

# THE ESTIMATION OF THE RAST TEST USEFULNESS IN MONITORING THE ANAEROBIC CAPACITY OF SPINTERS IN ATHLETICS

*The usefulness of the RAST test in athletics*

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## Abstract

**Introduction.** In athletic high-speed-forced competitions one of basic monitored parameters of the preparation is the level of the anaerobic capacity. The aim of the work was the qualification of the usefulness of the RAST (Running-based Anaerobic Sprint Test) in the estimation of the anaerobic capacity of athletes of sprint athletic competitions. **Material and methods.** 37 athletes (12 Female and 25 Male) specializing in sprint racing (100 m, 100 m hurdles, 110 m hurdles, 200 m) and the prolonged sprint (400 m and 400 m hurdles) partook in the research. The anaerobic capacity was evaluated by means of the RAST test and the Wingate test. **Results.** In the RAST test competitors obtained significantly higher values of the maximum power ( $p < 0.001$ ) and the average power ( $p < 0.001$ ), with relation to the Wingate test. Among women such dependences were not ascertained. The fundamentally lower ( $p < 0.001$ ) fatigue index in the RAST test characterized in turn both groups, which can testify about the better adaptation to the run effort. For both tests one ascertained significant dependence between the average power and the maximum power. Moreover, the significant dependence between the fatigue index (FI) and the average and maximum power in the Wingate test was shown. For the RAST test such dependence appeared among FI, and the maximum power. **Conclusions.** The RAST test gave statistically comparable results only in the case of the average and maximum power among women. The smaller physical load for competitors and decidedly easier organization of the research causes that the RAST test can be used for regular monitoring of the anaerobic capacity level of competitors of athletic run competitions.

**Key words:** anaerobic capacity, monitoring, RAST test, Wingate test, athletics, sprinting

## Introduction

Control and monitoring of the training is a requisite condition of the rational control over sports-training process. Tools, which utilization is not conditioned by a possession of the access to the specialist equipment or laboratories, have the special value. For athletic high-speed-forced competitions one of basic parameters, decisive in attained performance, is the level of the anaerobic capacity [1].

The anaerobic capacity determines the maximum quantity of the energy possible to obtain in anaerobic processes. It refers to short-lasting efforts of the high-speed character and the work in which comes to development and maintenance of the large muscular tension.

The effort of submaximum and maximum intensity, which competitors in sprint racing are subjected to, is mostly performed in anaerobic conditions and it demands the incurrence of the oxygenic debt, attaining even 18-22 litres in the case of 400-metre racing [2]. A runner faces the task of opposing to the growing fatigue during the very intensive exercise. The adaptation to the anaerobic lactic acid system together with the continuous lifting of the capacity and the power of the anaerobic nonlactic acid metabolism determines the efficient realization of the bioenergetic potential of readiness of a competitor, which outcomes in sports-result [2].

The most often used tool to qualify the anaerobic capacity is the Wingate test (WAnT) [3]. The contribution of anaerobic efforts in the Wingate test attains the level of 55-87% [2, 4]. In practice, the usage of the Wingate test demands the access to the properly equipped laboratory. However it gives more complex (containing e.g. the joint anaerobic effort or the time of the obtainment of the maximum power) scientifically verified results. The run test in turn, especially within a period of autumn-winter, requires a properly long hall, which also makes the usage of it difficult in the condition of insufficiently developed infrastructure.

Some authors suggest that on the ground of tests performed on a cycloergometer it is possible to foresee results of sprint racing [5]. This would be so much precious since it creates the possibility of the exchange-usage of both kinds of tools. The character of the movement performed on cycloergometer is however significantly different from the real technique of the run, therefore the research should be directed into such tools which would correspond to the structure of the movement to athletic competitions (sprint-run), and simultaneously keep the resemblance within the range of effort intensity in greater degree.

Hitherto existing tests prove that run tests based on maximum effort of the anaerobic character, can be one of helpful tools identifying various factors determining results in sprint competi-

tions [6]. RAST is one of the tests which in natural field conditions (a stadium), can be used for the estimation of the power of anaerobic capacity and the calculation of the fatigue index [7].

The aim of the work was the qualification of the usefulness of the RAST test in the estimation of the anaerobic capacity of competitors in the athletics, by comparison of the results obtained in it with the outcome of the Wingate test.

### Material and methods

37 athletes specializing in sprint racing (100 m, 100 m hurdles, 110 m hurdles, 200 m) and the lengthened sprint (400 m and 400 m hurdles) partook in the research. In this group there were 12 women and 25 men, representing a level from I to III of the sports-class. In detail the structure of the examined group was presented in the Table 1.

