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# Validation of BESS (Balance Errors Scoring System) Test in Physical Education

Claudia Magaly Espinosa-Méndez[1], Sebastián Leonardo San-Martin-Rodríguez[2], Enrique R.P. Buendia-Lozada[1] and Rodrigo Iván Aguilar Enríquez[1]

*1. Department of Physical Culture, Benemérita Universidad Autónoma de Puebla, Puebla, Puebla PC 72570, Mexico*

*2. Department of Physical Education, Ypsilanti College Puebla, Puebla PC 72580, Mexico*

**Abstract:** The scoring system BESS (balance errors scoring system), is a test commonly used by clinical investigators, however there is an increase of studies that couple the BESS system, as a measure of results beyond the scope of its original purpose introducing the field of sport, and in our case, as a possible assessment tool balance in physical education**.** In this paper, the application of BESS Test two different age groups, 5th-grade and 4 semester of high school, college Ypsilanti Puebla was conducted in order to validate it, using the Software ptets to analyze. It conducted a non-random selection of 26 elementary and 26 high school students, 13 men and 13 women in each case. The results were compared in 6 different positions, including 3 on a flat surface and the other 3 on an implement with an unstable surface, each position must be maintained for 20 seconds. It was obtained as a result; the BESS Test is valid for children 5th-grade, not valid for high school students study.

**Key words**: BESS Test, validation, physical education.

## 1. Introduction

The scoring system BESS (balance error scoring system), is a test commonly used by clinical investigators [1-3]. However, there is an increase of studies that couple the BESS system, as a measure of results beyond the scope of its original purpose [3] introducing the field of sport. Originally this test was created to evaluate postural control [2], postural instability after a concussion [1, 4] or after an uncle injury [5].

For its application are used 3 positions that must be maintained 20 seconds on a stable surface, the same 3 positions are repeated on an unstable surface [1, 3, 6], while the applicator counts errors in the execution.

### *1.1 Static Balance*

The balance is considered as a fundamental aspect of the physical activity [7]. Balance is defined as the ability to overcome the action of gravity and keep the body in the required posture [8]. The test commonly used to measure the static balance is kept in balance standing on one leg, while the other is elevated [9]. We consider that a complete evaluation is necessary to measure the static balance in physical education, so the primary objective of the present study is the validation of BESS test as a tool to know the characteristics of the balance in elementary and high school students.

## 2. Methods

### *2.1 Subjets and Study Desing*

The present study is of cross-sectional type and experimental modality. The universe is made up of 193 elementary students and 65 high school students from Ypsilanti College. The sample consisted of 26 students of 5 primary school, 13 women and 13 men, and 26 students of 4th-semester of high school, also 13 men and 13 women. The selection of the sample was non-probabilistic, and the validation structure of the test is based on the proposal by Morales in the book Sports biomechanics by Buendia et al. [10].

**Corresponding author:** Claudia Magaly Espinosa Méndez, MFD, Ph. D. candidate, associate professor, research field: exercise, prevention and physical readaptation.

*2.2 Procedure*

The legal framework of the investigation was based on the Declaration of Helsiniy 2008, which establishes ethical principles for research in humans.

A written permission was requested from the Ypsilanti school, specifying the purpose of the investigation, with the commitment to safeguard the personal data of both the participants and the school. An invitation to the students was made to participate in the project and an informed consent was elaborated to be signed by the parents of the participants, before starting the applications.

To start the application, first, a verbal explanation was given to all the participants, to recognize the procedure that would be carried out. Doubts were clarified and the participants were asked for commitment, attendance and punctuality, on the days of application of the test. The material used was as follows: whistle to indicate the beginning and the end of each of the 6 positions, square mat 35 × 35 cm with 5 cm of thickness (for the 3 tests in unstable surface), a chronometer to measure the 20 seconds of duration of each position, and the preexisting instrument for the error count of the BESS test [2, 4, 6] (Table 2). Two applications were carried out to each participant, in a personalized way, with a week and a half difference between each shot, the location and the applicator were the same in all cases. In the intermediate time of the applications, no specific exercises were performed to improve the test results. The first day of application was identified the dominant foot of each participant, through the objective test "precision kick" [12]. Then the 6 positions were executed (Fig. 1).

*2.3 Statistical Analyses*

For the statistics of all the data was used R language to use parametric and nonparametric, paired T test [11]. The data obtained by the applicator were introduced to the software ptets [13], in order to obtain results.

