SOFTWARE FOR LONGITUDINAL AND INTEGRATED ANALYSIS OF PHYSICAL CAPACITIES OF INDIVIDUALS AND GROUPS OF ATHLETES

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The purpose of this study is to present the Athlete Profile software which was developed to assist professionals involved in sport training to extract information from results of physical tests carried out by large groups of athletes. Through different graphic resources the software allows, in an interactive way, the simultaneous viewing of the performance of an athlete in all physical tests at different moments of training and the comparison with the evolution of his group. Using reference tables that classify the results of each test from very low to excelent, depending on the sex and age of the athlete, the software also allows the physical fitness characterization and the comparison of the physical development of the athlete with the expected.

KEY WORDS: training, physical tests, databases

INTRODUCTION: The physical tests results, when analyzed in an integrated way, provide information about the physical development of an athlete regarding himself, his training group and his peers of the same age and sex. In Brazil, several sports institutions conduct, with their young athletes, a battery of seven physical tests proposed by Brazil Sport Project - PROESP-BR (Gaya e Silva, 2007). The project provides a complex system of reference tables that classify the results of each test as very low, low, moderate, good, very good and excelent depending on the sex and age of the individual (from 7 to 18 years old).
The integrated and longitudinal analysis of performance in physical tests carried out by large groups of athletes is difficult in the sporting context. Associating this analysis with reference tables becomes an even bigger challenge. The Profile Athlete was developed with the goal of creating different graphs allowing the confrontation of results both individually and in group with the reference tables.

METHODS: The software was developed in Matlab ® environment and consists of two databases: one generated by the results in physical tests and another consisting of the reference tables. The seven proposed physical tests are: abdominal endurance, sit and reach, medicine ball throw, standing long jump, 20m sprint, 9 minutes running and square agility test.
The date of birth of each athlete is used to establish his age at time of the different physical assessments and also to create an individual code to preserve the identity of the subjects.
On the initial screen are the available commands for the user to interact with the software:
1. *Graphic analysis*: opens a window containing four graphs to show the performance of the athlete and his group at all physical assessments.
2. *Performance values*: opens a window that contains the detailed results of the athlete at the evaluation moment selected by the user.
3. *Body composition*: opens a window containing the values (when provided) of body composition of the athlete and his group at all the evaluation moments.
When an athlete is selected, the software generates four graphs that in Figure 1 were didactically enumerated to facilitate the analysis. Graph 1 shows the performance of the athlete at all moments of physical assessments. Each one of the graphs, from 2 to

4, presents the performance of the athlete and his group in a moment of physical assessment. The grid in polar coordinates, in which are shown the individual and group performances, is created from the reference tables interpolated for the age of the athlete at the moment of the physical assessment.
At the top of the screen displayed in Figure 1 are the athlete information (identity, number and sex) and below each graph are the information of the athlete in every moment of physical assessment (age, individual and group average performance in all physical tests).

RESULTS AND DISCUSSION: After choosing an athlete, Figure 1 is an example of the generated screen by the command "Graphic analysis". In the software, the results obtained in physical tests are represented at the vertices of the colored polygons and each color corresponds to a moment of evaluation. In the Graph 1 it is possible to monitor the development of the performance of the athlete regarding himself. The grey polygon corresponds to the upper limit of the very good classification for the age of the athlete in the last moment of evaluation. The other graphs show the performance of the athlete in every moment of physical evaluation and the five dashed polygons correspond to the limit of the intervals that classify the results in very low, low, moderate, good, very good and excelent in each test, to the age of the athlete at the evaluations moments. The black solid polygons correspond to the average performance of the group. The example presented in Figure 1 shows the evolution of the physical performance of the athlete, evaluated at three moments throughout the training.

