# 14 - INFLUENCE OF OVER-MAXIMAL RUNNING SPEED ON KINEMATICAL PARAMETERS OF RUNNING STRIDE

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## INTROCDUTION

Development of speed abilities is very topical problem of the sport theory and practice. During speed abilities development we must realise that “speed is mostly developed by speed.” That's why the most effective and most frequent method of the speed abilities' development is the repetitive method in maximal intensity. One of possibility for the maximal running speed development is the use of the contrast method, substance of which deals in the intentional change and combine (natural, easier, more difficult) of the speed exercises' performance. The creation of easier condition for the motor activity realisation is enabled by changing of several parameters which is manifested in reaching higher than maximal speed in natural conditions. We talk about over maximal at present termed like over limited or supra-maximal speed. The sport practice confirmed the reliability and efficiency of the use of the supra-maximal speed means, but in parallel demanded to ask more exact ways for its application. From the position of supra-maximal speed means' use there is a valid recommendation of Chomenkov (1974), Naglak (1974) and some others, that easier conditions can be done only up to the level that enable to reach such a speed which is the runner able to reproduce in natural conditions in the short period.

There was confirmed (Holland, 1984; Bosco – Vittori, 1986; Mero and all, 1987; Mero – Komi, 1990; Dintiman and all, 1997; Sedláček et all 2004) the different dynamism of kinematical parameters changes during the running increase of speed. For example on the running speed rise share stride length and stride rate but in higher velocities their relationship changes at undesirable way.

Many researchers and coaches confirmed the positive influence of supra-maximal speed means' use for the maximal running speed changes. But there can be said that the sport practice has not till now available rounded-off, scientifically justified methodology of the supra-maximal speed means' application.

## OBJECTIVES

The purpose of this contribution is to explain possible problems in training use with supra-maximal speed means and on this basis contribute for making optimal methodology of stimulus application.

## METHODS

Regarding the variety, demands and logical link-up of tasks solution we had to work with several groups in longer period.

Groups differed in quantity, the level of their preparation and sport performance. Members of groups (n = 57) were short distance runners (100 – 400 m), who were in the phase of special and top-level sport preparation. Their age ranged from 14 to 31 and sport performance in 100 m from 11,90 s to 10,90 s.

Tests were performed in relatively stable conditions of Bratislava indoor stadium.

The maximal running speed was learned in the run of 20 m flying start with 20 m approach. On the same distance the sprinters passed the supra-maximal speed run. The reach of it was enabled with help of pulling appliance known as SPEEDY (fig. 1). The runner “pulling athlete” by the force of his pull and by the mean of a single pulley quickens the partner who reaches double velocity. The substitution of fixed anchor by mobile enabled us later to regulate pulling force. The pulling forces of 20, 30, 40 and 50 N were applied.

For detecting and processing basic kinematics characteristics of sprinters motor activity during the maximal and supra-maximal speed running we employed the measuring instrument “Locomometer” (Šelinger – Holček, 1993). The system works on-line, and basic parameter processing is available 1 min. after finishing tested run.

We worked with following parameters:

-average and immediate running speed,

-stride rate and length,

-time periods of single steps, their contact and flying times,

-derived parameters for example technique stability expressed by variance and standard deviation of measured values, effectiveness given as a rate of flying and contact time, activity given by rate of stride length and lasting of contact time etc.

During processing of the parameters we used logical methods, and methods of mathematical statistics. Reached empirical research results were confronted with other authors' results as well as practical coach experience.

## RESULTS AND DISCUSSION

### 1.Changes of kinematics parameters of sprinter motor activity during supra-maximal speed running

We performed 143 measuring in natural and 85 in easier conditions. The use of the pulling appliance with fixed anchor did not enable us to define and stabilise the pulling force. That is why runners were reaching the different level of the supra-maximal speed.

The average time of the maximal speed running was 2,167 s and the supra-maximal speed 1,936 s. It means that sprinters reached on the flying 20 m run in easier conditions in average better time of 0,231 s that is they were faster at 10,66 % like in the maximal speed running.

The statistical characteristics of kinematics parameters of running in natural and easier conditions are presented in table 1. In the supra-maximal speed conditions can be seen considerably, statistic highly significant changes of all parameters apart from practically not changed stride rate. It means that higher speed was reached with runners only by stride length increase.

