89 - COMPARISON OF DIFFERENT SYSTEMS OF MEASUREMENT APPLIED TO THE SPEED TEST

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Introduction

Amongst the physical qualities that present basic importance in the sporting income, the speed represents one of the components most important for the performance in the different modalities (VERJOSHANSKY, 1990). Grosser (1992), considers it as the main motor requirement that allows the movement in such a way, how much the assimilation of other capacities as force, endurance and coordination.

For Verjoshanski (1990), speed and rapidity characterize, in differentiated way, motor functions it individual. The same it considers the rapidity a property of the central nervous system that if manifest predominantly in the motor reactions and the movements with overload absence. Zakharov (1992), considers rapidity one of the determinative factors of the speed capacities.The rapidity, according to this author, is differentiated in two main forms of manifestation: rapidity of action, related the simple and complex motor action, and the rapidity of movement, characterized in such a way for isolated movements how much for that if they repeat some times (frequency or rhythm of movement). The perfectioning of the rapidity, in all its forms of manifestation extremely is limited in virtue of its genetics dependence. However, the capacity speed can widely be developed from the improvement of other determinative aspects, such as force, endurance, flexibility and coordination (ZAKHAROV, 1992).

Elliot & Mester (2000), tell that the speed has basic influence in sporting modalities as the track and field, in which if it very considers important the increase of speed in relatively short distances, beyond the increase of the distance or the height the jumps and the launchings. In the contact sports the lesser time of reaction would be more excellent and the capacity to execute motor actions in high speed, while that in the complex sports, the speed would be important in the execution of dynamic elements and combinations of movements.

The control and the evaluation of the speed through physical tests must in accordance with allow to the characterization of excellent, trustworthy and valid form of this parameter in its diverse dimensions in according with the specific characteristics of each sporting modality, supplying to information detailed concerning the level of the individual in any moment of the preparation. Of this form, control element is presented while that strategically guides the plan of training by means of the prediction of the load more adjusted to be applied.

In its study with teams of handball and futsal, It Silva & Silva (2002) had evidenced that the athletes who had gotten the best ones resulted in the speed test corresponded to those that acted in the teams most classified.

The used protocols allow the register of the average speed through the distance and of the time of the passage, whose use in accordance with varies the available infrastructure, the specific characteristics of each modality and the characteristic of the evaluated one.

Baer et. al. (2001) they question the validity of the results of tests using manual chronometer, because in the gotten result they are added time of the initial and terminal reaction of the chronometer man. Menzel (1995) tells that the precision of the manual measurement would not be enough to determine with exactness the times in tests of speed in short distances. On the other hand, the automatic measurement of the time of displacement in the tests of speed through computerized systems makes possible to get values with high degree of exactness (GRANELL & CERVERA, 2003; SZMUCHROWSKI & LOPES, 1997). Amongst the different instruments for register, we detach the barriers of photoelectric cells, the plates of contact (interrupting) and the techniques based on filming technology (Foto-finish and Vídeo-finish). However, it must be standed out that the high cost of these equipment can make impracticable its use for the professionals of the area of sporting training.

The aim of the present study is to compare and to argue the results gotten by means of different instruments of measurement of the physical quality speed through the test of race in the distance of 20 meters. So, to present resources that, when leading in consideration the relation cost-benefit, can stimulate the conscientious work in the evaluation of this parameter.

Method

Sample*:* They had participated of the study, as voluntary, 8 individuals, not athletes, apparently healthful, students of Physical Education of the Universidade Federal de Minas Gerais.

