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REVIEW

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Comparison of Photocell and Stopwatch Time in a 20 Meter Sprint: A Case Study of a Non-Trained Analyst

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A B S T R A C T

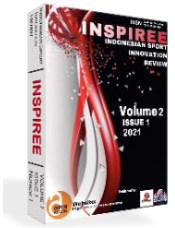
The purpose of the study. Running speed represents a global marker of individual performance and provides a simple method of objective measurement of motor performance for use in clinical and research environments. Speed is most often at relatively short distances at normal or fast pace, using methods of obtaining manual time (e.g., stopwatch) or automated (e.g., photocells).

Materials and methods. The sample consisted of 25 students, 12 males and 13 females, all 13 years old and walked a course 20 meters away, we used to obtain the time elapsed the time, and the method by photocells. The agreement was examined using Bland and Altman graphs and linear regression.

Results. The sample consisted of 25 students, 12 males and 13 females, all 13 years old and walked a course 20 meters away, we used to obtain the time elapsed the time, and the method by photocells. The agreement was examined using Bland and Altman graphs and linear regression.

Conclusions. This study suggests that for measurement in research context or in sports aimed at high yield it is advisable to use photocell, and the use of the timing method for recreational use.

A R T I C L E I N F O



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INTRODUCTION

In many modalities such as collective modalities, the ability to accelerate at short distances is critical, as players are constantly accelerating and slowing down (Cronin, John B, Templeton, & Rebecca L, 2008). On the other hand, in another type

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of sports such as athletics, it is very important to achieve a high maximum speed, for races, throws and jumps, in order to obtain a higher speed (Alcaraz et al., 2008).

Chronometers (i.e.: stopwatches) are widely used in physics teaching labs because of their low cost and reasonable simplicity of use. Its use makes it possible to highlight the importance of experimental care during data collection, a fundamental content in the initial stages of the training of natural science professionals (Almeida, 2017).

In the evaluation of high-performance athletes, there are numerous methods (Vieira, Gonçalves, & Stevan, 2015) to perform it, having a more validity than others and higher or lower percentage of error. In the case of photocells, older studies do not have much information about the methodology used in protocols such as the type of photocells, the height of placement of the photocells and the distance to the first photocell, factors that clearly affect the result (Cronin, Templeton & RL, 2008).

Recent studies (Gamma, 2015), have the information and show the influence that the height of the photocells and the placement in the match. Because of this, the recording time is shorter if the photocells are placed further down, and also if in the start the foot is slightly forward compared to the match with the two parallel feet (Cronin, 2007). The protocols can be performed with single beam, double and triple photocell (Cancian, 2013). The validity and reliability of photocells can be essential to detect beyond running time, in the ability to accelerate and achieve high speed, the influence it has on independent variables such as gender, level of performance, training and fatigue (Currell, 2008).

MATERIALS AND METHODS

Study participants

The sample consisted of 25 students, 12 males and 13 females, all 13 years old from the Paredes Secondary School (Paredes, Porto, Portugal), at the 8th grade in physical education class. All the procedures were in accordance with the Helsinki's declaration regarding research with humans.

Testing procedure

To determine the time that the students made 20 meters were used two methods simultaneously, the photocells and the chronometer. The photocells and reflectors were placed at the starting point (0 meters) and at the end point (20 meters), all photocells were placed at one of one meter each at a distance of 2 meters from their reflector and high of 1 meter.

At the "Go" starting signal, the student would start and at the same time pass through the first photocell and the stopwatch began to record the time, when reaching the second photocell, the stopwatch would stop and we got the final time in the Chronojump application (Boscosystems, Chronojump), through the photocells and through stopwatch.

Figure 1. Setup Procedures used on the day of evaluationath

It is important to note that the person who was responsible for recording the times in the photocells and the stopwatch was the same so that the percentage of error was lower.

