A NEW METHOD FOR EVALUATING THE BALANCE BETWEEN THE DIFFERENT PHASES IN 100 M SPRINTING

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The aim of this paper was to investigate, whether it is possible to objectively evaluate the relationship between three different phases of 100 m sprint running. Following correlation analyses from six major athletics championships, a linear regression based scoring system was created for the acceleration, maximum velocity and velocity maintenance phases. The scoring system can be used for athletes from international level down to moderate national level. Tests for two female juniors showed that the maximum velocity phase was the weakest part of their performance. Therefore, recommendations can be made to coaches for changes to be made in training. This strategy has already resulted in improved balance between different phases for a specific athlete. Current studies are expanding the analysis into the area of individual running gait variables.

KEY WORDS: kinematics, testing, linear regression, timing, female

INTRODUCTION: The performance of 100 m sprint running can be divided into a start and acceleration phase, a maximum velocity phase, and a velocity maintenance phase. Observation of competitions reveals that there are athletes who are very strong starters or have a good velocity maintenance phase. However, at the top level of participation, with times close to world records, it is clear that an athlete cannot afford to have major weaknesses at any point of the run.

In 1998, the Finnish Amateur Athletics Federation created a special project for young and talented athletes in sprint events. The aim of the project was to enable athletes to successfully compete in European Athletics Championships in 2002 and beyond. Traditionally, the Finnish coaching system uses testing in order to evaluate the athlete's condition during the training season. However, the normal speed testing results were given as a measured time and it was not always clear whether the athlete had achieved a balanced run and whether the training had developed the athlete in a desirable way.

Therefore, there was a need to evaluate objectively, the running performance especially for young, developing athletes. The first stage of the project was to look at the relative ratio of the different phases in a sprint. Consequently, one aim of the current study was to investigate, whether or not it was possible to create an objective method to evaluate the balance between the different phases of sprinting . A second aim was to demonstrate how the developed method could be applied in the evaluation and training of young athletes.

METHODS: The starting point of this study was the assumption that elite athletes have a reasonably balanced running strategy, and that these performances of international top level athletes could provide a benchmark for others. Additionally, from the coaching point of view, it was decided that an 80 m running test would be suitable performance indicator during the training season at the indoor tracks. The test distance was changed from the traditional 60 m test (which also is an indoor competition distance) to an 80 m test in order to accommodate all three different phases of sprinting.

The results of 100m. sprints from six world-level championships in athletics between 1987 and 1999 were used for the basic data. The data were obtained from the following competitions: World Championships (WC) in Rome 1987, Olympic Games (OG) in Seoul 1988, WC in Tokyo 1991, OG in Barcelona 1992, WC in Stuttgart 1993, and WC in Seville 1999. The split times of female finalists at the 30 m, 60 m, 80 m marks and the final 100 m time were collected from reports, e.g. Moravec et al. (1988) and Brüggemann & Glad (1990). Additionally, they were collected from the information, which was distributed for all teams during the particular Championships by the organisers and IAAF (e.g. Seville 1999). Data were also available from some of the semi-finals. However, no data were included from heats, as it was considered that the best athletes may not have performed to their individual limits during the heats, thus potentially disguising the real ratio between the different phases of the performance. Furthermore, the data from heats were heterogeneous and included athletes, whose ratio between the different phases were unlikely to be balanced.

Split times from 56 runs were used for the analysis. The 100m times varied from 10.54 s to 11.52 s (mean 11.06s and SD 0.20 s). From OG in Barcelona, 30m split times were not available, thus the number of data points was 48 for the related data sets. It can be seen that the same athletes have been used more than once. However, data from the same athlete were never used twice from the same games (i.e. from the semi-final and final), but only in different years. Thirty metre split time, interval time from 30 m to 60 m mark and interval time from 60 m to 80 m mark were correlated with the 100 m times. The correlation values were 0.78, 0.92 and 0.89, respectively, and all revealed significance at the p<.001 level (see Fig. 1.a-c). This high level of significance within the moderately homogenous group provided confidence that the linear regression could be used to predict the requirements at each phase for athletes with lower ability levels than those in the present study.