Instruments: For the comparison of the measurement systems a test of straight-line race of 20 meters was carried through (adapted of SZMUCHROWSKI & LOPES, 1997). During the test, they had been registered, simultaneously, the values gotten for 5 different systems of measurement, described below:

- Manual chronometer: Five appraisers had registered the time of passage through chronometers of manual drive and interruption. The chronometer man if had located next to the arrived line to and had been guided to initiate the counting from the moment where the evaluated one lost the contact with the surface of the track, and to finish the counting thus that the individual touched the region of the corresponding surface the arrival line.
- Plates of contact: Interruptors located in the beginning and the end of the passage, being this last one of similar width to the space destined to the test so that the evaluated one does not need to modify its standard of race to make right the contact plate. For the register in the arrival line, 2 plates of 1 meter of length had been used each, covering an area of 2 meters, correspondents to the last meter of the passage and the first meter after the arrival line. These plates had marking to each 25 centimeters, to assist in the register of the distance covered for the evaluated one (Figure 1). The volunteers had been instructed to step on in the point that better agreed to them. This system was connected to a computer equipped with MultiSprint software, developed in the Laboratory of Evaluation of Load (LAC) of the Centro de Excelência Esportiva (CENESP) of the Escola de Educação Física, Fisioterapia e Terapia Ocupacional da UFMG.



Figure 1: Plates of contact at the end of the passage.

- System of rope: Structure manufactured with synthetic, malleable material, few flexible, with approximately 2mm of thickness, canine tooth in the waist of the on volunteer and to an interruptor for 2 distant points in 20 meters, being that the first point corresponds of the start line and as to the line of arrival, as illustrated in Figure 2. The rope when strained until point '1' sets in motion the interruptor, the same happening when strained to the point '2'. The interruptor is located the 50 centimeters behind the start line and was regulated the height next to the line of the waist of each individual. This distance of 50 centimeters if made necessary for the

positioning of the interrupting device, and was adjusted not to intervene with the final result a time that the chronometer was only set in motion when the rope was strained and liberated the device that was imprisoned in the interruptor. This point corresponded accurately to the start line. The interruptor is connected to a computer equipped with MultiSprint software. The procedures for positioning of the rope during the race had also been standardized to prevent any type of interference of the system, as much in the race how much in the register of the time.

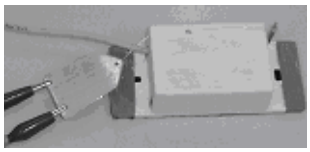

Figure 2: Device interruptor for rope.

- Tachometer: bobbin with 10cm of imprisoned diameter for a axle for where it turns freely. It is stimulated by a rope (resistant line, weightless, few flexible produced with nylon) imprisoned the volunteer and registers the time expense to carry through each complete rotation and the total number of rotations of the bobbin during the passage (Figure 3). The system makes possible to register with precision in the distance established for the test and the time expense during the passage, besides evaluating variations of the speed in small intervals, a time that, the device registers through software MCE.F (equipment developed in LAC/CENESP/UFMG) the average of speed to each 10cm.



Figure 3: Tachometer.

- Photoelectric cells: The Barriers of photoelectric cells allow the register of fractions of time from the use of electronic systems that make possible the detention of alterations produced in a luminous barrier through the mechanism of infra red light. They had been located in the beginning and the end of the passage and hardwired to MultiSprint software;



Figure 4: Photoeletric cells

Procedure: The tests had been carried through in the Escola de Educação Física, Fisioterapia e Terapia Ocupacional of the UFMG in a track coated with synthetic material (tartan) with referring markings to the start line and line of end of the test. The evaluated ones had been guided to carry through preparatory exercises moments before the execution of the test. The volunteer initiates the test in the position of passed (high exit) locating one of the feet on the line of beginning of the test. The posterior foot was located on the contact plate that if found 30cm behind the start line. At this moment the tip of the rope and the line of the tachometer were imprisoned to the waist-high volunteer. The beginning of the test was determined by the evaluated one. The evaluated ones had been instructed to cover the straight-line passage with the biggest possible speed and to only initiate the deceleration after to exceed the definitive place as final of the passage.

Four attempts for each volunteer had been carried through and, in each attempt, he was gotten the values registered for the different systems. It of the five markings of the valid chronometer as measured in each attempt was considered medium.