The examined group has been divided in two subgroups, according to the specialization:

- sprint – of 12 men, 7 women;
- prolonged sprint – of 13 men and 5 women.

**Table 1.** The biometrical characterization and the structure of the examined group (the average  $\pm$ SD)

Gender	Age [years]	Body height [cm]	Body weight [kg]	BMI
Female (n=12)	16.7 ( $\pm$ 1.6)	167.4 ( $\pm$ 5.0)	56.5 ( $\pm$ 5.3)	20.1 ( $\pm$ 1.0)
Male (n=25)	18.7 ( $\pm$ 3.7)	182.2 ( $\pm$ 5.2)	72.3 ( $\pm$ 6.4)	21.8 ( $\pm$ 1.7)

To the estimation of the anaerobic capacity the run test (RAST) was used. The test was preceded by measurement of the competitors body weight. Competitors performed a standard 10-15-minut athletic warm up, after which a 5-minute pause followed before the test. The test consisted of 6 runs with maximum speed on the distance of 35 metres, with a minimum 10-second pause among them (just for turning back). The power and the indicator of the strength decrease (FI) were counted according to the following algorithms [7]:

$$\text{POWER} = \text{BODY MASS} \times \text{DISTANCE}^2 \div \text{TIME}^3$$

$$\text{FATIGUE INDEX} = (\text{MAXIMAL POWER} - \text{MINIMUM POWER}) \div \text{TOTAL TIME of 6 RUNS}$$

The second research tool was the Wingate test on cycloergometer in 30-second-lasting time version on lower extremities with the weight of 7.5% of the body mass [8]. All the examined underwent the inspection of the body mass before the test, and then became introduced to the technique of the realization of the test. The basic goal was the obtainment of as greatest frequency of pedalling in as short time as possible and its maintenance for as long as possible. The ergometer bicycle of the type "Monark" 824-E, in which the resistance of fly-wheel is regulated mechanically, was used in the research. The calculations of mechanical indicators were performed by means of the computer programme MCE V 5.1 [9].

The competitors performed tests during two following days. Firstly the RAST test was performed, and after the outflow of 24 hours, the Wingate test took place. In both tests the registration encompassed:

- $P_{\text{max}^{\text{tot}}}$  – absolute maximal power (W),
- $P_{\text{max}^{\text{WZG}}}$  – relative maximal power (W/kg),
- $P_{\text{sr}^{\text{tot}}}$  – absolute average power (W),
- $P_{\text{sr}^{\text{WZG}}}$  – relative average power (W/kg),
- FI (Fatigue Index) – indicator of power decrease (W/s),
- $HR_{\text{max}}$  – maximal heart rate after the end of the effort.

The average of difference between the tests was counted accepting for 100% the results obtained in the Wingate test.

The differentiation of results obtained in RAST and Wingate tests at the most examined and with the regard of the partition on the sex, was qualified by means of the T test for dependent variables. The dependence of each parameter between each other was determined by means of the coefficient of Pearson correlation. The values on level  $\leq 0.05$  were accepted as significant.

### Results

The obtained results were characterized with the normal schedule. All the parameters denominating the power of competitors, reached significantly higher values in the run test (Fig. 2). Such dependence was not ascertained at women (Fig. 1). Both women and men obtained lower indicator of the strength decrease (fatigue) in the RAST test.

Regardless of the sex of the examined and the kind of the test – the mass of the body proved indeed to be correlated with all analysed parameters. In the group of women, it explained about 60% ( $r^2$ ) of the results of power tests (Tab. 2). Among females an significant dependence between the indicator of power decrease (FI) in the Wingate test and the maximal power in the RAST test was found. Moreover, there were significant dependences at women between the fatigue indicators in both tests, while such dependence was not observed in the group of men. The strong connection between the outcomes of the average and maximal power in both tests should be also noticed (Tab. 2).

