



## Comparison of Responses of the Organism to Load Exerted by Running with Poles and Without Poles

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### ABSTRACT

The objective of study is to compare the physiological load of the organism during running with poles (RWP) and without poles at the same speed. The said objective was achieved by assessing the average heart rate (HR) and lactate. Six women, at the ages of  $17.3 \pm 1.6$  years, with the average weight of  $55.5 \pm 3.9$  kg and the height of  $167.8 \pm 4$  cm, and six men at the ages of  $18.0 \pm 3.8$  years, with the average weight of  $63.6 \pm 7.9$  kg and the height of  $177.0 \pm 5.4$  cm. The effect of use of poles was evaluated for running with load intensity below anaerobic threshold. Running without poles considered, the average HR amounted to  $169.0 \pm 9.6$  pulse/min and lactate stood at  $2.6 \pm 1.0$  mmol/l.; during RWP, the average HR amounted  $176.8 \pm 9.6$  pulse/min and lactate stood at  $4.7 \pm 1.7$  mmol/l. Significant differences have been ascertained between running without poles and RWP in connection to the formation of lactate ( $\omega^2=0.485$ ) and HR ( $\omega^2=0.176$ ).

### KEYWORDS

Running with poles; lactate; heart rate; anaerobic threshold

### INTRODUCTION

In Nordic walking (NW), engagement of more muscles results in an increase in heart rate by 15 % in comparison with condition walking without poles. Walking with poles helps to increase the condition more effectively than walking as such (Sokelienė & Cesnaitienė, 2011). Similar parameters are expected also for running with poles (RWP).

As with NW, runners have begun to use poles for the same reasons – to higher stability and reducing the load exerted on the body (Daviaux et al., 2013) and to reduces the risk of injury (Bolt, 2000). In addition to a greater stability during running, poles reduce the load of supporting joints of lower extremities and the spine for the reason that a part of the load is assumed by arms. In the case of RWP, this load of supporting joints is reduced by the fact that hands are supported by poles. It has been discovered that, when poles are used, the load of lower extremities is reduced approximately by 5% for every tread-down – a significant relief for long runs (Tvrzník & Kůtek, 2012). Consequently could be used RWP also as one of the methods convalescence (Kůtek, 2012). Apart from health and preventive aspects of RWP, its training benefit must be emphasized owing to an increase in intensity. As a matter of fact, a runner with poles achieves a better performance, or has a considerably larger energetic output than during ordinary running. The runner breathes more intensively, engages upper extremities and chest muscles to a larger extent (Kůtek, 2013). The heart rate (HR) increases by 15-20 % and the total energetic output rises by ca. 25 % (Kůtek, 2012). High performance sportsmen and sportswomen take advantage of this fact in the framework of an intensive training unit. The increase in HR has its importance for recreational sportpersons and sportperson with overweight. The basis of the correct performance of RWP is to adhere to the technique of running, mainly the movement of arms and elbows, and engage poles in the running. Arms are kept bent in elbows approximately at the right angle. The hand that, in this case, holds the pole, is at the level of the shoulder in front and positioned toward the hip in the back (i.e. as in running without poles) (Kůtek, 2013).

An appreciable benefit of the use of poles for running is an improvement of the running technique and coordination abilities, i.e. an efficient coordination of muscles and extremities, which is a key prerequisite for increasing the running performance (Kůtek, 2012).

### OBJECTIVE

The objective of our study is to compare the load exerted on

the organism during running with poles and without poles at the same speed on the basis of the average heart rate and lactate.

### METHODOLOGY

#### Tested group

Twelve runners for medium and long tracks, out of which 6 women at the age of  $17.3 \pm 1.6$  years, average weight  $55.5 \pm 3.9$  kg and height  $167.8 \pm 4.1$  cm, and six men at the age of  $18.0 \pm 3.8$  years, average weight  $63.6 \pm 7.9$  kg and height  $177 \pm 5.4$  cm, participated in the study of their own accord. At the time of the test, all tested runners have engaged in endurance training for the period of at least two years. They had no long-term experience with RWP, having used poles only once, during one instructional training unit.

#### Course of the test

RWP and without poles was conducted in a tartan athletics stadium. To determine the degree of load exerted on organism, HR was measured by means of sport-testers Polar RS 300X and Accutrend lactate monitor by Roche, with a measurement error of 3% indicated by the manufacturer. The tested persons ran at the same speed two three-kilometre sections. The speed of running was determined below anaerobic threshold for running without poles, which corresponds to the range of 60 - 80 %  $\text{VO}_{2\text{max}}$  (Bunc, 1989; Dovalil, 2005). The same speed was applied to running with poles. The length of interval between the sections was 12 minutes. The speed of running at the level of anaerobic threshold was established by a test one week before the testing itself. The length of poles was chosen individually for every person: height  $\times 0.8 \pm 3$  cm. After completion of each section, the time needed for covering each section was noted down, along with the average heart rate and lactate value. Lactate was measured by a physician one minute after completion of each section.