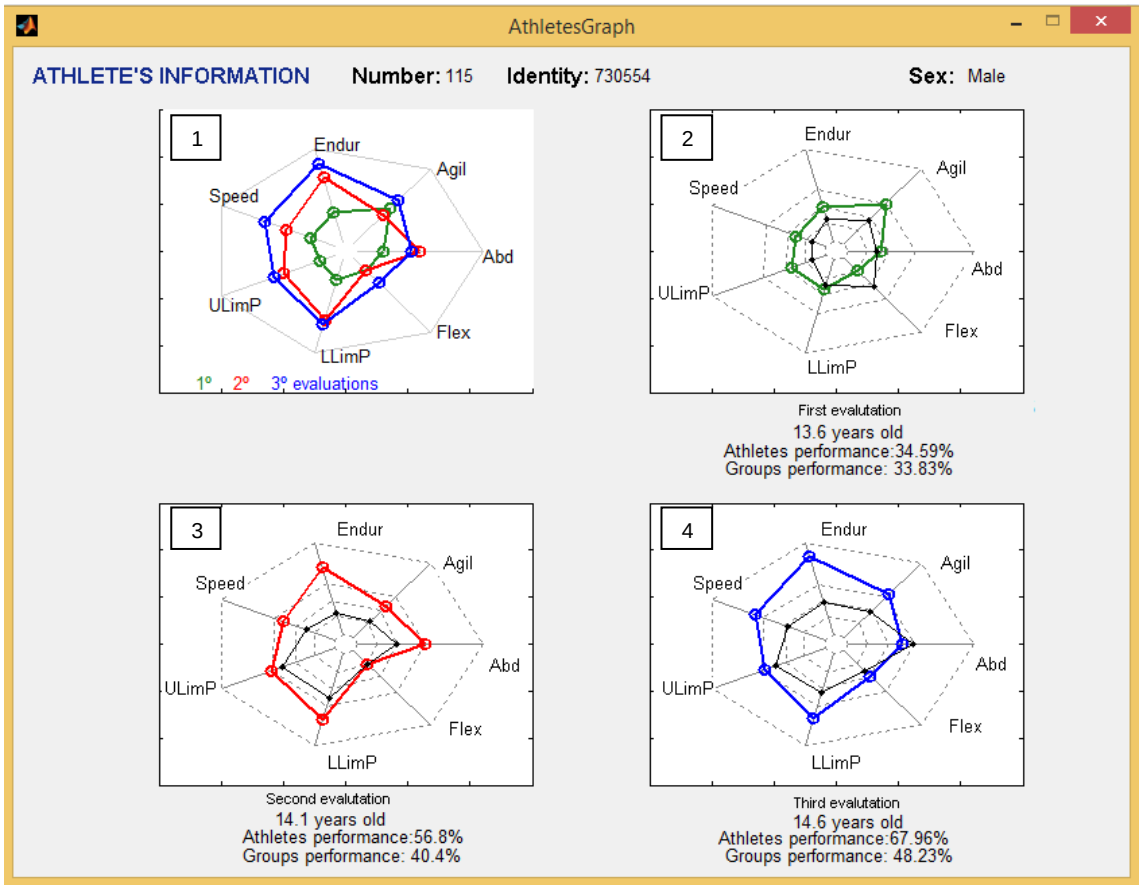


Figure 1: Screen for viewing the performances of the athlete and his group. Legend: Endur = Endurance, Agil = Agility, Abd = Abdominal Endurance, Flex = Flexibility, LLimP = Lower Limbs Power, ULimP = Upper Limbs Power.

In the graphs generated in Figure 1 we can follow the development of an athlete and his group throughout the training. In 2011, Reis et al have developed a software which allows the comparison of the results obtained by a group of athletes, in a specific physical test, in two different moments of evaluation. The software Athlete Profile becomes and innovative tool in the sporting environment for enabling the individual monitoring of the effects of training and integrated analysis of the athlete's conditioning in every physical capacity.

According to Hopkins (2004), the magnitude of improvement of performance is one of the most important information to be extracted from the physical tests and in the software it may be obtained through graphical analysis. In Graph 1 we see that athlete showed a great improvement in capacities of endurance, speed and muscle power. The capacity of agility was little responsive to training. This information is important to direct the training to the needs of the athlete and maximize its effects.

We can observe that in the first physical evaluation performed (Graph 2) the performance of the athlete was classified as moderate in all tests, with the exception of agility. At that moment the athlete presented a lower performance than his group in the flexibility test. In the second evaluation (Graph 3) the performance of the athlete was classified as good and very good in all physical tests and his performance in the flexibility test has improved, reaching the average performance of his group. In the third moment of evaluation (Graph 4) the performance on the flexibility test has progressed, being classified as good, and in all other tests the performance was classified as very good.