Analysis statistics: For the data analysis it was used descriptive statistics.

Results

It was selected the medium one of the four attempts of each valid individual as resulted for comparison effect. Table 1 shows the result of each volunteer, beyond the average of the values of the speeds registered for different systems. Statistics analysis: For analysis of the data it was used descriptive statistics and correlation of the averages.

	CHRONOM.	PLATES	PHCEL.	TACHOM.	ROPE	Average	SD
Volunteer 1	6,14	6,16	5,89	5,35	6,31	5,97	0,38
Volunteer 2	5,89	5,78	5,58	5,56	6,11	5,78	0,23
Volunteer 3	5,73	5,41	5,46	5,30	5,52	5,48	0,16
Volunteer 4	5,43	5,67	5,31	5,16	5,28	5,37	0,19
Volunteer 5	5,37	5,65	5,49	5,24	5,24	5,40	0,17
Volunteer 6	5,56	5,50	5,62	5,36	5,48	5,51	0,10
Volunteer 7	6,36	5,67	5,98	5,76	6,41	6,03	0,34
Volunteer 8	5,03	5,05	4,99	4,80	5,29	5,03	0,18
Average	5,69	5,61	5,54	5,32	5,71	5,57	
Standart Desviation	0,43	0,32	0,31	0,28	0,49		

Table 2 presents the correlation of the general average with the average of each system of measurement.

System	N	Correlation	Sig.
Chronometer	8	0,980	0,001
Plates	8	0,793	0,003
Photocells	8	0,957	0
Tachometer	8	0,892	0,019
Rope	8	0,929	0

Table 2: Correlation of the general average and the systems of measurement.

For the average speed of race in the 20 meters, the rope was the system that presented, in average, greaters resulted in

the measurement. All the systems had presented one high correlation with the general average of the sample. Being expressive the results found for the instruments Chronometer, Photocells, Rope and Tachometer, respectively. While the measurement system that presented the lesser correlation was the Plate of contact.

Table 3 presents the comparisons between the averages of the times gotten for each instrument, beyond the comparison with the general average.

COMPARISON	Sig.
Rope – Average	0,125
Tachometer – Average	0,002
Photocells – Average	0,396
Plates – Average	0,608
Chronometer – Average	0,092
Chronometer – Plates	0,505
Chronometer – Photocells	0,054
Chronometer – Tachometer	0,002
Chronometer – Rope	0,809
Plates – Photocells	0,394
Plates – Tachometer	0,020
Plates – Rope	0,505
Photocells – Tachometer	0,004
Photocells – Rope	0,155
Tachometer – Rope	0,012

Table 3 Comparison between averages of the different systems

In accordance with table 3, in the comparison enters the results gotten for each instrument, had significant difference ($p<0,05$) it enters the values gotten for the tachometer and the other systems, beyond the difference presented between this system and the general average.

Discussion

All the systems if had shown efficient for the measurement of the speed measured in the test of race of 20 meters, opposing some results found in literature. In the MENZEL study (1995), that it compared the results between chronometer and photocells in an agility test, had been registered significant differences between these systems, being the photocell the indicated instrument more for that procedure. However, the high correlation found for manual chronometer in the present study can be justified by the number of appraisers for the register of each attempt and the used form of analysis of the data, that the medium one of the values considered as valid, eliminating measured extreme in the attempt to diminish the degree of uncertainty of the results.