Further by the mean of the pair correlation analyse we were looking for the coherence between running speed and

other parameters (fig. 2, 3, 4). In the natural conditions we did not confirm the significant relations of running speed with lasting of contact or flying phases, even with stride rate (fig. 2, 3, 4). Very small relationship we founded only between the velocity and length of running stride. In easier conditions there is a clear tendency that faster sportsmen have shorter contact time (fig. 3) and closest relationship can be seen between the velocity and stride length (fig. 4). Except this we founded only insubstantial relationship between the velocity and stride rate (fig. 4) and the relationship of the velocity with time of lasting of flying phases did not reach statistic significance (fig. 2).

On the basis of positive changes of contact and flying times and stride length and vice versa practically unchanged stride rate as well as on the basis of relative high correlation between the supra-maximal speed and stride length, we suppose that in easier conditions runners were passive. The reach of higher quality in several parameters we explain mainly by the activity of outer force: pulling apparatus.

The pulling appliance on one side enables considerable increase of running speed but the kinematical structure of running is changed from the point of view of higher level of speed – strength co-ordination abilities in undesirable way. So called "live pulling" with the help of fixed anchor indicates various pulling forces and at the same time with the supra-maximal level speed increase (higher than optimal) becomes deeper the negative character of the several parameters' changes of movement activity (for example stride length).

**2.Optimising of pulling force by the supra-maximal speed running application**

In the second half of this problem solution we started to regulate the magnitude of pulling force by the use of the frictional mechanism with the help of the weight in the pulley "Speedy" appliance. Members of the third group (26 sprinters in age 14 – 18 years with the performance 11,9 – 11,0 s in 100 m run) passed except others 6 – 8 runs on 20 m from flying start in the supra-maximal speed with four increased pulling forces (20, 30, 40, 50 N).

The condition of making the pulling force optimal is connected with parallel creation of conditions for stride rate increase. From the methodical point of view we consider as a decisive not to pull the sprinter by too high force in order to be able to do movements actively with higher frequency on the whole covered distance. This way enables to improve co-ordination on higher speed level of single extremities and the centre of gravity. According performed measurements it seems to us that such an active choice in pulling conditions are able to realise sprinters at pulling force magnitude 20, 30 and sometimes 40 N. Higher force application negatively influences demanded stride rate rise, disproportionately lengthens stride, causes the passive tread-down and forces runners to keep attention to a safe realisation of movement activity.

We mean that in easier conditions is adequate the velocity 5 – 8 % higher than the maximal running speed. The aim of this training is even with help of relatively small pulling force to create faster co-ordination connection of neuromuscular apparatus and thus create dispositions for overcoming speed barrier. But even in optimising of pulling force we found inter-individual differences. As a significant we consider fact found that further stride rate increase in supra-maximal conditions are able to realise only those sprinters who dispose its high starting value as well as shorter time of stride contact phase. Stated problem is probably close connected with the level of special co-ordination abilities. We manifest it on the example of two runners. L.B. (fig. 5) had during natural conditions running stride rate 4,66 Hz and during supra-maximal speed conditions, with individually optimized pulling force 30 N, was able to reach it until 5,07 Hz. Further pulling force increase (40 N) led also at this sprinter to negative phenomenon in running structure that is expressed by frequency decrease. On the contrary at K.S. (fig. 6) with the higher pulling force the stride rate mildly but fluently decreased – from 4,14 Hz to 3.96 Hz by pulling force 50 N.

On the basis of above stated facts we consider as a rightful the demand to respect at the supra-maximal speed application also individual specificity of sportsmen.

**CONCLUSIONS**

1.Kinematics characteristic of supra-maximal speed with extremely high pulling force has different character of changes comparing natural conditions. Sprinters in easier conditions act passively, they rely themselves on the outer pulling force's function. Higher velocity is reached by practically unchanged stride rate, exclusively by stride lengthening. Negative trend of changes of selected movement activity parameters is deepened with supra-maximal speed increase.

Mentioned facts indicate that there is a need of making optimal the stimulation from the point of view of motor abilities' development especially speed-strength and co-ordination.

2.Making more effective the application methodology of supra-maximal speed requires to make optimal the pulling force magnitude with parallel creation of condition for runner activity increase in order to be able to perform movements with higher frequency during the whole run. For optimising the function contributes significantly the possibility of stimulus intensity regulation (magnitude of pulling force) of supra-maximal speed that is enabled by use of friction mechanism with help of weight in pulley appliance of accelerator "Speedy." Regarding the character of movement activity structure's changes and the individual sprinters' specialities (mainly stride rate magnitude in natural conditions) we consider as optimum pulling force 20 – 30 N, sometimes even 40 N, that is manifested by reaching 105–108% of maximal running speed. Higher force influence negatively demanded stride rate increase, causes passive step down, lengthen inaccurately stride and takes away runners' attention for the safe of movement activity realisation from the view of possibility of injury.