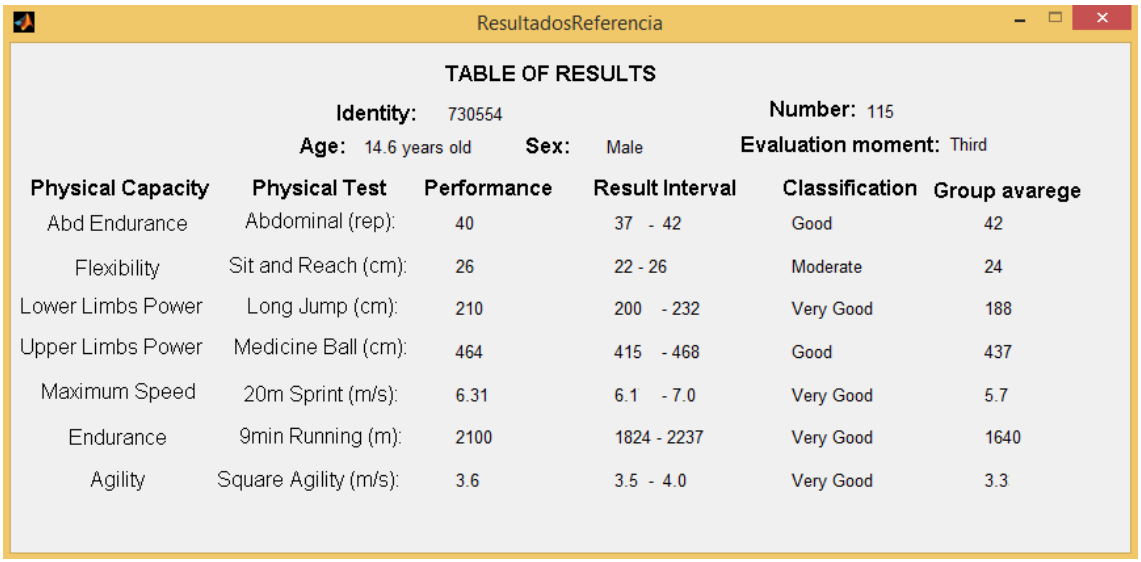
Under each graph are generated the average performance values of the athlete and his group in all physical tests (in percentage of the "very good" upper limit). This value provides an overall assessment of them in the physical abilities. In the example above we see that despite the average performance of the athlete and his group are similar in the first assessment, 34.6% and 33.8% respectively, the athlete was more responsive to training improving his average performance to 67.9%, while the group has evolved just to 48.2%.

Borresen and Lambert (2009) discuss about the diversity of responses in large groups of athletes facing the same training load. In the software it is possible to monitor and confront the adaptations of individuals and groups. We note that in the first physical assessment the performance of the athlete in the flexibility test was below that of its group, but it has improved throughout the training. The capacities of resistance and speed, which in initial evaluation presented performances next to the group, showed a greater magnitude of response to training.

The visual analysis of the performance of this athlete proved the efficiency of the training conducted. However, in other cases this analysis can identify the nonresponsive capacities to the physical training, generating important information for the individualization and targeting training to care for the needs of the athlete.

Another command available in the software is the "Performance value". Through this command it is possible to select an evaluation moment to access the detailed results of the athlete in the physical tests. Figure 2 presents the screen generated by selecting the second half of 2014.

On this screen (Figure 2) are shown all the physical capacities assessed and the respective physical tests performed. In the column "Performance" are the results of the athlete at the selected test moments. The values provided in "Result Interval" correspond to the reference intervals in which the athlete's performance is and his "Classification". If the goal is to compare the athlete with his group, the average performance of the group in each physical test is also available in "Group average".



Physical Capacity	Physical Test	Performance	Result Interval	Classification	Group avarege
Abd Endurance	Abdominal (rep):	40	37 - 42	Good	42
Flexibility	Sit and Reach (cm):	26	22 - 26	Moderate	24
Lower Limbs Power	Long Jump (cm):	210	200 - 232	Very Good	188
Upper Limbs Power	Medicine Ball (cm):	464	415 - 468	Good	437
Maximum Speed	20m Sprint (m/s):	6.31	6.1 - 7.0	Very Good	5.7
Endurance	9min Running (m):	2100	1824 - 2237	Very Good	1640
Agility	Square Agility (m/s):	3.6	3.5 - 4.0	Very Good	3.3

Figure 2: Screen for viewing athlete's detailed results in the selected evaluation moment.

We can see that only in the test of flexibility the athlete was classified as moderate. However, in the endurance test the performance of the athlete was classified as very good and well above his group. The information about the level of the performances of each athlete is valuable to enrich the tactical planning of the team.
If the group has been evaluated in body composition it is possible to access the body changes of the athlete and compare it with his group through the command "Body composition".

CONCLUSION: The software presented in this study has been used in the sporting environment with the aim to monitor and characterize the physical conditioning of individual and/or group of athletes. The different graphic resources used in the software and its easily managing allow the users, in an interactive way, to extract information relevant to sports training from data generated by physical tests.

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