

5. Conclusion

The novel method utilizing the OptojumpTM synchronized with dual beam timing gates demonstrated excellent accuracy in the assessment of 5 and 10 m sprint time. This method using the OptojumpTM or other similar valid infra-red photoelectric measurement system can be used by researchers and practitioners with confidence to assess short sprint performance from block starts or standing starts in real time.

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References

- [1] Duthie GM, Pyne DB, Ross AA, Livingstone SG and Hooper SL. The reliability of ten-meter sprint time using different starting techniques. *J. Strength Cond* 2006;20(2):246-51
- [2] Haugen TA, Tonnessen E and Seiler SK. The difference is in the start: Impact of timing and start procedure on sprint running performance. *J. Strength Cond* 2012;26(2):473-79.
- [3] Yeadon MR, Kato Tand Kerwin DG. Measuring running speed using photocells. *J of Sp Sci* 1999;17:249–57.
- [4] Bland JM and Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet* 1986;1:307–10.

- [5]Atkinson G and Nevill AM. Statistical methods for assessing measurement error (reliability) in variables relevant to sports medicine. *Sports Med* 1998;26:217-38.
- [6]Salo A and Bezodis I. Which starting style is faster in sprint running – standing or crouch start? *Sports Biomech* 2004;3:43-54.