Fig. 1a. 100 m times vs. 30 m times

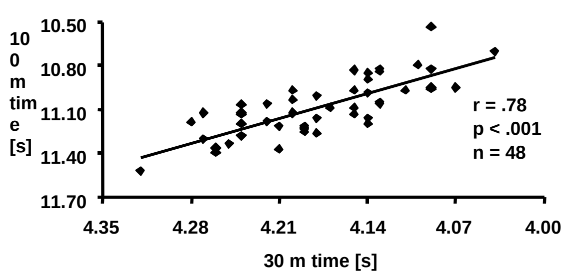

Fig. 1b. 100m times vs. 30-60 m times

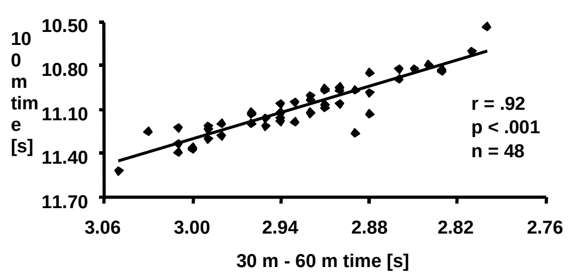

Fig. 1c. 100 m times vs. 60-80 m times

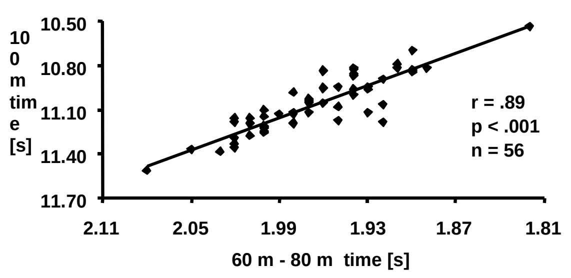

Table 1 The Point Scoring System for the Border Values in each

		10.70 s level	12.70 s level
Scoring		10 points	0 points
30 m time	[s]	4.02	4.85
30 m - 60 m time	[s]	2.80	3.46
60 m - 80 m time	[s]	1.86	2.41

Figure 1a-c - Correlations of 100 m times against times in each phase for international level female athletes.

Using linear regression, the respective values in each phase were calculated for athletes with 100 m times ranging from 10.70 s to 12.70 s (Table 1.). The first time that was obtained, represented the top level of elite international female sprinting (excluding Florence Griffith-Joyner's World Record of 10.49 s), consequently, the following time represented the level of a national junior athlete. The international top level time was given ten points and the lower limit time was given zero points (Table 1.). Subsequently, the linear equations for scaling all times for points in each running phase were calculated (see Results section).

The point scoring system was tested on two talented Finnish junior female athletes (both born in 1980). During this two year testing period, subject HH improved her personal best over 100 m from 11.83 s (1998) to 11.62 s (1999). The respective times for subject JM were 11.59 s and 11.44 s. The tests for the 80 m run were carried out in training. The tests were conducted using photocell equipment with an automatic start of the timing from the starting signal. The required times were transferred into data points and plotted as graphs. The potential strengths and weaknesses of the athletes were discussed with the individual coaches in order to emphasise the proposed changes needed in the training programme.

RESULTS AND DISCUSSION: The linear equations for the scaling of the times for points in each phase are as follows:

30 m time: $y = -12.052x + 58.441$
30 m - 60 m time: $y = -15.055x + 52.143$
60 m - 80 m time: $y = -18.263x + 44.059$,

where y = the point scored and x = the time for the respective phase.
As the scoring system is based on equations of linear regression, scores could be achieved with higher values than ten points, particularly if an athlete is exceptional at any particular phase. Similarly, points below zero are possible, although it is not recommended that this scoring system be adopted for athletes with a personal best of less than 12.70 s.
The results from four testing sessions for subject HH are presented in Fig. 2a. Additionally, for this athlete, split times from one 60m indoor competition were also available. Subsequently, the scores for 30 m and 30 to 60m from this competition have also been plotted in the same figure. Figure 2b. also includes the results from the athlete JM in a training situation. Additionally, the scores from the gold medallist (MJ, 10.70 s) and the silver medallist (IM, 10.79 s) from the WC in Seville in 1999 have been plotted for the comparison.