In the comparison between photocells and plates of contact, SILVA (2003) found significant differences between these systems for the measurement of the average speed in the race of 30 meters. However, for the fact not to have simultaneously been carried through, the instruments can have revealed diverse influence in the technique of race of the volunteer. As the plates need to be touched to set in motion or to interrupt the chronometer, the concern in making right them can provoke alteration in the rhythm of the passed ones, probably modifying the time of the passage, and consequently intervening with the final speed. When the simultaneous register for different instruments is made possible, all the involved systems in the collection registers the same interference, what it could justify not the verification of significant differences between the values gotten for the plate and the general average in this experiment. Moreover, the present study it looked for to minimize these interferences using plates of bigger dimensions in the final position, in order to provide a lesser discomfort of the individual in the boarding of the same one. However, the verification of the contact of the foot of support with the plate (that it determines in the distance accurate covered for the evaluated one) depended on the visual perception of the appraisers, sending to a certain margin of error to the gotten result.

In contrast of the contact plate, the tachometer makes possible the register of the accurate distance from the number of turns carried through for the device. To the end of this distance, the chronometer is interrupted. Of this form it is possible to measure the average speed in the passage from the sum of the time intervals. However, this system presented comparative significant differences ($p< 0,05$) when with the other evaluated instruments. This difference could be justified in function of the used type of rope to extremely turn the device to be light, exposed, the external interferences. One another possibility could be justified by inexact calibration of the equipment, of form that to each turn registered for the instrument had a small difference (addition) in real relation at a distance covered by the evaluated one. The sum of these interferences can have all provoked the mistake in the results gotten for this instrument for the average speed of the passage.

However, exactly without presenting precision in the result of the average speed of race for the test of 20 meters, the tachometer allows to evaluate the different phases of the passed one (landing and impulse phase), making possible the detention of possible asymmetries of the inferior members. This evaluation, however is limited to the first meters of the passage since the system made possible to register these data for speeds 6m/s.

Thus, we suggest others studies for the development of this system so that it if becomes efficient for the test of speed race, a time that it produces information of great value that they represent parameters for the training and games of a team, besides offering objective characteristics of the athletes, assisting in the elaboration of tactical plans.

The results found in the use of the rope system can be justified by the precision between the drive of the chronometer and the ticket of a point next to the mass center of the individual for the lines of start and arrived to the test (the system was connected to the individual in the line of the waist), made possible for the exactness of the measure between these points of the rope.

Conclusion

The five tested instruments supply resulted efficient the average speed of race in the 20 meters, a time that had presented high correlation with the general average.

In virtue of the proven trustworthiness already in other studies for the system of photocells, the comparison of other instruments sends regards for futures studies, mainly rope and tachometer with the values registered for this instrument (photoelectric cells).

Moreover, the trustworthiness of the results gotten from the manual cronometragem must be tested for inferior distances the 20 meters, using, if possible, the same methodology applied in the present study.

References

BAER, G; DURWARD, B; ROWE, P. *Movimento Funcional Humano: Mensuração e Análise.* 1ªed. Barueri: Ed. Manole Ltda, 2001. 233 p.

CERVERA, V. R.; GRANELL, J.C. *Teoria e planejamento do treinamento desportivo.* Porto Alegre: Artmed, 2003.

ELLIOT, B.; MESTER, J. *Treinamento no esporte: aplicando ciência no esporte.* São Paulo:Phorte Editora, 2000.

FERREIRA FILHO, E.; MENZEL, H-J. CHAGAS, M. *Determinação da Confiabilidade de diferentes Testes de Velocidade/Agilidade Aplicados na Modalidade Futsal, Revista Mineira de Educação Física*. Universidade Federal de Viçosa: 2003, vol.11, nº1, p. 47 - 55.

GROSSER, M. *Entrenamiento de la velocidad: Fundamentos, métodos y programas.* Barcelona: Ediciones Martinez Roca, 220p. 1992.