**Table 2.** Essential dependences among each parameters of Wingate and RAST tests, in the research group (r)

PARAMETER	Absolute average power $P_{\text{sr}^{\text{tot}}}$ Wingate		Relative average power $P_{\text{sr}^{\text{tot}}}$ RAST		Absolute maximal power $P_{\text{max}^{\text{tot}}}$ Wingate		Absolute maximal power $P_{\text{max}^{\text{tot}}}$ RAST		Fatigue Index Wingate	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Body weight	0.75	0.81	0.72	0.87	0.74	0.79	0.61	0.80	0.41	0.67
Absolute average power $P_{\text{sr}^{\text{tot}}}$ Wingate			0.55	0.77	0.96	0.97	0.56	0.71	0.57	0.60
Relative average power $P_{\text{sr}^{\text{tot}}}$ RAST					0.52	0.75	0.91	0.96	0.62	
Absolute maximal power $P_{\text{max}^{\text{tot}}}$ Wingate							0.55	0.70		
Fatigue Index Wingate					0.66	0.71	0.65			
Fatigue Index RAST			0.70				0.64	0.87		0.64

A differentiation for the dependence among each parameter of tests which brought the partition of the group according to the practised competition was also evaluated.

In the group of the men sprint significant correlations were found among:

- Body weight and the average power (WAnT  $r=0.62$ ; RAST  $r=0.82$ ),
- Body weight and the maximal power (WAnT  $r=0.66$ ; RAST  $r=0.81$ ),
- Maximal power in both tests ( $r=0.69$ ).

In the group of the prolonged sprint of men the significant relationship was observed among:

- Body weight and the average power in both tests (WAnT  $r=0.81$ ; RAST  $r=0.63$ ),

- Maximal power ( $r=0.78$ ) and the Fatigue Index ( $r=0.60$ ) – only in Wingate test.

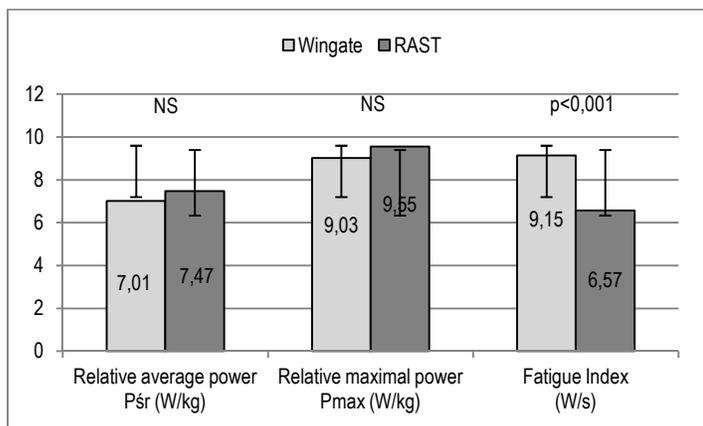
Irrespective of the subgroup, all parameters obtained in tests, Wingate and RAST, were indeed statistically different ( $p<0.001$ ).

In the group of women specializing in the prolonged sprint the analysis showed very strong, almost lineal dependences among:

- Body weight and the average power (WAnT  $r=0.91$ ; RAST  $r=0.98$ ),
- Maximal power (WAnT  $r=0.93$ ; RAST  $r=0.95$ ),
- Maximal power and the Fatigue Index in Wingate test ( $r=0.96$ ).

What is more, the parameter of the average power ( $r=0.93$ ) and the maximal power ( $r=0.97$ ) in both tests were strongly correlated. In this subgroup important statistical differences were found only for  $P_{max}$  ( $p=0.03$ ).

In the subgroup of female sprinters only the average power was a parameter which did not differ indeed statistically in both tests, however, no statistically significant connections between examined parameters were found.



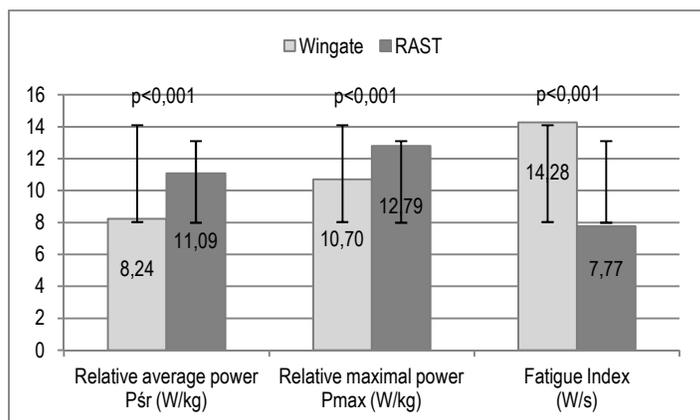
**Figure 1.** Average values of analysed parameters obtained in tests Wingate and RAST by examined females ( $n=12$ )

The sex of the examined had an influence on differences between the results of both tests. All the values of the power obtained by men were higher in the run test, while the indicator of the strength decrease in it had smaller values (Fig. 2). At women, the significant differentiation between the tests results referred only to the indicator of the strength decrease (Fig. 1). In the group of men the significant differentiation between the peak power result, the average power and the indicator of the strength decrease obtained in both tests was shown.

