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Letter to editor

Reliability and accuracy of 10 *Hz* GPS devices for short-distance exercise

Dear Editor-in-Chief

The use of GPS technology for training and research purposes requires a study of the reliability, validity and accuracy of the data generated (Petersen et al., 2009). To date, studies have focused on devices with a logging rate of 1 *Hz* and 5 *Hz* (Coutts and Duffield, 2010; Duffield et al., 2010; Jennings et al., 2010; MacLeod et al., 2009; Petersen et al., 2009; Portas et al., 2010), although it seems that more frequent sampling can increase the accuracy of the information provided by these devices (Jennings et al., 2010; MacLeod et al., 2009, Portas et al., 2010). However, we are unaware of any study of the reliability and accuracy of GPS devices using a sampling frequency of 10 *Hz*. Thus, the aim of the present research was to determine the reliability and accuracy of GPS devices operating at a sampling frequency of 10 *Hz*, in relation here to sprints of 15 m and 30 m and using both video and photoelectric cells.

Nine trained male athletes participated in the study. Each participant completed 7 and 6 linear runs of 15 m and 30 m, respectively (n = 117), with only one GPS device being used per participant. Each repetition required them to complete the route as quickly as possible, with 1 min recovery between sets. Distance was monitored through the use of GPS devices (MinimaxX v4.0, Catapult Innovations, Melbourne, Australia) operating at the above mentioned sampling frequency of 10 *Hz*. In addition, all tests were filmed with a video camera operating at a sampling frequency of 25 frames. Data were collected during what were considered to be good GPS conditions in terms of the weather and satellite conditions (number of satellites = 10.0 ± 0.2 and 10.3 ± 0.4 for sprints of 15 m and 30 m, respectively).

Distance was measured using a tape measure. Electronic timing gates (TAG-Heuer, CP 520 Training model, Switzerland) were used to obtain a criterion sprint time accurate to 0.01 s, with gates being placed at the beginning and end of the route (Petersen et al., 2009). Logan Plus v.4.0 software was used to synchronize the GPS files with the video, establishing the beginning of action when the participant crossed the initial photocell; this was then added to the duration obtained through the photoelectric cells.

The accuracy of data within and between devices is shown in Table 1. The average values are close to those established in tests of 15 m and 30 m, with errors getting smaller when the devices were used over 30 m.

The intra-device reliability is depicted in Figure 1, showing greater stability over 30 m than 15 m. The inter-device reliability yielded a CV = 1.3% and CV = 0.7% for sprints over 15 m and 30 m, respectively.

To our knowledge this is the first study to assess the reliability and accuracy of GPS devices operating at a sampling frequency of 10 *Hz.* A further point of note is that studies of intra- and inter-device reliability for the

Table 1. Average distances in m recorded by each of the GPS devices in sprints of 15 m and 30 m, and the different statistics used to quantify reliability and accuracy.

Test	GPS	χ (m)	SD (m)	TE (m)	CI 95%		Bias (%)	SEM (%)
15 m	**mean**	13.2	1.4	.2	13.6	12.9	11.9	10.9
	1	11.1	1.1	.4	11.8	10.3	26.3	9.6
	2	13.1	.6	.2	13.5	12.6	12.8	4.6
	3	11.5	.5	.1	11.6	11.4	23.5	4.5
	4	12.9	.4	.2	13.2	12.5	14.3	3.4
	5	14.6	.7	.3	15.2	14.1	2.4	5.1
	6	13.6	.7	.2	14.1	13.2	9.1	4.8
	7	14.5	.7	.3	15.0	14.0	3.3	5.1
	8	14.9	.9	.3	15.5	14.3	0.8	5.8
	9	12.7	.5	.2	13.1	12.4	15.0	3.8
30 m	**mean**	28.1	1.4	.3	28.4	27.7	6.5	5.1
	1	26.1	.6	.3	26.6	25.6	13.1	2.4
	2	27.4	1.8	.8	28.8	25.9	8.8	6.7
	3	27.2	.8	.1	27.5	27.0	9.2	3.0
	4	27.9	.5	.2	28.3	27.5	6.9	1.8
	5	28.7	.8	.3	29.3	28.0	4.4	2.9
	6	28.6	.7	.3	29.2	28.0	4.7	2.5
	7	28.9	.5	.2	29.3	28.6	3.5	1.7
	8	30.3	.9	.4	31.1	29.6	-1.1	3.1
	9	27.4	.7	.3	28.0	26.9	8.6	2.4

Note: χ (mean), m (meters), SD (standard deviation), TE (typical error), CV (coefficient of variation), 95% confidence interval (CI95%), SEM (standard error of measurement); n = 63 (15 m test), n = 54 (30 m test).

