Basic reliability parameters of a boxing punch

L'UBOSLAV ŠIŠKA¹, JAROSLAV BROŽÁNI², MILOŠ ŠTEFANOVSKÝ³, SVĀTOSLAV TODOROV⁴

^{1,2, 4} Department of physical education and sport, Faculty of education, Constantine the philosopher University in Nitra, SLOVAK REPUBLIC

³ Faculty of Physical Education and Sport, Department of gymnastic, Comenius University, Bratislava, SLOVAK REPUBLIC

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Abstract:

The main objective of this thesis was to verify the reliability of the diagnostic device "BOX-CHECK" which our team designed for measuring the force and the time duration of a boxing punch. The device comprises of an accelerometer measuring the acceleration of the boxing bag at the time of a shock which consequently indicates the force of the punch. Further part of the device is the FITRO agility plate with light emitting diode which gives the visual signal to start the punch. FITRO plate connects its circuit by the force of the punch and then measures the time of the duration of the punch. Through their relevant software both devices communicate with the computer displaying the measured values. The verification of the reliability of the device was carried out separately for each parameter: force and time duration of the punch. The experiment was carried out on the sample of boxers (8 female and 4 male) with the average age of 20.6 (+/- 4.4) years, average height of 170.8 (+/- 8.4) cms and average weight of 67.6 (+/- 10) kgs all with 2.5 (+/- 1.7) years of boxing training. ICC reliability index was used to process the measured data. The value of the reliability of the device for the time duration of the punch was established at 0.882 and at 0.969 for the force of the punch. In conclusion we can state that the diagnostic device "BOX-CHECK" is sufficiently reliable for the use in the training process.

Key words: Boxing, punch, diagnostics, reliability

Introduction

Boxing is a contact sport with high physical and mental demands. The primary objective is to hit the opponent as many times as possible while at the same time to avoid being hit back. The punches, their accuracy and force are scored by points which then determine the winning side. In a match the punches may occur as single ones or in combination. In conception of a punch as a single movement many authors specify as limiting factors its speed and force. In more detailed analysis we can divide the overall speed to the reaction speed and the acceleration speed. Basic parameters of a boxing punch have been analyzed by many authors. One of the first ones was (Fritsche 1978) who investigated the punching power with a water bag. In his experiment he observed changes of the water level in a column from which he could derive the force of punch. (Atha et al., 1985) conducted an experiment where he measured the speed and the force of a punch of professional boxer Frank Bruno. The instrumental part of the device used in the experiment was a metal plate softened with felt and leather allowed moved on the shaft. Behind the metal plate there was a pressure sensor for measuring the force of the punch. The boxer held an accelerometer recording the speed of the movement of the hand. (Smith et al., 2000) constructed a boxing dynamometer that measured the force of a punch based on data from pressure sensors calibrated with weights of known value and force of punch was expressed in special units. The dynamometer was adjustable in height. (Walilko et al., 2005) designed a measuring device with the help of conventional training dummy used in the training process. Using accelerometers - one mounted on the dummy and another one held by the boxer he was able to gather the basic information about the course of the punch. (Chadli et al., 2014) used strain gauges and accelerometers to measure the speed and the force of the punch but the structure of the actual device is different from the previous ones. The Hitting target of the device is placed on the iron pole which leans backwards after the punch. When designing the new diagnostic device we have to remember that new device must be simple and usable in practise. Based on our experience we can state that the easiest is to punch the classic boxing bag, and the easiest way to measure the variable is to calculate the power of a punch is by using an accelerometer to measure its acceleration. If we can add a visual signal to initiate the punch and can measure the time of the punch and if we can fix the whole device onto the bag we have a device matching our expectations. For the calculating of the reliability of the device we use intraclass correlation - ICC.

Material & methods

Device description: The proposed measuring device comprises of a FiTRO agility plate (Hamar, 2001) with light emitting diode which gives the visual signal for the start of the punch and an accelerometer. Values obtained by individual probands were displayed on a computer and each system including the FiTRO agility plate and the accelerometer had their own software (made by team of Dušan Hamar). The basic principle of the FiTRO agility consists of the measurement of the time interval starting when the signal is displayed on the computer screen and LEDs lighting flashing red up until the closure of the plate by the punch. The principle of the accelerometer is based on measuring the acceleration of the boxing bag from which we can express the force of punch using the mathematical formula $F = m \cdot a$ if the weight is known.

Fig. 1. Disassembled measuring device

The location of the individual components was as follows: FiTRO agility plate was fixed to the boxing bag using contrasting silver-coloured tape from each side which formed a clearly visible square creating a targets for probands to hit. A light emitting diode was fixed above this square which also created a highly visible contrast. The accelerometer was placed on the other side of the punching bag approximately at the height corresponding with the centre of the plate. The plate and the accelerometer had to be re-fixed due to the different heights of the boxers. The distribution was up to 170 cm and above. The height of the plate and the accelerometer was at the eye level of the boxers. The weight of the bag carrying the testing device was 50 kg, its height was 190 cms and it was suspended 1 m from the ceiling and 10 cm above the floor.