MENZEL, H. Desenvolvimento e Avaliação de um Teste da Velocidade e Agilidade no Futebol. *In: VI Congresso Brasileiro de Biomecânica - Anais.* 1995, p. 34-40.
SILVA, H.R.; *Teste de Velocidade: Comparação entre placas de contato e fotocélulas como instrumentos de medição.* EEFFTO-UFMG, Monografia de Especialização, 2003.
SILVA, P. & SILVA, F. Velocidade em 30 Metros: Um Estudo Comparativo no Desempenho da Capacidade Física em Jovens Atletas de Futsal e Handebol. *In: III Simpósio Internacional em Treinamento Esportivo - Anais .* João Pessoa, 2002, p. 36. (Abstract)
SZMUCHROWSKI, L. & LOPES, F. *Testes de Campo para Avaliação de Sistemas Anaeróbio-Alático através de Corridas de Curtas Distâncias*. In: GRECO, P.J.; SAMULSKI,D.; JUNIOR,E.C*. Temas atuais em Educação Física e Esportes,* Belo Horizonte, Health 1997.
VERJOSHANSKI, I. *Entrenamiento deportivo: planificación y programación*. Barcelona: Ediciones Martinez Roca, 1990.
WEINECK, J. *Treinamento ideal*. 9. ed. São Paulo: Editora Manole, 1999.
ZAKHAROV, Andrei. *Ciência do treinamento desportivo*. Rio de Janeiro: Grupo palestra sport, 1992.

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COMPARISON OF DIFFERENT APPLIED SYSTEMS OF MEASUREMENT TO THE SPEED TEST

The control of the sporting training if constitutes essential element in the improvement of the income, which depends on the adequate perfectioning of the displacement speed. The motor speed, understood as a capacity human being who conditions the accomplishment of the porting movements, constitutes a factor of the income to which if it has attributed great importance. Trainers and investigators have come back its concerns, toward the forms of manifestation that characterize it, but also for the way of them to not only transform into inductors of efficiency and effectiveness of the porting actions. The measurement of this physical quality requires the use of tests that supply to theoretical subsidies that contribute in the load application of determined orientation, facilitating the dialogue most coherent with the specific of each sporting modality. The aim of this study was to compare the performance of different systems of measurement (chronometer, plates of contact, photocells, tachometer and system of rope) in the speed test. For in such a way, a composed sample for 8 volunteers, who had been submitted the 4 races of 20 meters, from which was used if the average speed of the passage registered. The analysis of the results demonstrated one high correlation between the averages gotten for the different mechanisms of measurement and the general average (composed for all instruments), disclosing the effectiveness of the same ones in the register of the speed in the distance of 20 meters. The tachometer presented significant difference when comparative with the results gotten for the other tested systems. Key words: performance, speed, motor test

LA COMPARAISON DE DIFFÉRENTS SYSTÈMES DE LA MESURE S'EST APPLIQUÉE À L'ESSAI DE VITESSE

La commande de la formation d'esportive si constitue l'élément essentiel dans l'amélioration du revenu, qui dépend de à perfectioning proportionné de la vitesse de déplacement. La vitesse de moteur, comprise comme être humain de capacité qui conditionne l'accomplissement des mouvements de mise en communication, constitue un facteur du revenu auquel s'il a attribué la grande importance. Les entraîneurs et les investigateurs sont revenus ses soucis, vers les formes de manifestation qui la caractérisent, mais également pour la manière d'elles de transformer non seulement en inducteurs d'efficacité et d'efficacité des actions de mise en communication. Le medición de cette qualité physique exige l'utilisation des essais qui fournissent aux subventions théoriques qui contribuent dans l'application de charge de l'orientation déterminée, facilitant le dialogue le plus logique avec les especificidades de chaque modalité d'esportiva. L'objectif de cette étude était de comparer l'exécution de différents systèmes de la mesure (chronomètre, plats de contact, cellules photo-électriques, tachymètre et système de corde) dans l'essai de vitesse. Pour d'une telle manière, un échantillon composé pour 8 volontaires, qui avaient été soumis les 4 courses de 20 mètres, desquels a été employé si la vitesse moyenne du passage s'enregistrait. L'analyse des résultats a démontré une corrélation élevée écrit les moyennes obtenues pour les différents mécanismes de la mesure et de la moyenne générale (composée pour tous les instruments), révélant l'efficacité de la même chose ceux dans le registre de la vitesse dans la distance de 20 mètres. L'estatisticamente de système de tachymètre a présenté différence significative quand comparative avec les résultats obtenus pour les autres systèmes examinés. Mot-clef : revenu, vitesse, essai de moteur