Statistical Analysis

Means and standard deviations were evaluated. The Kolmogorov Smirnov and Levene tests allowed the assessment of the normality and homocedasticity of the distributions. The T-Test allowed comparing the groups and the linear regression the relationship between them. The Bland-Altman chart, or difference chart, is a graphical method for comparing two measurement techniques (Cardemil, 2017). In this graphical method, the differences (or, alternatively, the proportions) between the two techniques are conducted against the means of the two techniques. Alternatively (Krouwer JS, 2008)

differences can be plotted against one of two methods, if this method is a reference or "gold standard" method. Horizontal lines are drawn in the mean difference and in the agreement limits, which are defined as the mean difference plus and minus 1.96 times the standard deviation of the differences.

RESULTS

Figure 2 shows the means of the final results stopwatch, chronometer photocells and the average of the two methods together, where the chronometer has a average 4.5196 Seconds relatively superior To Of photograph cells What é 3.9728 Seconds.

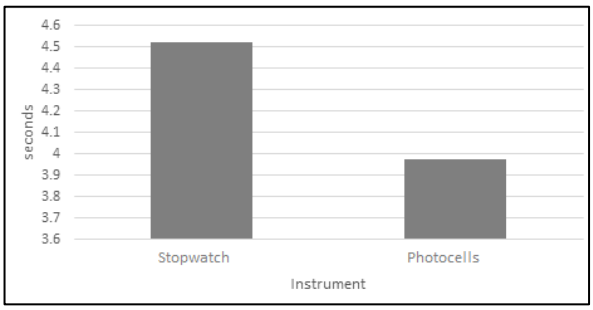

Figure 2. Photocell and chronometer averages

There are significant differences between the evaluation methods (T =14,205; p<0,001) and there was a significant and strong correlation between the variables (r = 0.902; r2 = 0.814; SEE = 0.18587; p<0.001).

The comparison between means allowed us to notice that the evaluations with chronometer overestimate the evaluations with photocells. Therefore, to adjust the values of photocells to the chronometer it is necessary to inflate the values by applying a linear regression equation (where Y = mx+b; Y = 1.43 + 0.78x). The figure 3 shows the graph that presents the equation of linear regression between the methods, showing the variation of the two evaluated methods.

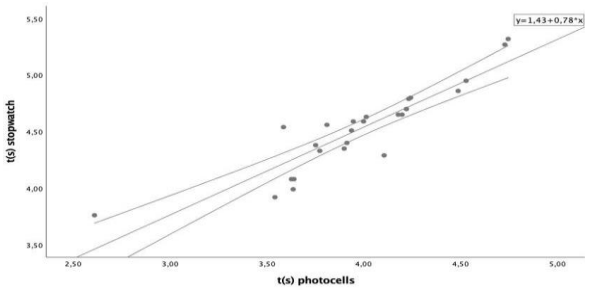

Figure 3. Linear regression plot with 95% mean ICC.

In Figure 4, the Bland-Altman Plot showed the results within the 95% confidence range by applying the midpoint of -0.5467, with the deviation error 0.19245, thus obtaining the -.4673 upper 95% confidence threshold values (-. 4673) and lower 95% confidence (-,6262).

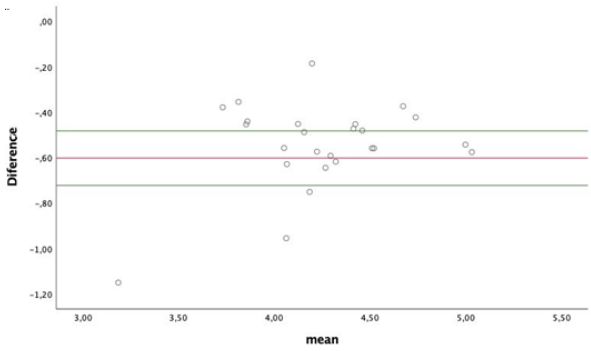

Figure 4. Linear regression plot with 95% mean ICC.

