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Variables in the Cuban baseball batter's performance using the *Blast Motion Baseball* sensor

Variables del rendimiento de los bateadores del béisbol cubano utilizando el sensor *Blast Motion baseball*

Variáveis do desempenho dos batedores do basebol cubano utilizando o *Sensor de Basebol de Movimento de Explosão*

Alfredo Ríos Fuentes[1*] iD https://orcid.org/0000-0002-5425-8184

Santiago Calero Morales[2] iD https://orcid.org/0000-0002-4702-331X

Ricardo Elaín Eizméndiz Domínguez[3] iD https://orcid.org/0000-0001-9020-9614

Yasser Aguiar Alpízar[4] iD https://orcid.org/0000-0001-8296-7490

Beatriz Sánchez Córdova[5] iD https://orcid.org/0000-0002-7425-8990

[1]Centro de Investigaciones del Deporte Cubano. La Habana, Cuba.
[2]Universidad de las Fuerzas Armadas ESPE. Quito, Ecuador.
[3]Escuela Nacional de béisbol. La Habana, Cuba.
[4]Universidad de la Habana. La Habana, Cuba.
[5]Universidad de Ciencias de la Cultura Física y el Deporte "Manuel Fajardo", La Habana, Cuba.

[*]Correspondence author: alfredo.rios.fuentes@gmail.com

ABSTRACT

The introduction of new technologies in baseball has optimized the systems for recording and analyzing information, both in training and in the game, contributing to a more accurate control of a player's performance. In this work, it is applied the *Blast Motion Baseball sensor* which objective is to identify the variables significantly influencing the performance of batters in Cuban baseball. There were chosen batters (N=24) belonging to the National Baseball Series LIX because it constitutes the national event of higher level in Cuban baseball. The information was recorded during batting practice, while the batter was performing the task of connecting balls thrown by the coach from the front toss, over the arm at a distance of 30 feet and at a speed of less than 50 mph. The results of Blast Motion Baseball were then compared with the official statistics of the LIX National Baseball Series. It was shown that batters with higher bat speed, higher top hand speed and more power achieved greater offensive performance. Therefore, knowing these characteristics of the swing in real

time helps to perfect the training process and predict the sports performance of a batter.

Keywords: Bat speed; *Blast Motion baseball*; Cuban baseball; Peak hand speed; performance; Power.

RESUMEN

La introducción de las nuevas tecnologías en el béisbol ha optimizado los sistemas para el registro y análisis de información, tanto en el entrenamiento como en el juego, contribuyendo a un control más exacto del rendimiento de un jugador. En el presente trabajo, se aplica el sensor *Blast Motion baseball* cuyo objetivo es identificar las variables significativamente influyentes en el rendimiento de los bateadores en el béisbol cubano. Se eligieron bateadores (N=24) pertenecientes a la Serie Nacional de béisbol LIX debido a que constituye el evento nacional de mayor nivel del béisbol cubano. La información fue registrada en prácticas de bateo, mientras el bateador ejecutaba la tarea de conectar bolas lanzadas por el entrenador de frente *(front toss)*, por encima del brazo a una distancia de 30 pies y a una velocidad inferior a las 50 mph. Posteriormente, se compararon los resultados del *Blast Motion Baseball* con las estadísticas oficiales de la Serie Nacional de Béisbol LIX. Se demostró que los bateadores con mayor velocidad del bate, mayor velocidad máxima de las manos y mayor potencia lograron un mayor rendimiento ofensivo. Por tanto, conocer en tiempo real estas características del *swing* contribuyen a perfeccionar el proceso de entrenamiento y predecir el rendimiento deportivo de un bateador.

Palabras clave: Béisbol cubano; *Blast Motion baseball*; Potencia; Rendimiento velocidad del bate; Velocidad máxima de las manos.

RESUMO

A introdução de novas tecnologias no basebol otimizou os sistemas de gravação e análise de informação, tanto no treino como no jogo, contribuindo para um controlo mais preciso do desempenho de um jogador. No presente trabalho, é aplicado o *Sensor de basebol Blast Motion*. O seu objetivo é identificar as variáveis que influenciam significativamente o desempenho dos batedores no basebol cubano. Os batedores (N=24) pertencentes à Série Nacional de basebol LIX foram escolhidos porque constitui o evento nacional de mais alto nível do basebol cubano. A informação foi registada durante o treino de batedores, enquanto o batedor executava a tarefa de ligar bolas lançadas pelo treinador a partir do lançamento frontal, sobre o braço a uma distância de 30 pés e a uma velocidade inferior a 50 mph. Os resultados do *Blast Motion Baseball* foram então comparados com as estatísticas oficiais da Série Nacional de Basebol LIX. Foi demonstrado que batedores com maiores velocidades de taco, maiores velocidades de mão superior, e mais potência alcançaram um maior desempenho ofensivo. Portanto, conhecer estas características do balanço em tempo real ajuda a refinar o processo de treino e a prever o desempenho atlético de um batedor.