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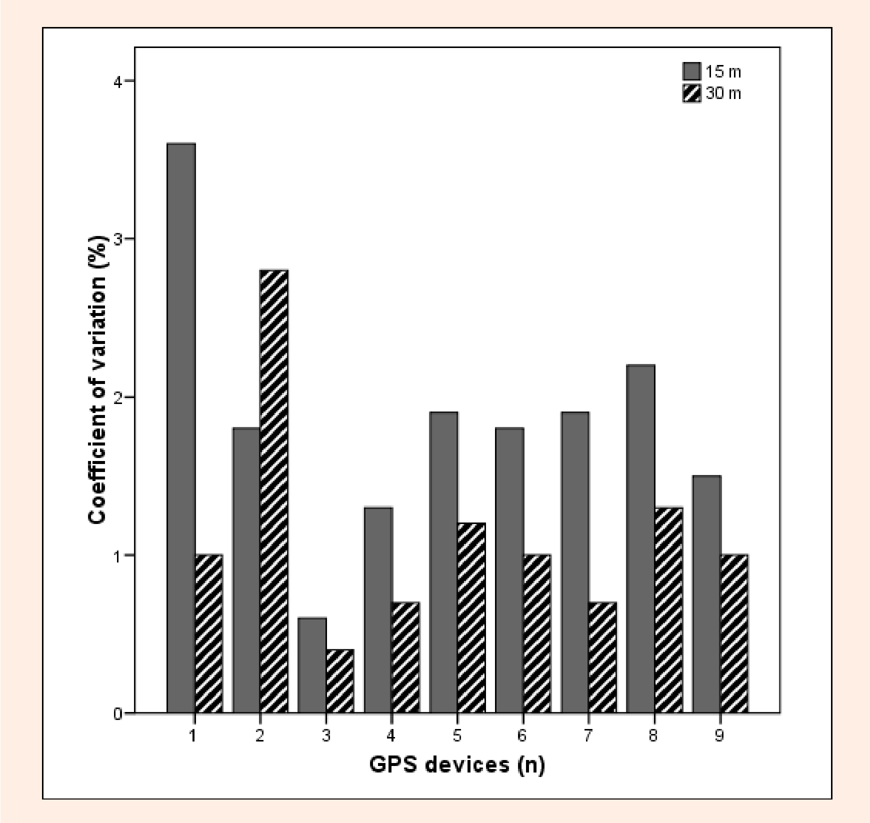

Figure 1. Coefficient of variation (CV) for each of the GPS devices in sprints of 15 m and 30 m.

same model of device (and therefore the same sampling rate) have traditionally used only two devices (Duffield et al., 2010; Petersen et al., 2009), whereas here a total of nine devices were studied.

The distance data were found to be highly accurate and only slightly underestimated by the GPS devices. Furthermore, high intra- and inter-device reliability was observed. Accuracy improved with increased distance, and the mean SEM of 10.9% when running 15 m was reduced by half over 30 m (Table 1). Using similar statistics and methodology, Petersen et al. (2009) found SEM values of between 5% and 24% for MinimaxX devices, and between 3% and 11% with SPI-Pro devices, both at a sampling frequency of 5 *Hz*. Here, only one device (number 1) produced values above 6% in the 15 m test, while another device (number 2) did so for runs of 30 m. We conclude that the increase in sampling frequency led to increased accuracy of the devices.

As regards intra-device reliability, high values were obtained in all cases, and increased when used over 30 m (Figure 1). Some studies have reported differences between devices, even of the same model, suggesting that a player must always be monitored with the same device (Coutts and Duffield, 2010; Duffield et al., 2010). However, we only found small variations between devices, with a CV of 1.3% and 0.7% in runs of 15 m and 30 m, respectively. Therefore, we conclude that it is not always necessary to monitor players with the same device.

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