DISCUSSION

The objective since the study was to verify whether the methods of obtaining time between chronometer and through photocells varied greatly between themselves. If they vary, it would make sense to use the methods in some context because of their cost differences as well. Our hypothesis was that there would actually be a significant difference between the two methods, where the chronometer values would be much higher than those of the photocells. We verified that method through timing overestimates photocell evaluations.

We can include the hypothesis of systematic errors, since it appears due to human, physical or instruments limitations. It is difficult, or even impossible, to detect systematic errors that appear due to faulty equipment, lack of calibration, incorrect procedure. There is no point in repeating the measurements under the same conditions, because statistic errors always occur in the same direction (Vieira, 2023). The reason for the error may also be present due to the motor reaction time of the fingers of the hand when clicking the stopwatch button and thus there is always a standard error. The students passing through the photocells, the final time is accurate, because when cutting signal /laser is given this time, but in the chronometer when

being a human there are always reaction times or contact, or looking that influences the result (Almeida, 2017).

The auditory and visual training of the individual has a great influence on the reliability of data and information recording. The literature shows that the experience that the evaluator has will have a great interference in the reliability of his visual and auditory evaluation (Helou, et al., 2010). Less experienced evaluators demonstrate less reliability compared to inexperienced evaluators. In this case, an experienced and untrained evaluator was used, which may have influenced the evaluations, possible errors are the delay in the time of hearing of the photocell cut and the time-consuming start-up of the child (Gama A. C., 2015).

In a study (Almeida, 2017) there were no significant differences between the evaluation method through stopwatch and photocells, much due to the great experience of the evaluators who, even with closed eyes, there was no variation of data between the methods. Since the reliability of the methods of this article is the average of 0.15 s, CCI = 0.995 ($p < 0.001$), CV= 0.85%, MDA= 1.08 s, and ET = 0.13 s for chronometer measurements, and difference is the average of 0.12 s, CCI = 0.999 ($p < 0.001$), CV= 0.60%, MDA= 0.52 s, and ET = 0.07 s for video analysis. Furthermore, 92.4% of the measurements of the chronometers and 93.9% of the measurements taken from the videos were below 0.3 s difference in relation to photocell measurements (Almeida, 2017).

Based on figure 3 of linear regression between the methods we can verify that the values obtained in the chronometers are less effective than the photocell method, in this case we have a significant error margin. The figure 4 shown that the data obtained through the chronometer are all beyond the 95% effective range of the data, In the present study, we analysed the reliability of the methods used, photocells and stopwatch, where reliability increases the slower the person, that is, a longer final time, due to the existence of a better reaction of the individual recording the times on the stopwatch (Stuck, 2020). Although it is confirmed that the measurements of an untrained subject differ significantly from the photocell measurements, it is important to highlight the following limitations of the present study: (i) only one subject was used

for the measurements, and therefore the individual values of an evaluator should be interpreted with caution; (ii) the rated sprint was 20m, which would imply two motor actions in a relatively short time interval and different distances and durations may influence the timing of the click on the stopwatch; (iii) the present study does not analyse the experience of different subjects; (iv) the sample consisted in 25 subjects and therefore, more participants would allow greater reliability of the results. As future research, it is important to assess the differences between untrained and trained analysts with photocells equipment and assess different age groups.

CONCLUSION

It was possible to conclude that the chronometer method for high yield purposes is not recommended to use by an untrained subject, it results from a high deviation error compared to the photocell method. Based on the results obtained, we can conclude that the method through the chronometer overestimates the evaluations of the photocells. However, the method through chronometer remains plausible its use outside the context of high yield, due to its low cost, where in this medium is necessary a high reliability rate of results. The method through photocells has a much higher degree of reliability, but with high economic cost, being thus recommended for the context of scientific and sports production, aiming at high performance.

CONFLICT OF INTEREST

Nothing to declare.

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APPENDIX

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