Palavras-chave: Basebol cubano; *Blast Motion basebol;* Potência; Desempenho da velocidade do taco; Velocidade máxima da mão.

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INTRODUCTION

The most important factor influencing the flying distance of a batted ball in baseball is its initial velocity. To increase the initial speed of a batted ball, batters must increase the speed with which they move their bat (Nakashima, Horiuchi, & Sakurai, 2020). This has been a conclusion agreed upon by different authors. According to Breen (1967) a successful batter is one whose batting average is above or at least close to 0.300, and one of the ways to achieve this result is by increasing the speed of the bat. The aforementioned author performs a cinematic analysis to determine what mechanical attributes contribute to the movements that occur when a baseball is effectively connected. It states that one of the five attributes in batting success is developing a high bat speed; this has been confirmed from the evolution of information and communication technologies (ICT), which among other aspects uses sensors validated and approved by the MLB as an official tool for the technical adjustment of batters' swing since 2016. About 70 % of MLB teams use sensors to intentionally train and improve the quality of their swings (Newman, 2016); and successful teams like the Houston Astros have more than 8000 active Blast MotionBaseball sensors (Reiter, 2018). In addition, other works published in recent years integrate new components that influence batter performance such as visual fielding and ocular motor skills (Liu, Edmunds, Burris, & Appelbaum, 2020; Gray, 2017; Higuchi, Nagami, Nakata, & Kanosue, 2018).

In recent years, sensors have been developed that simply measure the initial speed of a batted ball, bat speed, and other metrics, making it easier for players to evaluate their performance and understand their fitness states (Zou, Higuchi, Noma, Roberto, & Isaka, 2019). Recording and analyzing these metrics has allowed different hypotheses to be demonstrated, for example, Nathan (2003) identifies that the final speed of a batted ball is influenced more by the speed of the bat than by the speed of the pitch. In addition, according to Szymanski, Derenne, and Spaniol (2009) if batters increase the speed of the bat, they would decrease their swing time (as long as the mechanics of the swing do not change) and increase the decision time and exit speed of the balls hit.

Due to the importance of the speed of the bat, training sessions are being accompanied by technologies that allow this information to be consulted immediately, facilitating more exact adjustments in short periods of time. This has led to visible changes in the behavior of balls hit, mainly in Major League Baseball (MLB). In this league, according to Baseball Savant (2020), the percentage of batters capable of hitting balls averaging 90 mph or more has increased, contributing to the fact that in the 2019 season, the highest percentage of home runs in the history of MLB (3.6).

The impact of bat speed is evident; however, there are other factors that may be influencing batters' performance. For example, Adair (2002) states that, if a batter swings with a heavier bat with the same speed as his standard bat, or if a batter swings faster with his standard bat due to the increased bat speed, the ball will travel farther, be connected with more force, or both, due to the greater power transfer imparted to the ball. Precisely, metrics such as power, bat speed, and others related to batters' swing can be measured by sensors such as Blast Motion Baseball.

Therefore, the present work has as objective to identify the variables significantly influencing the performance of batters in Cuban baseball according to the information gathered through the *Blast Motion Baseball sensor*.

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MATERIALS AND METHODS

Sample

Batters (N=24) belonging to the National Baseball Series were chosen for the study because it is the highest-level national event of Cuban baseball.

Instruments

The *Blast Motion Baseball* device was used to record the information. It is a highly advanced and accurate 3D motion capture sensor that records batter's swings. The sensor is easily attached to the handle of any approved bat thanks to a specially developed flexible attachment. It uses intelligent Bluetooth technology to connect with Android and iOS devices.

Among the metrics that can be consulted instantly are: bat speed, contact time, hand speed, angle of attack, power, among others, allowing coaches and players to analyze in real time the characteristics of their swing and adjust in a short period of time the deficiencies identified through a set of specific suggested exercises.