LA COMPARACIÓN DE DIVERSOS SISTEMAS DE LA MEDIDA SE APLICÓ A LA PRUEBA DE VELOCIDAD

El control del entrenamiento del esportivo si constituye el elemento esencial en la mejora de la renta, que depende del aperfeiçoamento adecuado de la velocidad de la dislocación. La velocidad del motor, entendida como humano de la capacidad que condicione la realización de los movimientos que viran hacia el lado de babor, constituye un factor de la renta a la cual si ha atribuido gran importancia. Los amaestradores y los investigadores se han vuelto sus preocupaciones, hacia las formas de manifestación que la caracterizan, pero también para la manera de ellas de transformar no solamente en los inductores de la eficacia y de la eficacia de las acciones que viraban hacia el lado de babor. El mensuración de esta calidad física requiere el uso de las pruebas que proveen a los subsidios teóricos que contribuyen en el uso de la carga de la orientación resuelta, facilitando el diálogo más coherente con los especificidades de cada modalidad del esportiva. El objetivo de este estudio era comparar el funcionamiento de diversos sistemas de la medida (cronómetro, placas del contacto, fotocélulas, tacómetro y sistema de la cuerda) en la prueba de velocidad. Para de tal manera, una muestra compuesta para 8 voluntarios, que habían sido sometidos las 4 razas de 20 metros, de los cuales fue utilizado si la velocidad media del paso se colocó. El análisis de los resultados demostró una alta correlación incorpora los promedios conseguidos para los diversos mecanismos de la medida y del promedio general (compuesto para todos los instrumentos), divulgando la eficacia igual unas en el registro de la velocidad en la distancia de 20 metros. El sistema del tacómetro presentó diferencia significativa cuando comparativa con los resultados conseguidos para los otros sistemas probados.
Palabra-llave: renta, velocidad, prueba del motor

COMPARAÇÃO DE DIFERENTES SISTEMAS DE MEDIÇÃO APLICADOS AO TESTE DE VELOCIDADE

O controle do treinamento esportivo se constitui elemento imprescindível no aprimoramento do rendimento, o qual depende do adequado aperfeiçoamento da velocidade de deslocamento. A velocidade motora, entendida como uma capacidade humana que condiciona a realização dos movimentos desportivos, constitui um fator do rendimento ao qual se tem atribuído grande importância. Treinadores e investigadores têm voltado as suas preocupações, não só para as formas de manifestação que a caracterizam, mas também para o modo de as transformar em indutores de eficiência e eficácia das ações desportivas. A mensuração desta qualidade física requer a utilização de testes que fornecem subsídios teóricos que contribuem na aplicação de cargas de determinada orientação, facilitando o diálogo mais coerente com as especificidades de cada modalidade esportiva. O objetivo deste estudo foi comparar a atuação de diferentes sistemas de medição (cronômetro, placas de contato, fotocélulas, tacômetro e sistema de corda) no teste de velocidade. Para tanto, utilizou-se uma amostra composta por 8 voluntários, que foram submetidos a 4 corridas de 20 metros, a partir das quais se registrou a velocidade média do percurso. A análise dos resultados demonstrou uma alta correlação entre as médias obtidas pelos diferentes mecanismos de medição e a média geral (composta por todos instrumentos), revelando a eficácia dos mesmos no registro da velocidade na distância de 20 metros. O sistema de tacômetro apresentou diferença estatisticamente significativa quando comparado com os resultados obtidos pelos outros sistemas testados.
Palavras-chave: rendimento, velocidade, teste motor.