## 3. Results

Table 3 shows the statistic to test if the mean of the measurements is the same or there is a difference after one week. We first review the assumptions for the case of the parametric test and if not, a nonparametric test is applied to verify the equality or not of the means of the samples:

Sample x is normal [Shapiro Test]

The sample y is not normal [Shapiro Test]

The averages are the same, [U/Man Witney/Wilcoxon/Wilcoxon rank-sum, nonparametric]

**Table 1 BESS positions and errors.**

| Positions | Errors |
|---|---|
| 1. Feet together in biped position (firm and unstable surface)<br>2. One-foot stance on the floor and elevated dominant foot. (firm and unstable surface)<br>3. Tandem position, one foot in front of the other. (firm and unstable surface)<br>*In all positions the hands are in the hip and the eyes remain closed. | 1. Open the eyes<br>2. Raising hands from the hips<br>3. Taking a step<br>4. Stumbling or falling out of position<br>5. lifting of the front part of the foot or heel<br>6. Abduction of the hip in more than 30º<br>7. Return to the test position in more than 5 seconds. |

**Table 2 Instrument to count errors.**

| BESS test positions | Score |
|---|---|
| 1. Feet together in biped position | |
| 2. One-foot stance on the floor and elevated dominant foot. | |
| 3. Tandem | |
| 4. One-foot stance on the floor and elevated dominant foot on unstable surface | |
| 5. Feet together in biped position on unstable surface | |
| 6. Tandem on unstable surface | |
| Total | |

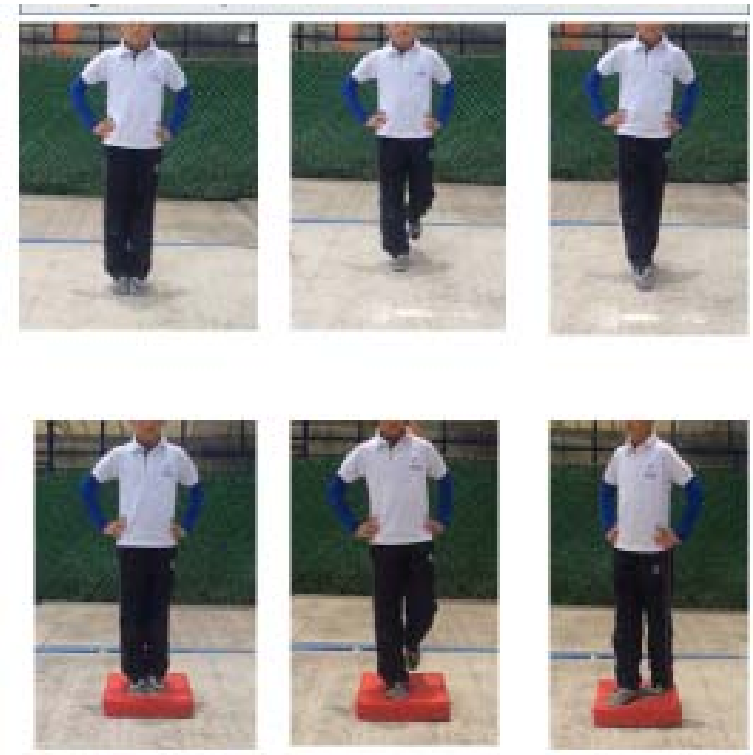

**Fig. 1 Sample test.**

Sample x is normal [Shapiro Test]
The sample y is normal [Shapiro Test]
The variances are the same, [F Test]
The averages are the same, [T]
Sample x is normal [Shapiro Test]
The sample y is normal [Shapiro Test]
The variances are the same, [F Test]
The averages are the same, [T]
Sample x is normal [Shapiro Test]
The sample y is normal [Shapiro Test]
The variances are the same, [F Test]
The averages are the same, [T]
Sample x is normal [Shapiro Test]
The sample y is normal [Shapiro Test]
The variances are the same, [F Test]
The averages are the same, [T]
Sample x is not normal [Shapiro Test]
The sample y is not normal [Shapiro Test]
The averages are the same, [U/Man Witney/Wilcoxon/Wilcoxon rank-sum, nonparametric].

Table 4 shows the statistic to test if the mean of the measurements is the same or there is a difference after one week.

We first review the assumptions for the case of the parametric test and if not, a nonparametric test is applied to verify the equality or not of the means of the samples:

Sample x is not normal [Shapiro Test]
The sample y is not normal [Shapiro Test]
The averages are different, [U/Man Witney/Wilcoxon/Wilcoxon rank-sum, non-parametric]
Sample x is not normal [Shapiro Test]
The sample y is not normal [Shapiro Test]
The averages are the same, [U/Man Witney/Wilcoxon/Wilcoxon rank-sum, nonparametric]
Sample x is not normal [Shapiro Test]
The sample y is not normal [Shapiro Test]
The averages are the same, [U/Man Witney/Wilcoxon/Wilcoxon rank-sum, nonparametric]
Sample x is not normal [Shapiro Test]
The sample y is normal [Shapiro Test]
The averages are different, [U/Man Witney/Wilcoxon/Wilcoxon rank-sum, non-parametric]