The evaluation of the significance of the mentioned instrument was established through the consultation to 13 Cuban experts in baseball for the studied senior category.

Procedure

The information was recorded during batting practice, while the batter was performing the task of connecting balls thrown by the coach from the front, over the arm at a distance of 30 feet and at a speed of less than 50 mph. Subsequently, a search was made for sports performance statistics in the National LIX Baseball Series belonging to the players in this work. For the statistical analysis of the previously recorded data, the statistical package IBM SPSS Statistics v23 was used. Meanwhile, for the treatment and presentation of the information, the Microsoft Excel 2016 spreadsheet was used.

Statistical analysis

In order to identify the variables significantly influencing the sports performance of batters in Cuban baseball, it was carried out a bivariate correlation study between the results of the Blast Motion Baseball sensor and the official statistics of each batter in the National Baseball Series LIX.

The following statistics were consulted in the official web page of the Cuban Baseball Federation: batting average (AVE), slugging (SLU) and percentage of home runs of the total number of appearances at bat (HR%). Their batting average (H/BIP) and home run percentage (HR/BIP) were determined from the batted balls (BIP).

The analysis variables will be processed with the Blast Motion Baseball sensor, characterizing the batters' swing. The following are the variables selected for this study:

- The bat speed represents the total speed of the bat mass at the time of impact.
- The power generated during the swing is measured in kilowatts (kw) and comes from the mass of the bat multiplied by the average bat acceleration. The greater the power, the greater the transfer of energy, the greater the power.
- The time to contact is measured from the beginning of the descent of the swing to the moment of impact with the ball.
- Rotational acceleration measures how fast the bat accelerates within the plane of the swing. It is a good indicator of how the batter builds the bat speed by transferring energy in a proper sequence rather than pulling the bat with the hands. The greater the rotational acceleration, the more power and the more time you have to adjust to different pitching locations.
- The maximum hand speed represents the maximum speed reached by the hands during the swing.
- From the results of the *Blast Motion Baseball* sensor, the averages of the following variables were calculated: power, time for contact, rotational acceleration, bat speed, maximum hand speed.
- For the correlational analysis, it was used Pearson's correlation coefficient, and there were identified the variables of Blast Motion Baseball significantly influencing the performance of batters in Cuban baseball with a significance level of *p<0.05*.

RESULTS AND DISCUSSION

The relationships between different variables of swing and performance (Table 1) of a sample of hitters (N=24) who participated in the National Series of Baseball LIX are established.

Table 1. - Correlation between Blast Motion Baseball variables and performance in the 59th National Baseball Series

	AVE	SLU	HR%	HR/BIP	H/BIP
Bat speed (mph)	0.60	0.67	0.53	0.47	0.57
p-value	0.00	0.00	0.01	0.02	0.00
Rotational Acceleration (g)	0.00	0.05	0.03	0.04	0.10
p-value	1.00	0.80	0.90	0.87	0.65
Power (kW)	0.64	0.76	0.65	0.59	0.64
p-value	0.00	0.00	0.00	0.00	0.00
Time for contact (sec)	-0.43	-0.54	-0.51	-0.46	-0.49
p-value	0.04	0.01	0.01	0.02	0.02
Maximum speed of the hands (mph)	0.57	0.67	0.49	0.47	0.61
p-value	0.00	0.00	0.02	0.02	0.00

According to the criteria of Hernández, Fernández, & Baptista (2010) the following significant correlations were identified for p<0.05.

- Average positive correlation between bat speed and AVE (r=0.60), SLU (r=0.67), HR% (r=0.53), HR/BIP (r=0.47), H/BIP (r=0.57).
- Average positive correlation of maximum hand speed with AVE (r=0.57), SLU (r=0.67), HR% (r=0.49), HR/BIP (r=0.47), H/BIP (r=0.61).
- Considerable positive correlation of power with SLU (r=0.76).
- Average positive correlation of power with SLU (r=0.64), HR% (r=0.65), HR/BIP (r=0.59), H/BIP (r=0.64).

The link between the characteristics of a batter's swing and his relationship with offensive production has been a field of research in constant evolution from applied sciences, as specified by Szymanski, DeRenne, & Spaniol, (2009). This process has been supported by the development of new technologies that allow recording and analyzing variables imperceptible to the human eye. Therefore, it has been possible to demonstrate a series of statements related to the success of hitters.