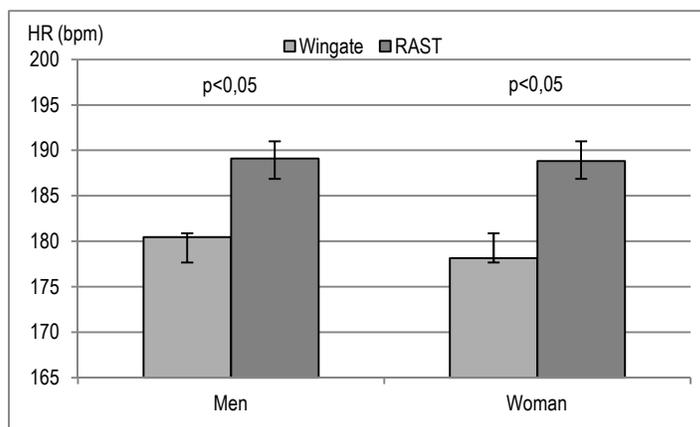
Average results of men from the RAST test showed to be higher respectively about: 25.7% ( $P_{sr}^{wzg}$ ); 16.3% ( $P_{max}^{wzg}$ ); 4.6% ( $HR_{max}$ ). In the group of women statistically significant differentiation of results obtained in both tests referred only to the indicator of the strength decrease. Average RAST test results at women were higher respectively about: 6.2% ( $P_{sr}^{wzg}$ ); 5.5% ( $P_{max}^{wzg}$ ); 5.6% ( $HR_{max}$ ). However in both groups in the Wingate test higher average values of the indicator of the strength decrease, respectively about 39.2% at women and 83.8% at men were obtained.

Although the Wingate test, due to a non-typical character of movement and use of the external load is considered to be "less friendly" for competitors, both, in the group of men, as well as women higher values of the peak pulse were reached during the RAST test. These differences appeared to be statistically significant (Fig. 3). This suggests comparable load during the effort in

the RAST test, therefore the energy-resemblance of both tests. In both groups the  $HR_{max}$  values in tests were statistically connected (men  $r=0.60$ ; women  $r=0.42$ ).



**Figure 2.** Average values of analysed parameters obtained in tests Wingate and RAST by examined competitors ( $n=25$ )



**Figure 3.** Average heart rate after the end of the test Wingate and RAST, in the group of women and men

## Discussion

The usefulness of the Wingate test in determining the anaerobic capacity of prolonged sprint competitors became confirmed with the strong relationship between the test results and the results on distances from 100 to 400 metres [10, 11, 12]. Significant dependences, which appear between the outcome of WAnT test and the traditional tests performed on the track, place it as the reliable form of the estimation of the anaerobic capacity. Out of all indicators which are possible to obtain, as most useful parameters Iskra et al. point the total work and the peak power [13]. The obtained results evidence the large dependence between the body mass and the average and maximum power in the group of the prolonged sprint (women and men) and sprinters. The evaluation of the dependence among these parameters and performance in racing on distances from 100 to 400 m seems to be an interesting direction for further research.

Laboratory tests give the possibility of the utilization of other tools, such as e.g. the ergometric test, according to Vandewalle [14] or the Bosco test [15]. The possibility of carrying them out is, however, blocked by various factors to which, the insufficient subsidiaries (laboratories) or the lack of qualified personnel able to run the tests can be classified. The limitation of their usage is also due to an unspecific structure of the movement for

many sports (among others for the athletics), which results in coaches' sceptical attitude towards them.

There is no lack of other forms of the estimation of the power to which belongs e.g. the throw with the medicine ball backward over the head (Backward Overhead Medicine Ball – BOMB) in coach practise. The BOMB test can be used in the estimation of the power obtained by lower limbs [16]. In turn Smirniotou et al. claim that the result of the jump upward from the knee bending test (squat jump) greatly permits to foresee the results of 100 m run [17].

A question of principle is however this, whether the test rating the power and the anaerobic capacity of competitors can be performed in natural, for them, conditions (the track) and fully portray the structure of the movement and the energetics of the effort of the athlete? The research suggests that with both, the utilization of the mechanical track as well as standard-conditions on the stadium, it is possible to create approximate conditions of the maximum effort of the anaerobic capacity [18]. What is more, the results of such tests can outcome the racing on distances from 400 to 1000 m to great extend [6].