Fig. 2. Schematic representation of device

Test Description: These tests consisted of the execution of a direct lead hand punch to a boxing bag at a visual signal where the distance between the front leg of the probands and the boxing bag was 80cm. Each proband executed the total of four series of punches divided into two separate measurements. In one series 10 punches were performed (load of about 1 sec.) with the pause of approx. 30 seconds between them so the duration of one set was approximately 5 min. In one measurement every proband completed two series of punches with the rest interval between sets of 10 minutes. For each set we calculated the average performance, than we had 4 values of each proband serving for calculating the reliability of the device. Proband started the punch from the basic boxing position with the front hand enclosed to the chin in order to maintain a uniform methodology for conducting the tests. On the visual signal the proband executed the punch with step towards the boxing bag. Before the testing the probands were instructed how to conduct the punches. Before each punch a proband was warned by the word "PREPARE" then the visual signal was displayed in the range of 1-3 seconds. Before each testing was performed the uniform warm-up followed the same test conditions.

Test group: 12 boxers of boxing club Ružinov 821, composed of male and female populations in the ratio of 4: 8 in the favour of females. Probandns were made of a competitive group of this club where each of them had completed at least three competitive matches in the ring. The average age of the group of 12 boxers

was 20.6 (± 4.4) years, the average height was 170.8 (± 8.4) cm, average weight 67.6 (± 10) kg and the average boxing experience was 2.6 (± 1.6) years.

Results

Time duration of the punch

Fig. 3. Whole group average performance in time duration of the punch in separate sets

In the first set, the average performance was 732.9 (± 53.9) ms. In II. set the average performance was 734 (± 57.8) ms. In III. set the average performance was 717 (± 32.9) ms. In IV. set the average performance was 723 (± 33.2) ms. Maximum performance for all sets was 549 ms and minimum performance 925 ms.

Fig. 4. Probands average performance in time duration of the punch in separate sets

ICC correlation coefficient of reliability was equal to 0.882.

Force of the punch

Fig. 5. Whole group average performance in force of the punch in separate sets

In the first set the average performance was 2953 (± 1600) N. In II. set the average performance was 3063.4 (± 1327.3) N. In III. set the average performance was 3536.9 (± 1442.8). In IV. set the average performance was 3585.9 (± 1366.2) N. Maximum performance for all sets was 6900 N and minimum performance 651 N.

Fig. 6. Probands average performance in force of the punch in separate sets

ICC correlation coefficient of reliability was equal to 0.969.

Discussion

By the combination of several diagnostic elements we managed to design an innovative device for measuring the force and time duration of the punch in boxing which according to our calculations proved to be reliable. To verify the reliability of the device "BOX CHECK" we used the ICC coefficient which the authors (Bartko 1976), (Weir 2005) referred to as the most appropriate method. The sufficient reliability is considered as the coefficient value greater than 0.8. For each parameter the coefficient values were: time duration of the punch - 0,882 and 0,969 for the force of the punch. However, when we compared the measured values of the force and time duration of the punch to each other, we can clearly state that the time component values form a more homogeneous set than the force component values which is obvious from the standard deviations. In the time component this was not even 10% of the average performance and in the force component this was 50% of the average performance. Paradoxically the reliability coefficient of the time component measurement was lower. This fact appears very interesting and can serve as an impulse for deeper research into the problem of verifying the reliability in the sport. In terms of construction of the device we considered as essential to unify the software that the force and the time can be operated by one program and the removal of the Fitro agility plate which is especially important in terms of an easy operation. In that case the device consists of only the accelerometer and the diode. By comparing the measured values with other authors we can conclude that in the time component of the punch we have reached similar values as (Šiška 2013) who measured the reaction time of the hit of the Fitro agility plate located at 1m high table from meter distance of 800 to 850 ms, which is close to our values and also (Chadli et al., 2014) who measured the time duration of the punch 600-1100 ms. In the punch force component in comparison with other authors we observed a large variability of the measured values from 1000 N measured by (Chadli et al., 2014) to 6900 N measured that was recorded by us. We attribute this difference to a different methodology, the measurement by the strain gauges and accelerometers. We must of course take into account the factors which may affect the measured values for example: height of the attachment for punching bag ceiling and method of the fixing of the punching bag, the material with which the bag is filled and the accelerometer location. This problem will have to be addressed in closer details in future.

Conclusion

Device "BOX CHECK" may be used in the actual training process where we can with the help of this device perform the whole training session i. e. : perform between 50 to 100 punches. This amount of punches gives us more accurate information of the efficiency of each punch. Different combinations of the front, rear and hook punches are also possible. In terms of diagnostics when focusing on the time component our main parameter was the total time duration of the punches conducted from the distance of 80 cm. The total time duration of the punch comprises of the reaction speed and the overall speed of the movement. In our opinion by the correct manipulation with the distance from which the punch is performed we can fairly accurately detect the reaction speed which is a very important parameter crucial for the success of the attack. In the force component the diagnostics must clearly focus on basic punches either directs or hooks.

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