**Table 3 Primary School**

| Feet together | Feet together (2 take) | One-foot stance on the floor and elevated dominant foot. | One-foot stance on the floor and elevated dominant foot. (2 take) | Tandem | Tandem (2 take) | Feet together in biped position on unstable surface | Feet together in biped position on unstable Surface (2 take) | One-foot stance on the floor and elevated dominant foot on unstable surface | One-foot stance on the floor and elevated dominant foot on unstable Surface (2 take) | Tandem on unstable surface | Tandem on unstable surface (2 take) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 4 | 4 | 5 | 6 | 3 | 3 | 4 | 4 | 5 | 7 |
| 1 | 1 | 3 | 3 | 4 | 4 | 2 | 2 | 4 | 4 | 4 | 4 |
| 3 | 3 | 9 | 0 | 6 | 6 | 4 | 4 | 8 | 8 | 4 | 7 |
| 3 | 3 | 8 | 8 | 3 | 4 | 4 | 4 | 9 | 9 | 4 | 4 |
| 5 | 5 | 7 | 7 | 4 | 5 |  | 6 | 8 | 8 | 4 | 5 |
| 4 | 4 | 6 | 6 | 7 | 6 | 4 | 4 | 5 | 5 | 9 | 7 |
| 1 | 1 | 3 | 3 | 9 | 7 | 1 | 1 | 5 | 5 | 9 | 8 |
| 4 | 4 | 4 | 4 | 6 | 5 | 4 | 4 | 8 | 8 | 7 | 6 |
| 2 | 3 | 4 | 5 | 7 | 7 | 3 | 5 | 6 | 6 | 7 | 5 |
| 5 | 5 | 4 | 4 | 8 | 6 | 4 | 4 | 6 | 6 | 6 | 7 |
| 4 | 4 | 4 | 4 | 9 | 9 | 5 | 5 | 9 | 5 | 7 | 9 |
| 1 | 3 | 5 | 6 | 5 | 5 | 3 | 3 | 4 | 4 | 6 | 6 |
| 2 | 4 | 8 | 6 | 8 | 6 | 3 | 5 | 8 | 5 | 9 | 9 |
| 3 | 3 | 8 | 6 | 3 | 3 | 4 | 4 | 9 | 7 | 4 | 4 |
| 3 | 3 | 6 | 5 | 6 | 5 | 5 | 5 | 7 | 6 | 6 | 6 |
| 4 | 4 | 9 | 7 | 6 | 6 | 6 | 6 | 10 | 5 | 4 | 4 |
| 5 | 4 | 6 | 6 | 3 | 4 | 6 | 6 | 4 | 4 | 5 | 8 |
| 1 | 1 | 2 | 2 | 4 | 3 | 2 | 2 | 2 | 2 | 6 | 4 |
| 6 | 4 | 5 | 5 | 5 | 7 | 7 | 7 | 7 | 7 | 9 | 8 |
| 1 | 1 | 5 | 5 | 7 | 5 | 4 | 6 | 6 | 6 | 9 | 8 |
| 4 | 3 | 4 | 5 | 5 | 5 | 4 | 5 | 6 | 7 | 7 | 6 |
| 2 | 2 | 7 | 7 | 7 | 6 | 3 | 3 | 8 | 7 | 9 | 8 |
| 2 | 4 | 4 | 5 | 4 | 6 | 4 | 5 | 6 | 6 | 7 | 8 |
| 3 | 4 | 5 | 6 | 5 | 5 | 4 | 4 | 7 | 7 | 8 | 8 |
| 3 | 1 | 6 | 5 | 6 | 5 | 4 | 4 | 7 | 6 | 9 | 7 |
| 3 | 2 | 8 | 7 | 7 | 6 | 7 | 5 | 8 | 8 | 9 | 7 |