#### Evaluation of results

The values measured were characterized by means of descriptive statistics and box plots. Substantive significance of values for the section run with poles and without poles was evaluated by coefficient  $\omega^2$  as a proportion, or, as the case may be, a percentage of treatment variance (Velicer et al., 2008). According to recommendation of Cohen (1988), we considered the value of  $\omega^2 \geq 0.14$  as substantively significant. Coefficient  $\omega^2$ , as an indicator of relative substantive significance. Furthermore, statistical significance was assessed at the level of  $\alpha = 0.01$ .

RESULTS

Table 1 clearly shows individual values of lactate and HR. Figure 1 documents differences in average values of lactate. Differences in average values of the average HR for running with and without poles are shown in Figure 2. As regards RWP, the average lactate reached  $4.7\pm1.7$  mmol/l and the average of measured values of the average HR amounted to  $176.8\pm9.6$  pulse/min. For running without poles, the average lactate stood at  $2.6\pm1.0$  mmol/l, with the average of measured values of the average HR amounting to  $169.0\pm9.6$  pulse/min. It has been discovered that if poles are used for running, lactate increases by 2.1 mmol/l in comparison with running without poles, which corresponds to the increase by 88.3 %. This increase is explained by the use of poles in 48.5 %. The average value of HR increased by 7.8 pulse/min, i.e. by 4.5 %. This increase in HR values is explained by the use of poles in 17.6 %. It may be stated that statistically ( $p<0.01$ ) and substantively significant differences ( $\omega^2>0.14$ ) refer to both lactate values and average HR values.

Table 1. Values of the average heart rate and lactate for individual probands during running with and without poles.

		Probands											
		PV	MG	DK	AF	JH	MB	KM	ŠH	VT	DK	JP	JV
HR	with poles	173	181	181	167	153	178	177	178	196	176	179	182
	without poles	170	169	177	158	146	169	166	170	187	172	168	176
Lactate	with poles	3,0	7,8	5,4	4,1	3,4	5,9	2,8	5,2	6,8	2,1	3,5	5,9
	without poles	1,9	4,2	2,7	2,4	1,3	4,1	1,1	2,9	2,8	1,3	2,1	3,9

Figure 1. Average of measured values of lactate ( $\pm s$ ) during running with and without poles.

\*  $p < 0.01$   
#  $\omega^2 > 0.14$

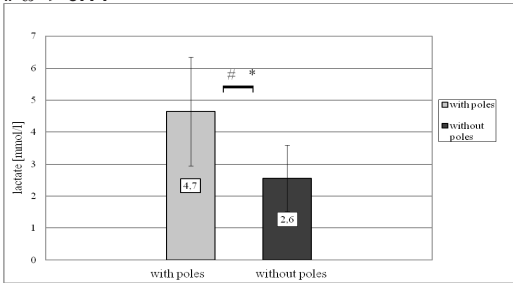
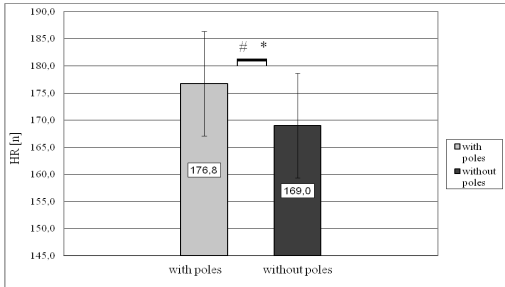


Figure 2. Average of values of the average heart rate ( $\pm s$ ) during running with and without poles.

\*  $p < 0.01$   
#  $\omega^2 > 0.14$



DISCUSSION

Some of the tested runners, for the reason of little experience and nervousness, were not successful in maintaining the same speed, which resulted in running at a lower level of lactate than planned. Nevertheless, this fact did not affect the result of our analysis to a considerable extent, since both sections were run at the same speed.

Our analysis confirmed the assumption that RWP is more demanding for the circulatory system than running without poles. Expectantly, the average HR and lactate values were higher after the section run with poles than that run without poles. The difference between the average HR after running with poles and without poles was measured at 4.5 %. This difference does not reach the 15-20 % presented by Kútek (2012); however, it may be stated that the increase in HR is substantively and statistically significant. Concerning lactate values, the difference of values was 88.3 % in the case of use of poles. The higher values of HR and lactate after running with poles are attributed to a more intensive engagement of the torso and higher extremities in the case of use of poles. The rate of engagement of arms was not evaluated, but, according to statements of participants to the study, the tartan surface did not provide an adequate support for pushing-off. A decreased propulsion work of arms could have contributed to a lower difference regarding the heart rate.

Inter-individual differences in the increase in lactate and the average HR may be explained by a dissimilar rate of engagement of arms during RWP and the variability of mastering of the correct running technique. The level of skills of RWP varied greatly in individual participants to the study.

Themes for further studies include issues dealing with organism responses to RWP in the terrain, responses of the organism to RWP over a longer period, the evaluation of the degree of engagement of arms or the influence of the correct technique on the physiological load of organism.

CONCLUSION

The load of organism was compared in 12 runners during running and RWP on the basis of values of average HR and lactate. Our study confirmed a significant difference between RWP and without poles for both the HR and lactate, when the load of organism exerted by RWP is demonstrably higher than that in the case of ordinary running. This fact may be used in sports programmes and the preparation of high performance and top sportsmen and sportswomen. A higher physiological load is determined by a more complex load of organism.

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