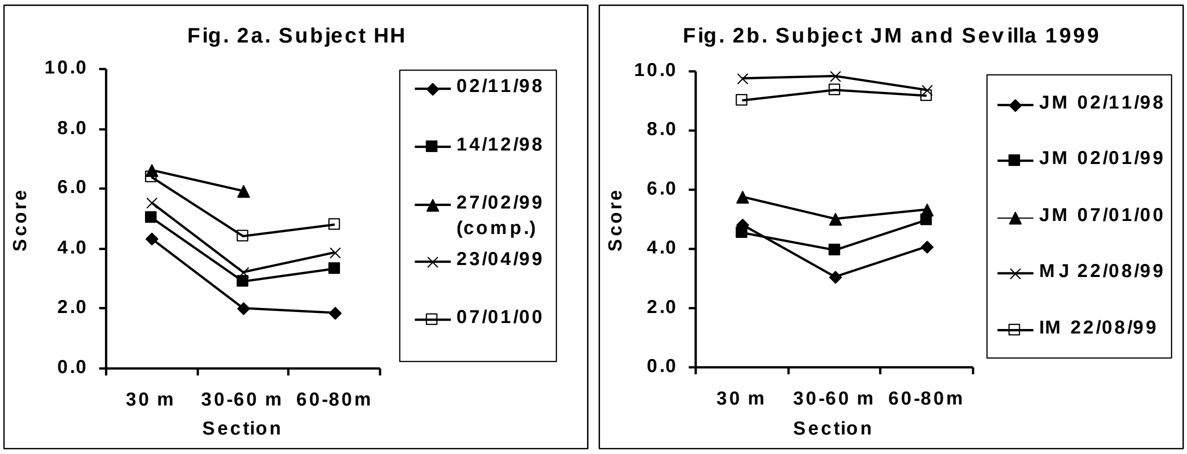

Figure 2a-b - The scoring results from the two test subjects and from the two medallists in the Seville World Championships 1999.

It was not surprising that the Finnish juniors did not score as well as the top international level athletes (Fig. 2b.). However, it is evident from the graphs that the scores (lines) for MJ and IM were more consistent than the results of the Finnish juniors. They showed the required balance between the different phases required to compete successfully at International Championships. Consequently, this should also be the aim for lower level athletes. Both Finnish test subjects showed a strong acceleration phase compared to the maximum velocity phase. This has traditionally been the case with Finnish athletes due to circumstances and training programmes. During the cold winter period, the training is more likely to overemphasise the strength component of the conditioning work, which improves the start. Also, running training is often carried out in short 'straights' indoors, which are not long enough to reach and especially, to maintain the maximum velocity. Furthermore, the coaching knowledge in the past may have placed too much emphasis on short runs. Based on the analysis obtained from this study, the main task for both subjects is to improve maximum velocity, which naturally is essential for reaching the top level. The scoring system highlights this need more clearly than absolute timing with photocells. It was noted that subject HH achieved the improved maximum velocity only in competition.

The competition analysis for subject HH provided an interesting comparison, and highlighted the differences between data in a training situation and a competition. Additionally, the influence of spring training was visible for HH, as the scores lowered from the competition in February to the next testing session in April 1999.

In competition, subject H H's difference between 30 m and 30 to 60 m scores was 0.7 points compared with differences varying from 2.0 to 2.3 in tests which were carried out in training. However, subject JM had the respective difference of 1.7 points in the first test, which decreased to deficits of 0.8 and 0.6 points in consecutive tests. This was mainly due to the improved maximum velocity phase (it can be noted that the second test had 0.2 points lower acceleration phase than the first test). Neither of the Finnish subjects achieved higher scores in the maximum velocity phase when compared with the acceleration phase, which was in contrast to the results of the two international athletes (Fig. 2a-b).

As a consequence, the recommendation for coaches is to create conditions and training programmes, which emphasise running at maximum velocity. High velocity running is a very skilful task and it can be learned only by practising. Obviously, the aim of training is to achieve improvement in all phases. The consecutive results for both Finnish athletes showed that the general trend was upwards.

The velocity maintenance phase scores for the Finnish subjects were relatively high when compared to the maximum velocity scores. However, the two international level athletes generally showed closer agreement between the scores at these two phases than the Finnish athletes. The reason for this may rely on what had occurred at the first phase of the run. As stated earlier, both athletes experienced problems in achieving high maximum velocity. This may be due to ineffective acceleration. If athletes were able to accelerate longer, then the maximum velocity phase and consequently the velocity maintenance phase would transfer into the later stage of the run. This would yield increased velocity at the velocity maintenance phase and subsequently a higher score for this phase.

The general perception was that athlete MJ had a very strong finish. Thus, it may be of interest to find out that the velocity maintenance score declined from the score of the maximum velocity phase. However, the time between 60 m and 80 m was 1.90 s for MJ, which is significantly longer than the exceptional finish by Florence Griffith-Joyner in Seoul Olympics 1988. The respective time of FGJ was 1.82 s, which yielded 10.8 points in comparison with 9.8 points for MJ. It is helpful to remember that in the final of the Seoul Olympics there was a 3.0 m/s following wind, which would have given extra advantage to FGJ.

CONCLUSION: A new linear regression based method to objectively evaluate the balance of 100 m sprint running performance was created and tested for two junior female athletes. The resulting point scoring system highlighted the strengths and weaknesses in athletes' performances. This enables recommendations to be made to coaches in order to change the emphasis of training. The scoring system can be easily adapted into a table format, which would enable coaches to have instant scoring in a test situation without recourse to formulae. For the athletes in this pilot study, it would be desirable to evolve the balance of running by improving the maximum velocity phase in comparison with the other two phases and to monitor their future performance. The athletes in this pilot study belong to the special project group aiming for the 2002 European Championships and beyond. Future studies in this project are under way. The next stage will investigate individual running strategies and will include running gait variables, which could provide further insight into strengths and weaknesses of individual athletes.

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