**Table 4 semester high school.**

| Feet together | Feet together (2 take) | One-foot stance on the floor and elevated dominant foot. | One-foot stance on the floor and elevated dominant foot. (2 take) | Tandem | Tandem (2 take) | Feet together in biped position on unstable surface | Feet together in biped position on unstable Surface (2 take) | One-foot stance on the floor and elevated dominant foot on unstable surface | One-foot stance on the floor and elevated dominant foot on unstable Surface (2 take) | Tandem on unstable surface | Tandem on unstable surface (2 take) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 3 | 6 | 5 | 3 | 4 | 8 | 8 | 8 | 8 | 5 | 6 |
| 3 | 3 | 8 | 8 | 5 | 4 | 4 | 6 | 6 | 6 | 7 | 6 |
| 3 | 3 | 6 | 5 | 5 | 7 | 6 | 5 | 7 | 8 | 7 | 7 |
| 2 | 4 | 6 | 6 | 4 | 4 | 5 | 5 | 7 | 9 | 4 | 4 |
| 5 | 6 | 10 | 10 | 10 | 10 | 7 | 8 | 10 | 10 | 9 | 9 |
| 7 | 7 | 10 | 10 | 10 | 10 | 8 | 8 | 10 | 10 | 10 | 10 |
| 4 | 5 | 6 | 6 | 7 | 7 | 4 | 6 | 10 | 10 | 5 | 6 |
| 5 | 3 | 10 | 10 | 6 | 6 | 4 | 5 | 8 | 8 | 6 | 7 |
| 4 | 5 | 10 | 10 | 9 | 9 | 4 | 6 | 10 | 10 | 10 | 10 |
| 5 | 6 | 9 | 9 | 6 | 6 | 5 | 7 | 10 | 10 | 8 | 7 |
| 2 | 6 | 10 | 10 | 6 | 6 | 5 | 7 | 10 | 10 | 8 | 9 |
| 2 | 4 | 7 | 9 | 6 | 5 | 3 | 5 | 9 | 9 | 5 | 7 |
| 2 | 3 | 6 | 6 | 3 | 4 | 3 | 6 | 8 | 8 | 5 | 4 |
| 5 | 6 | 9 | 9 | 5 | 7 | 5 | 7 | 10 | 10 | 8 | 8 |
| 3 | 4 | 5 | 5 | 4 | 4 | 4 | 5 | 7 | 8 | 7 | 8 |
| 2 | 3 | 5 | 6 | 5 | 6 | 2 | 4 | 7 | 8 | 7 | 7 |
| 32 | 4 | 7 | 7 | 5 | 5 | 5 | 6 | 9 | 9 | 6 | 7 |
| 4 | 3 | 8 | 8 | 10 | 10 | 3 | 4 | 10 | 10 | 10 | 10 |
| 3 | 5 | 6 | 6 | 5 | 6 | 4 | 6 | 9 | 9 | 9 | 9 |
| 3 | 4 | 9 | 9 | 5 | 5 | 3 | 7 | 10 | 10 | 5 | 6 |
| 6 | 6 | 7 | 8 | 7 | 9 | 8 | 9 | 10 | 10 | 10 | 10 |
| 3 | 5 | 8 | 8 | 7 | 8 | 8 | 8 | 10 | 10 | 10 | 10 |
| 5 | 5 | 7 | 7 | 9 | 9 | 10 | 10 | 10 | 10 | 9 | 10 |
| 4 | 6 | 7 | 8 | 10 | 10 | 9 | 9 | 10 | 10 | 9 | 9 |
| 8 | 8 | 9 | 9 | 9 | 10 | 9 | 9 | 10 | 10 | 10 | 10 |
| 4 | 6 | 6 | 6 | 7 | 7 | 6 | 8 | 9 | 9 | 9 | 9 |

Sample x is not normal [Shapiro Test].

The sample y is not normal [Shapiro Test]

The averages are the same, [U/Man Witney/Wilcoxon/Wilcoxon rank-sum, nonparametric]

Sample x is not normal [Shapiro Test]

The sample y is not normal [Shapiro Test]

The averages are the same, [U/Man Witney/Wilcoxon/Wilcoxon rank-sum, nonparametric].

Thus, it can be verified, in a mathematical way, that the BESS test is valid for 5th-grade students of primary school, but it is not valid for 4th semester of high school.

## 3. Discussion

To our knowledge, this research is the first to examine the possibility of using a clinical test in the area of physical education. We found valid the application of the BESS test for 5th grade primary students, but not for 4th semester high school students, a result related to the number of errors compared between the two samples for each student. The errors presented by the elementary students were similar in both takes, on the other hand, errors of the high school students increased, contradicting what was established by some studies, which assure that the test is commonly used to evaluate adolescents and young adults [14], and other who mention that the balance improves from youngest to oldest [15]. Coinciding, secondly, with studies that indicated that there are more errors in the test, by older people [4].

We found that it is necessary to use a complete test to evaluate the balance in physical education, and the BESS test is suitable since attempts to challenge the sensory systems by combining a variety of stances on a firm surface as well as a more unstable surface [5], instead of the most standard tests to evaluate static balance, as they included the stork stand for both legs, the diver's stand and the stick test [16].

## 4. Conclusions and Suggestions

We conclude that the BESS test is valid to obtain information about static balance in students of 5th-grade of primary, not so for high school students. However, these results cannot be generalized, there for we suggest doing more related studies, with larger samples and different ages, to obtain more accurate results.

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