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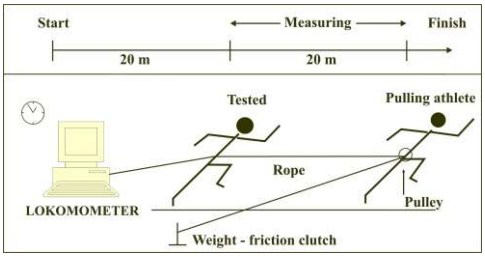


Fig. 1 Running methodology and supra-maximal speed measuring

Tab. 1 Statistical characteristics of kinematics parameters of maximal and supra-maximal speed running

| *PARAMETERS* | | Maximal | | Supra-maximal | | x1 - x2 |
|---|---|---|---|---|---|---|
| | | x1 | s1 | x2 | s2 | |
| **Speed** | [m.s$^{-1}$] | 9,23 | 0,27 | 10,33 | 0,39 | - 1,100** |
| **Contact time** | [s] | 0,113 | 0,008 | 0,105 | 0,008 | + 0,008** |
| **Flying time** | [s] | 0,114 | 0,008 | 0,121 | 0,007 | - 0,007** |
| **Stride length** | [m] | 2,10 | 0,10 | 2,34 | 0,11 | - 0,240** |
| **Stride rate** | [Hz] | 4,41 | 0,18 | 4,43 | 0,17 | - 0,020 |

Legend: ** $p < 0,01$ * $p < 0,05$

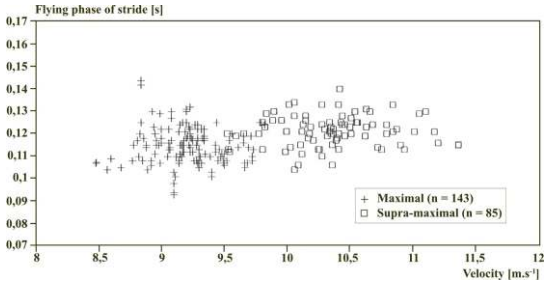


Fig. 2 Dependence of running speed and flying phase of stride at maximal and supra-maximal running speed

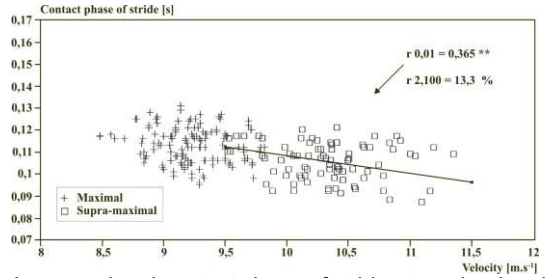


Fig. 3 Dependence of running speed and contact phase of stride at maximal and supra-maximal running speed

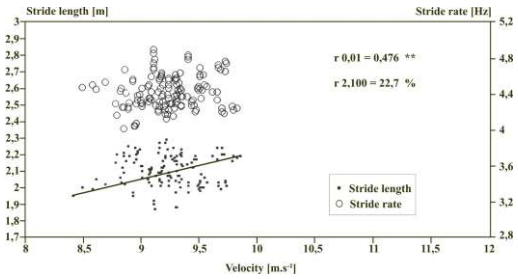


Fig. 4 Dependence of speed, stride length and rate at maximal speed running

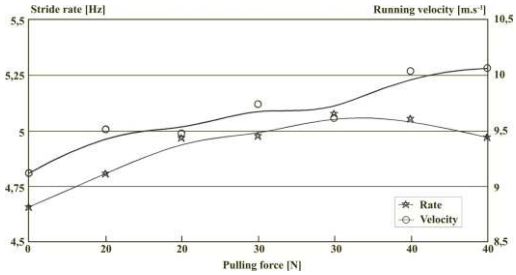


Fig. 5 Trends of running speed changes and stride rate at different pulling forces (runner L.B.)