The results found show that hitters with higher bat speed and more power tend to achieve higher batting averages, higher slugging and a higher percentage of home runs. These results are consistent with those described by Nathan (2003), Szymanski *et al.,* (2010), and Isaji (2019), but identifies maximum hand speed as another influential metric in a batter's success.

Power stands out as the variable with the greatest influence on the different metrics in offensive performance, coinciding with that proposed by Adair (2002). Therefore, it was decided to identify which of the variables measured by the *Blast Motion Baseball sensor* influence the power of the swing (Table 2).

Table 2. - Correlation between variables measured by the *Blast Motion Baseball sensor*

	Speed of the bat (mph)	Rotational acceleration (g)	Power (kW)	Time for the contact (sec)	Maximum speed of the hands(mph)
Velocidad del bate (mph)	1.00	0.10	0.93	-0.48	0.75
p-value		0.65	0.00	0.02	0.00
Rotational acceleration (g)	0.10	1.00	0.21	-0.51	0.10
p-value	0.65		0.33	0.01	0.63
Power (kW)	0.93	0.21	1.00	-0.74	0.77
p-value	0.00	0.33		0.00	0.00
Time for the contact (sec)	-0.48	-0.51	-0.74	1.00	-0.56
p-value	0.02	0.01	0.00		0.00
Maximum speed of the hands (mph)	0.75	0.10	0.77	-0.56	1.00
p-value	0.00	0.63	0.00	0.00	

With respect to power (Table 2), bat speed showed a very strong positive correlation (r=0.93) while hand speed exhibited a considerable positive correlation (r=0.77). Therefore, it can be stated that it is necessary to develop bat speed and hand speed in order to generate more power in the swing and increase batters' performance.

Furthermore, a considerable negative correlation was found between time for contact and power (r=-0,74), and average negative correlations between time for contact and bat speed (r=-0,48), rotational acceleration (r=-0,51), maximum speed of the hands (r=-0,56). These results are consistent with those obtained by Szymanski, DeRenne, & Spaniol (2009) who proposed that developing bat speed and power guarantees a shorter time for contact, increasing the batter's decision time to identify the type of pitch, its speed and location.

To better understand the impact of bat speed on batter performance, the group of batters studied was divided into two subgroups, using the average bat speed of each player as a criterion (Table 3). Subgroup I is comprised of hitters (n=14) with batting averages over 66 mph, while Subgroup II is comprised of the remaining batters (n=10).

Table 3. - Bat Speed Performance in the LIX National Baseball Series

	AVE	SLU	HR%	HR/BIP	H/BIP
Subgroup I	0.320	0.485	2.8%	3.9%	0.358
Average player of the LIX National Baseball Series	0.296	0.418	1.8%	2.5%	0.342
Subgroup II	0.258	0.346	1.0%	1.5%	0.304

The subgroups were compared based on their offensive performance using the statistics of the National LIX Baseball Series, and the following results were obtained:

Subgroup I batters performed better in all metrics than the average league player and subgroup II. Demonstrating that batters with higher swing speeds tend to achieve higher batting averages, higher slugging, greater likelihood of their batted balls turning into hits or home runs.

The results of this work are consistent with those of Breen (1967), Nathan (2003), Szymanski, DeRenne, & Spaniol (2009), Szymanski *et al*. Szymanski *et al.,* (2011), Isaji (2019) and Nakashima, Horiuchi, & Sakurai (2020) on the influence of bat speed on hitters' success.

However, although bat speed, as well as hand speed and power, are significantly correlated with offensive performance, they can only explain 60 % or less of the variation in the performance statistics of the batters analyzed. This result indicates the need for further research into other factors that influence a batter's success.

On the other hand, the experts selected to evaluate the significance of the implemented instrument, presented an acceptable degree of agreement (11 experts: ≈ 84.62 %) in terms of considering their approval in the use of these technological instruments, to achieve statistical information of interest that helps to optimize the process of sports training management applied to high-level baseball.

In this study, there were identified the variables significantly influencing the performance of batters in Cuban baseball according to the information gathered through the *Blast Motion Baseball sensor*. The results demonstrated the importance of the power generated in the swing, the speed of the bat and the maximum speed

reached by the hands. Therefore, knowing in real time these characteristics of a batter's swing contributes to improve the training process. Coaches should consider increasing bat speed as one of the main objectives in batter's preparation.

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The authors have participated in the writing of the work and analysis of the documents.