Hitherto existing experiences seem to suggest that run tests of about the maximum intensity performed on the track can be useful in qualifying factors connected with the time, speed or power, determining results in sprinting [6, 19]. Nummela et al. prove that such tests in the connection with the test of top speed on the 30-metres distance are a useful and practical method of monitoring the preparation of sportsmen in sprint competitions [20]. The RAST test itself became rated as the efficient manner of the estimation of the anaerobic run power and results on short distances, however hitherto existing tests were performed on non-training persons [21]. According to the methodics introduced by Vandewalle, the RAST test should be treated rather as the test not so much of the power – as anaerobic capacity [22]. On the other hand, confirmed with the dependence with  $HR_{max}$  the considerable effort which accompanies both tests, suggests their energy-resemblance, therefore it can suppose that both tests are based on approximate metabolic processes.

Results obtained by competitors in the RAST test indeed differed from indicators of the Wingate test. Lower indicators of the power in WAnT, especially at men, can be explained by comparatively young age of competitors [23]. The FI indicator at women practising the prolonged sprint and the average power in both subgroups of women can be the exception here. This, however, can be a result of the not large number of these groups, which makes the interpretation of data difficult, so these results demand further confirmation.

In spite that, especially in case of men, the results of the RAST test could not be transferred to Wingate test results, both tests can apply in the monitoring of the training. Nevertheless it seems that both higher parameters of the power, and first of all its smaller decrease (FI) observed in the test, can be connected with a lot better image of the effort character. The indicator itself, can however create interpretative problems [24]. The additional external load in the Wingate test, leads really to a marked decrease of the power, which expresses itself with the lowered cadence of pedalling. It refers to almost all competitors. In practice – in an athletic run – at maximum effort in the duration of about 30 seconds, drastic exhaustion of energy-resources and decrease of the length and the frequency of strides seldom happens. Such occurrence is characteristic rather for the maximum effort of a little longer duration (about 45 seconds). This almost univocally suggests that the Wingate test is considerably more exhausting for competitors than the test performed on the track, so as far as legitimate seems the usage of it within a period of preparatory, within a period of pre-starting and starting it should be replaced by a run test.

With the considerable number of parameters possibly computable in the Wingate test, the question, which one from them has the greatest value in the sports-diagnostics comes into being. As Iskra says, there is a correlation between the maximal power, the total work and performance in 110 and 400 metres hurdles [25]. The other from the most important criteria while estimating abilities to exercise the efforts of the maximum intensity at short duration, is so called decrease of the power [24]. It is worth to pay attention to the fact that both values of the maximal power as well as the indicator of the power decrease, are possible to show also in the RAST test, and the correlation analysis confirmed the significant dependence between the peak powers in both tests. Any dependence for the indicator of the power decrease was observed. The differentiation within distances practised by competitors could have the influence on that.

Wanting to seek the optimization of the test toward the approaching of obtained results, it can be reflected whether it would be better to measure six intervals of running without pauses. Such point of view leads to the conclusion, as much self-evident as in sport practice difficult to accept, that the best test for the runner on the 400 m distance is the run on 400 m. Such test would be the most approximate to the starting effort, while the aim of research is finding reliable tests not forcing sportsmen to run all the distance. Therefore it seems that obtained indicators can inform about parameters from the borderline of the anaerobic capacity and the special endurance, and in spite the considerable (reaching tens percent) divergence of results with the Wingate test, the RAST test can be a good verifying test of the preparation of athletes within the range of the anaerobic endurance and the ability of maintenance of power at time.

### Conclusions

1. Within the range of analysed parameters of the power, the results obtained in the RAST test are considerably higher. In the case of women, the smaller differentiation can be awaited. The indicator of the power decrease attained lower values in the RAST test, and especially large differentiation refers to groups of men.
2. The only parameters which results are comparable in both tests are the average and maximal power in the group of women (regardless of the specialization). The confirmation of the constancy of these differences demands further research.
3. There exists the strong dependence between the body weight and the average and maximum power at men specializing in different competitions of athletics sprint. At women significant dependences exist only for 400 m run and 400 m hurdles specialists.
4. The more specific structure of movement and effort in the Running-based Anaerobic Sprint Test (RAST), contributes probably to better results obtained by athletes in this test.
5. Because of the comparable physical effort, both tests can be used for the estimation of the anaerobic capacity, especially within a period of preparatory. Far easier organization of the research causes that the RAST test can be used regularly (e.g. on the mesocycle level every 4-6 weeks) for monitoring the level of the anaerobic capacity of competitors of athletic run competitions, also within a pre-starting and starting period.

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