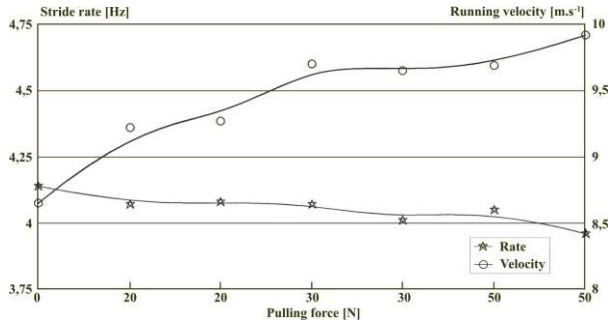


Fig. 6 Trends of running speed changes and stride rate at different pulling forces (runner K.S.)

**INFLUENCE OF OVER-MAXIMAL RUNNING SPEED ON KINEMATICAL PARAMETERS OF RUNNING STRIDE**

**ABSTRACT**

In the article author's present results of long-term research aimed at the maximal running speed development with use of the supra-maximal speed means. They succeeded to establish the optimal pulling force (20 – 40 N) that enables to reach 105 – 108 % of the maximal running speed. In this speed the kinematical parameters between maximal and supra-maximal speed do not differ considerably and this secures their optimal transfer into competition activity. Authors proved that there can be different effects on sprinters according stimulus magnitude of supra-maximal speed, but also according individual specialities of adaptation sprinters' reaction.

**KEY WORDS:** maximal speed development, supra-maximal sprint, kinematical parameters

**L´INFLUENCE DE LA VITESSE DE COURSE SUPRAMAXIMALLE SUR LES PARAMÈTRES CINÉMATIQUES DE LA FOULÉE DE COURSE**

**RÉSUMÉ**

Les auteurs de l´article présentent les résultats de la recherche longitudinale visant à développer la vitesse de course maximale avec utilisation des moyens de vitesse supra-maximales. Ils ont réussi à établir la force de traction optimale (20 - 40 N) qui permet d'atteindre de 105 à 108% de la vitesse maximale en cours d'exécution. Dans cette vitesse les paramètres cinématiques entre la vitesse maximale et supra-maximale ne diffèrent pas considérablement, ce qui assure leur transfert optimal dans l'activité de la concurrence. Auteurs prouvé qu'il peut y avoir des effets différents sur les sprinters selon l'ampleur du stimulus supra-maximale de vitesse, mais aussi selon les spécialités individuelles de réaction sprinters adaptation.

**MOTS CLÉS:** Développement la vitesse maximale, sprint supra-maximal, paramètres cinématiques

**LA INFLUENCIA DE LA VELOCIDAD SUPRA MÁXIMA DE CARRERAS EN LOS PARÁMETROS CINEMÁTICOS DE ZANCADAS**

**RESUMEN**

En el artículo los autores presentan los resultados de una de investigación a largo plazo orientada al desarrollo de la velocidad máxima de carrera con el uso de los medios de velocidad supramáxima. Ellos tuvieron éxito para establecer la fuerza de tracción óptima (20 - 40 N) que permite alcanzar 105-108% de la velocidad máxima. En esta velocidad los parámetros cinemáticos entre la velocidad máxima y supra-máxima no difieren considerablemente, lo que asegura sus traspasos óptimos en la competición. Los autores demostraron que pueden haber diferentes efectos sobre los velocistas no solo según la magnitud de estímulo de la velocidad supramáxima, sino también según las especialidades individuales de adaptación y reacción de los velocistas.

**PALABRAS CLAVE:** Desarrollo de la velocidad máxima, carrera supramáxima, parámetros cinemáticos.

**INFLUÊNCIA DA VELOCIDADE DA CORRIDA SUPRAMÁXIMA SOBRE OS PARÂMETROS CINEMÁTICOS DA PASSADA DE CORRIDA**

**RESUMO**

Os autores do artigo apresentam os resultados da pesquisa a longo prazo com o objetivo de desenvolver a velocidade máxima da corrida usando os meios de velocidade supramáximos. Eles conseguiram estabelecer a força de tração ideal (20 - 40 N) que permite alcançar de 105 até 108% da força máxima durante a execução. Nesta força, os parâmetros cinemáticos entre a velocidade máxima e supramáxima não são muito diferentes o que garante a sua transferência ótima na atividade durante a competição. Os autores provaram que podem existir os efeitos diferentes sobre os corredores de velocidades conforme a extensão do estímulo supramáximo da velocidade mas também confome as especialidades individuais da reação de adaptação dos corredores de velocidade.

**PALAVRAS-CHAVE:** Desenvolvimento da velocidade máxima, corrida de velocidade supramáxima, parâmetros cinemáticos